Problem 1: Finding intra-condition differences

In this problem you are given three files containing heart rate measurements from three different conditions.

1. *a.csv*: Contains measurements from a group of individuals during relaxation
2. *b.csv*: Contains measurements from a group of individuals during slow walking
3. *c.csv*: Contains measurements from a group of individuals during fast walking

(a) Data visualization: Load the data and plot the corresponding histograms using 10, 20, and 30 bins. The x-axis of the histograms corresponds to heart rate values, while the y-axis corresponds to total number of samples. **Note:** Make sure to determine a common range of the x-axis across all conditions. **Hint:** Use the *numpy.histogram* and *matplotlib.pyplot.plot* functions.

(b) 1-sample t-test: Use a 1-sample t-test to identify potential significant differences between the relaxation condition and the average heart rate of 63 bpm. **Hint:** Use the *scipy.stats.ttest_1samp* function.

(c) 2-sample t-test: Use a 2-sample t-test and a Wilcoxon test to identify potential significant differences between: 1) relaxation and slow walking, 2) relaxation and fast walking, and 3) slow and fast walking. **Hint:** Use the *scipy.stats.ttest_ind* function.

(d) Paired 2-sample t-test: Assuming that the samples from the slow and fast walking conditions come from the same participants, use a paired 2-sample t-test to identify potential significant differences between the two conditions. **Hint:** Use the *scipy.stats.ttest_rel* function.

(e) ANOVA: Until now we have seen ways to identify significant differences between groups. Analysis of variance (ANOVA) allows us to identify significant differences for more than two conditions. Use a 1-way ANOVA to identify potential significant differences between the three conditions. **Hint:** Use the *scipy.stats.f_oneway* function.

Problem 2: Generating synthetic normal data

(a) Generation of data: Generate 40 samples from two normal distributions: 1) D_1: Mean = 60, Variance = 0.01; 2) D_2 : Mean = 65, Variance = 0.01. Plot the corresponding histograms. Use a 2-sample t-test to identify potential significant differences between the samples generated from the two distributions. **Hint:** Use the *np.random.normal* function.

(b) Changing variance: Change the variance of the second distribution D_2 to $\{0.1, 1, 10, 100\}$. For each new variance: 1) plot the histograms of the samples derived from distributions D_1 and D_2 at the same plot; 2) Use a 2-sample t-test to identify potential significant differences between the samples generated from the two distributions. What do you observe?