

↳ Context Free Grammars.

1/11-1 proved!

- Start

$\langle S \rangle \rightarrow \langle S \rangle \langle S \rangle \mid \langle \text{fun-decl} \rangle \langle S \rangle$
 $\mid \langle \text{class-decl} \rangle \mid \langle S \rangle \mid \langle \text{main} \rangle \langle S \rangle$
 $\mid \epsilon$

Class definition

$\langle \text{class-decl} \rangle \rightarrow \langle C\text{-AM} \rangle \text{ class ID()} \langle \text{inh} \rangle$
 $\quad \quad \quad \langle C\text{-body} \rangle$

$\langle C\text{-AM} \rangle \rightarrow \text{public} \mid \text{private} \mid \epsilon$

$\langle \text{inh} \rangle \rightarrow \leftarrow \mid \text{extends ID}$

$\langle C\text{-body} \rangle \rightarrow ; \mid \{ \langle C\text{-MST} \rangle \}$

$\langle C\text{-MST} \rangle \rightarrow \langle C\text{-SST} \rangle \langle C\text{-MST} \rangle \mid \epsilon$

$\langle C\text{-SST} \rangle \rightarrow \langle \text{decl} \rangle \mid \langle \text{func-decl} \rangle \mid$

$\quad \quad \quad \langle \text{array-decl} \rangle \mid \langle \text{constructor} \rangle$

$\langle \text{decl} \rangle \rightarrow \langle \text{AM} \rangle \langle \text{DT} \rangle \text{ ID } \langle \text{init} \rangle \langle \text{List} \rangle$

$\langle \text{AM} \rangle \rightarrow \text{public} \mid \text{private} \mid \text{protected} \mid \epsilon$

$\langle \text{init} \rangle \rightarrow = \langle \text{OE} \rangle \mid \epsilon$

$\langle \text{List} \rangle \rightarrow ; \mid , \text{ ID } \langle \text{init} \rangle \langle \text{List} \rangle$

$\langle \text{Func-decl} \rangle \rightarrow \langle \text{AM} \rangle \text{ def } \langle \text{RT} \rangle \text{ ID }$

$\quad \quad \quad (\langle \text{parameter} \rangle) \langle \text{f-body} \rangle$

$\langle \text{RT} \rangle \rightarrow \text{void} \mid \langle \text{DT} \rangle$

$\langle \text{constructor} \rangle \rightarrow \text{ID()} \langle \text{f-body} \rangle$

$\langle f_body \rangle \rightarrow ; \mid \{ \langle f_MST \rangle \}$

$\langle f_MST \rangle \rightarrow \langle f_SST \rangle \langle f_MST \rangle \mid \epsilon$

$\langle f_SST \rangle \rightarrow \langle \text{decl}' \rangle \mid \langle \text{assign_st} \rangle \mid \langle \text{while_st} \rangle \mid \langle \text{for_st} \rangle \mid \langle \text{do_while} \rangle \mid \langle \text{if_else} \rangle \mid \langle \text{return} \rangle \mid \langle \text{print} \rangle$

$\langle \text{decl}' \rangle \rightarrow \langle \text{ts} \rangle \mid \text{ID} \langle \text{assign_op} \rangle \langle \text{op} \rangle \mid \langle \text{DT} \rangle \mid \text{ID} \langle \text{list} \rangle$

$\langle \text{ts} \rangle \rightarrow \text{this.} \mid \text{super.} \mid \epsilon$

$\langle \text{assign_op} \rangle \rightarrow = \mid \langle \text{comp_assign_op} \rangle$

For statement.

$\text{for-st} \rightarrow \text{for } \langle C1 \rangle \langle C2 \rangle ; \langle C3 \rangle$

$\langle \text{body} \rangle$

$C1 \rightarrow \langle \text{decl} \rangle | \langle \text{Assign-st} \rangle | \epsilon$

$C2 \rightarrow \langle \text{OE} \rangle | \epsilon$

$\langle C3 \rangle \rightarrow \langle \text{inc-dec-op} \rangle \langle t_s \rangle \text{ID} \langle R \rangle |$
 $\langle t_s \rangle \text{ID} \langle R \rangle \langle \text{SSI}'' \rangle | \epsilon$

$\langle \text{Assign-st} \rangle \rightarrow \langle t_s \rangle \text{ID} \langle R \rangle \langle \text{assign-op} \rangle$
 $\langle \text{OE} \rangle ;$

$\langle \text{assign-op} \rangle \rightarrow = | \langle \text{comp-assign-op} \rangle$

$\langle t_s \rangle \rightarrow \text{this.} | \text{super.} | \epsilon$

$\langle \text{inc-dec-st} \rangle \rightarrow \langle t_s \rangle \text{ID} \langle R \rangle \langle \text{inc-dec-op} \rangle ;$
 $\langle \text{inc-dec-op} \rangle \langle t_s \rangle \text{ID} \langle R \rangle ;$

$\langle R \rangle \rightarrow . \text{ID} \langle \text{ref} \rangle \langle \text{init} \rangle | \epsilon$

$\langle \text{ref} \rangle \rightarrow \langle \text{ID-ref} \rangle \langle \text{Fn-ref} \rangle \langle \text{Arr-ref} \rangle$
 $\langle \text{ref} \rangle | \epsilon$

~~$\langle \text{ref} \rangle \langle \text{ID-ref} \rangle \rightarrow . \text{ID} \langle \text{ref} \rangle | \epsilon$~~

$\langle \text{Fn-ref} \rangle \rightarrow . \text{Fn}() \langle \text{ref} \rangle | \epsilon$

$\langle \text{Arr-ref} \rangle \rightarrow . \text{arr}[] \langle \text{ref} \rangle | \epsilon$

$\langle \text{body} \rangle \rightarrow ; \mid \{ \langle M\bar{S}\bar{T} \rangle \}$
 $\langle M\bar{S}\bar{T} \rangle \rightarrow \langle S\bar{S}\bar{T} \rangle \langle M\bar{S}\bar{T} \rangle \mid \epsilon$
 $\langle S\bar{S}\bar{T} \rangle \rightarrow D\bar{T} \langle S\bar{S}\bar{T}' \rangle \mid ID \langle S\bar{S}\bar{T}'' \rangle$
 $\langle t_3 \rangle \mid ID \langle R \rangle \langle S\bar{S}\bar{T}''' \rangle \mid$
 $\langle \text{while-st} \rangle \mid \langle \text{if-else} \rangle$
 $\langle \text{for-st} \rangle \mid \langle \text{do-while} \rangle$
 $\langle \text{break} \rangle \mid \langle \text{continue} \rangle$
 ~~$\langle \text{obj-decl} \rangle \mid \langle \text{try-except} \rangle$~~
 $\langle \text{print} \rangle \mid \langle \text{return} \rangle \mid$
 $\langle \text{inc-dec-op} \rangle \langle t_3 \rangle \mid ID \langle$
 $\langle S\bar{S}\bar{T}' \rangle \rightarrow ID \langle \text{init} \rangle \langle \text{List} \rangle \mid$
 $\langle b\delta \rangle \mid ID \langle A \rangle \mid$

$\langle S\bar{S}\bar{T}'' \rangle \rightarrow (\langle \text{parameter} \rangle) \mid \langle R \rangle \langle \text{L}$
 $\mid ID = \text{new} \langle \text{c-name} \rangle \langle \text{par} \rangle;$
 $\langle S\bar{S}\bar{T}''' \rangle \rightarrow \langle \text{assign-op} \rangle \langle O\bar{E} \rangle ; \mid$
 $\langle \text{inc-dec-op} \rangle ;$

↳ Declaration

$\langle \text{decl} \rangle \rightarrow \langle \text{DT} \rangle \text{ID} \langle \text{init} \rangle \langle \text{list} \rangle$
 $\langle \text{init} \rangle \rightarrow = \langle \text{OE} \rangle | \epsilon$
 $\langle \text{list} \rangle \rightarrow ; \text{I}, \text{ID} \langle \text{init} \rangle \langle \text{list} \rangle$

While statement

$\langle \text{while-st} \rangle \rightarrow \text{while} (\langle \text{OE} \rangle) \langle \text{body} \rangle$

Do-while statement

$\langle \text{do_while-st} \rangle \rightarrow \text{do} \langle \text{body} \rangle \langle \text{while} \rangle$
 $\langle \text{while} \rangle \rightarrow \text{while} (\langle \text{OE} \rangle);$

7- If-else statement

$\langle \text{if_else} \rangle \rightarrow \text{if} (\langle \text{OE} \rangle) \langle \text{body} \rangle \langle \text{else} \rangle$
 $\langle \text{else} \rangle \rightarrow \text{else} \langle \text{body} \rangle | \epsilon$

8. Expression CFG

$\langle OE \rangle \rightarrow \langle AE \rangle \langle OE' \rangle$

$\langle OE' \rangle \rightarrow II \langle AE \rangle \langle OE' \rangle | \epsilon$

$\langle AE \rangle \rightarrow \langle RE \rangle \langle AE' \rangle$

$\langle AE' \rangle \rightarrow \epsilon \epsilon \langle RE \rangle \langle AE' \rangle | \epsilon$

$\langle RE \rangle \rightarrow \langle E \rangle \langle RE' \rangle$

$\langle RE' \rangle \rightarrow REO \langle E \rangle \langle RE' \rangle | \epsilon$

$\langle E \rangle \rightarrow \langle T \rangle \langle E' \rangle$

$\langle E' \rangle \rightarrow PM \langle T \rangle \langle E' \rangle | \epsilon$

$\langle T \rangle \rightarrow \langle F \rangle \langle T' \rangle$

$\langle T' \rangle \rightarrow MDM \langle F \rangle \langle T' \rangle | \epsilon$

$\langle F \rangle \rightarrow ID | \langle const \rangle | (\langle OE \rangle) |$

$| \langle F \rangle | \langle Fn-call \rangle |$

$\langle inc-dec-op \rangle \langle ts \rangle ID \langle R \rangle |$

$\langle ts \rangle ID \langle R \rangle \langle inc-dec-op \rangle |$

$\langle OE \rangle$

$\uparrow \langle F \rangle \text{ not left factored}$

$\langle F \rangle \rightarrow ID \langle F' \rangle | \langle const \rangle | ! \langle F \rangle |$

$\langle inc-dec-op \rangle \langle F \rangle ID \langle R \rangle |$

$\langle OE \rangle | \langle | (\langle OE \rangle)$

$\langle F' \rangle \rightarrow (\langle parameter \rangle) | \langle R \rangle \langle inc-dec-op \rangle$

left-factored

Function declaration

def
 $\langle \text{fun-decl} \rangle \rightarrow \downarrow \langle \text{DT} \rangle \text{ID} (\langle \text{parameters} \rangle) \langle \text{body} \rangle$

$\langle \text{parameters} \rangle \rightarrow \langle \text{DT} \rangle \text{ID} \langle P_1 \rangle | \epsilon$

$\langle P_1 \rangle \rightarrow = \langle \text{OE} \rangle \langle P_2 \rangle | \cancel{\langle P_1 \rangle \rightarrow \langle P_2 \rangle} | \epsilon$

$\langle P_2 \rangle \rightarrow , \langle \text{DT} \rangle \text{ID} \langle P_1 \rangle | \epsilon$

Main Method.

$\langle \text{main} \rangle \rightarrow \text{static} \langle \text{DT} \rangle \text{Main} (\text{string}[] \langle \text{args} \rangle) \langle \text{body} \rangle$

Assignment Statement.

$\langle \text{assign-st} \rangle \rightarrow \langle \text{ts} \rangle \text{ID} \langle R \rangle \langle \text{assign-op} \rangle \langle \text{OE} \rangle ;$

$\langle \text{ts} \rangle \rightarrow \text{this.} | \text{super.} | \epsilon$

$\langle \text{assign-op} \rangle \rightarrow = | \langle \text{comp-assign-op} \rangle$

$\langle \text{comp-assign-op} \rangle \rightarrow +=, -=, *=, /=, \% =$

↳ Increment / decrement.

$\langle \text{inc-dec-st} \rangle \rightarrow \langle ts \rangle \text{ID} \langle R \rangle \langle \text{inc-dec-op} \rangle$
 $\langle \text{inc-dec-op} \rangle \rightarrow \langle ts \rangle \text{ID} \langle R \rangle$
 $\langle \text{inc-dec-op} \rangle \rightarrow ++ | --$

↳ R CFG.

$\langle R \rangle \rightarrow \cdot \text{ID} \langle \text{ref} \rangle \langle \text{init} \rangle | \epsilon$
 $\langle \text{ref} \rangle \rightarrow \langle \text{ID-ref} \rangle \langle \text{Fn-ref} \rangle \langle \text{Arr-ref} \rangle$
 $\langle \text{ref} \rangle | \epsilon$
 $\langle \text{ID-ref} \rangle \rightarrow \cdot \text{ID} \langle \text{ref} \rangle | \epsilon$
 $\langle \text{Fn-ref} \rangle \rightarrow \cdot \text{Fn}() \langle \text{ref} \rangle | \epsilon$
 $\langle \text{Arr-ref} \rangle \rightarrow \cdot \text{arr}[] \langle \text{ref} \rangle | \epsilon$

↳ Array declaration

$\langle \text{array-dec} \rangle \rightarrow \langle \text{DT} \rangle \langle \text{bx} \rangle \text{ID} \langle \text{A1} \rangle$
 $\langle \text{bx} \rangle \rightarrow [] \langle \text{bx} \rangle | \epsilon$
 $\langle \text{A1} \rangle \rightarrow = \text{new} \langle \text{DT} \rangle \langle \text{bx1} \rangle ;$
 $\langle \text{bx1} \rangle \rightarrow [<\text{I}>] \langle \text{bx1} \rangle | \epsilon$
 $\langle \text{I} \rangle \rightarrow \text{int-const} | \epsilon$

Data Types

`DT >→ string | int | char | float | bool`

Constants

`<const> → int-const | string-const | float-const | bool-const.`

Break

`<break> → break ;`

Continue

`<continue> → continue ;`

return

`<return> → return <OE> ;`

Print

`<print> → print (<OE>) ;`

↳ Object Declaration.

$\langle \text{obj-decl} \rangle \rightarrow \langle \text{c-name} \rangle \text{ ID} = \text{new} \langle \text{c-name} \rangle$

↳ Body

$\langle \text{body} \rangle \rightarrow ; \mid \{\langle \text{MST} \rangle\}$

↳ Multi-line Statement.

$\langle \text{MST} \rangle \rightarrow \langle \text{SST} \rangle \langle \text{MST} \rangle \mid \epsilon$

↳ Single line Statement.

$\langle \text{SST} \rangle \rightarrow \text{D} \langle \text{SST}' \rangle \mid \text{ID} \langle \text{SST}'' \rangle \mid \langle \text{t} \rangle \text{ ID}$
 $\langle R \rangle \langle \text{SST}''' \rangle \mid \langle \text{while-st} \rangle \mid \langle \text{if-els} \rangle$
 $\mid \langle \text{for-st} \rangle \mid \langle \text{do-while} \rangle \mid \langle \text{break} \rangle \mid \langle \text{continue} \rangle \mid \langle \text{obj-decl} \rangle \mid \langle \text{try-except} \rangle$
 $\langle \text{print} \rangle \mid \langle \text{return} \rangle \mid \langle \text{inc-dec-up} \rangle \langle \text{t} \rangle \text{ ID}$

$\langle \text{SST}' \rangle \rightarrow \text{ID} \langle \text{init} \rangle \langle \text{List} \rangle \mid \langle \text{bx} \rangle \text{ ID} \langle \text{A1} \rangle$

$\langle \text{SST}'' \rangle \rightarrow (\langle \text{parameter} \rangle \mid \langle R \rangle \langle \text{SST}''' \rangle \mid$
 $ID = \text{new} \langle c\text{-name} \rangle (\langle \text{Parameter}' \rangle);$

$\langle \text{SST}''' \rangle \rightarrow \langle \text{assign-op} \rangle \langle \text{OF} \rangle ; \mid$
 $\langle \text{inc-dec-op} \rangle ;$