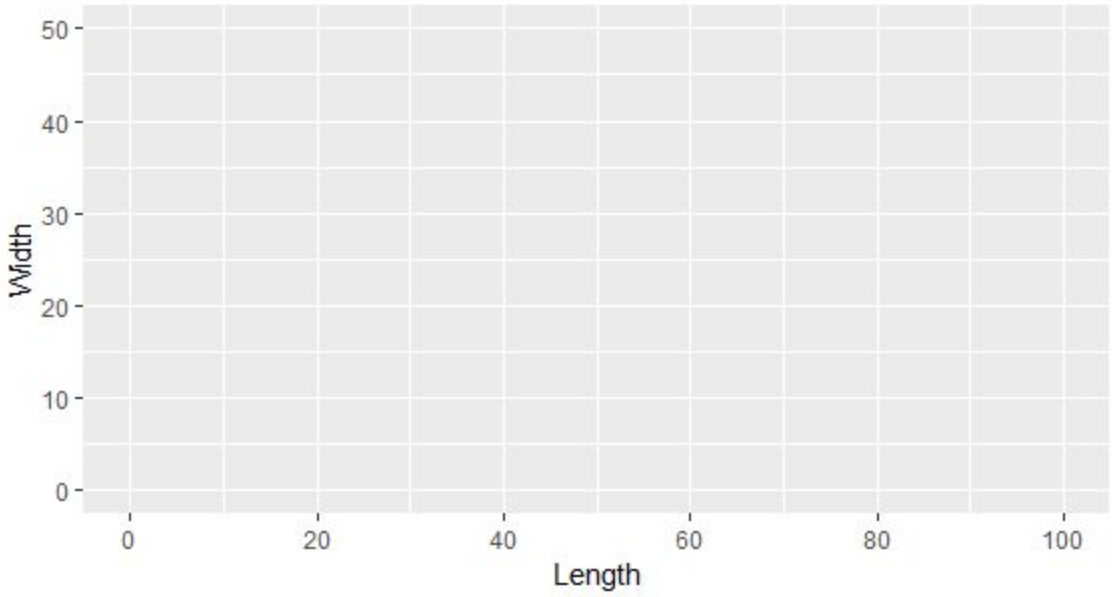
# Homework 3

**Due**: Tuesday 10/22, 5:30pm on Titanium. Prepare your answers as a single PDF file.
**Group work**: You may work in groups of 1-3. Include all group member names in the PDF file. Only one person in the group needs to submit to Titanium.

1. Consider the following dataset. (Note: do NOT write any code for this problem. The answers are to be computed by hand.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Length | 20 | 40 | 80 | 20 | 40 | 80 |
| Width | 20 | 20 | 20 | 40 | 40 | 40 |

a) Mark the data points on the graph below (use '+' to indicate each point).




b) Let k=2. Let one of the two initial centers be (Length=40, Width=20). Select the second center using the **Farthest Distance Heuristic**. Indicate the two centers on the graph (circle the centers).

c) Recompute the centers after the first iteration of the k-means algorithm.
New center 1:_____
New center 2:_____
Indicate the two new centers on the graph (mark new centers with squares).

d) What are the two clusters after this first iteration? Draw two ovals, each containing all the points in one cluster in the graph above.

e) Will the k-means algorithm terminate after this first iteration or will it continue? Answer in 1-2 sentences.

f) If a new point (Length=50, Width=25) is given, to which cluster will it belong?

**2.** Consider the attached file `breast-cancer-wisconsin.csv` which contains "Features computed from a digitized image of a fine needle aspirate (FNA) of a breast mass."[1] The goal is to automatically cluster the data based on the features to distinguish Benign and Malignant cases.

a. Load the data. Column 1 ("Code") is the anonymized subject code and will not be used here. Columns 2-10 are the 9 features. Column 11 is the diagnosis: [B]enign or [M]alignant.
   i. How many total cases are there in the data?: ___
   ii. How many [B]enign cases are there in the data?: ___
   iii. How many [M]alignant cases are there in the data?: ___

b. Run the k-means clustering algorithm using all the rows and all the 9 features. Use k=2, nstart=10.
   ~~i. What should be the value of k? k = ___~~ (already given)
   ii. Give R code:

c. Evaluation: Compare the resulting clusters with the known diagnosis .
   i. What is the contingency table of your clustering? (Note: you can arbitrarily assign cluster 1/2 to Benign/Malignant)

**3.** The goal is to evaluate three classifiers intending to identify gender (male/female) given the height and weight. The evaluation is to be based on the following dataset with 5 instances:

| Gender | Height (cm) | Weight (kg) |
|---|---|---|
| Male | 148 | 60 |
| Male | 149 | 66 |
| Female | 150 | 60 |
| Male | 151 | 62 |
| Male | 161 | 72 |

[1]Original dataset from Breast Cancer Wisconsin (Diagnostic) Data Set
https://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+(Diagnostic)

The three classifiers to be evaluated are:
C1: "*Everyone is male*"
C2: "*Anyone with height over 150cm is male; all others are female*"
C3: Classify using a 1-nearest neighbor classifier trained on the following dataset:

| | | |
|---|---|---|
| Male | 148 | 65 |
| Female | 149 | 61 |
| Male | 160 | 70 |

Calculate the following metrics for the classifiers

- Accuracy
- Error rate
- Precision of identifying males
- Recall of identifying males
- F1-score of identifying males

Note: do NOT write any code for this problem. The answers are to be computed by hand.

Complete the following table with your answers.

| Classifier | Accuracy | Error rate | Precision | Recall | F1-score |
|---|---|---|---|---|---|
| C1 | | | | | |
| C2 | | | | | |
| C3 | | | | | |

Hint: It is easiest to first complete a table with predictions:

| **Gender** | **Height (cm)** | **Weight (kg)** | **Predicted (C1)** | **Predicted (C2)** | **Predicted (C3)** |
|---|---|---|---|---|---|
| Male | 148 | | | | |
| Male | 149 | | | | |
| Female | 150 | | | | |
| Male | 151 | | | | |
| Male | 161 | | | | |