

## Syntax

|                  |         |  |
|------------------|---------|--|
| Literals         | $lit$   | $::= None \mid True \mid False \mid "a" \mid \dots \mid 1 \mid \dots$  |
| Expression       | $Exp$   | $::= lit@(\overline{A}) \mid Exp.id \mid f(\overline{Exp}) \mid Exp.f(\overline{Exp}) \mid C@(\overline{A}).(\overline{Exp})$  |
| Typed Expression | $TExp$  | $::= lit@(\overline{A}) : \tau \mid \dots$   |
| Assign Op.       | $AsgOp$ | $\in \{=, +=, -=, *=, /=, \%=, /\} = \}$   |
| Binary Op.       | $BinOp$ | $\in \{  , \&\&,  , \&, ==, !=, <, >, <=, >=, +, -, *, /, \%, **\}$  |
| Statement        | $Stm$   | $::= \text{pass} \mid \text{return } Exp \mid Exp \cdot Stm \mid id = Exp \cdot Stm$<br>$\mid Exp_1 \text{ } AsgOp \text{ } Exp_2 \cdot Stm \mid \text{if } Exp : Stm \text{ else } : Stm$<br>$\mid \text{try} : Stm \text{ except} : \text{raise } Exp ; Stm$ |

## Projection To Python

$$\begin{aligned}
(Exp) \quad \llbracket lit@(\overline{B}) : \tau \rrbracket^A &= \begin{cases} lit & \text{if } A \in \overline{B} \\ \text{Unit.id} & \text{otherwise} \end{cases} \\
\llbracket Exp.id : \tau \rrbracket^A &= \begin{cases} \llbracket Exp \rrbracket^A.id & \text{if } A \in \text{rolesOf}(Exp.id) \\ \text{absent} & \text{otherwise} \end{cases} \\
\llbracket f(\overline{Exp}) : \tau \rrbracket^A &= \begin{cases} f(\llbracket \overline{Exp} \rrbracket^A) & \text{if } A \in \text{rolesOf}(\overline{Exp}) \wedge A \in \text{rolesOf}(f(\overline{Exp})) \\ f(\llbracket \text{Unit.id} \rrbracket^A) & \text{if } A \notin \text{rolesOf}(\overline{Exp}) \wedge A \in \text{rolesOf}(f(\overline{Exp})) \\ \text{Unit.id}(\llbracket \overline{Exp} \rrbracket^A) & \text{otherwise} \end{cases} \\
\llbracket Exp.f(\overline{Exp}) : \tau \rrbracket^A &= \begin{cases} \llbracket Exp \rrbracket^A.f(\llbracket \overline{Exp} \rrbracket^A) & \text{if } A \in \text{rolesOf}(Exp) \wedge A \in \text{rolesOf}(\overline{Exp}) \\ \llbracket Exp \rrbracket^A.f(\llbracket \text{Unit.id} \rrbracket^A) & \text{if } A \in \text{rolesOf}(Exp) \wedge A \notin \text{rolesOf}(\overline{Exp}) \\ & \wedge A \in \text{rolesOf}(Exp.f(\overline{Exp})) \\ \text{Unit.id}(\llbracket Exp \rrbracket^A, \llbracket \overline{Exp} \rrbracket^A) & \text{otherwise} \end{cases} \\
\llbracket C@(\overline{B})(\overline{Exp}) : \tau \rrbracket^A &= \begin{cases} \llbracket C@(\overline{B}) \rrbracket^A(\llbracket \overline{Exp} \rrbracket^A) & A \in \overline{B} \\ \text{Unit.id}(\llbracket \overline{Exp} \rrbracket^A) & \text{otherwise} \end{cases} \\
\text{rolesOf}(\_ : \tau@(\overline{B})) &= \overline{B} \\
\text{rolesOf}(Exp.id : \tau) &= \overline{B} \quad \text{if } \text{rolesOf}(Exp) = \overline{B} \\
\text{rolesOf}(f(\overline{Exp}) : \tau) &= \overline{B} \quad \text{if } \text{rolesOf}(\overline{Exp}) = \overline{B} \\
\text{rolesOf}(Exp.f(\overline{Exp}) : \tau) &= \overline{B} \quad \text{if } \text{rolesOf}(Exp) = \overline{B}
\end{aligned}$$