SCHOOL OF MUSIC, THEATRE & DANCE
PERFORMING ARTS TECHNOLOGY
UNIVERSITY OF MICHIGAN

Creative Coding (PAT 204/504, Fall 2024)

Lecture 17 – Additive, AM & FM Synthesis

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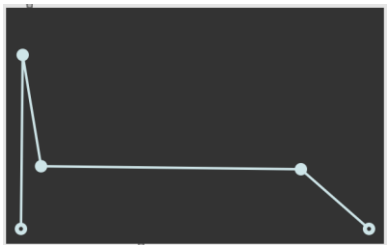
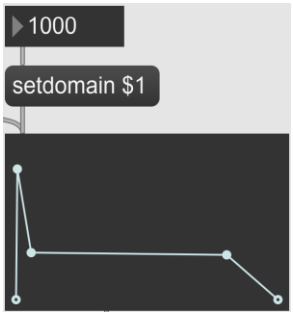
Example 1: ADSR envelopes ("1_adsr_envelope.maxpat")

- The ADSR envelope is a commonly used envelope for modulating the amplitude of an audio signal.

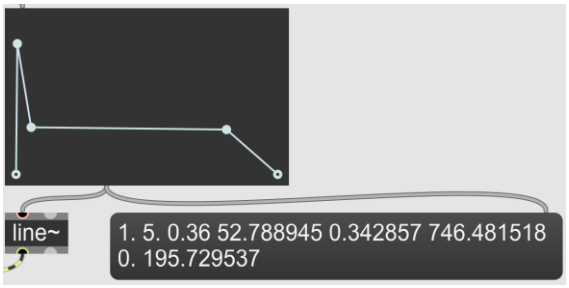
  - **Attack**: the **time** taken for the level to rise to the peak
  - **Decay**: the **time** taken for the level to reduce to the sustain level
  - **Sustain**: the **level** maintained until the key is released
  - **Release**: the **time** taken for the level to decay to zero
- Use the "function" object to create an interactable ADSR envelope



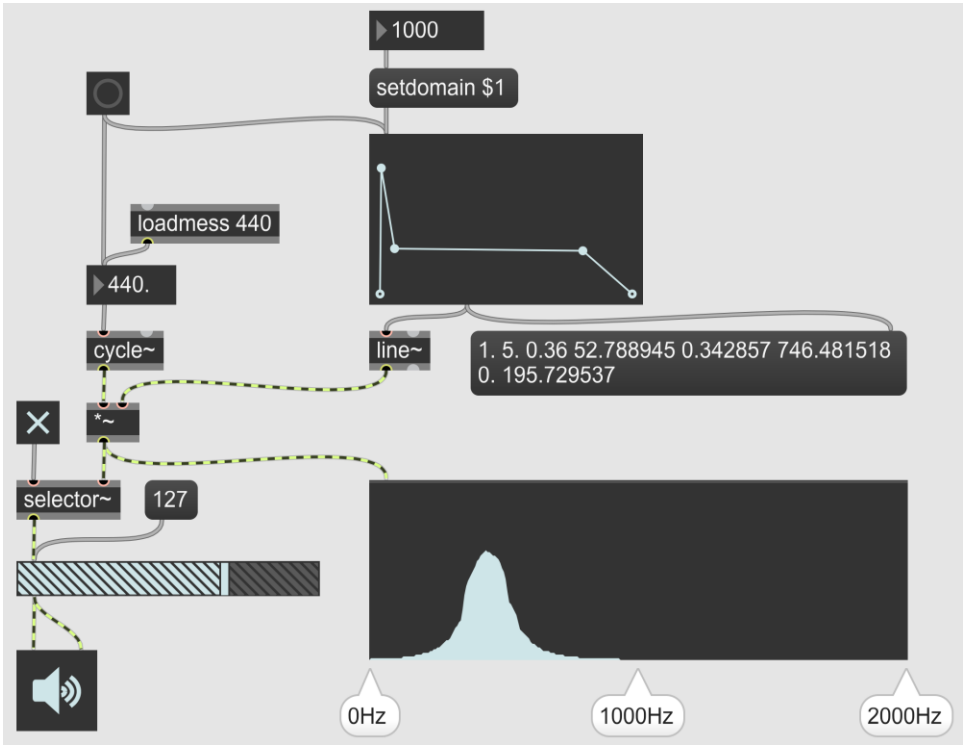
- Use a message "setdomain X" to set the range of the y-axis of the "function" object, which corresponds to the duration of the whole ADSR envelope



- Use a “line~” object connected to the second outlet of the “function” object, which outputs a series of numbers that describes the function

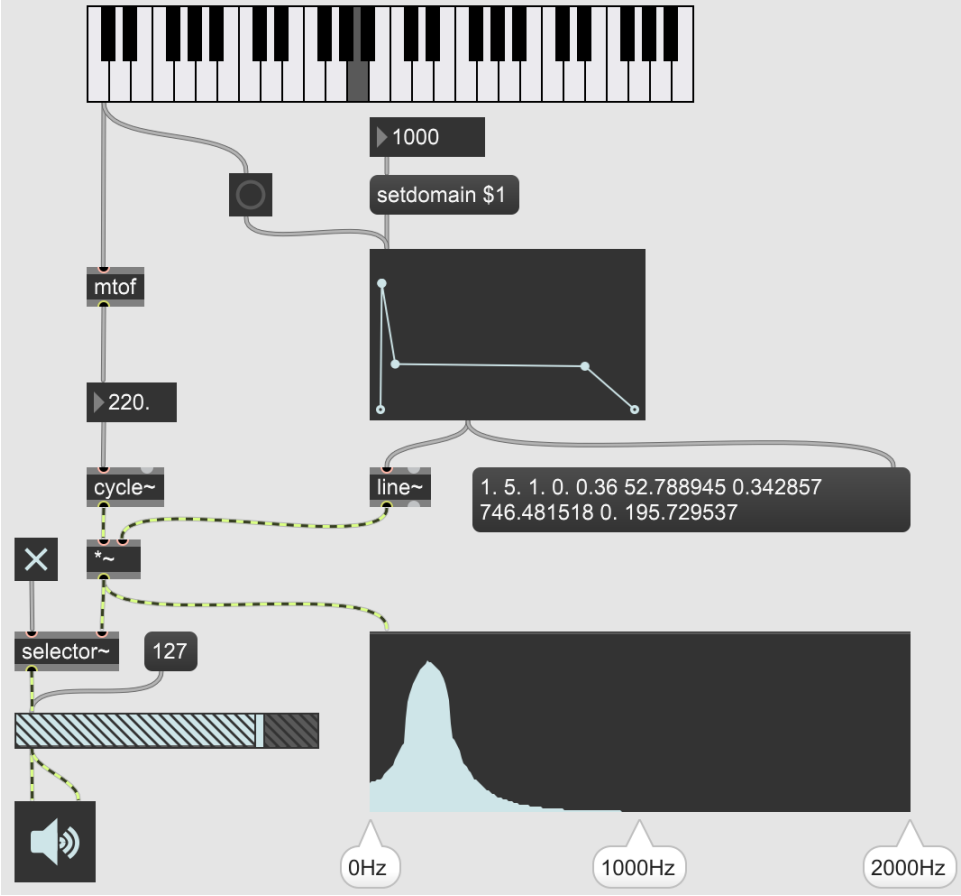


- Use the ADSR envelope to modulate the amplitude of a sinusoid signal

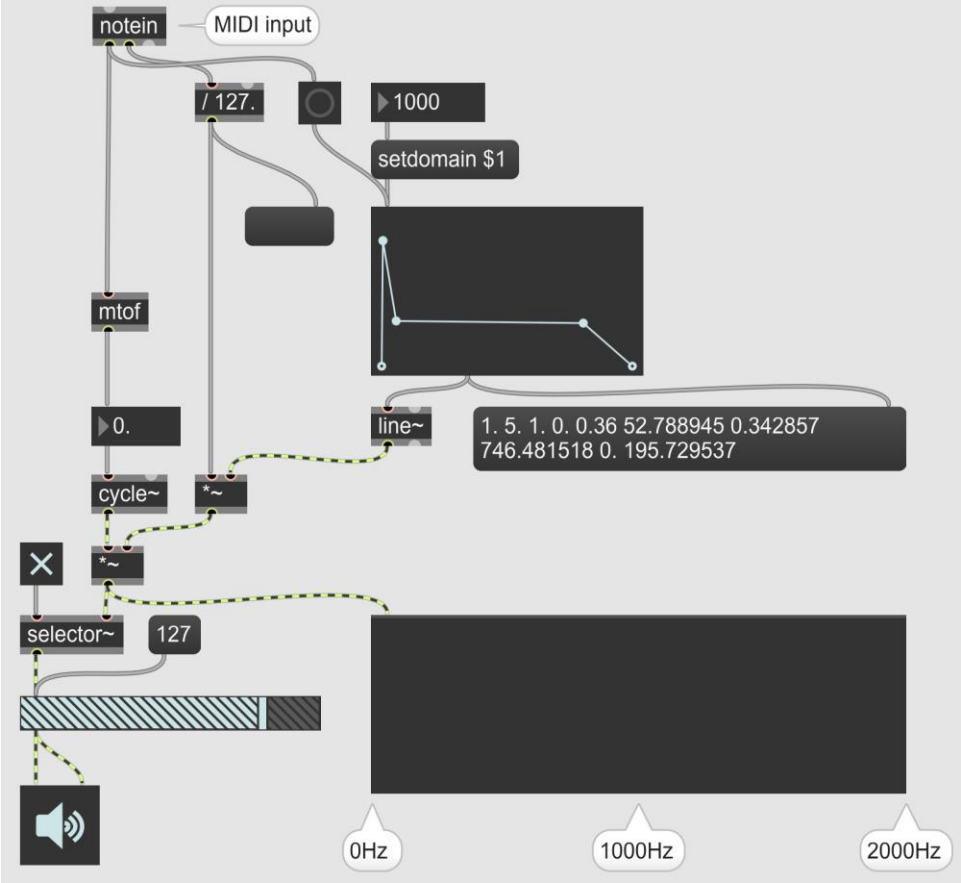


    - Note that a bang message is required to trigger the “function” object to send a message to “line~”

- Use the “kslider” object to create a MIDI keyboard that you can play with your mouse

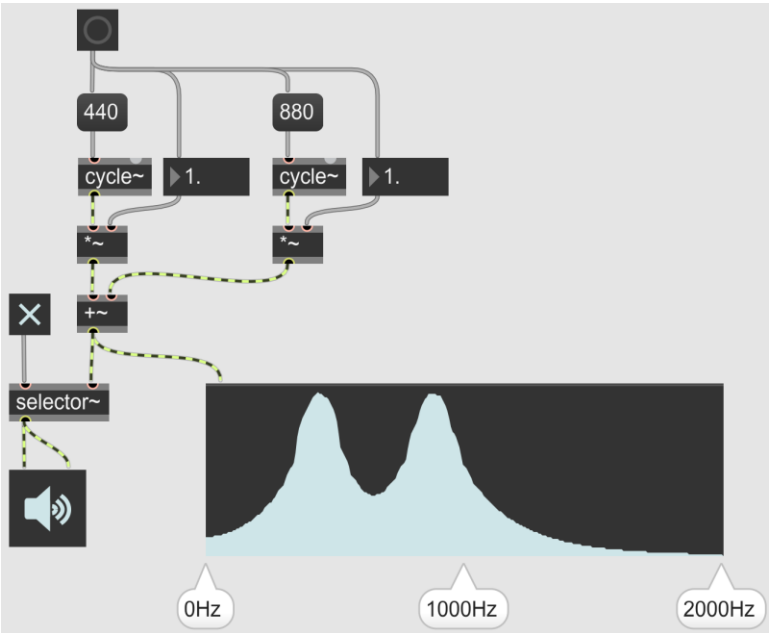


- Use the “notein” object to take MIDI inputs if you have a MIDI input device

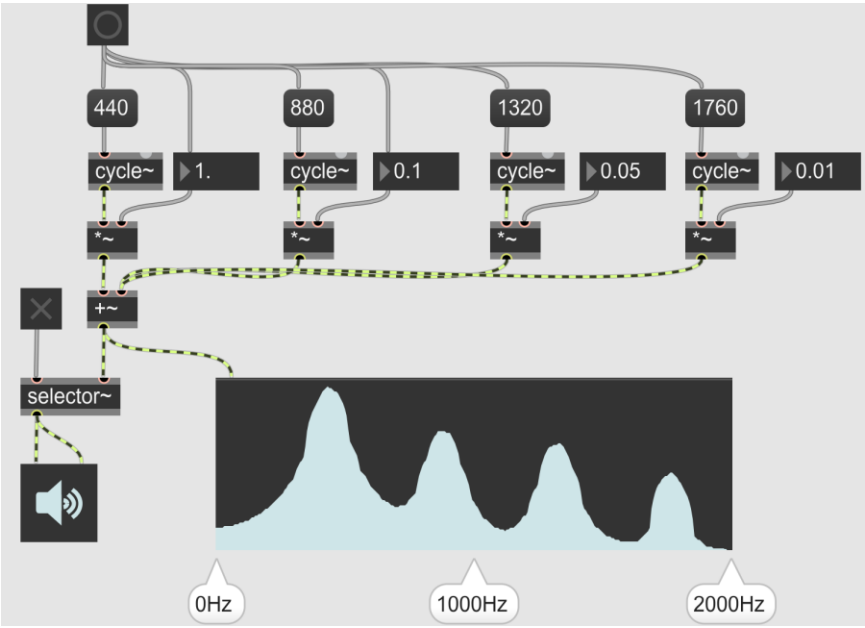


Example 2: Additive Synthesis (“2_additive_synth.maxpat”)

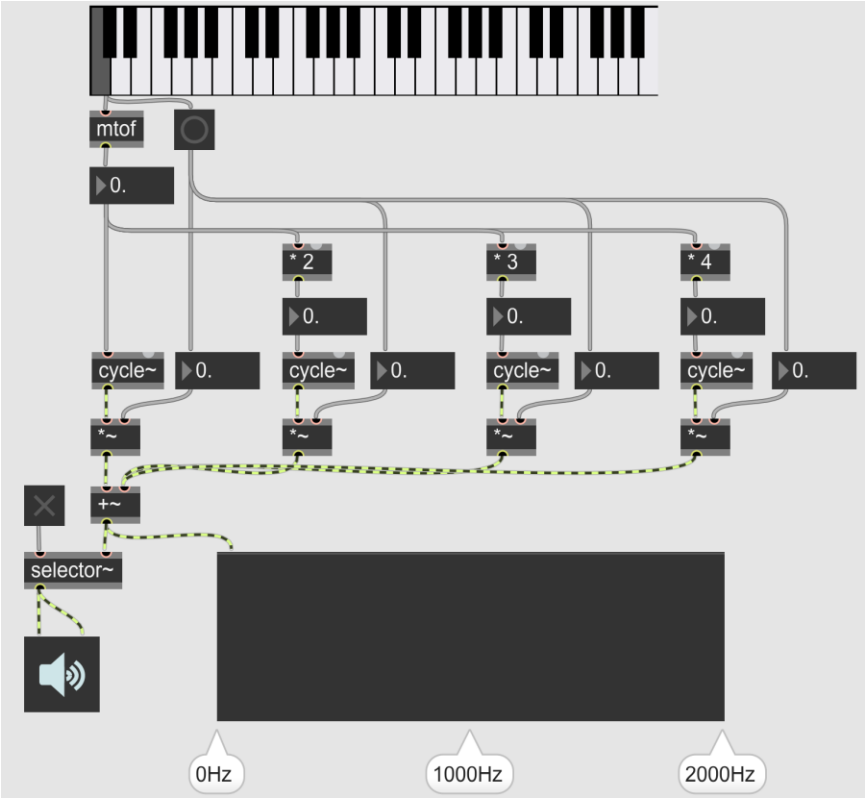
- Use a “+~” object to sum signals up



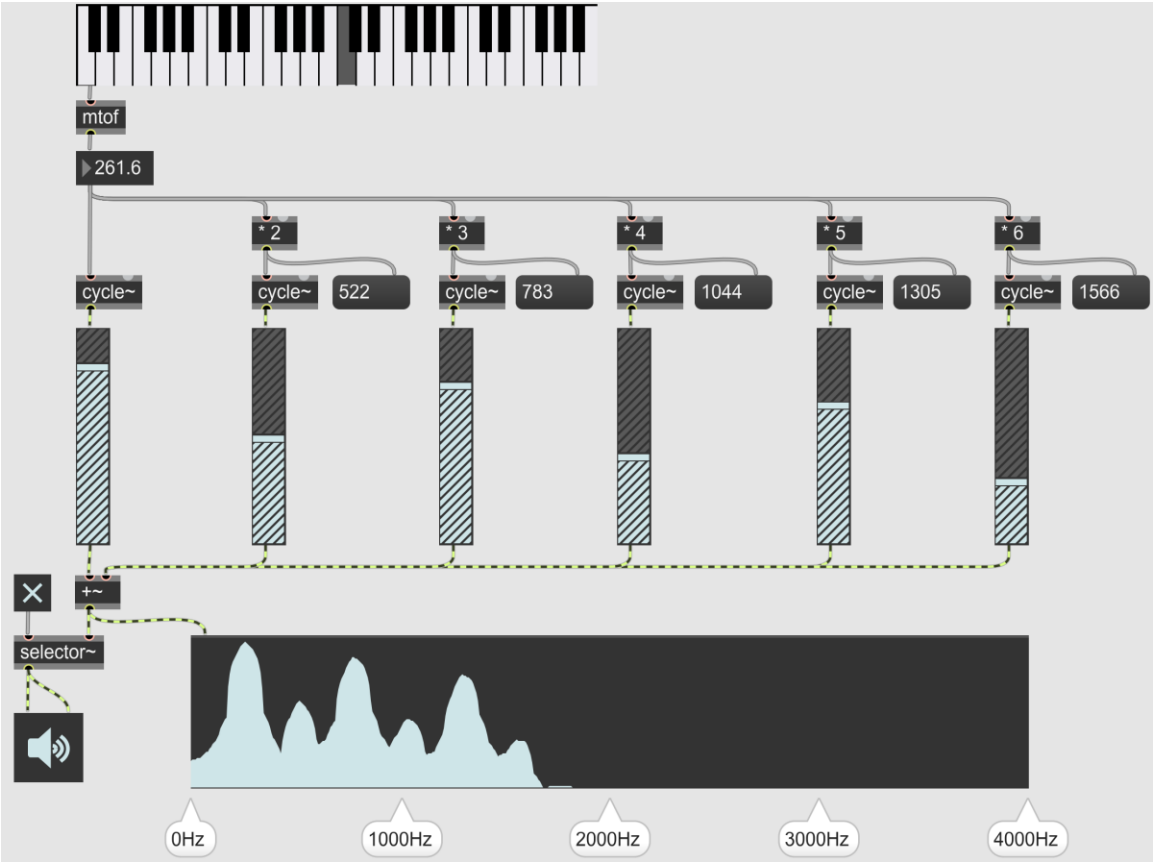
- Send multiple signals with different magnitudes to the “+~” object to sum them up



- Use a “kslider” object as the interface and set the frequencies of the signals as multiples of the base frequency

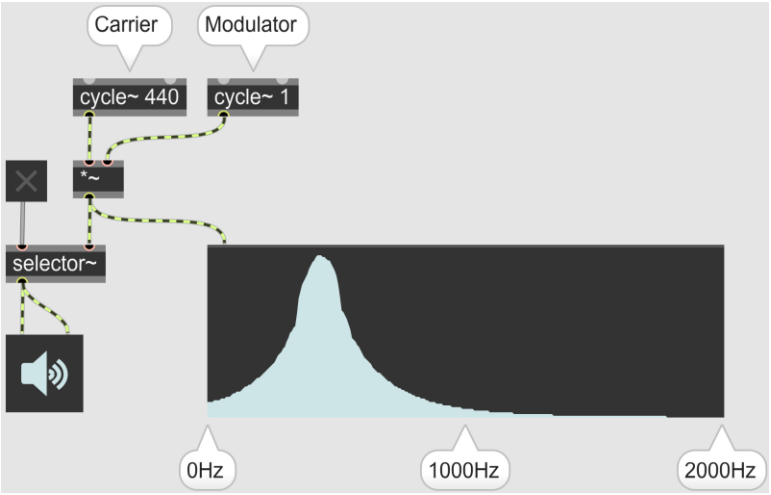


- Use the “gain~” objects for a more intuitive way to mix signals

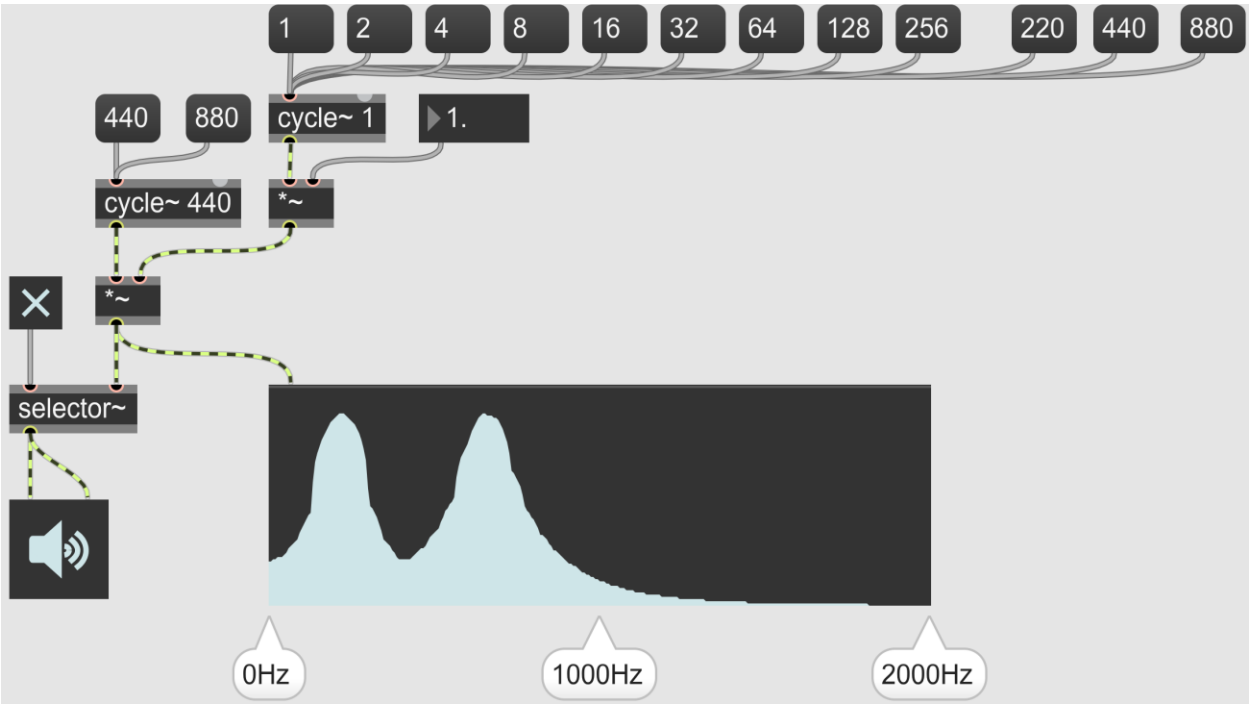


Example 3: AM Synthesis

- AM stands “amplitude modulation,” were we use another signal (called *modulator*) to “modulate“ the magnitude of a signal (called *carrier*)
- Amplitude modulation can be done by talking the product between a carrier signal and the modulator signal



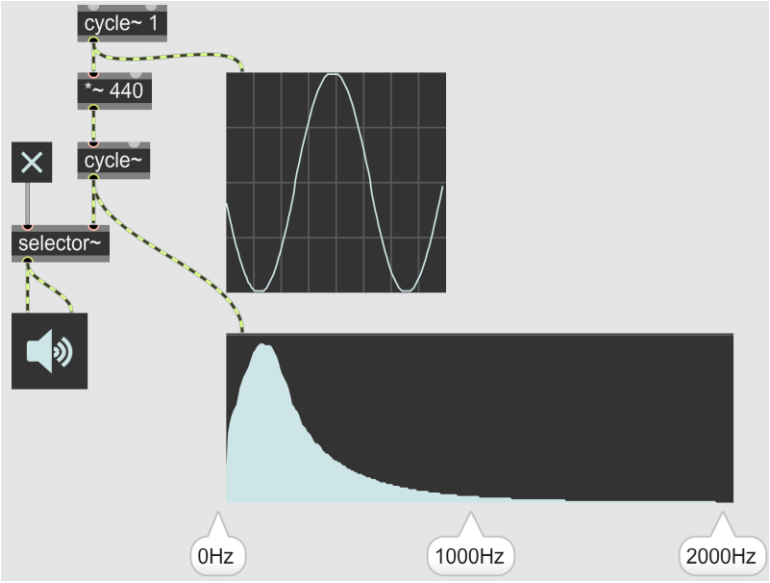
- When the frequency of the modulator signal is high, it actually creates a separate tone of its own



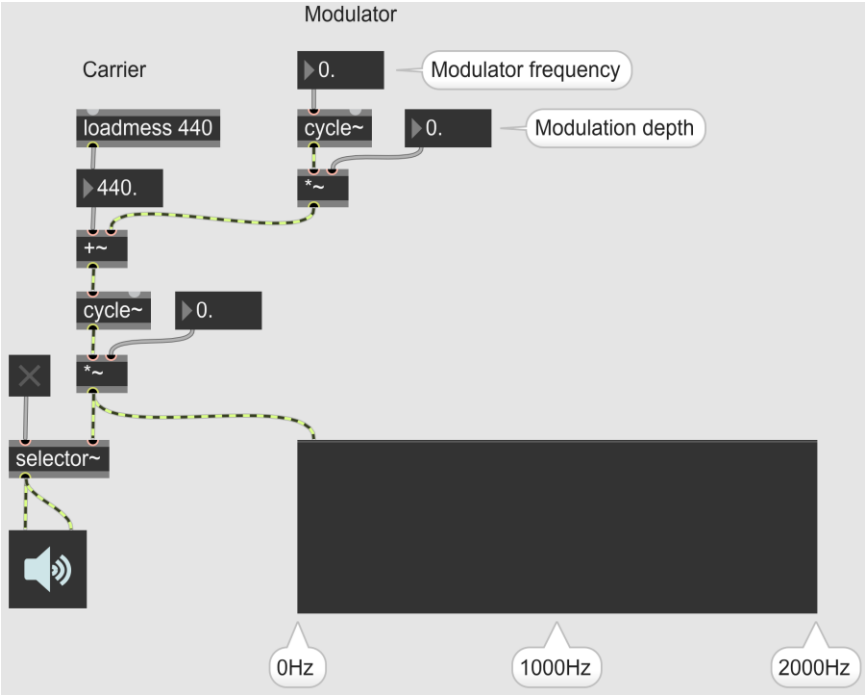
  - Above is an example when the carrier is 440Hz and the modulator is 220 Hz, and we see two tones at 220Hz (440Hz – 220Hz) and 660 Hz (440Hz + 220Hz)

Example 4: FM Synthesis

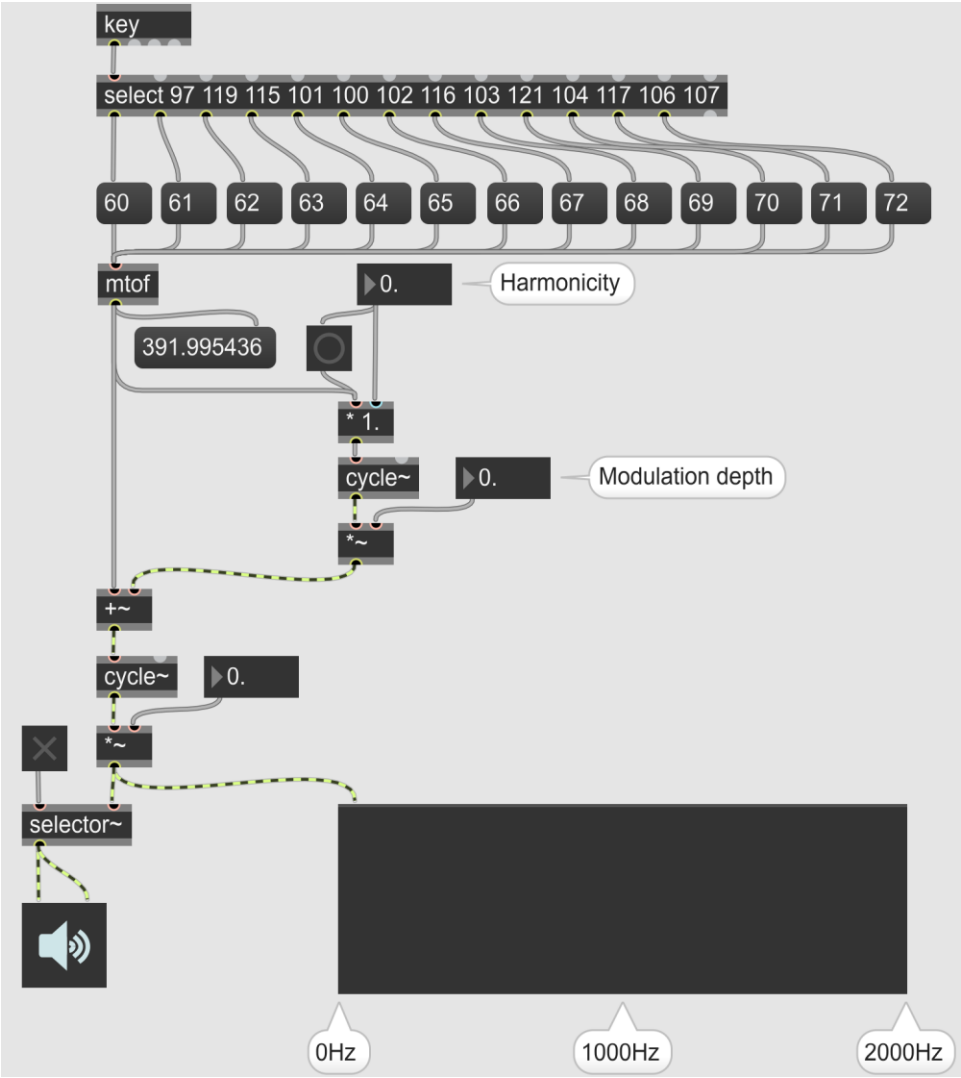
- Send a sinusoid signal to the first inlet of the “cycle~” object that “modulates” the frequency of the carrier signal (the second sinusoid signal)



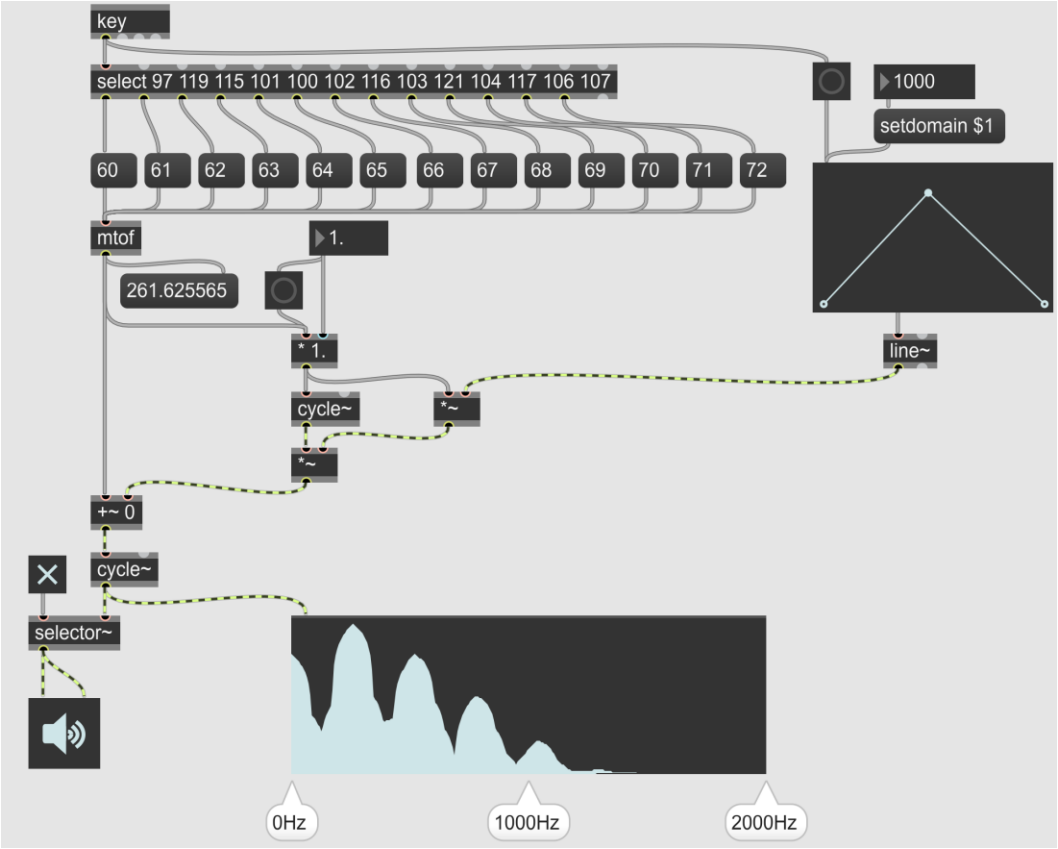
- Add a sinusoid signal to the carrier frequency to modulate the frequency



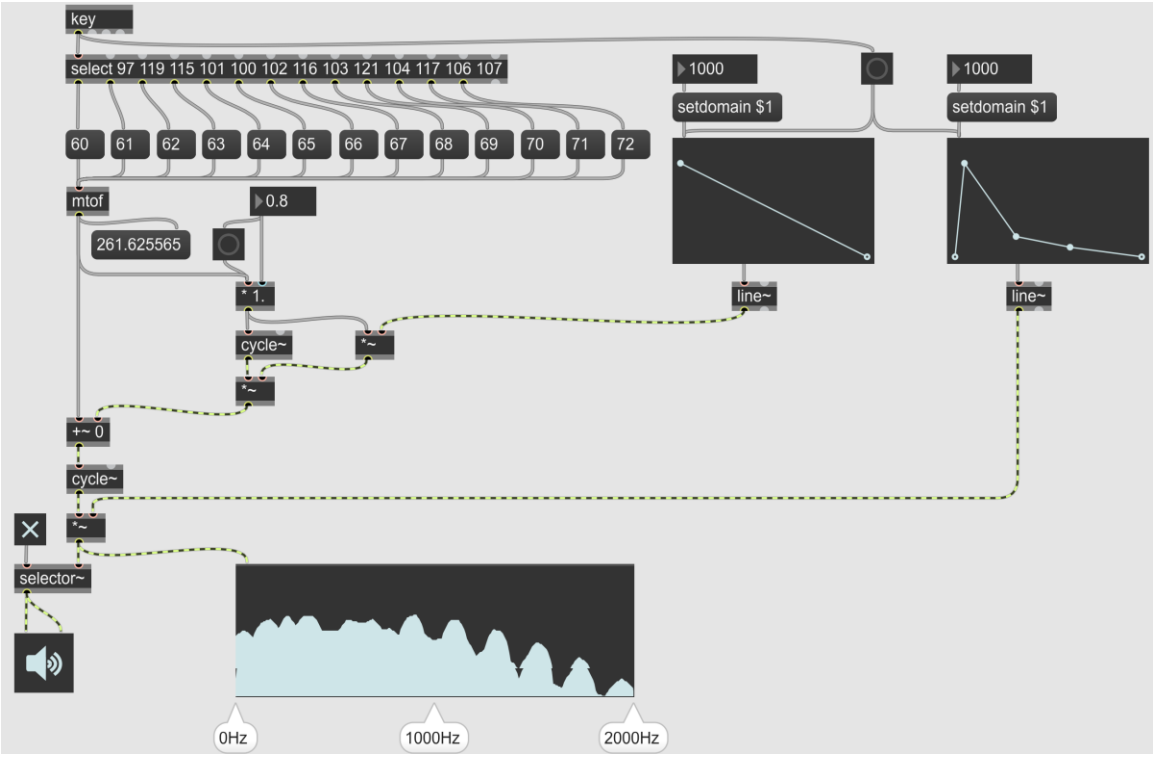
- Use the “kslider” object to allow easy control of the carrier frequency and set the modulator frequency as a specific multiple (doesn’t need to be a perfect multiple)



- Use a “function” object to create an automation that controls the modulation depth

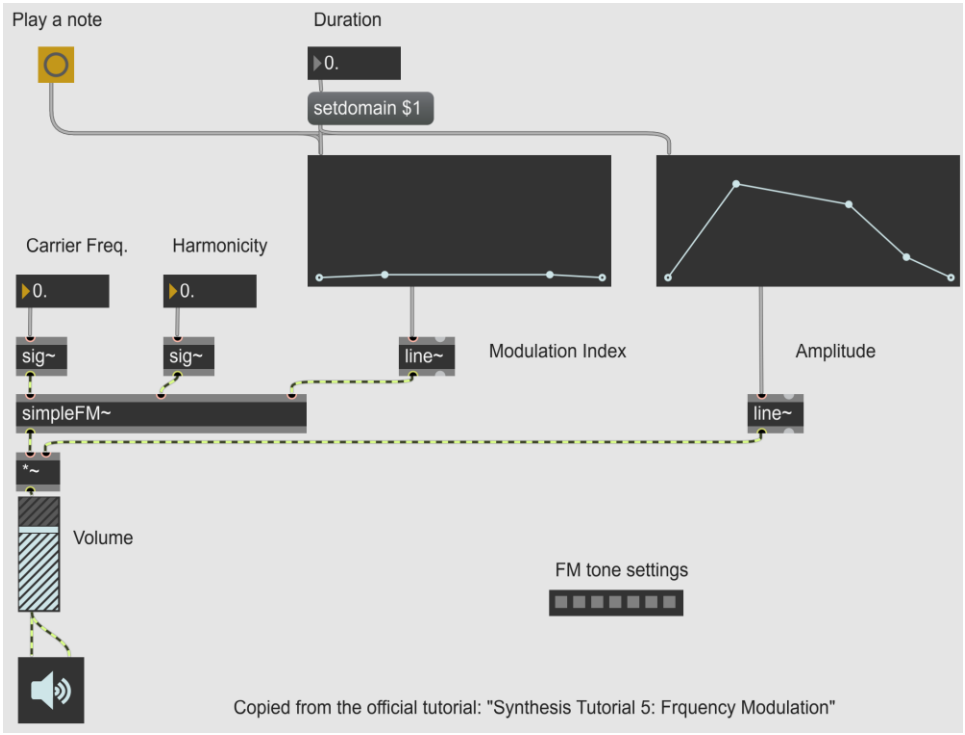


- Use another “function” to create an ADSR envelope to control the magnitude



Example 5: FM Synthesis (Alternative) (“5_FMSynthesis.maxpat”)

- This is the official MAX tutorial on FM Synthesis, where it provides several nice presets



  - Use the “preset” object to store the values of all interactable objects as a preset
  - Click on a certain square to recall, and Shift-click it to store/update a preset