Model Checking, SS2011: Exercise Sheet 11

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Exercise 11.1. Consider the code fragment.

```
while(x >= 0 && y >= 0){
  if (read ()){
    x = x - 1; /* a */
    y = x;
  } else {
    x = y - 2; /* b */
    y = x + 1;
  }
}
```

Consider the following functions f_1, f_2, f_3 corresponding to well-founded relations on program states wf_1, wf_2, wf_3.

$$f_1(x,y) = x$$

$$f_2(x,y) = y$$

$$f_3(x,y) = x + y$$

Let $(a|b)^+$ denote a composition of branch transitions ρ_a and ρ_b. Prove by case analysis on $(a|b)^+$ that $(a|b)^+ \subseteq wf_1 \cup wf_2 \cup wf_3$.

Exercise 11.2. Consider the code fragment and the relations wf_1, wf_2, wf_3 in exercise 11.1. Let $\rho = \rho_a \vee \rho_b$. Prove by induction on k that $\rho^k \subseteq wf_1 \cup wf_2 \cup wf_3$.

Exercise 11.3. Consider the rules given in class that define the set *Reach* for programs with procedures. Give rules that define a transition relation on states of programs with procedures.

Exercise 11.4. Consider the concrete reachability algorithm, and the forward symbolic reachability algorithm. For each, give rules defining the set of reachable states.