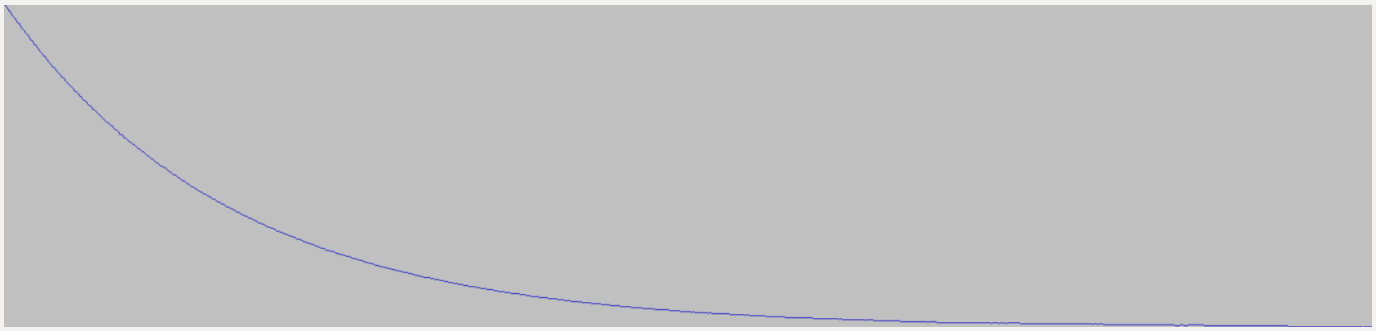
Decay base case: A 44100hz sample long enough to contain the longest possible decay

DECAY VALUE	DECAY DESCRIPTION	DELTA	DECAY DESCRIPTION WHEN ATTACK > 0
0	Frame 0 = 1.0, frame 1 = 0.72, frame 2 = 0.44, frame 3 = 0.16. Then a logarithmic curve starting at frame 3 from multiplier 0.16 to 0.0 over the course of 1059 frames (frame 3 included). See figure below for logarithmic part.		Same, but instead of 1059 it's 1168.
1	Frame 0 = 1.0, linear interpolate f1-4, frame 5 = 0.86. Then a logarithmic curve starting at frame 5 from multiplier 0.86 to 0.0 over the course of 1373 frames (frame 5 included). See figure below for logarithmic part.		
2	77 frames.		Logarithmic curve of 1411 frames.
3	193 frames.	116	Logarithmic curve of 1411 frames.
4	308 frames.	115	345 frames.
5	499 frames.	191	Linear 442 frames from 1.0 to 0.2. Then a logarithmic curve of 1168 frames.
6	691 frames	192	773 frames.
7	964 frames	273	1088 frames. In reality it does a slow logarithmic tail of 1100 frames after

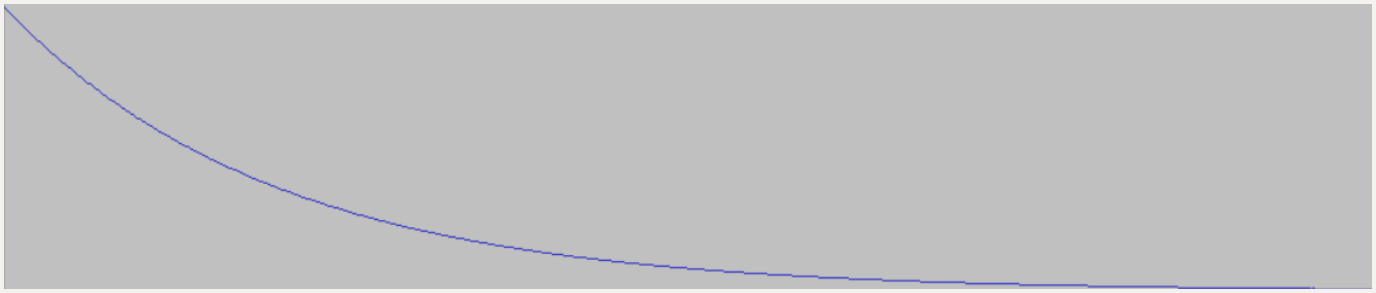
			completing ~90% of the decay, but this should be barely noticable.
8	1234 frames	270	1380. Here barely noticable log tail too.
9	1571 frames	337	1758
10	1912 frames	341	2140
11	2341 frames	429	2620
12	2798 frames	457	3131
13	3277 frames	479	3666
14	3823 frames	546	4277
15	4412 frames	589	4937
16	4988 frames	576	5581
17	5462 frames	474	6111
18	6371 frames	909	7129
19	7168 frames	797	8020
20	7646 frames	478	8555
21	8193 frames	547	9167
22	9558 frames	1365	10695
23	10425 frames	867	11665
24-25	11469 frames	1.044	12833
26	12742 frames	1274	14258
27-28	14334 frames	1592	16039
29-30	16388 frames	2.053	18282
31-32	19114 frames	2.730	21388
33-36	22937 frames	3.823	25666
37-42	28668 frames	5.731	32079
43-48	38222 frames	9.554	42770
49-63	57337 frames	19.115	64160

64-100	114673 frames	57.336	131048

Decay value 0 -- Logarithmic part, frame indices 3 to 1062



Decay value 0 -- Logarithmic part, frame indices 3 to 1377



Attack base case: A 44100hz sample long enough to contain the longest possible attack

ATTACK VALUE	ATTACK DESCRIPTION
0	8 frames at 0.87 the full potential. The voice is indeed softer as a result.
1	44 frames
2	88 frames
3	220 frames

4	352 frames
5	570 frames
6	790 frames
7	1102 frames
8	1410 frames
9	1796 frames
10	2185 frames
11	2676 frames
12	3197 frames
13	3745 frames
14	4369 frames
15	5043 frames
16	5700 frames
17	6240 frames
18	7280 frames
19	8190 frames
20	8740 frames
21	9360 frames
22	10930 frames
23	11920 frames
24-25	13100 frames
26	14560 frames
27-28	16380 frames
29-30	18730 frames
31-32	21840 frames
33-36	26210 frames
37-41	32770 frames
42-48	43670 frames
49-63	65530 frames

63-100	131050 frames

Concept definition: Playable frames of an active voice

The maximum number of frames that a voice can play at its internal sampling rate, given a sample with properties *start, end, length, samplerate* and *tuning*.

It is the exact span of frames that an envelope is concerned with over the lifetime of a specific active voice.

It is the maximum duration of a specific active voice.

Example 1

Let's say we have a voice playback engine running at 44.1KHz, and a sound with the following parameters:

- Length: 200.000
- Start: 0
- End: 100.000
- Sample rate: 44100Hz

If we play this sound back at its original pitch, there are 100.000 playable frames for the voice that handles this playback.

If play play it back at +12 semitones, there are 50.000 playable frames.

Example 2

Let's say we have example 1, but

- Sample rate: 22050Hz

The number of playable frames is the same as in example 1, because playable frames is about the number of frames a voice can render.

Example 3

Let's say we have example 1, but a voice engine running at 96KHz.

If we play this sound back at its original pitch, there are 200.000 playable frames for the voice that handles this playback.

If play play it back at +12 semitones, there are 100.000 playable frames.

Special behaviour (decay)

1. If the number of frames mentioned in the table above exceeds the number of playable frames, the decay will go faster in order to be at 0 when it reaches the voice's last playable frame.
2. When a sound is not a 44.1khz one, this does not affect decay duration.

Special behaviour (attack)

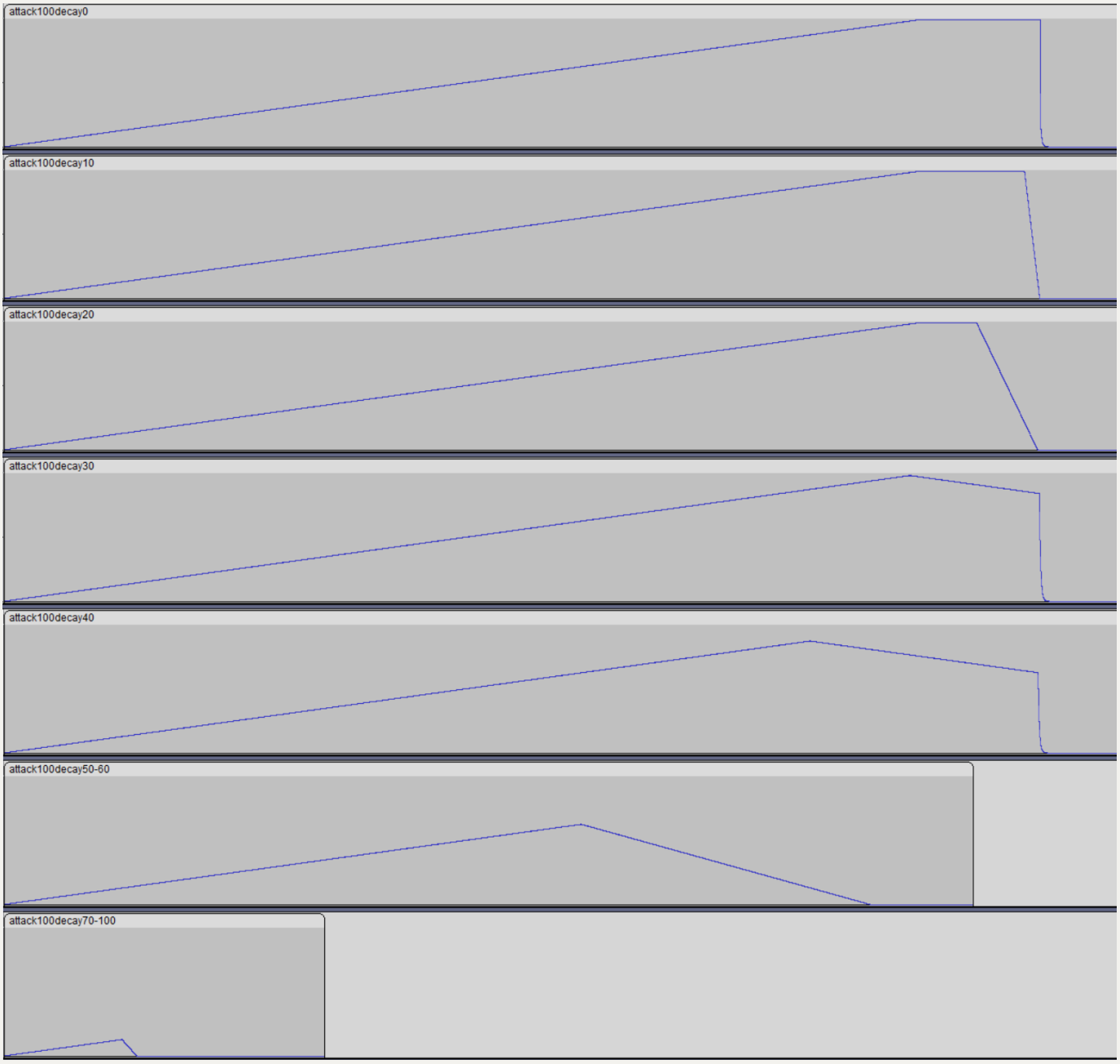
1. If you tune up a sound, such that it is shorter than the attack listed in the table, the attack will be truncated, and the envelope will never reach multiplier 1.0.

Fighting over frames - What to do when running out of space?

Attack 100, decay 0 - 100 in increments of 10

A 44.1KHz sound of 150.000 frames was used. The numbers in the table are estimates.

DECAY	VOICE DURATION	ATTACK	HOLD	DECAY STAGE 1	DECAY STAGE 2	NOTES
0	150000	131050	17890	1060, same shape as Decay 0 in table above		
10	150000	131050	16770	2180		
20	148250	131050	8500	8700		
30	150000	130000	0	18570 from 0.95 to 0.85	1430 from 0.85 to 0.0 logarithmically	Note that 1.0 is never reached. The env peaks at 0.95.
40	150000	115000	0	33000 from 0.9 to 0.7	2000 from 0.7 to 0.0 logarithmically	The attack truncation is clearly visible and measurable now. The env peaks at 0.9
50-60	124000	82800 from 0.0 to 0.6	0	41200 from 0.6 to 0.0		
70-100	19100	17000 from 0.0 to 0.1	0	2100 from 0.1 to 0.0		



Deriving a model

Layering 2 envelopes

Envelope 1 -- Attack-Hold-Decay

- Responsible for the linear segments in the graphs.
- Exposed to the user.
- When attack duration + decay duration >= `voice.durationInFrames`, hold would be negative. We remember the `holdRemainder`, and set hold itself to 0.
- If `holdRemainder` > 0, the attack stage is cut short by the decay stage by `holdRemainder / 2` frames.
- Decay stage is cut short by the decay stage of envelope 2 if a negative hold duration is computed and envelope 1 does not fully decay before the voice reaches its final frame.

Envelope 2 -- Hold-Decay

- Responsible for the logarithmic segments in the graphs.
- Internal envelope to avoid nasty pops and clicks.

Different model

In some cases a voice does not last long enough to fit the complete attack and decay. The following rules apply:

1. The decay is shifted to the left.
2. At lower decay values, it shifts only slightly to the left.
3. At higher values it shifts to the left exponentially more.
4. If after shifting the decay to the left, the decay starts before the attack starts, the attack becomes 0.
5. The attack stays prominent during lower decay values, and the voice is brought to a halt by a special envelope that only generates logarithmic curves for sudden stops.

Facts

At attack 100, decay 0, the minimum sound start - end interval is 1368. The attack length then is 8, hold 334, and then a logarithmic curve of about 1508 frames.

If the end of that interval also marks the end of the sound, an inaudible peak happens of 600 frames, peaking at 45/32767.