CISC 859 Pattern Recognition

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Many situations require recognition of patterns in data. The data can be one-dimensional as in speech and electrocardiograms, or two-dimensional as in document images and satellite images, or three-dimensional as in image sequences and volumetric medical data like CT scans. The field of pattern recognition provides general, domain-independent techniques for data analysis. In this course we study statistical and structural pattern recognition techniques.

Statistical pattern recognition is applied to classification problems: a sample is assigned to one of a prespecified set of classes. For example, in character recognition a pattern is classified as belonging to one of about 75 classes "a" to "z", "A" to "Z", "0" to "9", and punctuation. In contrast, signature validation uses only the two classes *real* and *forgery*. The following steps are used in statistical pattern recognition:

1. Choose a set of features that can be measured from the input data. For character recognition, we can choose to measure features such as symmetry, number of holes, average stroke direction, and so on.
2. Characterize the feature values that are observed on training data. For character recognition, we collect data about the feature values for samples from class "a", class "b", class "c" etc. This data is used to train the classifier; details of the training procedure depend on the type of classifier.
3. Classify an unknown pattern by measuring feature values and comparing to the feature values that we know (from step 2) are expected for "a", for "b", for "c", etc. This comparison can be done in many different ways. In this course we study template matching, the Bayes classifier, nearest neighbour classifier, decision tree, and other approaches.
4. Test the classifier to obtain an estimate of its performance. We discuss how to make good use of the available data to serve the needs of both classifier training and classifier testing. The test data must be distinct from the training data to avoid obtaining a falsely high estimate of classifier performance.

Structural pattern recognition builds a description of the internal structure of a pattern. Structural methods must be used when the pattern recognition problem is too complex to be stated as classification into prespecified categories. For example, consider the problem of analyzing an image obtained by a mobile robot: pattern recognition needs to produce a description that defines the objects in the image and how they are related. One form of structural pattern recognition is called *syntactic* pattern recognition. Grammatical techniques are used to describe and analyze pattern structure. We study various ways of extending string-based grammars and parsers (as used in compilers) so that they can be used to recognize patterns in noisy two-dimensional and three-dimensional data. We also discuss structural pattern recognition techniques that use various forms of inexact graph matching.