

# Introduction to learning, multiple and nonparametric regression


Machine Learning

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# Course details

Basic info:

- **My email:** [js.fi@cbs.dk](mailto:js.fi@cbs.dk) or [jonas.striaukas@gmail.com](mailto:jonas.striaukas@gmail.com)
- **Lecture time:** TBA
- **Auditorium:** TBA
- **Office hours:** TBA
- **Course website:** [https://jstriaukas.github.io/ml\\_course](https://jstriaukas.github.io/ml_course) 

Exam:

- **Structure:** TBA
- **When:** TBA

What I expect from you:

- ▶ Understand the concepts we learn in the class. In particular derivations of some simple theoretical results as well as full understanding of more complex theory.
- ▶ Be creative, active during class presentations and work hard! And try **not** to miss classes...

# Machine learning, computing, etc.

“The purpose of computing is **insight**, not numbers.”

*Richard Hamming*

# Topics

- Introduction to learning, multiple and nonparametric regression
  - ▶ BLAH BLAH
- High-dimensional linear regression
  - ▶ BLAH BLAH
- High-dimensional regression properties and generalized linear models (GLMs)
  - ▶ BLAH BLAH
- Prediction, loss functions and M-estimators
  - ▶ BLAH BLAH
- Introduction to deep learning
  - ▶ BLAH BLAH
- Introduction to causal machine learning
  - ▶ BLAH BLAH

# Learning, multiple and nonparametric regression

## Big data

Nowadays, Big Data are ubiquitous: from the internet, biology and medicine to government, business, economics, finance, ...

Some quotes:

- *“There were 5 exabytes of information created between the dawn of civilization through 2003, but that much information is now created every 2 days”*, according to Eric Schmidt, the CEO of Google, in 2010.
- *“Big data is not about the data”*, according to Gary King of Harvard University.

Do we need ML or even AI to understand economics and/or finance data?

- ▶ **Yes!** ML is not that different from classical econometrics... “Black-box” deep learning is not that black box after all...

# Learning, multiple and nonparametric regression

## Big data – examples

Examples in economics and finance:

- ▶ high-frequency financial assets data (e.g., stocks, bonds, fx, derivatives, ...);
- ▶ large panels of economic data (e.g., 131 macroeconomics time series (McCracken and Ng, 2015) with [FRED MD](#) database with monthly updates);
- ▶ spatial data (e.g., state-level data in US, euro area data);
- ▶ text-based data (e.g., newspaper articles, [GDELT project](#); [EC news data](#)).

# Learning, multiple and nonparametric regression

## Impact of Big Data & dimensionality

Problems associated with Big data:

- Data are collected from various sources and populations  $\implies$  **heterogeneity**;
- typically large numbers of variables are collected  $\implies$  some variables are **heavy-tailed**, i.e. have high kurtosis which is much higher than the normal distribution;
- incidental **endogeneity** due to high-dimensionality  $\implies$  huge impact on model selection and statistical inference (Fan and Liao, 2014);
- computation/optimization of model parameters  $\implies$  **convexity** so far is a way out to guarantee the stability of solutions;
- **noise accumulation** and **spurious correlation** has a large impact on model selection  $\implies$  high-dimensional statistics methods.

For curious students: see Fan, Han, and Liu (2014) for an overview of how these features impacts the developments of big data analysis techniques.

# Learning, multiple and nonparametric regression

## Spurious correlations – examples



# Learning, multiple and nonparametric regression

Spurious correlations – some explanation

# Learning, multiple and nonparametric regression

## Statistical learning theory

According to Bickel (2008), the main goals of high dimensional inferences are:

- to construct a method as effective as possible to predict future observations and;
- to gain insight into the relationship between features and responses for scientific purposes, as well as, hopefully, to construct an improved prediction method.