PRACTICE!

- The use the WEKA software. It is opensource (GNU) freely downloadable from
- http://www.cs.waikato.ac.nz/ml/weka/
- Weka 3.6 is the latest stable version of Weka.
- Weka is a collection of algorithms for data mining tasks and contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization.
- Tutorials can be found at the Weka web site

Machine Learning with Weka

- Comprehensive set of tools:
  - Pre-processing and data analysis
  - Mining algorithms
    (for classification, clustering, etc.)
  - Evaluation metrics
- Three modes of operation:
  - GUI
  - command-line (not discussed)
  - Java API (not discussed)

  Weka can read ARFF file or CSV files.

ARFF FILES

- ARFF files have two distinct sections.
- Header information: The Header of the ARFF file contains the name of the relation, a list of the attributes (the columns in the data), and their types.
- Data information.

Attribute-Relation File Format (ARFF)

- Weka reads ARFF files:

Header

Comma Separated Values (CSV)

- Supported attributes:
  - numeric, nominal, string, date

ARFF FILE: EXAMPLE

```
@RELATION iris
@ATTRIBUTE sepallength  NUMERIC
 @ATTRIBUTE sepalwidth   NUMERIC
 @ATTRIBUTE petallength  NUMERIC
 @ATTRIBUTE petalwidth   NUMERIC
@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
```

Data Mining Practice: Exploring Data

WHAT IS DATA EXPLORATION?

A preliminary exploration of the data to better understand its characteristics.

- Key motivations of data exploration include
  - Helping to select the right tool for preprocessing or analysis
  - Making use of humans' abilities to recognize patterns
    - People can recognize patterns not captured by data analysis tools
- Related to the area of Exploratory Data Analysis (EDA)

VISUALIZATION

Visualization is the conversion of data into a visual or tabular format so that the characteristics of the data and the relationships among data items or attributes can be analyzed or reported.

- Visualization of data is one of the most powerful and appealing techniques for data exploration.
  - Humans have a well developed ability to analyze large amounts of information that is presented visually
  - Can detect general patterns and trends
  - Can detect outliers and unusual patterns

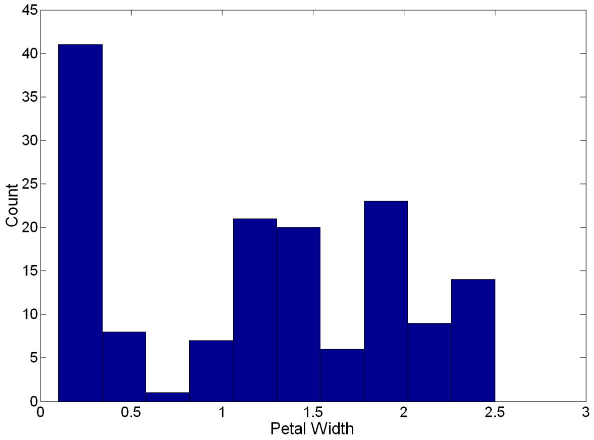
Iris Sample Data Set

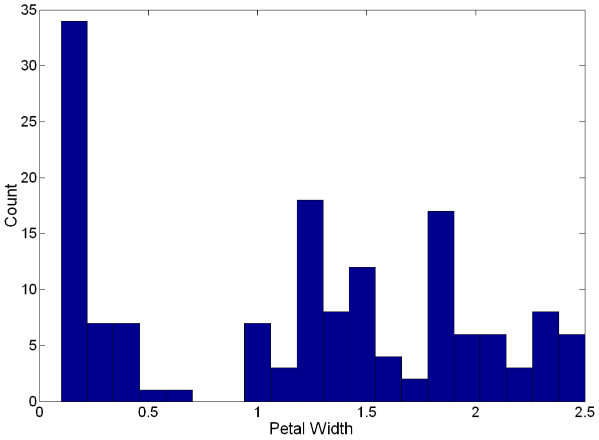
- Many of the exploratory data techniques are illustrated with the Iris Plant data set.
  - Can be obtained from the UCI Machine Learning Repository http://www.ics.uci.edu/~mlearn/MLRepository.html
  - From the statistician Douglas Fisher
  - Three flower types (classes):
    - Setosa
    - Virginica
    - Versicolour
  - Four (non-class) attributes
    - Sepal width and length
    - Petal width and length

Virginica. Robert H. Mohlenbrock. USDA NRCS. 1995. Northeast wetland flora: Field office guide to plant species. Northeast National Technical Center, Chester, PA. Courtesy of USDA NRCS Wetland Science Institute.

VISUALIZATION TECHNIQUES: HISTOGRAMS

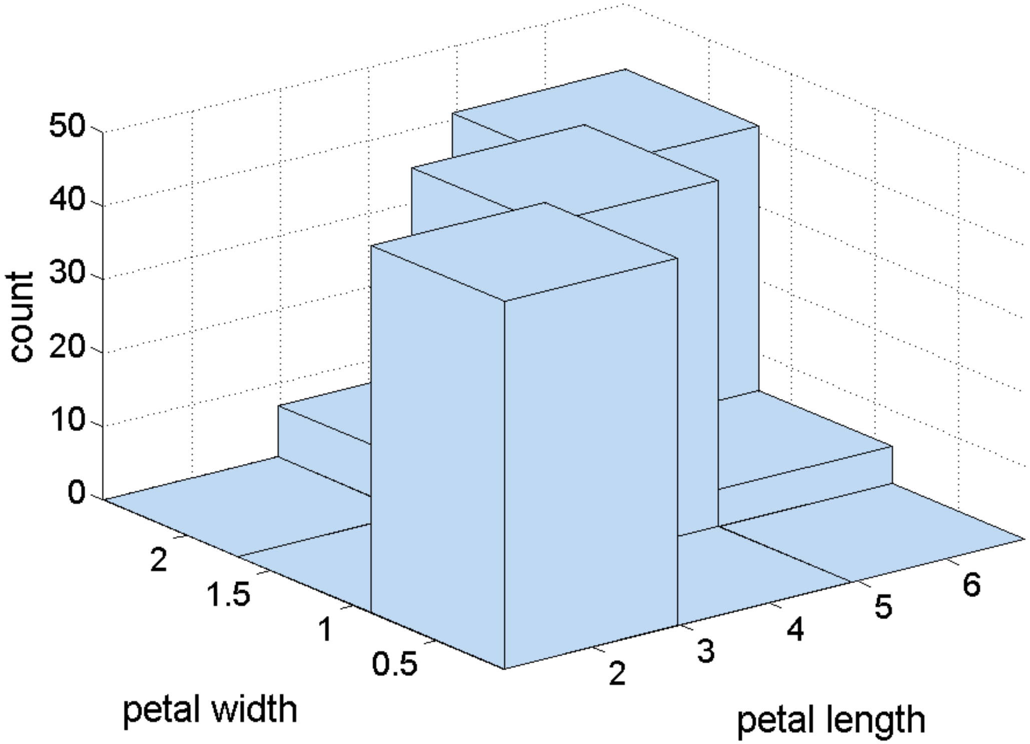
- Histogram
  - Usually shows the distribution of values of a single variable
  - Divide the values into bins and show a bar plot of the number of objects in each bin.
  - The height of each bar indicates the number of objects
  - Shape of histogram depends on the number of bins
- Example: Petal Width (10 and 20 bins, respectively)





Two-Dimensional Histograms

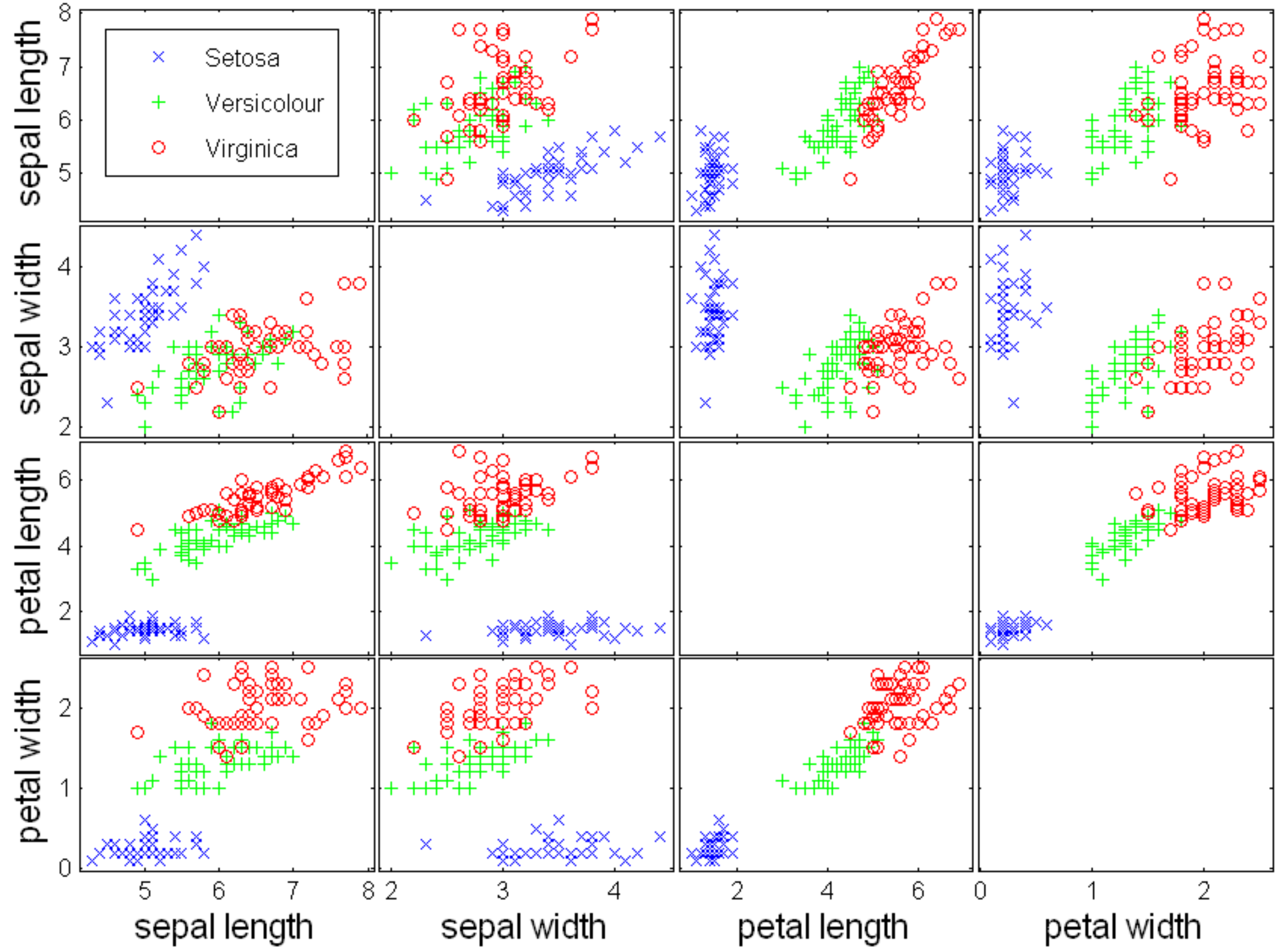
- Show the joint distribution of the values of two attributes
- Example: petal width and petal length



Visualization Techniques: Scatter Plots

- Scatter plots
  - Attributes values determine the position
  - Two-dimensional scatter plots most common, but can have three-dimensional scatter plots
  - Often additional attributes can be displayed by using the size, shape, and color of the markers that represent the objects
  - It is useful to have arrays of scatter plots can compactly summarize the relationships of several pairs of attributes
    - See example on the next slide

Scatter Plot Array of Iris Attributes



Which are the attributes most related?

Practice!

Data Preprocessing: Exercise 1

- Download and install the last stable version of Weka
- Open Weka, select the Explorer button and load the IRIS dataset
  - How many records are in this dataset?
  - How many attributes? And classes?
  - Which are the types of the attribute?
  - Which is the attribute with greatest standard deviation? Which is the interpretation of this value?
  - Visualize the plot of all the attributes. Which are the most correlated?

DATA PREPROCESSING: EXERCISE 2

- Preprocessing on the Iris dataset:
- Discretize the numeric attributes of the Iris dataset using the unsupervised Discretize filter into 5 bins.
- Notice the obtained discretization. How many elements in each interval? Is this discretization well balanced?
- Now “undo” and try supervised discretization: how many bins you have now? Are the intervals well balanced?
- Which are the attributes most relevant respect to the class?

DATA PREPROCESSING: EXERCISE 3

- Load the dataset old_faithful
- Use the visualization tab to perform visual inspection
- Visualize the scatter plot for the combinations of: F1 vs F2. Are these attributes related or not?
- Determine visually the data points that are the outliers (extreme high or low values).
- From the preprocessing tab, normalize the attributes to be in the [0,1] interval – use of the Normalize filter

Data Preprocessing: Exercise 4

- Load the breast cancer dataset CSV version
- How is the attribute values distribution?
- Remove the ID using the Remove filter
- How is the correlation between the variables?

DATA PREPROCESSING: EXERCISE 5

- Prepare data for Weka: read the car dataset information and edit the car dataset to be read by Weka.
- Remind you need the CSV format, therefore the name of the attributes must appear in the first row. You can use Excel or a text editor.

PREPROCESSING: EXERCISE 6

- Load the bank dataset.
- Edit data to make some missing values:

Delete some data in "region"(Nominal) and "children"(Numeric) attributes.

- Click on "OK" button when finish
- Choose "ReplaceMissingValues" filter
- Look into the data. How did those missing values get replaced ?
- Save the file as bank-data-missing.arff

Classification: Exercise 1

- Load in Weka the Weather dataset and select the Classify tab
- Select the classifier J48 and run with the default options.
- Visualize the tree
- Visualize the errors
- Play with the parameters of J48 to improve the quality of the classifier

Classification: Exercise 2

- Load the Bank dataset
- Run J48 with default values. How is the performance of the tree?
- Try to apply feature selection to improve the performance.
- Try Cross-validation 10 folds / Use training set / Percentage split. Which is the best?
- Play with parameters to improve the performance. Which is the best combination?

CLASSIFICATION: EXERCISE 3

- Load the Breast cancer dataset
- Run some of the classifiers available on weka (recall that decision tree needs discretized values…) with different options and to find the best result
- Which is the best classification and how many instances are incorrectly classified?
- What can you infer from the information shown in the Confusion Matrix?
- Visualize the classifier errors. In the plot, how can you differentiate between the correctly and incorrectly classified instances? In the plot, how can you see the detailed information of an incorrectly classified instance?
- Save the learned classifier to a file
- How can you load a learned classifier from a file?

Classification: Exercise 4

- Load the zoo dataset
- Go to the classifier tab and select the decision tree classifier j48
- Which percentage of instances is correctly classified by j48?
- Which families are mistaken for each other?
- Change to binarySplit and build a new decision tree. What is the difference?
- Experiment with some of the other classifiers and until you get a better classification performance. Write down the classifier and its performance.

CLASSIFICATION: EXERCISE 5

Load the ’labour’ data set (labor.arff) that contains data of acceptable and unacceptable labour contracts.

Examine the data and attributes and make sure you understand their meaning.

Run J48 with all options set to default. Make sure that the class attribute is selected as the classification label, and that you have selected cross-validation. Right click on the experiment (left panel – the Result list) and select the Visualize tree option.

Analyse the the resulting accuracy. Analyse the detailed accuracy by classes – what are TP and FP? Make sure you understand all the data reported in the classifier output pane (e.g. confusion matrix)? Which class is easier to predict?

Repeat the classification using the vacation attribute as the classification label. Are these results acceptable?

CLUSTERING: EXERCISE 1

- Load the Iris dataset
- Visualize the dataset from the Visualize tab.
- Now select the cluster tab, the “use training set” option and run the algorithms *cobweb* and *SimpleKmeans*.
- Right click each of the results and visualize the cluster assignments
- Compare the cluster assignment with the class labeled plot
- Which cluster is the best?

Clustering: Exercise 2

- Now run again the algorithms but select the option “classes to cluster evaluation”. In this mode Weka ignores the class attribute and generates the clustering. Then it compares the obtained cluster with the classes to compute the classification error.
- Which cluster is the best?
- Play with cluster options to improve clustering results.

Clustering: Exercise 3

- With the IRIS dataset loaded, remove the class attribute with the preprocessing tab.
- Then run the DBScan algorithm.
- How many clusters did it find?
- Change the parameters setting to improve the result

Clustering: Exercise 4

- Load the Bank dataset
- Run the simpleKMeans setting 6 clusters
- Which are centroids of the cluster? How can you characterize each cluster?
- Now visualize the clusters graphically. You can choose the cluster number and any of the other attributes for each of the three different dimensions available. Explore the discovered cluster.
- Now change the cluster parameters. How the cluster changes?
- Try the ignore attribute option. Which is the best clustering?
- Save the best clustering you find

Clustering: Exercise 5

- Load the flag dataset
- Run the coweb clustering algorithm (hierarchical) with parameters A=1.0 and C=0.4
- Visualize the cluster output.
- Change the parameters and visualize the results.
- How can you interpret the output?
- Try the "classes to cluster evaluation "option. How good is the resulting clustering?

Association rules: exercise 1

- Load the bank dataset and discretize the attributes that are numeric. This pre-processing can be done with filtering.
- Now run the association rule algorithm and play with the parameters.
- Which rules are always true? Write them down.
- Write down a couple of interesting rules and a couple of trivial rules.

Association rules: Exercise 2

- Load Iris dataset and run association analysis (note that association rules work on nominal attributes!)
- generate 10 association rules and discuss some inferences you would make from them
- Then change the support and confidence to lower values. What happened?
- Select the OutputItemset option and run again the Apriori algorithm. What's happened?

Association rules: Exercise 3

- Load the contact-lens dataset and run association analysis Apriori
- Which is the best rule found?
- Can you correlate this rule with the decision tree?

ASSOCIATION RULES: EXERCISE 4

Load the Weather-nominal dataset

- Run association analysis.
- How many rules fund?
- Which is the maximum support for which you can find rules? Try to adjust the confidence to find rules with higher support. What is the interpretation?

ASSOCIATION RULES: EXERCISE 5

Load the zoo dataset

Deselect the animal and legs attributes. The animal attribute is the name of the animal, and is not useful for mining.

The legs attribute is numeric and cannot be used directly with Apriori. Alternatively, you can try to use the Discretize Filter to discretize the legs attribute.

Try Apriori algorithm with the default parameters. Record the generated rules.

Vary the number of rules generated. Try 20, 30, ... Record how many rules you have to generate before generating a rule containing type=mammal.

Vary the maximum support until a rule containing type=mammal is the top rule generated. Record the maximum support needed.

Select one generated rule that was interesting to you. Why was it interesting? What does it mean? Check its confidence and support – are they high enough?