**The Frequency Values in Charles Ives’ *The Unanswered Question***

Charles Ives is a composer who indulged himself in an endlessly complicated style of music. Each one of his works were experimental in one way or another. Many avant-garde composers would later go on to adopt his music styles and techniques (Kennedy 438). He certainly had a very unique music style unlike any other composer, and such an odd ear as well. He seemed to be able to hear music within every sound he heard, and he even had two marching bands march by each other in opposite directions just to hear what it sounded like (Gerstein 15). His most interesting piece perhaps is the one entitled *The Unanswered Question.* It is a piece with fluctuating emotions and both clashing and harmonizing chords. This paper will explore the frequencies present in each of this song’s notes and how the different parts of the piece compare or contrast to one another.

*The Unanswered Question* was chosen because even though parts of it are not the most pleasing to ear, such as the clashing flutes that become more and more erotic as the piece goes on, it is still a fascinating piece to listen to. The strings within it seem to float through the air rather than just vibrate, giving off a feeling that is both calming and unnerving. As soon as it manages to relax the listener with its strings’ soothing chords, they become jolted back to reality by the sour notes of the flutes. All these differing parts that seem to jump around almost randomly would certainly make for an invigorating frequency exploration. How does it change as the song becomes more disorganized? How different are each of the parts from one another? Is there a trend or pattern anywhere among these neurotic notes?

The song has a grand total of nine instrument parts that play. Four belong exclusively to flutes, two are made up of violins, and the other three are played by a trumpet, a viola, and a violincello. It is easy to see the differences between the woodwinds and the strings simply by looking over the sheet music. The string parts are structure with long, held-out legato notes, and they mostly stay within a small range of pitches with many of their notes being repeated. On the other hand, the woodwinds are more unorganized. There are a multitude of different notes played, and many only last for a mere sixteenth note. In the calculations conducted, each note for each part was counted for however many beats it was held, whether it be an eighth of a beat or a full one. The woodwinds had erotic-looking results, with complicated fractions for almost every note—most of those fractions being less than one—with a total of almost thirty different occurring notes for each one. On the other hand, the strings had no fractions between them all, and many of the numbers exceeded above the value of one, with the highest being a total of 87 beats worth of the note B3 from the viola. Each string instrument only had between eleven and seven different notes occur for each.

Every music note has its own frequency value that can be determined using a certain formula. This formula goes as follows:

**frequency = 440×2n/12**

The resulting frequency is measured in hertz (htz). The value of *n* is however far away from the starting note the note you are calculating is. If it is above it, *n* is positive, and if it is below, then *n* is negative. In this case, the starting note is the note where *n* = 0, making the frequency worth 440. That note is A4.

*The Unanswered Question* has a huge range of pitches throughout all of its different parts. The violincello plays the lowest note, which is a C2 on the line below the bass clef, occurring for a total of 12 beats altogether. On the other hand, there is the flute I playing the highest note, a B♭6, for 3 beats at the very end. That is nearly seven total octaves worth of notes being played, with frequencies ranging from 65.41 htz to 1864.66 htz.

 When calculating the average frequency for one musical instrument part, the frequency value of each note present was multiplied by the corresponding amount of beats that its note was played for. After each of those were multiplied, the products were added together. Meanwhile, the amount of beats for that instrument were added to find the total amount of beats that that instrument played overall throughout the song. Finally, the sum of the frequency products was divided by the sum of the beats within the part. The product of the division was the average frequency of that part of the song. Below is a table that shows the frequencies for each instrument from the piece.

|  |  |
| --- | --- |
| **Part** | **Average Frequency (Hz)** |
| Flute I | 903.663 |
| Flute II | 667.179 |
| Flute III | 582.192 |
| Flute IV | 534.228 |
| Trumpet | 488.330 |
| Violin I | 1262.308 |
| Violin II | 575.198 |
| Viola | 307.632 |
| Violincello | 120.784 |

 As can be seen from the table, the violin I has the highest average frequency of 1262.308, while the violincello has the lowest frequency of 120.784. The violincello was expected when seeing its consistently low notes, however judging by how the flute I had the highest note, it is surprising that that is not the part with the highest average frequency, but rather the violin I. Even though the flute I contained the highest note of the song within its part, the violin I still had more high-pitched notes that allowed it to surpass the average frequency held by the flute I.

 One instrument that has not yet been discussed is the trumpet. It is the only instrument that does not fit into the categories of woodwinds or strings. This brass instrument had the simplest part within the entire piece. It only played a total of six different notes, making it have the smallest variability out of any of the other instruments. It would rest for a different number of measures each time—from four to twelve measures at a time, to be more precise—and then play the same ten-beat long rhythm, with only the last note within the ten beats being the one to change. It would alternate between a B4 and a C5 each time its part played. Its average frequency value is also the closest to the starting note’s frequency of 440 htz, being only a little over 88 htz above it.

 Finding the average frequencies does not have to be the end of the calculations. Using those values, it is possible to make a box and whisker plot to visually display the frequencies’ distribution and variability. This box and whisker plot can be seen below.

Q3

Q1

M

 The values of the box include quartile one (Q1) as 397.981, median (M) as violin II’s frequency of 575.198, and quartile 3 (Q3) as 785.421. Any values above and below the quartiles are outliers within the data. The lower outliers are the violincello and viola, while the higher outliers are the flute I and the violin I. The box stretches across a span of over 1,140 htz, visually showing the immense variability within all the frequencies contained in *The Unanswered Question.*

 Knowing the frequencies of the different parts of *The Unanswered Question* can help one to understand how the song effects them while listening to it. Different frequencies will have different effects on the brain. The strings will be playing chords with their consonant frequencies, causing a feeling of contentment and peace. Suddenly, the clashing, dissonant chords of the winds and trumpet will interrupt that feeling of serenity, causing discomfort and confusion. Then it will return to that sweet, gentle consonance of the strings, until the flutes and trumpet play once again, disrupting the peace. The differing frequencies all cause different, clashing emotions inside of the listener, which explains the insane, unique experience that is listening to *The Unanswered Question* by Charles Ives.

 It is very interesting to think that Charles Ives was “the first composer to write pieces that had radically different sorts of music going on at once” (Burrows 281). His hugely varied musical techniques are likely why his music has such a very wide range of frequencies. If his pieces were just made up of the same kinds of instruments, then the frequencies would be far less diverse and impactful. It is very likely that modern music would be much different today without the influence of Charles Ives. Who knows, without his avant-garde musical techniques, frequencies could be far less varied, and thus far less impactful to the listener overall. Even if it sounds displeasing to the ear, it cannot be denied that Ives’ work always leaves a big impression on the listener.

**Bibliography**

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**Beat values of notes for each instrument**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Note | Frequency | Flute I | Flute II | Flute III | Flute IV | Trumpet | Violin I | Violin II | Viola | Violincello |
| C2 | 65.41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| C#2/D♭2 | 69.30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D2 | 73.42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D#2/E♭2 | 77.78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E2 | 82.41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F2 | 87.31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F#2/G♭2 | 92.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| G2 | 98.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 |
| G#2/A♭2 | 103.83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A2 | 110.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| A#2/B♭2 | 116.54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B2 | 123.47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 |
| C3 | 130.81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| C#3/D♭3 | 138.59 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D3 | 146.83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D#3/#♭3 | 155.56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E3 | 164.81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| F3 | 174.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| F#3/G♭3 | 185.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| G3 | 196.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| G#3/A♭3 | 207.65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A3 | 220.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 |
| A#3/B♭3 | 233.08 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B3 | 246.94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87 | 8 |
| C4 | 261.63 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 48 | 6 |
| C4#/D♭4 | 277.18 | 1/3 | 1/3 | 5 1/3 | 4 7/12 | 5 | 0 | 0 | 0 | 0 |
| D4 | 293.66 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | 3 | 0 |
| D#4/E♭4 | 311.13 | 5 | 0 | 0 | 1 ¼ | 0 | 0 | 0 | 0 | 0 |
| E4 | 329.63 | 1/3 | 11/24 | 0 | 2 17/24 | 5 | 0 | 0 | 16 | 0 |
| F4 | 349.23 | 0 | 1/8 | 1 1/3 | 1 11/12 | 0 | 0 | 0 | 4 | 0 |
| F#4/G♭4 | 369.99 | 1/6 | 8 1/6 | 1/2 | 4 5/8 | 0 | 0 | 0 | 0 | 0 |
| G4 | 392.00 | 1/3 | 11/24 | 1/3 | 23/24 | 0 | 0 | 12 | 38 | 0 |
| G#4/A♭4 | 415.30 | 1/3 | 1/8 | 5/8 | 7 | 0 | 0 | 0 | 0 | 0 |
| A4 | 440.00 | 7/24 | 31/24 | 11/24 | 2 5/6 | 0 | 0 | 2 | 8 | 0 |
| A#4/B♭4 | 466.16 | 2 1/8 | 2 5/12 | 2 5/6 | 5/6 | 15 | 0 | 0 | 0 | 0 |
| B4 | 493.88 | ½ | 0 | 8 5/8 | 1 5/6 | 6 | 0 | 2 | 12 | 0 |
| C5 | 523.25 | 11/24 | 1/3 | 10 1/8 | 1 | 4 | 0 | 20 | 4 | 0 |
| C#5/D♭5 | 554.37 | 1/8 | 0 | 5 1/6 | 1 | 0 | 0 | 0 | 0 | 0 |
| D5 | 587.33 | 5/8 | 0 | 2 1/6 | ½ | 0 | 0 | 76 | 0 | 0 |
| D#5/E♭5 | 622.25 | 2 1/2 | 2 5/8 | 1 1/3 | 0 | 15 | 0 | 0 | 0 | 0 |
| E5 | 629.25 | 1 3/8 | 1 23/24 | 1 1/6 | 0 | 0 | 4 | 60 | 0 | 0 |
| F5 | 698.46 | 6 1/4 | 4 1/3 | 1 11/24 | 0 | 0 | 2 | 4 | 0 | 0 |
| F#5/G♭5 | 739.99 | 1/3 | 1/3 | 1 1/8 | 0 | 0 | 0 | 0 | 0 | 0 |
| G5 | 783.99 | 0 | 9 1/3 | 5/8 | 0 | 0 | 13 | 0 | 0 | 0 |
| G#5/A♭5 | 830.61 | 1 1/2 | 5/6 | 0 | ½ | 0 | 0 | 0 | 0 | 0 |
| A5 | 880.00 | 1 13/24 | 1 1/12 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| A#5/B♭5 | 932.33 | 5/6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B5 | 987.77 | 2 1/3 | 2/3 | 5/6 | 0 | 0 | 4 | 0 | 0 | 0 |
| C6 | 1046.50 | 2 1/2 | 0 | ½ | 0 | 0 | 51 | 0 | 0 | 0 |
| C#6/D♭6 | 1108.73 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D6 | 1174.66 | 2 17/24 | 11/24 | 0 | 0 | 0 | 15 | 0 | 0 | 0 |
| D#6/E♭6 | 1244.51 | 5/6 | 1/3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E6 | 1318.51 | 1 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |
| F6 | 1396.91 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| F#6/G♭6 | 1479.98 | 1 1/3 | 1/3 | 0 | 3 | 0 | 16 | 0 | 0 | 0 |
| G6 | 1567.98 | 2/3 | 3 2/3 | 0 | 0 | 0 | 70 | 0 | 0 | 0 |
| G#6/A♭6 | 1661.22 | 1/6 | 1/6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A6 | 1760.00 | 1/3 | 1/3 | 2 ½  | 0 | 0 | 0 | 0 | 0 | 0 |
| A#6/B♭6 | 1864.66 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

 **Other calculated data:**

Flute I = 41417.87667 / 45.83333333

Flute II = 30134.23667 / 45.16666667

Flute III = 27387.27875 / 47.04166667

Flute IV = 18987.37042 / 35.54166667

Trumpet = 24416.48 / 50

Violin I = 242363.07 / 192

Violin II = 101234.92 / 176

Viola = 68909.56 / 224

Violincello = 23069.7 / 191

Overall mean: 604.613

Standard deviation: 310.562

Max: 120.784

Q1: 397.981

Median: 575.198

Q3: 785.421

Min: 1262.308