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Tutorial for Cyber-Physical Systems - Hybrid Models Exercise Sheet 5

Exercise 1: Postcondition

We say that $post$ distributes over the connective \odot wrt. the first argument if the following equation holds.

$$post(\varphi_1 \odot \varphi_2, \rho) = post(\varphi_1, \rho) \odot post(\varphi_2, \rho)$$

We say that $post$ distributes over the connective \odot wrt. the second argument if the following equation holds.

$$post(\varphi, \rho_1 \odot \rho_2) = post(\varphi, \rho_1) \odot post(\varphi, \rho_2)$$

Determine for $\odot \in \{\wedge, \vee, \rightarrow\}$ if $post$ distributes over \odot wrt. the first argument or wrt. the second argument.

Give a proof for each positive answer, give a counterexample for each negative answer.

Exercise 2: Reachability

Consider the following integer program with input variables i and j .

```
l0 : x := i;  
l1 : y := j;  
l2 : while x ≠ 0 do {  
l3 :   x := x - 1;  
l4 :   y := y - 1;  
    }  
l6 : assert(i = j → y = 0);
```

- (a) Compute the set of reachable states φ_{reach} .

Hint: If you only apply the $post$ operator, your algorithm will not terminate. You need to find a relation between all variables which is true before and after each loop iteration (a loop invariant). Then use this to “jump over the loop”.

- (b) Is the program safe?