MONASH University

Information Technology

FIT5186 Intelligent Systems

Lecture 12

Unit Review and Exam Preparation

Lecture Topics

Lecture	Topic
1	Introduction to Intelligent Systems and Neural Networks
2	Neuron Learning and Perceptrons
3	Multilayered Networks
4	Supervised Learning - Backpropagation Learning Rule
5	Classification and Prediction with Case Studies
6	Unsupervised Learning - Clustering with Self-Organisation
7	Unsupervised Learning with Adaptive Resonance Theory
8	Data Mining and Knowledge Discovery
9	Other Intelligent Techniques
10	Fuzzy Logic
11	Business Intelligence Modelling - Decision Analysis under Uncertainty
12	Decision Trees, Decision Making using Sample Information

Research on Neural Networks

- Neural networks have very strong support and high expectations from business and industry; however, neural networks cannot do everything.
  - Learning and training:
    - Trying to get better performance and faster.
  - Which architecture for which problem?
  - Autonomous and adaptive learning:
    - Systems which are unsupervised and learn “on-line” in real time, which can be used to replace humans (in dangerous situations for example).
  - Deep learning for NNs with multiple hidden layers.

Emerging Directions

- Integration of Intelligent Systems with current technologies
  - Built into/onto business software (e.g. Excel).
  - Companies like IBM are already doing this.

- Speed and Storage
  - Need advances in hardware design.
  - This will be market-driven (smaller and faster).
  - Already we have neural chips for MFNN and self-organising neural networks (and others).
  - Also Field Programmable Gate Arrays (FPGA's) which allow hardware to be reconfigured from a PC.

Conclusion on NN Research

- Neural network research has come a long way since the days of the Perceptron in a relatively short time.
- The popularity and wide applicability of the field will ensure that developments continue.
- These developments will see neural networks (as part of intelligent systems) emerge as a powerful tool for business and industry in the 21st century.

Lecture 1: Introduction to Intelligent Systems and Neural Networks

- What is artificial intelligence (AI)?
  - AI is intelligence exhibited by machines
  - How to make computers do things at which people are doing better.
- What are neural networks?
  - Properties of Neural Networks
  - How do they work?
  - What can they do?
- Applications of neural networks
- A brief history of neural networks

Lecture 2: Neuron Learning and Perceptrons

- What is learning?
  - The modification of behaviour through experience.
- Simple artificial neuron models
  - McCulloch-Pitts model
- NN Learning
  - Learn relationships between inputs and outputs by adapting the weights to reflect some experience.
  - Supervised learning and unsupervised learning.
- Single Layer Discrete Perceptrons Learning
  - Decision boundaries
  - Classification
    - Dichotomisers
    - Multicategory (R-category) classifiers
  - Linear separability and limitations

Lecture 3: Multilayered Networks

- Multilayered Discrete Perceptrons
  - Can classify linearly non-separable data.
- The credit assignment problem
  - Need a continuous activation function.
- Multilayered Feedforward Neural Network (MFNN)
  - Input layer
  - Hidden layer
  - Output layer
  - Each neuron uses a sigmoidal activation function after summing weighted inputs.

Lecture 4: Supervised Learning - Backpropagation Learning Rule

- The backpropagation learning algorithm
- Training issues and parameter selection
  - Avoiding local minima
    - Through choice of initial weights, learning rate, number of hidden neurons, activation function parameters, and momentum term.
  - Generalisability - generalisation ability
- Practical issues

Lecture 5: Classification and Prediction with Case Studies

- Classification vs. Prediction
- Analysis issues for solving classification/prediction problems using MFNN models
  - Training set and test set;
  - Performance measure: classification accuracy rate, R^2, MSE or RMS error
- Case study 1: Classification
  - Involves learning to classify loan applicants as good or bad credit risks.
- Case study 2: Prediction
  - Involves learning to predict the daily exchange rate of the Australian dollar against the US dollar.
    - Pre-processing the data
      - 1-out-of-N Encoding technique.

Lecture 6: Unsupervised Learning - Clustering with Self-Organisation

- K-Means algorithm
- Winner-Take-All Networks
- Self-Organising Maps (SOMs)
  - Special learning features of SOMs
    - Use similarity (distance) measure to calculate the neuron output
    - Use the concept of a neighbourhood of weight updates
  - The SOM algorithm
  - Properties of SOMs
    - Global competition and local cooperation

Lecture 7: Unsupervised Learning with Adaptive Resonance Theory

- The neural network approach to clustering is via the SOM.
  - The stability-plasticity dilemma.
- The Adaptive Resonance Theory
  - The solution to the stability-plasticity dilemma.
  - An extension of some unsupervised competitive learning schemes (self-organisation).
  - ART1: classification of binary input patterns.
- The ART1 Algorithm
  - The vigilance factor

Lecture 8: Data Mining and Knowledge Discovery*

* Not examinable

- What is data mining?
  - Methodology; Holistic Approach
- Data Mining Purposes and Algorithms
- Knowledge Discovery Approach
  - Directed and Undirected Knowledge Discovery
  - Typically, we use a combination of both directed and undirected knowledge discovery (a.k.a. supervised and unsupervised learning in NN).
- Statistical Approaches
  - Correlation, linear regression, moving average, multiple regression, factor analysis
- Decision Trees
- Case studies

Lecture 9: Other Intelligent Techniques*
Lecture 10: Fuzzy Logic*

* Not examinable

- Optimisation
- Genetic Algorithms
  - Crossover and mutation
- Expert Systems
- Fuzzy logic provides a formal system of numerical computation for linguistic variables whose values are characterised by fuzzy sets (fuzzy numbers).
  - Membership functions
- Knowledge used in fuzzy systems is often represented by a set of conditional fuzzy rules.
  - Fuzzy rule calculation with AND, OR operators
- Hybridisation of intelligent techniques

Lecture 11: Decision Analysis under Uncertainty *

* Not examinable

- A payoff table or payoff matrix shows payoffs for all combinations of decision alternatives and states of nature.
- Decision rules without probability information (Example 1)
  - Maximax
  - Maximin
  - Minimax Regret
- Decision rules with probability information (Examples 1 and 2)
  - Expected Monetary Value (EMV)
  - Expected Regret or Opportunity Loss (EOL)
- Expected Value of Perfect Information (EVPI) (Examples 1 and 2)

  EVPI = Expected Value with Perfect Information – Maximum EMV

Lecture 12: Decision Trees and Decision Making Using Sample Information*

* Not examinable

- Decision Trees (Examples 1-3)
  - Drawing decision trees showing the decision alternatives, the states of nature (events), probabilities and payoffs.
  - Evaluating decision trees using the EMV decision rule.
- Decision Making Using Sample Information
  - Conditional probabilities given subjectively (Example 4).
  - Conditional probabilities calculated from joint probabilities obtained from historical data (Example 4)
  - Posterior probabilities (conditional probabilities) calculated from revising the prior probabilities based on the survey result using Bayes' Theorem. (Example 5)
  - Expected Value of Sample Information (Examples 4 and 5)

Exam Preparation Advice

- Make sure you understand (not memorise) the concepts/algorithms and the key issues discussed in lectures by
  - Going through the lecture notes, lecture examples, and tutorial exercises.
  - Practicing the sample exam paper for Lectures 1-4.
  - If you demonstrate understanding you will pass.
- All the formulas required will be provided in the exam paper.

Final Exam (60% of the total mark for the unit)

- Date: **Monday 4 June 2018**
- Time: **2:00 pm**
- Venue: **Room 8203** JGS building
- Duration: 2 hours (writing time)
  - plus 10 minutes reading time
- Format:
  - Part A: 10 short answer questions (44 marks)
  - Part B: 2 computation questions (16 marks)
- Scientific calculators are OK.
  - Graphical and programmable are not OK.

Final Exam

Part B: 2 computation questions (16 marks)

- Q11: Multilayered perceptron (6 marks)
  - Examples from Lecture 3 (the XOR problem)
- Q12: ART1 algorithm (10 marks)
  - Examples from Lecture 7
  - Week 8 Tutorial

Good Luck!