LEANDER: NAVIGATING MUSICAL POSSIBILITY SPACE through COLOR DATA SONIFICATION

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Abstract

Leander is an experimental film that sonifies color data to generate its musical soundtrack. The colors of Lake Michigan, captured in time lapse video, constitute ever-changing probability vectors that govern the behavior of musical sound-events over time. This *stochastic*, or probabilistic approach to data sonification imagines the musical experience as movement through a virtual possibility space, rather than the end result of a causal process. This pictorial describes how color data guides the various musical parameters at play in *Leander* through weighted chance.

Authors Keywords

stochastic music, data sonification, information art, parameter space, time lapse, SuperCollider, electronic music, video art, modern composition

Introduction

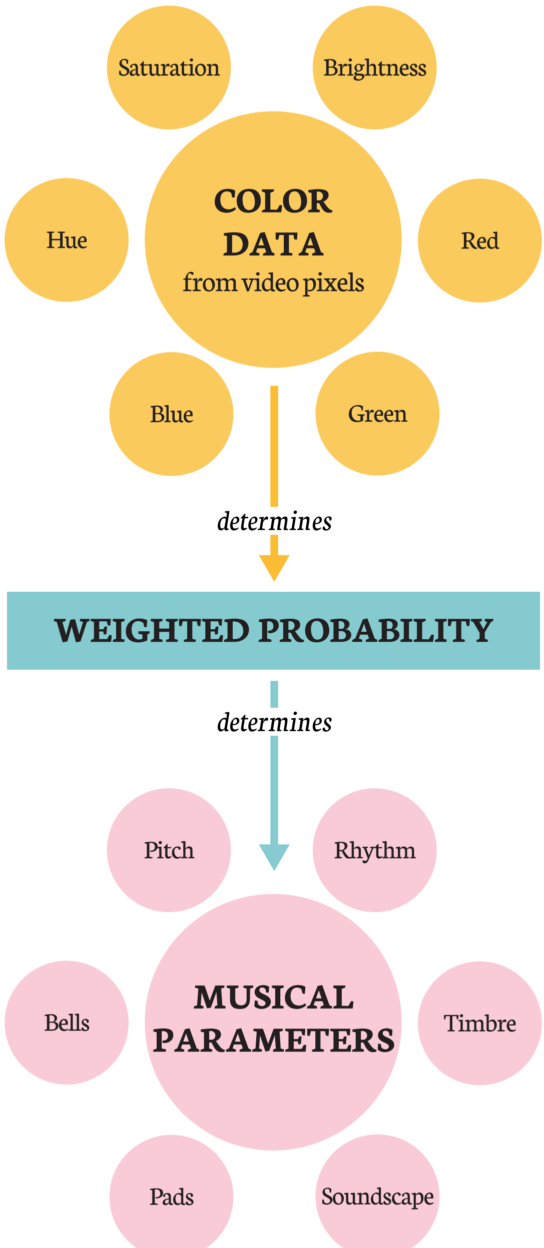
Even in the dreariest early spring months, Lake Michigan seems to change its colors almost daily, reflecting the most minute changes in the sky, tides, temperature, and other atmospheric conditions in the appearance of its waves. To document this chameleonic behavior, I took time-lapse videos of the lake from the same point on a cliff in Milwaukee County, Wisconsin over a series of days in March 2020. Each video began thirty minutes before sunset and ended thirty minutes after sunset. I also made audio recordings of the surrounding environment. After gathering and assembling the footage, I extracted the quantifiable color data of the video using Processing into a table of timestamped color values which can be read like a musical score into the audio programming environment SuperCollider, sonifying (or perhaps *musifying*) the color data in sync with the video. The film, in a sense, writes its own soundtrack. Rather than mapping the data directly to fixed sounds or musical parameters, the color values are used as probability vectors representing the likelihood that particular sound-events with particular characteristics will occur at each moment in the film. Leaving the moment-by-moment specifics to weighted random chance means that no two realization of *Leander* are exactly alike, while maintaining an overall musical structure and audio-visual synchronicity.

Named after the young man of Greek myth who swam nightly across the Dardanelles toward his lover Hero's lighthouse, *Leander* is a guide for navigating a musical landscape on a journey of patience and solitude. The lake and its colors provide a compass and bearing, but the specific path taken is a product of chance and algorithms, discovered only by experiencing the piece.

Leander can be viewed at www.lawtonhall.com/leander.

VISAP'20, Pictorials and annotated portfolios.

Flowchart of the process of generating music from video through color data sonification in *Leander*.



Chance Music

Delegating compositional decisions to random, or *aleatoric*, chance is not a new technique and the use of mechanized automation to assist with musical chance procedures long predates the digital age. Musical games (*musikalisches würfelspiele*) in which players build pieces of music by rolling dice to choose from precomposed fragments were popular in eighteenth-century Europe. A notable 1792 *würfelspiel* attributed to Mozart is capable of producing over 45 trillion different waltzes from its possible combinations of measures.[1]

In 1821, Dutch-German inventor Diederich Nikolaus Winkel mechanized the earlier dice games with an instrument called the *Componium*, a clockwork pipe organ that plays combinatorially-generated music from material pre-programmed onto pinned wooden cylinders like a music box.[2] The Componium uses a roulette wheel-like device to choose fragments randomly and can produce over 53 trillion different pieces without the use of dice or human intervention.[3]

This proto-chance music failed to catch on as music composition became increasingly complex and deterministic in the late nineteenth and twentieth centuries.[4] In reaction to these modernist tendencies, American composer John Cage championed chance procedures beginning in the 1950s. Many of his works from this era, such as *Music of Changes*, are almost entirely aleatoric, relying on coin flips, graphical scores, and (most famously) I Ching divination to determine musical parameters. Cage mapped these chance techniques to musical parameters (pitch, rhythm, etc.) much like the parametric mapping in data visualization and sonification.[5]

The sonic environment generates the musical experience in some aleatoric works, much like how *Leander* generates music from its visual landscape. In Cage's 1952 piece *4'33"*, the solo performer is instructed to *tacet* (not play) for the entire duration of the piece, allowing the listener to focus exclusively on ambient sounds in the concert hall.[6] Composer Alvin Lucier's *I Am Sitting in a Room* from 1969 features a recording of his spoken voice being played into an empty room and re-recorded. This process is repeated numerous times,with the acoustic qualities of the room becoming increasingly apparent with each iteration until all that remains are the resonant frequencies of the room itself.[7]

In the *würfelspiele* and more recent aleatoric works, the piece of music is not fixed entity, but rather a **possibility space** (or **parameter space**) that encompasses a large number of possible outcomes that each occupy a discrete point within such a space.[8] Every dynamic musical parameter (i.e. parameters whose values may change between realizations) represents a dimension in possibility space and the location of one particular outcome is determined by the value of each parameter at each moment as a piece is realized.

Random chance, then, drops the listener, performer, or even composer into an unexpected location within a possibility space without the personal biases that often blind us to out-of-the-box creative thinking. Each realization of an aleatoric work provides a different view of a musical landscape even when the full breadth of a possibility space is incomprehensibly vast. The results are often exciting and surprising and allow for the creation of works that are greater than the sum of their parts, especially when the process is automated.

Of course, random chance is not the only way to explore a possibility space. Composers of isorhythmic motets in the fourteenth century used fixed, repeating cycles of pitches and rhythms to explore the uncharted frontier of polyphonic music.[9] In the twentieth century, serialism and other modernist composition methods used rigid algorithms to avoid areas of musical possibility space that carried historical or extramusical baggage.[10] Even Mozart's *würfelspiel* could, in theory, be explored systematically, e.g. by choosing the fifth option every time instead of rolling dice or by using an integer series.

Such causal, deterministic algorithms are a means of locating those regions in a possibility space that meet certain aesthetic criteria.[11] Algorithms have the advantage of tweakability; if one fails to produce pleasing results, it can simply be adjusted and repeated while avoiding having to manipulate musical parameters directly. The element of surprise may be lost when exploratory methods are strictly causal, but interactive algorithms allow the composer, guided by her tastes and values, to take a hands-on role in finding "good" trajectories through parameter space.[12] In his 1963 book *Formalized Music*, Greek composer Iannis Xenakis detailed a synthesis of aleatoric and causal techniques by using probability to narrow the range of possible outcomes in an aleatoric context and to make some outcomes more likely than others through statistical distribution. Xenakis called this composition method **stochastic music** and demonstrated its use in *Pithoprakta* and many later works.[13]

Complex natural phenomena, such as the summer songs of cicadas, can be imitated musically by using statistical probability to determine the morphology and characteristics of large numbers of discrete **sound-events**. Each sound-event behaves independently of the others but all are governed by the same probability distributions, allowing a composer to assert creative agency without the rigidity of causal determinism. Most importantly, the probabilities used in stochastic music are not fixed, but rather the primary dynamic variables that a composer uses to shape pieces of music over time. The same vast probability space exists for the duration of a work, but sound-events can be constrained to specific subspaces as the music requires.

Leander hybridizes the combinatorial indeterminacy of the *würfelspiele*, the deterministic clarity of data sonification and medieval isorhythms and the probabilistic methods of stochastic music. It is both a generative musical possibility space defined by a small number of dynamic parameters, and a wide, winding path through this space defined by the fixed-media visuals. The colors of the time lapse video determine those regions in this musical landscape where listeners may find themselves at every moment in the piece.

Camera placement for *Leander*

The *Leander* Possibility Space

Only three different types of sounds are used in *Leander*: **bell tones**, with a short attack and immediate decay; sustained vocal-like **pads**; and a collage of **field recordings**. In musical terms, each of these three types of sound may be considered a voice in a virtual trio, responsible for performing individual sound-events.

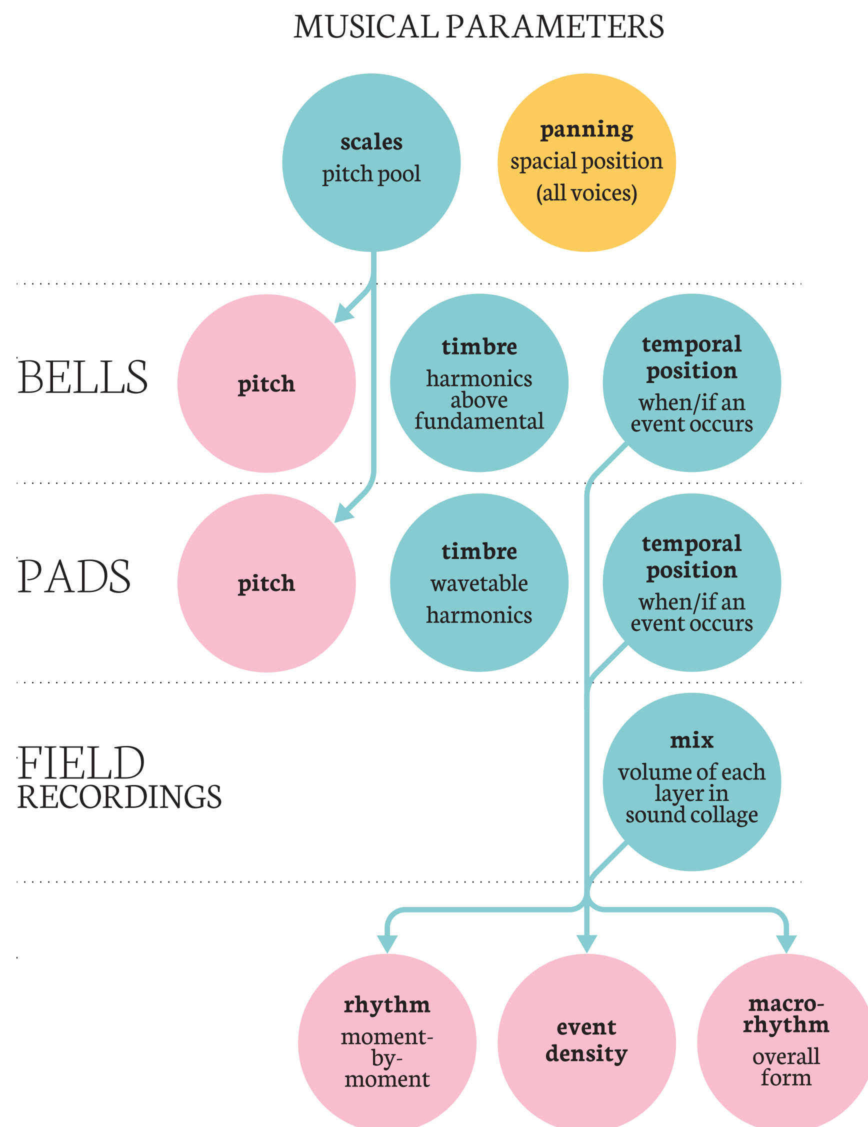
A variety of parameters determine the characteristic qualities of each sound-event played by each voice. The bells and pads are digitally synthesized using fairly simple techniques, so their characteristic qualities are governed by a small and finite number of parameters. The field recording voice is parameterized by changing the relative volume level of different recordings to create varying textures. In *Leander*, these parameters are discrete (non-continuous) to impose boundaries on its possibility space.

At right is a map of the dynamic musical parameters at play in *Leander*. They can be divided into three categories:

Primary parameters that are mapped to probability vectors derived from color data.	Secondary parameters that result from primary parameters but are not directly linked to color data.	Tertiary parameters that are dynamic, but governed by processes other than color data.

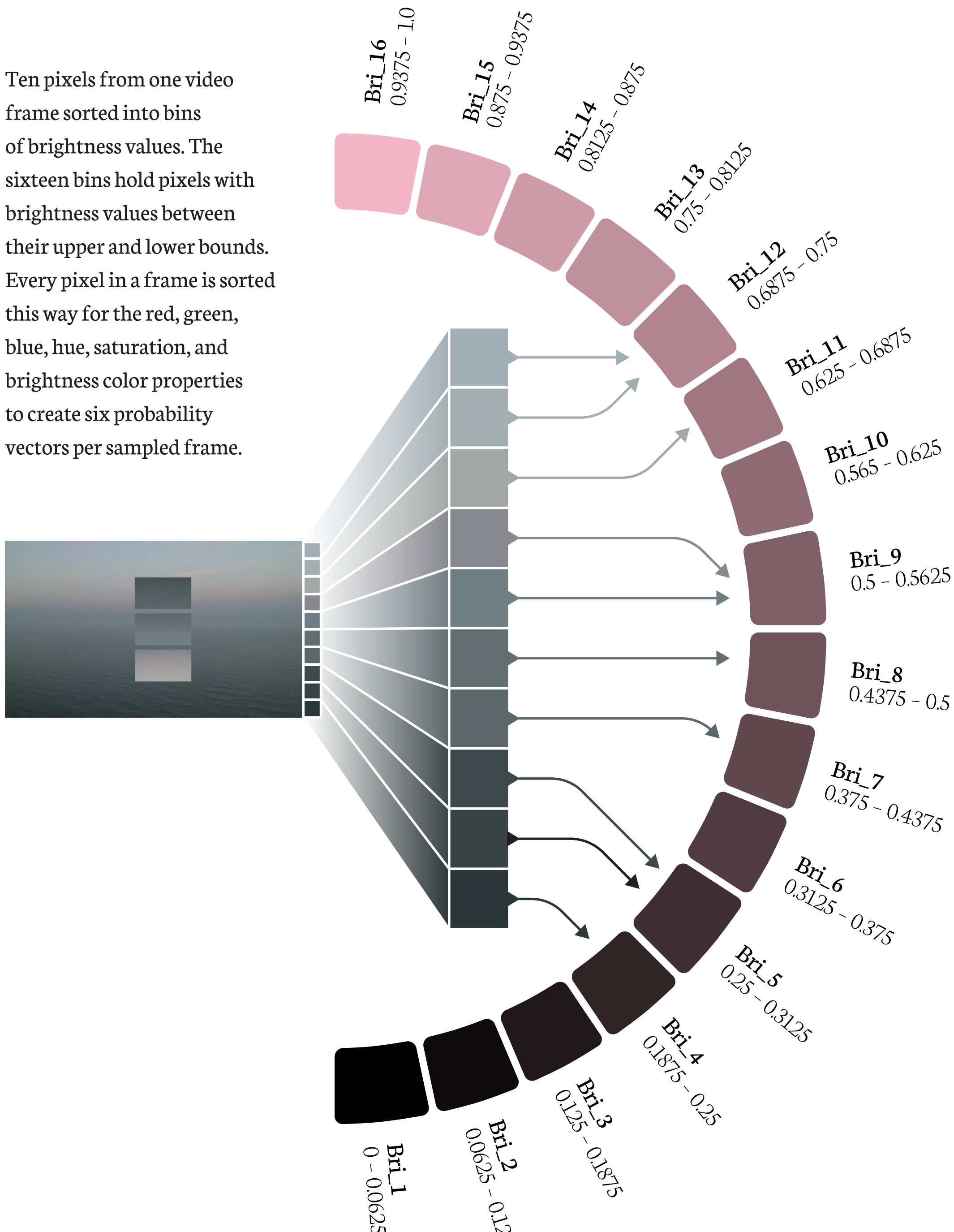
Each parameter represents a dimension in possibility space, the boundaries of which are delineated by the the gamut of parametric values in each dimension. Panning (the left-right spatial position of sound-events) is the only continuous parameter and is not determined by sonification; sound-events drift slowly and randomly around the stereo field to create an immersive soundscape. All other parameters (discussed individually below) are limited to a finite number of discrete states that represent specific locales within the possibility space.

The large-scale form of *Leander* is not predefined, but rather emerges from the amalgamation of sound-events over time, which occur as a result of the changing visual color data of the video.



VISAP'20, Pictorials and annotated portfolios.

Ten pixels from one video frame sorted into bins of brightness values. The sixteen bins hold pixels with brightness values between their upper and lower bounds. Every pixel in a frame is sorted this way for the red, green, blue, hue, saturation, and brightness color properties to create six probability vectors per sampled frame.



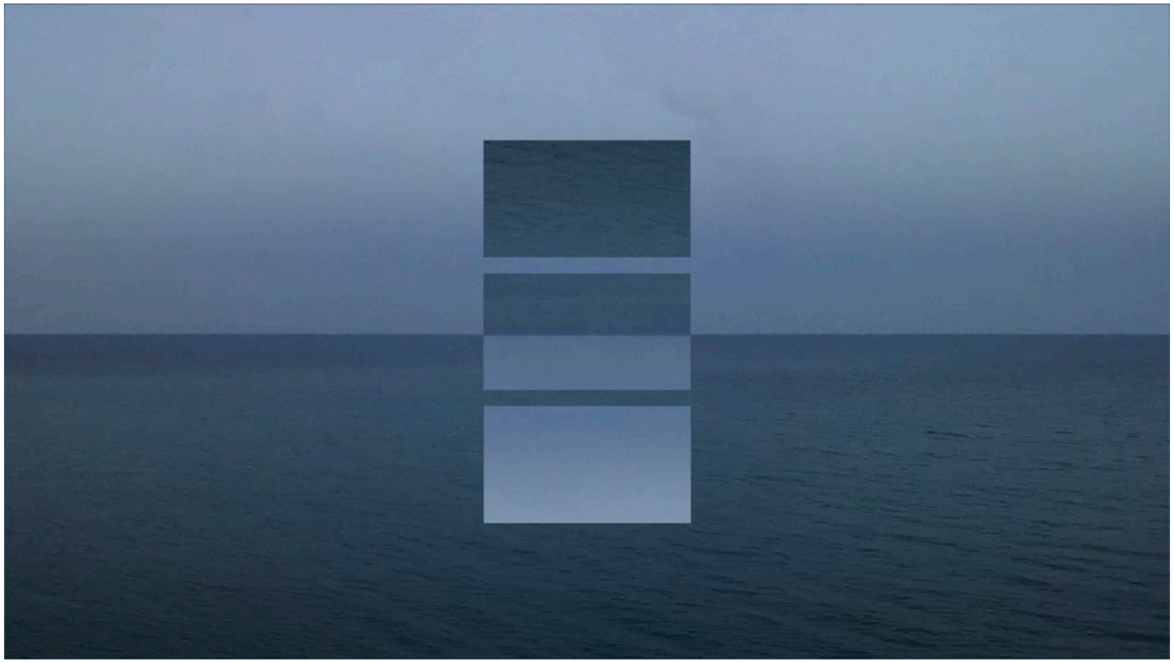
Probability Vectors from Color Values

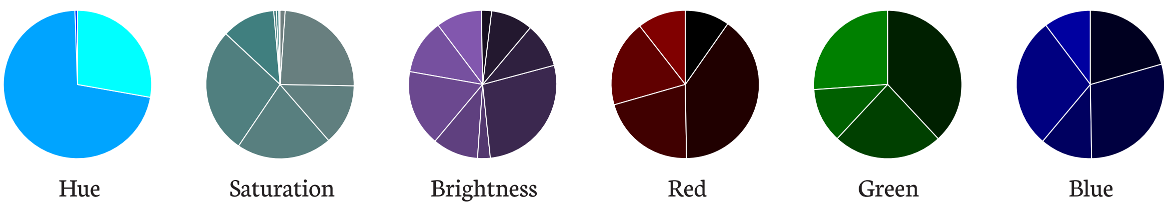
RGB and *HSB* are two of the most common digital color models. In RGB color space, the intensity of the **red**, **green**, and **blue** components of a color are indicated explicitly (often on a scale from 0–255 at 8 bits per channel). The HSB color space uses a coordinate system of **hue**, **saturation**, and **brightness** values to place colors within a virtual three-dimensional model that corresponds roughly to human visual perception (often on a 0.0–1.0 scale).[14] These six color properties are used to create the probability tables that drive the music in *Leander*.

At regular intervals in the video (four times per second), I extracted and tabulated the RGB and HSB values of every pixel of the current video frame using Processing. Each of the six values for each pixel is sorted into "bins" containing a range of possible values. The red, green, and blue gamuts are each divided into eight bins, while hue, saturation, and brightness are divided into sixteen bins (small changes in HSB values tend to have a greater impact on a color perception than RGB, hence the greater resolution). For example, the bin Bri_1 contains all pixels with a brightness value between 0.0 and 0.0625; Bri_2 contains those between 0.0625 and 0.125, etc.

Once all pixels in a frame have been sorted, it is possible to determine the percentage of overall pixels in each bin for each of the six color properties. These constantly-changing percentages constitute six **probability vectors**, which are mapped to the parameters that generate the music in *Leander*. A greater number of pixels in a particular bin correlates to a greater likelihood that its corresponding parametric value will occur.

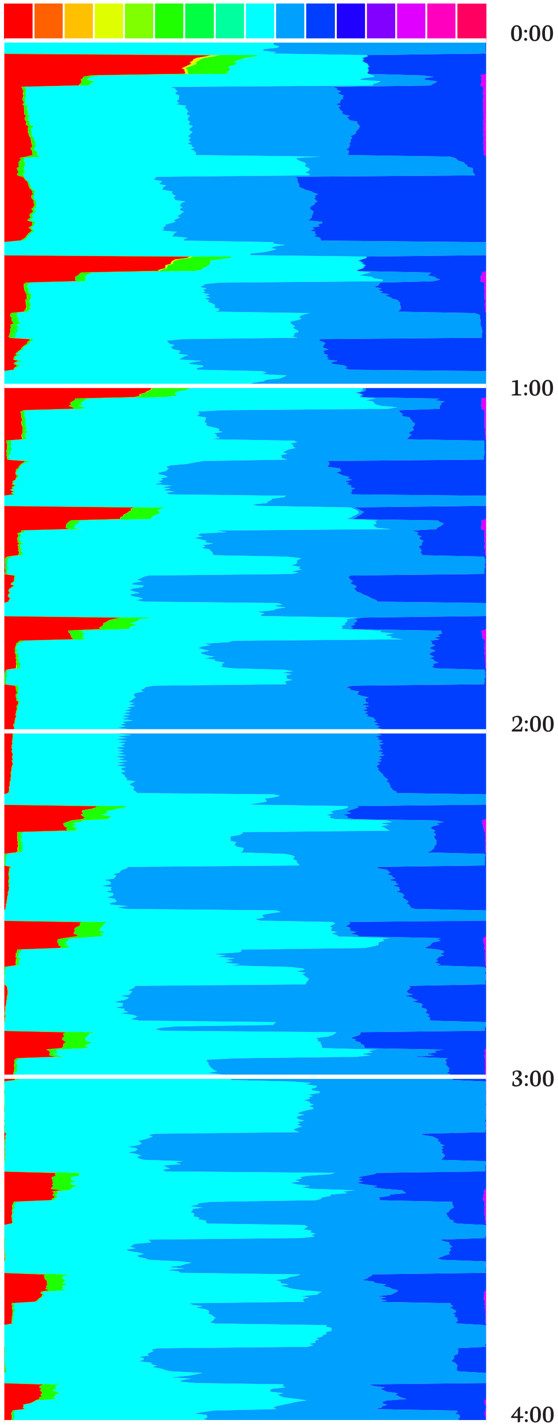
Color analysis (probability vectors) — 04:55:750





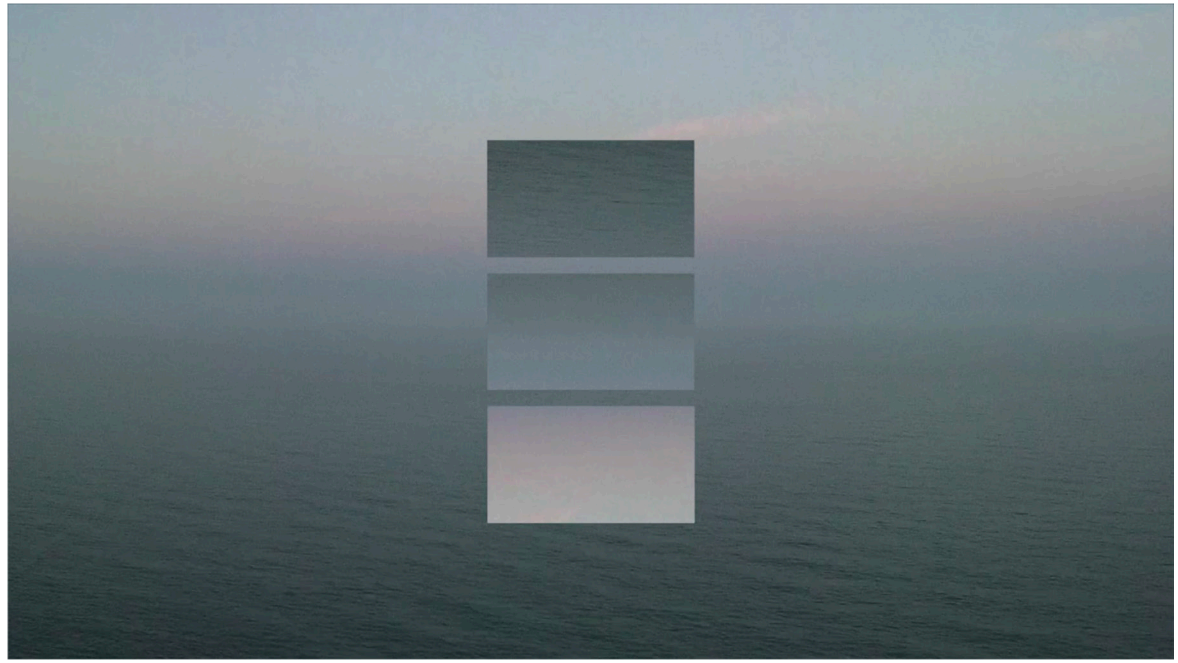
Right:
Color sorting Processing sketch. The current video frame is analyzed four times per second. The probability vectors from the color analysis are stored as columns in a CSV table. Each row of the CSV is read back at the same rate in the SuperCollider patch that generates the music.

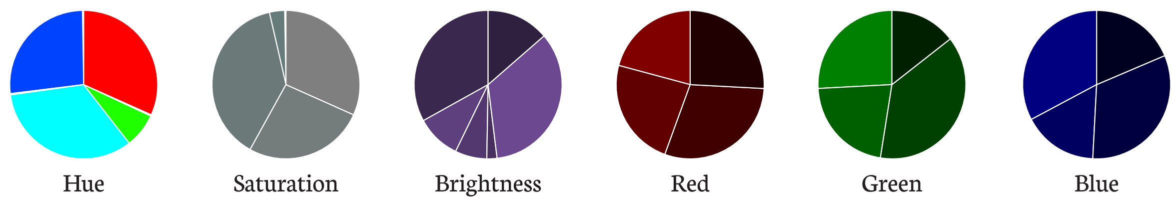
```
void analyzePixels() {
  loadPixels();

  /* Empty arrays for pixel data: */
  rgbVals = new int[3][colorQuant];
  hsbVals = new int[3][hsbQuant];

  /* Empty arrays for normalization: */
  rgbNorm = new float[3][colorQuant];
  hsbNorm = new float[3][hsbQuant];

  for(int i = 0; i < pixels.length; i++){
    int r = int(red(pixels[i]))/binStep;     // R
    rgbVals[0][r]++;
    int g = int(green(pixels[i]))/binStep;   // G
    rgbVals[1][g]++;
    int b = int(blue(pixels[i]))/binStep;    // B
    rgbVals[2][b]++;
    float hue = hue(pixels[i]);
    hue = round((hue / 255) * (hsbQuant-1)); // H
    hsbVals[0][int(hue)]++;
    float sat = saturation(pixels[i]);
    sat = round((sat / 255) * (hsbQuant-1)); // S
    hsbVals[1][int(sat)]++;
    float bri = brightness(pixels[i]);       // B
    bri = round((bri / 255) * (hsbQuant-1));
    hsbVals[2][int(bri)]++;
  }

  /* Normalize RGB and HSB Arrays: */
  for(int i = 0; i<rgbVals.length; i++){
    rgbNorm[i] = normIntArray(rgbVals[i], 4);
  }
  for(int i = 0; i<hsbVals.length; i++){
    hsbNorm[i] = normIntArray(hsbVals[i], 4);
  }

  /* Write values to table: */
  TableRow newRow = vidDataTable.addRow();
  newRow.setFloat("Timecode", timeRounded);
  for(int i = 0; i < hsbVals.length; i++){  // HSB
    for(int j = 0; j < hsbVals[i].length; j++){
      String[] hsbName = { "Hue_", "Sat_", "Bri_" };
      String dataLabel = hsbName[i]+j;
      newRow.setString(dataLabel,nf(hsbNorm[i][j],0,4));
    }
  }
  for(int i = 0; i < rgbVals.length; i++){  // RGB
    for(int j = 0; j < rgbVals[i].length; j++){
      String[] rgbName = { "Red_", "Grn_", "Blu_" };
      String dataLabel = rgbName[i]+j;
      newRow.setString(dataLabel,nf(rgbNorm[i][j],0,4));
    }
  }
}
```



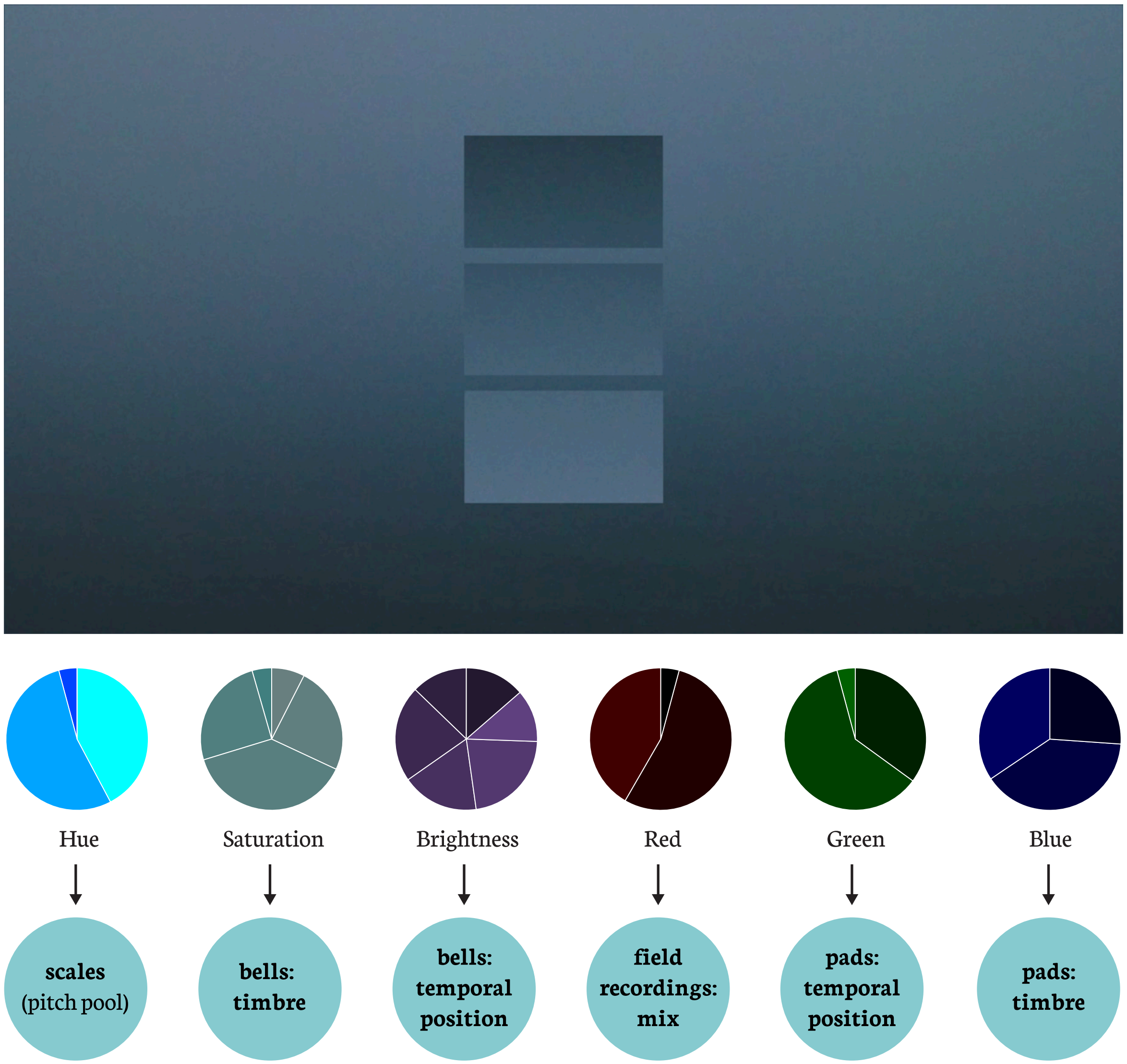
Left: Changes in the hue probability vector over the first four minutes of *Leander*.

Below: Color analysis (probability vectors) – 00:41:500





Color analysis (probability vectors) and parameter mappings — 07:36:500

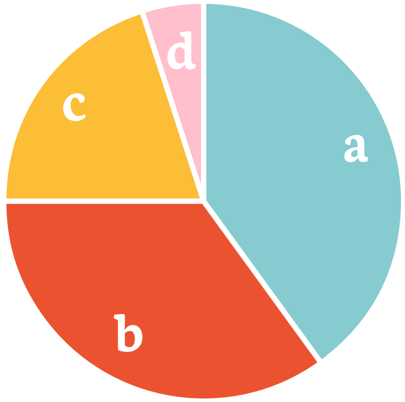


Parameter Mapping Overview

Each of the six probability vectors is mapped to only one musical parameter. **Hue** determines the musical **scales (pitch collections)** used throughout the piece, which help determine the pitches of notes in the bell and pad voices.

The bell tones are the most prominent and dynamic of the three voices and benefit from the larger size of the HSB vectors to create more parametric variety. **Brightness** is mapped to the **rhythm (temporal position)** of the bells, which in turn influences the event density and overall form of the piece. The ever-decreasing brightness in the video (due to the setting sun) is *Leander's* most apparent dynamic trajectory, and brightness values tend to be spread across numerous bins, creating rhythmic variety and interest. The **saturation** vector determines the **timbres** of the bell tones, creating the impression of a polyphonic musical texture.

The **temporal position** and **timbre** of the pad voice are determined by the **green** and **blue** vectors, respectively. The pad notes move much more slowly than the bell tones and fill in sonic space around the foreground voice. The **field recordings** are mapped to the **red** probability vector, which mixes different audio loops to create a subtle ambient background collage.



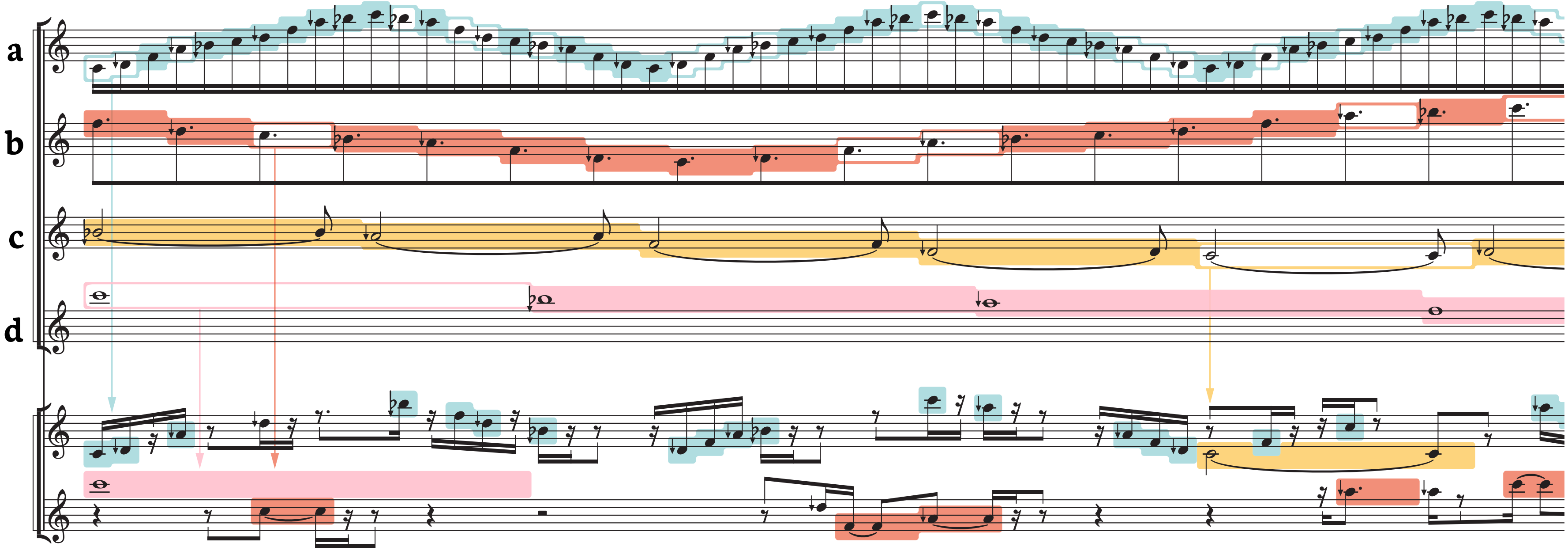
Four example pitch streams with different rhythmic durations (a, b, c, d) combine to form an aggregate texture (bottom two staves). The sample probability vector (above) determines the likelihood that notes will occur in one of the four pitch streams. The bell voice in *Leander* uses sixteen simultaneous streams.

Brightness > Bell Rhythm

Before other parameters can be applied to sound-events, it is necessary to determine when in time they occur. The **temporal position** (or **rhythm**) of bell-events in Leander is determined by selecting notes from sixteen simultaneous *pitch streams*. Each pitch stream constantly ascends and descends five-note scales over several octaves in regular durations. The duration of each note in a stream (the rate of change) is determined by its index. Stream #16 is the fastest (constant sixteenth notes), stream #15 is half the speed of #16 (eighth notes), #14 is one-third the speed (dotted eighth notes), and so on. All streams are synchronized to same underlying rhythmic grid and tempo.

The **brightness** probability vector governs the likelihood that the next note in a pitch stream will occur or if it will be a rest. Each of the sixteen bins in the brightness vector are mapped to a corresponding pitch stream. All streams continue in the background whether or not rests occur.

As the sun sets over the course of *Leander*, darker (low-brightness) pixels become more prevalent, resulting in more notes occurring in the lower (slower) pitch streams and less in the higher (faster) ones. There are, in turn, less notes overall as the piece goes on. This changing **event density** (the number of sound-events occurring in a given window of time) is an important dynamic characteristic of Leander.



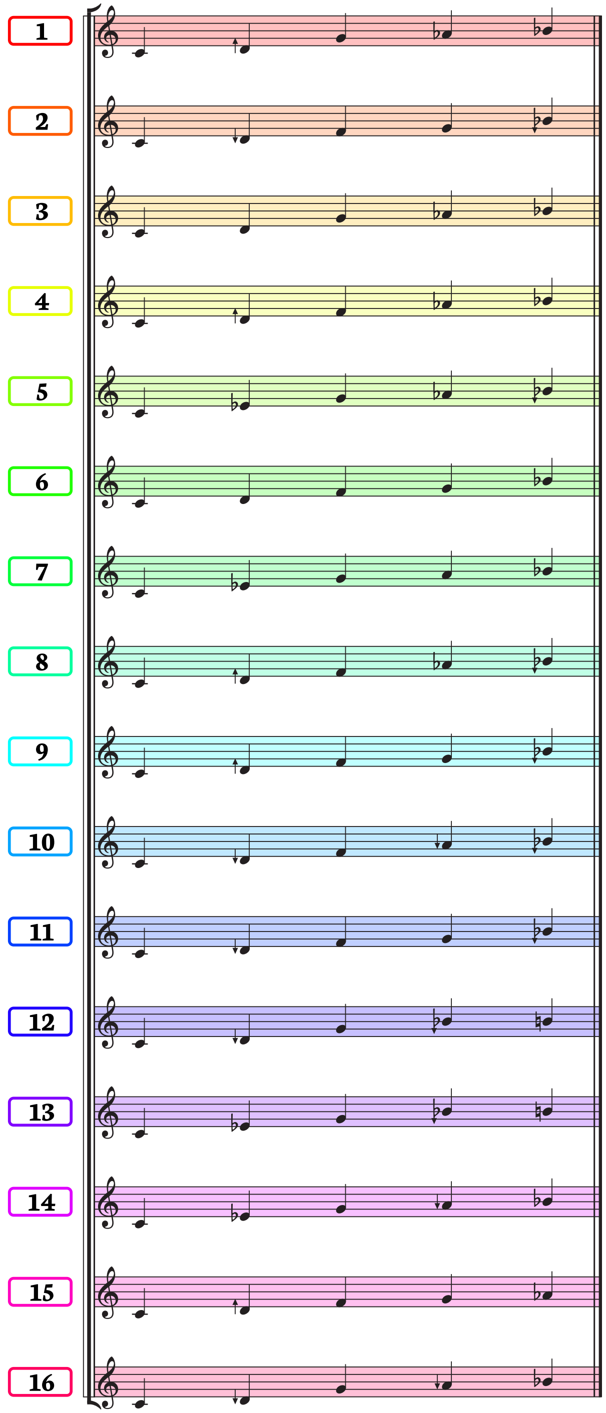
```
~leanderScales = [
    [ 1/1, 6/5,  3/2, 8/5, 9/5  ],
    [ 1/1, 7/6,  4/3, 3/2, 7/4  ],
    [ 1/1, 10/9, 3/2, 5/3, 15/8 ],
    [ 1/1, 6/5,  4/3, 8/5, 9/5  ],
    [ 1/1, 7/6,  3/2, 8/5, 7/4  ],
    [ 1/1, 10/9, 4/3, 3/2, 15/8 ],
    [ 1/1, 6/5,  3/2, 5/3, 9/5  ],
    [ 1/1, 7/6,  4/3, 8/5, 7/4  ],
    [ 1/1, 7/6,  4/3, 3/2, 7/4  ],
    [ 1/1, 10/9, 4/3, 5/3, 7/4  ],
    [ 1/1, 10/9, 4/3, 3/2, 7/4  ],
    [ 1/1, 10/9, 3/2, 7/4, 15/8 ],
    [ 1/1, 6/5,  3/2, 7/4, 15/8 ],
    [ 1/1, 6/5,  3/2, 5/3, 7/4  ],
    [ 1/1, 7/6,  4/3, 3/2, 8/5  ],
    [ 1/1, 10/9, 3/2, 5/3, 7/4  ],
]
```

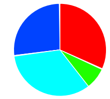
Above:

The sixteen just-intonation scales used in *Leander* expressed as whole-number frequency ratios in SuperCollider.

Right:

The same scales in musical notation color-coded with their corresponding hue bin. Up and down arrows indicate deviations from standard tuning (equal temperament).





Hue > Scale (Pitch Pool)

The pitch of each note is not parameterized directly. Each pitch stream begins on one of the five scale degrees (chosen randomly in a random octave) and climbs up and down over the span of several octaves for the duration of the piece. When the occurrence of notes from one particular stream is sparse (low brightness probability), the stepwise motion is obscured and the notes sound textural or harmonic. Tuneful melodic fragments emerge when several notes occur in succession from a single stream.

While the streams' movement through scale *degrees* is fixed, the specific pitches that comprise the underlying scale change based on the **hue** probability vector. Sixteen different five-note scales correspond to the sixteen hue bins. When, for example, scale degree #2 occurs in a pitch stream, the choice of which of the sixteen second scale degrees to play in that moment is determined by hue-weighted chance. The scales constitute a **pitch pool** from which the pitch streams retrieve notes.

Each scale begins on the note C but the intervals of the other four scale degrees vary; some are stable and consonant and want to return to C, others are unstable and dissonant and pull away from the C tonic, creating harmonic variety and tension. It is possible for pitches from different scales to occur simultaneously in different pitch streams, creating clashes. The scales are in *just intonation*, a tuning system that determines pitches by integer ratios between frequencies. Just-intonation intervals often fall outside of standard equal-tempered tuning and may be very sweet-sounding and consonant or strange and colorful depending on the frequency ratios.[15]

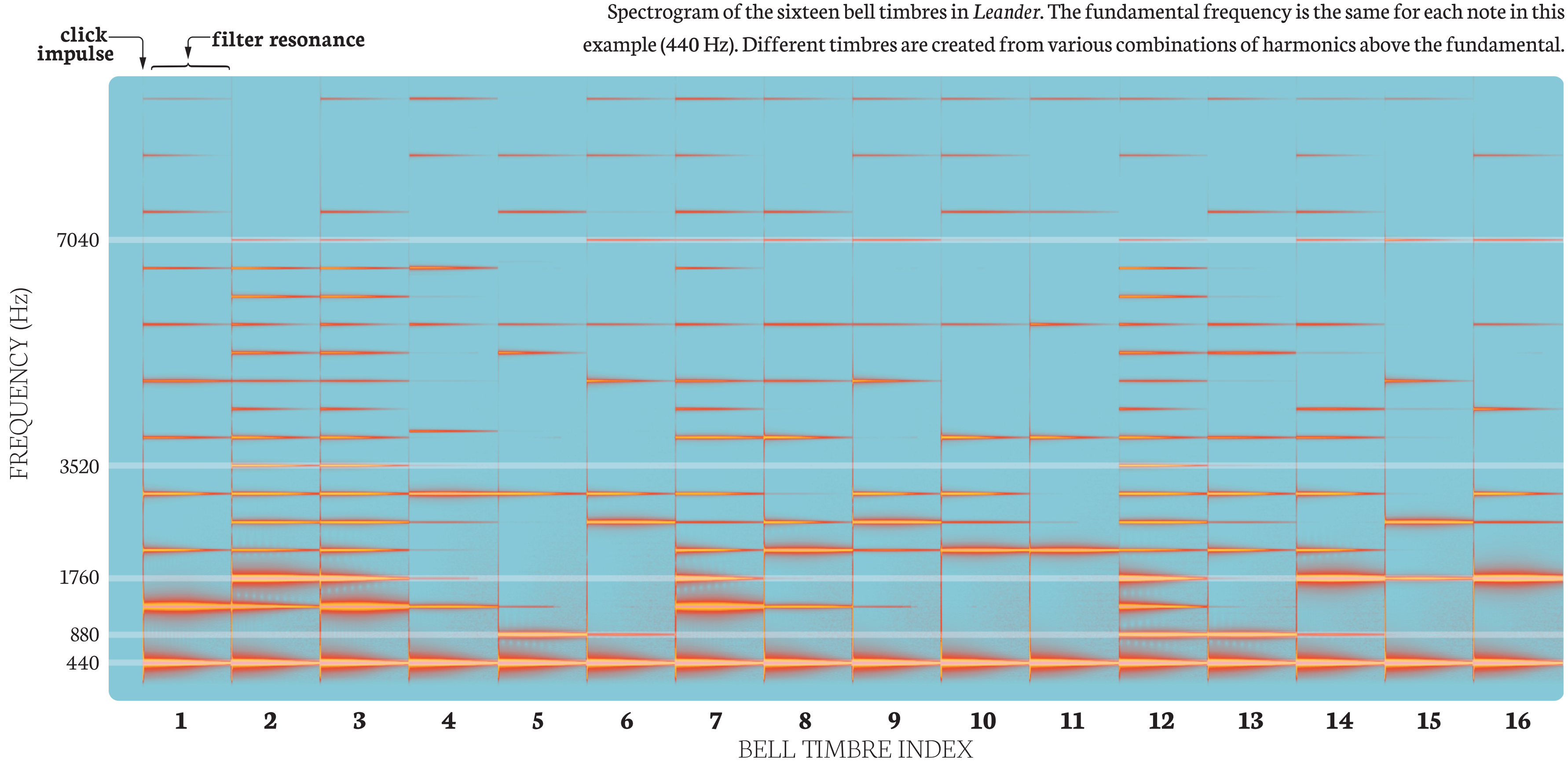
Saturation > Bell Timbre

When a note is played on an instrument, numerous **overtones** are created in addition to the main **fundamental** pitch. Often, the frequencies of these overtones are **harmonics** (multiples) of the fundamental frequency. Different instruments typically produce different overtones even when they play the same pitch. These varying harmonic spectra are one of the factors that affect our perception of **timbre**, the acoustic qualities that give sounds their characteristic tone colors.[16]

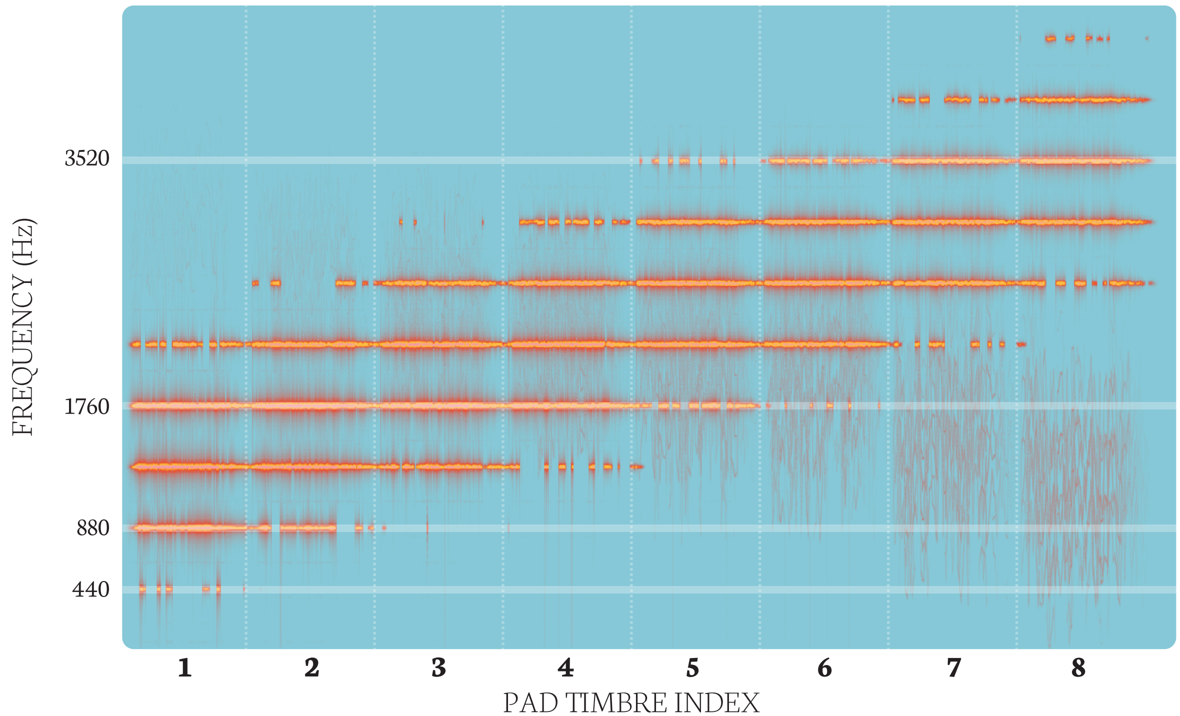
The bell tones in *Leander* are synthesized by filtering the sound of a drumstick click through a bank of tuned resonators. Each resonator rings at only a specific frequency.[17] To create a variety of bell-like timbres, sixteen different arrays, each representing a unique combination of harmonics, are multiplied by the fundamental frequencies produced by the pitch streams to determine the tunings of the filters in the resonator bank when a note occurs. The ringing resonators fuse into unified timbres characterized by their harmonic spectra.

The choice of the timbre of each note is determined by the **saturation** probability vector. Dividing pitch streams among timbres in this way is akin to a composer orchestrating a piano piece by assigning different parts to different instruments. Distinct timbres result in perceptual groupings that give passages a unifying logic separate from the pitch streams; brighter timbres may emerge as a foreground voice while duller timbres fade into the background or two alternating timbres may take on the character of a dialogue between voices.[18]

Spectrogram of the sixteen bell timbres in *Leander*. The fundamental frequency is the same for each note in this example (440 Hz). Different timbres are created from various combinations of harmonics above the fundamental.

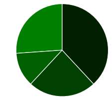


The eight pad timbres in Leander are stored as wavetables and each emphasize a different band of harmonics above a fundamental pitch (440 Hz in this example).

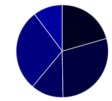


Durations of notes in pad pitch streams.

Pitch stream index and corresponding green bin	note duration
1	24 beats
2	48 beats
3	72 beats
4	96 beats
5	120 beats
6	144 beats
7	168 beats
8	192 beats



Green > Pad Rhythm

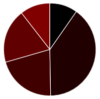


Blue > Pad Timbre

Sustained pads provide a contrasting texture and fill in sonic space between the percussive bell tones. Each pad note emerges and fades away slowly and their tuning and timbre are hazy and unstable, creating a background wash in sections of Leander. The pads occupy a lower register than the bells.

The pads share the same pitch pool as the bells and use a similar system of probabilistic pitch streams to determine rhythm. However, they use only eight different streams and move much more slowly; the durations of notes in the pad streams range between 24 and 192 beats each. These long, sustained tones provide a harmonic backdrop to the bells. The green probability vector determines the likelihood of notes occurring in the eight pitch streams.

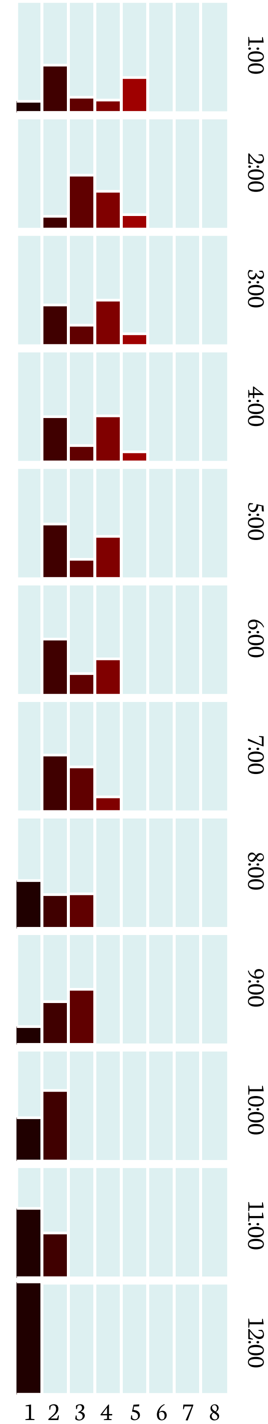
Eight different timbres, each emphasizing a progressively higher band of harmonics, are stored as wavetables[19] used by the pad synth to generate notes. The choice of wavetable is governed by the blue probability vector. The synth can interpolate smoothly between timbres, and the pads subtly and erratically shift between the two neighboring wavetables above and below the primary timbre. When low blue values become more prevalent in the film, timbres with lower, more stable harmonics become more common and the pads take on a more prominent role.



Red > Field Recordings

Audio **field recordings** were captured around the same location where the video footage was shot. These recordings are a counterpoint to the more abstract sonic elements in *Leander* and act as a bridge between the audio and visual components of the film. They are also the least aleatoric element.

The recordings were edited into eight long loops of different length that play throughout the film. The **red** probability vector maps directly to the volume levels of the loops. Lower-numbered loops were recorded closer to the lake while higher-numbered loops were farther away. Throughout most of the film, the red values are divided among several different loops, creating an indistinct ambient collage. In the final minutes of *Leander*, red values coalesce around loops #1 and #2 and the field recordings emerge as a more prominent, distinct texture as the other voices fade away.



Above and left:
Field recording near Lake Michigan.

Right:
The red vector determines the volume levels of the eight field recording loops throughout *Leander*. Sample vectors shown at one-minute intervals.

Future Paths

Even on the clearest days, March in Wisconsin is a fairly gray, dull place. To appreciate Lake Michigan's diversity of colors requires careful focus on changes within a narrow, low-saturation band of the color spectrum and. The minimalist style of *Leander* allows this opportunity. There are vast areas of the *Leander* possibility space that remain unexplored, simply because many other colors exist that are absent in the time lapse videos.

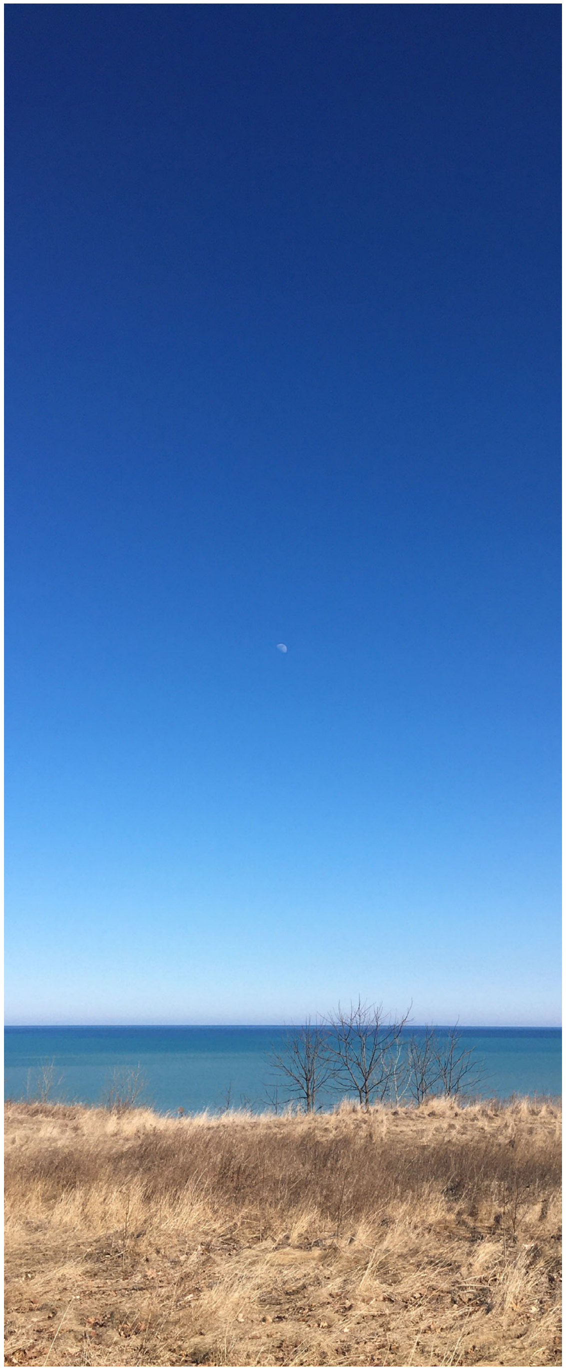
Composer Palle Dahlstedt has written that "The parameter space of an algorithm can be huge and there is no way for the composer to know all of it and predict what is going to happen for every single parameter set, but with clever design she can maximize the fraction of good results."[20]

The data mapping in *Leander* is not designed to provide a comprehensive look at its entire parameter space. The data is used to find paths through the space that produce musically satisfying results and respond to minute changes in the visuals. If time-lapse videos of different landscapes at different times of day are fed into this same data-sonification system, the sonic results will be vastly different, since this will generate a different morphology of probability vectors over the course of a piece.

The generative-stochastic system at the heart of *Leander* directs the musical course taken and also provides a means of judging if that course is a good one, since "good" data sonification reflects changes in the input data. With the data fixed and the parameter space limited to only six dimensions, the success of the sonification depends on the specifics of how each parameter interacts with the color probability vectors.

The system could be adapted to accept other types of video input data. Artists working with edge detection, pixel sorting, and other video processing methods may find novel uses for a hybrid stocastic-deterministic system to create generative music. Data can also be drawn from souces other than video to produce strictly sonic works, or audiovisual works in which the music is not dependent on the visuals.

This hybrid approach gives the artist control over the aesthetic experience indirectly by choosing musical material that suits the visuals while leaving the specific arrangement of the parameters to chance. The composer is has creative freedom to prescribe harmonic, rhythmic, and timbral palettes that become the sonic material used to generate a stochastic musical composition in sync with time-based data.



The moon over Lake Michigan. March 2020.

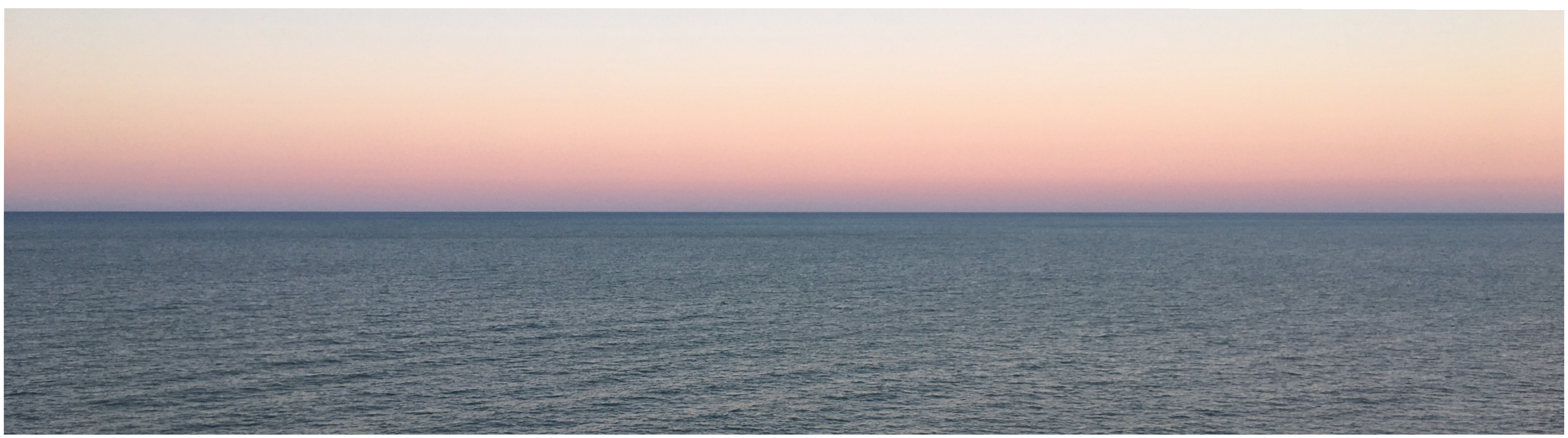
Discussion

I recorded the *Leander* time lapse videos between March 16 and 30, 2020 as the gravity of the COVID-19 pandemic was quickly setting in across the United States. On March 24, Wisconsin issued a “Safer at Home” order, effectively locking down the state. The full meaning of the now-familiar term “social distancing” became swiftly and abundantly clear. Every class, lesson, meeting, and appointment was now a video chat. Weddings and family reunions were cancelled. Friends, family, colleagues, and classmates suddenly felt an ocean away.

Time itself seemed to ebb and flow in the absence of the many quotidian events that mark its passage. The colors of the lake, captured in time lapse, remained a source of fascination and the driving force behind *Leander*, but the accelerated sunsets and hypnotic blurring of days felt especially apropos as quarantine hours seemed to drag on and fly by simultaneously.

In Greek mythology (and later immortalized in verse by Christopher Marlowe), Leander swam across the Dardanelles strait to be with his lover Hero, who lit a lantern to guide his voyage across the dark waters.[21] This seemed a fitting symbol for the patient determination required during this period of waiting and isolation. The grainy lake footage took on an increasingly distant, nostalgic character as I attempted to assemble it into a cohesive whole. I made the decision to invert the three rectangles in the center of every frame to represent an “other side” (the view from Hero’s lighthouse, perhaps) — either the old normal that suddenly felt like a distant memory or an as-yet-undetermined new normal that will come into focus in future months and years.

It is difficult to process events as you are living through them and even more difficult to express them in a creative and meaningful way. It may be natural to entertain escapist fantasies in times of crisis[22]; I just so happened to create a conceptual musical possibility space as my escape instead of a house in *Animal Crossing*. A stochastic approach to data sonification allowed me to gently guide the music toward those areas in its possibility space that felt right at the time while remaining open to the possibility that it may be different next time I listen, a freedom that would not be possible in a strictly deterministic context. It also allowed me to engage in a kind of dialogue with my own artwork by providing it with the materials needed to generate something beautiful, listening and suggesting changes to its behavior, and then letting it sing me generative lullabies to accompany each coming twilight.



Looking east over Lake Michigan at sunset, March 2020.

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