# Music Synthesis

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# The Philosophy

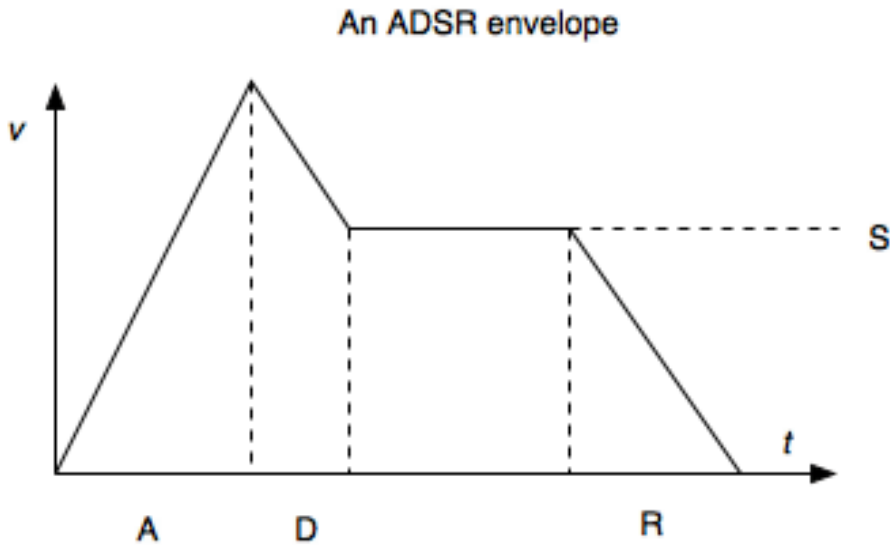
1. Introduction
   - Varying definitions
   - Composition refers to the manipulation of tone, note , pitch and timbre.
   - Comprises two major subparts:
   - Melody: refers to the ordering and disposing of two sounds such that their playing in succession is pleasant
   - Harmony: Rendering the disposition of two sounds played together pleasant

# Music Instruments: The general theme for music synthesis

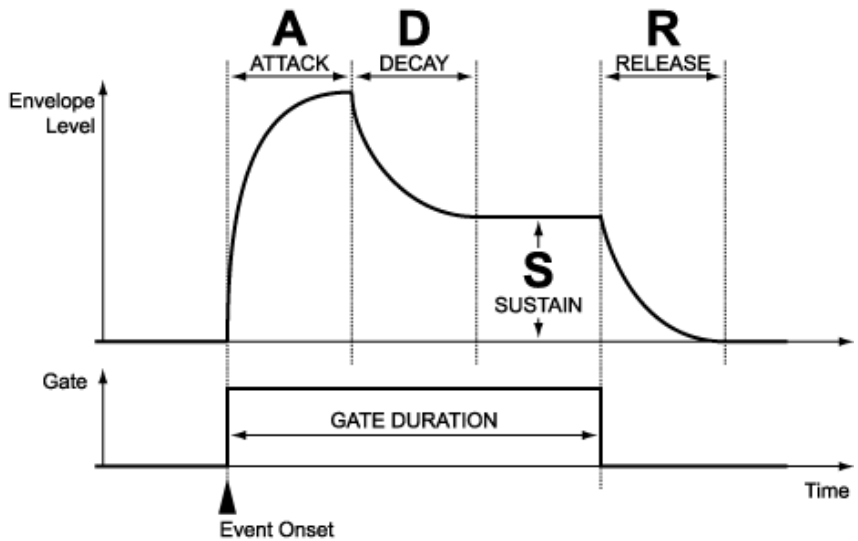
- Manipulate the notes to be played as their variation in the time and the frequency domain
- Spectral envelope and the Temporal envelope
- Theme used in generating music :
- Define the notes of fixed frequency
- Appropriate ADSR is chosen.
- Method of chord progression has been used to combine the notes of fixed frequency with the same weights which might not be true in general.
- Using the ADSR and chord progression the chosen song is played.
- Convolution reverberation is applied to show the effect of environment on the timbre and sound quality.

# ADSR envelope

- Acronym for Attack Decay Sustain Release
- Time domain envelope
- Attack : From zero to maximum
- Decay : From maximum to sustain level
- Release : From sustain level to zero




(a) ADSR Linear




(b) ADSR exponential

# ADSR envelope

Following functional forms were used for attack, delay and release periods ( M is the maximum level and T is the note duration)

- Attack

$$linear \quad y(t) = M\frac{t}{A}$$

$$Exponential \quad y(t) = M(1 - e^{\frac{-t}{\tau}}) \quad \tau = \frac{A}{5}$$

- Decay

$$linear \quad y(t) = M - \frac{M - S}{D}(t - A)$$

$$Exponential \quad C_1 + C_2 e^{\frac{-t}{\tau}} \quad \tau = \frac{D}{5}$$

- Release : From sustain level to zero

$$linear \quad y(t) = S - \frac{S}{R}(t - (T - R))$$

$$Exponential \quad C_1 + C_2 e^{\frac{-t}{\tau}} \quad \tau = \frac{R}{5}$$

# ADSR of Piano

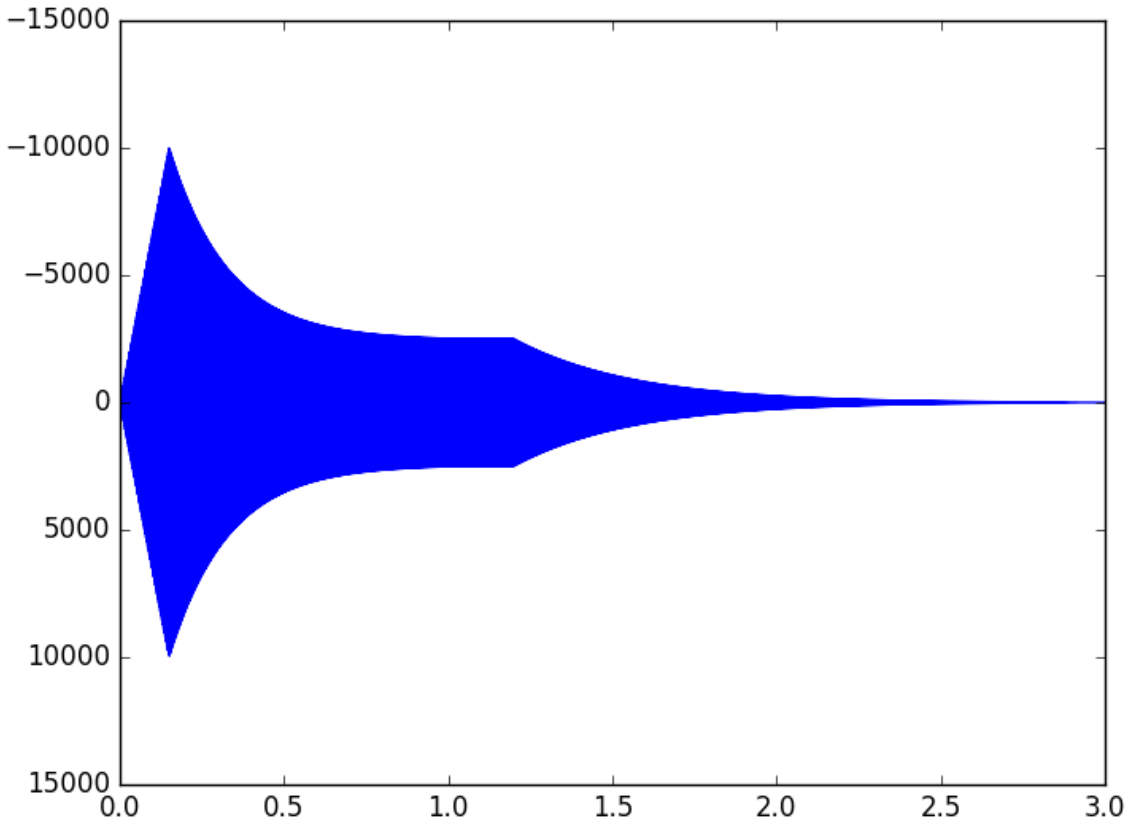



Figure: ADSR for C (523.25Hz) played on Piano

# ADSR of Violin

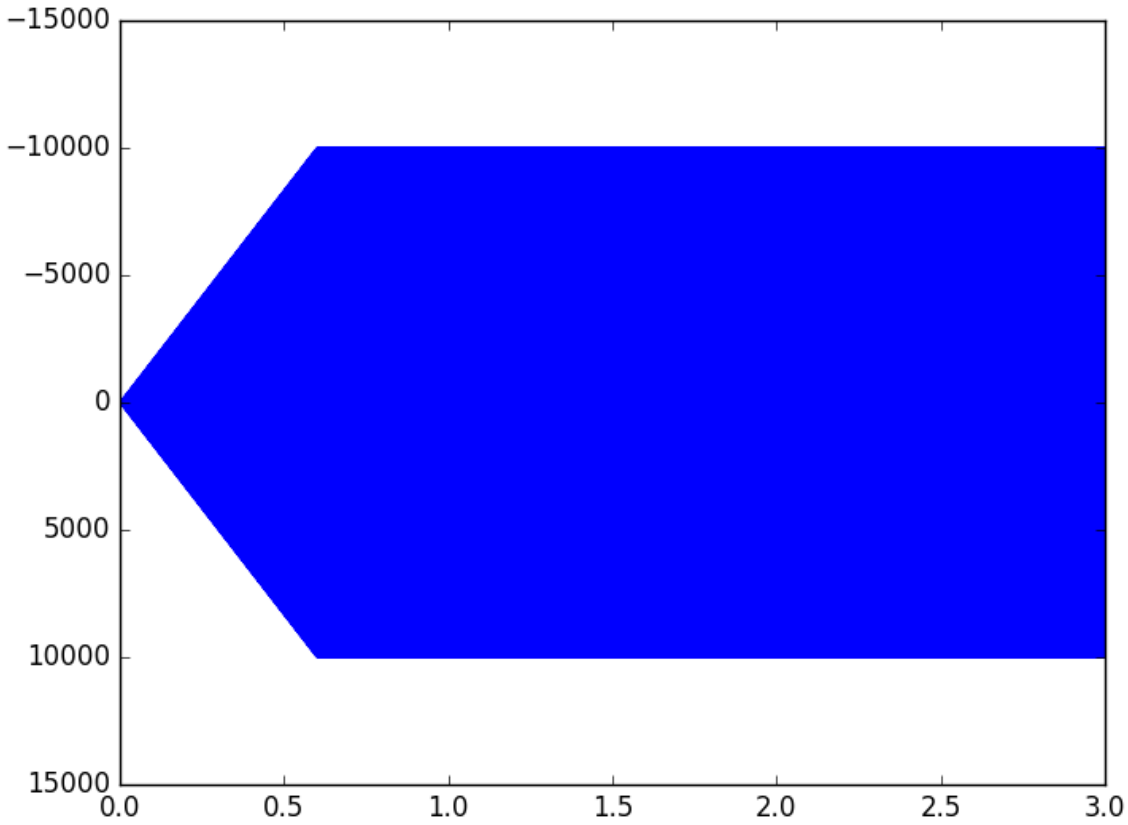



Figure: ADSR for C (523.25Hz) on Violin

# ADSR of Guitar

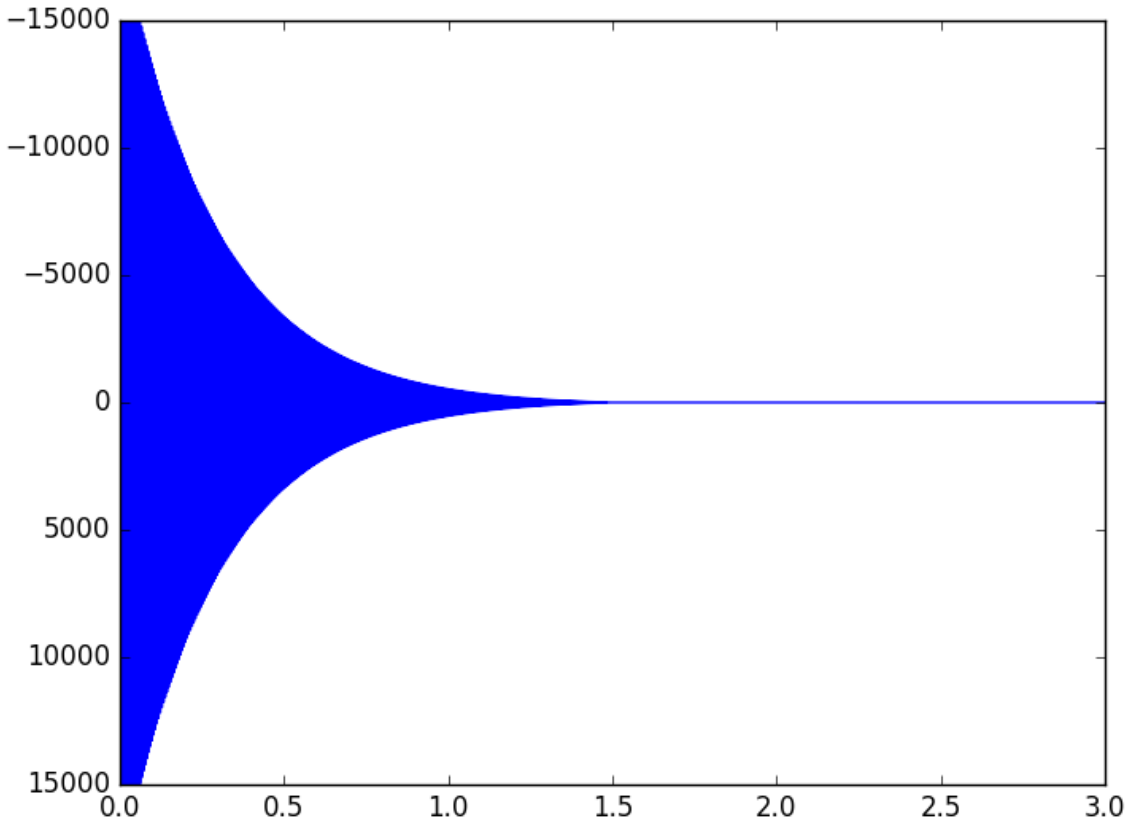



Figure: ADSR for Harmonics of G played on Guitar

# ADSR of Flute

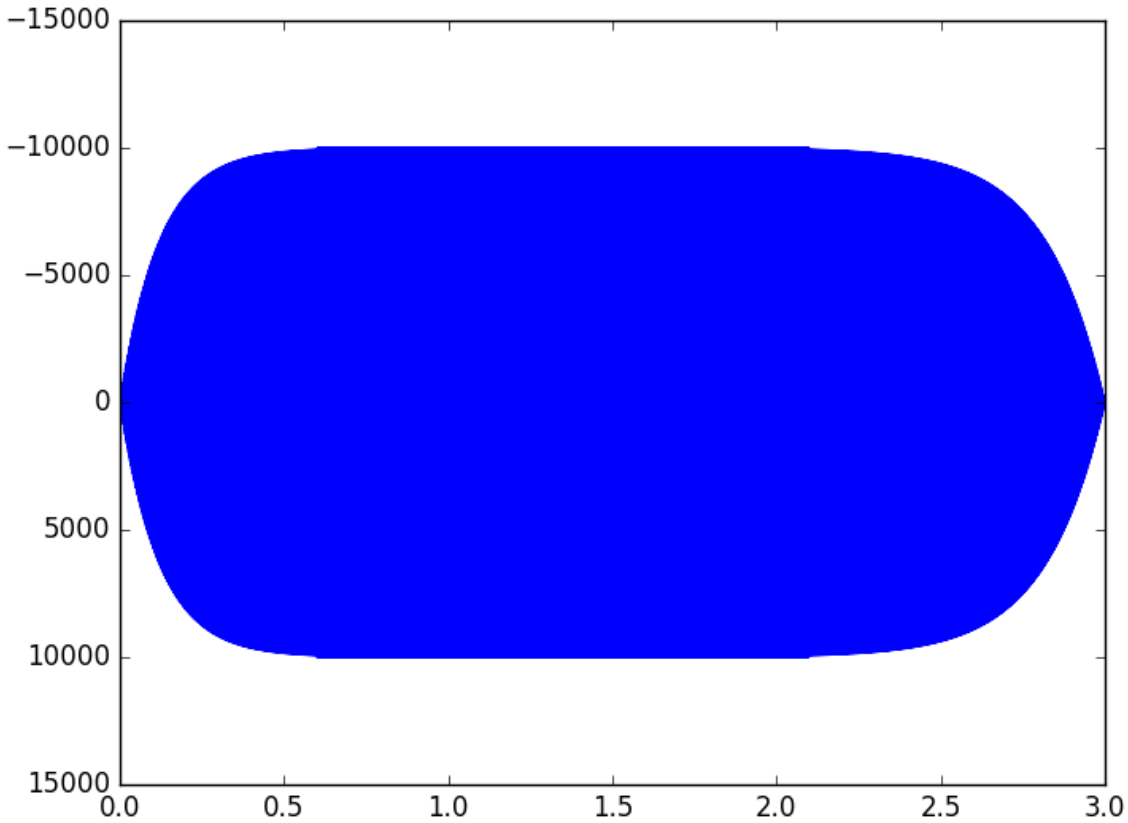



Figure: ADSR for A (440 Hz) played on Flute

# Convolution Reverberation

- Acoustic Reverberation can be considered as a Linear Time Invariant (LTI) System.
- The output can be completely determined by convolving input signal and impulse response.
- Discrete Convolution of 2 function f, g defined on integers is

$$(f * g)[n] = \sum_{m=-\infty}^{\infty} f[m]g[n-m] \tag{1}$$

- Previous impulses are getting added to the output with reduced amplitude according to the impulse response accounting for the reflection from different surfaces in the surrounding giving an echo effect in the output.

# Convolution Reverberation

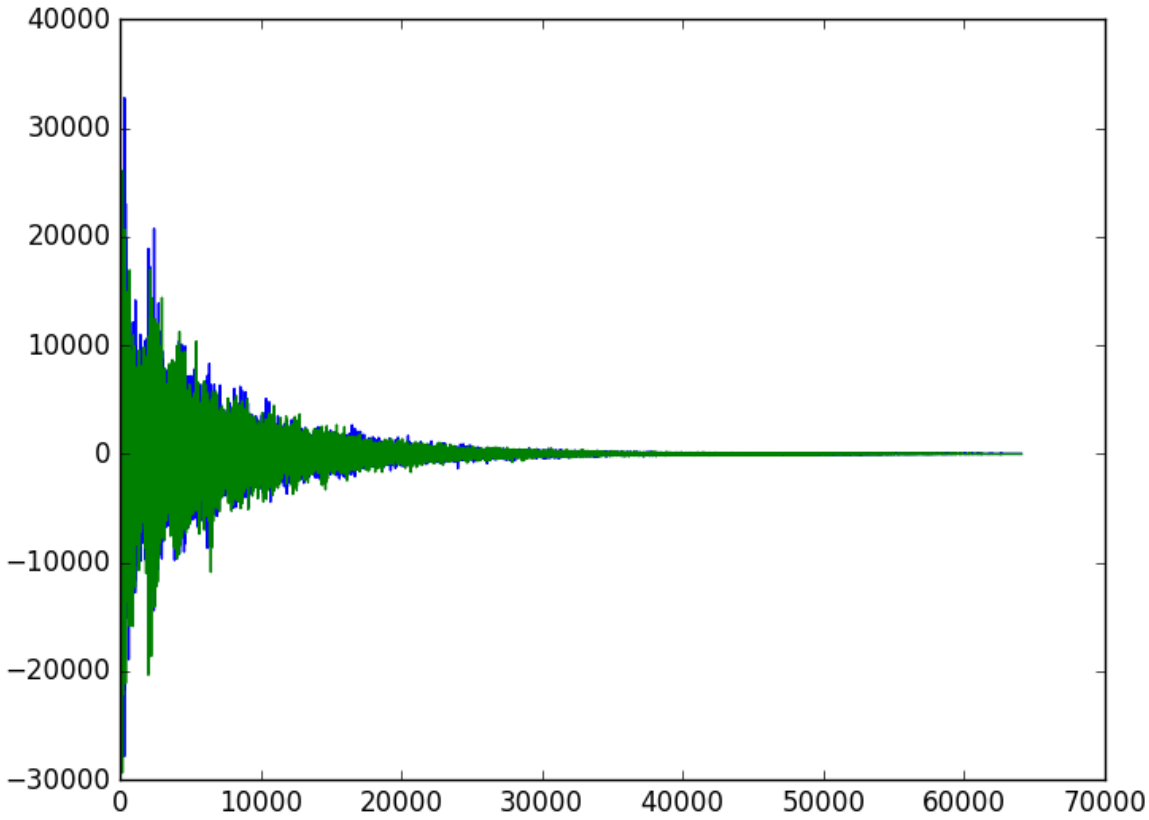



Figure: Impulse Response

# Convolution Reverberation

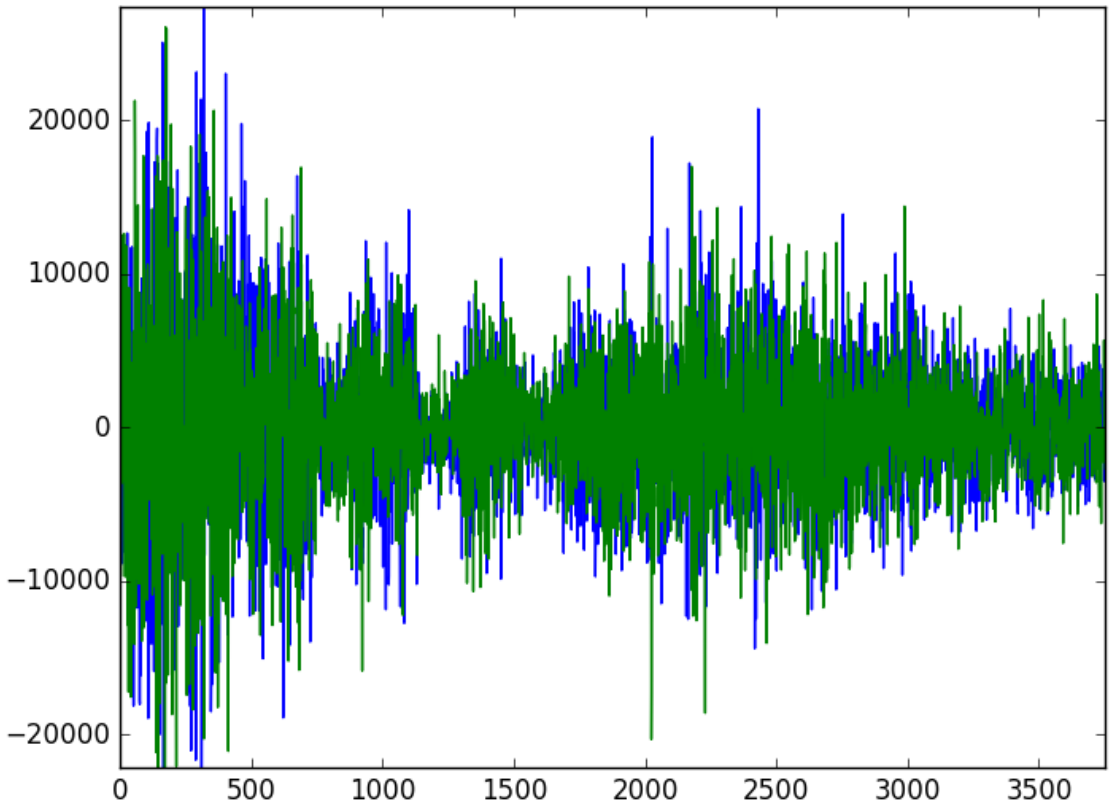



Figure: Impulse Response (Zoomed)

# Convolution Reverberation

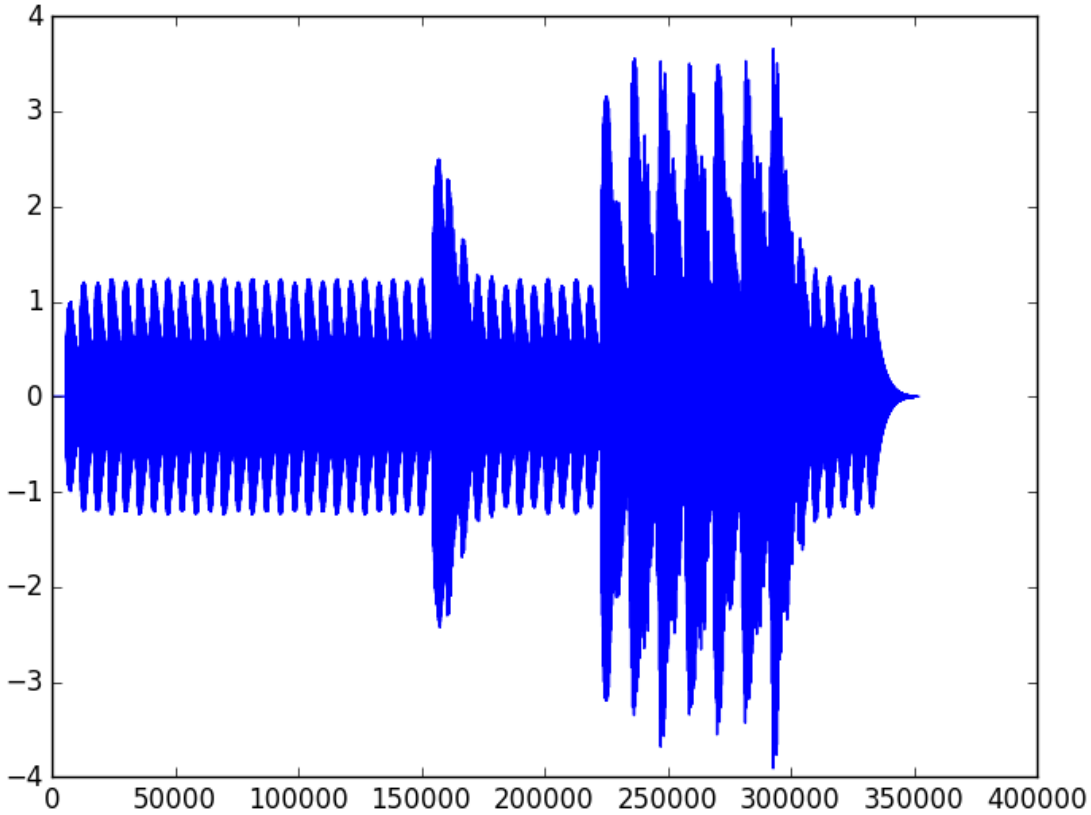



Figure: Temporal Output

# Convolution Reverberation

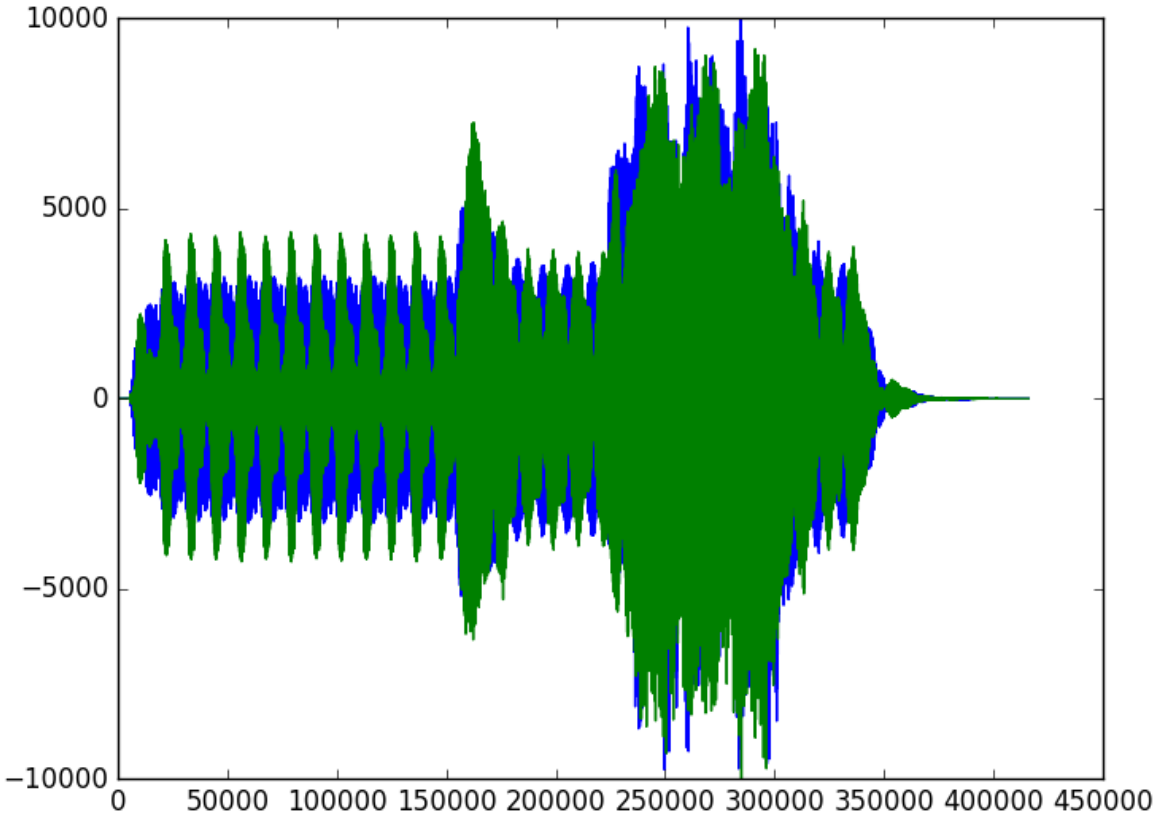



Figure: Temporal output with convolution

# Thank You!