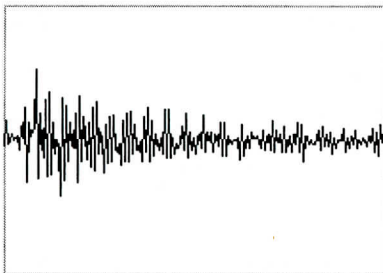


## Pitch 'n Time pitfalls

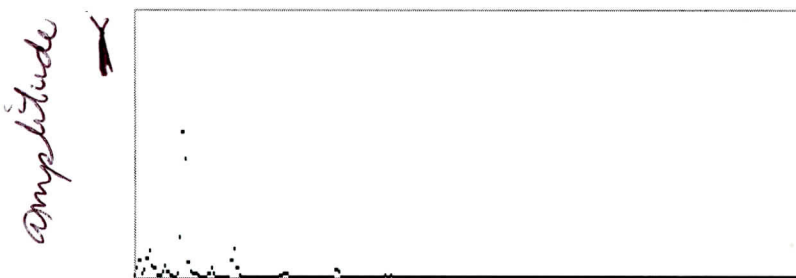
### Electronic Music I

Fall 2013

1. The Serato Pitch 'n Time plugin allows the user to alter the pitch and/or duration of a sound.
  - a. The user can choose to alter the pitch alone, duration alone, or both simultaneously.
  - b. The latter operation is very straightforward, and has been available since the beginning of fixed media electronic music.
  - c. The first and second operations require a mathematical operation called a Fourier transform.
2. Brief practical FFT explanation
  - a. The specific operation used by Serato is a variation of the Fourier transform optimized for speed of computation, called a Fast Fourier Transform (hence FFT).
  - b. FFT analyzes sounds in chunks, known as blocks. These are simply groups of continuous samples.
  - c. For each block, a calculation is done that determines the amplitude of a series of frequency ranges, known as bins.
  - d. For example, with a sound like the following,



One instance of analysis looks like this.



44.1K  
22050 Hz = highest rate  
at which

- e. This analysis represents the strength of frequencies between 0 and the Nyquist frequency (in this case 22.05 kHz).
  - f. A sound can be represented, often with striking accuracy, by a series of these analyses. Manipulations on the information provided by FFT allows for the alteration of pitch alone or duration alone.
3. Pitch alterations
    - a. Pitch alteration is accomplished by scaling the analysis (remember, that this is essentially a series of amplitudes-of-frequencies) higher or lower. This has different impacts on different sounds.
    - b. In the majority of cases, small pitch alterations are difficult to notice, especially since the Serato plugin is particularly precise in its calculations.
    - c. However, two things happen as a sound is pitch shifted:

- i. The frequencies which originally made up the most noticeable content of the sound move into ranges where they are less audible, or inaudible
  - ii. Frequencies which originally were imperceptible in the sound move into ranges where they now begin to qualify as noticeable content
  - d. This can lead to the presence of 'artifacts', the audible byproduct of the pitch shifting process. They are almost impossible to ignore, and typically are very difficult to remove from a processed sound.
  - e. The distinctive artifact sound is typically only a concern when pitch shifting up.
  - f. A sound which has a strong 'pitched' character (such as the sound of an acoustic instrument), the pitch can be shifted more widely than a sound lacking this character.
4. Time alterations
- a. Time alteration is accomplished by manipulating the rate of change from one analysis to the next.
  - b. As with pitch alterations, small time alterations are typically artifact-free.
  - c. Time alteration can have different effects, depending on whether one is elongating or shortening a sound:
    - i. When elongating, an artifact similar to the pitch shift artifact becomes present. This is because the analysis windows are being spaced far enough apart that the amplitude changes of each frequency bin become audible as discrete events, rather than being 'blurred' into 'one sound'.
    - ii. When shortening, an artifact sound is not added, but rather the character of a sound begins to be distorted. As the frequency analysis windows become spaced close enough together, some amplitude changes cease to be perceptible and the sound loses detail.
  - d. As with pitch shifting artifacts, these are extremely difficult to overcome once they exist in a sound.
  - e. Related to ii above, sounds with very short onsets (quick, percussive attacks) can have the attack 'smear,' due to the blocking involved in FFT analysis.