

## 2004 Comprehensive Examination Artificial Intelligence

### 1. Search.

There are several ways this can be done. The following are examples.

- (a) 9, 8, 7, 6, 5, 4, 3, 2, 1
- (b) 1, 2, 3, 4, 5, 6, 7, 8, 9

### 2. Logic

- (a) Incomplete
- (b) Incomplete
- (c) Complete
- (d) Incomplete
- (e) Complete

### 3. Automated Reasoning.

- 1.  $\{-p(a,y), q(a,y)\}$
- 2.  $\{p(a,y), -q(a,y)\}$
- 3.  $\{p(x,f(x)), q(x,g(x))\}$
- 4.  $\{-p(x,y), -q(x,y)\}$
  
- 5.  $\{-q(a,y)\}$
- 6.  $\{-p(a,y)\}$
- 7.  $\{q(a,g(a))\}$
- 8.  $\{\}$

### 4. Probability.

$$\begin{aligned} p(B1|Red) &= p(Red | B1) * p(B1) / p(Red) \\ &= 2/11 * 1/3 / (2/11 + 4/9 + 3/10) * 1/3 \\ &= 0.1963 \end{aligned}$$

## 5. Natural Language.

(a) There is no semantic interpretation in this case.

(b)  $\text{hates}(\text{tom}, \text{mary})$  &  $\text{hates}(\text{harry}, \text{mary})$

(c) One way is to add a number parameter, as shown below.

$$\begin{aligned} S(r(x, z) \wedge r(y, z)) &\rightarrow Q(r(\text{both}(x, y), z)) \\ Q(w(u, v)) &\rightarrow NP(u, n) \text{ Verb}(w, n) NP(v) \\ NP(x, s) &\rightarrow \text{Noun}(x) \\ NP(\text{both}(x, y), p) &\rightarrow NP(x, z) \text{ and } NP(y, z) \\ \text{Noun}(\text{tom}) &\rightarrow \text{Art} \\ \text{Noun}(\text{dick}) &\rightarrow \text{Bob} \\ \text{Noun}(\text{harry}) &\rightarrow \text{Cal} \\ \text{Noun}(\text{mary}) &\rightarrow \text{Deb} \\ \text{Verb}(\text{hates}, p) &\rightarrow \text{hate} \\ \text{Verb}(\text{hates}, s) &\rightarrow \text{hates} \end{aligned}$$

It is also possible to accomplish this by splitting the rules for  $Q$ ,  $NP$ , and  $\text{Verb}$ ; but this can be more cumbersome.