Q1 Provide responses to the following questions about the dataset.

1. ***How many instances does the dataset contain?***
   110 instances

2. ***How many input attributes does the dataset contain?***
   7 attributes (height ,weight ,beard ,hair_length ,shoe_size ,scarf ,eye_color)

3. ***How many possible values does the output attribute have?***
   2 (Male ,Female)

4. ***How many input attributes are categorical?***
   4 attributes (beard, hair_length, scarf, eye_color)

5. ***What is the class ratio (male vs female) in the dataset?***
   No.of male/no.of female = 62/48 = 31:24 = 1.3

Q2: Apply Logistic Regression, Support Vector Machines, and Multilayer Perceptron classification algorithms (using Python) on the gender prediction dataset with 2/3 train and 1/3 test split ratio and answer the following questions.

1. ***How many instances are incorrectly classified?***
   Accuracy (may vary in python ; dur to rerun the python code)
   MLP Accuracy: 81.08108108108108
   SVC Accuracy: 75.67567567567568
   LR Accuracy: 86.48648648648648
   Confusion Matrix of above given Accuracy:
   MLP Confusion_matrix:
   [[0 18]
   [0 19]]
   SVC Confusion_matrix:
   [[12 6]
   [3 16]]
   LR Confusion_matrix:
   [[13 5]
   [0 19]]
   Incorrectly Classified Instances:
   MLP : 18
   SVM : 9
   LR : 5

   - These all are found through python code.(given in attached python file)

2. ***Rerun the experiment using train/test split ratio of 80/20. Do you see any change in the results? Explain.***
   Increasing the training data size (80/20 split) generally leads to better model performance, as the models have more data to learn from. This is evident in the improved accuracy scores for all three models.

3. ***Name 2 attributes that you believe are the most "powerful" in the prediction task. Explain why?***

Attributes: beard & scarf
Beard – The presence or absence of a beard can be strongly associated with gender. In many cultures, facial hair, such as a beard, is often a characteristic more commonly associated with males. If the dataset exhibits a clear correlation between the presence of a beard and male gender, 'beard' could be a powerful predictor.
Scarf - The 'scarf' attribute might be associated with female gender, especially in certain cultural contexts where scarves are more commonly worn by females. If the dataset shows a distinct pattern where the presence of a scarf correlates with female gender, 'scarf' could be a powerful predictor.

4. ***Try to exclude these 2 attribute(s) from the dataset. Rerun the experiment (using 80/20 train/test split), did you find any change in the results? Explain.***
   In this comparison, we observe there is a significant change in accuracy after removing the 'beard' and 'scarf' attributes. Decreases accuracy, changes feature importance, makes handling ambiguous cases more difficult.The accuracy drops noticeably, it suggests that these attributes were contributing valuable information to the models. Decreases accuracy, changes feature importance, makes handling ambiguous cases more difficult.

Q3: Apply Random Forest classification algorithm (using Python) on the gender prediction dataset with Monte Carlo cross-validation and Leave P-Out cross-validation. Report F1 scores for both cross-validation strategies.

Kfolds – folds =10
Leave_p_out – lpo = 1
KFolds : [1.0, 0.923076923076923, 1.0, 1.0, 1.0, 0.9333333333333333, 1.0, 0.9333333333333333, 1.0, 1.0]
Mean: 0.98663
Leave_p_out : [1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 0. 1. 1. 1.1. 1. 1. 1. 0. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.1. 1. 1. 1. 1. 1. 1. 0. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
Mean: 0.9727272727272728

Q4: Add 10 sample instances into the dataset (you can ask your friends/relatives/sibling for the data). Run the ML experiment (using Python) by training the model using Gaussian Naïve Bayes classification algorithm and all the instances from the gender prediction dataset. Evaluate the trained model using the newly added 10 test instances. Report accuracy, precision, and recall scores.

New sample data:

```
new_sample_height =
[70,69,72,70,69,60,74,72,69,62]
new_sample_weight =
[175,174,170,172,171,160,169,169,174,130]
```

```
new_sample_beard                                                =
['no','yes','no','no','no','no','no','no','no','no']
new_sample_hairlength                                           =
['medium','short','short','short','short','long','short','short','medi
um','long']
new_sample_shoesize =
[40,41,42,43,40,37,45,42,44,38]
new_sample_scarf                                                =
['no','no','no','no','no','yes','no','no','no','yes']
new_sample_eyecolor                                             =
['brown','black','brown','gray','brown','brown','black','black','brown
','gray']
new_sample_out                                                  =
['female','male','male','male','male','female','male','male','male','f
emale']
Accuracy: 90.0
Precision: 0.9125
Recall score: 0.9
```