Chapter 2. Meeting 2, Foundations: Sounds, Signals, Samples, and Encodings

2.1. Announcements

- Reading and Listening Discussion Leader assignments will be posted today
- Note that I will not comment directly on posted notes (but do check that they are there)

2.2. Reading: Wang, A History of Programming and Music

- Wang, G. 2007. "A History of Programming and Music." In N. Collins and J. d'Escriván, eds. *The Cambridge Companion to Electronic Music*. Cambridge: Cambridge University Press, pp. 55-71.
- What non-software programming interfaces for music does Wang describe?
- What are some of the fundmental concepts shared by many music programming languages?
- What is the trajectory of programming languages proposed?

2.3. Reading: Puckette, Max at 17

- Puckette, M. 2002. "Max at 17." *Computer Music Journal* 26(4): pp. 31-43.
- Is there one Max?
- What was the background developement of Max?
- What is max good at? What is it not good at?
- What roles do style and aesthetic play in computer music software design?

2.4. Starting Pd, The Pd Window

- The Pd Window is the destination of all error messages and message sent with [print]
- The "compute audio" toggle
  - Controls all signal processing generation
  - Can also be toggled in Media menu, with key strokes, and also with text commands (to be shown later)

2.5. Basic Components

- Patches: windows or collections of windows
- Object boxes: process or create data or signals
- Message boxes: store data
- Data
  - Can be “event” data or “signal” data
  - Passed via “patch cables” between boxes
- Comments: notes to yourself
- Interface objects: number boxes, slides, signal boxes, etc.

2.6. The Patcher Window

- A window represents a patch
- Windows can communicate between each other
- A patch can be embedded in another patch using [pd name]
- A patch can be stored as a file and loaded into another patch, called an abstraction

2.7. The Patcher Window: Edit and Run Modes

- Patch windows have two modes: edit and run
- Changing modes: Menu: Edit > Edit mode (command E)
- Edit mode: configure objects, create patches, move things around, selected objects are blue
- Run mode: objects do not move, user interface components (knobs, sliders) function
- Example: Put a Vslider; when blue, in edit mode, cannot use slider; in run mode, black, can use slider

2.8. Object Boxes

- An object is generally a computational subroutine
- An object has a class: a paradigm, an archetype

- We can make many instances of the same object, each with its own behaviour and settings
- Example: [random 20], [random 4]

2.9. Object Boxes: Creation

- Use the Put menu: Menu: Put > Object (command 1)
- An empty dotted-line box emerges: this is not an object
- An object has to have at least one creation argument to specify its type
- Additional arguments can be used to configure the object
- Example: [+], [random], [line], [select], [print], [osc~]

2.10. Objects: Types

- There are event (control rate) objects and signal objects
- Event objects process data: [line], [select]
- Signal (tilde) objects process signals: [line~], [osc~]
- There may be two versions of a type of object, one for events, one for signals: [+], [+~]

2.11. Object Inlets

- Inlets provide data or signals into objects (not both)
- White (hollow) inlets are for data, dark (filled) inlets are for signals
- Example: [+], [+~]
- For many event objets, leftmost inlet is hot: output is provided only when values are provided in this inlet
- Example: [+], [pack]

2.12. Object Outlets

- White (hollow) outlets are for data, dark (filled) inlets are for signals
- Example: [+], [+~]

- Outlets almost always provide output from right to left
- Example: [unpack f f f]

2.13. Object Interconnections

- Connections between objects can transmit either signals or event data
- Signal and event data connections are different, and cannot be interconected
- To create a connection: in Edit mode, mouse over outlet until cursor is a circle; click and hold; mouse over desired inlet until cursor is a circle; release click.
- Example: [* 4] to [+ 3], [*~ 4] to [+~ 3]

2.14. Data

- Data can be bangs, numbers, symbols, lists, or signals
- Bangs (b): a trigger, an event, a "do something now"
- Numbers (f): all numbers are floating point values
- Symbols (s): character strings (not in quotes)
- Lists (l): a space separated collection of numbers or symbols
- Signals (v): floating-point number stream at the sampling rate (when "compute audio" is on)

2.15. Data Storage

- Data can be seen (in objects, interfaces, etc) and unseen (in objects, through patch connections)
- Only data that is "seen" is saved with patch

2.16. Data Storage: Object Boxes

- Objects can have additional construction arguments
- These arguments configure how the object performs on initialization
- These arguments can sometimes be overridden by inlet values
- Example: [* 2]

2.17. Data Storage: Message Boxes

- Use the Put menu: Menu: Put > Message (command 2)
- One inlet, one outlet; note curved left side distinguishes message boxes from object boxes
- Store bangs, numbers, symbols, or lists
- Saved with patches
- Provide a user interface: can be clicked in Run mode to provide output
- Example: (bang) to [random 10] to [print]
- Example: (3) and (10) to [+] to [print]

2.18. Interface Objects: Number Boxes

- Can be used to provide numerical inputs to other objects
- Can be used to receive the numbers outputted from objects
- Can be varried as a GUI only in Run mode
- Important: holding down shift permits enter flaoting point values
- Min and max values can be set with object properties

2.19. Interface Objects: Bang

- Can click to send a bang
- When receiving a bang, darkens
- Sending a bang can be replaced by a message box with “bang” specified

2.20. Selecting, Moving, and Copying Objects

- Objects can only be moved in edit mode
- Can click and drag to create a selection area
- Objects (and interconections) can be duplicated and copied
- Copying and pasting overlays existing objects: always duplicate

2.21. Object Help, Documentation, and Tutorials

- Control click on an object and select "help" to view a help patch
- Demo patches (when available) provide examples and explanation
- The PD Glossary http://www.flexatone.net/docs/pdg
- Kreidler, J. 2009. "Programming Electronic Music in Pd." Wolke Publishing House. Available online at http://www.pd-tutorial.com.

2.22. Object Properties

- Control click on a bang interface object and select "properties" to specify visual appearance
- Colors and other attributes can be configured

2.23. Comments

- Comments are notes left to readers of the program
- Comments cannot be used as data in a patch
- Comments are critical and are essential in good code
- Use the Put menu: Menu: Put > Comment (command 5)

2.24. Saving Patches and PD files

- Always save files with a .pd extension at the end
- PD files are text files that specify the interconnections between objects

2.25. Abstractions and Martingale

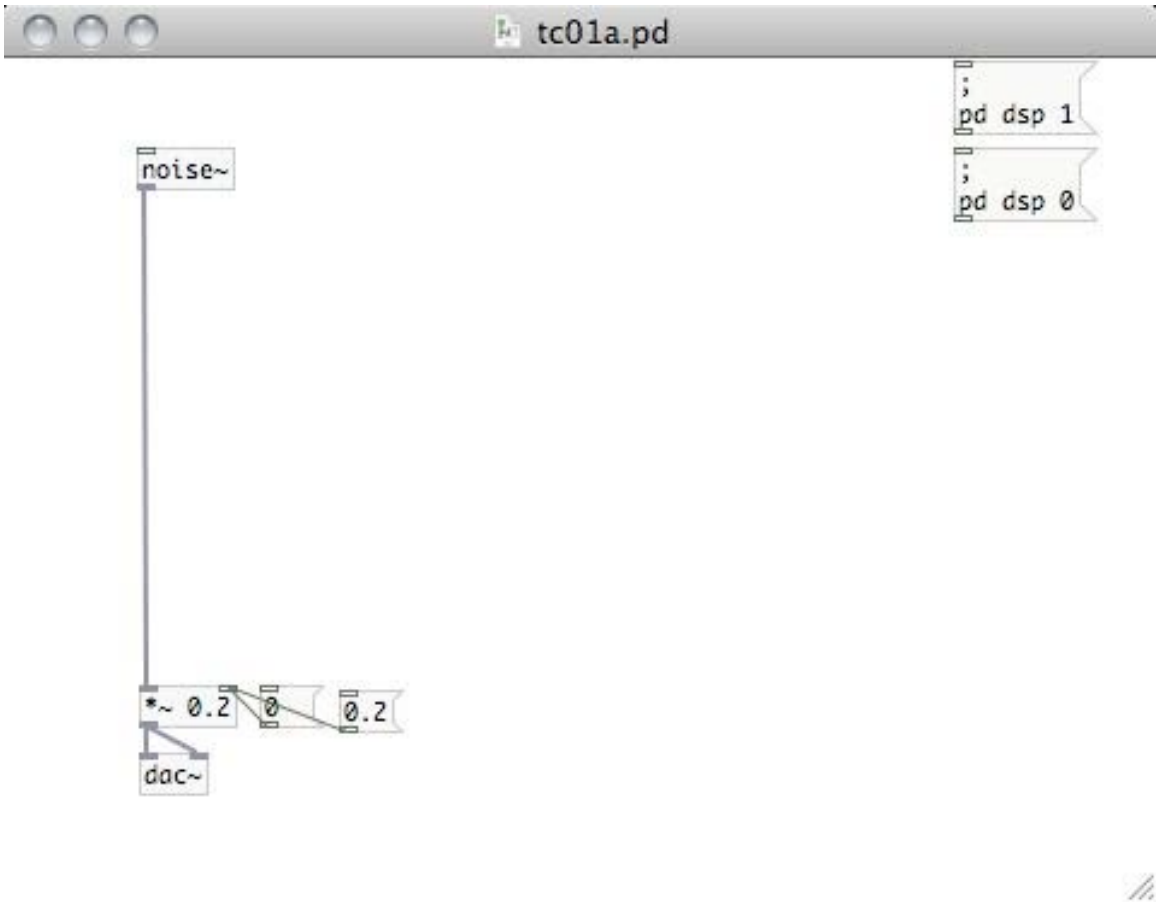
- Abstractions are PD patches that can be used in other PD patches
- Abstractions may have any number of inlets or outlets
- To load an abstraction, it must be placed in a directory that PD knows about
- Download Martingale manually: http://code.google.com/p/martingale/
- Add the "martingale/pd/lib" directory to Preferences > Path; this permits loading abstractions from the martingale library

2.26. Noise

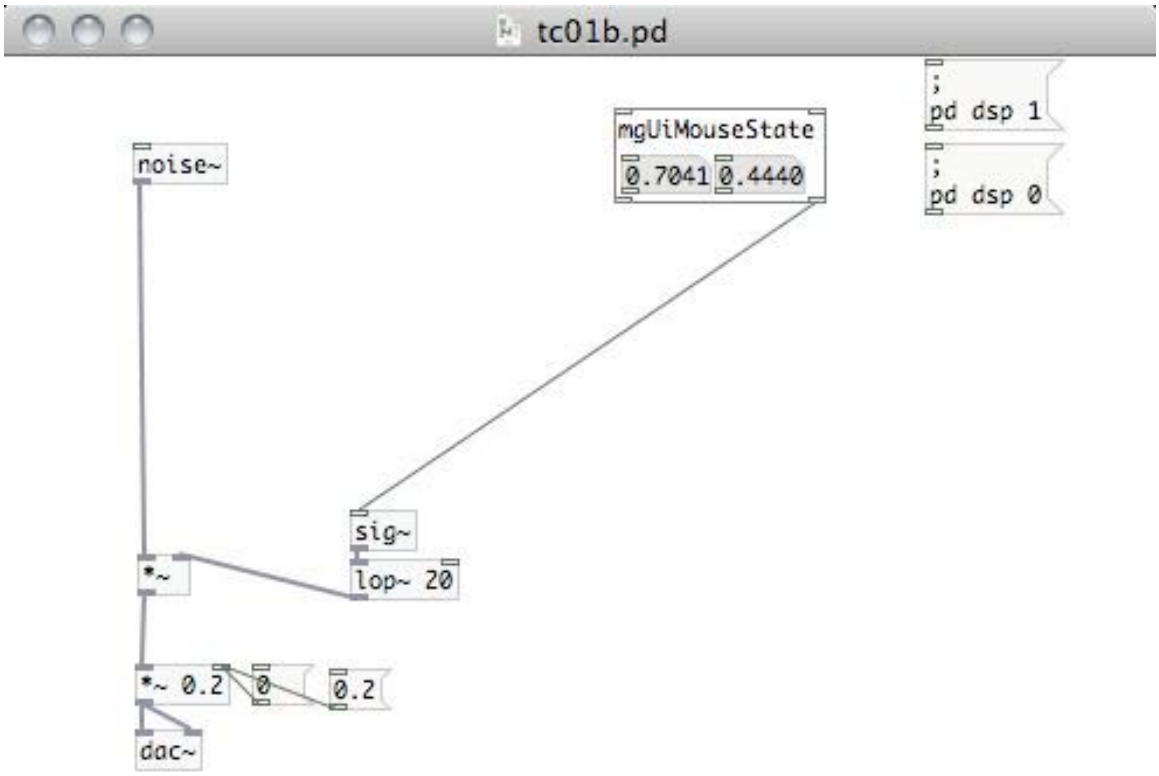
- Noise at the audio rate is random amplitudes, scaled between -1 and 1
- White noise produces equal energy across entire spectrum
- Source of rich signals and randomness
- [noise~] object provides random audio rate values between -1 and 1
- Example: martingale/demo/signalWaveforms.pd

2.27. Mouse State Noise

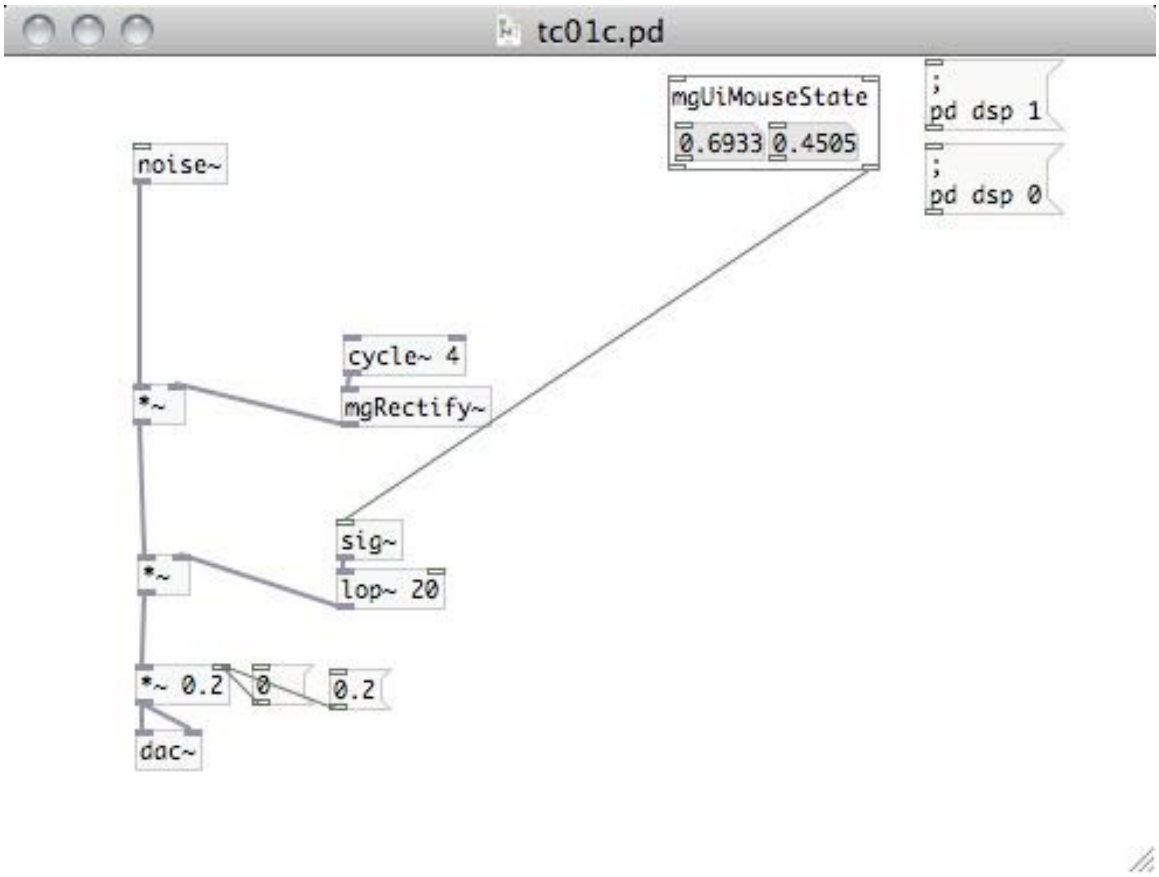
- 1. Connecting Noise to output; scaling amplitude with [*~], turning DSP on and off with message boxes



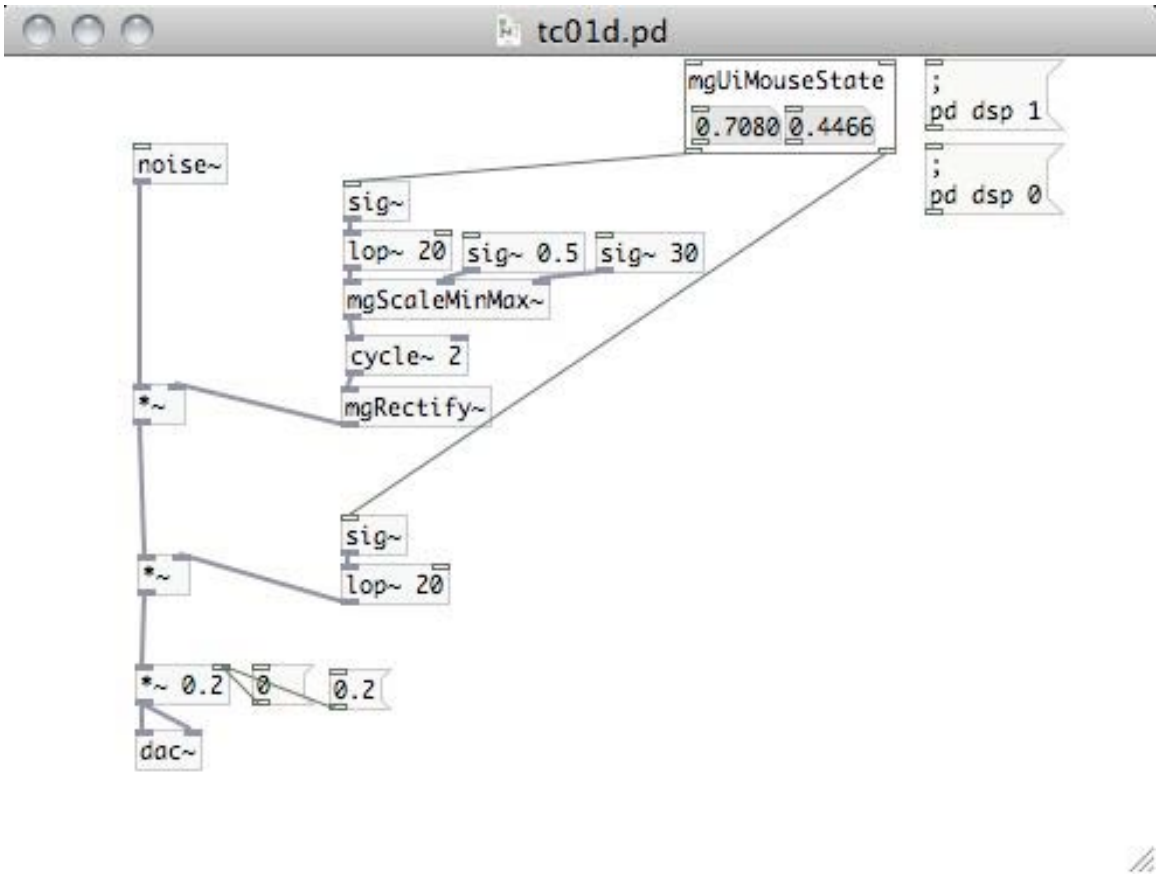
- 2. Smoothly controlling amplitude with [mgUiMouseState], [sig~], and [lop~ 20]; conversion of event data to audio rate data



- 3. Performing subsonic amplitude modulation (tremolo) with [cycle~] and [mgRectify~]



- 4. Scaling unit interval values with [mgScaleMinMax~]

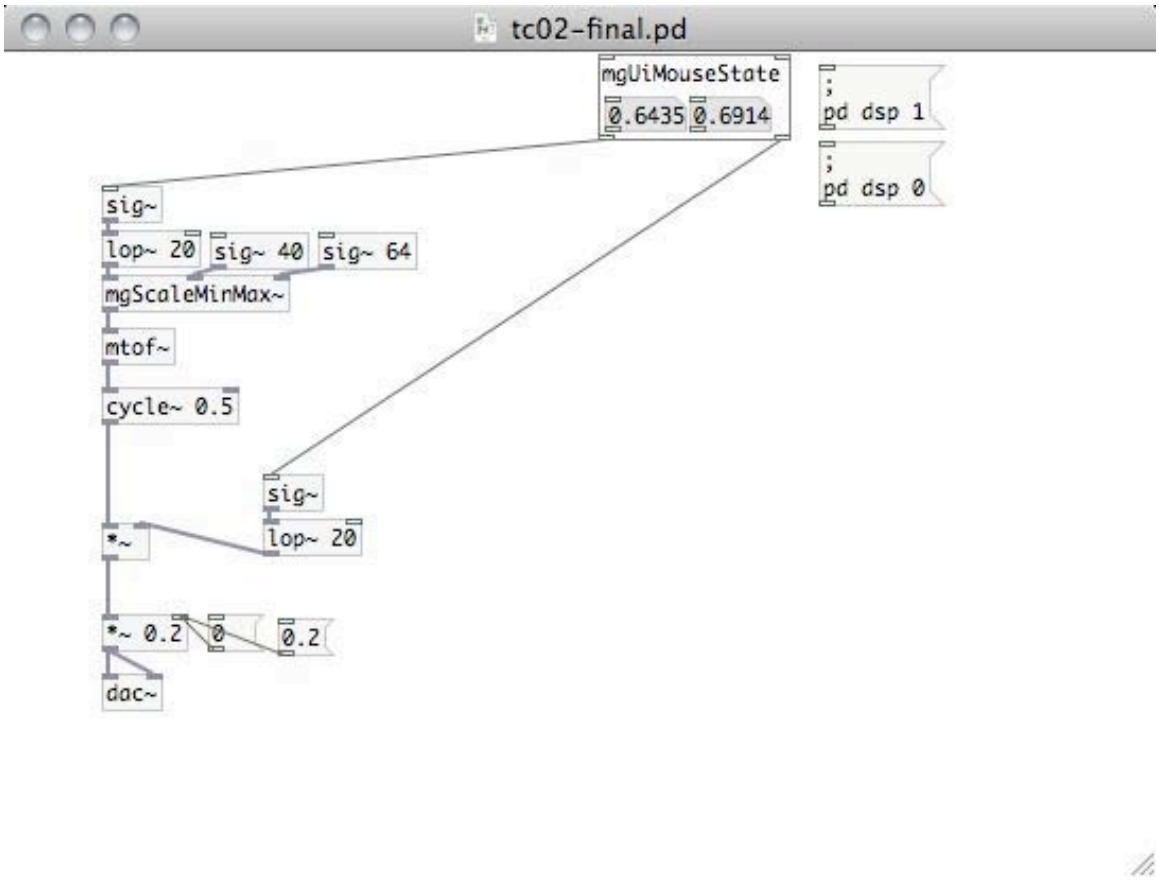


2.28. Sines

- Sine waves provide a perfect circular motion over time
- Produces single, perfect frequency with no overtones
- Example: martingale/demo/signalWaveforms.pd
- Audible range from 20 to 20,000 Hertz
- Example: martingale/demo/earLimits.pd
- Frequency is logarithmically related to pitch; equal pitch values are octaves, or a 2:1 frequency ratio
- Example: martingale/demo/earLogFrequency.pd
- MIDI pitch values are an integer to half-step mapping; can convert from MIDI to frequency with [mtof] and [ftom]

2.29. Mouse State Sines

- A mouse theremin: y axis controls amplitude, x axis control pitch (scaled between MIDI values 40 and 64 and converted with [mtof~])



2.30. Harmonic Waveforms and Wavetables

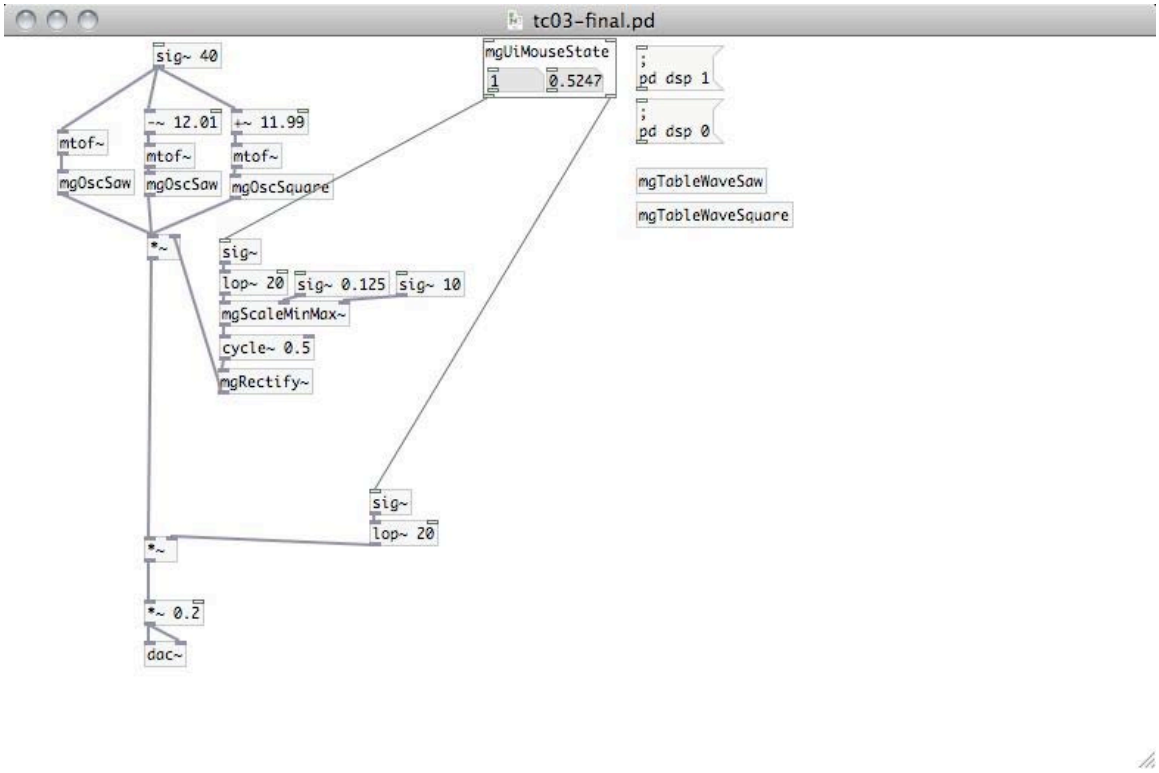
- Anything other than a sine tone has a rich (or richer) spectrum
- Many naturally resonating bodies produce secondary vibrations at whole-number multiples of the base frequency
- Common waveforms represent common arrangements of overtones produced by summing harmonic overtones: triangle, square, and sawtooth
- Example: martingale/demo/sumOfSines.pd

  Example: martingale/demo/signalWaveforms.pd
- A wavetable is an array that stores wave patterns (or other data) and reads them back at variable rates

- Arrays store (generally large) lists of values indexed from zero
- Each array in Pd must have a unique name; names can be provided as arguments

2.31. Mouse State Harmonic Drones

- Mixture of detuned saw and square waves; y axis controls amplitude, x axis controls tremolo



2.32. Listening: Schaeffer

- Listening: Pierre Schaeffer, *Cinq Etudes De Bruits: Etude Violette*, 1948

- Pierre Schaeffer, *Etude aux objets, 2. Objets étendus* , 1959

2.33. Listening: Cage and Oswald

- Listening: John Cage, *Williams Mix*, 1952

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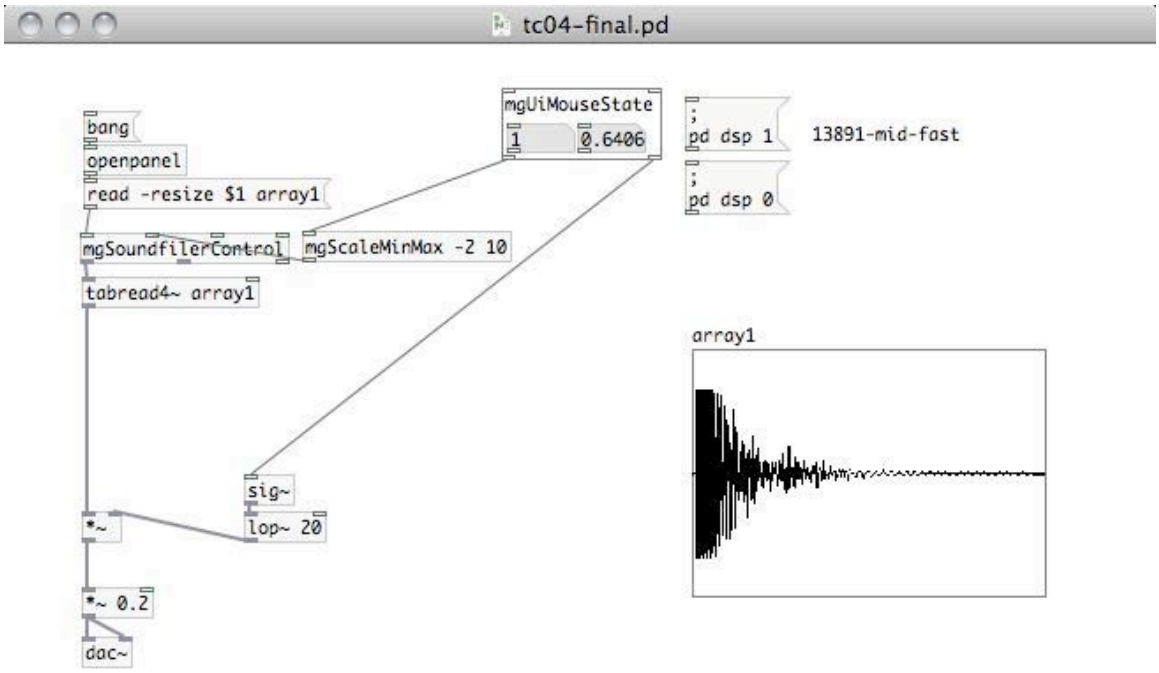
- John Oswald, "Dab," *Plunderphonics 69/96*, 1989

2.34. Stored Digital Audio

- Audio file data can be loaded into arrays and treated as a wavetable
- Audio files may have different bit depths and sampling rates; when loaded in Pd amplitudes range from -1 to 1

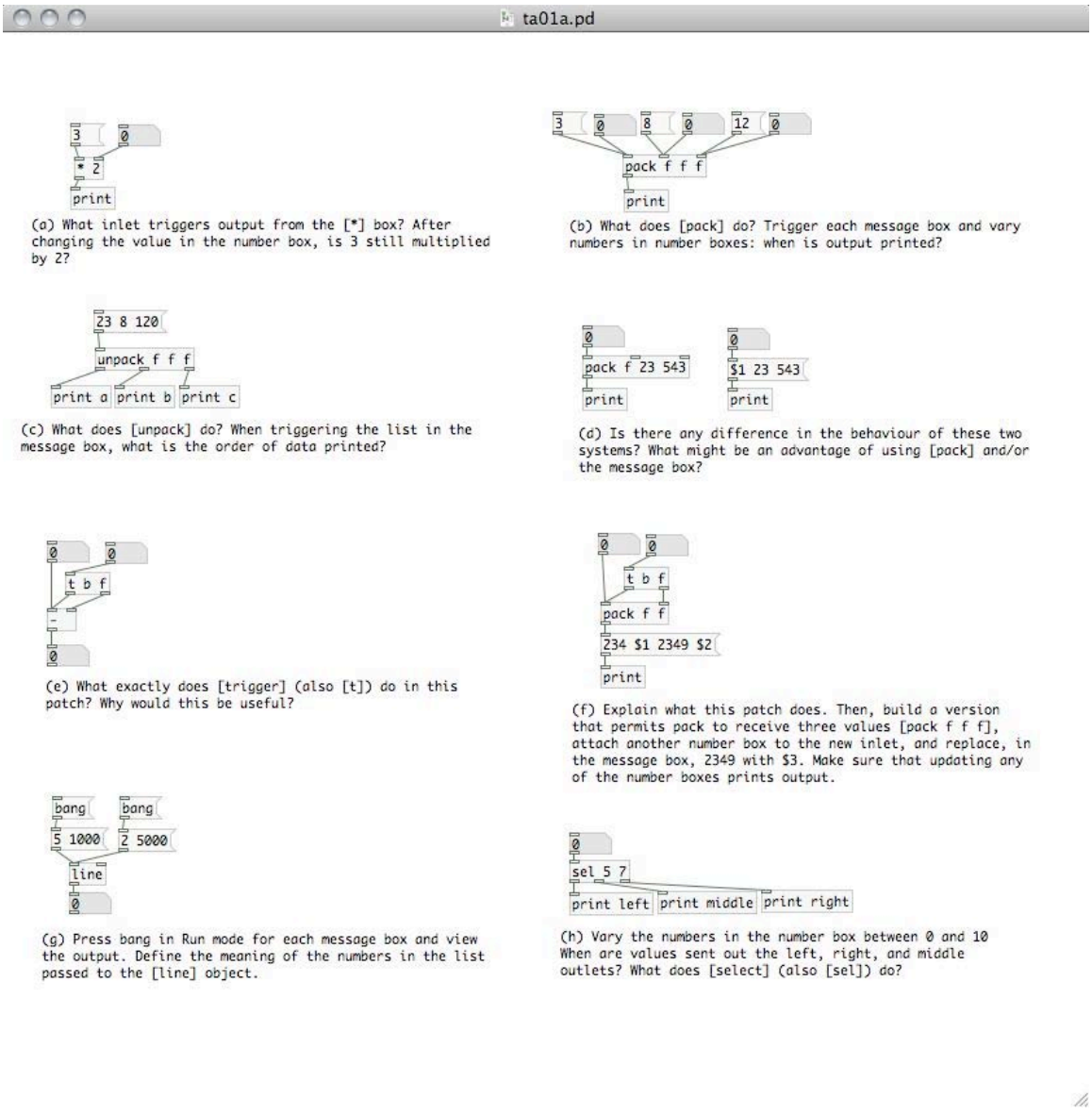
2.35. Mouse State Audio File Looper

- Variable rate audio file looper: y axis controls amplitude, x axis control rate of playback from -2 to 10



2.36. Pd Tutorial 1

1. The following examples demonstrate operations with Pd. Recreate the following patch components in a Pd file and and answer the provided questions as comments in the Pd file.



2. In a Pd file, re-create one of the demonstrated Mouse State instruments shown above. Extend the instrument in some way: alter fixed parameters, apply alternate mappings of mouse values, combine different sound sources.

21M.380 Music and Technology: Live Electronics Performance Practices
Spring 2011