Washington State University
School of Electrical Engineering and Computer Science
Fall 2018

CptS 440/540 Artificial Intelligence
Homework 6
Due: October 11, 2018 (11:59pm)

General Instructions: Put your answers to the following problems into a PDF document and submit as an attachment under Content → Homework 6 for the course CptS 440 Pullman (all sections of CptS 440 and 540 are merged under the CptS 440 Pullman section) on the Blackboard Learn system by the above deadline. Note that you may submit multiple times, but we will only grade the most recent entry submitted before the above deadline.

1. Translate the following sentences into propositional logic using the atomic sentences: Color(Sky,Blue), Color(Sky,Gray), Shining(Sun), Shining(Moon).

    a. If the color of the sky is blue, then the sun is shining.
    b. If the color of the sky is gray, then the sun is not shining.
    c. If the color of the sky is not blue and the color of the sky is not gray, then the sun is not shining, and the moon is shining.

2. Using the following propositional knowledge base, show a resolution proof by refutation that "DayTime" is true.
    i. Cloudy(Sky) $\Rightarrow$ Color(Sky,Gray)
    ii. Color(Sky,Gray) $\Rightarrow \neg$ Shining(Moon)
    iii. Shining(Moon) $\Leftrightarrow \neg$ DayTime
    iv. Cloudy(Sky)

    a. Convert the knowledge base and negated query to CNF. Give each clause a number.
    b. Show each resolution step by indicated the two clause numbers being resolved, and the resulting clause (give it a new number).

3. Translate these sentences into first-order logic using the predicates: Color(s,c,t), Shining(p,t), DayTime(t), NightTime(t), where s is a variable representing the Sky or Sea, c is a variable representing a color, p is a variable representing the Sun or Moon, and t is a variable representing a time of day.

    a. There exists a time when both the sun and the moon are shining.
    b. If the color of the sea is blue, then the sun is shining.

c. If it is day time, then the color of the sky is either blue or gray.
d. If the moon is shining, then it is night time.

4. Using the following first-order logic knowledge base, show a resolution proof by refutation that "$\exists t$ DayTime(t)" is true.

   i. $\forall t$ Shining(Sun,t) $\Rightarrow$ Color(Sky,Blue,t)
   ii. $\forall t$ (Color(Sea,Gray,t) $\vee$ Color(Sea,Blue,t)) $\Rightarrow \neg$ NightTime(t)
   iii. $\forall c,t$ Color(Sea,c,t) $\Leftrightarrow$ Color(Sky,c,t)
   iv. $\forall t \neg$ DayTime(t) $\Rightarrow$ NightTime(t)
   v. $\exists t$ Shining(Sun,t)

   b. Convert the knowledge base and negated query to CNF. Give each clause a number. Be sure to standardize variables.
   c. Show each resolution step by indicated the two clause numbers being resolved, the resulting clause (give it a new number), and any necessary substitutions.

5. *CptS 540 Students Only*. Create an input file for the Vampire theorem prover that can be used to solve Problem 4. Include your input file and the Vampire output, in the PDF document for your Homework 6 solution. Or, if you prefer, you can bundle your PDF along with the input and output text files into one zip file for submission. You can download the Vampire theorem prover from https://vprover.github.io/. There is a Linux binary available there that runs on the ssh1-ssh10 servers that all grad students have access to. You can run it on your own machine if you prefer.