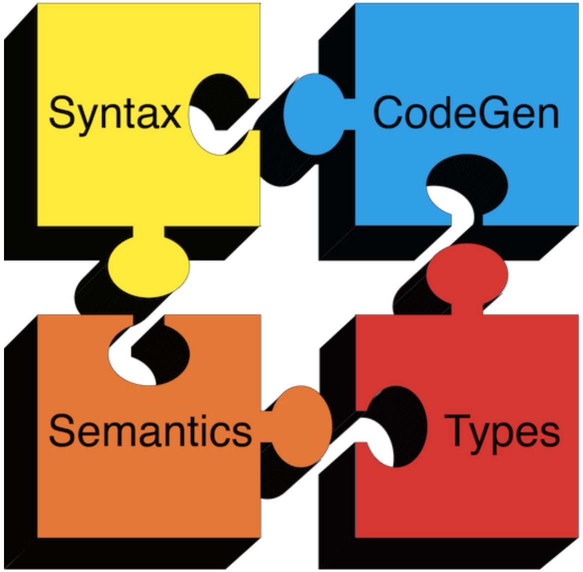

Compilers

Self Type Checking

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Self Type Checking

- SELF_TYPE's meaning depends on the enclosing class

$SELF\_TYPE_C$

$$\underbrace{O,M,C \vdash e : T}$$

An expression e occurring in the body of C has static type T given a variable type environment O and method signatures M

Self Type Checking

- The next step is to design type rules using SELF_TYPE

- Most of the rules remain the same
  - But use the new $\leq$ and lub

$$\frac{\begin{array}{l} O(Id) = T_0 \\ O,M,C \vdash e_1 : T_0 \\ T_1 \leq T_0 \end{array}}{O,M,C \vdash Id \leftarrow e_1 : T_1}$$

Self Type Checking

- Recall the old rule for dispatch

$$\frac{\begin{array}{l} O,M,C \vdash e_0 : T_0 \\ \qquad\vdots \\ O,M,C \vdash e_n : T_n \\ M(T_0, f) = (T_1',\ldots,T_n',T_{n+1}') \\ T_{n+1}' \neq SELF\_TYPE \\ T_i \leq T_i' \qquad\qquad 1 \leq i \leq n \end{array}}{O,M,C \vdash e_0.f(e_1,\ldots,e_n) : T_{n+1}'}$$

Self Type Checking

- If the return type of the method is SELF_TYPE then the type of the dispatch is the type of the dispatch expression:

$$
\begin{array}{l}
O,M,C \vdash e_0 : T_0 \\
\quad\vdots \\
O,M,C \vdash e_n : T_n \\
M(T_0, f) = (T_1',\ldots,T_n', \text{SELF\_TYPE}) \\
T_i \leq T_i' \qquad\qquad 1 \leq i \leq n \\
\hline
O,M,C \vdash e_0.f(e_1,\ldots,e_n) : T_0
\end{array}
$$

Self Type Checking

- Formal parameters cannot be SELF_TYPE
- Actual arguments can be SELF_TYPE
  - The extended ≤ relation handles this case
- The type T_0 of the dispatch expression could be SELF_TYPE
  - Which class is used to find the declaration of f?
  - Answer: it is safe to use the class where the dispatch appears

$$\frac{e_0 : \text{SELF\_TYPE}_C \qquad M(\underline{C}, f) = (\ \ldots\ )}{O, M, C \vdash e_0.f(e_1)}$$

Self Type Checking

- Recall the original rule for static dispatch

$$\frac{\begin{array}{l} O,M,C \vdash e_0 : T_0 \\ \quad\quad\vdots \\ O,M,C \vdash e_n : T_n \\ T_0 \leq T \\ M(T, f) = (T_1',\ldots,T_n',T_{n+1}') \\ T_{n+1}' \neq SELF\_TYPE \\ T_i \leq T_i' \quad\quad 1 \leq i \leq n \end{array}}{O,M,C \vdash e_0@T.f(e_1,\ldots,e_n) : T_{n+1}'}$$

Self Type Checking

- If the return type of the method is SELF_TYPE we have:

$$\frac{\begin{array}{l} O,M,C \vdash e_0 : T_0 \\ \quad\quad \vdots \\ O,M,C \vdash e_n : T_n \\ T_0 \le T \\ M(T, f) = (T_1',\ldots,T_n',SELF\_TYPE) \\ T_i \le T_i' \quad\quad 1 \le i \le n \end{array}}{O,M,C \vdash e_0@T.f(e_1,\ldots,e_n) : T_0}$$

Self Type Checking

- Why is this rule correct?

- If we dispatch a method returning SELF_TYPE in class T, don't we get back a T?

$T_0 \leq T$

- No. SELF_TYPE is the type of the self parameter, which may be a subtype of the class in which the method appears

Self Type Checking

- There are two new rules using SELF_TYPE

$$\frac{}{O,M,C \vdash \text{self} : \text{SELF\_TYPE}_C}$$

$$\frac{}{O,M,C \vdash \text{new SELF\_TYPE} : \text{SELF\_TYPE}_C}$$

Self Type Checking

Choose the static/dynamic type pairs that are correct. For dynamic type, assume execution has halted at line 15.

	Var	Static Type	Dynamic Type
☐	w	Animal	Pet
☐	x	Animal	Lion
☐	y	Pet	Pet
☐	z	Animal	Dog

```
1      class Animal {
2          clone() : SELF_TYPE { new SELF_TYPE }
3      }
4          class Pet inherits Animal {
5          clone() : Pet { new SELF_TYPE }
6      }
7      class Cat inherits Pet { ... }
8      class Dog inherits Pet { ... }
9      class Lion inherits Animal { ... }
10 class Main {
11     w:Animal <- (new Animal).clone();
12     x:Animal <- (new Lion).clone();
13     y:Pet <- (new Cat).clone();
14     z:Animal <- (new Dog)@Animal.clone();
→ 15   ...
16 }
```

Self Type Checking

- The extended $\leq$ and lub operations can do a lot of the work.

- SELF_TYPE can be used only in a few places. Be sure it isn't used anywhere else.

- A use of SELF_TYPE always refers to any subtype of the current class

  $M(\leq, f) = (\ldots, \text{SELF\_TYPE})$

  - The exception is the type checking of dispatch. The method return type of SELF_TYPE might have nothing to do with the current class

Self Type Checking

- SELF_TYPE is a research idea
  - It adds more expressiveness to the type system
- SELF_TYPE is itself not so important
  - except for the project
- Rather, SELF_TYPE is meant to illustrate that type checking can be quite subtle
- In practice, there should be a balance between the complexity of the type system and its expressiveness