Exercises for week 3

1. (a) Write down the definitions of the well-formedness conditions for configurations c:

$$tc - s(c), tc - p(c), p - targets(c), inv - pr(c), inv - rds(c)$$

on a single sheet of paper. You will need this in future lectures. It is the key to the speed, at which we can develop the material about C0. (10 credit points)

   (b) Illustrate the last 3 invariants with drawings (you can take them from the slides). (10 credit points)

2. Recall the following functions, which are used to define the semantics of statements in a $C0$-configuration c where e is an expression:

   - $lv(e, c)$: the subvariable specified by e (only defined if e has a left value),
   - $etype(e, f)$: the type of e,
   - $va(e, c)$: the value of e.

   Give definitions of $lv(e, c)$, $etype(e, f)$, and $va(e, c)$ for the following expressions:

   (a) $e = e'.n$ and n is a valid field of struct type $etype(e', f)$, (5 credit points)

   (b) $e = false$, (5 credit points)

   (c) $e = null$. (5 credit points)

3. Draw the derivation trees of the following statements and specify their semantics:

   (a) $e = e' \,!= e''$, (10 credit points)

   (b) $e = e' > e''$. (10 credit points)

   Attention: in the second case the semantics depends on the types involved.

4. Specify the semantics of the following assignments:

   (a) $e = e' >= e''$ && $e' < 0$, (5 credit points)

   (b) $e = e' * e'' - e'''$, (5 credit points)

(c) $e = x[e' * e'']$. (5 credit points)

Assume that the types involved permit the evaluation.

5. Same as above for

   (a) $e = e'\&*$, (10 bonus credit points)

   (b) $e = e'*.n\&$. (10 bonus credit points)

6. Fill in the following program such that $fc(x)$ returns ($x!$ mod 2^{32}).

```
int fc(uint n)
{
...
return res
}
```

(10 credit points)

7. Prove or disprove that $hd(c.pr) \in L(St)$ is an invariant during statement execution. (10 credit points)

8. Show that for variable names $X \in f$ with pointer type, i. e. $etype(X, f) = t*$ and configurations c obeying invariants $tc(c)$ and $p - targets(c)$ the 5 invariants for expression evaluation hold. (10 bonus credit points)

   Hint: you *must* use the hypothesis about the invariants obeyed by c.