

Principi programskih jezikov

Anatomija programskega jezika:

- sintaksa → konkretna
→ abstraktna
- statična ^{pomen} semantika: preverjanje tipov
izpeljava tipov
- dinamična ^{pomen} semantika: izvajanje programa
 - ↳ tolmači (interpreter)
 - ↳ prevajalniki (compiler)
 - ↳ JIT

Aritmetični izrazi

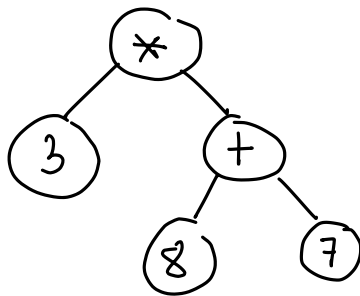
cela števila, + - * \mathbb{Z}

$$3 * (8 + 7)$$

Konkretna sintaksa: niz z izvorno kodo

"3 * (8 + 7)"

Abstraktna sintaksa: drevo (pod. str.), ki predstavlja kodo

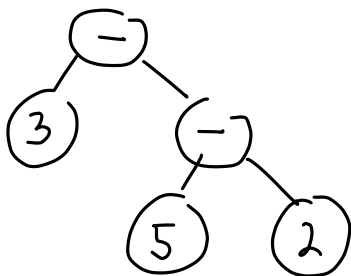


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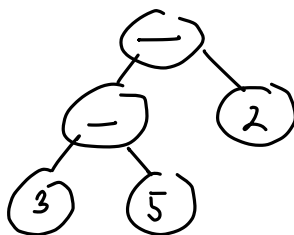
i := 0;
while i < 10 do
    i := i + 1;
    print i;
done

```

$$3 - 5 - 2 \Rightarrow -4$$



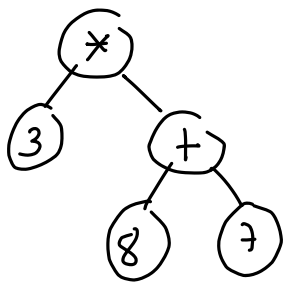
0



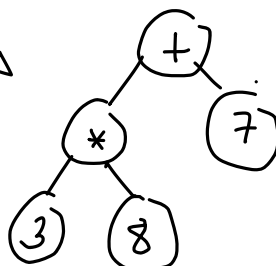
-4

$$3 * 8 + 7$$

$$(3 * 8) + 7$$



$$3 * (8 + 7)$$



$$(3 * 8) + 7$$

$$3 * 8 + 7$$

Konkretna

razčlenjevanje
(parsing)

Abstraktna

izpis (print)

Pravila: def.

(izraz) ::= (aditivni-izraz) EOF.
 (aditivni-izraz) ::= (multiplikativni-izraz) | (aditivni-izraz) + (multiplikativni-izraz)
 (multiplikativni-izraz) ::= (osnovni-izraz) | (multiplikativni-izraz) * (osnovni-izraz)
 (osnovni-izraz) ::= (spremenljivka) | (številka) | ((aditivni-izraz))
 (spremenljivka) ::= [a-zA-Z]+
 (številka) ::= -? [0-9]+

end-of-file

ali (alternativa)

(aditivni-izraz) ::= (multiplikativni-izraz) | (aditivni-izraz) + (multiplikativni-izraz)

(multiplikativni-izraz) ::= (osnovni-izraz) | (multiplikativni-izraz) * (osnovni-izraz)

(osnovni-izraz) ::= (spremenljivka) | (številka) | ((aditivni-izraz))

(spremenljivka) ::= [a-zA-Z]+

(številka) ::= -? [0-9]+

regularni izraz

neprazen niz števk
minus (ni obvezen)

[.....] znaki, ki pridejo v parter

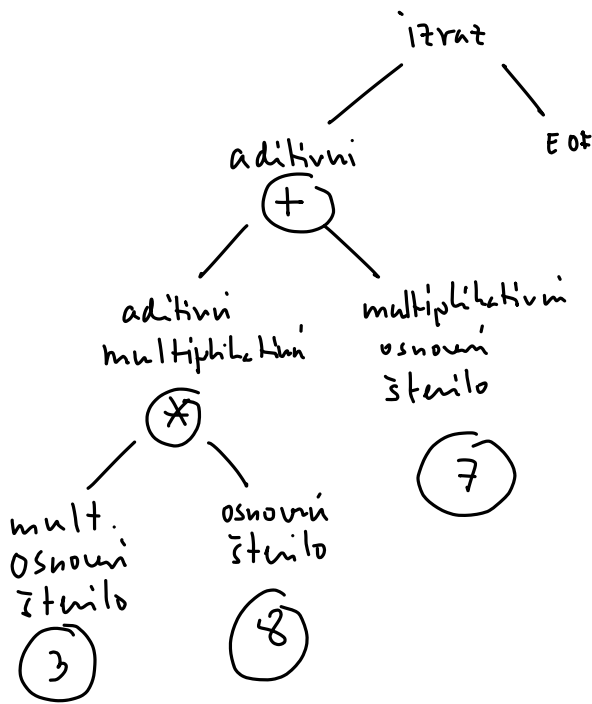
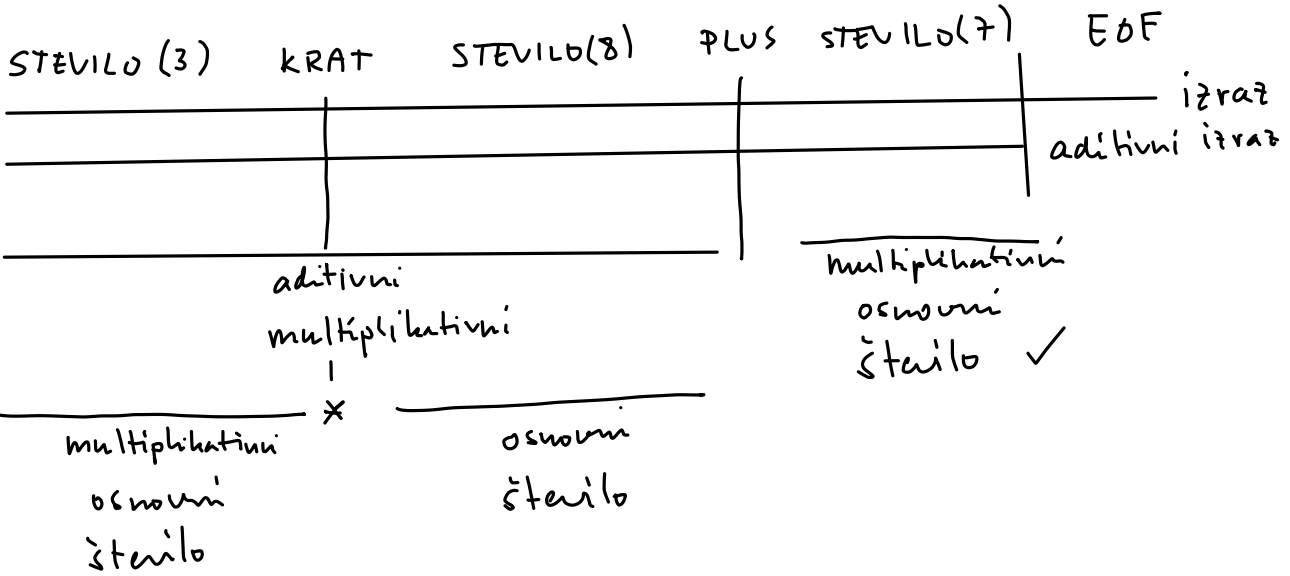
[a-zA-Z] mala ali velika črka

- + ena ali več ponovitev
- ? nič ali ena ponovitev
- * nič ali več ponovitev

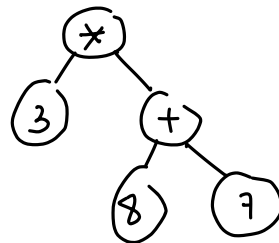
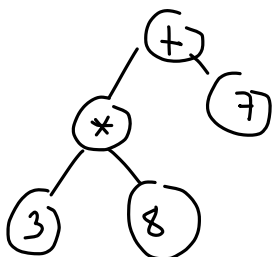
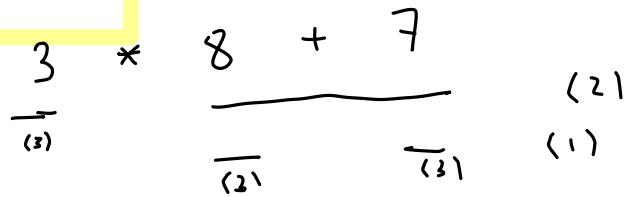
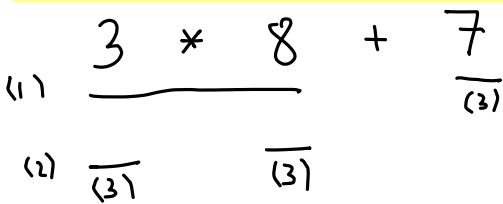
3 * 8 + 7



$$3 * 8 + 7$$



(1) (2) (3)
 izraz := izraz + izraz | izraz * izraz | stevilo



if p then if q then A else B

if p then (if q then A) else B

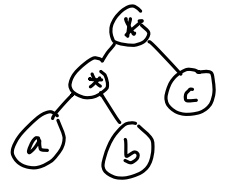
if p then (if q then A else B)

Prioriteta & asociiranost operatorjev

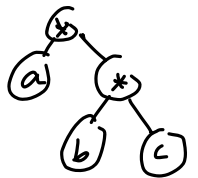
Prioriteta: * ima prednost pred +

Asociiranost:

leva: $a * b * c = (a * b) * c$



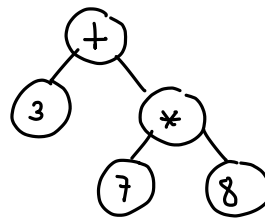
desna: $a * b * c = a * (b * c)$



nima asociiranosti: $a * b * c$ dvoumen zapis

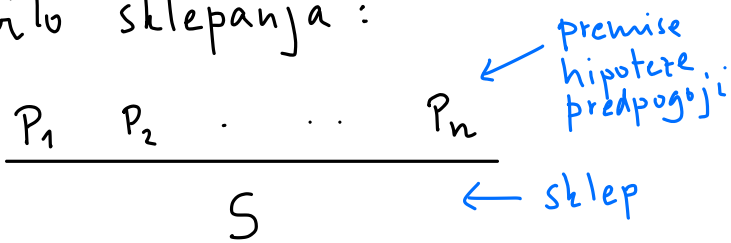
Operacijska semantika

" $3 + (7 * 8)$ " $\xrightarrow{\text{razčlenimo}}$

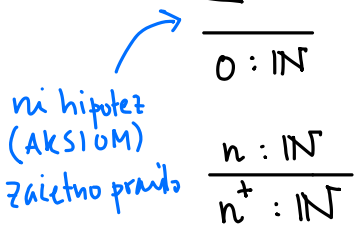


↓ evalvacija ?

Pravilo sklepanja :



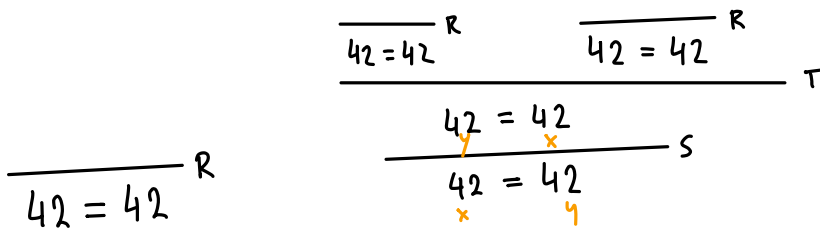
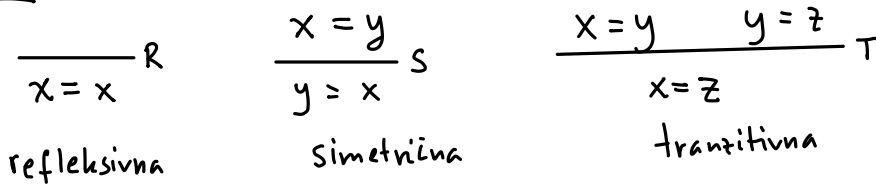
Primeri:



nič je element tipa \mathbb{N}

če smo konstruirali $n : \mathbb{N}$,
potem lahko tvorimo naslednik $n^+ : \mathbb{N}$

Primer:



Semantika velikih korakov

Cela števila, +, x, -, spremenljivke

Okolje (runtime environment) :

preslikava iz imen spremenljivk v njihove vrednosti

zapis: $[x \mapsto 5, y \mapsto 3, z \mapsto 2]$

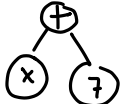
$[\]$

$\eta = [x \mapsto 5, a \mapsto 42]$

Relacija: $\eta \mid e \leftrightarrow n$

okolje η | izraz $e \leftrightarrow$ celo število n

V okolju η se izraz e evalvira (izračuna)
v vrednost n

$[x \mapsto 5, y \mapsto 8] \mid$  $\leftrightarrow 12$ ✓

$[x \mapsto 5, y \mapsto 8] \mid x + 7 \leftrightarrow 10$ ✗

$$\frac{x\eta(x) = n}{\eta \mid x \leftrightarrow n}$$

$$\eta \mid n \leftrightarrow n$$

$$\eta \mid e_1 \leftrightarrow n_1 \quad \eta \mid e_2 \leftrightarrow n_2 \quad n_1 \cdot n_2 = n$$

$$\eta \mid e_1 * e_2 \leftrightarrow n$$

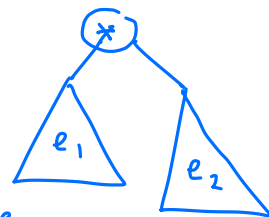
$$\eta \mid e_1 \leftrightarrow n_1 \quad \eta \mid e_2 \leftrightarrow n_2 \quad n_1 + n_2 = n$$

$$\eta \mid e_1 + e_2 \leftrightarrow n$$

gradnik PLUS

matematična operacija množenje

seštevanje



Primer: $\eta = [x \mapsto 7, y \mapsto 2]$

$$\frac{\eta(x) = 7}{\eta \mid x \leftrightarrow 7} \quad 2 \cdot 7 = 14$$

$$\eta \mid 2 * x \leftrightarrow 14$$

$$\eta \mid 3 \leftrightarrow 3 \quad 14 + 3 = 17$$

$$\eta \mid 2 * x + 3 \leftrightarrow 17$$

$$3 * 8 + 7 * 2 \underset{\mapsto}{=} 24 + 7 * 2 \underset{\mapsto}{=} 24 + 14 \underset{\mapsto}{=} 38$$

Semantika malih korakov

Ideja: kako naredimo en računski korak

$$\eta \mid e \mapsto e'$$

V okolju η se
v enem koraku e
predele v e'