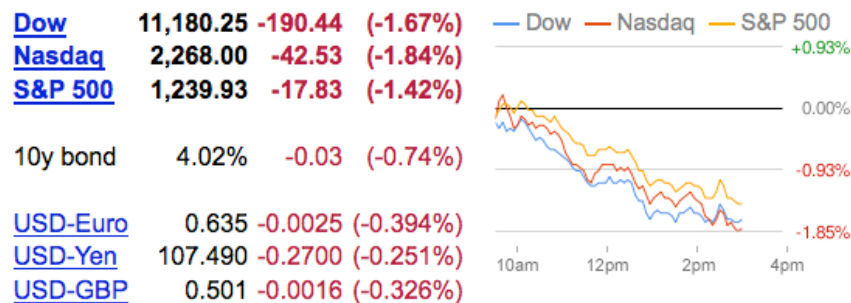**Day 1 WS 1 -- Overview and Introduction**

Introduction: Goals and Overview

About me (William Stein):

1. I am a professor whose main research area is **theoretical and computational number theory** (prime numbers, equations involving rational numbers, cryptography, Fermat's last theorem, the Birch and Swinnerton-Dyer conjecture).
2. I started the free open source **Sage mathematical software system** in 2005 and direct its development.
3. I am not so interested in money or "getting rich". I am very interested in understanding something deep about how financial markets work since they have such profound implication for my life (and yours!). For this there is only one real test of understanding.

Financial Time Series

This is a workshop about the financial time series that stock markets generates, like this one:

and this one...

The Dow Jones Industrial Average from 1920 to 2008

Or this very famous one:

```
dji = load('http://sage.math.washington.edu/home/simuw/simuw08/data/sobj/DJI.sobj')
```
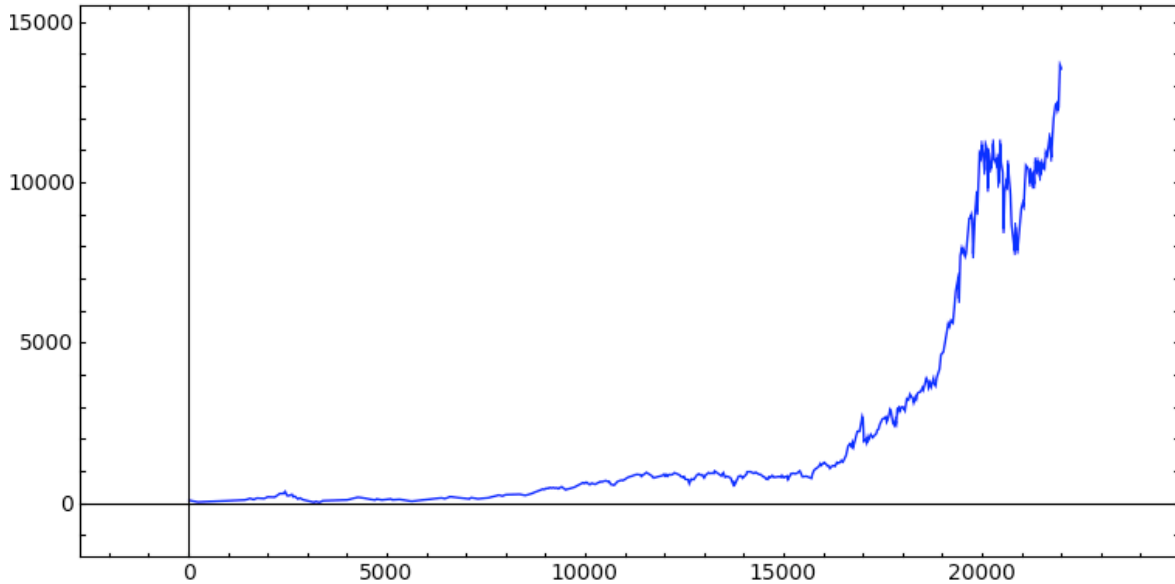
```
    Attempting to load remote file:
    http://sage.math.washington.edu/home/simuw/simuw08/data/sobj/DJI.sob\
    j
    Loading: [.......]
```

```
dji.plot().show(figsize=[8,4],frame=True)
```

The DJI is a stock market index that is a weighted average of 30 of the largest and most widely held public companies.

The above picture is **very famous** -- it's the Mona Lisa of quantitative finance.


Plotting the logarithms of prices shows the famous stock market crash of 1929 (Oct 24-29, 1929) much more clearly. This was the most devastating stock market crash ever in the US. **The Dow did not return to pre-1929 levels until late 1954!**

```
dji.log().plot().show(figsize=[8,4],frame=True)
```
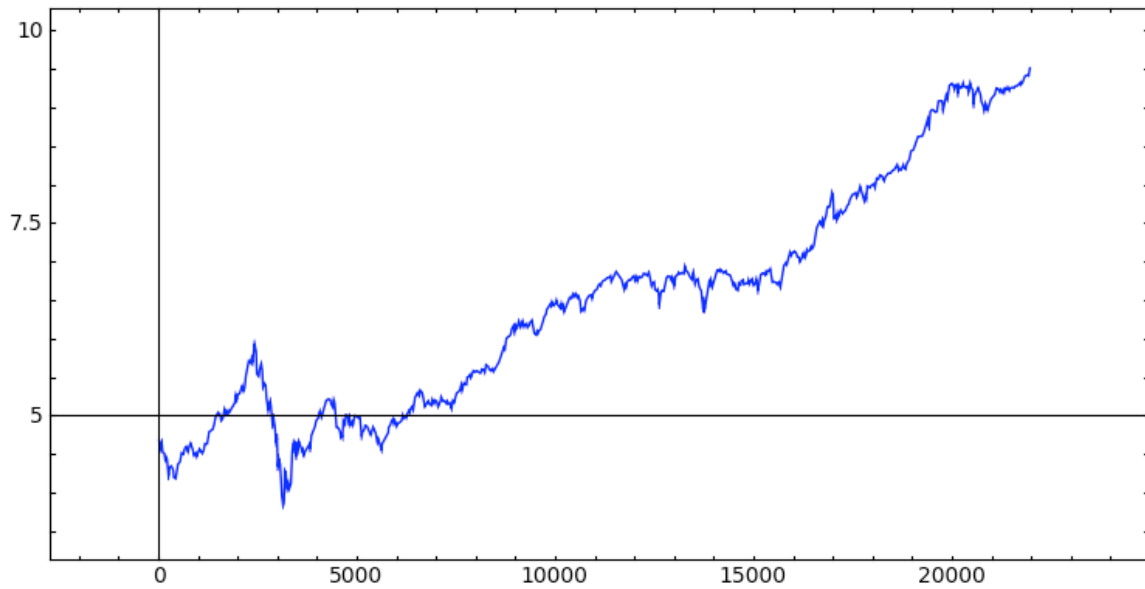
Also [see the Wikipedia page on the 1987 crash](#), which was the worst single-day crash ever.

Dow Jones (19-Jul-1987 through 19-Jan-1988)
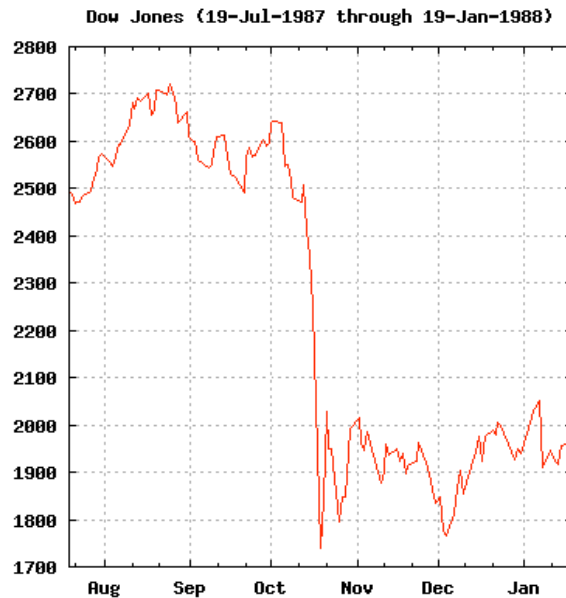
Goals of this SIMUW course

1. Using **Sage** for basic statistics, data visualization and acquisition.

2. Get a "feel" for the **stock market**.
3. Understand **Mandelbrot's Multifractal Model of Asset Return** (key point: stock market crashes are inevitable)
4. Learn about **Hidden Markov Models**: a brilliant general technique for machine learning and inference
5. Combining Multifractals and Hidden Markov Models

Thus this course will be very nontraditional and will focus on **two key ideas** that are seemingly strongly at odds with each other, and how to combine them:

- Multifractals
- Hidden Markov models

We emphasize that this is **not** a course about how to make money by investing in markets. For that, one would consider a *much* wider range of instruments: derivatives (options), currency ratios (FX), bonds, etc. On the last day I'll have a professional come in to talk about that sort of stuff. Also, this course is completely **technical** -- we will not bother at all with **fundamental analysis**, since that's not where the interesting mathematics is.

That said, please **tap into both your greediness and curiosity** in order to better motivate your interest in the material we will cover.