T1. What is the accuracy of Model A?

ANS:

Accuracy = Correct Pred / Total = 70/100 = 0.7

T2. Consider cats as 'class 1' (positive) and dogs as 'class 0' (negative), calculate the precision, recall, and F1.

ANS:

TP = 40, TN = 30, FP= 20 , FP = 20, FN = 10

Precision = TP / (TP + FP) = 40/60 = 0.67

Recall = TP/ (TP + FN) = 40/50 = 0.8

F1 = 2 * (Precision * recall) / (Precision+Recall) = 0.729

T3. Consider class cat as 'class 0' and class dog as 'class 1', calculate the precision, recall, and F1.

ANS:

TP = 30, TN = 40, FP= 20 , FP = 10, FN = 20

Precision = TP / (TP + FP) = 30/40 = 0.75

Recall = TP/ (TP + FN) = 30/50 = 0.6

F1 = 2 * (Precision * recall) / (Precision+Recall) = 0.67

T4. Now consider a lopsided population where there are 80% cats. What is the accuracy of Model A? Using dog as the positive class, what is the precision, recall, and F1? Explain how and why these numbers change (or does not change) from the previous questions.

ANS:

Consider Actual 80 Cats and 20 Dogs, And the prediction rate still the same

TP= 20 * 0.6 (rate of correctly identify dog) = 12, TN = 80 * 0.8 (rate of correctly identify cat) = 64,

FP = 80 – 64 = 16, FN = 20 - 12 = 8

Accuracy = 0.76, Precision = 0.43, Recall = 0.6, F1 = 0.5

Accuracy increase as this model is better at identifying cat, increasing number of cats would make the weight better, resulting in more accuracy

Precision drop heavily from this imbalance, with more cats, the false positive overwhelm the calculation

Recall only relate to dog identification, which stay the same throughout the change,

OT1. Consider the equations for accuracy and F1

ANS:

Using given equation we can rewrite both equation for comparison as

ACC = TP + (TN) / TP + (TN) + FP + FN

F1 = TP + (TP) / TP + (TP) + FP + FN

The only different in F1and F1 would be the TP and TN

If TP == TN : Then ACC = F1

If TP > TN: Then ACC < F1

If TP < TN: Then ACC > F1

So ACC will be equal to F1 when TP == TN

ACC will be less than F1 when TP > TN

ACC will be more than F1 when TP < TN

The code relate to T5-T7, OT2 will be after this section's text answer

T5. If the starting points are (3,3), (2,2), and (-3,-3). Describe each assign and update step. What are the points assigned? What are the updated centroids? You may do this calculation by hand or write a program to do it.

ANS: Output cell in the code section

T6. If the starting points are (-3,-3), (2,2), and (-7,-7), what happens?

ANS: Output cell in the code section

T7. Between the two starting set of points in the previous two questions,

which one do you think is better? How would you measure the 'goodness' quality

of a set of starting points?

ANS:

From the result in T5 and T6 , without any visulization or standard method, T6 might look better from it's minimal iteration with only 2 iterations until convergence while T5 require 3 iterations, showing that the starting position is already close to a centroid

Using more standardize method to actually measure 'goodness' we can use Within-Cluster Sum of Squares (WCSS), Silhouette Score, Inter-Cluster Distance, Average Distance from Centroid. All of the measure are implement is code section, the result are below.

WCSS: Showing how each point are close to their centroid, the lower the better. T5 gives 29.33 and T6 gives 77.83, Showing that T6 Cluster is more fuzzy than T5

Silhouette Score: Showing how close it is to their centroid compare to other centroid, closer to 1 is better, -1 is worst. T5 gives 0.67 and T6 gives 0.5, Showing that T5 is giving more compact and distict clustering.

Inter-Cluster Distance: Showing how far it is from other centroid, higher mean clusters are seperated well. T5 and T6 give the same number at around 10.7-10.9

Average Distance from Centroid: Same as WCSS but interpret directly. T5 gives 1.47 and T6 gives 2.44, showing that on average T6 point is position farer than T5.

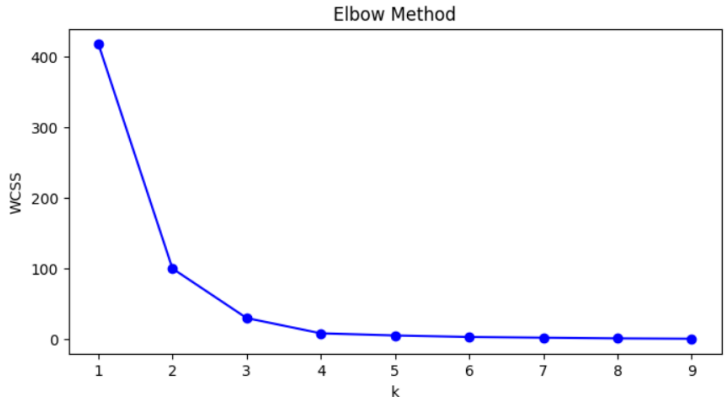
From standardize result, we can see that T5 starting centroid is significantly better than T6.

Ultimately, the starting centroid should also depend on the bussiness use cases by selecting the centroids that would show expected insight from bussiness views.

OT2. What would be the best K for this question? Describe your reasoning.

ANS:

We can determine the beat K using elbow method. The code for elbow method is in code section



We can select k to be around 3 or 4 for optimal k.

The code relate to T8-T11, OT 3-4 will be after this section's text answer

T8. What is the median age of the training set? You can easily modify the age in the dataframe by

ANS: 24

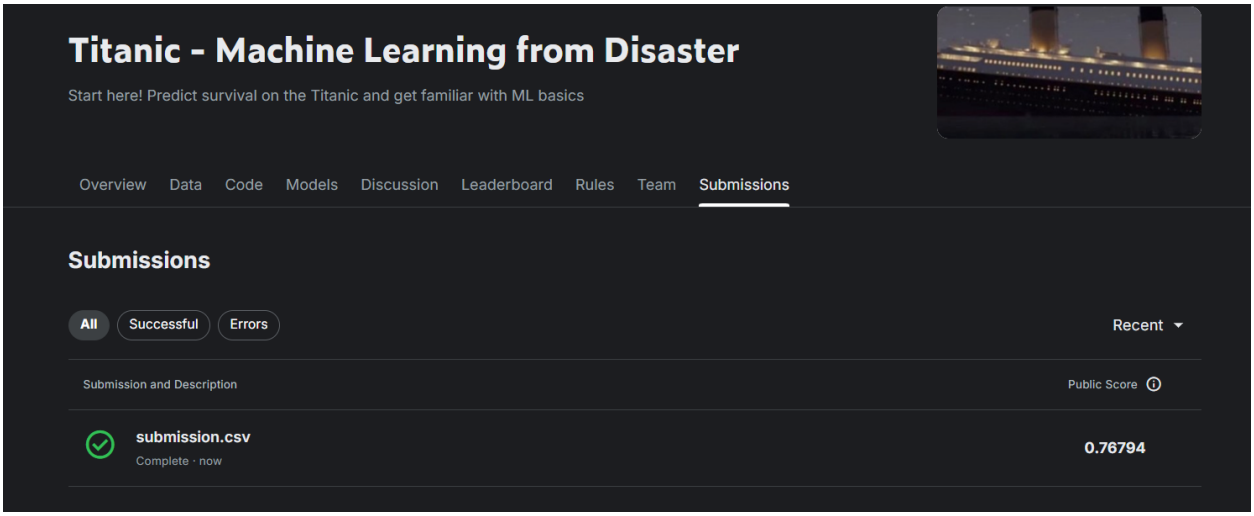
T9. Some fields like 'Embarked' are categorical. They need to be converted to numbers first. We will represent S with 0, C with 1, and Q with 2. What is the mode of Embarked? Fill the missing values with the mode

T10.. Write a logistic regression classifier using gradient descent as learned in class. Use PClass, Sex, Age, and Embarked as input features.

ANS: I implemented T9-T10 in code section (see code section), The accuracy on training is 79.69%

T11. Submit a screenshot of your submission (with the scores). Upload your code to courseville.

ANS: Test score is 76.79%



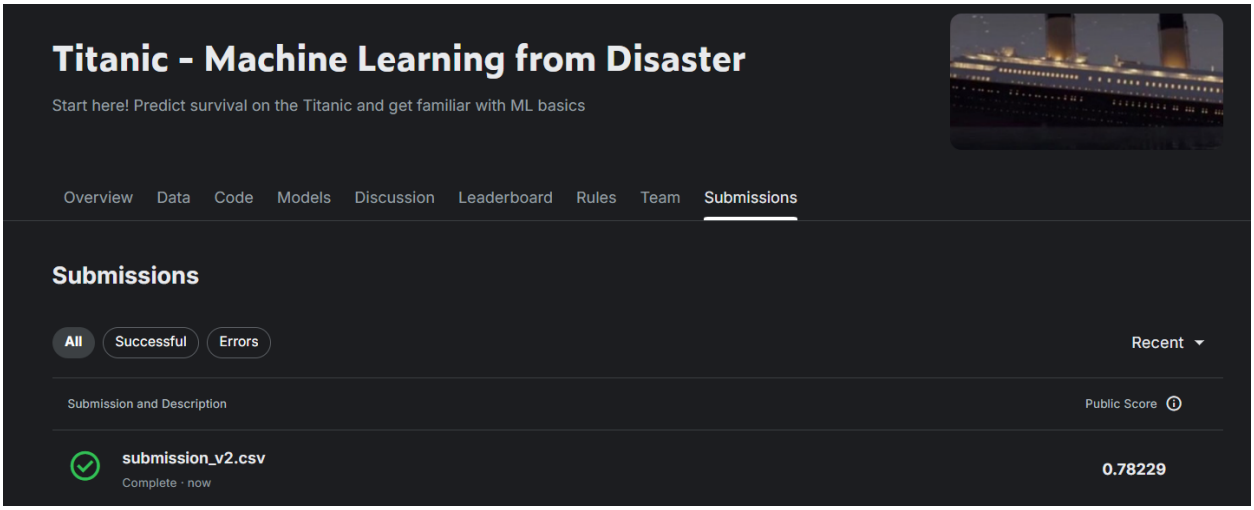
T12. Try adding some higher order features to your training (x21, x1x2,...).

Does this model has better accuracy on the training set? How does it

perform on the test set?

ANS: The code for this version will be shown after this text answer (only change in model and predict part)

The accuracy on training set is 82.15%, slightly better than non-higher order data.



Test data accuraccy is also higher at 78.23%

T13. What happens if you reduce the amount of features to just Sex and

Age?

ANS: The code for this version will be shown after this text answer (only change in model and predict part)

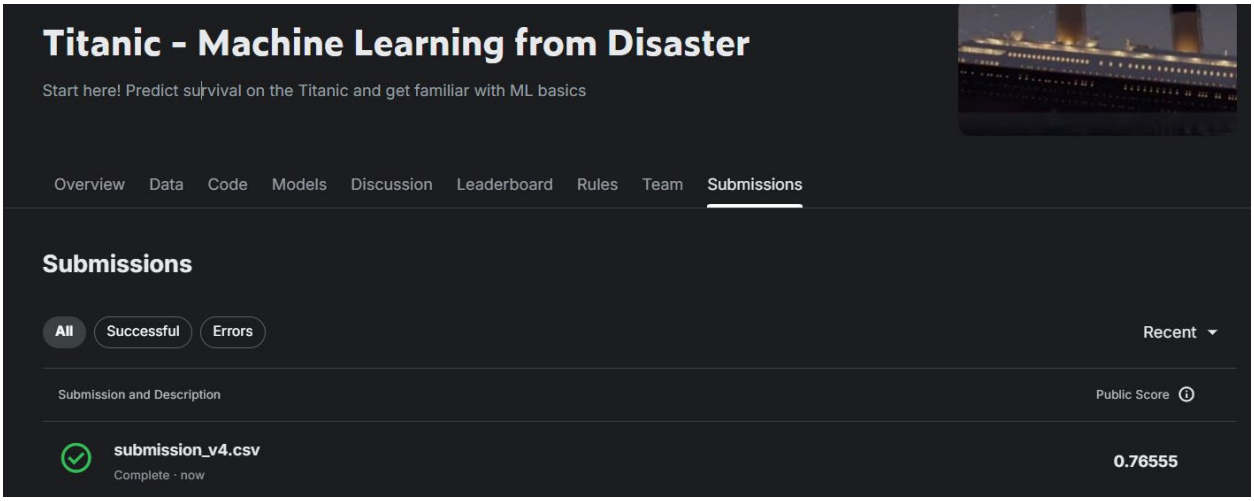
The accuracy on training set is 78.68%%, slightly better than normal bur lower than higher order data.

But the test result is worst than normal case, only 76.55%

OT3. We want to show that matrix inversion yields the same answer as the gradient descent method. However, there is no closed form solution for logistic regression. Thus, we will use normal linear regression instead. Re-do the Titanic task as a regression problem by using linear regression. Use the gradient descent method.

ANS: The code for this version will be shown after this text answer (only change in model and predict part)

The accuracy on training set is 78.68%



The test result is the same as only using age and sex, only 76.55%

OT4. Now try using matrix inversion instead. However Are the weights learned from the two methods similar? Report the Mean Squared Errors (MSE) of the difference between the two weights.

ANS:

```
theta_matrix = np.linalg.inv(X_b.T.dot(X_b)).dot(X_b.T).dot(y)

print("Theta (Gradient Descent):", theta)
print("Theta (Matrix Inversion):", theta_matrix)

weight_mse = np.mean((theta - theta_matrix) ** 2)
print(f"\nMSE of the weight difference: {weight_mse}")
```

✓ 0.0s

```
Theta (Gradient Descent): [ 1.02648941 -0.94338079  2.53270066 -0.01848152  0.31728152]
Theta (Matrix Inversion): [ 0.76512686 -0.18828708  0.49299994 -0.00478358  0.04513561]

MSE of the weight difference: 0.9746213905435914
```

OT5-OT7 will be prove in hand writing below