## Typing $\Gamma \vdash e : \tau$

$$\frac{\Gamma, x_2 : \tau_2 \vdash e_1 : \tau_1}{\Gamma \vdash \lambda x_2.\, e_1 : \tau_2 \to \tau_1}\ \mathsf{tp/lam} \qquad \frac{x : \tau \in \Gamma}{\Gamma \vdash x : \tau}\ \mathsf{tp/var}$$

$$\frac{\Gamma \vdash e_1 : \tau_2 \to \tau_1 \quad \Gamma \vdash e_2 : \tau_2}{\Gamma \vdash e_1\, e_2 : \tau_1}\ \mathsf{tp/app}$$

## Reduction $e \longrightarrow e'$ and $e \longrightarrow^* e'$

$$\frac{}{(\lambda x.\, e_1)\, e_2 \longrightarrow [e_2/x]e_1}\ \mathsf{red/beta}$$

$$\frac{e \longrightarrow e'}{\lambda x.\, e \longrightarrow \lambda x.\, e'}\ \mathsf{red/lam} \qquad \frac{e_1 \longrightarrow e_1'}{e_1\, e_2 \longrightarrow e_1'\, e_2}\ \mathsf{red/app_1} \qquad \frac{e_2 \longrightarrow e_2'}{e_1\, e_2 \longrightarrow e_1\, e_2'}\ \mathsf{red/app_2}$$

$$\frac{e \longrightarrow e'}{e \longrightarrow^* e'}\ \mathsf{red^*/step} \qquad \frac{}{e \longrightarrow^* e}\ \mathsf{red^*/refl} \qquad \frac{e \longrightarrow^* e' \quad e' \longrightarrow^* e''}{e \longrightarrow^* e''}\ \mathsf{red^*/trans}$$

## Reducible $e \longrightarrow$

$$\frac{}{(\lambda x.\, e_1)\, e_2 \longrightarrow}\ \mathsf{rbl/beta}$$

$$\frac{e \longrightarrow}{\lambda x.\, e \longrightarrow}\ \mathsf{rbl/lam} \qquad \frac{e_1 \longrightarrow}{e_1\, e_2 \longrightarrow}\ \mathsf{rbl/app_1} \qquad \frac{e_2 \longrightarrow}{e_1\, e_2 \longrightarrow}\ \mathsf{rbl/app_2}$$

## Normal and Neutral Expressions $e$ *normal* and $e$ *neutral*

$$\frac{e\ \textit{normal}}{\lambda x.\, e\ \textit{normal}}\ \mathsf{norm/lam} \qquad \frac{e\ \textit{neutral}}{e\ \textit{normal}}\ \mathsf{norm/neut}$$

$$\frac{}{x\ \textit{neutral}}\ \mathsf{neut/var} \qquad \frac{e_1\ \textit{neutral} \quad e_2\ \textit{normal}}{e_1\, e_2\ \textit{neutral}}\ \mathsf{neut/app}$$