ABSTRACT

Audio production techniques which previously only existed in GUI-constrained digital audio workstations, live-coding environments, or C++ APIs are now accessible with our new Python module called DawDreamer. DawDreamer therefore bridges the gap between real sound engineers and coders imitating them with offline batch-processing. Like contemporary modules in this domain, DawDreamer can create directed acyclic graphs of audio processors such as VSTs which generate or manipulate audio streams. Our paper discusses DawDreamer’s unique features in detail and potential applications across music information retrieval including source separation, transcription, parameter inference, and more. We provide fully cross-platform PyPi installs, a Linux Dockerfile, and an example Jupyter notebook for making tempo-matched audio mashups.

INTRODUCTION

A digital audio workstation (DAW) is a software system which integrates most music production tasks including composing, recording, editing, adjusting effects, and exporting to audio files. An audio engineer typically uses a mouse and keyboard or expensive mixing console to carry out these tasks, making it difficult to explore efficiently the large action space of effects and their parameters. Moreover, some digital instruments and effects are platform specific, such as Audio Units on macOS or LV2 plug-ins on Linux. The ideal batch-processing audio framework with relevance to machine learning should both overcome the hurdles of mouse-and-keyboard interfaces and unify instruments and effects across all platforms.

One project in this domain is RenderMan, a Python module which served as the starting codebase for DawDreamer. RenderMan uses the JUCE framework for rendering audio from VST instruments. RenderMan played a crucial role in research on software synthesizer presets and massive audio generation, but its development has been slow to branch into other aspects of music production such as bussing.

FluidSynth is a sample-based synthesizer engine with command-line support, but its reliance on SoundFont samples limits broader applications.

Pedalboard is a new project with similarities to RenderMan and DawDreamer. It has a promising future but currently lacks support for Faust, parameter automation, efficient time-stretching and pitch-bending, and audio processor graph building (generalized bussing).

FAUST

Faust (Functional Audio STream) is a programming language for real-time signal processing. Faust’s built-in libraries include functions for reverb, compressors, oscillators, filters, ambisonics, Yamaha DX7 emulation, and more. Visit https://faustlibraries.grame.fr for more examples.

Faust uses the libfaust backend to compile Faust code just-in-time. Elements in the Faust source code that would usually designate user interfaces such as sliders or toggles instead become parameters which can be automated according to numpy arrays.

This coupling between Faust user interfaces and DawDreamer also enables easy control of polyphonic Faust instruments. A developer can write Faust code with a single voice of polyphony in mind and provide MIDI notes from Python or from a MIDI file. All of the voice allocation is done automatically.

DawDreamer includes great starting-point Faust examples:

• Faust Library’s Yamaha DX7 recreation
• A sidechain compressor
• A polyphonic wavetable synthesizer
• A polyphonic sampler instrument (like a drum machine)

The synthesizer’s wavetable and the sampler’s sample can be specified with numpy arrays. If a VST has limits on which audio files it can use, or some parameters aren’t accessible to the user, you should consider using Faust to recreate the instrument. The sampler example shows the simplicity of using MIDI-triggered ADSR envelopes and information to modulate the sample’s pitch, volume, and filter cutoff.

Beyond DawDreamer, Faust code can be compiled for Windows, Linux, macOS, Android, iOS, and many microcontrollers such as Teensy, SHARC, Bela, and most recently FPGAs. It can also be exported in many project formats and languages such as JUCE, Max, vcvrack, rust, julia, soul, C++, and more. Researchers would be wise to not restrict themselves to VST and LV2 audio plug-ins when Faust can be deployed so widely.

POTENTIAL USE CASES

Music Information Retrieval

A researcher of universal music source separation could use DawDreamer and generative music composition networks to create ground truth mixes of tens of audio tracks rather than the common four (vocals, drums, bass, and other). These generated mixes could become increasingly realistic and helpful for source separation, transcription, lyrics alignment, instrument identification, cover identification, and more.

Intelligent Music Production

DeepFAK achieved high quality automatic audio mastering through gradient approximation of a fixed series of LV2 audio effects. DeepFAKs also succeeded at picking plug-in parameters to match a guitar pedal’s distortion. In both cases, DawDreamer could learn the same mastering or compressor with Faust effects, but thanks to Faust, the effect could be deployed easily to more microcontrollers.

CONCLUSION

Much of music production is a series of actions taken inside a DAW environment, yet some ML researchers study musical audio as a raw series of numbers. To be fair, this domain-agnosticism helps models generalize to other domains, but it forfeits the helpful inductive biases from understanding music as the interaction of MIDI notes, sample packs, signal chains, effects, and parameter settings. Those building blocks and domain knowledge form a large part of the DNA of music. Researchers can now use DawDreamer as the physically unconstrained software engine that grows musical DNA into fully-realized audio data.

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DawDreamer: Bridging the Gap Between Digital Audio Workstations and Python Interfaces

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