Python

Functions

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Define functions to create higher-level operations

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Define functions to create higher-level operations

"Create a language in which the solution to your original problem is trivial."

Define functions using def

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```
def greet():
  return 'Good evening, master'
```

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```
def greet():
  return 'Good evening, master'

temp = greet()
print temp
Good evening, master
```

Give them parameters

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def greet(name):
  answer = 'Hello, ' + name
  return answer
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```
def greet(name):
  answer = 'Hello, ' + name
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temp = 'doctor'
```

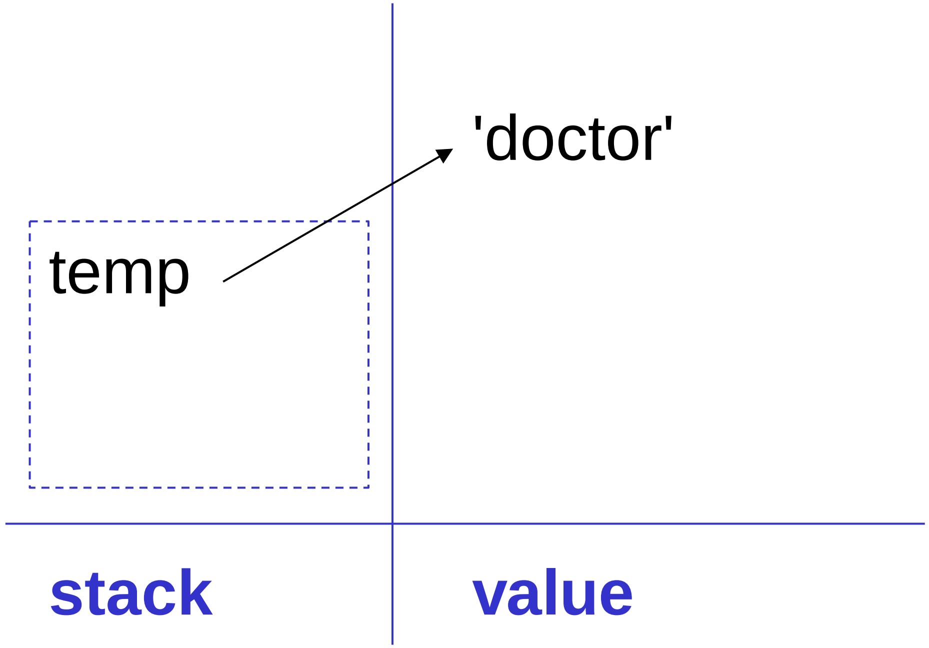

Give them parameters

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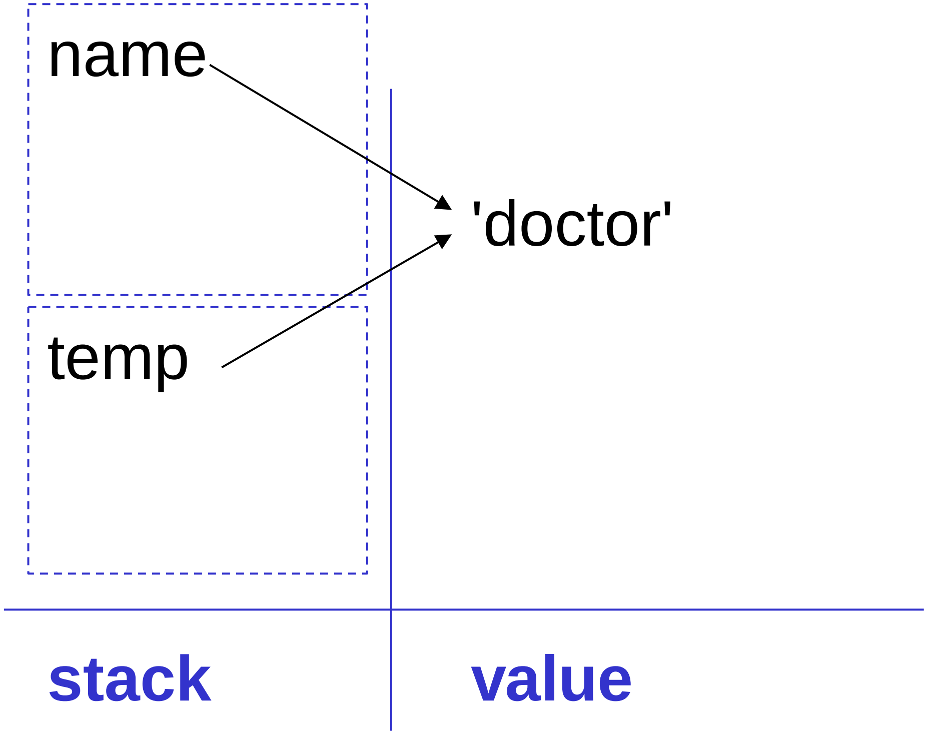
def greet(name):
  answer = 'Hello, ' + name
  return answer

temp = 'doctor'
result = greet(temp)
```



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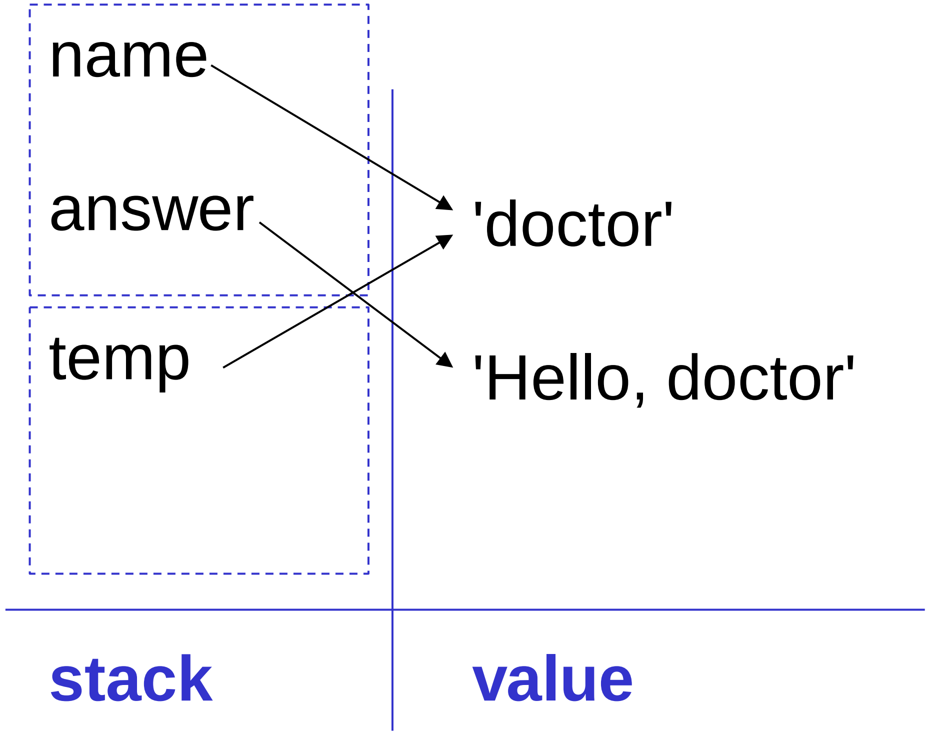

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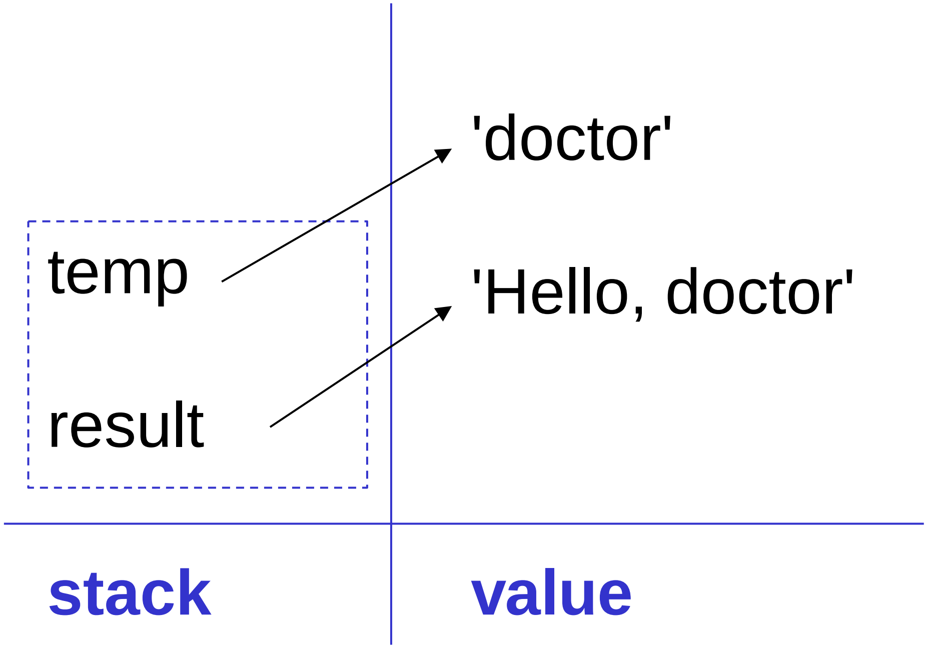

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  temp = 'Hello, ' + name
  return temp

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```

Can pass values in and accept results directly

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```
def greet(name):
  return 'Hello, ' + name

print greet('doctor')
```

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```
def sign(num):
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    return 1
  elif num == 0:
    return 0
  else:
    return -1
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```

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def sign(num):
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print sign(3)
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print sign(-9)
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```

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Over-use makes functions

hard to understand

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print sign(3)
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print sign(-9)
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```

Over-use makes functions hard to understand

No prescription possible, but:

- a few at the beginning to handle special cases
- one at the end for the "general" result

Every function returns something

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def sign(num):
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# else:
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print sign(3)
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print sign(-9)
None
```

Every function returns something

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print sign(-9)
None
```

If the function doesn't return

a value, Python returns None

Every function returns something

```
def sign(num):
  if num > 0:
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  elif num == 0:
    return 0
# else:
#   return -1

print sign(3)
1
print sign(-9)
None
```

If the function doesn't return a value, Python returns None

Yet another reason why commenting out blocks of code is a bad idea...

Functions and parameters don't have types

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def double(x):
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twotwo
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print double(2)
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```

Only use this when the function's behavior depends *only* on properties that all possible arguments share

Functions and parameters don't have types

```
def double(x):
  return 2 * x

print double(2)
4
print double('two')
twotwo
```

Only use this when the function's behavior depends *only* on properties that all possible arguments share

```
if type(arg) == int:
  ...
elif type(arg) == str:
  ...
...
```

Can define *default parameter values*

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```
def adjust(value, amount=2.0):
  return value * amount
```

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def adjust(value, amount=2.0):
  return value * amount

print adjust(5)
10
```

Can define *default parameter values*

```
def adjust(value, amount=2.0):
  return value * amount

print adjust(5)
10
print adjust(5, 1.001)
5.005
```

"When should I write a function?"

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Break it into comprehensible pieces with functions

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If someone has to keep more than a dozen things

in their mind at once to understand a block of code,

it's too long

Break it into comprehensible pieces with functions

Even if each function is only called once

STOP

Python: more on functions

Extracted from material by:

software carpentry

You can assign a function to a variable

```
def threshold(signal):
    return 1.0 / sum(signal)

t = threshold
print t([0.1, 0.4, 0.2])
1.42857
```

Can put (a reference to) the function in a list

```
def area(r):
    return PI * r * r

def circumference(r):
    return 2 * PI * r

funcs = [area, circumference]

for f in funcs:
    print f(1.0)
3.14159
6.28318
```

Can pass (a reference to) the function into a function

```
def call_it(func, value):
    return func(value)

print call_it(area, 1.0)
3.14159

print call_it(circumference, 1.0)
6.28318
```

Must need to know *something* about the function

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Like number of arguments

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```
def add_all(*args):
    total = 0
    for a in args:
        total += a
    return total
```

Must need to know *something* about the function

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```

Must need to know *something* about the function

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Like ~~number of arguments~~

```
def add_all(*args):
    total = 0
    for a in args:
        total += a
    return total

print add_all()
0
```

Must need to know *something* about the function

in order to call it

Like ~~number of arguments~~

```
def add_all(*args):
    total = 0
    for a in args:
        total += a
    return total

print add_all()
0
print add_all(1, 2, 3)
6
```

Connecting functions to sequences

filter(F, S)	select elements of S for which F is True

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filter(F, S)	select elements of S for which F is True
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reduce(F, S)	use F to combine all elements of S

```
def positive(x): return x >= 0
print filter(positive, [-3, -2, 0, 1, 2])
[0, 1, 2]
```

Connecting functions to sequences

filter(F, S)	select elements of S for which F is True
map(F, S)	apply F to each element of S
reduce(F, S)	use F to combine all elements of S

```
def positive(x): return x >= 0
print filter(positive, [-3, -2, 0, 1, 2])
[0, 1, 2]

def negate(x): return -x
print map(negate, [-3, -2, 0, 1, 2])
[3, 2, 0, -1, -2]
```

Connecting functions to sequences

filter(F, S)	select elements of S for which F is True
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```
def positive(x): return x >= 0
print filter(positive, [-3, -2, 0, 1, 2])
[0, 1, 2]

def negate(x): return -x
print map(negate, [-3, -2, 0, 1, 2])
[3, 2, 0, -1, -2]

def add(x, y): return x+y
print reduce(add, [-3, -2, 0, 1, 2])
-2
```

Example

```
for x in range(1, GRID_WIDTH-1):
  for y in range(1, GRID_HEIGHT-1):
    if (density[x-1][y] > density_threshold) or \
       (density[x+1][y] > density_threshold):
      if (flow[x][y-1] < flow_threshold) or\
         (flow[x][y+1] < flow_threshold):
        temp = (density[x-1][y] + density[x+1][y]) / 2
        if abs(temp - density[x][y]) > update_threshold:
          density[x][y] = temp
```

Refactoring #1: grid interior

```
for x in grid_interior(GRID_WIDTH):
  for y in grid_interior(GRID_HEIGHT):
    if (density[x-1][y] > density_threshold) or \
       (density[x+1][y] > density_threshold):
      if (flow[x][y-1] < flow_threshold) or\
         (flow[x][y+1] < flow_threshold):
        temp = (density[x-1][y] + density[x+1][y]) / 2
        if abs(temp - density[x][y]) > update_threshold:
          density[x][y] = temp
```

Refactoring #2: tests on X and Y axes

```
for x in grid_interior(GRID_WIDTH):
  for y in grid_interior(GRID_HEIGHT):
    if density_exceeds(density, x, y, density_threshold):
      if flow_exceeds(flow, x, y, flow_threshold):
        temp = (density[x-1][y] + density[x+1][y]) / 2
        if abs(temp - density[x][y]) > tolerance:
          density[x][y] = temp
```

Refactoring #3: update rule

```
for x in grid_interior(GRID_WIDTH):
  for y in grid_interior(GRID_HEIGHT):
    if density_exceeds(density, x, y, density_threshold):
      if flow_exceeds(flow, x, y, flow_threshold):
        update_on_tolerance(density, x, y, tolerance)
```

Refactoring #3: update rule

```
for x in grid_interior(GRID_WIDTH):
  for y in grid_interior(GRID_HEIGHT):
    if density_exceeds(density, x, y, density_threshold):
      if flow_exceeds(flow, x, y, flow_threshold):
        update_on_tolerance(density, x, y, tolerance)
```

Good programmers will write this first

Refactoring #3: update rule

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for x in grid_interior(GRID_WIDTH):
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Then write the functions it implies

Refactoring #3: update rule

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for x in grid_interior(GRID_WIDTH):
  for y in grid_interior(GRID_HEIGHT):
    if density_exceeds(density, x, y, density_threshold):
      if flow_exceeds(flow, x, y, flow_threshold):
        update_on_tolerance(density, x, y, tolerance)
```

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Then write the functions it implies

Then refactor any overlap

created by

Greg Wilson

October 2010