Machine Learning and Data Mining with Weka

What you need

1. Program: Weka
2. How to install Weka: Go to this website http://www.cs.waikato.ac.nz/ml/weka/downloading.html and download the weka version that is supported by your os.
3. Now you should be good to run weka.

What will be Covered in this Lab

This lab will go over the very basics of what data mining and machine learning is. Also it will go over what weka is, and show you how to run a very simple test in weka. We will go over a couple of the classifiers that are used in data mining and in machine learning.

What is Machine Learning and Data Mining?

Machine learning is the ability for a computer to be able to predict the outcome of a dataset based on the information provided by that dataset. Data mining very similar to machine learning, since it uses many of its techniques, in that it tries to find the best possible way for a computer to solve a real world problem using algorithms that are used by machine learning. Data mining however tends to deal with more of a statistical aspect, like finding out how many people are willing to buy your brand given seemingly random information, while machine learning is purely for finding ways for machines to operate with little to no human interactions.

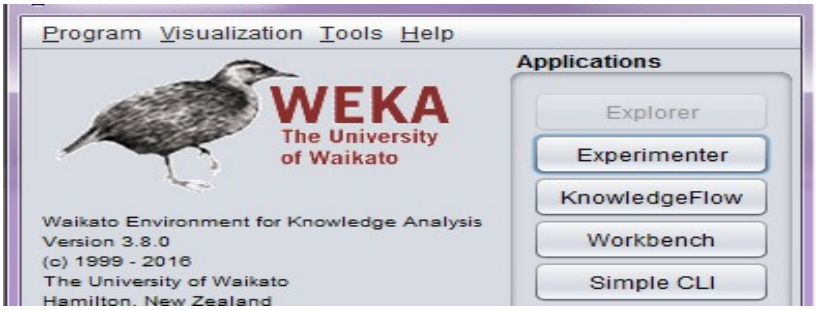
What is Weka?

Weka is a machine learning program that runs on java. It is very powerful program that is capable of using predefined algorithms to predict possible outcomes of supplied datasets. It simplifies the processes of machine learning and data mining by giving the user an easy to use interface to navigate through.

How to use Weka

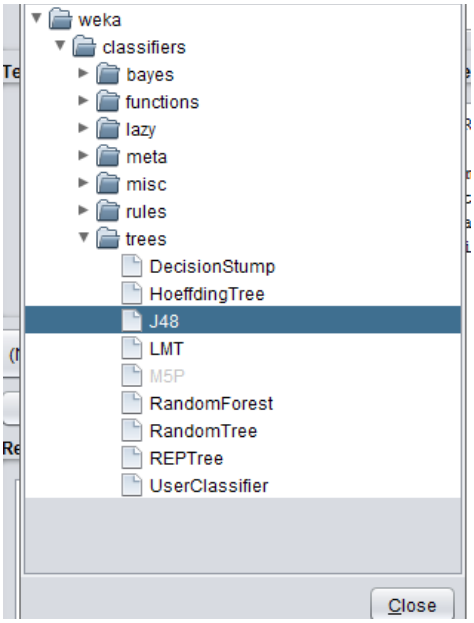
The Explorer tab

Once you have downloaded weka start it either by clicking on the start icon, or by going to where you had downloaded weka and start it with the weka <version> shortcut. Now you should see a screen similar to this.



Now click on the explorer tab and you should see this new window.

Now we can run some tests to see how weka would handle a well defined dataset with its predefined classifiers. Open a file called weather.nominal.arff, this file can be found at Weka-version\data, in the preprocess tab you can see the many predefined attributes that this file had already been given. Here you can edit these attributes in anyway that you would like, but for now we will leave them as is. Now we can run a test and see how well weka can predict the outcome defined by this dataset by going to the classify tab. Here we can choose a classifier to run over this data set. Select J48 from the trees classifiers.



Now click start and you should see a similar output in the classifier output box as mine.

```
=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances           7               50      %
Incorrectly Classified Instances         7               50      %
Kappa statistic                         -0.0426
Mean absolute error                      0.4167
Root mean squared error                  0.5984
Relative absolute error                 87.5    %
Root relative squared error            121.2987 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.556    0.600    0.625      0.556    0.588      -0.043   0.633     0.758     yes
                 0.400    0.444    0.333      0.400    0.364      -0.043   0.633     0.457     no
Weighted Avg.    0.500    0.544    0.521      0.500    0.508      -0.043   0.633     0.650

=== Confusion Matrix ===

 a b   <-- classified as
 5 4 | a = yes
 3 2 | b = no
```

Here we can see some very cool information that was collected from running J48. We can see that it correctly classified 7 of the 14 total instances. The kappa statistic gives the result of the revealed accuracy versus the accuracy that was expected. The mean absolute error is given by the error between the the true value and what was expected. The root mean squared error is given by the difference between the value that the classifier got and the value it predicted. The relative absolute error is given by the magnitude between the true value and the predicted value. The root relative squared error is the error given by the absolute error divided by the ZeroR's error, ZeroR is a classifier that justs takes into consideration the top attribute in deciding what the outcome should be. Considering the small size of the dataset and the few attributes this is a fairly good output, but we can do better. Choose the NaiveBayes classifier found under the bayes classifiers. Click start and you should a similar output as mine.

```
=== Summary ===

Correctly Classified Instances           8               57.1429 %
Incorrectly Classified Instances         6               42.8571 %
Kappa statistic                         -0.0244
Mean absolute error                      0.4374
Root mean squared error                  0.4916
Relative absolute error                 91.8631 %
Root relative squared error             99.6492 %
Total Number of Instances               14

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure  MCC      ROC Area  PRC Area  Class
               0.778     0.800     0.636       0.778   0.700      -0.026   0.578     0.697     yes
               0.200     0.222     0.333       0.200   0.250      -0.026   0.578     0.557     no
Weighted Avg.  0.571     0.594     0.528       0.571   0.539      -0.026   0.578     0.647

=== Confusion Matrix ===

 a b   <-- classified as
 7 2 | a = yes
 4 1 | b = no
```

It is easy to see that naivebayes will get a better result of this dataset, however naivebayes will not always get the better outcome. It is easy to see from the information provided by weka that

Weka Classifiers

Classifiers are algorithms that are able to classify new data based upon the attributes from the dataset. There are many many classifiers in weka and for that reason I will not go over all of the classifiers but just the ones that I have gotten familiar with.

J48

This classifier is based off the C4.5 algorithm, which is referred to by many as a statistical classifier. It basically builds a tree with leaves that branch out with each new attribute and gives a + or - based on what is gathered from the test.

Naive Bayes

This classifier is based off of bayes theorem, which states that the probability of an event happening may be determined by a given condition related to that event. This formula is by P(A|B) = (P(B|A)P(A))/P(B).

Random Forest

Random forest is an extremely good classifier when it comes to having a lot of noise in a dataset. Noise is referring to the unwanted data that is being mixed in with the data that you want to use to predict

accurately what the outcome should be. It is similar to that of J48, in that it uses trees to sort the dataset of what is and what is not important.

Weka's ability to let the user choose which classifier is best to use, and the ability to alter them with ease makes it stand out above most machine learning programs.

What can Weka be Used For?

There are many uses for weka and data mining in general. First it can be used to help identify similarities between events and their outcomes. This can be useful in marketing, security, health fields, and many more situations. For example with data mining it is possible to identify over 50% of American citizens by their birthday, sex, and the city that they were born in.

What I hope to be able to use weka for is for network security reasons. With its ability to use algorithms to find the possible outcome of the dataset it would be able to potentially protect networks from malicious intent. This would be a huge step forward for that network to be able to correctly identify a DDOS attack before it can overload the network.

Future Labs on Weka

Future labs will go into greater details on how to use weka with different datasets and how to modify the classifiers so that you can get the truest probability possible. I also want to go over the importance of gathering information and how collecting a good dataset is more important than how well your algorithm is. Another thing I plan on doing in future labs is to focus on how to be able to use weka as a security tool for a network, so that it could correctly identify DDOS attacks.

Conclusion

Data mining and machine learning are very powerful tools and can be applied to just about any situations that has well defined datasets.

If you want a more indepth view of weka for now you can watch the youtube series that go over weka in great detail at https://www.youtube.com/user/WekaMOOC and go to the datamining with weka playlist.