Semantics & Type Checking

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Adapted from Autumn 2020

Announcements

- HW 3 due tonight at 11:00PM on Gradescope!
- Semantics project *released*
  - **START EARLY! START EARLY! START EARLY!**
  - **Check-in next week!**
- Week 6, How are we feeling about the class so far?
- How are we feeling in general?

May				
Monday	Tuesday	Wednesday	Thursday	Friday
03 14:30-15:20 Lecture zoom link *x86-64 (everything you forgot from 351)* handout (rest of slides same as Friday)	04	05 14:30-15:20 Lecture zoom link *Code shape I - basics* slides	06 Section *ASTs & semantics* 23:00 hw3 due (LL grammars & parsing)	07 14:30-15:20 Lecture zoom link *Code shape II - objects and dynamic dispatch*
10 14:30-15:20 Lecture zoom link *Codeshape (concl.); Start project codegen*	11	12 14:30-15:20 Lecture zoom link *Project codegen*	13 Section *Semantics project checkin and work session*	14 14:30-15:20 Lecture zoom link *IRs*

Agenda

- Semantics & Type Checking
  - Review: Semantics vs. Type Checking
  - Type Checking for MiniJava

Semantics, Dynamic and Static

semantics: precise meaning of program syntax

what interpretation or code generation implements

dynamic semantics: systematic rules to define runtime behavior

static semantics: systematic rules to define *statically correct* behavior

what type checking implements

Static Semantics of MiniJava

Every language has its own idea of “statically correct,”
but in MiniJava, statically correct code must...

1. *never* add, subtract, multiply, or print non-integers
2. *never* call a non-existent method
3. *never* access a non-existent field

n. … and so on (see the assignment page for more)

How do type checks relate to these conditions?

Type Checking for MiniJava

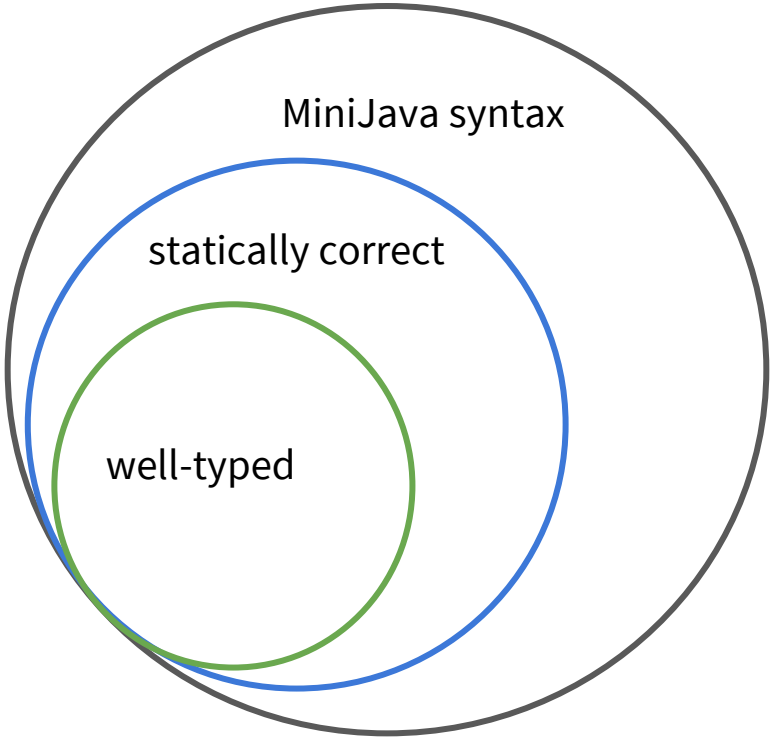
The type checker's goal is to verify that a source program is statically correct.

We can't check that directly, but we can build a checkable type system so that:

well-typed $\Longrightarrow$ ***statically correct***

Note: type checking depends on context – an implementation will depend on keeping track of types across different contexts (a scoped symbol table)

Type Checking for MiniJava



Examples

Suppose the following declarations are in effect:

Global scope: `class Foo { int f; int m(boolean b); }`
Local scope: `Foo this (implicit); int x; boolean y;`

In these scopes, which MiniJava expressions have type `int`? Why (not)?

`56`	`x+(new Foo()).f`	`x+this.m()`
`2+x`	`x+y`	`x+z.m(y)`
`this.f`	`(new Bar()).f`	`x+this.m(true)`

Scopes and Symbol Tables

Accurately tracking scope information, via symbol tables, is critical to type checking.

Some guiding observations from today:

- All classes in MiniJava will need symbol tables
  - When looking for a symbol, start in method table, then enclosing class, then global
- To generate symbol tables, it will make your life easier to go layer-by-layer
  - Global information needed everywhere! Makes sense to do that first
  - Easier to check a method body once global information is already computed

- Implementation tip:
  - Add pointers in your AST nodes to relevant type/symbol table information

The Take-Away

Static semantics is usually about what code must **not** do.

- ∴ ruling out ill-behaved traces is a useful mental model
- ∴ implementing and debugging a type checker is all about **edge cases**
- ∴ need to consider all names in scope, with their type (signatures)

Problem 1: Static Semantics & Type Checking