Working with Sequential Data Session 1

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- **Why are we here today?**

Introduction

Organizational

Overview

- German Mexican national.
- Bsc. in Business Informatics, Hons. deg. in Technology Management
- Master's degrees in International Management Masters Big Data Systems.
- Internet entrepreneur with an exit.
- 6 years leading data teams, 3 years as software engineer.

Companies & institutions where I have been affiliated:

Technische Universität München

National University of Singapore

TEL AVIV UNIVERSITY אוניברסיטת תל אביב

experteer ROCKETINTERNET lamoda PHILIP MORRIS INTERNATIONAL

Introduction

Organizational

- **For whom is this course?**

Introduction

Organizational

- **Who are you?**
- Write on notecard your
  - Name
  - (If applicable) preferred form of address (nickname, etc)
  - Study program
  - Previous math and stat classes
  - Previous programming experience
    - Used Python before? A lot, a little?
    - Other languages or skills (Excel, R, etc)
  - Application area(s) of interest
    - Finance, macro, marketing, tech, something else?

Course info

Organizational

- See syllabus

Why we need forecasting?

Making Forecasts

- Planning ahead is a key component of prudent decision making
- Businesses and governments make investments and strategic decisions whose value will depend on the situation they face in the future.
  - A firm which acquires too much inventory relative to sales will have spent extra on product which does not sell
  - A firm which acquires too little leaves profits on the table.
- An investor who buys when the price will go down will lose money, as will one who sells when the price will go up.
- A government agency which makes preparations for one event may find itself flatfooted if a different event happens instead.
- A college student who chooses one major, in anticipation of plentiful and remunerative employment opportunities, may end up rewarded or deeply disappointed after graduation depending on whether those opportunities indeed arise.

Why we need forecasting?

Making Forecasts

- In all these situations, and many more, it is crucial to have a good guess of what will happen in the future
- Of course, most of the time, one cannot know the future with certainty
- The world, and our understanding of it, is subject to change, in ways both gradual and sudden
- What can be done in this situation is to use, to the best of our ability, whatever limited knowledge and understanding we do have of the situation, along with principled reasoning, to make the best guesses we can.
- The task of forecasting is to formalize this process, devising reliable methods to come up with high quality guesses that can be used as an aid to planning and decision making.

Why we need forecasting?

Making Forecasts

- There is no one perfect and universally applicable way to predict the future,
- We will introduce some of the principles by which forecasts can be produced and evaluated
  - Focus on ideas and methods applicable to economic and business decisions
- More specifically, on those which actually have been and continue to be applied in these situations
- Practical examples will be used to illustrate
- Applications
  - Technology, finance, marketing and sales, macroeconomics and more.
- Discussion will be (fairly) quantitative
- Concentrate on numerical quantities observed repeatedly over time
  - Company or unit level outcomes,
  - Prices in financial and other markets
  - And other sequential data

Forecasting

- Modern forecasting practice draws from a variety of disciplines
  - Statistics, econometrics, machine learning, optimization,
- Forecasting has distinctive goals, methods, and origins.
- Focus will not be on the "prediction" setting of machine learning
  - One observes many units of the same kind of object (customers, documents, photographs, etc)
  - Goal is to determine some information about unobserved units by using the information about the observed units.
- Also different from statistical or econometric Time Series analysis,
  - Seeks to learn about properties of data observed over time.
- Ideas and tools from these areas will be extensively discussed and applied
  - But due to distinctive goals and methods, many results from these other fields not applicable

Depiction of the Pythia (Oracle) at Delphi, ca. 330 BCE. Source: British Museum, courtesy Wikipedia

- The Ancient Greeks would consult the Oracle to hear predictions about future events.

Depiction of the Pythia (Oracle) at Delphi, ca. 330 BCE. Source: British Museum, courtesy Wikipedia

- While the goal of learning about the future is long held, forecasting methods have changed substantially over 2500 years.

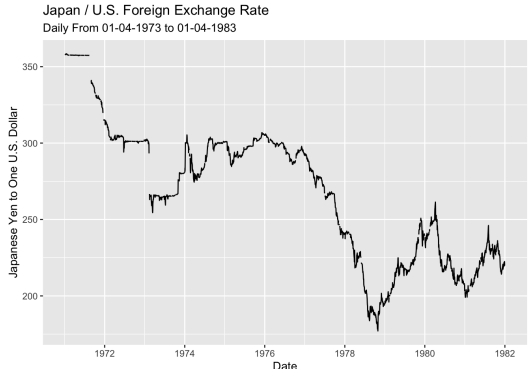
Real World Forecasting Examples

- To motivate and illustrate the methods and models that will be discussed, we will look at a variety of applications where forecasting methods have been applied. Different applications have unique features which motivate particular approaches, but at the same time illustrate principles that can be applied in other cases.

Exchange Rates

Real World Forecasting Examples

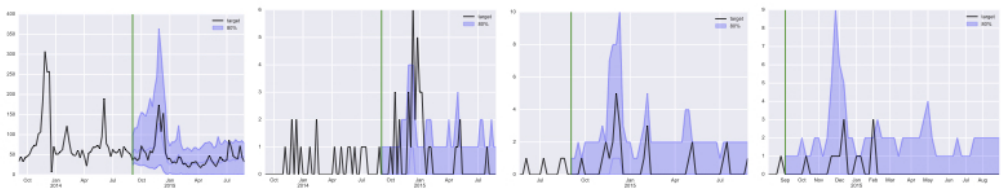
- Any firm or financial institution which transacts internationally may be exposed to financial losses due to changes in exchange rates, and national and international economic policy makers keep close track of these series. Forecasting these changes has proven to be a particularly difficult problem, illustrating many of the peculiar challenges of forecasting economic data.



Product Sales

Real World Forecasting Examples

- Amazon sells hundreds of thousands of products in dozens of categories, and employs a team to forecast sales, using both product-specific and shared information.

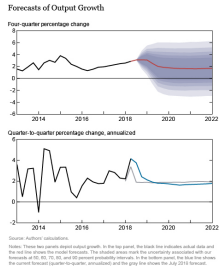


Weekly observed and forecast sales for 4 of over 500,000 products on Amazon. Source: Flunkert et. al. (2017)

Macroeconomic Forecasting for Policy

Real World Forecasting Examples

- National banks contributes to decision-making in and execution of monetary policy.
- Researchers incorporate economic theory, statistical principles, and individual judgment, to produce staff forecasts of inflation, output, and other macroeconomic variables relevant to monetary policy.

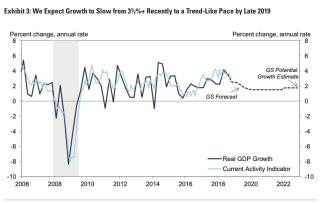


Model-based forecasts of GDP growth from FRBNY from October 2018 Source: Cai et al (2018), Liberty Street Economics

Macroeconomic Forecasting for Finance

Real World Forecasting Examples

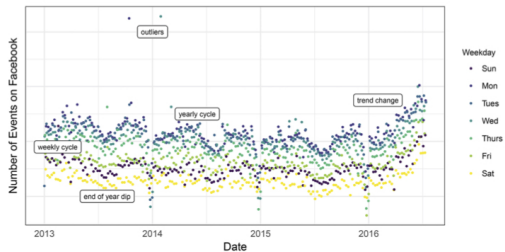
- Investment banks employ large teams of economic and financial experts to follow and predict the global economic situation to guide investment opportunities for themselves and their clients.
- Reliably forecasting multiple macroeconomic series is one part of this task, and one to which a former Goldman Sachs Chief Economist made important contributions.



Goldman Sachs Economic Outlook Report GDP Forecast, Nov 2018 Source: Hatzius et al (2018)

Web Activity

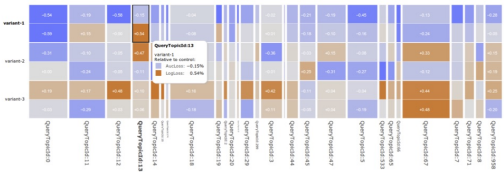
- Major internet companies like Facebook have both cost and revenue streams closely tied to patterns of traffic to their websites, which are monitored and forecast continuously
- The scale and frequency of the data have led to unique challenges and solutions from their internal forecasting team.



Events created per day on Facebook, with commentary on data features. Source: Taylor & Letham (2018)

Ad Auctions

- Google derives most of its revenue from advertising sales on keywords, sold by auction.
- This process involves using billions of different characteristics to predict the value of diverse advertisements to contribute to an automated system that generates and applies predictions in real time in an automated fashion.
- The methods used for this task involve innovations not only in the implementation but in the foundational principles of how and why to perform forecasting.

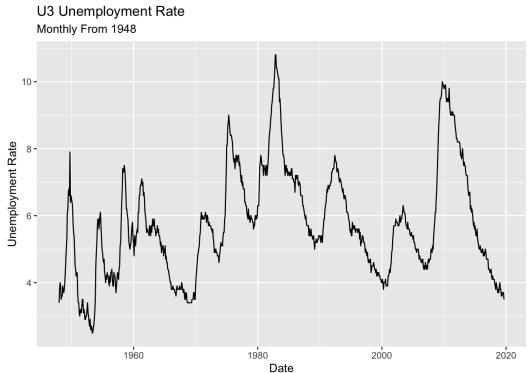


Tool for display of ad click model performance used internally at Google. Source: McMahan et al (2013)

Monthly Unemployment Releases

Ad Auctions

- Due to its frequency and economic importance, this is the most tracked regular economic data release
- Policy makers and market participants spend considerable effort to forecast the outcomes, which can move asset returns and policy decisions.



Questions?

- Anything unclear?
- Curious about something?

Break

- **15 minutes break**