

MiniML + unit

tip  $\tau ::= \text{int} \mid \text{bool} \mid \tau_1 \rightarrow \tau_2 \mid \text{unit}$   
vrednost  $v ::= n \mid \text{true} \mid \text{false} \mid \text{fun } f(x:\tau_1):\tau_2 \text{ is } e \mid ()$

Preverjanje tipov:

Pravil za evaluacijo ni potrebno spreminjati.

$\frac{}{\Gamma \vdash () : \text{unit}}$

MiniML + and, or

~~Definiranje~~  $e ::= e_1 \text{ and } e_2 \mid e_1 \text{ or } e_2 \mid \dots$

Preverjanje tipov:

$$\frac{\Gamma \mid e_1 : \text{bool} \quad \Gamma \mid e_2 : \text{bool}}{\Gamma \mid e_1 \text{ and } e_2 : \text{bool}} \quad \frac{\Gamma \mid e_1 : \text{bool} \quad \Gamma \mid e_2 : \text{bool}}{\Gamma \mid e_1 \text{ or } e_2 : \text{bool}}$$

Naivna evaluacija - vedno se izvedeta oba izraza (kot npr. & in | v C in Javi)

$$\frac{e = b_1 \wedge b_2}{b_1 \text{ and } b_2 \rightarrow b} \quad \frac{e \rightarrow e'}{b_1 \text{ and } e \rightarrow b_1 \text{ and } e'} \quad \frac{e_1 \rightarrow e_1'}{e_1 \text{ and } e_2 \rightarrow e_1' \text{ and } e_2}$$

(podobno še za or)

"Short-circuit" evaluacija - če je končna vrednost znana iz prvega izraza, se drugi ne evaluirajo (kot && in || v C in Javi)

$$\frac{\text{true and } e_2 \rightarrow e_2 \quad \text{false and } e_2 \rightarrow \text{false}}{e_1 \rightarrow e_1'} \quad \frac{e_1 \text{ and } e_2 \rightarrow e_1' \text{ and } e_2}{\text{false or } e_2 \rightarrow e_2} \quad \frac{e_1 \rightarrow e_1'}{e_1 \text{ or } e_2 \rightarrow e_1' \text{ or } e_2}$$

Semantika velikih korakov za MiniML  
I. Vrednosti in spremenljivke

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$$\eta \mid m \hookrightarrow \text{Int } m$$

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$$\eta \mid \text{true} \hookrightarrow \text{Bool true}$$

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$$\eta \mid \text{false} \hookrightarrow \text{Bool false}$$

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$$\eta \mid () \hookrightarrow \text{Unit}$$

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$$\eta \mid \text{fun } f(x:\tau_1):\tau_2 \text{ is } e \hookrightarrow \text{Fun}(f, x, \tau_1, \tau_2, e)$$

$$\eta(x) = v$$

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$$\eta \mid x \hookrightarrow v$$

II. Operacije na celih številih

$$\frac{\eta|e_1 \hookrightarrow \text{Int } n_1 \quad \eta|e_2 \hookrightarrow \text{Int } n_2}{\eta|e_1 + e_2 \hookrightarrow \text{Int}(n_1 + n_2)}$$

$$\frac{\eta|e_1 \hookrightarrow \text{Int } n_1 \quad \eta|e_2 \hookrightarrow \text{Int } n_2}{\eta|e_1 = e_2 \hookrightarrow \text{Bool}(n_1 = n_2)}$$

$$\frac{\eta|e_1 \hookrightarrow \text{Int } n_1 \quad \eta|e_2 \hookrightarrow \text{Int } n_2}{\eta|e_1 - e_2 \hookrightarrow \text{Int}(n_1 - n_2)}$$

$$\frac{\eta|e_1 \hookrightarrow \text{Int } n_1 \quad \eta|e_2 \hookrightarrow \text{Int } n_2}{\eta|e_1 < e_2 \hookrightarrow \text{Bool}(n_1 < n_2)}$$

$$\frac{\eta|e_1 \hookrightarrow \text{Int } n_1 \quad \eta|e_2 \hookrightarrow \text{Int } n_2}{\eta|e_1 * e_2 \hookrightarrow \text{Int}(n_1 * n_2)}$$

III. Logična operatorja ("short-circuit" evaluacija)

$$\frac{\eta | e_1 \hookrightarrow \text{Bool false}}{\quad}$$

$$\eta | e_1 \text{ and } e_2 \hookrightarrow \text{Bool false}$$

$$\frac{\eta | e_1 \hookrightarrow \text{Bool true}}{\quad}$$

$$\eta | e_1 \text{ or } e_2 \hookrightarrow \text{Bool true}$$

$$\frac{\eta | e_1 \hookrightarrow \text{Bool true} \quad \eta | e_2 \hookrightarrow v}{\quad}$$

$$\eta | e_1 \text{ and } e_2 \hookrightarrow v$$

$$\frac{\eta | e_1 \hookrightarrow \text{Bool false} \quad \eta | e_2 \hookrightarrow v}{\quad}$$

$$\eta | e_1 \text{ or } e_2 \hookrightarrow v$$

IV. Stavak if

$$\frac{\eta | e_1 \hookrightarrow \text{Bool true} \quad \eta | e_2 \hookrightarrow v}{\quad}$$

$$\eta | \text{if } e_1 \text{ then } e_2 \text{ else } e_3 \hookrightarrow v$$

$$\frac{\eta | e_1 \hookrightarrow \text{false} \quad \eta | e_3 \hookrightarrow v}{\quad}$$

$$\eta | \text{if } e_1 \text{ then } e_2 \text{ else } e_3 \hookrightarrow v$$

V. Aplikacija funkcije

$$\frac{\eta | e_1 \hookrightarrow \text{Fun}(f, x, t_1, t_2, e) \quad \eta | e_2 \hookrightarrow v \quad x \neq t_2, f: \text{Fun}(f, x, t_1, t_2, e), \eta | e \hookrightarrow v}{\eta | e_1 e_2 \hookrightarrow v}$$

Evaluacija izraza s semantiko velikih korakov

Okolja:  $\eta_1 = f: \text{fun } g \dots, h: \text{fun } h$   
 $\eta_2 = n: 42, g: \text{fun } g \dots, \eta_1$   
 $\eta_3 = n: 85, g: \dots$

Vrednosti nismo posebej evaluirali.

$$\eta_2(m) = 42 \quad 85$$

$$\eta_2 | n \hookrightarrow 42 \quad 85$$

$$\eta_2 | 2 * n \hookrightarrow 84 \quad 170$$

$$\eta | f = \text{fun } g \dots$$

$$\eta_1(f) = \text{fun } g \dots$$

$$\eta_1 | f \hookrightarrow \text{fun } g \dots$$

$$\eta_2 | 2 * n + 1 \hookrightarrow 85 \quad 171$$

Evaluacija aplikacije se nadaljuje podobno kot zgoraj, le da se uporabi okolje  $\eta_3$ . Evaluirane vrednosti so prikazane z rdečo barvo.

$$\eta_1 | f \hookrightarrow \text{fun } g \dots$$

$$\eta_1 | fh2 \hookrightarrow 85$$

$$\eta_1 | f(fh2) \hookrightarrow 171$$

$(\text{fun } h(f: \text{int} \rightarrow \text{int}): \text{int} \text{ is } f(fh2))$

$(\text{fun } g(n: \text{int}): \text{int} \text{ is } 2 * n + 1) \hookrightarrow 171$