

### Sintaksa

"(2 + 3) \* 8 + 7"



"+ (\* (+ (2, 3), 8), 7)"



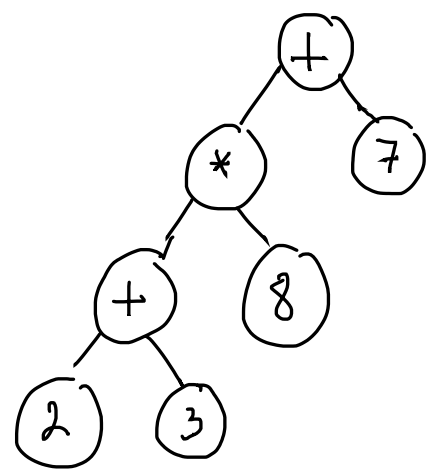
konkretna sintaksa: izraz / program = niz znakov, ki zahteva slovnicih pravilom

- Oklepaji
- presledki
- komentarji
- prioritete operatorjev (\* ima prednost pred +)

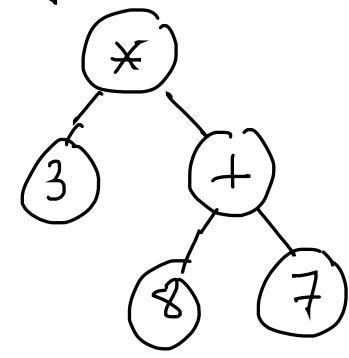
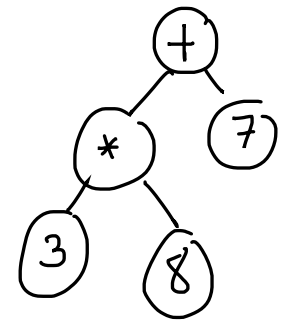
### Abstraktna sintaksa:

- ni oklepajev, komentarjev

"3 \* 8 + 7"

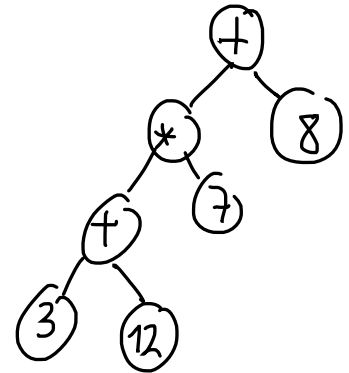
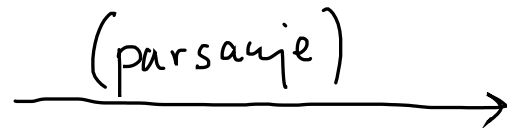


(2+3)\*8+7



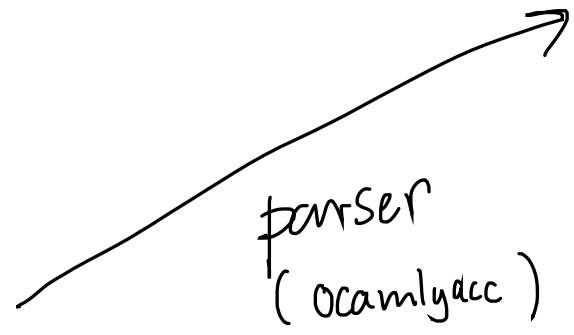
### Razčlenjevalnik (parser)

"(3 + 12) \* 7 + 8"



↓ lekser  
(ocamllex)

- [ OKLEPA ,
- STEVILLO 3 ,
- PLUS
- STEVILLO 12 ,
- ZAKLEPA ] ,
- KRAT ,
- STEVILLO 7 ,
- PLUS ,
- STEVILLO 8 ,
- KONEC ]



menhir  
(menhir)

Leksemi: osnovne enote, na katere razčlenjuemo vhodni niz

## Pravila sklepanja

$$\frac{P_1 \quad P_2 \quad \dots \quad P_n}{P} \quad \begin{array}{l} \leftarrow \text{hipotete} \\ \leftarrow \text{sklep} \end{array}$$

Primeri:

$$\frac{A \quad B}{A \wedge B}$$

$$\frac{A \wedge B}{A}$$

$$\frac{A}{A \vee B}$$

$$\frac{e_1 : \text{int} \quad e_2 : \text{int}}{e_1 + e_2 : \text{int}}$$

## Sintaksa

↓  
 Statična semantika → preverjanje tipe

↓  
 Dinamična semantika → izvajanje

## Dinamična semantika aritmetičnih izrazov: semantika velikih korakov

Definiramo relacijo  $\hookrightarrow$ 

$$e \hookrightarrow n$$

"izraz  $e$  se evalмира v število  $n$ "

S pravili sklepanja:

$$\frac{}{\text{Numeral } n \hookrightarrow n}$$

$$\frac{e_1 \hookrightarrow n_1 \quad e_2 \hookrightarrow n_2}{\text{Plus}(e_1, e_2) \hookrightarrow n_1 + n_2}$$

(podobno za Times, Minus)

$$\frac{e_1 \hookrightarrow n_1 \quad e_2 \hookrightarrow n_2 \quad n_2 \neq 0}{\text{Divide}(e_1, e_2) \hookrightarrow n_1 / n_2}$$

↑ celoštevilsko deljenje

$$\frac{e \hookrightarrow n}{\text{Negate } e \hookrightarrow -n}$$

$$\text{Numeral } 3 \hookrightarrow 3$$

$$\text{Numeral } 7 \hookrightarrow 7$$

$$\text{Plus}(\text{Numeral } 3, \text{Numeral } 7) \hookrightarrow 10$$

Deljenje z 0

$$\begin{array}{l} \text{Numer. 3} \leftrightarrow 3 \quad \text{Numer. 7} \leftrightarrow 7 \\ \hline \end{array}$$

$$\text{Plus (Numer. 3, Numer. 7)} \leftrightarrow 10$$

$$\text{Numer. 0} \leftrightarrow 0$$

? NI RES  
 $0 \neq 0$

$$\text{Divide (Plus (Numer. 3, Numer. 7), Numer. 0)} \rightarrow$$

## Semantika malih korakov

Ideja: relacija  $\mapsto$ , ki pove

$$e \mapsto e'$$

"v enem koraku se program  $e$  transformira v  $e'$ ."

Izvajanje programa:  $e \mapsto e' \mapsto e'' \mapsto e''' \mapsto \dots \mapsto e^{(n)}$

1) Določimo, kateri izrazi so "končni rezultati", pravimo jim vrednosti

Vrednost  $N ::= \text{Numeral } n$

2) Določimo pravila  $th \mapsto$ :

Pravila:

$$\frac{e_1 \mapsto e_1'}{\text{Plus}(e_1, e_2) \mapsto \text{Plus}(e_1', e_2)}$$

$$\frac{e_2 \mapsto e_2'}{\text{Plus}(\text{Numeral } n_1, e_2) \mapsto \text{Plus}(\text{Numeral } n_1, e_2')}$$

$$\text{Plus}(\text{Numeral } n_1, \text{Numeral } n_2) \mapsto \text{Numeral } (n_1 + n_2)$$

sistevanje

$$\frac{\text{Numeral } 7 \mapsto}{\text{Plus}(\text{Numeral } 7, e_2) \mapsto}$$

podobno Times, Minus

$$\frac{e \mapsto e'}{\text{Negate } e \mapsto \text{Negate } e'}$$

$$\text{Negate}(\text{Numeral } n) \mapsto \text{Numeral } (-n)$$

$$\frac{e_2 \mapsto e_2'}{\text{Divide}(\text{Num } n, e_2) \mapsto \text{Divide}(\text{Num } n, e_2')}$$

$$\text{Divide}(\text{Num } n, e_2) \mapsto \text{Divide}(\text{Num } n, e_2')$$

$$\frac{e_1 \mapsto e_1'}{\text{Divide}(e_1, e_2) \mapsto \text{Divide}(e_1', e_2)}$$

$$\frac{n_2 \neq 0}{\text{Divide}(\text{Num } n_1, \text{Num } n_2) \mapsto \text{Numeral}(n_1 / n_2)}$$

Primer

$$(7 + 3) * 8 \quad \mapsto \quad 10 * 8 \quad \mapsto \quad 80$$



## BNF zapis gramatičnih pravil

Konstanta  $n ::= \underbrace{['0' - '9']^+}_{\text{regularni izraz: neprazen niz števk}}$

Osnovni izraz  $\sigma ::= n \mid -\sigma \mid (\sigma)$

Multiplikativni izraz  $M ::= \sigma \mid m * \sigma$

Aditivni izraz  $a ::= m \mid a + m$

Primer: "23 + 7"

a

a + m

=

m = σ

=

σ = 5

=

n = 7

=

" = 23

"7 \* 5 + 8"

a

a + m

m

m \* σ

σ = n

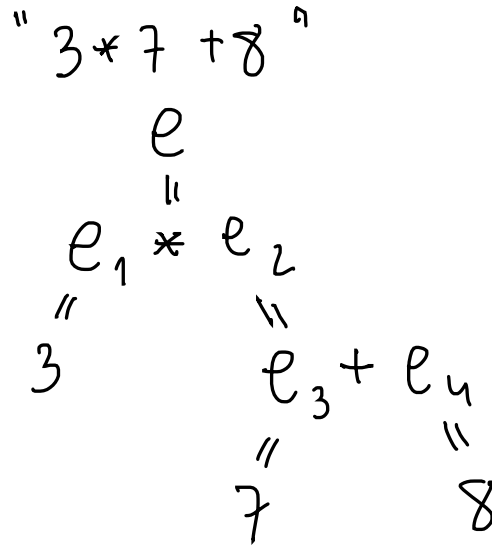
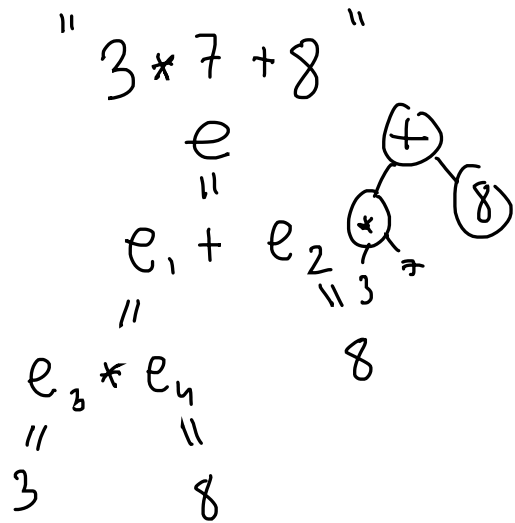
n = 5

σ = n

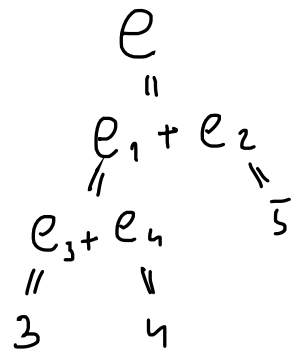
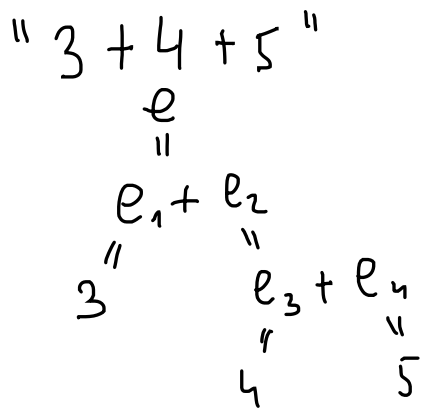
n = 8

## Dvounma pravila

(zrať  $e ::= [0-9]^+ \mid -e \mid (e) \mid e_1 * e_2 \mid e_1 + e_2$



priority operací



asociativnost operací  
 $x \circ y \circ z = (x \circ y) \circ z$  levo asoci.  
 $x \circ y \circ z = x \circ (y \circ z)$  desno asoci.