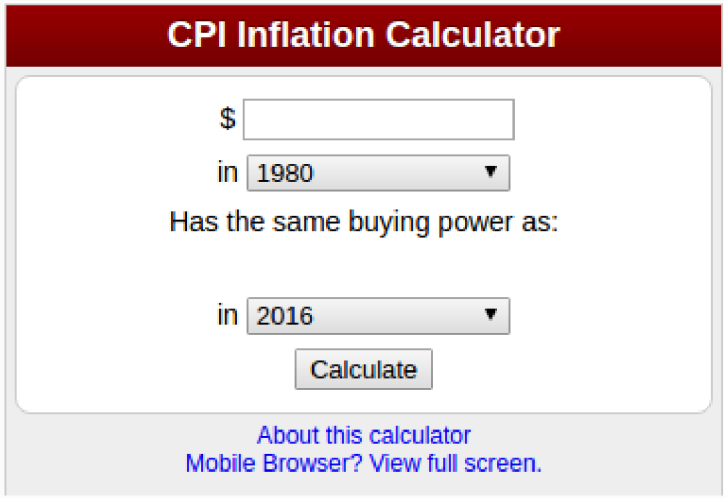
Problem Solving - Part 2

CORE-UA 109.01, Joanna Klukowska

inflation

inflation

or what is your money going to be worth tomorrow?



- Each year things cost more than a year before.
- This is called **inflation**.
- U.S. Bureau of Labor Statistics provides the inflation calculator http://www.bls.gov/data/inflation_calculator.htm

- Using the inflation calculator we can find out what $100 of some past year is worth these days.
- For the inflation rate data see *Current US Inflation Rates: 2006-2017* at http://www.usinflationcalculator.com/inflation/current-inflation-rates/

inflation

- If you bought an item that cost $100.00 ten years ago, how much would you need to spend today for an equivalent item? (or what amount of money has the same **buying power** as the $100.00 from a decade ago)
- Guess:
  - Can you guess what $100 from 2014 would be *equivalent to* in 2017?
  - How about $100 from 1998 (this is roughly when you were born, isn't it)?
  - How about 1913 (the earliest year in the calculator)?

why do we care about inflation?

- Say you are one of the college graduates of 2015 and you get a job paying $50,000 a year with the guaranteed annual increase of 2%.
- Are you really making $51,000 the following year?
- Nominally yes, but it is not worth the same as $51,000 in the year that you were hired.

correcting for inflation

(this is a simple approximation; for a more complete analysis we would need to use the consumer price index)

What is the inflation rate?

- If the \$100 in 2016 is equivalent to \$101.63 in 2017 (according to the inflation calculator from June 2016 to June 2017), then how can we figure out the inflation rate from 2016 to 2017?

$$\frac{\$101.63 - \$100.00}{\$100.00} = \frac{\$1.63}{\$100} = 0.0163$$

  inflation rate: 1.63%

Inflation is a negative rate, it decreases the value of money.

- Your salary of \$51,000 in 2017 is worth only

  $\$51,000 \times (1 - 0.0163) = \$50{,}168.70$

  (if we think of 2016 as a baseline for the buying power of money).

  Not a 2% increase!

inflation summary

If the annual increase in one's salary is

- less than the inflation rate, the income effectively decreases
- more than the inflation rate, the income effectively increases

If an interest rate offered by a bank is

- below the inflation rate, the bank account is effectively losing value
- above the inflation rate, the bank account is effectively gaining value

electricity bills

electricity bills

- You may or may not be paying electricity bills, but one day you will and it is interesting to know how they work.
- If you use twice as much electricity in June as you did in February is your bill twice as big (assume that the price is still the same)?
- If so, we could calculate the amount of the bill as follows (note that electricity consumption is calculated in kilo-watt-hours, kwh):

$$\textit{cost in a given month} = \textit{price per one kwh} \times \textit{number of kwh used}$$

$$b(k) = price \times k$$

- (Note that the above formula will need to be adjusted to really represent the function that models electricity bills.)

electricity bills

- Lane Electric is a power supplier company. Their website has a nifty calculator that allows one to estimate the amount of the monthly bill (see http://laneelectric.com/tools/bill-estimator/. Let's try to figure out if we can actually come up with a pattern.

kWh used	monthly price
25	$14.05
50	$16.10
75	$18.15
100	$20.20

- Can you figure out how much a single kWh of electricity costs?

  Work with a partner (or two) to see if you can come up with a formula.

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- The answer does not seem to be straight forward, does it?

  But what if you knew that the same company will issue a bill for $12.00 per month even if you do not use any electricity?

electricity bills

- Here is the table again with the added column:

kWh used	monthly price	monthly price - $12.00
25	$14.05	$2.05
50	$16.20	$4.10
75	$18.15	$6.15
100	$20.20	$8.20

- Can you figure out the pattern now?
- It seems that each 25 kWh of electricity costs exactly $2.05.
- This means that 1 kW costs $2.05/25 or $0.082 or 8.2¢.
- And the bill can be calculated as

$$b(k) = 0.082 \times k + 12.00$$

electricity bills

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What other bills *behave* this way?

try it yourself: car rental

- You are about to move and you need to rent a track to transfer all your things from the old place to the new place. You did your research regarding available rental places. Here is the information you collected:

	Watertown	U-Haul	Budget	Enterprise
fixed cost	$79.00	$29.95	$29.95	$59.95
$ per mile	0.00	$1.39	$0.99	$0.59 (after the first 100 miles)

- Which company should you use?
  - for a very short move (just couple of blocks)?
  - for a very long move (the East Coast to Alaska)?
  - what about a medium size move, let's say 35 miles
- What is the function for price for each of those companies (this should be a function of miles driven).

a picture is worth ...

example 1 - a simple plot

```
# these lines import plotting tools that
# we will need for this problem
import numpy as np
import matplotlib.pyplot as plt

# think of plt as our drawing canvas
# or a whiteboard

# first draw the plot
plt.plot([1,2,3,2,3,4,3,4,5])
# then show it to have a window pop-up with
# the actual plot
plt.show()
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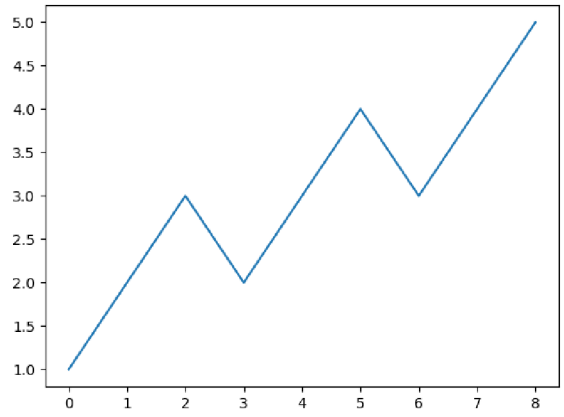

example 2 - quadratic function

```
import numpy as np
import matplotlib.pyplot as plt

# let's try to plot a quadratic function y = (x-3)^2 - 25

# first let's get some points for the x axis np.linspace works similar to the range()
# function, but 1) both end points are included, 2) the last parameter states
# how many values we want, not the interval
x = np.linspace(0, 10.0, 6)

# now we calculate the corresponding y values
y = (x-3)**2 - 25

#finally, plot the graph and show it
plt.plot(x, y)
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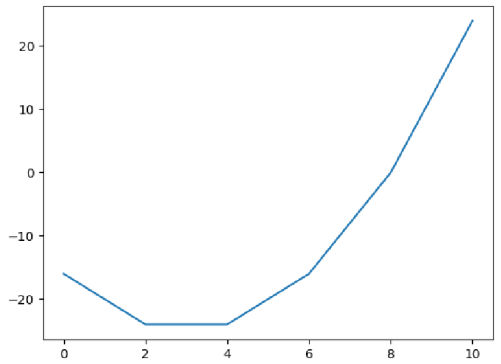
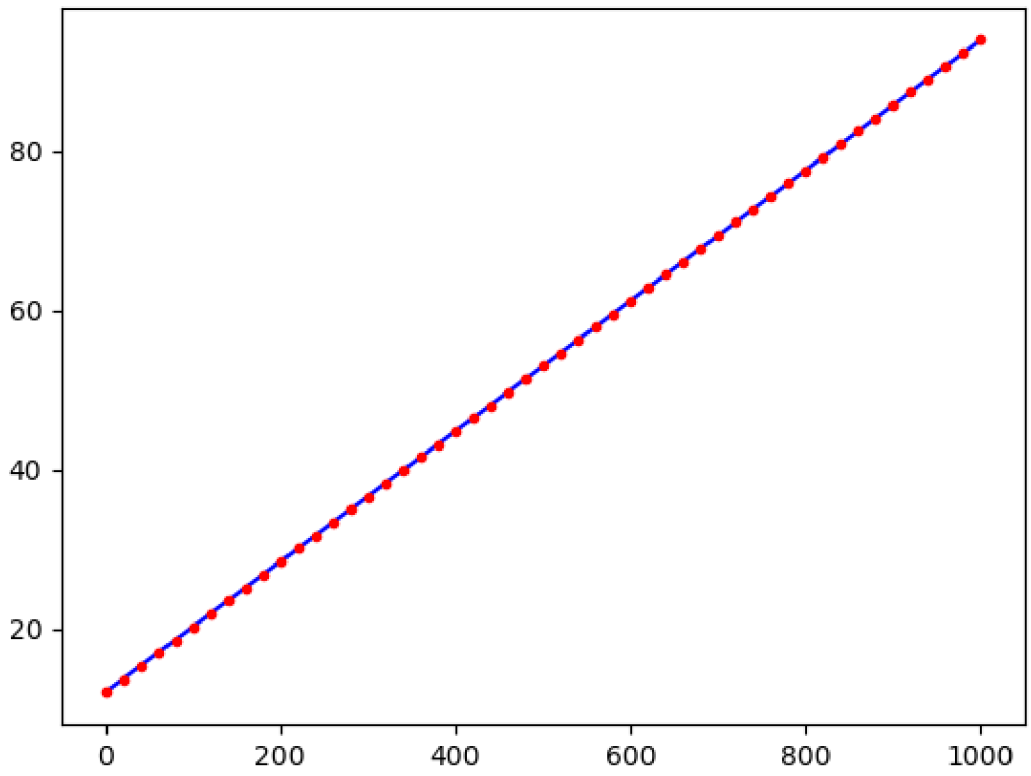


example 3 - electric bill

```
import numpy as np
import matplotlib.pyplot as plt

# let's try to plot the values of our electric bill from Lane
# Electric b(k)=0.082 * k + 12.00

# we want the plot for number of kilo-watt-hours ranging from 0 to 1000,
# in increments of 20 kilo-watt-hours (so we need 51 points between 0 and 1000)
k = np.linspace(0, 1000.0, 51)

# we calculate the corresponding bill amount
b = 0.082 * k + 12

#finally, plot the graph and show it
plt.plot(k, b, 'b')   # plot a blue line
plt.plot(k, b, 'r.')  # mark each point with a red dot
plt.show()
```

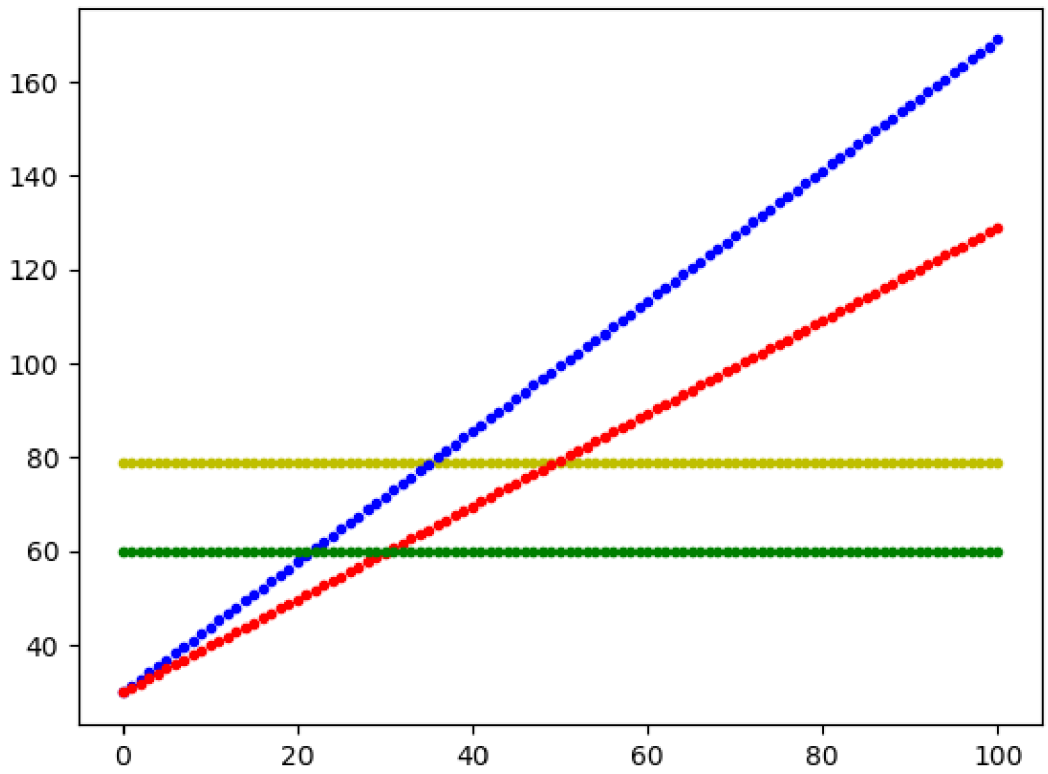
example 3 - electric bill



example 4 - track rental <100 mi

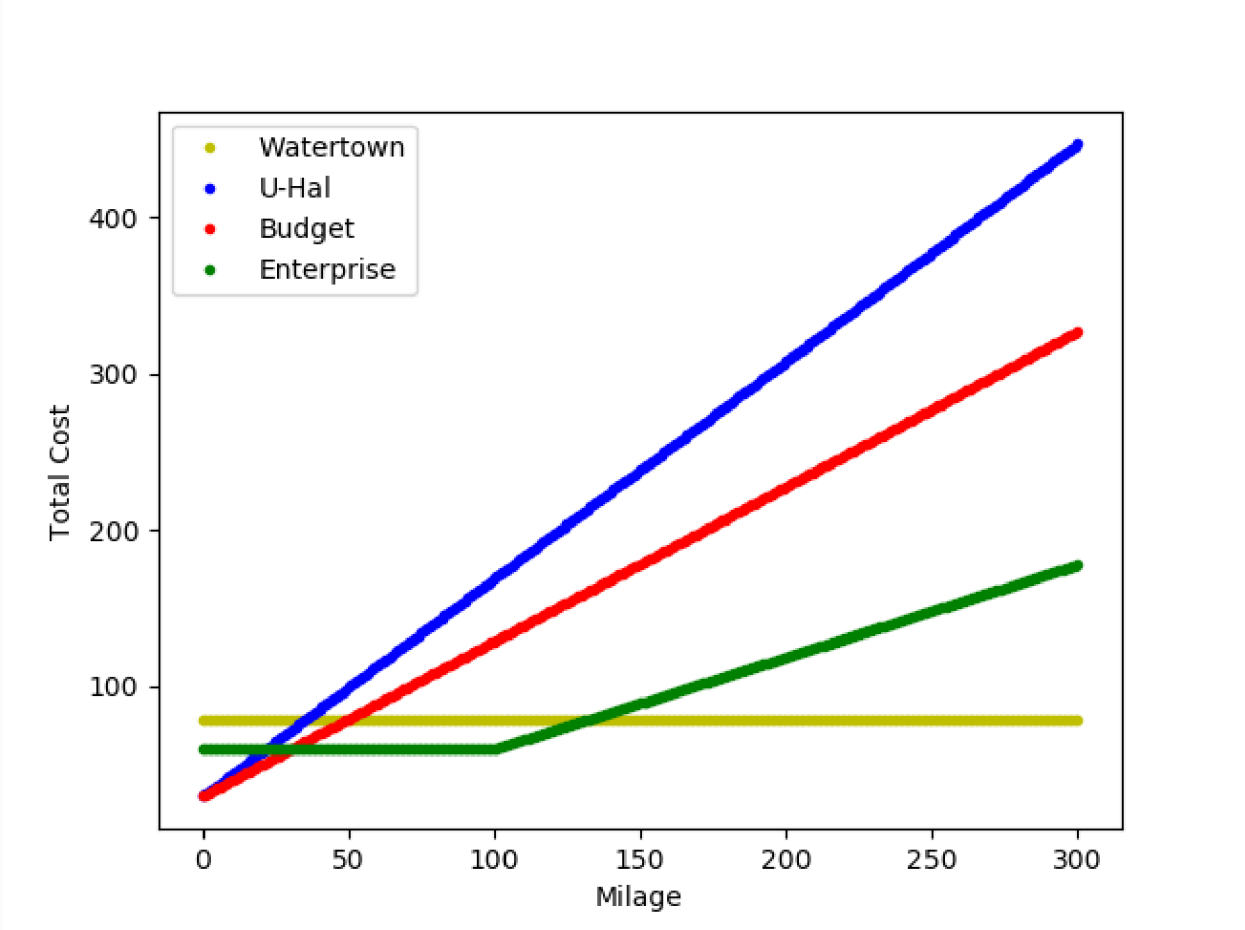
```
import numpy as np
import matplotlib.pyplot as plt

# let's try to plot the cost of renting a track from each of the four
# companies - the price is a function of the milage driven

# we want the plot for number of miles ranging from 0 to 100
num_of_points = 101
miles = np.linspace(0, 100, num_of_points )

# we calculate the corresponding prices for each company
watertown = 79.0 * np.ones(num_of_points)
uhal = miles * 1.39 + 29.95
budget = miles * 0.99 + 29.95
enterprise100 = 59.95 * np.ones(num_of_points)


#finally, plot the graph and show it
plt.plot(miles, watertown, 'y.')
plt.plot(miles, uhal, 'b.')
plt.plot(miles, budget, 'r.')
plt.plot(miles, enterprise100, 'g.')
plt.show()


# save plot to file
plt.savefig('/home/asia/Data/NYU_Teaching/core109/code/plotting/CarRental_100.png')
```

example 4 - track rental <100 mi



example 5 - track rental >100 mi

There is too much code to see it on the slide: example5.py.



Programming challenge

Revisit the salaries of graduates from 2016.

- assume starting salary of $50,000
- assume annual percentage increase of 2% Plot the salaries at the end of each year in the range 1 - 10. Hint: you will need to figure out the function that calculates that salary based on the given year number (we did that on the board last week).

Now consider inflation.

- assume that the inflation for the next ten years will be 1.6% a year Plot both, the salaries as calculated above and the salaries reduced by inflation.