# Getting Started with Python and Excel Building a Basic Model in Both Excel and Python

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Basic Problem

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 The focus today is to get familiar working in both Excel and Python

Basic Problem

 We will approach this by building a simple model with both tools

 In later lectures, we will move to combining the tools

$$\begin{array}{l} (x+v)x + (-u+v)y + (5u+2v)z - 3u + v = 0 \ (2v)x = x_{1}+mt, \ y = y_{1}+nt, \ z_{1}=z+pt \\ x = mz + a, \ y = nz + b \frac{x-a}{m} = \frac{y-b}{n} = \frac{z}{1} \\ y^{2} (x+c)^{2} + y^{2} = 4a - 4aV(x-c)^{2} + y^{2} + (x-c)^{2} + y^{2} + (x-c)^{2} + y^{2} + (x-c)^{2} + y^{2} + (x-c)^{2} + y^{2} + y^$$

# A Simple Retirement Problem

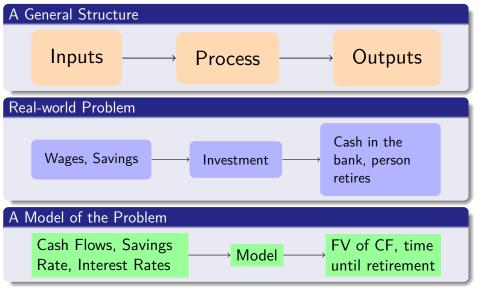
 Let's take what is perhaps the simplest finance problem, which everyone should understand

 While you may have approached such a problem with a calculator before, we will build models for it instead

 Martha is saving for retirement. She earns \$60,000 per year and is able to save 25% of that. If she invests her savings, earning 5% per year, and she needs \$1,500,000 to retire, how soon can she retire?

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# Breaking Down the Retirement Problem



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# Solving the Problem in Excel

- It is easy to use Excel as a calculator and just type the math in directly. But we want to build a model.
- Changing inputs should result in a change to outputs. The way to do this in Excel is cell references
- Fixed references become important when trying to drag formulas, e.g. \$A\$2 (fully fixed), \$A2 (fixed on column), or A\$2 (fixed on row).



### Simple Retirement Problem in Excel

### Intro Excel Exercise

- Go to the course site and download Simple Retirement Model Excel
- Follow along as I recreate the simple model.

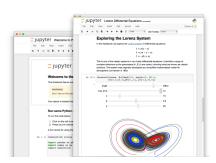
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# How We'll Work in Python

- Using Python in the terminal is kind of a pain. And so, tools were born.
- Jupyter is a graphical interface we can use for Python. It also supports over 40 other languages such as R, SAS, Julia, and Scala
- You can use jupyter notebook or jupyter lab. The latter has a lot more features outside of the notebook. We will focus on using jupyter lab in this class as it is the future of Jupyter.



# Let's Get Set up with Jupyter

### Launch Jupyter Notebook

- Launch Anaconda Navigator
- 2 Find Jupyter Notebook on the main screen, and click launch
- 3 You should see a list of folders and files. Click New and then Python 3
- Now you should see a code cell with In []: next to it

If you don't have Anaconda Navigator, just open a terminal (search cmd on Windows, terminal on Mac). Then in the terminal, type jupyter lab and enter. Then continue with the third step.

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# Some Python Basics

- In Excel, the basic unit is a cell. In Python, the basic unit is an object.
- In Excel, content in a cell is either a number (123) or a string (ABC)
- In Python, all objects have types. They might also be a number or a string, or something else.
- Rather than using a cell reference like \$A\$2, we assign names to objects in Python

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# Doing Some Math in Python



### Note: Deprecation warning

In the future, these numpy financial functions are being moved to a separate package numpy\_financial. For the purposes of this class, this won't matter, but in the future you may have to install numpy\_financial to use these functions. In the meantime, you will see a warning come up when calling the functions.

- Basic operations in Python are straightforward
- $\bullet$  6 2 = 4
- 2 \* 3 = 6
- 5 / 2 = 2.5
- A lot more is available using the numpy package
- np.pv, np.nper, np.fv, np.pmt
- All numpy financial functions

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# Simple Retirement Problem in Python

### Intro Python Exercise

- Go to the course site and download Simple Retirement Model Python
- In Jupyter, then navigate to your Downloads folder (or wherever you saved it)
- You should then see Simple Retirement Model.ipynb come up in the list of files in Jupyter. Click it to open it and follow along.

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# Extending the Model - Multiple Interest Rates

 Now we've got basic models to determine how long it will take Martha to retire.

 We've got a few assumptions built into the model. One is that Martha will earn 5% on her investments

• Rates of return are volatile, so we want to see how long it would take her to retire if her return was different

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# Programming Fundamentals - Iteration

- In programming, for model building or otherwise, you often need to repeat the same process for multiple different things
- In Excel, you would do this by dragging formulas.
- In Python, as in most other programming languages, we would use a for loop
- This says, do something, for each value I pass into the loop

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# Iteration - Python vs. Excel

### Python Iteration

```
inputs = [5, 10, 15]
for item in inputs:
    new_value = item + 2
    print(new_value)
```

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Excel Iteration		
Input	Output	Function
5	7	=B4+2
10	12	=B5+2
15	17	=B6+2

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# Explaining Python Iteration

- There's a few things to unpack here
- Here's another type of object: not a number or a string, but a list
- A list holds multiple objects, and you can add or remove items from lists

### Python Iteration

```
inputs = [5, 10, 15]
for item in inputs:
   new value = item + 2
   print(new value)
```

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# Explaining Python Iteration (pt. 2)

- Here we define a list of three numbers as inputs
- Then we use a for loop to get each input out of the list, and add 2 to it to create the new value
- Finally we print each value as it is generated

### Python Iteration

```
inputs = [5, 10, 15]
for item in inputs:
    new_value = item + 2
    print(new_value)
```

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```
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```

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# Iterating the Existing Model

### Expanding on Python and Excel

- I will now expand the existing Excel and Python models to examine multiple interest rates
- Continue viewing the same previously downloaded files.

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# Vary Savings Rate Lab

### Extending a Simple Retirement Model

- Now we want to see the effect of savings rate on time until retirement, in addition to interest rate
- 2 In both Excel and Python, calculate the years to retirement for savings rates of 10%, 25%, and 40%, and each of these cases with each of the interest rate cases, 4%, 5%, and 6%
- Be sure that you drag formulas in Excel and use for loops in Python to accomplish this
- In total you should have 9 calculated years to retirement numbers, in each of the two models.

Answers: Slide 24 Resources: Slide 25

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#### Lecture Resources

#### Lecture Resources

- Slides Getting Started with Python and Excel
- Lecture Notes Getting Started with Python and Excel
- Simple Retirement Model Excel
- Simple Retirement Model Python

## Vary Savings Rate Lab, Answers

### Extending a Simple Retirement Model, Answers

- 1 Martha has 61.1 years to retirement if she earns a 4% return and saves 10%.
- ② Martha has 41.0 years to retirement if she earns a 4% return and saves 25%.
- Martha has 31.9 years to retirement if she earns a 4% return and saves 40%.
- ${\color{red} \bullet}$  Martha has 53.3 years to retirement if she earns a 5% return and saves 10%.
- Martha has 36.7 years to retirement if she earns a 5% return and saves 25%.
- $\odot$  Martha has 29.0 years to retirement if she earns a 5% return and saves 40%.
- $oldsymbol{0}$  Martha has 47.6 years to retirement if she earns a 6% return and saves 10%.
- Martha has 33.4 years to retirement if she earns a 6% return and saves 25%.
- Martha has 26.7 years to retirement if she earns a 6% return and saves 40%.

Exercise: Slide <u>22</u> Resources: Slide <u>25</u>

### Vary Savings Rate Lab Resources

### Extending a Simple Retirement Model Resources

- Simple Retirement Model Excel
- Simple Retirement Model Python
- Slides Getting Started with Python and Excel

Exercise: Slide 22 Answers: Slide 24