

**Part I - Multiple Choice. 10 points total.**

Circle *the one* answer that best answers the question.

**1. Which of the following is an effect axiom in situation calculus?**

- a.  $\text{Holding}(g,s) \rightarrow \text{Poss}(\text{Release}(g),s)$
- b.  $\text{Poss}(\text{Grab}(g),s) \rightarrow \text{Holding}(g,\text{Result}(\text{Grab}(g),s))$
- c.  $\text{At}(\text{Agent},[1,2],\text{Result}(\text{Go}([1,1],[1,2],S_0))$
- d. Effect:  $\sim\text{Holding}(g)$

**2. Inference by enumeration**

- a. is based on conditional probabilities between atomic events
- b. is based on a list of random variables along
- c. is based on the full joint distribution of atomic events
- d. is based on a list of atomic events alone

**3. An ontology**

- a. is a method for representing uncertainty
- b. is a subset of first-order logic
- c. is an inference mechanism
- d. provides a vocabulary for expressing knowledge

**4. An inference procedure**

- a. is a knowledge representation
- b. provides rules for deriving new facts from existing facts
- c. is a proof
- d. is a type of Bayesian network

**5. An inference method is *sound* if it**

- a. can derive any sentence that is entailed
- b. only derives entailed sentences
- c. is efficient in both time and space
- d. is not NP-complete

6. An inference method is *complete* if it

- a. can derive any sentence that is entailed
- b. only derives entailed sentences
- c. is efficient in both time and space
- d. is not NP-complete.

7. The most general unifier of  $Q(y,G(A,B)), Q(G(x,x),y)$  is

- a.  $\{x/A, y/A\}$
- b.  $\{x/A, y/B\}$
- c.  $\{x/A, y/(G(A,B))\}$
- d. no unifier

8. Which of the following sentences is not always TRUE?

- a.  $A \Rightarrow A$
- b.  $A \Rightarrow B$
- c.  $A \vee B \vee \sim B$
- d. none of the above

9. Which of the following illustrates the *product rule*?

- a.  $P(A,B) = P(B|A)P(A)$
- b.  $P(A,B) = P(A|B)P(B|A)$
- c.  $P(A,B) = P(A)P(B)$
- d. none of the above

10. Conditional probabilities can be defined in terms of unconditional probabilities using which equation?

- a.  $P(A,B) = P(A)P(B)$
- b.  $P(B|A) = (P(A|B)P(B)) / P(A)$
- c.  $P(A|B) = P(A,B) / P(B)$
- d. none of the above

## **Part II – Problem Solving. 75 points total.**

### **1. [15 points] Representation: AI as Search**

Describe how to formulate STRIPS, POP, and Resolution Theorem Proving as heuristic search.

#### **a) STRIPS**

- What does each state represent?
- What is the initial state?
- Describe the goal state/test.
- Explain how the successor function would operate.
- Give an example heuristic function.