

## 61A Lecture 2

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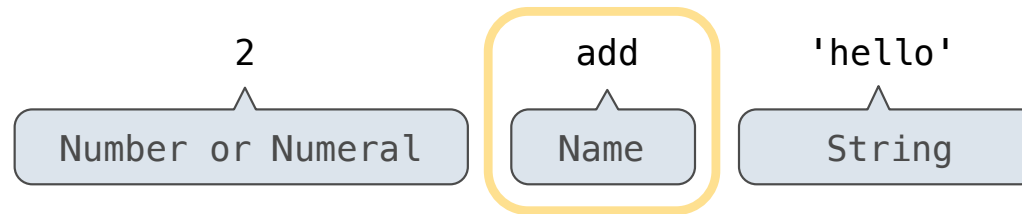
## Announcements

# Names, Assignment, and User-Defined Functions

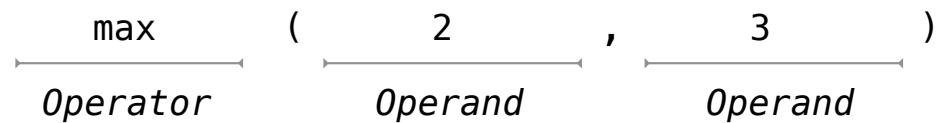
(Demo)

## Types of Expressions

**Primitive expressions:**



**Call expressions:**



An operand can also be a call expression

`max(min(pow(3, 5), -4), min(1, -2))`

## Discussion Question 1

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What is the value of the final expression in this sequence?

```
>>> f = min
```

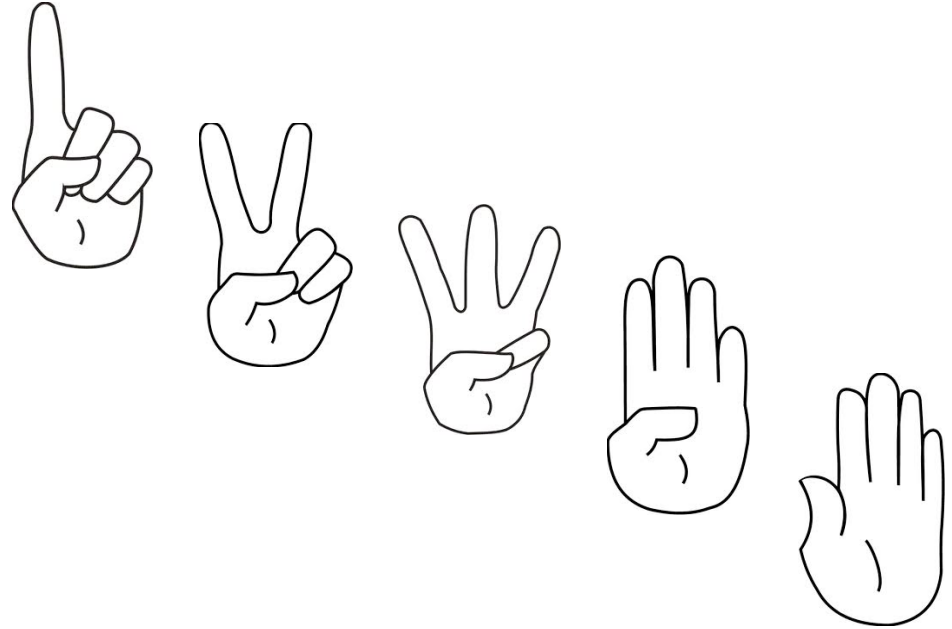
```
>>> f = max
```

```
>>> g, h = min, max
```

```
>>> max = g
```

```
>>> max(f(2, g(h(1, 5), 3)), 4)
```

???

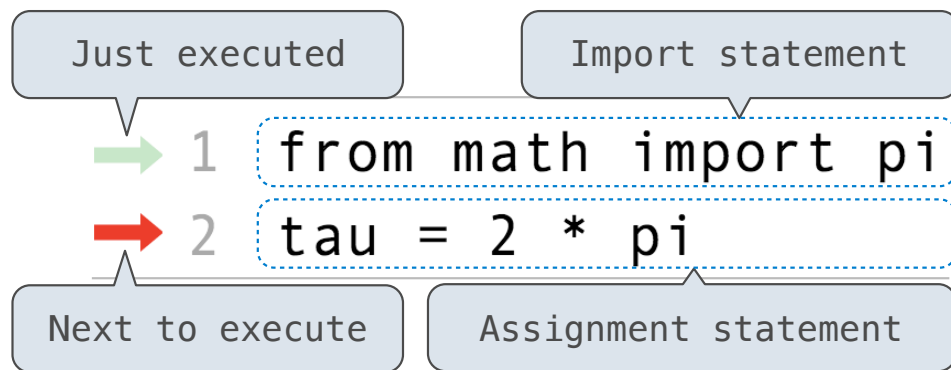


## Environment Diagrams

Environment: the way an interpreter keeps track of what names meet;  
the memory that keeps track of the binding between names and values

## Environment Diagrams

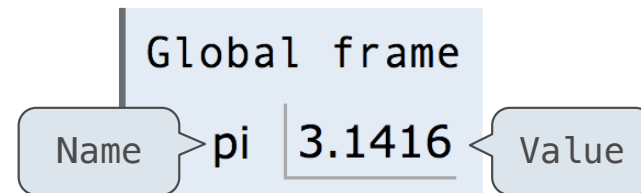
Environment diagrams visualize the interpreter's process.



### Code (left):

Statements and expressions

Arrows indicate evaluation order



### Frames (right):

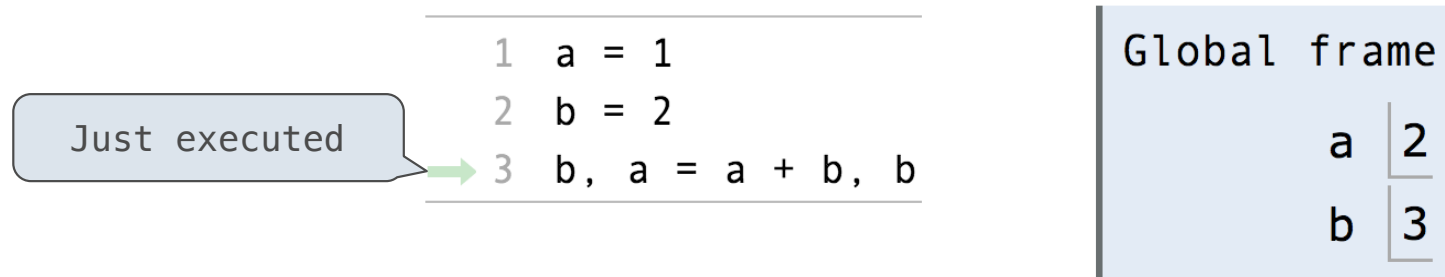
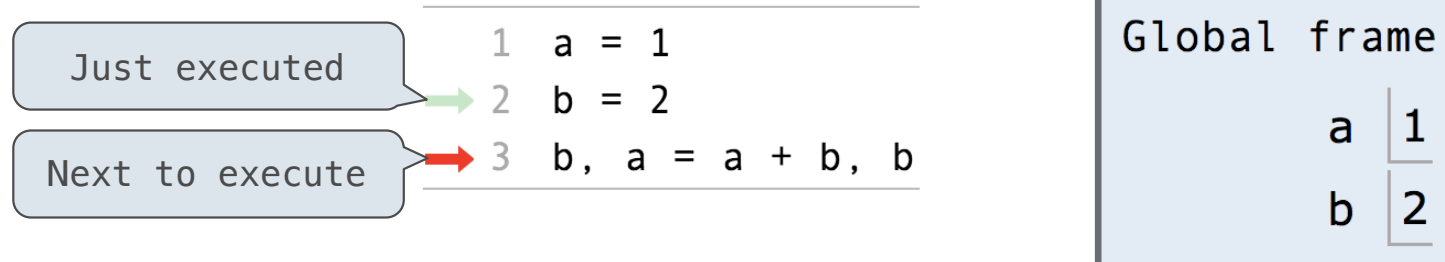
Each name is bound to a value

Within a frame, a name cannot be repeated

(Demo)

Interactive Diagram

## Assignment Statements

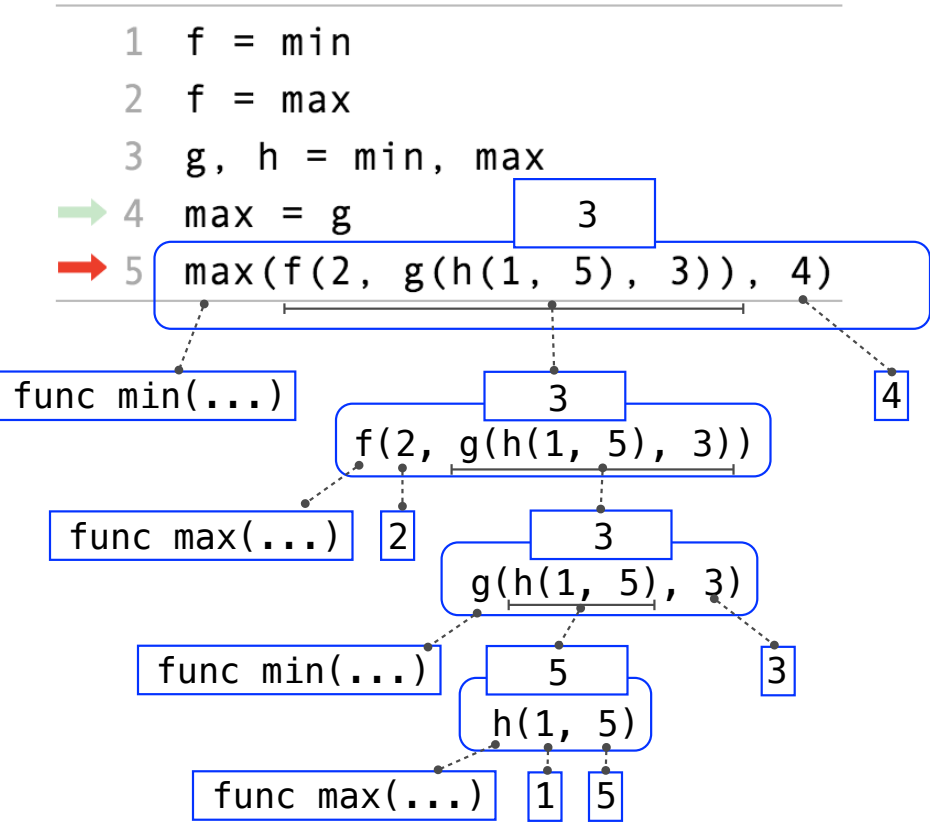


### Execution rule for assignment statements:

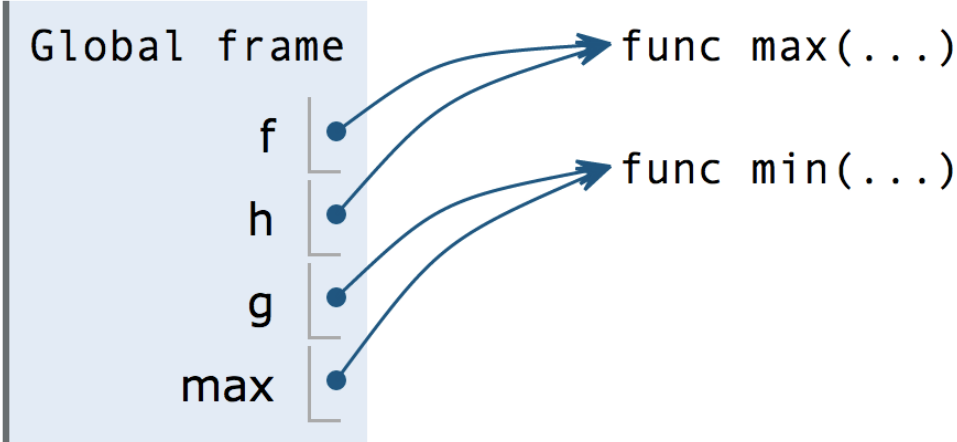
1. Evaluate all expressions to the right of `=` from left to right.
2. Bind all names to the left of `=` to those resulting values in the current frame.



Discussion Question 1 Solution



(Demo)



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## Defining Functions

## Defining Functions

Assignment is a simple means of abstraction: binds names to values

Function definition is a more powerful means of abstraction: binds names to expressions

Function **signature** indicates how many arguments a function takes

```
>>> def <name>(<formal parameters>):  
    return <return expression>
```

Function **body** defines the computation performed when the function is applied

### Execution procedure for def statements:

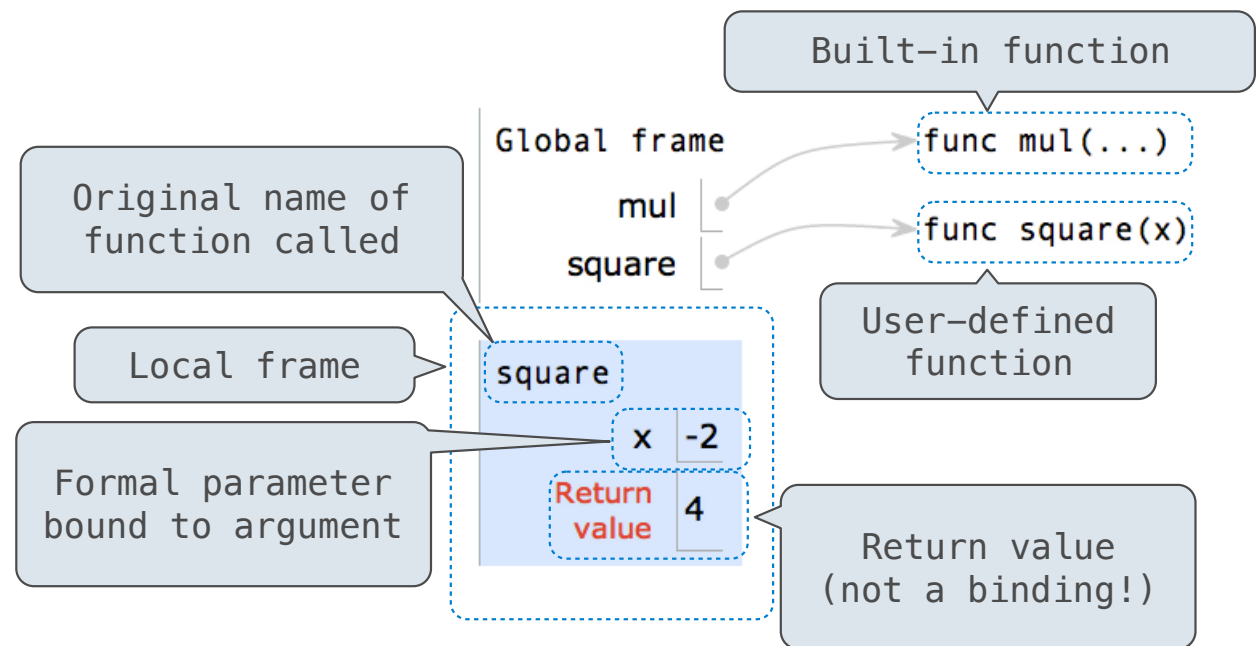
1. Create a function with signature `<name>(<formal parameters>)`
  2. Set the body of that function to be everything indented after the first line
  3. Bind `<name>` to that function in the current frame
- not executed until the function is called

## Calling User-Defined Functions

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

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

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



Interactive Diagram

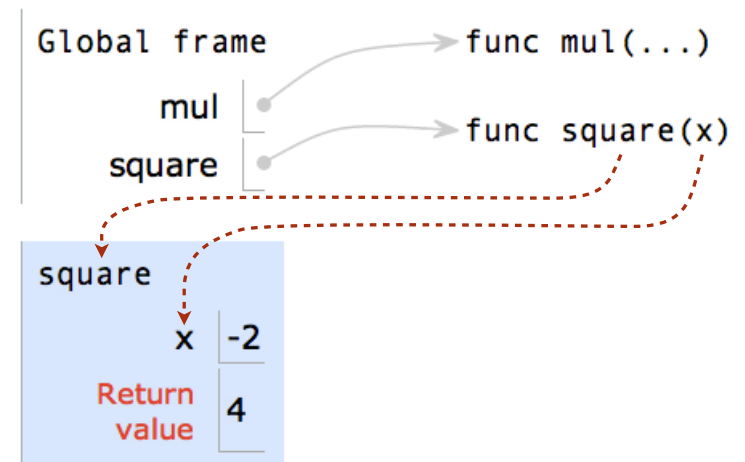
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A function's signature has all the information needed to create a local frame



## Looking Up Names In Environments

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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 for that name in the local frame.
- If not found, look for it in the global frame.  
(Built-in names like “max” are in the global frame too,  
but we don't draw them in environment diagrams.)

(Demo)

## Looking Up Names In Environments

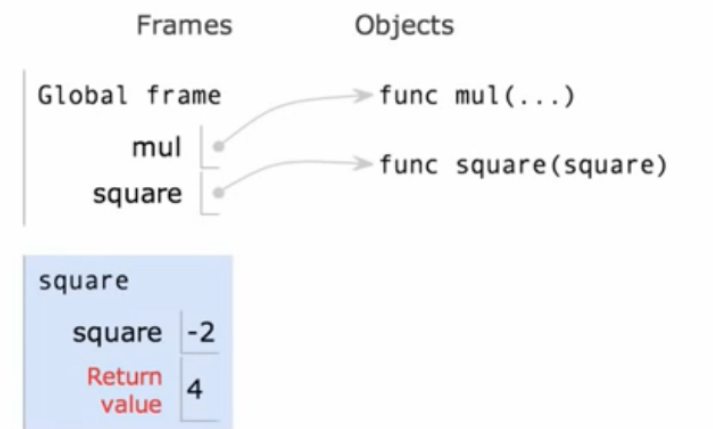
```
1 from operator import mul
2 def square(square):
3     return mul(square, square)
4 square(-2)
```

[Edit code](#)

Step 5 of 5

<< First < Back Forward > Last >>

→ line that has just executed  
→ next line to execute



Here we have a square in the local frame, so we won't look for it in the global frame, and there will be no disaster.

- Look for that name in the local frame.
- If not found, look for it in the global frame.  
(Built-in names like “max” are in the global frame too, but we don't draw them in environment diagrams.)