# Python Programming

Start your python scripts in PyCharm

Harry Lee 1/10/2018

CEE 696 & Stanford CEE 268

### Automation





1

1. PyCharm Setup

# PyCharm Setup

How can you execute your python scripts?

- go to terminal ("Command Prompt" in Windows) run python
- go to terminal run ipython
- Jupyter Notebook

Command Prompt - Python

You can run a python script by typing "python your\_script \_name.py" or open interactive shell by simply typing "python"

Ipython is an interactive command-line terminal with extra features like tab-completion, testing, debugging, system calls and other features.

type "ipython" in the terminal

How will we write and execute python scripts in this class?

- go to terminal python, ipython
- PyCharm (with ipython) we will use this
- $\cdot$  We can use Jupyter Notebook using PyCharm as well

#### 1. Start PyCharm



### Start PyCharm (2)

- 1. Start PyCharm
- 2. Create new project



## Start PyCharm (3)

- 1. Start PyCharm
- 2. Create new project choose your directory create a new folder if needed

| Select Base Directory                                               | ×         |
|---------------------------------------------------------------------|-----------|
| Select base directory for the project       New Folder (Alt+Insert) | Hide path |
| C:\Users\Harry\Dropbox\Class\2018 Spring\CEE 696                    | 1         |
| > 2014-2015 Spring                                                  |           |
| > 2014-2015 Winter                                                  |           |
| > 🖿 2015-2016 Spring                                                |           |
| > 2015-2016 Winter                                                  |           |
| > 🖿 2016-2017 Fall                                                  |           |
| > 🖿 2016-2017 Spring                                                |           |
| > 🖿 2016-2017 Winter                                                |           |
| 🗸 🖿 2018 Spring                                                     |           |
| > 🖿 CEE 696                                                         |           |
| > 🖿 329 Emperical Bayes                                             |           |
| > cee                                                               |           |

9

## Start PyCharm (4)

- 1. Start PyCharm
- 2. Create new project choose your directory

| Select Base Directory                                        | ×         |
|--------------------------------------------------------------|-----------|
| Select base directory for the project                        |           |
| ☆ □ ■ □ × Ø ■                                                | Hide path |
| C:\Users\Harry\Dropbox\Class\2018 Spring\CEE 696\scripts\ex1 | <b></b>   |
| > 🖿 examples                                                 |           |
| > 🖿 figures                                                  |           |
| > 🖿 images                                                   |           |
| > MF2005.1_12                                                |           |
| > mf_ex1                                                     |           |
| > 🖿 python                                                   |           |
| > 🖿 reference                                                |           |
| ✓ ■ scripts                                                  |           |
| ex1                                                          |           |
| > 🖿 329 Emperical Bayes                                      |           |
| > 🖿 cee                                                      |           |
| CIVE502                                                      |           |

# Start PyCharm (5)

- 1. Start PyCharm
- 2. Create new project choose your directory
- 3. Project Interpreter- New environment using Virtualenv Inherit global site-packages unless you want to build everything from scratch

| 😫 New Project           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ×      |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 🍦 Pure Python           | Location: C:\Users\Harn\Dropbox\Class\2018 Spring\CEE 696\scripts\ex1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |
| 🚺 Django                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| C Flask                 | * Project Interpreter: New Virtualenv environment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |
| Google App Engine       | New environment using dividend with the second s |        |
| 🔅 Pyramid               | Location: C:\Users\Harry\Dropbox\Class\2018 Spring\CEE 696\scripts\ex1\venv                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |
| Web2Py                  | Base interpreter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |
| Angular CLI             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| AngularJS               | Innerit global site-packages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |
| Foundation              | Make available to all projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |
| HTML5 Boilerplate       | Existing interpreter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |
| React App     React App | Interpreter: 💀 Python 3.6 (python_12182018) C\Users\Harry\Dropbox\Work\IKE_WAI\r                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | × 🔅    |
| W Twitter Rootstrap     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| Web Starter Kit         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
| C Heb Starter fat       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |
|                         | Create                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Cancel |

#### We are almost there! Create your first python script



### Start Pycharm

Now you can write your own script.

### Installation of Python packages

- 1. NumPy : N-dimensional array package
- 2. SciPy : Scientific computing library package
- 3. Matplotlib : Plotting package
- 4. FloPy : MODFLOW python interface package
- 5. Jupytor : Jupyter Notebook (not required)

Package installation:

- You can install them in our Anaconda Python ("Anaconda Navigator" - Environments - root - change "installed"" to "not installed" - and "search Packages": this might require root or administrator permission)
- Or, we can install them separately within your virtual environment

What is Virtual Environment?

- It is a tool to create isolated Python development environments
- This will address the issue of version dependencies and permissions.
- For example, your current application requires version 1.0 of program A and another application needs version 1.57 of program A, how can you maintain both applications?
- Or, you accidentally upgrade program A to its version 2.0 and your applications stop working. How can you deal with this.
- virtualenv basically creates a development environment that has its own installation directory under your current workspace.

# Package installation (1)

| Q                                             | Project: ex1 > Project Interpre | ter 🐵 For current project                            |                                            |      |
|-----------------------------------------------|---------------------------------|------------------------------------------------------|--------------------------------------------|------|
| <ul> <li>Appearance &amp; Behavior</li> </ul> | Project Interpreter: 🔥 Python   | 3.6 (ex1) C:\Users\Harry\Dropbox\Class\2018 Spring\C | EE 696\scripts\ex1\venv\Scripts\python.exe | ~ 1  |
| Appearance                                    |                                 |                                                      |                                            |      |
| Menus and Toolbars                            | Package                         | Version                                              | latest                                     | Inst |
| System Settings                               | Babel                           | 2.4.0                                                | ⇒ 2.5.1                                    |      |
| Si o l                                        | Bottleneck                      | 12.1                                                 | 1.2.1                                      |      |
| File Colors                                   | Cython                          | 0.25.2                                               | 0.27.3                                     |      |
| Scopes                                        | Django                          | 1.11.8                                               | ⇒ 2.0.1                                    |      |
| Notifications                                 | Flask                           | 0.12.2                                               | 0.12.2                                     |      |
| Quick Lists                                   | Flask-Cors                      | 3.0.2                                                | ➡ 3.0.3                                    |      |
| Kauman                                        | HeapDict                        | 1.0.0                                                | 1.0.0                                      |      |
| кеутар                                        | Jinja2                          | 2.9.6                                                | ⇒ 2.10                                     |      |
| Editor                                        | Keras                           | 2.0.9                                                | ⇒ 2.1.2                                    |      |
| Plugins                                       | Markdown                        | 2.6.9                                                | 2.6.11                                     |      |
| Version Control                               | MarkupSafe                      | 0.23                                                 | ⇒ 1.0                                      |      |
| Project: ev1                                  | Pillow                          | 4.1.1                                                | ➡ 5.0.0                                    |      |
| Project. ex i                                 | PyWavelets                      | 0.5.2                                                | 0.5.2                                      |      |
| Project Interpreter                           | PyYAML                          | 3.12                                                 | 3.12                                       |      |
| Project Structure                             | Pygments                        | 2.2.0                                                | 2.2.0                                      |      |
| Build, Execution, Deployment                  | QtAwesome                       | 0.4.4                                                | 0.4.4                                      |      |
| Languager & Frameworks                        | QtPy                            | 1.2.1                                                | ➡ 1.3.1                                    |      |
|                                               | SQLAIchemy                      | 1.1.9                                                | ➡ 1.2.0                                    |      |
| lools                                         | SciTools                        | 0.9.0                                                | 0.8                                        |      |
|                                               | Werkzeug                        | 0.12.2                                               | 0.14.1                                     |      |
|                                               | XlsxWriter                      | 0.9.6                                                | ➡ 1.0.2                                    |      |
|                                               | alabaster                       | 0.7.10                                               | 0.7.10                                     |      |
|                                               | anaconda-client                 | 1.6.3                                                | 1.2.2                                      |      |
|                                               | anaconda-navigator              | 1.6.2                                                | 0.1.0                                      |      |
|                                               | anaconda-project                | 0.6.0                                                | ⇒ 0.8.2                                    |      |
|                                               | asn1crypto                      | 0.22.0                                               | • 0.24.0                                   |      |
|                                               | astroid                         | 1.4.9                                                | ➡ 1.6.0                                    |      |
|                                               | astropy                         | 1.3.2                                                | 3.0rc1                                     |      |

File - Settings - Project - Project Interpretator + click "+" button

### Package installation (2)

| Q* numpy         |   |                                                                           | ¢ |
|------------------|---|---------------------------------------------------------------------------|---|
| hypothesis-numpy | Ø | Description                                                               |   |
| idx2numpy        |   | MumDu array pressessing for symphone strings research and shipsts         |   |
| intel-numpy      |   | Variation Variation Processing for numbers, samigs, records, and objects. |   |
| mapchete-numpy   |   | 1140                                                                      |   |
| msgpack-numpy    |   | Author                                                                    |   |
| nose-numpyseterr |   | NumPy Developers                                                          |   |
| numpy            |   |                                                                           |   |
| numpy-indexed    |   | mailto.numpy-discussion@python.org                                        |   |
| numpy-mkl        |   | http://www.numpy.org                                                      |   |
| numpy-quaternion |   |                                                                           |   |
| numpy-stl        |   |                                                                           |   |
| numpy-sugar      |   |                                                                           |   |
| numpy_display    |   |                                                                           |   |
| numpy_groupies   |   |                                                                           |   |
| numpy_ringbuffer |   |                                                                           |   |
| numpydoc         |   |                                                                           |   |
| numpysane        |   |                                                                           |   |
| numpyson         |   |                                                                           |   |
| numpythia        |   |                                                                           |   |
| numpyx           |   |                                                                           |   |
| p4a-numpy        |   |                                                                           |   |
| pnumpy           |   |                                                                           |   |
| root_numpy       |   |                                                                           |   |
| tinynumpy        |   |                                                                           |   |
| topas2numpy      |   |                                                                           |   |
| wrapnumpy3       |   |                                                                           |   |
| xnumpy           |   | Specify version 1.14.0                                                    |   |
| zmgnumpy         |   | Options                                                                   |   |

Install numpy, scipy, matplotlib and flopy (and jupyter if you want)

If you have issues with installation, you can go to "Command Prompt" (Windows) or Terminal (Linux or Mac) and type

"pip install your\_package" for example, "pip install flopy"

### Write your first script

#### Then turn on "Scientific mode" View - Scientific Mode

| 🕷 ex1 [C:\Users\Harry\Dropbox\Class\2018 Spring\CEE 696\scripts\ex1]\my_first_script.py (ex1) - PyCharm             |                               |                     |        | -       |                | ×          |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------------|--------|---------|----------------|------------|
| Elle Edit View Navigate Code Befactor Run Iools VCS Window Help                                                     |                               |                     |        |         |                |            |
| = ext ) 👼 my_first_scriptpy )                                                                                       |                               | 🔮 my_first_script 🗠 | ▶ ₩    | N 69    | - <b>F</b> - I | = Q        |
| 🗊 Project + 🕲 III III - III IIII IIII IIII - IIII IIII IIII IIII IIII IIII IIII IIII                                | Documentation my_first_script |                     |        |         | A              | 令~ 기       |
| Image: C(Users)Harry(Drop)                                                                                          | Y 🔶 🔶 🛧 🗋 😨 🗌                 | ine ext             |        |         |                | 0          |
| A were library root                                                                                                 | No decumentation              | found               |        |         |                |            |
| b mg.inst.combtay                                                                                                   | No documentation              | Touria.             |        |         |                |            |
| P Control Constants                                                                                                 |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
| Python Console                                                                                                      |                               |                     |        |         |                | 令- 上       |
| G import sys; print('Python %s on %s' % (sys.version, sys.platform))                                                | Special Variables             |                     |        |         |                |            |
| <pre>sys.path.extend(['C:\\Users\\Harry\\Dropbox\\Class\\2018 Spring\\CEE 696\\scripts\\ex1', 'C:/Users/Harry</pre> | w.                            |                     |        |         |                |            |
| ×                                                                                                                   |                               |                     |        |         |                |            |
| Buthon 2 6 1 (Continuum Analution The L (default May 11 2017 12:25:24) (MSC v 1900 64 bit (AMD64))                  |                               |                     |        |         |                |            |
| 2                                                                                                                   |                               |                     |        |         |                |            |
| · ·                                                                                                                 |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
| 64 <sup>2</sup>                                                                                                     |                               |                     |        |         |                |            |
|                                                                                                                     |                               |                     |        |         |                |            |
| Packages installed successfully: Installed packages: humpy (3 minutes ago)                                          |                               |                     | 1:1 CR | F: UTF- | 8: b           | - Hanger 🕄 |

```
nlay = 5 # number of layers
nrow = 10 # number of rows
ncol = 20 # number of columns
```

```
nlay,nrow,ncol = 5,10,20 # more compact way
# spacing along a row (ncol) and column (nrow), respecti
delr, delc = 1.5, 2.5
```

print("nrow: %d, delc: %f" % (nrow, delc))

- run you script by Run Run or Alt+Shift+F10
- or you can select lines and mouse right-click Execute Selection in Console or Alt+Shift+E

Jupyter Notebook is another interactive computational environment on your web browser supported by Python community. While we stick to PyCharm in this class, you can use the Notebook for interactive python scripting.

- 1. Create your notebook file : File New Jupyter Notebook
- 2. click "green" run cell button
- 3. cancel the dialog box below
- 4. click "Run Jupyter Notebook" in yellow error message
- 5. click the url "http://127.0.0.1:8888...." below to open your default browser
- 6. When you finish the notebook, stop it by clicking the red stop button in Run Tool Window (or Ctrl+F2)



We will look into the code later in detail

```
import numpy as np # n-dimensional array
x = np.linspace(0,2*np.pi,100)
y = np.sin(x)
```

```
import matplotlib.pylab as plt
plt.figure()
plt.plot(x,y)
plt.title('my first plot!')
plt.show()
```