What is Music

Just a function!
Sampling

44.1 KHz
192 KHz

Nyquist Shannon
2 MaxFrequency
Reconstruction

Whittacker-Shannon formula

\[ \sum_{n} x(n) \text{sinc}(t-n) \]
A Wave Form

Bilding block
Abs
Look at successive minima or maxima
frequency = \(440 \times 2\)
5 Tone

Frequency change is $5^{1/5}$

Stockhausen: 1928-2007
KREUZSPIEL
(1951)
16 Tone

Frequency change is $2^{1/16}$
Interference

\[ f(x) = \sin(300 \, x) + \sin(301 \, x) \]
Approximating functions

\[ f(x) = \frac{\sin(x)}{1} + \frac{\sin(2x)}{2} + \frac{\sin(3x)}{3} + \ldots + \frac{\sin(10x)}{10} \]
Approximating functions

\[ f(x) = \frac{\sin(x)}{1} + \frac{\sin(2x)}{2} + \frac{\sin(3x)}{3} + \ldots + \frac{\sin(20x)}{20} \]
Sound Decomposition

Speaking Piano, Source: 3Sat, 2009
Problem 1: How does this sound?

\[ f(x) = \sin(10000 \sqrt{x}) \]
\[ f(x) = \sin(10000 \sqrt{x}) \]
Problem 2: How does this sound?

\[ f(x) = \sin(1000 x^2) \]
$f(x) = \sin(1000 \, x^x)$
Problem 3: How does this sound?

\[ f(x) = \sin(\sin(1000x)) \]
f(x) = \sin(\sin(1000x))
Problem 4: How does this sound?

\[ f(x) = \sin(x) \sin(1000 \, x) \]
Amplitude modulation

\[ f(x) = \sin(x) \sin(1000 \, x) \]
Sound Functions

More operations

Differentiate
Sound Functions

Differentiate
Sound Functions

Here is the result
Palindrome
Palindrome
Filtering
Which Scale is Best?