Foundations of Artificial Intelligence

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Exercise Sheet 4

Due: Wednesday, June 19, 2019, before 12:00

Exercise 4.1 (DPLL)

Use the Davis-Putnam-Logemann-Loveland (DPLL) procedure to find a satisfying assignment for the formula ϕ_i. Write down all steps carried out by the algorithm during the process. If you have to apply a splitting rule, split on variables in alphabetical order, trying *true* first, then *false*. Indicate the satisfying assignment.

(a)

$$\phi_1 = (\neg A \vee C \vee \neg D) \wedge (A \vee B \vee C \vee \neg D) \wedge (\neg A \vee \neg E) \wedge \neg C \wedge (A \vee D) \wedge (A \vee C \vee E) \wedge (D \vee E)$$

(b)

$$\phi_2 = (E \vee A) \wedge (B \vee \neg A \vee C) \wedge (E \vee \neg D) \wedge (B \vee \neg C) \wedge (\neg B \vee D) \wedge (\neg E \vee \neg A \vee \neg D \vee \neg B)$$

Exercise 4.2 (Semantics of Predicate Logic)

Consider the Interpretation $\mathcal{I} = < \mathcal{D}, \cdot^{\mathcal{I}} >$ with

- $D = \{0, 1, 2, 3\}$
- $even^{\mathcal{I}} = \{0, 2\}$
- $odd^{\mathcal{I}} = \{1, 3\}$
- $lessThan^{\mathcal{I}} = \{(0,1), (0,2), (0,3), (1,2), (1,3), (2,3)\}$
- $two^{\mathcal{I}} = 2$
- $plus^{\mathcal{I}} : D \times D \to D, plus^{\mathcal{I}}(a, b) = (a + b) \mod 4$

and the variable assignment $\alpha = \{(x, 0), (y, 1)\}$.
Decide for the following formulae θ_i if $\mathcal{I}$ is a model for θ_i under α, i.e. if $\mathcal{I}, \alpha \models \theta_i$.
Explain your answer by formally applying the semantics.

(a) $\theta_1 = odd(y) \wedge even(two)$

(b) $\theta_2 = \forall x \ (even(x) \vee odd(x))$

(c) $\theta_3 = \forall x \exists y \ lessThan(x, y)$

(d) $\theta_4 = \forall x \ (even(x) \Rightarrow \exists y \ lessThan(x, y))$

(e) $\theta_5 = \forall x\ (odd(x) \Rightarrow even(plus(x, y)))$

Exercise 4.3 (Planning)

Consider the following STRIPS-Task $\Pi = \langle \mathcal{S}, O, I, G \rangle$:

- $\mathcal{S}$: {X, Y, Z, G}
- $O : \{A, B, C, D, E, F\}$ where

$$\begin{array}{ll} A:\ pre(A) = \{X\}, & eff(A) = \{Y, Z\} \\ B:\ pre(B) = \{X\}, & eff(B) = \{\neg X, Z\} \\ C:\ pre(C) = \{\neg Y\}, & eff(C) = \{Z\} \\ D:\ pre(D) = \{\neg Z\}, & eff(D) = \{Y\} \\ E:\ pre(E) = \{\neg X, Y\}, & eff(E) = \{\neg Y, G\} \\ F:\ pre(F) = \{Z\}, & eff(F) = \{\neg Z, G\} \end{array}$$

- I: {X, Y}
- G: {G}

(a) State for each operator from O if it is applicable in I or not. For each applicable operator also give the resulting state after applying that operator in I.

Operator	Applicable?	Resulting State
A		
B		
C		
D		
E		
F		

(b) Give an applicable plan π that leads from I to G.

The exercise sheets may and should be worked on in groups of three (3) students. Please write all your names on your solution.