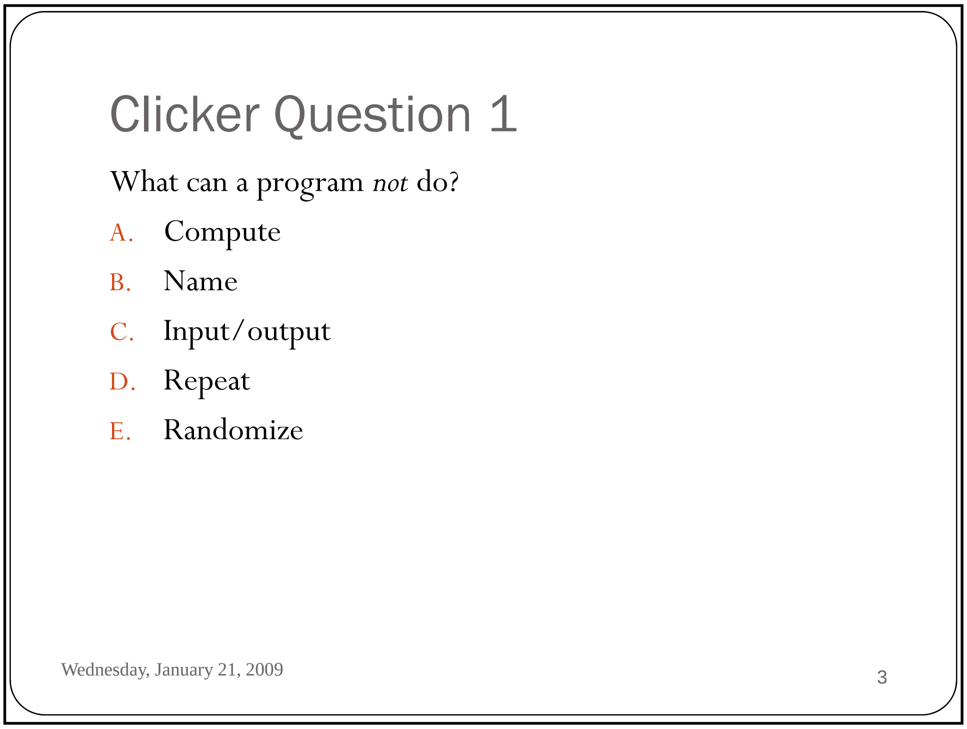
Topics for today

- Reading for this week…
  Chapters 3 &4: Computing with Numbers & Strings
  Chapter 7.1-7.3: If statement
- Reminder
  - Course notes available at the course website
  - Lab work is posted after the lab; take a look at it
  - Decide how you will be taking your files with you from the lab
- Topics for today
  - Dealing with numbers and the math library
  - Strings
  - If-statement

Summary: What Can a Program Do?

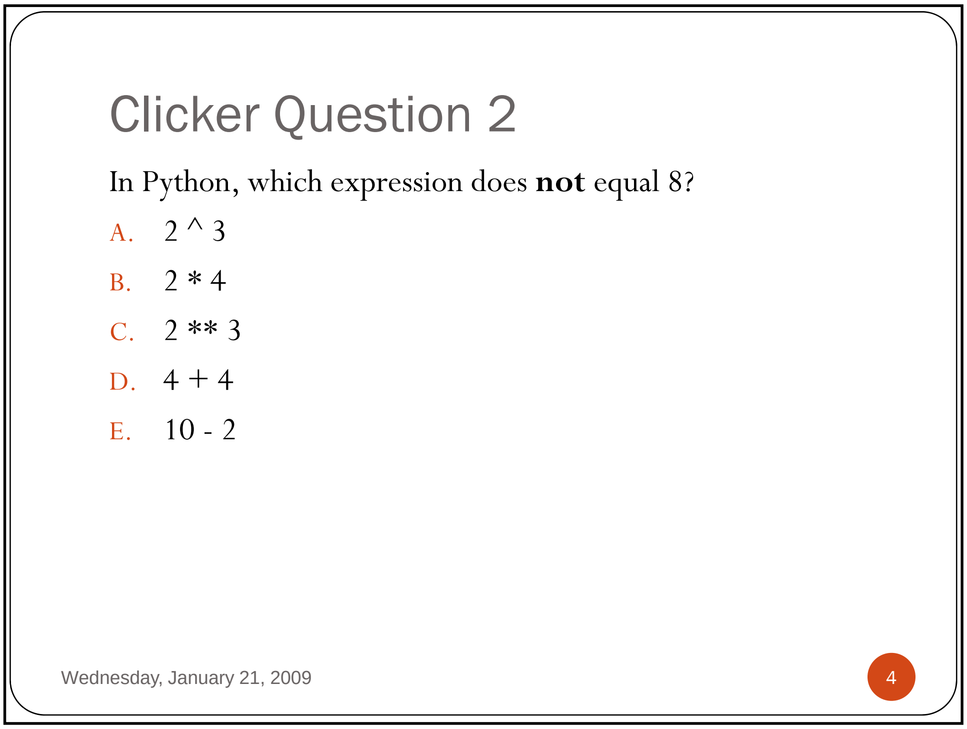
- Compute “things” (using numbers, strings)
- Name “things” (using variables)
- Put sequences of statements into functions (name functions)
  - Functions can be parameterized and return values
- Import modules written by others or by you
- Input (e.g., x = input("Enter a number: "))
- Output (e.g., print "x and y are", x, y)
- Repeat sequences of statements (for loop using range; more loop constructs later))
- Make decisions based on a condition being true (if-statement)



Clicker Question 1

What can a program *not* do?

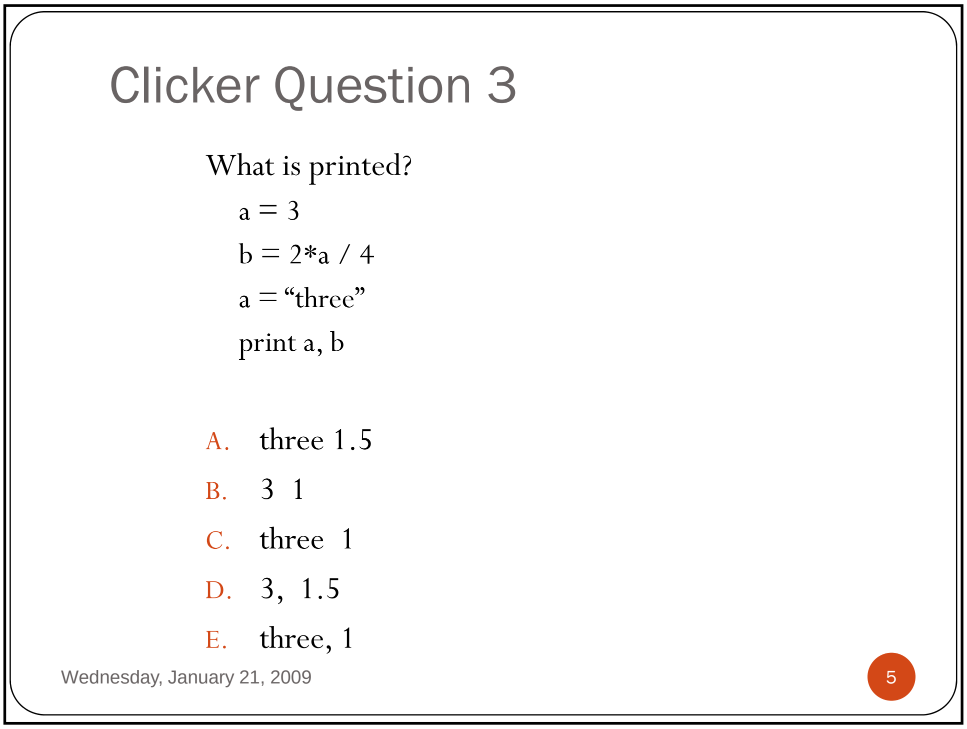
A. Compute
B. Name
C. Input/output
D. Repeat
E. Randomize



Clicker Question 2

In Python, which expression does **not** equal 8?

A. 2 ^ 3
B. 2 * 4
C. 2 ** 3
D. 4 + 4
E. 10 - 2



Clicker Question 3

What is printed?

```
a = 3
b = 2*a / 4
a = “three”
print a, b
```

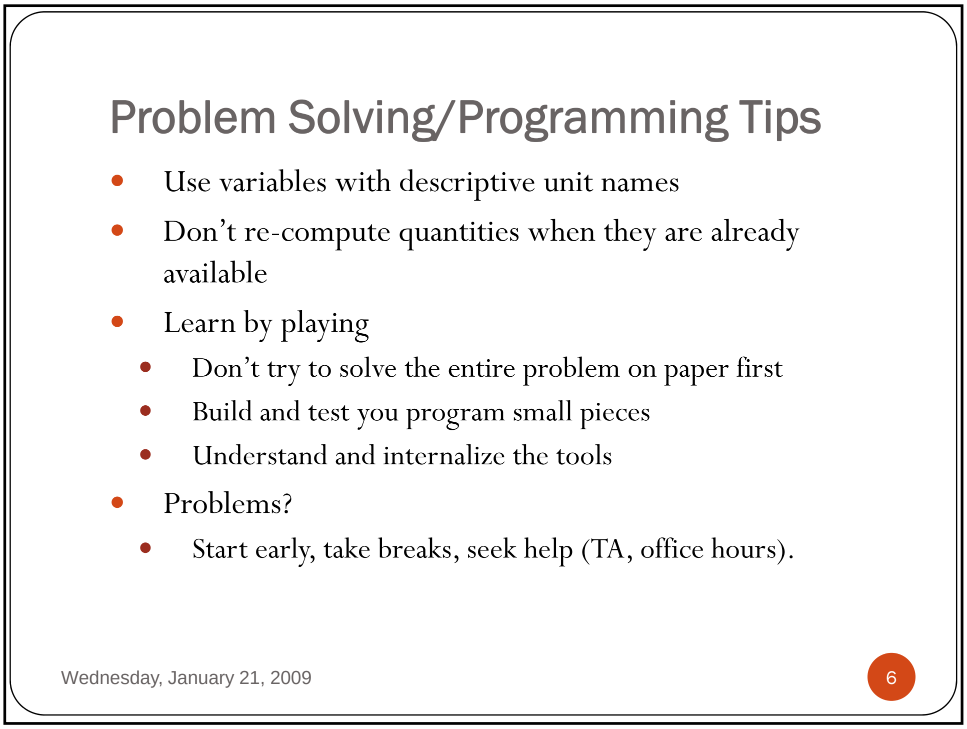
A. three 1.5

B. 3 1

C. three 1

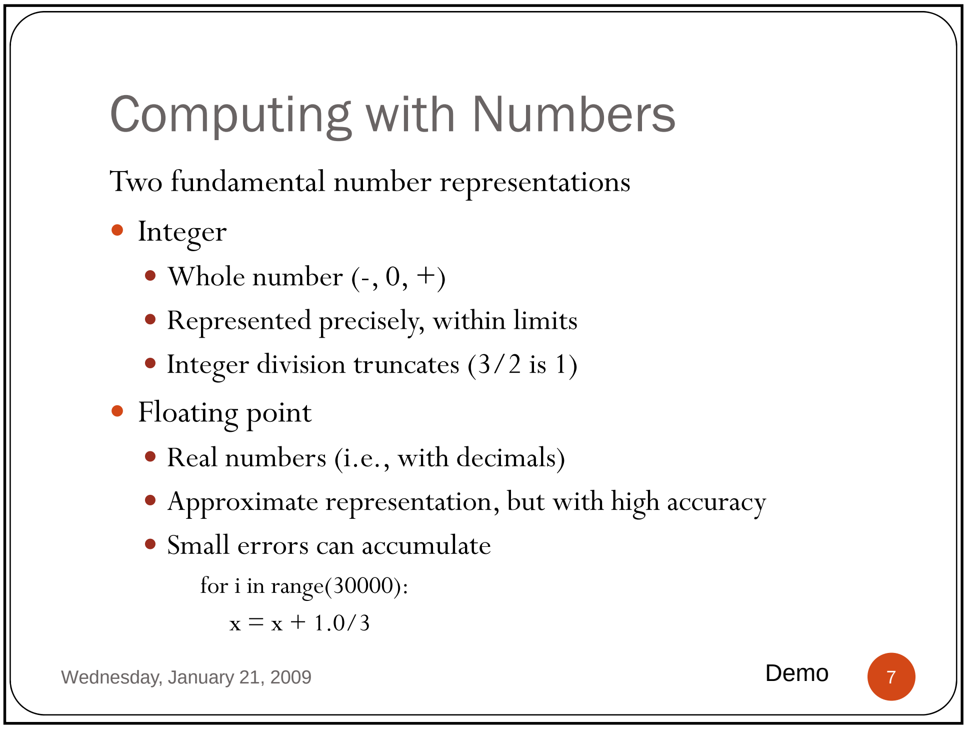
D. 3, 1.5

E. three, 1



Problem Solving/Programming Tips

- Use variables with descriptive unit names
- Don’t re-compute quantities when they are already available
- Learn by playing
  - Don’t try to solve the entire problem on paper first
  - Build and test you program small pieces
  - Understand and internalize the tools
- Problems?
  - Start early, take breaks, seek help (TA, office hours).



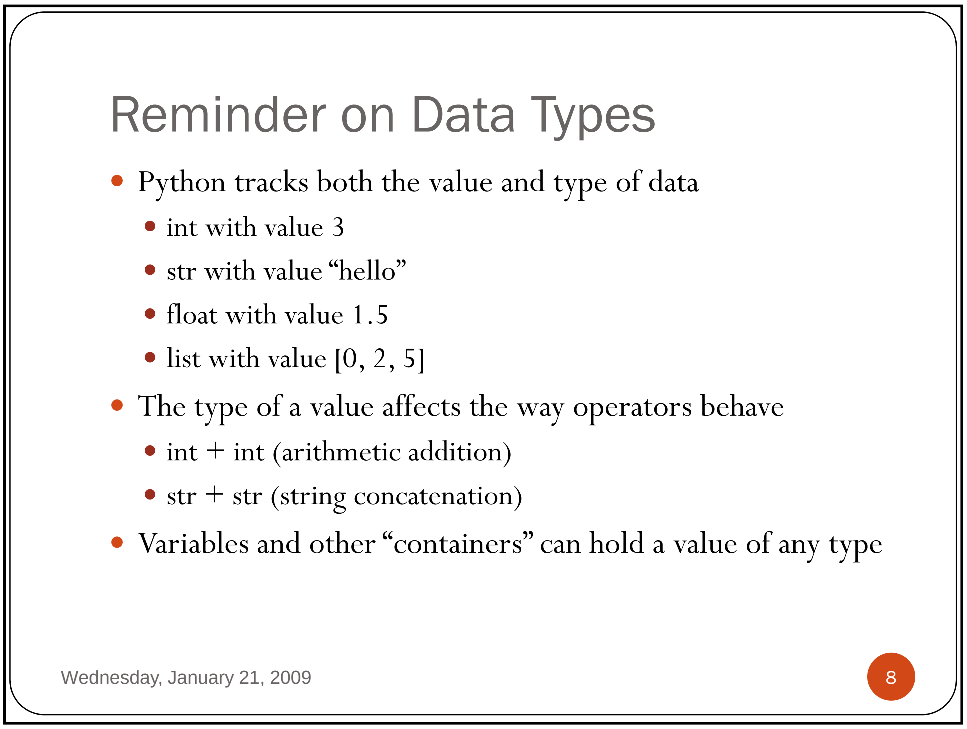
Computing with Numbers

Two fundamental number representations

- Integer
  - Whole number (-, 0, +)
  - Represented precisely, within limits
  - Integer division truncates (3/2 is 1)
- Floating point
  - Real numbers (i.e., with decimals)
  - Approximate representation, but with high accuracy
  - Small errors can accumulate

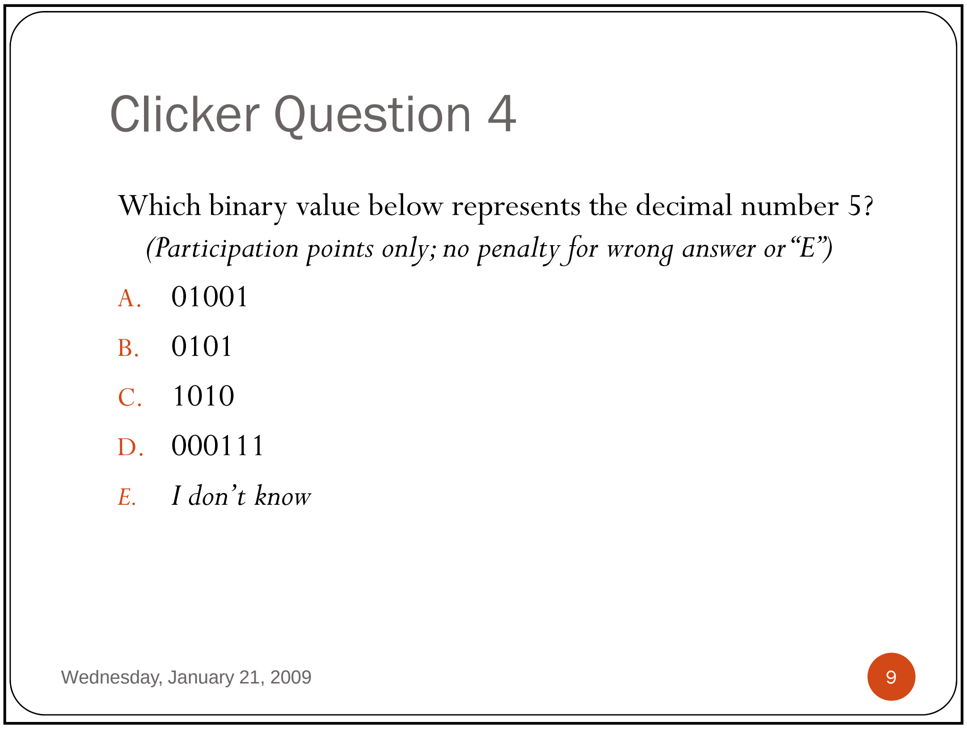
```
for i in range(30000):
    x = x + 1.0/3
```

Demo



Reminder on Data Types

- Python tracks both the value and type of data
  - int with value 3
  - str with value “hello”
  - float with value 1.5
  - list with value [0, 2, 5]
- The type of a value affects the way operators behave
  - int + int (arithmetic addition)
  - str + str (string concatenation)
- Variables and other “containers” can hold a value of any type



Clicker Question 4

Which binary value below represents the decimal number 5?

(Participation points only; no penalty for wrong answer or "E")

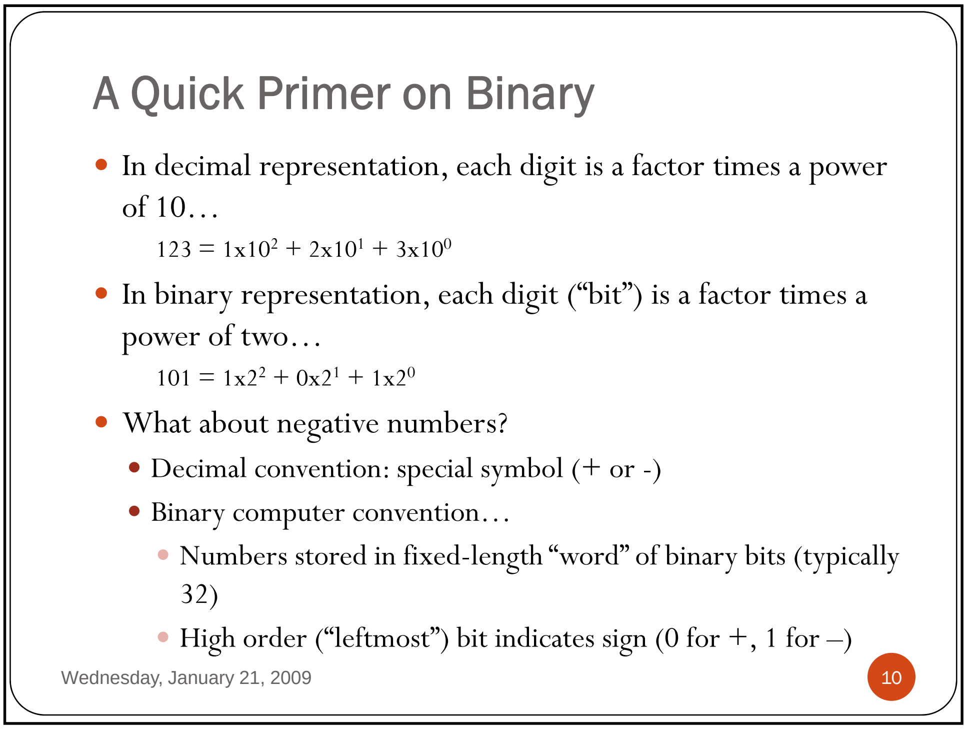
A. 01001

B. 0101

C. 1010

D. 000111

E. *I don't know*

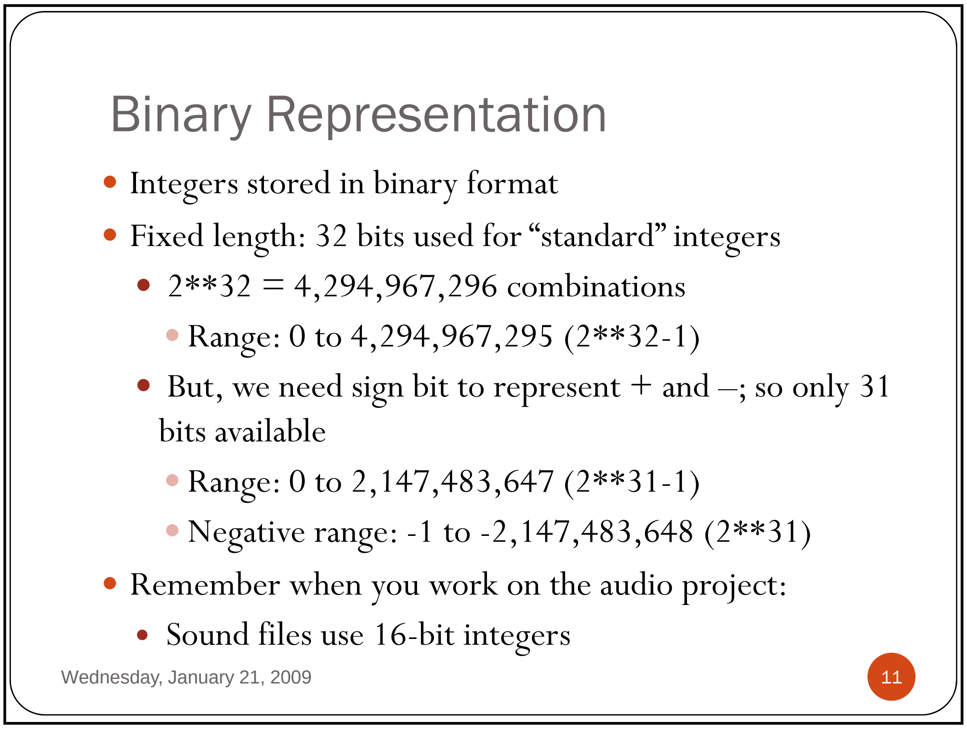


A Quick Primer on Binary

- In decimal representation, each digit is a factor times a power of 10…

  $123 = 1x10^2 + 2x10^1 + 3x10^0$
- In binary representation, each digit ("bit") is a factor times a power of two…

  $101 = 1x2^2 + 0x2^1 + 1x2^0$
- What about negative numbers?
  - Decimal convention: special symbol (+ or -)
  - Binary computer convention…
    - Numbers stored in fixed-length "word" of binary bits (typically 32)
    - High order ("leftmost") bit indicates sign (0 for +, 1 for –)



Binary Representation

- Integers stored in binary format
- Fixed length: 32 bits used for "standard" integers
  - 2**32 = 4,294,967,296 combinations
    - Range: 0 to 4,294,967,295 (2**32-1)
  - But, we need sign bit to represent + and –; so only 31 bits available
    - Range: 0 to 2,147,483,647 (2**31-1)
    - Negative range: -1 to -2,147,483,648 (2**31)
- Remember when you work on the audio project:
  - Sound files use 16-bit integers

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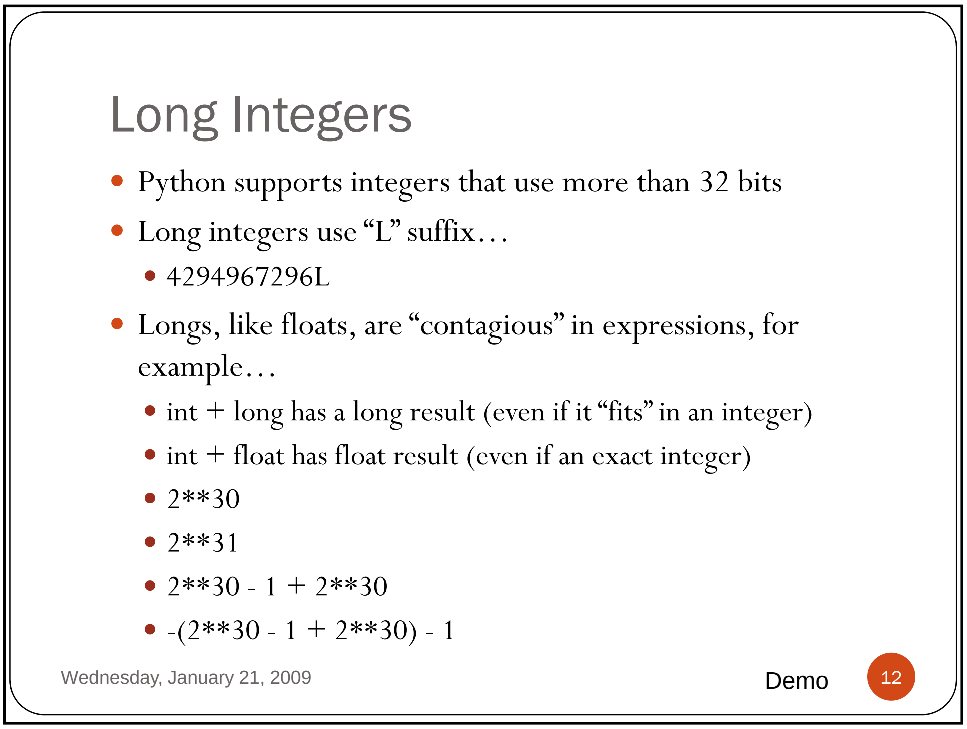

Long Integers

- Python supports integers that use more than 32 bits
- Long integers use "L" suffix…
  - 4294967296L
- Longs, like floats, are "contagious" in expressions, for example…
  - int + long has a long result (even if it "fits" in an integer)
  - int + float has float result (even if an exact integer)
  - 2**30
  - 2**31
  - 2**30 - 1 + 2**30
  - -(2**30 - 1 + 2**30) - 1

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Demo

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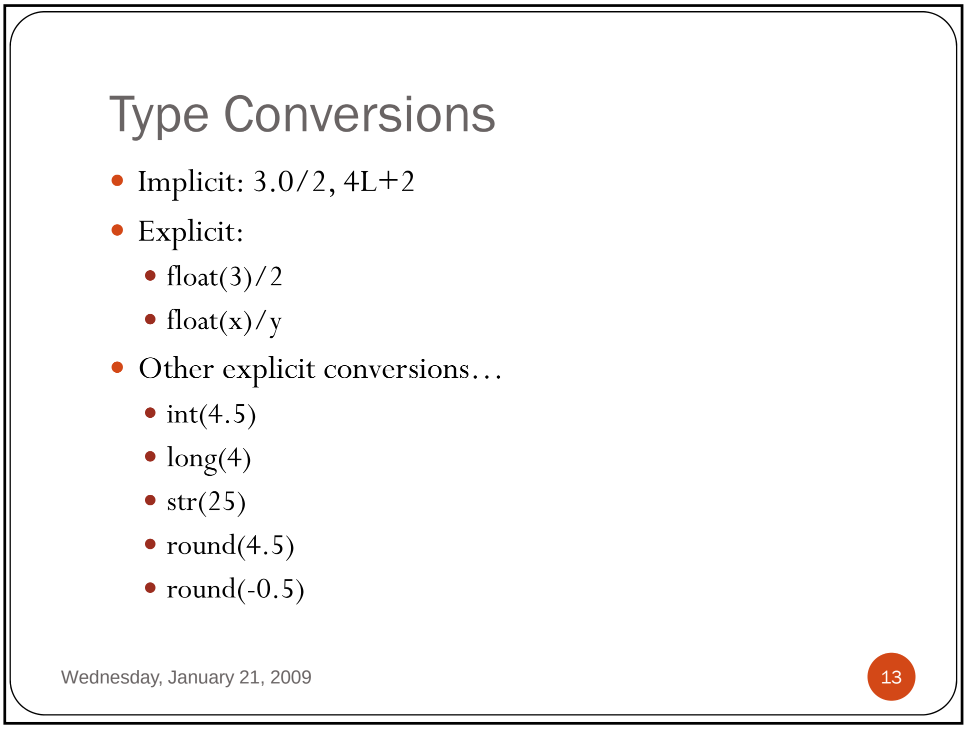
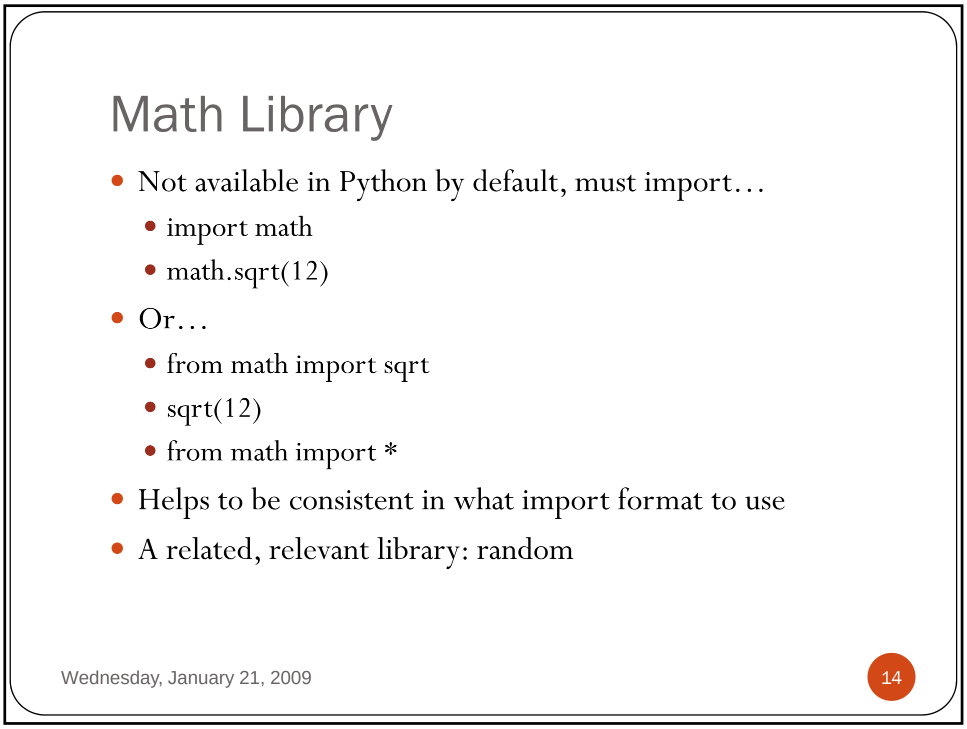


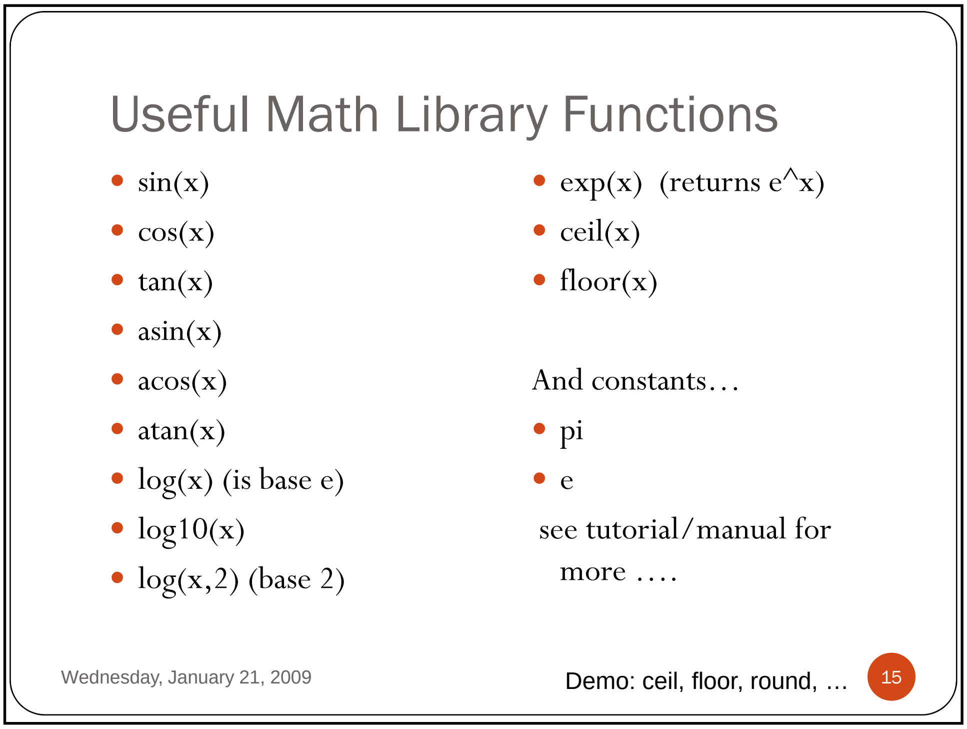
Type Conversions

- Implicit: 3.0/2, 4L+2
- Explicit:
  - float(3)/2
  - float(x)/y
- Other explicit conversions…
  - int(4.5)
  - long(4)
  - str(25)
  - round(4.5)
  - round(-0.5)



Math Library

- Not available in Python by default, must import…
  - import math
  - math.sqrt(12)
- Or…
  - from math import sqrt
  - sqrt(12)
  - from math import *
- Helps to be consistent in what import format to use
- A related, relevant library: random



Useful Math Library Functions

- sin(x)
- cos(x)
- tan(x)
- asin(x)
- acos(x)
- atan(x)
- log(x) (is base e)
- log10(x)
- log(x,2) (base 2)

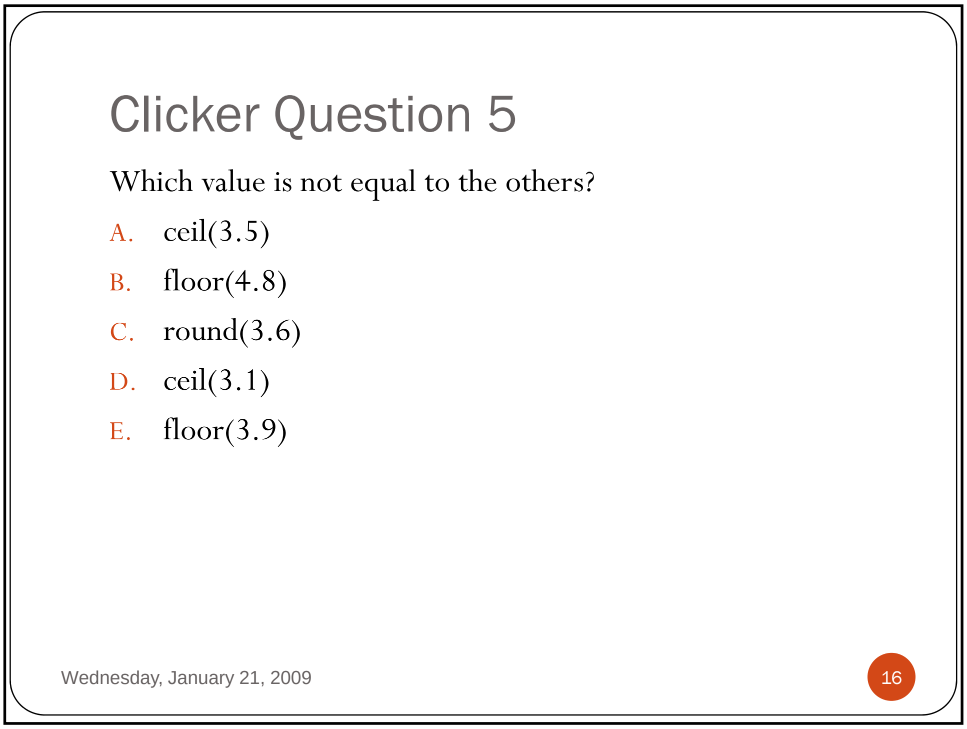
- exp(x) (returns e^x)
- ceil(x)
- floor(x)

And constants…

- pi
- e

see tutorial/manual for more ….

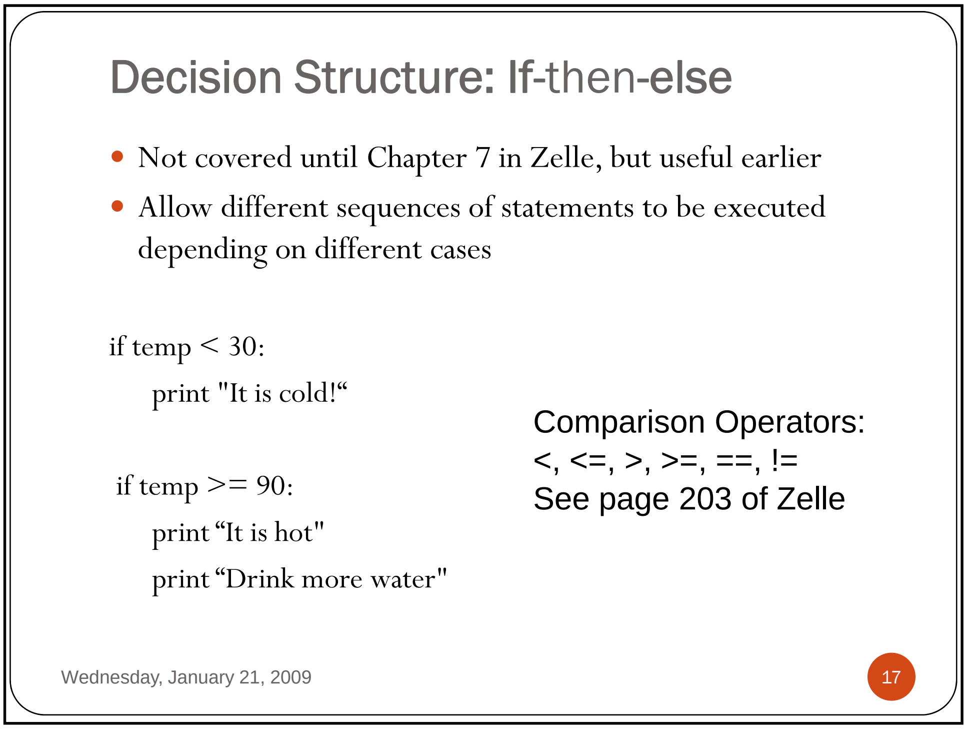
Demo: ceil, floor, round, …



Clicker Question 5

Which value is not equal to the others?

A. ceil(3.5)
B. floor(4.8)
C. round(3.6)
D. ceil(3.1)
E. floor(3.9)



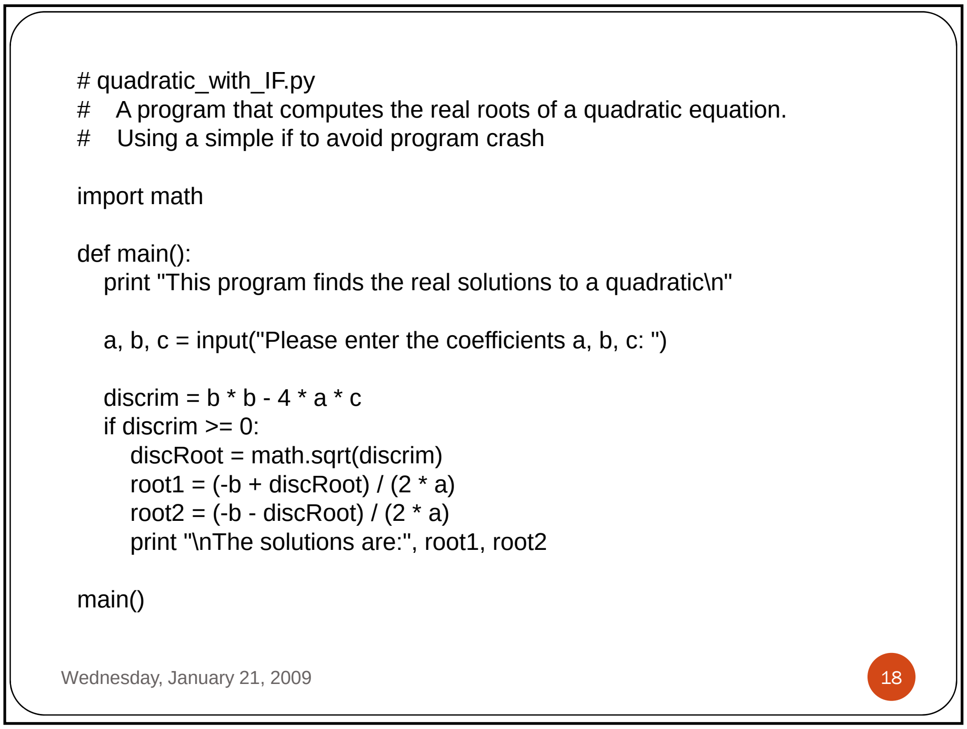
Decision Structure: If-then-else

- Not covered until Chapter 7 in Zelle, but useful earlier
- Allow different sequences of statements to be executed depending on different cases

```
if temp < 30:
    print "It is cold!“

 if temp >= 90:
    print “It is hot"
    print “Drink more water"
```

Comparison Operators:
<, <=, >, >=, ==, !=
See page 203 of Zelle



```
# quadratic_with_IF.py
#    A program that computes the real roots of a quadratic equation.
#    Using a simple if to avoid program crash

import math

def main():
    print "This program finds the real solutions to a quadratic\n"

    a, b, c = input("Please enter the coefficients a, b, c: ")

    discrim = b * b - 4 * a * c
    if discrim >= 0:
        discRoot = math.sqrt(discrim)
        root1 = (-b + discRoot) / (2 * a)
        root2 = (-b - discRoot) / (2 * a)
        print "\nThe solutions are:", root1, root2

main()
```