Lecture 2
Applications of ANN

Outline

- **General models of ANN Applications**
  - Pattern Classifications
  - Control, time series modeling, estimation
  - Optimization
- **Real world application examples**

Applications of ANN

- Many memoryless ANN paradigms, such as MLP can be modeled mathematically as a *nonlinear mapping* between the inputs (feature vectors) and outputs.
  - Discrete output values: classification problem
  - Continuous output values: approximation problem
- ANN structures with feed-back loops such as recurrent net can be used to model dynamic systems where state information is used.

Pattern Classification Applications

- Speech Recognition and Speech Synthesis
- Classification of radar/sonar signals
- Remote Sensing and image classification
- Handwritten character/digits Recognition
- ECG/EEG/EMG Filtering/Classification
- Credit card application screening
- Data mining, Information retrieval

Control, Time series, Estimation

- Machine Control/Robot manipulation
- Financial/Scientific/Engineering Time series forecasting.
- Inverse modeling of vocal tract

Optimization

- Traveling sales person
- Multiprocessor scheduling and task assignment
- VLSI placement and routing

Real World Application Examples

- S&P 500 index prediction
- Real Estate appraisal
- Credit scoring
- Geochemical modeling
- Hospital patient stay length prediction
- Breast cancer cell image classification
- Jury summoning prediction
- Precision direct mailing
- Natural gas price prediction

Financial Applications

- S&P 500 Index Prediction by LBS Capital management, Clearwater,FL
  - Input: commodity available indicators ADX, MACD, volume, etc.
  - Output: S&P 5 days in future.
  - Combine an expert system with a neural network.
  - Retrained every night to keep current
  - Claimed to achieve 95% accuracy in buy/sell signals.

www.calsci.com/S&P500.html

Business Applications

- ## Real estate appraisal

  - R. A. Borst, *Artificial Neural Networks: The Next Modeling / Calibration Technology for the Assessment Community?*, Property Tax Journal (International Association of Assessing Officers), 10(1):69-94, 1991.

  - Richard Borst, a Senior Vice President at Day & Zimmerman, Inc., the nation's leading provider of mass appraisal services to state and local governments, has successfully trained a neural network to appraise real estate in the New York area.

  - 18 inputs. Output is the apprised price of a property.

  - Use 217 sales records as training data.

www.calsci.com/REAppraisal.html

Business Applications

- ## Credit Scoring
  - ### Determine whether a load should be approved based on features extracted from applicant's information

- ## Inputs:
  - ### Own/Rent your home, Years with Employer, Credit Cards, Store Account, Bank Account, Occupation, Previous Account, Credit Bureau

- ## Outputs:
  - ### credit scores: delinquent, charged-off, or paid-off

Mining Applications

- ## Geochemical modeling
    - By applying neural pattern recognition technology, Uranerz USA is reinterpreting the Ren gold property in the Carlin trend of northern Nevada -- **The Northern Miner, September 15, 1997**
    - Developed by William Henderson, chairman of US mineral Labs.

  - Examine 52 variables from 7000 soil samples over a 1 mi^2 area and produce a map of mineral deposit's alteration system.
  - Result indicates possible gold porphyry at depth.

Medical Administration Appl.

- Hospital Patient stay length prediction System:
  - Steven Epstein at Anderson Memorial Hospital in South Carolina developed the CRTS/QURI system with a neural network that predicts how many days a patient will stay in hospital and the mode of discharge (routine to death).

- Benefit: Better patient care, save money.

- Input: 7 categories
  - diagnosis, complications/comorbidity, body systems involved (e.g., cardiac and respiratory), procedure codes and their relationships (surgical or nonsurgical), general health indicators (smoking, obesity, anemia, etc.), patient demographics (race, age, sex, etc.), and admission category.

- Output: length of Hospital stay

- Performance: 95% accuracy

- Training:
  - 3 years of patient data. 80,000 patients and 473 primary diagnosis. Two networks are trained for each diagnosis: one for predicting the length of stay and the second predict the mode of discharge.

Medical Diagnosis

- ## Classification of Breast Cancer Cells
  - ### By Andrea Dawson, MD of the University of Rochester Medical Center, et al.
- ## Goal: to automate the classification process
- ## Input: 17 morphometric features including
  - object size, object shape, object sum density, object average density, object texture, angular second moment
  contrast, difference moment, sum variance, difference variance (Fisher), difference entropy, information measure B, maximum correlation coefficient, difference variance, diagonal moment, second diagonal moment, product moment
- ## Outputs:
  - ### well differentiated, moderate, poor, benign

- ## Performance: 52%-89%

Management Applications

- ## Jury Summoning Prediction
  - Problem: Courts often waste money by calling (and paying for) more potential jurors to show up and wait around than are needed for the cases being heard
  - Solution: Use a neural network to predict # of jurors needed for the next day
  - Input: Judge #, type of cases,
  - Output: total jurors needed.
  - Benefit: saving over 70 millions.
  - Developed by Mr. Robert MacNeel as Director of Data Processing for Montgomery Courthouse, Norristown, PA.

Marketing Application

- ## Improving direct mailing response rate
    - ### Problem: Each year, Microsoft sends out about 40 million pieces of direct mail to 8.5 million registered customers. Generally, the first mailing includes everyone in the database. The key is to send the second mailing to only those individuals who are most likely to respond
    - ### Solution: Use a neural network to select those who are likely to respond to the second mailing.
    - ### Input: 9 variables,
    - ### Output: score between 0 and 1 indicating whether an individual should receive 2nd mailing.
    - ### Benefit: improve response rate from 4.9% to 8.2%, saving 35% of mailing cost.

Energy Cost Prediction

- ## Natural gas price prediction
  - Dr. Al Behrens of Northern Natural Gas in Nebraska has developed a neural network that predicts next month's gas price change
  - Inputs: quarter of the year, season, NNG's sales commodity rate last year, NNG's market sensitive price last year, Nat. Gas Week price index last month, Nat. Gas Week price index last year, Degree-days last month
  - Output: gas index next month
  - Benefit: an average accuracy of 97%.