CSE 4/563 Knowledge Representation
Professor Shapiro
Homework 5
Maximum Points: 25
Due: 2:00 PM, Tuesday, October 21, 2009

Name(s)$\langle$user name(s)$\rangle$: ________________________________

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October 14, 2009

You must turn in the answers to this homework set as hard-copy on $8\frac{1}{2} \times 11$ in. paper, with your name(s) and user name(s) at the top. Staple multiple pages once in the upper-left hand corner. Write extremely neatly. Anything unreadable will be considered incorrect.

1. (3) Using the Fitch-style proof theory presented in lecture, prove that

$$\exists x P(x), \forall x \forall y (P(x) \land P(y) \Rightarrow R(x,y)) \vdash \exists x (P(x) \land \forall y (P(y) \Rightarrow R(x,y)))$$

2. (3) Using the Fitch-style proof theory presented in lecture, prove that

$$\exists x (P(x) \land \forall y (P(y) \Rightarrow R(x,y))), \forall x \forall y \forall z (R(x,y) \land R(x,z) \Rightarrow R(y,z)) \vdash \forall x \forall y (P(x) \land P(y) \Rightarrow R(x,y))$$

3. (10) For each of the following pairs of wffs: if they unify, show an mgu; if they fail to unify, say so and give the reason. Assume that: P and Q are predicate symbols; f and g are function symbols; a, b, and c are individual constants; x, y, and z are variables.

   (a) (2) $P(a,b,c)$ and $Q(a,b,c)$
   (b) (2) $P(a,x,c)$ and $P(a,b,y)$
   (c) (2) $P(a,x,c)$ and $P(y,b,y)$
   (d) (2) $P(f(a),x,c)$ and $P(y,g(y),z)$
   (e) (2) $P(f(x),x,c)$ and $P(y,g(y),z)$

4. (3) Show the substitution that results from the following substitution composition. Assume that: f and g are function symbols; a, b, and c are individual constants; u, v, w, x, y, and z are variables.

$$\{u/x, f(v)/y, w/z\} \circ \{a/x, b/v, f(u)/w, g(c)/z\}$$

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5. (3) Translate
$$\forall x(\exists y P(x,y) \Leftrightarrow \forall y \exists z R(x,y,z))$$
into clause form. Show all steps. Don't show any step where nothing changes.

6. (3) Using resolution refutation prove that
$$\exists x P(x), \forall x \forall y(P(x) \wedge P(y) \Rightarrow R(x,y)) \vdash \exists x(P(x) \wedge \forall y(P(y) \Rightarrow R(x,y)))$$