

Software 2 WS 2016 #3

Chebyshev Shaping Functions

$$T_k(\cos[\theta]) = \cos(k \theta)$$

where T_k is the n th Chebyshev function.

By Applying the n th Chebyshev polynomial to an input sine wave, we obtain a cosine wave at the k th harmonic.

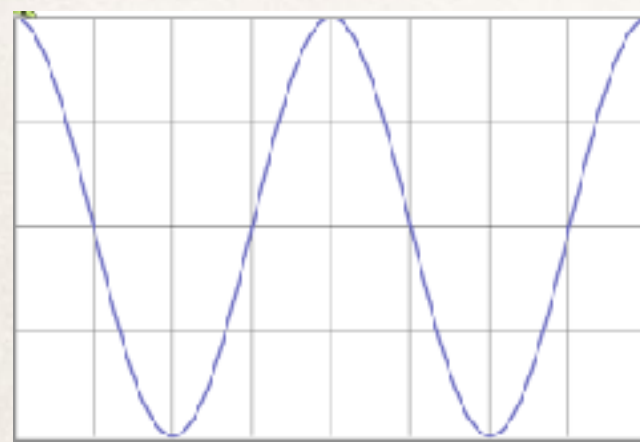
Chebyshev Shaping Functions

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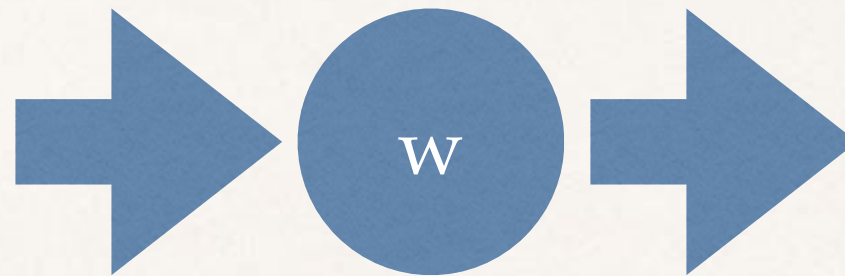
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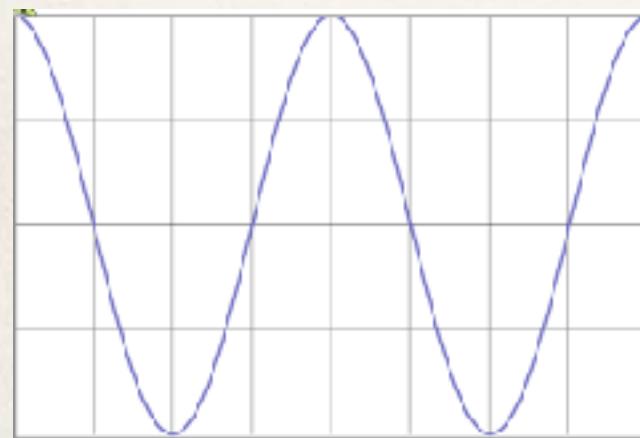
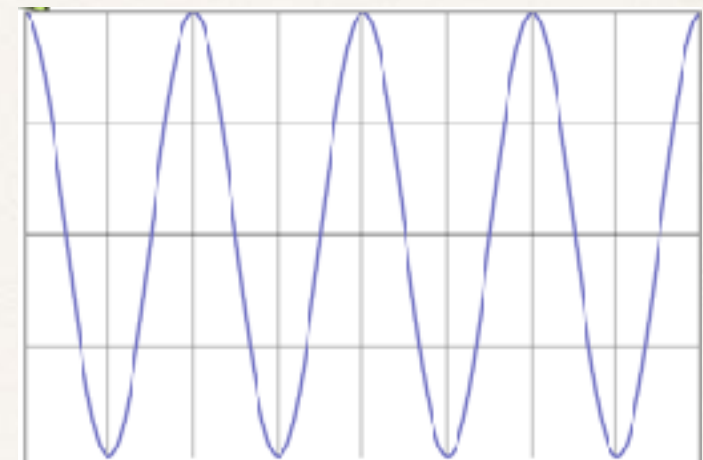
Chebyshev Shaping Functions



funktion



Oberton



Oberton



Chebyshev Shaping Functions

Table 6.1 Chebyshev functions T_0 through T_8

$$T_0 = 1$$

$$T_1 = x$$

$$T_2 = 2x^2 - 1$$

$$T_3 = 4x^3 - 3x$$

$$T_4 = 8x^4 - 8x^2 + 1$$

$$T_5 = 16x^5 - 20x^3 + 5x$$

$$T_6 = 32x^6 - 48x^4 + 18x^2 - 1$$

$$T_7 = 64x^7 - 112x^5 + 56x^3 - 7x$$

$$T_8 = 128x^8 - 256x^6 + 160x^4 - 32x^2 + 1$$

Chebyshev Shaping Functions

$$T_k x (\cos[\theta]) = \cos(k \times \theta)$$

$$T_1 = x$$

$$x(\cos[\theta]) = \cos(\theta)$$

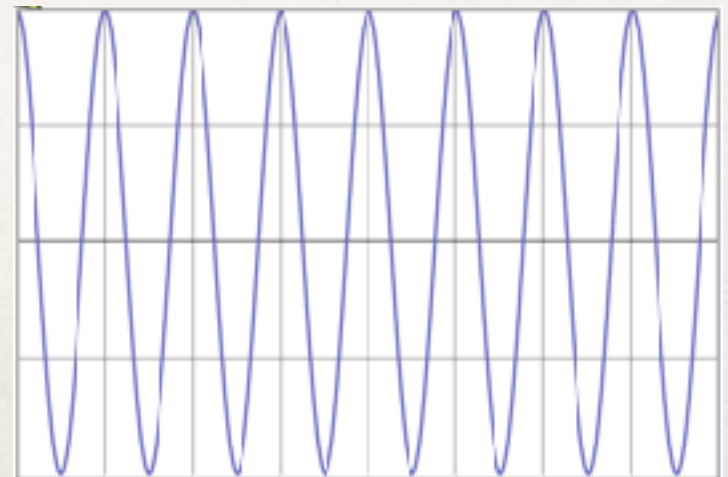
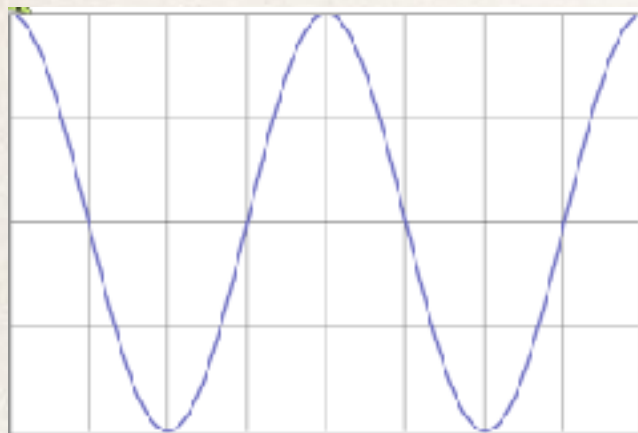
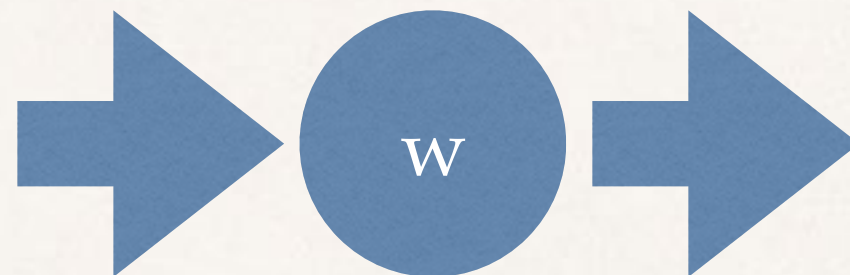
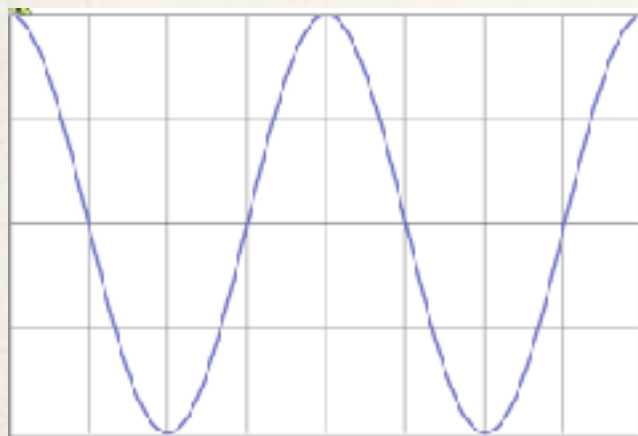
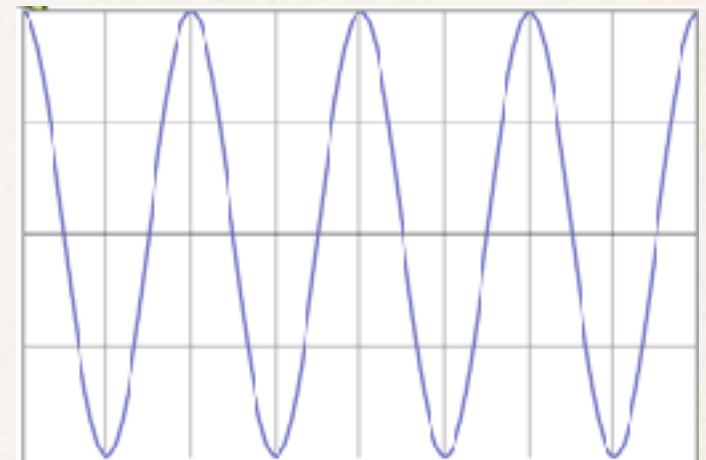
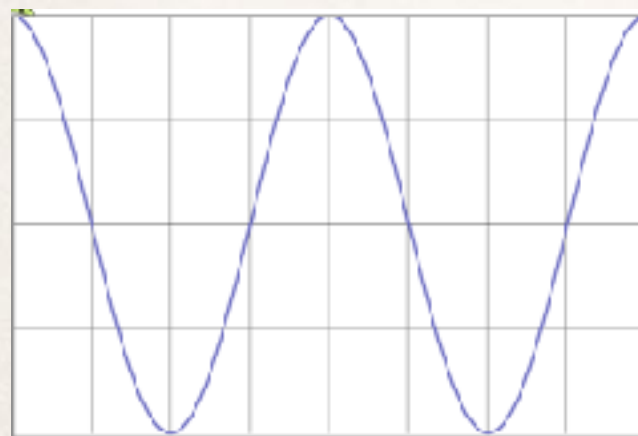
$$T_2 = 2x^2 - 1$$

$$(2x^2 - 1)(\cos[\theta]) = \cos(2\theta)$$

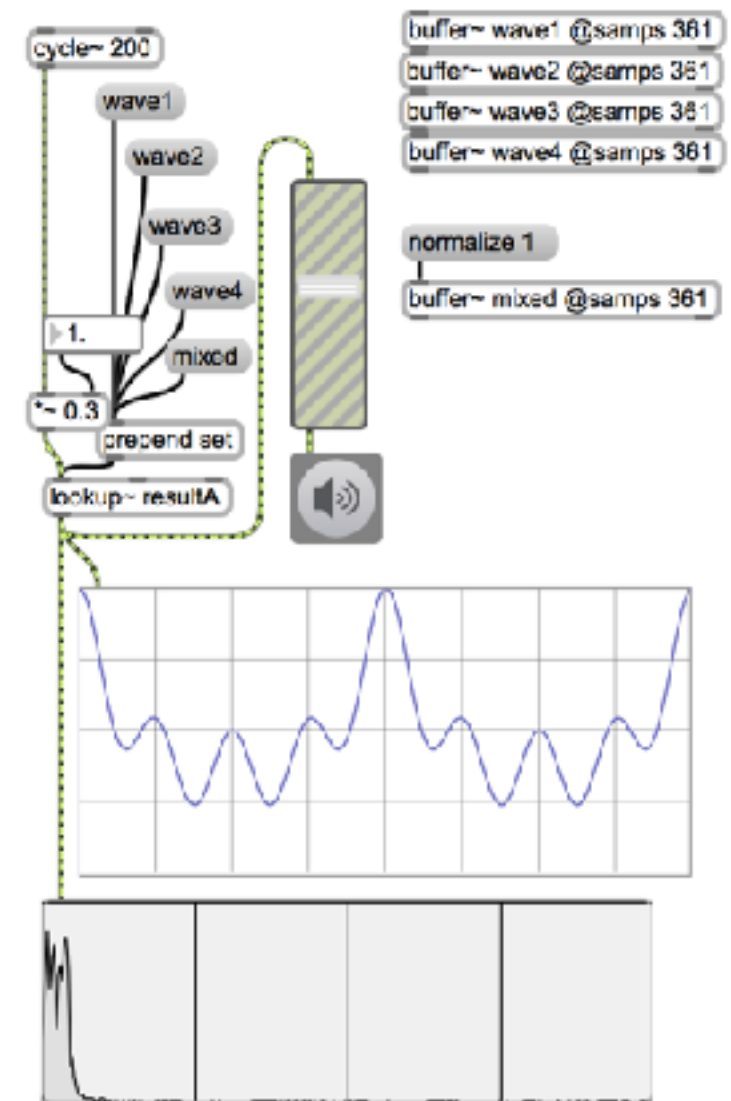
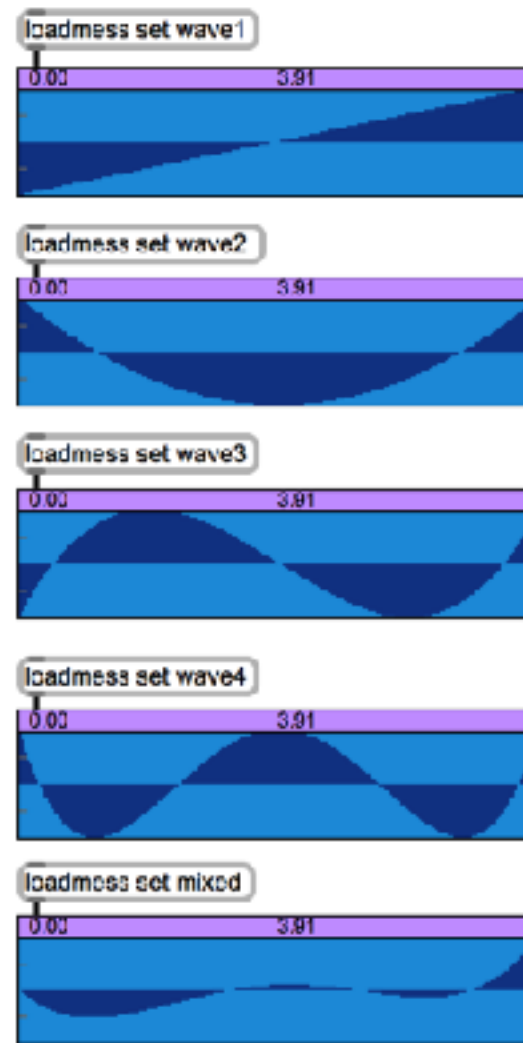
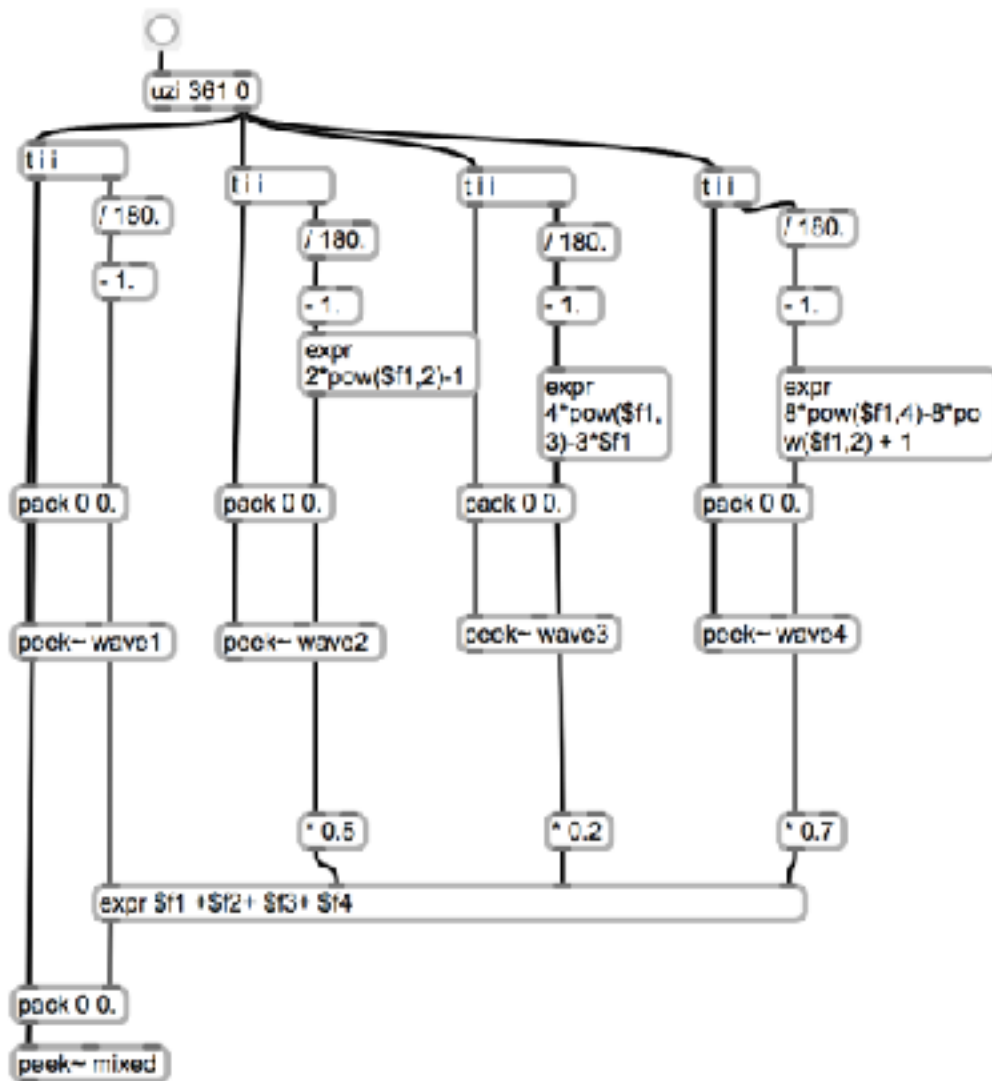
$$T_3 = 4x^3 - 3x$$

$$(4x^3 - 3x)(\cos[\theta]) = \cos(3\theta)$$

Chebyshev Shaping Functions



Experiment mit Max



chebychev.maxmsp

Chebyshev Shaping Functions

- ❖ F: Was ist der Vorteil der Chebyshev Funktion?

Chebyshev Shaping Functions

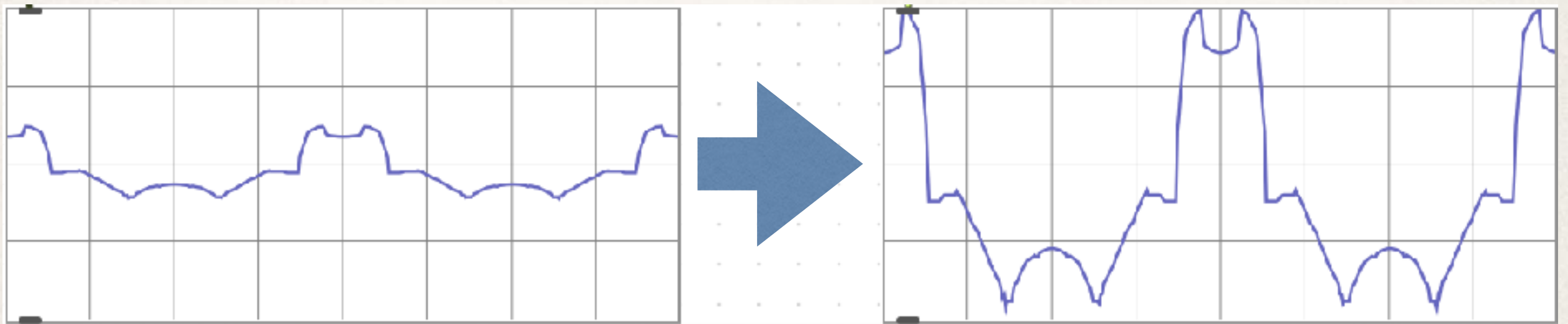
❖ A: Bandlimited = Keine Aliasing

Amplitude Normalisation

- ❖ Waveshaping: Klangfarbe ist abhängig von Amplitude
- ❖ F: Wie kann man Klangfarbe unabhängig von Amplitude steuern?

Amplitude Normalisation

❖ A: Amplitude Normalisation



❖ F: Drei Methoden?

Amplitude Normalisation

- ❖ Drei Methoden
 - ❖ loudness normalisation
 - ❖ power normalisation
 - ❖ peak normalisation

Amplitude Normalisation

| Kommentare | |
|------------|--|
| loudness | ideal für Musik kompliziert (psychoakustik) |
| power | Forschung von Le Brun (1979) Digital Waveshaping Synthesis" in Journal of the Audio Engineering Society, 27(4) |
| peak | die einfachste Methode, praktisch |

Amplitude Normalisation (Peak)

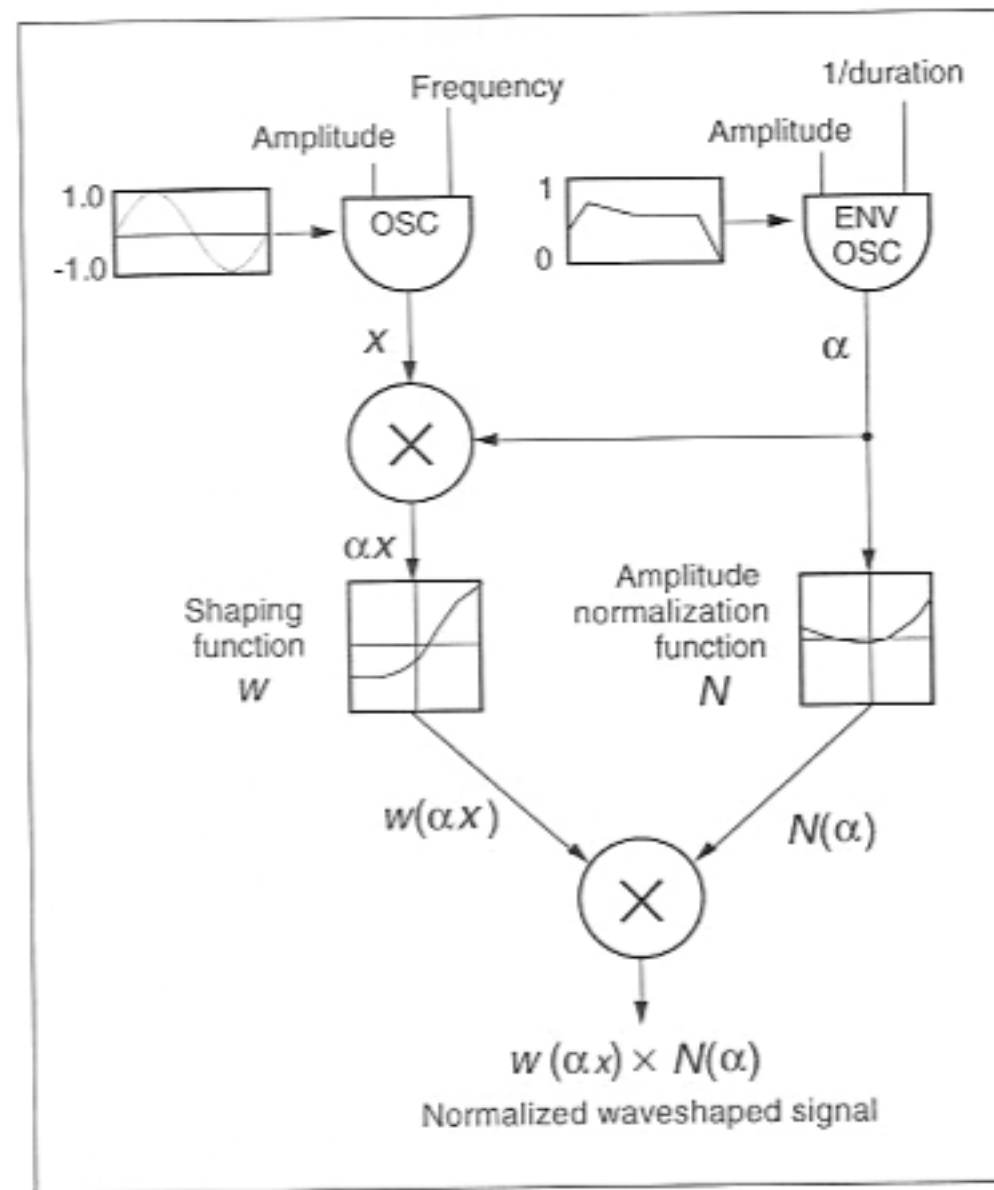
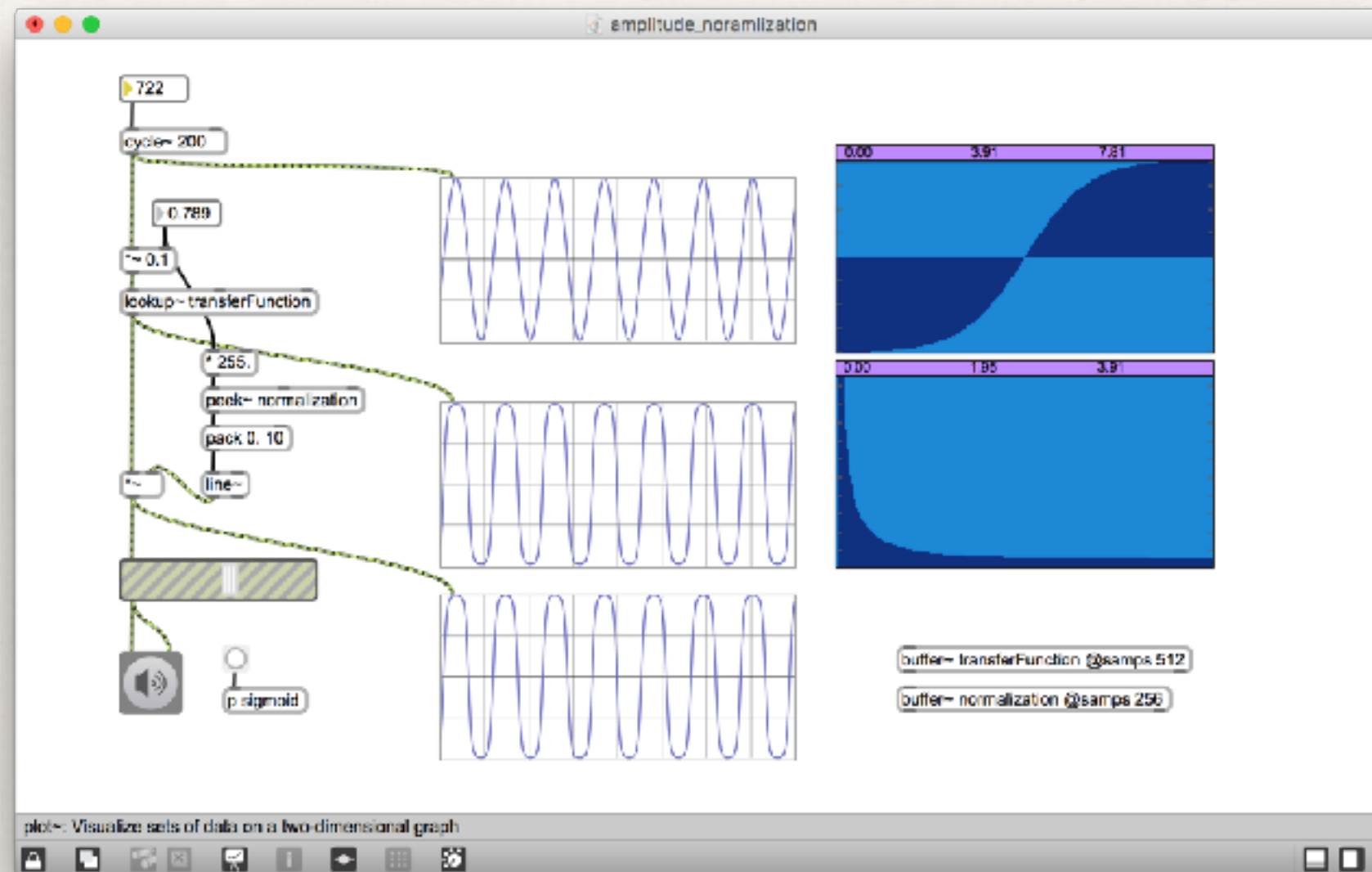


Figure 6.29 Waveshaping instrument with a normalization section. The value α indexes a value in the normalization table that scales the output of the waveshaper.

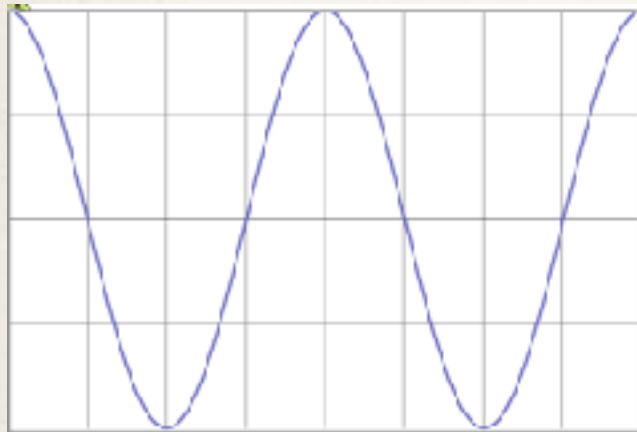
amplitude_normalization.maxpat

Experiment mit Max



amplitude_noramalization

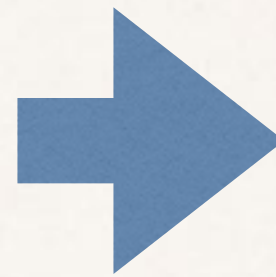
Klassische Waveshaping



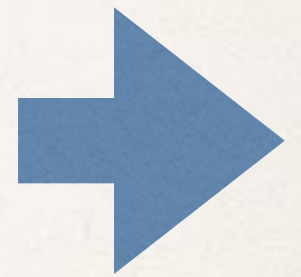
Chebyshev

Andere Quellen

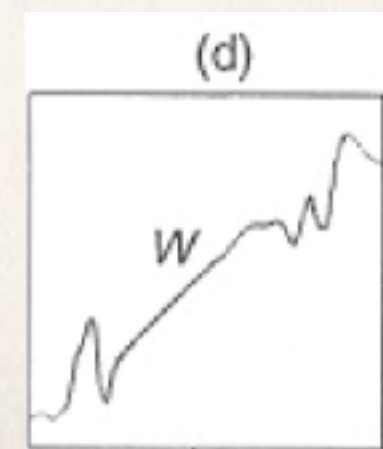
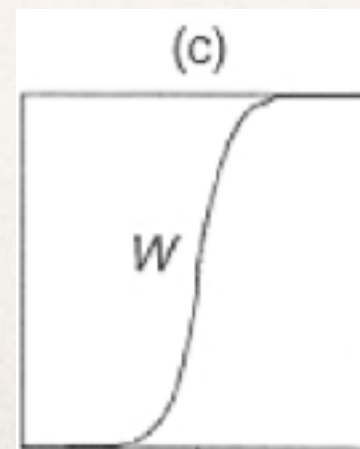
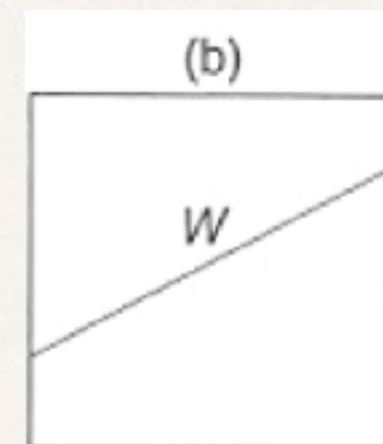
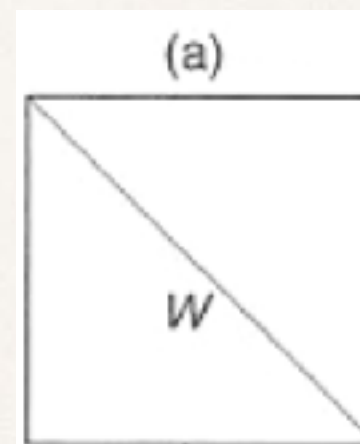
Andere Quellen



Funktion

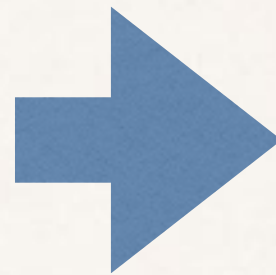


- ?
- ?
- ?

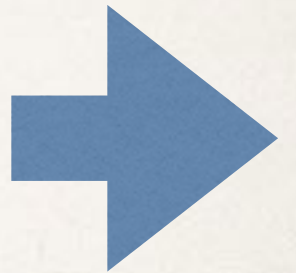


Andere Quellen

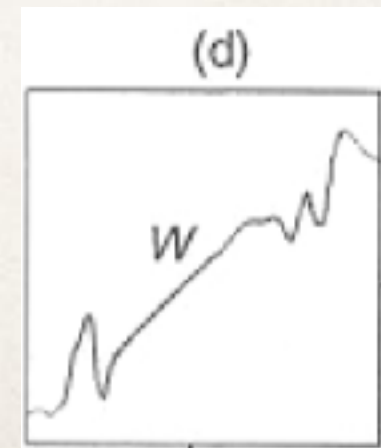
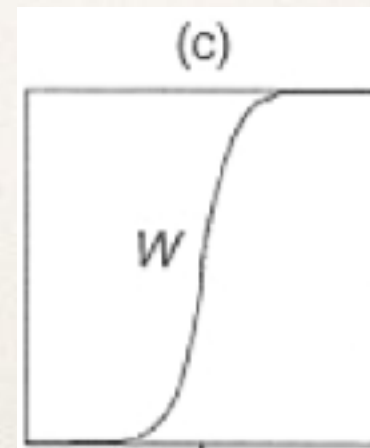
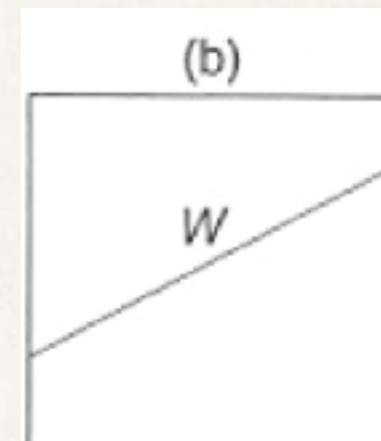
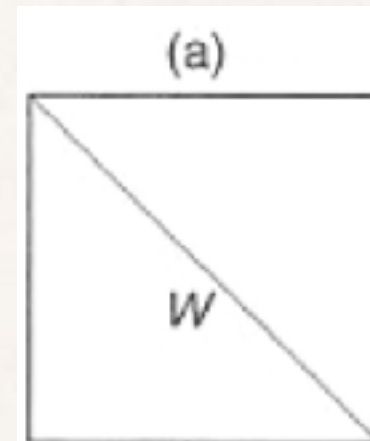
Andere Quellen



Funktion

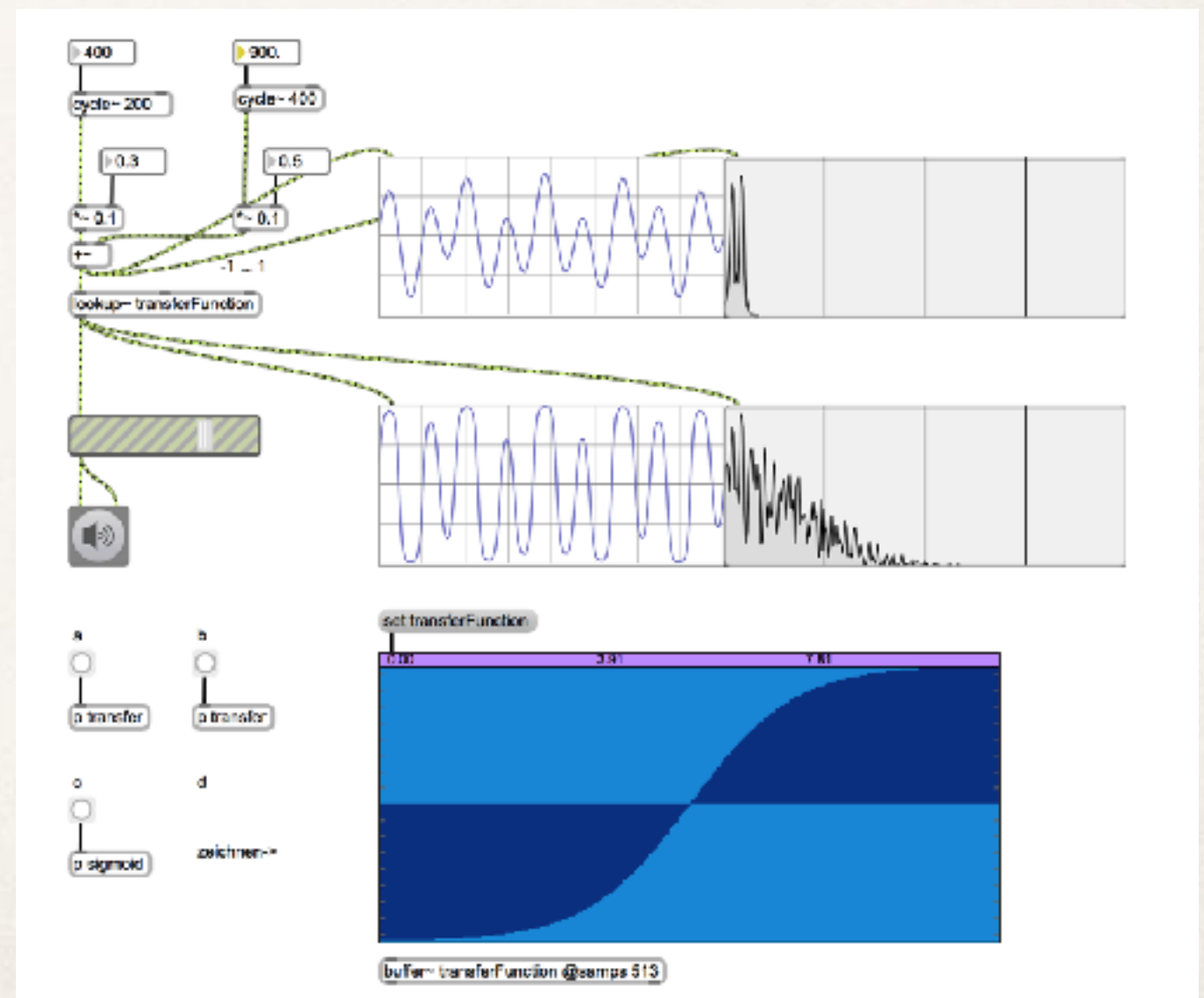


- ❖ 2x Kosinusse mit unterschiedlichen Frequenzen
- ❖ FM
- ❖ Sample (Aufgenommene Klänge)



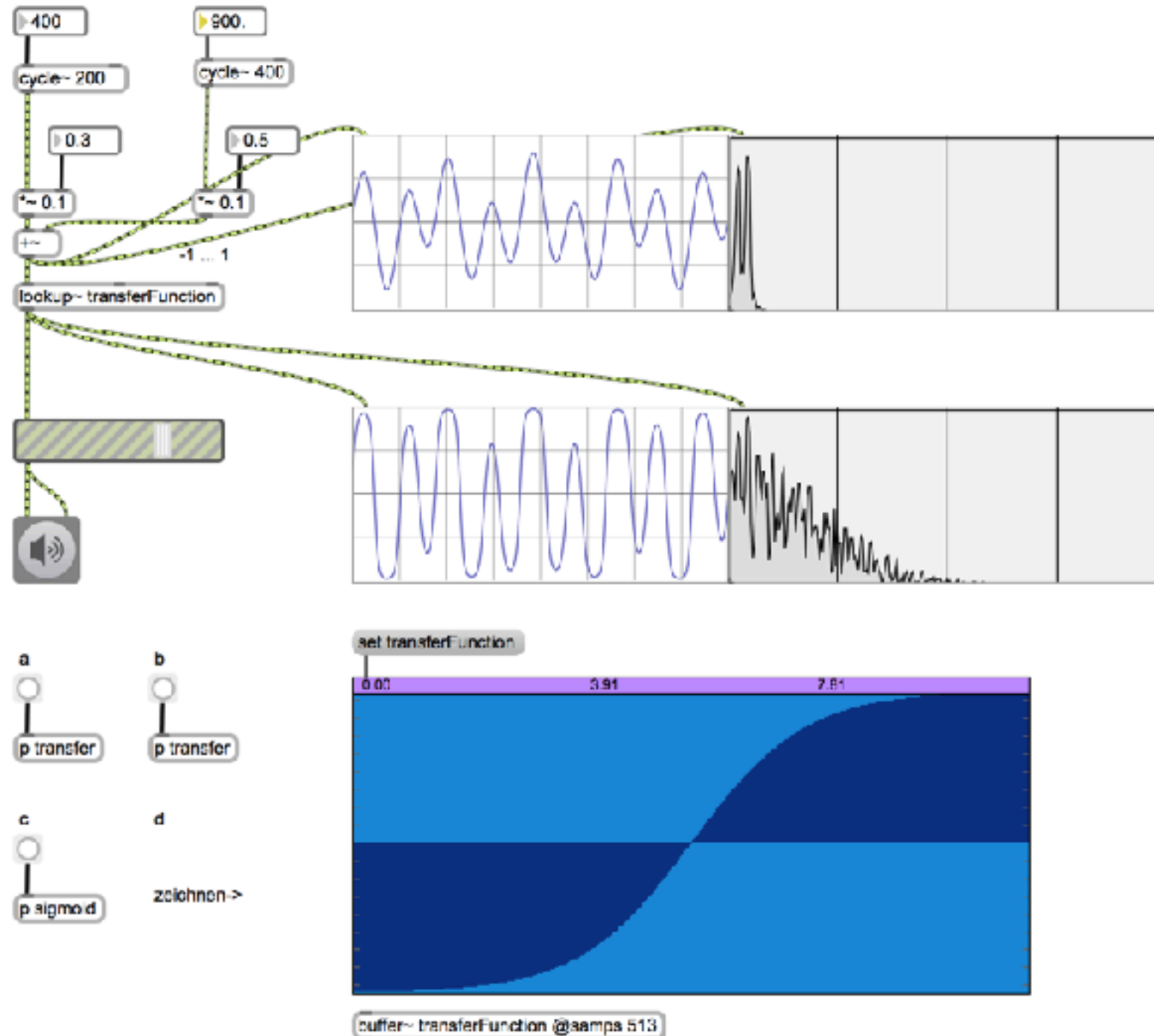
Experiment mit Max

- ❖ 2x Kosinusse mit unterschiedlichen Frequenzen

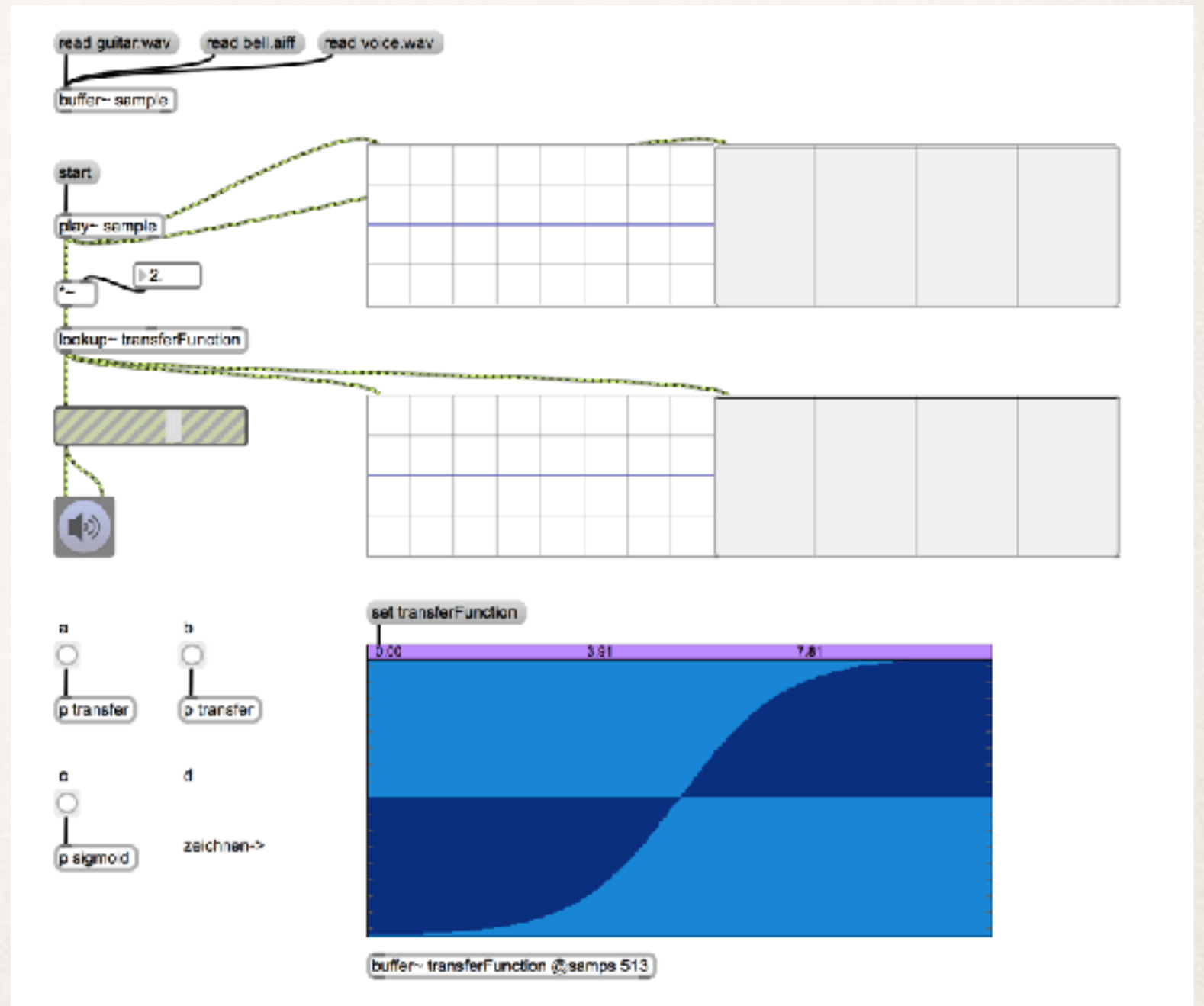


Experiment mit Max

❖ FM

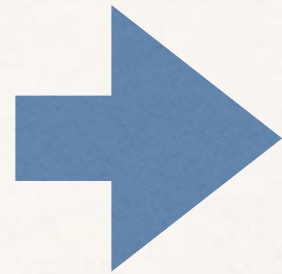


✿ Aufgenommene Klänge

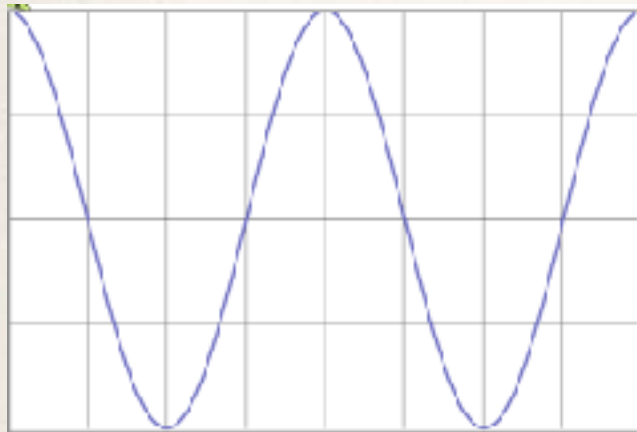
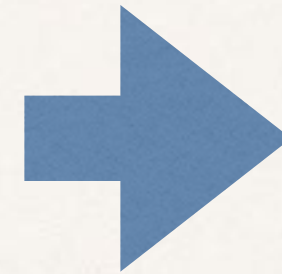


Andere Funktionen

Input



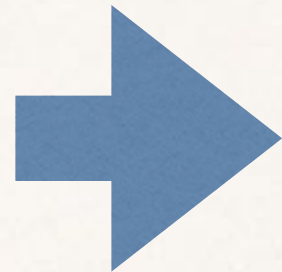
Funktion



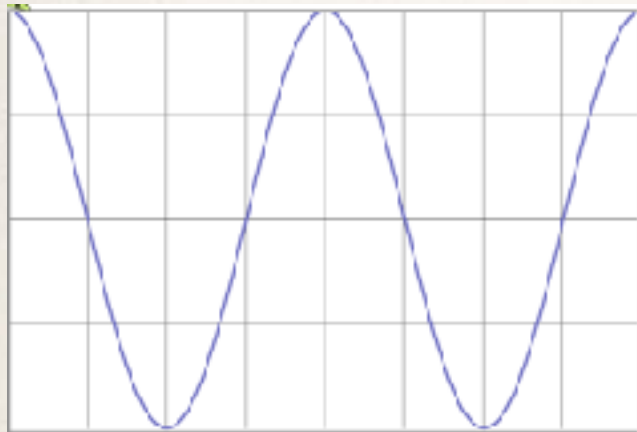
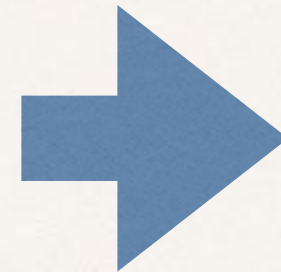
- ?
- ?
- ?

Andere Funktionen

Input



Funktion



- z.B Handschrift

Problem : erzeugt (?)

Weitere Entwicklungsmöglichkeiten

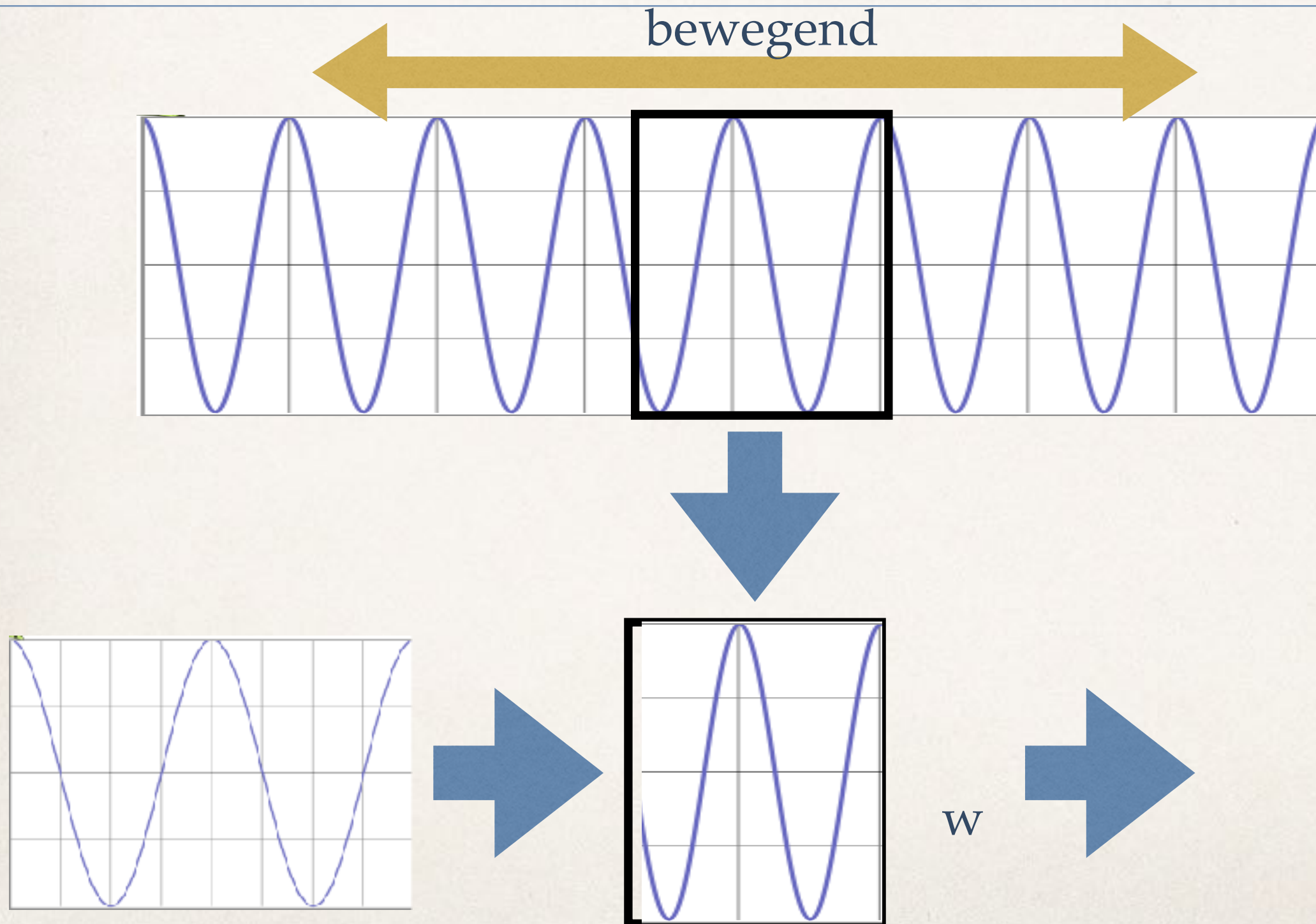
- ❖ Movable Waveshaping
- ❖ Fractional Waveshaping
- ❖ Postprocessing and Parameter Estimation

Movable Waveshaping

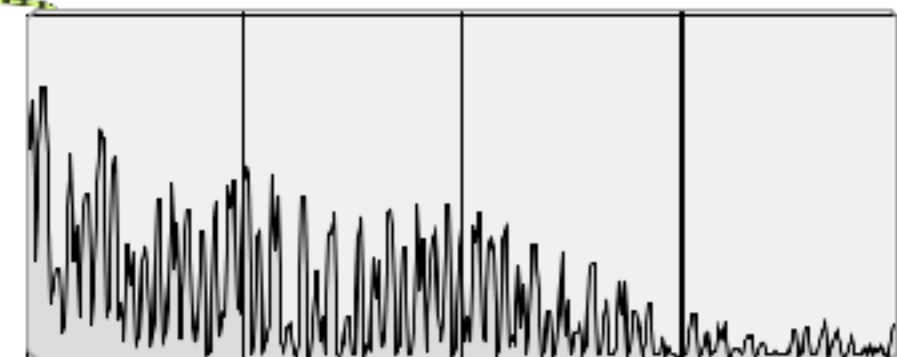
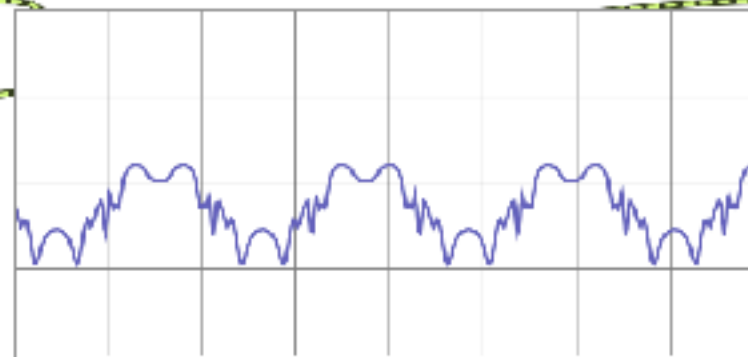
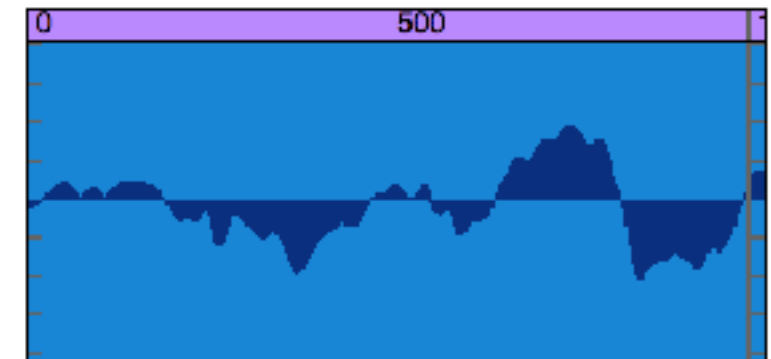
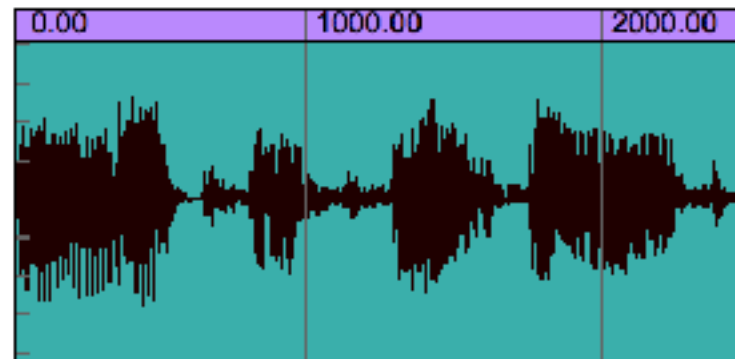
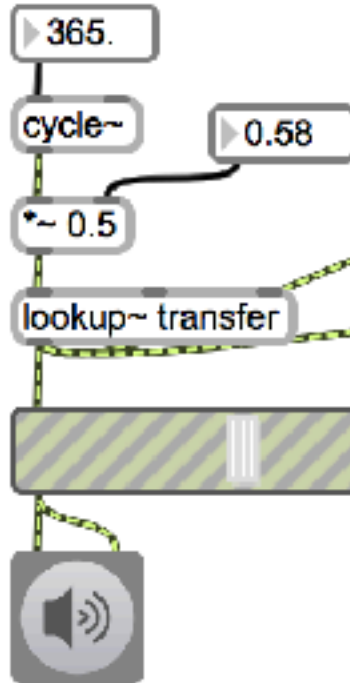
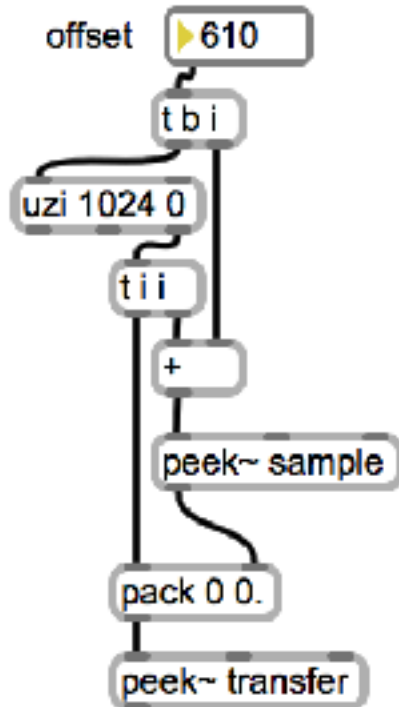
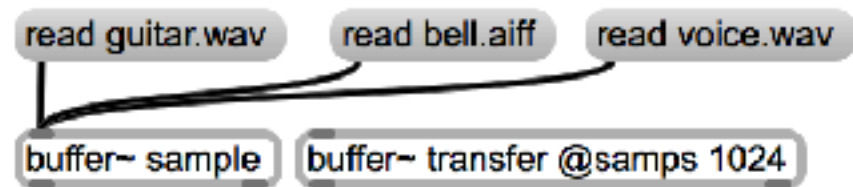
❖ Was ist Movable Waveshaping?

Erfinder : Xin Chong (1987)

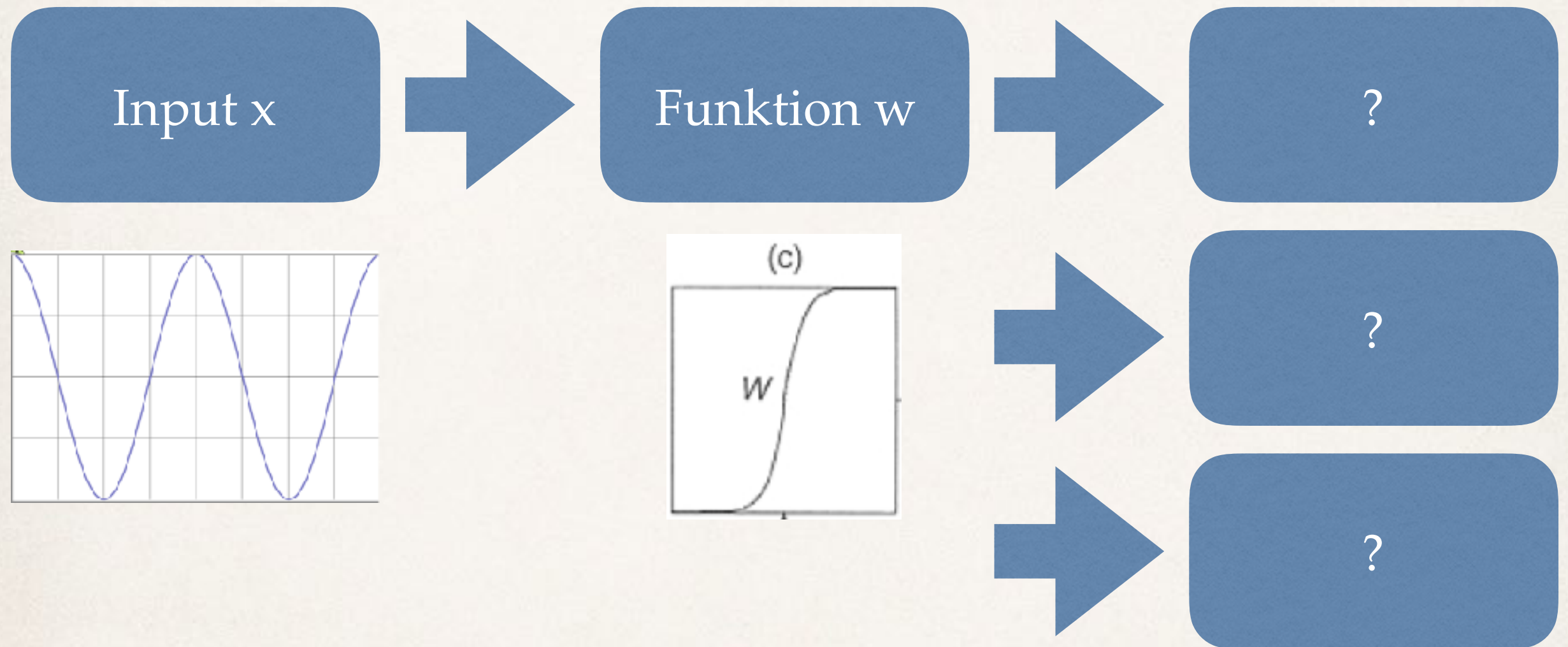
Movable Waveshaping



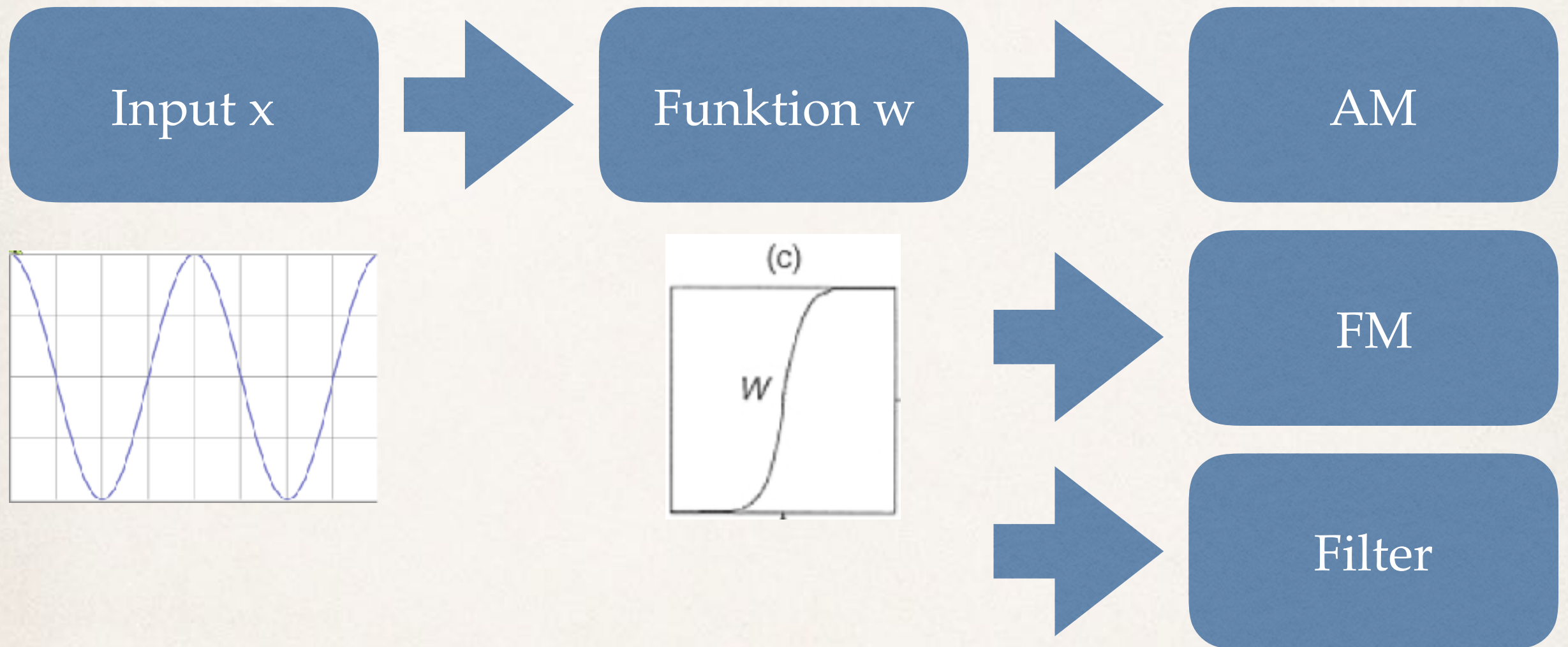
Experiment mit Max

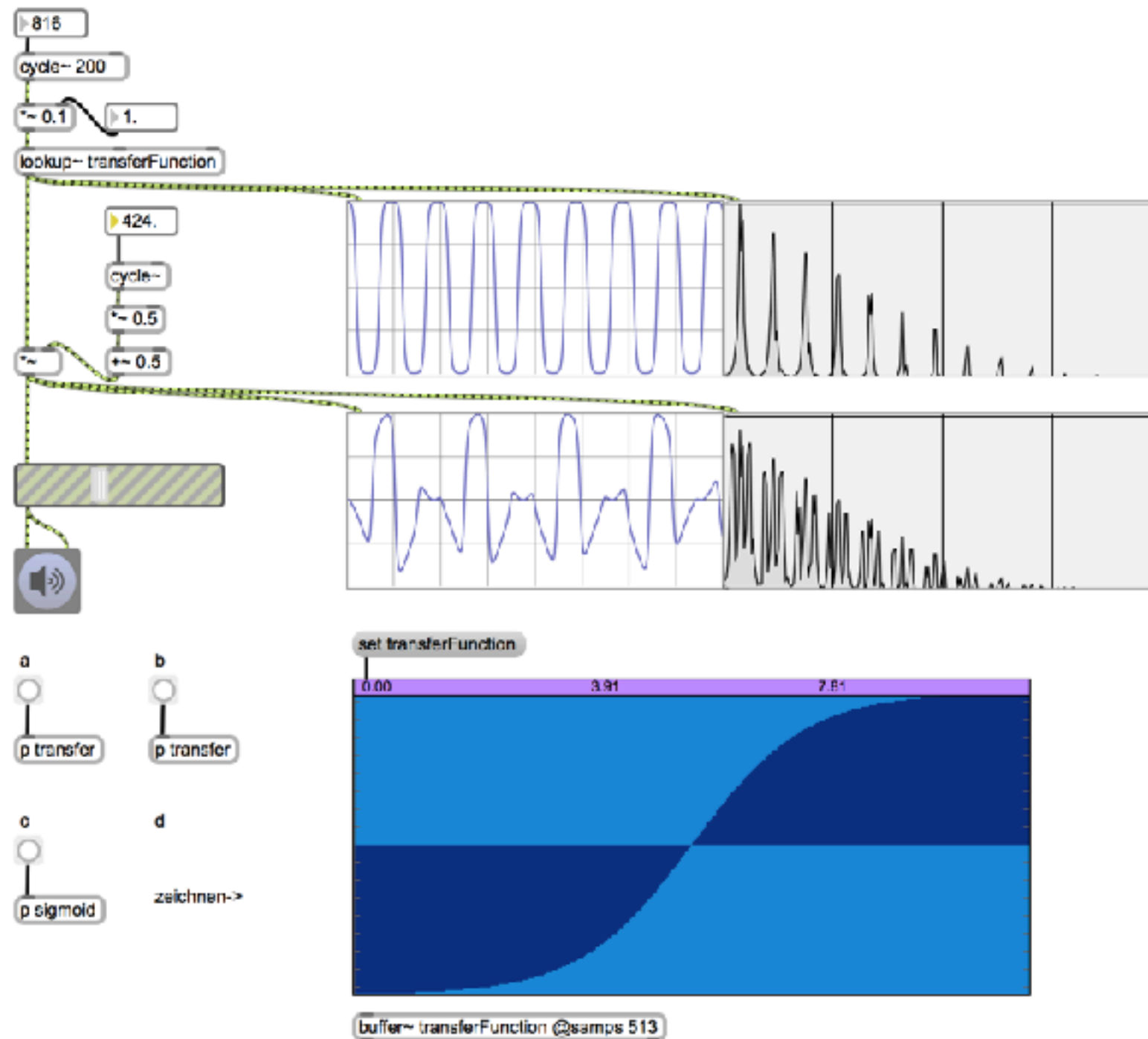


Postprocessing

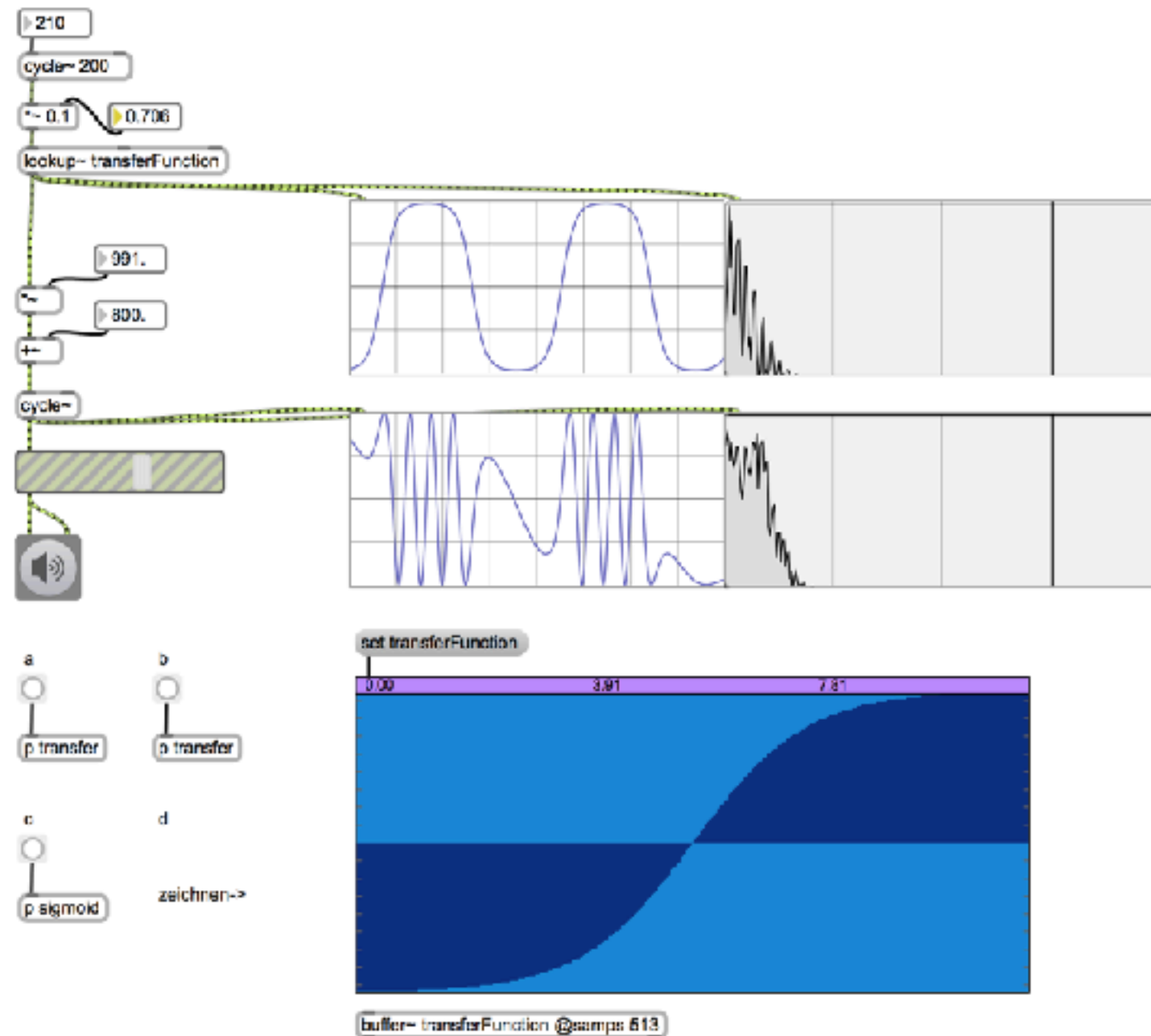


Postprocessing

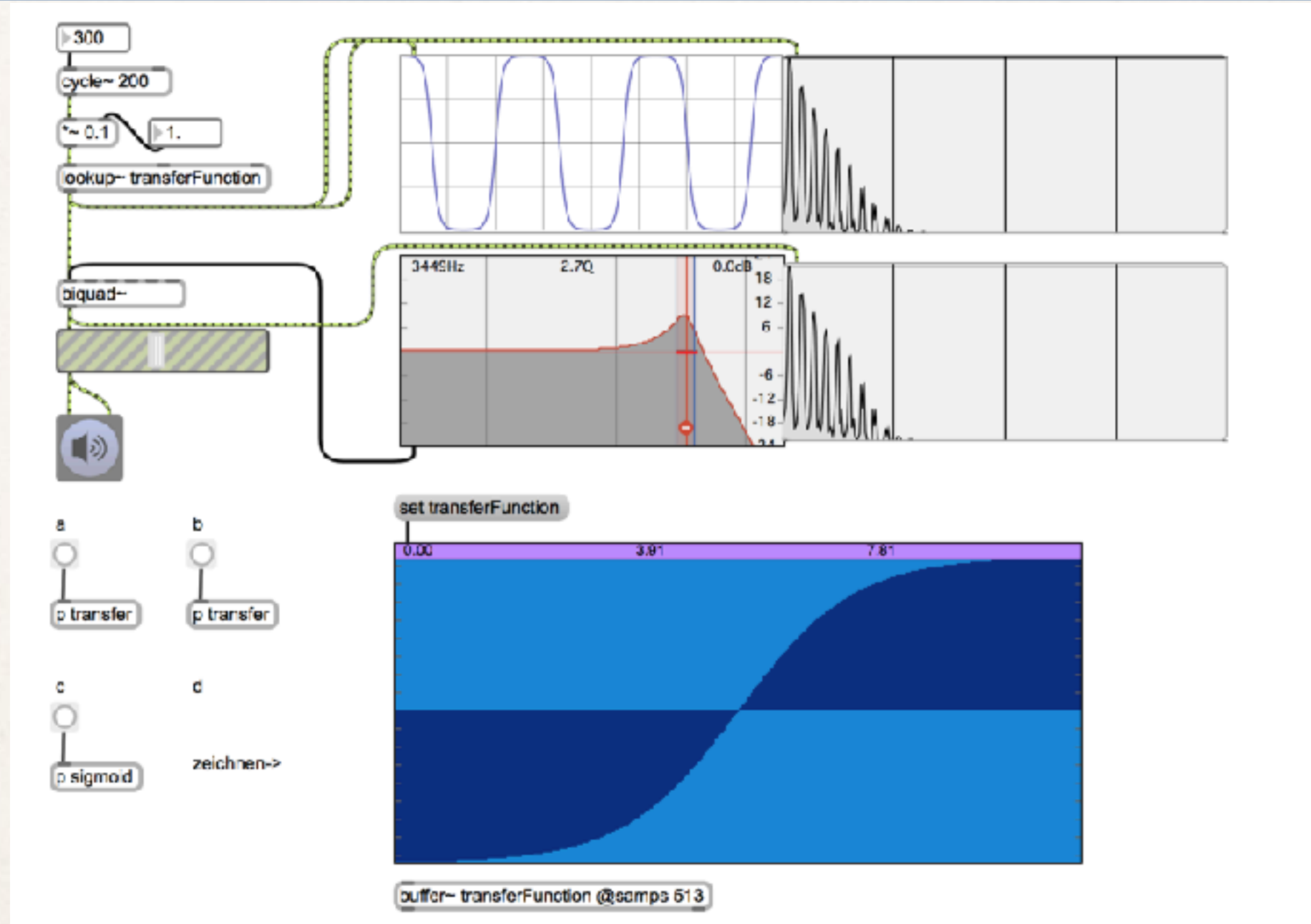




Experiment mit FM



Experiment mit Filter



H.A.

Lesen Sie "The Computer Music Tutorials " Seite. 265-279