Carnegie Mellon University
Heinz College

94-775 Unstructured Data Analytics for Policy

Lecture 1: Course overview

Slides by George H. Chen

What is this course about?

Big Data

We’re now collecting data on virtually every human endeavor





An IDC report* found that 90% of data generated in 2022 by organizations were unstructured

How do we turn unstructured data into actionable insights?

*Source: IDC. "Untapped value: What every executive needs to know about unstructured data". Aug 2023.

What does it mean for data to be "unstructured"?

Structured Data

Well-defined elements, relationships between elements

Patients Table

Patient ID	First Name	Last Name	Middle Initial
0	…	…	…
1	…	…	…
2	…	…	…

Doctors Table

Doctor ID	First Name	Last Name	Middle Initial
0	…	…	…
1	…	…	…
2	…	…	…

Appointments Table

Appointment ID	Patient ID	Doctor ID	Start time	End time
0	…	…	…	…
1	…	…	…	…
2	…	…	…	…

Can be labor-intensive to collect/curate structured data

Unstructured Data

No pre-defined model—elements and relationships ambiguous

Common examples:

- Text
- Images
- Videos
- Audio

Often: Want to make decisions using multiple types of unstructured data, or unstructured + structured data

Of course, there *is* structure in "unstructured" data but it is not neatly spelled out for us

We have to extract what elements matter and figure out how they are related!

Just because something *can* be stored as any of these doesn't mean that it must be unstructured!

Example 1: Health Care

Is a patient at risk of getting a nasty disease?

Data

- Chart measurements (e.g., weight, blood pressure)
- Lab measurements (e.g., draw blood and send to lab)
- Doctor's notes
- Patient's medical history
- Family history
- Medical images

Example 2: Electrification

Where should we install cost-effective solar panels in developing countries?

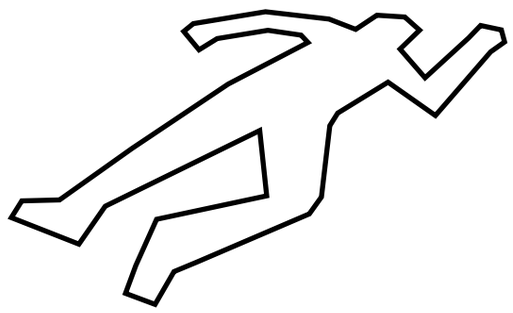
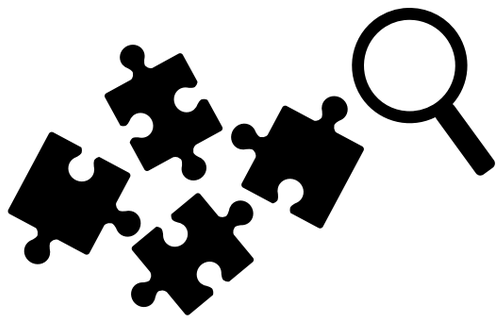
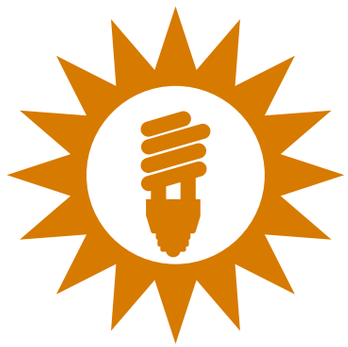
Data

- Power distribution data for existing grid infrastructure
- Survey of electricity needs for different populations
- Labor costs
- Raw materials costs (e.g., solar panels, batteries, inverters)
- Satellite images

Image source: African Reporter

Unstructured Data Analytics (UDA)

Much like how many murder mysteries go unsolved,
many data analysis (unstructured or not) problems can be extremely difficult

Question	Data	Finding Structure	Insights
			
The dead body	*The evidence*	*Puzzle solving, careful analysis*	*When? Where? Why? How? Perpetrator catchable?*
This is provided by a domain expert	Some times you have to collect more evidence!	Exploratory data analysis	Answer original question

Not detailed in lecture but addressed by your final project,
which must address a public policy problem

Sometimes: we aim to solve a prediction problem

UDA involves *lots* of data ➔ write computer programs to assist analysis

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Prereq: Python programming for data analysis at the level of 90-803

Part I: Exploratory data analysis

Part II: Predictive data analysis

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Part I: Exploratory data analysis

Identify structure present in "unstructured" data

- Frequency and co-occurrence analysis
- Visualizing high-dimensional data/dimensionality reduction
- Clustering
- Topic modeling

Part II: Predictive data analysis

Make predictions using known structure in data

- Basic concepts and how to assess quality of prediction models
- Neural nets and deep learning for analyzing images and text

Course Goals

By the end of this course, you should have:

- Lots of hands-on programming experience with exploratory and predictive data analysis
- A high-level understanding of what methods are out there and which methods are appropriate for different problems
- A *very* high-level understanding of how these methods work *and what their limitations are*
- The ability to apply and interpret the methods taught to solve problems faced by organizations

I want you to leave the course with practically useful skills solving real-world problems with unstructured data analytics!

As we go from covering classical methods to modern ones, it's good to understand *why* newer methods were developed

UDA technologies change very rapidly! GPTs might be hot today but be out of fashion tomorrow!

Course ~~Textbook~~ Materials

No existing textbook matches the course… =(

Main source of material: lectures slides

We'll post supplemental reading as we progress

Check course webpage

http://www.andrew.cmu.edu/user/georgech/94-775/

In general, announcements & links to all course-related things will be in Canvas

Homework assignments are submitted via Gradescope (link is within Canvas)

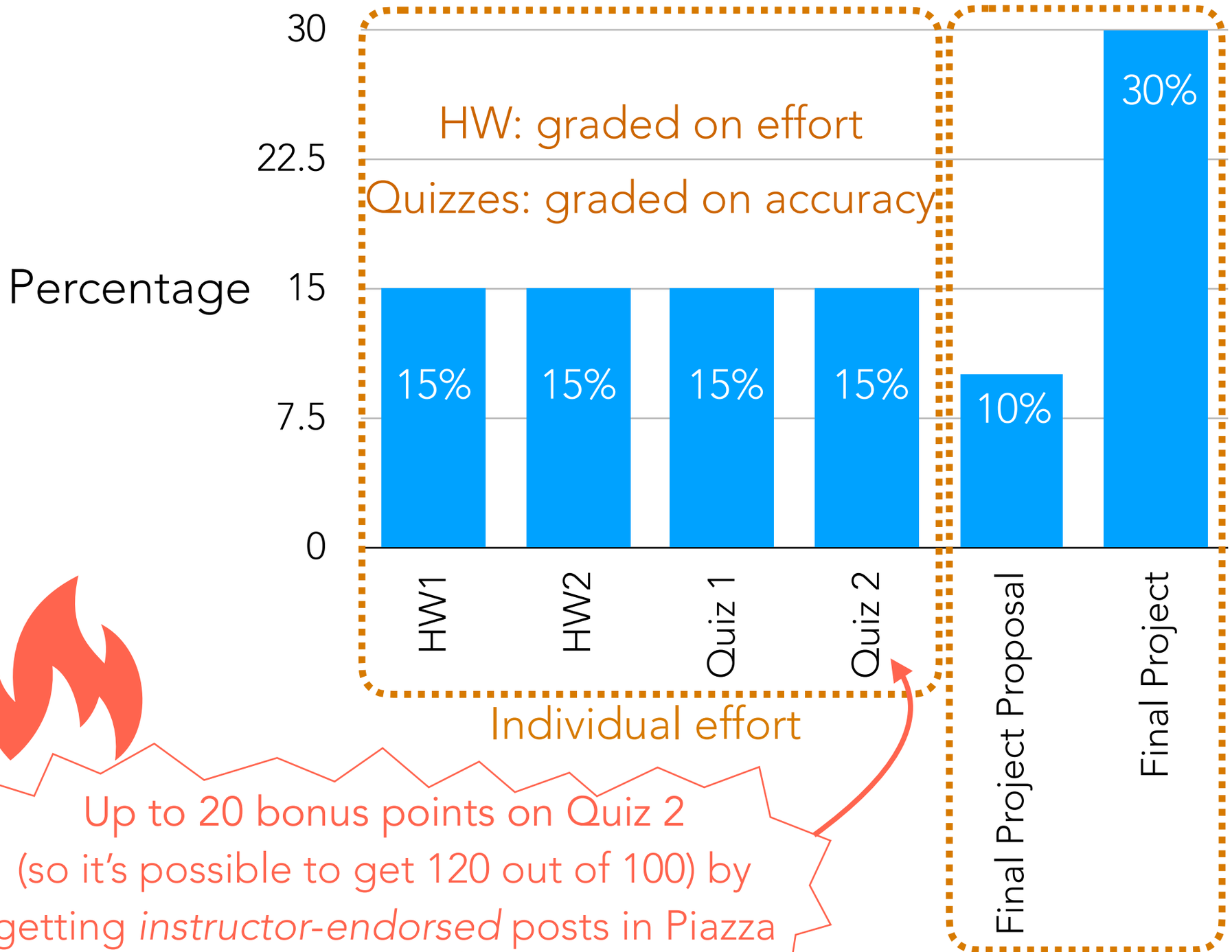
Please post questions to Piazza (link is within Canvas)

Note Regarding Generative AI Technologies

- AI assistants such as but not limited to (Chat)GPT, Claude, Gemini, Grok, Llama, and DeepSeek will continue to get better over time
  - As of July 2025, OpenAI and Google can achieve gold-medal performance for International Math Olympiad problems [link]
  - These systems use concepts you'll be learning in this class!
- For this class, I will view whether you get help from AI **to be the same as whether you get help from a human**
  - Regardless of whether you get info from an AI or a human, I want *you* to be able to tell whether this info is correct or not
- Importantly: this class is about learning **fundamental concepts of UDA**
  - We will start with *classical, usually easier to understand* concepts and progress to *modern, often less intuitive* concepts
    - It's important to see *why* newer methods were developed and *how* they try to address limitations of older methods
  - At the end of the semester, we will go over a basic version of GPT

Deliverables & Grading

Contribution of Different Assignments to Overall Grade



Letter grades are assigned based on a curve

Up to 20 bonus points on Quiz 2
(so it's possible to get 120 out of 100) by
getting *instructor-endorsed* posts in Piazza

Individual Effort Assignments: Collaboration & Academic Integrity

- If you are having trouble, ***please ask for help!***
  - We will answer questions on Piazza and will also expect students to help answer questions!
  - **Do not post your candidate solutions on Piazza**
  - For code: post smallest snippet, how you know it's buggy (error message, etc), & what you've already tried to resolve the issue
  - In the real world, you will unlikely be working alone
    - We encourage discussing concepts
    - Please acknowledge classmates you talked to or resources you consulted (e.g., ChatGPT, Gemini, stackoverflow)
  - **For individual effort assignments, do not share your code with classmates (instant message, email, Box, Dropbox, AWS, etc)**
  - **Do not use solutions from past semesters**

Penalties for cheating are severe: 0 on assignment, possibly fail the course ☹️

The Two Quizzes

Format:

- **In-person, on paper**
- Each quiz is **40 minutes**
- No electronics may be used during the exam
  (e.g., do <u>not</u> use a laptop, tablet, phone, calculator)
- Open notes (must be on paper and <u>not electronic</u>)

Quiz 1: Friday March 27 during recitation slot

Quiz 2: Friday April 17 during recitation slot

This is a relatively new format for 94-775 quizzes; I only have 1 set of real past 94-775 quizzes of this format (from Spring 2025)

I aim to provide you with additional practice problems from my other course 95-865 (the format & coverage of 95-865 quizzes are a bit different so that I might just pick and choose practice problems to share with you)

Gradescope

- We're using Gradescope for grading everything (homework & quizzes)
- Your homework will involve coding *but we will ask that you save your code notebook as a PDF and submit only the PDF*
    - **Since we will not be re-running your code, make sure that your PDF includes all the code output!**
- We will scan your quizzes and grade them on Gradescope

Final Project

- Must be done in a group of ~3-5 students
  - You choose your own groups
  - Final project proposals (~2 pages) are due **Friday April 3, 11:59pm (by email, 1 email per group)** & must specify who the group members are
- Required components will be stated in 2 slides
- **Monday April 27** (this is during final exam week) is the big day:
  - 8:30am until no later than 11:30am: final project presentations (location TBA)
  - Project reports due the same day by 11:59pm by email, consisting of:
    - Jupyter notebook (edited down to be clean, concise)
    - Slide deck for your final project presentation (can be slightly different from what you actually presented to incorporated feedback; please specify if there are changes)

Final Project Rubric

- **Policy question (15%):** what public policy question are you addressing? Please be clear and concise.
- **Data analysis (30%):** clearly state what part of your data are unstructured (some but not all of the data you are analyzing must be unstructured), and carefully justify every step of your analysis with supporting visualizations/intermediate outputs as needed
- **Code (30%):** your code should actually run!
- **Conclusions (15%):** come up with insights that are based on your quantitative data analysis and that address your original policy question
- **Presentation (10%):** how polished is your final project presentation? — this is based on the live presentation your group makes (changes made to the slides after the presentation don't affect this score)

Final Project *Proposal*

- **Policy question:** what public policy question are you addressing? Please be clear and concise.
- **Data:** what data have you found that you want to analyze, and why is at least some portion of it unstructured?
- **Proposed analysis:** what specific methods do you want to try and why? In what way would these address your proposed policy question? Are there specific obstacles you think you will have to address? What would a "successful" analysis look like?

Important: you should have already downloaded & looked at the data

Common problem in previous years: some groups didn't actually look at the data, and then after they looked at the data, they had to completely change their proposal

Five final projects from the past years have already been posted on Canvas

Note: I have omitted Jupyter notebooks from these past projects though, and only included the proposals & final slide decks

One of these final projects has a proposal title that ended up being different from the title used in the final project presentation slide deck (that's okay!)

Late Homework Policy

- You are allotted 2 late days
    - If you use up a late day on a HW, you can submit it up to 24 hours late with no penalty
    - If you use up both late days on the same HW, you can submit up to 48 hours late with no penalty
- Late days are *not* fractional
- This policy is in place precisely to account for various emergencies (health issues, etc) and you will not be given additional late days
- There is no need to tell us if you're using a late day or not (we'll figure it out from submission timestamps)

Course Staff

TA: Shurui Cao

Instructor: George Chen

Office hours start next week (we're still sorting out the schedule): details will be posted on Canvas