Waveshaping or Nonlinear Distortion

Kreatives Programmieren 1

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Waveshaping

Waveshaping is a technique of distortion synthesis that realizes spectra that have dynamic evolution of their components. Like FM, it is more computationally efficient than additive synthesis for the realization of complex timbres. Unlike FM, waveshaping provides the capability of generating a band-limited spectrum with a specifiable maximum harmonic number.

The spectrum produced by a waveshaping instrument changes with the amplitude of the sound. Because this change corresponds to the characteristics of the spectra of acoustic instruments, waveshaping synthesis has proven effective in the production of tones that resemble those of traditional instruments. The synthesis of brass tones has been particularly successful.

Waveshaping

Waveshaping is the distortion of the amplitude of a sound - a process that produces an alteration in the waveform. A simple example of this type of distortion can be heard in the clipping that occurs when an audio amplifier is overdriven. However, the introduction of carefully controlled distortion to a signal can be used to yield a broad range of musically useful timbres. Like FM synthesis, waveshaping provides for the continuous control of the spectrum by means of an index, making possible dynamic spectra through time variation of the index.

The central element of any such instrument is a waveshaper, or `nonlinear processor` that alters the shape of the waveform passing through it.

In Computer Music: Charles Dodge, Thomas A. Jerse

Waveshaping

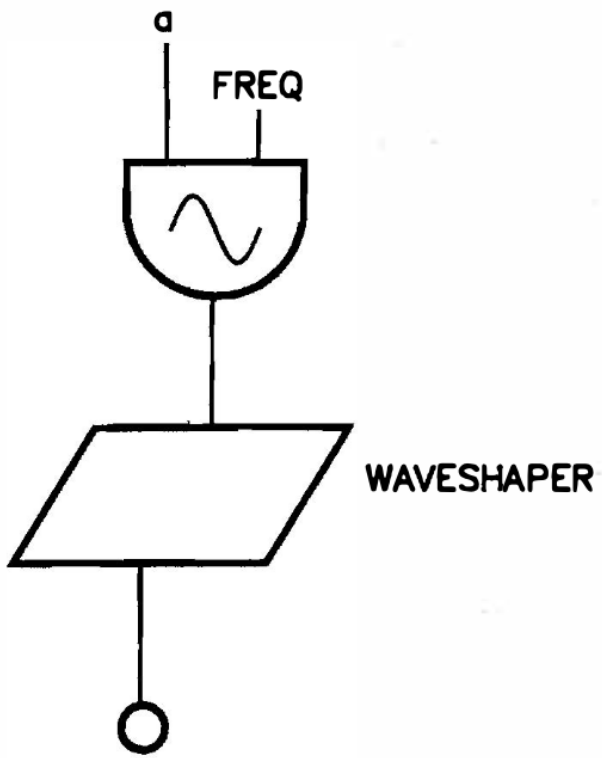


FIGURE 5.19 Basic waveshaping instrument.

Figure: Waveshaper

Transfer Functions (Mapping)

A waveshaper is characterized by its transfer function, which relates the amplitude of the signal at the output to the input. This function can be represented graphically with the amplitude of the input signal plotted on the horizontal axis and the amplitude of the output signal on the vertical axis.

Transfer Functions (Mapping)

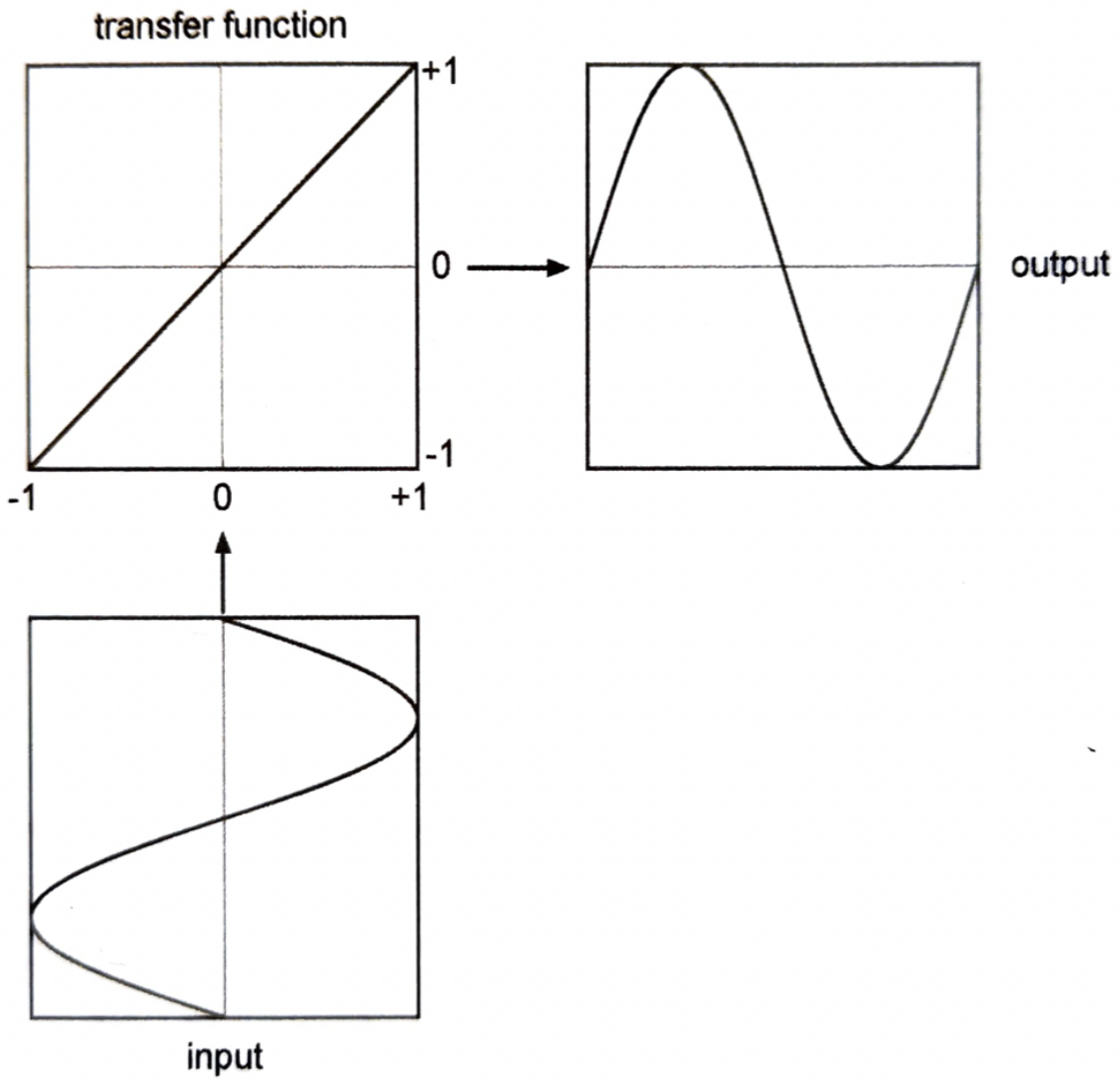


Figure: Linear transfer function

Transfer Functions (Mapping)

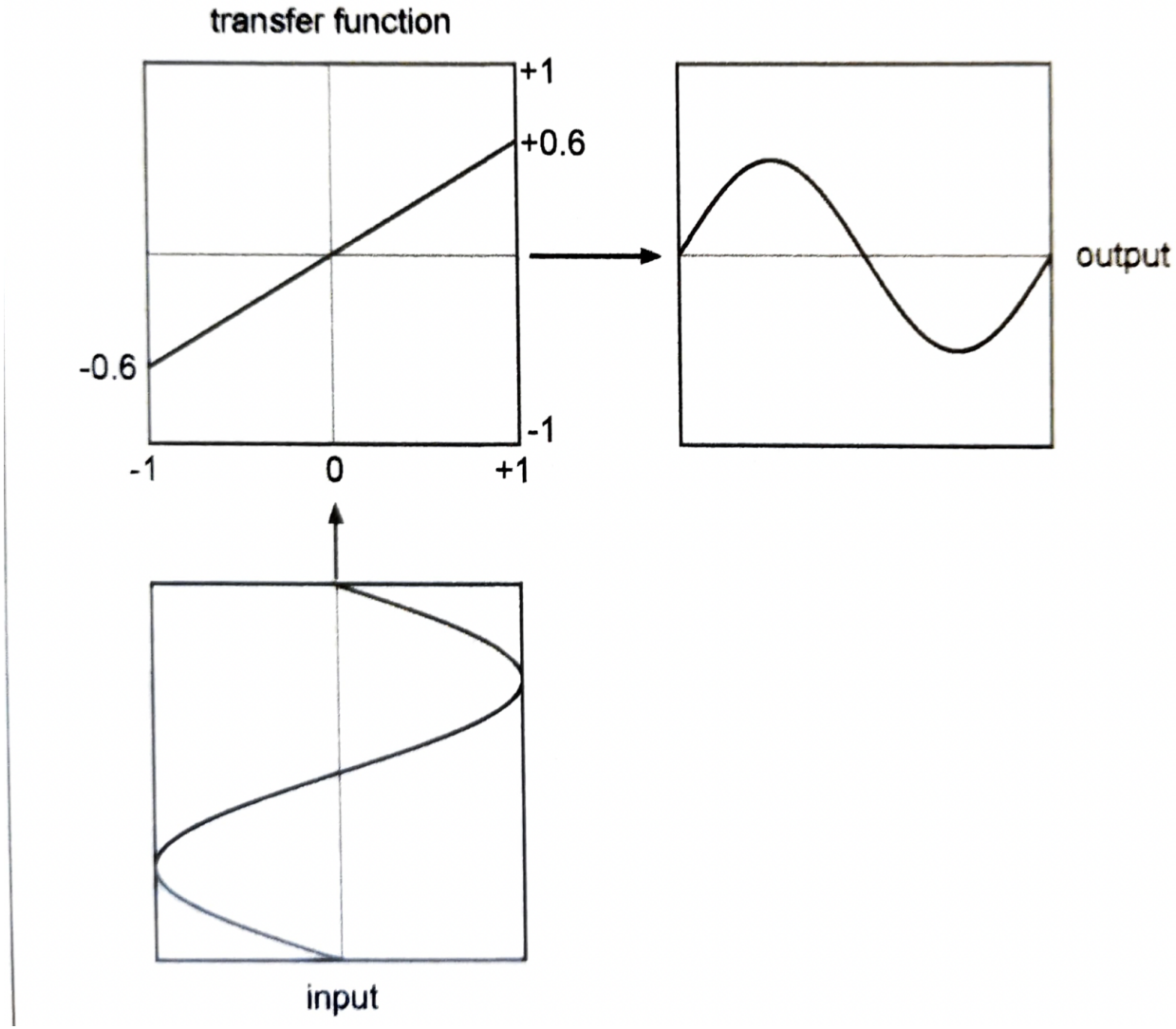


Figure: Amplitude attenuation

Transfer Functions (Mapping)

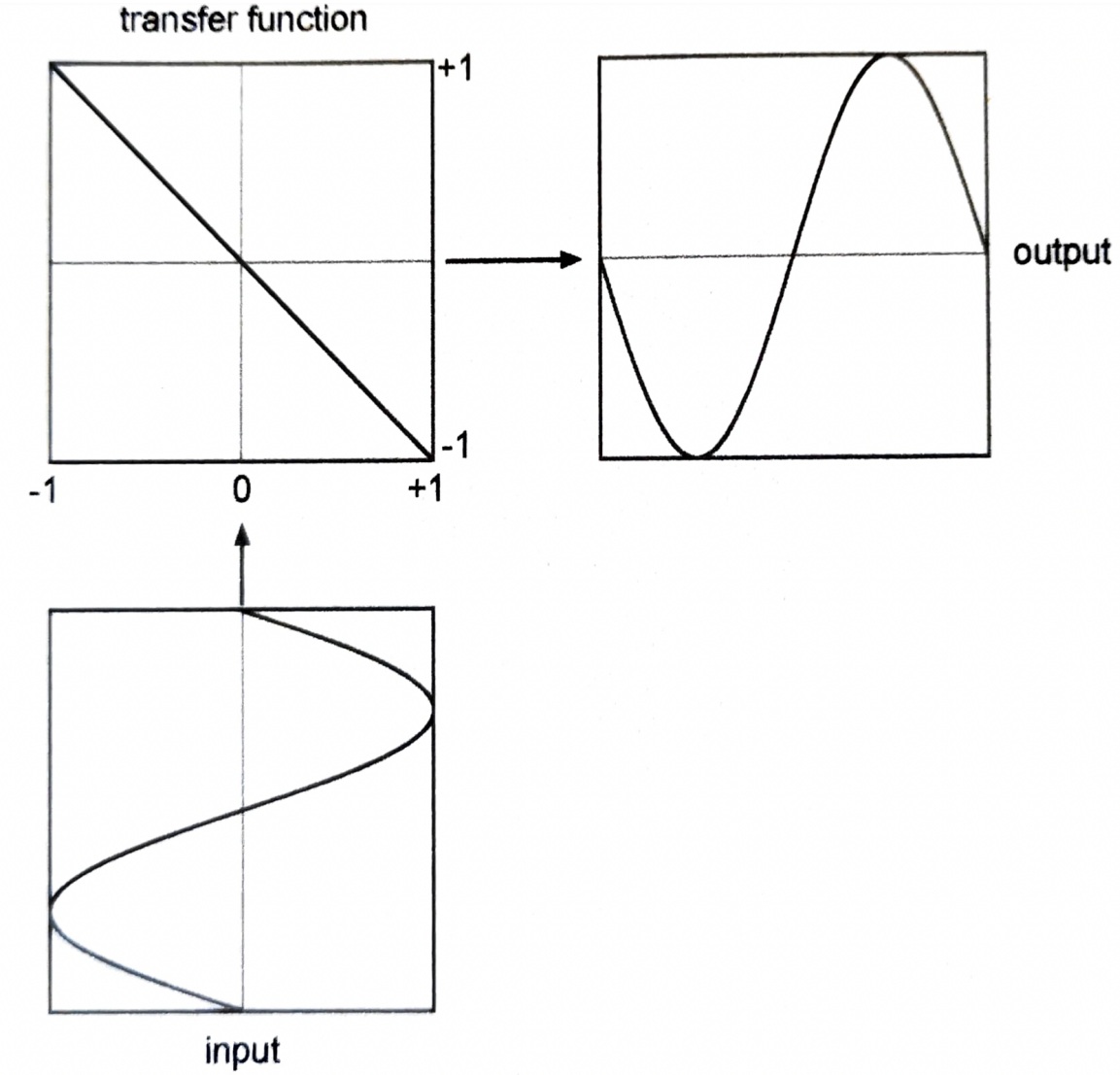


Figure: Phase inversion

Transfer Functions (Mapping)

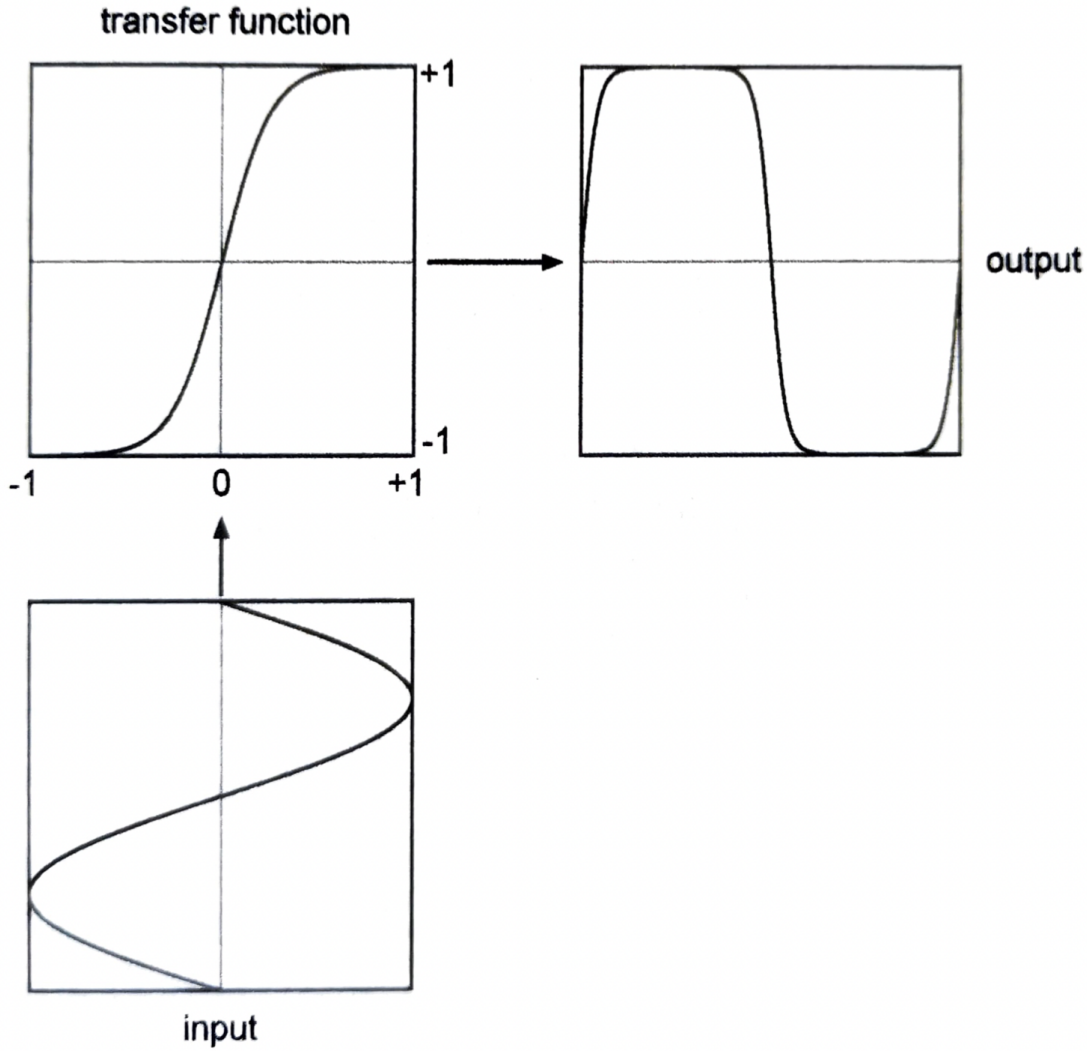


Figure: Soft clipping

Transfer Functions (Mapping)

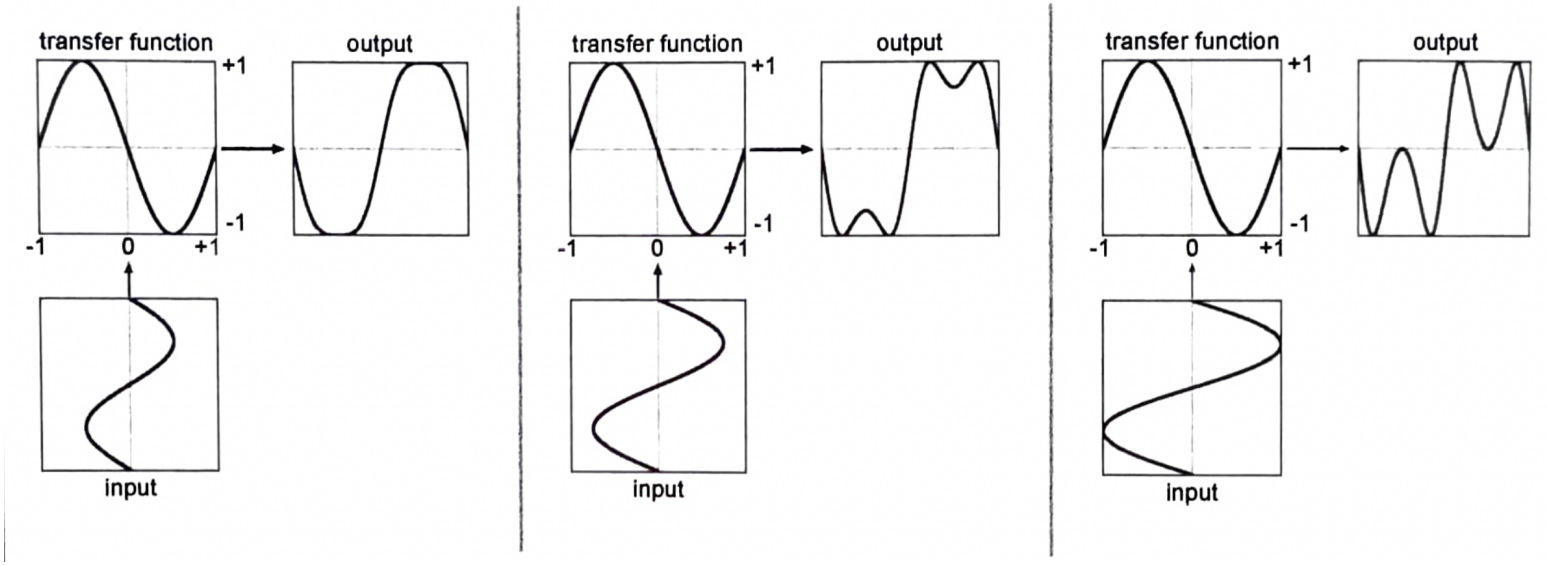
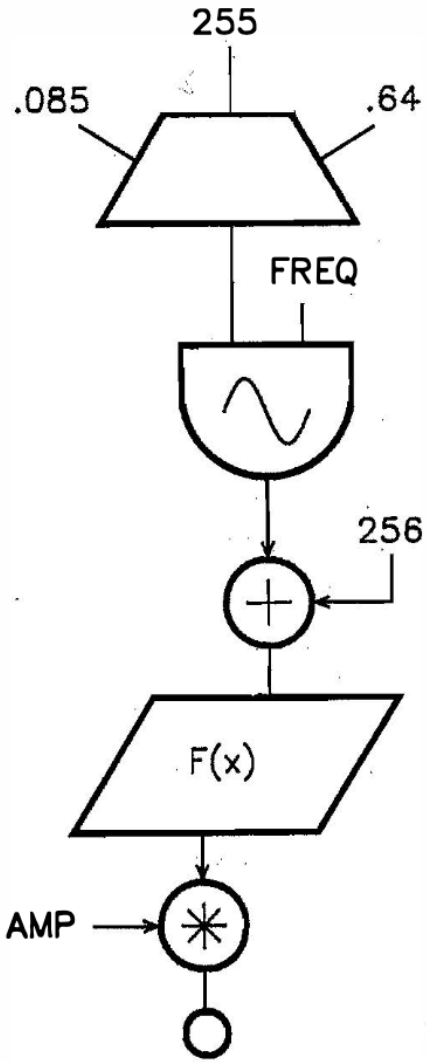
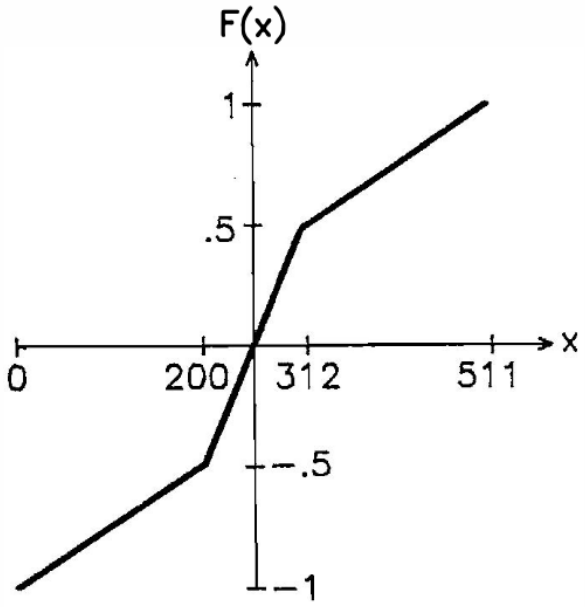


Figure: Sinewave as a transfer function

Example





MaxMSP Opcodes

waveshaping

- buffer~
- wave~
- uzi
- itable
- peek~
- lookup~

wavefolding

- clip~ [low and high values]
- pong~ [fold, wrap, clip]

Patches

- $13_{\text{waveshaping01.maxpat}}$ [sine player loop]
- $13_{\text{waveshaping02.maxpat}}$ [waveshapping with wave~]
- $13_{\text{waveshaping03.maxpat}}$ [draw you own buffer]
- $13_{\text{distortion.maxpat}}$ [draw you own buffer - use different sound sources]
- $13_{\text{waveshaping04.maxpat}}$ [randomize buffer + sample precise metro-object]