**Assignment 1: Decision tree learning for cancer diagnosis**

In this mini-project, you will implement a decision-tree algorithm and apply it to breast cancer diagnosis. For each patient, an image of a fine needle aspirate (FNA) of a breast mass was taken, and nine features in the image potentially correlated with breast cancer were extracted. Your task is to develop a decision tree algorithm, learn from data, and predict for new patients whether they have breast cancer. Dataset can be downloaded from U.C. Irvine Machine Learning Repository.

1. Each patient is represented by one line, with columns separated by commas: the first one is the identifier number, the last is the class (benign or malignant), the rest are attribute values, which are integers ranging from 1 to 10. The attributes are (in case you are curious): Clump Thickness, Uniformity of Cell Size, Uniformity of Cell Shape, Marginal Adhesion, Single Epithelial Cell Size, Bare Nuclei, Bland Chromatin, Normal Nucleoli, Mitoses. (Note that the UCI document page specifies a different number of attributes, because it refers to a set of several related datasets. For detailed information of the dataset that we use here, see this document.)
2. Implement the ID3 decision tree learner, as described in Chapter 3 of Mitchell. You may program in C/C++, Java. Your program should assume input in the above format.
3. Implement *information gain* for evaluation criterion.
4. Divide the data set randomly between training (80%) and testing (20%) sets. Use your algorithm to train a decision tree classifier and report accuracy on test. Run the same experiment 100 times. Then calculate average test performances (accuracy, precision, recall, f-measure, g-mean).
5. Compare performances by varying the evaluation criteria. Make a table as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Evaluation Criteria | Accuracy | Precision | Recall | F-measure | G-mean |
| *information gain* |  |  |  |  |  |

1. Prepare yourself to answer the following types of question/ concept:
   1. Do you see evidence of overfitting in some experiments? Explain.
   2. How to handle continuous attributes?
   3. What is the inductive bias?

Ans:

Inductive bias is the set of assumptions that, together with the training data, deductively justify the classifications assigned by the learner to future instances. Given a collection of training examples, there are typically many decision trees consistent with these examples. Describing the inductive bias of ID3 therefore consists of describing the basis by which it chooses one of these consistent hypotheses over the others. ID3 prefers short decision trees over complex trees.

Trees that place high information gain attributes close to the root are preferred over those that do not.

* 1. What should we do for attributes like date, serial no, mobile number?
  2. Decision Tree Representation.

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