Homework 3 (4%)
Generative Classification Models

The goal of this homework is to provide you a chance to get familiar with the basic procedure in constructing and evaluating classifiers. You will implement a binary generative classification model based on the maximum likelihood solution in Section 4.2.2 and evaluate the classification performance using 10-fold cross-validation.

We use the ldpa30_train dataset in this homework. Since we are modeling our data using a binary classification model, the outcome need to be preprocessed. For a given week_index, sort the data points according to week_return1 and assign the data points with top 6 week_return1 with outcome 1. The outcome for the remaining data points are 0. By doing so, we have 6/30=20% of data points with outcome 1 and 80% of data points with outcome 0.

Your classifier takes the input features, including alpha, beta_mkt, beta_hml, beta_smb, and sigma, and output the outcome value that you generated in the pre-processing step. You may consider enrich your input features by shifting the values or applying some types of transformations.

Use the 10-fold classification procedure to evaluate your classifier. Sort your dataset in a random order and divide it into 10 bins. Use data points from 9 of the 10 bins to train your model and compute performance using data points from the remaining bin. You should report the performance of individual testing bins as well as the mean and standard deviation of the 10 figures.

For classification performance, you should compute accuracy, precision, recall, and F-measure. The definitions are listed below.

For classification tasks, the terms **true positives**, **true negatives**, **false positives**, and **false negatives** compare the results of the classifier under test with trusted external judgments. The terms *positive* and *negative* refer to the classifier's prediction (sometimes known as the *expectation*), and the terms *true* and *false* refer to whether that prediction corresponds to the external judgment (sometimes known as the *observation*). This is illustrated by the table below:

		actual class (observation)
predicted class (expectation)	**tp** (true positive) Correct result	**fp** (false positive) Unexpected result
	fn (false negative) Missing result	**tn** (true negative) Correct absence of result

Precision, recall, and accuracy are then defined as:

$$precision = \frac{tp}{tp + fp}$$

$$recall = \frac{tp}{tp + fn}$$

$$accuracy = \frac{tp + tn}{tp + tn + fp + fn}$$

F-measure is the harmonic mean of precision and recall. We use the traditional F-measure or balanced F-score here:

$$F = 2\frac{precision \cdot recall}{precision + recall}$$

You will need to turn in your code and a report that summarize your findings.