Introduction to AI - Exercise II

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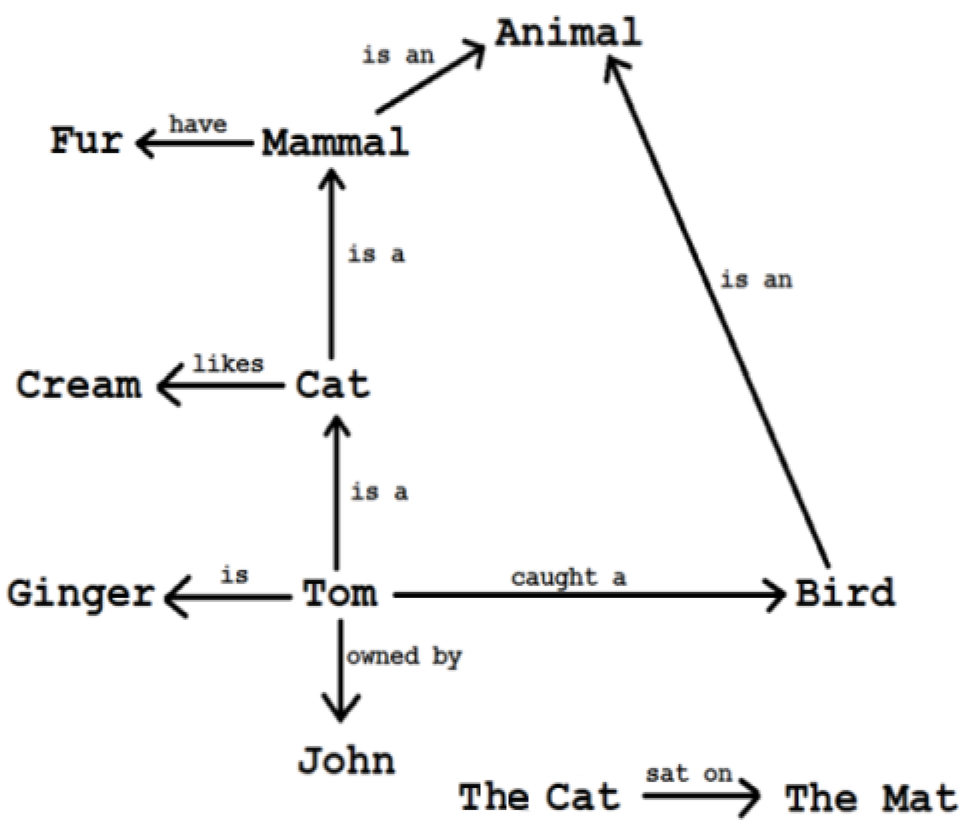
1 Question One

1.1 Brief

Draw a semantic net that represents the following data: [20%]

Tom is a cat.
Tom caught a bird.
Tom is owned by John.
Tom is ginger in colour.
Cats like cream.
The cat sat on the mat.
A cat is a mammal.
A bird is an animal.
All mammals are animals.
Mammals have fur.

1.2 Answer



2 Question Two

2.1 Brief

There are three hardware companies manufacturing graphics cards. The table below gives the single joint probability distribution for the following two random variables: [20%]

(a) a card is good or defective,
(b) a card has been manufactured by company X.

		G	**D**
	Company	*Good*	*Defective*
A	*Alf-Leiters*	0.475	0.025
B	*Biodes & Son*	0.279	0.021
C	*Condictors Ltd.*	0.180	0.020

Consider the following questions:

(a) What is the market share of Alf-Leiters?
(b) What is the probability a randomly selected card is defective?
(c) What is the likelihood of Condictors Ltd. producing a defective card?
(d) What is the probability that a defective product came from Biodes & Son?
(e) Show whether or not the two events Product is defective and Product is from company X are independent.

2.2 Answer - (a)

Market share of **A** is:

$$0.475 + 0.025 = 0.5$$

2.3 Answer - (b)

Randomly selected card is defective =

$$\sum_{D_i} P(D), \quad D_i = (A_D, B_D, C_D)$$
$$= 0.025 + 0.021 + 0.020 = 0.066$$

2.4 Answer - (c)

Since we are finding the probability that the card is defective given that it was manufactured by company **C**,

$$P(D|C) = \frac{P(D \cap C)}{P(C)}$$

$$P(D \cap C) = 0.020, \ \textit{which is the probability that it is defective and from company } \mathbf{C}.$$

$$P(C) = 0.180 + 0.020, \ \textit{which is the market share of } \mathbf{C}.$$

$$\textit{Hence}, \quad P(D|C) = \frac{0.020}{0.200} = 0.1$$

2.5 Answer - (d)

Since we are finding the probability that company **B** make the card, given that it is defective,

$$P(B|D) = \frac{P(B \cap D)}{P(D)}$$

$$P(B \cap D) = 0.021 \; which\ is\ the\ probability\ that\ it\ is\ defective\ and\ from\ company\ \mathbf{B}.$$

$$P(D) = 0.066, \; (see\ Answer\ \mathbf{(b)}).$$

$$Hence, \quad P(B|D) = \frac{0.021}{0.066} = \frac{7}{22} \approx 0.\overline{318}$$

2.6 Answer - (e)

Two events, A and B, are independent iff $P(A \cap B) = P(A)P(B)$. This means we need to test the following cases for independence:

$$P(D) \wedge P(A)$$

$$P(D) \wedge P(B)$$

$$P(D) \wedge P(C)$$

$$P(D \cap A) = 0.025$$
$$P(D)P(A) = 0.066 \cdot 0.5 = 0.033$$

Since $P(D \cap A) \neq P(D)P(A)$, the two are dependent.

$$P(D \cap B) = 0.021$$
$$P(D)P(B) = 0.066 \cdot 0.3 = 0.0198$$

Since $P(D \cap B) \neq P(D)P(B)$, the two are dependent.

$$P(D \cap C) = 0.020$$
$$P(D)P(C) = 0.066 \cdot 0.2 = 0.0132$$

Since $P(D \cap C) \neq P(D)P(C)$, the two are dependent.

Hence, the events ”Product is defective” and ”Product is from company X” are dependent.

3 Question 3

3.1 Brief

The following is a small planning problem, involving moving passengers using planes. The predicates for the domain are:

at(Person, Airport), place(Airport), passenger(Person), atPlane(Airport), emptyPlane, onPlane(Person), planeless(Airport)

The Strips operators are:

BOARD(X,Y)
Preconditions: at(X,Y), place(Y), passenger(X), atPlane(Y), emptyPlane
Delete List: at(X,Y), emptyPlane
Add List: onPlane(X)

FLY(X,Y)
Preconditions: atPlane(X), place(X), place(Y), planeless(Y)
Delete List: atPlane(X), planeless(Y)
Add List: atPlane(Y), planeless(X)

DISEMBARK(X,Y)
Preconditions: onPlane(X), passenger(X), place(Y), atPlane(Y)
Delete List:onPlane(X)
Add List: at(X,Y), emptyPlane

Show how STRIPS would solve this planning problem using forward chaining for the initial and goal state below. Assume that STRIPS always makes the correct choice. Write down carefully all the intermediate states. [30%]

Initial State*: place(bhx), place(cdg), passenger(john), at(john,bhx), passenger(mary), at(mary, cdg), atPlane(bhx), planeless(cdg), emptyPlane*

Goal State*: at(john, cdg), at(mary, bhx)*

3.2 Answer

place(bhx), place(cdg), passenger(john), at(john,bhx), passenger(mary), at(mary, cdg), atPlane(bhx), planeless(cdg), emptyPlane

BOARD(john, bhx)
- at(john, bhx)
- emptyPlane
+ onPlane(john)

place(bhx), place(cdg), passenger(john), passenger(mary), at(mary, cdg), atPlane(bhx), planeless(cdg), onPlane(john)

FLY(bhx, cdg)
- atPlane(bhx)
- planeless(cdg)

+ atPlane(cdg)
+ planeless(bhx)

place(bhx), place(cdg), passenger(john), passenger(mary), at(mary, cdg), onPlane(john), atPlane(cdg), planeless(bhx),

DISEMBARK(john, cdg)
- onPlane(john)
+ at(john, cdg)
+ emptyPlane

place(bhx), place(cdg), passenger(john), passenger(mary), at(mary, cdg), atPlane(cdg), planeless(bhx), at(john, cdg), emptyPlane

BOARD(mary, cdg)
- at(mary, cdg)
- emptyPlane
+ onPlane(mary)

place(bhx), place(cdg), passenger(john), passenger(mary), atPlane(cdg), planeless(bhx), at(john, cdg), onPlane(mary)

FLY(cdg, bhx)
- atPlane(cdg)
- planeless(bhx)
+ atPlane(bhx)
+ planeless(cdg)

place(bhx), place(cdg), passenger(john), passenger(mary), at(john, cdg), onPlane(mary), atPlane(bhx), planeless(cdg)

DISEMBARK(mary, bhx)
- onPlane(mary
+ at(mary, bhx)
+ emptyPlane

place(bhx), place(cdg), passenger(john), passenger(mary), at(john, cdg), atPlane(bhx), planeless(cdg), at(mary, bhx), emptyPlane

4 Question 4

4.1 Brief

Take the previous planning example:

(a) Extend the formalisation to allow for multiple planes.
(b) Reformulate the previous problem to include two planes: one at CDG and one at BHX.
(c) Read up on Partial Order Plans in the textbook AI:AMA. Give a partial order plan to solve the planning problem.
(d) How many total order plans can you compile from the partial order plan? [30%]

4.2 Answer - (a)

Assuming that each airport can now house multiple planes.

Predicates:

at(Person, Airport), place(Airport), passenger(Person), atPlane(Airport, Plane), emptyPlane(Plane), onPlane(Person, Plane), plane(Plane)

Strips operators:

BOARD(X,Y,Z)
Preconditions: at(X,Y,Z), place(Y), passenger(X), plane(Z), atPlane(Y,Z), emptyPlane(Z)
Delete List: at(X,Y), emptyPlane(Z)
Add List: onPlane(X,Z)

FLY(X,Y,Z)
Preconditions: atPlane(X,Z), place(X), place(Y), plane(Z)
Delete List: atPlane(X,Z)
Add List: atPlane(Y,Z)

DISEMBARK(X,Y.Z)
Preconditions: onPlane(X,Z), passenger(X), place(Y), plane(Z), atPlane(Y,Z)
Delete List: onPlane(X,Z)
Add List: at(X,Y), emptyPlane(Z)

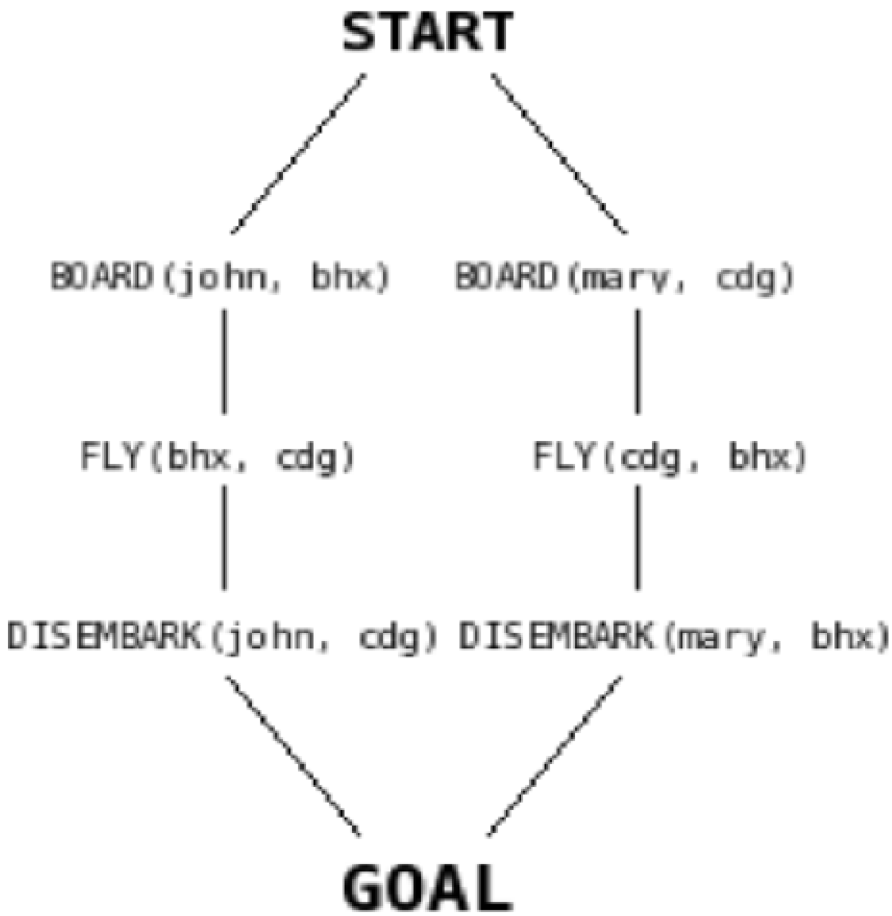
4.3 Answer - (b)

Initial State: place(bhx), place(cdg), passenger(john), at(john,bhx), passenger(mary), at(mary, cdg), atPlane(bhx.α), emptyPlane(α), emptyPlane(ω), atPlane(cdg,ω), Plane(α), Plane(ω)

Goal State: at(john, cdg), at(mary, bhx)

4.4 Answer - (c)

For the sake of conciseness, I have omitted the Plane predicate from the partial order plan, as it doesn't matter which plane they fly on.



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4.5 Answer - (d)

Let the LHS of the plan be x1, x2 and x3 respectively. Similarly, let the RHS of the plan be y1, y2 and y3 respectively. There are four possible placements of our x1/y1 values:

$$x1\ x2\ x3\ y1\ y2\ y3$$
$$y1\ x1\ x2\ x3\ y2\ y3$$
$$x1\ y1\ x2\ x3\ y2\ y3$$
$$x1\ x2\ y1\ x3\ y2\ y3$$

Hence, there are also 10 possible places for our x2/y2 values. We subtract 4 from this though, to avoid repetition. Finally, there are twenty possible places for our x3/y3 values. We subtract 10 from this to avoid repetition. This gives us:

$$4 + 6 + 10 = 20$$

Hence, there are 20 total-order plans that can be compiled from our partial-order plan.