

Ukazni programski jezik

Aritmetički izrazi \rightarrow int

Boolovi izrazi

Minikl
 Mini Haskell
 Poly

} tip

Newvar $x := e$ in C

int

bool

Comm

{ int x ;

} C

{ int x = e ;

C

}

Operacijska semantika

Aritmetični izrazi

$$e \hookrightarrow n$$

$$\frac{e_1 \hookrightarrow n_1 \quad e_2 \hookrightarrow n_2 \quad n = n_1 + n_2}{e_1 + e_2 \hookrightarrow n}$$

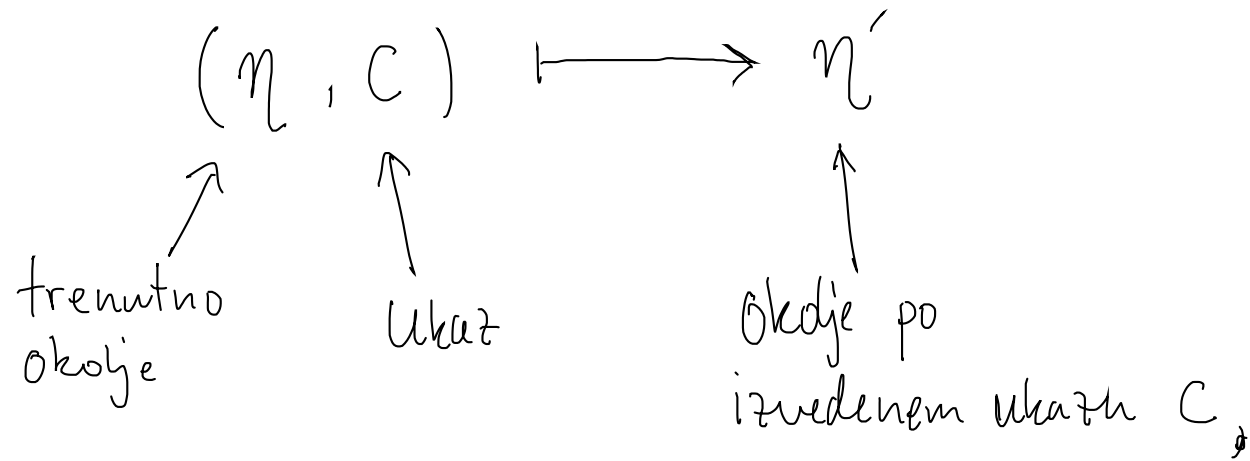
~~Ar~~ Aritmetika + spremenljivke

$$\eta \mid e \hookrightarrow n$$

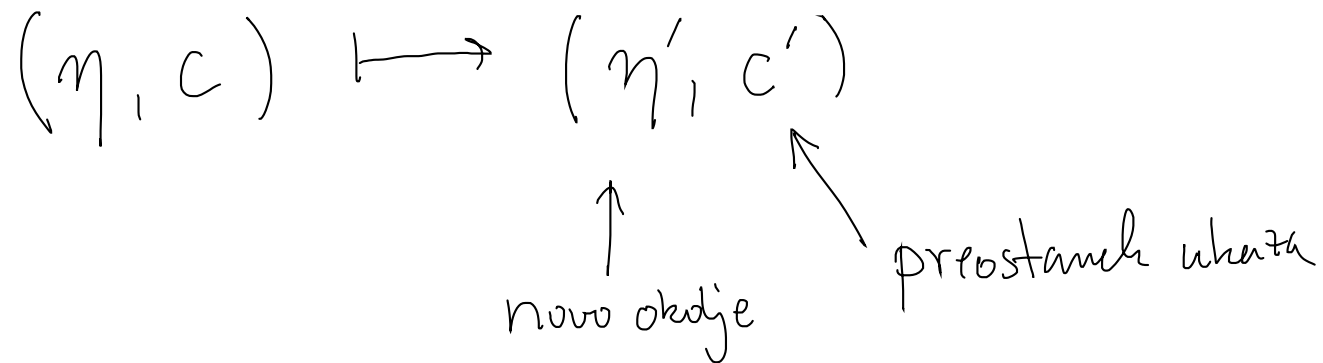
$$\eta = [(x_1, n_1); (x_2, n_2); \dots; (x_k, n_k)]$$

$$\frac{(x_i, n_i) \in \eta}{\eta \mid x_i \hookrightarrow n_i}$$

Operacijska semantika ukazov



$$\frac{e, \vdash e'}{e_1 + e_2 \vdash e'_1 + e'_2}$$



newvar

$$\eta = [(x, 3)]$$

$$(\eta, (x := 5 ; (\text{newvar } x := 10 \text{ in } x := 8) ; x := 6)) \mapsto$$

$$([(x, 5)], (\text{newvar } \underline{x} := 10 \text{ in } \underline{x} := 8) ; x := 6) \mapsto$$

$$(\vec{[(x, 10); (x, 5)]} ; (x := 8 ; x := 6)) \mapsto$$

$$([(x, 8); (x, 5)] ; (x := 6)) \mapsto$$

~~$$[(x, 6); (x, 5)]$$~~

$$(\eta ; \text{print } 7 ; \text{print } 8) \xrightarrow{!7} (\eta ; \text{print } 8) \xrightarrow{!8} \eta$$

!m pošlji

?m preberi

kanal
C!m

C?m

Pravilnost programov

Specifikacija \rightarrow kaj zahtevamo od programa

Implementacija \rightarrow program

$\eta = [\{i, -\}; (N,); (n,)]$	$[n \geq 0]$ $i := 0; N := 0;$ while $i < n$ do $N := N + i;$ $i := i + 1$ done	$[True]$ $- -$
$[N = \frac{1}{2}(n-1)n]$	$[N = \max(0, \frac{1}{2}(n-1)n)]$	

$[x=a \wedge y=b]$

if $x < y$ then

~~z~~ := x;

x := y;

y := z

else

z := y;

y := x;

x := z

$[x=b \wedge y=a]$

a, b "strašni spremeljivci"

$\{n \geq 1\}$

$i := \overset{-1}{1}$; k := 1;

while $k \leq n$ do

$i := i + 1$;

$k := 2 * k$

done;

~~$i := i + 1$~~

$\{2^i \leq n < 2^{i+1}\}$

FV(...)= $\{i, k, n\}$

FAC(...)= $\{i, k\}$

mogoče
pravilno

"Obi-wan error"

"off-by-one error"

i	k
0	1
1	2
2	4

n=3

[...] in {...}

{True} c {True}

vedno velja

{False} c {True}

vedno velja

{False} c {False}

vedno velja

{True} c {False}

c divergira

[True] c [True]

c se konca

[False] c [True]

vedno

[False] c [False]

vedno

[True] c [False]

nikoli ne velja

{7 < 8}

x := 7

{x < 8}

$\not\equiv x < \infty$

$[n \geq 1]$

$i := 0;$

while $n > 1$ do

$i := i + 1;$

$n := n / 2$

done

$[2^i \leq n < 2^{i+1}]$

$[n = a \wedge a \geq 1]$

\vdots

$[2^i \leq a \leq 2^{i+1} \wedge n = a]$

Problem: spremeni samo n

$[n \geq 1]$

$n := 3;$

$i := 1$

$[2^i \leq n < 2^{i+1}]$

Primer

```

• {n >= 0}
  i := 0 ;
  {n >= 0 && i = 0}
  v := 0 ;
  {n >= 0 && i = 0 && v = 0}
  {v = i (i - 1) / 2 && n >= 0 && i <= n}
  while i < n do
    {v = i (i - 1) / 2 && n >= 0 && i <= n && i < n}
    v := v + i ;
    {v = i + i * (i - 1) / 2 && n >= 0 && i <= n && i < n}
    i := i + 1
    {v = (i-1) + (i-1) * (i-2)/2 && n >= 0 && i-1 <= n && i-1 < n}
    {v = i (i - 1) / 2 && n >= 0 && i <= n}
  done
  {v = i (i - 1) / 2 && n >= 0 && i <= n && i >= n}
  {v = n (n - 1) / 2 }

```