

Chapter 0 – Introduction

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Motivation

There is a growing interest among applied economists in using machine learning models for applied economic analysis

- ▶ Accurate forecasting of economic and time-series variables (Moritz and Zimmermann 2016)
- ▶ Non-parametric tools for estimation (Belloni et al. 2012) and inference (Athey and Imbens 2016)
- ▶ Modelling of previously inaccessible data for economic analysis (Mueller et al. 2021; Combes et al. 2023)

Motivation

Neural networks represent the best-performing approach to image and language modelling (LeCun et al. 2015)

- ▶ Mapping high-dimensional data structure into lower-dimensional representations (Bengio et al. 2013)
- ▶ Latent representations encode large amounts of information, disentangling sources of variation
- ▶ Powerful numerical properties, e.g., locally generalizable, distributed, hierarchical, disentangled

Motivation

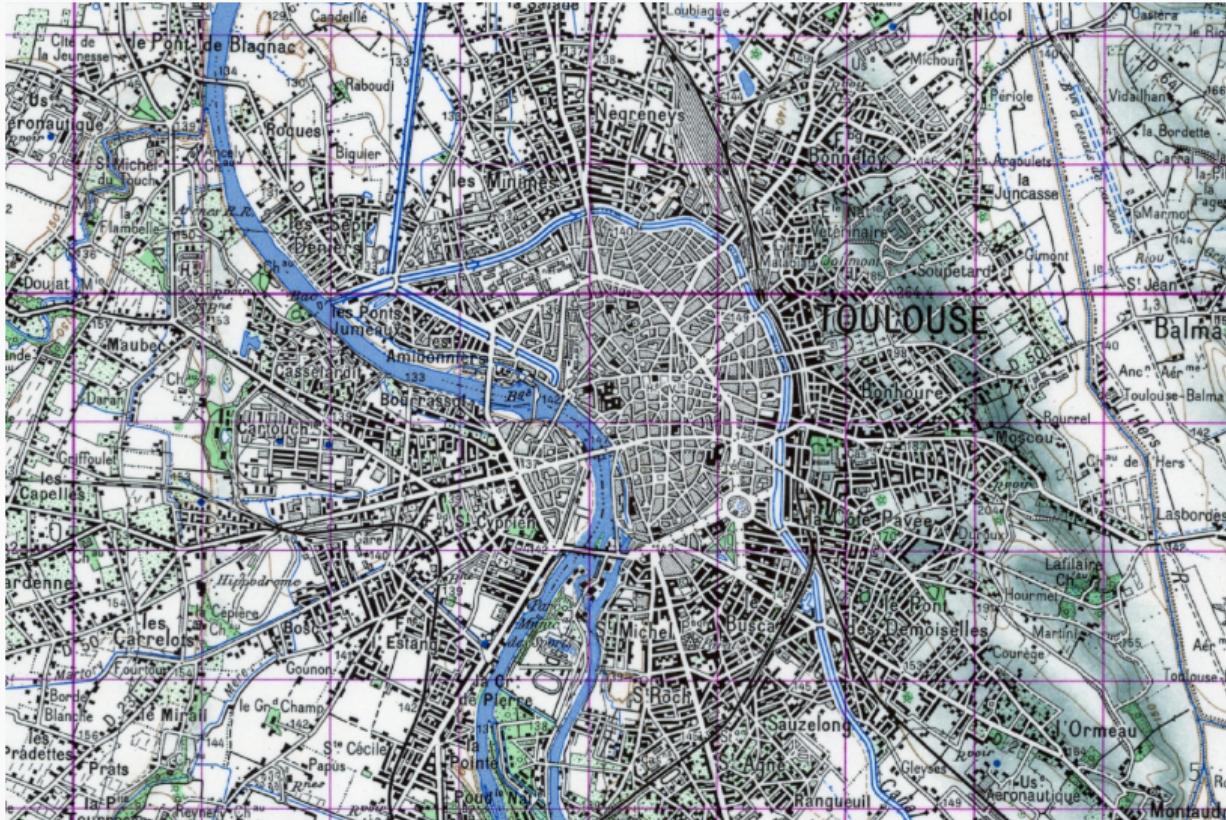
This course introduces neural networks with a language and approach familiar to economists

1. Provides a comprehensive understanding of neural network models and their optimization
2. Introduces some of the most capable supervised approaches to images and language modeling
3. Articulate intuition and formalization

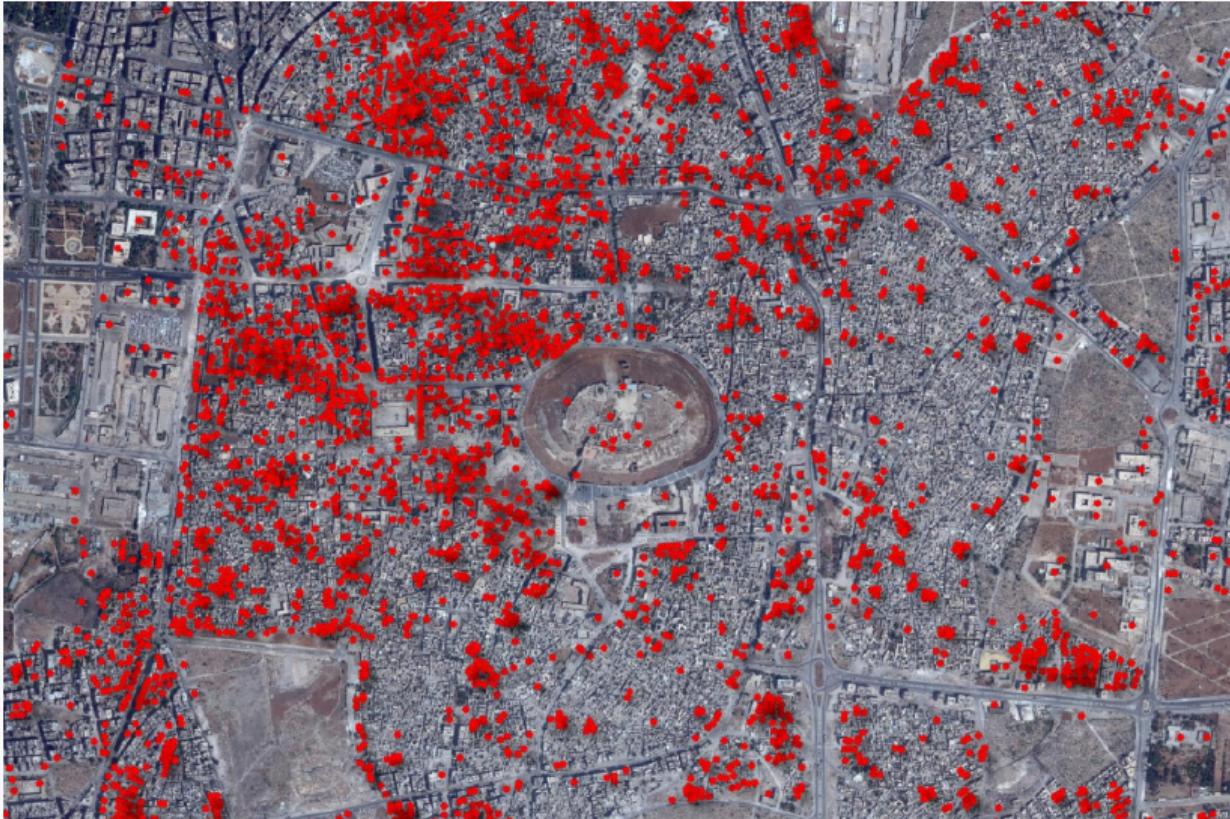
Roadmap

1. **Neural Networks**: Predictive Modelling, Regularization, Neural Networks, Backpropagation
2. **Image Modelling**: Image Data, Image processing, Convolutional Networks, Representations
3. **Language Modelling**: Text Data, Embeddings Networks, Recurrent Networks, Transformers

Examples – Historical Maps



Examples – Satellite Images



Examples – Nightlight Data



Examples – Street View



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Examples – Written Documents

58	Saturday The first part time showers of rain Time The Wind and latter East北風北東風 End. 24 strong gale AM sent the 2 Uplanders at Day, travel. Rain at the house self and man earlier employed	59 employed at Harvey jobs AM to the Indians of 4 today have 1000 bushels sand until them 12 day 60 Wednesday Wood fraying leather 12 PM 4 today The man employed building Martin house self employed J. Harvey, Carter : Martin
59	Sunday Cloudy and much snow 1 ^o C. 12 strong gale spent the day in helping Tom Captin Collings and family on the plantation but I got very blowing hard	60 Thursday till 2 ^o AM 1 ^o C. employed in the 2 Martins and 2 rabbits is all for Tuesday
60	Monday Clear & cool 9 ^o AM Karel light snow self and man employed digging so bricks at the stone near the salt factory was signed up 1000 of brick stones and gave him 3M money back At 12 o'clock and time of the workers gave them 2000 of bread to drink and sent them to the tent	61 Friday 4 ^o AM but having showers of rain. Time from 1 ^o to 3 ^o I employed at Harvey's house and bought the house
61	Saturday The first 1000 and 1 ^o M rain time and self employed to get ready AM bams & Indians in the camp and took 2 men brought 1500 of fish water board for the fish had 1000 men have 1000 bushels sand fins in the house to last to dinner 12 6 ^o AM	

Details

Class Times: Room 15, IBD

- ▶ June 19th (9 AM to 12 PM)
- ▶ June 23rd (9 AM to 12 PM)
- ▶ June 26th (9 AM to 12 PM)
- ▶ June 30th (2 PM to 5 PM)

Details

Learning Material

- ▶ The repository github.com/FabienPetitEconomics/deeplearning contains the materials
- ▶ Files are updated right before every session
- ▶ This course builds on the material developed and previously taught by Clément Gorin, whose contributions are gratefully acknowledged

Examination

- ▶ Write a 2-page research proposal on how you could use deep learning in your research
- ▶ We will discuss your preliminary ideas during the 4th session of this course (June 30th) in a 'pitch-an-idea' session

Textbooks

- ▶ Hastie, Trevor, Robert Tibshirani, and Jerome Friedman (2009). *The elements of statistical learning*. Springer.
- ▶ Nielsen, Michael A. (2015). *Neural networks and deep learning*. Determination Press.
- ▶ Goodfellow, Ian, Yoshua Bengio, and Aaron Courville (2016). *Deep Learning*. MIT Press.
- ▶ Zhang, Aston et al. (2023). *Dive into Deep Learning*. <https://D2L.ai>. Cambridge University Press.
- ▶ Breiman, Leo (2001). "Statistical modeling: The two cultures". In: *Statistical Science* 16.3, pp. 199-231.
- ▶ LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton (2015). "Deep learning". In: *Nature* 521, pp. 436-444.
- ▶ Mullainathan, Sendhil and Jann Spiess (2017). "Machine learning: An applied econometric approach". In: *Journal of Economic Perspective* 31.2, pp. 87-106.
- ▶ Chollet, Francois (2019). "On the Measure of Intelligence". In: CoRR abs/1911.01547.
- ▶ Gentzkow, Matthew, Bryan Kelly, and Matt Taddy (2019). "Text as data". In: *Journal of Economic Literature* 57.3, pp. 535-574.
- ▶ Lones, Michael A. (2021). "How to avoid machine learning pitfalls: A guide for academic researchers". In: CoRR abs/2108.02497.