61A Lecture 2

Monday, August 27, 2012

Lightning Review: Types of Expressions

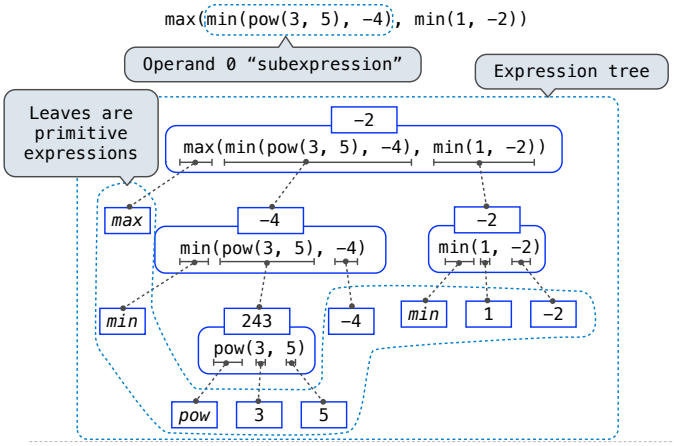
Primitive expressions: `2` (Number) `add` (Name) `'hello'` (String)

Call expressions:

`max` (*Operator*) `2` (*Operand 0*) , `3` (*Operand 1*)

One big nested call expression: `max(min(pow(3, 5), -4), min(1, -2))`

Lightning Review: Expression Trees



The Print Function

(Demo)

Pure Functions & Non-Pure Functions

Pure Functions

`-2` ▶ *abs*(number): ▶ `2` (Return value)

Argument: `-2`

Only produces return values

`2, 100` ▶ *pow*(x, y): ▶ `126765060022822940149670320537 6`

Non-Pure Functions

`-2` ▶ *print*(...): ▶ None (Returns None!)

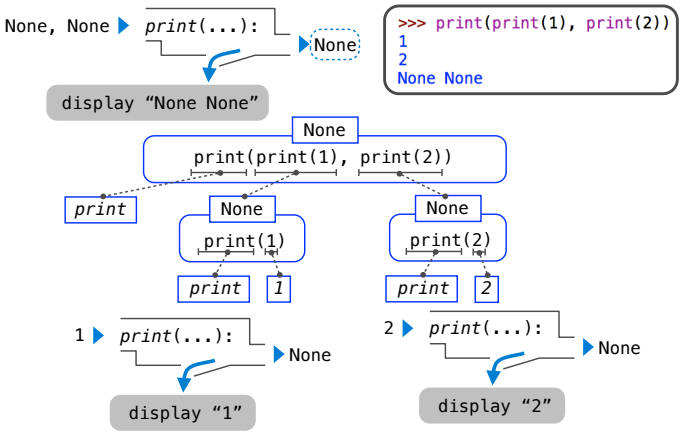
Side effect: `-2`

Python displays the output "-2"

May create side effects

The Interactive interpreter displays all return values except None.

Nested Expressions with Print



The Elements of Programming

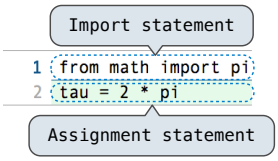
- Primitive Expressions and Statements
  - *The simplest building blocks of a language*
- Means of Combination
  - *Compound elements are built from simpler ones*
- Means of Abstraction
  - *Compound elements can be named and manipulated as units*

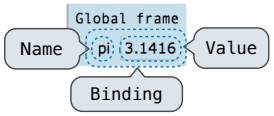
Names, Assignment, and User-Defined Functions

(Demo)

Environment Diagrams

Environment diagrams visualize the interpreter's process.





Code (left):

Statements and expressions

Next line is highlighted

Frames (right):

A name is bound to a value

In a frame, there is at most one binding per name

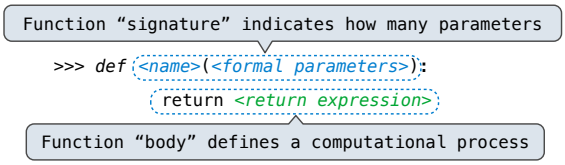
(Demo)

Example: http://goo.gl/sQabt

User-Defined Functions

Named values are a simple means of abstraction

Named *expressions* are a more powerful means of abstraction



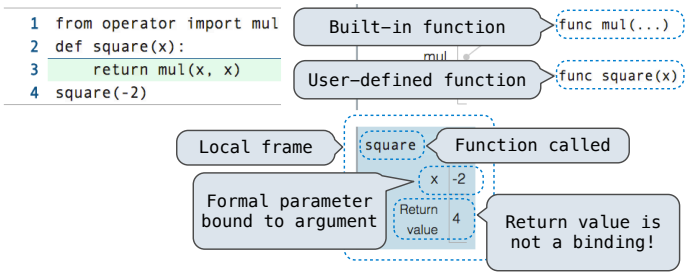
Execution procedure for def statements:

1. Create a function value with signature <name>(<formal parameters>)
2. Bind <name> to that value in the current frame

Calling User-Defined Functions

Procedure for applying user-defined functions (version 1):

1. Add a local frame
2. Bind formal parameters to arguments in that frame
3. Execute the body of the function in the new environment



Example: http://goo.gl/0apJa

Calling User-Defined Functions

Procedure for applying user-defined functions (version 1):

1. Add a local frame
2. Bind formal parameters to arguments in that frame
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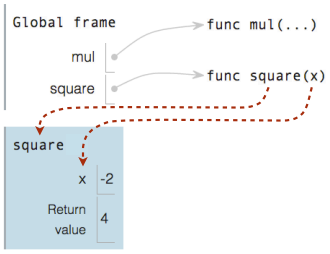
```
1 from operator import mul
2 def square(x):
3     return mul(x, x)
4 square(-2)
```

A function's *signature* has all the information to create a local frame



Example: http://goo.gl/0apJa

Looking Up Names In Environments

Every expression is evaluated in the context of an environment.

So far, the current environment is either:

- The global frame alone, *or*
- A local frame, followed by the global frame.

Most important two things I'll say all day:

An environment is a *sequence* of frames.

A name evaluates to the value bound to that name in the earliest frame of the current environment in which that name is found.

E.g., to look up some name in the body of the *square* function:

- Look up the name in the local frame.
- If not found, look it up in the global frame.
  (Built-in names like "print" are in the global frame too, but we don't draw them in environment diagrams.)

(Demo)

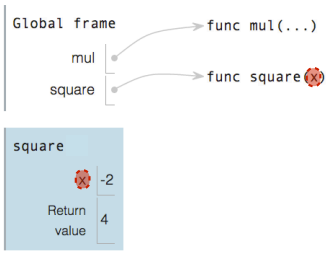
Formal Parameters

```
def square(x):
    return mul(x, x)
```

vs

```
def square(y):
    return mul(y, y)
```

```
1 from operator import mul
2 def square(x):
3     return mul(x, x)
4 square(-2)
```



Formal parameters have local scope

(Demo)

Example: http://goo.gl/0apJa