WEKA 3

CCS7 – Intelligent Systems

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Exploring WEKA 3

WEKA 3

What is WEKA?

- **WEKA** is an open-source software that provides tools for data preprocessing, machine learning, and visualization.
- It allows you to develop machine learning techniques and apply them to real-world data mining problems.
- **WEKA 3** is the latest version of the software and is developed with the Java programming language.

What is WEKA?

- Its algorithms can either be applied directly to a dataset or called from a Java code.
- WEKA stands for Waikato Environment for Knowledge Analysis.

Why use WEKA?

- Why would we want to use WEKA for machine learning?
  - *It is a free open-source tool*
  - *It is portable, since it is implemented in the Java programming language, and thus runs on any Java compatible device*
  - *It has a comprehensive collection of data preprocessing and modeling techniques*
  - *It is easy to use due to its simple user interface*

Why use WEKA?

- These are some characteristics of the WEKA tool:
  - *WEKA's techniques are predicated on the assumption that the data is available as a single flat file or relation*
  - *Each data point in the file should be described by a fixed number of attributes*
  - *WEKA provides access to SQL databases*

File Types Supported by WEKA 3

- WEKA uses the **Attribute Relation File Format** for data analysis, by default.
- These are some of the formats that WEKA supports:
  - *CSV*
  - *ARFF*
  - *Database using ODBC*

```
@RELATION iris

@ATTRIBUTE sepallength  REAL
@ATTRIBUTE sepalwidth   REAL
@ATTRIBUTE petallength  REAL
@ATTRIBUTE petalwidth   REAL
@ATTRIBUTE class        {Iris-setosa,Iris-versicolor,Iris-virginica}

@DATA
5.1,3.5,1.4,0.2,Iris-setosa
4.9,3.0,1.4,0.2,Iris-setosa
4.7,3.2,1.3,0.2,Iris-setosa
4.6,3.1,1.5,0.2,Iris-setosa
5.0,3.6,1.4,0.2,Iris-setosa
5.4,3.9,1.7,0.4,Iris-setosa
4.6,3.4,1.4,0.3,Iris-setosa
5.0,3.4,1.5,0.2,Iris-setosa
4.4,2.9,1.4,0.2,Iris-setosa
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5.1,3.7,1.5,0.4,Iris-setosa
4.6,3.6,1.0,0.2,Iris-setosa
```
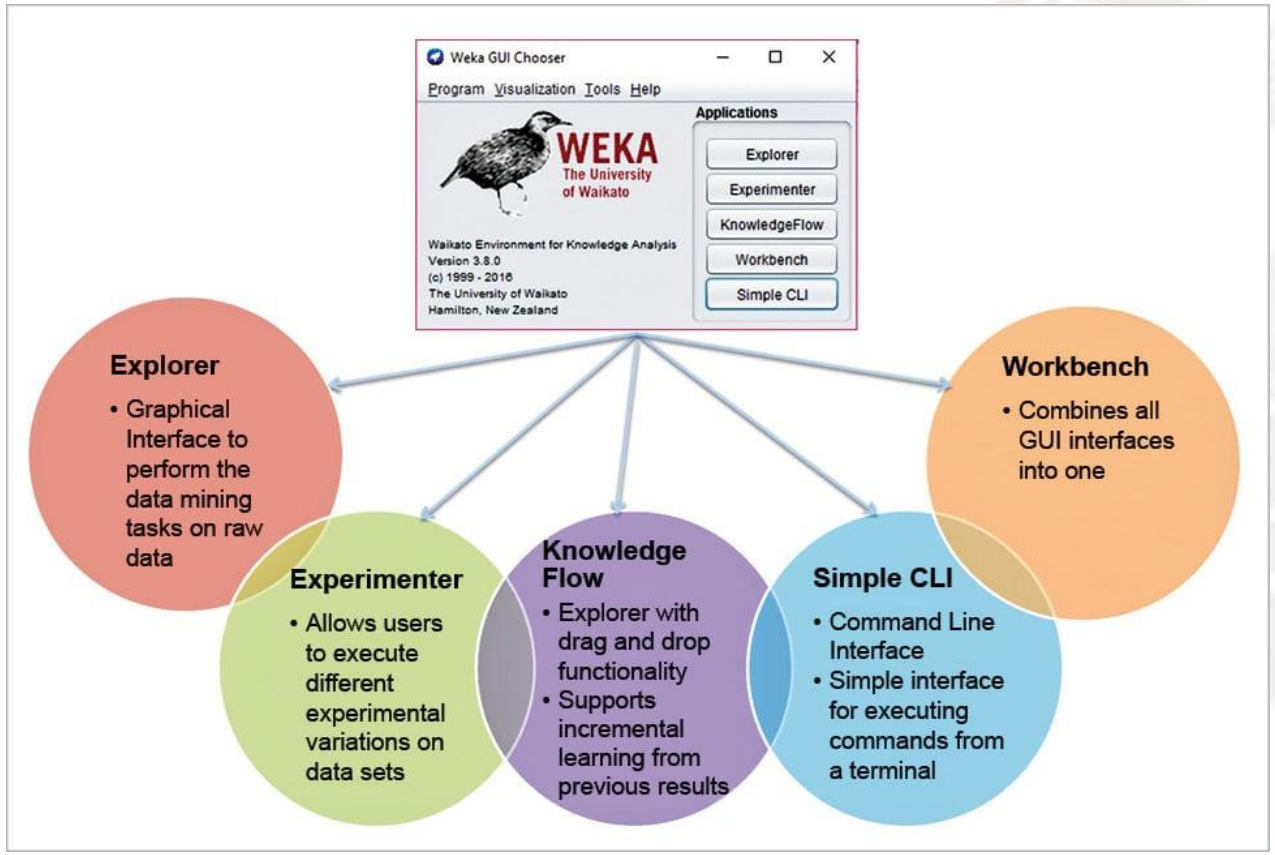

Installing WEKA

- You can download WEKA from their official website:
  - https://www.cs.waikato.ac.nz/ml/weka/
- Make sure that you also install **Java 8 or later** for WEKA to work.
- Once installed, you can then run the application.

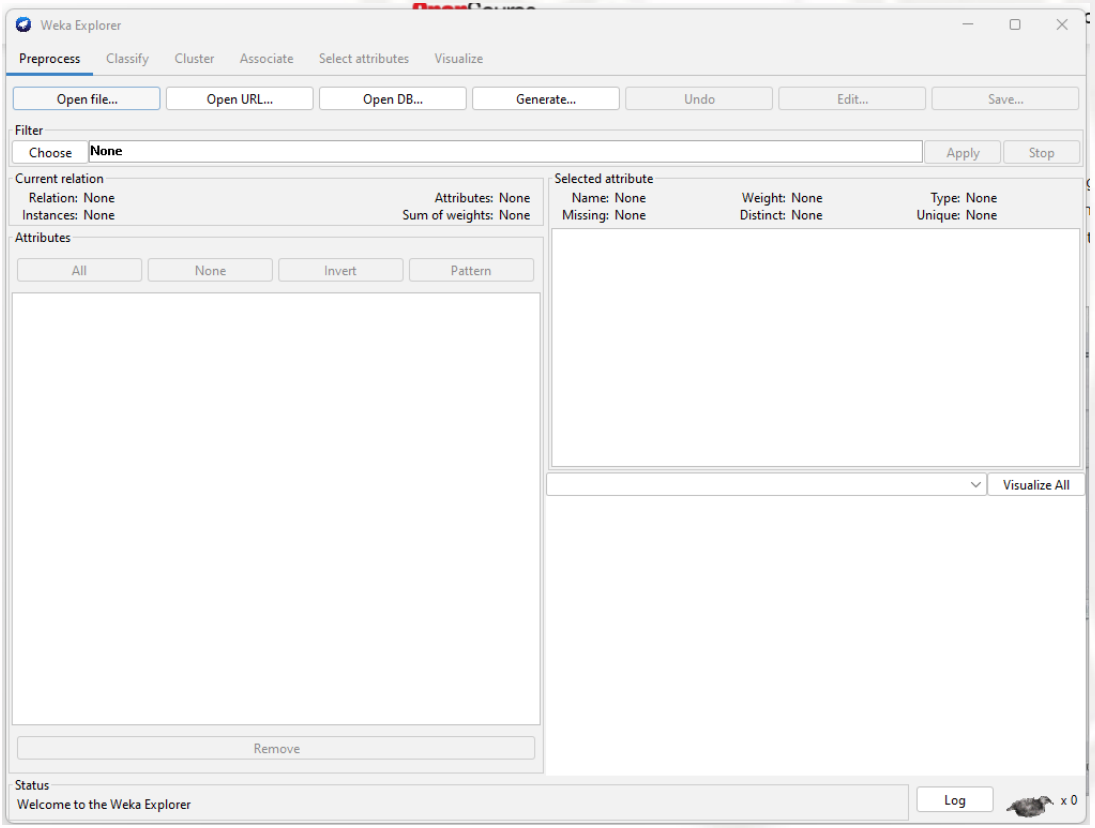
Exploring the WEKA 3 UI

- Shown below are the parts of the UI for the WEKA software:



WEKA Explorer

- The main tab that we will be focusing on for the WEKA tool is the **Explorer** tab.
- When clicked, the explorer tab will being up a new interface, shown on the right.



WEKA Explorer

- The uses of the different tabs shown are as follows:
  - ***Preprocess*** *– this allows us to choose the data file*
  - ***Classify*** *– this allows us to apply and experiment with different algorithms on preprocessed data files*
  - ***Cluster*** *– this allows us to apply different clustering tools, which identify clusters within the data file*

WEKA Explorer

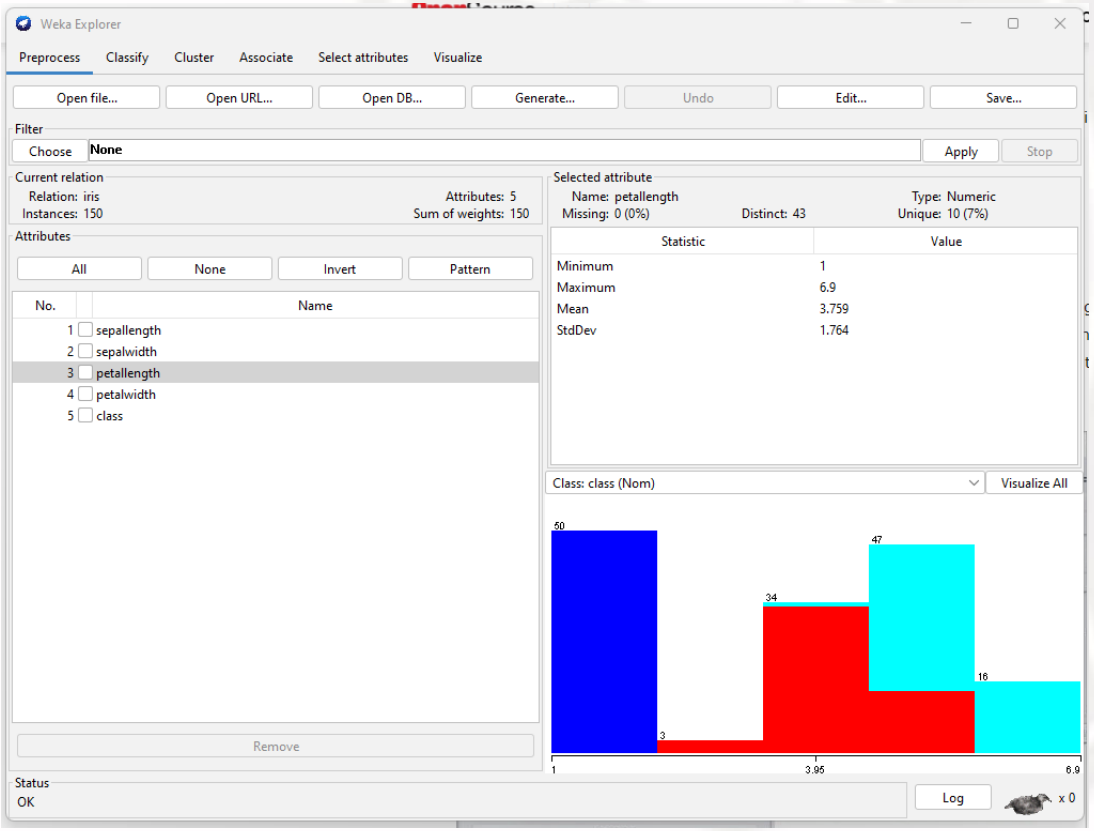
- The uses of the different tabs shown are as follows:
  - ***Associate*** *– this allows us to apply association rules, which identify the association within the data*
  - ***Select attributes*** *– this allows us to see the changes on the inclusion and exclusion of attributes from the experiment*
  - ***Visualize*** *– this provides a visualization produced on the data set in a 2D format, in a scatter plot and bar graph output*

Preprocessing

- **Preprocessing** refers to manipulating and adjusting data before it is used.
- We can prepare our data for preprocessing in 3 ways:
  - ***Open File*** *– enables the user to select the file from the local machine*
  - ***Open URL*** *– enables the user to select the data file from different locations*
  - ***Open DB*** *– enables the user to retrieve a data file from a database source*

Preprocessing

- After selecting a file and loading it into the tool, we can then refine the data or use it as is.
- We need to load data first before we can use the other tools in the explorer.



Using WEKA for Classification

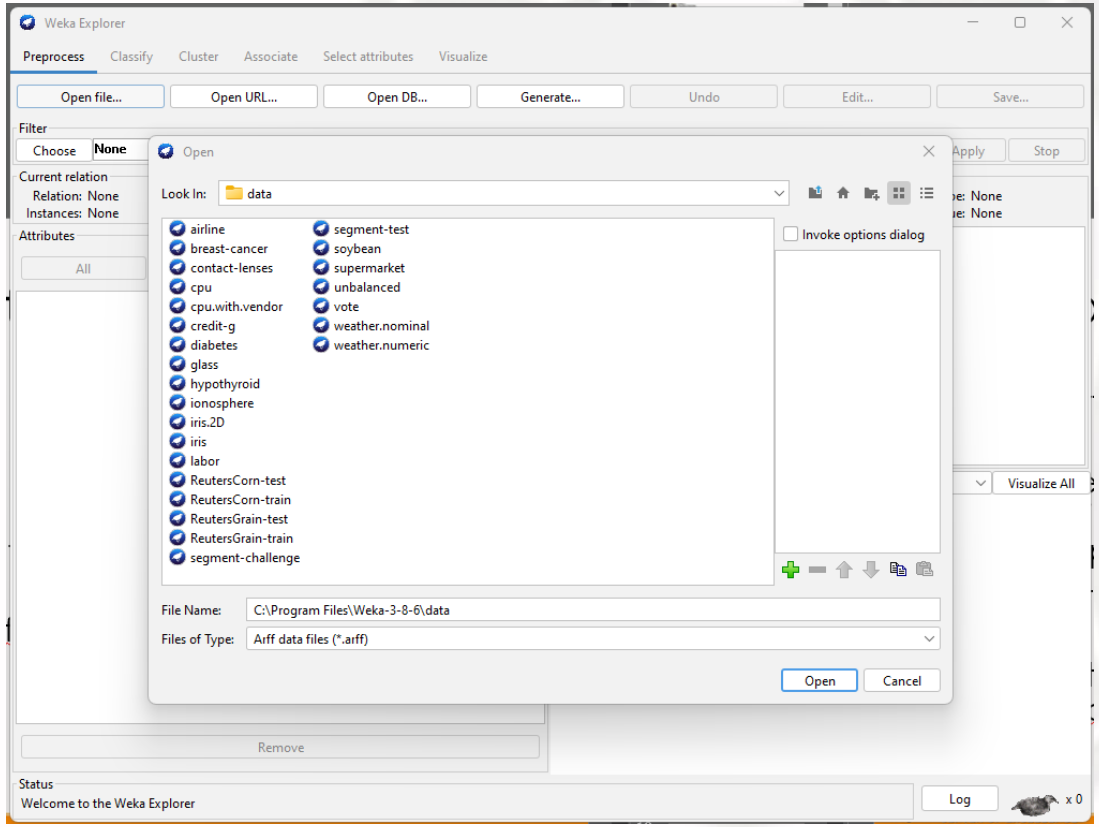
WEKA 3

Classifying with WEKA

- There are many models that we can use for classification in WEKA, such as:
  - ***Decision Trees***
  - ***Support Vector Machines***
  - ***Instance-based Classifiers***
  - ***Logistic Regression***
  - ***Bayes' Nets***

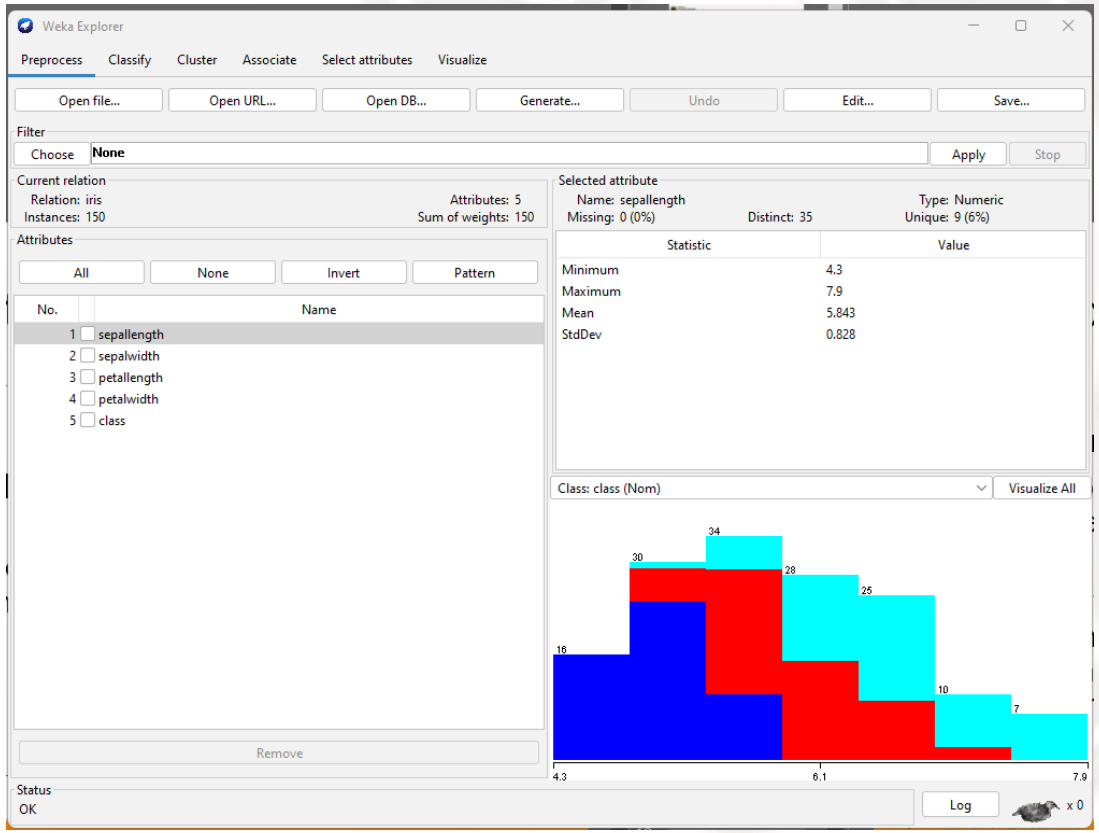
Preparing our Data

- We start by **loading in the data that we will be classifying**.
- We select the Explorer option in WEKA, and select the preprocess tab.
- We can then select an .arff file or a .csv file.



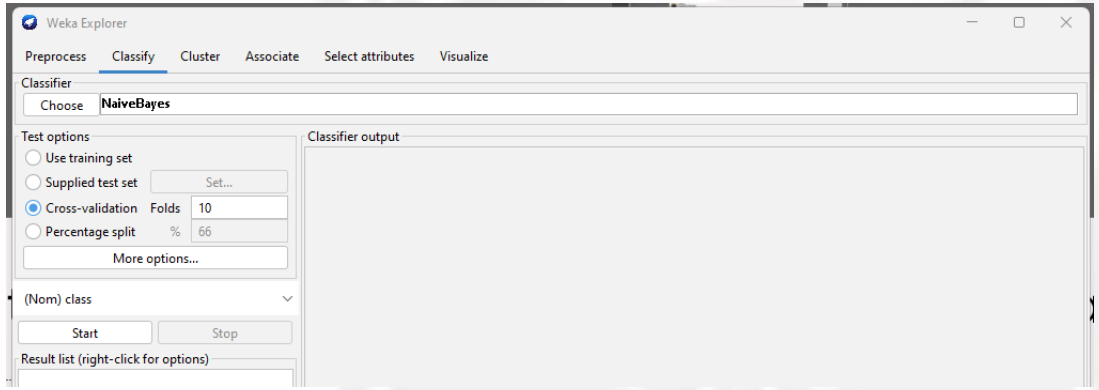
Preparing our Data

- We will make use of the "iris" data for our example.
- This data has 3 classes, with 50 instances each.
- We will then attempt to see how different classification algorithms perform given this dataset.



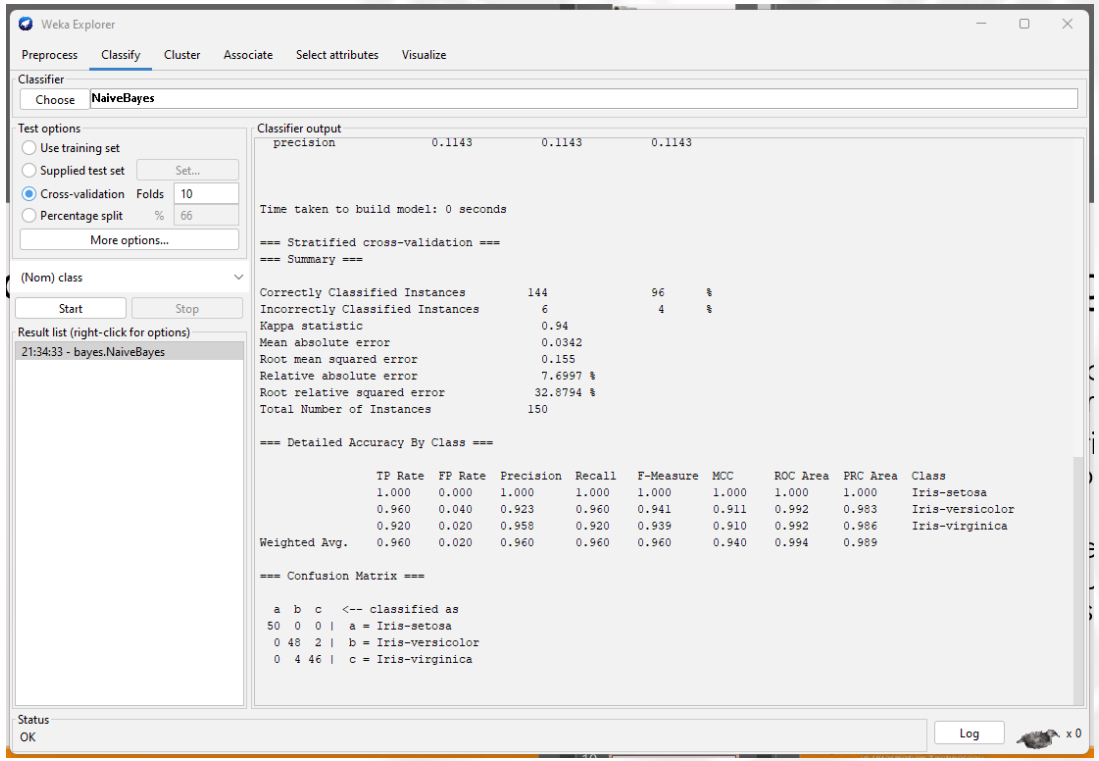
Preparing our Data

- Once our data has been loaded, lets head over to the "Classify" tab for the next step.
- We are going to make use of the model **NaiveBayes** to classify our data.



Classifying our Data

- We can then click start to classify our given data.
- After processing our data, we will be shown the number of correctly and incorrectly classified instances.
- It will also give additional metrics, such as the **mean absolute error**.



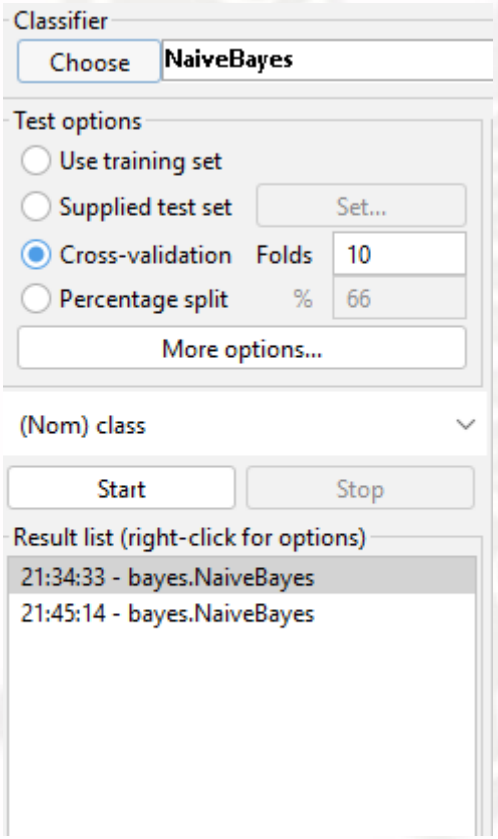
Classifying our Data

- Another part of note in the results is the **Confusion Matrix**.
- This serves as an important metric in showing how well the model performs when classifying the different classes.
- It can help reveal biases in the data.

```
=== Confusion Matrix ===

  a  b  c   <-- classified as
 50  0  0 |  a = Iris-setosa
  0 48  2 |  b = Iris-versicolor
  0  4 46 |  c = Iris-virginica
```

Testing the Classification Process

- We can also quickly compare the performance of different models by clicking on each result under the **Result list**.
- This allows us to test and evaluate many models on the same data.



Using WEKA for Clustering

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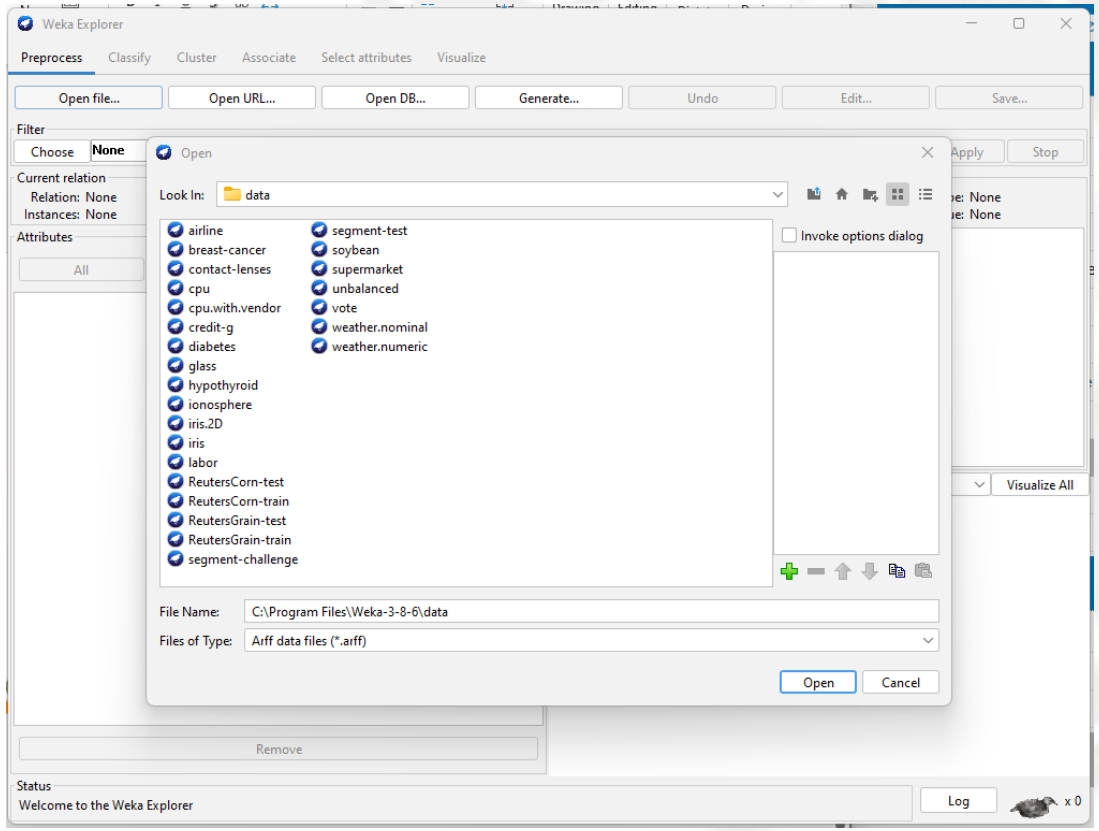
Clustering with WEKA

- WEKA allows you to use several clustering algorithms such as:
  - ***E-M Algorithm***
  - ***FilteredClusterer***
  - ***HierarchicalClusterer***
  - ***Simple K-Means***
- These clustering algorithms all have their own characteristics and specific uses.

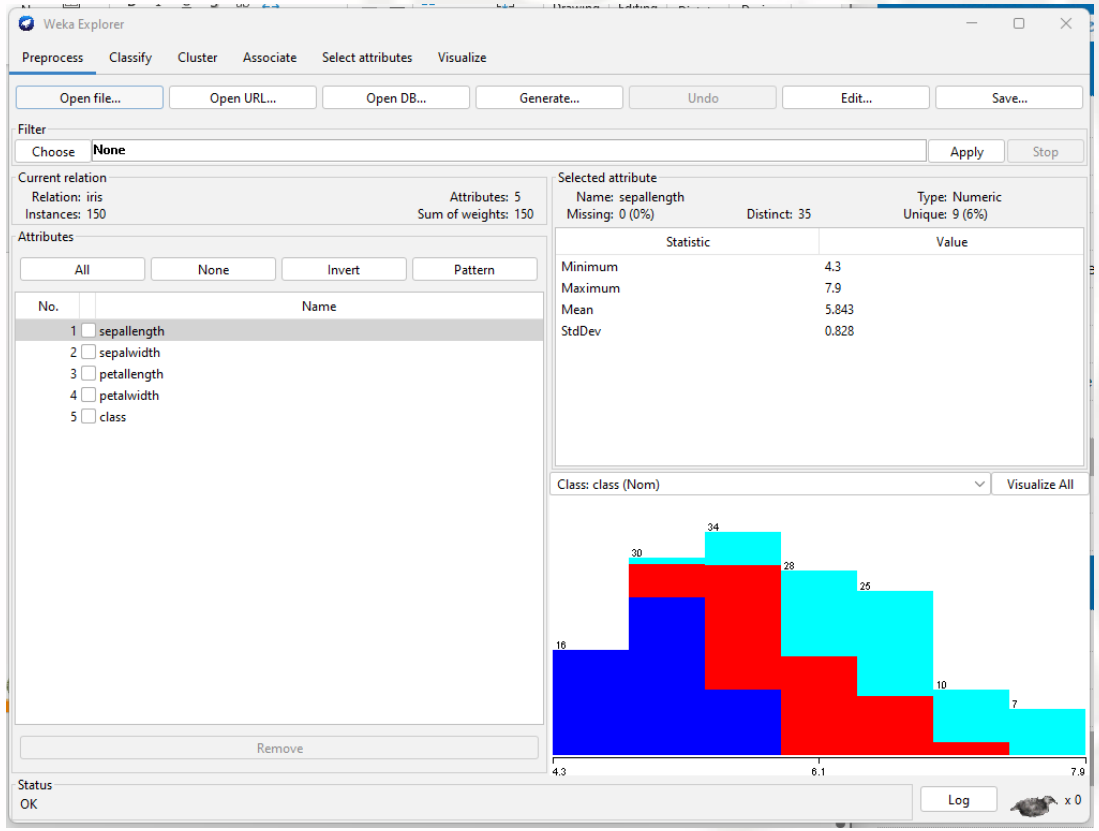
Preparing our Data

- We again start by **preparing our data to be processed**.
- We select the Explorer option in WEKA, then select the preprocess tab.



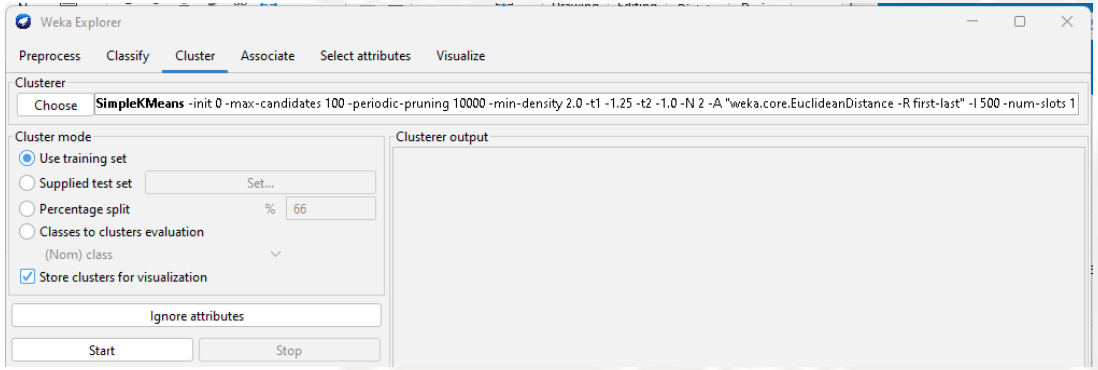
Preparing our Data

- We will again make use of the "iris" data for our example.
- We know that this data has 3 classes with 50 instances each.
- We will then see how the different clustering algorithms perform when clustering this data.



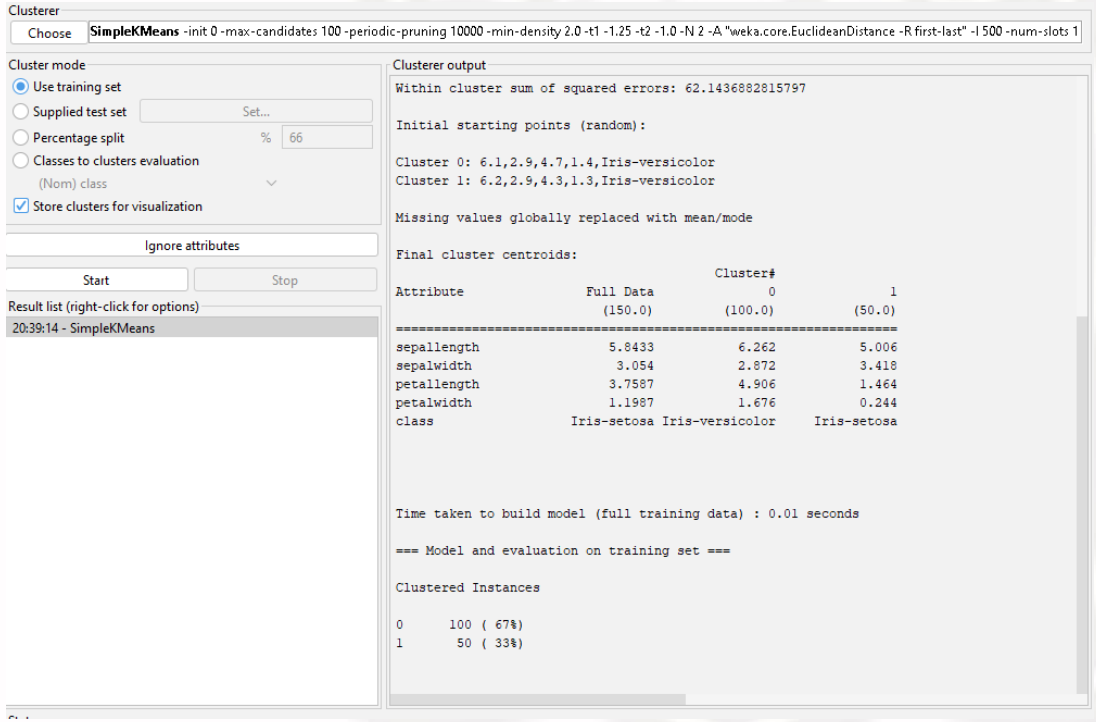
Preparing our Data

- Once we have loaded our data, we will then select the “Cluster” tab on the header.
- We will then select choose and then select **SimpleKMeans** for our example.



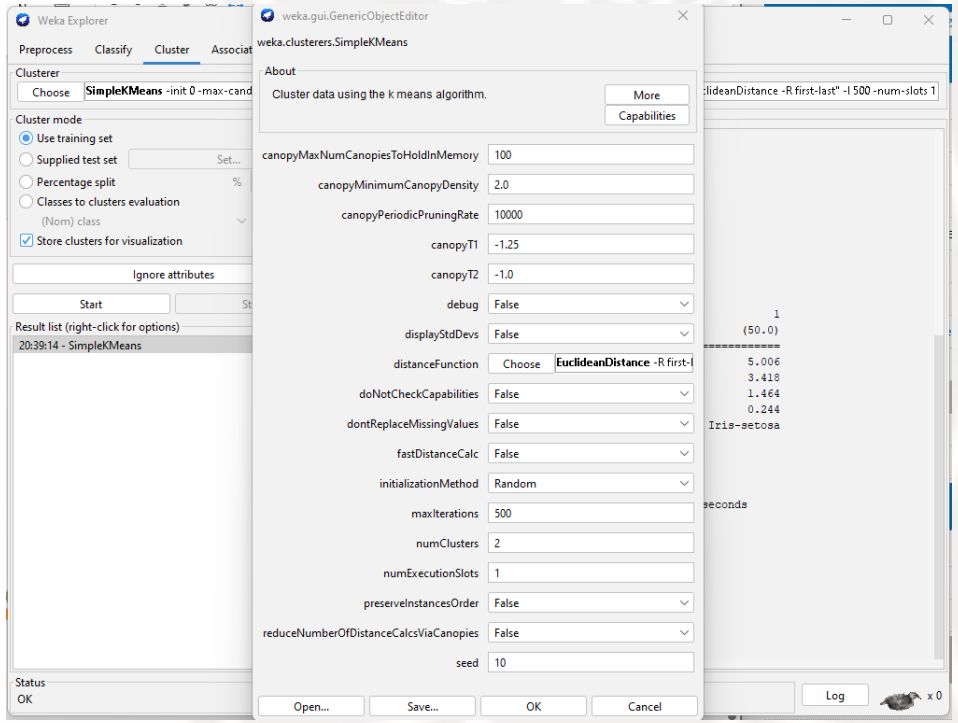
Clustering our Data

- We can then click start to get our clustering result.
- You might notice that we only have two clusters (0 and 1).
- It would be better if we have three clusters so let us adjust our cluster algorithm.



Clustering our Data

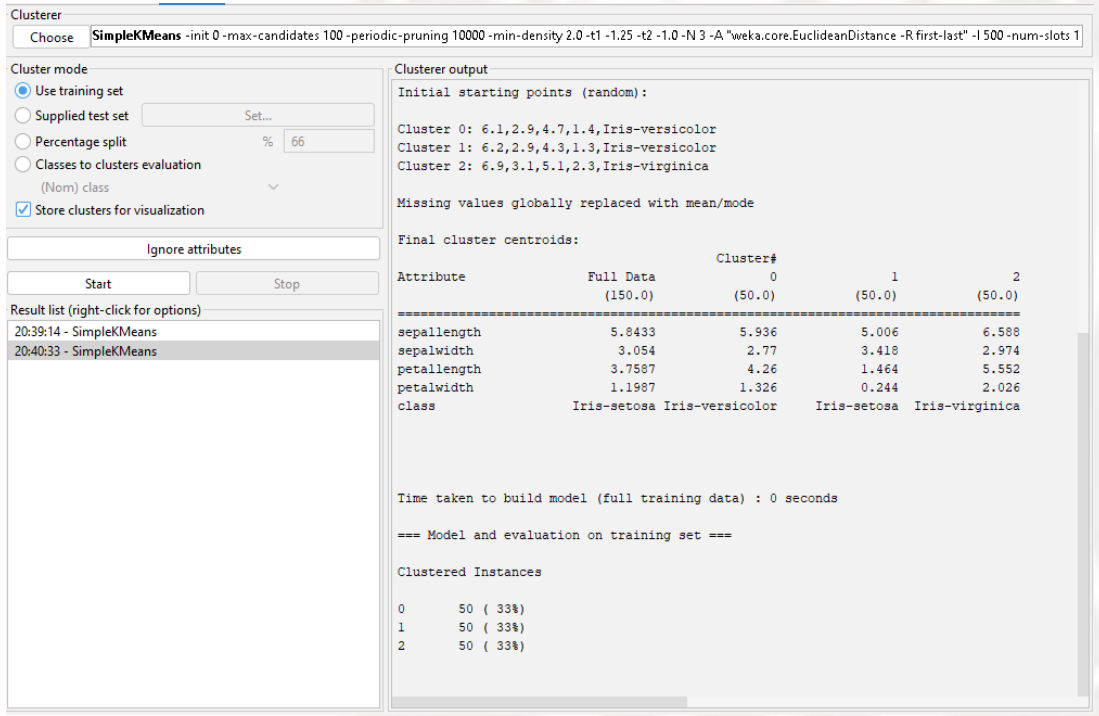
- We can access the parameters of the cluster algorithm by right clicking or double clicking it.
- This will allow us to adjust our cluster as needed.
- In this case, we will change the numbers of clusters from 2 to 3.



numClusters 3

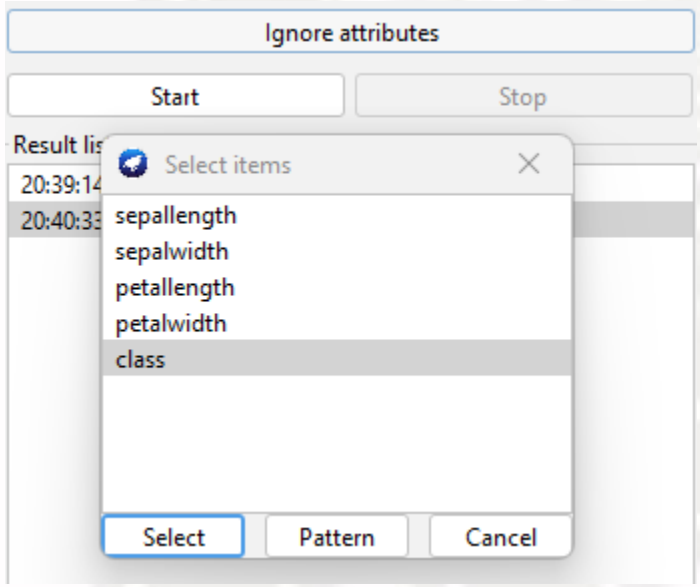
Clustering our Data

- We can see that we now have 3 clusters for our data.
- It seems like the algorithm perfectly clustered the three types of flowers.
- There is a problem here, but we will fix it later.



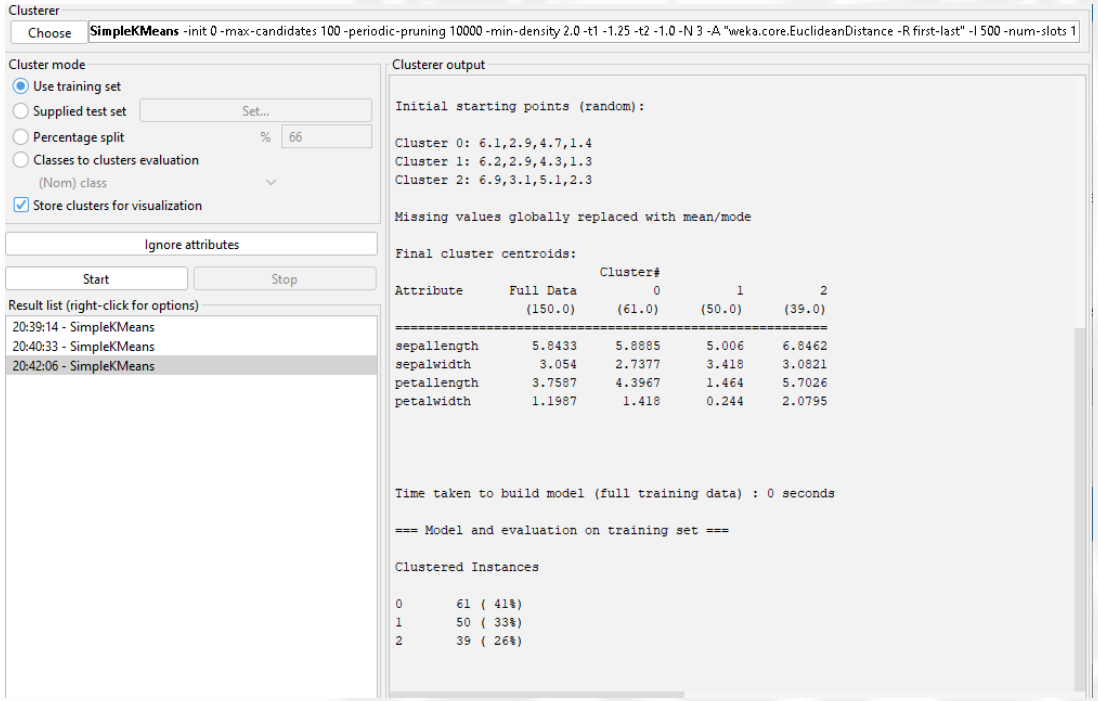
Improving our Clusters

- Now, we need to make some adjustments to our clusters to make it more "realistic".
- We were getting perfect results due to a "class" attribute which specified the class for our data.
- We will need to ignore this attribute when clustering our data.



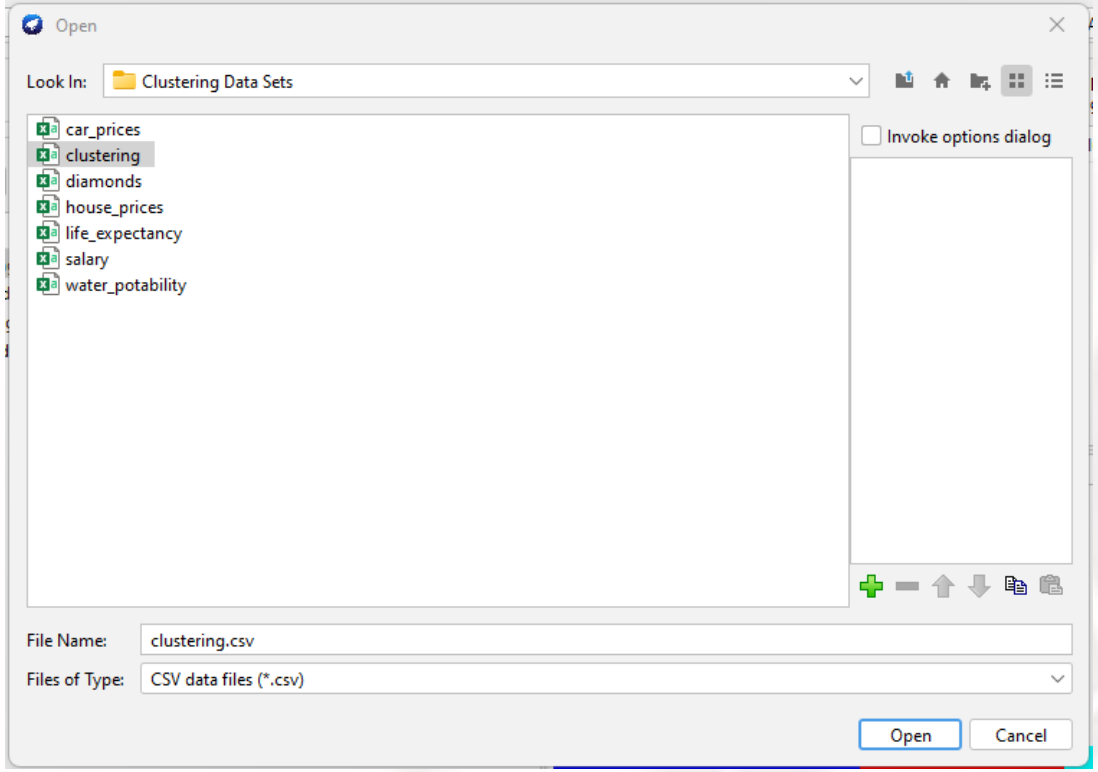
Improving our Clusters

- After ignoring the "class" attribute, we will then cluster our data again.
- We can now see that we have more realistic results for our algorithm.
- We can then choose to visualize this or cluster it with a different algorithm.



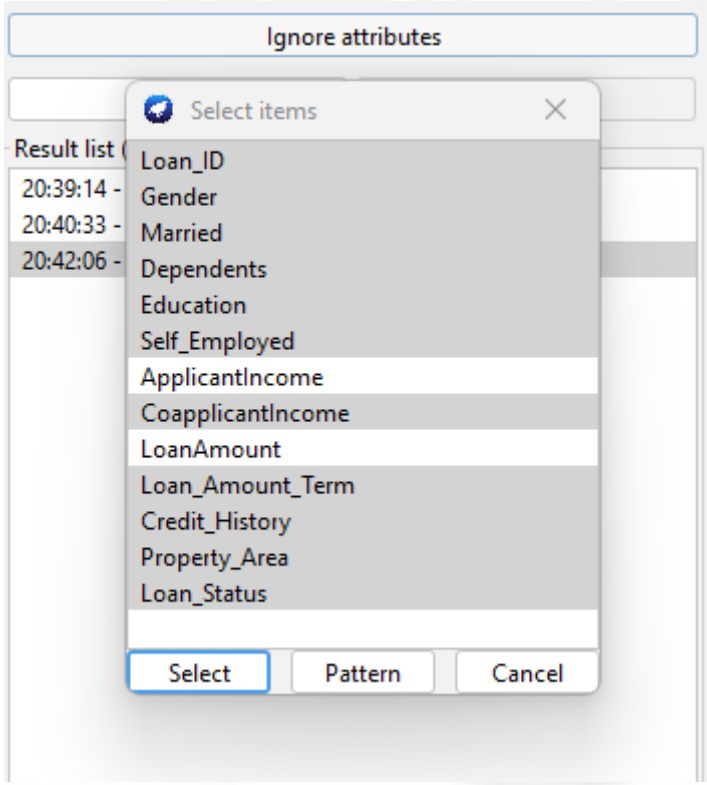
Clustering other file types

- We can also cluster other file types by selecting to appropriate file time in the preprocess menu.
- This allows us to cluster spreadsheets and other types of data.



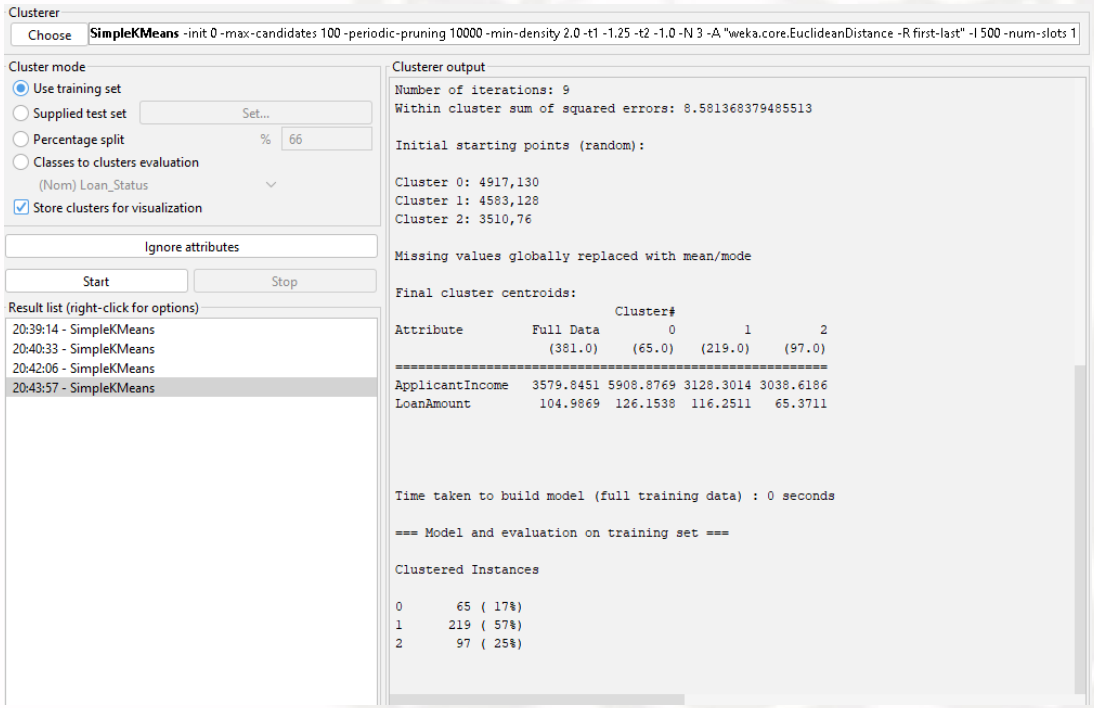
Clustering other file types

- In the case of the clustering.csv file, we will open it into WEKA.
- We will then ignore the other attributes since most of them are text and will not help with the clustering process.



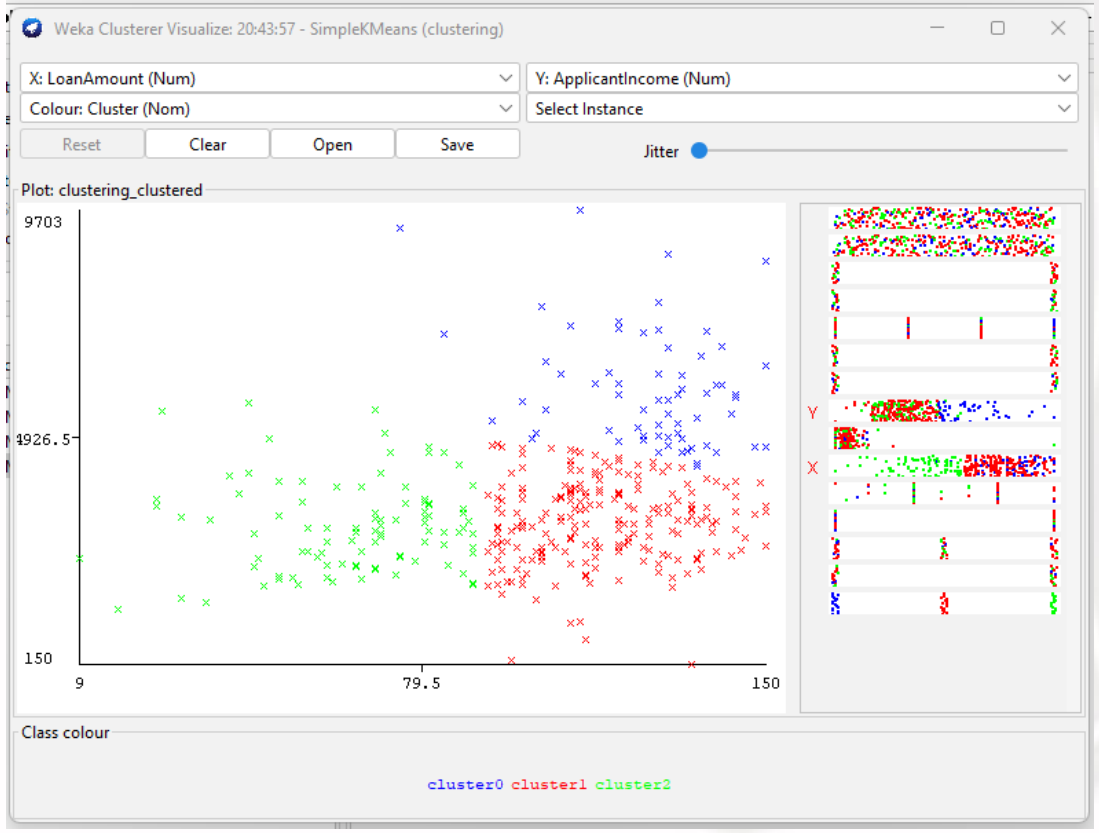
Clustering other file types

- We can now see how the algorithm clusters the data using **SimpleKMeans** with 3 clusters.
- We can adjust the algorithm or number of clusters and compare the results.



Clustering other file types

- We can then visualize our clusters with the same steps as before by right clicking the results.
- This will allow us to see how the algorithm clustered the given data in our data set.

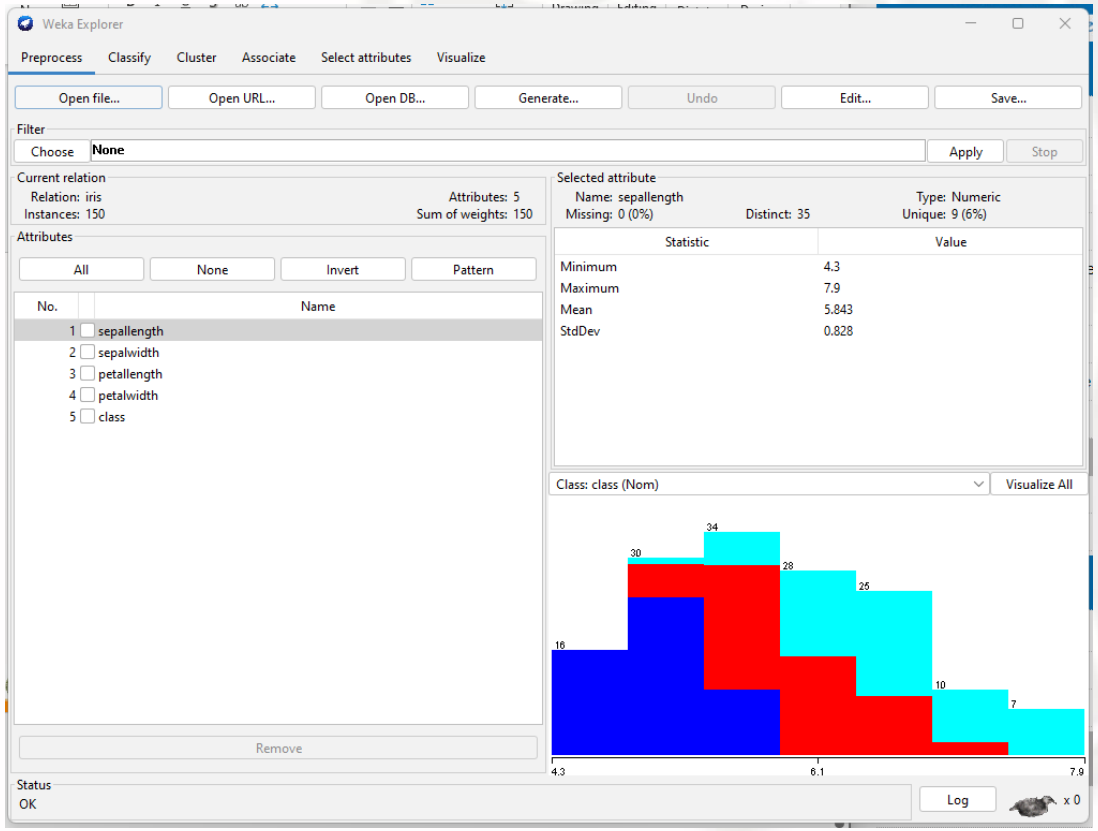


Classes-to-clusters Evaluation

- **Classes-to-clusters Evaluation** is a tool used to evaluate the accuracy of a given clustering algorithm.
- In this mode, WEKA ignores the class attribute and generates the clusters.
- It then assigns the classes to the clusters and computes the errors based on mismatching clusters and classes.
- It then provides a value for the number of incorrectly clustered instances.

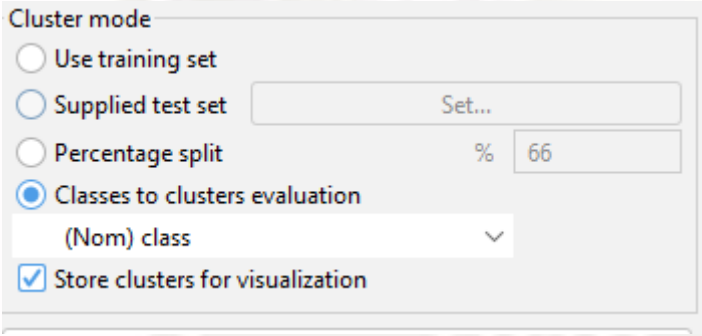
Classes-to-clusters Evaluation

- We can make use of an option in our cluster to evaluate the **accuracy of the clusters**.
- This will allow us to use the given classes in our data to check the accuracy of our clusters.
- Let us make use of the "iris" dataset for this example.



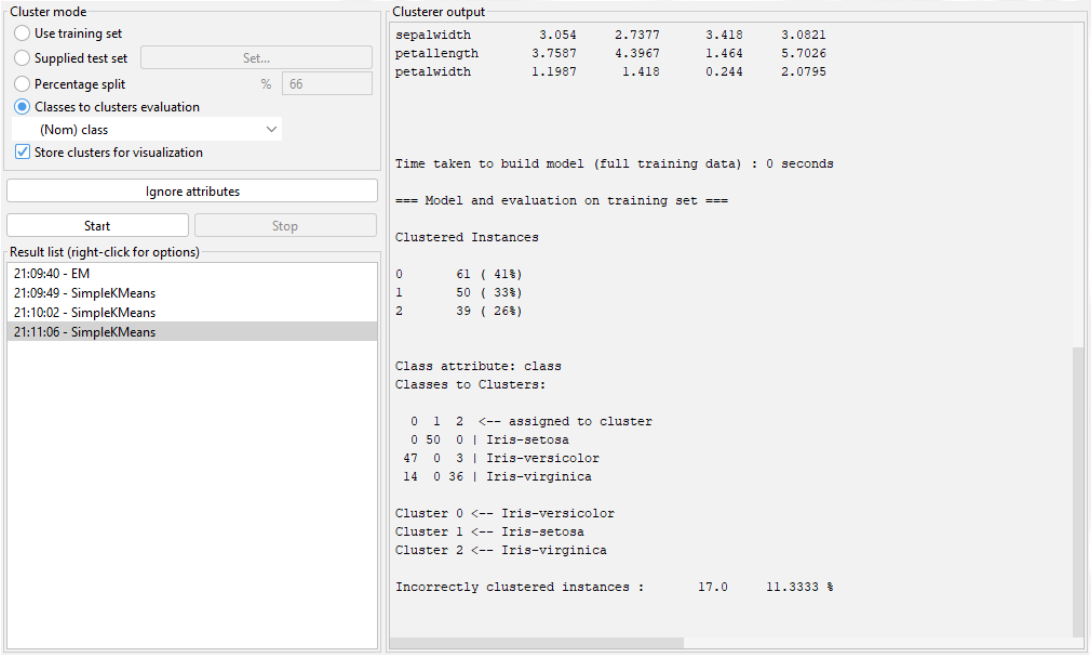
Classes-to-clusters Evaluation

- We will head to the "Cluster" page and select the "Classes to clusters evaluation".
- We will then select class in the dropdown box.
- This will specify that attribute as the class.



Classes-to-clusters Evaluation

- We can now see the results of the evaluation.
- This showcases how accurate the clustering is and what specific clusters had the greatest number of errors.
- Take note that this method does not work without a proper class attribute.



Other uses of WEKA

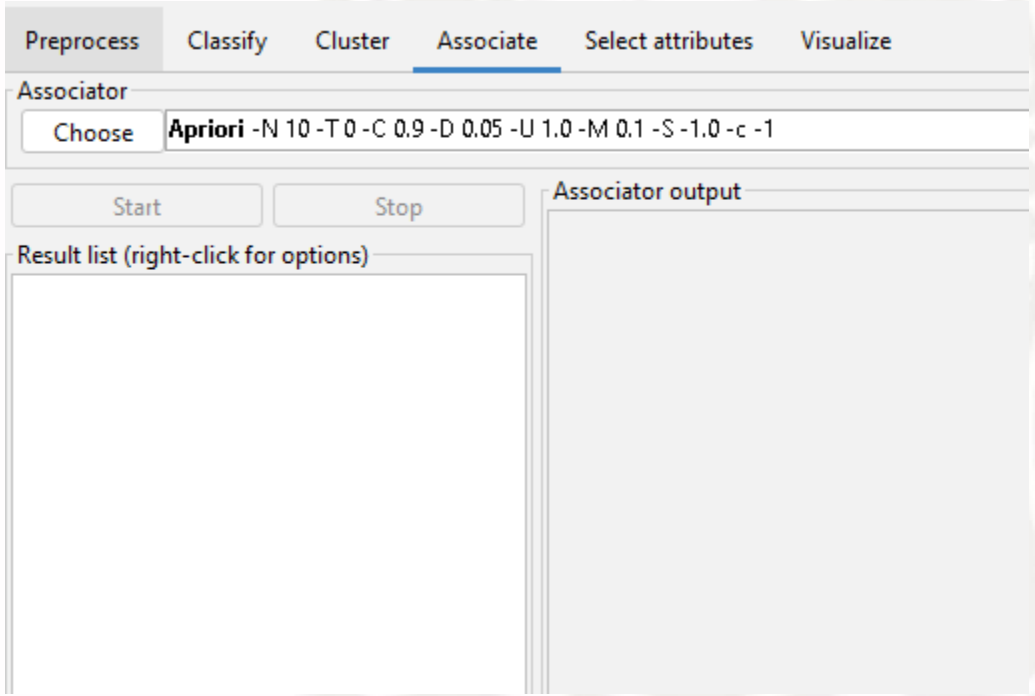
WEKA 3

Other Features of WEKA

- Aside from classification and clustering, there are other tools that you can use in WEKA to process data.
- These are some of the other tools available in WEKA:
  - ***Association***
  - ***Attribute Selection***
  - ***Visualization***

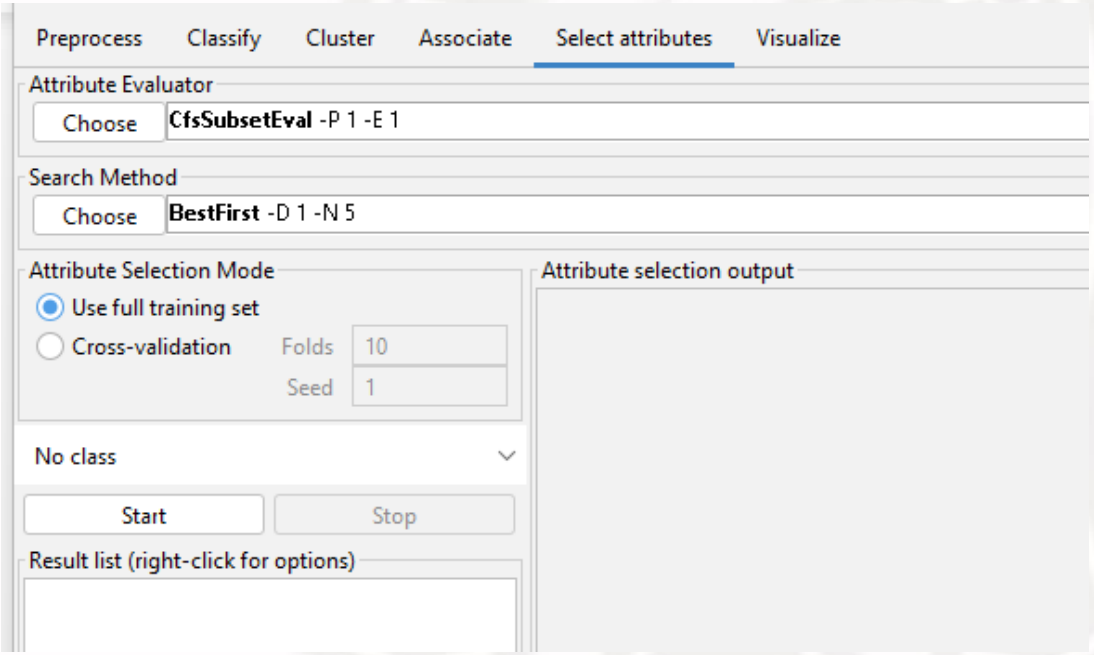
Association

- **Association** is an unsupervised learning technique that looks for relationships between variables or features in a dataset.
- The main model available in WEKA for association is the Apriori algorithm.



Attribute Selection

- **Attribute Selection** is a method of choosing the best features for use in a machine learning model.
- This is done to remove redundant or irrelevant data from the dataset.



Visualization

- **Visualization** allows us to view the different data in a 2D format.
- We can visualize single attributes (1D) and pairs of attributes (2D) in WEKA.