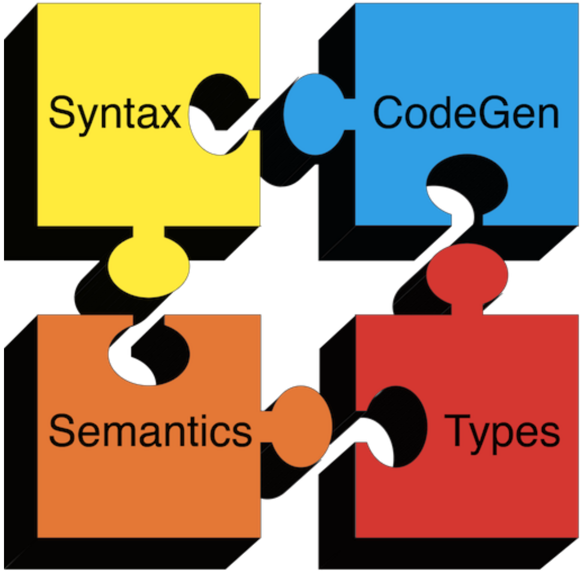


Compilers

Activations

Alex Aiken

Activations

- Two goals:
  - Correctness
  - Speed

- Complications in code generation come from trying to be fast as well as correct

Activations

Two assumptions:

1. Execution is sequential; control moves from one point in a program to another in a well-defined order

   concurrency

2. When a procedure is called, control always returns to the point immediately after the call

   exceptions call/cc

Activations

- An invocation of procedure P is an *activation* of P

- The *lifetime* of an activation of P is
  - All the steps to execute P
  - Including all the steps in procedures P calls

Activations

- The *lifetime* of a variable x is the portion of execution in which x is defined

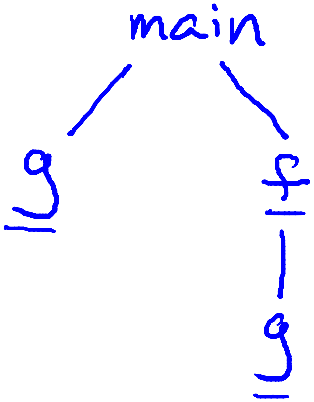
- Note that
  - Lifetime is a dynamic (run-time) concept
  - Scope is a static concept

Activations

- Observation
  - When P calls Q, then Q returns before P returns
- Lifetimes of procedure activations are properly nested
- Activation lifetimes can be depicted as a tree

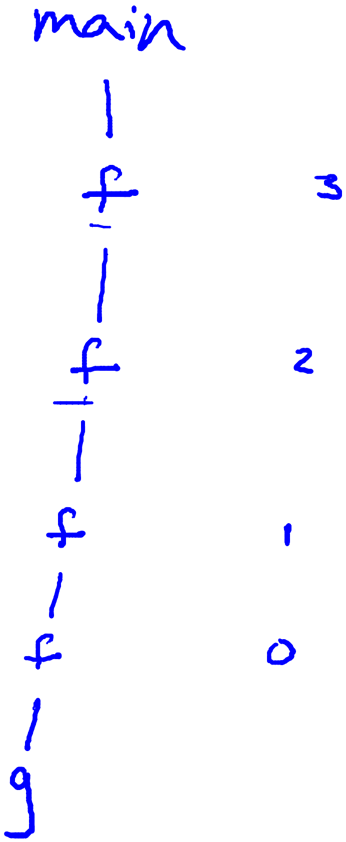
Activations

```
Class Main {
    g() : Int { 1 };
    f():  Int { g() };
    main(): Int {{ g(); f(); }};
}
```



Activations

```
Class Main {
    g() : Int { 1 };
    f(x:Int):  Int { if x = 0 then g() else f(x - 1) fi};
    main(): Int {{f(3); }};
}
```



Activations

The powerOfTwo() function, shown to the right, returns true if its argument is a power of two, false otherwise. What is the activation tree for powerOfTwo(4)?

```
isEven(x:Int) : Bool { x % 2 == 0 };
isOne(x:Int) : Bool { x == 1 };
powerOfTwo(x:Int) : Bool {
   if isEven(x) then powerOfTwo(x / 2)
   else isOne(x)
};
```

```
powerOfTwo
    |
  isEven
    |
powerOfTwo
    |
  isEven
    |
powerOfTwo
    |
  isEven
    |
  isOne
```

```
powerOfTwo
  /      \
isEven  powerOfTwo
          /      \
        isEven  powerOfTwo
                    |
                  isOne
```

```
powerOfTwo
    |
powerOfTwo
    |
powerOfTwo
    |
  isOne
```

```
powerOfTwo
  /      \
isEven  powerOfTwo
          /      \
        isEven  powerOfTwo
                  /     \
                isEven  isOne
```

Activations

- The activation tree depends on run-time behavior

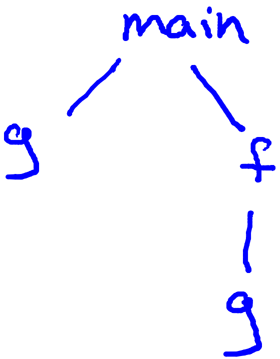
- The activation tree may be different for every program input

- Since activations are properly nested, a stack can track currently active procedures

Activations

```
Class Main {
    g() : Int { 1 };
    f():  Int { g() };
    main(): Int {{ g(); f(); }};
}
```

Tree



Stack

Activations