Introduction to Beamer

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This is the title

Beamer is a LaTeX class for preparing presentations.

1. Slides are called frames in Beamer.
2. This is the usual ordered list in LaTeX.
3. Following slides will contain random content which will show you various ways of using it. You need to replicate it.
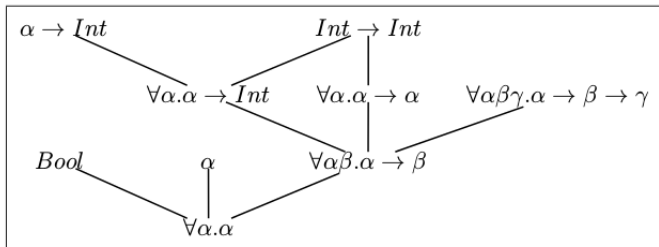4. Of course! we will give you boilerplate code!

Type Rules

Figure: This is the caption.

Type Rules

- A *substitution* is a list of pairs denoted as $S = \{\alpha_1/\tau_1 \ldots \alpha_n/\tau_n\}$.
- A substitution S applied on a type expression σ, denoted by $S(\sigma)$ involves simultaneous substitution of the variables $\alpha_1 \ldots \alpha_n$, if they occur free in σ, by the corresponding type expressions $\tau_1 \ldots \tau_n$.

Definition

Let $\sigma = \forall \alpha_1 \ldots \alpha_m.\tau$ and $\sigma' = \forall \beta_1 \ldots \beta_m.\tau'$. Then σ' is a *generic instance* of σ, iff there is a substitution S acting only on $\{\alpha_1 \ldots \alpha_m\}$ such that $\tau' = S(\tau)$ and no β_i is free in σ.

- Clearly, the restriction that no β_i is free in σ is needed, else we would have absurdities like $\alpha \rightarrow Int \leq \forall \alpha.\alpha \rightarrow Int$.

Recapitulation – Type rules for λ_2

$$\Gamma \cup \{x :: \sigma\} \vdash x :: \sigma \qquad\qquad (\text{VAR})$$

$$\Gamma \cup \{c :: \sigma\} \vdash c :: \sigma \qquad\qquad (\text{CON})$$

$$\frac{\Gamma \vdash M :: \sigma \qquad \sigma' \geq \sigma}{\Gamma \vdash M :: \sigma'} \qquad\qquad (\text{INST})$$
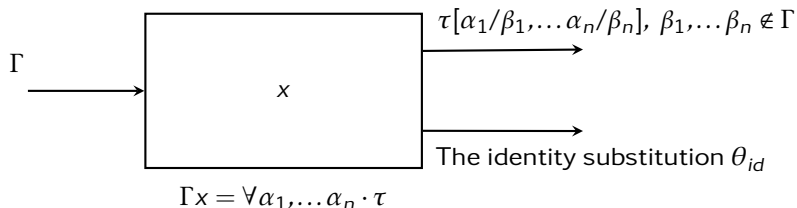
$$\frac{\Gamma \vdash M :: \sigma \qquad \alpha \notin FV(\Gamma)}{\Gamma \vdash M :: \forall \alpha.\sigma} \qquad\qquad (\text{GEN})$$

$$\frac{\Gamma \vdash M :: \tau_1 \rightarrow \tau_2 \qquad \Gamma \vdash N :: \tau_1}{\Gamma \vdash M\ N :: \tau_2} \qquad\qquad (\text{M-APP})$$

$$\frac{\Gamma, x :: \tau_1 \vdash M :: \tau_2}{\Gamma \vdash \lambda x.M :: \tau_1 \rightarrow \tau_2} \qquad\qquad (\text{M-ABS})$$

Hindley-Milner - Type checking variables

1: *t* **is a variable** *x*

$$\Gamma$$

$$x$$

$$\Gamma x = \forall \alpha_1, \dots \alpha_n \cdot \tau$$

$$\tau[\alpha_1/\beta_1, \dots \alpha_n/\beta_n], \ \beta_1, \dots \beta_n \notin \Gamma$$

The identity substitution θ_{id}

- $\beta_1, \dots, \beta_n$ are fresh variables.
- Reason for monomorphising the type of *x*: We try to find the type of a variable only in the context of an application, and our application is monomorphic.

Hindley-Milner - Type checking variables

1. Typecheck e_1 with the initial environment Γ. Result is τ_1 and θ_1.
2. Typecheck e_2 with the environment $\theta_1 \Gamma$. Result is τ_2 and θ_2.
3. Unify $\theta_2 \tau_1$ and $\tau_2 \to \alpha$. Assume that unifier is θ. And the unified term $(\theta \alpha)$ is τ_3.
4. Type of the application is τ_3 and the final substitution is $\theta \circ \theta_2 \circ \theta_1$.