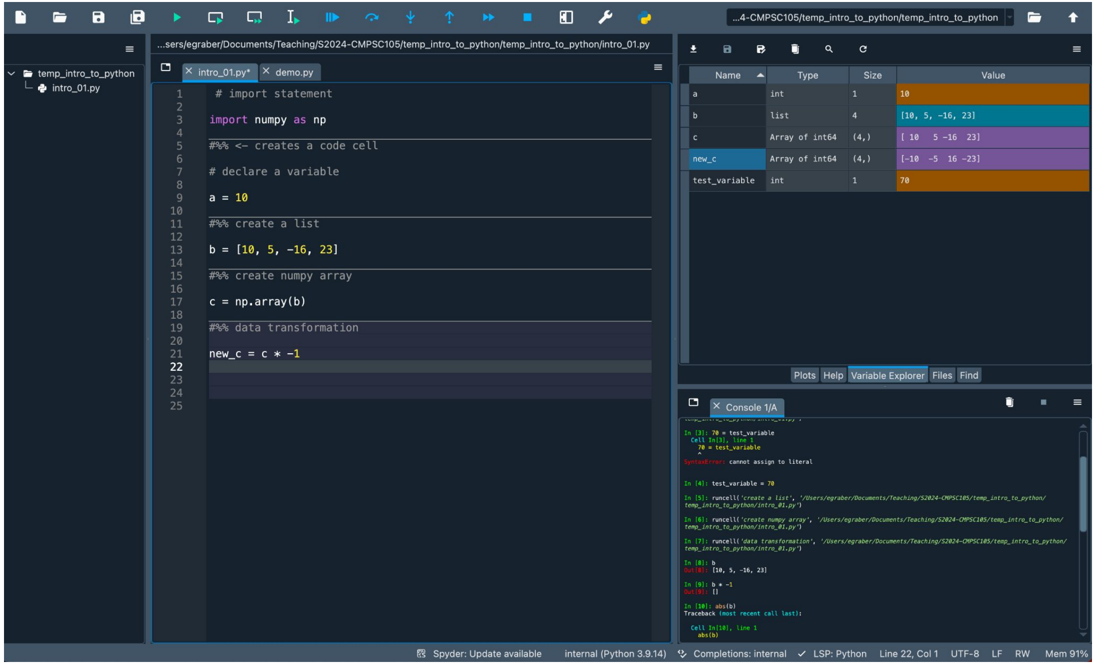
Transformations Revisited

Last time

Transformations were applied using google sheets and pre written python code

This time

new transformations in python with numpy



List of example transformations / computations

- given starting array, x
  - mean, $\bar{x}$
  - for every observation, i
    - error, $x_i - \bar{x}$
    - squared error, $(x_i - \bar{x})^2$
  - Sum over all squared error
  - Sum over all squared error normalized by number of observations - 1

Underlying math: mean

array: x = $3, 4, 4, 5, 5, 5, 6, 6, 6, 7, 7, 8, 9$

$$\bar{x} = \frac{3+4+4+5+5+5+6+6+6+7+7+8+9}{13}$$

$$\bar{x} = 5.8$$

Underlying math: error and squared error

x	$\bar{x}$	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$
3	5.8	−2.8	7.84
4	5.8	−1.8	3.24
4	5.8	−1.8	3.24
5	5.8	−0.8	0.64
5	5.8	−0.8	0.64
5	5.8	−0.8	0.64
6	5.8	0.2	0.04
6	5.8	0.2	0.04
6	5.8	0.2	0.04
7	5.8	1.2	1.44
7	5.8	1.2	1.44
8	5.8	2.2	4.84
9	5.8	3.2	10.24

Underlying math: sum over all squared error

x	$\bar{x}$	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$
3	5.8	−2.8	7.84
4	5.8	−1.8	3.24
4	5.8	−1.8	3.24
5	5.8	−0.8	0.64
5	5.8	−0.8	0.64
5	5.8	−0.8	0.64
6	5.8	0.2	0.04
6	5.8	0.2	0.04
6	5.8	0.2	0.04
7	5.8	1.2	1.44
7	5.8	1.2	1.44
8	5.8	2.2	4.84
9	5.8	3.2	10.24

Sum = 34.32

Underlying math: normalization by num observations - 1

x = $3, 4, 4, 5, 5, 5, 6, 6, 6, 7, 7, 8, 9$

number observations = 13

number observations - 1 = 12

Sum = 34.32

34.32 / 12

Code

```
import numpy as np

# create numpy array with original data
x = np.array([3, 4, 4, 5, 5, 5, 6, 6, 6, 7, 7, 8, 9])

# find number of observations
n = np.size(x)

# mean
xbar = np.sum(x) / n

# error
error = x - xbar

# squared error
se = error**2

# sum of squared error over all observations
sse = np.sum(se)

# normalization by number observations - 1
result = sse/(n-1)

# look at the result
print(result)
```

```
2.858974358974359
```

Benefit of code

The size of the original array does not matter in code!

But imagine how annoying it would be to deal with **10 million** rows in google sheets…

```python
import numpy as np

# create numpy array with 10 million numbers
x = np.arange(10000000)

# find number of observations
n = np.size(x)

# mean
xbar = np.sum(x) / n

# error
error = x - xbar

# squared error
se = error**2

# sum of squared error over all observations
sse = np.sum(se)

# normalization by number observations - 1
result = sse/(n-1)

# look at the result
print(result)
```

```
8333334166666.48
```

Exercise

Copy in the code shown in these slides into spyder and explore all the variables created!

What is the value of:

- n
- xbar
- error
- se
- sse
- result

Change x and repeat the exploration

fill in your results here: https://forms.gle/CKWEnykPyyH3Xxch6