

IAI - Exercise Sheet 10

This week we have a set of exam style questions about the treatment of uncertainty and machine learning. They should be read in conjunction with your lecture notes and handouts for Weeks 10 and 11.

Question 1

In the context of the treatment of uncertainty in AI systems:

- (a) Explain the distinction between *imperfect domain knowledge* and *imperfect case data*, and provide a simple example of each.
- (b) Describe the three principal types of uncertainty that we may encounter, and provide a simple example of each.

Question 2

- (a) What is meant by the *frequentist* approach to probability theory?
- (b) Explain the distinction between *prior probability* and *conditional probability*.
- (c) What is *Bayes Rule*? How can it be derived? Provide a simple example of a problem for which it is useful.
- (d) What is meant by the *relative likelihood* of two events? Provide a simple example of a problem for which this concept is useful.
- (e) What are *conditional independencies*? Why are these important for probabilistic reasoning?
- (f) Outline what *Bayesian Belief Networks* are, and what they can be used for.

Question 3

- (a) Outline the important features of *Demster-Shafer Theory*, and how it is used.
- (b) Suggest an advantage that it has over traditional Bayesian reasoning.

Question 4

- (a) Outline what is meant by the terms *Fuzzy Set Theory* and *Fuzzy Logic*, and how they can be used for the treatment of uncertainty in AI systems. To what extent can they be used for all types of uncertainty, or are they only useful for particular types?
- (b) Suggest a disadvantage that Fuzzy Logic has compared with traditional Bayesian reasoning. Illustrate your answer with a simple example.

Question 5

- (a) Give a definition of the term *Machine Learning*.
- (b) Learning can be classified as being either: *Rote*, *Supervised*, *Reinforcement*, or *Unsupervised*. Explain what each of these terms mean, and provide a simple AI example for each.
- (c) Outline how *gradient descent learning* can be used for training neural networks. Suppose we train a neural network on a set of input values and associated classification outputs. What do we usually want the trained network to be able to do?
- (d) Outline how simulated evolution by natural selection can be used to develop useful AI systems. Describe an example of where this approach has proved successful for a real world application.

Question 6

- (a) What are the main aspects of building rule based expert systems that can be usefully assisted by using machine learning techniques?
- (b) Explain the distinction between *inductive rule learning* and *deductive rule learning*. Describe how each approach works.
- (c) Draw a flowchart for a simple *rule induction system*. Explain what happens at each stage of the induction process.
- (d) Outline the important operations that a good *rule refinement program* should be able to perform. Explain why each operation is useful.

Question 7

- (a) In the context of *concept learning* and *classification*, what is meant by the term *version space*?
- (b) Define the related concepts of *partial ordering* and *boundary set*.
- (c) Describe how training data can be used to refine the boundary sets in version space learning.

Question 8

- (a) What is a *decision tree*? How are decision trees related to rule based systems? Illustrate your answer with a simple example.
- (b) Outline an algorithm that is able to build up an appropriate decision tree from a set of training data.