TJURINGOVE MAŠINE

ZA IZRAČUNAVANJE ARITHETIČKIH F-JA U AZBUCI $\Sigma = \{1\}$

1) OSNOVNE KRETNJE I PISANJA

l - MALA LEVA

0	*	L	1
0	1	L	1
1	*	H	1
1	1	H	1

r - MALA DESNA

0	*	R	1
0	1	R	1
1	*	H	1
1	1	H	1

$*$ - BLANKO

0	*	*	1
0	1	*	1
1	*	H	1
1	1	H	1

$|$ - RECKA

0	*	1	1
0	1	1	1
1	*	H	1
1	1	H	1

2) PRETRAŽIVANJA

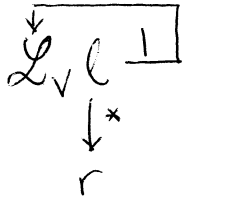
$\mathcal{L}_V$ - VELIKA LEVA

0	*	L	1
0	1	L	1
1	*	H	1
1	1	L	1

λ - LEVA ISTRAŽNA

0	*	L	1
0	1	L	1
1	*	L	1
1	1	H	1

L - LEVA



Dualno $\mathcal{R}_V, \varrho, R$

3) K_n - MAŠINA ZA KOPIRANJE : $*x_1*\ \ *x_n*\ \longrightarrow\ *x_1*\ \ *x_n*x_1*$

$$\mathcal{L}_v^n r \xrightarrow{1} *\mathcal{R}_v^{n+1}|\mathcal{L}_v^{n+1}|$$
$$\downarrow *$$
$$\mathcal{R}_v^n$$

SABIRANJE: Σ - $*x*y* \longrightarrow *x*y*x+y*$

$$K_2^2 \mathcal{L}_v|\mathcal{R}_v(\ell*)^2$$

S_g

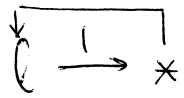
$$\ell^2 \xrightarrow{1} r^3(1r)^2$$
$$\downarrow *$$
$$r^3|r$$

$\overline{S_g}$

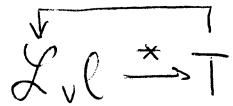
$$\ell^2 \xrightarrow{1} r^3|r$$
$$\downarrow *$$
$$r^3(1r)^2$$

4) MAŠINE ZA SPREMANJE

Del - BRISANJE : $\sim * x * \longrightarrow \sim *$



Dr - PRIVLAČENJE : $* \bar{x} * * \ldots * y * \longrightarrow * \bar{x} * y *$



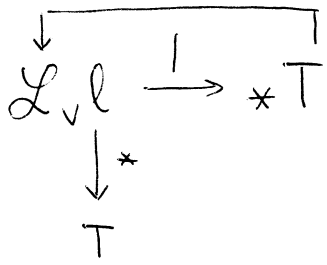
T - TRANSLACIJA : $\sim * x * \longrightarrow \sim x *$

$r^2 \xrightarrow{1} \ell 1 \mathcal{R}_v \ell *$

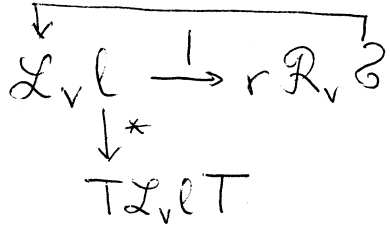
$\downarrow *$

ℓ^2

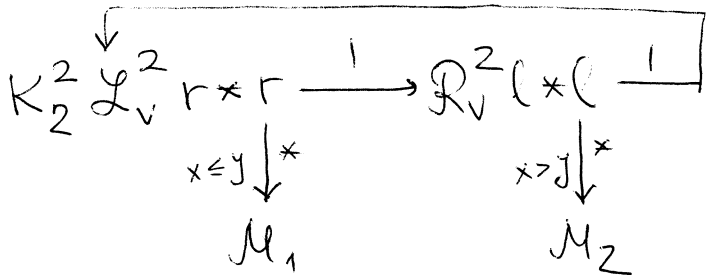
$\mathcal{S}$ - SMICANJE ("SHIFT") : $\sim * x * y * \longrightarrow \sim * y *$



C - ČIŠĆENJE : $\sim ** \bar{x} * y * \longrightarrow \sim y *$ $\quad (\bar{x} \equiv x_1 * \ldots * x_n)$



5) OPŠTA POREDBENA MAŠINA



Abs

M_1: $\mathcal{R}_V$ Dr

M_2: Ir Dr

Sub

M_1: $\mathcal{R}_V$ Del $\lambda r^2 Ir$

M_2: Ir Dr

Max

M_1: $\mathcal{R}_V$ Del $\lambda r K_1$

M_2: Del $\lambda r K_2$

Min

M_1: $\mathcal{R}_V$ Del $\lambda r K_2$

M_2: Del $\lambda r K_1$

Geq

M_1: $\mathcal{R}_V$ Dr ℓ^2 → 1 → r^2 Del r Ir

↓ *

$r^2 Ir$

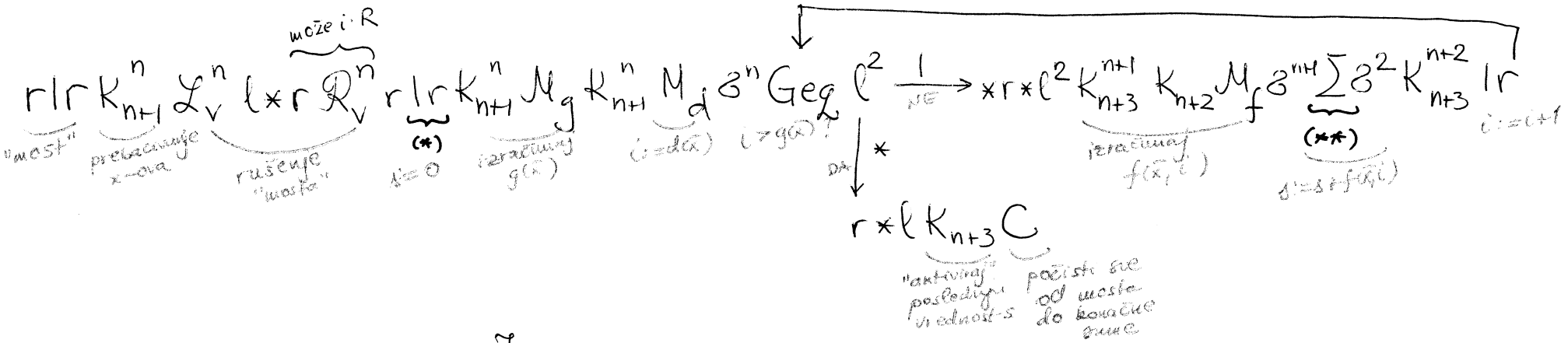
M_2: Del $\lambda r^2 (Ir)^2$

Leq

M_1: $\mathcal{R}_V$ Del $\lambda r^2 (Ir)^2$

M_2: Del $\lambda r^2 Ir$

6) OPŠTA MAŠINA ZA SUMIRANJE: $h(x_1,\dots,x_n)=\sum_{i=d(\bar{x})}^{g(\bar{x})} f(x_1,\dots,x_n,i)$ (ako $d\le g$ inače 0)



PROIZVOD Π: $xy=\sum_{i=1}^{y} x$. Dakle: $M_d : r(|r)^2$

$M_g : K_1$

$M_f : K_3$

7) OPŠTA MAŠINA ZA PROIZVOD: $h(x_1,\dots,x_n)=\prod_{i=d(\bar{x})}^{g(\bar{x})} f(x_1,\dots,x_n,i)$ (ako $d\le g$ inače 1)

- isto kao šablon za sumu, sa modifikacijama

(*): $(|r)^2$

(**): Π

PRIMERI

- Exp: $x * y *$ $\longrightarrow$ $x * y * x^y *$ $\quad (0^0 = 1)$

$x^y = \prod_{i=1}^{y} x$

$M_d : r(1r)^2$
$M_g : K_1$
$M_f : K_3$

$\longrightarrow$ šablon za proizvod

- Fac: $x * \longrightarrow x * x! *$

$x! = \prod_{i=1}^{x} i$

$M_d : r(1r)^2$
$M_g : K_1$
$M_f : K_1$

$\longrightarrow$ šablon za proizvod

- Δ: $x * y *$ $\longrightarrow$ $x * y * \lfloor \frac{x}{y} \rfloor *$

$\lfloor \frac{x}{y} \rfloor = \sum_{i=1}^{x} geq(x, yi)$

$M_d : r(1r)^2$
$M_g : K_2$
$M_f : K_3^3 \Pi 3^2 Geq 3^2$

- Rest: $rest(x,y) = x \dot{-} y \lfloor \frac{x}{y} \rfloor$

$\Delta \Pi 3 K_3 K_2 Sub 3^3$

- Div: $div(x,y) = \overline{sg}(rest(x,y))$

$Rest \overline{Sg} 2$

8) SVAKA REKURZIVNA F-JA IMA SVOJU MAŠINU

a) OSNOVNE F-JE

$N(x) = 0$ $\quad r\,|\,r$

$S(x) = x+1$ $\quad K_1\,|\,r$

$I^n_K(x_1,\dots,x_n) = x_K$ $\quad K_{n-K+1}$

b) KOMPOZICIJA: $f(x_1,\dots,x_n) = g(h_1(x_1,\dots,x_n),\dots,h_K(x_1,\dots,x_n))$

$$\underbrace{r\,|\,r}_{\text{"most"}}\ \underbrace{K^n_{n+1}}_{\text{prebac.}}\ \underbrace{\mathcal{L}^n_v}_{\text{rušenje "mosta"}}\ (*\ R\ \mathcal{M}_{h_1} K^n_{n+1}\ \underbrace{\mathcal{M}_{h_2} K^n_{n+1}}_{\text{računanje } h_i(\bar{x})\text{-ova}}\ \cdots\ K^n_{n+1}\mathcal{M}_{h_K}\ \underbrace{K_{(K-1)(n+1)+1}\ K_{(K-2)(n+1)+2}\ \cdots\ K_K}_{\text{prikupljanje originala za } g}\ \underbrace{\mathcal{M}_g\ C}_{\text{konačan rezultat}}$$

"počisti sve do "mosta"

c) ŠEMA PROSTE REKURZIJE: $f(x_1,\dots,x_n,0) = g(x_1,\dots,x_n)\ ;\ f(x_1,\dots,x_n,y+1) = h(x_1,\dots,x_n,y,f(x_1,\dots,x_n,y))$

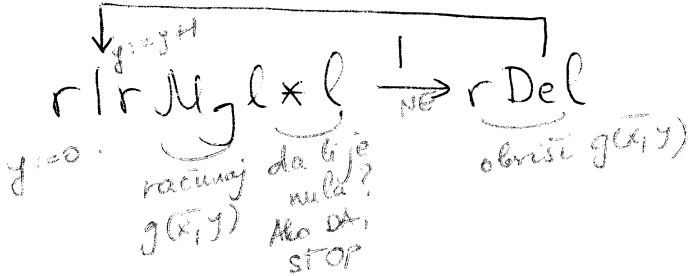
$$\underbrace{r\,|\,r}_{\text{"most"}}\ \underbrace{K_2\,K^n_{n+3}}_{\text{prebac. } y,\,\bar{x}}\ \underbrace{\mathcal{L}^{n+1}_v}_{\text{rušenje "mosta"}}\ (*\ R\ \underbrace{\mathcal{M}_g}_{f(\bar{x},0)}\ K_{n+2}\ \underbrace{(*(}_{i:=y}\ \underbrace{\xrightarrow[y:=0]{!}\ r\,K^n_{n+2}}_{\text{kopiraj } \bar{x}}\ \underbrace{r\,|\,r\,K_{n+3}}_{\text{kopiraj pr. } f\text{-a}}\ \underbrace{\mathcal{M}_h}_{f(\bar{x},j)}\ K_{n+4}\ \underbrace{(*(}_{i:=i-1}\ \underbrace{\xrightarrow[i:=0]{!}\ r\,K^{n+1}_{n+4}}_{\text{pripremi parametre za naredni korak rekurzije}}$$

$y=0$: $\downarrow x$ → C (počisti — kraj rekurzije)

$j:=0$, $j:=j+1$

$i=i-1$: $\downarrow x$ ($i=0$) → C (počisti — kraj rekurzije)

d) MINIMALIZACIJA : $f(x_1,\dots,x_n) = \mu_y(g(x_1,\dots,x_n,y)=0)$



PRIMER: P - *x* → *x*p_x* ; P? *x* → *x*Pr(x)* ; E: *x*y*exp_y X*

$$g(x) = \sum_{i=1}^{x} div(x,i)$$

M_d : r(|r)²
M_g : K_1
M_f : Div
→ šablon za sumu → Γ

$$Pr(x) = \overline{sg}\,|g(x)-2| \qquad P?: \Gamma r(|r)^2 Abs\,\partial^2 \overline{Sg}\,\partial$$

$$\Pi(x) = \sum_{i=1}^{x} Pr(x)$$

M_d : r(|r)²
M_g : K_1
M_f : P?
→ šablon za sumu → Pi

$$p(x) = \mu_y(|\Pi(y) - (x+1)| = 0)$$

M_g : Pi K_3 |r Abs ∂^2 → šablon za minimalizaciju → P

$$exp_y x = \mu_z(div(x, p(y)^{z+1}) = 0)$$

M_g : K_3^2 P6 K_3 |r Exp ∂^2 Div ∂^2

↓ šablon za minimalizaciju ↓ E