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MATH 2270-2

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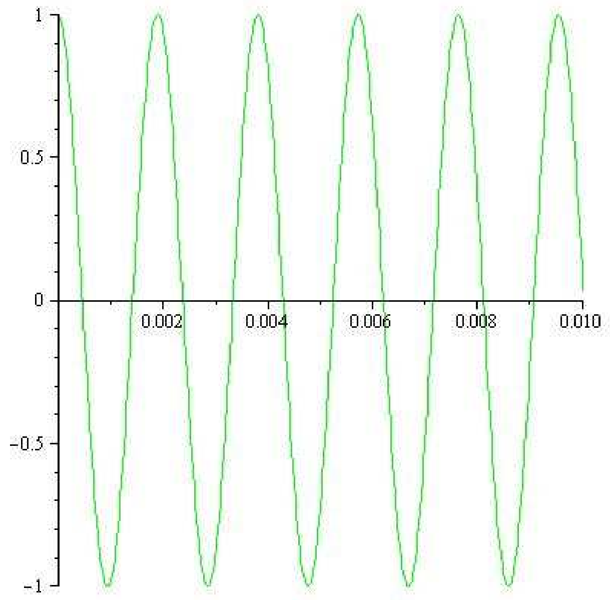
Instrument Wavelength Comparisons

Throughout history we continuously intertwine music and science as they seem to go hand in hand. It was Albert Einstein that said, "If I were not a physicist, I would probably be a musician. I often think in music. I live my daydreams in music. I see my life in terms of music."

The basis that stems the love for music is in fact science. Wave vibrations that are traveling through the air, that once reach our ear canals can be translated to what we call sound. Each sound we hear can be viewed in its most basic form of wavelengths. Wavelengths are essentially the distance between the oscillating waves at certain points.

Each and every sound, depending on its wavelength can produce a different tone or pitch. Depending on how fast the wavelength is allows the human ear to hear a middle C on the piano and know its wavelength is different from playing a G. Now, what if the same note is played just through different instruments? To be shown are the puretone, flute, piano, and trumpet wavelengths playing a C5.

A pure tone in the same regards to wavelength display a "pure" sin cos graph upon viewing the data as shown in the graph below. As you can see the graph depicting the vibration/wavelengths of the puretone display a proper Cos graph. We were able to view these graphs through Markov Chains.

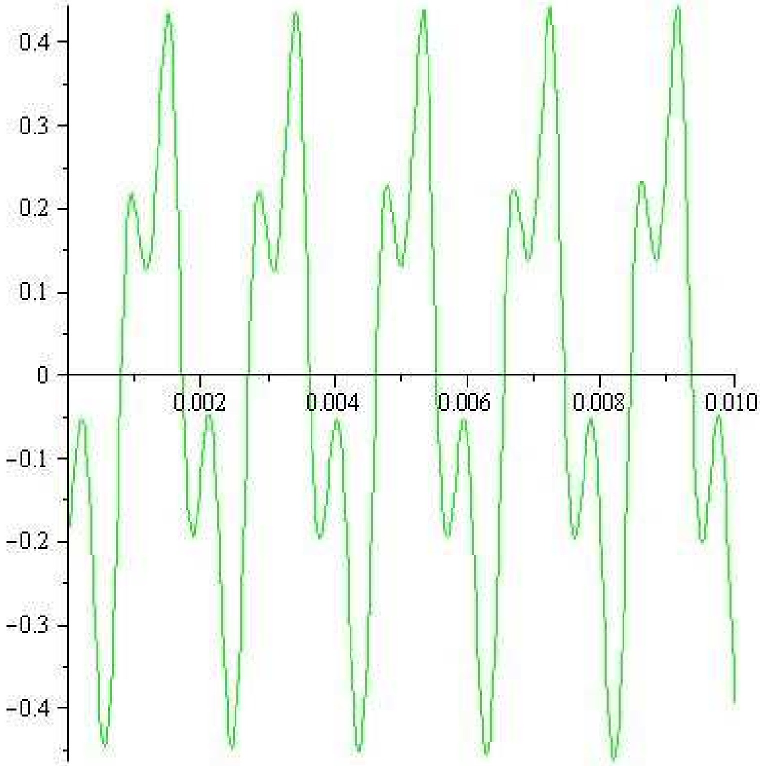


Markov Chains are mathematical models that allow us to measure the different wavelengths of any frequency. The outcome of each of the following models of the instruments playing the same C5 tone will be based off of the puretone data. Such data can also be used to possibly predict the future of two predator/prey animal populations, expanded growth of crops etc..

The instruments brought in for the experiment were a flute, a piano, and trumpet. Each instrument while able to play the same note creates the sound differently from each other. For the flute, an elongated metal tube with holes and coverings are used while the player blows a steady stream of air across an opening on the flute that allows it to produce its sound. By changing the variations of hole coverings, new pitches are created. The piano's sound is created when a key releases a hammer that then strikes at a string that is specifically tuned to the note that is being played until the key is let go placing a suppressor upon the note muting it once again. Finally the trumpet's sound is the most tricky to describe. Made completely out of brass, a buzzing sound is made through a mouthpiece that reverberates through varying air columns that are created through three column shifters. The change of intensity from the person playing allows for a wider range when playing the trumpet.

After using the Markov Chains to translate all the instruments playing a C5 note the results are shown on the ending pages. In order, the graphs are flute piano and trumpet respectively. As can be seen, the graphs each display a widely different graph than the puretone. How can this be? All these instruments are providing the same note of C5, yet these graphs somehow display their own graphs. The answer comes to us in the form of the instruments themselves as well as the initial creation of the sound.

The instruments are all constructed out of different materials, brass, steel, wood etc., each material reverberates soundwaves differently. Another factor that needs to be taken into account is the way the sound is produced. For the flute, its a straight stream of air, the piano is a striking of a string, and the trumpet, while a steady stream of air, is caused by the buzzing sound made by the player's lips. With these key factors in place, the Markov Chains sets allow us to view the individual changes within each instrument.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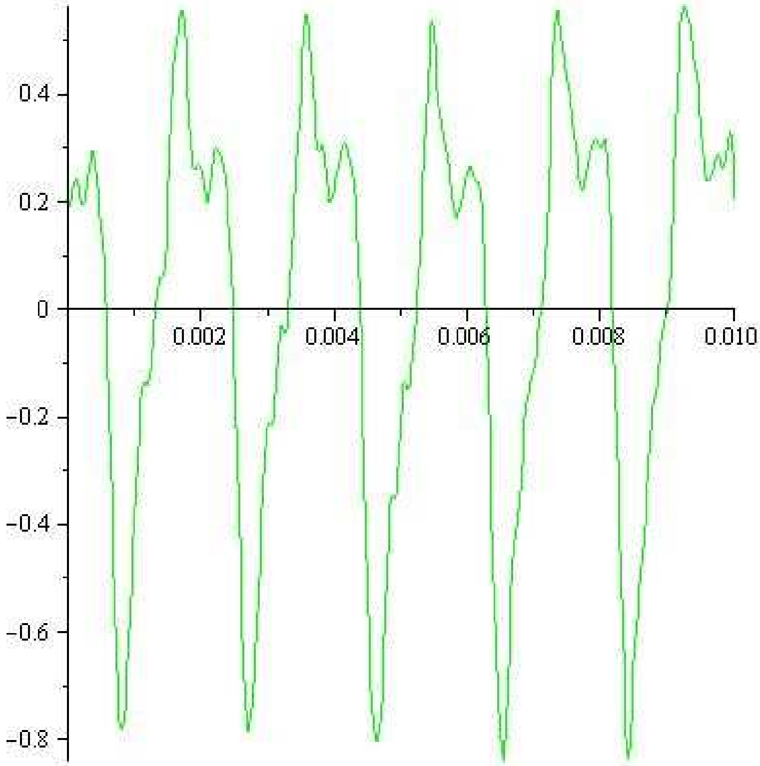
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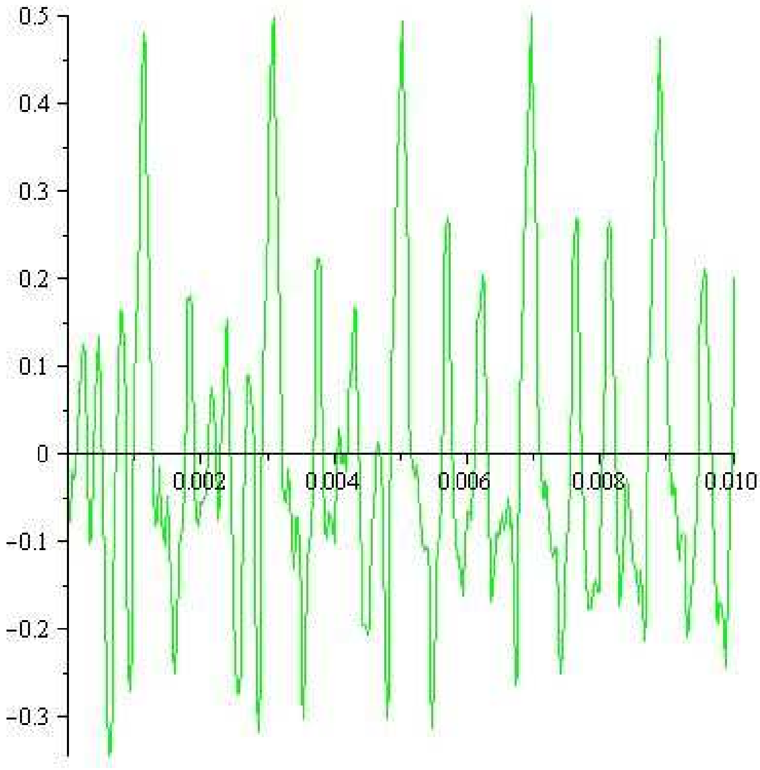
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