Advanced Image Processing and Analysis

ECE 4438B/ECE 9202B/ECE 9022B

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Instructor

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So far…

- Topics and Themes
- Course outline
- Course policy
- Implementation Tools
    - Python as a programming language
    - SimpleITK for Image Processing and Analysis
    - Jupyter Notebooks as the environment

Why Python

- Do you know
  - [Dropbox client was written entirely in python](#)
  - Google:
    - "[Python where we can, C++ where we must](#)"

Why SimpleITK

- Implementation tools
    - Matlab (https://www.mathworks.com/)
    - Insight Segmentation and Registration Toolkit (ITK, https://itk.org/)
    - 3D Slicer (https://www.slicer.org/)
- All are very good tools, serving different purposes

Implementation Tools

- Matlab: Processing + visualization, large number of algorithms, best suited for 2D

- ITK: Processing only, vary large number of algorithms, suited for 2D/3D/4D/nD

- 3D Slicer: Processing + visualization, small number of algorithms, best suited for 3D
  - Very useful/popular as a research platform

Why ITK

- ITK
  - Open source
  - Very large number of algorithms
  - Implemented in C++ (with language bindings)
  - Need external programs (3D Slicer) for visualization

Why ITK

- Built starting in 1999 using funding from the National Library of Medicine (NIH)
- ITK consortium consisted of three industrial partners (GE Corporate R&D, Kitware, and MathSoft) and three academic partners (U. North Carolina, U. Tennessee, U.Penn)
- Currently
  - 1.7 million lines of code
  - >300 contributors
  - >1500 new code commits per year
  - Requires 494 person-years of effort to build

Why ITK

- Has code that
  - Read/write many 3D medical imaging file formats
  - Implements many widely-used algorithms for
    - Filtering
    - Segmentation
    - Registration
    - 3D mesh processing
    - Finite element modelling
    - And much more...

Why SimpleITK

- To perform image processing in ITK
  - Need a C++ compiler
  - Knowledge in C++ programming (Templated C++)
  - Download and "build" ITK as an external library
  - Write you own code and link it against ITK
  - Use external program to visualize the result
  - Steep learning curve

Why SimpleITK

- Simplified layer built on top of ITK
- Intended to facilitate its use in rapid prototyping, education
- C++ library
- Object-Oriented
  - Without templates
- Language binding for Python and Java (and others)
- With Jupyter Notebooks, allows us to program (in python) interactively and visualize the results immediately
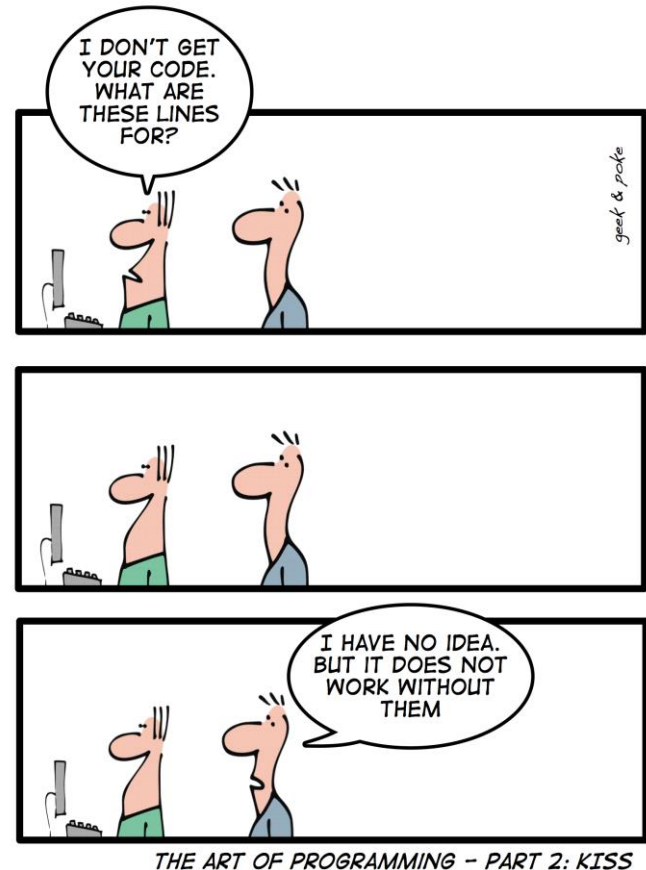
Jupyter Notebook

- The Jupyter Notebook (https://jupyter.org/) is an open-source web application that allows one to create and share documents that contains:
  - Live code
  - Equations
  - Visualizations
  - Narrative texts

Notebook document

- Documents produced by the Jupyter Notebook App, which contains both computer codes (python) and rich text elements (markdown)
  - Highly readable
  - As we go through the course, more course materials will be presented through Notebook documents instead of PowerPoint slides
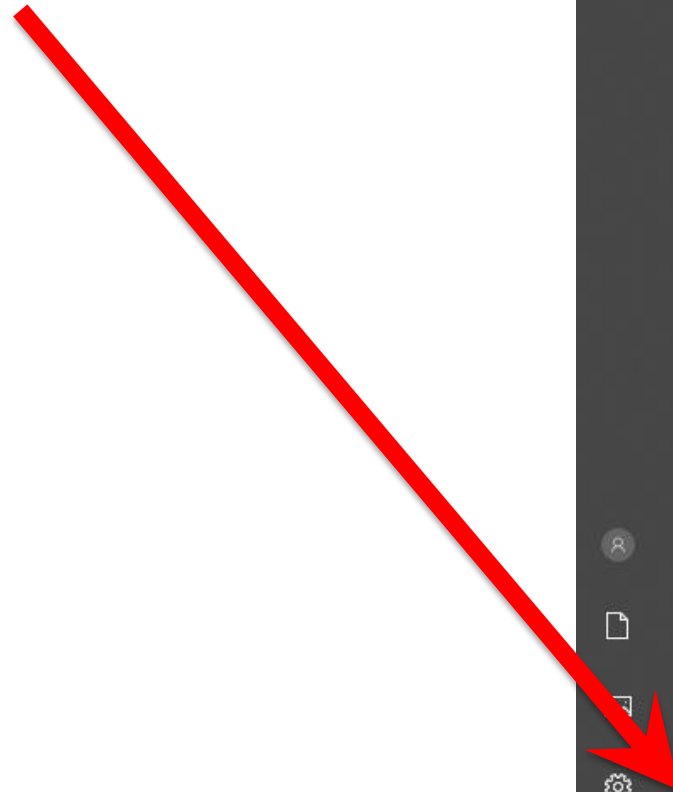 - You will be writing your assignment using Notebook document

Why Notebook document

- Use rich text (Markdown) to explain your thoughts
- Use comments to document your codes
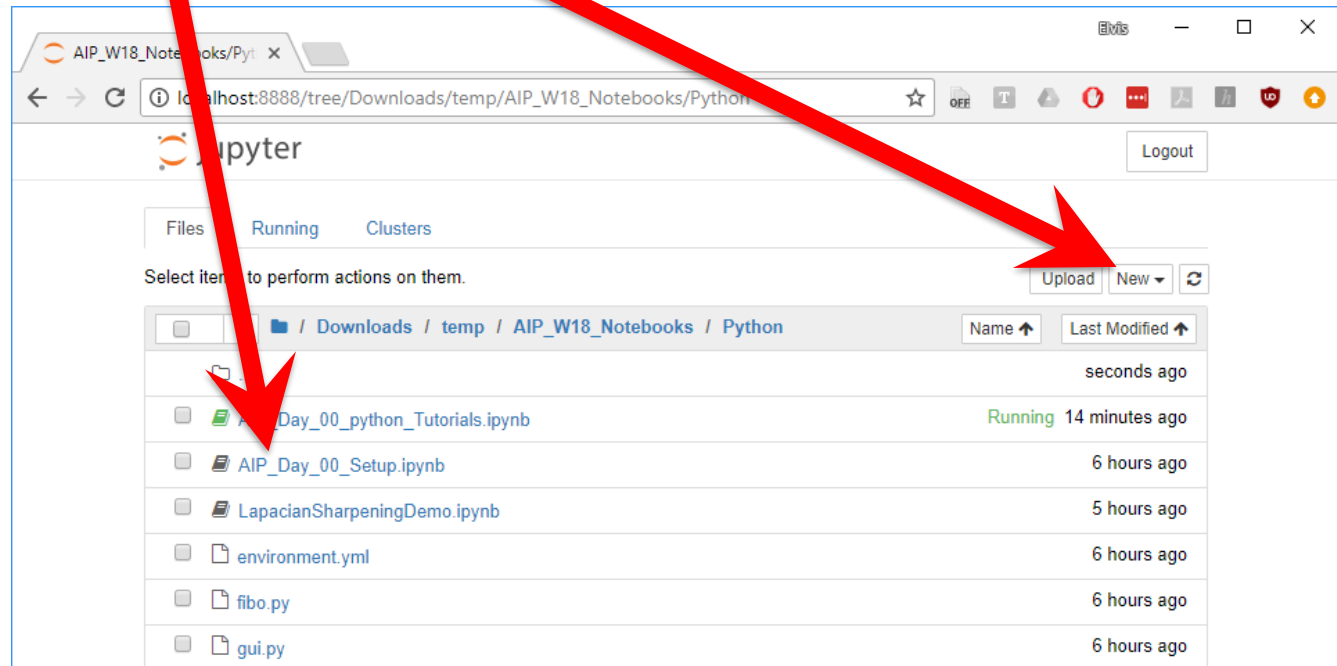- Debugging is trivial
- In-text visualization
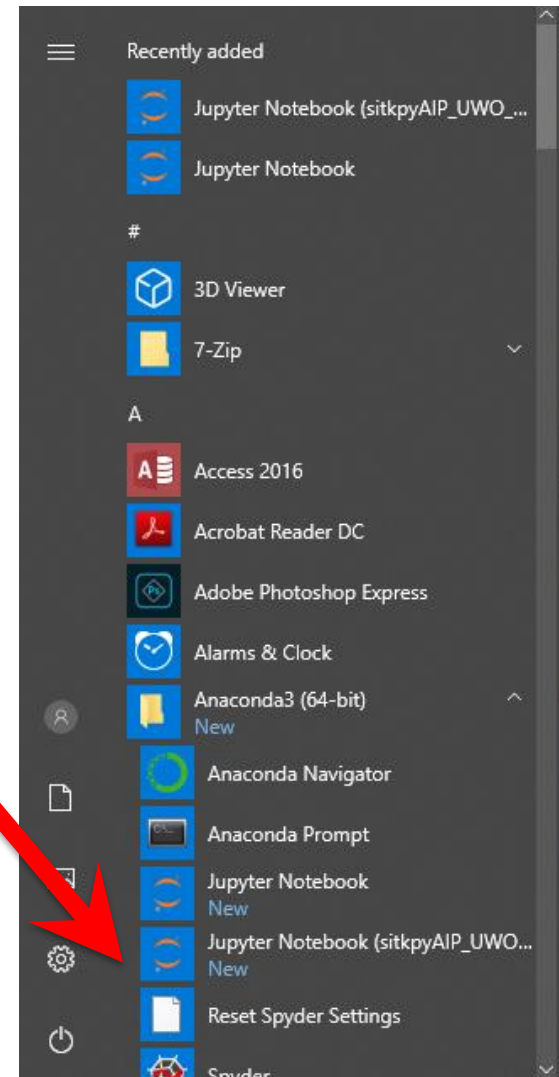
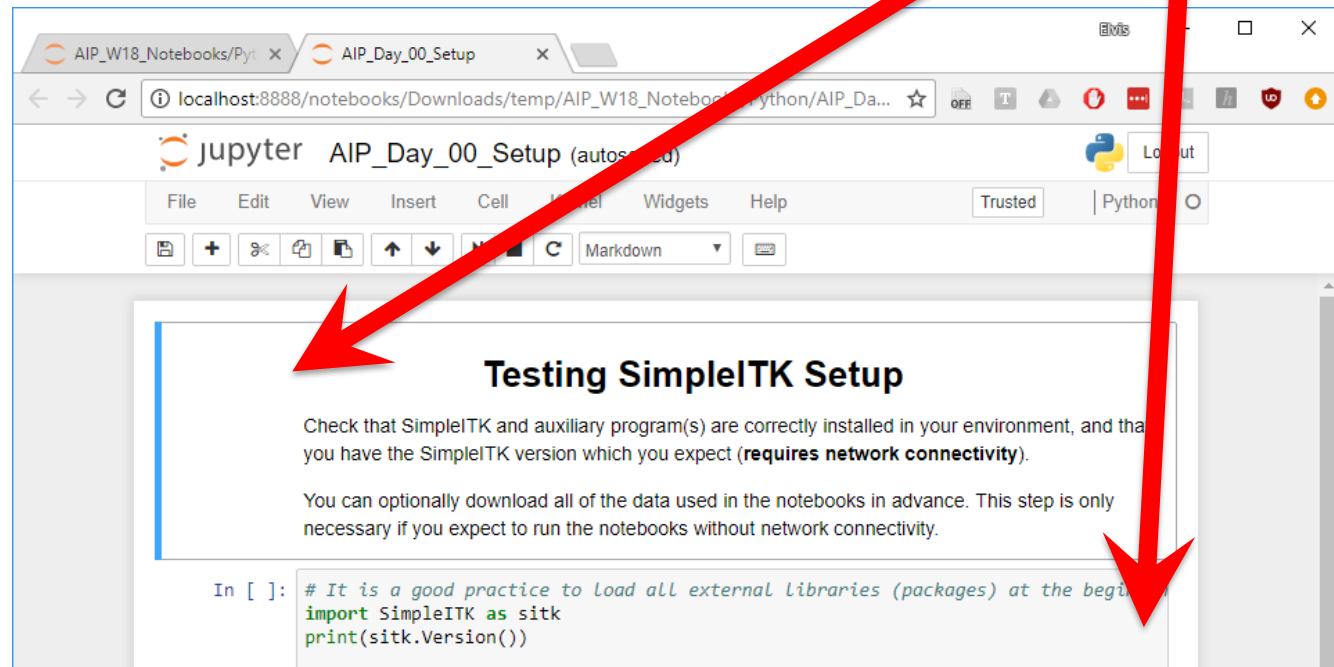# Jupyter Notebook interface

- Starts here

Jupyter Notebook interface
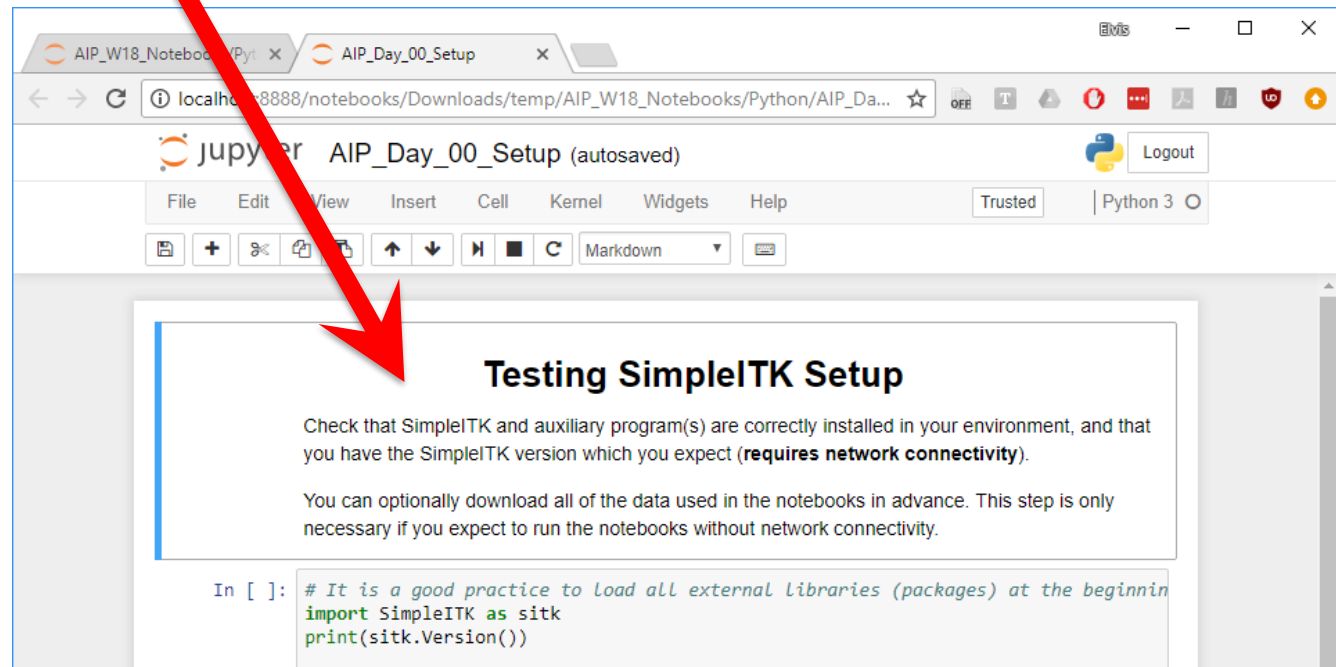
- Starts here

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Jupyter Notebook interface

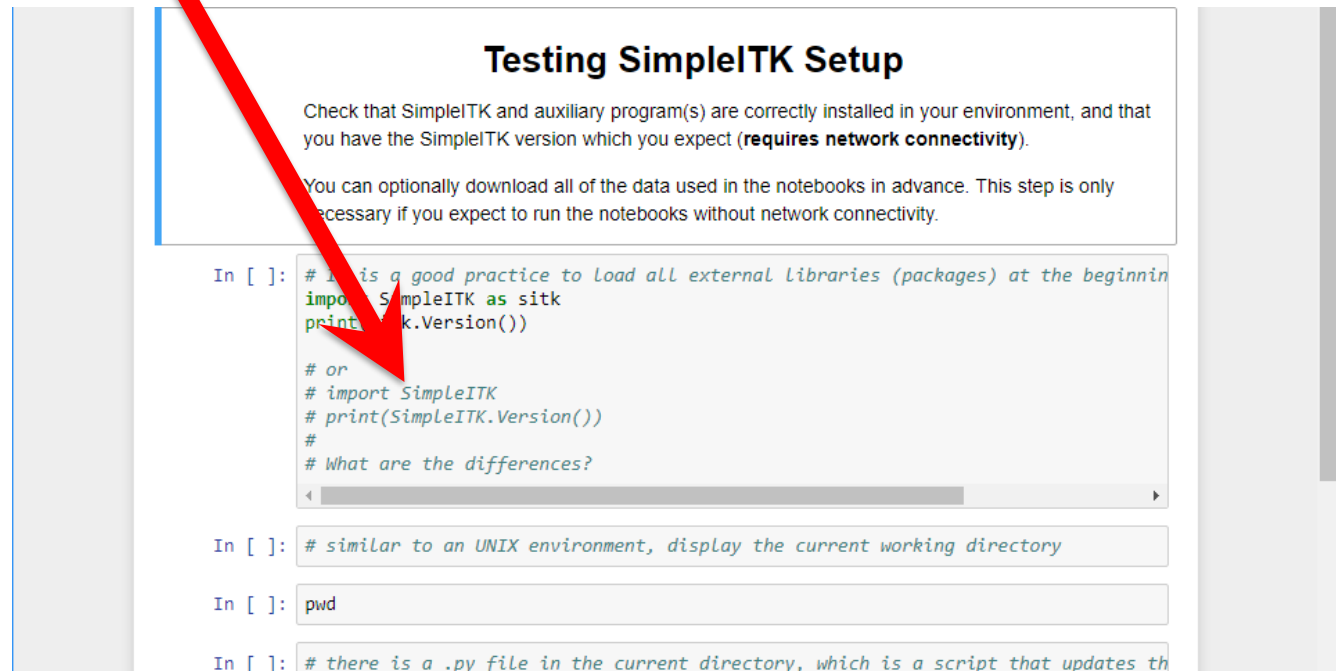- A notebook consists of a sequence of cells

Jupyter Notebook interface

- Markdown cells: rich text, a superset of HTML

Jupyter Notebook interface

- Code cells: edit/write code with syntax highlighting and tab completion

Moving on

- Now let's move on Jupyter Notebook
- Assume that you already have (Day 1 slides)
  - Installed anaconda and updated it
  - Installed git (within anaconda)
    - Git clone my Github repository
  - Created a SimpleITK environment
- We will now see if SimpleITK is installed properly
- If so, move onto Python tutorial

Questions/Comments

- Instructor
  - Elvis Chen, PhD, LEL
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- Teaching Assistant
  - Reid Francis Vassallo
  - rvassall@uwo.ca
  - 1hr/week, email for appointment