Functional Abstraction

Announcements

Zero-Argument Functions

(Demo)

Dice Functions

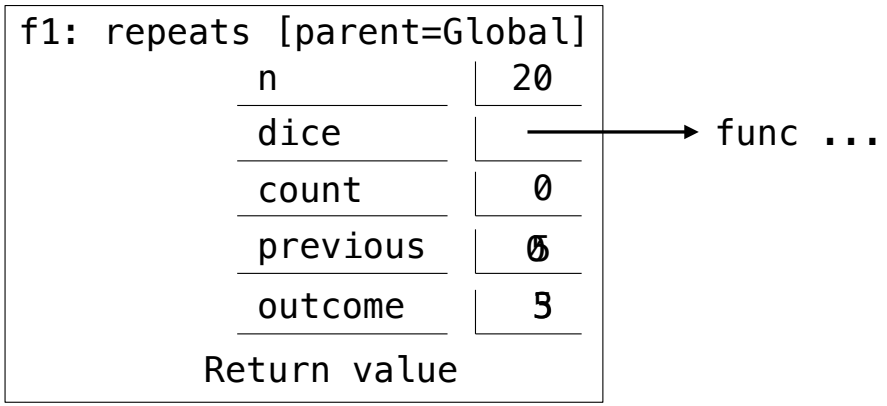
In the Hog project, there are multiple zero-argument functions that represent dice.

A dice function returns an integer that is the outcome of rolling once. (Demo)

Implement repeat, which returns the # of times in n rolls that an outcome repeats.

5 3 3 4 2 1 6 5 3 4 2 2 2 4 4 3 4 3 5 5 repeat(20, six_sided) -> 5

```
def repeats(n, dice):
    count = 0
    previous = 0
    while n:
        outcome = dice()
        if previous == outcome:
            count += 1
        previous = outcome
        n -= 1
    return count
```



Higher-Order Loops

(Demo)

https://pythontutor.com/cp/composingprograms.html#code=def%20reprint%28n%29%3A%0A%20%20%20%20def%20a%28word%29%3A%0A%20%20%20%20%20%20%20%20k%20%3D%20n%0A%20%20%20%20%20%20%20%20while%20k%3A%0A%20%20%20%20%20%20%20%20%20%20%20%20print%28word%29%0A%20%20%20%20%20%20%20%20%20%20%20%20k%20-%3D%201%0A%20%20%20%20return%20a%0A%20%20%20%20%0Areprint%282%29%28'hey'%29%0A&cumulative=true&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D

Conditional Expressions Practice

Fall 2022 Midterm 1 Question 1

```
(3 and 4) - 5
```

True and False Values

The built-in bool(x) returns True for true x and False for false x.

```
>>> bool(0)
False
>>> bool(-1)
True
>>> bool(0.0)
False
>>> bool(' ')
True
>>> bool('')
False
>>> bool(False)
False
>>> bool(print('fool'))
fool
False
```

Lambda Expressions Practice

Lambda and Def

Any program containing lambda expressions can be rewritten using def statements.

```
                        twice                          square
>>> (lambda f: lambda x: f(f(x)))(lambda y: y * y)(3)
81

>>> def twice(f):
...     def g(x):
...         return f(f(x))
...     return g
...
>>> def square(y):
...     return y * y
...
>>> twice(square)(3)
81
```

Fall 2022 Midterm 1 Question 4(a)

(2.0 pt) Choose **all** correct implementations of `funsquare`, a function that takes a one-argument function `f`. It returns a one-argument function `f2` such that `f2(x)` has the same behavior as `f(f(x))` for all `x`.

```
>>> triple = lambda x: 3 * x
>>> funsquare(triple)(5)  # Equivalent to triple(triple(5))
45
```

A:
```
def funsquare(f):
    return f(f)
```

B:
```
def funsquare(f):
    return lambda: f(f)
```

C:
```
def funsquare(f, x):
    def g(x):
        return f(f(x))
    return g
```

D:
```
def funsquare(f):
    return lambda x: f(f(x))
```

E:
```
def funsquare(f, x):
    return f(f(x))
```

F:
```
def funsquare(f):
    def g(x):
        return f(f(x))
    return g
```

Spring 2020 Midterm 1 Question 1

```
>>> snap = lambda chat: lambda: snap(chat)
>>> snap, chat = print, snap(2020)
What is displayed here?
>>> chat()
What is displayed here?
```


https://pythontutor.com/cp/composingprograms.html#code=snap%20%3D%20lambda%20chat%3A%20lambda%3A%20snap%28chat%29%0Asnap,%20chat%20%3D%20print,%20snap%282020%29%0Achat%28%29%0A%0A&cumulative=true&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D

Call Expressions

Assigning Names to Values

There are three ways of assigning a name to a value:

- Assignment statements (e.g., y = x) assign names in the current frame
- Def statements assign names in the current frame
- Call expressions assign names in a new local frame

```
h = lambda f: lambda x: f(f(x))
h(abs)(-3)
```

```
f = abs
x = -3
f(f(x))
```

```
h = lambda f: f(f(x))
x = -3
h(abs)
```

Environment Diagram Practice

Fall 2022 CS 61A Midterm 1, Question 2

- **The Diagram**
- **Annotations**

```
 1: def f(x):
 2:     """f(x)(t) returns max(x*x, 3*x)
 3:     if t(x) > 0, and 0 otherwise.
 4:     """
 5:     y = max(x * x, 3 * x)
 6:     def zero(t):
 7:         if t(x) > 0:
 8:             return y
 9:         return 0
10:     return zero
11:
12: # Find the largest positive y below 10
13: # for which f(y)(lambda z: z - y + 10)
14: # is not 0.
15: y = 1
16: while y < 10:
17:     if f(y)(lambda z: z - y + 10):
18:         max = y
19:     y = y + 1
```