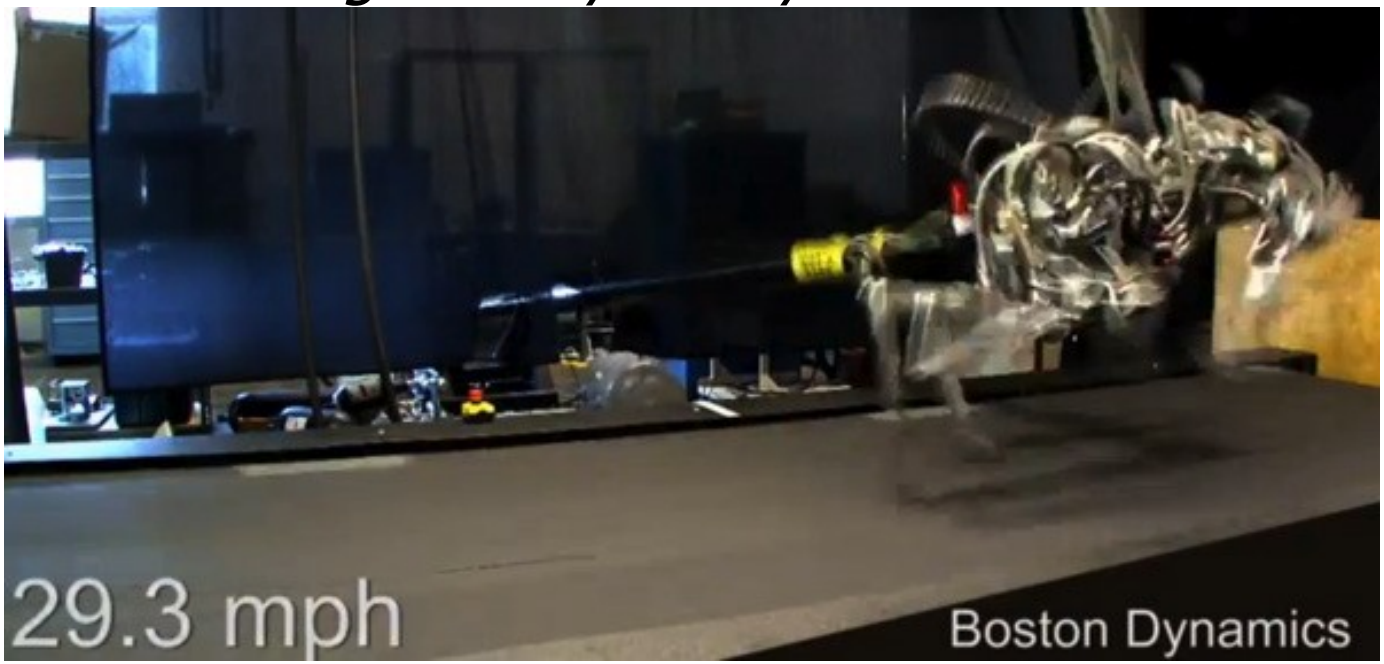
Boston Dynamics' sprinting robot, Cheetah, has now broken the land-speed record for humans, clocking speeds of 29.3 miles per hour, meaning not even the 27.79mph Usain Bolt can escape. Fortunately for us, it's got a fatal flaw; a balance problem that means it can only remain upright with a boom keeping it steady. Unfortunately, that's not going to be a problem for long, since field-testing on an independently upright version begins early next year.



http://news.cnet.com/8301-17938_105-57506996-1/all-hope-lost-as-cheetah-robot-outruns-usain-bolt/
http://news.cnet.com/8301-17938_105-57373477-1/darpa-takes-bigger-bigdog-out-for-walkies/

- Lab: don't worry precision of `-3.3333333333`
  - We'll come back to this

- Difference between interpreter and IDLE editor?
- Lab 1 graded
  - Hand in .py files

- Lab 2 continuing today
- Other questions about lab?

Practice: Distance Averager

- Problem:
  - Our poor European study-abroad student needs to know average distance between three cities, in miles
  - 1 Kilometer = 0.62 Mile

Analyze the Problem

Determine Specification

Create a Design

Implement Design

Test/Debug the Program

Maintain Program

Numeric Data Types (Chapter 3)

- Info stored & manipulated by programs is ***data***

- Two kinds of numbers:
  - Whole numbers (5, 4, 3, 6) don't have fractional part
  - Decimal numbers (3.25, 2.10, 1.05, 0.01) do

Numeric Data Types

- decimal numbers and whole numbers are two different ***data types***

- The **data type** of an object determines what values it can have and what operations can be performed on it.

Numeric Data Types

- Whole numbers are represented using the ***integer*** (***int*** for short) data type
- Values can be positive or negative

Numeric Data Types

- Numbers that *can* have fractional parts are represented as ***floating point*** (or ***float***) values
- Which is which?
  - Numeric literal without a decimal point: an **int**
  - Literal with decimal point is: **float**
    - (even if the fractional part is 0)

Which witch is which?

type(val)

- Python has a special function to tell us the data type of any value.

```
>>> type(3)
<class 'int'>
>>> type(3.1)
<class 'float'>
>>> type(3.0)
<class 'float'>
>>> myInt = 32
>>> type(myInt)
<class 'int'>
>>>
```

- Wonderful. Why would this be useful?

Numeric Data Types

- Why do we need two number types?
  - Values that represent counts can't be fractional
    - you can't have 3 ½ quarters
    - can you ever half ½ a piece of chalk?
  - Most mathematical algorithms very **efficient with integers**
  - The float type stores only ***approximation*** to the actual number being represented!
    - `1/3`
    - `3.0 + 1/3`
  - Float: Slow & inexact, but sometimes necessary

Numeric Data Types

- Operations on ints produce ints, operations on floats produce floats (except for /).

```
>>> 3.0+4.0
7.0
>>> 3+4
7
>>> 3.0*4.0
12.0
>>> 3*4
12
>>> 10.0/3.0
3.3333333333333335
>>> 10/3
3.3333333333333335
>>> 10 // 3
3
>>> 10.0 // 3.0
3.0
```

Numeric Data Types

- Integer division produces a whole number:
  10//3 = 3

- Mod produces the remainder (of ints):
  10%3 = 1

$$a = (a//b)(b) + (a\%b)$$

Cash Register

- Input: Number of cents, from 0 to 99
- Output: Number of pennies and quarters

Create a Design

Implement Design

Test the Program

Using the Math Library

- Besides (+, -, *, /, //, **, %, abs), we have lots of math functions available in the ***math library***

- ***library*****:** a module with definitions/functions

Using the Math Library

- Program to compute roots of a quadratic equation?

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- Don't know how to find a square root… *but it's in the math library*

Using the Math Library

- To use a library, add this line :

```
import math
```

- Importing a library makes whatever functions are defined within it available to the program

- Key point: want to use others' code when possible

Using the Math Library

- To access the sqrt library routine:
  - **`math.sqrt(x)`**
- Using **dot notation** tells Python to use **sqrt** function found in math library module

Using math.sqrt()

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

```
x1 = ?
x2 = ?
```

Help!

- One nice feature of python is the help mechanism
- As we start doing more complex things it will be useful

Help!

```
>>> import math
>>> help(math)
Help on built-in module math:

NAME
    math

FILE
    (built-in)

DESCRIPTION
    This module is always available.  It provides access to the
    mathematical functions defined by the C standard.

FUNCTIONS
    acos(...)
        acos(x)
```

- (10 % 4) + (6 / 2)
- (10 % (4+6)) / 2
- ((3 ** 3) // 3) % 3

- Find the sum of the first n integers, where n is specified by the user
- Sum a series of numbers entered by the user. First prompt for how many numbers there will be then let them input the numbers. Finally, print the sum.