Check in 18

Lecture Review – Error Checking

Give an example of a program analysis that is sound but not complete

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Parameters

Administrivia

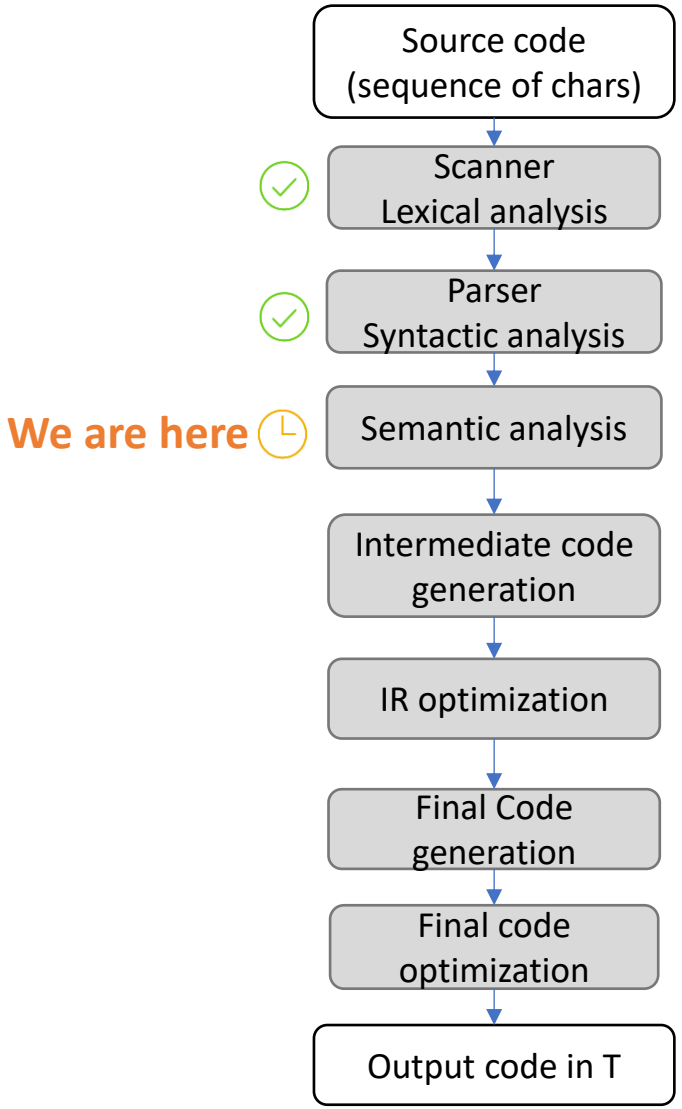
Announcements

Compiler Construction: Progress

You are here

Continuing exploration of language semantic features

- Informs design/behavior of our semantic analysis



Last Time

Lecture Review – Error Checking

The Limits of Error Checking

- Halting problem

Partial Correctness

- Partial Correctness
- Soundness
- Completeness

Semantics

Today's Outline

Parameters

Vocabulary

- lval/rval
- Memory references
- Calls

Parameter Passing

- Call by value
- Call by reference
- Call by name
- Call by value-result

Semantics

Vocabulary

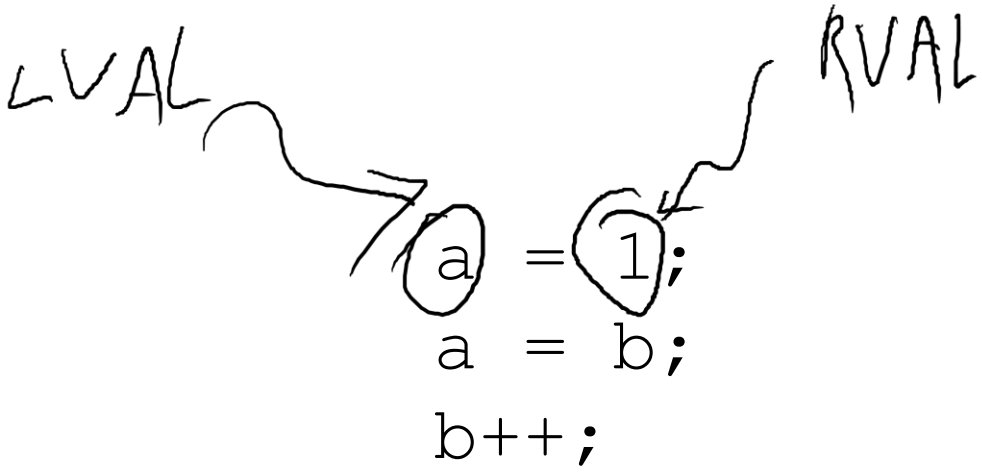
Parameters

- Define a couple of terms that are helpful to talk about parameters
  - We already encountered some of these in passing

L and R Values

Parameters

- L-Value
  - A value with a place of storage
- R-Value
  - A value that may not have storage



Bad Use of R-Values

Parameters

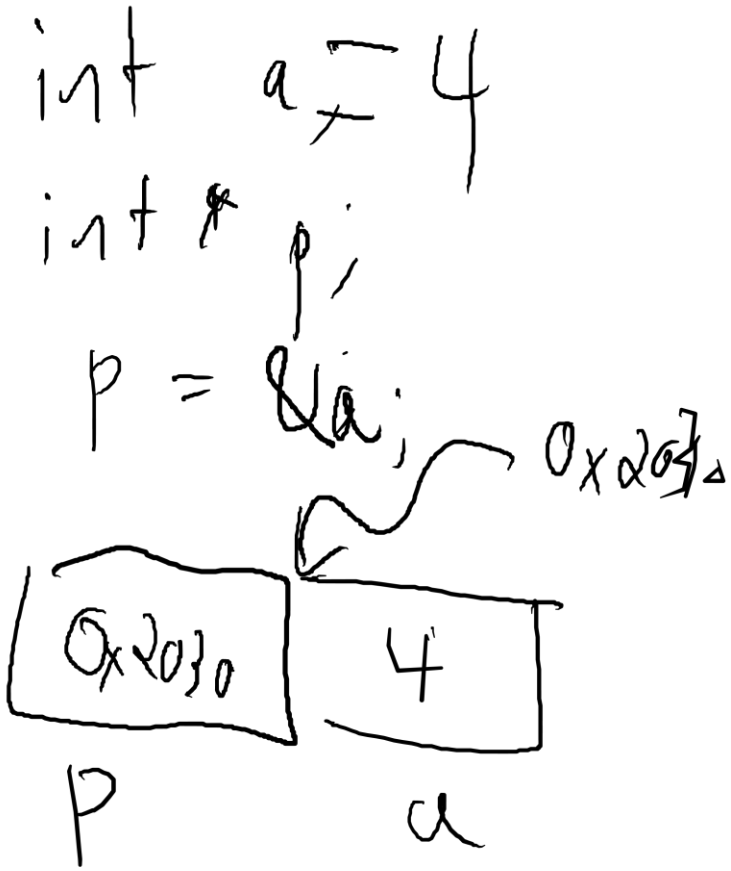
- Can prevent programs that are valid in pass by value from working in pass by reference
  - Literals (for example) do not have locations in memory
- The type checker should catch these errors.

Memory References

Parameters

- Pointer
  - A variable whose value is a memory address
- Aliasing
  - When two or more variables reference the same address

```
int g;
int b(int& a, int& z) {
    g = a + z;
    a = 7;
}
int main() {
    b(g, g);
}
```



Calls
Parameters

Caller

- The *source* function initiating the call

Callee

- The *target* function receiving the call

Call Site

- The location within the caller where the call happens

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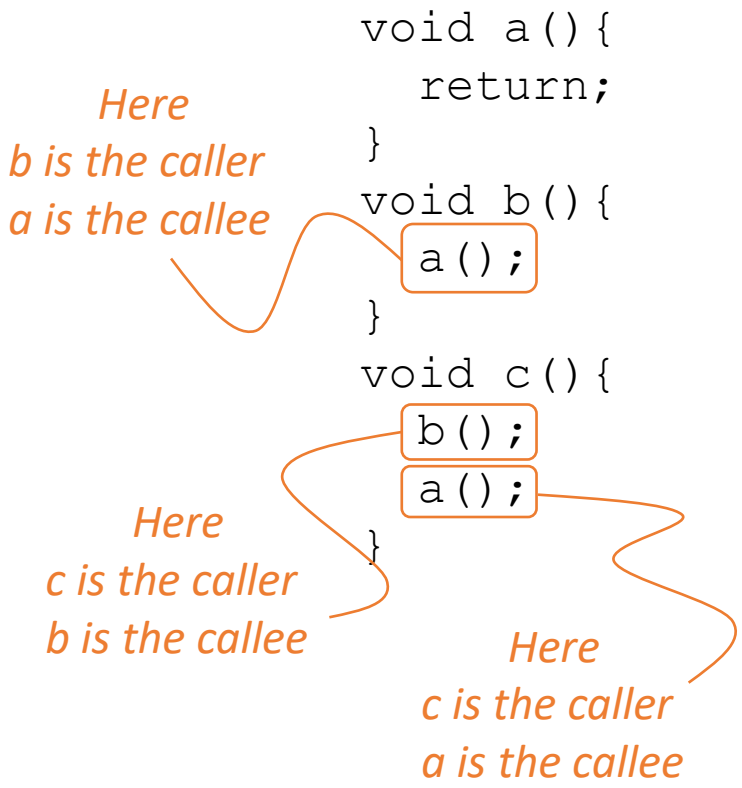


Call Chains & Graphs

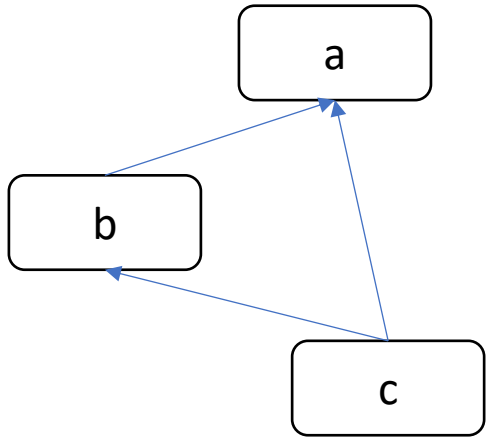
Parameters

Call Graph

- A node-based representation of possible call structure
  - Edge: caller -> callee

Call chain

- A realizable path of calls (c,b,a)




```
void a(){
  return;
}
void b(){
  a();
}
void c(){
  b();
  a();
}
```

Arguments
Parameters

- In definition:

  void v(int a, int b, bool c) { … }

  - Terms
    - Formals / formal parameters / parameters
- In call:

  v(a+b,8,true);

  - Terms
    - Actuals / actual parameters / arguments

Parameter Passing Schemes

Parameters

- We'll talk about some different varieties
  - Some of these are more used than others
  - Each has advantages / uses

Pass by Value

Parameters

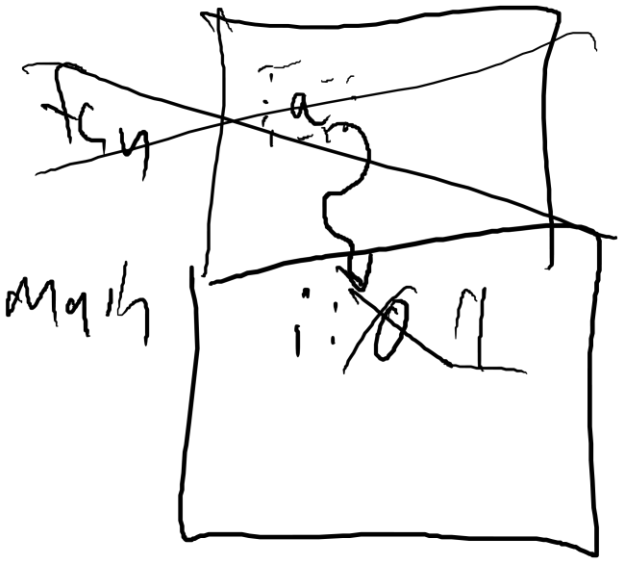
- On function call
  - *Values* of actuals are copied into the formals
  - C and java <u>always</u> pass by value

```
void fun(int a){
    int a = 1;
}
void main(){
    int i = 0;
    fun(i);
    print(i);
}
```

Pass by Reference
Parameters

- On function call
  - The address of the actuals are *implicitly* copied

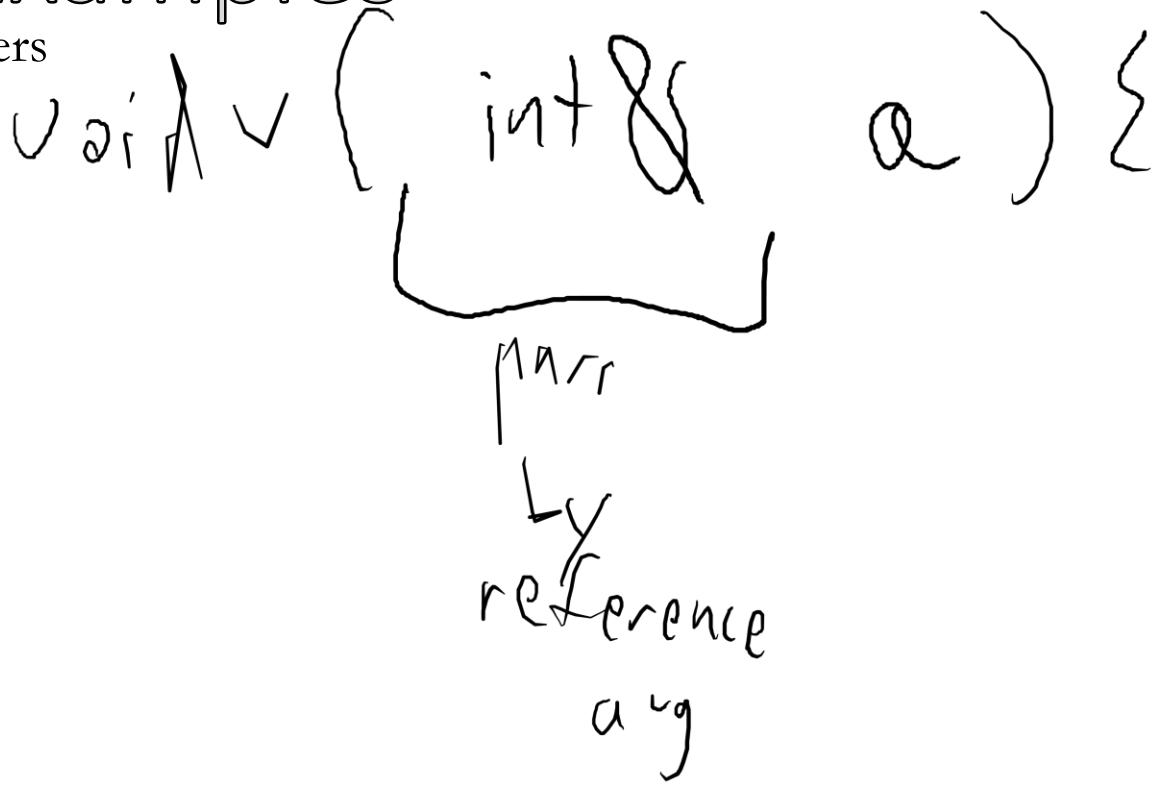
```
void fun(int a){
    a = 1;
}
void main(){
    int i = 0;
    fun(i);
    print(i);
}
```



Language Examples

Parameters

- Pass by value
  - C, Java, C#
- Pass by reference
  - Allowed in C++ and Pascal



Java and C# Are Pass by Value?!

Parameters

- All non-primitive L-values are references

```
void fun(int a, Point p){
    a = 0;
    p.x = 5;
}
void main(){
    int i = 0;
    Point k = new Point(1, 2);
    fun(i,k);
}
```

Pass by Value-Result

Parameters

- When function is called
  - Value of actual is passed
- When function returns
  - Final values are copied back to the actuals
- Used by Fortran IV, Ada
  - As the language examples show, not very modern

Pass by Name

Parameters

- Conceptually works as follows:
  - When a function is called
    - Body of the callee is rewritten with the **text** of the argument
    - Only really makes sense with non-local scope rules
  - Like macros in C / C++


COMPILER
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Optimization
Execution
Codegen
Runtimes
Intermediate Representation
SDD
Parsing
Semantics
Lexical Analysis
Syntactic Definiton
GLOPPY
KING KANDY
CANDY CASTLE
QUEEN FROSTINE
GRAMMA NUTT
PRINCESS LOLLY
LORD LICORICE
LICORICE CASTLE
JOLLY
PLUMPY