Informatics 2D: Tutorial 5

Generalised Modus Ponens, Resolution, and Situation Calculus

Week 6

1   Generalised Modus Ponens

Part 1: Convert the following sentences to first-order logic formulae suitable for use with Generalised Modus Ponens.

1. Horses, cows and pigs are mammals.

2. An offspring of a horse is a horse.

3. Bluebeard is a horse.

4. Bluebeard is Charlie's parent.

5. Offspring and parent are inverse relations.

Part 2: Use the sentences to answer a query using a backward-chaining algorithm.

- Draw the proof tree generated by an exhaustive backward-chaining algorithm for the query $Horse(h)$, where clauses are matched in the order given.

- How many solutions are a logical consequence of your knowledge base?

- How could we solve this problem?

2   Resolution

From "Horses are animals" it follows that "The head of a horse is the head of an animal". Demonstrate that this inference is valid by carrying out the following steps:

1. Translate the premise and the conclusion into the language of First-Order Logic. Use three predicates: $HeadOf(h, x)$ (meaning "h is the head of x"), $Horse(x)$, and $Animal(x)$.

2. Negate the conclusion, and convert the premise and the negated conclusion into Conjunctive Normal Form.

3. Use resolution to show that the conclusion follows from the premises.

3   Situation Calculus

Last week you learnt about the frame problem and you were shown how it can be fixed by adding frame axioms.

Consider the following predicates and functions:

1. $At(sq, s)$ means that the agent is at square sq in situation s.

2. $Heading(dir, s)$ means that the agent is facing in direction dir in situation s.

3. $Next(sq1, dir, sq2)$ means that square $sq2$ is adjacent to square $sq1$ in direction dir.

4. $Result(act, s)$ is the situation resulting from executing the action act in situation s.

5. $Turn(x)$ is the action of turning x where $x \in \{left, right\}$.

6. $Shoot$ is the action of shooting once forward.

7. $Newdir(dir1, x, dir2)$ means that $dir2$ is the new direction the agent will face if it is facing in direction $dir1$ and turns $x \in \{left, right\}$

8. $Wumpus(sq, s)$ means that that the Wumpus is in square sq in situation s.

In the following we assume that the action $Shoot$ only has an effect in directly adjacent squares.

a) Formalise a precondition and an effect axiom for the Wumpus World that best describes the action $Turn(x)$.

b) Formalise a precondition and an effect axiom that best describes the $Shoot$ action in the Wumpus World.

c) Formalise a frame axiom that best describes the $Shoot$ action in the Wumpus World. You only need to do this for the $Wumpus$ fluent.