

## CSC384 Knowledge representation

### Problem 1

Suppose that you are given the following axioms:

1.  $0 \leq 3$ .
2.  $7 \leq 9$ .
3.  $\forall x. x \leq x$ .
4.  $\forall x. x \leq x + 0$ .
5.  $\forall x, y. x + y \leq y + x$ .
6.  $\forall w, x, y, z, w. w \leq y \wedge x \leq z \Rightarrow w + x \leq y + z$ .
7.  $\forall x, y, z. x \leq y \wedge y \leq z \Rightarrow x \leq z$ .

Give a forward-chaining proof of the sentence  $7 \leq 3 + 9$ . (Be sure, of course, to use only the axioms given here, not anything else you might know about arithmetic.) Show only the steps that lead to success, not the irrelevant steps.

### Solution

From (1), (2), (6)  $\{w/0, x/7, y/3, z/9\}$  infer

(9)  $0 + 7 \leq 3 + 9$ .

From (9), (5), (7)  $\{x1/0, y1/7, x2/0 + 7, y2/7 + 0, z2/3 + 9\}$  infer

(10)  $7 + 0 \leq 3 + 9$ .

(x1, y1 are renamed variables in (5). x2, y2, z2 are renamed variables in (7).)

From (4), (10), (8)  $\{x3/7, x4/7, y4/7 + 0, z4/3 + 9\}$  infer

(11)  $7 \leq 3 + 9$ .

(x3 is a renamed variable in (4). x4, y4, z4 are renamed variables in (8).)

### Problem 2

Given the following sentences, answer the question ‘What is connected to the Bahen building?’ using resolution with answer extraction:

*Connected* is a binary symmetric relation.

An object X *is part of* another object Y iff everything X is connected to, Y is also connected to.

Room BA1180 is part of Bahen building.

Room BA1180 is connected to itself.