

2007 Comprehensive Examination Solutions

Artificial Intelligence

1. Search. (20 points)

(a) Depth-first: $k + 1$

Breadth-first: 2^k

Iterative Deepening: $2^{k+1} - 1$

(b) Depth-first: $2^{d+1} - 2^{d-k+1} + 1$

Breadth-first: $2^{k+1} - 1$

Iterative Deepening: $\sum_{i=0}^k (2^{i+1} - 1) =$

$$(2^{k+1} - 1) + \dots + (2^{0+1} - 1) =$$

$$2^{k+1} + \dots + 2^1 - k - 1 =$$

$$2^{k+2} - k - 3$$

(c) Depth-first: $d + 1$

Breadth-first: 2^k

Iterative Deepening: $k + 1$

2. Constraint Satisfaction Problems. (20 points) (d) \leq (b) \leq (a).

3. Logic. (20 points)

(a) Valid

(b) Contingent

(c) Contingent

(d) Valid

(e) Contingent

(f) Valid

(g) Contingent

(h) Contingent

(i) Unsatisfiable

(j) Valid

4. Resolution. (20 points)

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|--|--------------------|
| 1. $\{\neg p(x, y), q(x, y, f(x, y))\}$ | Premise |
| 2. $\{\neg r(x, y), \neg q(x, w, z)\}$ | Premise |
| 3. $\{p(x, g(x)), q(x, g(x), z)\}$ | Premise |
| 4. $\{r(y, z), \neg q(a, y, z)\}$ | Negated Goal |
| 5. $\{\neg q(a, x, y), \neg q(x, w, z)\}$ | 2, 4 |
| 6. $\{q(x, g(x), f(x, g(x))), q(x, g(x), z)\}$ | 1, 3 |
| 7. $\{\neg q(g(a), w, z)\}$ | 5, 6 (factoring 6) |
| 8. $\{\}$ | 6, 7 (factoring 6) |

5. Machine Learning. (20 points)

(a) The maximum likelihood estimate is: $\max_i x^i$

(b)(i) Try choice A. The current algorithm appears to be overfitting the training set. High variance problem.

(b)(ii) Try choice B. The current model cannot represent even the training data well. High bias problem.