**Bayesian Classification**

used for statistical classification(especially mathematical statistics) - "predicts" the class membership probabilities for a given tuple for "classification" of the tuples in the input data set - mainly based on bayes' theorem - broadly categorised into Simple or Naive Bayesian Classifiers and Bayesian Belief Networks

Bayes' Theorem

Given a tuple X (or evidence) characterised by a n-dimensional attribute vector can be classified into a specified class C among all the available classes based on a hypothesis H.

For classification, the *posterior* or *posteriori* probability P(H|X) (ie. probability that the particular hypothesis holds the "evidence") and *prior or priori* probability P(H) (ie. probability of the hypothesis in general under no specific conditions) are determined. The postpriori and the priori probabilities of X given H can also be computed. The estimation of either of these four quantities can be given by the relation between them, provided other three probabilities are readily available or readily computed.



Naive Bayesian Classifiers

In a training set of tuples D with each tuple having their associated class labels, each tuple can be classified into its respective class. Each tuple is a n-dimensional attribute vector and *m* number of classes are given to contain these tuples. The classifier will predict that a particular tuple X will fit in a class which has the *maximum posteriori probability.*

The naive classifiers work on the principle of *Class Conditional Independence (CCI)*. This is a basic assumption that no two attributes describing a tuple will hold any relations between,ie. each attribute is conditionally independent of one another. This is taken into consideration to reduce and simplify the computations involved in estimating the probabilities.

Another fundamental assumption is that D is so large that adding one to each count that we need would only make a negligible difference in the estimated probability value, yet would conveniently avoid the case of probability values of zero. Thus Laplacian Correction or Laplace Estimator is used for probability estimation.

This classifier deals with both categorical and continuous-valued attributes. For computing from continuous values, Gaussian Distribution can also be used.

Bayesian Belief Networks

this is a representation of dependencies among subsets of attributes - deals with joint conditional probability distributions - gives the probability dependence - graphical model of causal relations and represents causal knowledge.

Two components - directed acyclic graph and continuous probability tables. From this technique, actual as well as hidden random variables can be computed for further categorization of the tuple X.

Bayesian Inference

used for dynamic analysis of sequence of data - adaptable for running or stagnant water analysis and also dynamic change in weather conditions immediately above the water body - based on "subjective" probability - uses rational method to update beliefs

Every unique Bayesian procedure is admissable - Characterized and admissible procedures as Bayesian procedures make the Bayesian formalism a "central" technique in areas of :

frequentist inference

parameter estimation

hypothesis testing

computing confidence intervals

< thought of successful implementation of this theorem in the field of water monitoring is done for the first time by us >

(>?>?>?) Experiments in water quality systems using this theorem are going on. A model for the above, based on the features transmitted from the local fusion centers to fuse them and provide decisions and format the thresholds, can be figured. The implementation of this formula for the proposed system can be done easily and scope is large too.(>?>?>?)

<<<<The model accurately describes the observed patterns and also provides realistic estimates of predictive uncertainty for water quality variables. The Bayesian estimations are also used for appraising the exceedance frequency and confidence of compliance of different water quality criteria. The second part introduces a Bayesian hierarchical framework (BHF) for calibrating eutrophication models at multiple systems (or sites of the same system). The models calibrated under the BHF provided accurate system representations for all the scenarios examined. The BHF allows overcoming problems of insufficient local data by “borrowing strength” from well-studied sites. Both frameworks can facilitate environmental management decisions. >>>>

**Advantages**

1. comparable in performance with decision tree and selected neural nnetwork classifiers.

2. high accuracy and speed when applied to large databases

3. minimum error rate

**Disadvantages**

1. computationally expensive for data sets with many attributes, but can be reduced using *CCI.*

2. inaccuracies due to *CCI* and lack of available probability data

**References**

1. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Second Edition, Elsevier, 2007

2. Wikipedia "Bayesian Inference"