

Formation rules for Types

$$\frac{}{X \vdash X} \quad \frac{}{\Gamma \vdash I} \quad \frac{\Gamma \vdash T_1 \quad \Gamma \vdash T_2}{\Gamma \vdash T_1 \oplus T_2} \quad \frac{\Gamma \vdash T_1 \quad \Gamma \vdash T_2}{\Gamma \vdash T_1 \otimes T_2} \quad \frac{\Gamma \vdash T}{\Gamma \vdash T^\star} \quad \frac{X \vdash T}{\Gamma \vdash \mu X.T}$$

Formation rules for Values

$$\frac{}{\vdash e^{i\theta} : I} \quad \frac{\vdash v_1 : T_1 \quad \vdash v_2 : T_2}{\vdash v_1 \times v_2 : T_1 \otimes T_2} \quad \frac{\vdash v : T_1}{\vdash \text{inl } v : T_1 \oplus T_2} \quad \frac{\vdash v : T_2}{\vdash \text{inr } v : T_1 \oplus T_2} \quad \frac{\vdash v : T}{\vdash \bar{v} : T^\star} \quad \frac{\vdash v : T[\mu X.T/X]}{\vdash \text{fold } v : \mu X.T}$$

$$\frac{\vdash v_1 : T \quad \vdash v_2 : T}{\vdash v_1 + v_2 : T} \quad \frac{\vdash v_1 : T^\star \quad \vdash v_2 : T}{\vdash v_1, v_2 : T^\star \otimes T} \quad \frac{\vdash v_1 : T_1 \quad \vdash v_2 : T_1^\star \otimes T_2}{\vdash v_1 v_2 : T_2} \quad \frac{\vdash v_1 : T_1^\star \otimes T_2 \quad \vdash v_2 : T_2^\star \otimes T_3}{\vdash v_1 \circ v_2 : T_1^\star \otimes T_3}$$

Typing rules for Terms

$$\frac{x : T \in \Gamma}{\Gamma \vdash x : T}$$

$$\frac{\vdash v : T}{\Gamma \vdash \text{measure } v : T}$$

$$\frac{\Gamma \vdash t : T_1 \oplus T_2 \quad \Gamma, x : T_1 \vdash u_1 : T \quad \Gamma, y : T_2 \vdash u_2 : T}{\Gamma \vdash \text{case } t \text{ of } \text{inl } x \text{ to } u_1 \text{ inr } y \text{ to } u_2 : T}$$

$$\frac{\Gamma \vdash t : T_1 \otimes T_2}{\Gamma \vdash \text{fst } t : T_1}$$

$$\frac{\Gamma \vdash t : T_1 \otimes T_2}{\Gamma \vdash \text{snd } t : T_2}$$

$$\frac{\Gamma \vdash t : T \quad \Gamma, x : T \vdash u : U}{\Gamma \vdash \text{let } x \text{ be } t \text{ in } u : U}$$

$$\frac{\Gamma, x : T \vdash t : T \quad \Gamma, x : T \vdash u : U}{\Gamma \vdash \text{rec } x \text{ be } t \text{ in } u : U}$$

Substitution

$$Y[S/X] = \begin{cases} S & \text{if } X = Y \\ Y & \text{otherwise} \end{cases}$$

$$I[S/X] = I$$

$$T_1 \otimes T_2[S/X] = T_1[S/X] \otimes T_2[S/X]$$

$$T_1 \oplus T_2[S/X] = T_1[S/X] \oplus T_2[S/X]$$

$$T^\star[S/X] = T[S/X]^\star$$

$$\mu Y.T[S/X] = \mu Y.(T[S/X])$$