CS141 **Introduction to AI** **Professor Meinolf Sellmann**

Homework 6
A Logic Sandwich

Due: 6:00pm on 11/04/09

Problem 6.1

Read Chapter 14 from Russel and Norvig.

Problem 6.2

You can represent a queue as an abstract data structure in predicate logic. The following axioms define the basic operations enqueue, dequeue, and first on a queue:

a. $Queue(\epsilon)$

b. $\forall x : Queue(x) \Rightarrow x = \epsilon \vee \exists y, z : Queue(y) \wedge x = Enqueue(y, z)$

c. $\forall x, y : Queue(x) \Rightarrow Queue(Enqueue(x, y))$

d. $\forall y : Front(Enqueue(\epsilon, y)) = y$

e. $\forall x, y : Queue(x) \Rightarrow x = \epsilon \vee Front(x) = Front(Enqueue(x, y))$

f. $\forall y : Dequeue(Enqueue(\epsilon, y)) = \epsilon$

g. $\forall x, y : Queue(x) \Rightarrow x = \epsilon \vee Dequeue(Enqueue(x, y)) = Enqueue(Dequeue(x), y)$

Using the above as the basis for your queue:

a. Give the axioms for the function, Append(x,y) that takes the contents of one queue and appends it onto queue in predicate logic.

b. Give the axioms for Reverse(x), which reverses the order of the elements in a queue, in predicate logic using Append from part a.

Problem 6.3

a. Transform the following into Skolem normal form:

$$\alpha = \forall x \forall y \forall z [f(f(x, y), z) = f(x, f(y, z)) \wedge \exists e \forall x (f(x, e) = x \wedge \exists x' (f(x, x') = e))]$$

b. Unify the following atomic sentences or give an argument why this is not possible. P is a predicate, a and b are constants, f, g and h are functions and x, y, z, x_0, x_1, x_2 are variables. Assume that standardizing apart has already been performed, i.e., unify the pair of sentences without performing any variable renaming.

(a) $\{p(f(f(f(a, x_0), x_1), x_2)),$
$p(f(x_2, f(x_1, f(x_0, a))))\}$

(b) $\{p(x),$
$p(f(x))\}$

(c) $\{p(x, h(x, y), y),$
$p(x, z, b)\}$

(d) $\{p(x, x, y, y),$
$p(x, f(y), y, f(x))\}$

Problem 6.4

Matt is attempting to cook mushrooms for the TAs to enjoy during a grading meeting. This might have some unexpected consequences.

Here is what we know in predicate logic:

Let Matt, Yuri and Ilke be constants. Let x and y be variables. Let Meet, MustEatMushroom, HatesMatt, and LikesEachOther be functions.

$$Meet(Yuri, Matt) \wedge$$
$$Meet(Ilke, Matt) \wedge$$
$$(\ \forall x, y(Meet(x, Matt) \Rightarrow MustEatMushroom(x)\ ) \wedge$$
$$(\ MustEatMushroom(x) \Rightarrow HatesMatt(x)\ ) \wedge$$
$$(\ HatesMatt(x) \wedge HatesMatt(y) \Rightarrow LikesEachOther(x, y)\ ))$$

a. Bring the above to Prenex normal form

b. Show $LikesEachOther(Yuri, Ilke)$