

Computational Physics ps-8 Report

Tongzhou Wang,
GitHub account: TZW56203, repository: phys-ga2000.
<https://github.com/TZW56203/phys-ga2000>

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1 Problem 1

Listing 1 shows the maximum likelihood values, formal errors, and covariance matrix of β_0 and β_1 .

Listing 1: Likelihood maximization.

```
beta_0, beta_1: [-5.62023141  0.10956337]
Errors: [1.05719973  0.02078095]
Covariance matrix:
[[ 1.11767127e+00 -2.10939323e-02]
 [-2.10939323e-02  4.31848070e-04]]
```

Figure 1 shows the survey results and the logistic model.

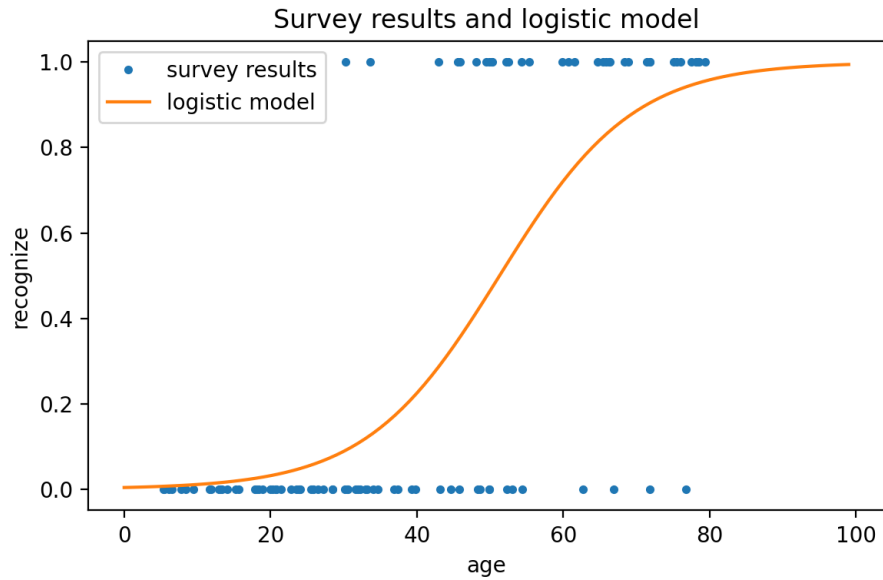


Figure 1: Survey results and logistic model.

The logistic model seems to make sense because it gives a probability distribution that seems to explain the survey results, as shown in Figure 1. For example, the logistic model is nearly zero between 0 and 20, and indeed no respondents between 0 and 20 years old recognizes the phrase.

2 Problem 2

2.1 Part (a)

The waveforms of the note played on a piano and a trumpet are shown in Figure 2, 3, and 4.

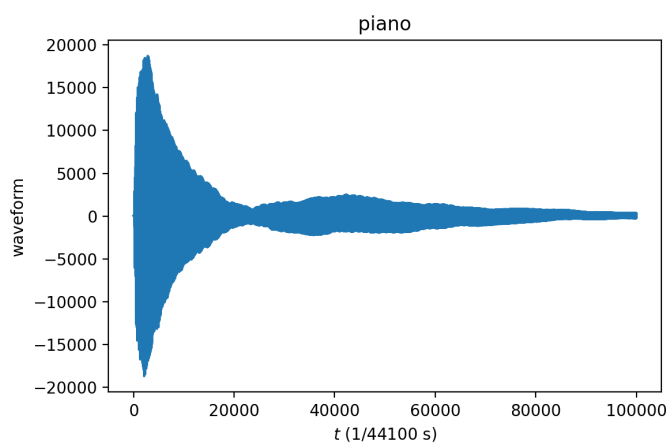


Figure 2: Piano.

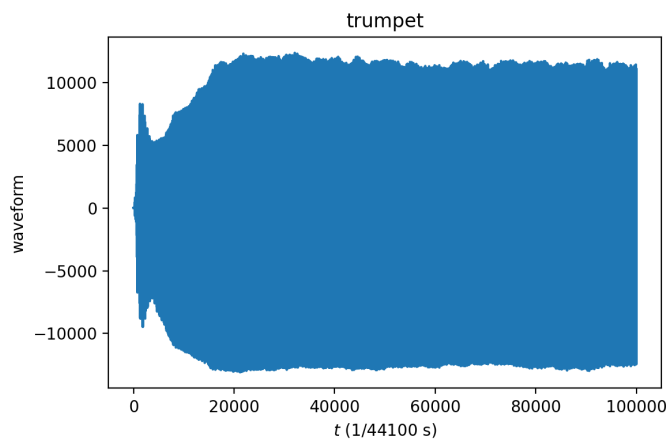


Figure 3: Trumpet.

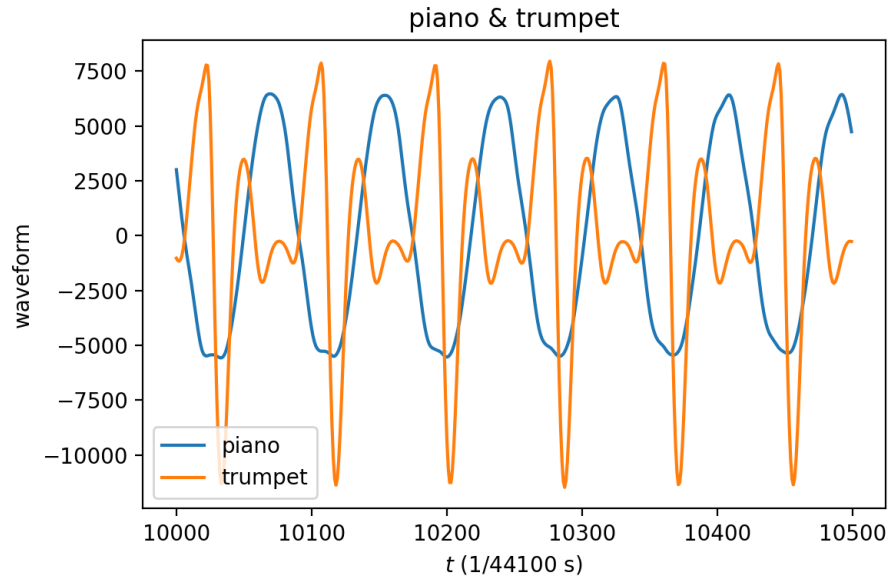


Figure 4: Piano and trumpet.

Figure 5 and 6 show magnitudes of the first 10000 Fourier coefficients of the discrete Fourier transforms. We can conclude that the sound of the piano is more precise because only the first harmonic has large Fourier coefficient. On the other hand, the sound of the trumpet contains several higher harmonics.

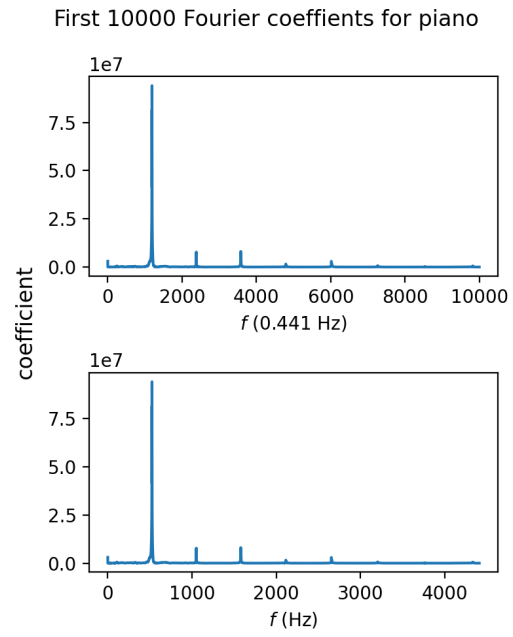


Figure 5: First 10000 Fourier coefficients for piano.

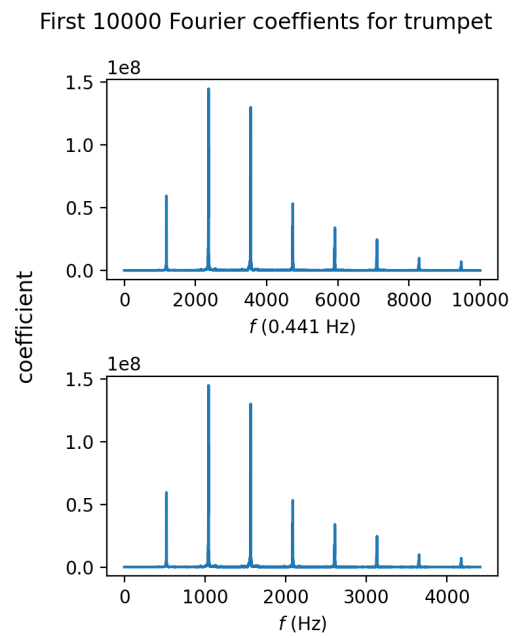


Figure 6: First 10000 Fourier coefficients for trumpet.

2.2 Part (b)

Listing 2 shows the piano and trumpet frequencies where the Fourier coefficients are large. According to https://en.wikipedia.org/wiki/Scientific_pitch_notation, the frequency of C_5 is 523.2511 Hz. We can conclude that the piano and the trumpet are playing C_5 .

Listing 2: Harmonics.

```
piano frequencies where the coefficients > 7e7:
[523.908 524.79 525.231]
trumpet frequencies where the coefficients > 5e7:
[ 521.703 1042.524 1043.847 1562.904 1563.345 1563.786 1564.227 1565.109
 1565.55 1565.991 2087.694]
```

3 Problem 3

Figure 7 shows the original data and the inverse Fourier transforms where all but the first 10% and 2% of the Fourier coefficients are set to zero. We can see that the general trend of the original plot is preserved, and the plot becomes smoother.

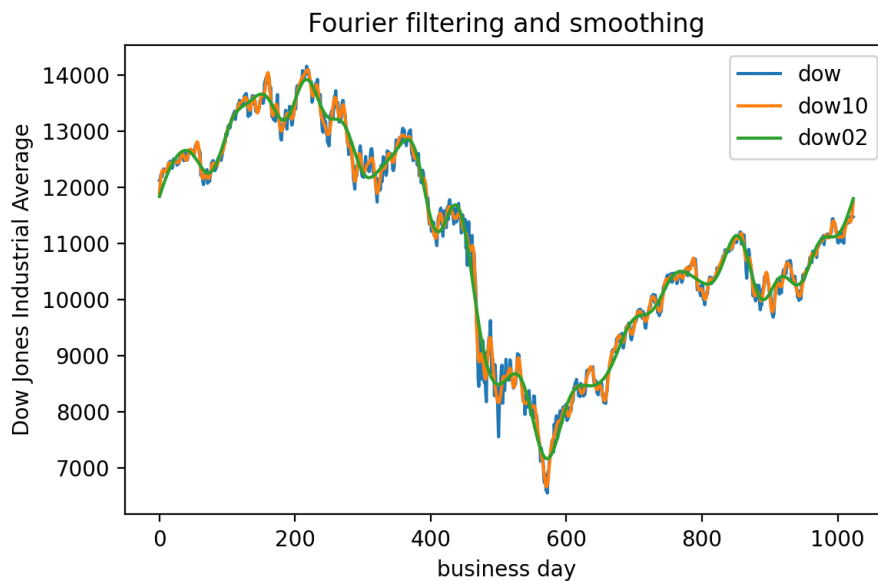


Figure 7: Fourier filtering and smoothing.