

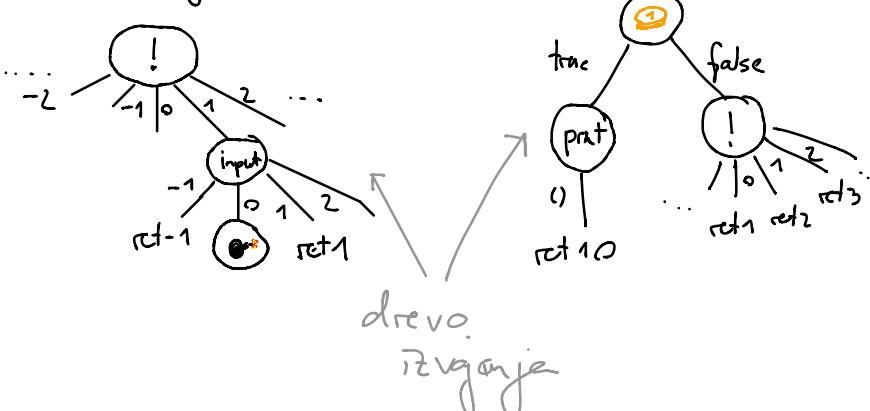
Algebrajski učinki

Ideja: vsak program lahko vrne vrednost ali sproži učinek, ki preostanka programa vrne rezultat (ali se zacetka)

do $x \leftarrow !l$ in

do $y \leftarrow$ uporabnika vprašaj za število in

ret x/y



do $b \leftarrow \text{randomBool}()$
 if b then
 print "X"; ret 10
 else
 do $y \leftarrow !l$;
 do $z \leftarrow y + 1$;
 ret z

Vsač učinek predstavimo s primitivnimi operacijami.

$$\text{op: } A \xrightarrow{\text{tip argумента}} B \xrightarrow{\text{tip результата}}$$

randomBool : unit \rightarrow bool

print : string \rightarrow unit

input : unit \rightarrow string

raise : exc \rightarrow empty

! ... lookup : loc \rightarrow int

:= ... update : loc \times int \rightarrow unit

$A + B$ $\text{in } N / \text{inr } N$

empty /

match N
 with nil $x \rightarrow C_1$
 | inr $y \rightarrow C_2$
 match N with /
 absurd N

$$\frac{r \vdash n : \text{empty}}{\Gamma \vdash \text{absurd } n : C}$$

Jezik razširimo s kljucem:

$$C ::= \dots \mid op(n; y. C)$$

argument preostanek programa,
 ki čaka na y ... kontinuacija

$$\frac{op : A \rightarrow B \quad \Gamma \vdash v : A \quad \Gamma, y : B \vdash c : C}{\Gamma \vdash op(n; y. c) : C}$$

alternativna predstavitev z implicitno kontinuacijo:

$$C ::= \dots \mid \underline{op(n)}$$

$$\frac{op : A \rightarrow B \quad \Gamma \vdash v : A}{\Gamma \vdash \underline{op(n)} : B}$$

Vsaka predstavitev ima svoj \dagger , sta pa med seboj ekvivalentni.

$$\underline{op(n)} = op(n; y. \text{ret } y)$$

$$op(n; y. c) = \text{do } y \leftarrow \underline{op(n)} \text{ in } c$$

Operacijska semantika

$$\text{do } x \leftarrow op(n; y. c_1) \text{ in } c_2 \rightsquigarrow op(n; y. \text{do } x \leftarrow c_1 \text{ in } c_2)$$

Ostalih pravil za specifične operacije ne bomo povedali, ker jih boma simuliirali s prestrezniki.

Prestrezniki

$\nu ::= \dots | \{ op_1(x; k) \rightarrow c_1, \dots, op_n(x; k) \rightarrow c_n, \text{return } x \rightarrow c_{\text{ret}} \}$
 $c ::= \dots | \text{handle } c \text{ with } \nu$

$$c \rightsquigarrow c'$$

$\text{handle } c \text{ with } \nu \rightsquigarrow \text{handle } c' \text{ with } \nu$

$\text{handle } (\text{return } \nu) \text{ with } h \rightsquigarrow c_{\text{ret}}[\nu/x]$

$\text{handle } op_i(\nu; y, c) \text{ with } h \rightsquigarrow c_i[\nu/x, (\lambda y. \text{handle } c \text{ with } h)/k]$

$op \text{ nima vež } v \ h$

$\text{handle } op(\nu; y, c) \text{ with } h \rightsquigarrow op(\nu; y. \text{handle } c \text{ with } h)$

$A ::= \dots | A \Rightarrow B$

$$\frac{\Gamma \vdash c : A \quad \Gamma \vdash \nu : A \Rightarrow B}{\Gamma \vdash \text{handle } c \text{ with } \nu : B}$$

$(op_i : A_i \rightarrow B_i) \quad \Gamma, x : A_i, k : B_i \rightarrow B \vdash c_i : B \quad \Gamma, x : A \vdash c_{\text{ret}} : B$

$\Gamma \vdash \{ (op_i(x; k) \rightarrow c_i)_{i \in \text{dom}}, \text{return } x \rightarrow c_{\text{ret}} \} : A \Rightarrow B$