CS534 ARTIFICIAL INTELLIGENCE. A97 **PRACTICE FINAL EXAM**
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Problem 1 - Reasoning with Uncertainty (25 Points)

Consider the belief net on p. 446 (Russell and Norvig's book). Assume the prior and conditional probabilities given below:

- $P(B) = 0.95$
- $P(R|B) = .8 \qquad P(R|\neg B) = 0$
- $P(I|B) = 0.98 \qquad P(I|\neg B) = 0$
- $P(G) = 0.65$
- $P(S|I,G) = 0.9 \qquad P(S|I,\neg G) = 0 \qquad P(S|\neg I,G) = 0 \qquad P(S|\neg I,\ G) = 0$
- $P(M|S) = 0.7 \qquad P(M|\neg S) = 0$

Compute the following conditional probabilities (follow the algorithm on p. 452 as much as possible):

1. *(4 points diagnosis)* $P(\neg B|\neg M)$
2. *(4 points causal inference)* $P(\neg M|\neg B)$
3. *(4 points intercausal inference)* $P(\neg G|S,I)$
4. *(4 points mixed inference)* $P(R,G|I)$ (Hint: note that R and G are conditionally independent given I.)
5. *Multiple connected belief nets*: Add a root node event "Maintenance" (abbreviated by "A") which influences Ignition and Gas:

   $P(A) = 0.85 \qquad P(I|A) = 0.9 \qquad P(G|A) = 0.8.$

   (a) (5 points) Using the clustering method, transform the new net into a polytree and compute the conditional probabilities of the resulting meganode(s).

   (b) (4 points) Find $P(M|A)$.

Problem 2 - Decision Trees (20 points)

The clerk at a movie rental place wants to predict the behavior of one of his customers based on the customer's last 8 rentals (shown below):

GENRE	S&E REVIEW	RELEASE	RENTS
comedy	good	old release	yes
comedy	good	new release	yes
comedy	bad	old release	no
comedy	bad	new release	yes
action	good	old release	yes
action	good	new release	no
action	bad	old release	no
action	bad	new release	no

1. (15 points) Use information theory to construct a minimal decision tree that predicts whether or not the customer would rent a given movie. (Show each step of the computation.)

2. (5 points) Translate your decision tree into a collection of decision rules.

Problem 3 - Neural Networks and Genetic Algorithms (20 points)

1. (5 points) Consider a neural net with stair-step threshold functions. Suppose that you multiply all weights and thresholds by a constant. Will the behavior of the net change?

2. (5 points) Construct a neural net that computes the logical function $\Rightarrow$. Specify appropriate weights and thresholds.

A	B	A $\Rightarrow$ B
1	1	1
1	0	0
0	1	1
0	0	1

3. (10 points) Consider applying genetic algorithms to the task of finding appropriate set of weights for a neural net. Consider a 3x2x1 layered, feedforward network. Describe

   (a) an encoding of network weights as a bit string

   (b) appropriate set of crossover operators

   (c) fitness function

Problem 4 - Other AI Applications (35 points)

Answer all questions below except the ones about your own project 4.

1. **Machine Vision** (10 points) Suppose that the brightness of each pixel in an image is recorded as an integer number (see e.g. Figure 24.4 in the textbook).
   (a) (7 points) Describe in detail an algorithm for edge detection based on the associated brightness values.
   (b) (3 points) Illustrate the behavior of your algorithm with an example.
2. **Object Recognition** (5 points)
   (a) (2 points) Describe in words what a Fourier descriptor is.
   (b) (3 points) Describe how Fourier descriptors can be used for object recognition.
3. **Character Recognition** (5 points)
   (a) (3 points) Describe the approach followed in this project to recognize printed characters.
   (b) (2 points) Which of the assumptions made on this project fail to hold for the general case of handwritten character recognition?
4. **Chess and Checkers** (5 points)
   (a) Explain at least 3 heuristics for chess playing described on this project but not in class before. For each one, discuss its advantages and disadvantages.
5. **Fuzzy Logic and Manual Fire Suppression** (5 points)
   (a) (3 points) Describe what a fuzzy set is.
   (b) (2 points) Describe how fuzzy logic is used for fire protection on this project.
6. **Multi-agent collaborative learning** (5 points)
   (a) (3 points) Describe each of the two learning approaches used to implement the individual agents.
   (b) (2 points) Describe what type of collaboration took place between the agents.
7. **Constraint Satisfaction for Design** (5 points)
   (a) (3 points) What is a constraint satisfaction problem?
   (b) (2 points) What is a *dynamic* constraint satisfaction problem?
