CS444 Propositional Logic Exercises

1. Exercise 5.3[1]

   You are given the following knowledge base:

   $a \leftarrow b \wedge c.$
   $a \leftarrow e \wedge f.$
   $b \leftarrow d.$
   $b \leftarrow f \wedge h.$
   $c \leftarrow e.$
   $d \leftarrow h.$
   $e.$
   $f \leftarrow g.$
   $g \leftarrow c.$

   (a) Give a model of the knowledge base.

   (b) Give an interpretation that is not a model of the knowledge base.

   (c) Give two atoms that are logical consequences of the knowledge base.

   (d) Give two atoms that are not logical consequences of the knowledge base.

2. Exercise 5.4

   You are given the knowledge base KB containing the following clauses:

   $a \leftarrow b \wedge c.$
   $b \leftarrow d.$
   $b \leftarrow e.$
   $c.$
   $d \leftarrow h.$
   $e.$
   $f \leftarrow g \wedge b.$
   $g \leftarrow c \wedge k.$
   $j \leftarrow a \wedge b.$

   (a) Show how the bottom-up proof procedure works for this example. Give all logical consequences of KB.

   (b) f is not a logical consequence of KB. Give a model of KB in which f is false.

   (c) a is a logical consequence of KB. Give a top-down derivation for the query ask a.

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[1] *Artificial Intelligence: Foundations of Computational Agents*,David Poole and Alan Mackworth, Cambridge University Press, 2010.

3. Imagine that you work for an auto-maker, and that your company is introducing a new safety feature: SUPERBRAKES. Deploying the Superbrakes cuts the stopping distance of the car in half, potentially avoiding an accident. Unfortunately, the Superbrake canister only supports a single use, and must be professionally reset after deployment.

Your job is to design an AI system to determine whether or not the current driving situation warrants the deployment of the Superbrake system.

Inputs to the decision system include:

- The speed of the car.
- Several sensor values for each of the four wheels
  - wet
  - slipping
  - damaged

A particular wheel is considered "dangerous" if it is slipping, damaged or wet. Superbrakes should deploy if the speed is above 50 miles/hour, at least one wheel is slipping, and at least three of the four wheels are "dangerous".

(a) Express the Superbrake decision procedure as a propositional knowledge base.

(b) Express the Superbrake decision procedure as a set of definite clauses using AILog syntax (<- for ←, & for ∧).