[This is ok. It has all of the required components, though a more thorough conclusion would be nice. The roman numerals should be omitted in the inference toolbox part of the paper. Overall, it's an awkward context to work with, because it's not really drawing a random sample, and this makes it more difficult to write about.]

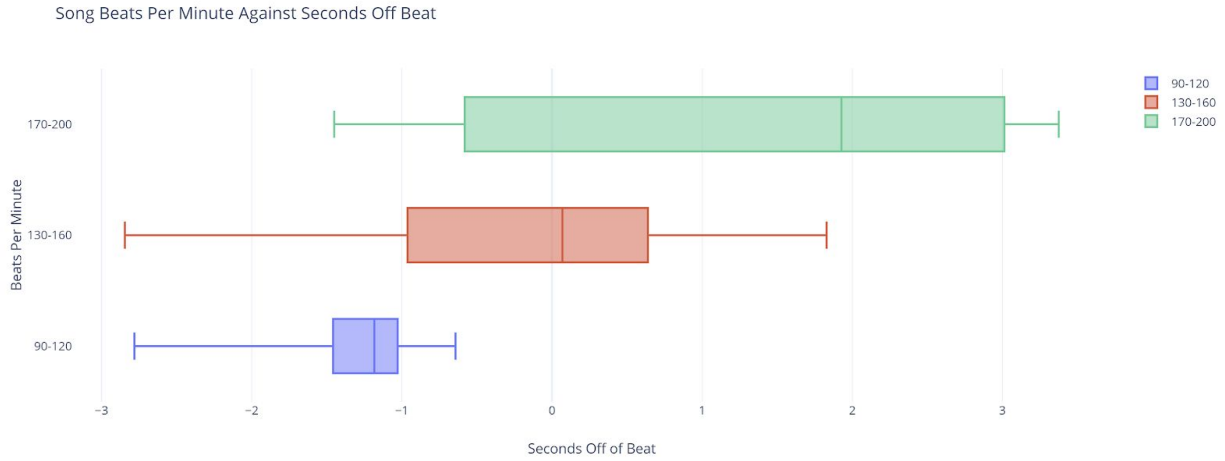
Introduction

I am a big fan of the online rhythm video game Osu. Osu, unlike other rhythm games that I've played, gathers a lot of player data on timing and accuracy. I want to improve my overall score on Osu levels, so I want to do an inference test to see if I perform better on levels with specific characteristics. I chose to see if my performances improved with higher or lower beats per minute or bpm. I couldn't base my accuracy off of the Osu score because the Osu score is weighted towards length of combos and not beat accuracy. In order to accurately measure my performance, I will calculate the average amount of time off the beat. For example, if I click one hundredth of a second early, it will be represented as -1. If I click one hundredth of a second late, it will be represented as 1.

Data

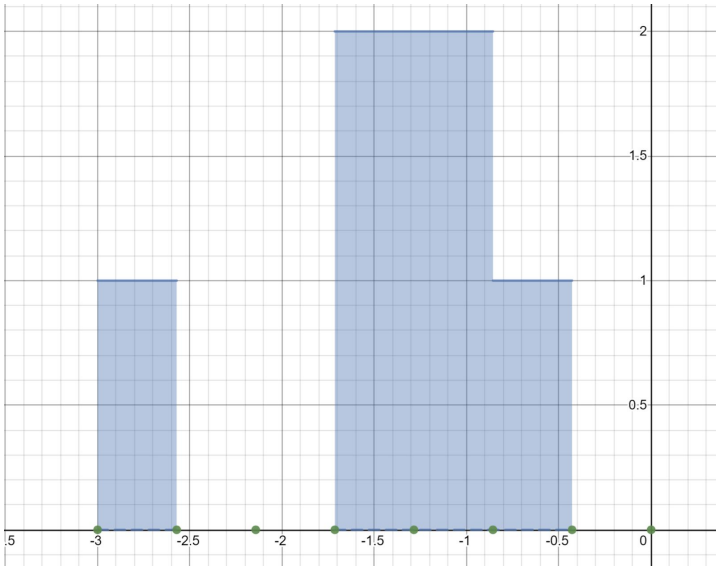
90-120 bpm	130-160 bpm	170-200 bpm
-1.0276	-2.84470	-0.636460
-0.64233	1.82910	-0.414720
-1.03280	0.56377	2.79030
-1.33280	0.66306	1.92780
-2.781	-1.05900	3.08770
-1.45810	-0.6701	-1.45030
n/a	0.0694410	3.37520

	n	$\bar{x}$	S_x
90-120 bpm	6	-1.21244	0.92697
130-160 bpm	7	-0.20692	1.49839
170-200 bpm	7	1.23993	2.01439

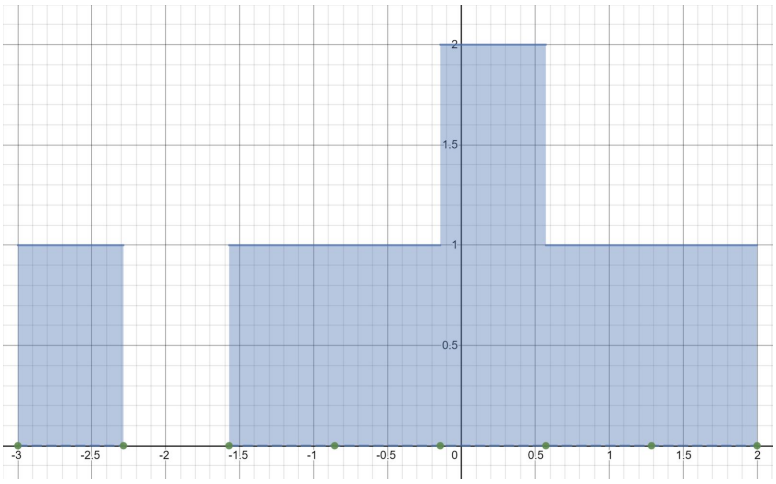


Histograms

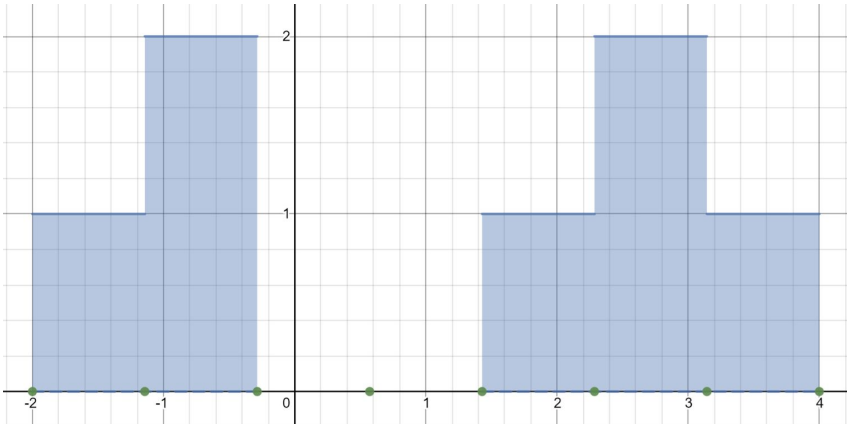
90-120 bpm



130-160 bpm



170-200bpm



Sampling Method

In order to gather my data I played 20 random songs of equivalent difficulty and grouped them into three groups, 90-120 bpm, 130-160 bpm, and 170-200 bpm. Since Osu is a fast paced game, there were fewer songs at 90-120 bpm, so the sample population is one lower than the other two sample populations. For each of the songs, I took the average time off from the actual beat and recorded it. I repeated this process for all of the songs and then organized the data into a box plot.

Inference Test/ Analysis

I. My populations of interest are all songs at the same difficulty on Osu with 90-120 bpm, 130-160 bpm, and 170-200 bpm. The parameters we wish to compare are μ_1, μ_2, and μ_3, the true mean time offbeat per song for songs between 90-120 bpm, 130-160 bpm, and 170-200 bpm respectively.

H_0: $\mu_1 = \mu_2 = \mu_3$

H_a: not all of the mean time offbeat for the different bpm groups are the same.

II. Because we wish to compare the means for three distinct populations, we will conduct an ANOVA test. The sample populations were sampled randomly, but not by SRS, so my calculations may not generalize to the populations of interest. There are more than 60 $(10 \times 6 = 10 \times n_1)$ songs in Osu with a bpm of 90-120, and more than 70 $(10 \times 7 = 10 \times n_2)$ songs in Osu with bpms between 130 and 160 and 170 and 200 so our sampling is independent so we can use the equation for standard deviation. The lowest standard deviation doubled is smaller than the largest standard deviation $(0.92697 \times 2 = 1.85394 < 2.01439)$ so our calculations may not be accurate. None of the populations are large $(n_1 = 6 \leq 30 \text{ and } n_2 = n_3 = 7 \leq 30)$ however, according to the histograms for all the populations, there is no strong skew and a vague mound shape. Therefore, the data are approximately normal and our calculations will be partially accurate.

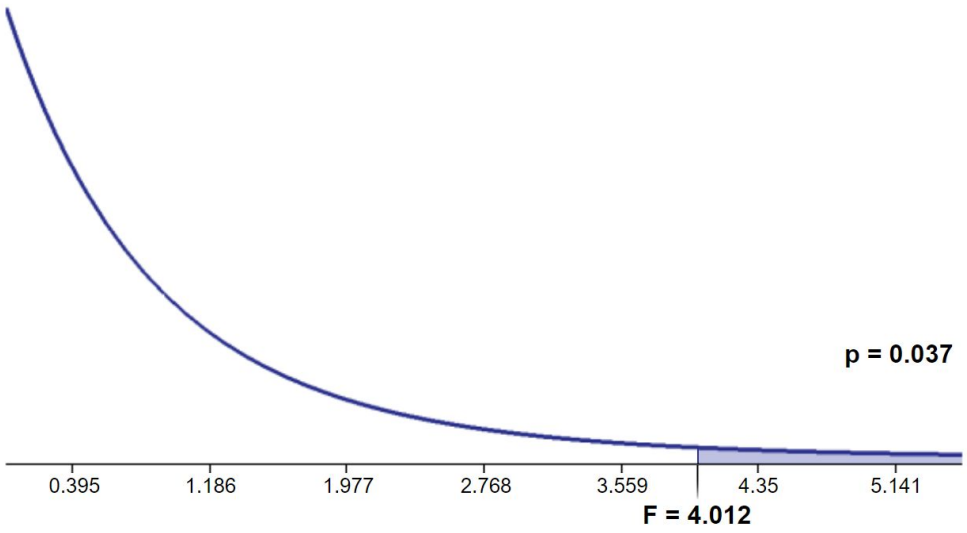
III. $\bar{X} = \frac{\Sigma \bar{x}_i \times n_i}{n_{total}} = \frac{(-1.21244 \times 6) + (-0.20692 \times 7) + (1.23993 \times 7)}{20} = -0.0021785$

$MSG = \frac{\Sigma n_i (\bar{x}_i - \bar{x})^2}{k-1} = \frac{6(-1.21244 - (-0.0021785))^2 + 7(-0.20692 - (-0.0021785))^2 + 7(1.23993 - (-0.0021785))^2}{3-1} = 9.940831$

$MSE = \frac{\Sigma (n_i - 1) s_i^2}{N-k} = \frac{(6-1)0.92697^2 + (7-1)1.49839^2 + (7-1)2.01439^2}{20-3} = 2.47729$

$F = \frac{MSG}{MSE} = \frac{9.940831}{2.47729} = 4.01279$

$df = F(k-1, N-k) = F(2, 17)$



p-value = 0.0373724

IV. Assuming H_o to be true, I'd get results like this about 4% of the time by random chance alone. Therefore, we reject H_o and have reason to believe that my accuracy on Osu beatmaps is affected by their bpms. This is of course, with concerns about calculations and sampling.

Conclusion

While my calculations seem to imply that my performance changes based on bpm, my calculations may not be accurate and my performances may be a lot more similar. If I were to repeat this experiment, I'd want to have larger sample sizes to minimize my standard deviations and make my calculations more accurate. I might also want to see if there are other things that affect my performance, such as the length of song.