School of Electrical Engineering and Computer Science, Washington State University

Fall 2016

CptS 440/540 Artificial Intelligence

**Homework 5**

Due: Sunday, December 11, 2016 (before midnight / 11:59pm)

**General Instructions:** Put your answers to the following problems into electronic form. Please submit your entire HW5 as a single PDF document by the above deadline. Please make sure to submit a single pdf online. If you’re based in Pullman, and you get it done early, you can turn in a paper/hard copy in class on 12/08, or else you can also slide your HW under the instructor’s door (Sloan 339) on Thursday or Friday (Dec. 8-9). After that, please just upload your HW5 online at BB-Learn for the class.

Note: For Pullman students, paper hard copy submission (for the non-programming exercises) remains acceptable. However, ***please also make sure to upload your HW assignment online***, so that we don’t run into problems with BB-Learn and in particular entering your score there later.

**Problem 1** (FOL): Which of the following FOL sentences are valid? (Meaning, they are necessarily TRUE in all possible worlds/interpretations.) Explain in 1-2 to-the-point English sentences for each case.

1. (∃t)(t=t) ⇒((∀u)( ∃v)(u=v)), where t, u, v are FOL variables
2. (∀z)(P(z) ∧ NOT(P(z))), where **P(z)** is an arbitrary PL sentence
3. (∀x)(Fast(x) ∨ Slow(x) ∨(x=x)), where ***Fast*** and ***Slow*** are unary FOL predicates
4. (∀y)(Fast(y) ∨Slow(y), where ***Fast***and ***Slow*** have same meaning as in part c)

**Problem 2** (FOL):

1. Translate the following FOL expression to “plain”, everyday English (meaning: no variables such as x, y, no FOL binary or unary relations, etc.). ***SpeaksLang*** and ***Understands*** are binary FOL predicates, whereas *x, y, l* are FOL variables.

(∀x) (∀y) (∀l)(SpeaksLang(x,l) ∧ SpeaksLang(y,l) ⇒ Understands(x,y))

1. Translate the following English sentences into FOL expressions:
2. “Empathy leads to Sympathy.”
3. “If one person sympathizes with another, and that second person sympathizes with a third person, then the first person will also sympathize with the third person.”

**Problem 3** (FOL Inference): Suppose a KB contains a single FOL sentence:

(∃x)(AsBraveAs(x, Julian)) where ***AsBraveAs*** is a binary predicate.

Which of the following FOL sentences (top of the next page) are legitimate results of applying *Existential Instantiation* to this FOL KB? Explain each answer in 1-2 concrete sentences.

1. AsBraveAs(Julian, Julian)
2. AsBraveAs(Ed, Julian)
3. AsBraveAs(Ed, Julian) ∧ AsBraveAs(Don, Julian) (after applying Exist. Instantiation twice)

**Problem 4** (Basic probability concepts): Suppose X and Y are some random events, and that their probabilities are P(X) = 0.4, P(Y) = 0.3.

1. Is it rational for an agent reasoning under uncertainty (and who uses classical probability theory), to believe that P(X or Y) = 0.5 ? Explain briefly (using 2-3 sentences plus some math). Hint: read Section 13.2 in AIMA and/or use Venn’s diagrams.
2. What range of probabilities would it be rational for this agent to hold about P(X and Y)?

0 (X and Y are dependent) – 0.12

1. Is it rational for another agent, without any further information about events X and Y other than their individual probabilities, to believe that P(X or Y) = 0.7 ? Explain briefly.
2. For this second agent, who believes that P(X) = 0.4, P(Y) = 0.3, P(X or Y) = 0.7, what can you say about that agent’s beliefs about P(X and Y)? Explain briefly.

**Problem 5** (Bayesian inference): You visit your dentist for your annual exam, and your dentist has some bad news and some good news. The Bad news: the X-rays, which are 99% accurate, suggest you have a rare gum disease. (This accuracy applies to both positive and negative test results: it’s always 99% likely the test result was correct, whether good or bad.) The Good news: this gum disease is quite rare, as only about 1 in 10,000 people from your age & demographic group get the disease.

1. Why did your dentist say, “it’s a good news this gum disease is so rare”? Explain briefly using probability theory.
2. What is the actual probability that you actually have the gum disease?

**Extra credit problem (worth up to 20 bonus points):**

You are to do a Turing-test like exercise that should be fun (at least, for those who have an interest in AI). Go to website <http://www.mitsuku.com/> and engage the chatbot in conversation. Read the instructions on the website carefully and agree to terms. (OK you don’t have to, but then no bonus points for you.) Use proper English (or your very best approximation to it), and eliminate or minimize slang, abbreviations, “c u” instead of proper “see you”, and similar. Engage Mitsuku on the following three topics (no flirting with “her”, please! ☺ ):

1. Weather;
2. Sports (your pick; don’t choose something too arcane, i.e., stick to major American and/or international sports such as soccer, football, basketball or similar);
3. Movies.

On each topic, engage in a reasonable conversation for 5-10 minutes. How did Mitsuku do? Would “she” pass the Turing test? Why or why not? Include a snapshot of some “unusual” and/or interesting answers or statements by Mitsuku, for each of the three topics. Explain briefly, what you think of this (more or less) state-of-the-arts Chatbot some 65 years after Alan Turing proposed his test for “machine intelligence”? Keep your answers short, specific and to-the-point.

***Warning:*** *do this problem entirely on your own, no cooperation of any kind is allowed!*