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Musical Considerations in Interactive Design for Performance

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Musical Considerations in Interactive Design for Performance

A Thesis submitted in partial satisfaction of the requirements
for the degree Master of Fine Arts

in

Theater & Dance
(Design)

by

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Committee in charge:

Professor Shahrokh Yadegari, Chair
Professor Robert Brill
Professor Miller Puckette
Professor Gabor Tompa

2017

The Thesis of Steven M. Leffue is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Chair

University of California, San Diego

2017

DEDICATION

For Beth, who made it all possible.

EPIGRAPH

Improvisation is a compositional method.

—Evan Parker

So, yes, I am in the underground,

but actually, it feels like home.

—Anthony Braxton

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ACKNOWLEDGEMENTS

This work would not have been possible without the influence of hundreds of artists who unfortunately cannot all be named.

Thanks to Shahrokh Yadegari for his mentorship, philosophy, and for reciting poetry. Thanks also to Miller Puckette who changed my art forever (and showed me that I can use math). Thanks to Grady Kestler, who was my better half in much of the work presented in this paper.

Thank you to my past mentors including John Sampen, Jean-Michel Goury, Johnathan Helton, and Dale Underwood whose gifts continue to inspire me.

Lastly, all thanks to Alec Duffy for being a friend.

ABSTRACT OF THE THESIS

Musical Considerations in Interactive Design for Performance

by

Steven M. Leffue

Master of Fine Arts in Theater & Dance
(Design)

University of California, San Diego, 2017

Professor Shahrokh Yadegari, Chair

This thesis will be an analysis of some of my approaches to rendering musical personality to structures in the Pure Data programming environment. The inspiration for this work stems from the desire to make sounds which display autonomous organic characteristics for use in live performance. Examples will be pulled from past works including *Aiis* (2016) and *The Eyes of Seht* (2017). The concepts themselves and the design process from which they stem are discussed.

Chapter 1

Development of an Interactive Aesthetic: Musical Necessity

I do not fully understand the self-similar manner by which I arrived at electronic music, whether my music (a saxophonist by trade) inspired my work in theater (for certainly the opposite is also true), or if either theater or music lead me to sound and noise. The influence of La Monte Young, Anthony Braxton, Merzbow, Beethoven, Coltrane, Borbetomagus, Dolphy onwards *ad nauseum* is so intertwined with my perception of Beckett, Brecht, Parks, Ionesco, Kane *et al* that they no longer belong to separate practices.

Suffice it to say that I eventually found myself in need of making sound on a computer. My composer friend Kyle Johnson, who was studying composition in the department of music at University of California San Diego, recommended I try out Pure Data[Puc97]; a mutualism ensued which has become at the very least the underpinning of all my work since. I found Pure Data to be an extremely natural way to construct and control sound. Very quickly I became fluent enough that I was creating new programs—called patches—for each new performance that came along.

I imagine the period of time thereafter was a growth spurt of technical ability. Several things happened then: I became able to express myself musically through a computer, that expression began to affect my conception of design for given performances, and I began exploring automation of parameters within my patches. It seemed natural that a sound source should itself have movement within it which is musical; my solution was to construct essentially "if/then" statements which translate nicely into suggesting creative, organic, or evolutionary sound. These processes can be applied to any number of control parameters including pitch, time, effect control parameters, speed, volume, regularity of rhythm, etc.

My creative process is the recursive discovery of what is needed sonically in a given situation, creating the means by which to create that sound, and then judging whether those processes bring about a satisfying musical outcome. As such, I have developed a personal design toolbox for mapping human performative characteristics onto data processing structures, because it seems imbuing sound with human musical qualities leads for whatever reason to enjoyable results (it is also interesting to invert these paradigms and arrive at something else entirely). These methods coexist naturally in my work with more formulaic or algorithmic generative structures, but are derived in their implementation explicitly from my lived experience as a performing musician. Whether human musicality and decision making should or could be boiled down to a series of simple math formulas is for someone else to explore.

I have used these methods in theater, music, and dance over the past decade and found that the mutualism continues to grow; pieces beget the need of an instrument which then influences the delivery of the media and therefore the manner of performance of the piece itself, ergo, the piece itself. Some of my most significant work to date has been the creation of interactive performance structures which lend themselves to multiple usages. A prime example *Aiis*[LK16], which is an interactive patch for the creation of music, was originally an audio project between myself, Grady Kestler (UCSD), and saxophonist Rhonda Taylor (New Mexico State University) though it went on to make appearances in downtown noise shows, Ionesco's *Rhinoceros*, Okada's *Quiet Comfort*, and as sound, movement, and lights piece in collaboration with choreographer Anne Gehmann. Another recent piece, *The Eyes of Seht*, is an interactive quartet for two performers and two interactive software objects named *peter~* and *ryan~* (dedicatees of the piece). This patch works equally well as a trio for soloist, and as a duo for the computer instruments themselves.

This paper shall address a few of the core musical truisms that I have experienced throughout my own performing career and examples of solutions for eliciting these behaviors in computer based musical expression. I will first focus on controlled randomness as a model for creativity, then describe weighted percentages as a model for decision making, and finally look at a few mechanisms for representing time. In Chapter 3, "Self-Similarity as Approach to Design", I will describe how the process of developing interactive tools has shaped my conception of design, music, and artistic growth. Examples and control patches will be drawn from my work in theater and music over the past five years. I will be especially focusing on two pieces for live performer and electronics: *Aiis* [LK16] (2016) and *The Eyes of Seht* (2017). My hope is that this paper will serve as a description of my solutions to some questions arising from programming interactive digital elements; I hope the following is presented in such a way that a thorough knowledge of Pure Data is not necessary for the discussion.

Chapter 2

Solutions to Musical Considerations

2.1 Sensitivity

The first issue when dealing with creating interactive mannerisms is dealing with the reception of an input signal by the software object. Factors like an input's gain (amplitude), pitch, and timbre can be reference points from which we can draw assumptions of behavior. These criteria can be hard to quantify, for example pitch tracking can be extremely difficult to implement, so creative solutions for distilling multiple characteristics from one parameter can be beneficial to a designer.

2.1.1 Averaging gain

I would like to start by showing some examples of how a good amount of data can be stripped from a signal using its gain. In this case we are able to determine an inputs relative amplitude, monitor onsets (attacks), the regularity of its activity, and the manner of its activity relative to onsets. Figure 2.1 shows a subpatch for assigning a value to an input's average amplitude. Here we are averaging an event's amplitude over ten consecutive samplings. By subtracting a threshold amount any event whose gain is over that threshold can be counted as an attack onset.

In *The Eyes of Seht* (for two performers and two interactive software objects) the gain onset and threshold numbers are routed to the abstraction stats_getter5 (Figure 2.2). The sensing apparatus of *Seht* is built from a series of three stats_getter5 devices tracking 3, 12, and 48 second time frames (Figure A.1). This abstraction monitors the relationship of input gain to the averaged gain in order to record three arrays of data: the average gain over time, the average time between consecutive attacks, and the number of attacks within a user defined period. If we can determine the number of attacks in a given window of elapsed time then we know one parameter relating to the level of activity of the input source. From this data we can derive a standard deviation from the average time between attacks, in other words whether attacks are highly periodic (stable) or irregular. With this tool, we can now describe to a system an input's relative amplitude, its regularity, and its activity relative to onsets; these together are an approximation of non-pitch based sound information that a human performer would probably track. This distilled data is now ready to be mapped to a series of probable outcomes.

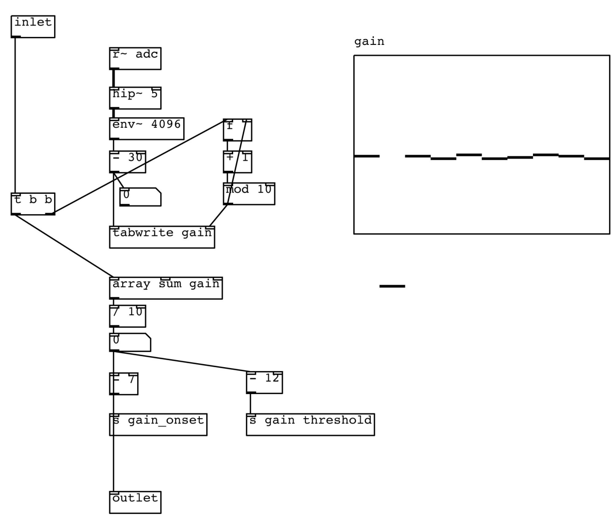

Figure 2.1: Input gain averaging module as a medium for setting average gain from *The Eyes of Seht*.

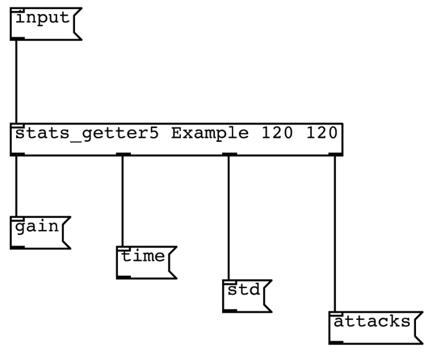

Figure 2.2: Abstraction for converting gain signals into data. Stats_getter5 abstraction from *The Eyes of Seht*.

2.1.2 Gain thresholds as control

One implementation in *Aiis* (Figure A.2) demonstrates how gain thresholds are used to control the entrance and exit of channels of voices. An input's gain is parsed into three thresholds (soft, medium, loud) which then control the number of software object voices present at a given time. This creates an "increased amplitude generally equals more dense contour" relationship (I say generally because this reaction itself is governed by probabilistic measures which further break overtly reactive bonds). Extending this concept a bit further, multiple thresholds could be set for a given range of gain with each producing control over different behaviors, parameters, or scales of structure. Through this mapping we can model a performative entity by setting up a system that is chaotically unpredictable moment to moment but which exhibits general behaviors over longer periods of time.

2.2 Creativity as Controlled Variable Randomness

In the milieu of experimental performance practices of the early 21st century, creative thought is a basic concept in both design and performance. Perhaps as an outcome of post modernism, there is an ample cadre of artists whose primary objectives are the production and discovery of new, yet highly personal, modes of communication. Since creation is a process that evolves from one moment to the next, I imagine one way to perceive creativity is as the rejection of repetition within a given context. While it is simple to force a reactive effect from stimuli in an “if/then” paradigm, rendering the complexity of evolutionary or explorational thinking paradigms requires more attention. If the generation of randomized data points fulfills the requirement of definably new content (that which is truly random cannot have existed *a priori*), one may extend this control to various stations of sonification and interaction.

In 2012, in a Brooklyn garage turned bar turned theater, one of my earliest exercises when learning the ability to improvise in diverse circumstances was to build a play-along sequencer of random notes from simple generators in Pure Data (Figure 2.3). The first of these, while random in its content’s single parameter, quickly became predictable in its manner of delivery. As a result I began linking chains of controlled randomness to expand the behavior of the structure. With only a few iterations we arrive at interesting outcomes.

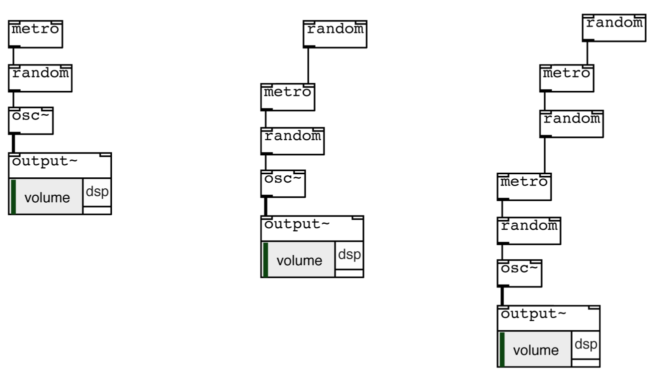

Figure 2.3: Random chains. Simple chains of random tone generators.

The left hand column in Figure 2.3 is able to achieve a string of tones at a given rate of speed from the metronome. The second column produces random pitches in groupings of varying speeds but which are themselves produced within a regularized pulse: essentially regularly metric subdivision. The third iteration allows for randomized variable speed at which the metric subdivisions are generated - from periods of rapidly changing textures to less temporally complicated structuring.

This model approximates a performers ability to produce tones in a sequence which becomes more and less saturated or complicated depending on reaction to stimuli. An implementation of this basic idea can be seen in phase sweeping oscillators built for performances by theater band *The Georges* (Figure A.3). In this early patch built for live performance I manually controlled the ranges of random values in performance.

The next step in the process was to automate my control behavior so that I could be free to interact with the software object in other ways. A slightly more automated version of randomized control can be seen in the pitch_shifter object from *Aiis* (Figure 2.4). Here, a temporally randomized onset produces narrowly random sets of pitches over a 20 semitone range. This process occurs continuously throughout the piece as a characteristic musicality of the system.

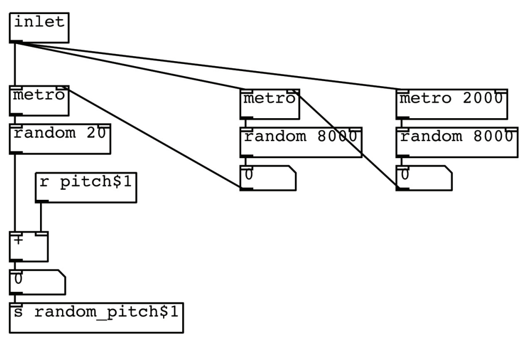

Figure 2.4: Random variables for pitch shifting.

Figure 2.5 shows that by simply mapping an event's gain to surface level factors, such as time or tempo, we can achieve movement to which a little bit of controlled randomness adds character. Banded randomness produces a nonlinear accelerando one might hear in the work of Berio, Braxton, Ferneyhough, Evan Parker or the serial music of someone like Robert Morris. This example, from an interactive patch created for the University of California San Diego's production of Beckett's *Waiting for Godot*, shows a sample's play point (tabplay) is randomly chosen at ranged random intervals. As the amplitude of actors voices increases, the range moves towards faster tempi producing greater and greater density in a distinctly non-linear fashion. The left column of this patch is the processes for making sure this behavior builds slowly within a scene and subsides more quickly when the scene's sonic energy comes to its conclusion.

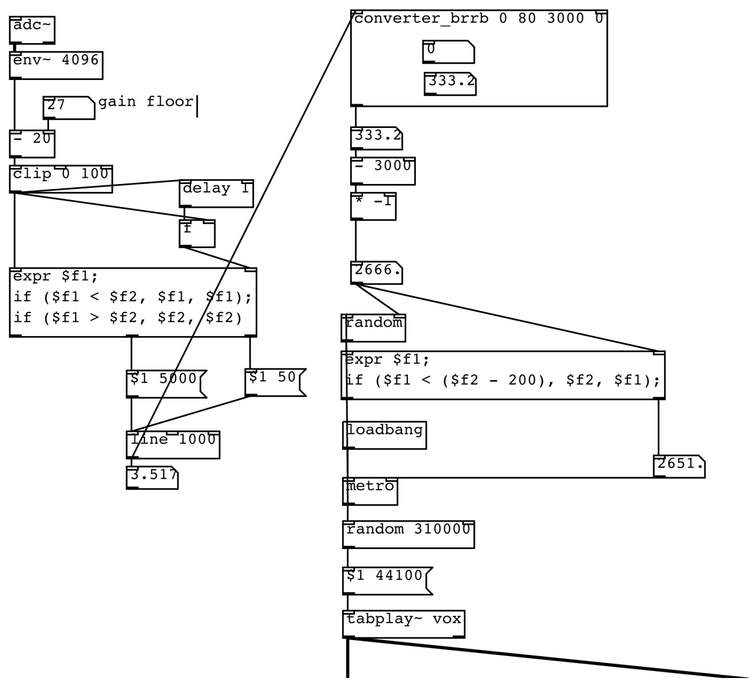

Figure 2.5: Gain controlled variable random accelerando developed for University of California San Diego's production of *Waiting for Godot* (2017).

A simple abstraction called double_random (Figure 2.6) was developed as the need for this tiered randomness became more prevalent. A given range of random numbers can be given at a variable of a separate range of random values. This structure outputs both the value (with a third definable value allowing for on the fly scaling) and a control impulse.

These models of never ending creation within a given superstructure can be

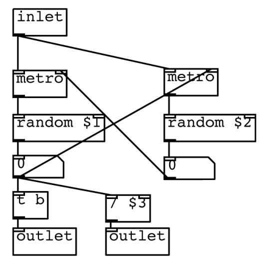

Figure 2.6: Double random abstraction developed for control in *Aiis*.

applied not only to pitch or gain, but also just as easily to dynamics, tone/timbre, phrase shaping and any number of controllable values as we will see. Alone the general pattern will eventually become recognizable, but when combined with just a few other parameters controlled in this manner a good amount of controllably chaotic content is able to be generated. In my practice I find that these controlled/interactive randomizations make for the ability to create rich and endlessly generative textures in surface level contours.

2.3 Personality as Percentages

Once manneristic structures have been devised, the next step is to address musical personality. For as complicated as this topic might seem, I have found success in imagining a certain musical proclivity represented as a weighted percentage. For example: if I am playing with a performer who tends to match the volume at which I am performing, I could denote that tendency as a 80% chance of matching input gain. The remaining 20% would then represent the moments in which this performer pushes against their own tastes and performs with a more contrapuntal conception.

Figure 2.7 shows a subpatch in *The Eyes of Seht* by which a stimuli presents weighted responses, in this case gain controlling the endings of musical gestures. Eventually a behavioral propensity emerges: when a performer stops playing the system will do nothing 75% of the time, pause for 50 milliseconds 10%, 500 milliseconds 10%, and 8 seconds 5%. This is a performative entity that will take somewhat infrequent breaths in accordance with the live input and from time to time take longer pauses. The interactivity is obviously only complete if a performer then hears these nuances and reacts in kind.

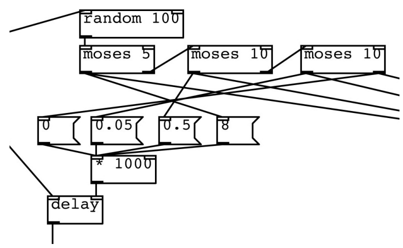

Figure 2.7: Weighted percentages as performance style. Detail of makenote subpatch in The Eyes of Seht showing four enveloping styles weighted to model decision making.

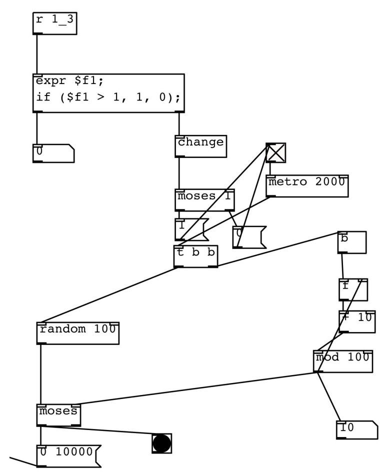

Figure 2.8: Weighted percentages as decision making. Gain value dropping below threshold triggers variable increasing probability of system stopping from *The Eyes of Seht*.

The second example from *The Eyes of Seht* (Figure 2.8) shows the mechanism by which the system makes its decision to stop. When the input's gain parameter passes beneath a threshold (1), a random number is generated every two seconds. For every number generated the probability that it will trigger a fade out increases by ten percent. In this manner we simulate a performer's decision which may come about abruptly in accordance with their partner, or may take longer as the performer chooses to end on a solo cadenza.

The examples of this concept from my work are too numerous to list in this paper, but can include upwards of 40 instances in a given patch. Much like the butterfly effect in weather production, by layering the potentials of movement instead of describing laws, we can know that a system exists without knowing where it will exist at any given time. This is imperative for constructing systems which can continuously surprise and inspire a human counterpart.

2.4 Representations of Time

Much of the interactive or improvisational music I hear, with few exceptions, seems to fall into medium scale pulses (typically somewhere in the vicinity of quarter note = 40 from my perspective). Sometimes in highly contrapuntal or thick rhythmic passages without overtly established downbeats, I imagine it as the ghost image revealed by many layers of offbeat hemiola. This idea of "groove" may not necessarily affect major changes in the content of the music of the moment, but is none the less perceptible in its regularity, ebb, and flow. It could be that my reception of this quality arises from my own internal biological or psychological processing of the event, but, in either case, it is something which I hear and is therefore worth exploring and implementing in my design when necessary.

Almost all performers listen to the context in which their sound will occur and are influenced by this context. However, when performing with an electronic system, its ability to commence performance consistently in accordance with the beginning of input into the system is a stumbling block to perceived interactivity. During listening sessions for early versions of *Aiis* it was obvious that adding a predetermined fade in/out relative to phrase beginnings and endings quickly became predictably inauthentic.

The solution was to create a response time mechanism (Figures 2.9 and 2.10) by which the time of delay after input onset is a variably random function based on another unit of input signal (the number of registered attacks in a given recent time window for example). This provides the sense of deliberation with which a performer will calculate their reaction to stimuli. The reaction itself is variable according to context derived from input. Ultimately the response time is based in relation to a master time clock which provides us our groove. This master time clock is also narrowly variable and will accelerate or de-accelerate over time according to input gain (Figure 2.11).

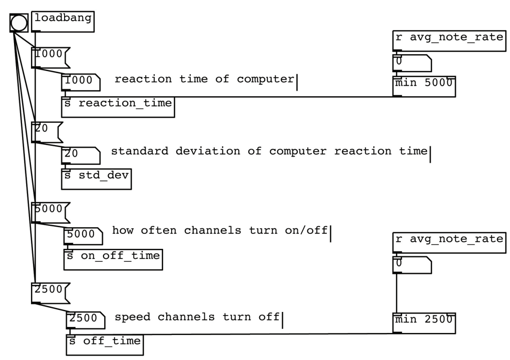

Figure 2.9: Setting a master time. Average note rate determines variables of master time and speed of voice entrances and exit from *Aiis*.

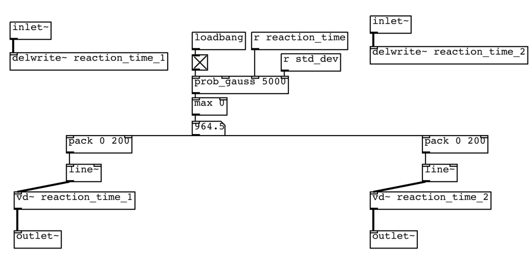

Figure 2.10: Variable probability determined reaction time. Reaction time and standard deviation determine Gaussian probabilities of variable reaction time from *Aiis*.

Two other solutions to denoting time structures are explored in *The Eyes of Seht*. Consider the control variables we have already discussed: what if we were to

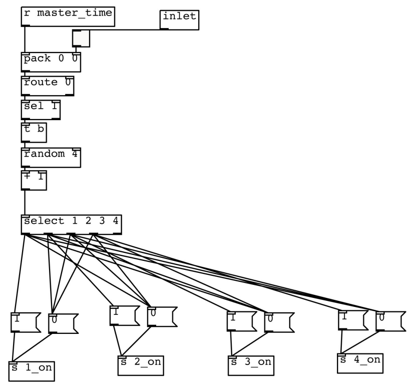

Figure 2.11: Variable probability determined textures. Grady Kestler's channel_on abstraction governed by narrowly variable ”master time” from *Aiis*.

recalculate the decisions that produce variable behavior on an impulse whose frequency is controllable and ranges from random to regular? In order to establish this interior or underlying pulse, input parameters are continuously monitored but control values are only polled every 1.5 seconds (Figure A.4). The chaos that ensues from multiple changing parameters masks the change creating implied musical responses.

Simultaneously, *The Eyes of Seht* also deals with large scale time structures. The longest data sampling window is forty-eight seconds. Input is mapped to control parameters and these controls drive the instruments audio parameters. Figure A.6 demonstrates how this relationship is re-evaluated every forty-eight seconds according to a percentage based decision (for this example only one parametric mapping is shown though there are 8 such mappings in the piece controlling multiple reactions). This parameter is set to have a general mapping 70% of the time while the control signals inverse is chosen the other 30%. When these percentage based decisions are applied to multiple controls the original cumulative mapping becomes less likely to occur: the resulting weighted combinatoriality produces evolutionary responses to input that exhibit a general behavior. In subsequent versions I imagine that the rate of this decision will increase and decrease in a similar fashion.

Chapter 3

Self-Similarity as Approach to Design

Building systems that imitate my understanding of musicality is a strong dose of the self-referential. This self-similarity can be seen in the ways in which pieces move me; I construct instruments for their performance, and then performance is sculpted by the instruments output.

This has always been the case as far as I can remember. I found myself creating my own content in all fields simultaneously: I enjoyed creating and performing on the computer keyboard, but also continued my saxophone playing which had at the time taken a hard turn in the direction of improvisation. From the perspective of saxophone I began using Pure Data as a source for random pitches, my theory being that I would be a better improvisor if I could maintain anything interesting over the atonal ostinati of random pitches. This lead to the construction of more complicated pattern generators their offspring, and their idiosyncrasies. However, at the same time I was constructing for Bertolt Brechts play *Baal* a vague approximation of a violin orchestra which played itself (at least in regards to pitch, grouping, rhythm, and structure according to a series of a priori decisions), and therefore did not solely arrive at constructing concepts of interactive elements through a purely performative need.

Having been a instrumentalist for the majority of my life, I came to Pure Data late it my development. That it enabled me to follow my musical path for sounds beyond my lived experience, and served as a platform for (seemingly) an atypical approach to sound in performance- including theater and dance -, made it indispensable as a design/creative tool. Further, I imagine the relationship between user and software came to resemble a model of recursive learning in the programming process.

In the beginning I needed a way to generate computer sound and was afforded phasors which I controlled manually; naturally, I began experimenting with automating effects with which to generate increasingly complicated content for later mixing and mastering. Eventually this process of the "benevolent clock maker" itself morphed into the creation of that which begins to walk with increasingly minimal guidance from its creator. The further I delved into creating interactive mechanisms for sound generation, the more they taught me about their construction, foibles within the given language, and manner by which one may, with data, elicit many examples of desired outcomes. This, then, became a conception of mapping musical personality into a network of possible outcomes.

Concurrently, the piece of the Free Improvisation scene which I can currently see across the United States and Europe is teeming with a philosophical interest in continuing to push the boundaries of sound while simultaneously arriving at a very grounded and organic music. As musicians have continued to push the physical limitations of bodies and instruments, the integration of the artform itself into different modes of performance is responsible for an ever increasing variety of musical situations in which a musician might find themselves. A few such situations which have caught my attention have been those in which an artist uses analogue/digital effects to manipulate a given acoustic instrument (see Don Dietrich, Jim Sauter, and Donald Miller of *Borbetomagus*) and the incorporation of synthetic instruments whether analogue or digital. This area of the musical sphere most certainly shares overlapping territories with what becomes considered noise music and no input mixing, as well the practices of Jazz, Art music, and theatrical communal happenings.

The synthesis of these two worlds results in a referential mode of performance and design which relies on interactive principles in creation and conception. For example: the philosophies which allow for the creation of any given sound can also be used to create the context in which the sound is played e.g. sound = music = performance = sound. Transcribed this says something along the lines of "there is a thing called sound which when used becomes music; the manner in which this music is received is determined on account of the necessity a sound". This *modus operandi* is a helpful tool in design for theater, dance, performance art, installations, public art and onwards.

It seems unimportant which was my primary artistic motivation: my experiments with computer music in theater, interests in electronically/digitally enhanced music, or subscription to the philosophical position that improvisation and composition cannot be, as such, distilled from their originating source (this statement exists only as a belief at this point and perhaps is a subject of further inquiry). Where I have found myself is as a performative artist who relies on interactive concepts to generate work in theater, music, and dance. I understand the technology with which I create music and sound from the musicians perspective of necessity, and yet am then able to instantiate the mechanisms which will solve a given performative need.

The tangles of influence are myriad. Art, work, life, and music flow endlessly from the communal fount of time. For if it is true that these paths of learning are all connected in an intricate patchwork of events feeding events, and that all elements of our lives are nodes inextricably connected to one another, I think it enjoyable to serve as an sympathetic reverberator for the system's working.

Appendix A

Patches

This appendix includes larger patch diagrams referenced in this discussion which show the inner workings of subpatches and abstractions.

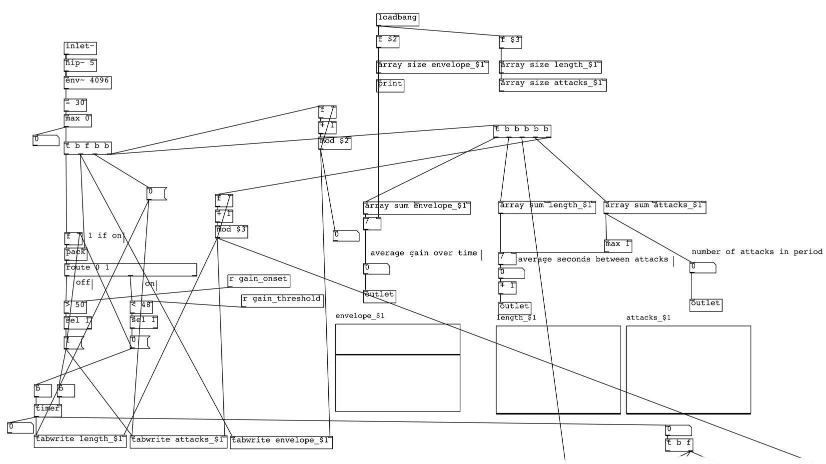

Figure A.1: Monitoring of gain onsets and relevant data within the stats_getter abstraction from *The Eyes of Seht*.

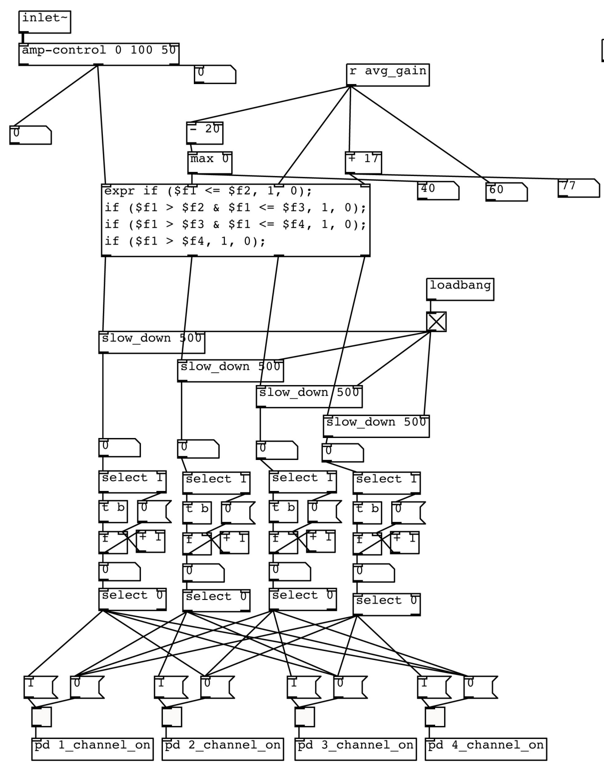

Figure A.2: Gain controlled contours. Input gain thresholds determine the number of software channels present from *Aiis* (courtesy of Grady Kestler).

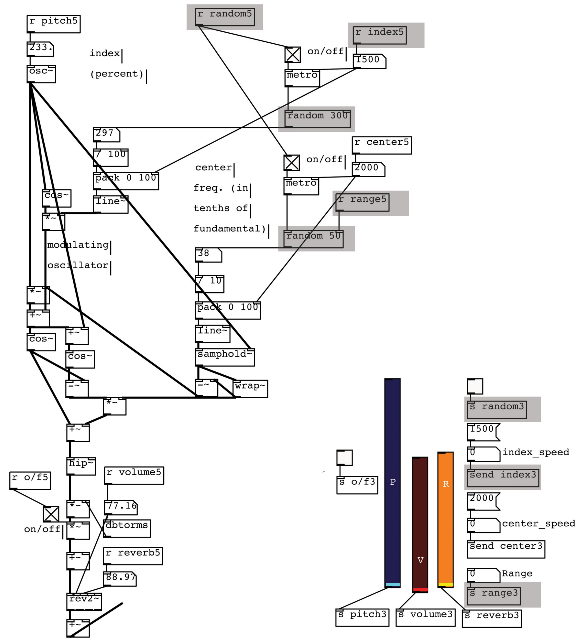

Figure A.3: Performer controlled variable random phasor overtones from *Hoi Polloi's: Alarmed*.

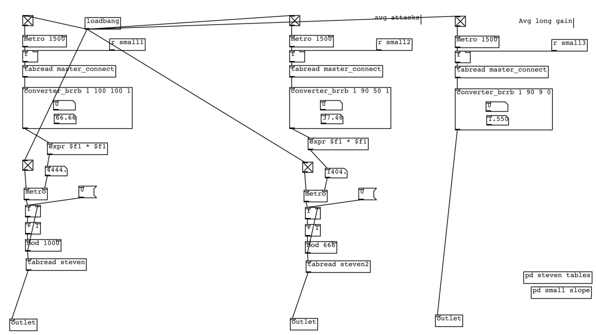

Figure A.4: Polling data at a set master tempo from *The Eyes of Seht*.

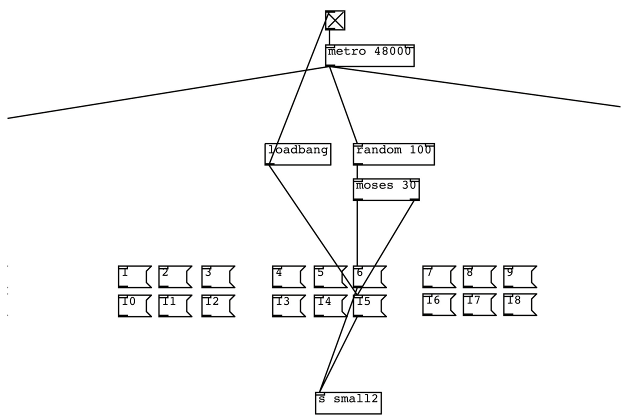

Figure A.5: Large scale structures from weighted parameter switching. Detail of metronome reseting parameter mapping according to weighted percentages *The Eyes of Seht*.

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