

Synthesis Simplified: Developing A Python Driven Synthesizer Using wxPython and PYO

Miles Rochester and Dr. Sofia Visa (Advisor)

Abstract

Computer scientists and musicians alike can benefit from this thesis, which explores programming in Supercollider and Python alongside foundational sound design principles and music theory. Using these topics as a foundation, we develop a polyphonic synthesizer and provide an abstracted, step-by-step guide for replicating the project. This work bridges the gap between code and creativity, offering both technical insight and artistic application.

Synthesis

•A **synthesizer** is a sound machine that creates signals using electronic or digital tools.

- Oscillators:** Generate periodic waveforms (sine, square, triangle, sawtooth).
- These waveforms serve as the foundational elements of sound.

•**Additive Synthesis:** Involves combining multiple waveforms to produce complex sounds.

•**Sound Design Techniques** such as frequency modulation and envelope shaping are crucial for crafting nuanced sonic textures.

ADSR Envelopes

An **envelope** is a function that modulates a sound’s amplitude over time. The ADSR model includes:

- Attack:** How quickly the sound reaches peak amplitude
- Decay:** How quickly it drops to the sustain level
- Sustain:** The steady level of the sound while held
- Release:** How long it takes to fade to silence

Waveforms

Basic waveforms—sine, square, triangle, and sawtooth—are the fundamental building blocks of synthesized sound..

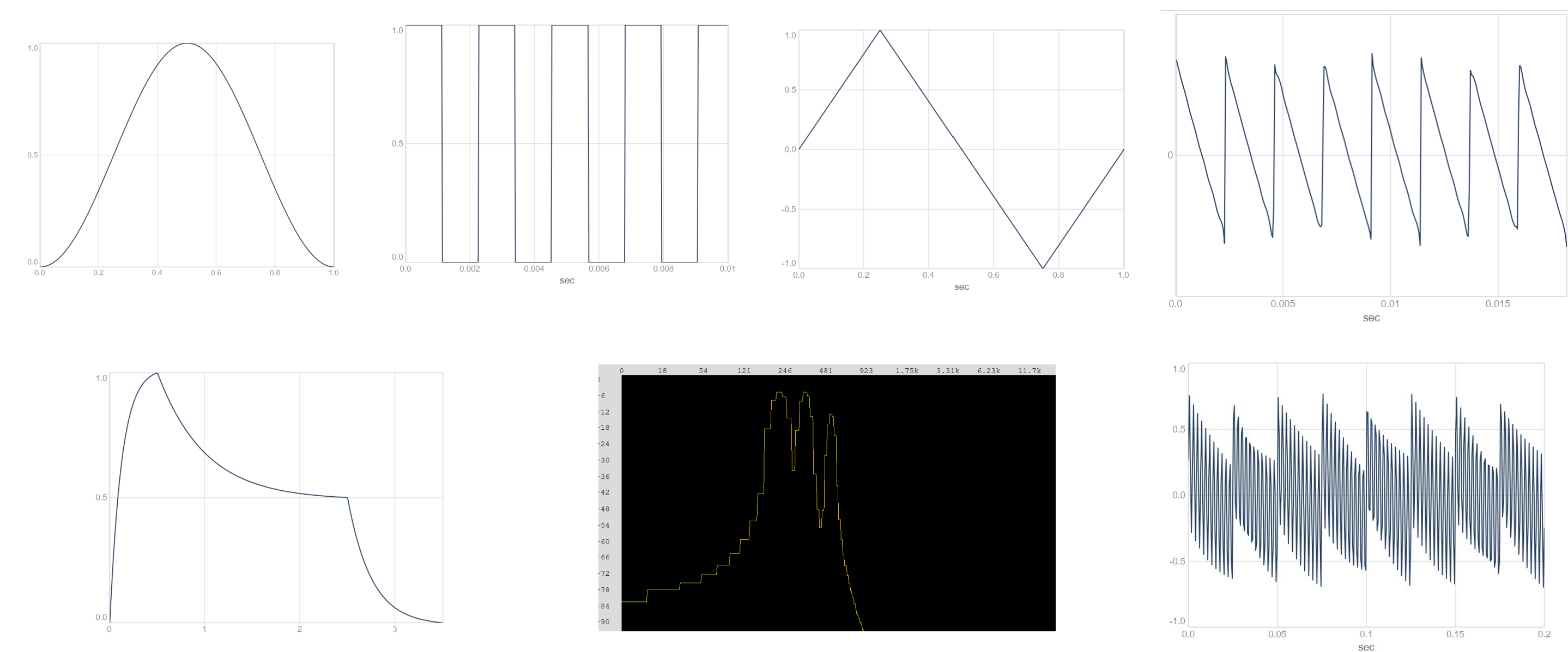


Figure 1-7: Various graphs of discussed waveforms – Figure 6 depicts a graph of a chord being play through the sine waveform

Musical Background

Music is a form of communication that transcends language and culture. This project integrates foundational music theory to enhance the usability and playability of the synthesizer. Concepts like:

chords, progressions, and the **Circle of Fifths** are used to guide the user toward musically coherent choices, even if they lack formal training.

Application Abstraction

In order to demonstrate the processes our program’s main logic undergoes we provide Figure 1 which details the steps behind the scenes. This **abstraction** is intended to be used to guide future works.

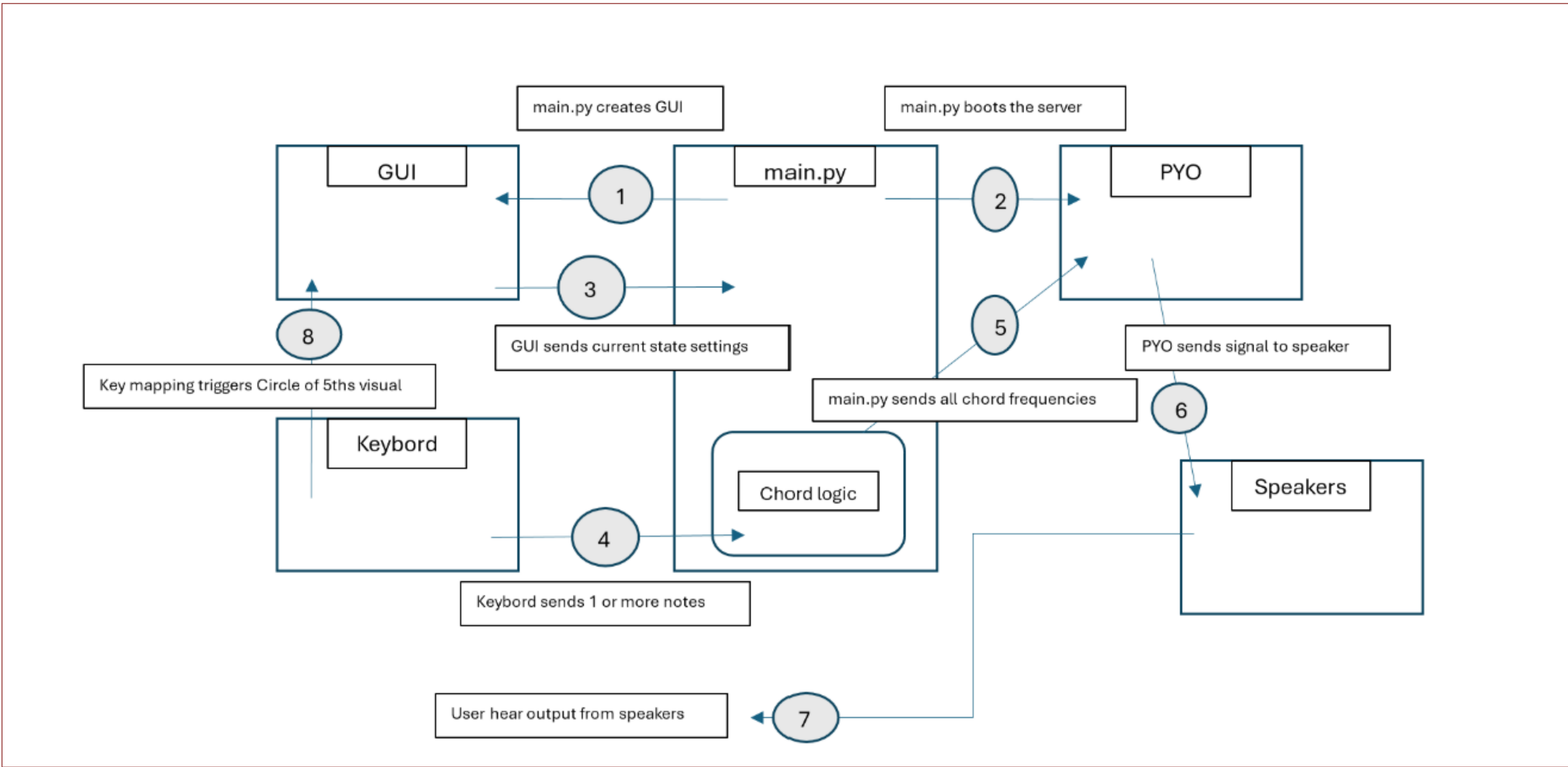


Figure 1: Behind-the-scenes abstraction of our synthesizer’s main logic. This flowchart details the structure of the program, from user interaction to sound output, and serves as a reference point for those aiming to build upon this educational synthesis framework.

wxPython & PYO

The synthesizer is built using two key Python libraries: **Pyo** and **wxPython**.

Pyo (Audio Engine):

- Python module for real-time audio signal processing.
- Supports waveform generation, envelope shaping, frequency and amplitude control.
- Offers low-latency audio, making it ideal for interactive music applications.

wxPython (Graphical User Interface):

- Provides GUI components like knobs, sliders, dropdowns, and buttons.
- Enables real-time control of audio parameters via user interaction.
- Each GUI element is directly tied to an audio event.

Our Synthesizer

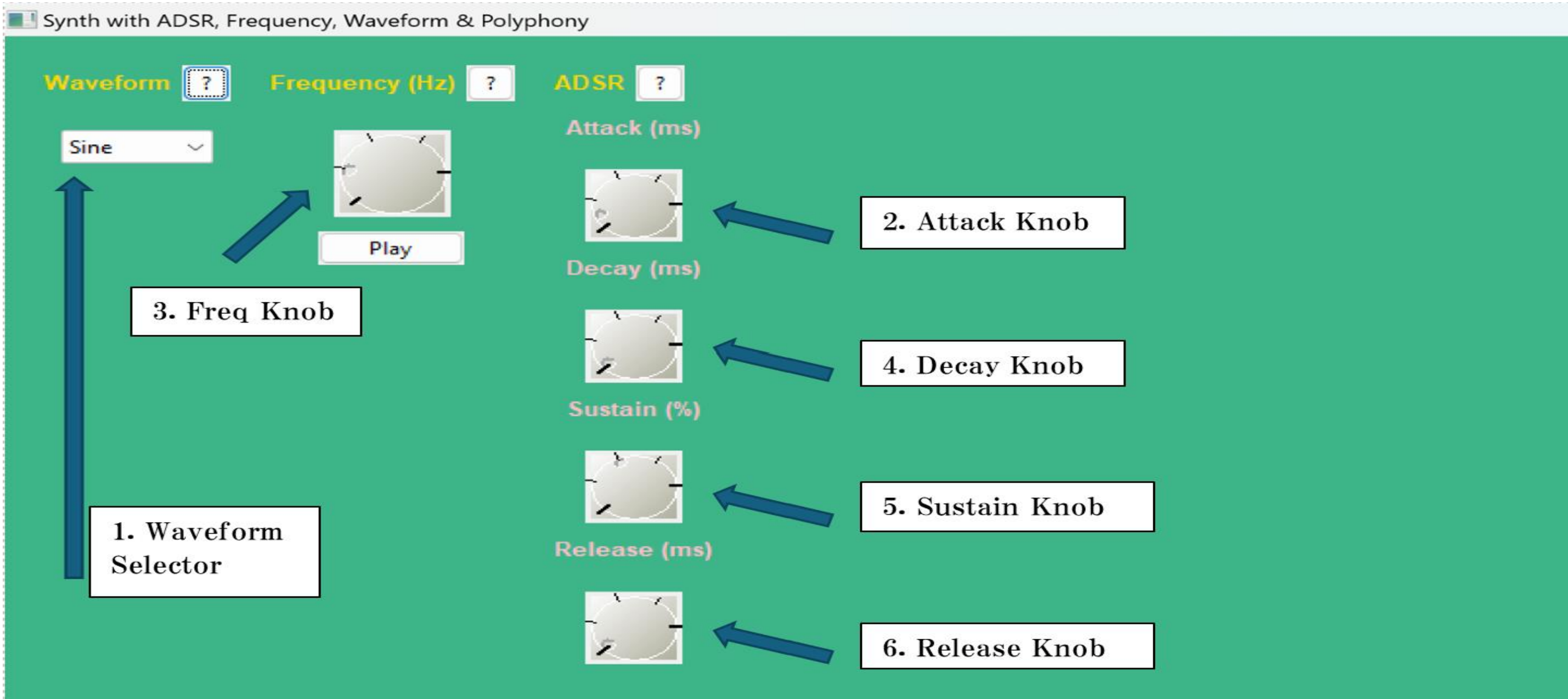


Figure 8: The synthesizer we implement

The synthesizer features a clean, beginner-friendly interface built with wxPython and powered by Pyo for real-time audio. Users can:

- Select a waveform (sine, square, or sawtooth)
- Control pitch with the **Frequency knob**
- Shape sound using **ADSR knobs:** Attack, Decay, Sustain, Release
- Play sounds instantly with a single button

The layout is designed for hands-on learning, letting users explore synthesis concepts visually and aurally.

Figure 9: Omnisphere, an industry standard in synthesis [1]



•**Serum** and **Omnisphere** are industry-standard synthesizers

•Known for powerful sound engines, deep modulation, and sleek UIs

•These tools can be intimidating for beginners due to their complexity

•This project offers a simplified, educational alternative

Figure 10: Serum, an industry standard in synthesis [2]

Conclusion

- Synthesizer connects music production with computer science
- Designed to be beginner-friendly for learning sound design
- Integrates music theory (e.g., Circle of Fifths)
- Features technical elements like ADSR envelopes and frequency modulation
- Functions as both an educational tool and a creative platform

References

- [1] Spectrasonics. *Omnisphere Power Synth*. <https://www.spectrasonics.net/products/omnisphere/>
[2] Xfer Records. *Serum Advanced Wavetable Synthesizer*. <https://xferrecords.com/products/serum>