61A Lecture 7

Monday, September 12

Pig Contest Rules

- The score for an entry is the sum of win rates against every other entry.
- All strategies must be deterministic functions of the current score! Non-deterministic strategies will be disqualified.
- Winner: 3 points extra credit on Project 1
- Second place: 2 points
- Third place: 1 point
- The real prize: honor and glory
- To enter: submit a file pig.py that contains a function called final_strategy as assignment p1contest by Monday, 9/26

Function Decorators

(demo)

Function decorator

```
@trace1
def triple(x):
    return 3 * x
```

Decorated function

is identical to

Why not just use this?

```
def triple(x):
    return 3 * x
triple = trace1(triple)
```

The Art of the Function

Practical guidance

Each function should have exactly one job

Separation of concerns

Testing functions stay small

Don't repeat yourself (DRY)

Revisions should require few code changes

Isolates problems

Functions should be defined generally

Writing fewer lines of code saves you time

Copy/Paste has a steep price

These are guidelines, not strict rules!

Choosing Names

Practical guidance

Names typically *don't* matter for correctness

but

they matter tremendously for legibility

From:	**To:**
boolean	turn_is_over
d	dice
play_helper	take_turn

```
>>> from operator import mul
>>> def square(let):
    return mul(let, let)
```

Functional Abstractions

```
def square(x):                def sum_squares(x, y):
    return mul(x, x)              return square(x) + square(y)
```

What does sum_squares need to know about square to use it?

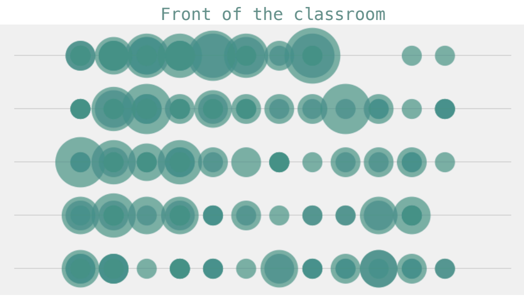
- Square takes one argument. **Yes**
- Square has the intrinsic name "square". **No**
- Square computes the square of a number. **Yes**
- Square computes the square by calling *mul*. **No**

```
def square(x):                  def square(x):
    return pow(x, 2)                return mul(x, x-1) + x
```

If the name "square" were bound to a built-in function, sum_squares would still work identically

Data

Student seating preferences at MIT



http://www.skyrill.com/seatinghabits/

Objects

- Representations of information
- Data and behavior, bundled together to create...

Abstractions

- Objects represent properties, interactions, & processes
- Object-oriented programming:
  - A metaphor for organizing large programs
  - Special syntax for implementing classic ideas

(Demo)

Python Objects

In Python, every value is an object.

- All objects have attributes
- A lot of data manipulation happens through methods
- Functions do one thing; objects do many related things

The next four weeks:

- Use built-in objects to introduce ideas
- Create our own objects using the built-in object system
- Implement an object system using built-in objects

Native Data Types

In Python, every object has a type.

```
>>> type(today)
<class 'datetime.date'>
```

Properties of native data types:

1. There are primitive expressions that evaluate to native objects of these types.
2. There are built-in functions, operators, and methods to manipulate these objects.

Numeric Data Types

Four
~~Three~~ numeric types in Python:

```
>>> type(2)
<class 'int'>
```

Represents integers exactly

```
>>> type(1.5)
<class 'float'>
```

Represents real numbers approximately

```
>>> type(1+1j)
<class 'complex'>
```

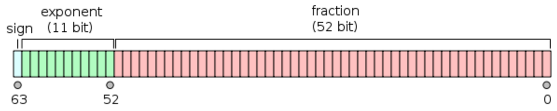
(demo)

Working with Real Numbers

Care must be taken when computing with real numbers!

(Demo)

Representing real numbers:



1/3 = 0011 1111 1101 0101 0101 0101 0101 0101 0101 0101 0101 0101 0101 0101 0101 0101

False in a Boolean contexts:

```
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

1000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
```

http://en.wikipedia.org/wiki/File:IEEE_754_Double_Floating_Point_Format.svg

Working with Real Numbers

```
>>> def approx_eq_1(x, y, tolerance=1e−18):
        return abs(x − y) <= tolerance


>>> def approx_eq_2(x, y, tolerance=1e−7):
        return abs(x − y) <= abs(x) * tolerance


>>> def approx_eq(x, y):
        if x == y:
            return True
        return approx_eq_1(x, y) or approx_eq_2(x, y)


>>> def near(x, f, g):
        return approx_eq(f(x), g(x))
```

```
or approx_eq_2(y,x)
```

Moral of the Story

Life was better when numbers were just numbers!

Having to know the details of an abstraction:

- Makes programming harder and more knowledge−intensive
- Creates opportunities to make mistakes
- Introduces dependencies that prevent future changes

Coming Soon: Data Abstraction