COGS118C: Neural Signal Processing

Introduction & Course Outline

Lecture 1
July 1, 2019

Goals for Today

1. **Introduce ourselves & motivations**
2. **Course outline**
3. **Syllabus & course expectations**

Motivation

Why are you here?

…in the summer?

Brain Technology is **Awesome**

Brain Technology is **Awesome**

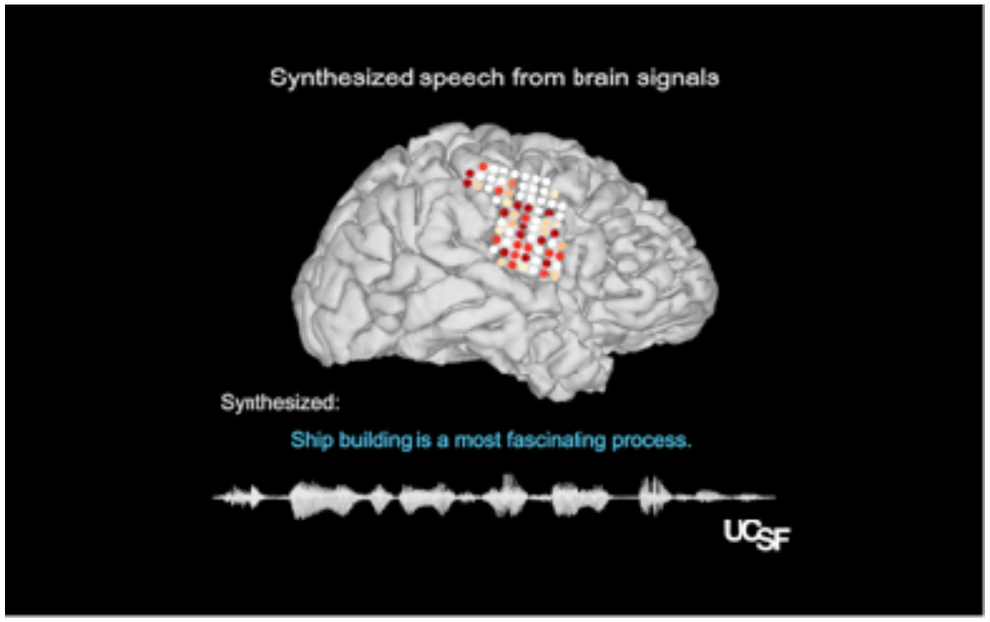
NEUROSCIENCE

Scientists Take a Step Toward Decoding Speech from the Brain

New study gets closer to restoring natural communication for those who cannot speak

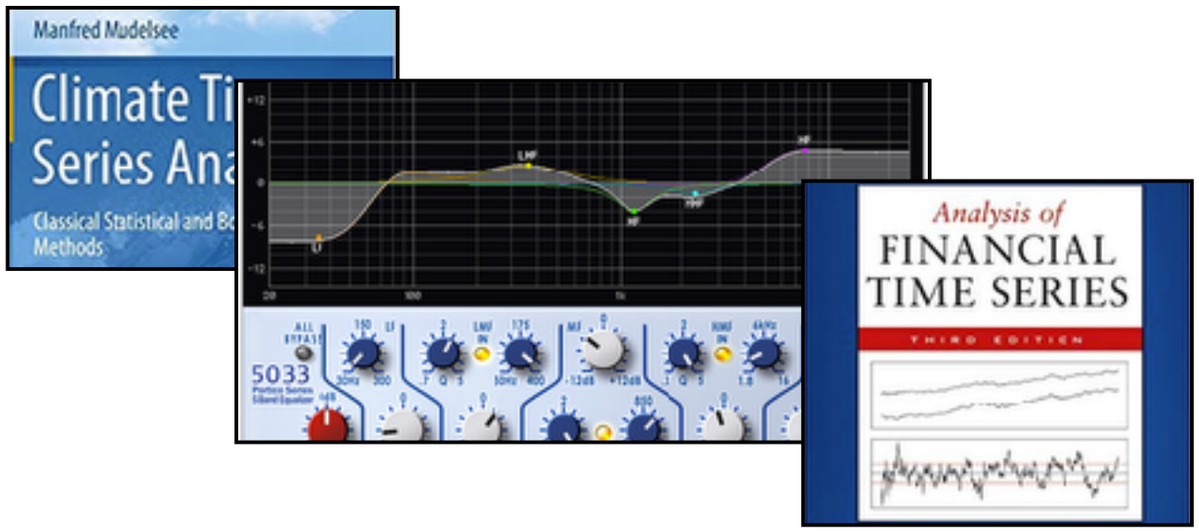
By Karen Weintraub on April 24, 2019

Brain Technology is **Awesome**



More Generally…

Time series *analysis* comprises methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. **Time series *forecasting*** is the use of a model to predict future values based on previously observed values. While regression



Brain signals represent a subset of signals called time series, which are just fluctuations over time. All the methods we will learn can be applied directly to other time series.

More Generally…

Torben's Technologically Outdated Blog

Some thoughts about neuroscience and other thoughts not about neuroscience

Home | Posts | Friends of the Blog | Me | Code

Friday, March 11, 2016

Trying Electrophysiological Analyses on Stock Market Data

In this post I'm going to analyze data from the stock market using some of the techniques that I typically use to understand brain data. I can't think of a very good reason for why this makes sense or why it should work... but I'm going to do it anyways and you can't tell me what to do.

What you get when you google "crazy stock market people"

Motivation

Why are you here?

4 min: Find a partner, and tell each other why you are here and what you hope to learn/accomplish.

8 min: Find another pair, convince the other pair why your partner's motivation is the **coolest**.

Pair think-pair-share activity: introduce yourself, share with a partner why you are here and what motivates you to take this class.

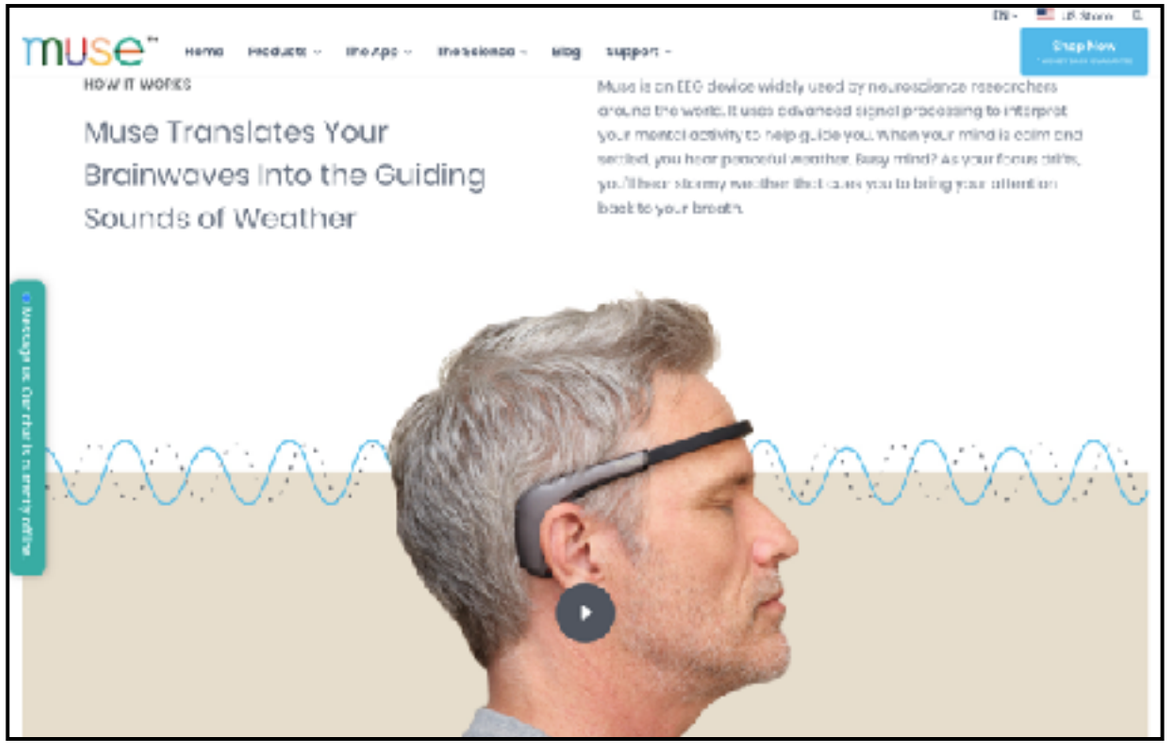
Then, find another pair, and convince the other pair why your partner's motivation is the coolest.

Who Am I?

Why am I here?

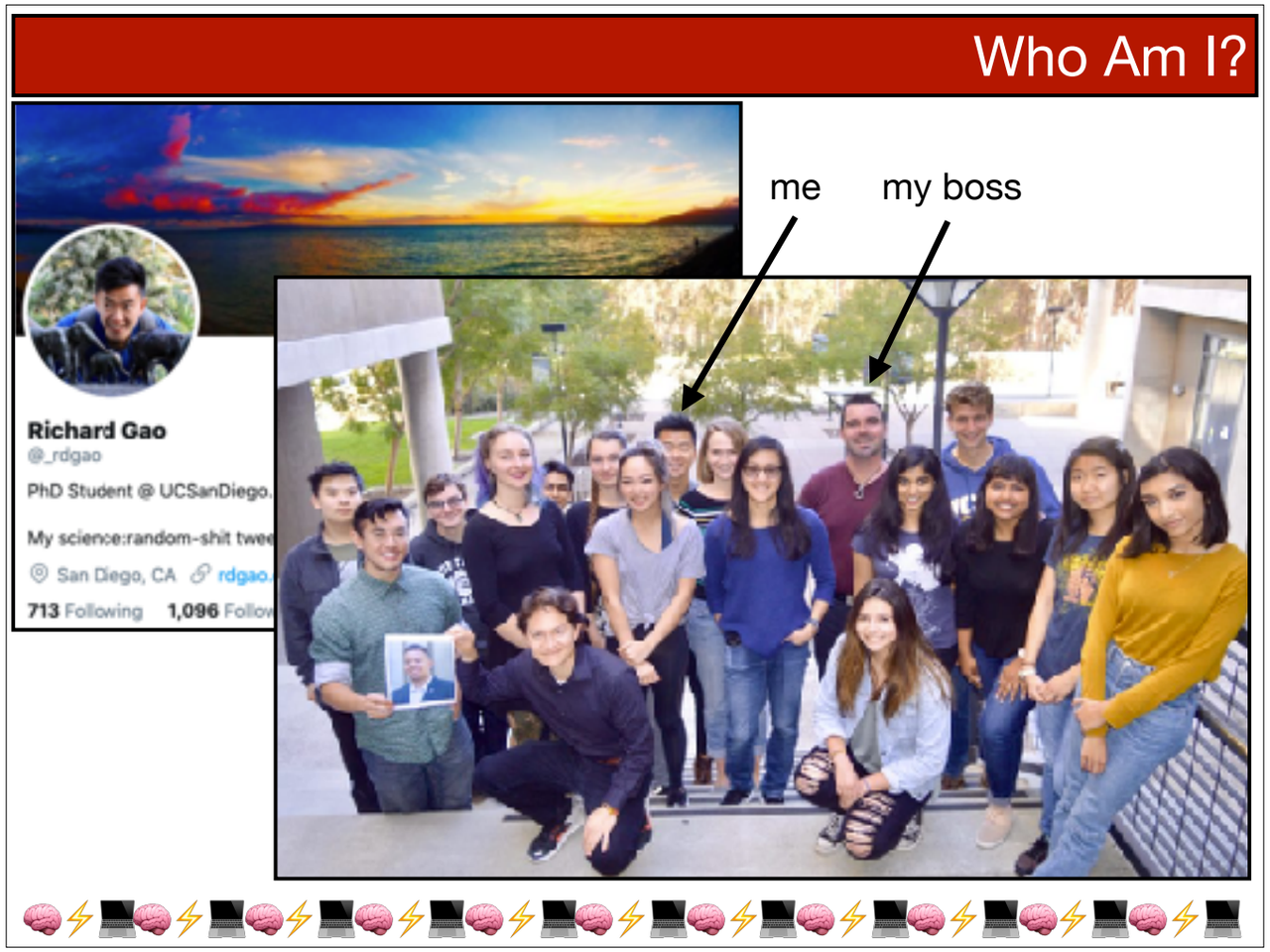
…in the summer?

Who Am I?



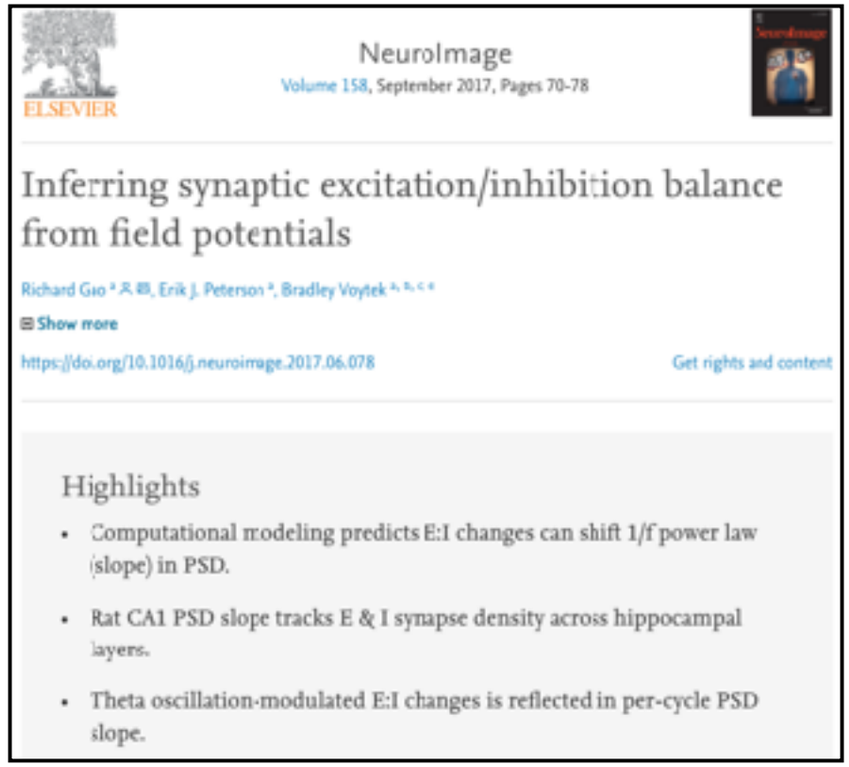
🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻🧠⚡💻

Preambling. Me from previous life at 4:00


Who Am I?
me
my boss
Richard Gao
@_rdgao
PhD Student @ UCSanDiego.
My science:random-shit twee
San Diego, CA
rdgao.
713 Following
1,096 Follow

Preambling.

Who Am I?



NeuroImage

Volume 158, September 2017, Pages 70-78

ELSEVIER

Inferring synaptic excitation/inhibition balance from field potentials

Richard Gao [a] [A] [B], Erik J. Peterson [a], Bradley Voytek [a, b, c, d]

Show more

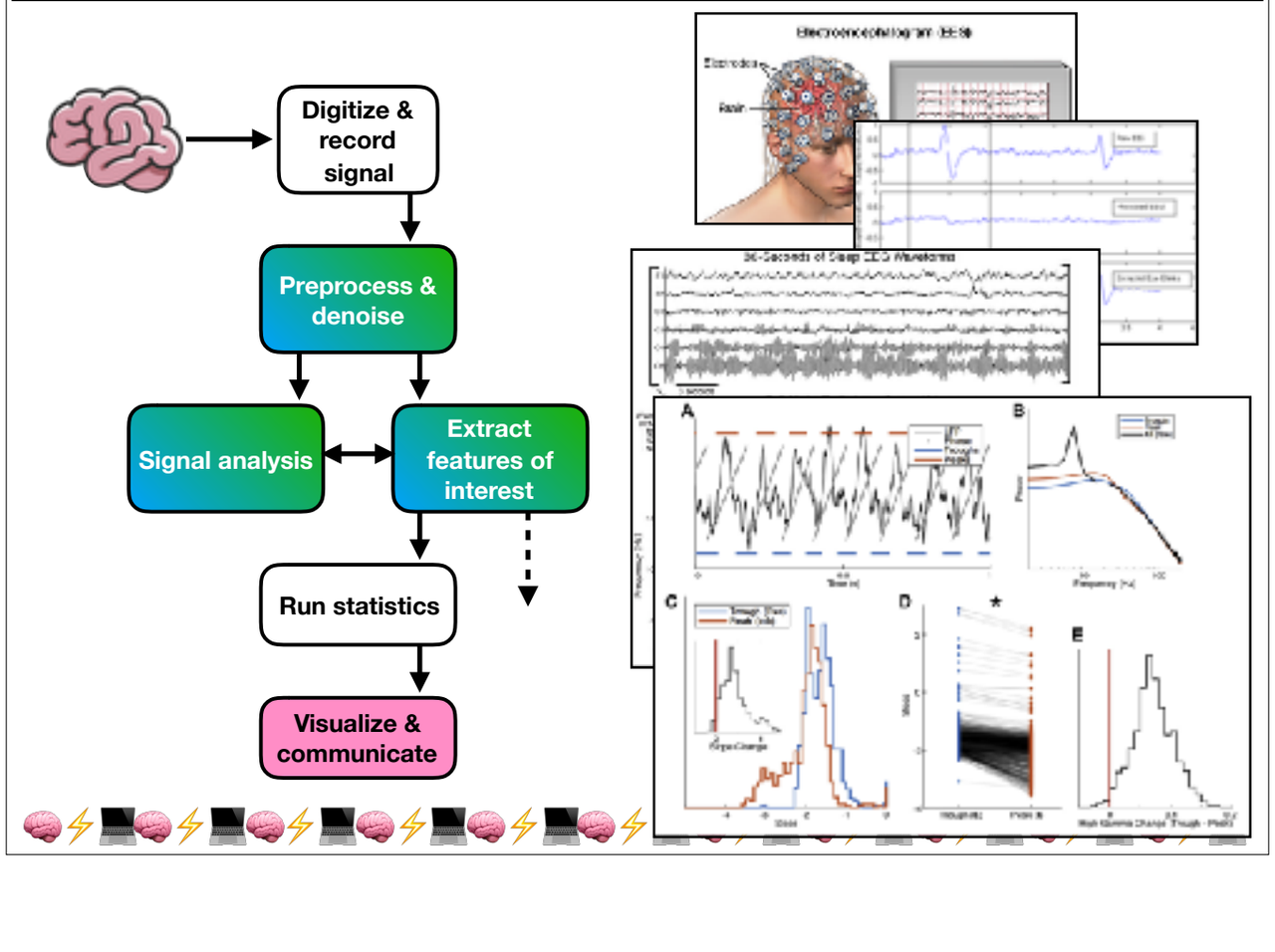
https://doi.org/10.1016/j.neuroimage.2017.06.078

Highlights

- Computational modeling predicts E:I changes can shift 1/f power law (slope) in PSD.
- Rat CA1 PSD slope tracks E & I synapse density across hippocampal layers.
- Theta oscillation-modulated E:I changes is reflected in per-cycle PSD slope.

More preambling.

Example of a Standard Processing Pipeline



Goal for the Course

Leave this course with

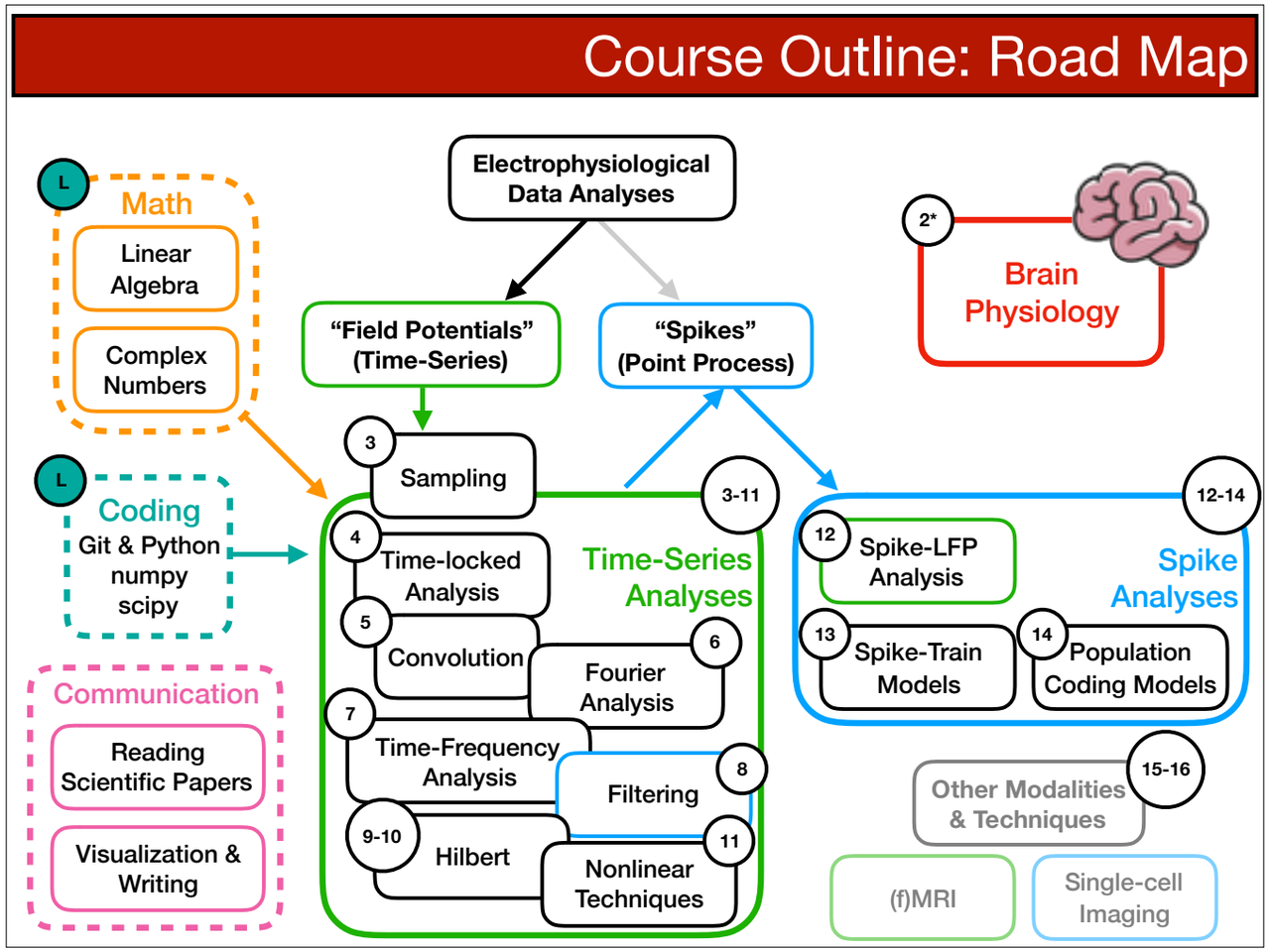
concrete and **demonstrable**

coding skills,

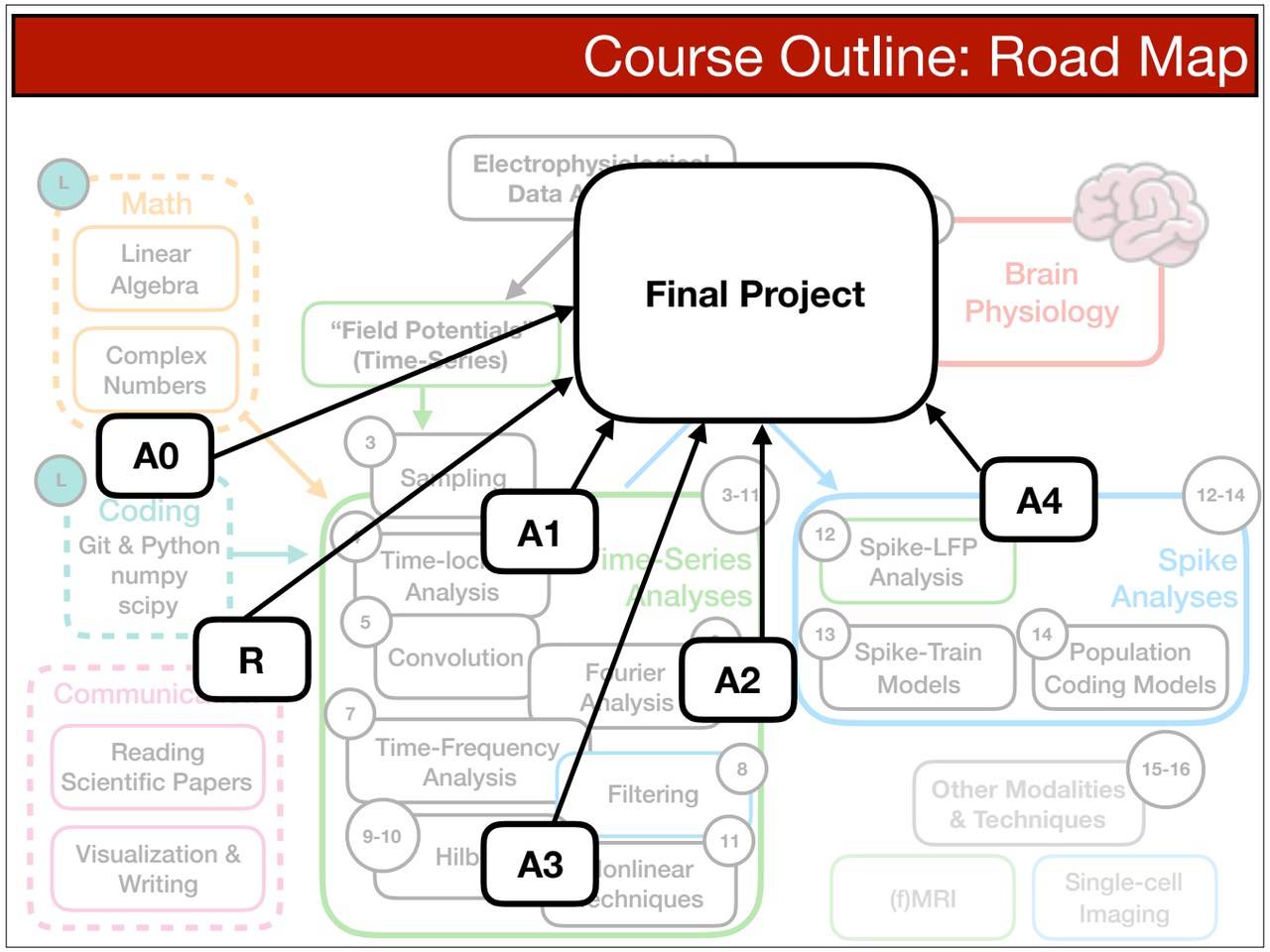
with the requisite **understanding** of

math and *physiology*,

for neural signal processing.



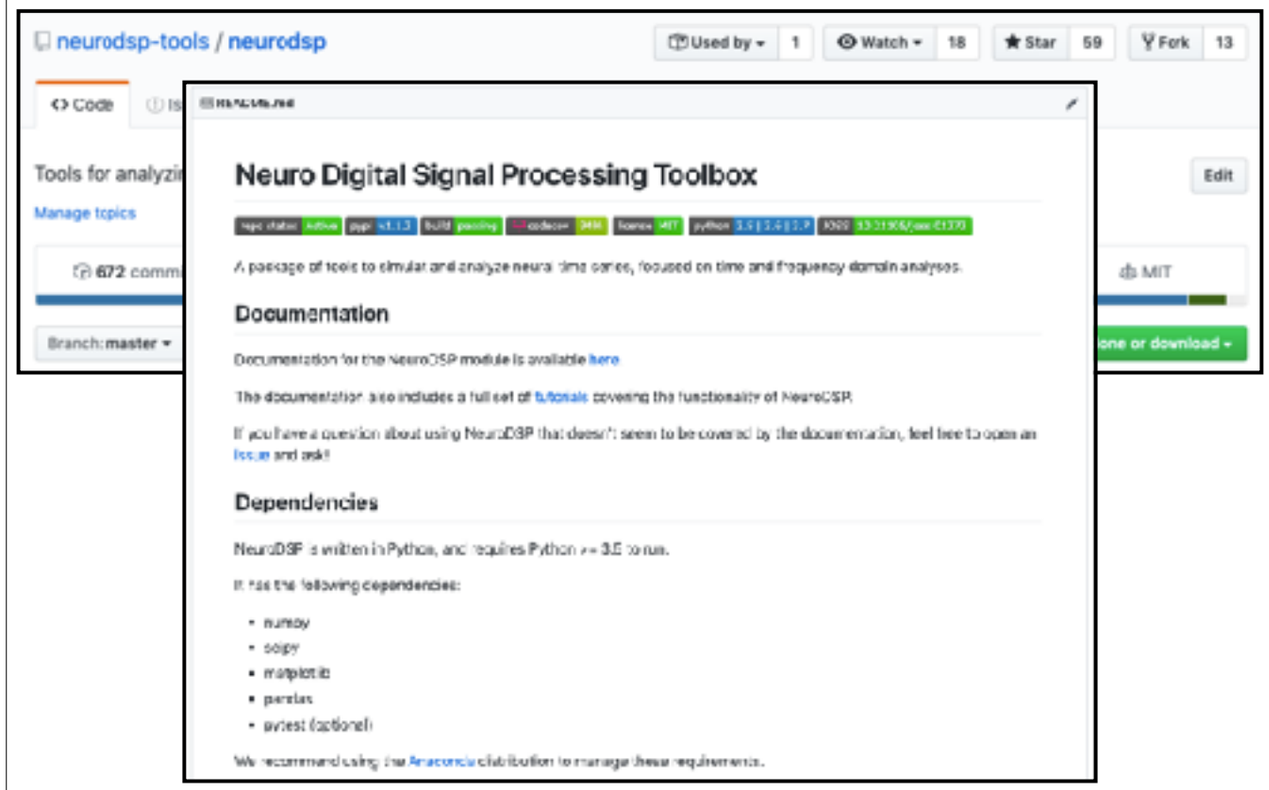
These are the progression of topics we will cover.



The assignments cover the building blocks of a (traditional) signal processing pipeline, each building on the next.
The readings show you examples of how to think about, visualize, and communicate real scientific findings.
All these things come together for the final project, where you reproduce the entire pipeline to demonstrate that you have a holistic understanding of, not just the technical skills, but the thinking and communication skills required.

Cash money. Or graduate school. Whatever floats your boat.

Programming Tools & Skills



Marketable portfolio of skills.

Syllabus

Week	Day	Date	Lecture	Topic
W1	M	1-Jul	L1	Introduction
	M	1-Jul	Lab1	**Tech Setup + Math Review + A0**
	T	2-Jul	L2	Neurophysiology & modalities
	W	3-Jul	L3	Time-series: sampling and ADC
	W	3-Jul	Lab2	**A1: time-series & epoch analyses**
	Th	4-Jul	HOLIDAY	
W2	M	8-Jul	L4	Epoch, averaging & trial-based analysis
	M	8-Jul	Lab3	**A1 + paper discussion**
	T	9-Jul	L5	Correlation & Convolution
	W	10-Jul	L6	Fourier analyses: FT, DFT, FFT
	W	10-Jul	Lab4	**A2: code your own Fourier Transform**
	Th	11-Jul	L7	Time-frequency analyses
W3	M	15-Jul	T1	**Test 1**
	M	15-Jul	Lab5	**paper discussion**
	T	16-Jul	L8	Filters & wavelets
	W	17-Jul	L9	Hilbert-based methods
	W	17-Jul	Lab6	**A3: code your own filter & Hilbert**
	Th	18-Jul	L10	Equivalence of kernel methods
W4	M	22-Jul	L11	Nonlinear TS methods ***
	M	22-Jul	Lab7	**paper discussion**
	T	23-Jul	L12	Spikes, physiology, and spike-LFP analyses
	W	24-Jul	L13	Spike train models
	W	24-Jul	Lab8	**A4: spike & LFP analyses**
	Th	25-Jul	L14	Population models & analyses
W5	M	29-Jul	T2	**Test 2**
	M	29-Jul	Lab9	**paper discussion**
	T	30-Jul	L15	Denoising and Statistical analyses
	W	31-Jul	L16	Other modalities ***
	W	31-Jul	Lab10	**Work period for project**
	Th	1-Aug	L17	Wrap-up
Finals	F	2-Aug	3-6pm	**Final project presentation**

Discuss syllabus (5-10 min)