Chapter 1

Computer Applications

SuperCollider Programming Language.

1.1 Spectral Tracking

1.1.1 PartialTracker

```
SynthDef.writeOnce(\numpar, {arg fftbuf, magbuf, freqbuf, bus = 1, num = 1, vol = 1;
var in, chain;
in = AudioIn.ar(bus, vol);
chain = FFT(fftbuf, in);
chain = PV_MaxMagN(chain, num);
chain = PV_MagBuffer(chain, magbuf);
chain = PV_FreqBuffer(chain, freqbuf);
IFFT(chain);
});
```

1.1.2 FFTFilter

1.1.3 SpearToSC and SpearToMIDI

SpearToSC is a SuperCollider class that takes data from the open source software application called SPEAR[1] and transfers it to an array in SuperCollider. SPEAR uses a variation of the traditional McAulay-Quartieri procedure and "attempts to represent a sound with many individual sinusoidal tracks (partials), each corresponding to a single sinusoidal wave with time varying frequency and

[1]Michael Klingbeil, SPEAR, 2005, URL: http://www.klingbeil.com/spear/.

amplitude."[2] SPEAR provides a graphical representation of a sound[3] (as seen in Figure 1.1) in which it is possible to select the individual sinusoidal tracks and allows to isolate and access the information for each individual partial. The amplitude and frequency information of each partial

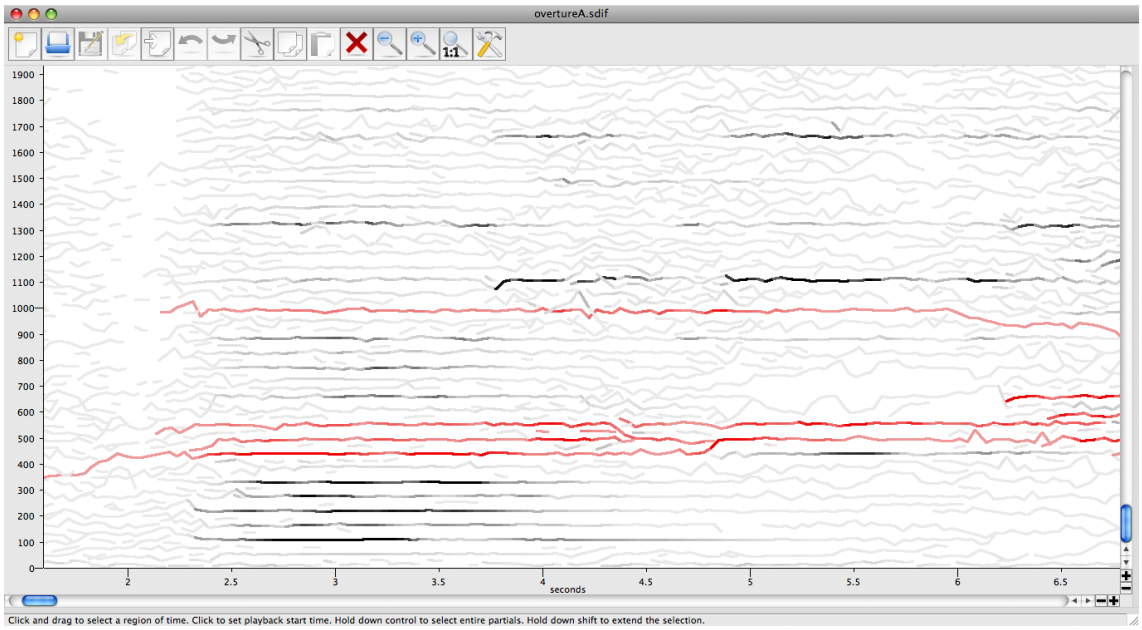

Figure 1.1: SPEAR graphical interface.

given by frame can be stored in a text file. SpearToSC reads text files produced by SPEAR[4] as a string and strips it into a multidimensional array in SuperCollider. It is therefore possible to process this data within the SuperCollider language and server and re-synthesize this information not only with sinusoidal waves, but with any type of Unit Generator.

SpearToMIDI reduces the information given by SPEAR to be used as data to produce a MIDI file or to control SuperCollider synthesis definitions. The purpose of this class is to reduce the spectral information to an amount of data that can later produce notated material for a written score, a MIDI file or a control system to be used for triggering synthesis algorithms. The data in the text file generated by SPEAR is available by frame and gives too much information for this purpose. Therefore, the SpearToMIDI class reduces this data in four stages: First, the class takes an amplitude threshold argument which gets rid of all of the partial data that lies bellow this value (as seen in Figure 1.2). In other words, it breaks the partial in different groups by introducing silences instead of the data that lies bellow the threshold and at the same time keeps track of the

[2]Michael Klingbeil, M. 2005. "Software for spectral analysis, editing, and synthesis." in *Proceedings of ICMC*, vol. 2005, 2005. URL: http://www.klingbeil.com/papers/spearfinal05.pdf.

[3]Spectral analysis where the y-axis represents frequency in hertz and the x-axis represents time in seconds.

[4]SpearToSC reads SPEAR text files in the *Text - Partials* format only.

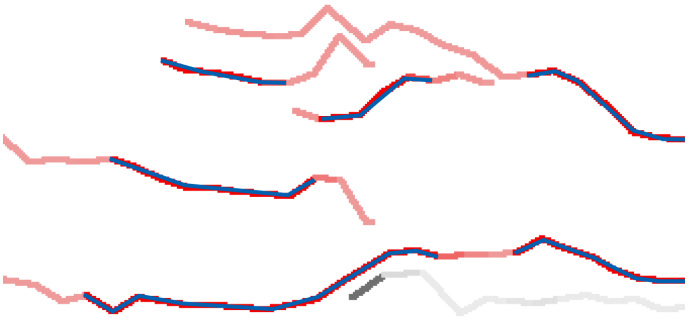

Figure 1.2: Amplitude threshold selection.

beginning and the end of each group. The second stage reduces data with a frequency modulation threshold. Each group is taken as a line and the computer only stores the points in the line which cross a given interval (the modulation threshold). For example, Figure 1.3 shows how the lines representing the groups in Figure 1.2 are traced by selecting the points that cross a given interval.[5] If the interval is of one semitone then the frequencies are averaged to the closest chromatic note. It is possible to make microtonal divisions of the equal-tempered scale by using floating point values for the note modulation threshold. After these first two stages, the original data from Spear is reduced

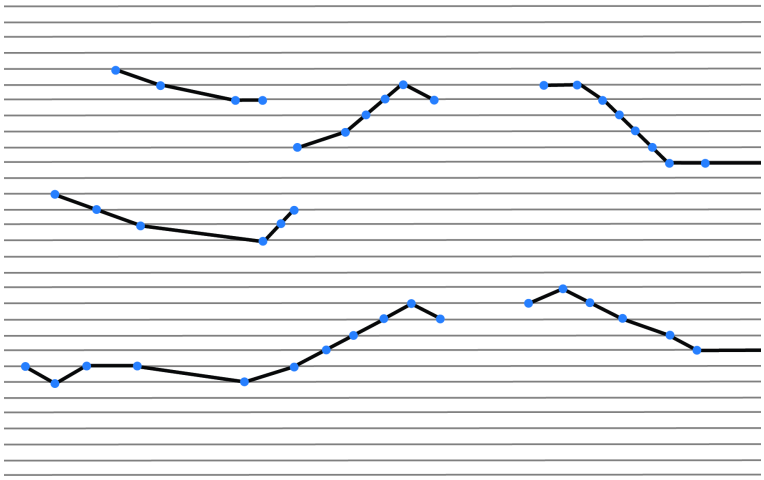

Figure 1.3: Point selection through note modulation threshold.

considerably by disregarding details that are not vital for the given purpose.

The third stage, takes a note modulation threshold and averages the frequency of the pivot points

[5]The grid represents the intervals as shown in the y-axis. For the purpose of simplification, the diagram doesn't show a logarithmic representation of frequency.

to the closest given equal-tempered interval. The forth stage is divided in two different steps: The first step translates the lines with pivot points into a format that is compatible with the MIDI *note on* and *note off* paradigm. The pivot points are then considered as representing *note on* messages and the *note off* messages are calculated depending on whether there is a silence after the note or a new pivot point. Hence, a *note off* is inserted before a new *note on* or in case of a silence proceeding the pivot point. Figure 1.4 shows the glissando representation, where the notes are seen as green lines.

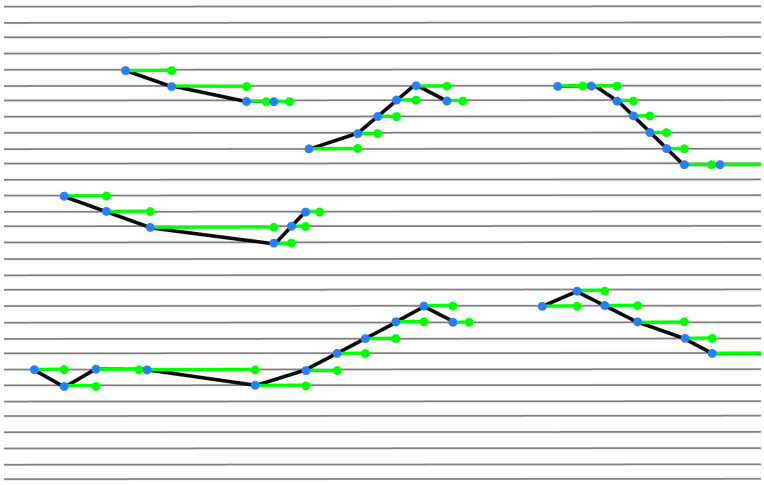

Figure 1.4: Note representation.

The results of this step can be acceded if the user's intention is to notate the partials as glissando's or if this information needs to be used to control a gradual frequency change in a synthesis definition. Lastly, the second step breaks the lines that exceed the interval set in the note modulation threshold. Therefore, it introduces new notes when the line passes the interval limit by introducing the *note on* and *note off* messages (as seen in Figure 1.5).

1.2 Real-Time Scoring

1.2.1 AlgorithmicScore

1.3 Pre-compositional Tools

1.3.1 MIDI Mapping

1.3.2 MIDI Triggering

Chapter 2

E-tudes

E-tudes is a set of electronic études for six stage pianos, live electronics and Disklavier[1]. These compositions where written for the ensemble **piano***circus*[2] for a project that became a two-year collaboration and lead to two performances[3]. What initially attracted me to this ensemble was it's very particular instrumentation consisting of six electronic stage pianos. I thought this to be a suitable platform to experiment with the concept of *Real-time Plunderphonics*[4] considering that these instruments are electronic and therefore produce no considerable audible acoustic sound.[5] Therefore, if the original music that the pianists play would be processed by the computer, the live-treatment of the sounds would be the only audible result—it would not be necessary to deal with the acoustic sound that would sound regardless of the computer processing if the instruments were acoustic. In other words, the music being played would be hidden from the audience when stripped away from its original sound. Another advantage that I found in using these keyboards is that I could not only use audio signals, but also the MIDI messages as building blocks for the composition. Considering these opportunities for experimentation, I embarked in this large project which I plan to continue in the long-run.

Like a book of études from the repertoire, E-tudes consists of a set of pieces that can be performed

[1] In case a Disklavier is not available, it is possible to use an electronic stage piano or a sampler with piano sounds.

[2] The original six piano ensemble was formed in 1989 to perform Steve Reich's Six Pianos. Since then the original members have changed and now comprise of David Appleton, Adam Caird, Kate Halsall, Semra Kuruta, Paul Cassidy and Dawn Hardwic.

[3] Enterprise 08 Festival, The Space, London, 14 May, 2008, and The Sound Source, Kings Place, London, 9 July, 2009, sponsored by the PRS Foundation Live Connections scheme and Sound and Music.

[4] See pp. xx-xx for a discussion about this concept.

[5] The only acoustic sounds that can be heard are the keyclicks produced by the physical contact with the stage pianos while playing. This noise is slightly audible mostly when the sounds in the speakers are quiet or at moments where the speakers are silent.

together at the same event or individually as separate short pieces. At present time, I have completed four 'e-tudes', and as an ongoing project I will continue adding new pieces to the group. The way in which these 'e-tudes' are presented can also be modular: depending on the set of circumstances for a given event, they can be presented either as a concert performance or an installation with perforative elements. In the installation version, the audience walks into, out of, and around the area surrounding the musicians and has creative control over how they want to experience the performance. By choosing between listening to the speakers in the room or through headphones generating different outputs and distributed through the performance space, each member of the audience fabricates their own version of the piece. Therefore, in the installation version their are various possible outputs generated by the processing of the

Hello sentence.

simultaneously a performance and an installation. A single multilayered composition will be performed at various times over the course of the event.

The ensemble of six stage pianos is placed in hexagonal formation and divided into two subgroups. The first subgroup consisting of three pianists are asked to select études from the western piano repertoire [6] and are to play them in the order of their choice during the duration of the performance. The second subgroup consisting of the remaining three pianists perform together from *The Sixth Book of Madrigals* by Don Carlo Gesualdo da Venosa (1566-1613).

The pianists playing the madrigals send MIDI information to two laptops that will transform the audio signal from the etudes and schedule the digital signal processing events. The audience will not be able to hear in the room what the pianists are playing as the stage pianos do not produce an acoustic sound. The seventh performer -the composer himself- will speak the Madrigals' text through a microphone and the spectral information from this signal will be used to process the final audio output and to trigger other sound events. The composer will also play a MIDI controller and will not have a fixed score, leaving space for an improvisational element within the human/computer interaction. Finally, through the analysis of all the inputs the computers will send MIDI messages to a Disklavier (mechanical piano) that will play the role of "virtual soloist" for the performance. In the room one will be able to hear the final result of the creative process of combining the simultaneous performances in diverse arrangements. The headphones that will be spread through the performance space will portray the inner life of the performance sounding in the room and reveal the inner layers of computer processing as well as the appropriated compositions.

E-tudes also challenges the audience by questioning traditional performance practice and creating

[6] Examples of these are études by Chopin, Ligeti and Debussy, to mention just a few.

a cognitive dissonance: what you see is not necessarily what you hear, and certainly not what your past experience leads you to expect.

Piano Circus, an ensemble featuring six pianists: Kate Halsall, David Appleton, Adam Caird, Semra Kurutac, Helen Reid and Graham Rix, will perform the piece. They will be playing on Roland RD700 Stage Pianos. The composer, Federico Reuben, will join them performing live-electronics: laptops, midi-controllers, microphone and mixer.

The ensemble will stay in their usual hexagonal formation but will be divided into two subgroups. Three pianists will choose etudes that are established in the piano repertoire (Chopin, Ligeti, etc.) and perform them whenever they want during the duration of the piece. They will be monitored individually through headphones. The other three pianists will perform together from the 6th book of Madrigals by Don Carlo Gesualdo da Venosa (1566-1613) and will be able to hear each other through headphone monitoring. The pianists playing the Gesualdo will send MIDI information to two laptops that will transform the audio signal from the etudes and schedule the digital signal processing events. The audience will not be able to hear in the room what the pianists are playing as the stage pianos do not produce an acoustic sound. The seventh performer -the composer himself- will speak the Madrigals' text through a microphone and the spectral information from this signal will be used to process the final audio output and to trigger other sound events. The composer will also play a MIDI controller and will not have a fixed score, leaving space for an improvisational element within the human/computer interaction. Finally, through the analysis of all the inputs the computers will send MIDI messages to a Disklavier (mechanical piano) that will play the role of "virtual soloist" for the performance. In the room one will be able to hear the final result of the creative process of combining the simultaneous performances in diverse arrangements. The headphones that will be spread through the performance space will portray the inner life of the performance sounding in the room and reveal the inner layers of computer processing as well as the appropriated compositions.

The music will be specifically composed for this event and for Jerwood Space. Since the piece is conceived as an installation as well as a performance it is best suited to a space that encourages moving around and interacting with the work. In contrast to the concert hall, where the audience is locked to a single location, the space should promote interaction and invite the audience to pick up the headphones, which will be spread around. People should also be able to walk around and experience the piece from several locations and focus on various aspects of the different performances taking place. This venue offers all of these possibilities as well as giving the opportunity to go out and re-enter the space during the duration of the event. One can argue that these elements are fundamental for a piece that seeks to form a relationship with the listener and thus, it remains

important that this event take place in this type of setting.

E-tudes questions the traditional role and relationships between performer, composer and listener and gives a unique and innovative approach to the use of found objects. The composer in this piece does not communicate with the performers by writing a score or by teaching them the music by ear as in previous performance practice conventions. He even lets the performers decide which pieces to play within a given repertoire. Therefore, the creative role of the composer is not to provide the music the performer should play but rather, in Oswaldian terms, to plunder their audio signal. On the other hand, E-tudes differentiates itself from John Oswalds Plunderphonics in that the plundering occurs in a live situation and that makes the performer an accomplice in the process of appropriation (of themselves). In a way, since E-tudes appropriates several live performances simultaneously, it proposes the notion of plundering in real-time, or Real-Time Plunderphonics. It is therefore important that the event take place in a live situation, as the theatrical effect of being plundered will be evident visually in relationship to the audio. Consequently, the amount of processing of the audio signals will be visible to the audience and the more processed the performances are, the more contrasting they will look in relationship to what is heard through the speakers. In E-tudes, this premise is consciously used to create a narrative that navigates, in literary terms, between the real (actual performance) and the surreal (more extreme processed audio). In contrast with the acousmatic tradition (music presented through loudspeakers in a fixed medium where the sound sources are not visible), the live performance makes the process of appropriation transparent to its audience as a result of the cognitive association between audio and visuals. In an acousmatic approach, a sound that is radically processed loses its characteristics and therefore the cognitive relationship between source and result may be lost. On the other hand, if the source is exposed visually in a live performance, the audience will have more audio/visual links and one may suppose that the audio processing could be even more extreme without losing the association with the source. Furthermore, E-tudes approach is atypical in relationship to Plunderphonics or other music that borrows found material (for example, by musical quotation) in that plundering is not the central purpose of the creative process, but rather a tool for creating a new idiosyncratic audio/visual result. This difference is rather important since it addresses the question inherent in the ambivalence of plundering oneself to create something new as opposed to performing something new in an immediate and direct fashion. Therefore, the idiosyncratic result justifies the conscious participation of the performer in a piece in which what he or she plays is not directly heard by the audience. This position proposes a new relationship between performer and composer and it also presents a new approach to composition. The composers role is not to establish direct communication with the performer (through a score or oral tradition) but rather

to use live audio signals of existing music as building blocks to create a new work. All of this is achieved by writing computer software (using SuperCollider 3 a programming language specialized in audio applications) specifically for the piece. Moreover, E-tudes takes a didactic attitude toward the process of appropriation by giving the listener access to the processed and unprocessed building blocks to show the different layers within the composition, not with the intention of being explicit, but to engage and establish a relationship with the listener. Finally, this composition combines the use of improvisation and generative music to have an unfixed output that changes for each performance of the work. This enables the piece to run in a loop during a long extended time frame without repeating itself. Every time the piece will be played not only will the audiences experiences differ, because of their own choices, but also the content of the piece itself will vary. E-tudes takes many elements used before in electronic music and live performance such as improvisation, appropriation, generative music, installation and traditional performance practice, and by combining them points to a development in performing with live electronics. By introducing a dynamic group of live performers and an appealing and interesting visual scenario, this event deals with the problematic of the lack of visual clues and theatrical elements that live electronics performance has faced since its beginning. Hopefully, it will also encourage other creators that deal with live electronics to think seriously about the visual, theatrical and ritualistic aspects of performance. This composition will also contribute to instigating awareness within the contemporary music community on how the presentation of a piece can be as crucial as the sound. It also proposes that the creator is able to innovate by searching for new ways that the audience relates to the work. The event will also contribute to the creative development of the artists because it will give them the opportunity to try out and experiment on the various interactive and performative aspects of the piece and later examine and evaluate how these processes may be improved.

2.0.3 Other important aspects about E-tudes

Performance/Installation

Audience will have creative control over how they want to experience the performance.

By choosing between listening to the speakers in the room or through headphones they will fabricate their own version of the piece.

Didactic attitude towards appropriation: listener will access processed and unprocessed building blocks, not with the intention of being explicit, but to engage and establish a relationship with the audience.

Relational aspect: it proposes the idea that one may innovate by searching for new ways that the

audience relates to the work.

Elements of improvisation and generative music. Every time the piece will be played not only will the audiences experience differ, because of their own choices, but also the content of the piece itself will vary.

2.1 E-tude 1

2.2 E-tude 2

2.3 E-tude 3

2.4 E-tude 4