

# Semântica Operacional Small-Step de Uma Linguagem Imperativa

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## 1 Semântica Operacional Small-Step da Linguagem IMP

### 1.1 Sintaxe

$n \in \mathbb{N}$	números naturais
$x \in \mathbf{Var}$	variáveis
$b \in \{\mathbf{True}, \mathbf{False}\}$	valores booleanos
$E$	expressões aritméticas
$E ::= n$	número inteiro
$  x$	váriavel
$  E + E$	soma
$  E * E$	multiplicação
$B$	expressões booleanas
$B ::= b$	valor booleano
$  \neg B$	negação
$  B \vee B$	ou
$  B \wedge B$	e
$  E \leq E$	menor ou igual
$C$	comandos
$C ::= \mathbf{Skip}$	skip
$  x := E$	atribuição
$  C ; C$	sequência de comandos
$  \text{if } B \text{ then } C \text{ else } C$	if
$  \text{while } B \text{ do } C$	while

### 1.2 Semântica de Expressões Aritméticas

$$\frac{}{\langle x, \sigma \rangle \longrightarrow \langle \sigma(x), \sigma \rangle} (\mathbf{VAR})$$

$$\frac{\langle E_1, \sigma \rangle \longrightarrow \langle E'_1, \sigma \rangle}{\langle E_1 + E_2, \sigma \rangle \longrightarrow \langle E'_1 + E_2, \sigma \rangle} (\mathbf{SOMA1})$$

$$\frac{\langle E, \sigma \rangle \longrightarrow \langle E', \sigma \rangle}{\langle n + E, \sigma \rangle \longrightarrow \langle n + E', \sigma \rangle} \text{ (SOMA2)}$$

$$\overline{\langle n_1 + n_2, \sigma \rangle \longrightarrow \langle n, \sigma \rangle} \quad n = n_1 + n_2 \text{ (SOMA3)}$$

$$\frac{\langle E_1, \sigma \rangle \longrightarrow \langle E'_1, \sigma \rangle}{\langle E_1 * E_2, \sigma \rangle \longrightarrow \langle E'_1 * E_2, \sigma \rangle} \text{ (MULT1)}$$

$$\frac{\langle E, \sigma \rangle \longrightarrow \langle E', \sigma \rangle}{\langle n * E, \sigma \rangle \longrightarrow \langle n * E', \sigma \rangle} \text{ (MULT2)}$$

$$\overline{\langle n_1 * n_2, \sigma \rangle \longrightarrow \langle n, \sigma \rangle} \quad n = n_1 * n_2 \text{ (MULT3)}$$

### 1.3 Semântica de Expressões Booleanas

$$\frac{\langle B, \sigma \rangle \longrightarrow \langle B', \sigma \rangle}{\langle \neg B, \sigma \rangle \longrightarrow \langle \neg B', \sigma \rangle} \text{ NOT1}$$

$$\overline{\langle \neg True, \sigma \rangle \longrightarrow \langle False, \sigma \rangle} \text{ NOT2}$$

$$\overline{\langle \neg False, \sigma \rangle \longrightarrow \langle True, \sigma \rangle} \text{ NOT3}$$

$$\frac{\langle B1, \sigma \rangle \longrightarrow \langle B1', \sigma \rangle}{\langle B1 \wedge B2, \sigma \rangle \longrightarrow \langle B1' \wedge B2, \sigma \rangle} \text{ AND1}$$

$$\overline{\langle True \wedge B, \sigma \rangle \longrightarrow \langle B, \sigma \rangle} \text{ AND2}$$

$$\overline{\langle False \wedge B, \sigma \rangle \longrightarrow \langle False, \sigma \rangle} \text{ AND3}$$

$$\frac{\langle B1, \sigma \rangle \longrightarrow \langle B1', \sigma \rangle}{\langle B1 \vee B2, \sigma \rangle \longrightarrow \langle B1' \vee B2, \sigma \rangle} \text{ OR1}$$

$$\overline{\langle True \vee B, \sigma \rangle \longrightarrow \langle True, \sigma \rangle} \text{ OR2}$$

$$\overline{\langle False \vee B, \sigma \rangle \longrightarrow \langle B, \sigma \rangle} \text{ OR3}$$

$$\frac{\langle E_1, \sigma \rangle \longrightarrow \langle E'_1, \sigma \rangle}{\langle E_1 \leq E_2, \sigma \rangle \longrightarrow \langle E'_1 \leq E_2, \sigma \rangle} \text{ (LEQ1)}$$

$$\frac{\langle E, \sigma \rangle \longrightarrow \langle E', \sigma \rangle}{\langle n \leq E, \sigma \rangle \longrightarrow \langle n \leq E', \sigma \rangle} \text{ (LEQ2)}$$

$$\overline{\langle n_1 \leq n_2, \sigma \rangle \longrightarrow \langle b, \sigma \rangle} \quad b = n_1 \leq n_2 \text{ (LEQ3)}$$

#### 1.4 Semântica de Comandos

$$\frac{\langle E, \sigma \rangle \longrightarrow \langle E', \sigma \rangle}{\langle x := E, \sigma \rangle \longrightarrow \langle x := E', \sigma \rangle} \text{ (ATRIB1)}$$

$$\frac{}{\langle x := n, \sigma \rangle \longrightarrow \langle \text{Skip}, \sigma[x \mapsto n] \rangle} \text{ (ATRIB2)}$$

$$\frac{\langle C_1, \sigma \rangle \longrightarrow \langle C'_1, \sigma' \rangle}{\langle C_1 ; C_2, \sigma \rangle \longrightarrow \langle C'_1 ; C_2, \sigma' \rangle} \text{ (SEQ1)}$$

$$\frac{}{\langle \text{Skip} ; C_2, \sigma \rangle \longrightarrow \langle C_2, \sigma \rangle} \text{ (SEQ2)}$$

$$\frac{\langle B, \sigma \rangle \longrightarrow \langle B', \sigma \rangle}{\langle \text{if } B \text{ then } C1 \text{ else } C2, \sigma \rangle \longrightarrow \langle \text{if } B' \text{ then } C1 \text{ else } C2, \sigma \rangle} \text{ (IF1)}$$

$$\frac{}{\langle \text{if } \text{True} \text{ then } C1 \text{ else } C2, \sigma \rangle \longrightarrow \langle C1, \sigma \rangle} \text{ (IF2)}$$

$$\frac{}{\langle \text{if } \text{False} \text{ then } C1 \text{ else } C2, \sigma \rangle \longrightarrow \langle C2, \sigma \rangle} \text{ (IF3)}$$

$$\frac{}{\langle \text{While } B \text{ do } C, \sigma \rangle \longrightarrow \langle \text{if } B \text{ then } (C; \text{While } B \text{ do } C) \text{ else } \text{Skip}, \sigma \rangle} \text{ (WHILE)}$$