EE 290T High-dim Data Analysis with Low-dim Models
Homework 1, Due September 25, 11:59pm

Colab Instructions

We will use Colab (https://colab.research.google.com) as the platform for our programming exercises. Colab has several advantages:

1. It is a fully-functional python development environment, you do not need to bother any installation issues.

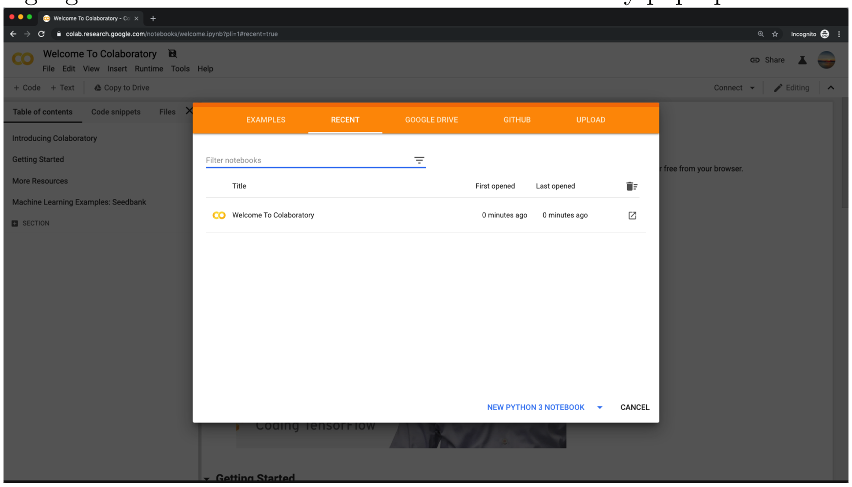
2. Using it make grading easier, avoiding results inconsistency due to version difference.

The goal of this homework is to get you familiar with colab as well as the format of data, which will be used in later homework. There is no heavy implementation burden.

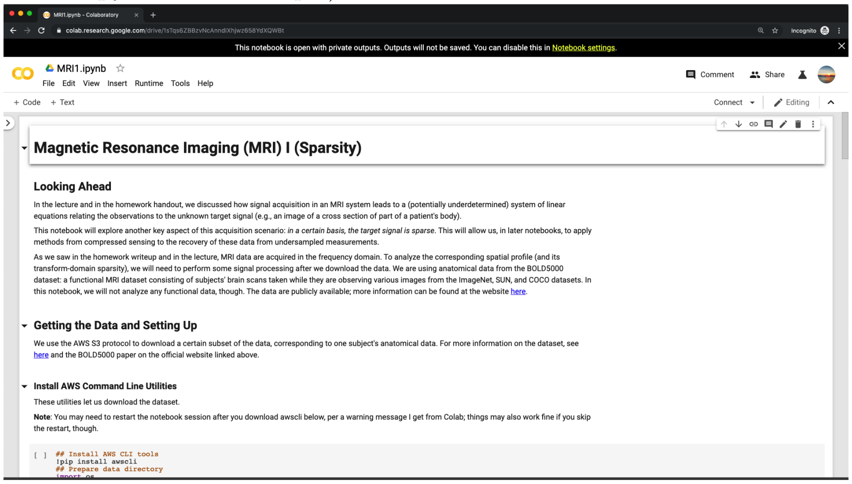
Download hw1_programming.zip from piazza's resources page. You will see two .ipynb files corresponding to each part of the homework.

Next we briefly introduce how to use Colab to open and setup our homework:

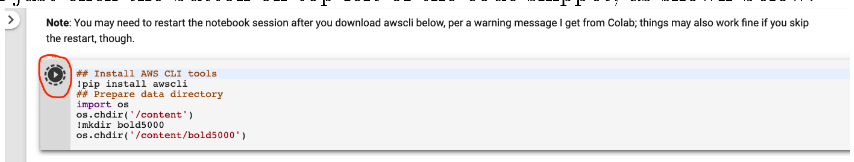
1. Open `https://colab.research.google.com` from your browser. Then sign in with your google account. Then one window will automatically pop-up:



2. Select Upload and upload any of the notebook from the homework folder (Here we show MRI.ipynb as an example).



3. The content will be automatically displayed. To run or execute one command, one can just click the button on top-left of the code snippet, as shown below.



Magnetic Resonance Imaging

In this demo, we study the wavelet-domain sparsity of anatomical MRI data from a real dataset, the BOLD5000 fMRI dataset. As we saw in the vignette presented in lecture, the signal acquired in MRI settings is the 2D Fourier transform of the relevant spatial slice of the object being imaged; the specific mathematical details of a modeling and analysis of this acquisition process are presented in the textbook. Compressive MRI[1] is a promising area of research that combines many of the interesting algorithmic advances we will discuss in this class with ingenious engineering to translate into key improvements in metrics that really matter for medical patients, such as time spent in the scanner, time spent holding one's breath, and more. This makes it one of the notable "success stories" for compressed sensing ideas making headway into engineering practice, and in this and later notebooks on this topic we will be able to get a good sense of the mathematical and algorithmic content that underlies these successes.

The focus in this demo is on understanding the data, and in particular the relationships between its representations in several transform domains (spatial, 2D Fourier frequency, and 2D discrete wavelet). Since, in this setting, the MR image is sparse in the *wavelet* domain but acquired in the *frequency* domain, there is a question of whether the composite acquisition map will have the properties necessary for us to perform recovery from underdetermined measurement maps. We will study this question in detail in the next homework: for now, we build our intuition about the data and the computational tools we need to manipulate it.

[1] See e.g., here.