Lunds Tekniska Högskola
Institutionen för datavetenskap

EDA132
VT 2011

Tillämpad Artificiell Intelligens
Applied Artificial Intelligence
Tentamen 2011-05-30, 08.00–13.00, MA8

You can give your answers in Swedish or English.
You are welcome to use a combination of figures and text in your answers.

1. (JM) Make a comparison of *minimax* and *alpha-beta* algorithms and clarify the differences with figures and explaining text. Answer in particular the following question: How much better result could you obtain by using alpha-beta? (4p)

2. (JM) Planning

   (a) Describe the wumpus domain as a planning problem, using STRIPS-kind of operators and the first-order (predicate) logic for states. What should be the goal of your agent? (3p)

   (b) Explain the terms *conformant planning* and *contingency planning*. (2p)

3. (JM) Reasoning

   (a) Describe the resolution inference rule. Give a concrete example of how it works. (2p)

   (b) What does it mean that resolution is a sound inference rule? (1p)

   (c) What are the differences between the resolution rule for the propositional case and for the first-order case? (2p)

4. (JM) A robot is located on the upper-left corner field on a $n \times n$ square grid, and we want to use different search algorithms to find a path to the opposite single corner. A robot can move to any adjacent field, i.e. horizontally, vertically or diagonally one step in each of the eight directions. Assume randomly placed obstacles.

   Describe the three search methods: depth first, breadth first, and A*, by showing typical examples of how they might find a path from start to goal. Give a good heuristic function for A*. Also state advantages and disadvantages of the three methods. (4p)

5. (JM) Explain the term *utility-based agent*. Name and describe its modules. (2p)

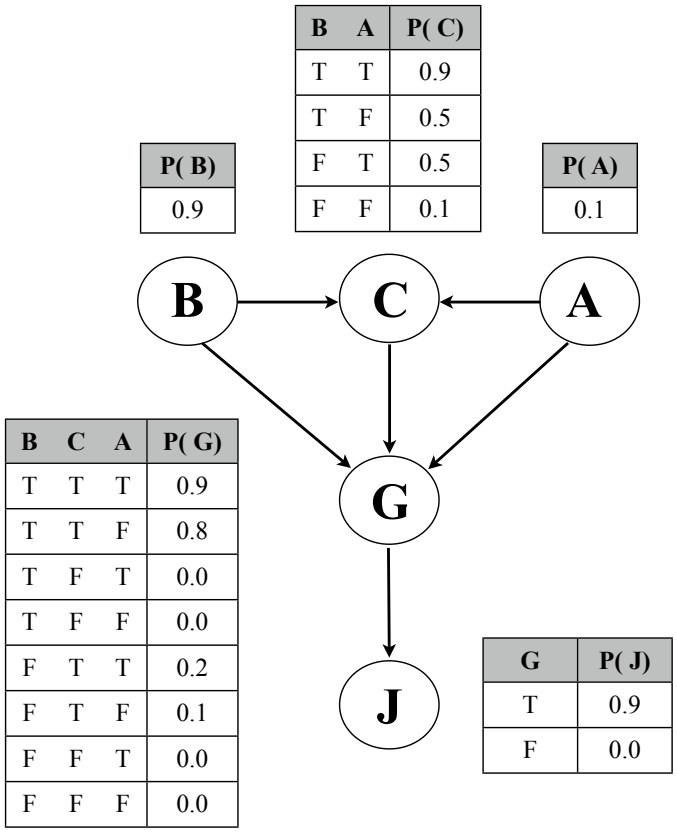

Figure 1: A simple Bayesian net with Boolean variables B = BrokeAnimalProtectionLaw, C = BroughtToCourt, A = AnimalLovingProsecutor, G = FoundGuilty, J = Jailed.

6. (EAT) Consider the Bayesian network, shown in Figure 1. It represents someone breaking the law for the protection of animals (B), and being brought to court (C), where there might be an animal-loving prosecutor (A). The person might be found guilty (G) and sent to jail (J).

   a) Which, if any, of the following expressions are asserted by the network structure (ignoring the CPTs)?
      i) $\mathbf{P}(B, C, A) = \mathbf{P}(B)\mathbf{P}(C)\mathbf{P}(A)$
      ii) $\mathbf{P}(J \mid G) = \mathbf{P}(J \mid G, C)$
      iii) $\mathbf{P}(A \mid G, B, C) = \mathbf{P}(A \mid G, B, C, J)$ (3p)

   b) A *context-specific* independence has the following form: X is conditionally independent of Y given Z in context $\mathbf{C} = \mathbf{c}$ if $\mathbf{P}(X \mid Y, Z, \mathbf{C} = \mathbf{c}) = \mathbf{P}(X \mid Z, \mathbf{C} = \mathbf{c})$. In addition to the usual

conditional independencies given by the graph structure, what context-specific independencies exist in the Bayes net in Figure 1? (2p)

7. (PN) The k-nearest neighbors method is a machine-learning algorithm:

   - Describe how it works.
   - Create an imaginary but plausible data set, where examples are points (two numerical attributes) divided in two classes. The data set should have 5 to 10 examples in each class.
   - Represent your examples on paper with dots and crosses to differentiate the classes.
   - You have created a data set that can either be linearly separable or not. To which class does your data set belong? Explain your answer.
   - Draw approximately the results of the nearest neighbors method for $k = 1$ and $k = 5$. (Two pictures). (4p)

   Write an algorithm that implements the k-nearest neighbors, where $NN(k, \mathbf{xq})$ is the set of k nearest neighbors of the **xq** input vector. You will consider the easy search formulation that uses a sequential list and you will use the Euclidean distance to compute the neighbors. You can use either a programming language or a pseudo-algorithmic presentation. The programming language you can use are: C, C++, Java, Perl, Python, Ruby or Prolog. (2p)

   Discuss possible improvements, such as binary trees and locality-sensitive hash maps. (2p)

8. (PN) The Table 1 below shows a parsed sentence from the Talbanken corpus of Swedish used in CoNLL 2006.

1	Men	men	++	++	_	3	++	_	_
2	numera	numera	AB	AB	_	3	TA	_	_
3	kan	kunna	QV	QV	_	0	ROOT	_	_
4	även	även	AB	AB	_	5	+A	_	_
5	dessa	denna	PO	PO	_	3	SS	_	_
6	försörja	försörja	VV	VV	_	3	VG	_	_
7	sig	sig	PO	PO	_	6	OO	_	_
8	själva	själv	PO	PO	_	7	PT	_	_

Table 1: An example Swedish sentence.

Draw the dependency graph of the sentence and annotate the links with the functions. Use the convention that the arc direction is from the head to the dependent.

Describe the four operations used by Nivre's parser: shift, reduce, left-arc, and right-arc.

Using gold-standard parsing, give the sequence of transitions that will produce the correct graph for this sentence. You will draw a figure representing the stack and the queue involved in each operation. You should not need more than 16 steps and thus 16 figures. Use the dedicated sheets, where the three first operations (shift, shift, left arc) are given. You will not use the ROOT dummy word. You will assign a root head to the words remaining in the stack after the parsing is complete.

Show that Nivre's parser has a linear parsing time that is bounded by $2n$ operations where n is the sentence length. Think of how a word will move in and out of the stack. (5p)

9. (PN) Text classification (or categorization) is a technique used in information processing.

   - Describe what it is
   - The vector space model is widely used to represent documents in categorization. Describe what it is and give the representation of these two sentences:
     (a) Text classification is a technique used in information processing
     (b) Genre classification is an example of text classification

   Describe how supervised learning can be applied to determine the category (or class) of a text. Describe the steps involved in this process. Describe what kind of machine-learning techniques can be applied to text categorization and which one has proven to have the best results.

   (5p)

10. (JM) Explain the terms *forward chaining* and *backward chaining* in the context of rule-based reasoning. Describe advantages and disadvantages of each. (2p)

Good Luck!