FAIP - Fundamentals of Artificial Intelligence Programme

Symbolic methods in AI - Suggested correction sheet

Course: FAIP - Fundamentals of Artificial Intelligence Programme, TU Delft
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This practicum focuses on three main skills.

1. Knowing how to read a formula in propositional logic and give an explanation in natural language (in this course, English).
2. Knowing how to model a natural language description of a situation in the real world into one or several formulas in propositional logic.
3. Compute the truth value of a formula given an interpretation (an assignment of the propositional variables that are in the formula).

Exercise 1: from propositional logic to natural language. Write an explanation in English of each of the following propositional formulas. Do you think they accurately model real world situations?

1.1. $robot \wedge \neg can\_move$

> The robot can not move. The robot is not moving. There is a robot that can not move.

1.2. $(percepting \vee moving) \wedge metal \leftrightarrow robot$

> Something that is moving or can perceive and is made of metal is a robot. A robot is defined as something that is made of metal, and that is moving or percepting.

1.3. $organic \wedge robot \rightarrow biorobot$

> An organic robot is a biorobot. If something is organic and a robot then it is a biorobot.

1.4. $robot\_is\_moving \wedge (operator\_in\_danger \vee (operator\_requests\_stop \wedge operator\_has\_clearance)) \rightarrow \neg robot\_is\_moving$

> If the robot is moving and the operator is in danger or if the operator has clearance and requests a stop then the robot stops moving.

Exercise 2: from natural language to propositional logic. Write a formula of propositional logic for each of the following sentences in natural language.

2.1. A robot with a working arm can pick up fruit.

> $robot \wedge working\_arm \rightarrow can\_pick\_up\_fruit$

2.2. Philosophers are defined as people who love wisdom.

$philosopher \leftrightarrow love\_wisdom \wedge people$

2.3. Spot[1] is a robot made by Boston Dynamics.

$Spot \leftrightarrow made\_by\_Boston\_Dynamics \wedge robot$

2.4. Every robot has a designer.

$robot \rightarrow has\_designer$
A little question: how would you write "There is a robot who has no designer?" Look into predicate logic for the answer!

Exercise 3: truth values and interpretation of a formula.

3.1. How many propositional variables are there in the following formula?
$robot \wedge broken\_wheels \wedge can\_move \wedge (broken\_wheels \rightarrow \neg can\_move)$

There are 3 propositional variables in the formula: *robot*, *broken_wheels*, and *can_move*.

Compute its truth table.

The formula has the following truth table.

robot	broken_wheels	can_move	(formula)
F	F	F	F
F	F	T	F
F	T	F	F
F	T	T	F
T	F	F	F
T	F	T	F
T	T	F	F
T	T	T	F

How many rows are there in the truth table?

The truth table has $8 = 2^3$ rows.

What can you say about the number of rows of a truth table of a formula with n propositional variables?

There are 2^n rows in a truth table of a formula with n propositional variables: each row corresponds to a different truth assignment for the n variables.

3.2. Is the formula satisfiable? If so, give an assignment of variables that makes it true.

[1] https://www.bostondynamics.com/products/spot

The formula is *not* satisfiable! Indeed, its truth table is a column of "False". This means that no matter what variable assignment we apply to the formula, the formula is interpreted as False.

What can you conclude about the situation it models?

Notice that the situation modelled by the formula can be understood in several parts. First,

$$robot \wedge broken\_wheels$$

describes the situation: a robot with broken wheels. Then,

$$can\_move$$

describes some knowledge we may want to get: can the robot move? Finally,

$$(broken\_wheels \rightarrow \neg can\_move)$$

describes knowledge we have about the world or, here, the robot: if its wheels are broken, then it cannot move. Since the whole formula is unsatisfiable, this means that what we know about the world is incompatible with the fact that the robot can move: thus, the robot cannot move.