AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Science and Technology

Assignment Cover Sheet

Assignment Title:	Data Warehousing and Data Mining Final Project		
Assignment No:	Click here to enter text.	Date of Submission:	7 November 2022
Course Title:	Data Warehousing and Data Mining		
Course Code:	CSC4285	Section:	E
Semester:	Summer 2021-22	Course Teacher:	Akinul Islam Jony

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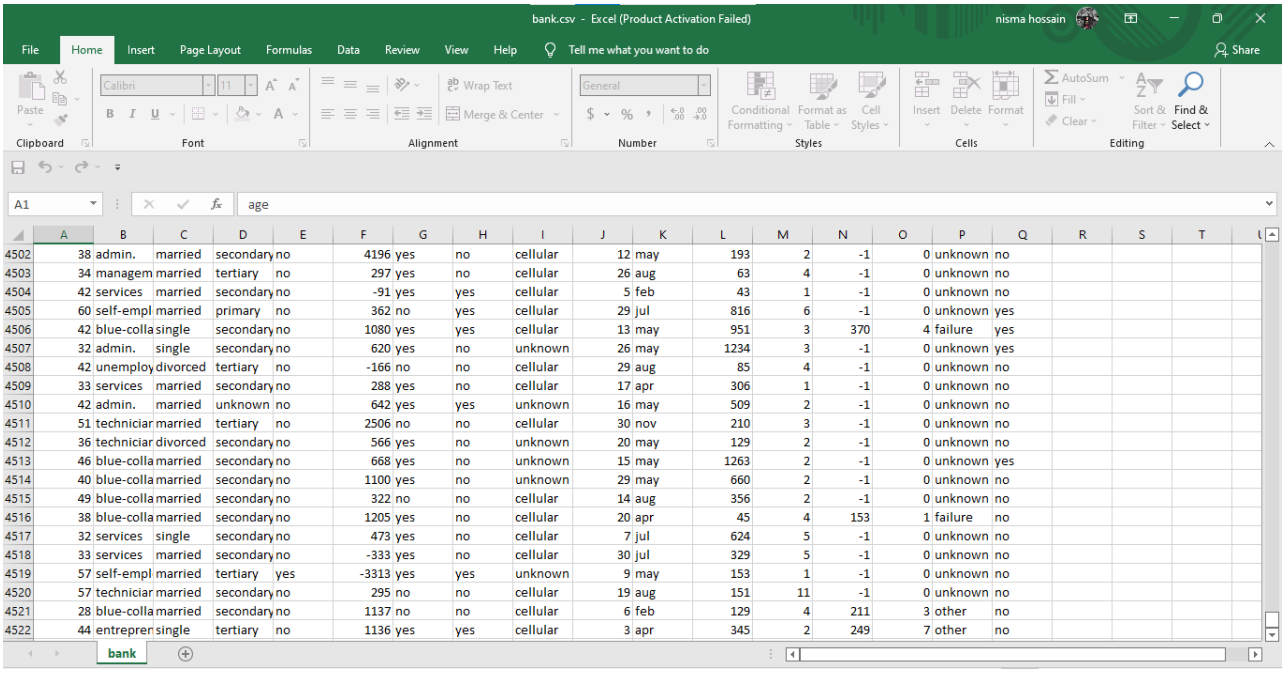
Project Overview:

Extraction of interesting (non-trivial, implicit, previously unknown, and potentially helpful) patterns or information from huge amounts of data is what data mining (knowledge discovery from data) is all about. Data mining is used in many different industries, including business and research. Data mining is a comprehensive field in computer science and statistics that aims to extract information from data sets and structure it for subsequent use. k-NN, Naive Bayes, and Decision Tree are examples of classification algorithms used in data mining.

Bank Marketing Dataset is the dataset we've picked for our project's classification application. This dataset was obtained from the www.kaggle.com website. The data is related to direct marketing campaigns of a Portuguese banking institution. The marketing campaigns were based on phone calls. Often, more than one contact with the same client was required, in order to access if the product (bank term deposit) would be ('yes') or not ('no') subscribed.

Dataset Overview:



	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previous	poutcome	y
4502	38	admin.	married	secondary	no	4196	yes	no	cellular	12	may	193	2	-1	0	unknown	no
4503	34	managem	married	tertiary	no	297	yes	no	cellular	26	aug	63	4	-1	0	unknown	no
4504	42	services	married	secondary	no	-91	yes	yes	cellular	5	feb	43	1	-1	0	unknown	no
4505	60	self-empl	married	primary	no	362	no	yes	cellular	29	jul	816	6	-1	0	unknown	yes
4506	42	blue-colla	single	secondary	no	1080	yes	yes	cellular	13	may	951	3	370	4	failure	yes
4507	32	admin.	single	secondary	no	620	yes	no	unknown	26	may	1234	3	-1	0	unknown	yes
4508	42	unemploy	divorced	tertiary	no	-166	no	no	cellular	29	aug	85	4	-1	0	unknown	no
4509	33	services	married	secondary	no	288	yes	no	cellular	17	apr	306	1	-1	0	unknown	no
4510	42	admin.	married	unknown	no	642	yes	yes	unknown	16	may	509	2	-1	0	unknown	no
4511	51	technician	married	tertiary	no	2506	no	no	cellular	30	nov	210	3	-1	0	unknown	no
4512	36	technician	divorced	secondary	no	566	yes	no	unknown	20	may	129	2	-1	0	unknown	no
4513	46	blue-colla	married	secondary	no	668	yes	no	unknown	15	may	1263	2	-1	0	unknown	yes
4514	40	blue-colla	married	secondary	no	1100	yes	no	unknown	29	may	660	2	-1	0	unknown	no
4515	49	blue-colla	married	secondary	no	322	no	no	cellular	14	aug	356	2	-1	0	unknown	no
4516	38	blue-colla	married	secondary	no	1205	yes	no	cellular	20	apr	45	4	153	1	failure	no
4517	32	services	single	secondary	no	473	yes	no	cellular	7	jul	624	5	-1	0	unknown	no
4518	33	services	married	secondary	no	-333	yes	no	cellular	30	jul	329	5	-1	0	unknown	no
4519	57	self-empl	married	tertiary	yes	-3313	yes	yes	unknown	9	may	153	1	-1	0	unknown	no
4520	57	technician	married	secondary	no	295	no	no	cellular	19	aug	151	11	-1	0	unknown	no
4521	28	blue-colla	married	secondary	no	1137	no	no	cellular	6	feb	129	4	211	3	other	no
4522	44	entrepren	single	tertiary	no	1136	yes	yes	cellular	3	apr	345	2	249	7	other	no

Figure 1: Bank Marketing Dataset

The dataset has a total of 17 attributes and 4522 instances. The sample of the figure has shown above and for the whole dataset please go to https://www.kaggle.com/datasets/hariharanpavan/bank-marketing-dataset-analysis-classification

Attributes:

Age -Age of customer

Job- Job of customer

Martial- Martial status of customer

Education- Customer education level

Default- Has credit in default?

Housing- If the customer has a housing loan

Loan -Has Personal Loan

Balance- Customer's individual balance

Contact- Communication type

Month- Last contact month of the year

Day- Last contact day of the week

Duration- Last contact duration, in seconds

Campaign- Number of contacts performed during this campaign and for this client

P days - Number of days that passed by after the client was last contacted from a previous campaign

Previous- Number of contacts performed before this campaign and for this client

Poutcome- the outcome of the previous marketing campaign

Y -has the client subscribed to a term deposit (yes/no)

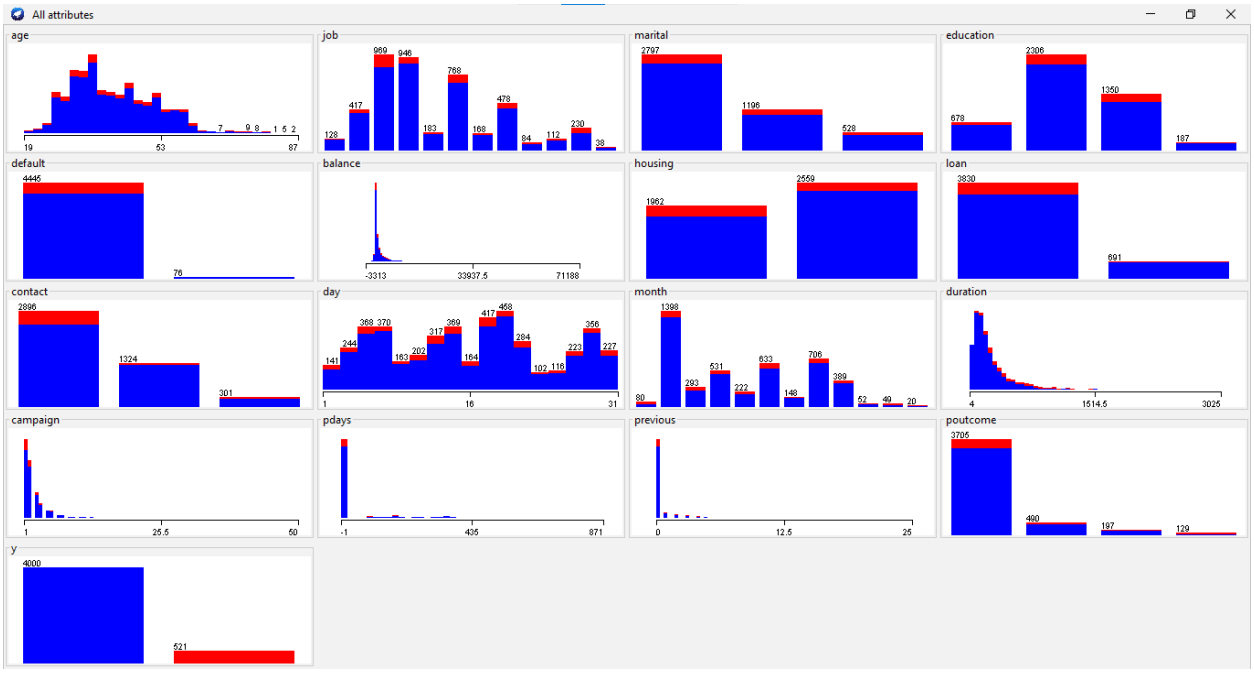


Figure 2: Visualization of all attributes

Model Development:

Classification is one form of prediction which occurs very frequently in everyday life. Essentially it involves dividing up objects so that each is assigned to one of a number of mutually exhaustive and exclusive categories known as classes. If the designated attribute is categorical, the task is called classification. In classification, there are many classifiers.
For our project, we need to develop 3 classifier models and compare them which is better for our dataset. The classifiers are Naive Bayes, Decision tree, and k-NN (nearest neighbor).

Naive Bayes:

Naive Bayes is a method of classification that uses probability theory to find the most likely of the possible classifications. It is dependent on categorical attributes for all attributes. The Naive Bayes algorithm combines the prior probability and conditional probabilities in a single formula. The Naive Bayes algorithm is comparatively easy to build and apply.

Process:

For Naive Bayes first task is to convert all the attributes to nominal. then from the **weka** tool, we need to select the naive Bayes from the classifiers.

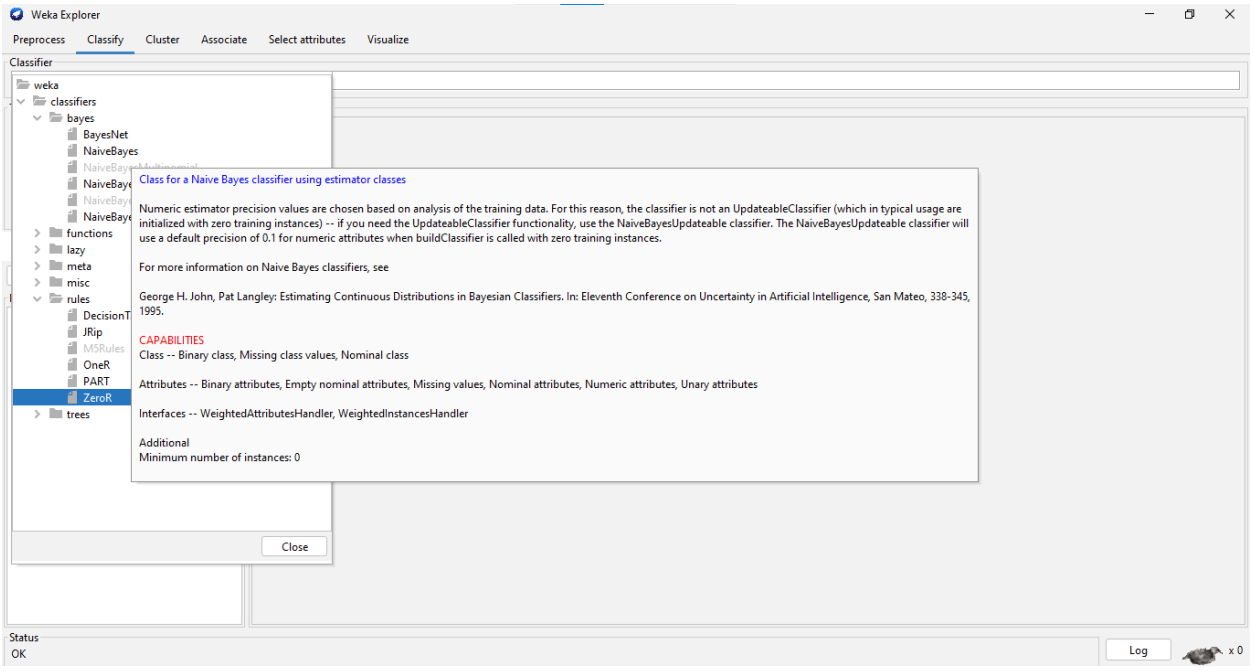


Figure 3: Naive Bayes selection

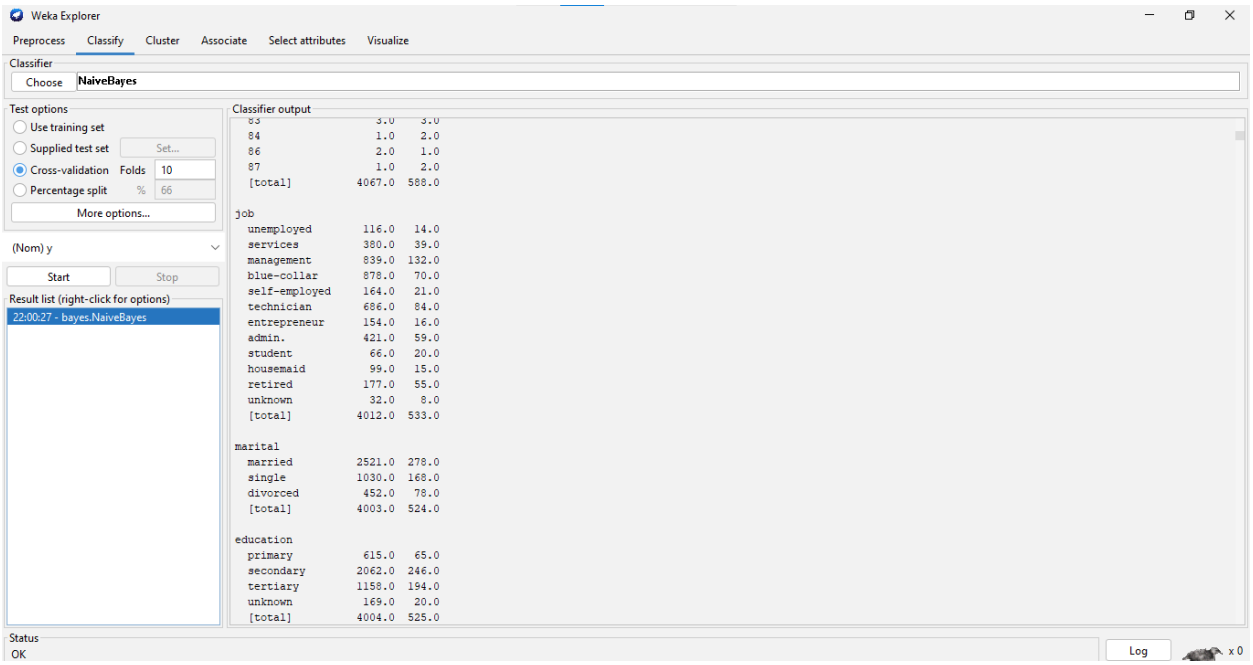


Figure 4: Naive Bayes results

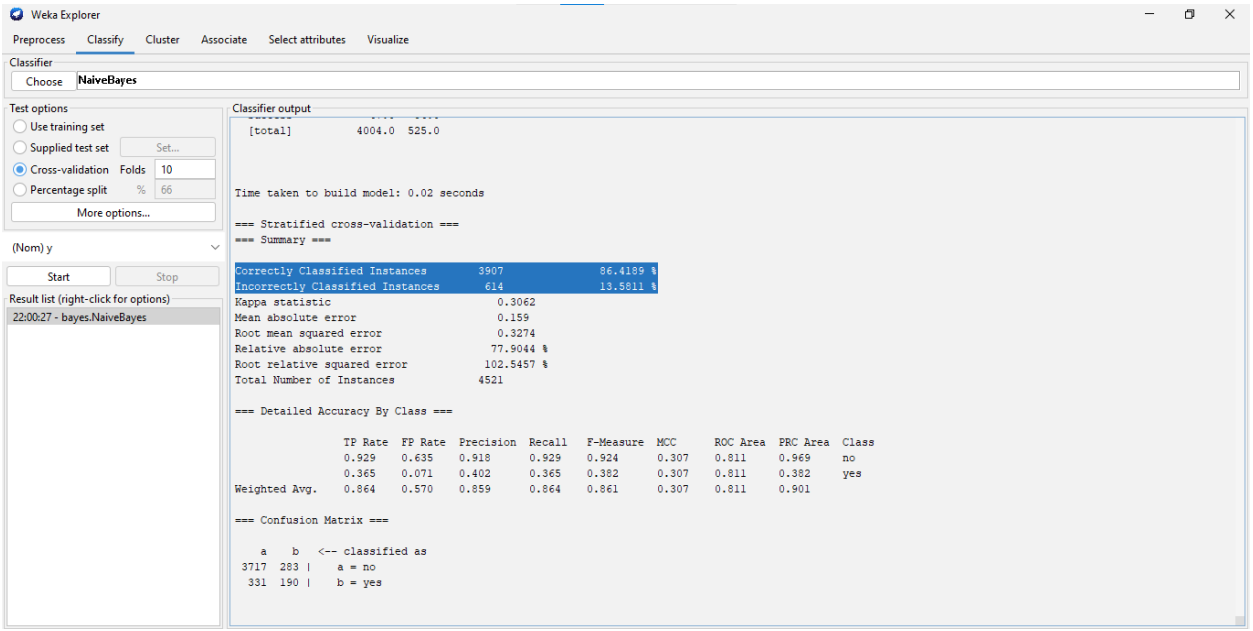


Figure 5: Naive Bayes results (correctly, incorrectly classified instances)

Results:

Time is taken to build the model: 0.02 seconds

Correctly Classified Instances	3907	86.4189 %
Incorrectly Classified Instances	614	13.5811 %

=== Confusion Matrix ===

a	b	<-- classified as
3717	283	a = no
331	190	b = yes

Nearest Neighbor(k-NN):

Nearest Neighbor classification is mainly used when all attribute values are continuous, although they can be modified to deal with categorical attributes. It is usual to base the classification on those of the k nearest neighbors (where k is a small integer such as 3 or 5), not just the nearest one. The method is then known as k-Nearest Neighbor or just k-NN classification.

Process:

For k-NN we need to choose IBk from the weka tool lazy folder. Then apply that

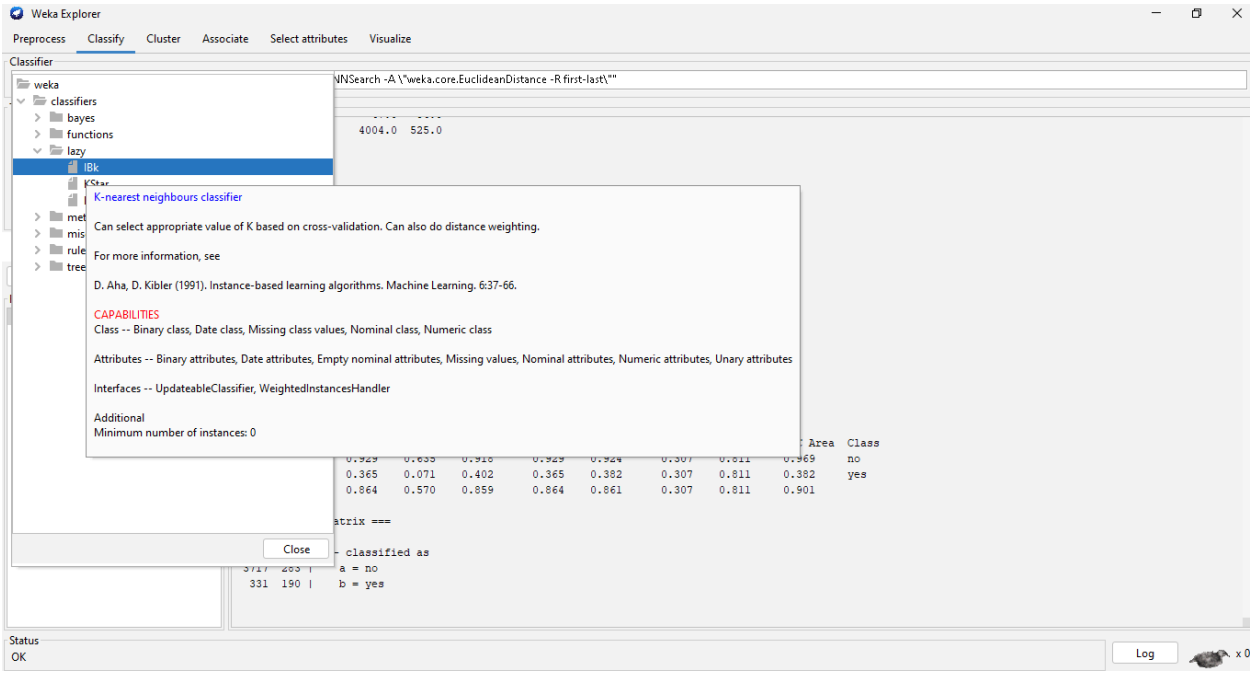


Figure 6: k-NN selection

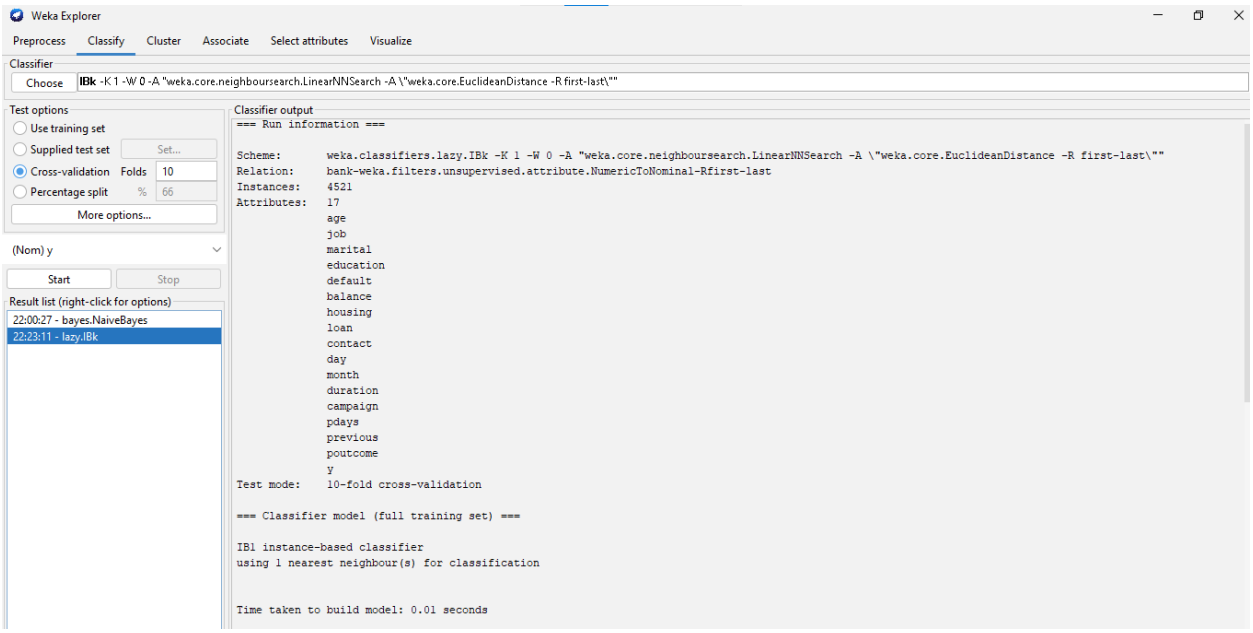


Figure 7: k-NN results

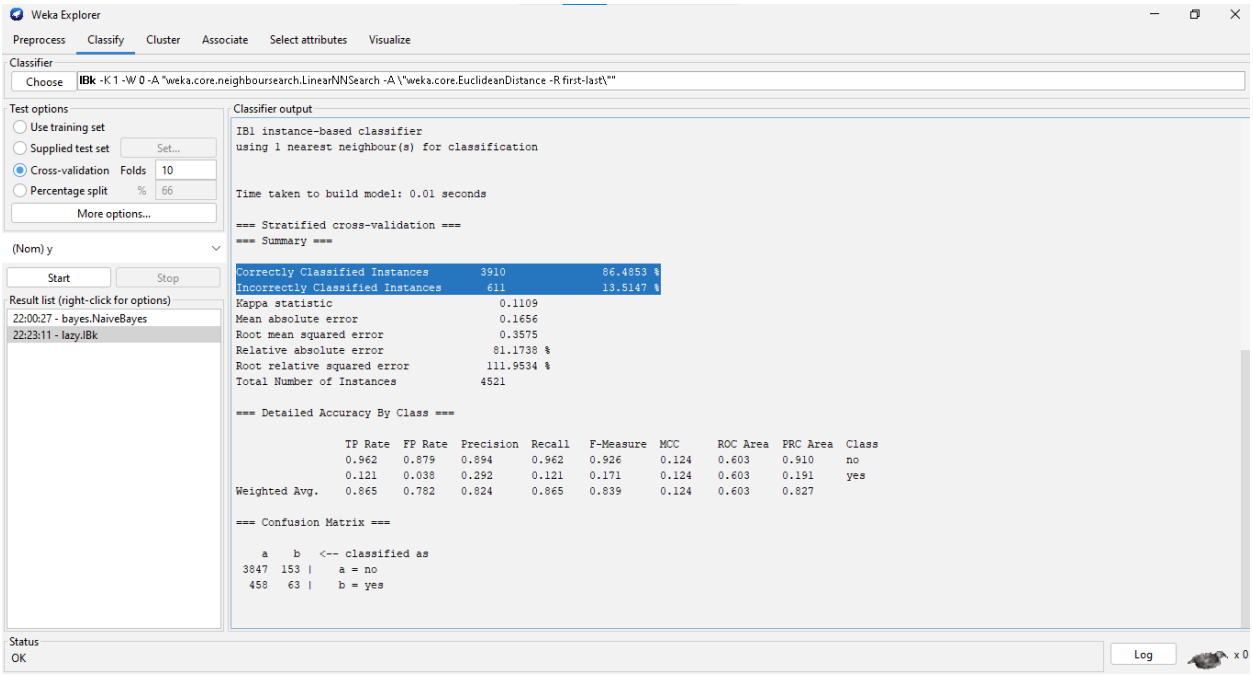


Figure 8: k-NN (correctly, incorrectly classified)

Results:

Time is taken to build the model: 0.01 seconds

Correctly Classified Instances	3910	86.4853 %
Incorrectly Classified Instances	611	13.5147 %

=== Confusion Matrix ===

a	b	<-- classified as
3847	153	a = no
458	63	b = yes

Decision tree:

The Decision Tree classification approach consists of three components: the root node, the branch (edge or link), and the leaf node. The root node contains the test condition for various attributes, the branch node represents all possible outcomes in the test, and the leaf nodes contain the label of the class to which it belongs. The root node is located at the beginning of the tree, often known as the tree's top.

J48 is an algorithm used by C4.5 to create a decision tree (an extension of ID3). It is often referred to as a statistical classifier. To use the j48 decision tree, we must now perform the following procedures.

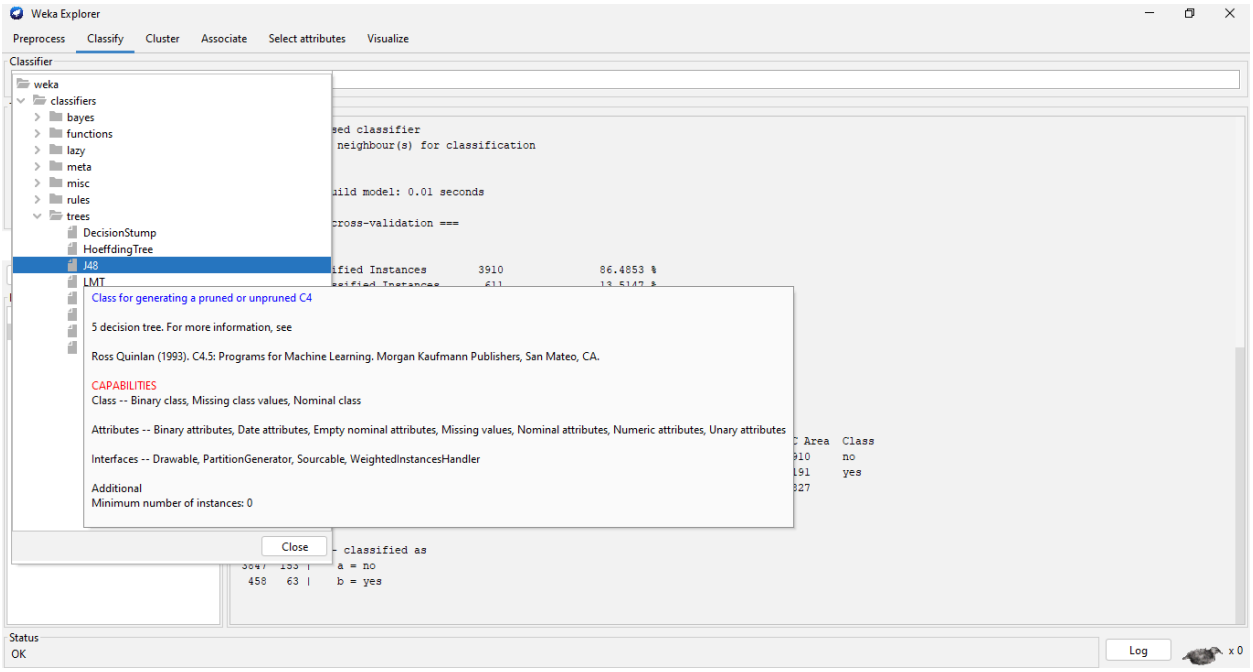


Figure 9: Decision tree selection

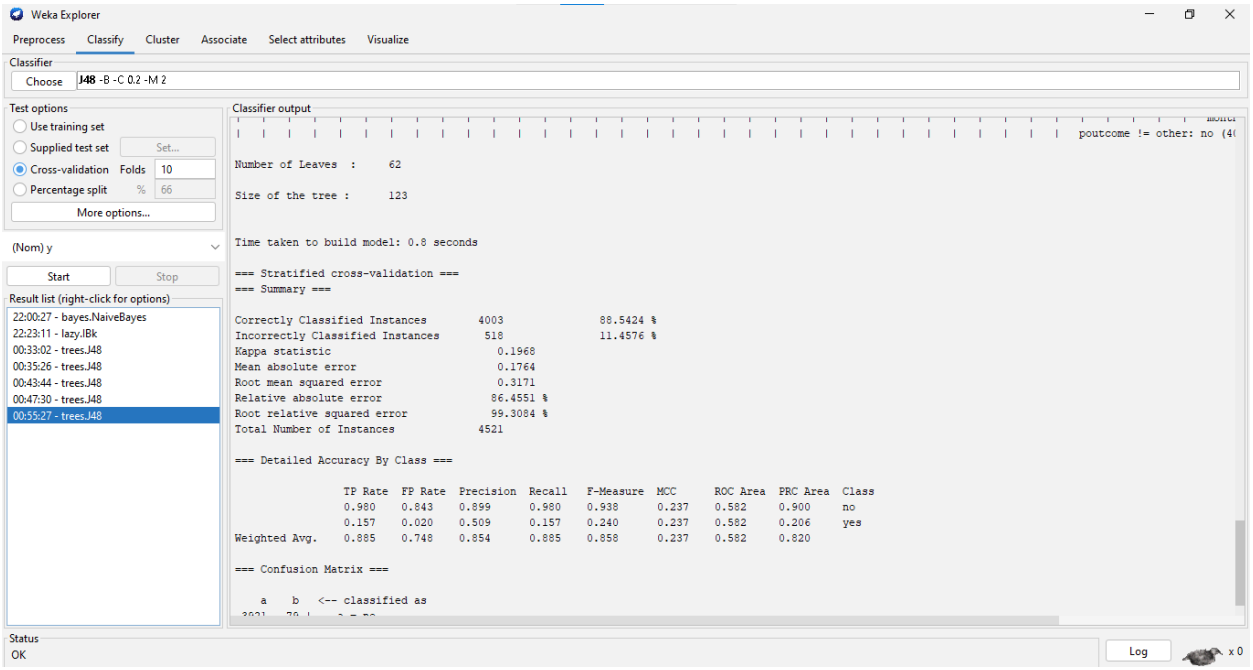


Figure 10: Decision tree results

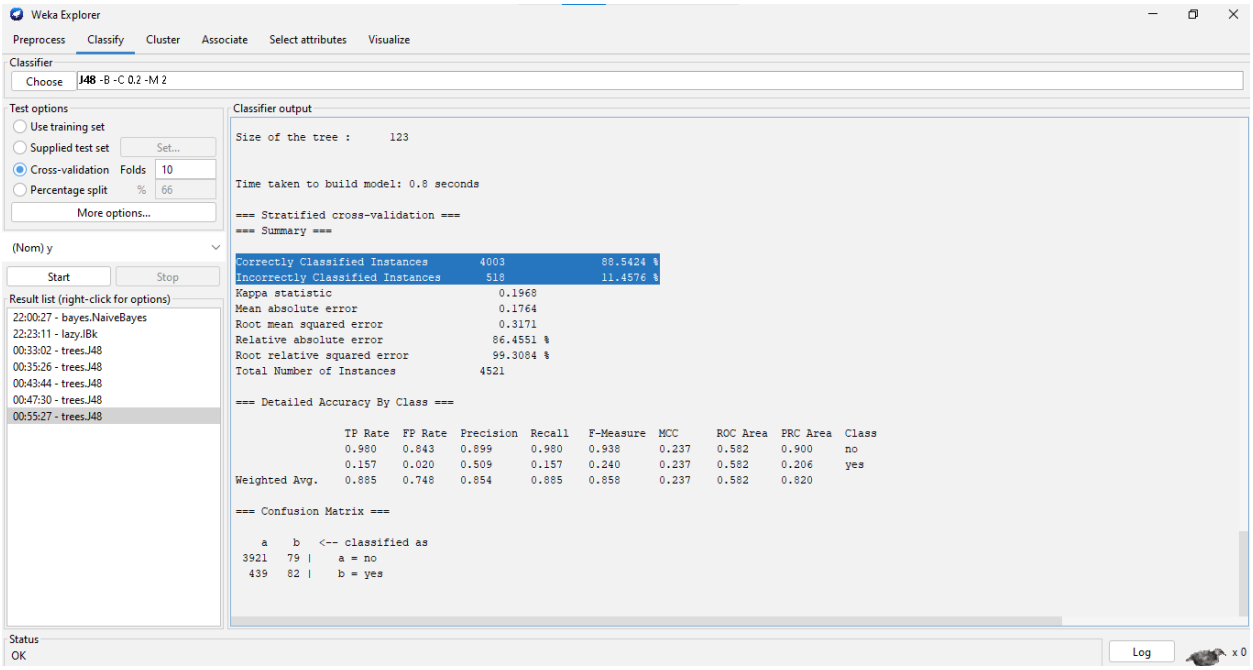


Figure 11: Decision tree (correctly, incorrectly classified)

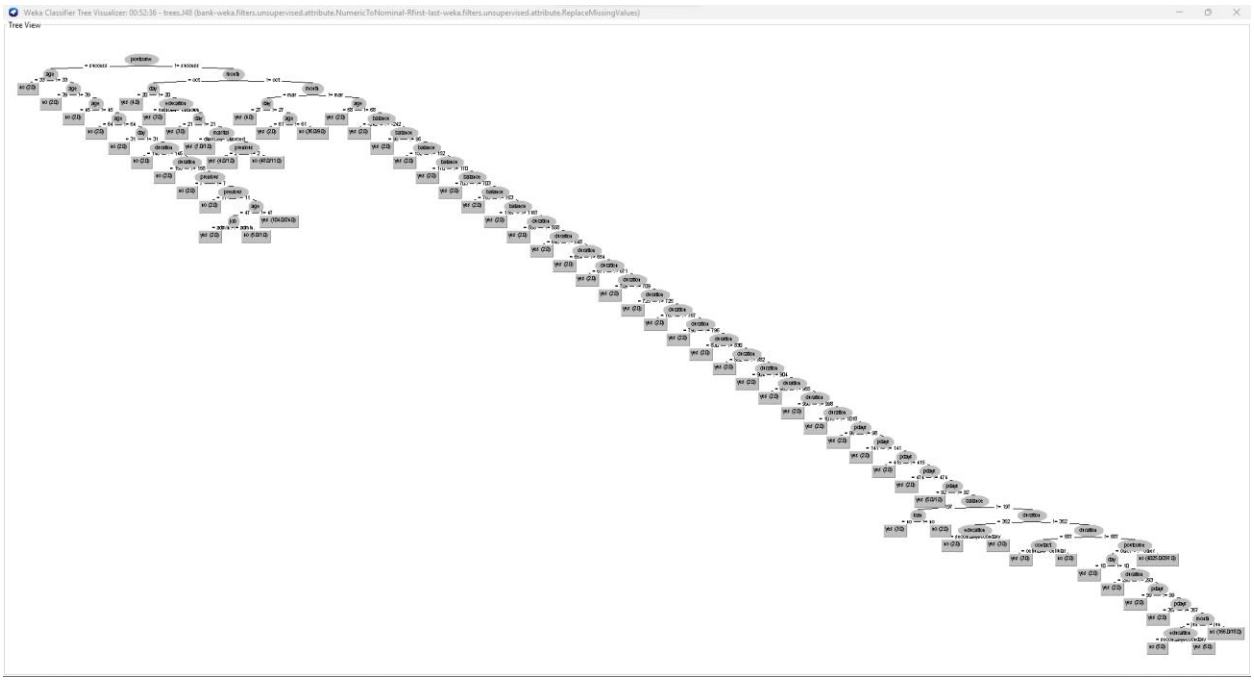


Figure 12: visualization of tree

Results:

Time is taken to build the model: 0.8 seconds

Correctly Classified Instances	4003	88.5424 %
Incorrectly Classified Instances	518	11.4576 %

=== Confusion Matrix ===

a	b	<-- classified as
3921	79	a = no
439	82	b = yes

Discussion & Conclusion:

Naive Bayes:
Total instances were 4522 instances in the data set. In naive Bayes,
correctly classified Instances were 3907 (86.4189 %) and incorrectly classified instances were 614 (13.5811 %). Total time is taken to build the model: 0.02 seconds.

k-NN:
The number of instances was 4522. In k-NN (nearest neighbor), correctly classified instances were 3910(86.4853 %) and incorrectly classified Instances were 611(13.5147 %). Total time is taken to build the model: 0.01 seconds.

Decision tree:
The number of instances was 4522.In decision tree, correctly classified Instances were 4003(88.5424 %),incorrectly classified Instances were 518(11.4576 %).Total time taken to build the model: 0.8 seconds.

We can clearly see that in the decision tree(88.54%)the number of correctly classified instances is higher than k-NN(86.43%) and Naive Bayes(86.41%). Because the Decision tree has a higher percentage of properly classified instances than Nave Bayes and k-NN, we may conclude that it is better in this dataset. Also, we can conclude the answer by seeing the confusion matrix

Naive Bayes === Confusion Matrix ===	k-NN === Confusion Matrix ===	Decision tree === Confusion Matrix ===
a b <-- classified as 3717 283 | a = no 331 190 | b = yes	a b <-- classified as 3847 153 | a = no 458 63 | b = yes	a b <-- classified as 3921 79 | a = no 439 82 | b = yes

If we see closely in decision tree no is predicted correctly 3921, in k-NN no is correctly predicted 3847 times and in naive Bayes it has correctly predicted 3717 times. In the decision tree yes is correctly predicted 439 times wrongly and 82 times correctly.

In conclusion, it is clearly seen that the Decision tree is the best algorithm for this dataset.