

Users@Planet CCRMA (*The Linux Survival Guide*)

Juan Reyes
juanig@ccrma.stanford.edu

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Abstract

This guide takes the approach of a traveler's survival companion and its sole purpose is to illustrate, show and inform new CCRMA users and visitors about computer resources and the Linux environment and applications which might be helpful for doing scientific research and compositional work at CCRMA. It also briefly describes the meaning of Open Source as a part of the laboratory and community philosophy here at CCRMA. Following is a brief history of hardware at CCRMA and descriptions of Linux as an operating system, the Unix environment, useful shell commands and many X windows, Gnome and KDE applications. In the applications section there will be useful descriptions of programs and information provided by developers' documentation but do not discard some of the tricks and options as to our knowledge we present to the reader in some of these sections. If additional information is required in the case of a particular command, program or application, the reader is encouraged to look for more in-depth information on the Unix manual pages, on the web or in the links to home pages which are also provided here. Furthermore, there is some effort in several sections, to present solutions to common problems or challenges the system presents to the common user, beware of them.

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1 Motivation: Computer Music

Intuition, curiosity, discovery and high spirit are qualities which can help enhance your lifestyle around the various activities that keep CCRMA alive. The spirit of an explorer to get and to find out about the unknown as well as the intuition of an artist to know what is good, are good advice for you in order to express freely and as good as possible around the knoll and also with the established Computer Music community. The field of this subject matter is so dynamic that even the definition of Computer Music is being changed as we speak. Perhaps we can establish Bill Schottstaedt's vision which bounds Computer Music as the production of expressive music by means of computational tools, systems or devices. Research and composition produced at CCRMA is generally geared toward this goal.

2 Some of the History of Hardware at CCRMA

- AI Department at Stanford:

In the keynote speech address at the International Computer Music Conference of 1993 in Tokyo John Chowning says:

The computer system to which I had access was powerful indeed. It comprised an IBM 7090 that had an enormous memory of 36k 36-bit words and a hard disk whose capacity was well over 500k words and about the size of a refrigerator. The hard disk was shared by a DEC PDP-1 computer. By September 1964, with a great amount of help from a young Stanford undergraduate mathematics major, we implemented the Music IV program, provided by Max Mathews on the IBM 7090 and used the PDP-1 as buffer memory to send the samples from the hard disk to the DEC scope. The x-y converters for deflecting the electron beam of

the CRT were connected to separate channels of an audio system, thus providing for stereo output.

The young undergraduate who engineered this system was David Poole. He was extraordinarily helpful and patient as I at age 30, learned from him about things that I would have never have thought to be important to music. He was not only responsible for this, the first on-line computer music system, but later went on to design and build really large computers, one of which served many years as the platform for CCRMA's digital synthesizer. This synthesizer was fondly known as the "Samson Box " After its designer Peter Samson of System Concepts in San Francisco.

With this powerful sound synthesis concept at the center, the adventure of computer music began. Music IV was so well-conceived that it was the progenitor of a number of offspring on a variety of systems used by a number of people from a variety of disciplines who intermingled and conversed as they waited for jobs to run or terminals to become free. Quite by chance, surprising and serendipitous alliances were made. Seemingly disparate fields found substantive connections. Composer/musicians needed to know what engineering scientists and cognitive/perceptual psychologists knew and heard. Signal processing, acoustics, psycho-acoustics and computer programming became familiar and necessary terrains of knowledge for musicians and music became a rich domain of application for engineering and perceptual sciences. Escher, Sheperd, and Risset (graphic artist, cognitive psychologist, and composer/physicist) became linked through compositions in which powerful visual illusions suggested compelling auditory counterparts. Young composers were nurtured by scientists and engineers- Godfrey Winham at Princeton, David Poole and George Gucker at Stanford, Jim Beauchamp at Illinois and, of course, Max Mathews. What a beginning – the field of music would acquire another dimension. [1, Chowning, 1993].

- Samson BOX:

In October 1977, CCRMA took delivery of the Systems Concepts Digital Synthesizer affectionately known as the "Samson Box," named after its designer Peter Samson. The Samson Box resembled a green refrigerator in the machine room at the Stanford Artificial Intelligence Laboratory, and it cost on the order of 100,000. In its hardware architecture, it provided 256 generators (waveform oscillators with several modes and controls, complete with amplitude and frequency envelope support), and 128 modifiers (each of which could be a second-order filter, random-number generator, or amplitude-modulator, among other functions).[2, Loy, 1991]. Up to 64 Kwords of delay memory with 32 access ports could be used to construct large wave-tables and delay lines. A modifier could be combined with a delay port to construct a high-order comb filter or Schroeder all-pass filter–fundamental building blocks of digital reverberators. Finally, four digital-to-analog converters came with the Box to supply four-channel sound output. These analog lines were fed to a 16-by-32 audio switch that routed sound to various listening stations around the lab.

The Samson Box was an elegant implementation of nearly all known, desirable, unit-generators in hardware form, and sound synthesis was sped up by three orders of magnitude in many cases. Additive, subtractive, and nonlinear FM synthesis and wave-shaping were well supported. Much music was produced by many composers on the Samson Box over more than a decade. It was a clear success. [3, Smith,1991]

- The NeXT Machines:

The NeXT computer still found at CCRMA in its black or white architecture was the first computer with a DSP or signal processing chip which could be dedicated to sound or music. In 1989 and for the sole purpose of developing a music workstation NeXT Inc. of Redwood City CA., hired Stanford Graduate Julius O. Smith and composer David A. Jaffe as well as chief software engineer Lee Boynton

to develop the NeXT Music Kit. The Music Kit is an object-oriented software system for building music, sound, signal processing and MIDI applications on the NeXT computer. It has been used in such diverse commercial applications as music sequencers, notation packages, computer games, and document processors. Professors and students in the academia have used the Music Kit in a host of areas, such as music performance, scientific experiments, computer aided instruction and physical modeling. The Music Kit was the first system to unify the MIDI and Music V paradigm, thus combining interaction with generality. It was developed by NeXT Computer, Inc. from 1986 to 1991, and by CCRMA at Stanford University from 1992 to 1996. It has also been supported by developers such as Pinnacle Research, Inc., as well as the Stanford University Office of Technology Licensing. Furthermore Julius Smith and David Jaffe designed and implemented DSP56001 software supporting the NeXT Music Kit, including the real-time DSP monitor and unit-generator modules for sound synthesis and signal processing and also wrote and supported The NeXT DSP Library. Helped support and debug the Sound/DSP Mach driver and the NeXT Sound Library.

The entire collection and algorithms of the Samson Box were translated to the NeXT by means of Common Lisp and a Music V dialect known as CLM or Common Lisp Music all done by hand by composer/scientist Bill Schottstaedt. Most of the composition work at CCRMA in the 1990's was done using home brewed software like Common Lisp Music, Common Music, the Music Kit and more. The CCRMA environment at the moment (circa 1993) consisted of an Ethernet network which connected workstations running the NeXTStep operating system and Macintosh computers plus a gateway that connected the workstations to the campus at large and also to national and international networks.

- The Lab and Open Source Community, Linux:

At this time, the CCRMA computing environment is supported by more than 40 machines that include fast Pentium class PCs running Linux (some of them dual-booting Linux and NEXTSTEP), Silicon Graphics workstations, NeXT workstations (for old time's sake) and PowerPC Macintosh computers. All machines are connected through a switched high speed backbone and several servers provide shared services and resources to all computers in a way that is transparent to the users. A high speed connection to the Stanford University Network (SUNET) provides connectivity with the rest of the world, including direct access to the new Internet 2 network. Sound-file manipulation and MIDI input and output are supported on all platforms. Multichannel playback is supported on some Linux and SGI workstations and on the Macs through several Pro Tools systems. Digital audio processors include a Studer-Editech Dyaxis II system, two Digidesign Pro-Tools systems with CD-R drives, digital i/o cards on Linux systems, Singular Solutions analog and digital audio input systems for the NeXTs, and several Panasonic DAT recorders. Text and graphics are handled by an HP 4c color scanner on the Unix-based systems and by high resolution network connected printers

3 Current Hardware at CCRMA

Following is a table with machines spread around the CCRMA workspace as of March 25, 2002. Kindly note their operating systems and speeds. As previously stated all are fully networked around CCRMA, Stanford and the World !!! There are three networked printers one in the terminal corridor, one in the classroom and one in the trailer. Most workstations are equipped with the state of the art high rate 24 bit audio systems some with midi capabilities and some with multichannel amplification.

4 Down to specifics: Linux

4.1 What-is-Linux

Linux is an operating system, a software program that controls your computer. An operating system solves several problems arising from several hardware variations like computer keyboards, mice, monitors, graphic

cards and even MIDI or sound input and output devices. The problem is solved by providing a standard way for applications (programs) to access hardware devices. When an operating system exists, applications can be more compact, because they share the commonly used code for accessing the hardware. The operating system can do many other things as well like for example, providing a file system so that you can store and retrieve data and very important, a user interface so that you can control the operation of your computer.

4.2 Open-Source

Some, including MIT scientist Richard Stallman, yearned for the return of those happier times and the mutual cooperation of programmers that existed when Unix was not commercial. So in 1983, Stallman launched the GNU (GNU's not Unix) project, which aimed at creating a free Unix-like operating system. Like early Unix, the GNU operating was to be distributed in source form so that programmers could read, modify, and redistribute it without restriction. Stallman's work at MIT had taught him that by using the Internet as a means of communication, programmers the world over could improve and adapt software at incredible speed, far out pacing the fastest rate possible using traditional software development models, in which few programmers actually see one another source code. [4, McCarty,1999]

4.3 Why-Linux at CCRMA

Linux is a real Unix, multiuser, multitasking and file sharing operating system and yes because Linux is a hacker's playground. Linux is a cross-platform operating system that runs on many computer models. Linux is free and many Linux applications are distributed in source making possible for you and others to modify or improve them. And because Linux is a good if not an ideal platform for developing your own software. Sound and music applications are maturing and provide an unprecedented flexibility only found years ago on the NeXT computers with the music kit. Linux offers a good choice of compilers for all the tastes around CCRMA. No other present popular operating system is more stable and reliable than Linux and it has a blazing fast performance.

4.4 Choices: Why RedHat,... Fedora

Choice is always difficult and trying to be as democratic as possible is not an easy job. Fernando Lopez-Lezcano responds at the issue of linux distributions as follows:

There are several reasons, I guess mostly historical at this point. Please keep in mind that PlanetCCRMA as a project was not "designed" (ie: We did not say at some point "let's get a project started and let's base it on RedHat"). What you see now as "PlanetCCRMA" is just the result of initially making available to the world the custom-built packages that I was using to maintain a Linux based, music and audio-friendly environment at CCRMA. Through mostly user feedback the project has recently grown out of control, and now I can truly say: "I have created a monster" :-).

The Linux environment at CCRMA has been RedHat based for quite a while (I think the first version I installed was RedHat version 4 or something like that back in '97). At that time one of the appeals of RedHat was RPM (the package manager) and an easy to use installer (I was previously using Slackware, first Linux install was done some time in '96). At several points in time (even before what I was doing internally at CCRMA became available as "PlanetCCRMA") I considered switching to a different distro, and I really considered Debian (and others), but Debian was not (at that time) as easy to install as RedHat and the stable release was `_too_stable` (for my taste). For good or bad, the choice was made a long time ago and each time I have again considered switching, there have not been enough incentives to do so(*).

Regarding "apt" (the almost automatic installer up-grader and updater), PlanetCCRMA originally did not use it, and, as you may guess, it was not very usable without it :-). Apt made a huge difference in making it easy to install and update for non-CCRMA users, but the choice of

apt was not "to make the distro act more like Debian". I could have used another program other than apt, but at that time, apt was, I think, the best choice (for example, there was also a free implementation of the up2date server that I considered but it was too young in its development cycle and apt for rpm seemed like a better and potentially more stable choice that leveraged on Debian's experience with it). If I started from scratch today I could use yum, for example (and I will, when I have a slice of that mythical thing called "free time").

Anyway, sorry for the long post, but hope it clarifies *some* of the reasons. This is not to say that CCRMA and (as a side effect) PlanetCCRMA will stay forever with RedHat - Fedora Core. Who knows what the future will bring(**)- Fernando(*) there has to be a considerable advantage, I maintain a customized environment of 40+ machines so switching involves learning all the quirks of a new distro, plus customizing it so that it behaves in pretty much the same way as before and creates the same environment. Not impossible, of course, but a lot of work. Even a version transition within the same distro involves a lot of work! And it is harder now because it is not just CCRMA anymore...(**) for example Progeny is porting the anaconda installer to Debian! So, Debian could, at some point, be as easy to install as RedHat-Fedora.

4.5 The Unix Environment

UNIX is an operating system consisting of three important features; a kernel, the shell and a file system.

As its name implies, the kernel is at the core of each UNIX system and is loaded in whenever the system is started up - referred to as a boot of the system. It manages the entire resources of the system, presenting them to you and every other user as a coherent system. You do not need to know anything about the kernel in order to use a UNIX system. Amongst the functions performed by the kernel are:

- managing the machine's memory and allocating it to each process.
- scheduling the work done by the CPU so that the work of each user is carried out as efficiently as is possible.
- organizing the transfer of data from one part of the machine to another.
- accepting instructions from the shell and carrying them out.
- enforcing the access permissions that are in force on the file system.

Whenever you login to a Unix system you are placed in a program called the **shell**. You can see its prompt at the bottom left of your screen. To get your work done, you enter commands at this prompt. The shell acts as a command interpreter; it takes each command and passes it to the operating system kernel to be acted upon. It then displays the results of this operation on your screen. The shell provides you with one or more of the following features. You can:

- create an environment that meets your needs
- write shell scripts
- define command aliases
- manipulate the command history
- automatically complete the command line
- edit the command line

A **file system** is a logical method for organizing and storing large amounts of information in a way which makes it easy manage. The **file system** is the smallest unit in which information is stored. The UNIX file system has several important features:

- Different types of files

To you, the user, it appears as though there is only one type of file in UNIX - the file which is used to hold your information. In fact, the UNIX file system contains several types of files.

- **Ordinary File:** This type of file is used to store your information, such as some text you have written or an image you have drawn. This is the type of file that you usually work with.

- **Directories:** A directory is a file that holds other files and other directories. You can create directories in your home directory to hold files and other sub-directories.

Having your own directory structure gives you a definable place to work from and allows you to structure your information in a way that makes best sense to you.

Directories which you create belong to you - you are said to "own" them - and you can set access permissions to control which other users can have access to the information they contain.

- **Special files:** This type of file is used to represent a real physical device such as a printer, tape drive or terminal.

It may seem unusual to think of a physical device as a file, but it allows you to send the output of a command to a device in the same way that you send it to a file. For example:

```
cat scream.au > /dev/audio
```

This sends the contents of the sound file scream.au to the file /dev/audio which represents the audio device attached to the system. Guess what sound this makes?

The directory /dev contains the special files which are used to represent devices on a UNIX system.

- **Pipes:** UNIX allows you to link commands together using a pipe. The pipe acts a temporary file which only exists to hold data from one command until it is read by another.

- Structure of the File System

- **Your home directory:** Any UNIX system can have many users on it at any one time. As a user you are given a home directory in which you are placed whenever you log on to the system.

User's home directories are usually grouped together under a system directory such as /home. A large UNIX system may have several hundred users, with their home directories grouped in sub directories according to some schema such as their organizational department.

- **Your current directory:** When you log on to the system you are always placed in your home directory. At first this is your current directory. If you then change to another directory this becomes your current directory. The command **pwd** displays the full path name to your current directory.

- **Pathnames:** Every file and directory in the file system can be identified by a complete list of the names of the directories that are on the route from the root directory to that file or directory.

- **Access permissions:** Every file and directory in your account can be protected from or made accessible to other users by changing its access permissions. You can only change the permissions for files and directories that you own.

5 Unix-software examples:

- Shell Commands:

A good tour suggestion from Craig Sapp is a nice tutorial of the Unix shell which found at:

LinuxCommand.org

http://www.linuxcommand.org/learning_the_shell.php

manual pages (or rather ...help) of shell commands can also be found at:

SuperMan pages

http://www.linuxcommand.org/superman_pages.php

A good palette of useful Unix at CCRMA commands which will safely help you navigate in a Unix/Linux environment might include:

5.1 General use:

<code>man</code>	Get information or help about a <code>command</code>
<code>apropos</code>	Locate commands by keyword look up
<code>ls</code>	List directory contents
<code>pwd</code>	Path of working directory
<code>cd</code>	Change working directory
<code>mv</code>	Move file or change name
<code>cp</code>	Copy file
<code>mkdir</code>	Make directory
<code>rm</code>	Remove files and directories
<code>cat</code>	output contents of a file
<code>grep</code>	search for a string of text
<code>mount /mnt/zip</code>	Mount zip disk on directory /mnt/zip
<code>mount /mnt/cdrom</code>	Mount cd disk on directory /mnt/cdrom

5.2 Archiving Commands

<code>tar -xvzf</code>	Uncompress a file-name.tar.gz
<code>tar -xvf</code>	Uncompress a file-name.tar
<code>gunzip</code>	Uncompress a file-name.zip
<code>tar -cvzf</code>	Compress a file-name.tar.gz from directory-name /

5.3 Communications:

<code>finger</code>	look for all ccrma users
<code>finger login@</code>	look for particular user
<code>ssh</code>	secure login on remote machine
<code>scp</code>	secure file copy from or to machine
<code>talk login@cmn</code>	talk to other user on this terminal
<code>find</code>	look for file

5.4 Sound-software and CCRMA related:

<code>sox</code>	different audio file utilities
<code>ecasound</code>	high quality audio recording, filtering and playback
<code>cdrecord</code>	burn "Wav" tracks in current directory
<code>cdparanoia</code>	copy cd tracks to a sound file in current directory
<code>resample</code>	change sample rate in a soundfile
<code>sndplay</code>	play a sound file
<code>sndinfo</code>	information about a sound file
<code>sndrecord</code>	record sound
<code>sndsine</code>	generate a sine signal

5.5 Text-Graphics and Desktop Publishing

<code>vi</code>	text editor
<code>emacs</code>	development text editor
<code>latex</code>	compile a TeX file
<code>dvips</code>	convert a dvi file to postscript

5.6 Shell-printing printing by a shell command

<code>lpr</code>	print a document
<code>lpr -P np2</code>	print a document in the trailer
<code>psnup</code>	resize to 2 or more pages in one
<code>psresize</code>	change size of a ps file
<code>ps2pdf</code>	convert a ps file into a pdf file
<code>pdf2ps</code>	convert a pdf file into a ps file

More on printing commands in the typesetting and shell commands sections.

5.7 SysAd-Commands: system administration commands

<code>chmod</code>	change permissions on files and directories
<code>yppasswd</code>	change password

5.8 The-X-Window System

Another important component of Linux is its graphical user interface, The X Window system. Unix was originally mouse less, text-based system that used noisy teletype machines rather than modern CRT monitors. The Unix command interface is very sophisticated and, even today, some power users prefer it to a point-and-click graphical environment, using their monitor as though it were a noiseless Teletype. Nevertheless Unix now provides users a choice of graphical or command interfaces.

X is a unique graphical user interface in two major respects. First, X integrates with a computer network, letting users access local and remote applications. Second, X lets you configure its look and feel to an amazing degree. To do so you run a special application-called a window manager- on top of X.

All the windows on the screen, keyboard and mouse user interface on Unix systems are possible thanks to the X windows server. Most applications which run straight on an X window start with x or capital X.

Although you can run X windows by itself using another layer call desktop can help you work more efficiently. A desktop is a set of desktop tools and applications such as Netscape, Real Audio, and accessories such as note pads, calculators games, or dictionaries. You can choose window managers depending on your desktop. GNOME and KDE are some of the desktops managers used at CCRMA. Sawfish is the default window manager in GNOME and you can change the feel and looks of your windows and backgrounds by using the configuration tools of your desktop of choice.

5.9 Popular-Xwindow applications examples at CCRMA

<code>xemacs,</code>	X window and improved interface to emacs http://www.xemacs.org/
<code>xfig,</code>	Draw and manipulate objects interactively http://www.xfig.org/
<code>gv,</code>	An X user interface for GhostScript http://wwwthep.physik.uni-mainz.de/~plass/gv/
<code>xcircuit,</code>	Drawing program tailored to circuits http://xcircuit.ece.jhu.edu/
<code>xmms,</code>	X multimedia system http://www.xmms.org/
<code>xmixer,</code>	Mixer to control volume settings n/a
<code>xsane,</code>	User-interface to control an image acquisition device http://www.xsane.org/
<code>xcdroast,</code>	Front end for programs like cdrecord and mkisofs http://www.xcdroast.org/
<code>xpdf,</code>	Viewer for Portable Document Format (PDF) files n/a

6 GNOME: <http://www.gnome.org/>

As with most GNU programs, GNOME has been designed to run on all modern strains of Unix-like operating systems.

The initials stand for GNU Network Object Model Environment but this doesn't really help explain what it does, though. GNOME is a part of the GNU Project and an attempt to make a desktop environment which is free software and which runs on lots of platforms is consistent so that you use the same approach to do the same tasks in different programs, can be used by developers to develop software easily and is fun to use. GNOME can be used with several window managers including Sawfish <http://sawmill.sourceforge.net/>, Enlightenment, <http://www.enlightenment.org> and Window Maker which allows a Next Step look like environment.

One of GNOME's most interesting features is session awareness. When you re-enter GNOME, it reconfigures your desktop to match the state at the time you exited. GNOME even restores each application to its former state. GNOME provides desktop tools including games, calendar, address book, etc, plus GIMP, the GNU Image manipulation program, office applications plus many more. Explore these application by clicking and holding the GNOME (footprint) icon. Once you are logged in.

The GNOME project acts as an umbrella, the major components of GNOME are:

- The GNOME desktop: an easy to use windows-based environment for users.
- The GNOME development platform: a rich collection of tools, libraries, and components to develop powerful applications on Unix.

- The GNOME Office: A set of office productivity applications.

GNOME is a large collection of software, created over the last years. It ranges in scope from small utilities to large, powerful systems, and from low-level development libraries to end-user applications. So what is it that all parts of GNOME have in common?

- The GNOME project was the first to provide a fully free desktop environment for Unix-like systems. Free Software is about empowering users, and about granting them rights over the software they use.
- The GNOME Usability Project aims to improve the ease-of-use of GNOME and make the GNOME experience as enjoyable and natural as possible.
- GNOME is chock-full of cutting edge technologies. Network transparent component technology using CORBA, extensive use of XML, and one of the most advanced imaging models on any platform are only some of the features that makes GNOME the closest to rocket science you're likely to run on your desktop. In addition, it's all implemented in extremely efficient C, which makes it fast, lean, and very portable.
- The GNOME developer community is vast, tightly knit, and very friendly. If you're a developer who wants to get started on modern Unix GUI applications, GNOME is the emerging standard, and the large amount of developer documentation and other resources will help you find your way quickly. The GNOME libraries and infrastructure take care of most of the boring work for you, and let you focus on the code that makes your application unique. For more developer information, go to the GNOME Developer's Site.
- GNOME is used, developed and documented in hundreds of countries across the globe, and with the new GNOME internationalization features, GNOME lets you work in your language, no matter if it's Japanese, Russian, Swahili or English, complete with documentation, help, and menus in your native language.
- Accessibility is about enabling people with disabilities to participate in substantial life activities that include work and the use of services, products, and information. The GNOME Accessibility Project is developing a suite of software services and support in GNOME that allows people with disabilities to utilize all of the functionality of the GNOME user environment.

Even though it's extremely user-friendly, GNOME is a large and complex system, and as such, requires some learning to utilize to the fullest. To make that easier, we've provided some pointers to useful documentation.

The first resource you should look at is the GNOME User's Guide. It contains a wealth of useful information for the novice and experienced GNOME user alike. If you'd like, you can download the HTML or PDF version from: <http://www.gnome.org/>

7 KDE <http://www.kde.org/>

KDE is a powerful Open Source graphical desktop environment for Unix workstations. It combines ease of use, contemporary functionality, and outstanding graphical design. KDE (the K Desktop Environment) includes KWM, the K Window Manager, as an integral component and provides a file manager, a help system, a configuration utility and a variety of accessories and applications, including: games such as Kmines, Kpoker, and Ktetrtris, graphical applications such as Kfract, a fractal generator and Kview, an image viewer, multimedia applications such as Kmix , a sound mixer and Kmedia, a media player. For more information

point go to the KDE home page and if you have a question make sure you go through their FAQs or frequently asked questions section.

8 ALSA <http://www.alsa-project.org/>

is the Advanced Linux Architecture. It consists of a system of device drivers for different sound-cards, a library API, utilities and of course programs that run on top of it. In general it is a set of software tools for manipulating high quality audio and MIDI inside the computer and the external world. ALSA has been in development for the past years and because of its “state of art” it was recently adopted as part of the standard Linus Torwalds Kernel.

Given this state of excitement you might get interested in getting into this group of developers and improve on existing drivers or even write your own driver for your favorite sound-card using the ALSA API. Otherwise you might get tempted on developing your own ALSA audio application and added to a growing collection of programs which include a full feature sound editor, MIDI sequencers, software synthesizers and certainly, algorithmic composition packages.

Extensive documentation can be found at various places including the `PlanetCCRMA@Home` page, the `ALSA` home page as well as the `Agnula Project` home page. A detailed description is a bit beyond the scope of this guide but the reader is encouraged also to read the mail archives of the `planetCCRMA` list as well as various Linux Audio lists and of course the ALSA users or developers list.

At CCRMA ALSA runs smoothly in the background and in theory all your favorite applications should run without much knowledge of it. However minimal information might prove helpful in case of troubleshooting audio in Linux. One of this situations might arise if for instance you are trying to plug in a MIDI-USB device to one of CCRMA’s workstations (if this is the case please read the section on USB further on below and consult the USB devices section of `PlanetCCRMA@Home`).

9 Applications

Following are descriptions in their original form found in the documentation of Linux software available at CCRMA. Wherever possible hints or examples of their use will be provided but the reader is encouraged to further enhance his or her knowledge with the full documentation either on man pages or on the web links provided here. Some of this sites have very complete and operational descriptions in addition to to FAQs or frequently asked questions and even user’s groups and mailing lists. Most of the following applications have been tested and are working, however there is a slight chance that they might not work accordingly. Don’t panic, most of the time is not your mistake but instead a configuration error. Kindly let know anyone at CCRMA staff of your problem or email `local-users@ccrma.stanford.edu`. There is a big chance that someone else at CCRMA had the same problem or better of that knows a solution to your problem.

9.1 Terminal “Window”

- GNOME Terminal
<http://www.gnome.org>

This is perhaps the most important item on your desktop. It is your window to Unix and the rest of the world. You can open it by clicking on the footprint icon on the lower left GNOME panel. The GNOME Terminal application starts the default shell(command line interpreter) for you. It can be configured to different colors, backgrounds, or sizes. Make sure you set the scrolling option to a value bigger than 100. Character sets, fonts can also be adjusted but keep in mind that most Unix commands are in English with ASCII characters. However, in special cases like when you are using pine or text editors like Vi or Joe and you want to type non English characters, for western languages use the ISO-8859-1 character set which includes special characters for languages like Spanish, French, Portuguese German or Italian. You can open as many terminals as necessary. At CCRMA we use the C-Shell as default for the terminal window.

Craig Sapp suggests a nice collection of tutorials of the shell which can be found at:

LinuxCommand.org

http://www.linuxcommand.org/learning_the_shell.php

Manual pages can also be found at:

SuperMan pages

http://www.linuxcommand.org/superman_pages.php

9.2 Electronic Mail - email

- Pine
<http://www.washington.edu/pine> This is a Program for Internet News & Email - is a tool for reading, sending, and managing electronic messages. Pine was designed by the Office of Computing & Communications at the University of Washington specifically with novice computer users in mind, but it can be tailored to accommodate the needs of "power users" as well. Versions are available for various flavors of Unix as well as for personal computers running a Microsoft operating system.
- evolution
<http://www.ximian.com/devzone/projects/evolution-devel.html> Evolution is the GNOME mailer, calendar, contact manager and communications tool. Perhaps NeXT mailer look-like, although some people might claim is Eudora-like if not others. Evolution represents the next step forward in GNOME applications. The tools which make up Evolution are tightly integrated with one another and act as a seamless personal information-management tool. Evolution is extensible and it will be possible to use it to solve a huge variety of information-sharing problems like contact makers, schedules, mailing lists and more. Evolution will import email and email addresses and contacts from older email clients like pine or Netscape.

To setup evolution for the first time just type:

```
evolution
```

and follow the dialogs. The information you need to know as of now is your cram login when you get the email account information dialog. Make sure you type your account with the `ccrma.stanford.EDU` domain as follows:

```
your-login@ccrma.stanford.edu
```

For receiving email select the mail server type as "Local Delivery". Make sure your `/var/spool/mail/` - directory is on the configuration path.

For sending email make sure you select the "SMTP" mail server type. In the Host section type "localhost".

If you previously used pine or any other mail client at CCRMA it will ask you if you want to import your mailboxes and your email addresses. Just choose the appropriate selection.

Evolution has an extensive list of tool-tips, on-line help as well as FAQs and tips.

To export contacts (email-addresses) in Evolution Left-click on the very first contact, now hold down Shift and left-click on the very last contact. Now right click and select "Save as VCard". You'll get a nice, 100% standard-compliant .vcf (palm compatible) file which can be read in other address-book programs and even sync to hardware palms.

For Mailboxes also Left-click first, Shift-left-click last, Right-click Save As. It saves as standard mbox file with an .mbox extension which might be exported to other operating systems mail clients.

When in doubt in Evolution, highlight and right-click!

– Evolution: More than an Email Reader

You can filter or rather direct your email to different folders. While procmail and spamassassin can filter unwanted spam mail (see below), you can still filter way more by using the filter utilities in Evolution. But let's start on how to redirect email to a specific folder:

Suppose you want to archive email from a particular list you are subscribed, let's say the PlanetCCRMA list.

1. Create a PlanetCCRMA folder
2. Go to the Tools menu and select "Filters"
3. On the filters window click "Add"
4. Name the rule something like "planetcrma mailing list"
5. On execute actions select "if all criteria met"
6. Add action if there is not one
7. Select the mailing list criteria
8. Then on the whitespace write "planetccrma@ccrma.stanford.edu"
9. On the "then" side below of the rule box select action: "move to folder"
10. and then select "PlanetCCRMA in local folders"
11. Email from this list should be redirected to the PlanetCCRMA folder the next time you receive email.

It would be a good idea to take a look at different criteria in the *rules* window for familiarizing with different filters if you want to classify your email and even if you want to have your own spam filters. Most email filters are created the way explained above just by changing rules and actions.

– Evolution Contacts

Working with contacts is also a very useful feature. Contacts not only file email address information, they also can store telephones, fax numbers, birthday information, you name it. Each contact can act like a card and as your phone book directory. In fact each contact can be a Vcard and exported to contact programs in other operating systems' software. You can attach a Vcard and send it over the Internet but perhaps the most useful feature is that you can synchronize your "palm pilot" with Evolution's contacts.

– Synchronizing your Palm-Pilot

Evolution has a built-in script which runs "gnome-pilot" to synchronize information to and from your pilot just by following these steps:

1. Select your Palm ID
2. Select the conduits of information you want to have between your desktop and the pilot.
3. Share calendar data, ToDo's, etc.

Whether you have a serial Palm or a USB you should not run into much trouble while trying the *HotSync* push button on your device. If synchronization is not working make sure that Pilot Link is properly configured. You will need to make sure that you have read and write permissions on the device, which is normally /dev/pilot. If that does not work, check /dev/ttyS0 (maybe /dev/ttyS1) if you have a serial connection, or /dev/ttyUSB0 for a USB connection. You can do this by asking your system administrator for the right permissions or in your own system by becoming root and running the command: `chmod 777 /dev/ttyUSB0` (or `chmod 777 /dev/ttyS0`).

– Evolution Composer: Emacs-like key bindings

You can have Evolution's composer (compose email window) Emacs-like key bindings. On older versions there is a tab in tools/ settings/ composer and even in the composer window menus over preferences. In newer versions this setup is done via your Gnome editor preferences. For this go to keyboard shortcuts on the Gnome-preferences menu and on the Text editing shortcuts tab select "emacs".

- Mozilla

<http://www.mozilla.org> , is an open-source web browser, designed for standards compliance, performance and portability and is the browser of choice at CCRMA. You can also read email, news and transfer files plus it offers a very good multilingual interface. It works in a similar fashion or better than Netscape or eXplorer.

- Procmail

<http://www.procmail.org>

CCRMA is now processing email at the server level and the final delivery agent is *procmail*.

Procmail can be used to create mailing lists, sort your incoming mail into separate folders/files (real convenient when subscribing to one or more mailing lists or for prioritising your mail), preprocess your mail, start any programs upon mail arrival (e.g. to generate different chimes on your workstation for different types of mail) or selectively forward certain incoming mail automatically to someone.

Procmail should be invoked automatically over the .forward file mechanism as soon as mail arrives. Alternatively, when installed by a system administrator (and in the standard Red Hat Linux configuration), it can be invoked from within the mailer immediately. When invoked, it first sets some environment variables to default values, reads the mail message from stdin until an EOF, separates the body from the header, and then, if no command line arguments are present, it starts to look for a file named \$HOME/.procmailrc. According to the processing recipes in this file, the mail message that just arrived gets distributed into the right folder (and more). If no rcfile is found, or processing of the rcfile falls off the end, procmail will store the mail in the default system mailbox.

You're not supposed to start procmail from the command line. Procmail expects exactly one mail message to be presented to it on its stdin. Usually the mail system feeds it into procmail.

There exists an excellent FAQ about Emailfilters (and procmail in particular), maintained by Nancy McGough which can be obtained and seen at: <http://www.cis.ohio-state.edu/hypertext/faq/usenet/mail/filtering-faq/faq.html>

- SpamAssassin

<http://spamassassin.taint.org>

If you are getting a lot of spam mail:

SpamAssassin is a mail filter to identify spam.

Using its rule base, it uses a wide range of heuristic tests on mail headers and body text to identify "spam", also known as unsolicited commercial email.

The spam-identification tactics used include:

- header analysis: spammers use a number of tricks to mask their identities, fool you into thinking they've sent a valid mail, or fool you into thinking you must have subscribed at some stage. SpamAssassin tries to spot these.
- text analysis: again, spam mails often have a characteristic style (to put it politely), and some characteristic disclaimers and CYA text. SpamAssassin can spot these, too.
- blacklists: SpamAssassin supports many useful existing blacklists, such as mail-abuse.org, ordb.org or others.
- Razor: Vipul's Razor is a collaborative spam-tracking database, which works by taking a signature of spam messages. Since spam typically operates by sending an identical message to hundreds of people, Razor short-circuits this by allowing the first person to receive a spam to add it to the database – at which point everyone else will automatically block it.

Once identified, the mail can then be optionally tagged as spam for later filtering using the user's own mail user-agent application.

SpamAssassin requires very little configuration; you do not need to continually update it with details of your mail accounts, mailing list memberships, etc. It accomplishes filtering without this knowledge, as much as possible.

So, SpamAssassin can be activated on your account by adding a filtering recipe to your ".procmailrc" file, if you have one, or creating one if you don't. Beware, you can lose email if you don't configure your .procmail file properly.

Please contact your system's administrator or staff for getting a current and correct procmail configuration and make sure you understand your regexps (regular expressions) and filters.

An example of a "\$HOME/.procmailrc" configured to use SpamAssassin and which you can tailor to your specific requirements might be something like (procmail man page has more details on the syntax and structure of this file):

```
# SpamAssassin sample procmailrc
#
# Pipe the mail through spamassassin (replace 'spamassassin' with 'spamc'
# if you use the spamc/spamd combination)
#
# The condition line ensures that only messages smaller than 250 kB
# (250 * 1024 = 256000 bytes) are processed by SpamAssassin. Most spam
# isn't bigger than a few k and working with big messages can bring
# SpamAssassin to its knees.
#
# The lock file ensures that only 1 spamassassin invocation happens
# at 1 time, to keep the load down.
#
:0fw: spamassassin.lock
* < 256000
| spamassassin

# Mails with a score of 15 or higher are almost certainly spam (with 0.05%
# false positives according to rules/STATISTICS.txt). Let's put them in a
# different mbox. (This one is optional.)
:0:
* ^X-Spam-Level: \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*
almost-certainly-spam

# All mail tagged as spam (eg. with a score higher than the set threshold)
# is moved to "probably-spam".
:0:
* ^X-Spam-Status: Yes
probably-spam

# Work around procmail bug: any output on stderr will cause the "F" in "From"
# to be dropped. This will re-add it.
# NOTE: This is probably NOT needed in recent versions of procmail
:0
* ^rom[ ]
{
  LOG="*** Dropped F off From_ header! Fixing up. "
```

```

:0 fhw
| sed -e '1s/~/F/'
}

```

- Using SpamAssassin inside Evolution:

You can also use SpamAssassin directly inside Evolution. For this you will need to create a filter in order to process the message and then place it inside a “spam folder”. Following are the steps needed while in evolution:

1. Create a Spam Folder
2. Go to the menu Tools —> and look for Filters
3. Under Filter Rules, choose the “Add” button
4. look for the “Add Rule” dialog and,
 - (a) Under the Criterion, “IF,” frame,
 - i. Choose a rule name, something like “spam-filter”
 - ii. Choose “Pipe Message to Shell Command” from the conditions list.
 - iii. Write the command “spamassassin -e %i /dev/null” in the command text box.
 - iv. Select “returns greater than” from the return drop down list.
 - v. Set 0 to the number box.
 - (b) Under the Action, “THEN,” frame,
 - i. Choose the “Move” action and set the destination to your new spam folder.
 - ii. Click on the “Add Action” button.
 - iii. Choose “Stop processing” from the new action list.
 - (c) Move the new “spam rule” to the top of the filter list because Evolution performs filter rules sequentially.
5. *Some known issues:*

It is advisable to do email backups and testing before using a spam filter. Sometimes some messages will get trapped inside the spam folder. If this kind of situation repeats you might want to add another rule to your spam filter to fix the problem. Therefore, periodically reviewing your spam folder for legitimate mail is a good idea.

Be aware that no matter how fast your computer is, adding a spam filter might slow down your mail download from the server significantly. However, depending on the volume of mail you receive, adding this kind of filtering will significantly reduce dealing with junk mail.

9.3 Web Browsing

There are several Linux Web browsers each one with its own very appealing features for browsing and file viewing. Most prominent candidates include Mozilla, Konqueror, Opera, and Netscape browsers. Out of curiosity you may want to know that can use any one of about 50 browsers in Linux, but of course many are experimental or immature. Alternatively you might want to be more conservative and choose Netscape which is still available. No word about eXplorer in Linux.

All of the major browsers carry on exciting features that make browsing more pleasurable in ways only available to Linux and Unix users. For example, both Mozilla and Konqueror let you disable pop-up ads, and are smart on how they do it too. -The browser detects when the user clicks on a link that will open up in another window and allows that kind of action, while denying the ability of a web page to open its own window without user interaction.

Linux browsers pioneered true page scaling, allowing for the viewing of a web site as Small as a PDA screen up to resolutions so that a page can be comfortably read in a 1600x1200 pixel screen. This is a great feature in particular when you are projecting browser windows on a LCD projector.

- Mozilla

<http://www.mozilla.org> , is an open-source web browser, designed for standards compliance, performance and portability and is the browser of choice at CCRMA. You can also read email, news and transfer files plus it offers a very good multilingual interface. It works in a similar fashion or better than Netscape or eXplorer.

Mozilla is probably the most advanced Linux browser, considering the way that Red Hat has configured it in Red Hat 7.3. Everything works and works well. You can bet that most sites will work with Mozilla.

- Firefox

<http://www.mozilla.org/products/firefox/> , is the newest generation browsing based on technology developed over the years for Mozilla and Netscape.

It is small, fast and easy to use and offers many advantages such as the ability to block pop-up windows and tab browsing. Firefox lets you to accomplish your on line activities faster, more safely and efficiently because it is light. The built-in Google bar provides convenient access to the best search engine on the web. With Tab browsing, there is a fast and convenient way to browse the web. This means you can open several pages in one window in separate browser tabs. Open links in the background while you read a web page, then continue to the links when you're done. Pages are available when you need them, making the web feel faster even over slow connections. Firefox shields you from unwanted popup windows and lets you allow certain sites to open popup windows if necessary.

- Konkeror

<http://www.konkeror.org> , is an Open Source web browser based for the K Desktop Environment with features such as HTML4.0 compliance, Java applets support, JavaScript, CSS1 and (partially) CSS2, as well as Netscape plugins (for example, Flash or RealVideo plugins).

Konqueror might also serve as the file manager for the K Desktop Environment. It supports basic file management on local UNIX filesystems, from simple cut/copy and paste operations to advanced remote and local network file browsing.

Among its features if you where and know how to look for them, you can browse an Audio CD in your machine, and automatically rip tracks from CDs while surfing them.

- Amaya

<http://www.w3.org/Amaya/> , is a Web editor, (i.e. a tool used to create and update documents directly on the Web). Browsing features are seamlessly integrated with the editing and remote access features in a uniform environment. This follows the original vision of the Web as a space for collaboration and not just a one-way publishing medium.

Work on Amaya started at W3C in 1996 to showcase Web technologies in a fully-featured Web client. The main motivation for developing Amaya was to provide a framework that can integrate as many W3C technologies as possible. It is used to demonstrate these technologies in action while taking advantage of their combination in a single, consistent environment.

Amaya started as an HTML + CSS style sheets editor. Since that time it was extended to support XML and an increasing number of XML applications such as the XHTML family, MathML, and SVG. It allows all those vocabularies to be edited simultaneously in compound documents.

- Galeon

<http://galeon.sourceforge.net/> , is the Web browser created by Gnome and it is based on gecko (the Mozilla rendering engine). It's fast, it has a light interface and it is full standards compliant.

It is appealing because of its slender design and speed. The icons on the browser itself are small and cleanly designed, and for some people look better than other cartoony buttons found on most Web browsers. The buttons take up little of the space that one would rather use for browsing. Pages load quickly and almost flawlessly, although some standard fonts looked a little less clear than one might like.

- Netscape
<http://www.netscape.com> This is a Mail, Calendar, Instant Messenger, Search and web surfer application but it is not longer part of most Linux distributions.

9.3.1 Customizing Mozilla

Skins:

Dress Mozilla up with new appearances!. Yes, you can download new skins and install them so that next time you start Mozilla, it will have a different look.

Mozilla comes standard with two themes, Classic and Modern. These themes were designed for an enjoyable browsing experience but soon developers realized that people might desire to dress-up their browser to meet their own particular tastes and thus provided a means for independent designers to develop their own themes. You can take advantage of new on the edge state of the art themes to tailor your taste. To install new themes on Mozilla:

1. Before installing the themes, launch Mozilla.
2. JavaScript has to be enabled for Navigator in advanced preferences.
3. Software Installation has to be enabled in advanced preferences.
4. Themes can be automatically installed from the <http://themes.mozdev.org/> site.
5. Alternatively, themes are supplied as xpi files; meaning they can be downloaded and installed later.

Tabbed Browsing:

Tabbed browsing gives you a better way to surf the net. You no longer have to open one page at a time. With tabbed browsing, open several pages at once with one click. And now your homepage can be multiple tabbed pages.

1. Ctrl-T opens a new tab.
2. Ctrl-PgUp and Ctrl-PgDn cycle between tabs.
3. Right-click on a link to Open Link In New Tab.
4. Save a window of tabs as a group bookmark by going to Bookmarks, File Bookmark and checking "File as group" when you go to the bookmark, all the tabs will open at once.
5. Set tabbed browsing preferences in Edit / Preferences / Navigator / Tabbed Browsing.

Pop up window blocking:

You can configure Mozilla so pop-up windows will not open. Popup blocker lets you surf the web without intrusion. Advanced popup blocker notifies you when popups are blocked. You can also block pop-ups on a site per site basis.

1. Open the Mozilla Preferences window.
2. Select the Advanced Category and then Scripts & Plugins.
3. In this window, uncheck (disable) the Open Unrequested Windows.
4. Disable Move or Resize Existing Windows.
5. Uncheck Raise or Lower Windows.

Plug-Ins:

If installing plug-ins without root permissions, use `$home/.mozilla/plugins` instead of the plug-ins subdirectory where Mozilla is installed. You may have to create this directory first. Mozilla Firefox also uses `$home/.mozilla/plugins` for this. Java and Flash are already installed system-wide at CCRMA. You should not need to re-install any plug-in. If that is the case please contact the system administrator. You can go to the

plugindoc.mozdev.org

<http://plugindoc.mozdev.org/linux.html> web page for instructions and additional support about Mozilla plug-ins.

Privoxy:

The privoxy daemon comes standard on most Linux distributions and chances are that it might be configured and running on your workstation. Privoxy can block annoying ads and animations but it can also prevent useful information on you browser so it must therefore be tested on favorite web sites so that it behaves accordingly.

Privoxy is a web proxy with advanced filtering capabilities for protecting privacy, modifying web page content, managing cookies, controlling access, and removing ads, banners, pop-ups and other obnoxious Internet junk. Privoxy has a very flexible configuration and can be customized to suit individual needs and tastes. Privoxy has application for both stand-alone systems and multi-user networks.

These are the steps for using Privoxy in Mozilla:

1. In the Edit menu go to — Preferences — Advanced — Proxies —
2. Select “Manual Proxy configuration”
3. Type 127.0.0.1 on the “HTTP Proxy” space and 8118 on “Port” space.
4. Type 127.0.0.1 on the “SSL Proxy” space and 8118 on “Port” space.
5. After doing this, flush your browser’s disk and memory caches to force a re-reading of all pages and to get rid of any ads that may be cached. You are now ready to start enjoying the benefits of using Privoxy!

Cookies:

A cookie is a small amount of information used by some web sites. A web site that sets cookies will ask your browser to place one or more cookies on your hard disk when you visit the site. Later, when you return to the site, your browser sends back the cookies that belong to the site. You can specify how cookies should be handled by setting your cookie preferences and by using the Cookie Manager. To change cookie preferences:

1. Open the Edit menu and choose Preferences.
2. Under the Privacy & Security category, choose Cookies. (If no subcategories are visible, double-click the category to expand the list.)
3. Click one of the radio buttons:
 - Disable cookies: Choose this to refuse all cookies.
 - Enable cookies for the originating web site only: Choose this if you don’t want to accept or return Foreign cookies. Cookies received through email (when the message contains a web page) are treated as foreign cookies.
 - Enable all cookies: Choose this to permit all web sites to set cookies on your computer and receive them back during subsequent visits. Note: If you select this option, and later choose to reject all cookies, you may still have some older cookies stored on your computer (though no new ones will be set).

Viewing Cookies

To view detailed information about cookies:

1. Open the Tasks menu, choose Privacy & Security, and then choose Cookie Manager.

2. Choose View Stored Cookies from the submenu. The Cookie Manager window opens with a list of all the cookies stored on your computer.
3. To see details for a particular cookie, click on it:
 - *Name*, means the name assigned to the cookie by its originator.
 - *Information*, is a string of characters and the data a web site tracks for you. It might contain a user key or name by which you are identified to the web site, information about your interests, and so forth.
 - *Host or Domain*, this item tells you whether the cookie is a host cookie or a domain cookie.
 - *Path*, This is the file pathway. If a cookie comes from a particular part of a web site, instead of the main page, a path is given.
 - *Server Secure*, indicates whether the cookie was sent over a secure server. If a cookie is secure, it will only be sent over a secure (https) connection. Before sending a secure cookie, your browser checks the connection and will not send if the connection is not secure.
 - *Expires*, is the date and time at which the cookie is deactivated.

Using the Password Manager:

Password Manager can help you by storing your user names and passwords on your computer's hard disk, and entering them for you automatically when you visit such sites.

When you enter your user name and password at a web site a dialog box appears asking, "Do you want Password Manager to remember this logon?" You can choose the following options:

1. *Yes*, the next time you return to the web site you'll see that your user name and password are already filled in.
2. *Never for this site*, password Manager will not ask in the future if you want to save your user name and password for that site.
3. *No*, password Manager won't remember the user name and password, but will ask again the next time you visit the site.

Password Manager saves your user names and passwords on your own computer in a file that's difficult, but not impossible, for an intruder to read.

Becareful if you provide personal information such as your name, phone number, or email address to a web site, because it is free to store that information in its database and use it later. A web site might use this information to improve its service to you or target advertising to your interests. A web site could sell the information it has gathered to other companies.

To turn on encryption for your stored sensitive information:

1. Open the Edit menu and choose Preferences.
2. Under the Privacy & Security category, choose Web Passwords. (If no subcategories are visible, double-click the category to expand the list.)
3. In the Encrypting versus Obscuring section, select "Use encryption when storing sensitive data."
4. Click OK. If you haven't previously set a master password, a new dialog box appears and leads you through the process of setting it.

Useful Hints:

- Make Mozilla behave like Netscape:

1. On the top [http://] blank address space just type: [about:config]
2. Scroll down to general and look for: “general.useragent.vendor”
3. Change its value to: [netscape 7.0]
4. Alternatively, you can look for the filter blank line and type: [“general.useragent”]
5. Scroll down and look for: “ general.useragent.vendor”
6. If “general.useragent.vendor” is not in the list:
 - right-click and select new and type, [general.useragent.vendor]
 - Follow dialogs and add the value: [netscape 7.0]
 - click [ok]

9.4 terminal- shell commands

There is a lot of information inside the “manual” **man** pages for almost every Unix shell command. Also most commands suggested here should work on a (ssh) secure shell environment.

At CCRMA the shell of choice is the C-shell. There should be a **.cshrc** file in your home directory and familiarity with its meaning can be really helpful on getting acquainted with the behavior of your terminal window. You can write scripts or shortcuts which can be stored on your **.cshrc** file and therefore this means that you can have your own shell commands. You can find more information in the man pages or in

<http://www.gnu.org/help/gethelp.html>

or simply,

<http://www.gnu.org/>

A good source for information and tutorials on Unix commands can be found at,

<http://www.geek-girl.com/Unixhelp/>

If you have read the Unix section of this guide you will find the following commands ‘very’ useful:

General and file manipulation commands:

man	Get information or help about a command
apropos	Locate commands by keyword look up
ls	List directory contents
pwd	Path of working directory
cd	Change working directory
mv	Move file or change name
cp	Copy file
mkdir	Make directory
rm	Remove files and directories
mount /mnt/zip	Mount zip disk on directory /mnt/zip

Commands for printing:

lpr file.ps	Print a file in default printer (knoll)
lpr -P np2 file.ps	Print a file in the trailer’s printer
lpq	Show printer jobs in the queue
lprm	Remove the last job submitted if it is in the queue
lprm -np2 25	Remove job 25 in spool queue np2

WARNING !!! PLEASE, DO NOT use the *lpr* command to print Adobe Acrobat “pdf” files or postscript definition files. Open Acrobat Reader instead and print from within inside Acrobat Reader or use the command *pdf2ps* to convert to a “ps” postscript file.

Postscript utilities:

As a wonderful ecological solution suggested by Julius Smith and to save some trees the following commands will let to print two pages in one from a postscript file. You type:

```
psnup -n 2 infile.ps > outfile.ps
psnup -pletter -n 2 infile.ps > outfile_2up.ps
```

To print an A4 formatted document you need to re size it to the American standard “letter-size”. For this, you use the command **psresize** in the following way:

```
psresize -PA4 -pletter infile.ps > outfile.ps
```

For connectivity and file transfer and text manipulation:

<code>finger</code>	look for all ccrma users
<code>finger login@</code>	look for particular user
<code>ssh</code>	secure login on remote machine
<code>scp</code>	secure file copy from or to machine
<code>talk login@cmnXX</code>	talk to other user on this terminal
<code>find</code>	look for file
<code>cat</code>	output contents of a file
<code>grep</code>	search for a string of text

Editors and publishing:

<code>vi</code>		text editor
<code>emacs</code>	development text editor	
<code>latex</code>	compile a L ^A T _E Xfile	
<code>dvips</code>	convert a dvi file to postscript	
<code>ps2pdf</code>	convert a ps file into a pdf file	

Account Administration:

<code>chmod</code>	change permissions on files and directories
<code>yppasswd</code>	change password

9.5 Multimedia

Most of these programs can be accessed through the Gnome footprint print menu in the lower left corner of your Linux desktop. Mplayer can be started form the command line.

- XMMS, man-page, can play your favorite mp3 files but it can also play audio-stream radio stations with this feature. Just add the file name or the URL to its. play-list. URLs might be in a file with the .pls suffix like kcsml.pls and the file should be in the following format:

```
[playlist]
NumberOfEntries=1
File1=http://hifi.kcsm.org:8002/
```

The X Multimedia System is a player with the following features:

1. Seeking in files Volume/Balance Shuffle play Repeat play
2. Equalizer Playlist editor
3. Spectrum Analyzer Oscilloscope
4. User Interface: One line mode al'a WinShade in WinAmp Timer Elapsed/Timer Remaining Double Size option
Full Winamp 2.0 skin support Gnome/Afterstep/WindowMaker dock app GTK Interface for requesters (with theme support) Auto remove borders if the WM has support for it Plugins:

5. Visualization Effects Input Output

Streaming/Shoutcast(1.0/1.1)/Icecast support Fast jump in playlist Scroll wheel support Save to wav option Saves http streams to HD HTTP authentication Plays mpeg layer 1/2/3 also wav and formats supported by mikmod Proxy authentication support Compiles on other systems (FreeBSD, Solaris, LinuxPPC, AIX, Irix)

- Mplayer

<http://www.mplayerhq.hu/homepage/>

You missed a class at Stanford and you want watch its video. Your friend just sent you a video clip of her birthday.

Yes, you can watch it in your Linux workstation at CCRMA and Mplayer is your solution.

“MPlayer is a movie player for LINUX (runs on many other Unices, and non-x86 CPUs, see the documentation). It plays most MPEG, VOB, AVI, VIVO, ASF/WMV, QT/MOV, FLI, NuppelVideo, yuv4mpeg, FILM, RoQ, OGG and some RealMedia files, supported by many native, XAnim, and Win32 DLL codecs. You can watch VideoCD, SVCD, DVD, 3ivx, FLI, and even DivX movies too (and you don’t need the avifile library at all!).”

You can launch the Mplayer application by typing something like (because you should read its man-page):

```
mplayer -vo xv yourfile &
```

or

```
mplayer -vo xv 'url of your videofile'
```

Well, you can also watch DVDs with Mplayer.

In some machines sampling rate playback is synchronized to the CD-Player / DVD-writer. If this is the case audio playback will be faster or slower. Please change the synchronization options with the *envy24control* command.

- xmixer

<http://www.hdk-berlin.de/rasca/xmixer/>

This is a Gtk+ / Xaw-based soundcard mixer program for Linux.

- Cd Player

<http://www.gnome.org/>

A front end cd player for loading, playing, and skipping tracks of compact discs which are in the cd tray of your workststion.

- KDE Media Player

<http://www.kde.org/>

A MPEG file player application for KDE.

- Real Player is A MPEG file player application.

- KDE MIDI Player

<http://www.kde.org/>

A MIDI file player application for KDE. Files will be played on the soundcard internal synthesizer.

9.6 Word Processing, Spreadsheets, Presentations, Office Tools

9.6.1 Open-Office (OO)

OpenOffice

<http://www.openoffice.org/> This is the real open source version of SUN's Star Office which is periodically updated at CCRMA. In modern RedHat versions you can run OpenOffice from Gnome's footprint main menu under applications. You can also run OpenOffice by invoking the "openoffice" command. If you are running the program for the first time, it will query some questions in regards to its license and it will also create an **OpenOffice.org** directory in your home directory.

OpenOffice.org is both an Open Source product and a project. The product is a multi-platform office productivity suite. It includes the key desktop applications, such as a word processor, spreadsheet, presentation manager, and drawing program, with a user interface and feature set similar to other office suites?. Sophisticated and flexible, OpenOffice.org also works transparently with a variety of file formats, including those of Microsoft Office.

StarDivision, the original author of the StarOffice suite of software, was founded in Germany in the mid-1980s. It was acquired by Sun Microsystems during the summer of 1999 and StarOffice 5.2 was released in June of 2000. Future versions of StarOffice software, beginning with 6.0, will be built using the OpenOffice.org source, APIs, file formats, and reference implementation.

The OpenOffice.org source code initially includes the technology which Sun Microsystems has been developing for the future versions of StarOffice(TM) software. The source is written in C++ and delivers language-neutral and scriptable functionality, including Java(TM) APIs. This source technology introduces the next-stage architecture, allowing use of the suite as separate applications or as embedded components in other applications. Numerous other features are also present including XML-based file formats and other resources.

OO-Features The suite covers pretty much everything you need with a word processor, spreadsheet, presentation software, equation editor and a drawing program. It opens most major formats such as MS Office almost flawlessly (Macros aren't converted), saves to PDF* , has comprehensive help, and spellchecking in 15 languages. Having said that, let's detail some of the major features: The Entire OpenOffice Suite is a powerful yet simple environment for you to work. All of the following features are used throughout the program.

- The ability to import and export many different types of documents and templates in a huge range of formats from HTML to MS Office XP. You can work seamlessly with your colleagues, school or friends, no matter what computer you use. Although we think the OpenOffice.org Open File Formats are technically superior many people are still locked into other products so you can set OpenOffice.org to use any other file format by default if you wish.
- Runs natively on almost every modern operating system except Mac OS X. This port is under development, and a volunteer porting team is working hard on it. You can give them a hand and get it running quicker by joining the project: <http://mac.openoffice.org>
- Import address books from Mozilla/ Netscape 6.x/7 or LDAP. You don't have to keep on typing in those contact details.
- Unicode support allows at least 23 localisations of OpenOffice.org. Not only will OpenOffice.org run on practically anything but it'll run in practically any language. There are more being added all the time. Even if yours isn't there yet we might be able to put you in touch with some fellow speakers to get the work done in double time. Together we work better.
- Vastly enhanced printing capabilities and options over all platforms, with extras like 'Print to PDF' under UNIX. If you want to see all that work in hard copy, OpenOffice.org will take care of it for you; or if you want to go for the 'paperless office' we can create 'digital paper' PDF files that can be

read on practically anything. OpenOffice.org is all about bringing this sort of sophisticated, expensive functionality to the ordinary user.

- Autopilot guides you through creating complex document, clearly. Do you know what to do but aren't sure how to do it? Let the autopilot help. It'll ask you a few simple questions before creating a template for you to use again and again. Impress everyone with your brilliant skills, but don't let them know it was the autopilot!
- The Stylist allows you to change the entire look of your document instantly. It's that little box in the corner of the screen and it's an easy way to get a consistent look and apply formatting throughout your document. Just select some text, a cell or an object and choose a different option to move simply and easily between different styles. You can either use the built in defaults or create your own. And if it gets in your way just press F11 or click the little button near the top of your screen. You can get it back the same way or change styles in the box on the left hand side of the font selection.
- A native XML file format for small, yet powerful documents. File size is typically half that of MS Office formats. XML is the computer industry standard for data exchange. You're buying into the future and your documents will always be readable, even in a simple text editor.
- The powerful OpenOffice.org API allows you to create external functions to leverage the power of the suite just how you need it. Independent programmers can use our free software development kit (SDK) to extend the suite in ways we haven't even thought of. You can use OpenOffice.org Basic or Java and C/C++. More languages are being worked on at <http://api.openoffice.org/>.

OO-Writer Word Processing

- Form-letter management to send letters to addresses in a database. Automate chores and make complex things easy, it's the way we've tried to design OpenOffice.org and we think it shows through here.
- Compare changes and work collaboratively using the Versions system. If you need to work on a document together, but can't be at the same computer then OpenOffice.org's powerful 'Versioning' will come in handy. It lets you see what's changed, who's changed it and accept or reject the changes either individually or with a powerful series of filters. Currently versioning information doesn't export perfectly to some other formats.
- Direct connection with external email software to seamlessly send your documents worldwide. Cut down on the number of clicks and get your work into the hands of the people who need it.
- AutoCorrect word completion speeds up your writing in a non-obtrusive and powerful way. As you're typing it makes its best guess at what you mean to say. You can accept it by pressing enter or just keep on typing to ignore. If you make a mistake at any time just press Ctrl+Z for a quick and simple undo. Now I love this but I understand that these AutoCorrect features can drive some people up the wall. So there's a flexible menu where you can choose exactly what you want on or off. You won't find AutoCorrect word completion anywhere else, it's just another optional feature that makes OpenOffice.org unique.
- Indexing functions make moving around inside a document easy. A simple bibliography database makes it easy to store sources for essays.
- Sophisticated layout manager, with extensive Desktop Publishing (DTP) functionality that allows you to display everything you want simply and clearly.

OO-Calc: Spreadsheet

- You're also free to pull in data from corporate databases, and cross-tabulate, summarise, and manipulate with advanced DataPilot technology.
- Natural language formulas let you create formulas using words (e.g. "sales - costs").
- You can be your own spreadsheet expert thanks to templates with built-in functions, allowing you to concentrate on your real work.
- Scenario Manager allows "what if..." analysis at the touch of a button.
- Charting tools to visualise data in 2D or 3D.

OO-Draw: Drawing tool DRAW - from a quick sketch to a complex plan, DRAW gives you the tools to communicate with graphics and diagrams. It won't organise or edit your digital photo's as well as other programs but if you need to create a diagram, picture or illustration then you'll be glad to have it.

- FontWork allows you shape stunning 2D and 3D images from text for an extra effect.
- Quick and easy creation of complex 3D shapes. Sophisticated rendering let you create photo realistic images with your own texture, lighting effect, transparency, perspective, and so on.
- Bezier curves, for realistic smooth curves.
- Eyedropper to change any pixel colour into another.
- Raster tools and effects.
- Enjoy single click access to the objects you need for your diagrams.
- Arrange objects, rotate in two or three dimensions; the 3D controller puts spheres, rings, cubes, etc at your disposal.
- Smart connectors make short work of flowcharts, organisation charts, network diagrams etc.
- Import and Export graphics to and from all common formats (including BMP, GIF, JPEG, PNG, TIFF, and WMF).

OO-Impress: presentations IMPRESS is a truly outstanding tool for creating effective multimedia presentations. Your presentations will stand out with 2D and 3D clip art, special effects animation, and high-impact drawing tools.

- Exploits all the effects and graphics tools from Draw for the complete range of easy-to-use drawing and diagramming tools to spice up your presentation.
- AutoLayout makes sure your presentations look professional. Even quickly produced presentations look great, less time micromanaging bullet placement, more productivity.
- A complete range of Views are supported: Drawing / Outline / Slides / Notes / Handouts to meet all the needs of presenters and audiences.
- Slide show Animation and Effects bring your presentation to life.

9.6.2 StarOffice

StarOffice

<http://www.sun.com/staroffice/>

The program can be started from the command line by typing "soffice". If it is the first time you are running StarOffice you will be prompted to configure it (to be able to run, soffice needs to copy some files to your home directory). Just follow the prompts, you might want to put the local directory in, for example, Library/, so that it does not clutter your home directory. After you are done with the configuration you should be able to start the program by typing "soffice".

Staroffice is a huge program and rather slow to start, but quite complete. It has a decent word processor, spreadsheet, presentation editor, vector graphics editor and so on and so forth. It has some future because there's now an Open Source version (which at this point is not ready for everyday use), that means that you (hopefully) will not be locked into a proprietary document format.

For presentations in StarOffice follow the autopilot or the online help. You can start from templates also and to some extent you can import or export data to or from powerpoint.

9.6.3 LyX

LyX is a graphical front to the very capable L^AT_EX page description language. L^AT_EX is really a programming language that enables you to do almost anything you could think off, with the added advantage that the output of L^AT_EX is device independent. That is, no matter where you print it or how you view it, it will look exactly the same (within the hardware limitations of the printing or viewing device). But it is hard to learn. With Lyx you can easily access a subset of L^AT_EX by using a GUI. You will not see the exact rendering of the document in the Lyx window but it is very easy to render to dvi (the native output format of latex) or postscript. Lyx is described as a "WYSIWYM" editor (what you see is what you mean :-)

9.6.4 gnotepad

gnotepad

<http://gnotepad.sourceforge.net/>

It is an easy-to-use, yet fairly feature-rich, simple HTML and text editor. GNOME. gnotepad was designed to have as little bloat as possible, while still providing many of the common features found in a modern GUI-based text editor. It is still fairly light-weight, especially for the features it offers, and aims to remain that way. Additionally, gnotepad+ is not intended to be fancy, so it leverages its text editing capabilities on the GTK Text Widget. Hence, if you are looking for a programmer's editor, look for another text editor or help improve the GTK Text Widget.

9.6.5 Gnumeric

Gnumeric

<http://www.gnome.org/>

The Gnumeric spreadsheet which is part of the GNOME desktop environment and is intended to be a drop in replacement for commercial spreadsheets and it offers a customizable feel that attempts to minimize the costs and pain of transition. Gnumeric will import your existing Excel, 1-2-3, Applix, Syk, XBase and Oleo files. You should be able to start the program by typing "gnumeric". There is also good documentation online by clicking on the help menu.

9.6.6 AbiWord

AbiWord

<http://www.abisource.com/>

A lightweight word processor, can import most formats. Abiword's features include it's "look & feel", the ability to format pages and paragraphs, a spell checker, an interactive rule, the integration of styles,

the unlimited capacity to undo/redo , a find and replace function and the image insertion. It is also able to import documents from Microsoft Word 97 and rtf (Rich Text Format) and to save documents using Internet HTML format.

A document saved under AbiWord has an extension by default of * abw and is written in XML and thus in ASCII format. These files can then be read by any text editor but that does not mean that AbiWord is a XML editor.

AbiWord might be open through the gnome menu (footprint) -i programs -i Applications -i AbiWord or you might simply type the command:

```
AbiWord &
```

on the shell.

9.6.7 WordPerfect

WordPerfect

<http://linux.corel.com/>

Word Perfect 8 is available by typing `wp8` at the command line. As it is a proprietary software package with uncertain future support I would not recommend it at this point.

9.6.8 GnomeCard

Address Book - GnomeCard

<http://www.gnome.org/>

GnomeCard is the combination of an address book (contact manager) and an electronic business card manager. At the moment, the program shows two views: a tree view and a WYSIWYG view. From the tree view, the user can visualize every contact registered in the loaded file, with the possibility to expand the record to the desired detail, and will be able to perform actions, like DnD, dialing and sending e-mail. From the WYSIWYG view, the user will be able to edit the presentation of the business card, including photos and logos that may come with the card record, and view its contacts in a more comfortable way. You should be able to start this program by typing "`gnomecard`" on the command line.

9.7 Text-Editors

- XEmacs

XEmacs, man-page is a highly customizable text editor and application development system. Learning XEmacs is a lifelong activity and even people who have used Emacs for years keep discovering new features. You should be able to start Xemacs by typing `xemacs` on the command shell. Almost all features of Emacs are supported in XEmacs (the ones that aren't supported are generally implemented in a better way in XEmacs). XEmacs has an extensive interactive help facility, but assumes that you know how to manipulate XEmacs windows and buffers. CTRL-h enters the Help facility. Help Tutorial (CTRL-h t) requests an interactive tutorial which can teach beginners the fundamentals of XEmacs in a few minutes. Help Apropos (CTRL-h a) helps you find a command given its functionality, Help Key Binding (CTRL-h k) describes a given key sequence's effect, and Help Function (CTRL-h f) describes a given Lisp function specified by name. All of these help functions, and more, are available on the Help menu if you are using a window system.

One of the interesting features that makes XEmacs useful at ccrma is that it can run lisp as a subprocess in one of the buffers so that all emacs editing commands can be applied to the lisp expressions you are evaluating. For this (and other features) to work you need to have the proper incantations in a file in your home directory called ".emacs". This file takes care of initializing things properly for all supported programming, typing or text modes.

- Emacs

To quote the emacs, man-page manual: Emacs is the extensible, customizable, self-documenting real-time display editor. If this seems to be a bit of a mouthful, an easier explanation is Emacs is a text editor and more. At its core is an interpreter for Emacs Lisp (“elisp”, for short), a dialect of the Lisp programming language with extensions to support text editing. Some of the features of GNU Emacs include:

- Content sensitive major modes for a wide variety of file types, from plain text to source code to HTML files.
- Complete online documentation, including a tutorial for new users.
- Highly extensible through the Emacs Lisp language.
- Support for many languages and their scripts, including all the European “Latin” scripts, Russian, Greek, Japanese, Chinese, Korean, Thai, Vietnamese, Lao, Ethiopian, and some Indian scripts.
- A large number of extensions which add other functionality. The GNU Emacs distribution includes many extensions; many others are available separately—even a web browser.

- vi

Even though Vi, man-page is somewhat awkward to use at first, it enables fast, simple, and effective editing once you get the hang of it. A key concept in Vi is combining a certain action (delete, copy to buffer, capitalize, etc.) with a movement (go to line 25, go to end of document, go to next occurrence of “foo,” go to 2ND occurrence of character “x” in this line, etc.). The action is performed on all lines or characters between the current cursor position and the destination cursor position. Vi is extremely powerful in moving around within (or between) files—Vim in particular is excellent. You can jump to a specific line, to the line where you were before jumping to the current line, to the line in the middle of the screen, to the line where you just changed “foo” into “bar,” etc. You’ll never have to mess with arrow keys to move around within a file. VIM is an improved version of the editor “vi”, one of the standard text editors on UNIX systems.

- gnotepad

<http://gnotepad.sourceforge.net/>

Please see the word processing section§9.6.

9.7.1 Silly emacs Xemacs tricks

The following emacs commands can make your life much simpler if you are editing with emacs or Xemacs. Remember that these are text editors and their world is very dependent on the computer keyboard. Yeah right, by now you shouldn’t be using the mouse at all.

[c-x means control-x or the keyboard combination *ctrl*_{*x*}] [m-x means meta-x and at CCRMA is the keyboard combination *esc*_{*x*}]

```
c-w:  cut
m-w:  copy
c-y:  yank (paste)
c-k:  kill (delete) line

c-a:  move cursor to line beginning
c-e:  move cursor to line end
c-v:  move cursor to middle of file
```

```

c-l:  position window so cursor is in the middle
c-f:  move cursor ahead character
c-b:  move cursor back one character

c-s:  search for char-string (word) forward
c-r   search for char-string (word) backward
c-g:  quit emacs command (mini-buffer)

c-x-3: start two windows (vertical)
c-x-2: start two windows (horizontal)
c-x-1: go back to one window

c-[space-bar]: mark set (start selection)

c-a: beginning of line
c-e: end of line
m-a: beginning of paragraph
m-e: en of paragraph
c-x-[: goto beginning of file
c-x-]: goto end of file

m-[shift] \% replace character string (word)

c-[space-bar] c-e      select a line
m-a c-[space-bar] m-e  select a paragraph (region)

m-x -> ispell-buffer  spell check file
m-x -> ispell-region  spell check paragraph
m-x -> latex-mode     go to \LaTeX mode

```

Make sure you also have a backup of your .emacs file or emacs preferences file. It would be a good idea to open it and understand it. You can add to this file your own command definitions and combinations. Pay good attention to the following lines and make sure the mode you are intending to use is part of this list.

```

(mapcar #'(lambda (element) ;; emacs modes
           (setq auto-mode-alist
                 (pushnew element auto-mode-alist)))
        '(("\\.pike$"          . pike-mode)
          ("\\.pmod$"         . pike-mode)
          ("\\.ats$"          . lisp-mode)
          ("\\.clm$"          . lisp-mode)
          ("\\.cm$"           . lisp-mode)
          ("\\.cmn$"          . lisp-mode)
          ("\\.ins$"          . lisp-mode)
          ("\\.cl$"           . lisp-mode)
          ("\\.lisp$"         . lisp-mode)
          ("\\.scm$"          . scheme-mode)
          ("\\.sh$"           . sh-mode)
          ("\\.bashrc"        . sh-mode)
          ("\\.gnus"          . emacs-lisp-mode)
          ("\\.c$"            . c-mode)

```

```

("\\.h$" . c-mode)
("\\.l$" . c-mode)
("\\.y$" . c-mode)
("\\.awk$" . c-mode)
("\\.cc$" . c-mode)
("\\.x$" . c-mode)
("\\.m$" . matlab-mode)
("\\.s$" . asm-mode)
("\\.p$" . pascal-mode)
("\\.txt$" . text-mode)
("\\.text$" . text-mode)
("\\.tex$" . latex-mode)
("\\.sm$" . latex-mode)
("\\.sty$" . latex-mode)
("\\.bib$" . bibtex-mode)
("\\.el$" . emacs-lisp-mode)
("\\.tcl$" . tcl-mode)
("\\.java$" . java-mode)
("\\.html$" . html-mode)
("\\.ohtml$" . html-mode)
("[>:/]Makefile" . makefile-mode)
("[>:/]\\.*emacs" . emacs-lisp-mode)
("\\.rfc$" . rfc-mode)
("\\.id$" . rfc-mode)
("\\.isl$" . isl-mode)
("\\.php? $" . php-mode)
("\\.Xdefaults$" . xrdm-mode)
("\\.Xenvironment$" . xrdm-mode)
("\\.Xresources$" . xrdm-mode)
("*.\\.ad$" . xrdm-mode)
("\\.sql$" . sql-mode)
("\\.tbl$" . sql-mode)
("\\.sp$" . sql-mode)
)
)

```

Emacs is smart enough to recognize the file extension when you are opening a file and automatically will load the necessary mode so that your text will be formatted according to the text-mode you are going to edit. You turn-on this feature by adding file extensions and their relevant mode.

Suppose you want to use matlab mode. You also need to add the following code to you .emacs file:

```

;-----;
; Enable MATLAB mode ;
;-----;
(autoload 'matlab-mode "matlab" "Matlab Editing Mode" t)
(add-to-list 'auto-mode-alist '("\\.m$" . matlab-mode))
(setq matlab-indent-function t)

(defun my-matlab-mode-hook ()
  (setq matlab-indent-function t) ; if you want function bodies indented

```

```
(setq fill-column 76)           ; where auto-fill should wrap
(turn-on-auto-fill))

(setq matlab-mode-hook 'my-matlab-mode-hook)
(autoload 'matlab-shell "matlab" "Interactive Matlab mode." t)
```

Emacs is very good for editing documents. The next lines will add some functionality to emacs so that you will feel at home while editing files in Emacs, feel free to add this code to your dot-emacs file.

```
;;* Initialise aucTeX
;;*(require 'tex-site)
;;*=====
;;* load TeX-toolbar
;;*(require 'tex-toolbar)
;;*=====
;;* autoload style files
(setq TeX-auto-save t)
(setq TeX-parse-self t)
;;*=====
;; The documentstyle command is usually near the beginning.
(setq-default TeX-auto-parse-length 200)
(setq LaTeX-default-options "letterpaper,12pt,english,normalheadings")
(setq-default TeX-master t)
;;*
(add-hook 'latex-mode-hook
  (function (lambda ()
    (local-set-key (quote [228]) (quote "\"a\"))
    (local-set-key (quote [246]) (quote "\"o\"))
    (local-set-key (quote [252]) (quote "\"u\"))
    (local-set-key (quote [223]) (quote "\"s\"))
    (local-set-key (quote [196]) (quote "\"A\"))
    (local-set-key (quote [214]) (quote "\"0\"))
    (local-set-key (quote [220]) (quote "\"U\"))

    (setq ispell-extra-args '("-t")) ; start ispell in TeX mode
  )))
```

In general before buying any books related to the subject matter of text editing, you should run the emacs tutorial inside emacs which will last about an hour but you will graduate as an “EmacSoologist”.

9.8 Image Manipulation

- GIMP Gnu Image Manipulation Program
<http://www.gimp.org/>

The GIMP is the GNU Image Manipulation Program. It is a piece of software suitable for such tasks as photo retouching, image composition and image authoring. For all of you who know the terminology, a brief list of features and capabilities which GIMP provides might be:

- Full suite of painting tools including brushes, a pencil, an airbrush, an ink tool and cloning.

- Advanced scripting capabilities provided by a procedural database so you can call internal GIMP functions from external scripts, such as Perl-Fu(Perl scripts and Python-Fu(Python scripts)).
- Multiple undo and redo, limited only by disk space.
- Transformation tools including rotate, scale, shear, and flip.
- File formats supported include Post script, JPEG, GIF, PNG, XPM, TIFF, TGA, MPEG, PCX, BMP, and many others.
- Selection tools including rectangular, elliptical, free, fuzzy, paths, and intelligent scissors.
- Plug-ins that allow for easy addition of new functions, new file formats, and new effect filters.
- Tile-based memory management so image size is limited only by available space.
- Sub-pixel sampling for all paint tools, allowing for high-quality anti-aliasing.
- Full Alpha channel (transparency) support.
- Layers and channels.

Once in GIMP you open a new image (file) by choosing “new” from the File menu in the toolbox window. You can also scan images with GIMP.

9.9 Typesetting

- \LaTeX , man-page is a high-quality typesetting system, with features designed for the production of technical and scientific documentation. \LaTeX is the de facto standard for the communication and publication of scientific documents.

\LaTeX is not a word processor! Instead, \LaTeX encourages authors not to worry too much about the appearance of their documents, but to concentrate on getting the right content. It is based on the idea that it is better to leave document design to document designers, and to let authors get on with writing documents. \LaTeX is based on Donald E. Knuth’s TeX typesetting language. \LaTeX was first developed in 1985 by Leslie Lamport, and is now being maintained and developed by the LaTeX3 Project.

LaTeX here at ccrma is installed as part of the teTeX distribution. LaTeX is highly recommended for papers and other documents where very high quality and portability are essential. The TeX system generates device independent output so that not matter where you view or print your document, it will always look the same (up to the available resolution of the hardware device you are using, of course). You do have to learn a language, but it is worth it. See section §9.6.3 for LyX, a gui frontend that you can use to reap most of the benefits of LaTeX without the steep learning curve.

Some of the commands that are part of the teTeX packages:

<code>tex</code>	<code>tex</code> formats the interspersed text and commands contained in the named files and outputs a typesetter independent file (called DVI, which is short for DeVice Independent)
<code>latex</code>	<code>latex</code> enables the \LaTeX set of TeX macros and outputs a dvi file
<code>dvips</code>	converts a dvi file into postscript
<code>xdvi</code>	a very simple dvi file viewer

To get a postscript file you might want to type following commands,

```

latex yourfile.tex
...
...
...
dvips -o yourfile.ps yourfile.dvi
...

```

...
...

where yourfile is the name of your file. Also please note that the `latex` command produces a dvi file which need further to be translated to ps format or Acrobat's pdf's format. To get a pdf format you type:

```
dvipdf yourfile.dvi yourfile.pdf
```

A good L^AT_EX reference manual can also be found at

- LatexHelp

http://www.emerson.emory.edu/services/latex/latex_toc.html

To save some trees and as suggested by Julius Smith the following commands will let to print two pages in one from a ps file:

```
psnup -n 2 infile.ps > outfile.ps  
psnup -pletter -n 2 infile.ps > outfile_2up.ps
```

To print an A4 formatted document you need to re size to “letter-size” by using `psresize` as follows:

```
psresize -PA4 -pletter infile.ps > outfile.ps
```

- Producing PDF Output using pdfL^AT_EX, man-page:

The Portable Document Format (PDF) is a-page oriented format available for electronic documents. It is based on Postscript and combines fixed textual contents with hypertext elements, compression elements and security measures.

Adobe (developers of Postscript) has made the “PDF” specification public and freely available so that anyone is entitled to write software to produce and to read files in this format. They have also made available a free reader program called “Acrobat Reader” (also known in Linux as the “acroread” command). Today most graphical and text processing programs are capable of generating PDF output.

While having a T_EX or L^AT_EX file there are several ways the user can take. The choice depends more on the kind of graphics being used. As we know L^AT_EX can handle a long list of graphic formats including “ps” and “eps”. If L^AT_EX is your choice for generating your “pdf” files, first you need to compile the device independent file or “dvi” (see previous section) and then use the “dvipdf” command as follows:

```
dvipdf yourfile.dvi yourfile.pdf
```

The other more direct method is to use the “pdflatex” program to get a “PDF” file right away. When started, the program reads a configuration file “pdf.cfg” which can set many parameter such as page size, offsets, compression level, dvi or pdf output, and can specify the names of the font mapping files.

“pdflatex” handling of graphics is different from L^AT_EX. For best results graphics should be imported as “PDF” also before running the “pdflatex” command. For instance if you have “eps” graphic files you can use the “epstopdf” to get a graphic “PDF” file like,

```
epstopdf your_graph.eps
```

If you are using *Xfig* §5.9 for diagrams or graphics you can export directly to “PDF” format. In some cases you might need to adjust your figure by using the L^AT_EX commands such as `scalebox` and `rotatebox` to place the figure as desired.

As a matter of choice, here is an example of a L^AT_EX- file heading for better handling of graphics in both programs by means of “latex” or “pdflatex” commands:

```
\documentclass[letterpaper,11pt]{article}
\usepackage{times}

\ifx\pdftexversion\undefined
  \usepackage[dvips]{graphics}
\else
  \usepackage[pdftex]{graphics}
\fi
```

- LaTeX2HTML (see man-page), is a convertor written in Perl that converts L^AT_EX documents to HTML. This way e.g. scientific papers - primarily typeset for printing - can be put on the Web for online viewing.

Very very useful stuff. The CCRMA Planet guide itself is written in L^AT_EX and published on the web through latex2html. At ccrma the complete latex2html online documentation can be found at file:///usr/lib/latex2html/docs/manual/index.html

9.10 Presentation-Applications

There are several presentation packages available for Linux aside from commercial pointing software. You can do your presentations by using HTML itself. You can also try L^AT_EXslide feature or better try latex2HTML, §9.9. Additionally you can try Open Office Impress (see the office software section §9.6.1). However, there is an extension of the L^AT_EXslide class which can give you outstanding results with effects that will not distract your audience. This is the prosper class.

9.10.1 Using Prosper for Presentations

You can use the L^AT_EXprosper class to take advantage of the quality of L^AT_EX formatting with colorful presentation styles that can be used to obtain high-quality PDF files. These files are web-friendly and can be displayed in full resolution quality, full-screen mode with a feeling much better than other point presentation packages on any computer using PDF readers or acroread (more at §9.22).

The prosper class was developed by Frdric Goualard and it makes sense when you want to reuse some material of an article written in L^AT_EX for papers or slides. Here, you can find more examples and prosper documentation courtesy of the math department at the University of Colorado.

At ccrma prosper documentation can be found at file:///usr/share/doc/tetex-prosper-1.5

Following there is an example of a T_EX file for a presentation (which you can copy-and-paste to file to see results). Notice preamble and document class definitions.

```
\documentclass[letterpaper,contemporain,pdf,colorBG,slideColor]{prosper}
\hypersetup{pdfpagemode=FullScreen}
%
% process with these commands:
% latex filename.tex
% dvipdf filename.dvi
%
\title{VictorBook of the Fourier Transform}
\subtitle{A Musician's Approach}
```

```

\author{Juan Reyes}
\email{juanig@CCRMA.Stanford.EDU}
\institution{CCRMA\Center for Computer Research in Music and Acoustics}

\newcommand{\abs}[1]{\ensuremath{\left|#1\right|}}
\newcommand{\ejoT}{\ensuremath{e^{j\omega T}}}
\newcommand{\defined}{\ensuremath{\stackrel{\scriptscriptstyle\Delta}{=}}}

\begin{document}
\maketitle

\begin{slide}{Fourier Series}

Fourier series are defined as:

\[ f_{\text{per}}(\omega_0 t) = a_0 + \sum_{m=1}^{\infty} b_m \cos(2\pi m \omega_0 t) + c_m \sin(2\pi m \omega_0 t) \]

\begin{itemize}
\item where  $a_0$ , is the D.C. component and
\item where the coefficients  $b_m$ , and  $c_m$ , represent magnitudes of sine and cosine components for each frequency  $\omega_0 t$ , respectively.
\end{itemize}
\end{slide}

\begin{slide}[Dissolve]{Fourier Transforms}

\begin{itemize}
\item By using Euler's identity and in terms of sines and cosines the Fourier Transform is defined as:
\[\mathcal{S}(\omega_0) = \int_{-\infty}^{\infty} s(t) [\cos(2\pi\omega_0 t) + j\sin(2\pi\omega_0 t)] \, dt, \]
\item The Inverse Fourier Transform is defined as:
\[\mathcal{S}(t) = \int_{-\infty}^{\infty} S(\omega_0) [\cos(2\pi\omega_0 t) + j\sin(2\pi\omega_0 t)] \, dt, \]
\end{itemize}
\end{slide}

\begin{slide}{IDFT}

The \emph{ IDFT} in terms of its angular frequency  $\omega$ , is defined as:

\[ y(n) \stackrel{\text{defined}}{=} \frac{1}{N} \sum_{k=0}^{N-1} Y(k) e^{j\omega_k n}, \quad k=0,1,2,\dots, N-1 \]

```

```

\vspace{0.125in}
where  $y(n) \rightarrow Y(k)$ , conform a pair of transforms.
The term  $k$  is the frequency index and  $n$  is the time index.

\end{slide}
\end{document}

```

Once you have your \TeX file to make a presentation using the *prosper class*, type these commands to compile and process the postscript files:

```
latex filename.tex
```

and,

```
dvipdf filename.dvi
```

You can use *acroread* for your presentation:

```
acroread filename.pdf &
```

9.11 Music-Typesetting

- CMN
<http://www-ccrma.stanford.edu/software/cmn/>

CMN (Common Music Notation) is a Common Lisp based music notation package. Bill Schottstaedt describes it as “a simple little hack” but that would be an understatement, to say the least. It outputs directly to postscript so that the rendering quality is only limited by the resolution of the viewing or printing hardware. It includes its own music postscript font. The CMN manual is available online at “<http://www-ccrma.stanford.edu/software/cmn/cmn/cmn.html>” .

If you are at ccrma, start the *cm-clm* lisp image, type “(in-package 'cmn)” to make all *cmn* symbols available and enter the following score (extracted from the *cmn* manual):

```

(cmn (output-file "test.eps")(size 24)
  (system brace
    (staff treble (meter 6 8)
      (c4 e. tenuto) (d4 s) (ef4 e sf)
      (c4 e) (d4 s) (en4 s) (fs4 e (fingering 3)))
    (staff treble (meter 3 4)
      (c5 e. marcato) (d5 s bartok-pizzicato) (ef5 e)
      (c5 e staccato tenuto) (d5 s down-bow)
      (en5 s) (fs5 e)))
  (system bracket
    (staff bar bass (meter 6 16)
      (c4 e. wedge) (d4 s staccato)
      (ef4 e left-hand-pizzicato)
      (c4 e tenuto accent rfz) (d4 s mordent)
      (en4 s pp) (fs4 e fermata))))

```

LilyPond prints beautiful sheet music. It produces music notation from a description file. Lilypond uses \LaTeX typesetting language as the basic rendering engine so it shares all of its advantages.

Here's a very short example you can test. In your favorite text editor, enter the following input, and save the file as test.ly:

```
\score {  
  \notes { c'4 e' g' }  
}
```

To run LilyPond, you invoke ly2dvi to compile your LilyPond source file:

```
ly2dvi -P test.ly
```

The results of the ly2dvi run are two files, test.dvi and test.ps. The postscript file (test.ps) is the one you can print. You can view the postscript file using ghostview by typing “gv test.ps”. The dvi (device-independent) file (test.dvi) is the output of \LaTeX and can be viewed by typing “xdvi test.dvi”.

9.12 JACK

<http://jackit.sourceforge.net> is a low-latency audio server. It can connect several client applications to an audio device, and allow them to share audio with each other. Clients can run as separate processes like normal applications, or within the JACK server as “plug-ins”.

Traditionally it has been hard if not impossible to write audio applications that can share data with each other. In addition, configuring and managing audio interface hardware has often been one of the most complex aspects of writing audio software.

JACK allows applications to send and receive audio data to/from each other as well as the audio interface. There is difference in how an application sends or receives data regardless of whether it comes from another application or an audio interface. From the programmers point of view it is an API that provides a high level abstraction and removes the audio interface hardware from the picture and allows them to concentrate on the core functionality of their software.

9.12.1 Using-JACK

In order to obtain high quality audio and avoid dropouts, under-run or overrun errors during audio recording or playback it is advisable to run JACK. Since it is a Unix process which acquires top priority you should use it only for sound purposes. You normally start JACK in a terminal window by issuing the following command:

```
jackstart -d alsa -d hw -r 44100
```

Please notice that the `-r` follows the audio sampling rate. If you are working with CLM instruments you might want to use a lower sampling rate like 22050. Provided your sound-card will have this sampling rate available (not in the case of synchronized cards like the Delta 1010's) you might want to start jack by issuing the following command:

```
jackstart -d alsa -d hw -r 22050
```

In the case of a real-time situation like a concert situation, you can give JACK priority over all the other Linux processes with this options in the jackstart command:

```
jackstart --realtime --driver=alsa
```

WARNING: When you are done with your audio or sound job please make sure to quit or stop the JACK process by issuing:

```
C-c [control-c] sequence
```

Alternatively you might want to use the Qjackconnect GUI (graphical user interface) for starting and stopping JACK manually with a mouse click. Qjackconnect is found at the sound & video tab of the main menu.

9.13 SND

<http://ccrma.stanford.edu/software/snd/snd/snd.html> is a sound editor modeled loosely after Emacs and an old, sorely-missed PDP-10 sound editor named Dpysnd. It can accommodate any number of sounds each with any number of channels, and can be customized and extended using guile and Ruby. SND is started by typing the `snd` command.

To get started, go to the File menu, and open a sound file. To hear the sound, click the 'play' button. To see an fft, click the 'f' button on the left. The left mouse button is used for most pointing operations; the middle button pastes in the current selection; the right button brings up the SND pop up menu. Make sure you go through the help pull down menu to find more about all the features SND. In addition to this there is an enormous amount of information in the snd manual available online.

Start **SND** by typing:

```
[cmn19] snd &
```

in the command line.

If you have a sound you want to listen, you can type for instance,

```
[cmn19] snd /zap/dog.snd &
```

9.13.1 Editing soundfiles with SND

For sound editing with SND our best advice is to learn first some emacs like keyboard combinations (see below), and then try them on a SND window. To make things easier start with a short (3 secs) mono (one - channel) soundfile.

[c-x means control-x or the keyboard combination \textit{jctrl}_x] [m-x means meta-x and at CCRMA is the keyboard combination \textit{jesc}_x]

Now, if you have a soundfile in the active window try the following combinations and watch the cursor in the displayed soundfile active window. If you don't have a soundfile you can use the **open** command in the file pull-down menu of SND.

```
c-a: move cursor to window start
c-e: move cursor to window end
c-v: move cursor to mid-window
c-l: position window so cursor is in the middle
c-f: move cursor ahead one sample
c-b: move cursor back one sample

c-q: play current channel starting at cursor
c-t: stop playing
```

c-[Space]: start selection definition

c-m: place (or remove) mark at cursor location

c-j: goto mark

c-w: delete (cut) current region

M-w: (copy) current region

c-y: paste in last deleted region

c-_: undo

c-x c-s: save your current edition.

TIP: To play a sound file from a place other than the beginning:

1. Activate sync or sync/unite modes in the lower right check-boxes
2. Create a synchronize marker by:

```
c-s-M (control-shift capital)
```

You should you get markers for all the channels.

3. To play from that location just click on the triangle in any of the markers.
4. Playback should start.
5. You can also move this markers and even 'rock the reels' by dragging the mouse.

A more complex but very useful combination for doing zero padding to your soundfile (i.e. adding silence) might be:

```
c-u 0.5 c-o
```

The real number in this case *0.5*, means that you will insert *0.5* seconds of silence after your cursor position. Of course you can use whatever value (in seconds) you might want.

Try to move forward or backward using the following combinations:

```
c-a          ;;; move cursors to the beginning
c-u 0.4 c-f   ;;; move cursor forward 0.4 seconds
c-e          ;;; move cursor to the end
c-u 1.12 c-b  ;;; move cursor backwards 1.12 seconds
c-[Space]    ;;; start selection definition
c-e          ;;; a selection of 1.12 seconds
```

If,

```
c-u
```

is followed by a float number, the actual count is that number multiplied by the current sampling rate.

Note: These combinations and more can be viewed on the online Help menu at the overview command at the right side of the **SND** active window.

9.13.2 Digital-Signal-Processing with SND

As you might figure SND is a full featured signal processing toolbox. Most standard techniques have been implemented and new ones can be programmed. As a starting point you might want to try copying “**new-effects.scm**” to your working or “/zap” directory and then load it in the scheme listener with the following steps:

```
cp /usr/ccrma/lisp/src/snd/new-effects.scm /zap/
```

and then on the SND listener,

```
(load ‘‘new-effects.scm’’)
```

Not by magic notice that there is a new menu called “**effects**” on top of the “SND” GUI. This is a standard collection of DSP tools which might also help to understand and preview how audio signals can be manipulated. As a bonus just for trying, you get sliders to control most of these effects.

Of course you are encouraged to try all of these effects but make sure you already have an opened sound. If you are not happy with the processing you can undo it by **C-x C-u** or simply “undo” in SND’s edit menu. If you are really curious about signal processing you can also look at the code and customize these filters or create new ones. Make sure you share them with the DSP and SND communities.

The effects include:

- Reverse soundfile.
- Normalize soundfile.
- Gain change
- Rubber soundfile
- Filters, bandpass, lo-pass, hi-pass and others.
- Flange effects
- Delay effects like echo, filtered echo and modulated echo
- Frequency effects
- Modulation effects
- Convolution
- and more

Most of these are either simple calls on SND functions or use functions in the other scm files. If you are using two or more channels sound-files the actual processing follows the sync chain or the currently active channels but aside from reverb it is good practice to work with DSP effects on each channel separately.

N O T E: on PlanetCCRMA Linux machines outside CCRMA network, Snd sources are located on,

```
/usr/lib/snd/scheme/
```

Alternatively, if you decide to download Snd sources yourself, or if you want to compile Snd, untar a `snd-X.tar.gz` file by using the command:

```
tar xvzf snd-X.tar.gz
```

your sources will be at

```
./snd-X
```

where X is the Snd version. Instructions for compiling Snd are part of the documentation described at the links on: §9.13

9.13.3 Ladspa-DSP plug-ins in SND

As previously stated LADSPA is the Linux Audio Developer's Simple Plug-in API. LADSPA provides a standard way for 'plug-in' audio processors to be used with a wide range of these packages. Dave Phillips in his O'Reilly <http://www.linuxdevcenter.com/pub/a/linux/2001/02/02/ladspa.html> clearly explains what a 'simple plug-in' is as follows:

A plug-in is a software module that adds new functions or extensions to a host application, without the need to recompile the program. The plug-in functions are stored within a shared object file (*.so in Linux, *.dll in Windows) that may contain one or several plug-ins. The application provides the entry points to dock an object, and the new functions are immediately available. The user accesses the plug-in as a normal part of the host's interface.

Therefore, plug-ins add flexibility to Snd or the ability to do additional signal processing to an existing sound. Many of the plug-ins that are available in Snd are Open Source version of plug-ins used in other operating systems. Many of them are improved versions of commercial products done by Steve Harris and a talented group of DSP hackers. You are encouraged to try most of them. You can find more information about each plug-in at the <http://www.ladspa.org/> web page and its links to the developers.

N O T E: on PlanetCCRMA Linux machines outside CCRMA network, Snd sources are located on,

```
/usr/lib/snd/scheme/
```

1. First start by opening a new sound or a sound to be processed on Snd:

```
(new-sound "/zap/test.snd")
```

2. On a terminal shell copy "ladspa.scm" from the Snd sources directory:

```
cp /usr/ccrma/lisp/src/snd/ladspa.scm /zap/
```

3. you can also copy the ladspa help as a reference for many plug-ins:

```
cp /usr/ccrma/lisp/src/snd/ladspa-help.scm /zap/
```

4. Make sure Snd's listener window is active and somewhere around the editor window. Now you can load both scheme files as follows:

```
(load "/zap/ladspa.scm")
```

and,

```
(load "/zap/ladspa-help.scm")
```

Now 'ladspa.scm' should load and if everything has gone well, you should get the familiar Guile response,

```
#<unspecified>
```

you should now have a new "Ladspa" menu along with other Snd menus on top of Snd's GUI. Now it's a good time to take a look at this enormous collection of LADSPA plug-ins to be used at your own discretion.

5. To apply or process a region or a complete soundfile, just make active the soundfile window you want to process, select the region or the whole soundfile and, then from the LADSPA menu choose the plug-in you want to apply.

The following plug-in categories are available in Snd

- *Utilities*

Ambisonic, Tap Pink Fractal noise, signal sum, signal product, signal difference, signal ratio, signal branch, quantizer, karaoke, ms to stereo and many others.

- *Generators*

Oscillators, random wave generators, analog voice, granular scatter processor, syn drum , gong model, harmonic generator and many others.

- *Simulators*

Step sequencer, tap rotary speaker, tape delay simulation, valve saturation, valve rectifier and many others.

- *Time*

Delays, flangers, phasers, chorus, tap reflector and signal shifter.

- *Frequency*

Measurement, filters, EQ and frequency modulators.

- *Amplitude*

Amplifiers, wave-shapers, modulators, distortions and dynamics like gates, limiters and compressors.

- *Spectral*

Bode frequency shifter and Impulse convolver.

- *Uncategorized*

10 Band Eq, Mono Amplifier, Pulse-VCO, versatile plate reverb and many others.

9.13.4 A-more-powerful SND

Snd can use either `guile`, (a Scheme interpreter) or `ruby` as an internal scripting language. For example to create a new sound from a Scheme instrument like `bird.scm`, you type the following commands on the guile listener provided that “`bird.scm`” is on your working directory.

1. `(new-sound "/zap/test.snd")` or
`(open-sound "/zap/test.snd")`
2. `(load "bird.scm")`
3. `(make-birds)`
4. `(play)`

A simple “*hello-world*” sine instrument in **Scheme** might look like:

```
(define sine
  (lambda (beg dur freq amp)
    (let* ((start (floor (* beg (srate))))
           (len (floor (* dur (srate))))
           (phase-inc (hz->radians freq))
           (out-data (make-vct len)))
      (do ((i 0 (1+ i)))
          ((= i len))
        (vct-set! out-data i (* amp (sin (* i phase-inc))))
      )
      (vct->channel out-data start len))))
```

You can copy and paste this instrument to your favorite text editor although we recommend an emacs like editor (and make sure you have SND as your inferior-lisp process). Once saved as **yoursine.scm** you can load it to the interpreter by typing:

1. `(new-sound "/zap/test.snd")` or `(open-sound "/zap/test.snd")`
2. `(load "yoursine.scm")`

This definition of `sine` has the following parameters in the lambda list: **beg** as for offset or beginning of sound, **dur** for durations of the sound **freq** for frequency and **amp** for amplitude or volume of the sound which in this case should be less than one. Therefore to create a sound file with a simple 1000Hz sine tone you type:

3. `(sine 0 5 1000 .5)`

To listen to the sound:

4. `(play)`

If you want successive beep tones then you can type something like:

```
(do ((i 0 (1+ i)))
    ((= i 9))
  (sine i 0.5 777 0.5))
```

and then:

```
(play)
```

A basic Signal Processing instrument to do “Fourier Convolution” instrument which can be found on **examples.scm** as part of the SND distribution is written as follows. Copy and paste this code to a .scm file in your home directory or in the /zap directory and save it as “**myconvolve.scm**”

```
(define cnvttest
  (lambda (snd0 snd1 amp)
    (let* ((flt-len (frames snd0))
          (total-len (+ flt-len (frames snd1)))
          (cnv (make-convolve :filter (channel->vct 0 flt-len snd0)))
          (sf (make-sample-reader 0 snd1))
          (out-data (make-vct total-len)))
      (vct-map! out-data
                (lambda ()
                  (convolve cnv (lambda (dir) (next-sample sf))))))
    (free-sample-reader sf)
    (vct-scale! out-data amp)
    (let ((max-samp (vct-peak out-data)))
      (vct->channel out-data 0 total-len snd1)
      (if (> max-samp 1.0) (set! (y-bounds snd1) (list (- max-samp) max-samp)))
      max-samp))))
```

1. On the SND listener load myconvolve.scm by typing

```
(load " /myconvolve.scm") or (load "/zap/myconvolve.scm")
```

2. Then go ahead and open your source sound file which will be sound 0 or (snd0) by,

```
(open-sound "/zap/source.snd")
```

3. Open your impulse sound file which will be sound 1 or (snd1) typing,

```
(open-sound "/zap/impulse.snd")
```

4. Perform “Fourier Convolution” on these two sounds as follows (pay attention to the amplitude factor which is the third field in the definition of **cnvttest**).

```
(cnvttest 0 1 .5)
```

5. To listen to your convolved file make sure that the region or soundfile selected on the SND window is the impulse soundfile window and on the listener type:

```
(play)
```

9.13.5 Tutorials-and-More about SND

Anything inside SND can be customized. New commands and configuration options can be added in much the same way that emacs or xemacs can be extended through its own built in lisp interpreter. You can have several of your own customization in the .snd file in your home directory.

Make sure to look and pay **attention !** to the SND documentation for more illustrated and elaborate examples. We all encourage you to create your own “.snd” dot-snd file and place it in your home directory. The file examp.scm in the snd sources contains also many ways, explanations and of course examples on how to get around SND.

If you are used to Mac or Windoze “soundfile editors” or if you are somehow more curious about SND, Dave Phillips has published a good description, comparison and customization article part-1 and part-2 about SND also available online at: http://linux.oreillynet.com/pub/a/linux/2001/10/05/snd_partone.html http://linux.oreillynet.com/pub/a/linux/2001/10/18/snd_parttwo.html

O'Reilly has generously given permission to include this tutorial with SND without restrictions and you can also find them in the sources directory of SND. At CCRMA the tutorials path is:

```
/usr/ccrma/lisp/src/snd/contrib/tutorial
```

9.13.6 Additive Synthesis on SND

Signal theory tells us that by means of the Fourier Transform, any periodic waveform can be represented as a sum of harmonically related sinusoids, each one with its own particular amplitude and phase. The timbre or the spectra of a sound can be viewed from two different perspectives known as the “time domain” and the “frequency domain”. Depending on conditions and how a sound is being analyzed one view might be more useful than the other. For example in the case of additive synthesis, the frequency domain is more useful while if we were to edit a complete chunk of sound the time domain will certainly be more useful.

In theory the Fourier Transform (FFT) generates most of the information necessary to reconstruct a signal from a complex sound. Additive synthesis can be used for reconstructing a signal by synthesizing each partial as given on the FFT of the original signal but more generally speaking additive synthesis is used to sum and mix sinusoids to produce more complex sounds. This allows for control over the individual simple components by means of individual envelopes for amplitude and frequency.

Therefore one should be able to add up a bunch of sine waves and get any complex arbitrary signal. The simplest case is when all overtones are integer multiples of the fundamental frequency. In this simple case the waveform is periodic. As the periodic waveform repeats over time we can implement additive synthesis by using a table to store the values of one cycle instead of adding the output of all the equivalent sine oscillators (it is a lot more efficient). Here's a simple Snd instrument inspired on Fernando Lopez-Lezcano's (*circa 1996*) that implements additive synthesis by using the *table-lookup* unit generator. This is called harmonic synthesis by means of wave-table synthesis.

```
(define dowave
  (lambda* (start-time dur frequency amplitude harmonics)
    (let* ((start (floor (* start-time (srate))))
           (len (floor (* dur (srate))))
           ;;
           ;; create a table called "waveform" with the harmonics
           ;;
           (waveform (partials->wave harmonics ))
           ;;
           ;; create the table lookup unit generator
           ;;
           (s (make-table-lookup :frequency frequency :wave waveform)))
      ;;
```

```

;; add a simple amplitude envelope...
;;
(amp-env (make-env :envelope '(0 0 0.5 1 1 0)
                  :duration dur
                  :scaler amplitude))
  (output (make-vct len)))
(do ((i 0 (1+ i)))
    ((= i len)
     (vct-set! output i (* (env amp-env) (table-lookup s)) ))
    (vct->channel output start len )))

```

You can try the following function calls to listen to the tones.

- Open a new sound:

```
(new-sound "/zap/test.snd")
```

- A simple function call to produce a single tone sound.

```
(dowave 0 1 400 .5 '(1 .5 ))
```

- A function call to produce a “square-wave” sound.

```
(dowave 0 1 400 .5 '(1 1 3 .33 5 0.2 7 0.14286))
```

Open the frequencies view or F-view on Snd’s graphic interface to get a good look at the spectra of the sound. Move the sliders to see how the sound evolves.

- A simple function call to do a “Sawtooth” sound.

```
(dowave 0 1 400 .5 '(1 1 2 .5 3 .333 4 .25))
```

- A call to have a “triangular-wave” sound.

```
(dowave 0 1 400 .5 '(1 1 3 0.1111 5 0.04 7 0.20408))
```

- Type the (*play*) function call to listen the sound (you can always type ‘C-x u ’ to undo or erase the active sound you just created on Snd’s editing window).

```
(play)
```

In Partial Synthesis the overtones are not integer multiples of a fundamental frequency and thus we do not resort to the previous shortcut of a table. Therefore, in this case each component (partial) needs to be implemented independently and separately and furthermore sum each signal component to get the more complex sound. This means a lot of computing resources which translate in more computations and time.

Here is a very simple instrument that implements additive synthesis with three partials.

```

(define doadd
  (lambda* (start-time duration frequency amplitude
           #:key
            (partial1 1.0)(amp1 0.3)
            (partial2 2.0)(amp2 0.3)
            (partial3 3.0)(amp3 0.3)
            (ampenv '(0 0 0.5 1 1 0)))
    ;;
    (let* ((start (floor (* start-time (srate))))
           (len (floor (* duration (srate))))
           (sine1 (make-oscil :frequency (* partial1 frequency)))
           (sine2 (make-oscil :frequency (* partial2 frequency)))
           (sine3 (make-oscil :frequency (* partial3 frequency)))
           (amp-env (make-env :envelope ampenv
                             :scaler amplitude
                             :start start
                             :end len))
           (output (make-vct len)))
      ;;
      (vct-map! output (lambda ()
                        (* (env amp-env)
                           (+ (* amp1 (oscil sine1))
                              (* amp2 (oscil sine2))
                              (* amp3 (oscil sine3))))))
      (vct->channel output start len ))
    ))

```

The function calls for this instruments are as follows:

- Open a new sound:

```
(new-sound "/zap/test.snd")
```

- A simple function call to the instrument with it default values:

```
(doadd 0 1 440 0.75 )
```

In the most general case all parameters of each sine wave are also a function of time (that is, they are controlled by envelopes). This is the most interesting case but also the most expensive computationally and the most difficult to control. But the problem is: "how do we create or generate the enormous amount of data that we need to accurately represent hundreds of points in the envelopes or all partials?"

- Import from somewhere else ?
- Program generated ?
- High level musical concepts ?
- Synth parameters ?
- Manually ?
- Analysis –> Re-synthesis ?

9.13.7 FM synthesis on SND

1. Description:

Frequency Modulation (or FM) synthesis was discovered and introduced by John Chowning at Stanford around 1973. FM is one of the pillars of CCRMA and was the underlying technology for a very successful synthesizer manufactured by Yamaha and known as the DX-7 during the 1980's. Many of its trademark sounds are still a novel but in the past FM has been an efficient and simple method for generating and simulating complex textures as the vibrato of the singing voice. FM at its core is a simple and powerful method for creating and controlling complex spectra and is also categorized as a worshipping method of audio synthesis. In its simplest form it involves a sine wave carrier whose instantaneous frequency is modulated according to another waveform called the modulator. If the mean frequency of the modulator reaches as high as audio frequency range, sidebands appear as partials of the new modulated sound. This model then is often called simple FM or sine-wave FM. Other forms of FM are extensions of the basic model.

The position of each sideband is a function of the carrier modulator ratio or *C:M ratio*, and its number and amplitude change as function of the amplitude of the modulator or depth of the modulation. While the precise relationship between the sidebands, the *c:m* ratio and the amplitude of the modulator (better known as modulation index) is determined by the use of Bessel functions, it is common practice to say that the number of sidebands produced on either side of the carrier equals to the modulation index plus 2.

2. Implementation:

FM synthesis is done by means of signal generators. In *Snd oscil* is Bill Shottstaedt's basic and outstanding signal generator among a very vast array of other generators. Bill's description of a signal generator is as follows:

“A generator is a function that returns the next sample in an infinite stream of samples each time it is called. An oscillator, for example, returns an endless sine wave, one sample at a time”.

For more on signal generators see Dick Moore's *Elements of Computer Music* or Charles Dodge's *Computer Music*.

“Furthermore each generator is made of a set of functions: `Make-[gen]` sets up the data structure associated with the generator at initialization time; `[gen]` produces a new sample; `[gen?]` checks whether a variable is that kind of generator”.

`[gen]` is the name of a generator like *oscil* therefore *make-oscil* sets up a data structure (interpolation values) at initialization time. Then *oscil* produces a new sample in an stream of samples inside a loop which repeats itself the duration of the desired sound in seconds times the current sampling-rate.

“The initialization function normally takes a number of optional arguments, setting whatever state the given generator needs to operate on. The run-time (loop) function's first argument is always its associated structure. Its second argument is nearly always something like an FM input, whatever run-time modulation might be desired; in other cases it can be a function to provide input data or editing operations. Amplitude envelopes are handled with a separate env generator. Frequency sweeps of all kinds (vibrato, glissando, breath noise, FM proper) are all forms of run-time frequency modulation”.

In *Snd*'s Scheme the initialization function might be something like:

```
(sine-wave (make-oscil :frequency frequency))
```

where frequency is in Hz or cycles per second (cps). There is an optional parameter to this function which is *initial-phase* or the initial angle of phase for the oscillator (oscil uses the Sine function for sine wave generation). The run-time (loop) function might look like:

```
(oscil sine-wave )
```

or using the optional parameters a more complex *Oscil* function call with vibrato, glissando and frequency modulation value looks like:

```
(oscil sine-wave (+ vibrato glissando frequency-modulation))
```

The Oscil signal generator definition in Snd is:

“oscil produces a sine wave (using sin) with optional frequency change (i.e. fm). Its first argument is an oscil created by make-oscil. Oscil’s second (optional) argument is the current (sample-wise) frequency change (it defaults to 0). The optional third argument is the (sample-wise) phase change (in addition to the carrier increment and so on). So the second argument can be viewed as FM, while the third is PM (phase modulation). The initial-phase argument to make-oscil is in radians. You can use degrees- \rightarrow radians to convert from degrees to radians. To get a cosine (as opposed to sin), set the initial-phase to (/ pi 2)”.

As can be seen a simple signal generator like *Oscil* can be used for Frequency Modulation and its closely related cousin Phase Modulation.

The terms Frequency Modulation (FM) and Phase Modulation (PM) are source of some confusion and ambiguities. The main source of the diverging paths taken by FM implementers can be traced to a discrepancy between the standard analytical FM formula cited above and “Music-V” implementation which have appeared in most texts on the subject. As to this issue Bill Schottstaedt points out: “The difference is that FM integrates, whereas PM does not. – this does not make up any difference in computational speed, or musical results”.

A better explanation in Bill Shottstaedt’s *FM.html* should clear this confusion:

“The terms ”angle modulation”, ”phase modulation”, and ”frequency modulation” (not to mention ”exponential modulation” and ”angular modulation”) are used almost interchangeably in the radio literature, but the textbooks on the subject normally distinguish between PM and FM as follows: if f(t) is directly proportional to the modulating signal then it’s PM; if f(t) is directly proportional to the derivative of the modulating signal, then it’s FM. Of course, you can’t tell which is in use either from the waveform or the mathematical expression of the waveform – you have to know what the modulating signal was. That is a roundabout way of saying that in computer music applications there is no essential difference between frequency and phase modulation. However, the fact that phase and frequency modulation are just two ways of interpreting the same thing should not mislead us into thinking ”phase doesn’t matter” – the initial phases of the parts of the FM formula do make a difference, as we’ll see below”.

As a benefit for the reader, this tutorial shows “both” an instrument doing simple FM and another doing simple PM. The reader should listen for any audible or perceptual differences.

3. Frequency Increment (Frequency change parameter)

In order to understand some of the details in Frequency Modulation it is important to understand the notion of frequency increment. Frequency increment is expressed in terms of radians per second (RPS). In the case of vibrato, or FM or any time we need to specify values to the optional 2nd argument of

some oscillator, it is necessary to deal explicitly in RPS. The Snd scheme function *hz->radians* converts frequencies expressed in cycles per second “Hz” to frequencies expressed in radians per second over the actual sampling rate.

Since we know there are 2π radians in one cycle and if we know Snd’s sampling rate is 22050 therefore, if we want to express this rate in terms of radians per second, the result should be also equal to 2π . To make sure this is true you can try typing the following command on Snd’s listener window,

```
(hz->radians 22050)
```

and you should get,

```
6.2831850751536
```

which indeed is two π .

This also means that the radian frequency of half the sampling rate is π , the radian frequency of 1/4 the sampling rate or quarter cycle is π over two and so on.

4. Frequency Increment Instrument

A frequency increment instrument and other instruments inspired on Nicky Hind’s tutorials will illustrate this issue on Snd’s Scheme (you can copy and paste them directly on Snd’s listener window):

```
(define constant-freq-inc
  (lambda (beg dur frequency amplitude freq-inc)
    (let* ((start (floor (* beg (srates))))
          (len (floor (* dur (srates))))
          (sine-wave (make-oscil :frequency frequency))
          (freq-inc-radians-per-sec (hz->radians freq-inc))
          (output (make-vct len)))
      (do ((i 0 (1+ i)))
          ((= i len)
           (vct-set! output i (* amplitude (oscil sine-wave freq-inc-radians-per-sec ))
                     ))
          (vct->channel output start len )))))
```

- First start by opening a new sound window on Snd:

```
(new-sound "/zap/test.snd")
```

- Now you can try the following function calls on the constant-freq-inc instrument:

```
– (constant-freq-inc 0 1 440 0.3 0)
```

Will produce a single one second 440Hz sound.

```
– (constant-freq-inc 0 1 440 0.3 440)
```

Notice a frequency change of 440 which synthesizes a tone one octave higher than 440Hz at 880Hz.

```
– (constant-freq-inc 0 1 440 0.3 220)
```

Will produce a tone a fifth higher than 440Hz at 660Hz.

```
– (constant-freq-inc 0 1 440 0.3 -220)
```

A frequency change of -220 will produce a tone an octave lower than 440Hz at 220Hz.

5. Sine-Wave Instrument with Enveloped Frequency-Increment

```
(define enveloped-freq-inc
  (lambda* (beg dur frequency amplitude #:key (freq-inc 0))
    (let* ((start (floor (* beg (srate))))
          (len (floor (* dur (srate))))
          (freq-inc-func '(0 0 50 1 100 0))
          (sine-wave (make-oscil :frequency frequency))
          (freq-env (make-env :envelope freq-inc-func
                             :scaler (hz->radians freq-inc)
                             :start beg
                             :duration dur))
          (output (make-vct len)))
      (do ((i 0 (1+ i)))
          ((= i len)
           (vct-set! output i (* amplitude (oscil sine-wave (env freq-env) ))
                     ))
          (vct->channel output start len))))))
```

- Start by opening a new sound window on Snd if you don't already have one.

```
(new-sound "/zap/test.snd")
```

- Now try the following function calls on the enveloped-freq-inc instrument:

```
– (enveloped-freq-inc 0 1 440 0.3)
```

Will produce a one second sound at 440Hz with no frequency increment.

```
– (enveloped-freq-inc 0 1 440 0.3 :freq-inc 440)
```

This call produces a glissando up to one octave higher and back again.

```
– (enveloped-freq-inc 0 1 440 0.3 :freq-inc -220)
```

This call produces a glissando down to one octave below and back again. Notice -220 frequency change.

Following we have Scheme code for a very simple FM instrument which can be used as a template for more complex instruments and in fact more complex projects in Snd. Notice that *make-oscil* and *make-env* are the definitions for the the signal generators *oscil* and *env* respectively. Here we are creating two oscillators for the carrier and modulator plus one amplitude envelope and a modulation-index envelopes which changes as sound unfolds.

6. Simple FM Instrument

```
(define simple-fm
  (lambda* (start dur freq amp #:key
           (ampenv '(0 0 25 1 75 1 100 0))
           (mratio 1) (index 1) (indenv '(0 1 100 1)))
    ;;
    (let* ((beg (floor (* start (srate))))
          (end (floor (* dur (srate))))
          (car (make-oscil :frequency freq))
          (mod (make-oscil :frequency (* freq mratio))))
```

```

    (ampf (make-env :envelope ampenv :scaler amp
                  :start start :end end))
    (devf (make-env :envelope indenv
                  :scaler (in-hz (* freq mratio index))
                  :start start :end end))

    ;;
    ;; Here we create a vector data structure to store
    ;; the processed audio data
    ;;
    (out-data (make-vct end)))

    ;;
    ;; The part that follows is like the Run loop in CLM
    ;; or where the actual sound data is assigned to the
    ;; out-data vector
    ;;
    (vct-map! out-data (lambda ()
                        (* (env ampf)
                           (oscil car (* (env devf)
                                         (oscil mod))))))

    ;;
    ;; This function outputs samples to the actice soundfile
    ;; window in SND
    ;;
    (vct->channel out-data beg end ))
))

```

The function calls for this instrument are as follows:

- Open a new sound:

```
(new-sound "/zap/test.snd")
```

- A simple function call to the instrument with it default values:

```
(simple-fm 0 3 400 0.5)
```

There is a carrier frequency of 400Hz and a sideband of 800Hz with 0.65 the value of the amplitude of the carrier. You can activate the FFT or (f) view of your Snd sound file to make sure these are the values of this spectra.

- Changing the modulation-index to 0.75

```
(simple-fm 0 3 400 0.5 :index 0.75)
```

Here we get a different spectrum with a carrier frequency at its maximum amplitude and a second sideband frequency which decreases 40% the value of the peak amplitude.

- In the next function call we are manipulating the modulation index as well as $C:M$ ratio. In this case we are using a $C:M$ ratio of 4:1

```
(simple-fm 0 3 400 0.5 :index 0.75 :mratio 4)
```

then we obtain sidebands on 100Hz with 0.95 amplitude and at 690Hz and the same 0.95 amplitude.

- Now if we change both the modulation-index to 1.75 and the $C:M$ ratio also to 4,

```
(simple-fm 0 3 400 0.5 :index 1.75 :mratio 4)
```

here we get a fundamental frequency around 200Hz at the peak amplitude and average sidebands at 200Hz and 975Hz each one with an average amplitude of 0.925 the peak amplitude.

- In this last example of function call we change the default modulation-index envelope to '(0 0.25 100 1.75) meaning that the value of the modulation index increases from 0.25 to 1.75 along the duration of the sound. Make sure to open the frequencies view or F-view on Snd's graphic interface to get a good look at the spectra of the sound. Move the sliders to see how the sound evolves.

```
(simple-fm 0 3 400 0.5 :index 0.75 :mratio 4 :indenv '(0 0.25 100 1.75))
```

Notice that we get a changing spectra with an average carrier frequency of 400Hz.

- You can always play an active sound window in Snd by using the *(play)* function call (you can always type '*C-x u*' to undo or erase the active sound you just created on Snd's editing window):

```
(play)
```

7. Simple Phase Modulation Instrument

As previously discussed if $f(t)$ is directly proportional to the modulating signal then we have Phase Modulation. If $f(t)$ is directly proportional to the derivative of the modulating signal, then we have Frequency Modulation or FM. This means that difference between PM and FM lies in that FM integrates, whereas PM does not. This does not mean that there is any difference in computational speed, musical or perceptual results. Snd provides tools to check this analytically with its spectrogram windows which can be dragged to change with time. Here we have a simple "Phase Modulation" instrument. Notice the modulating frequency at *oscil's* fourth parameter.

```
(define simple-pm
  (lambda* (start dur freq amp #:key
            (ampenv '(0 0 25 1 75 1 100 0))
            (mratio 1) (index 1) (indenv '(0 1 100 1))
            (fmp-inc 0.0)) ;; FM phase increment
    ;;
    (let* ((beg (floor (* start (srate))))
           (end (floor (* dur (srate))))
           (freq-mod (hz->radians fmp-inc))
           (phase-mod 0.00)
           (car (make-oscil :frequency freq))
           (mod (make-oscil :frequency (* freq mratio)))
           (ampf (make-env :envelope ampenv :scaler amp
                          :start start :end end))
           (devf (make-env :envelope indenv
                          :scaler (in-hz (* freq mratio index))
                          :start start :end end))
           (out-data (make-vct end)))
      ;;
      ;; Here we generate an out-data vector.
      ;; Notice the phase-mod part inside "oscil" which is
      ;; incremented on each pass. This instrument is actually
      ;; doing Phase Modulation
```

```

;;
(do ((i 0 (1+ i)))
    ((= i end))
    (vct-set! out-data i (* (env ampf)
                            (oscil car freq-mod (* (env devf)(oscil mod)))))) )
;;
;; Output samples to the active soundfile window in SND
;;
(vct->channel out-data beg end ))
))

```

The same function calls for the Phase Modulation instrument are:

- Open a new sound:

```
(new-sound "/zap/test.snd")
```

- A simple function call to the instrument with it default values:

```
(simple-pm 0 3 400 0.5)
```

Notice the carrier frequency of 400Hz and a sideband of 800Hz with 0.65 the value of the amplitude of the carrier. You can activate the FFT or (f) view of your Snd sound file to make sure these are the values of this spectra.

The other function calls which should match the FM instrument calls are as follows:

- Changing the modulation-index to 0.75

```
(simple-pm 0 3 400 0.5 :index 0.75)
```

- Manipulating the modulation index as well as $C:M$ ratio.

```
(simple-pm 0 3 400 0.5 :index 0.75 :mratio 4)
```

- Now if we change both the modulation-index to 1.75 and the $C:M$ ratio also to 4,

```
(simple-pm 0 3 400 0.5 :index 1.75 :mratio 4)
```

- In this last example of function call we change the default modulation-index envelope to '(0 0.25 100 1.75) meaning that the value of the modulation index increases from 0.25 to 1.75 along the duration of the sound.

```
(simple-pm 0 3 400 0.5 :index 0.75 :mratio 4 :indenv '(0 0.25 100 1.75))
```

We should get a changing spectra with an average carrier frequency of 400Hz similar to the FM instrument. The reader is encouraged to check this out and compare spectra given by both the FM PM instruments in addition to tweaking more of this parameters.

8. Conclusion

Synthesis of audio by means of Frequency Modulation and its relatives is still a powerful method for generating complex spectra. Many instruments using this principle as a basis have been developed and include violins, trumpets, plucked strings as well as bells, gongs, drums and more. As John Chowning points out, the richness of FM lies in the ability to manipulate on the time domain the spectrum of a sound. We have seen that this can be easily accomplished by using envelope generators which control the modulation-index over time.

9. Further information:

- John Chowning. *The synthesis of complex audio spectra by means of frequency modulation*. Journal of the Audio Engineering Society, 7:pp:526-534, 1973.
- William Schottstaedt. *The simulation of natural instrument tones using frequency modulation with a complex modulating wave*. Computer Music Journal, 1(4), 1977.
- Barry Truax. *Organizational techniques for c:m ratios in frequency modulation*. Computer Music Journal, pages 39-45, 1978. Reprinted in Foundations of Computer Music, C. Roads and J. Strawn (eds.). MIT Press, 1985.
- Dexter Morrill. *Trumpet algorithms for computer composition*. Computer Music Journal, 1(1):46-52, 1977. Reprinted in Foundations of Computer Music, C. Roads and J. Strawn (eds.). MIT Press, 1985.
- James Beauchamp. *Letters to the editor: Will the real fm equation please stand up ?* Computer Music Journal, 16(4), 1992.

9.13.8 A simple tutorial of STK on Scheme and SND

Perry Cook and Gary Scavone describe **STK** as a set of audio signal processing C++ classes and instruments for music synthesis. The **scheme** counterpart are a set of instrument primarily following the plucked string, bowed string, flute, clarinet and brass families of Physical Models. You can combine these instruments to create programs which make cool sounds using a variety of synthesis techniques.

More on STK

<http://www-ccrma.stanford.edu/software/stk/>

At CCRMA you can copy the file `prc95.scm` to your `/zap` directory by issuing the next commands:

```
scp /usr/ccrma/lisp/src/snd/prc95.scm /zap/prc95.scm
```

Alternatively you can look in the SND distribution for this file and also place it in your `/zap` or `/tmp` directories.

Open this file with Xemacs or with your favorite text editor.

Start your STK or rather Physical modeling experimentation with the usual steps for working with SND and scheme

1. Open a new sound in SND

```
(new-sound "/zap/test.snd") or (open-sound "/zap/test.snd")
```

2. And now load your STK instruments,

```
(load "prc95.scm")
```

Careful analysis of the code will make you aware of these instruments and their calls:

- Plucked string `-i` plucky
- Bowed string `-i` bow
- Brass Horns `-i` brass
- Clarinet `-i` clarinet
- Flute winds `-i` flute

Also notice the parameters for the scheme function call.

```
(beg dur freq amplitude maxa)
```

Where **beg** is start time of sound, **dur** is the duration of the sound, **freq** is the frequency in Hertz of the sound, **amplitude** is attack intensity or initial pressure of the sound and **maxa** is the overall maximum amplitude of the Physical Model. Note that there is a ratio between amplitude and maxa. You can read more about these parameters on the STK web pages, in the various paper written on the subject by Perry Cook and Gary Scavone or you can simply read the code to figure them out.

You can listen to the plucked string by typing the following function call in the SND listener:

```
(plucky 0 2 505 .7 1.0)
```

In this case the start time is zero, duration of sound is 2 seconds, frequency is 505Hz and amp is 0.7 while maximum output is function of 1.0.

Try the following plucked sound:

```
(plucky 0 0.3 643.4317 .2 1.0)
```

and try to perceive the difference.

A very long and low clarinet sound might be:

```
(clarinet 0 4 300 .7 1.2)
```

If it sounds like a clarinet, try to play expression markings by changing the **amplitude** and **maxa** ratio. And what about if you want to add vibrato ?

Next, here is a sequence of brass sounds:

```
(define (brassy)
  (brass 0 .5 261.62555 .6 1.2)
  (brass 1 .8 391.99542 .4 1.1)
  (brass 2 1.4 523.2511 .4 1.1)
  (brass 3.5 .5 261.62555 .6 1.2)
  (brass 4 .8 391.99542 .4 1.1)
  (brass 5 1.4 523.2511 .7 1.1)
  (brass 7 .4 698.4565 .8 1.2)
  (brass 7.8 1.6 391.99542 .2 1.0)
  (brass 9 2 261.62555 .3 1.6))
```

In this case we are defining a scheme function called “brassy” which carries the score for the physical model. This is sort of like the “SKINI” protocol for the C++ version of STK. Please note the different start times and durations and very important!! don’t take for granted that start times are function of durations themselves.

In order to make sound you type the following function call on the scheme listener.

```
(brassy)
```

Try to experiment changing the order of those sound and make them sound more like a wake up call bugle.

More to come !!! on STK and physical modeling in SND.

9.14 Sound-Utilities

- SoX
<http://sox.sourceforge.net/>

is a sound file format converter for Unix. It also does sample rate conversion and some sound effects. It's the swiss army knife of sound tools: the interface isn't great, but it does almost everything.

SoX uses file suffixes to determine the nature of a sound sample file. If it finds the suffix in its list, it uses the appropriate read or write handler to deal with that file. SoX has an auto-detect feature that attempts to figure out the nature of an unmarked sound sample. This is the 'auto' file format.

Here are some examples on how to use SoX at the shell prompt but first make sure you have the correct file suffix.

SoX does not like the “.snd” file suffix (extension), therefore you need to change your sound-file extension to Sun's “au” extension. You can do this with the mv command like,

```
mv File.snd file.au
```

To translate a sound-file in SUN Sparc “.AU” format into a Microsoft “.WAV” or “Riff” file you do,

```
sox File.au file.wav
```

The following example lowers the amplitude of “ifile.au” by half and establishes a sample rate of “22.05K” to the Macintosh compatible file “ofile.aiff”

```
sox -v 0.5 ifile.au -r 22050 ofile.aiff
```

You can use the '-V' option on all your command lines. It makes SoX print out its idea of what is going on. To add a low-pass filter (note use of stdout for output of the first stage and stdin for input on the second stage) you can use Unix pipes in the following fashion,

```
sox infile.wav -t raw -s -w -c 1 - lowpass 3700 |
  sox -t raw -r 11025 -s -w -c 1 - -t au -r 8000 -U -b
  -c 1 ofile.au
```

There are more SoX examples in the CD mastering section.

- sndlib
<http://ccrma-www.stanford.edu/software/snd/sndlib/>

The “sndlib” sound library is a collection of sound file and audio hardware handlers written in C. It provides relatively straightforward access to many sound file headers and data types, and most of the features of the audio hardware. Its manual is available online at “<http://www-ccrma.stanford.edu/software/snd/snd/sndlib.html>” .

Some command line example programs written with sndlib (that are part of the snd package) are quite useful on their own:

sndplay	<i>play a soundfile</i>
sndinfo	<i>print information about a sound file</i>
sndrecord	<i>record a mono or multichannel sound</i>
sndsine	<i>generate a sinusoidal signal</i>

For example if you want to listen to a sound file you can type:

```
sndplay soundfile.snd  
sndplay soundfile.wav
```

If you need information about a particular, let's say the number of channels, you type:

```
sndinfo soundfile.au  
sndinfo soundfile.aiff
```

- **resample**

<http://ccrma.stanford.edu/jos/resample/>

is a much needed and useful tool for high quality sampling rate conversion that Julius Smith wrote a long time ago (during the NeXT days). You use *resample* in the command line by writing something like:

```
resample -to 44100 clm.snd cd-ready.snd
```

The *resample* program takes a 16-bit mono or stereo sound file and a "sampling- rate conversion factor" *r*, specified as a floating-point number, and produces an output sound file whose sampling rate is *r* times that of the input file.

The output file is in AIFF format. If you omit the output file name, *resample* will create a file using the input file name, with ".resamp" appended.

Use *resample* to create CD-ready soundfiles or transfer from one medium to another. Beware that the default sampling rate in "*clm*" is set to 22050 samples per second because in this way sounds are faster to render. You can use *resample* to get your soundfile up to CD rate and then use SOX to get the correct timing and WAV "riff" formats for burning a CD.

- **Ecasound**

<http://www.eca.cx/ecasound/>

This is a full software package designed for multitrack audio processing. It can be used for simple tasks like audio playback, recording and format conversions, as well as for multitrack effect processing, mixing, recording and signal recycling. Ecasound supports a wide range of audio inputs, outputs and effect algorithms. Effects and audio objects can be combined in various ways, and their parameters can be controlled by operator objects like oscillators and MIDI-CCs. As most functionality is located in shared libraries, creating alternative user-interfaces is easy. A versatile console mode interface is included in the package.

Ecasound has a text user interface that includes an interactive interpreter, see the `man` page for details. The `man` page documents the some additional commands:

ecaplay	<i>plays input soundfiles</i>
ecaconvert	<i>converts a set of files to a given format</i>
ecafixdc	<i>fixes DC offsets in a soundfile</i>
ecanormalize	<i>normalizes a soundfile</i>
ecasignalview	<i>monitors input signal level and statistics</i>

Comprehensive customization can be done by creating a configuration file in your home directory, see the `man` page for details.

Since Ecasound is a synchronized ALSA application it might prove very useful in special audio situations which require a high level of audio performance. Perhaps in a real time “Tape” concert situation or if you find yourself in a situation where you want to transfer a multi-channel sound-file to tape media like ADAT or DTRS, and if you want to avoid digital dropouts, `ecasound` is like a Swiss Army audio tool. In addition to sound-file recording or playback you can also do digital signal processing.

Please make sure about the audio-header-type and the sampling rate of your sound-file. You can do this at CCRMA by issuing *ONE* of the following commands:

```
sndinfo soundfile.wav  
sndinfo soundfile.snd
```

Ecasound only likes Riff or Wav files and obviously doesn't like NeXT's `snd` files. If you need to convert your sound-file you can use the `sox` command for up to 2-channel stereo files. If your sound-file is a `snd` file you need to rename it and convert it in the following way:

```
mv soundfile.snd soundfile.au  
sox soundfile.au sox soundfile.wav
```

For multichannel sound-files you might want to use the `srconvert` functions of `SND` or `CLM`. A “`sr-convert.ins`” instrument invocation in `CLM` might look like this (for more information please consult `CLM` or `SND` documentation).

```
(with-sound (:output "new.wav"  
             :header-type mus-riff  
             :srate 44100  
             :channels 4  
             :play nil)  
  (sr-convert 0 "~/zap/test.snd" :width 7))
```

Please notice the “header type” key inside `with-sound` it should be “`mus-riff`” to write multichannel wav files. Once you have your `.wav` file you just use `ecasound` in *interactive* mode with the following command:

```
ecasound -c -i new.wav -f 32,10,44100 -o alsahw,0,0
```

At this point and inside the `ecasound` command line (because of the `-i` switch) , you can start, forward and rewind your sound-file from almost any point with any offset.

Other examples of playback might be in the following renditions:

1. With JACK a two channel sound file and 44100 sampling rate.

```
ecasound -f:32,2,44100 -i new.wav -o jack_alsa
```

2. A JACK client that has one input and one output port.

```
ecasound -f:32,1,44100 -i jack -o jack \  
-ef3:800,1.5,0.9 -km:1,400,4200,74,0 -km:2,0.1,1.5,71,0
```

3. Realtime inputs (recording from soundcard)

```
ecasound -i alsahw,0,0 -o somefile.wav
```

4. Realtime Outputs (soundcard playback)

```
ecasound -i somefile.mp3 -o alsahw,0,0
```

More examples can be found in the Ecasound documentation or at its web page.

- ecawave

<http://www.wakkanet.fi/kaiv/ecawave/welcome.html>

is a simple graphical audio file editor. The user-interface is based on Qt libraries, while almost all audio functionality is taken directly from ecasound libraries. As ecawave is designed for editing large audio files, all processing is done direct-to-disk. Simple waveform caching is used to speed-up file operations. Ecawave supports all audio file formats and effect algorithms provided by ecasound libraries. This includes OSS, ALSA, aRts, over 20 file formats, over 30 effect types, LADSPA plugins and multi-operator effect presets.”

- cdparanoia

<http://www.xiph.org/paranoia/>

retrieves audio tracks from CDDA capable CDROM drives. The data can be saved to a file or directed to standard output in WAV, AIFF, AIFF-C or raw format. Most ATAPI, SCSI and several proprietary CDROM drive makes are supported; cdparanoia can determine if the target drive is CDDA capable.

In addition to simple reading, cdparanoia adds extra-robust data verification, synchronization, error handling and scratch reconstruction capability.

- STK

<http://www-ccrma.stanford.edu/software/stk/>

“The synthesis toolkit is a set of audio signal processing C++ classes and instruments for music synthesis. You can use these classes to create programs which make cool sounds using a variety of synthesis techniques. This is not a terribly novel concept, except that STK is very portable (it’s mostly platform-independent C and C++ code) AND it’s completely user-extensible. So, the code you write using STK actually has some chance of working in another 5-10 years. STK currently runs with realtime support (audio and MIDI) on SGI (Irix), Linux, and Windows computer platforms. Generic, non-realtime support has been tested under NeXTStep, but should work with any standard C++ compiler.”

- SMS

<http://www.iua.upf.es/sms/>

“SMS is a set of techniques and software implementations for the analysis, transformation and synthesis of musical sounds. The aim of this work is to get general and musically meaningful sound representations based on analysis, from which musical parameters might be manipulated while maintaining high quality sound. These techniques can be used for synthesis, processing and coding applications, while some of the intermediate results might also be applied to other music related problems, such as sound source separation, musical acoustics, music perception, or performance analysis.”

If you feel you are into Linux and Sound or simply for general knowledge make sure you take a look at Larry Ayers’ *Soundings: Explorations In Linux Sound*
<http://www.linuxgazette.com/issue47/ayers.html>

9.15 Sound-Compression

The PCM (pulse-code modulation) established for CD-DA discs is not very compact and doesn't suit for delivering music via the net. That is why developers now are working on a number of complex compression algorithms. All of them differ very much in the sound quality, that is why a user has always to make a choice of an algorithm for its favorite music to be recorded.

- Ogg Vorbis
<http://www.vorbis.com>

is a fully Open, non-proprietary, patent-and-royalty-free, general-purpose compressed audio format for high quality (44.1-48.0kHz, 16+ bit, polyphonic) audio and music at fixed and variable bitrates from 16 to 128 kbps/channel. This places Vorbis in the same class as audio representations including MPEG-1 audio layer 3, MPEG-4 audio (AAC and TwinVQ), and PAC.

Ogg Vorbis provides a high-quality format for you to listen to your music. Its file size is also smaller than MP3 and getting smaller as development continues. Vorbis already enjoys widespread player support and should be compatible with several major hardware players soon. With Vorbis, you can listen to your music with higher quality in less space. Also, using Vorbis means your player and encoder choices aren't bound by licensing terms.

– *oggenc*

is part of the “vorbis-tools” package. This program is a complete encoder that creates Ogg Vorbis compressed soundfiles. OggEnc input files must currently be 16 or 8 bit PCM WAV, AIFF, or AIFF/C files. Files may be mono or stereo (or more channels) and sampling rates between 8kHz and 56kHz. Call *oggenc* with the “-h” flag or see the *oggenc* man page for more details.

This will create a “sample.ogg” output soundfile:

```
oggenc sample.wav
```

You can do a format conversion and pipe that to *oggenc* using unix pipes, for example the following command will convert a soundfile from .snd format to .wav and feed it to the encoder:

```
sox -t .au sample.snd -t .wav - | oggenc -o sample.ogg -
```

– *ogg123*

is also part of the “vorbis-tools” package. In essence it is simple command line Ogg Vorbis decoder and player. You can play your “ogg files” with *ogg123* with:

```
ogg123 -d oss sample.ogg
```

– Play your Ogg files with *xmms*

<http://www.xmms.org>

The X Multimedia System (*xmms*) can recognize and play Ogg Vorbis encoded files. Just open *xmms* as follows:

```
xmms sample.ogg &
```

- mp3
<http://www.mp3licensing.com>

does not need an introduction. It is a stereo compression standard that has become widespread in hardware and firmware based players, and is widely used for web distribution of music content. Regretfully even though it is a standard, it is not for free. Patent licenses under the combined patent portfolio of Fraunhofer IIS-A and Thomson multimedia are granted by Thomson multimedia exclusively

and cover format encoders and decoders and commercial (revenue-generating) distribution of music. Read all the details in <http://www.mp3licensing.com>.

According to the patent owners it is not possible to independently create an mp3 encoder without infringing on the patents. Recently they have started to crack down on open source projects that have created free alternatives to the commercial mp3 encoders. Read more about this in the lame (<http://www.sulaco.org/mp3>) and bladeenc (<http://bladeenc.mp3.no/>) web sites

A couple of widely available encoders are available in PlanetCCRMA, but are only intended to be used as tools for learning about mp3. If you encode your own mp3s you should own a properly licensed encoder.

– lame

<http://www.sulaco.org/mp3>

means, Lame Ain't an MP3 Encoder and is an educational tool to be used for learning about MP3 encoding. The goal of the LAME project is to use the open source model to improve the psycho acoustics, noise shaping and speed of MP3. Run lame with the “-help” option or see the lame man page for more details.

Audio files created with Lame can be played back by popular MP3 players such as Xmms mpg123 or madplay.

For example a command for a fixed bit rate jstereo 128kbs encoding, highest quality :

```
lame -h sample.wav sample.mp3
```

A good choice for Music with a broad dynamic range might be :

```
lame -abr sample.wav sample.mp3
```

– Compressing audio with Lame presets

The Lame -preset switches are designed to provide the highest possible quality. These are continually updated to coincide with the latest developments that occur and as a result should provide you with nearly the best quality currently possible from LAME.

To activate these presets:

1. **--preset standard**

This preset should generally be transparent to most people on most music and is already quite high in quality.

2. **--preset extreme**

If you have extremely good hearing and similar equipment, this preset will generally provide slightly higher quality than the standard mode.

3. **--preset insane**

This preset will usually be to much for the common user and most situations, but if you must have the absolute highest quality with no regard to filesize, this is the way to go.

4. **--preset kbps**

Using this preset will usually give you good quality at a specified bitrate. Depending on the bitrate entered, this preset will determine the optimal settings for that particular situation. While this approach works, it is not nearly as flexible as VBR, and usually will not attain the same level of quality as VBR at higher bitrates.

For example to use the extreme preset you will use this command:

```
lame --preset extreme infile.wav outfile.mp3
```

- Converting MP3s to raw audio to create audio CDs

```
mpg123 -s file.mp3 | sox -c2 -s -w -t raw \-r 44100 - -t wav - > newsoundfile.wav
```

mpg123 converts file.mp3 to the .wav file newsoundfile.wav and makes it ready to be part of audio CDs.

- bladeenc

<http://bladeenc.mp3.no/>

is a freeware MP3 encoder. It is based on the same ISO compression routines as mpegEnc, so you can expect roughly the same, or better, quality. The main difference is the appearance and speed. BladeEnc doesn't have a nice, user-friendly interface like mpegEnc, but it is more than three times faster, and it works with several popular front-end graphical user interfaces. Run bladeenc without arguments to get a usage description. Unfortunately BladeEnc is not longer in development but its features appear to be part of the Ogg team now.

9.16 Composition Environments

- CLM

<http://www-ccrma.stanford.edu/software/clm/>

Common Lisp Music is a music synthesis and signal processing package in the Music V family. CLM provides functions to experiment with sounds and although you can use CLM simply as a bunch of canned functions, it's a lot more fun to make your own. In CLM, these are called "generators" and "instruments", and a sequence of instrumental calls is a "note list". To create your own generators and instruments, you need to write the Lisp function that expresses in CLM's terms the sound processing actions you want.

- CM

<http://www-ccrma.stanford.edu/software/cm/cm.html>

Common Music is an object-oriented music composition environment. It produces sound by transforming a high-level representation of musical structure into a variety of control protocols for sound synthesis and display. Common Music defines an extensive library of compositional tools and an API through which the composer can easily modify and extend the system.

- CMN

<http://www-ccrma.stanford.edu/software/cmn/>

Common Music Notation is a free western music notation package written in Common Lisp that can create and display traditional western music scores. `cmn` is the main Lisp function and it reads in all its arguments, organizes the musical data into systems and staves, adds line and page breaks, beams, ties, slurs, dynamics, and so on, aligns and justifies the result, and as a result produces an "encapsulated Postscript" file.

- IMPROV

<http://improv.sapp.org/>

is a C++ environment for writing programs that enable musician/computer interaction using MIDI instruments. Improv programs can be written in special pre-defined environments, or they can be written from scratch using just the basic MIDI input and output classes.

Example programs are provided which demonstrate how to use the Improv library. The programs range from simple programs such as one which switches the key number and attack velocity parameters of a MIDI message (switch1) to more complicated programs such as one which statistically analyzes the input notes to estimate the musical key of the performance (keyan).

- PD

<http://www.pure-data.org/>

stands for "pure data". Pd is a real-time software system for live musical and multimedia (video) performances. It is in active development by Miller Puckette, and perhaps others. The system is unfinished, but quite useable for sophisticated projects. The best documentation can only be viewed by running Pd. Click on the "Pure Documentation" menu item on the "Help" menu when you run Pd.

There is official documentation as well as useful links for pd under the software guides section of the CCRMA home web page at pd_guide@ccrma
<http://www-ccrma.stanford.edu/guides/package/pd/> To run Pd just type,

```
pd -alsa &
```

or just,

```
pd &
```

This will start Pd and a new Pd "GTK" box will appear. You can test you audio settings, MIDI settings and see if your audio system is running properly. DIO Digital input output errors might appear while you are running Pd, please pay attention to them since normally these mean audio input and output synchronization errors.

You can try various Pd switch options in order to tune and optimize your setup. Here are the most common flags which you can see with the command:

```
pd -help
```

-listdev	list audio and MIDI devices
-noadc	suppress audio input
-nodac	suppress audio output
-audioindev	audio in devices
-audiodev	specify input and output together
-audiobuf (n)	specify size of audio buffer in msec
-blocksize (n)	specify audio I/O block size in sample frames
-midiindev	midi in device list
-nomidiin	suppress MIDI input
-nomidi	suppress MIDI input and output
-oss	use OSS audio API
-alsa	use ALSA audio API
-jack	use JACK audio API (default for Linux)

Pd also works with video signals provided your workstation has a video capture board. You can combine MIDI, audio, signal processing and also video by using an extra library called GEM.

To run Pd with GEM just type,

```
pd -lib /usr/lib/pd/externs/Gem
```

(Thanks to Bill Verplank who first tested this command at CCRMA).

GEM is the Graphics Environment for Multimedia. It was written by Mark Danks to generate real-time computer graphics, especially for audio-visual compositions. Because GEM is a visual programming environment, users do not need any experience in traditional computer languages.

GEM is a collection of externals which allow the user to create OpenGL graphics within Pd, a program for real-time audio processing by Miller Puckette (of Max fame).

GEM currently has many different shapes and objects, including polygonal graphics, lighting, texture mapping, image processing, and camera motion. All of this is possible in real-time without any previous programming experience. Because GEM is an add-on library for Pd, users can combine audio and graphics, controlling one medium from another.

more information can be found at:

GEM SITE

<http://iem.kug.ac.at/GEM/>

9.17 MIDI-and-Sound

- JACK

<http://jackit.sourceforge.net>

is a started a terminal window by issuing one the following commands depending on the sample rate:

```
jackstart -d alsa -d hw -r 44100
jackstart -d alsa -d hw -r 22050
```

*Please see the **JACK section** for an explanation and the options in the jackstart command.*

In the case of a real-time situation like a concert situation, you can give JACK priority with the following options in the jackstart command:

```
jackstart -realtime -driver=alsa
```

When you are done with your audio or sound job make sure quit quit or stop the JACK process by issuing the: C-c [control-c] sequence

- PD

<http://www.pure-data.org/>

*Please see the **Composition Environments section**.*

- playmidi

<http://sourceforge.net/projects/playmidi/>

is a curses and X11-based MIDI file player for Linux. It supports playback to any OSS-supported synth device including external MIDI.

To play a MIDI file through a external synthesizer you should type something like:

```
playmidi -e /zap/test.mid
```

- Timidity

Timidity is a software synthesizer that can play MIDI files by converting them into PCM waveform data.

Timidity is a MIDI to WAVE converter and player that uses Gravis Ultrasound(*)-compatible patch files to generate digital audio data from general MIDI files. The audio data can be played through any sound device or stored on disk. On a fast machine, music can be played in real time. Type,

```
timidity /zap/test.midi
```

to hear a synthesized version for your MIDI file or to run timidity as a background process.

```
timidity -iA &
```

As being designed with “general MIDI” and with ALSA, Timidity can play in real time with more elaborate sounds and options as follows:

```
timidity -Os -A130 -p3 -Ei5 -module=2 -q20 -T140 test.midi
```

The options in this case mean:

- -Os , use Alsa
- -A100, , scale amplitude by factor(100)
- -p3 , 3 voice polyphony
- -Ei4 , sound (patch) 4
- -module=2 , Roland 88 behaviour
- -q20 , audio buffer size of 20/100 default 5/100
- -T140 , tempo of 140 bps

- muse

<http://muse.seh.de/>

is a MIDI/Audio sequencer with recording and editing capabilities and the following features:

1. standard midifile (smf) import-/export
2. organizes songs in tracks and parts which you can arrange with the part editor
3. midi editors: pianoroll, drum, list, controller
4. score editor with high quality postscript printer output
5. realtime: editing while playing
6. unlimited number of open editors
7. unlimited undo/redo
8. realtime and step-recording
9. multiple midi devices

10. unlimited number of tracks
11. audio tracks, LADSPA host for master effects
12. multithreaded
13. uses raw midi devices (ALSA, OSS & serial ports)
14. XML project file
15. project file contains complete app state (session data)
16. Application spanning Cut/Paste Drag/Drop
17. C++
18. QT2 GUI Library
19. STL

Note: If you don't have a synthesizer on hand at your workstation you can take advantage of TiMidity to listen your MIDI file in the MusE time-line or track window. For this you need to have timidity as a background process as described above and while in MusE go to the "config" menu and select the "MIDI ports" command. A new window will appear and in any of the ports you will notice that if you select the device name pull down menu, there are two options for ports of timidity. Once selected just play your MIDI sequence and listen with your favorite TiMidity sound.

9.18 Graphics, vector-based

- dia

<http://www.lysator.liu.se/alla/dia/>

can be used to draw many different kinds of diagrams. It currently has special objects to help draw entity relationship diagrams, UML diagrams, flowcharts, network diagrams, and simple circuits. It can load and save diagrams to a custom XML format (gzipped by default, to save space), can export diagrams to EPS or SVG formats and can print diagrams (including ones that span multiple pages).

- xfig

<http://www.xfig.org/>

is an interactive drawing tool which runs under the X Windows System. In xfig, figures may be drawn using objects such as circles, boxes, lines, spline curves, text, etc. It is also possible to import images in formats such as GIF, JPEG, EPSF (Postscript), etc. Those objects can be created, deleted, moved or modified. Attributes such as colors or line styles can be selected from various options. For text, various fonts are available.

You can start xfig on the command line by typing,

```
xfig &
```

- xcircuit

<http://www.artsoft.com.br/linux/ldpp/en/app/xcircuit/>

is flexible enough to be used as a generic program for drawing just about anything, and is competitive with powerful programs such as "xfig". It is especially good for any task requiring repeated use of a standard set of graphical objects, including architectural drawing, printed circuit board layouts, and music typography. XCircuit is a program for drawing publishable-quality electrical circuit schematic diagrams and related figures, and produce circuit net lists through schematic capture. XCircuit regards circuits as inherently hierarchical, and writes both hierarchical PostScript output and hierarchical SPICE net lists. Circuit components are saved in and retrieved from libraries which are fully editable.

You can start xcircuit by typing the command,

- OpenOffice
<http://www.openoffice.org/>
 Please see the word processing / presentation section §9.6.1
- StarOffice
<http://www.sun.com/staroffice/>
 Please see the word processing / presentation section §9.6.2
- gnuplot
<http://www.cs.uni.edu/Help/gnuplot/>
 is a command-driven interactive function plotting program. It can be used to plot functions and data points in both two- and three-dimensional plots in many different formats, and will accommodate many of the needs of today's scientists for graphic data representation. It features plotting of two-dimensional functions and data points in many different styles (points, lines, error bars). It allows computations in integer, float and complex arithmetic plotting of three-dimensional data points and surfaces in many different. Styles (contour plot, mesh) and support for complex arithmetic can also be added. It has self - defined functions support for a large number of operating systems, graphics file formats and devices. Please look for the extensive on-line help labels for title, axes, data points command line editing and history on most platforms.

9.19 Signal-Processing

- matlab
<http://www.mathworks.com/>
 integrates mathematical computing, visualization, and a powerful language to provide a flexible environment for technical computing. MATLAB handles a range of computing tasks in engineering and science, from data acquisition and analysis to application development.
- octave
<http://www.che.wisc.edu/octave/>
 is a high-level language, primarily intended for numerical computations. It provides a convenient command line interface for solving linear and nonlinear problems numerically, and for performing other numerical experiments using a language that is mostly compatible with Matlab. It may also be used as a batch-oriented language.
 GNU Octave has extensive tools for solving common numerical linear algebra problems, finding the roots of nonlinear equations, integrating ordinary functions, manipulating polynomials, and integrating ordinary differential and differential-algebraic equations. It is easily extensible and customizable via user-defined functions written in Octave's own language, or using dynamically loaded modules written in C++, C, Fortran, or other languages.
- STK
<http://www-ccrma.stanford.edu/software/stk/>
Please see the MIDI and sound section for more information in regards to stk and don't forget to visit its web page.
- SMS
<http://www.iaa.upf.es/sms/>
Please see the sound utilities section for more information about sms. There is a front end web implementation that you should try in order to get more familiar with Spectral Models.

9.20 Development Environment

– gcc

<http://gcc.gnu.org/>

several versions of the compiler (C, C++, Objective C, Fortran, Java) are integrated in a set and this is why people use the name GCC or "*GNU Compiler Collection*". GCC can compile programs written in any of these languages. The Fortran and Java compilers are described in separate manuals.

When you invoke GCC, it normally does preprocessing, compilation, assembly and linking. The "overall options" allow you to stop this process at an intermediate stage. For example, the '-c' option says not to run the linker. Then the output consists of object files output by the assembler. Other options are passed on to one stage of processing. Some options control the preprocessor and others the compiler itself. Yet other options control the assembler and linker; most of these are not documented here, since you rarely need to use any of them.

Most of the command line options that you can use with GCC are useful for C programs; when an option is only useful with another language (usually C++), the explanation says so explicitly. If the description for a particular option does not mention a source language, you can use that option with all supported languages.

Please consult the man page for gcc.

– gdb

<http://gdbwww.gdb.org/>

is the GNU Project debugger, allows you to see what is going on 'inside' another program while it executes – or what another program was doing at the moment it crashed.

GDB can do four main kinds of things (plus other things in support of these) to help you catch bugs in the act:

1. Start your program, specifying anything that might affect its behavior.
2. Make your program stop on specified conditions.
3. Examine what has happened, when your program has stopped.
4. Change things in your program, so you can experiment with correcting the effects of one bug and go on to learn about another.

9.21 Spelling Checkers

– ispell

<http://ficus-www.cs.ucla.edu/geoff/ispell.htm>

is a fast screen-oriented spelling checker that shows you your errors in the context of the original file, and suggests possible corrections when it can figure them out. Compared to UNIX spell, it is faster and much easier to use. Ispell can also handle languages other than English.

Aspell is a spelling checker written by Kevin Atkinson. Its primary advantage is that it is better at making suggestions when a word is seriously misspelled. For example, when given "trubble", ispell will suggest only "rubble", where aspell suggests "trouble" (as its first choice" as well as "dribble", "rubble", and a lot of other words. Its disadvantage is that the approximate-matching algorithm is specific to English.

You normally use ispell or aspell inside the Emacs environment, actually in the mini buffer. You can invoke spell checking with M-x ispell-region or M-x ispell-buffer. The sequence M-s will usually do spell checking on a "marked" region. Please go to the silly emacs tricks section for more on these combinations.

9.22 Postscript and other Graphic Formats

- gv
<http://wwwthep.physik.uni-mainz.de/~plass/gv/>
allows to view and navigate through PostScript and PDF documents on an X display by providing a user interface for the ghostscript interpreter.

```
gv /zap/test.ps &
```

will open the PostScript file /zap/test.ps

- ghostscript
<http://www.cs.wisc.edu/~ghost/>
is an interpreter for the PostScript (TM) language. A PostScript interpreter usually takes as input a set of graphics commands. The output is usually a page bitmap which is then sent to an output device such as a printer or display. PostScript is embedded in many printers.

Ghostscript has several main uses:

1. Display a PostScript file.
2. Display a PostScript file to decide if you really need to print it.
3. Print a PostScript file to a non-PostScript printer.

- acroread
<http://www.adobe.com/products/acrobat/>
Acrobat Reader enables you to view, print, navigate, and browse PDF files seamlessly on its own or within leading Web browsers such as Netscape Navigator or Mozilla.
Adobe Portable Document Format (PDF) is a standard for electronic document distribution worldwide. Adobe PDF is a universal file format that preserves all the fonts, formatting, graphics, and color of any source document, regardless of the application and platform used to create it. Adobe PDF files are compact and can be shared, viewed, navigated, and printed exactly as intended by anyone with Acrobat Reader software.

9.23 Making-DVDs at CCRMA Workstations

You can backup a lot of data onto a single DVD. Perhaps sound-files, graphics, photos, presentations or even your \$HOME directory. You can also author a digital movie on a DVD to play on household DVD players or on computer DVD drives. A Linux Journal article on DVD authoring might get you started on the subject of DVD video authoring. There are several tutorials and howto's on creating DVD-video. In general you might want to use dvdauthor. There is a tutorial on using dvdauthor at 'thoughts on DVD authoring'.

Since most of the time DVDs are used for data purposes here are some guidelines:

- DVD kinds, drives:
There are several formats for DVDs. DVD-RAM, DVD-R, DVD+R, DVD-RW, DVD+RW plus dual layer versions of these. The distinctions are actually based on how data is written and read from the disk. Some manufacturers prefer one method over the other but in past months more and more drives are compatible with all standards. Other things to note is that DVD-R and DVD+R can only be recorded once while DVD-RW, DVD+RW can be recorded several times. In general if you are authoring and fixating movies, DVD-R are more compatible with home DVD players and legacy computer DVD drives.
DVD+R DL and DVD-R DL Dual layer are based on a technology which provides two individual recordable layers on a single-sided DVD disc. The dual layered discs can hold 7.95GB

DVD-RAM discs can be recorded and erased repeatedly but are compatible only with devices manufactured by the companies that support the DVD-RAM format. DVD-RAM discs are typically housed in cartridges.

– For burning DVDs

- * “K3b is a CD and DVD burning application for Linux systems optimized for KDE window manager in Linux. It provides a comfortable user interface to perform most CD/DVD burning tasks like creating an Audio CD from a set of audio files or copying a CD. While the experienced user can take influence in all steps of the burning process the beginner may find comfort in the automatic settings and the reasonable K3b defaults which allow a quick start. The actual burning in K3b is done by the command line utilities `cdrecord`, `cdrdao`, and `growisofs`.” With K3b you can create data CDs, audio Cds, Video Cds, Mixed Mode CDs, eMovix CD. You can do CD copy as well as CD ripping. Additionally you can do DVD Ripping and DivX/XviD encoding plus many other actions. K3b is on the Red Hat-Fedora or PlanetCCRMA menu under the Sound and Video applications. It can also be run on a terminal window with the `'k3b'` command. Documentation for this program is huge and include several tutorials.
- * “`dvdauthor` is a simple set of tools to help you author a DVD. The idea is to be able to create menus, buttons, chapters, etc, but for now you can just take an mpeg stream (as created by `mplex -f 8` from `mjpegtools 1.6.0`) and write it to DVD.”
- * The man-page of `growisofs` states:
 - “ `growisofs` was originally designed as a frontend to `mkisofs` to facilitate appending of data to ISO9660 volumes residing on random-access media such as DVD+RW, DVD-RAM, plain files, hard disk partitions. In the course of development general purpose DVD recording support was implemented, and as of now `growisofs` supports not only random-access media, but even mastering of multi-session DVD media such as DVD+R and DVD-R/-RW. In addition `growisofs` supports first-/single-session recording of arbitrary pre-mastered image (formatted as UDF, ISO9660 or any other file system, if formatted at all) to all supported DVD media types.”
- * “X-CD-Roast provides a GUI interface for commands like `cdrecord` and `mkisofs`. X-CDRoast includes a self-explanatory X11 user interface, automatic SCSI and IDE hardware setup, support for mastering of new ISO9660 data CDs, support for production of new audio CDs, fast copying of CDs without hard disk buffering, and a log file option. You can use `Xcdroast` for graphical user interface to write DVDs but you need enter a ProDVD key in the setup.” (see the Mastering Cd’s section at §9.24).

– Commands for backing up and storing data on DVDs.

The easiest way to burn or record data DVD’s is with the `growisofs` command on a terminal window. Typically once you have your data directory burning is done in one step. Beware that permissions on the data directory are changed and therefore a `'tarball'` is recommended provided that data size is not huge. You can have several tarballs though.

The great advantage with the `'growisofs'` command is that you don’t need to create an image of the data you want to store on a DVD. To master and burn an ISO9660 volume use the Rock-Ridge extensions in order to keep the filenames intact with a command that looks like:

```
growisofs -Z /dev/dvd -R dvd/
```

Where `'dvd/'` is your data directory.

If you have and iso image of the DVD type something like:

```
growisofs -dvd-compatible -Z /dev/dvd=fc5.iso
```

Note: DVD ISO-images can be created with K3b.

9.24 Mastering Cd's

9.24.1 Xcdroast

Xcdroast
<http://www.xcdroast.org/>

X-CD-Roast is a graphical user interface (GUI) for the command-line set of cdr tools. With the X-CD-Roast front end things are a bit nicer and easier. The cdrtools set contains `cdrecord` which does the hard job supporting all the cd writers and also the actual writing of CDs, `readcd` which is a command line that reads data-tracks of CDs, `mkisofs` a utility that masters CD-images from given file-trees on the hard disk and `cdda2wav` which reads audio-tracks.

You can master two kinds of CDs: audio or data. For audio you need to have “.wav” format audio files in the /scratch directory. For data CDs you need to create an image of the files you want on your Cd also on /scratch . Once you have your audio files or images you can proceed to write them by accepting the track layout. Try to test your parameters by writing a Cd in simulation mode and once you are sure you can start duplicating your data or sound-files.

To burn an audio CD you can follow these procedures:

Make sure all the sound-files are in riff or **wav** format, and also 44.1KHz sampling rate (CD quality!).

To find information about your sound-files you can type:

```
sndinfo yourfile.wav
```

or if you don't know the kind of sound-file you have, you can also type,

```
sndinfo yourfile.snd
```

Please make sure you find out about the sampling rate of your soundfile. At CCRMA you can use Julius Smith's high quality *resample* utility to get your soundfiles up to CD-rate. If you are not familiar make sure you read the sound utilities section or simply read the `resample` man page to create CD-ready soundfiles or if you transfer from one medium to another (i.e. dat, dtrs or adat to cd).

Beware that in general “*clm's*” default sampling rate is 22050 because of historical reasons and of course because of lower speed processors. Being the case with a stereo 22.05Ksr sound-file you can type the following options in order to have a CD-ready sound-file.

```
resample -by 2.00 soundfile.snd cd.snd
```

Nevertheless, if you still need a quick solution you can use `sox` to do a reasonable job:

```
sox -t au -r 22050 yourfile.snd -r 44100 newfile.wav
```

or better

```
sox -t au -r 22050 yourfile.snd -r 44100 /zap/newfile.wav
```

To make sure your **wav** file has the correct timing for being a CD track, you also use `sox` with the next options:

```
sox oldfile.wav newfile.wav
```

or

```
sox -t au oldfile.snd newfile.wav
```

or

```
sox oldfile.aiff newfile.wav
```

Again, make sure the sampling rate is 44100 KHz.

Next, launch `xcdroast` on the command line and you should get its graphic interface. Make sure you have the correct cd-writer settings by clicking on the setup push button, and selecting the correct device for the machine you are using. Don't forget to save your configuration.

- To Master Audio Cd's

Select the “Write Tracks” push button and you should get a new window with the list of tracks, provided they are on the `/scratch` directory. Notice there are two tabs above the track list and, select the layout tracks tab. Add the sound-files, change the order of your tracks and once done, click on the “Accept track layout” push button at the bottom. Now select the “Write tracks” tab to go back to the main Write tracks window and make sure you select the “track at once” (TAO) check mark or radio button. Finally click on the Write tracks push button to start burning your CD.

- To create Data Cd's

Select the Create CD push button to start mastering your Data CD. A new window will appear with few more options. Select “Master Tracks” button and you will get yet another window with directories and may be information of your CD tracks. Explore this window and if necessary go to to the `/zap` or `/scratch` directories for the location of your files. Add directories or files and make sure they appear in the session list. Once done, you can select the “Create session/image” tab, “calculate the size” of your image and either “master to image file” or “Master and Write on-the-fly” push buttons.

If you selected “Master and Write on-the-fly” the CD burning process will start, otherwise after the “image to file” process is finished, you can click on the big “Write Tracks” push button, select the layout tracks tab add your image file to the “tracks to write” list and finally click on the “accept this track layout” push-button. Select the write tracks tab and make sure your image file is on the tracks to write list. Make sure the Disk at Once radio button option is selected and finally click on the “Write tracks” button to start data CD burning.

The underlying tools that are called by `xcdroast` are sometimes easier to use standalone, follow to the next section for the glory of all the details:

9.24.2 `cdrecord`

`cdrecord`

<http://www.fokus.gmd.de/research/cc/glone/employees/joerg.schilling/private/cdrecord.html>
, is used to record data or audio Compact Discs on an Orange Book CD-Recorder.

The easiest not so intuitive way for making or burning Cd's is to type the following commands:

```
mkisofs -J -v -o image.iso datadirectory/
```

and then,

```
cdrecord -v dev=0,0,0 speed=16 -data image.iso
```

Warning: Make sure dev=0,0,0 is your correct cd-burning device by issuing the command:

```
cdrecord -scanbus
```

In this case you are making a data CD from an image called “image.iso” which in turn is like a blueprint of the specified files you want to copy into a CD. *cdrecord* transfers that image to a standard CD tracks provided you have media in the CD drive of your computer. Some of the options here like (dev)ice and speed are dependent on the machine and drive you are using.

To make audio Cd’s you don’t need the *mkisofs* command, instead you probably would like to use the *sox* command which is explained in the following section. Once all your audio tracks are ready you can type something like:

```
cdrecord -v speed=1 dev=2,0 -audio track*.cdaudio
```

You can read more about *cdrecord* on its man page but if this doesn’t seem so straightforward you can also try X-CD-roast as explained in the previous section.

If you already have an iso9660 image or cd tracks ready to burn it is quite easy to use, just type:

```
cdrecord -v speed=8 dev=0,0,0 iso_image_name
```

to burn an iso9660 disk image.

Cdrecord can give you a great deal of flexibility by using the command line instead of a graphical interface like XCDroast and it also provides useful information. Again, make sure you read the *man* page for a better understanding of the following commands.

Warning: Once again, make sure [dev=0,0,0] is your correct CD-burning device by issuing the command:

```
cdrecord -scanbus
```

Otherwise change [dev=0,0,0] accordingly and make sure is working by doing,

```
cdrecord -checkdrive dev=0,0,0
```

Note: On newer Linux distributions, Fedora Core, etc., the cd-recorder device might be found as:

```
/dev/cdrom
```

Following are useful examples for using the Cdrecord command line. (Please notice the *-dummy* mode).

The *-dummy* option will not write anything but it is very helpful for testing and see if the write speed is good enough and if the read/write buffer of the burning device are always filled with CD data. The *-dummy* mode is safe mode. Once you know everything is working just do not use when issuing the **cdrecord** command and you will have a burned CD ready for playback.

1. Rip an audio CD

You might want to change your current directory to “/zap” by `cd /zap`. Then make sure your audio CD is “in” the CD drive. You can start ripping by,

```
cdparanoia -X -B -w --force-read-speed 1
```

This will rip the audio CD and deposit .wav files in the current directory (/zap normally). In audio CDs if the first track does not start at the beginning (sector 0) of the disc, the unused space before the first song will be written as a very short `track00.cdda.wav`. It is a good idea to delete that file.

2. Create an audio CD:

```
cdrecord -v dev=0,0 -dummy -dao -useinfo -pad -audio *.wav
```

This will write all the .wav files to the empty CD, creating a standard audio CD. Do not use CD-RW media because it can not be played by many audio CD players.

3. Converting MP3s to raw audio to create audio CDs

```
mpg123 -s file.mp3 | sox -c2 -s -w -t raw -r 44100 - -t wav - > newsoundfile.wav
```

`mpg123` converts file.mp3 to the .wav file newsoundfile.wav and makes it ready to be part of audio CDs.

4. Converting raw audio WAV files to MP3

```
lame --preset extreme infile.wav outfile.mp3
```

Please see the sound utilities section for more information about *Lame*. In this case *Lame* will encode the raw WAV file infile.wav to the MP3 file outfile.mp3 using high quality settings.

9.24.3 cdparanoia

cdparanoia

<http://www.xiph.org/paranoia/>, retrieves audio tracks from CDDA capable CDROM drives.

Few examples:

1. Extract an entire disc, putting each track in a separate file:

```
cdparanoia -vsQ
```

2. Extract from the beginning of the disc up to track 3:

```
cdparanoia -- "-3"
```

3. Extract from track 1, time 0:30.00 to 1:25.00:

```
cdparanoia "1[:30.00]-1[1:25]"
```

4. Ripping from the beginning of track 2 to the end of track 4:

```
cdparanoia "2-4"
```

5. Rip only track 5, from beginning to the end.

```
cdparanoia "5:[0.00]"
```

9.24.4 Printing-labels: cdlabegen

cdlabegen
<http://www.red-bean.com/bwf/software/cdlabegen/>
, was designed to simplify the process of generating labels for CD's. It originated as a program to allow auto generation of front-cards and traycards for CD's burned via an automated mechanism (specifically for archiving data), but has now become popular for labelling CD compilations of mp3's, and copies of CDs. Note that cdlabegen does not actually print anything—it just spits out postscript, which you can then do with as you please.

You can try to generate your label with:

```
cdlabegen -c "title of cd" \  
-s "subtitle" \  
-i "Piece 1%Piece 2%a third song %and more" \  
-e recycle.eps > bar.ps
```

Here is a more elaborate example which you can try in a terminal window (all the following options should go as a single line command or you might opt to put them in a script). Notice that the “%” character means a new line inside the “-i” option.

```
cdlabegen -c "John Chowning" \  
-s "http://www-ccrma.stanford.edu/~jc"\  
-i " % % 1- Turenas (1972) % %\  
2- Phone (1981) % %\  
3- Sabelithe (1971)% %\  
4- Stria (1977) % %\  
-e cd.eps > chowning-cd.ps
```

Make sure you have right path for the file “cd.eps”. Once you have the file “chowning-cd.ps” you can try to print it in one of the CCRMA printers and do the folding and unfolding for standard “Norelco” CD trays but first test your output with:

```
gv chowning-cd.ps
```

If you are satisfied with the aesthetics you can print on a standard letter size paper by issuing:

```
lpr chowning-cd.ps
```

9.24.5 Stamping a CD with L^AT_EX

Here is some L^AT_EXcode which might be copied to a file for generating the actual CD-Label but you will need clear or white self adhesive CD-labels which are available at *Arcal* or Fry's. For L^AT_EXinstructions go to the typesetting section §9.9.

```
\documentclass[12pt]{article}  
  
% funky manipulation of text.
```

```

%only useful for producing ps not pdf

\usepackage{pstricks}

% extra pstricks pieces
\usepackage{pst-text}
\usepackage{pst-eps}

% allows \includegraphics
% most likely, we'll be using dvips for output
\usepackage[dvips]{graphicx}

% allows \so (stretched-out)
\usepackage{soul}

% set default pstricks unit to 1cm
\psset{unit=1cm}

% don't do page numbers, etc
\pagestyle{empty}

% environment for actual content
\begin{document}

% The rest is compressed, because you can't have any
% blank lines. they will start a new paragraph
% which isn't something we want in the middle of
% a picture..

% A pstricks trick, to help produce the right
% bounding box for eps
\TeXtoEPS

% pstricks pspicture environment. width/height/offset etc.
\begin{pspicture}(-1,-11)(11,1)

% default font attributes
\Huge\ttfamily\bfseries

% draw a little cross at the center (5,-5) (two straight lines)
\qline(4.6,-5)(5.4,-5)\qline(5,-4.6)(5,-5.4) % mark center

% the text "\so{CCRMA Open House}" drawn around in an arc.
\pstextpath[c](0,0){
  \psarcn[linestyle=none](5,-5){3.5}{270}{0}}
{\so{CCRMA Open House}}

% put an .eps at (7.7, -7.7)
\rput(7.7,-7.7){\includegraphics[width=3cm]{ccrma.eps}}

```

```

% put some text (in a table, to get layout correct)
\rput(3.5,-8.5){\mdseries\sffamily\small%
\begin{tabular}{r}
Friday May 9, 2003 \\
The Knoll, Stanford University \\
U.S.A.
\end{tabular}}

% uncomment for cd border:
%\pscircle(5,-5){2}
%\pscircle(5,-5){6}

\end{pspicture}
\endTeXtoEPS

\end{document}

```

Make sure you have the right path the logo file "ccrma.eps".

9.25 Coming or untested applications

- Gmix
<http://www.gnome.org/>
A front end Gnome audio mixer application for manipulating sound levels of all audio devices in a Linux workstation.
- GTV MPEG Player
<http://www.gnome.org/>
A MPEG file player application.
- G Sound Recorder
<http://www.gnome.org/>
A simple sound recorder and sound player for Gnome.
- ardour
<http://ardour.sourceforge.net/>
This is a "professional" multitrack, multichannel audio recorder and DAW (digital audio workstation) application. It supports up to 32 bit samples, 24+ channels at up to 96kHz, full MMC control, non-destructive, non-linear editor and LADSA plugins. Ardour is intended to be a full, professional replacement for recording equipment such as multiple Alesis ADAT or Tascam MDM tape systems, and the new HDR platforms.
- musickit
<http://musickit.sourceforge.net/>
The MusicKit is an object-oriented software system for building music, sound, signal processing, and MIDI applications. It has been used in such diverse commercial applications as music sequencers, computer games, and document processors. Professors and students in academia have used the MusicKit in a host of areas, including music performance, scientific experiments, computer-aided instruction, and physical modeling. The MusicKit was the first to unify the MIDI and Music V paradigms, thus combining interaction with generality.
The NeXT MusicKit was first demonstrated at the 1988 NeXT product introduction and was bundled in NeXT software releases 1.0 and 2.0. Beginning with NeXT's 3.0 release, the MusicKit was no longer part of the standard NeXT software release. Instead, it was being distributed and

supported by the Center for Computer Research in Music and Acoustics (CCRMA) of Stanford University. Since 1999 and version 5.0, the most recent releases run on several more popular operating systems.

– jazz

<http://www.jazzware.com/cgi-bin/Zope.cgi/jazzware/>

Jazz is a full size midi sequencer with audio support allowing record/play and many edit functions as quantize, copy, transpose ..., multiple undo; two main windows operating on whole tracks and single events; graphic pitch and controller editing, GS and XG sound editing and more ...

10 Hardware:

- Workstations Most computers at CCRMA are running Linux and therefore are Linux workstations. All the peripherals around your system are part of the workstation configuration. These might include screen monitor, computer keyboard, CPU, hard drive, compact disc units, zip drives as well as sound cards, input output devices such as MIDI interfaces or audio boxes. A Multimedia (audio and video as well as storage media) setup with speakers, microphones and even video camera is also part of the workstation configuration. Take time to familiarize yourself with the operation and handling of all these devices since you will be using them on a daily basis. Try backing up your data and sound-files to zip discs, cd-r or cd-rw's. A recordable dvd can also store your home directory and even your composition soundfiles.
- Audio I/O Most CCRMA workstations are configured to play and record audio. The applications in the sound and composition sections make extensive use of audio inputs and outputs. Audio connectors for headphones or recorders can be plugged in through the outputs of the OMNI I/O interfaces which are part of the system, in this way you are “monitoring” your audio through headphones or speakers. The OMNI I/O can also be used to record or process your audio signal through its balanced or unbalanced input. Make sure you adjust your recording levels in order to avoid clipping or saturation.
- ALSA is The Advanced Linux Sound Architecture project, please see the MIDI and Sound section for more information.
- MIDI In addition to audio input and output some sound-cards like Creative Labs Sound-Blaster or compatible provide a joystick- like MPU-401 connector that is used for MIDI IN and OUT when hooked up with a Y shaped adapter cable. Some CCRMA workstations are equipped with this feature allowing MIDI in and OUT. Programs like playmidi or aplay only support MIDI out from the computer, while PD and Jazz allow MIDI in. Make sure the cables are connected properly since this is the most popular source of MIDI malfunctioning.

The input port on the interface card, the adapter cable and the instrument act as receiving bins. Before your MIDI instrument can process the information sent to it by the computer, it has to have this information sent in through its IN port. When you want to communicate your performance to your computer from your instrument, the computer must receive the information into its IN port (the MIDI IN port on your interface). The output ports work in the same way. Your instrument's MIDI OUT port sends OUT information to the interface card (your interface receives the data through it's MIDI IN port). The interface's MIDI OUT port sends out information to your instrument (your instrument receives the data through the MIDI IN port).

- OMNI I/O Audio Interfaces

The Omni i/O by M Audio is a record/playback ”front end” for the M-Audio Delta 44, Delta 66 audio interface cards, combining together to form a complete system capable of adapting to many studio scenarios.

More than simply adding mic preamps to an audio card, the Omni I/O emulates a "split console" mixer design, making any routing scenario possible. The unit contains everything needed to record mics, guitars, keyboards and all other instruments, monitor playback, add effects, and mixdown.

Two mic/instr pre-amps can be switched to line input for a total of four line inputs. Use the direct outs, or route to the Omni i/O's extremely quiet mixer to add effects, blend in keyboards using the unity gain aux ins, and even reroute them to the inputs for recording. Monitor and mix with separate control room level, plus two headphone outs with individual level controls. A detailed user guide takes you step by step, making it easy to get the most out of the Omni I/O and your recording system.

11 The OS-X Linux Connection

Mac OS X is evolved enough so that its features and what you can accomplish is far above better and beyond NEXTSTEP / OPENSTEP. Some regard that it might be an understatement to say that OS X is derived from NEXTSTEP / OPENSTEP. In many respects it's functionality resembles the same and one might think of it as OpenStep 5 or 6. However, the similarities should not mislead you. Mac OS X nowadays is based on Darwin and chunks of existing open source software from a large number of sources like BSD, GNU, Mach, ... and even Linux.

Although Darwin is an operating system in itself, it can be best understood as a collection of technologies that have been integrated by Apple to form a major, central part of Mac OS X. Critical application environments of Mac OS X, such as Cocoa and Carbon, are not part of Darwin. Furthermore Aqua which is the standard graphical interface of Mac OS X including the Windowing System, and several other components are neither part of Darwin.

The OS-X Linux connection exists for several reasons:

You only have or like Apple hardware.

Interaction with commercial software.

Input / Output devices only compatible with Apple hardware.

Audio or Video interfaces that don't have Linux drivers.

Customized software that only works in one platform.

Perhaps you are not used to compile Linux kernels.

File transfer and exchanging.

The missing link between OS X and Linux in many respects is X11 or the X window system referenced above in its own section. Many of the commands only available in Unix systems before are becoming more and more available in OS X in particular because of the Fink project which is also an Open Source initiative. Therefore it should not be hard to have that same Linux functionality with Apple hardware.

If you want to have that Apple's **geek** machine you need to get some packages that Apple offers for free download until now in addition to Fink. The Apple OS X developer tools, X11 for Mac OS X and of course Xemacs for Apple's X11. You get Xemacs after you have installed Fink.

As suggested by Rick Taube, following are the steps for having a "ready made" OS-X Linux like Apple hardware machine.

- If you don't have Fink installed already, you need to do that first. You can download Fink from:

fink

<http://fink.sourceforge.net/download/index.php>

- Download and install Apple's X11 server from:

X11

<http://www.apple.com/macosx/x11/download/>

Note: *If you are using Panther (OSX-10.3x) or above X11 comes as part of its distribution CDs which you can install at your own discretion.*

- Next you might want to install Apple's Developer Tools as well:

Note: *Apple's new Xcode (developer) tools are also included in every copy of Mac OS X v10.3 or above and should be installed from its CD (2).*

If still you need to download Apple's developer tools, they might be found at:

Developer Tools

<http://developer.apple.com/tools/index.html>

- Now, to get the CCRMA Lisp world running on OS X you should download OpenMCL from:

openmcl

<http://openmcl.closure.com/>

- SBCL now seems to be a good option for OS-X and can be found at:

sbcl

<http://www.sbcl.org/>

Instructions for compiling the CCRMA Lisp world on OpenMCL or other OS-X Lisps like SBCL can be found in the documentation of each package (CM, CLM, CMN).

11.1 Fink

Fink is a project that wants to bring more Unix software to Mac OS X, which results in two main goals:

1. Porting software to Mac OS X. Meaning that the Fink project takes commodity Open Source Unix software and fixes whatever is necessary so that it will compile and run on Mac OS X.
2. To make the results available to casual users. For this, the Fink people builds a distribution using package management tools like dpkg and apt-get ported from Linux and the Debian GNU/Linux project. The binary distribution uses the .deb package format.

These are the options you can use when using "fink" on OS X:

<code>fink list</code>	list all packages in database
<code>fink install foo</code>	install package "foo"
<code>fink update-all</code>	update all installed packages
<code>fink info foo</code>	more info about package foo
<code>fink list "xemacs*"</code>	list all packages that start with 'xemacs'
<code>fink help</code>	list more fink options and help

11.2 SND-on-OSX

For more information and tutorials on SND please look at the Snd section: §9.13.

Cristopher Pierson Ewing has provided the steps for installing SND on OS-X (thanks Chris !)

1. The first step (and it is a vital one) is to make sure that your version of fink is fully up-to-date. Start by running:

- fink selfupdate
 - fink update-all
2. Verify that you have a working version of X11 on your machine. This must include the development libs found in the X11SDK. If you are using apple's version of X11, the SDK package is `_not_` installed by default when you install X11. You have to do a custom install from the X Code disk to get the package.

Once all this is in place, use fink to install openmotif3

3. fink install openmotif3

Next, install guile16 and its development libraries:

4. fink install guile16
5. fink install guile16-dev

You can also use fink to install the fftw package. It really takes a longtime to build, but helps to speed up the fft-based functions in snd.

6. fink install fftw

Beware that installation of fftw takes a while because it needs to compile itself and several dependencies.

7. Download and untar the latest SND sources from ccrma-ftp

Cris Ewing suggests:

“If you have trouble with the configure process, you may want to check to make sure what the guile binaries are named. All the information you will need to get configure to work successfully is in README.Snd inside the snd distribution. It seems important to use the switch `-disable-nls`. I'm not sure why, but I couldn't get the build to work with nls enabled. This is the configuration command that I used after following the instructions above:”

8. On the SND directory you can try this options with the configure command on the `tsch` before making its binaries (all in one line or using backslash):

```
./configure CFLAGS=-I/sw/include LDFLAGS=-L/sw/lib \  
GUILE_CONFIG_path=/sw/bin/ --disable-nls \  
--with-guile --with-motif --with-static-xm \  
--with-motif-prefix=/sw
```

This config was run from a bash shell. If you are using `tcsh` (and you might be if you upgraded to panther) then you will have to omit the part about CFLAGS and LDFLAGS above. Instead, you can set these through the shell by running:

9. setenv LDFLAGS "-L/sw/lib -lmx -bind_at_load"
10. setenv CFLAGS "-I/sw/include"

After this, you're nearly home:

11. make
12. sudo make install

(you need to sudo make install, because it will install a Snd executable in /usr/local/bin)

11.3 SND-GTK-on-OSX

Snd can be built for OS-X with the GTK libraries for its windowing interface. The advantage of having a Snd-GTK version is that some of the effects with sliders to control its parameters make use of GTK widgets. This include various effects in “gtk-effects.scm” and some in “ladspa.scm” (see the DSP processing with Snd and Ladspa sections: §9.13.2, §9.13.3). This version of Snd also runs under OS-X’s X11, make sure you have Apple’s X11 and developer tools installed in your computer §11.

In general to build Snd with GTK, you need to get Fink and the same packages as for the Motif version plus the GTK dependencies as follows:

1. Make sure that your version of fink is fully up-to-date (if you don’t have Fink or X11 follow the instructions on the previous sections §11.1, §11.2).
 - fink selfupdate
 - fink update-all
2. fink install guile16 guile16-dev
3. fink install fftw (this takes a long time)
4. fink install gtk+2 gtk+2-dev gtk+2-shlibs gtk-engines
5. fink isntall pango1-xft2 pango1-xft2-dev pango1-xft2-shlibs
6. fink install gdk-pixbuf gdk-pixbuf-shlibs
7. There is a bug in X fonts and GTK which can be solved by:
 - fink install applesystemfonts
 - fink install fnlib-fonts
 - and running:

```
sudo fc-cache
```

8. After this, on the Snd directory run the ./configure command with the options for Gtk (all in one line or using backslash):

```
./configure CFLAGS=-I/sw/include LDFLAGS=-L/sw/lib \  
GUILE_CONFIG_path=/sw/bin --disable-nls --with-guile \  
--with-gtk --with-static-xm --with-builtin-gtkrc \  

```

9. After configure is done and on the Snd directory run the “make” command.

11.4 SND-binary-on-OSX

If you don’t want to start from scratch or if you want to install an already statically compiled binary version of SND, follow the next steps: (*more information about these steps can be found on the previous section*)

1. Install the developer package for OS-X 10.2, 10.3, 10.4, or above on the OS-X CDs.
2. Install the ‘X-window’ application on the OS-X CDs or download it if needed.

3. Download Fink for 10.2, 10.3, 10.4 or above.

4. `fink selfupdate`

5. `fink update-all`

Once all this is in place, use `fink` to install `guile-1.6` and its development libraries:

6. `fink install guile16`

7. `fink install guile16-dev`

8. Go to your home “bin” directory or if you are a super user, go to “/usr/local/bin” by:

```
cd $HOME/bin
```

or alternatively by

```
cd /usr/local/bin
```

9. In this directory now download the SND binary from `ccrma-ftp.stanford.edu`

SND binaries are in `pub/Lisp/` and should be one of `osx-10.2-snd`, `osx-10.3-snd`, `osx-10.4-snd`, or above, depending on the OS-X version you are running.

10. Make sure you are on a terminal window and running the `tcsh` shell. The `xterm` application on X11 would be a good idea at this point.

11. Provided that `guile` was installed on `/sw/` which is the Fink standard, type the following command on the terminal:

```
setenv GUILE_LOAD_PATH /sw/share/guile/1.6
```

12. Now on the terminal and on the “bin” directory where SND is type the following command in order to make SND an executable application,

(make sure about the SND version you are running)

```
chmod 777 osx-10.3-snd
```

13. You need to run SND under X11 using the “xterm” application. Make sure you set your environment “PATH” variables so that the bin directories are on the the binary path. To run SND just type:

(Again, make make sure about your SND version)

```
./osx-10.3-snd
```

or if they are on the binary path,

```
osx-10.3-snd
```

12 USB-MIDI:

The Advanced Linux Sound Architecture (ALSA) is a major component in most Linux distributions. At PlanetCCRMA is an essential part since most audio and MIDI applications used at CCRMA depend on it. Extensive research and testing is done on a daily basis to be up-to date with the latest drivers and kernel related ALSA API. Recently many improvements have been done to many old and newer hardware sound-cards but perhaps attention should be paid toward USB related audio and MIDI devices because newer hardware seems to be geared to this direction in these days.

Testing was performed with various commercial USB-MIDI and USB-AUDIO interfaces to the extent that we are able to consider USB as good as an alternative (or better in some cases) to serial and parallel interfaces and even to audio sound-cards. The “usb-audio” module of ALSA has been updated and improved to the extent that most hardware tested, behaved in a reliable fashion with standard Linux and PlanetCCRMA applications. In our tests hardware included not only interfaces but controllers such as keyboards and wheels.

MIDI is a very important part at CCRMA because of its close relationship with human computer interface (HCI). Our testing focused not only on ALSA sequencers but also with the PD Linux environment and more specialized software such as Max Matthews’ Scanned synthesis program and Craig Sapp’s Improv. In most cases USB-Audio performed accurately even with the combination of Scanned synthesis audio and Radio Baton MIDI input using M-Audio’s Quattro interface. With the Quattro we were also able to listen to four discrete 44.1KHz audio channels and record audio at 96KHz sampling rate.

For more updated information on the ALSA “usb-audio” module and for additional USB audio an related issues, point to the USB audio web pages on the Nano HOWTOs section at PlanetCCRMA @ Home: <http://ccrma.stanford.edu/planetccrma/software/>

13 CCRMA-lize your computer

If you want to mimic your \$HOME/ directory at your dorm, or somewhere in some far away island, dessert or galaxy using CCRMA’s Linux environment (A.K.A. PlanetCCRMA). Good news, it can be done. Furthermore, it might be that you want to “CCRMALIZE” your laptop or workstation with the Linux operating system. It can also be done! §13.2.

13.1 Mimic your CCRMA Home Directory

If you already have Linux installed on your computer you can follow the next steps using unison or rsync. If you don’t have Linux installed on your machine you might consider installing Linux §13.3 and PlanetCCRMA.

- With the ‘unison’ command: Suppose you want to sychronize the directory ‘doc’ in your computer with the ‘doc’ in your CCRMA \$HOME/ directory. You simply type a ‘unison’ command like,

```
unison doc ssh://ccrma-gate/doc
```

Make sure you are in the \$HOME/ directory in both machines.

- With the ‘rsync’ command: Suppose you want to sychronize the directory ‘mail’ in your computer with the ‘mail’ in your CCRMA \$HOME/ directory. You type a ‘rsync’ command like,

```
rsync -a -vv -e ssh mail/ ccrma-gate:mail/
```

- To sychronize a single file, use the ‘rsync’ command like:

```
rsync -vv -e ssh myfile.mat ccrma-gate:matlab/myfile.dat
```

- You can find more information at the MAN pages for unison and more rsync.

13.2 PlanetCCRMA-DVD

In case of an out-of-the box alternative, Fernando Lopez-Lezcano has made available a PlanetCCRMAFedora-Core(N) Linux distribution DVD with many of the standard audio and Video applications and a lot more. In addition to the standard fedora disks, the planetCCRMA DVD contains a low-latency Linux kernel optimized for audio applications in real-time, RPM packages with many Computer Music applications as well as popular open source music packages all tied together and as a Linux workstation ready to go. For most situations no compilation and tedious configurations are needed for this Linux to be used by a computer music composer or musician. The sources for the planetCCRMA DVD are located at CCRMA-FTP.

Instead of using the standard Red Hat Fedora Core installation CDs or DVDs, you can use the PlanetCCRMA DVD in the very same fashion. Once you have your Linux partition boot your computer with the PlanetCCRMA DVD. Make sure you read the “README” and related documentation files after you have downloaded the sources for the DVD.

13.3 Custom-Linux-Installation

Note: This is almost a verbatim of a RHFC Linux installation. For detailed information please consult the main Fedora site at RedHat.

1. Make sure you have a Linux Partition on your Laptop or Workstation. (Before creating a partition on a windoze (vfat) drive make sure you backup sensitive data). People use commercial software like Partition Magic to get a Linux partition. You can also use the program. If you are not so familiar with the command window it might be worth to ask for some help.

It is recommended to have at least 3 partitions:

- A 'home' partition where your home directories and files are installed. The larger the better but keep in mind that this is the partition you most often backup.
- A root or '/' partition where system files are installed. A complete Fedora Core installation require almost 10GB plus the extras you might want to install.
- A 'swap' partition which should be at least as large as your physical memory. If you have 1GB of ram memory your 'swap' partition should be at least 1GB.

2. Download or get Linux DVDs or CDs from the main Fedora site at RedHat or at one of its mirrors.
3. Boot your computer with Fedora Core CD-1 or the DVD and follow its graphical instructions (default values are appropriate for most common installations. If you have a laptop make sure to use LCD screen when asked about your monitor type).

If you can't get to a graphical mode installation, the graphics might not be supported on X.ORG windows yet. Check the chipset while boot on windoze and got to X.ORG to see how can it be configured.

By experience it might be a good idea that you do a full (Install Everything) installation.

4. Get fedora updates (beware of Kernel version numbers and good bandwidth). You can use the yum command:

```
yum -y update
```

At this time it is a good idea to get familiar with the yum command or read about it at the yum site.

5. Complete the Fedora Core installation with Fedora Extras (see section §13.4).
6. Last but not least! Immerse yourself into PlanetCCRMA @ Home

13.4 After-a-Fedora-Linux Installation

For functionality and compatibility with other operating systems, after you have done a full Fedora Core installation some additional packages might be also considered. Most of these packages are available at every workstation in CCRMA but they don't come standard in Fedora Core distributions.

Most of these packages are found at Fedora Extras site, and may be installed just by issuing the yum command like,

```
yum install 'name-of-package'
```

There should be an `/etc/yum.repos.d/fedora-extras.repo` file with Urls pointing to fedora-extras sites. If this is not the case YUM might have to be installed or re-installed as these files are part of the yum install package.

It might be useful to install the following packages (please consult PlanetCCRMA @ Home for more):

- Xemacs,§13.4
- XMMS,§13.4
- Mozilla, Firefox plug-ins,§13.4
 - Macromedia Flash
 - Java runtime Plugin j2re
 - Real Player and Acroread (see below)
- RealPlayer,§13.4
- Acroread,§13.4
- Prosper,§13.4
- Ncftp,§13.4
- Octave,§13.4
- Octave-forge,§13.4

- Xemacs:

XEmacs (more at §9.7) is a version of Emacs, compatible with and containing many improvements over GNU Emacs. XEmacs is a highly customizable open source text editor and application development system. To install XEmacs use yum as follows:

```
yum install xemacs
```

- XMMS:
XMMS (read more at §9.5), is the X Multimedia System. It is used to play audio and other kinds of media files. By default XMMS can play MPEG audio, Ogg Vorbis, RIFF wav, most module formats, and a few other for- mats. XMMS can be extended through plug-ins to play a number of other audio and video formats.

Fedora Core does NOT ship with XMMS, you must install from the Fedora Extras site or issuing the following yum command:

```
yum install xmms xmms-devel
```

There are not MP3 plug-ins at the Fedora Extras site. The RPMs at freshrpms work and include MP3 support. You must download each RPM and install it manually by using the RPM command accordingly:

Look for xmms-mp3 at freshrpms and also download xmms-skins from also at freshrpms.

Then install as root with these commands:

```
rpm -Uvh xmms-mp3 xmms-skins
```

- Mozilla, Firefox plug-ins:

- *Macromedia Flash:*

The Flash RPM plug-in can be downloaded from Macromedia. Read more about Linux web browsers at §9.2.

Install the RPM by

```
rpm -Uvh flash-plugin
```

Make sure you are logged into the X server (init 5, runlevel 5) and do not have Mozilla or FireFox open when you install the RPM. Make sure to (read) accept the agreement. Close the terminal and reboot your machine.

- *Java runtime Plug-in JRE:*

Download J2SE from SunSite

There are RPM and self extracting files. If you download the RPM, just install it by typing in the terminal window something like (*you might have different version numbers*):

```
sh jre-1_5_0_07-linux-i586-rpm.bin
```

or

```
rpm -Uvh jre-1_5_0_07-linux-i586-rpm
```

Then link the library to the Mozilla plug-ins directories with a command like (*it should be a one-line-command*):

```
ln -s /usr/java/jre1.5.0_03/plugin/i386/ns7/libjavaplugin_oji.so \
/usr/lib/mozilla/plugins/libjavaplugin_oji.so
```

If you download the binary installer as root follow these steps:

```
* mkdir /opt
* mv *.bin /opt
* cd /opt
* chmod +x *-linux-i586.bin
* sh *-linux-i586.bin
```

* Link the library to the Mozilla plug-ins with a command like (*it might not be the same version numbers. Make sure type all in a one line command*):

```
ln -s /opt/jre1.5/plugin/i386/ns7/libjavaplugin_oji.so \
/usr/lib/mozilla/plugins/libjavaplugin_oji.so
```

– *Real Player and Acroread (see below): §13.4*

- RealPlayer:

- RealPlayer, plays streaming audio and video over the Internet in real-time. It plays RealAudio, RealVideo, MP3, 3GPP Video, Flash, SMIL 2.0, JPEG, GIF, PNG, RealPix, RealText, Ogg Vorbis, and Ogg Theora (more at section §9.5).
- Download RealPlayer GOLD from RealSite.
- Install RealPlayer GOLD as root with something like:

```
rpm -Uvh RealPlayerXGOLD.rpm
```

- Try the KQED or the NPR site to test RealPlayer.

- Acroread:

- Adobe Acroread, lets you view and print documents in Portable Document Format (PDF). PDF files retain all the formatting, fonts, and graphics of the original document, and virtually any Postscript document can be converted into PDF. \LaTeX can also generate PDF files (see section §9.22 for using acrobat reader and postscript formats).
- Download the Acroread RPMs from dag site
- Install Acroread RPMs by:

```
rpm -Uvh acroread-7.0 mozilla-acroread-7.0
```

- Prosper:

- Prosper is a \LaTeX class for writing transparencies and presentations by using the PDF file format. It is a much better and cleaner alternative to other presentation programs by offering an environment for writing high-quality slides for both printing and displaying with a video-projector. Prosper is in the Fedora Extras repository.
- To install Prosper just issue the 'yum' command:

```
yum install tetex-prosper
```

- Ncftp:

- “The purpose of ncftp is to provide a powerful and flexible interface to the Internet standard File Transfer Protocol. It is intended to replace the stock ftp program that comes with the system”.
- “Some of the cooler features include progress meters, filename completion, command-line editing, background processing, auto-resume downloads, bookmarking, cached directory listings, host redialing, working with firewalls and proxies, downloading entire directory trees, etc”.
- To install Ncftp simply use the yum command:

```
yum install ncftp
```

- Octave:

- “GNU Octave, is a high-level language, primarily intended for numerical computations. It provides a convenient command line interface for solving linear and nonlinear problems numerically. Octave can be useful for performing numerical experiments using a language that is mostly compatible with Matlab”.

- Octave can also be installed with yum.

```
yum install octave
```

- Octave-forge:

- Octave Forge has the signal processing toolbox items for Octave. It serves as an add-on utility collection that includes many functions compatible with the Matlab Signal Processing Tool Box and others.
- Both octave and octave-forge are included in Fedora Extras and therefore can be installed with:

```
yum install octave-forge
```

14 Wireless-Tools and Networking with Linux at CCRMA

2200urlhttp://atrpms.net/name/ipw2200/

For using the wireless (guestnet) network at CCRMA please follow the instructions at CCRMA guestnet.

If you have a laptop with a wireless card the probability that you might use Linux and all the PlanetCCRMA features is very high. Many standard cards already have drivers which work on many Linux kernels. Perhaps the only issue is to let the Linux Kernel guess what kind of wireless card your laptop is using in case it has not recognized it.

The best way to find out about a wireless card is by issuing the command:

```
lspci
```

and look for a wireless chip-set. There are several sites which document wireless network cards for Linux, utilities as well as Howto's. If you find you need more information, kindly look at the Wireless LAN resources for Linux at wireless tools.

A very popular wireless card in many laptops today is the 'Intel Pro Wireless' (IPW) which is part of most Centrino system's configurations and packages. Therefore as an example of getting your wireless card to work in a Linux laptop setup at CCRMA, the driver for an IPW card namely ipw2200 will be configured.

First of all you might need to find out if the package wireless-tools is already installed in your computer. Type the following command:

```
rpm -q wireless-tools
```

If you don't have wireless tools installed you can use yum to install them although they are part of a full Fedora Core installation:

```
yum install wireless-tools
```

Furthermore, the ipw2200 is already compiled in many kernels but in case you need a fresher version or for some other reason ipw2200 RPMs can be found at ATrpms:

- IPW2200 driver
- IPW2200 firmware

Download the ipw2200- rpm and the ipw2200-firmware- rpm.

Install both packages by issuing a rpm command like.

```
rpm -Uvh ipw2200-* ipw2200-firmware-*
```

Firmware for the IPW2200 is constantly updated and usually is the cause for not loading the driver modules into the kernel. Try to have the most up-to-date version.

Once you have successfully installed the above packages you can proceed configuring you wireless setup.

- Do a

```
dmesg | grep ipw2200
```

to see how the kernel is detecting your IPW card.

- Do

```
iwconfig
```

to see how your IPW card is bound to the hardware.

- If eth1 is found to be bound as a wireless network interface, to see what networks are available type:

```
iwlist eth1 scan
```

– this will scan for all available networks.

- Since the CCRMA guestnet wlan network is protected find with someone at staff or with the network administrator what is the “SSID” (access point name) and also the “WEP” key. Beware that your card must be registered in guestnet and that you must also have a CCRMA login.

- Now configure your wireless card “eth1” or other as follows:

–

```
'iwconfig eth1 essid YOURSSID
```

–

```
iwconfig eth1 key xxxxxxxxxxxx
```

- For a DHCP client you can type:

```
dhclient eth1
```

- To see the status of your wireless setup you can type,

```
iwconfig
```

- To start a network connection type:

```
ifup eth1
```

- To see the network status type:

```
ifconfig
```

- then do a

```
ping cmn10.stanford.edu
```

to see how the connection is working.

References

- [1] J.M. Chowning, *Computer Music: A Grand Adventure and Some thoughts About Loudness*, Proceedings of the 1993 International Computer Music Conference, pp-2 -3, Tokyo, Japan, International Computer Music Association, San Francisco, USA, 1993
- [2] Loy, D. G., *Notes on the implementation of MUSBOX: A compiler for the Systems Concepts digital synthesizer*, In Roads, C., editor, *The Music Machine*, pages 333-349. MIT Press, Cambridge, MA., 1981
- [3] J.O Smith, *Viewpoints on the History of Digital Synthesis*, Proceedings of the International Computer Music Conference (ICMC-91, Montreal), pp. 1-10, Computer Music Association, October 1991
- [4] B. McCarty, *Learning DEBIAN GNU/Linux*, O'Reilly & Associates, Inc., Sebastopol CA,USA, 1999

Name	OS	Processor	Model	Speed(MHz)	L2Cache(KB)	Notes
cmn1	linux	1	Pentium III	733	256	.
cmn2	linux	1	Pentium II	450	512	.
cmn3	linux	1	Pentium II	450	512	.
cmn4	linux	1	Pentium II	450	512	.
cmn5	linux	2	Pentium III	600	256	.
cmn6	linux	1	Pentium III	500	512	.
cmn7	linux	1	Pentium III	500	512	.
cmn8	linux	2	Pentium III	930	256	.
cmn9	linux	1	Pentium III	865	256	.
cmn10	linux	1	Pentium III	865	256	.
cmn11	linux	1	Pentium Pro	200	256	.
cmn12	nextstep	1	Motorola	.	.	.
cmn13	unknown	.	.	.	.	.
cmn14	nextstep	1	Motorola	.	.	.
cmn15	osx	1	PowerPC .	.	.	.
cmn16	linux	1	Athlon XP1700	1466	256	.
cmn17	linux	1	Pentium III	733	256	.
cmn18	linux	1	Pentium III	733	256	.
cmn19	linux	2	Pentium III	666	256	.
cmn20	linux	1	Pentium III	600	256	.
cmn21	unknown	.	.	.	.	.
cmn22	unknown	.	.	.	.	.
cmn23	nextstep	1	Pentium	.	.	.
cmn24	linux	2	Athlon XP1800	1533	256	.
cmn25	unknown	.	.	.	.	.
cmn26	linux	1	Pentium 166	0	(f00f_bug)	.
cmn27	linux	1	Pentium 166	0	(f00f_bug)	.
cmn28	nextstep	1	Motorola	.	.	.
cmn29	nextstep	1	i486	.	.	cmn30
cmn31	linux	1	Pentium Pro	200	256	.
cmn32	nextstep	1	i486	.	.	.
cmn33	linux	1	Pentium II	266	512	.
cmn34	linux	1	Pentium II	266	512	.
cmn35	linux	1	Pentium II	266	512	.
cmn36	linux	1	Pentium II	333	512	.
cmn37	linux	1	Pentium II	450	512	.
cmn38	linux	1	Pentium II	333	512	.
cmn39	linux	1	Pentium II	450	512	.
cmn40	linux	1	Pentium II	450	512	.
cmn41	linux	1	Pentium III	870	256	.
cmn42	.	.	.	.	.	.
cmn43	.	.	.	.	.	.
cmn44	.	.	.	.	.	.
cmn45	.	.	.	.	.	.
cmn46	.	.	.	.	.	.
cmn47	linux	1	Athlon XP1800	1533	256	.
cmn48	linux	1	Athlon XP1800	1533	256	.
cmn49	linux	1	Athlon XP1800	1533	256	.
cmn50	linux	2	Athlon XP1800	1533	256	.
cmn51	linux	2	Athlon XP1800	1533	256	.
cmn52	linux	2	Athlon XP1800	1533	256	.