

ISA 401: Business Intelligence & Data Visualization

01: Introduction to BI and Data Viz

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Office Hours: Automated Scheduler for Virtual Office Hours

Spring 2022

Learning Objectives for Today's Class

- Describe **course objectives** and **structure**.
- Define **data visualization** and describe its **main goals**.
- Describe the **BI methodology** and its **major concepts**.

Course Design, Expectations, and Overview

The Analytics Journey: Pre-Analytics [1]

- **Pre-Analytics/Data Management:** where one attempts to **extract** the needed *data* for analysis. Data can either be:



- Stale, uninteresting, convenient
- Highly processed and archived
- Example: `iris`, `mtcars`, `titanic`



- Fresh, interesting, challenging
- Impactful and sometimes locally collected
- Examples: [Cincinnati Open Data Portal](#), [Ohio Data Portal](#), [US Government's Open Data](#).

Footnotes:

- While the highly processed data can be useful in learning basic concepts, **real-world (often messy)** data are much more interesting to work with -- **e.g., we can make useful & meaningful decisions from the data.** In this class, we will learn how to scrape, extract and clean messy data in addition to visualizing clean[ed] data.
- Source: Slide inspired by [Kia Ora's What I mean by "data"](#).

The Analytics Journey: Pre-Analytics [2]

Non-Graded Class Activity # 1

Take 5 minutes to discuss with your partner

Activity	Your Solution	Fadel's Approach (No Solution Shown)
----------	---------------	--------------------------------------

- Go to <https://data.cincinnati-oh.gov/Safety/Traffic-Crash-Reports-CPD-/rvmt-pkmq/data>
- Download the data utilizing the export column and answer the following questions:
 - How many **observations/rows** and **columns** do we have in the dataset?
 - How many **crashes** are reported in the dataset?

The Analytics Journey: Pre-Analytics [2]

Non-Graded Class Activity # 1

Take 5 minutes to discuss with your partner

Activity

Your Solution

Fadel's Approach (No Solution Shown)

- Insert your solution here, **which you can do by capitalizing on the pencil icon on the top right of the screen**. This will likely only work if you are viewing this file outside of Canvas.

The Analytics Journey: Pre-Analytics [2]

Non-Graded Class Activity # 1

Take 5 minutes to discuss with your partner

Activity

Your Solution

Fadel's Approach (No Solution Shown)

```
if(require(tidyverse) == FALSE) install.packages("tidyverse")

# Link obtained from site -> Export -> "Right Click on" CSV
crashes = readr::read_csv("https://data.cincinnati-oh.gov/api/views/rvmt-pkmq/rows.csv?accessType=DOWNLOAI

# Number of rows and columns
nrow(crashes)
ncol(crashes)
# Or alternatively
dim(crashes)

# Total number of crashes
# Will be discussed in class in greater detail
```

The Analytics Journey: Descriptive [1]

- **Descriptive Analytics:** where one attempts to **understand** the data through **descriptive statistics** and **visualizations**.

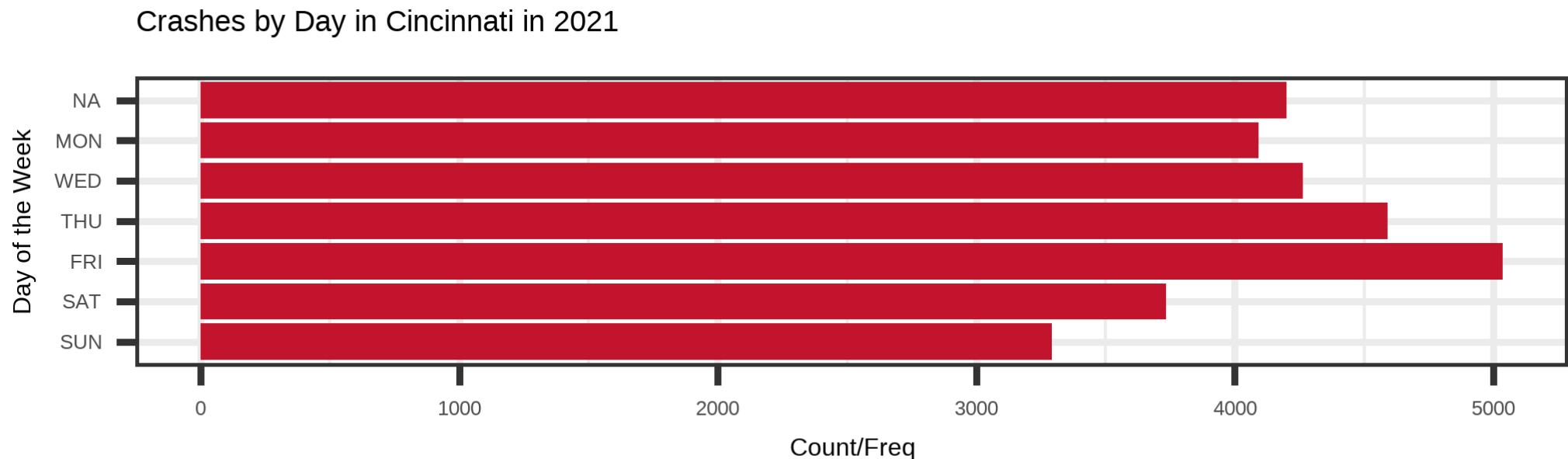
Descriptive Statistics for 2 Categorical Variables

```
## $dayofweek
##
##   FRI   SAT   TUE   MON   WED   SUN   THU
## 5036 3735 4199 4093 4264 3291 4592
##
## $weather
##
##           1 - CLEAR                      4 - RAIN
##                   19902                     3771
##           2 - CLOUDY                     99 - OTHER/UNKNOWN
##                   4550                      267
##           6 - SNOW                      3 - FOG, SMOG, SMOKE
##                   638                        18
##     8 - BLOWING SAND, SOIL, DIRT, SNOW 9 - FREEZING RAIN OR FREEZING DRIZZLE
##                           2                         20
##           5 - SLEET, HAIL                  7 - SEVERE CROSSWINDS
##                           41                         2
```

The Analytics Journey: Descriptive [2]

- **Descriptive Analytics:** where one attempts to **understand** the data through **descriptive statistics** and **visualizations**.

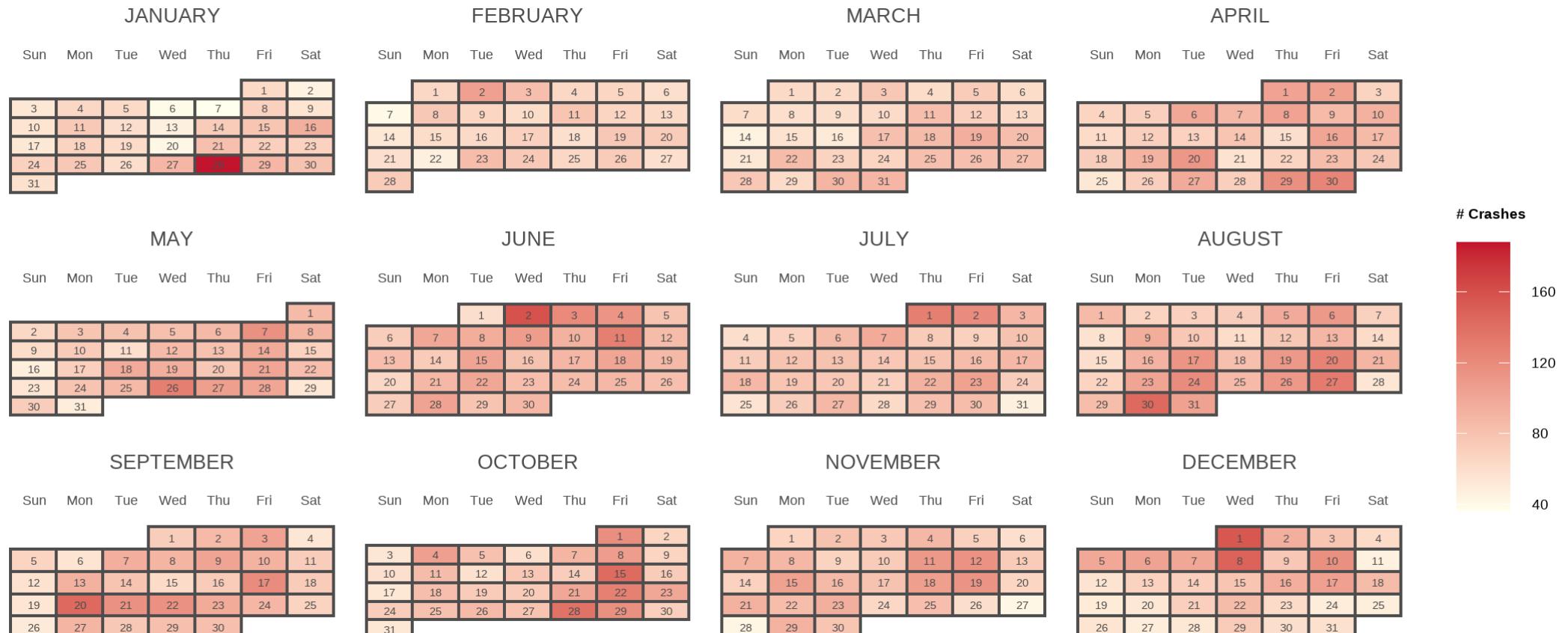
A Simple Visualization - A Bar Chart of Crashes Per Day



Created by: Fadel Megahed | Data source: City of Cincy Open Data Portal (rvmt-pkmq)

The Analytics Journey: Descriptive [3]

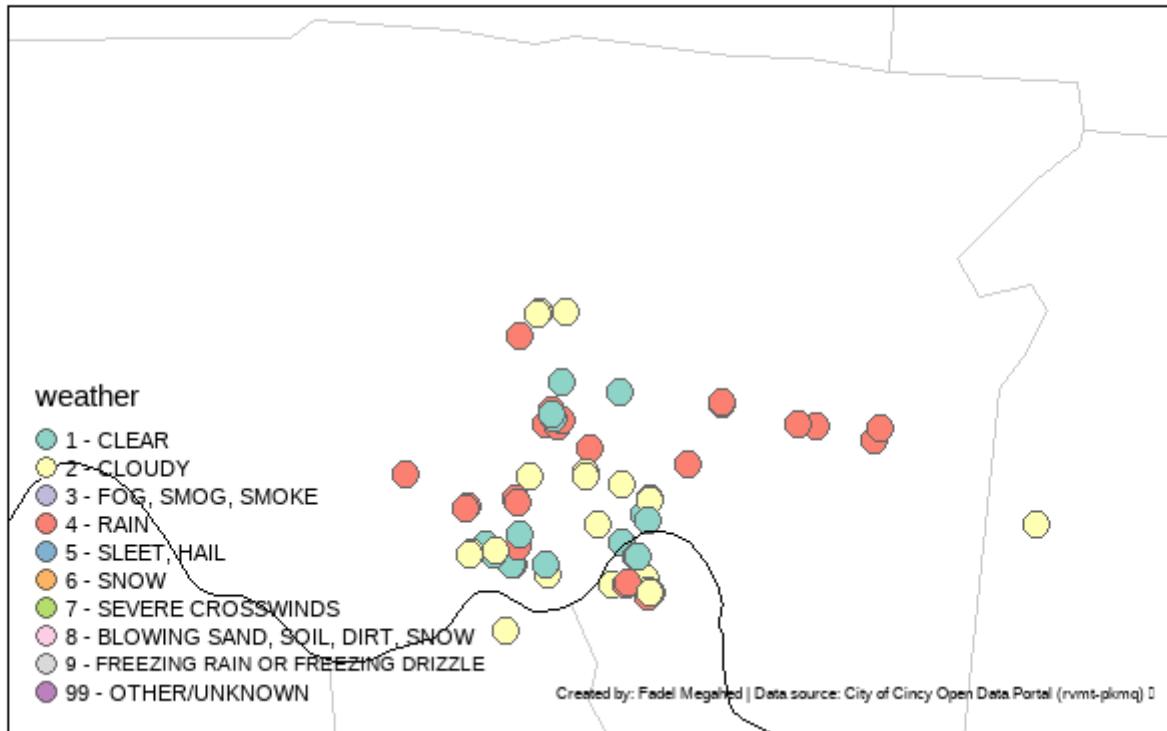
- **Descriptive Analytics:** where one attempts to **understand** the data through **descriptive statistics** and **visualizations**.



The Analytics Journey: Descriptive [4]

- **Descriptive Analytics:** where one attempts to **understand** the data through **descriptive statistics** and **visualizations**.

2021-01-01



The Analytics Journey: Descriptive [5]

Activity

Q1 Solution

Q2 Solution

- How do the previous two graphs complement each other?
- If you were to pick one of the two charts, which one is more informative?
- You will be asked to write down your answers on in the next two panels.

03:00

The Analytics Journey: Descriptive [5]

Activity

Q1 Solution

Q2 Solution

Go to www.menti.com/spcmam4f23

How the two graphs complement each other?



The Analytics Journey: Descriptive [5]

Activity

Q1 Solution

Q2 Solution

Go to www.menti.com/z15vty41xg

Which one of the charts is more informative?



The Analytics Journey: Predictive [1]

- **Predictive Analytics:** where **statistical** and **machine learning** models are used to help us utilize independent variable[s] to predict an outcome variable of choice (which can be binary/dichotomous, multinomial/multi-class, or continuous).
 - From my teaching/research/consulting experience, **many** consider this component to be the  aspect of the analytics journey.
 - That being said, your success in this stage is **hinged on having:**
 - **Correct**  data, i.e.,
 - *Do you actually capture the important predictors as potential independent variables?*
 - *Is your data aggregated to the right level?*
 - **Cleaned**  data, i.e.,
 - *Is your data tidy?*
 - *Is your data technically correct?*
 - *Is your data consistent?*
 - With the above constraints/setup, now you can explore how to model the data using statistical and machine learning models? **Some recommendations:**
 - Start with the simplest (which is also often the most easy-to-explain) model first.
 - If you are happy with the predictive performance (i.e., no gains would be of practical benefit), you are done .
 - If not,  and try other models.

The Analytics Journey: Predictive [2]

- **Predictive Analytics:** where **statistical** and **machine learning** models are used to help us utilize independent variable[s] to predict an outcome variable of choice (which can be binary/dichotomous, multinomial/multi-class, or continuous). **For two transportation safety examples, see:**

Transportation Research Part C 126 (2021) 103016



Contents lists available at ScienceDirect

TRANSPORTATION
RESEARCH
Part C: Emerging Technologies

Transportation Research Part C

journal homepage: www.elsevier.com/locate/trc



The association between crashes and safety-critical events:
Synthesized evidence from crash reports and naturalistic driving
data among commercial truck drivers

Miao Cai ^a, Mohammad Ali Alamdar Yazdi ^b, Amir Mehdizadeh ^c, Qiong Hu ^c,
Alexander Vinel ^c, Karen Davis ^d, Hong Xian ^e, Fadel M. Megahed ^f,
Steven E. Rigdon ^{e,*}

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^c Department of Industrial and Systems Engineering, Auburn University, Auburn, AL 36849, United States

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ARTICLE INFO

Keywords:

Truck
Naturalistic driving studies
Safety critical events
Crashes
Injuries
Fatalities

ABSTRACT

The past decade has witnessed continuous growth of naturalistic driving studies (NDSs). When analysing NDS data, safety-critical events (SCEs) are commonly used as surrogates for safety, since actual crashes are very rare. However, the association between SCEs and crashes is not consistent in previous studies and has not been verified among commercial truck drivers. Based on routinely collected kinematic data from 31,828 truck drivers in a large commercial trucking company, this paper examines the association between four types of SCEs (headway, hard brake, collision mitigation, and rolling stability) and crashes, as well as injuries and fatalities. Compared to existing studies on the subject, that are based on up to about 2 million miles driven, our study involves an estimated 2.3 billion miles driven. Bayesian negative binomial models were applied to

Accident Analysis and Prevention 159 (2021) 106285



Contents lists available at ScienceDirect

TRANSPORTATION
RESEARCH
Part C: Emerging Technologies

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap



Predicting unsafe driving risk among commercial truck drivers using
machine learning: Lessons learned from the surveillance of 20 million
driving miles

Amir Mehdizadeh ^a, Mohammad Ali Alamdar Yazdi ^b, Miao Cai ^c, Qiong Hu ^a, Alexander Vinel ^a,
Steven E. Rigdon ^c, Karen Davis ^d, Fadel M. Megahed ^{e,*}

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^b Carey Business School, Johns Hopkins University, Baltimore, MD 21218, USA

^c Department of Epidemiology and Biostatistics, Saint Louis University, Saint Louis, MO 63104, USA

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^e Farmer School of Business, Miami University, Oxford, OH 45056, USA

ARTICLE INFO

Keywords:

Artificial intelligence
Big data analytics
Crash risk prediction
Naturalistic driving
Near crashes
Safety critical events

ABSTRACT

The emergence of sensor-based *Internet of Things* (IoT) monitoring technologies have paved the way for conducting large-scale naturalistic driving studies, where continuous kinematic driver-based data are generated, capturing crash/near-crash safety critical events (SCEs) and their precursors. However, it is unknown whether the SCEs risk can be predicted to inform driver decisions in the medium term (e.g., hours ahead) since the literature has focused on SCE predictions either for a given road segment or for automated braking applications, i.e., immediately before the event. In this paper, we examine the SCE data generated from 20+ million miles driven by 496 commercial truck drivers to address three main questions. First, whether SCEs can be predicted using disparate driving-related data sources. Second, if so, what the relative importance of the different predictors examined is. Third, whether the prediction models can be generalized to new drivers and future time periods. We show that SCEs can be predicted 30 min in advance, using machine learning techniques and dependent variables capturing the driver's characteristics, weather conditions, and day/time categories, where an area under the curve (AUC) up to 76% can be achieved. Moreover, the predictive performance remains relatively stable when tested on new (i.e., not in the training set) drivers and a future two-month time period.

The Analytics Journey: Prescriptive [1]

- **Prescriptive Analytics:** where **mathematical models** are used to make recommendations for business actions.
- Recall that our **overarching goal** behind data/business analytics, is to **make informed decisions based on what we have learned from the data**. Hence, this stage is where we build on what we learned during the *descriptive* and *predictive* stages to make more informed decisions.
- Now imagine that you are a large trucking company (e.g., Amazon, Fedex, JB Hunt, etc), and you have models that show **both**:
 - The factors that your on-board sensors capture driving safety critical events that are associated with crashes.
 - You have a reasonable model that helps you predict the occurrence of safety critical events as a function of:
 - Driver characteristics
 - Weather conditions
 - Traffic conditions
- **As a business analyst, what two reasonable questions would you attempt to approach/optimize for?**

The Analytics Journey: Prescriptive [2]

- **Prescriptive Analytics:** where **mathematical models** are used to make recommendations for business actions.

Non-Graded Class Activity # 3

| Take 3 minutes to formulate the two best questions with your partner

Activity Your Solution Our Work in this Area

As a business analyst, what two reasonable questions would you attempt to approach/optimize for?

The Analytics Journey: Prescriptive [2]

- **Prescriptive Analytics:** where **mathematical models** are used to make recommendations for business actions.

Non-Graded Class Activity # 3

| Take 3 minutes to formulate the two best questions with your partner

Activity Your Solution Our Work in this Area

- Insert your solution here, **which you can do by capitalizing on the pencil icon on the top right of the screen**. This will likely only work if you are viewing this file outside of Canvas.

The Analytics Journey: Prescriptive [2]

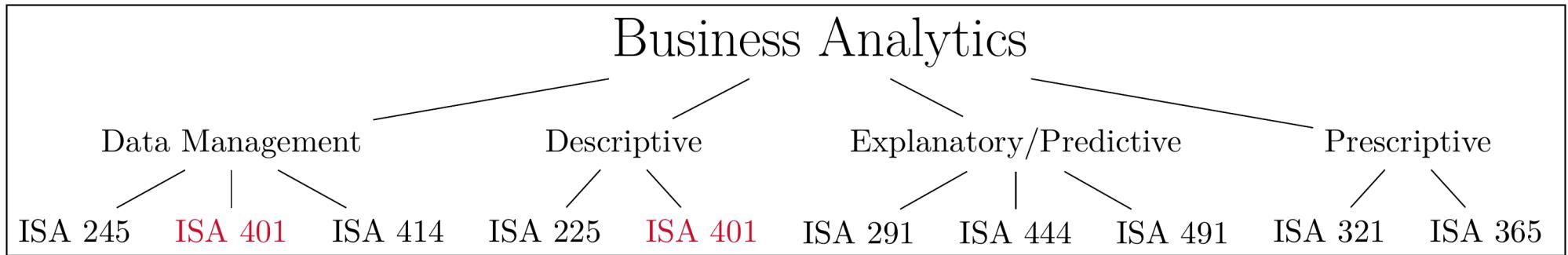
- **Prescriptive Analytics:** where **mathematical models** are used to make recommendations for business actions.

Non-Graded Class Activity # 3

Take 3 minutes to formulate the two best questions with your partner

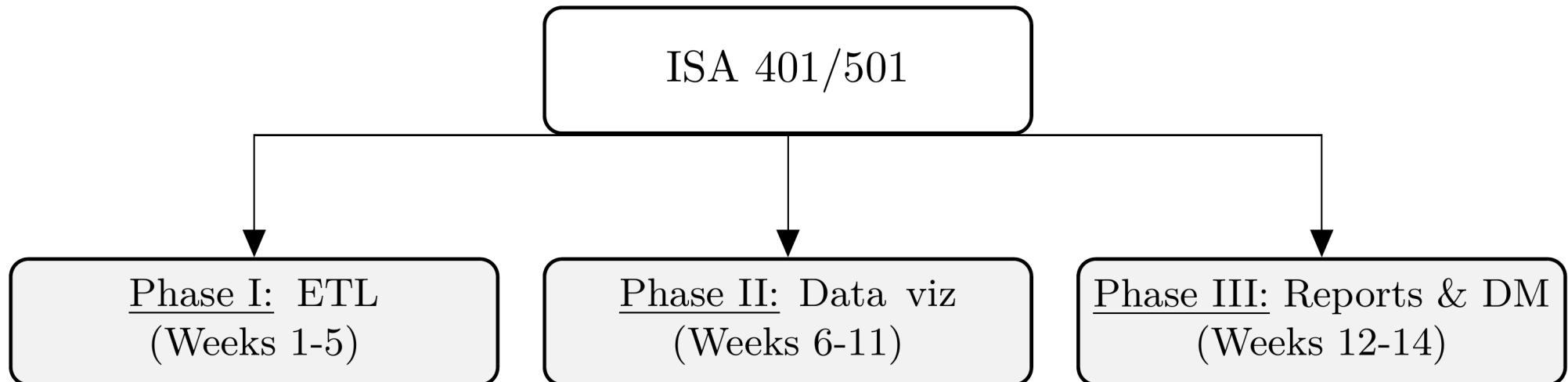
Activity	Your Solution	Our Work in this Area
		 A map of Indiana and surrounding states (Illinois, Michigan, Ohio, Kentucky, Tennessee) showing a blue line path from Chicago to Louisville. The path follows the northern edge of Indiana, then turns inland through South Bend, Fort Wayne, and Evansville before reaching Louisville. A legend on the right indicates 'path_index' with a blue line segment labeled 'path1'. Rank=1
		 A map of Indiana and surrounding states showing two paths. A blue line path1 follows the same route as the first map. A red line path3 starts from Chicago, goes south through South Bend and Fort Wayne, then turns east to Evansville and finally south to Louisville. A legend on the right indicates 'path_index' with a blue line segment labeled 'path1' and a red line segment labeled 'path3'. Rank=2
		 A map of Indiana and surrounding states showing two paths. A blue line path4 follows the same route as the previous maps. A red line path8 starts from Chicago, goes south through South Bend and Fort Wayne, then turns east to Evansville and finally south to Louisville. A legend on the right indicates 'path_index' with a blue line segment labeled 'path4' and a red line segment labeled 'path8'. Rank=3

How does our Curriculum at Miami University Prepare you for this Journey?



My take on the courses within the business analytics major/minor at Miami University

ISA 401/501 Course: An Overview



How the ISA 401/501 course is organized.

ISA 401/501 Course Objectives

Even though software will be extensively used, this is not a software class. **Instead, the focus is on understanding the underlying methods and mindset of how data should be approached.**

- Be capable of extracting, transforming and loading (ETL) data using multiple platforms (e.g. R, Power BI and/or Tableau).
- Write basic R scripts to preprocess and clean the data.
- Explore the data using visualization approaches that are based on sound human factors.
- Understand how statistical/machine learning can capitalize on the insights generated from the data visualization process.
- Create interactive dashboards that can be used for business decision making, reporting and/or performance management.
- Be able to apply the skills from this class in your future career.

Should you Care? Indeed [1]

Technology > Data & Database Occupations > Data Scientists & Statisticians

Date Posted ▾ Remote ▾ \$100,000+ X Job Type ▾ Location ▾ Company ▾ Entry Level X

Upload your resume - Let employers find you

data wrangling \$100,000 jobs in United States

Sort by: relevance - date Page 1 of 19 jobs ⓘ

Data Science Fellow
Jacaranda Health
Remote
Easily apply
ETL and data wrangling, particularly with less-than-ideal datasets.
Experience managing data science projects across teams.
30+ days ago • Save job • More...

Statistician (Data Scientist) *12 month Roster* *Direct Hire...
US Department of the Treasury 4.0 ★
Birmingham, AL • Remote
\$91,231 - \$144,676 a year
Experience working with multiple data types and formats as a part of a data science project.
Apply statistical methods and concepts including data mining,...

Be the first to see new data wrangling \$100,000 jobs in United States

My email:
Activate
By creating a job alert, you agree to our [Terms](#). You can change your consent settings at any time by unsubscribing or as detailed in our terms.

My recent searches

data wrangling R \$100,000 - United States
web scraping R \$100,000 - United States
» clear searches

Entry-Level Data Wrangling Jobs on Indeed.com

Should you Care? Indeed [2]

The screenshot shows a job search interface on Indeed.com. At the top, there are several filters: Date Posted (dropdown), Remote (checkbox), \$100,000+ (checkbox), Full-time (checkbox), Location (dropdown), Company (dropdown), and Entry Level (checkbox). Below the filters, the search query "data visualization \$100,000 jobs in United States" is displayed. The results are sorted by relevance - date, with 572 jobs found on page 1. A specific job listing for a Data Scientist at CompGain LLC in Woodlawn, MD (temporarily remote) is highlighted. The listing includes a company logo (CompuGain), job title, employer, location, and a "Temporarily remote" note. It also shows an "Easily apply" button and a list of required skills: Experience in advance data visualizations and interpretation, Data manipulation and data engineering experience involving structured and unstructured data. The job was posted 4 days ago and has a "Save job" option. To the right of the main search area, there is a sidebar with a "Be the first to see new data visualization \$100,000 jobs in United States" section, which includes a "My email:" input field and an "Activate" button. A note below explains that by creating a job alert, users agree to Terms and can change their consent settings.

Entry-Level Data Visualization Jobs on Indeed.com

Should you Care? Read this Job Ad

When I have designed this course, I have incorporated a lot of feedback from **industry collaborators, peer/leading academic programs, and state-of-the-art-research advancements**. Thus, this is meant to be a hands-on, practically-relevant course.

Non-Graded Class Activity # 4

*Take 4 minutes to pinpoint the **skills and qualifications that you have prior to taking this class**, and **document what you will learn in this course to make you more competitive**.*

Activity

Documentation Space

To demonstrate the practicality of this course, let us consider [this job ad](#).

- Please open the Data Scientist (6257U) - CED Data Scientist position at UC - Berkeley by clicking [here](#).
- Compare the **responsibilities** and the **required qualifications** with the course objectives.
- Read through the required qualifications.
- **Document what you will learn in this course to make you more competitive.**

Should you Care? Read this Job Ad

When I have designed this course, I have incorporated a lot of feedback from **industry collaborators, peer/leading academic programs, and state-of-the-art-research advancements.** Thus, this is meant to be a hands-on, practically-relevant course.

Non-Graded Class Activity # 4

*Take 4 minutes to pinpoint the **skills and qualifications that you have prior to taking this class**, and **document what you will learn in this course to make you more competitive.***

Activity

Documentation Space

Should you Care? Recent Alumni Testimonials

Hi Fadel,

I hope you had a nice summer and are having a great start to the school year! In a bunch of my trainings at Deloitte we have gone over data visualization and wow, I am definitely ahead of the curve. I am also using R every day on my project. So, thank you! Your 401 class prepared me perfectly for the start of my career!

I am reaching out on behalf of Deloitte Consulting's Miami Recruiting team. We are recruiting Miami students this fall for Full-Time and Summer Scholar (internship) positions. The attached page outlines the two full-time roles we are hiring for: Business Analysts (Strategy & Operations competency) and Business Technology Analysts (Technology competency). You should also be receiving additional information via a newsletter from your department chair shortly as well.

If you are interested in learning more about Deloitte Consulting and opportunities for your students, please reach out to our Miami Recruiting Campus Leads, [Erica Guidobono](#) or [Haley Johnson](#), they would be happy to connect with you.

Thank you!

Hi Fadel,

I'm not sure if you remember me but I took a couple of your classes (Data Visualization and Optimization) a few years ago.

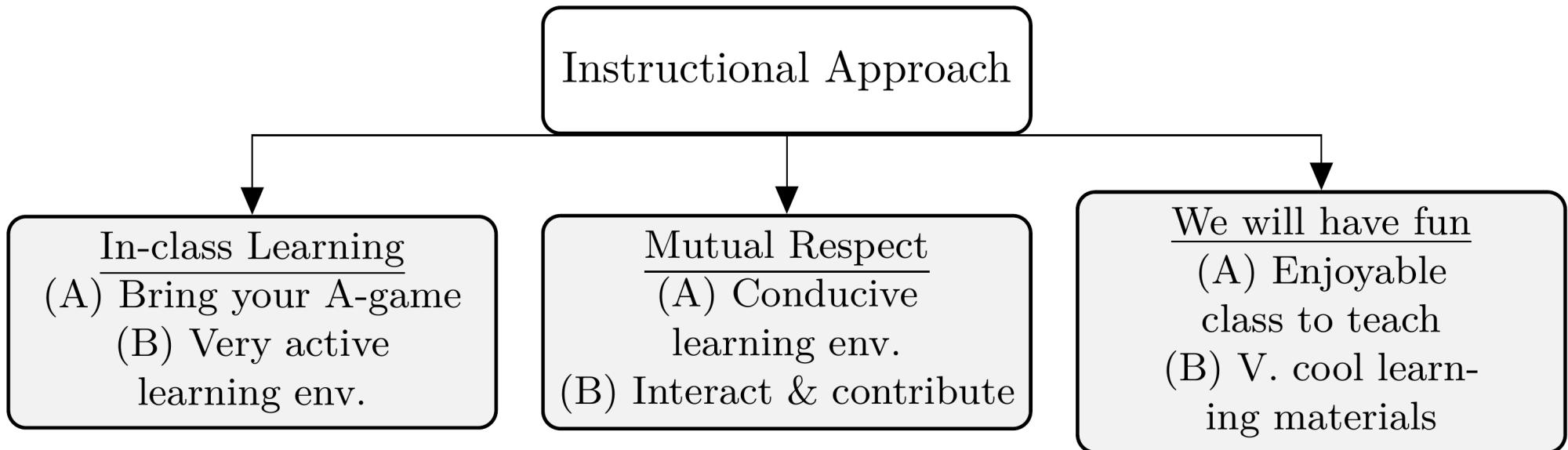
I'm reaching out because I wanted to express how grateful I am that I took your classes and how impactful they have been since I graduated.

When I graduated I got a job as an IT Auditor with EY. I didn't expect to use what I learned in my analytics classes in my job, but consistently throughout my first year here, it has been my analytics background that has set me apart from so many of my peers. The ability to code, to understand data, and to speak confidently about analytics has helped me form close relationships with partners in the firm, helped me to get staffed on projects that nobody in my start class has had the opportunity to get staffed on, and has helped to get my name out there in the firm faster than I could have ever imagined. For example, I was recently staffed on a project using a language I have never touched before to test data I have never seen before and the firm is confident I can handle it because of my experiences at Miami and the results that I've produced so far using that education.

I owe a lot of this to you. You were by far my favorite analytics professor and I find the way that you taught to be the most applicable to the working world.

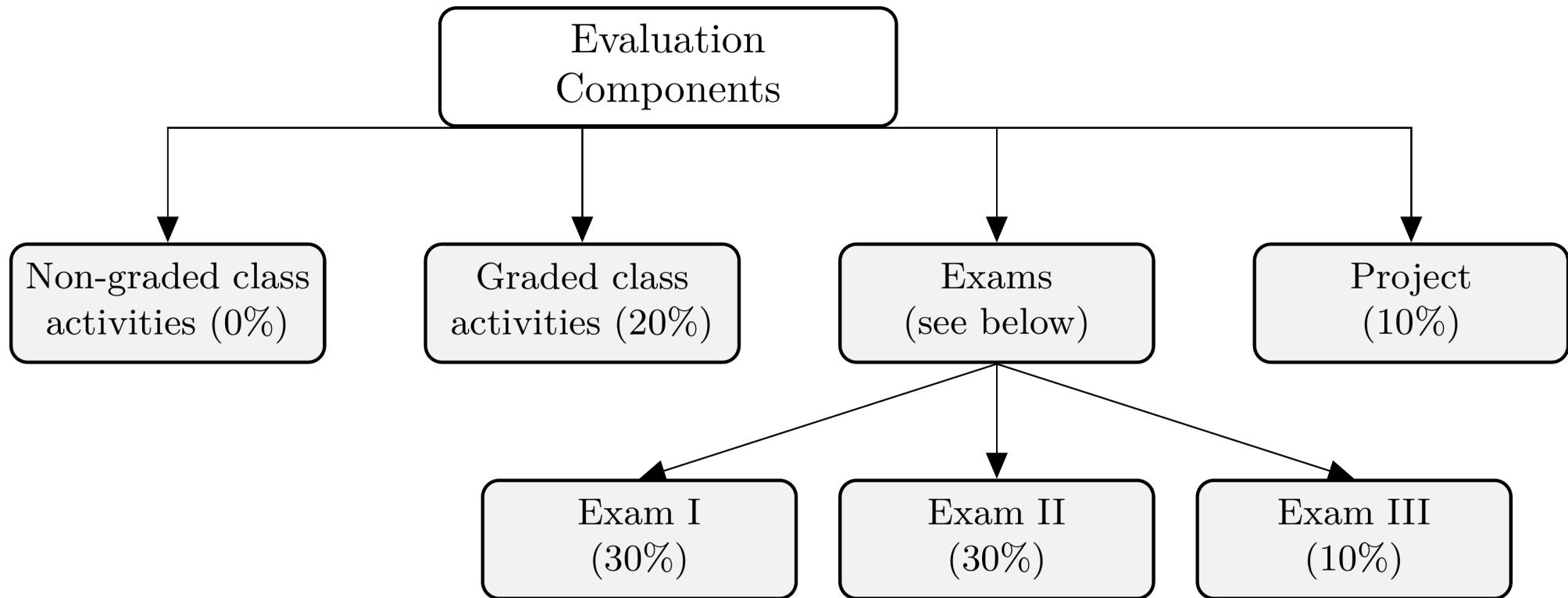
Really I just want to say thank you. Looking back on my time at Miami, you made a huge impact on my time there and now my time at work too. Your classes kept me interested and motivated to learn about analytics and now I see those dividends being paid off. I feel very blessed to have had you as my educator.

Instructional Approach



An overview of the instructional approach for ISA 401/501.

How will I Evaluate your Learning?



An overview of the evaluation components for ISA 401/501.

Introductions: Getting to Know Each Other

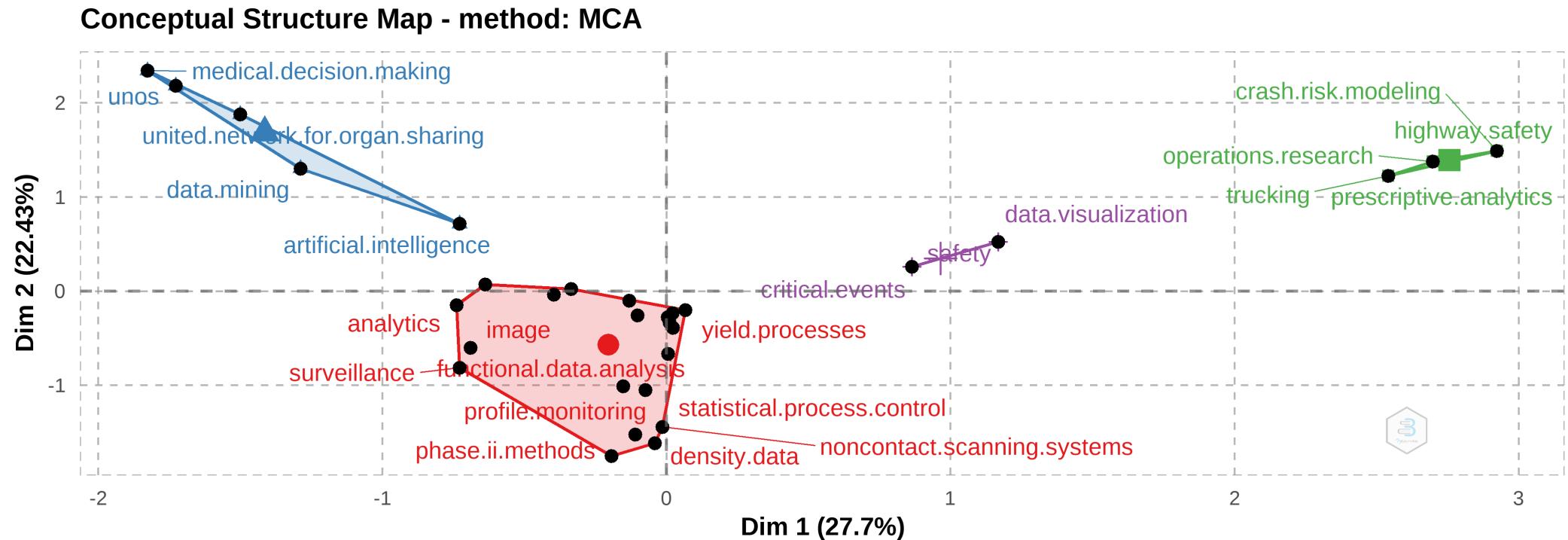
About Me – My route to Miami University

- Application of data-driven decisions (D3) in 3 continents.
- **Interests:** Applications in logistics, manufacturing, occupational safety & portfolios.
- **Collaborations with:** Aflac, GE Research, IBM Research, JB Hunt, & Tennibot



My journey with data-driven decision making.

An Overview of My Research Portfolio

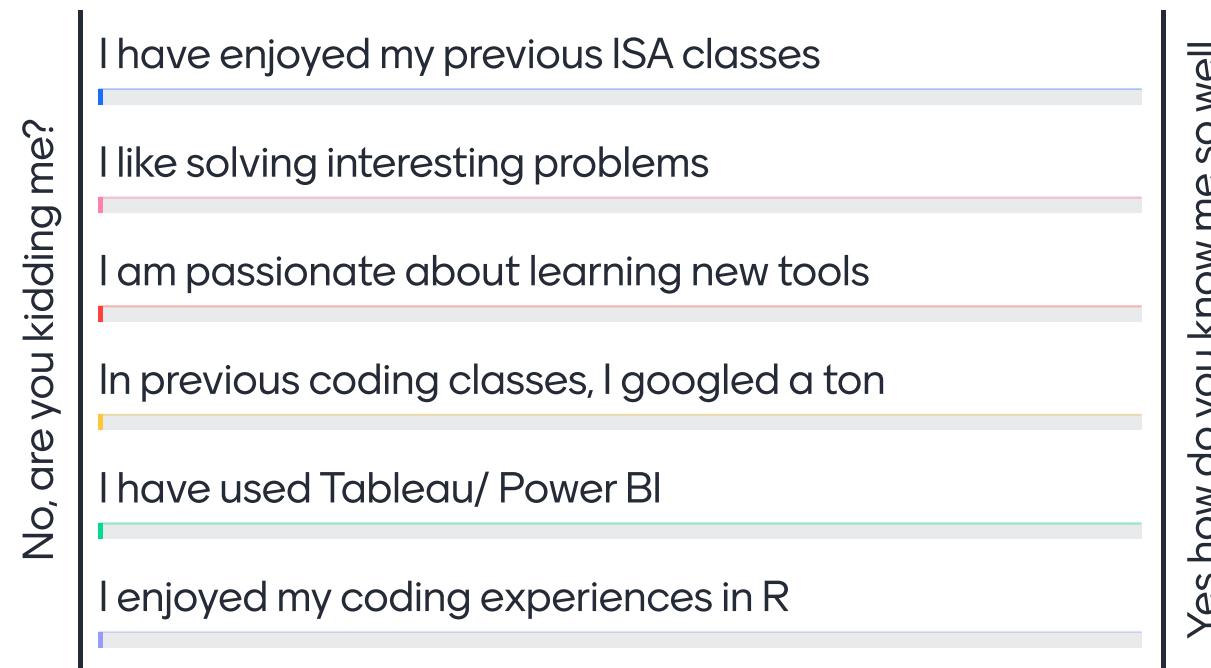


My work can be grouped into four different clusters.

Your Academic/Professional Experience

Go to www.menti.com/dcc974

On this scale, please answer the following:



Getting to Know Your Learning Objectives

Go to www.menti.com/epeqmvc7rw

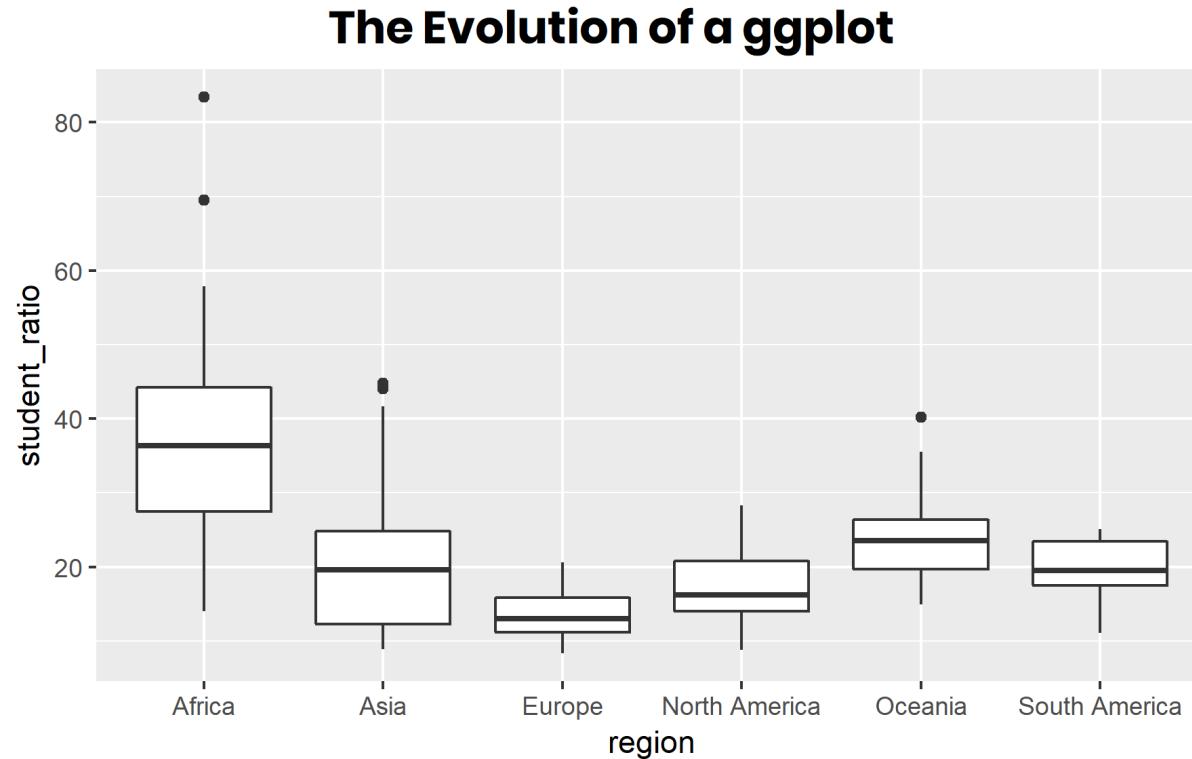
What are you hoping to get out of ISA 401/501?



So What is Data Visualization?

What is Data Visualization?

Data visualization involves **presenting data in a graphical format**. It is really a process that starts by getting data, creating initial plot(s) and modifying them to answer questions of interest (and possibly making the plot aesthetically pleasing). For example, see [Cedric Scherer's visualization of the UNESCO data on global student to teacher ratios](#).



Data: UNESCO Institute for Statistics
Visualization by Cédric Scherer

The Goals of Data Visualization

- **Record** information
- **Analyze** data to support reasoning
 - Develop and assess hypotheses (EDA)
 - Reveal patterns
 - Discover errors in data
- **Communicate** ideas to others
 - Infographics
 - Statistic charts
 - Interactive charts
 - Dashboards
- **Interact with the data (which supports all the above)**

Record: My Great Grandparents



Record: A More Modern Example



Tanya Shapiro
@tanya_shapiro

I'm a sucker for clean tables. Last week, I used **#RStats** and **gtExtra** magic to summarize by Peloton data.

This week, I couldn't resist taking **reactablefmtr** for a test drive too. [@kc_analytics](#), this package is beautiful!

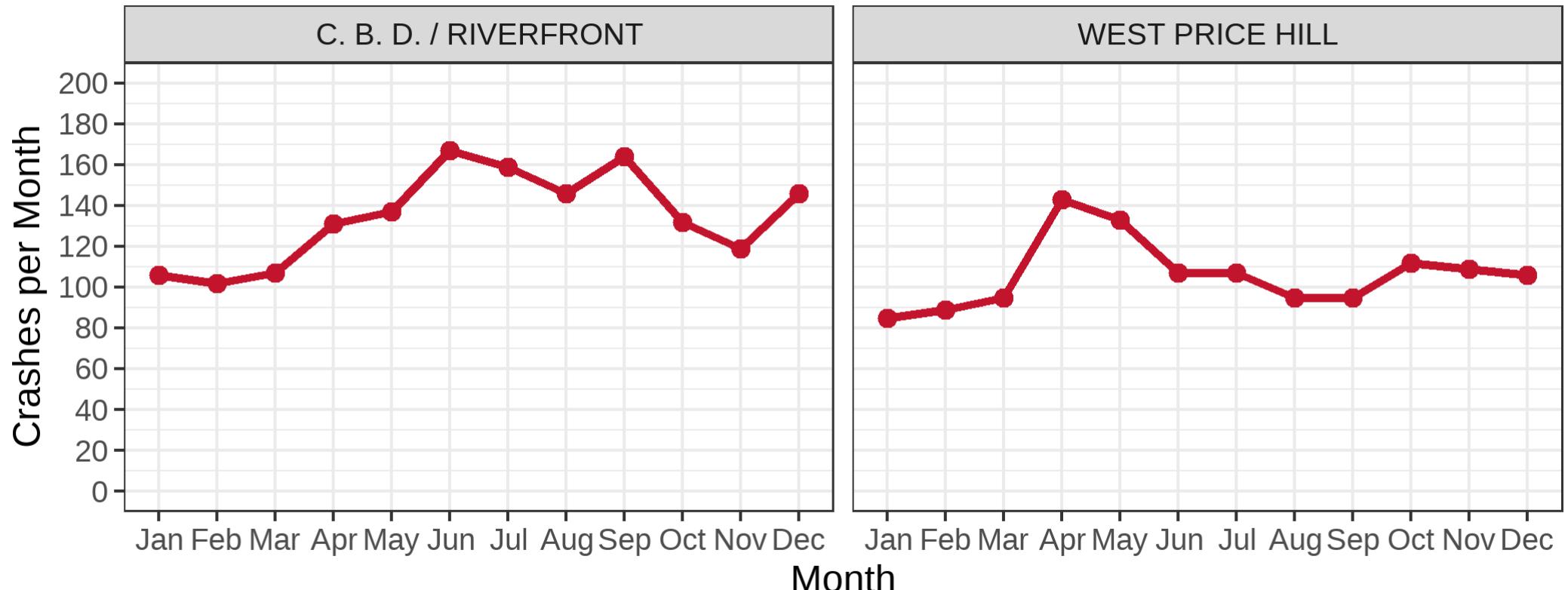
: tanyashapiro.com/interactive-vi...

INSTRUCTOR	TOP CLASS TYPE	TOTAL CLASSES	AVG DIFFICULTY	MONTHLY CLASSES
	Olivia Amato	Strength	<div style="width: 100%;">184</div> 7.36	
	Anna Greenberg	Yoga	<div style="width: 100%;">77</div> 5.81	
	Matty Maggiacomo	Strength	<div style="width: 100%;">76</div> 6.75	
	Kendall Toole	Cycling	<div style="width: 100%;">43</div> 7.67	
	Jess Sims	Bike Bootcamp	<div style="width: 100%;">39</div> 7.62	
	Tunde Oyeneyin	Cycling	<div style="width: 100%;">31</div> 7.85	

INSTRUCTOR	TOP CLASS TYPE	TOTAL CLASSES	AVG DIFFICULTY	MONTHLY CLASSES
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	Jess Sims	Bike Bootcamp	<div style="width: 100%;">39</div> 7.62	
	Tunde Oyeneyin	Cycling	<div style="width: 100%;">31</div> 7.85	
	Jess King	Cycling	<div style="width: 100%;">29</div> 7.32	
	Aditi Shah	Yoga	<div style="width: 100%;">27</div> 4.91	
	Adrian Williams	Strength	<div style="width: 100%;">26</div> 7	

Analyze Data

Crashes Recorded in Two Cincinnati Neighborhoods in 2021



Created by: Fadel Megahed | Data source: City of Cincy Open Data Portal (rvmt-pkmq)

Reveal Patterns: The 1854 Cholera Outbreak

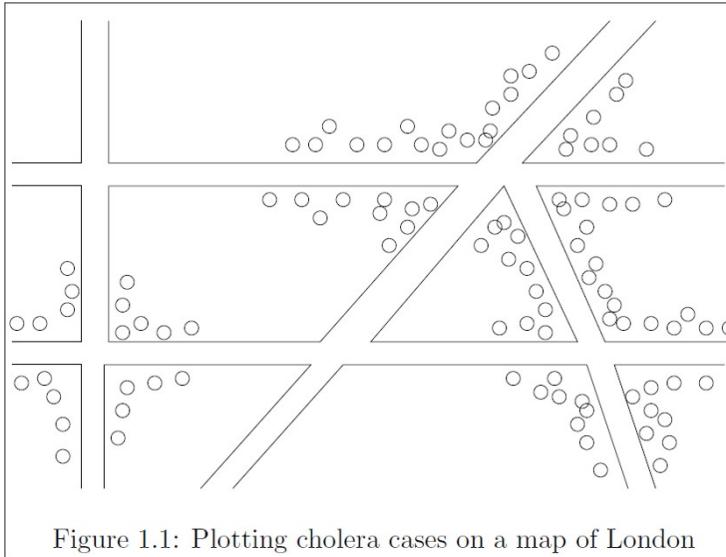


Figure 1.1: Plotting cholera cases on a map of London

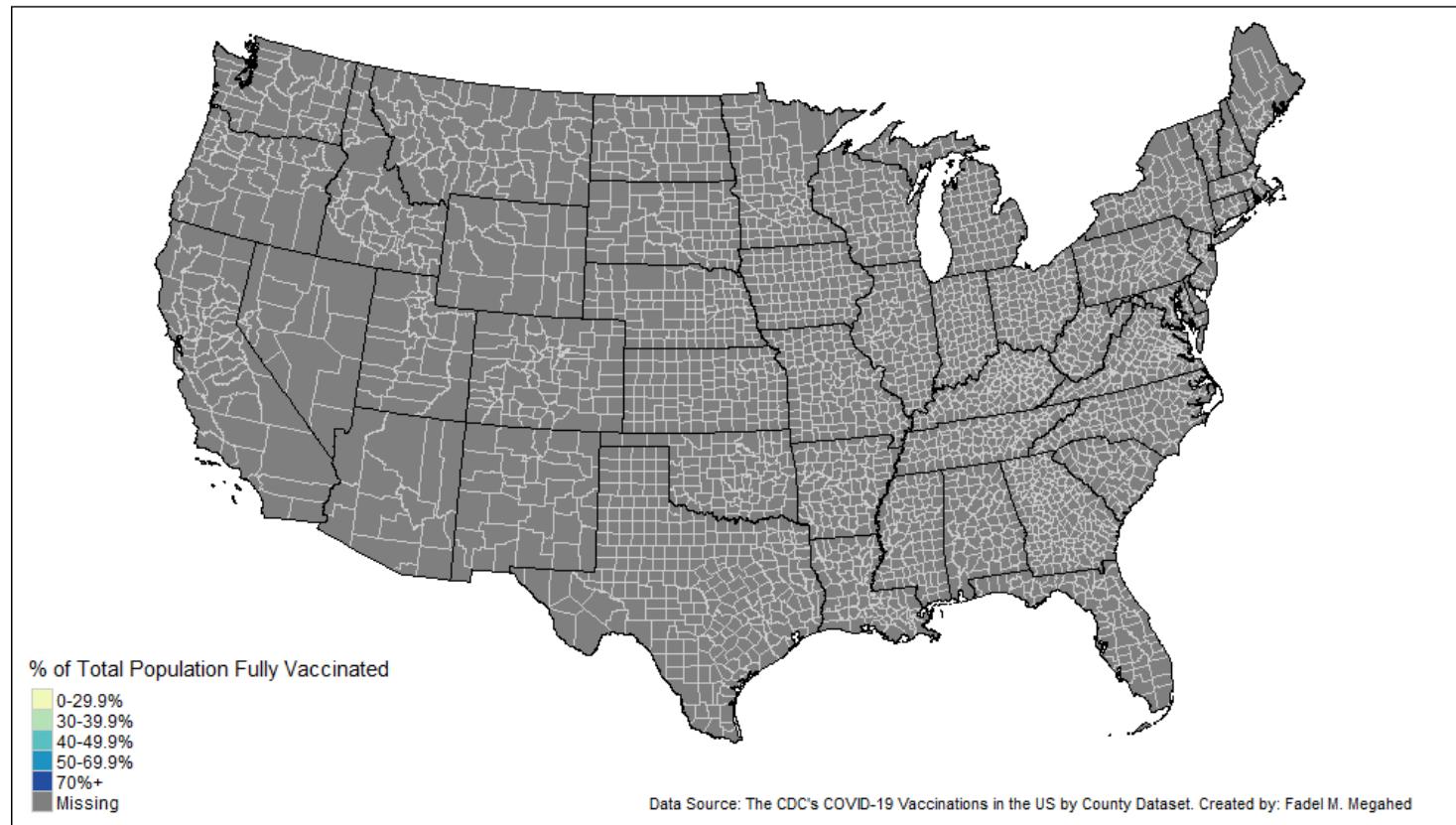
The physician John Snow, dealing with a Cholera outbreak plotted the cases on a map of the city (see schematic above).

Credits:

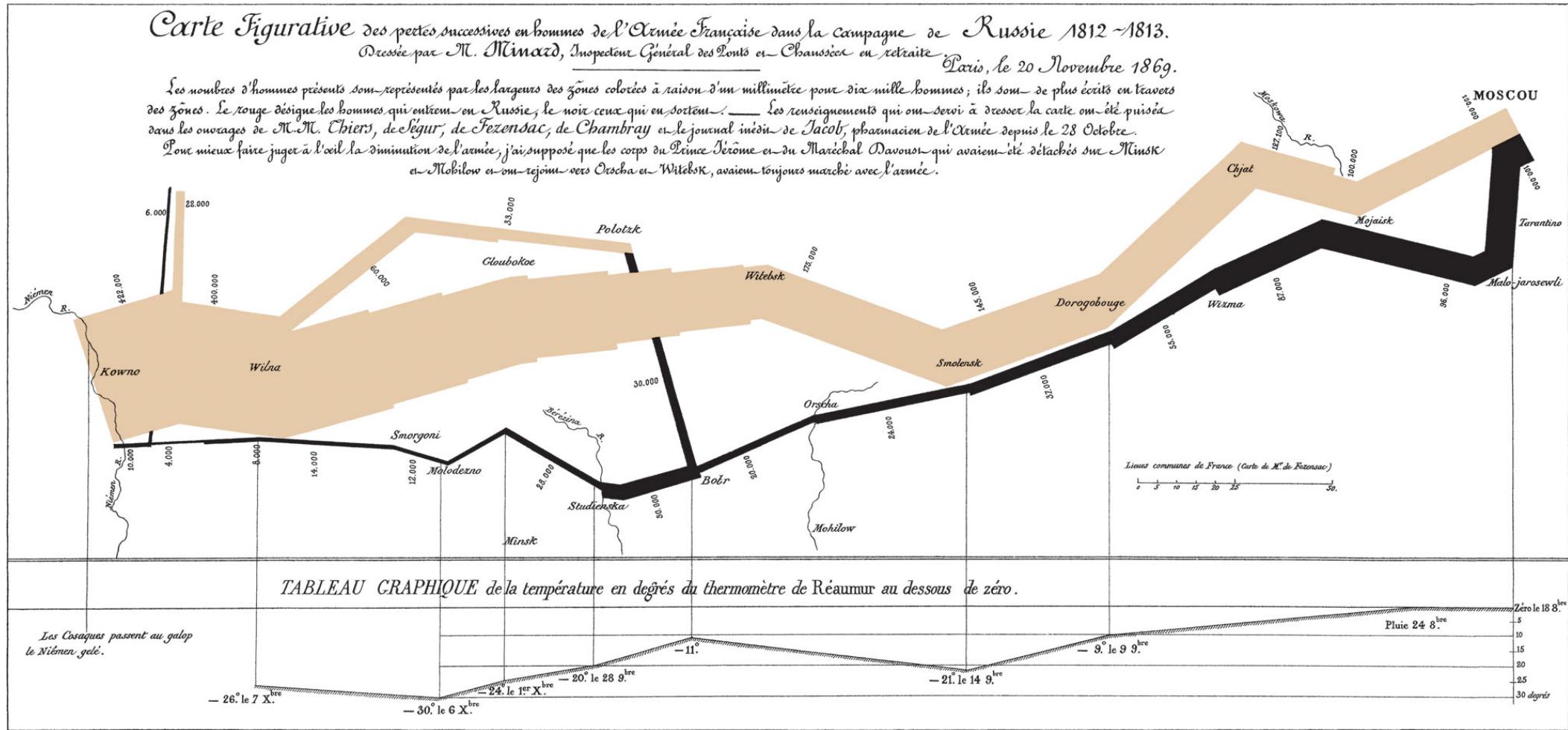
- Source: Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). Mining of Massive Data Sets (Third Edition). Cambridge University Press. Image is from Chapter 1, which can be accessed [here](#).

Reveal Patterns: COVID-19 Vaccination Rates

2020-12-13



Communicate Ideas: C.J Minard 1869



Communicate Ideas

Activity

Your Solution

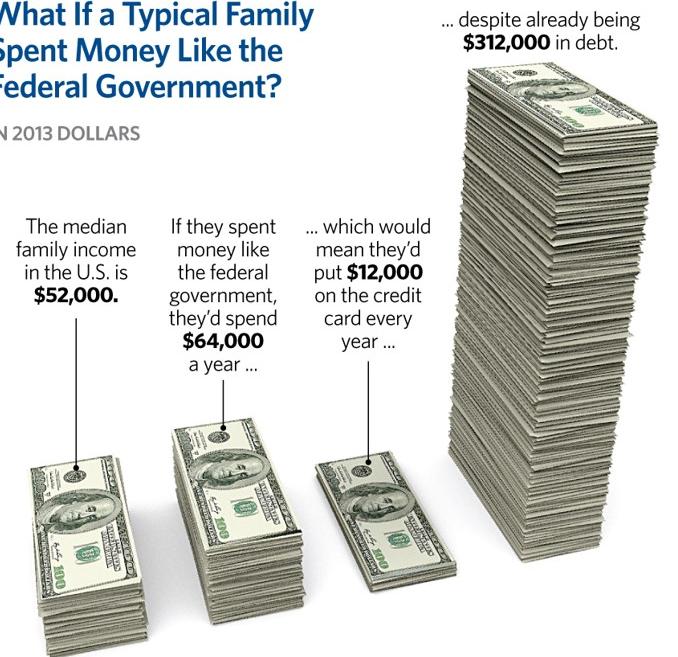
Non-Graded Class Activity #5

Take 5 minutes to discuss this visualization from the WA Post with a colleague

- Who is the target audience?
- What is the data represented in this visualization? Be Specific.
- How is the data visually encoded?
- Do you like/dislike this visualization? Why?
- Would you do visualization like this for a similar dataset? Why? Why not?

What If a Typical Family Spent Money Like the Federal Government?

IN 2013 DOLLARS



Source: Heritage Foundation calculations based on data from the Congressional Budget Office, *Updated Budget Projections: Fiscal Years 2013 to 2023*, May 2013, <http://www.cbo.gov/publication/44172> (accessed May 15, 2013).

Federal Spending by the Numbers 2013  heritage.org

05:00

Communicate Ideas

Activity

Your Solution

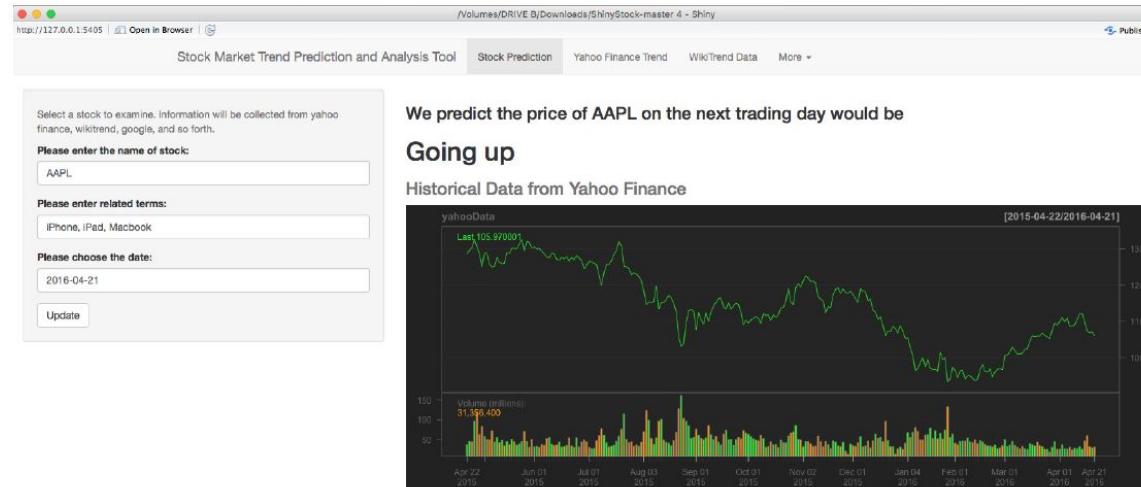
Interact



Business Intelligence: From Visualizations to Dashboards to Insights

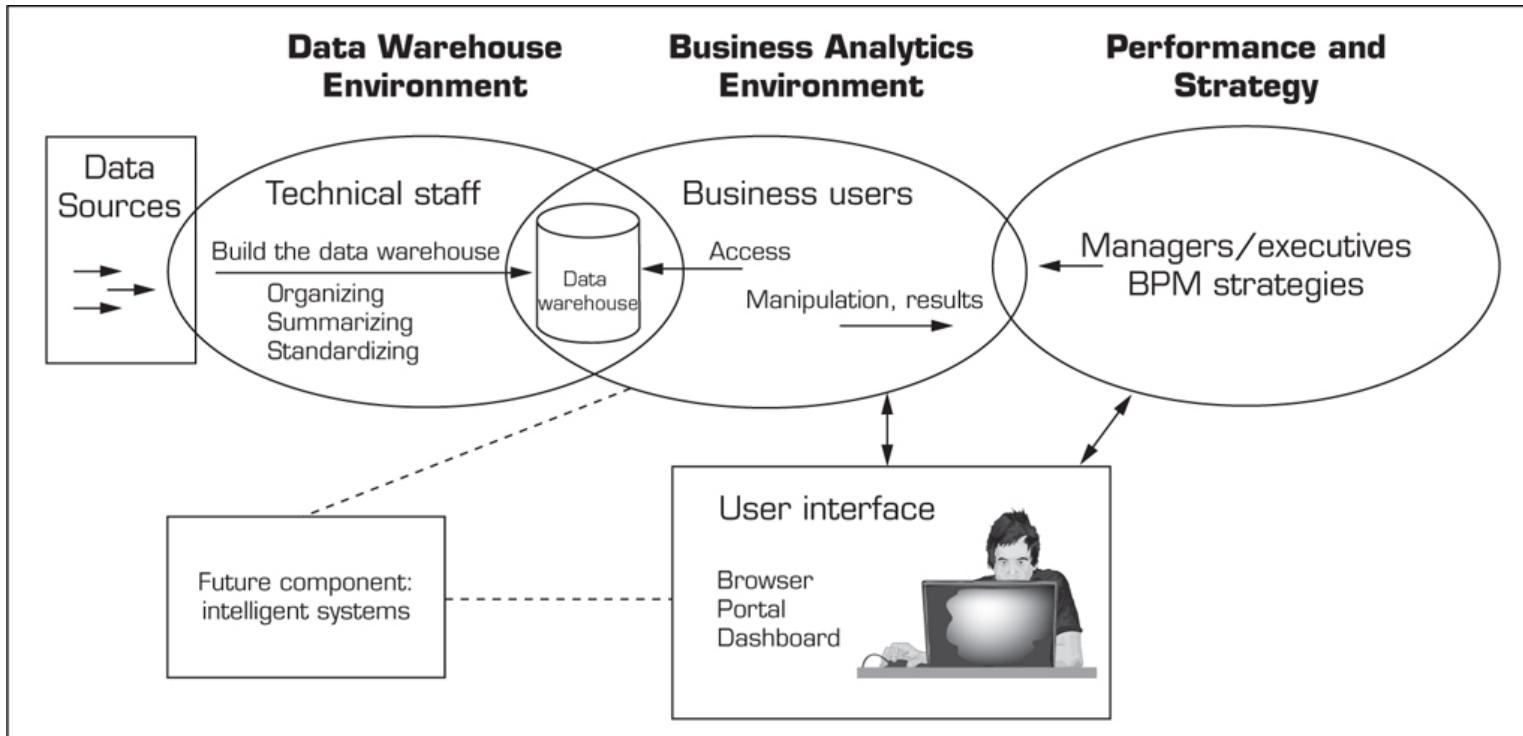
What is Business Intelligence?

"... to enable **interactive access (sometimes in real time)** to data, to enable manipulation of data, and to give business managers and analysts the ability to conduct appropriate analysis. By analyzing ... data, situations, and performances, decision makers get valuable insights that enable them to **make more informed and better decisions** ... BI is based on the **transformation of data to information, then to decisions, and finally to actions.**"



- **Quote** from Sharda, R., Delen, D., & Turban, E. (2013). Business Intelligence: A managerial perspective on analytics. Prentice Hall Press.
- **Image Credit:** Joint work with Bin Weng.

The BI Process



Source: Based on W. Eckerson, Smart Companies in the 21st Century: The Secrets of Creating Successful Business Intelligent Solutions.

The Data Warehousing Institute, Seattle, WA 2003, p. 32, Illustration 5.

- **Image Credit:** Sharda, R., Delen, D., & Turban, E. (2013). Business Intelligence: A managerial perspective on analytics. Prentice Hall Press.

Recap

Summary of Main Points

By now, you should be able to do the following: