TIMESERIES

10.20.2020

HOMEWORK 4

* due next week

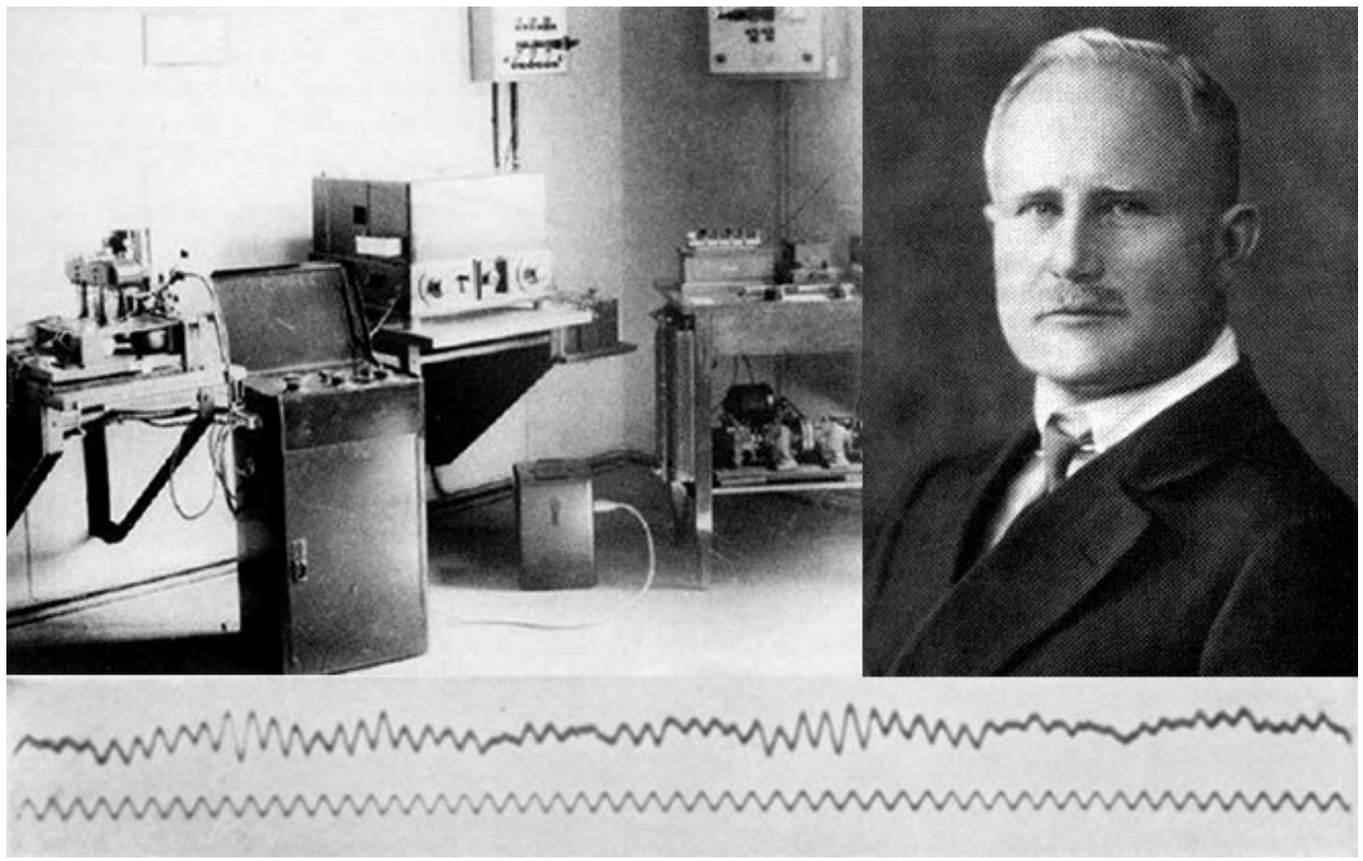
* you might want to start?

* the last problem will be ~ *f u n* ~

TIMESERIES

* lots of functional data (fMRI, EEG, neural recordings) are **timeseries**

Hans Berger:
inventor of EEG
& crackpot



TIMESERIES

* **MORE GENERALLY:** ***timeseries*** are what happens when data is recorded at fixed intervals in time

* e.g. in fMRI we usually get one data point every 2 seconds

* electrophysiological recordings (HW 3 data) get 20,000+ data points per second

TIMESERIES

* timeseries are not like other data

* timeseries are *special*

* timeseries have specific properties that should & must be accounted for in analyses

TIMESERIES

* what is it that makes timeseries special?

TIMESERIES

* it’s that data from nearby times are *related*

* *statistically:* each data point is not independent of the others

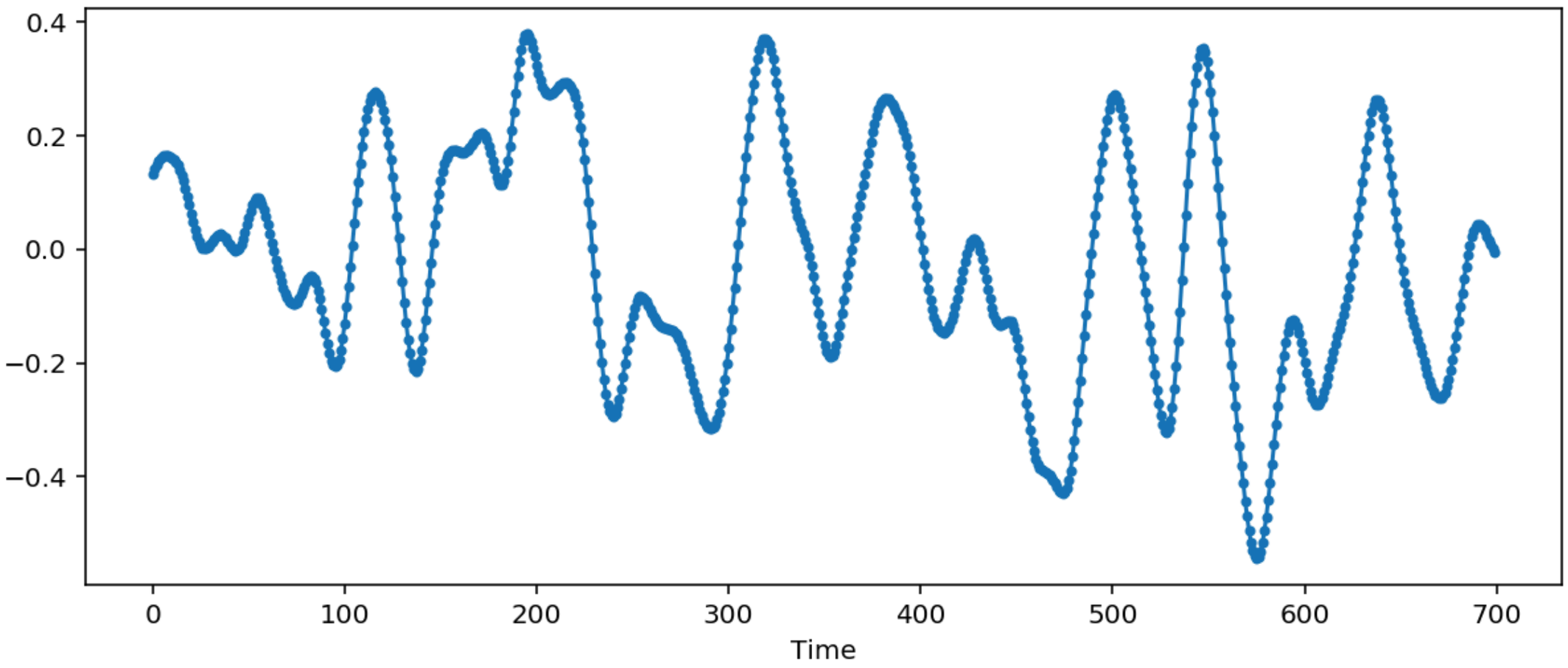
TIMESERIES

* the degree of relatedness often depends on *how close* two data points are to each other in time

* points that are very close are often very related

* points that are far away are usually not too related

AUTOCORRELATION



TIMESERIES TOOLS

1. Convolution

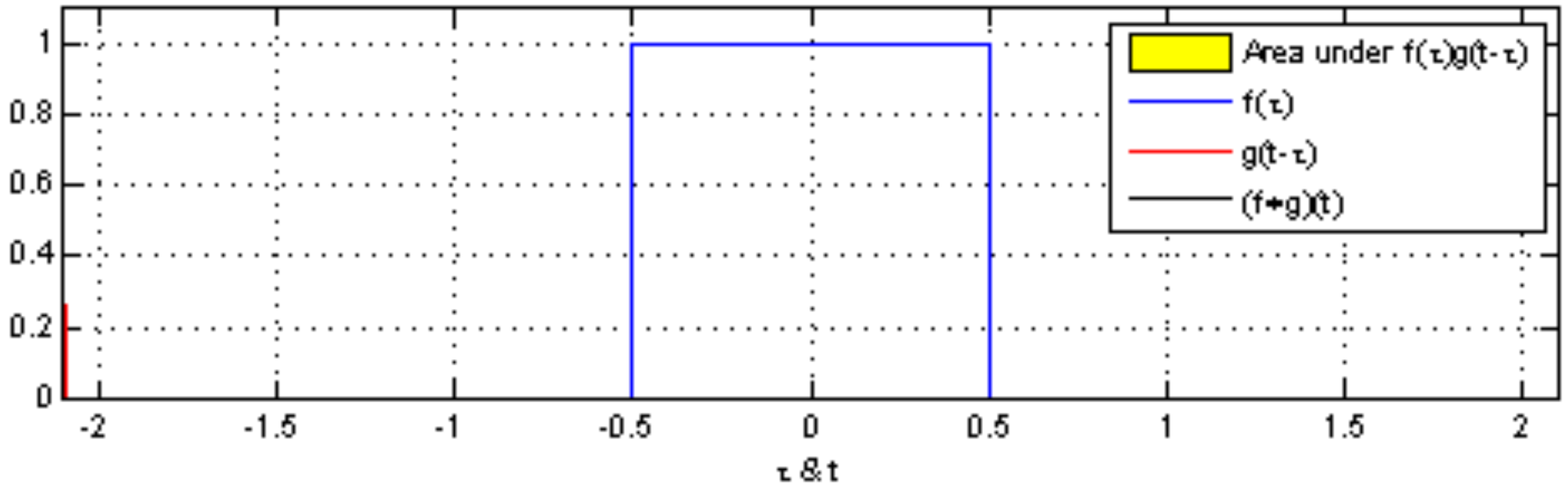
CONVOLUTION

* **convolution** is the most basic & important operation in timeseries analysis

* the convolution between f and g is defined as:

$$(f * g)[n] = \sum_{m=-\infty}^{\infty} f[m]g[n-m]$$

CONVOLUTION



from https://en.wikipedia.org/wiki/Convolution

CONVOLUTION

* *convolution is usually written with the star symbol *, but that's a bit confusing so I'll use this star ✶*

* often we will convolve a timeseries with a smaller array (called a **kernel**) to change something specific about the timeseries

CONVOLUTION

* *Example:* we could **convolve** a **timeseries** with a **kernel** that looks like this:

* kernel = [0.25, 0.25, 0.25, 0.25]

CONVOLUTION

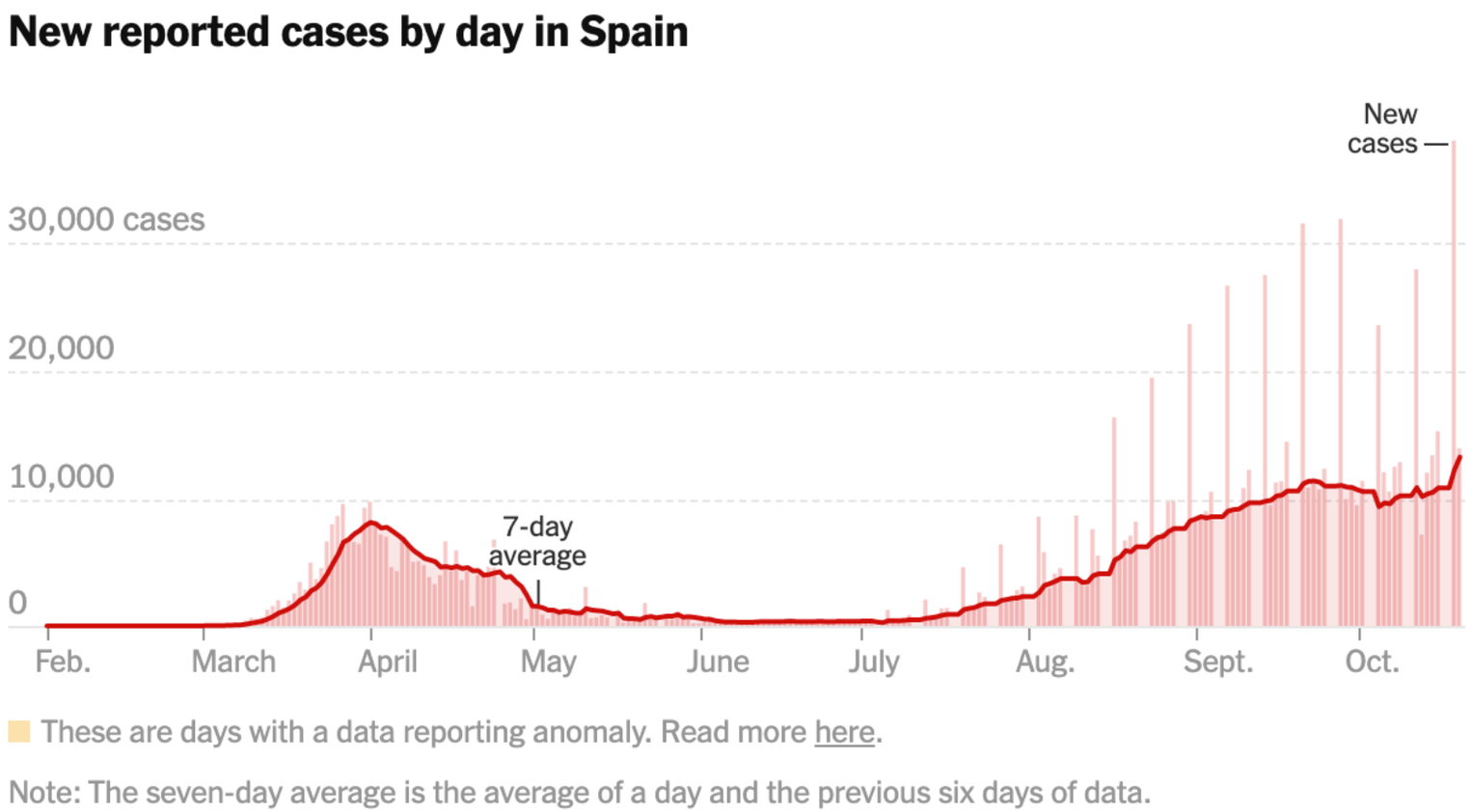
* *Example:* we could **convolve** a **timeseries** with a **kernel** that looks like this:

* kernel = [0.25, 0.25, 0.25, 0.25]

  * ^ this will take a running average of every 4 timepoints in the signal!

CONVOLUTION

* If you've been staring at the news as much as I have over the past few months, you've seen examples of this:

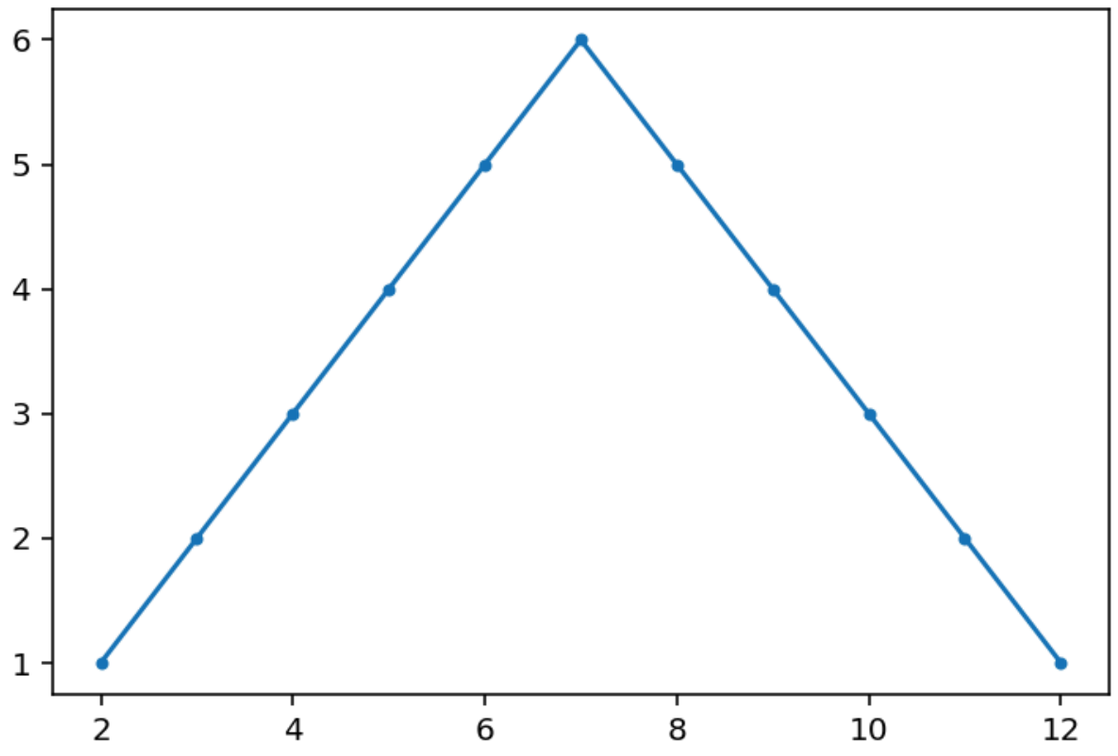


CONVOLUTION & STATS

* convolution is also important in statistics!
  * suppose X ~ U{1,6}, a random number in the range 1..6 (like throwing dice)
  * suppose also Y ~ U{1,6}
* what is the distribution of X + Y?

CONVOLUTION & STATS

* X + Y ~ U{1,6} ✶ U{1,6}, the convolution of the two probability distributions



CONVOLUTION & STATS

* generally, for the sum of any two random numbers, the distribution is the convolution of their two distributions

CONVOLUTION & STATS

* where else have we talked about adding together random numbers, and what happens to their distributions…?

CONVOLUTION & STATS

* by the central limit theorem, if you convolve *anything* with itself enough times, the result will be a gaussian distribution

NEXT TIME

* Fourier!

END