Logic Programming

## Tutorial for week 8 (November 9–13)

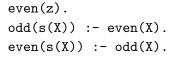
## Quiz tutorial

Tutorial structure: 25 minutes for the quiz, followed by 25 minutes for marking and discussing solutions.

1. Here is a small propositional Prolog program.

```
godot :- waiting.
waiting :- tick, waiting.
tick.
```

- (a) Rewrite the program in standard logical notation.
- (b) Draw the search tree resulting from the initial query ?- godot.
- (c) What response does Prolog give to this query?
- (d) What response would a decision procedure for propositional logic give to the query godot?
- 2. Consider the following program operating on unary natural numbers, as seen in Programming lecture 3.



- (a) Write the program in logical notation, with each line written as a sentence with all quantifiers given explicitly.
- (b) Write the query below in logical notation, again with all quantifiers given explicitly.

```
?- odd(X), even(X).
```

(c) Consider three structures  $S_1, S_2, S_3$  defined as follows. The sets  $U_1, U_2, U_3$  are the corresponding universes (or domains) for the interpretations:

$$\begin{split} & U_1 = \mathbb{N} & \text{ i.e. } \{1,2,3,\dots\} \\ & U_2 = \{ \ 0,1,2 \ \} \\ & U_3 = \{ \ 0,1,2 \ \} \end{split}$$

The interpretation of the constant z, function symbol s and predicate symbols even and odd are given as follows (here, for example,  $even^{S_1}$  is the interpretation of the predicate even in  $S_1$ ):

$z^{S_1} = 0$	$z^{S_2} = 0$	$z^{S_3} = 0$
$\mathbf{s}^{S_1}(x) = x + 1$	$\mathbf{s}^{\mathbf{S}_2}(\mathbf{x}) = \mathbf{x} + 1 \bmod 3$	$\mathtt{s}^{S_3}(\mathtt{x}) = \mathtt{x} + 1 \bmod 3$
$even^{S_1}(x) = x$ is even	$even^{S_2}(x) = x$ is even	$even^{S_3}(x)$ is always true
$\operatorname{odd}^{S_1}(x) = x \text{ is odd}$	$\operatorname{odd}^{S_2}(x) = x$ is odd	$\operatorname{odd}^{S_3}(x)$ is always true

Which of these structures are models of the program?

- (d) The query in part (b) is not a logical consequence of the program. Justify this statement.
- (e) Is  $\neg \exists X (even(X) \land odd(X))$  a logical consequence of the program?
- (f) Is  $\exists X \text{ odd}(X)$  a logical consequence of the program?