Exercise Sheet 8: Advanced LaTeX
Maximilian Marx, Markus Krötzsch
Academic Skills in Computer Science, 2019-06-04, Summer Term 2019

Please prepare exercise 8.4 for the exercise session on 2019-06-18.

Exercise 8.1. (continuation of exercise 7.2)
Typeset the following formulae:

$$\neg A \sqcap \exists R^{-}.A \sqcap (\leq 1\ R) \sqcap \forall (R^{-})^{+}.(\exists R^{-}.A \sqcap (\leq 1\ R)) \tag{1.1}$$

$$\pi_x(\leq n\ R) = \exists^{\leq n} y.R(x,y) = \exists y_1, \ldots, y_n. \bigwedge_{i \neq j} y_i \neq y_j \supset \bigvee_i \neg R(x, y_i) \tag{1.2}$$

$$\mathtt{Tree} \equiv \mu X.(\mathtt{EmptyTree} \sqcup (\mathtt{Node} \sqcap \leq 1\ \mathtt{child}^{-} \sqcap \exists \mathtt{child}.\top \sqcap \forall \mathtt{child}.X)) \tag{1.3}$$

$$(\mu X.C)^{\mathcal{I}}_{\rho} = \bigcap \{\mathcal{E} \subseteq \Delta^{\mathcal{I}} \mid C^{\mathcal{I}}_{\rho[X/\mathcal{E}]} \subseteq \mathcal{E}\} \tag{1.4}$$

$$s \rightarrow_E t \text{ iff } \exists (l, r) \in E, p \in \mathcal{P}os(s), \sigma \in \mathcal{S}ub.\ s|_p = \sigma(l) \text{ and } t = s[\sigma(r)]_p \tag{1.5}$$

$$\mathbb{K}[\mathfrak{C}]_r := (G \cup \mathfrak{C}_{min}, M \cup \mathfrak{C}_{max}, I_{\mathfrak{C}} \cap (G \cup \mathfrak{C}_{min}) \times (M \cup \mathfrak{C}_{max})) \tag{1.6}$$

$$0 = \int_{\left\{s_n(u) > \frac{1}{k} + \mathsf{E}^{\mathcal{A}_n} u\right\}} \left(s_n(u) - \mathsf{E}^{\mathcal{A}_n} u\right) d\mu \geq \frac{1}{k} \mu \left(\left\{s_n(u) > \frac{1}{k} + \mathsf{E}^{\mathcal{A}_n} u\right\}\right) \tag{1.7}$$

Exercise 8.2. Use `bibtex` to typeset a bibliography of all published literature referenced on exercise sheets 0–7. Make all references as complete as possible, and strive for consistency among the references.

Exercise 8.3. Typeset the following paragraph.

> **Lemma 8.2 (Yoneda)** *Let* $\mathbf{C}$ *be locally small. For any object* $C \in \mathbf{C}$ *and functor* $F \in \mathbf{Sets}^{\mathbf{C}^{op}}$ *there is an isomorphism*
>
> $$\mathrm{Hom}(yC, F) \cong FC$$
>
> *which, moreover, is natural in both* F *and* C.
>
> *Here:*
>
> *(1) the Hom is* $\mathrm{Hom}_{\mathbf{Sets}^{\mathbf{C}^{op}}}$,
>
> *(2) naturality in* F *means that, given any* $\vartheta : F \to G$, *the following diagram commutes:*
>
> $$\begin{tikzcd} \mathrm{Hom}(yC, F) \arrow[r, "\cong"] \arrow[d, "\mathrm{Hom}(yC,\vartheta)"'] & FC \arrow[d, "\vartheta_C"] \\ \mathrm{Hom}(yC, G) \arrow[r, "\cong"] & GC \end{tikzcd}$$
>
> *(3) naturality in* C *means that, given any* $h : C \to D$, *the following diagram commutes:*
>
> $$\begin{tikzcd} \mathrm{Hom}(yC, F) \arrow[r, "\cong"] & FC \\ \mathrm{Hom}(yD, F) \arrow[r, "\cong"] \arrow[u, "\mathrm{Hom}(yh,F)"] & FD \arrow[u, "Fh"'] \end{tikzcd}$$
>
> (Awodey, Steve. 2006. Category Theory. Oxford University Press. p. 162)

Hint: You can use tikz[1] with the `tikz-cd` library to typeset the *commutative diagrams*, but several other packages are also available.

Exercise 8.4. (Homework)
Write a paper proving the *binomial theorem*:

> Let $n \in \mathbb{N}$. Then
> $$(x+y)^n = \sum_{k=0}^{n} \binom{n}{k} x^k y^{n-k}.$$

You may use any sources that you need, provided that you properly cite them. Make sure your paper includes an introduction, a conclusion, and all necessary preliminaries. Try to make your paper as easy to read as possible.

[1] https://github.com/pgf-tikz/pgf