190F Foundations of Data Science

Fall 2018

Lecture 4

Expressions

Announcements

Arithmetic

Arithmetic Operators

Operation	Operator	Example	Value
Addition	+	2 + 3	5
Subtraction	-	2 - 3	-1
Multiplication	*	2 * 3	6
Division	/	7 / 3	2.66667
Remainder	%	7 % 3	1
Exponentiation	**	2 ** 0.5	1.41421

Ints and Floats

Python has two types of numbers:

- `int`: a signed integer of any size (no limits)
- `float`: a real number with an optional decimal part

- An `int` never has a decimal point; a **float** always does
- A `float` might be printed using scientific notation

Ints and Floats

Three limitations of float values:

- They have limited size (but the limit is huge)
- They have limited precision of 15-16 decimal places
- After arithmetic, the final few decimal places can be wrong

(Demo)

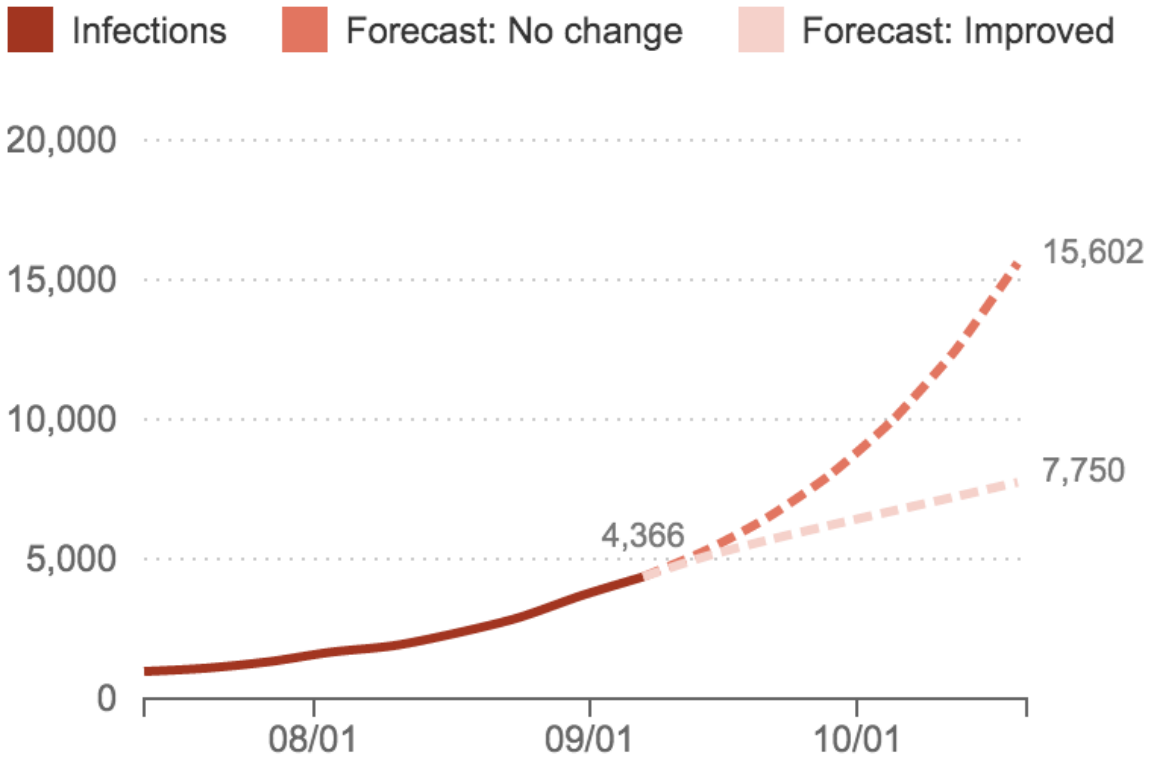
Exponential Growth

Ebola Epidemic, Sept. 2014

A Frightening Curve: How Fast Is The Ebola Outbreak Growing?

"It's spreading and growing *exponentially*," President Obama said.

"This is a disease outbreak that is advancing in an exponential fashion," said Dr. David Nabarro, who is heading the U.N.'s effort against Ebola.



http://www.npr.org/sections/goatsandsoda/2014/09/18/349341606/why-the-math-of-the-ebola-epidemic-is-so-scary

Source: Columbia Prediction of Infectious Diseases, World Health Organization

Growth Rate

- The rate of increase per unit time
- After one time unit, a quantity `x` growing at rate `g` will be

```
x * (1 + g)
```

- After `t` time units, a quantity `x` growing at rate `g` will be

```
x * (1 + g) ** t
```

- If `after` and `before` are measurements of the same quantity taken `t` time units apart, then the *growth rate* is

```
(after/before) ** (1/t) - 1
```

(Demo)

Strings

Text and Strings

A string value is a snippet of text of any length

- `'a'`
- `'word'`
- `"there can be 2 sentences. Here's the second!"`

Strings that contain numbers can be converted to numbers

- `int('12')`
- `float('1.2')`

Any value can be converted to a string

- `str(5)`

(Demo)

Discussion Question

Assume you have run the following statements

```
x = 3
y = '4'
z = '5.6'
```

What's the source of the error in each example?

A.
```
x + y
```

B.
```
x + int(y + z)
```

C.
```
str(x) + int(y)
```

D.
```
str(x, y) + z
```

Arrays

Arrays

An array contains a sequence of values

- All elements of an array should have the same type
- Operations are applied to each element individually
- When two arrays of numbers are added, they must have the same size; corresponding elements are added in the result
- A column of a table is an array

(Demo)

Ranges

Ranges

A range is an array of consecutive numbers

- **`np.arange(end)`**: An array of increasing integers from 0 up to (but not including) **`end`**
- **`np.arange(start, end)`**: An array of increasing integers from **`start`** up to (but not including) **`end`**
- **`np.arange(start, end, step)`**: A range with **`step`** between consecutive values

The range always includes **`start`** but excludes **`end`**