61A Lecture 7

Monday, September 10

Hog Contest Rules

- Two people submit one entry; Max of one entry per person
- The score for an entry is the sum of win rates against every other entry.
- All strategies must be deterministic, pure functions of the current player scores! *Non-deterministic strategies will be disqualified*.
- To enter: *submit proj1contest* with a file hog.py that defines a final_strategy function by **Monday 9/24 @ 11:59pm**
- All winning entries will receive 2 points of extra credit
- The real prize: honor and glory

Fall 2011 Winners

Keegan Mann,
Yan Duan & Ziming Li,
Brian Prike & Zhenghao Qian,
Parker Schuh & Robert Chatham

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)
```

Which Values Deserve a Name

Practical guidance

Repeated compound expressions:

```
if sqrt(square(a) + square(b)) > 1:
    x = x + sqrt(square(a) + square(b))
```

```
h = sqrt(square(a) + square(b))
if h > 1:
    x = x + h
```

Meaningful parts of complex expressions:

```
x = (-b + sqrt(square(b) - 4 * a * c)) / (2 * a)
```

```
d = sqrt(square(b) - 4 * a * c)
x = (-b + d) / (2 * a)
```

Test-Driven Development

Practical guidance

Write the test of a function before you write the function

A test will clarify the (one) job of the function

Your tests can help identify tricky edge cases

Develop incrementally and test each piece before moving on

You can't depend upon code that hasn't been tested

Run your old tests again after you make new changes

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)
```

Functional Abstractions

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

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

What does sum_squares need to know about square?

- 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**

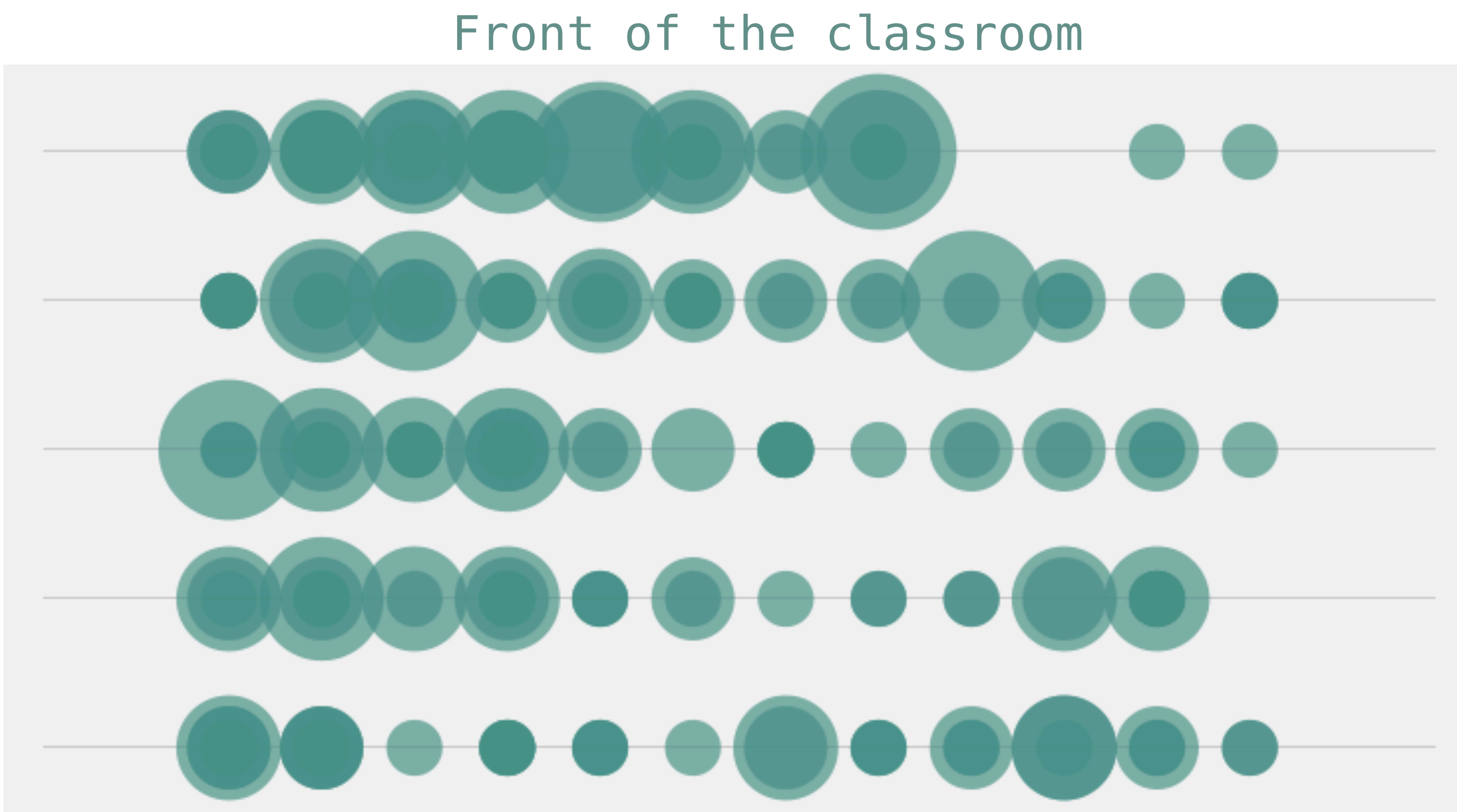
```
def square(x):
    return pow(x, 2)
```

```
def square(x):
    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 classic 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

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)

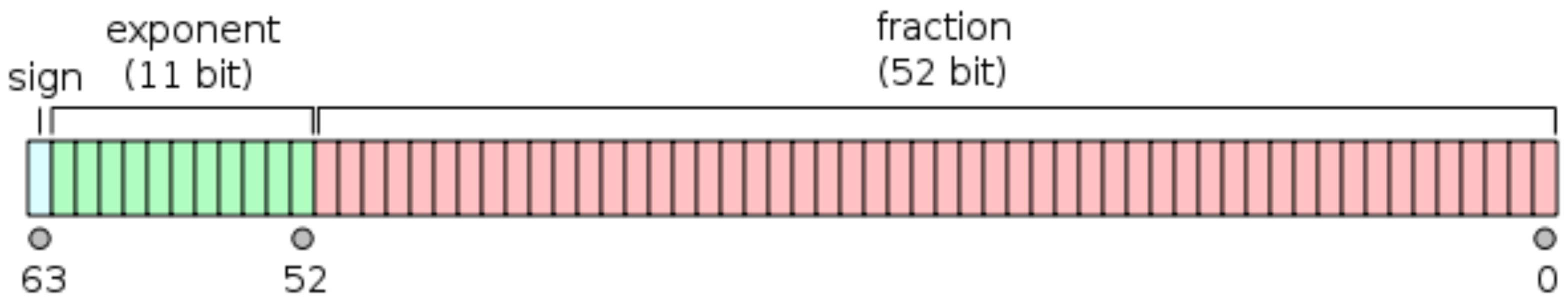
Working with Real Numbers

Bonus Material

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

Bonus Material

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