Lecture 1

Overview and Values of Data Science

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University of Washington

RE 519 Real Estate Data Analytics and Visualization
Course Website: www.yuehaoyu.com/data-analytics-visualization/
Autumn 2025

Welcome to start the journey in **data science**

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Ph.D. Student, Interdisciplinary Urban Design and Planning
Ph.D. Researcher, Urban Infrastructure Lab
Graduate Student, Statistics

Research Area

artificial intelligence, climate planning, renewable energy, quant methods

Christian Phillips
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Ph.D. Researcher, Urban Infrastructure Lab & Washington State Real Estate Research Center
2024

Siman Ning
Ph.D. Student, Interdisciplinary Urban Design and Planning
Ph.D. Researcher, Urban Infrastructure Lab
2022, 2023

Feiyang Sun, Ph.D.
Assistant Professor
University of California, San Diego
2020, 2021

Brief Intro

Class Survey Results

- **Did you take RE 506 Quantitative Methods, URBAN 520 Quantitative Methods, or at least 1 course about statistics in your undergrad or graduate study?**
  - I took at least one statistics course. **(20/21)**
  - I'm taking a statistics course this quarter.
  - I have no statistics background so far.
  - I know a lot about statistics without needing to take a class. **(1/21)**

Brief Intro

Class Survey Results

- **Did you take RE 597 Real Estate Data Modeling, URBAN 504 Introduction to GIS, or at least 1 course about GIS in your undergrad or graduate study?**
  - I took at least one GIS course. **(1/21)**
  - I'm taking a GIS course this quarter. **(1/21)**
  - I have no GIS background so far. **(17/21)**
  - I know a lot about GIS without needing to take a class. **(1/21)**
  - I took R E 397 in my undergrad, but that was not about GIS. **(1/21)**

Brief Intro

Class Survey Results

- **Are you scared of coding (Python, R, C++, etc.)?**
  - Yes, I hate coding. **(1/21)**
  - Not much, but I can try some easy lines of coding. **(3/21)**
  - I don't know because I don't have any experience. **(9/21)**
  - No experience, but I'd love to learn with the help of AI. **(6/21)**
  - I code much in my work. **(2/21)**
- **Do you have any working experience in the real estate or other fields?**
  - Yes, but not related to any data science. **(18/21)**
  - Yes, and related to data science!
  - No working experience. **(3/21)**

Brief Intro

Class Survey Results

- **Which programming language do you prefer to learn? Yes, I hate coding.**
  - R **(1/21)**
  - Python **(6/21)**
  - I don't have any preference and am open to both. **(11/21)**
  - I don't know the difference, but I want to do data science in my future career. **(1/21)**
  - I don't have any interest in data science; I took this class because it was required. **(2/21)**

Brief Intro

Self Introduction

- Your name
- Your pronouns
- Your affiliation
- Year in the program
- Your experience/interests with data analysis and visualization
- Your expectation from this class
- Recent happiness (accomplishment, hobby, adventure, etc.)

Course Overview

Class Sessions

- **Two sessions per week** (MW 3:30-4:50 pm)
  - Typically, the first half of the class will be some sort of lecture, and the rest of the class will be dedicated to lab time, where you can work in groups
- **Location**
  - Mechanical Engineering Building 245 (sorry, the room is not so desirable!)
- **Office hours**
  - By appointment via link - online via Zoom
  - Anytime after each class session

Course Overview

Pre-requisites, Materials, Class Website, and Canvas

- **No prerequisites required for this class**
  - Basic knowledge of any programming language is appreciated.
- **Readings and slides**
  - Slides will be published on the website before the class
  - A few required readings, but lots of optional readings and resources
  - Can be accessed via the links on the website, although some may require a UW NetID login
- **Course website**
  - https://www.yuehaoyu.com/data-analytics-visualization/
  - Add to your bookmark for this quarter!
- **Canvas**
  - Only for survey, quiz, lab submission, and grading

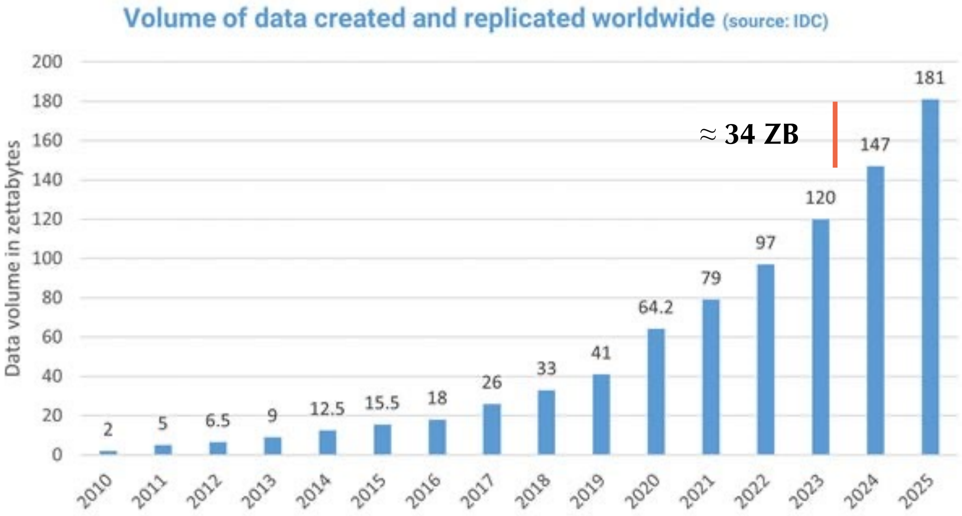
Course Overview

Class Communication

- **Asynchronous Discussion Board**
  - Using Ed Discussion for announcements, discussion, and technical questions
  - linked from Canvas
  - We'll try and respond to all questions by the end of each working day
  - Please use the Ed Discussion as the first place to ask general questions. If you have a question about the course material or assignment, other students may have the same question. If you email me with a question like this, I will ask you to post it on the discussion board.
  - I also encourage students to answer each other's questions on the discussion board
- **Email communication**
  - Please use yohaoyu@uw.edu. Additionally, please put RE 519 in the subject line.

The Value of Data Analysis and Visualization

The Exponential Growth of Data



≈ 34 ZB

~2x every 3 years

1 ZB ≈

200 trillion photos taken by iPhone

Take 70 photos for each person on earth every day for a year

34 ZB ≈

Every 36 seconds, take one photo for each person on earth for a year

Source: Exponential Growth of Data
https://medium.com/@mwaliph/exponential-growth-of-data-2f53df89124

A DAY IN DATA

The exponential growth of data is undisputed, but the numbers behind this explosion – fuelled by internet of things and the use of connected devcies – are hard to comprehend, particularly when looked at in the context of one day

500m

tweets are sent every day

Twitter

4PB

of data created by Facebook, including

350m photos

100m hours of video watch time

Facebook Research

294bn

billion emails are sent

Radicati Group

320bn

emails to be sent each day by 2021

306bn

emails to be sent each day by 2020

3.9bn

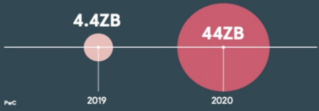
people use emails

4TB

of data produced by a connected car

Intel

ACCUMULATED DIGITAL UNIVERSE OF DATA



PwC

DEMYSTIFIYING DATA UNITS

From the more familiar 'bit' or 'megabyte', larger units of measurement are more frequently being used to explain the masses of data

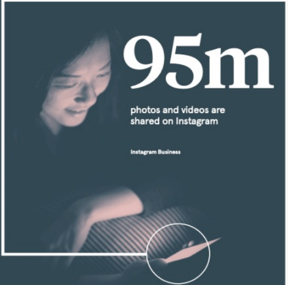
Unit		Value	Size
b	bit	0 or 1	1/8 of a byte
B	byte	8 bits	1 byte
KB	kilobyte	1,000 bytes	1,000 bytes
MB	megabyte	1,000^2 bytes	1,000,000 bytes
GB	gigabyte	1,000^3 bytes	1,000,000,000 bytes
TB	terabyte	1,000^4 bytes	1,000,000,000,000 bytes
PB	petabyte	1,000^5 bytes	1,000,000,000,000,000 bytes
EB	exabyte	1,000^6 bytes	1,000,000,000,000,000,000 bytes
ZB	zettabyte	1,000^7 bytes	1,000,000,000,000,000,000,000 bytes
YB	yottabyte	1,000^8 bytes	1,000,000,000,000,000,000,000,000 bytes

*A lowercase "b" is used as an abbreviation for bits, while an uppercase "B" represents bytes.

463EB

of data will be created every day by 2025

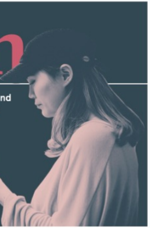
IDC



95m

photos and videos are shared on Instagram

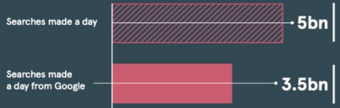
Instagram Business



65bn

messages sent over WhatsApp and two billion minutes of voice and video calls made

Facebook



Smart insights

28PB

to be generated from wearable devices by 2020

Statista

Source: A Day in Data; https://www.raconteur.net/infographics/a-day-in-data

RACONTEUR

The Value of Data Analysis and Visualization

How many 6 here? Which number is more likely to pair with A?

A	B	A	C	A	A	B	A	A	C	A	B
9	7	8	8	7	9	7	9	9	6	8	7

A	B	A	B	A	A	A	B	A	B	A	B
9	7	8	7	8	9	7	9	9	7	8	7

A	A	C	A	A	C	A	B	C	A	C	A
8	9	6	8	9	6	9	7	6	9	6	9

The Value of Data Analysis and Visualization

How many 6 here? Which number is more likely to pair with A?

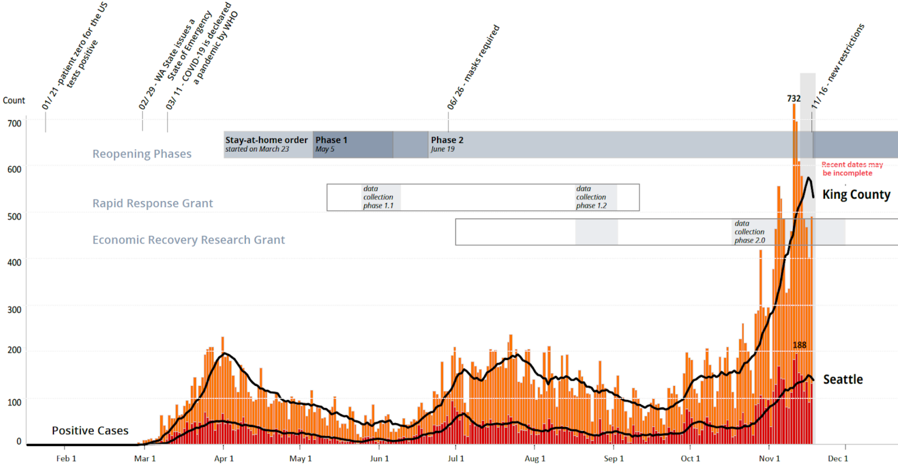
A	B	A	C	A	A	B	A	A	C	A	B
9	7	8	8	7	9	7	9	9	6	8	7
A	B	A	B	A	A	A	B	A	B	A	B
9	7	8	7	8	9	7	9	9	7	8	7
A	A	C	A	A	C	A	B	C	A	C	A
8	9	6	8	9	6	9	7	6	9	6	9

Pair	Frequency
A ~ 7	2
A ~ 8	6
A ~ 9	11
B ~ 7	7
B ~ 9	1
C ~ 6	5
C ~ 8	1

The Value of Data Analysis and Visualization

Why data visualization?

- <u>**Because our brains love graphics.**</u>
- **Analyze** data to support reasoning (exploratory visualization)
  - Develop and assess hypotheses
  - Find patterns / errors in data
  - Expand memory
- **Communicate** information to others (narrative/explanatory visualization)
  - Share and persuade
  - Collaborate and revise



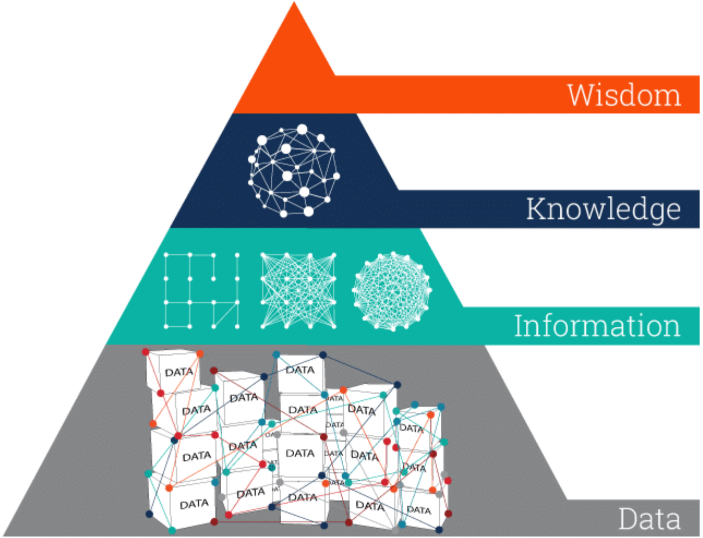
Source: Whittington, J. and Proksch, G. “Design Determinants of COVID-19 Impacts to Food-Related Essential Business and Service” University of Washington, February 9, 2021

"The ability to take data—to be able to **understand** it, to **process** it, to **extract value** from it, to **visualize** it, to **communicate** it—that's going to be a hugely important skill in the next decades, […] because now we really do have **essentially free and ubiquitous data**. So, the complementary scarce factor is the ability to understand that data and extract value from it."

Hal Varian, Google's Chief Economist
The McKinsey Quarterly, Jan 2009

The Value of Data Analysis and Visualization

The DIKW Pyramid

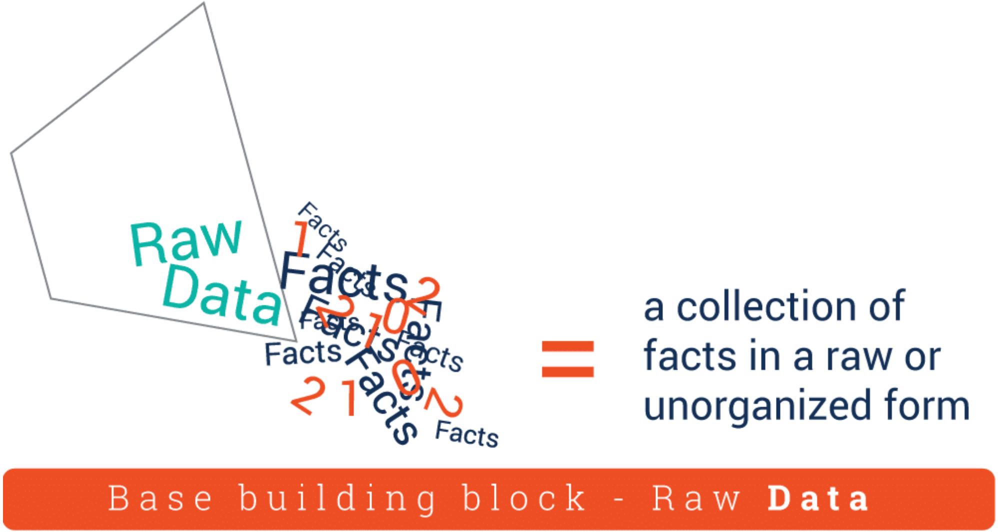


Source: https://www.ontotext.com/knowledgehub/fundamentals/dikw-pyramid/

Each step up the pyramid answers questions about and adds value to the initial data.

The Value of Data Analysis and Visualization

The DIKW Pyramid - Data



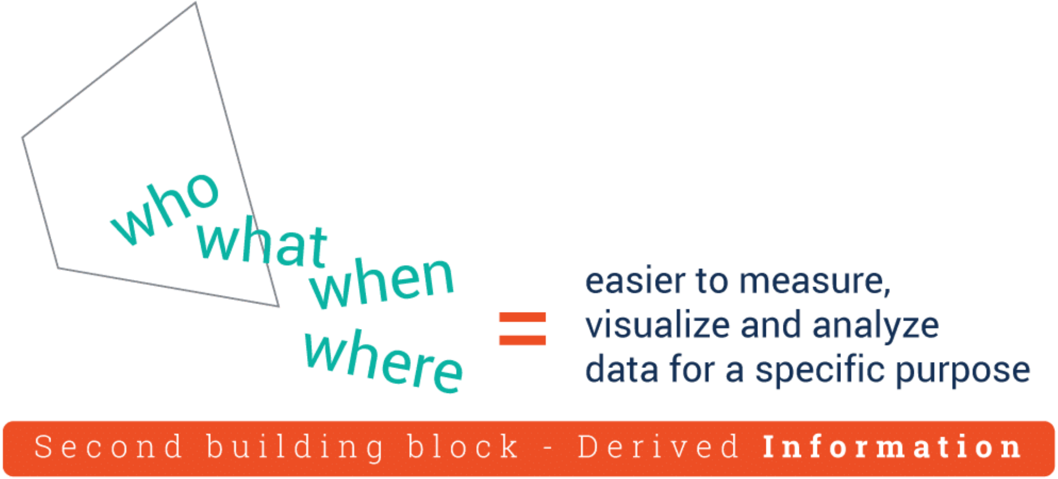
a collection of facts in a raw or unorganized form

Base building block - Raw **Data**

Source: https://www.ontotext.com/knowledgehub/fundamentals/dikw-pyramid/

The Value of Data Analysis and Visualization

The DIKW Pyramid - Information



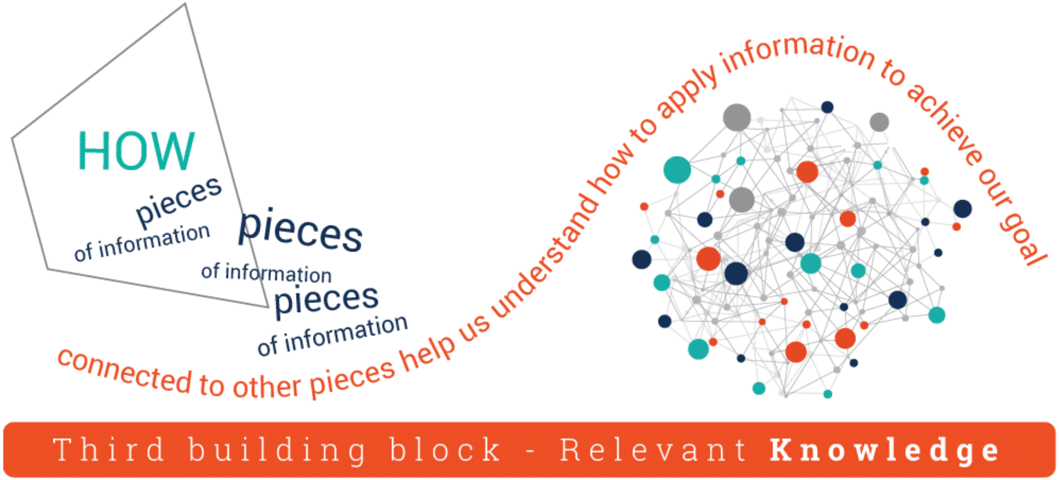
easier to measure, visualize and analyze data for a specific purpose

Second building block - Derived **Information**

Source: https://www.ontotext.com/knowledgehub/fundamentals/dikw-pyramid/

The Value of Data Analysis and Visualization

The DIKW Pyramid - Knowledge


HOW
pieces
of information
pieces
of information
pieces
of information
connected to other pieces help us understand how to apply information to achieve our goal
Third building block - Relevant **Knowledge**

Source: https://www.ontotext.com/knowledgehub/fundamentals/dikw-pyramid/

The Value of Data Analysis and Visualization

The DIKW Pyramid - Wisdom

why do something?
what is best?
Wisdom is knowledge applied in action
The top of the DIKW hierarchy - Guiding Wisdom

Source: https://www.ontotext.com/knowledgehub/fundamentals/dikw-pyramid/

The Value of Data Analysis and Visualization

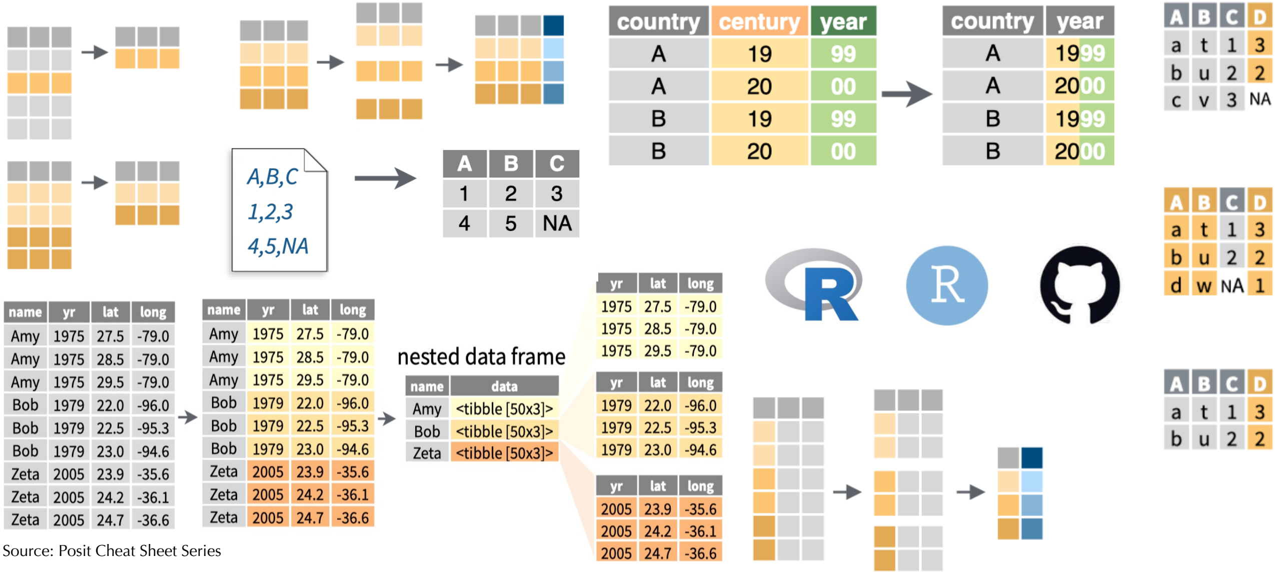
Example of Job Posting

- Strong organizational and analytical skills
- Ability to provide efficient, timely, reliable and courteous service to customers
- **Ability to effectively present information**
- Requires knowledge of financial terms and principles
- Conducts basic financial analysis
- Ability to comprehend, analyze, and interpret documents
- Ability to solve problems involving several options in situations
- **Requires intermediate analytical and quantitative skills**
- **Experience in analyzing data to draw business-relevant conclusions and in data visualization techniques**
- **Technical expertise in techniques regarding data models and database design development**
- Sound knowledge of and experience with **reporting/dashboarding packages**, i.e., Power BI, **Tableau**, Datastudio, SSRS, Plx
- Strong knowledge of databases (MS SQL, BigQuery, etc)
- Adept at queries, report writing, and presenting findings
- Effective analytical skills with the ability to collect, organize, analyze, and disseminate significant amounts of information with attention to detail and accuracy

Source: CBRE

Course Overview

Module 1 – Introduction and Data Processing



country	century	year
A	19	99
A	20	00
B	19	99
B	20	00

country	year
A	1999
A	2000
B	1999
B	2000

A	B	C	D
a	t	1	3
b	u	2	2
c	v	3	NA

A	B	C	D
a	t	1	3
b	u	2	2
d	w	NA	1

A	B	C	D
a	t	1	3
b	u	2	2

```
A,B,C
1,2,3
4,5,NA
```

A	B	C
1	2	3
4	5	NA

name	yr	lat	long
Amy	1975	27.5	-79.0
Amy	1975	28.5	-79.0
Amy	1975	29.5	-79.0
Bob	1979	22.0	-96.0
Bob	1979	22.5	-95.3
Bob	1979	23.0	-94.6
Zeta	2005	23.9	-35.6
Zeta	2005	24.2	-36.1
Zeta	2005	24.7	-36.6

name	yr	lat	long
Amy	1975	27.5	-79.0
Amy	1975	28.5	-79.0
Amy	1975	29.5	-79.0
Bob	1979	22.0	-96.0
Bob	1979	22.5	-95.3
Bob	1979	23.0	-94.6
Zeta	2005	23.9	-35.6
Zeta	2005	24.2	-36.1
Zeta	2005	24.7	-36.6

nested data frame

name	data
Amy	<tibble [50x3]>
Bob	<tibble [50x3]>
Zeta	<tibble [50x3]>

yr	lat	long
1975	27.5	-79.0
1975	28.5	-79.0
1975	29.5	-79.0

yr	lat	long
1979	22.0	-96.0
1979	22.5	-95.3
1979	23.0	-94.6

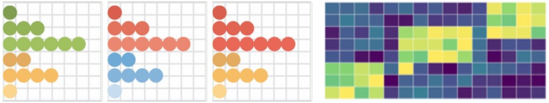
yr	lat	long
2005	23.9	-35.6
2005	24.2	-36.1
2005	24.7	-36.6

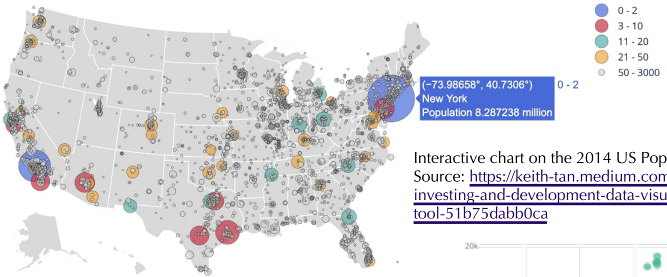
Source: Posit Cheat Sheet Series

Course Overview

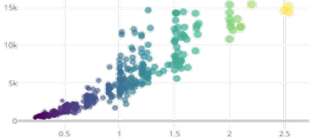
Module 2 – Data Visualization

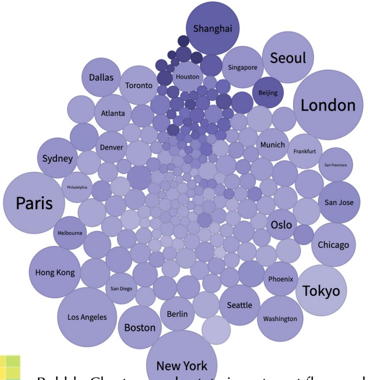
Source: Posit Cheat Sheet Series



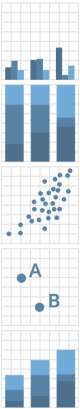


Interactive chart on the 2014 US Population, by city
Source: https://keith-tan.medium.com/real-estate-investing-and-development-data-visualization-as-a-tool-51b75dabb0ca





Bubble Chart on real estate investment flow and GDP
Source: https://keith-tan.medium.com/real-estate-investing-and-development-data-visualization-as-a-tool-51b75dabb0ca

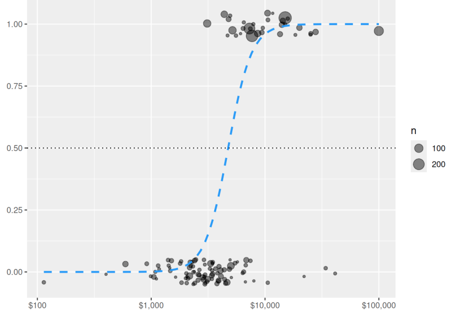


ZOOM
NORTH BAY
SAN FRANCISCO
EAST BAY
Estately

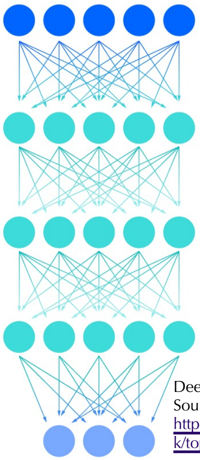
Infographic of SF Housing Price,
Reddit: Original post by /u/surf2japan in r/bayarea

Course Overview

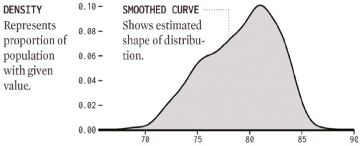
Module 3 – Data Modeling



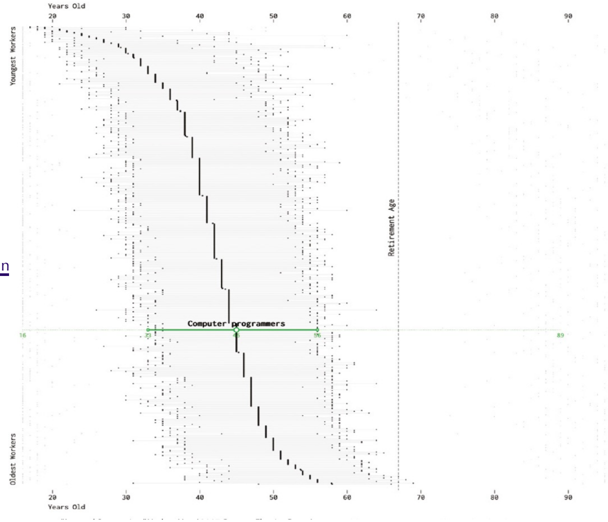
Source: Modern Data Science with R
https://mdsr-book.github.io/mdsr3e/

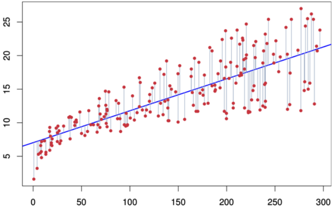


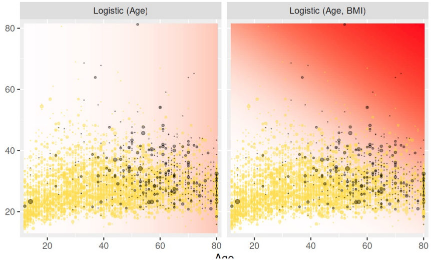
Deep neural network
Source: IBM
https://www.ibm.com/think/topics/neural-networks



Source: Visualize This - The Flowing Data Guide to Design, Visualization, and Statistics







Source: "Age and Occupation," Nathan Yau / 2007-Present FlowingData / https://flowingdata.com/2021/09/30/age-and-occupation / last accessed February 08, 2024.

Course Overview

About this Course

The class is about

- Data processing using R
- Exploratory data analysis
- Dashboard using Tableau and R
- Visual design for many forms of data
- Simple statistics methods

The class is NOT about

- Analysis using Excel
- Advanced statistics methods
- Machine learning
- Artificial intelligence
- Databases and data management

We will just introduce a little bit on those topics

The class is

- Required for MSRE (Regular Standing)
- Selective for MSRE (Advanced Standing)
- Selective for the Master of Urban Planning
- An overview of data science and a gateway to future data science study

Course Overview

Why are we using programming languages?

R vs. Python vs. Excel

R - A free, open-source software environment for statistical computing and graphics
http://www.r-project.org

RStudio - An open-source integrated development environment (IDE)
https://posit.co/products/open-source/rstudio

GitHub Copilot in RStudio
https://docs.posit.co/ide/user/ide/guide/tools/copilot.html

Course Overview

Guest Speakers

Drew Dolan

Principal, Fund Manager

DXD Capital

Keywords: Data-driven Real Estate, Self Storage Real Estate

October 27, 2025 (in-person at MEB 245)

Dr. Andy Krause

Director of Applied Science in AI

Zillow

Keywords: Home Valuation, Machine Learning, Artificial Intelligence

Date & Location TBD

Course Overview

Statistics and Data Science @ UW

- **Coursework**
  - STAT 180/CSE 180/INFO 180 Introduction to Data Science
  - CSE 583 Software Development for Data Scientists
  - CSSS 508 Introduction to R for Social Scientists
  - CSE 512 Data Visualization
  - CSSS 569 Visualizing Data and Models
  - CSE 416/STAT 416 Introduction to Machine Learning
  - CEWA 567 Geospatial Data Analysis with Python
- **Institutes and Centers (they usually offer a weekly seminar)**
  - eScience Institute (Data Science)
  - Center for Studies in Demography and Ecology
  - Center for Statistics and the Social Sciences

Course Overview

Course Requirement – Labs (64%)

- In total, there will be 8 labs (8% each), and for each lab, there will be 2~3 parts.
- We will use class time to review certain parts of the labs, and you will have some tasks.
- In each lab, the expected finish time is ~1 to 2 hours after class.
- Each student is expected to submit their own lab, but study groups are allowed. But you're expected to acknowledge the names of collaborators along with a short description of the types of collaborations being done at the beginning of each lab submission.
- You may use generative AI tools, but please check the AI policy for each lab.
- You only need to submit once after each lab (due Monday at 11:59 PM PST), via Canvas.

Course Overview

Course Requirement - Data Analytics and Visualization Projects (30%)

- 1~3 students for each group.
- Start to think about the topic and data for the project now!
- The project could be, for example:
  - A modeling of interesting datasets to derive new insights
  - Pure visualization for some datasets
  - A replication of an interesting academic article
- The requirements include:
  - Team Formation (1% of the total grade)
  - Project proposal (1 page; 5%)
  - Draft work presentation (in the last class, graded by peers and instructors; 8%)
  - Final delivery (could be any format, like report, website, poster; 15%)
  - Peer Review (1% of the total grade)

Course Overview

Course Requirement – Participation and Extra Credits (6% + 3%)

- There will be several surveys and in-class quizzes (only graded on completion; 6%).
- There will be two ways to receive extra credits:
  - **Dataset sharing** (2%): From week 2 to 6, share high-quality online datasets directly related to real estate and housing on Ed Discussion.
    - The dataset cannot be repeated with the previous datasets shared by other students.
    - 5 unique datasets to receive 2%, 3 unique datasets to receive 1%.
  - **Course evaluation** (1%): We will leave some time in the last class to participate in the anonymous course evaluation.

- **Participating in the course evaluation is important to the course and me!**
  - Formal course evaluation occurs at the end of the quarter, university-widely. If you are experiencing a problem with the class, please let me know as soon as possible, as I might be able to make changes if needed within the course of the class.

Course Overview

Time Commitment, Final Grade, and Late Days

- According to the estimates for UW courses, it should take about **9** hours of work to complete a three-credit class each week. If you spend more than **6** hours beyond the classroom, please let me know as early as plan, and we will adjust the class content or specific study plans for you.

- The total scores will be curved and transformed into the UW numerical grading system for graduate courses, ranging from 4.0 to 1.7 in 0.1 increments as the final grade.

- Late days: You will have 6 penalty-free late days for assignments and projects (max 3 late days per assignment). Any delayed submission after the first 3 days will be penalized 10% per day for that specific assignment (but will not count towards your used late days).
  - Late days **cannot be used** for the project presentation and final delivery.

Course Overview

Generative AI Tools, GPT, Copilot, etc.

- **We encourage to use of generative AI tools beginning from Lab 4**
    - All sources, including AI tools, must be properly cited.
        - Example: “Describe the symbolism of the green light in the book The Great Gatsby by F. Scott Fitzgerald” prompt. ChatGPT, 13 Feb. version, OpenAI, 8 Mar. 2023.
- **Some caveats**
    - First, try finding the information you’re looking for yourself with Google, StackOverflow, etc.
        - It helps you learn how to format your questions
    - Don’t put sensitive information into ChatGPT…
    - ChatGPT will hallucinate and make up packages/functions that don’t exist
    - Sometimes, ChatGPT can make your code more unreadable or difficult to follow
- Note: Microsoft Copilot is the official AI tool for UW with commercial data protection.

Course Overview

Software and Computing

- R, R-studio: http://www.r-project.org, http://www.rstudio.com
- Tableau: https://www.tableau.com/academic/students
- Python: https://www.python.org
- Anaconda: https://www.anaconda.com
- GitHub: https://github.com

- Bring your computer (Windows, MacBook, or Linux is acceptable) to the class. If you have any trouble with having a computer, you may check the computing resources from the college, Student Technology Loan Program, or UW libraries computer service.

Reminders

- Finish Lab 1-A (setting up R and RStudio)
- Talk to me if you are going to use Python, or try to waive this class, or have other questions or concerns.

Thank you!

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RE 519 Real Estate Data Analysis and Visualization
Course Website: www.yuehaoyu.com/data-analytics-visualization/
Autumn 2025

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Cover page credits: Visax