

Exercises for “Decision Procedures for Verification”  
Exercise sheet 4-2

**Exercise 4.1:** (2 P)

Compute the results of the following substitutions:

- |  |   |
|--|---|
| (a) $f(g(x), x)[g(a)/x]$               | (c) $\forall y(p(f(y, x), x))[y/x]$   |
| (b) $p(f(y, x), g(x))[x/y]$            | (d) $\forall y(p(f(z, g(y)), g(x)) \vee \exists z(g(z) \approx y))[g(b)/z]$                 |
| (c) $\forall y(p(f(y, x), g(y)))[x/y]$ | (e) $\exists y(f(x, y) \approx x \rightarrow \forall x(f(x, y) \approx x))[g(y)/y, g(z)/x]$ |

**Exercise 4.2:** (1 P)

Consider the structure  $\mathbb{N}$  introduced in the lecture from 25.11.2014 (on slides 25 and 26). Let  $x, y \in X$  and let  $\beta : X \rightarrow U_{\mathbb{N}}$  with  $\beta(x) = 1$  and  $\beta(y) = 3$ .

Compute:

- (1)  $\mathbb{N}(\beta)(\forall x \exists y(x < y))$
- (2)  $\mathbb{N}(\beta)(\exists x \forall y(x < y))$

Please submit your solution until Wednesday, November 26, 2014 at 13:00. Joint solutions prepared by up to three persons are allowed. Please do not forget to write your name on your solution.

Submission possibilities:

- By e-mail to [sofronie@uni-koblenz.de](mailto:sofronie@uni-koblenz.de) with the keyword “Homework DP” in the subject.
- Put it in the box in front of Room B 222.