Formale Übersetzungsmodelle

Exercise 20 (Negation normal form)

Consider the ranked alphabet $\Sigma = \{\wedge^{(2)}, \vee^{(2)}, \neg^{(1)}, a^{(0)}, b^{(0)}\}$. The trees over Σ represent propositional logic formulas.

(a) Construct a td-tt T which brings propositional formulas into negation normal form. E.g., the negation normal form of the formula $\neg(\neg a \vee b)$ is $a \wedge \neg b$.

(b) Can this tree transformation also be performed by a bu-tt?

Exercise 21 (Symbolic derivation)

Let $k \in \mathbb{N}$ and $\Sigma = \left\{+^{(2)}, \cdot^{(2)}, X^{(0)}\right\} \cup \left\{0^{(0)}, \ldots, k^{(0)}\right\}$ be a ranked alphabet. The trees ξ over Σ represent certain polynomials with natural number coefficients.

(a) Give a td-tt T which computes the symbolic derivation $d\xi/dx$ of a given polynomial. E.g., the symbolic derivation of the polynomial $(X \cdot X + 5) \cdot X$ is $((1 \cdot X + X \cdot 1) + 0) \cdot X + (X \cdot X + 5) \cdot 1$, using the well-known sum and product rules from calculus.

(b) Give a derivation of $\xi = \cdot(+(\cdot(X, X), 5), X)$ in T.

(c) Can this tree transformation also be performed by a bu-tt?

(d) *Extra task:* Can we model (natural number) exponents, or other more interesting operations like $\sin(x)$, $\exp(x)$?

Exercise 22 (Subclasses of TOP)

Describe the relations of the classes of tree transformations induced by the following transducers:

- td-tt,
- deterministic td-tt,
- total td-tt,
- total and deterministic td-tt,
- top-down tree homomorphisms,
- top-down relabelings,
- linear td-tt,
- nondeleting td-tt,
- and linear and nondeleting td-tt.

Use the abbreviations TOP, *d*-TOP, *t*-TOP, *dt*-TOP, *h*-TOP, *r*-TOP, *l*-TOP, *n*-TOP, and *ln*-TOP.

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