

Notes comparing the rule extraction of two different systems

Systems' description

1. Blip

A Band limited impulse generator. It produces a fundamental frequency to which a certain number of harmonics are added. All harmonics have equal amplitude. It is represented in the following way:

Blip (freq, numharm, amp);

Where freq is the fundamental frequency, numharm is the number of upper harmonics added, and amp is the amplitude of the signal.

2. Additive synthesis of Sawtooth waves

It consists of four sawtooth waves of frequencies freq, freq2, freq - 1 and freq2 + 1, all having the same amplitude denoted amp.

Perceptual properties

For the experiment different perceptual properties were selected for each system. Those are described below. We need to have in mind that, as the system is designed for the exploration of general perceptual properties, it is the consistency of the results with the selected perception which determines the parameters used during the rule extraction process.

1. Blip For this system the output perceptual properties selected were the following. Rhythmic, rough, and tone. This are generally described in the following way:

The sensation of rhythm is associated with low fundamental frequencies (less than 20Hz), in which the number of harmonics added controls the perceived pitch of the successive beats.

The rough sensation is generally associated with fundamental frequencies around 15 and 35 Hz. However, the upper harmonics added create important variations in such perception. For example, if the number of harmonics is zero, frequencies from around 20 to 45 are perceived as pure tones.

Pure tone perception is generally associated with frequencies greater than 20 Hz without upper harmonics. However, also frequencies with high number of upper harmonics (>50) may also be perceived as pure tones.

2. Additive synthesis of sawtooths The selected perceptual property for this system was defined as follows: The spectrum of frequencies was divided in three parts: 0 - 101, 101 - 201, 201 - 301. At each of these parts audible consonant (specially octaves) and low dissonant combination were chosen.

To favor the compression of the data and to systematize the exploration process, one frequency remained static at each division while the other was varied.

Data rule extraction thresholds and extracted rules

Blip

The collected data is shown below.

0	,	[11.354432	,	20	,	0.6	,	1]
1	,	[10.203962	,	20	,	0.6	,	1]
2	,	[5.504405	,	20	,	0.6	,	1]
3	,	[1.854298	,	230	,	0.6	,	1]
4	,	[7.653983	,	230	,	0.6	,	1]
5	,	[15.012693	,	230	,	0.6	,	1]
6	,	[4.294679	,	230	,	0.6	,	1]
7	,	[20.425354	,	260	,	0.6	,	2]
8	,	[24.548191	,	260	,	0.6	,	2]
9	,	[21.10586	,	260	,	0.6	,	2]
10	,	[21.10586	,	67	,	0.6	,	2]
11	,	[21.10586	,	370	,	0.6	,	2]
12	,	[21.10586	,	26	,	0.6	,	2]
13	,	[99.598908	,	7.928433	,	0.6	,	3]
14	,	[99.598908	,	14.141092	,	0.6	,	3]
15	,	[55.781054	,	7.807612	,	0.6	,	3]
16	,	[55.781054	,	1.90927	,	0.6	,	3]

The extracted rules were extracted using $[0, \text{inf}]$ threshold 10, $[0, \text{inf}]$ threshold 200 and $[0,1]$ threshold 1 for the respective parameters.

class 1

0 [[5.504405, 10.203962, 11.354432], 20, 0.6, 1]
1 [[1.854298, 4.294679, 7.653983, 15.012693], 230, 0.6, 1]

class 2

0 [[20.425354, 21.10586, 24.548191], 260, 0.6, 2]
1 [21.10586, [26, 67, 260, 370], 0.6, 2]

class 3

0 , [99.598908, [7.928433, 14.141092], 0.6, 3]
1 , [55.781054, [7.807612, 1.90927], 0.6, 3]

Additive Sawtooth

Collected data

0	,	[101,	20,	0.1,	1]
1	,	[101,	76.607595,	0.1,	1]
2	,	[101,	12.133835,	0.1,	1]
3	,	[101,	4.173377,	0.1,	1]
4	,	[101,	101,	0.1,	1]
5	,	[101,	50.5,	0.1,	1]
6	,	[152.462853,	101,	0.1,	2]
7	,	[135.960639,	101,	0.1,	2]
8	,	[105.081368,	101,	0.1,	2]
9	,	[155.236317,	101,	0.1,	2]
10	,	[201,	101,	0.1,	2]
11	,	[150,	101,	0.1,	2]
12	,	[201,	401.877295,	0.1,	3]
13	,	[201,	399.408419,	0.1,	3]
14	,	[201,	265.83709,	0.1,	3]
15	,	[201,	268.431116,	0.1,	3]
16	,	[201,	301,	0.1,	3]

The extracted rules used the following intervals and thresholds for the respective parameters: frequency [0, inf] threshold of 10, frequenc?2 [0,inf] threshold of 10 and for amplitude [0,inf] threshold of 1.

class 1

- 0 , [101, 76.607595, 0.1, 1]
- 1 , [101, 101, 0.1, 1]]
- 2 , [101, 50.5, 0.1, 1]
- 3 , [101, [4.173377, 12.133835, 20], 0.1, 1]

class 2

- 0 , [135.960639, 101, 0.1, 2]
- 1 , [105.081368, 101, 0.1, 2]
- 2 , [201, 101, 0.1, 2]
- 3 , [[150, 152.462853, 155.236317], 101, 0.1, 2]

class 3

- 0 , [201, [265.83709, 268.431116, 301], 0.1, 3]
- 1 , [201, [399.408419, 401.877295], 0.1, 3]