CAUSAL INFERENCE IN NATURAL LANGUAGE PROCESSING FOR ECONOMICS

(MSc in Economics, WiSo Universität Hamburg)

Summer Semester 2022

Instructor : Dr. Huyen Nguyen

Website: http://huyenttnguyen.com

E-mail: huyen.nguyen-1@uni-hamburg.de

COURSE SUMMARY

This course introduces causal inference techniques for social scientists through the lens of applied microeconometrics. The ability to determine causal pathways is instrumental for social science research and holds the key to understand the effects of policy. The ever-increasing availability of large-scale text corpora and computing power, along with advances in methods theory has boosted researchers' ability to estimate causal relationships, not just between policy variables and demographic information, but also hidden novel insights about relevant institutional and human patterns in texts.

By the end of the course, you are able to apply experimental and quasi-experimental econometric methods for the causal analysis of public policies, especially in the context of text as data. You can interpret complex econometric models and their results. Furthermore, you can develop an empirical strategy for causal identification and to select and apply the appropriate econometric method for a specific research question. By critically reading and evaluating state-of-the-art research articles in text as data application within a causal framework, you become familiar with developing and testing your own research questions and performing your own empirical work.

The first 4 lectures will go through the key fundamentals of contemporary causal inference techniques and some real-life applications with text. Topics include, for instance: experiments, matching and weighing, instrument variables, regression discontinuity designs, panel data (differences-in-differences and synthetic control methods).

The subsequent lectures will explore various applications of Text as Outcome, as Treatment, and as Mediator, in the form of flipped classrooms. Examples include, but are not limited to: how texts on job ads impact different types of applicants; how the market reacts to FOMC releases; how deliberation affects opinion changes on a controversial topic. These sessions consist of a short lecture, followed by either: (1) a presentation by groups of 2-3 students on the required readings of that week and (2) critical discussions from remaining class members; or (2) an interactive coding exercise session in groups.

COURSE OBJECTIVES

- Comprehensive overview of contemporary causal inference methods in social science policy questions, especially in the context of non-standard data.
- Familiarity with statistical and practical issues around non-standard data, especially text data, in policy impact evaluation.
- Ability to critically present relevant scientific articles/applications to peers and discuss presentations of other participants.
- Ability to fit, interpret and apply causal inference analysis techniques in chosen policy contexts to independent research projects.

PRE-REQUISITES

This course requires a basic understanding of Python, Stata, statistics, probability theories and applied econometric techniques used in social sciences. As a pre-requisite, participants are required to be familiar with:

(1) the basics of text as data in Python (text data acquisition, cleaning, feature reduction, and basics of relevant supervised & unsupervised ML methods)
(2) Stata (at the level obtained after BSc Econometrics courses)

You are encouraged to self-study/check your Python/text mining understanding from the previous course: https://github.com/httn21uhh/Text-Analysis-for-Social-Sciences-in-Python

ALL students are required to check their math and stats background. you don't have a solid background in calculus, linear algebra, and probability, read part 1 from this online book.

COURSE LOGISTICS & HOUSE RULES

1) **Lectures** are held in Room WiWi 2019/2201 in VMP5 OR, unless otherwise noted, on Zoom **every Tuesdays from 08.15 to 10.45AM**, from 05.04.2022 to 05.07.2022.

   There are two *exceptions*:
   (i) Tuesday 24.05: Pfingsten break.
   (ii) Tuesday 31.05: There will be individual group consultation appointments to discuss your mid-term pitch & research proposal.

   In the final week 11.07 – 15.07, we will schedule the final oral exam date via Zoom, tentatively on Friday 15.07, unless otherwise noted.

Lecturers are roughly structured as follows: 60′ of lecture/codes → 15′ break → either:

(i) 60′ exercise. (Week 2 to 4)
(ii) 30′ of interactive presentation (from own groups/peers) → 30′ of evaluation & discussion. (Week 5 onwards)

Students are expected to read the required readings and do any exercises before class, as well as actively participating in all classes. Attendance on at least 11/14 sessions is expected.

2) **Materials** (slides, exercise links, data sources, tips) are uploaded **on GitHub** https://github.com/httn21uhh/Causal_Inference_NLP_Economists

- ***Lectures*** will be added to GitHub → Lectures folder every Wednesday morning, unless otherwise noticed. The list of required readings and exercise links are in the detailed syllabus overview below.

- ***Exercises*** (on Jupyter notebook/Google Colab and Stata) that are used in class (and accessible after class for your own practice) will be updated in Github → Exercises folder.

- **Papers** (required readings for presentations & peer critic presentation each week, from Week 5 onwards):

  - Most of the readings can be found in this comprehensive list https://github.com/causaltext/causal-text-papers.
    And some selected tutorials from https://nlp-css-201-tutorials.github.io/nlp-css-201-tutorials/

  - Exact/Any other readings per week can be found in the Group Matching Google Sheet OR the Syllabus below.

- ***Data sources and tips*** are updated regularly in the detailed Syllabus below as the course proceeds.

3) **Forum** (introduction, teammate mix-and-match, exchange of ideas, code bugs) **on Slack channel:**
https://join.slack.com/t/uni-hamburg-world/shared_invite/zt-16xt0sqhs-Og~ctCHgWoZiYujAgnHCXw

How to join in this Slack channel? Use your @uhh account to create an account, register and log into the channel (Desktop apps are also downloadable) using the above link.

There are 4 channels, as follows:

- *#introduce_yourself*: [COMPULSORY, during 1st session] Introduce yourself, your course expectations and levels of understanding for text as data and causal inference framework
- *#group_mix_and_match* [COMPULSORY, deadline in Week 3]: For the paper presentation, peer project deliverables you need to be in a group of 3 students. You can sign up on the following Google Sheet form (also available in this Slack channel): https://docs.google.com/spreadsheets/d/1EEUJp1Srz05BwEUH2u3CbYwMykmqEUhZdn2SqrmeaRs/edit?usp=sharing

- *#qna_code_bugs*: The Q&A space for code issues, solutions, Stackoverflow/Stata materials and any useful exercises you found.
- *#research_ideas_plans*: The space to discuss/pitch research project ideas, interesting papers, planning, and recording resources.

NOTE: Announcement and notices will be done mainly via STINE messages.

4) Course setup

- From Week 2 to Week 5, we will go through the step-by-step exercises together in class, and you need to go through any remaining parts on your own after the next lecture.

- From Week 6 onwards, the first hour will be a coding/lecture session together. Afterwards, assigned groups X needs to prepare a 30' mini lecture/presentation on the required readings (research paper(s) applying text in a causal context in real life); whereas assigned group Y will need to prepare a critique discussion of group X presentation (30'), along with relevant questions and discussions of the readings (30'). The group pair X-Y is as follows.

WEEK	Presenting Group X	Response Group Y
Week 6 (10.05)	G2	G7
Week 7 (17.05)	G3	G6
Week 8 (31.05)	Group Research Project Consultation (via Zoom)	
Week 9 (07.06)	G4	G8
Week 10 (14.06)	G5	G2
Week 11 (21.06)	G6	G3
Week 12 (28.06)	G7	G4
Week 13 (05.07)	G8	G5

- There are 7 groups in total, with **2 to 3 students/group**. You can find your group members with similar research interests on the Slack channel and via the following Google Sheet: https://docs.google.com/spreadsheets/d/1EEUJp1Srz05BwEUH2u3CbYwMykmqEUhZdn2SqrmeaRs/edit?usp=sharing

(!)Kindly DO NOT CHANGE any information here

- Based on your indicated group interests, I will assign suitable papers for your group to read and prepare a mini-lecture (30′/group) to your class on the assigned date. The articles will be assigned to you at least 2 weeks in advance, giving you ample time to prepare. Another group will prepare a response/critic presentation and a discussion plan of this group (30′).

- Your tasks as a group include:
    - Midterm pitch recording (5′) of your NLP causal inference research design
    - Midterm 1-page research design proposal
    - Final 25′ research project presentation
    - Final proof-of-concept analysis plan (BONUS/optional part only)
    - Research Paper presentation (30′)
    - Peer Response presentation & discussion (30′)

COURSE GRADING POLICY & WORKLOAD

All course deliverables are done in **groups of two to three students**. In general, your course commitment is on average between 7.5 – 10 hours/week. This includes 2.5 hours of lecture and a max 5 – 7.5 hours of individual reading and groupwork research.

The hours vary depending on your previous knowledge of applied microeconometrics and text coding analysis.

The course will be graded on the usual grading scale with passing grades from 1.0 (very good) to 4.0 (sufficient), and with a failing grade 5.0 (insufficient). The grades are determined as follows:

- 30%: Midterm pitch recording (5′) + 1-page CI research design proposal
  (Deadline: 23.59 Tuesday 17.05)

- 40%: Group research project oral presentation (25′)
  (Deadline: 23.59 Friday 08.07)
- **BONUS:** proof-of-concept analysis plan (gain an upgrade of 0.7 on final grade)
  (Deadline: 23.59 Friday 08.07)

- 15%: Research paper presentation (30′)
  (own group chosen date, from Week 5 onwards)

- 15%: Peer evaluation oral presentation (30′)
  (own group chosen date, from Week 5 onwards)

Submission rule:

Paper presentation: For presentation groups, please discuss with your assigned peer evaluation group in that same week to arrange such that you hand over your presentation slides to them promptly. This allows them to properly prepare a response presentation and discussion plan, right after your presentation.

Midterm & final submissions: For every hour of late submission of the midterm pitch & proposal, everyone in the team will receive a 5% reduction of the score. Should you have verifiable extenuating circumstances (e.g. illness, personal loss, hardship, or caring duties), an extension can be granted. In such cases, please contact the course instructor as soon as possible before the deadline.

You can find more detailed instructions on the pitch, proposals, the consultation sessions in a separate file in Github and Slack.

GETTING STARTED

1) Python

The examples in the course will mainly use Python. Additionally, when we move to regression exercises, Stata might be used in economic examples. You are strongly recommended to install and set up Python before the course, using the instructions in the following links:

Python Setup Instructions
Codecademy Online Python Course

2) Jupyter Notebook

Read the following step-by-step blog to get familiar with Jupyter Notebook.

https://medium.com/codingthesmartway-com-blog/getting-started-with-jupyter-notebook-for-python-4e7082bd5d46

For installation and trying out Jupyter Notebook, read this:

https://jupyter.readthedocs.io/en/latest/install/notebook-classic.html

https://satyaborg.com/posts/accessing-virtualenv-in-jupyter-notebooks

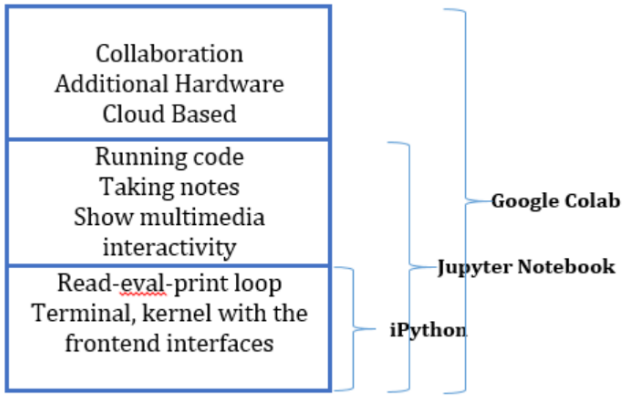
3) Google Colab

If Jupyter Notebook on the web does not work for you during class exercise sessions, use Google Colab.

Google Colab is a specialized version of Jupyter Notebook, which runs on the cloud and offers free computing resources. It does not require a setup, plus the notebooks that you will create can be simultaneously edited by your team members – in a similar manner you edit documents

in Google Docs. The greatest advantage is that Colab supports most popular machine learning libraries which can be easily loaded in your notebook. In order to use Google Colab, you will need a Google Account. Your files are by default linked to your Google Drive. For more information and instructions, please check the following link: https://colab.research.google.com/?utm_source=scs-index

The following diagram summarizes the relationship between iPython, Google Colab and Jupyter Notebook:



4) **StackOverflow** https://stackoverflow.com/
Your go-to website (in addition to Google) for ANY programming bug, installation, package issues. Good programming and data wrangling skills = good Googling/StackOverflow skills.

NOTE! I will IGNORE any questions and e-mails related to programming/installation/package issues. The answers are highly likely available on StackOverflow or from your classmates (use Slack forum to ask, or ask them directly in class).

SYLLABUS & MATERIALS

This detailed syllabus is subject to changes as the course proceeds. I will update it regularly on the Github repository, please check it on a weekly basis.

Week	Date & location	Topic & Content	Readings	Practice
1	Tue 05.04	Introduction and course logistics	[Lecture video on Causal Inference, MIT CourseWave]	[Python] A beginner's guide to Python

		Causal inference ft. text as data overview	https://www.youtube.com/watch?v=gRkUhg9Wb-I The State of Applied Microeconometrics: Causality and Policy Evaluation (Athey & Imbens, JEP 2017)	https://wiki.python.org/moin/BeginnersGuide [Python] Python for Data Science Cheat Sheets [Text analysis] Check Chapter 4 to 6 of the NLTK book Text Analysis Starter Guide [Stata] Treatment effects/causal inference video library https://www.stata.com/features/treatment-effects/ [Stata] Stata to Python equivalent http://www.danielmsullivan.com/pages/tutorial_stata_to_python.html
2	Tue 12.04	Causal inference – Text as Treatment	Causal Inference in Economics and Marketing (Varian, PNAS, 2016) Text and Causal Inference: A Review of Using Text to Remove Confounding from Causal Estimates Katherine A. Keith, David Jensen, and Brendan O'Connor	[Optional] Full Tutorial: Causal inference and Machine Learning in Practice with Industry cases (Microsoft, Tripadvisor and Uber) [In class] TripAdvisor A/B Recommender System [Notebook]https://colab.research.go

			How to Make Causal Inferences Using Texts Naoki Egami, Christian J. Fong, Justin Grimmer, Margaret E. Roberts, and Brandon M. Stewart	ogle.com/drive/1nUhkLVpanv-gm_oA7FbValhpDpEs02wR#scrollTo=qk4_f4tx5gZz [Slides] https://drive.google.com/file/d/1yyIu_3epIVXbwzJj658Iv4vxHGjtPh8n/view
3	Tue 19.04 DUE @ 23.59 Tue 19.04: group matching + research interests	Causal inference – Text as Outcomes	Tweetment effect on the Tweeted: Experimentally reducing racist harrassments (Munger 2017, Political Behavior) How judicial identity changes the text of legal outcomes (Gill and Hall 2013)	[Stata] Propensity Score Matching W3_PSM_Stata_instruction.pdf W3_PSM_cattaneo2_example.do [Python] W3_Case_Study_CeviChe_PSM.ipnb W3_KDD2021_Case Study #1 Causal Impact Analysis – CeviChe.pdf
4	Tue 26.04	Causal inference – Text as Mediators	Causal Mediation Analysis for Interpreting Neural NLP: A case of gender bias (2020) The effect of moderation on Online Mental Health Conversations (Wadden et al., 2021) Text as causal mediators: Research Design for Causal Estimates of Differential Treatment of Social Groups via Language Aspects	[Python] W4_Aggregate_Classification_Pipelines_NLP.pdf W4_Aggregated Classification Pipelines: NLP from start to finish

			(Keith, Rice and Connor 2021)	
5	Tue 03.05	Causal inference – Debiasing techniques	What is debiasing? Why is it important? (Tiwari, Medium)	[Python] W5_DoubleML_NLP_CSS201_slides.pdf W5_DoubleML_Control_for_Text.ipnb [Optional Reading] Theoretical details of Double ML (Chernozukov et al., 2016) lecture note of Chris Felton
6	Tue 10.05 (presentation G2 + response G7)	Application- Text as Treatment (1)		[Python] [polite emails and response speed] W6_CI_with_noisy_proxies.ipynb W6_CI_with_noisy_proxies.pdf
7	Tue 17.05 (presentation G3 + response G6) DUE @ 23.59 Tue 17.05: midterm pitch & research design	Application- Text as Treatment (2)		[Python] W7_Moving from words to phrases in NLP extraction_part_1.pdf W7_Moving_from_words_to_phrases_PhraseBERT_part_2.pdf
	Tue 24.05	Pfingsten Break		
8	Tue 31.05	Consultation on project midterm deliverables (via Zoom)		
9	Tue 07.06 (presentation G4 + response G1)	Application Text as Outcomes (1)		Tutorial on causal text algorithm (1) https://towardsdatascience.com/text-based-causal-

				inference-86e640efb2af
10	Tue 14.06 (presentationG5 + response G2)	Application Text as Outcomes (2)		Tutorial on causal text algorithm (2) https://towardsdatascience.com/text-based-causal-inference-86e640efb2af
11	Tue 21.06 (presentationG6 + response G3)	Application Text as Outcomes (3)		
12	Tue 28.06 (presentation G7 + response G4)	Application Text as Mediators		
13	Tue 05.07 (presentation G8 + response G5) DUE @ 23.59 Fri 08.07: Final slides & bonus proof-of-concept analysis plan	Application Text as Mediators		
14	Friday 15.07 (FINAL PRESENTATION, via Zoom)		Check your assigned group time slot & Zoom link [GOOGLE DOC]	

SUPPLEMENTARY MATERIALS FOR DATA ANALYSIS

The course will be mainly based on the weekly lecture slides and research articles, but the following books and code exercises can be used as reference along with the slide content.

Natural Language Processing in Python, Third Edition, available at nltk.org/book.

· Aurelien Geron, Hands-On Machine Learning with Scikit-Learn & TensorFlow, O'Reilly 2017 (link)

. Jupyter notebooks Github for Geron's book.

· Google Developers Text Classification Guide (This guide contains some practical tips and code examples for using text data)

. For Python syntax programming, this book Fluent Python (O'Reilly 2015) serves as a good guideline
https://www.oreilly.com/library/view/fluent-python/9781491946237/