



XAVIER
UNIVERSITY

Political Campaigns as a Motivation for Data Science

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MathFest 2023, Tampa, FL, August 4, 2023

What is “Data Science”?

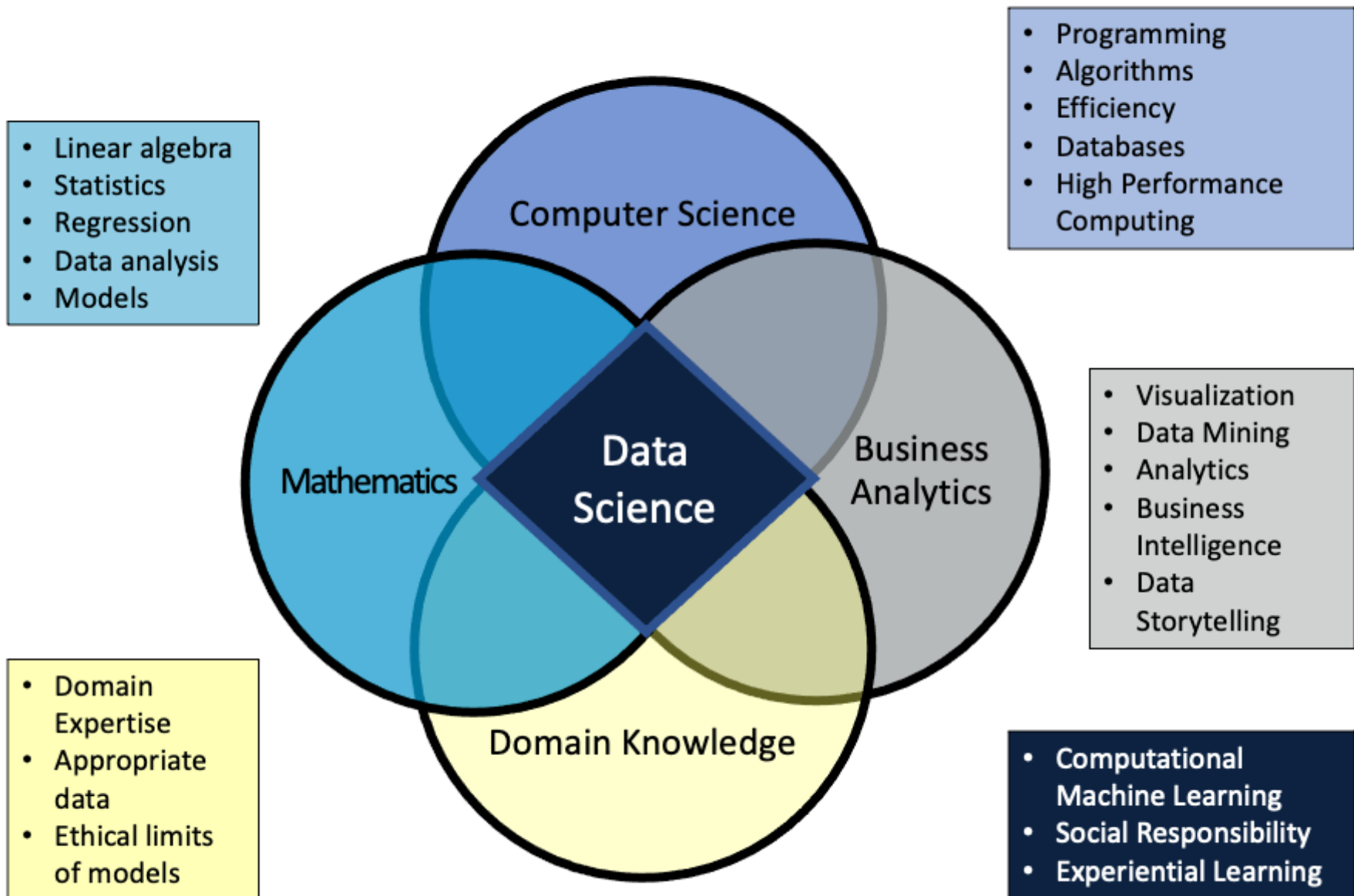
- NOT SURE ANYBODY REALLY KNOWS EXACTLY!!
 - Field didn’t even exist when I was in college

Large,
messy
data



Insights
to make
decisions

Xavier Data Science Honors Program



Visiting Data Science Educator program at Microsoft

- Embedded in COSINE Data Science Team for month in Summer 2020
- Goal of giving educators first-hand experience with DS careers
- Activities fell into the following categories:
 - In-depth, small group discussions with COSINE data scientists and key leaders
 - Attendance at recurring meetings across the larger Data Team
 - Independent learning of DS topics using internal resources
 - Mock interviews.

Importance of “soft skills”

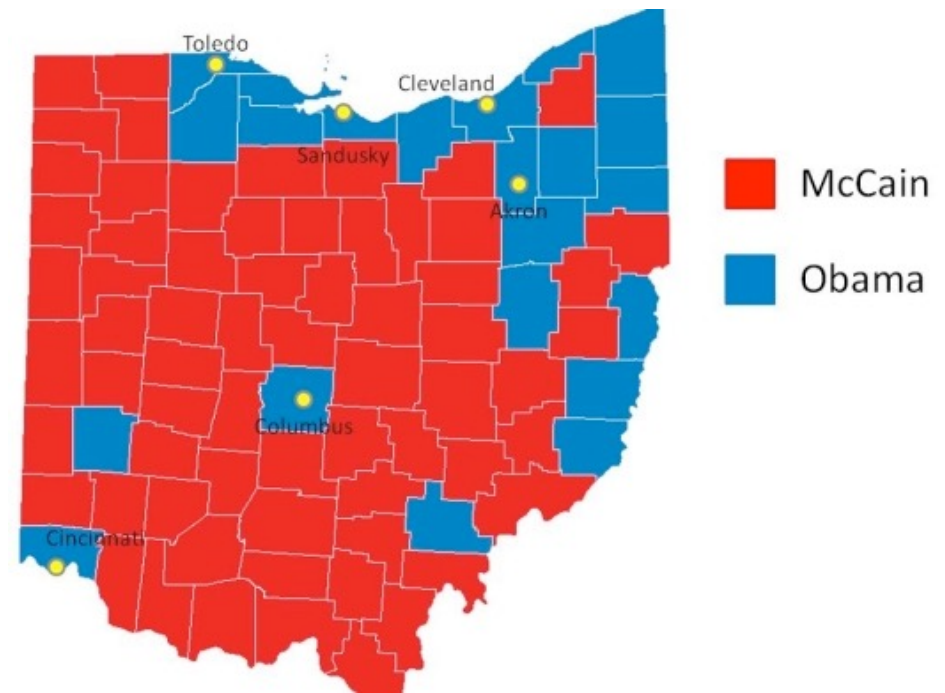
Communication ability.

Finding DS with excellent communication skills who can “tell a story with data,” is more difficult than finding the DS with necessary technical skills. One of the primary roles that DS play is that of a consultant. Even at an organization like Microsoft, DS often involves being able to successfully collaborate with individuals that lack necessary quantitative skills for a project. A successful data scientist must be well-rounded and communicate well enough to understand the question at hand in the client’s domain, work to find appropriate answers for the question and communicate the results so that appropriate actions can be taken. This is one aspect in which the liberal arts tradition of Xavier would be uniquely positioned to produce successful data scientists.

How did I get involved in politics?

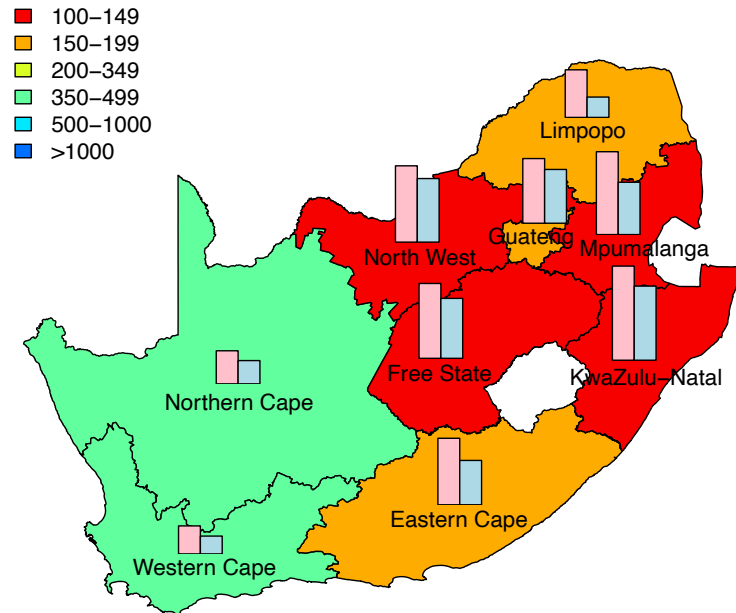
- Philosophy, Politics, and the Public (PPP)
Honors Program at Xavier

- Sophomore PPP students embedded in local political campaigns
- Learn how campaigns work
- Develop campaign strategy for their candidate



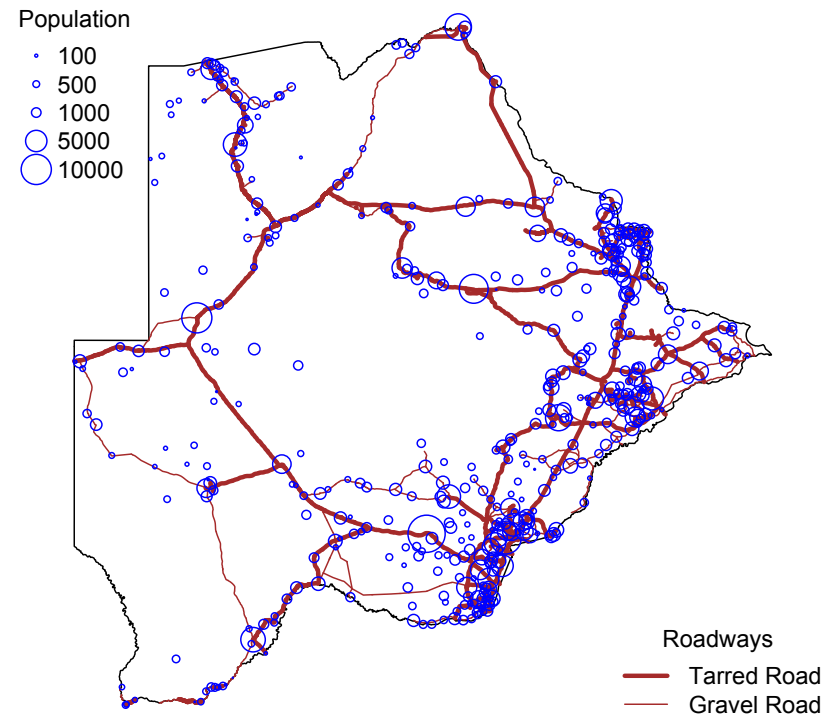
2008: Presidential Election

HIV modeling work @ UCLA



Spatial variation in cost-effectiveness of HIV interventions in South Africa

Botswana - Population Density and Roadways



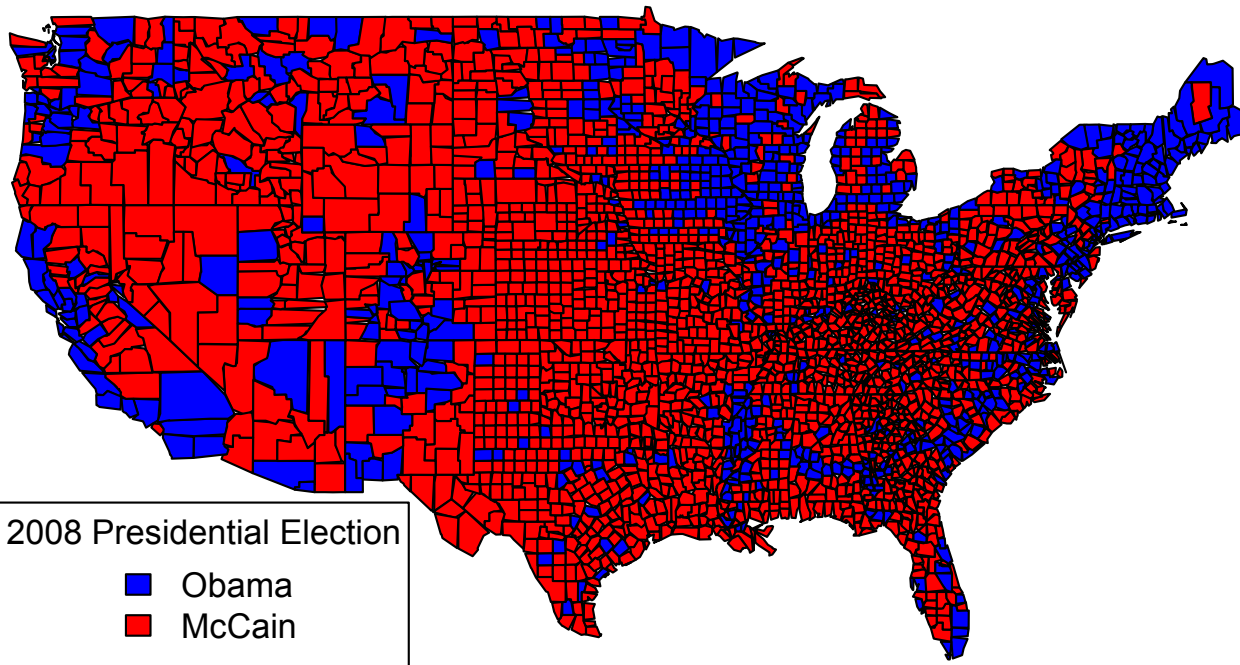
The R Project for Statistical Computing

<https://www.r-project.org/>



Teach PPP group to program in R

2008 Presidential Election



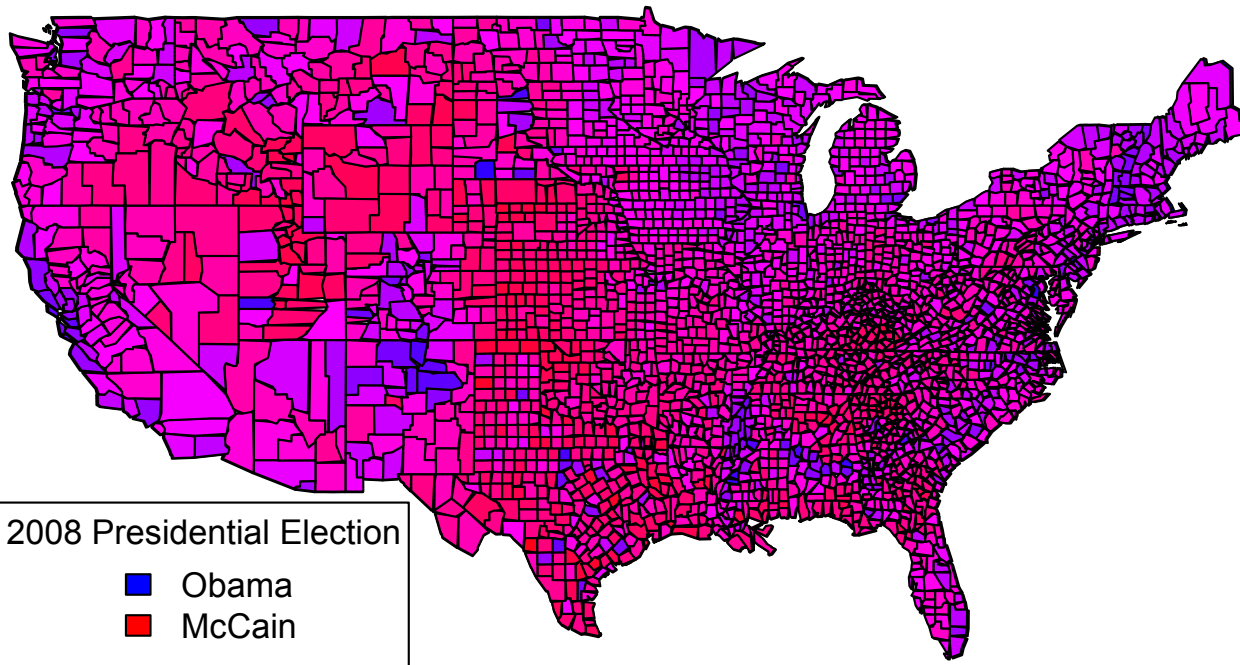
- All 3082 counties in continental US
 - made in seconds
- Minimal coding required

```
myStateData <- apply( array(stateNames), 1, URLfunc)
myStateDF <- do.call( "rbind", myStateData)

countyBlueOrRedUSA <- rep(2,times=3082)
countyBlueOrRedUSA[myStateDF[[1]] >= 50] <- 4
map('county', plot = TRUE, fill=TRUE, col=countyBlueOrRedUSA)
title('2008 Presidential Election')
legend("bottomleft", title="2008 Presidential Election", legend=c('Obama','McCain'), fill=c("blue","red"))
```

Teach PPP group to program in R

2008 Presidential Election



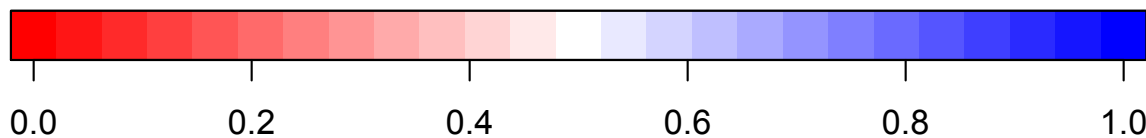
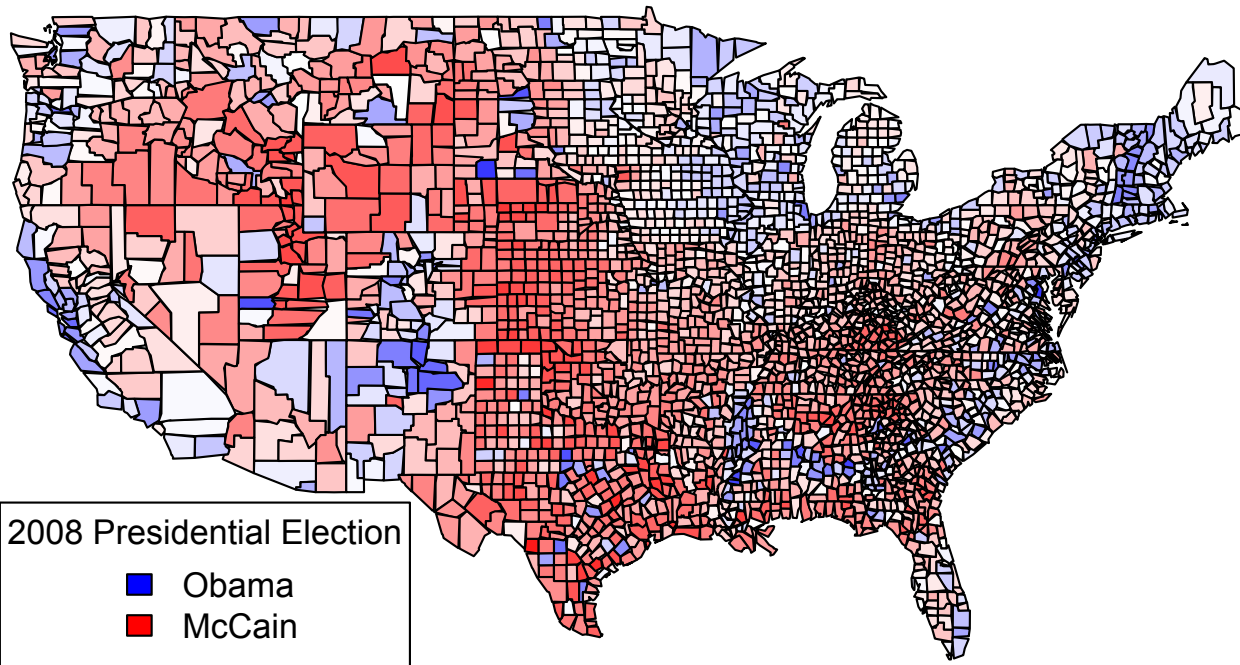
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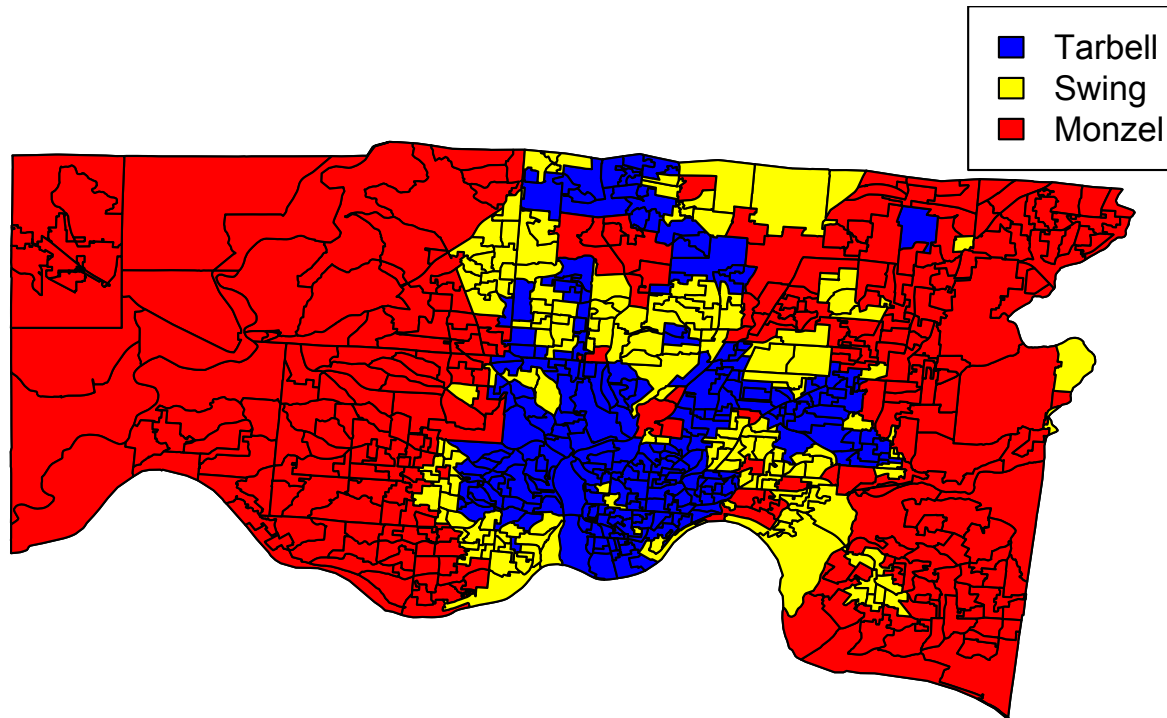
Teach PPP group to program in R

2008 Presidential Election



- Saves time
- Flexibility in visualizations
- More informative maps

2012-2021: PPP & just me

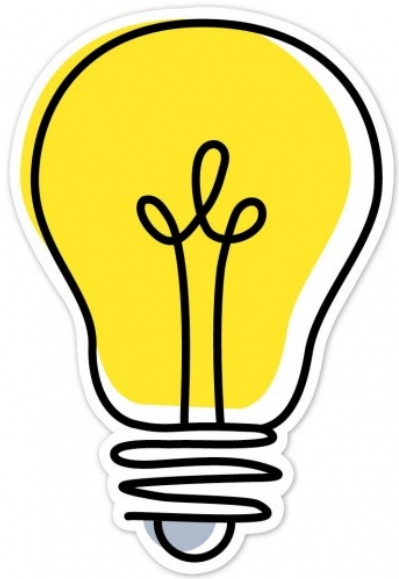


Base/Swing maps

- Base: >60%
- Swing: 40-60%
- Residual: <40%

- I obtained election data, cleaned, put in R
- Showed PPP students how to make base/swing maps
- They changed candidates to make maps for their campaigns

2022: PPP & Data Science students



Sophomore PPP students
+ Sophomore Data Science students

A good experience for everyone

- DS students obtained election data, cleaned, put in R
- Start with base/swing maps

★ Much deeper and cooler analyses than ever before!

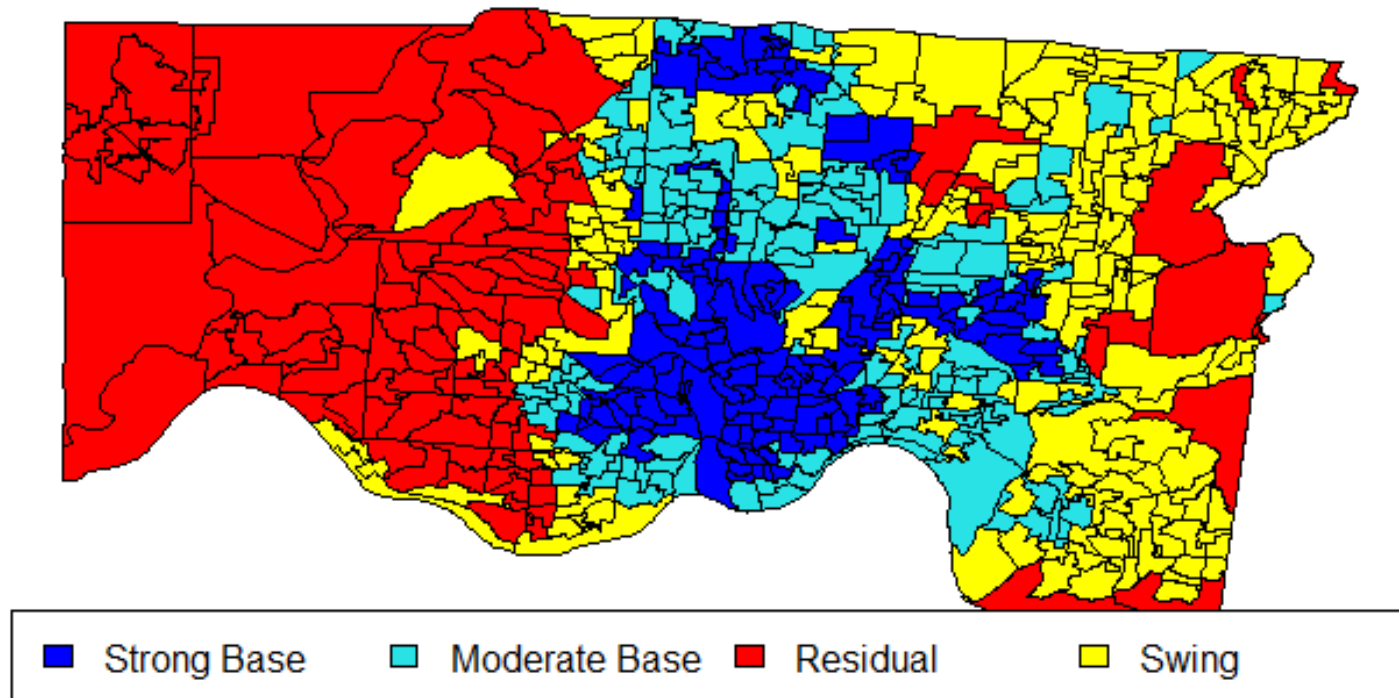
Obtaining Election Data

HAMILTON COUNTY, OHIO RESULTS ELECTION 2022					OFFICIAL GENERAL NOVEMBER 8,					Governor and Lieutenant Governor			Attorney General		Auditor of State		
PRC #	PRECINCT	REGISTERED VOTERS TOTAL	BALLOTS CAST TOTAL	PERCENT	Mike DeWine & Jon Husted (Rep)	Timothy Grady & Dayna Bickley (Write-In)	Craig Patton & Collin Cook (Write-In)	Renea Turner & Adina Pelletier (Write-In)	Marshall Usher & Shannon Walker (Write- In)	Nan Whaley & Cheryl L. Stephens (Dem)	Jeffrey A. Crossman (Dem)	Dave Yost (Rep)	Keith Faber (Rep)	Taylor Sappington (Dem)	Chelsea (Dem)		
101	0101 CIN 1-A	323	175	54.18%	119	0	0	0	0	54	55	117	116	54	54		
102	0102 CIN 1-B	1,322	834	63.09%	360	1	0	0	0	468	489	338	321	492	487		
103	0103 CIN 1-C	1,217	595	48.89%	222	0	0	0	0	371	385	207	195	391	383		
104	0104 CIN 1-D	796	392	49.25%	153	0	0	0	0	233	239	144	143	235	238		
105	0105 CIN 1-E	1,331	624	46.88%	238	0	0	0	0	377	399	216	219	391	391		
106	0106 CIN 1-F	1,202	736	61.23%	342	0	0	0	0	385	415	309	296	416	409		
107	0107 CIN 1-G	973	561	57.66%	263	0	0	0	0	289	308	242	237	309	294		
108	0108 CIN 1-H	723	443	61.27%	201	0	0	0	0	236	250	183	190	239	233		
109	0109 CIN 1-I	1,154	673	58.32%	307	1	0	0	0	356	375	289	283	373	366		
110	0110 CIN 1-J	1,233	674	54.66%	298	0	0	0	0	374	401	263	266	387	393		
111	0111 CIN 1-K	1,170	539	46.07%	218	0	0	0	0	314	334	200	199	333	328		
112	0112 CIN 1-L	683	445	65.15%	240	0	0	0	0	197	211	226	221	210	210		

- 562 rows, one for each Voting Precinct in Hamilton County
- ~150 columns, one for each voting possibility (candidate/issue)
 - Needs formatted, cleaned, loaded in R

Finally, different base/swing maps

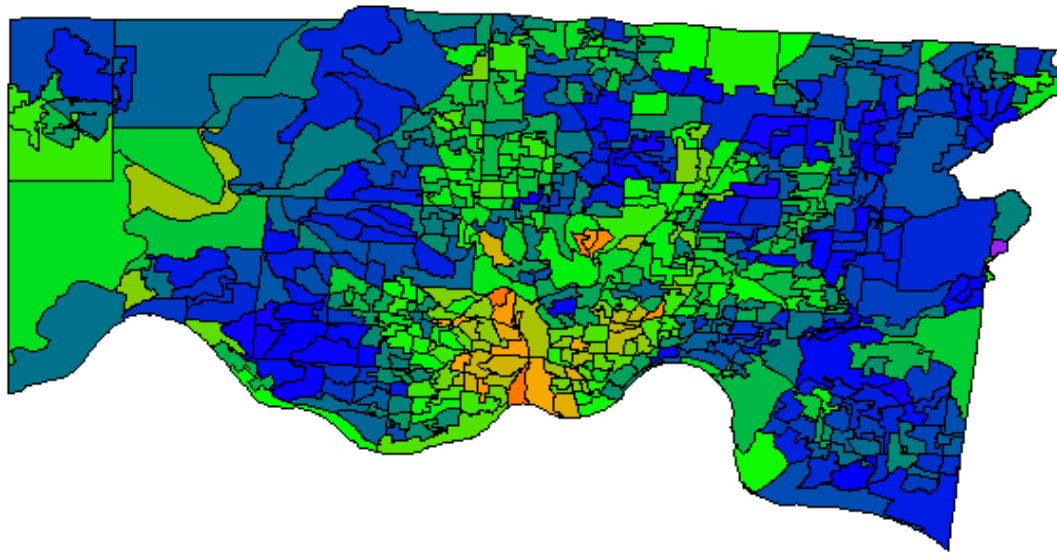
2022 Predicted Map



Strong base: > 80%, Moderate Base: 60-80%,
Swing: 40-60%, Residual: <40%

Doesn't matter if people don't vote

2018 Election Turnout



Voter turnout significantly higher in suburbs than in the City of Cincinnati



Voter "Drop-off"

Sample Ballot

General Election
November 3, 2020
HAMILTON COUNTY, OH

Precinct: 6901 FAIRFX A-1
Page 1 of 3

Instructions to Voter:
To Vote: completely darken the box to the left of your choice.
Please use a black or blue ink pen only.

Correct  Incorrect 

- Note the permitted number of choices directly below the title of each candidate office. Do not mark the ballot for more choices than allowed.
- If you mark the ballot for more choices than permitted, that contest or question will not be counted.
- To vote for a write-in candidate: completely darken the box to the left of the blank line and write in the candidate's name. Only votes cast for candidates who filed as write-in candidates can be counted.
- Do not write-in a candidate's name if that person's name is already printed on the ballot for that same contest.
- If you make a mistake or want to change your vote: return your ballot to an election official and get a new ballot. You may ask for

Instructions to Voters for the Office of President and Vice President:
A vote for any candidates for President and Vice President shall be a vote for the electors of those candidates whose names have been certified to the Secretary of State.

For President and Vice President
(Vote for not more than 1 pair)

- For President
Howie Hawkins
For Vice President
Angela Walker
- For President
Jo Jorgensen
For Vice President
Spike Cohen
Libertarian
- For President
Donald J. Trump
For Vice President
Michael R. Pence
Republican
- For President
Joseph R. Biden
For Vice President
Kamala D. Harris
Democratic
- _____
Write-in President

For State Representative (27th District)
(Vote for not more than 1)

- Sara Bitter**
Democratic
- Tom Brinkman**
Republican

For County Commissioner (Full term commencing 1-2-2021)
(Vote for not more than 1)

- Herman J. Najoli**
Nonparty candidate
- Alicia Reece**
Democratic
- Andy Black**
Republican

For County Commissioner (Full term commencing 1-3-2021)
(Vote for not more than 1)

- Matthew Paul O'Neill**
Republican
- Denise Driehaus**
Democratic

For Prosecuting Attorney
(Vote for not more than 1)

- Fanon A. Rucker**
Democratic
- Joseph T. Deters**
Republican

Sample Ballot

General Election
November 3, 2020
HAMILTON COUNTY, OH

Precinct: 6901 FAIRFX A-1
Page 2 of 3

For County Recorder
(Vote for not more than 1)

- Norbert A. Nadel**
Republican
- Scott Crowley**
Democratic

For County Treasurer
(Vote for not more than 1)

- Charlie Winburn**
Republican
- Jill Schiller**
Democratic

For County Engineer
(Vote for not more than 1)

- Eric J. Beck**
Republican

For Coroner
(Vote for not more than 1)

- Lakshmi Kode Sammarco**
Democratic

For Justice of the Supreme Court (Full term commencing 1-1-2021)
(Vote for not more than 1)

- John P. O'Donnell**
- Sharon L. Kennedy**

For Justice of the Supreme Court (Full term commencing 1-2-2021)
(Vote for not more than 1)

- Judi French**

For Judge of the Court of Common Pleas (Full term commencing 1-1-2021)
(Vote for not more than 1)

- Heidi Rosales**
- Melba Marsh**

For Judge of the Court of Common Pleas (Full term commencing 1-2-2021)
(Vote for not more than 1)

- Christian A. Jenkins**
- Pat Dinkelacker**

For Judge of the Court of Common Pleas (Full term commencing 1-4-2021)
(Vote for not more than 1)

- Chris Wagner**
- Curt C. Hartman**

For Judge of the Court of Common Pleas (Full term commencing 2-9-2021)
(Vote for not more than 1)

- Elizabeth Callan**
- Jennifer Branch**

For Judge of the Court of Common Pleas (Full term commencing 2-10-2021)
(Vote for not more than 1)

- Alan C. Triggs**
- Stacey DeGraffenreid**

For Judge of the Court of Common Pleas (Full term commencing 2-12-2021)
(Vote for not more than 1)

- Wende Cross**
- Ethna Marie Cooper**

For Judge of the Court of Common Pleas (Full term commencing 2-13-2021)
(Vote for not more than 1)

- Charles J. Kubicki, Jr.**
- Alison Hatheway**

For Judge of the Court of Common Pleas (Drug Court Division) (Full term commencing 1-3-2021)
(Vote for not more than 1)

- Nicole Sanders**
- Kim Wilson Burke**

For Judge of the Court of Common Pleas (Probate Division) (Full term commencing 2-9-2021)
(Vote for not more than 1)

- Ralph Winkler**
- Pavan Parikh**

For Judge of the Court of Common Pleas (Juvenile Division) (Full term commencing 2-14-2021)
(Vote for not more than 1)

- _____



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For Vice President
Spike Cohen

For State Representative (27th District)
(Vote for not more than 1)

Sara Bitter
Democratic

Tom Brinkman
Republican

For County Commissioner (Full term commencing 1-2-2021)
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Herman J. Najoli
Nonparty candidate

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Democratic

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Republican

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Charles J. Kubicki, Jr.

Alison Hatheway

For Judge of the Court of Common Pleas (Drug Court Division) (Full term commencing 1-3-2021)
(Vote for not more than 1)

Nicole Sanders

Kim Wilson Burke

41276 v1

Ballots are long!

Not all voters vote on every item

Drop-off = % of people who skip a certain item

If you make a mistake or want to change your vote: return your ballot to an election official and get a new ballot. You may ask for

Democratic

Write-in President

Democratic

Joseph T. Deters
Republican

Court (Full term commencing 1-2-2021)
(Vote for not more than 1)

Judi French

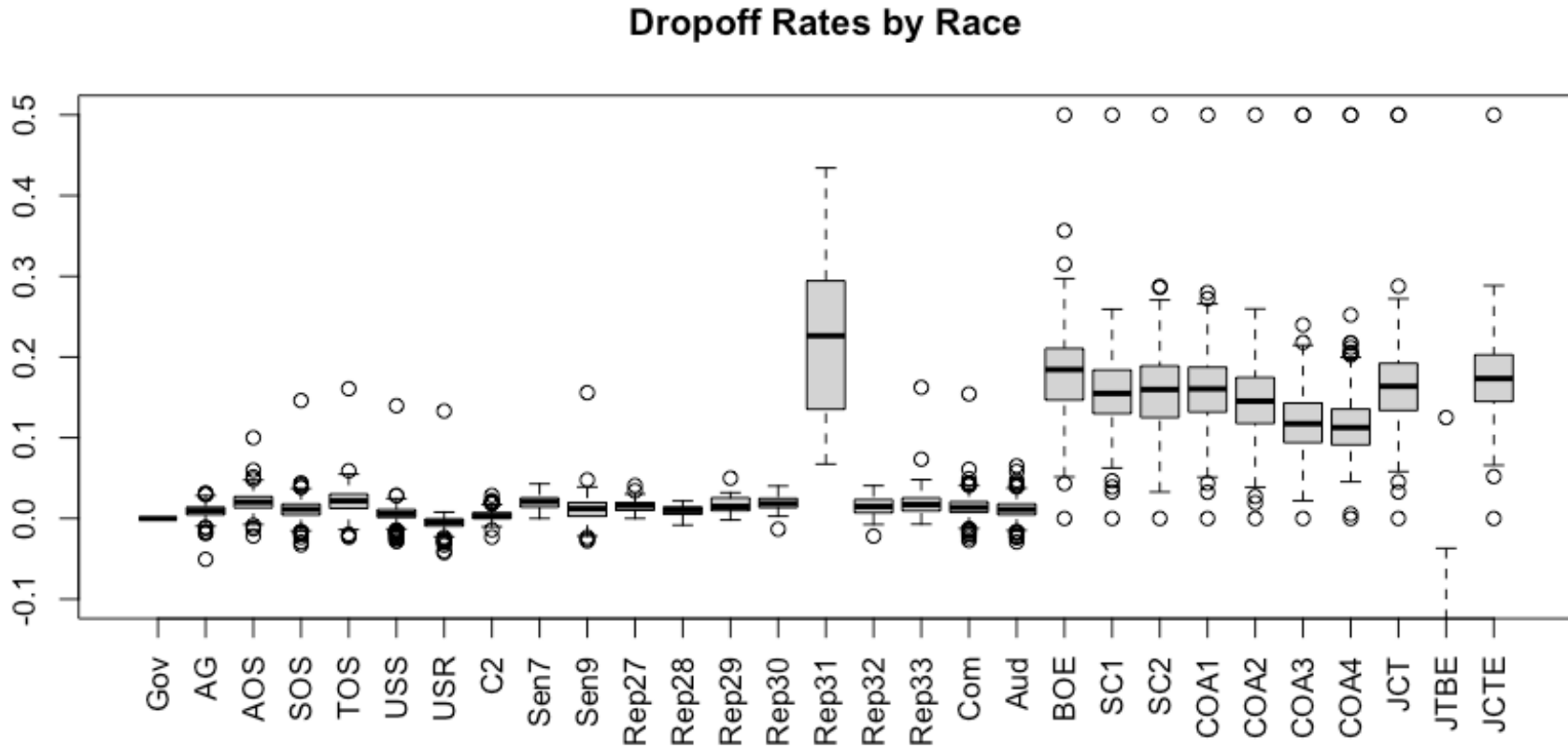
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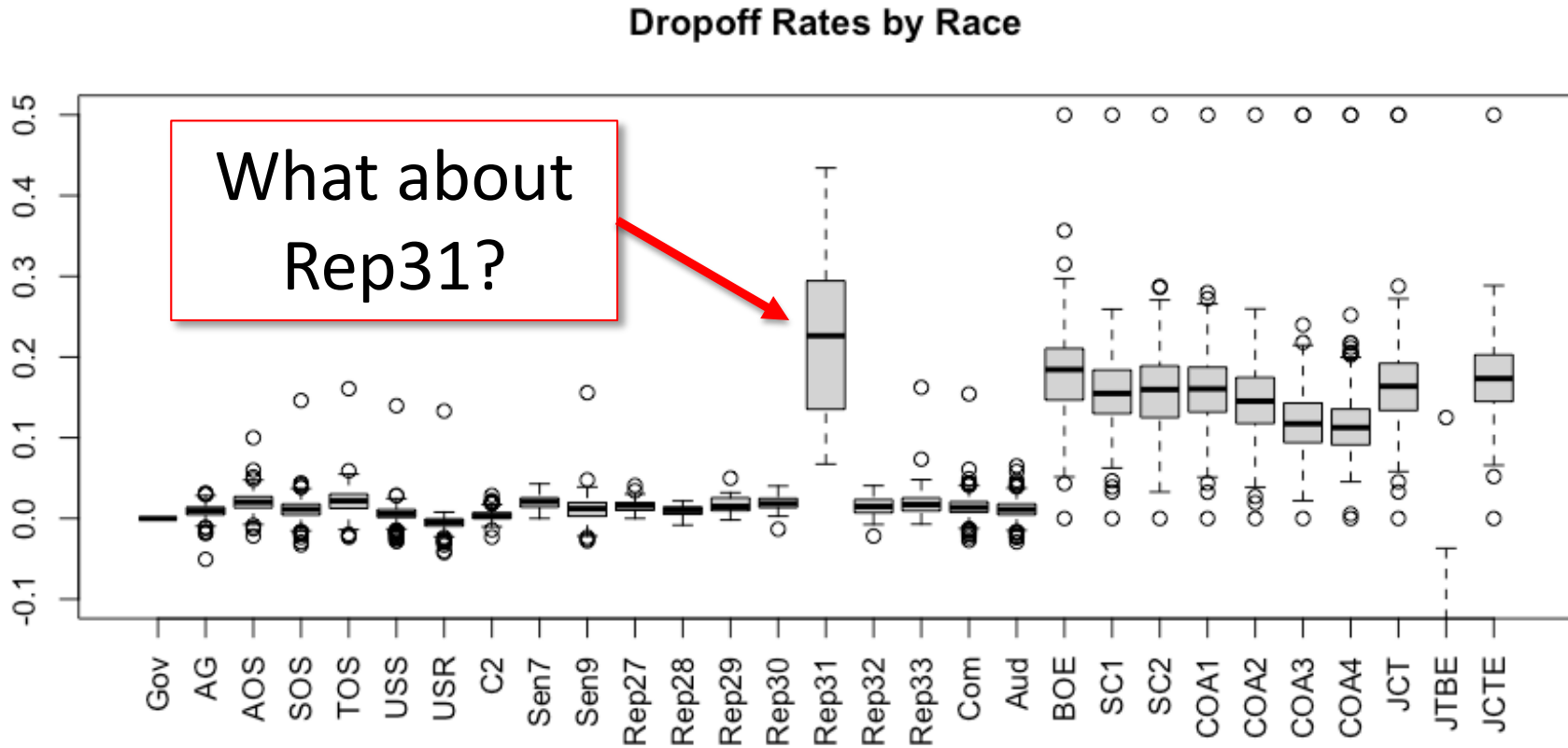
Common Pleas (Juvenile Division) (Full term commencing 2-14-2021)
(Vote for not more than 1)

Voter “Drop-off”



- Drop-off rates are much lower than expected

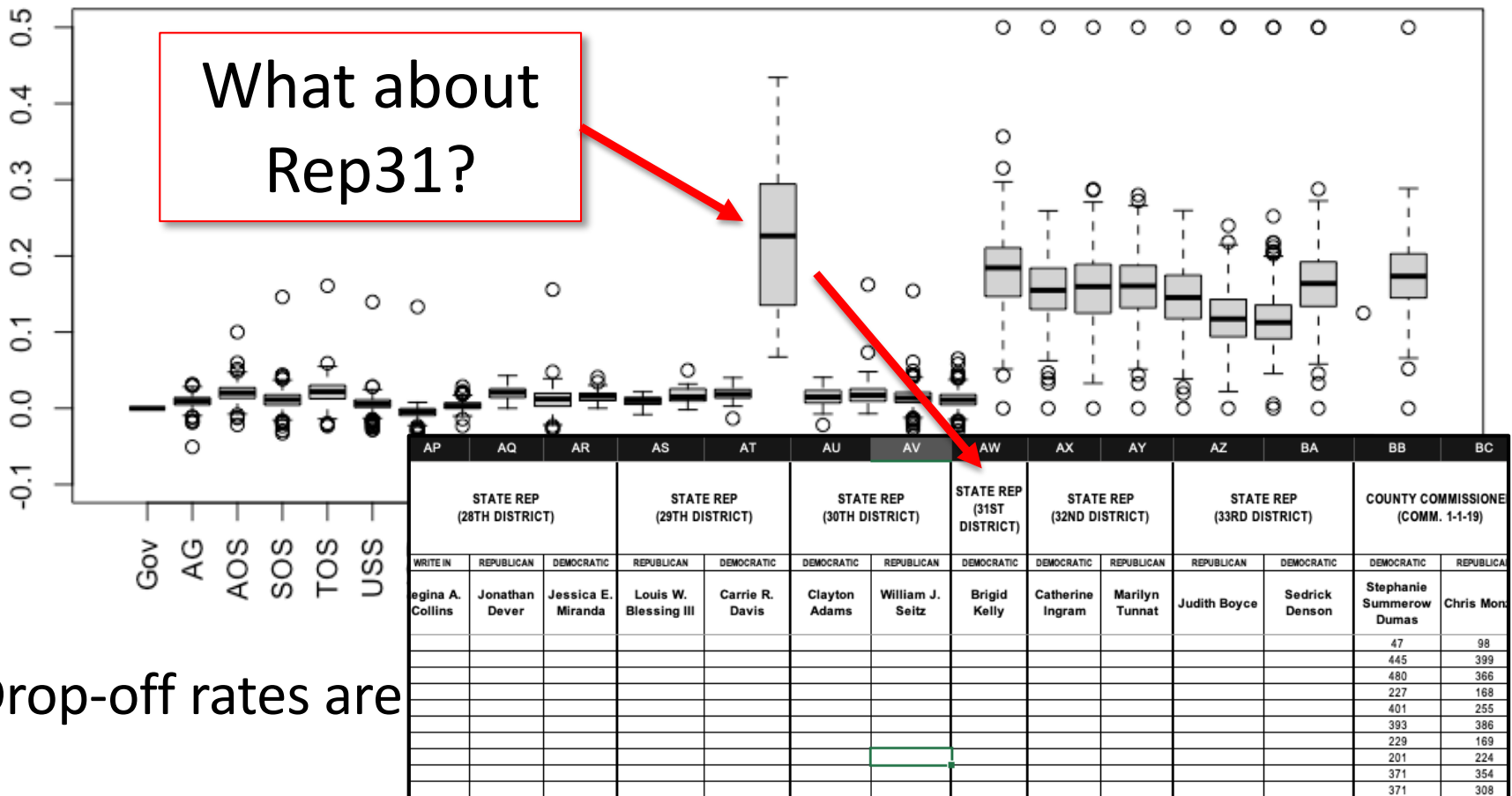
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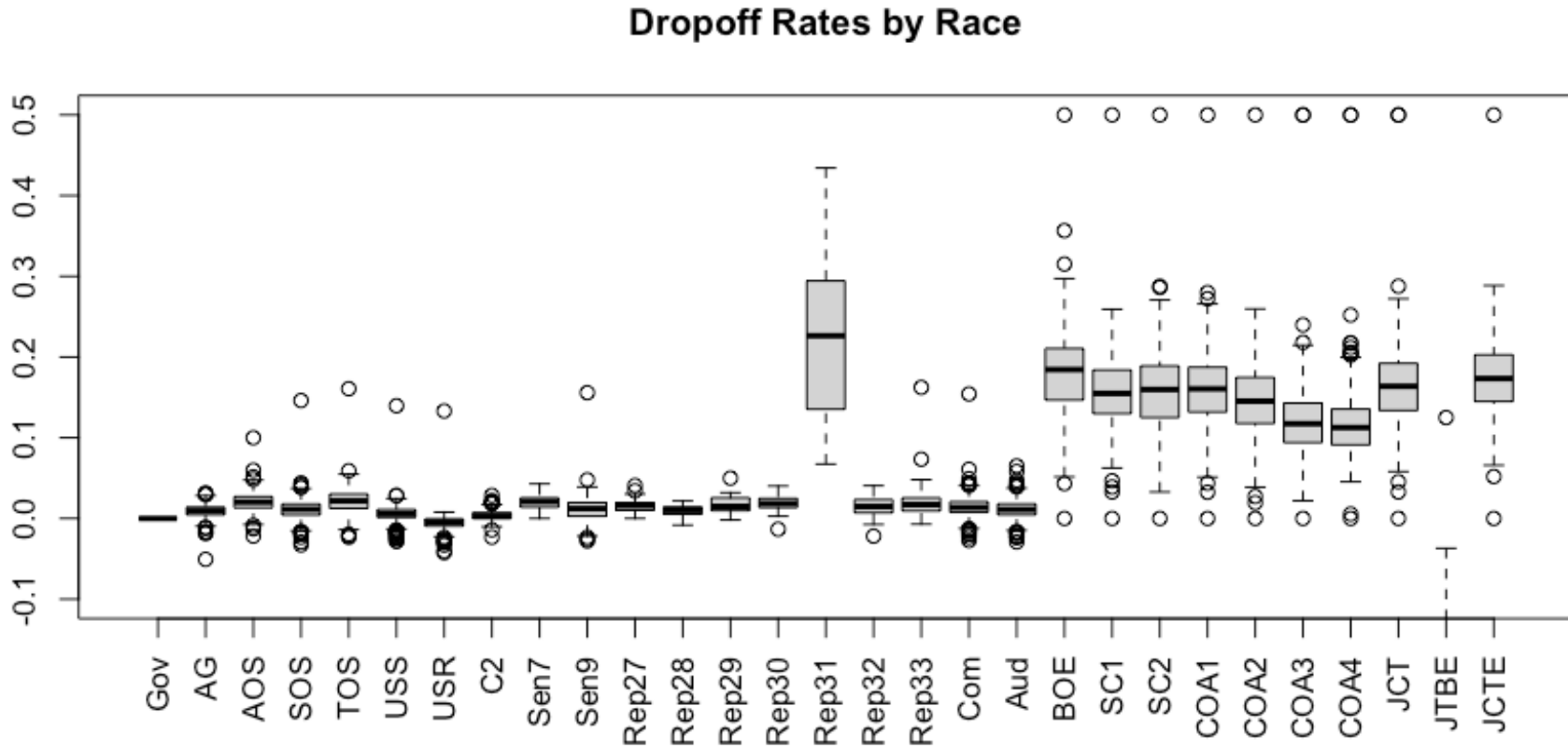
Voter "Drop-off"

Dropoff Rates by Race



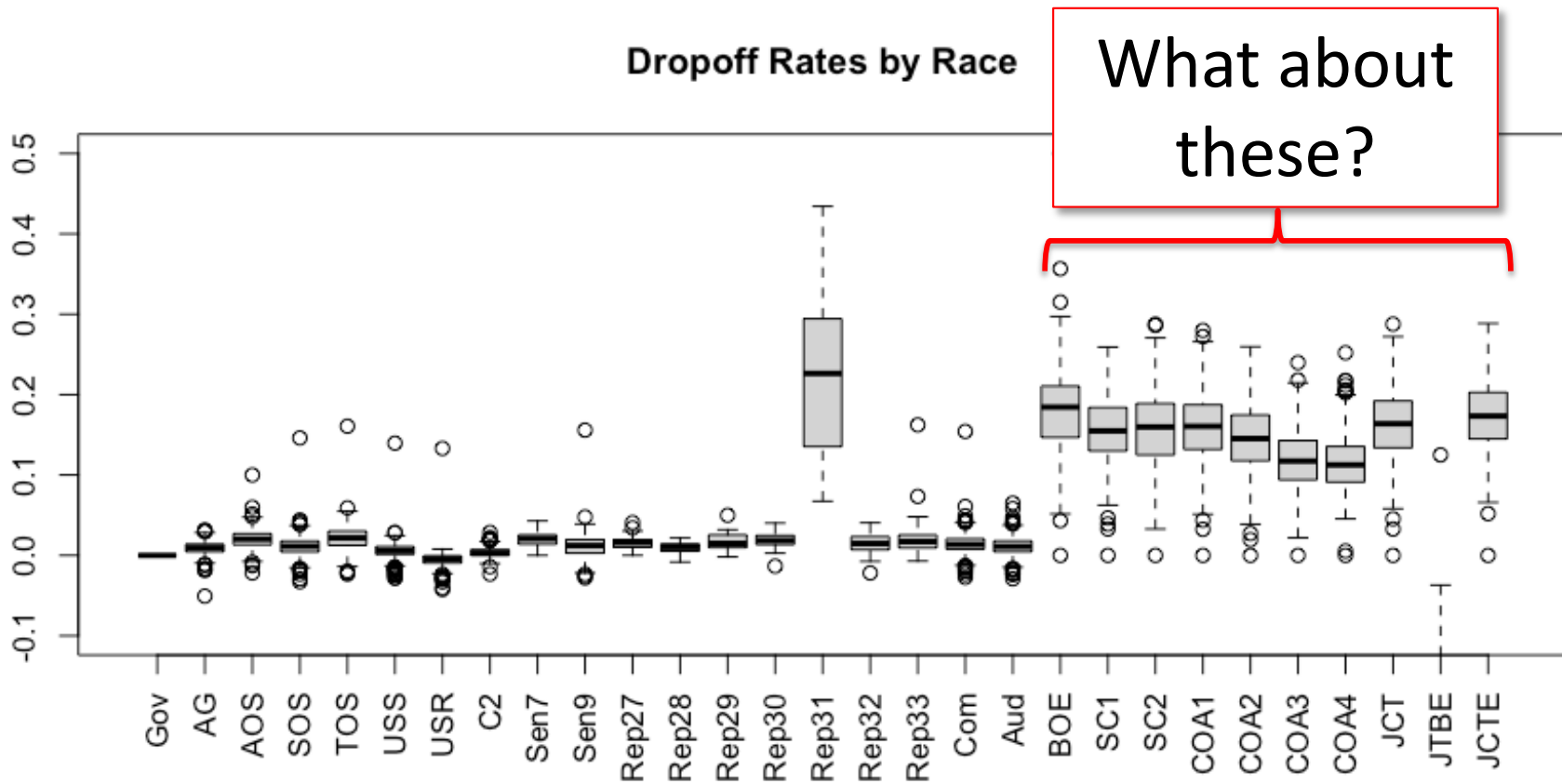
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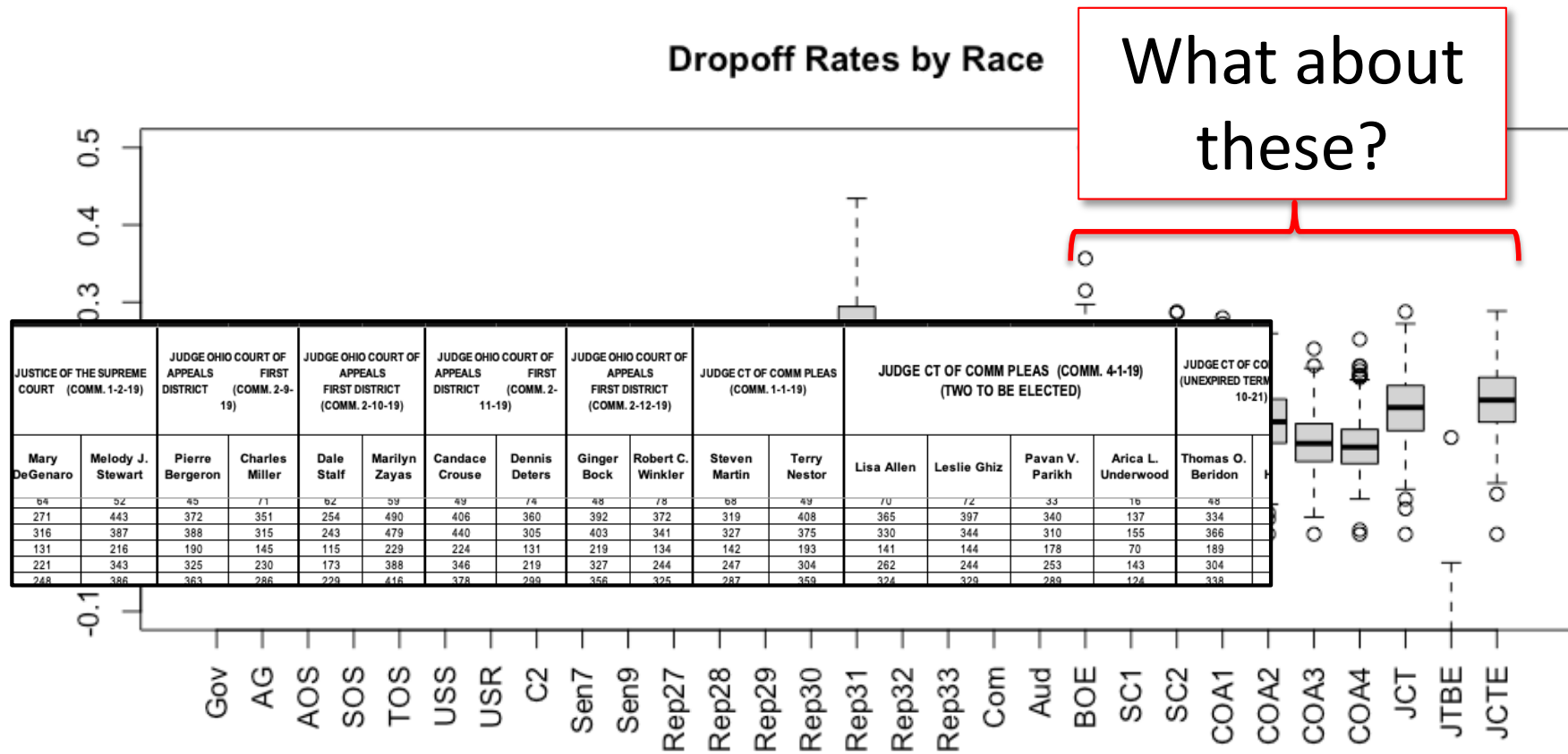
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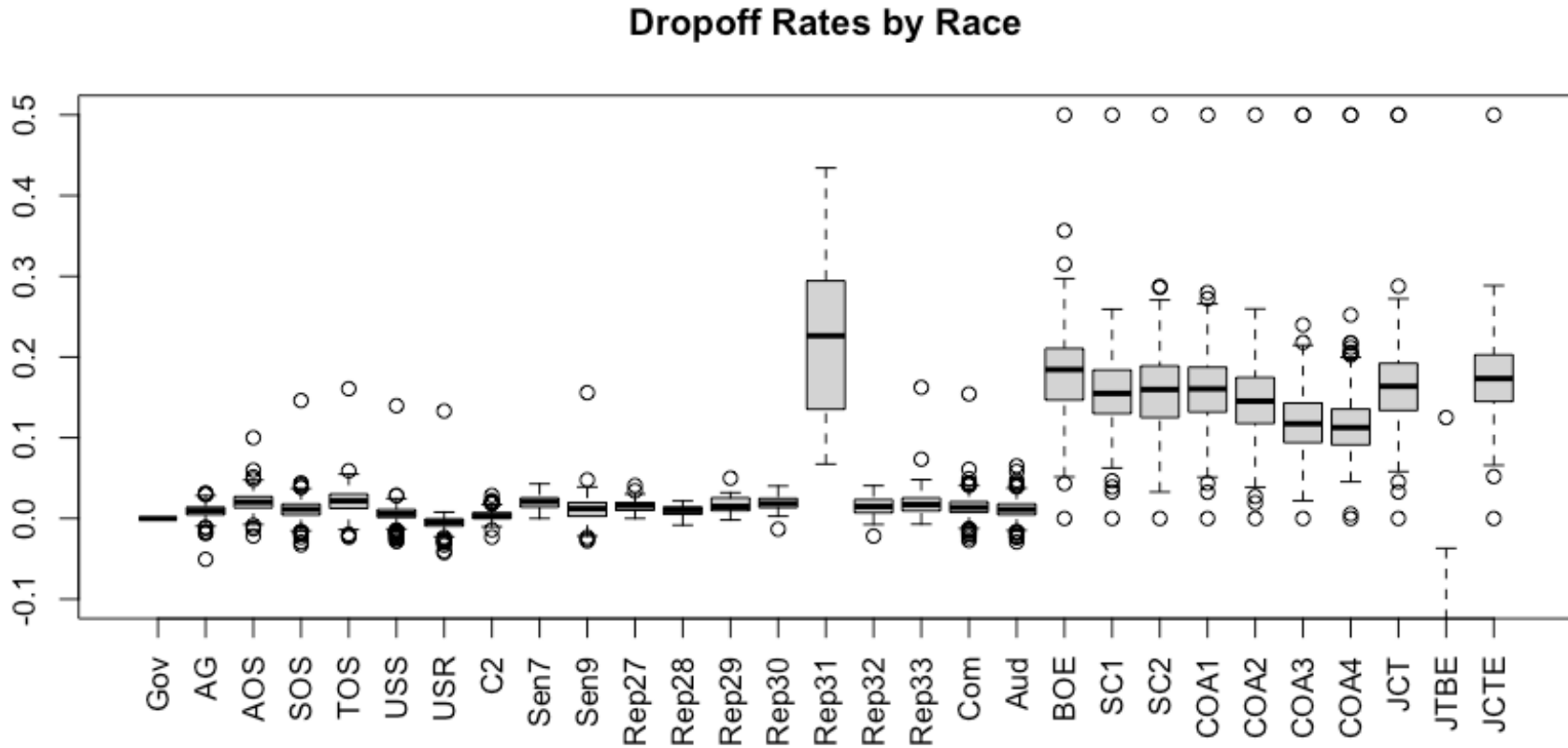
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Hamilton County Voter List

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	VoterIdent	PrecinctNum	Prec	PrecinctName	RegisteredDt	FirstName	MiddleName	LastName	Su	M	St	Phone	Sta	PartyCc	BirthYear	Ad	AddressNum	A	AddressStre	Addr	Ad	CityName
2	1885774	2510	0	CINCINNATI 25-J	1/28/16	LHOUCINE		AACHAQ					A	NON	1970		3080		WEST TOWE	AVE		CINCINNATI
3	2009691	2510	0	CINCINNATI 25-J	5/29/19	OUMAIMA		AACHAQ					A	NON	2001		3080		WEST TOWE	AVE		CINCINNATI
4	2087869	2506	0	CINCINNATI 25-F	10/4/21	LAURRA MICHELLE		AAGAARD				7204355614	A	NON	1960		1040		KREIS	LN		CINCINNATI
5	2100228	8707	0	SPRINGFIELD G	6/9/22	ALICEN ROSEMARY TISCH		AALAEI					A	NON	1993		9960		DALY	RD		CINCINNATI
6	2045052	8707	0	SPRINGFIELD G	8/4/20	BENJAMIN CYRUS		AALAEI					A	DEM	1993		9960		DALY	RD		CINCINNATI
7	1916018	5630	0	ANDERSON DD	8/9/16	ALEX MICHAEL		AANDERUD					A	NON	1991		8519		LINDERWOO	LN		CINCINNATI
8	1723831	5630	0	ANDERSON DD	1/6/11	ALEXA KATHERINE		AANDERUD					A	NON	1990		8519		LINDERWOO	LN		CINCINNATI
9	1914383	4007	0	MONTGOMERY G	8/2/16	CHARLES JON		AARDEMA				5132261608	A	DEM	1958		10466		ADVENTURE	LN		CINCINNATI
10	1655595	4007	0	MONTGOMERY G	8/27/08	CYNTHIA KAY		AARDEMA					A	DEM	1967		10466		ADVENTURE	LN		CINCINNATI

W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO				
At	Congress	Senate	House	Judicial	School	Col	Vocatio	Registrati	GE	PRIMARY_A	PRIMARY_M	GENERAL_N	GENERAL_N	PRIMARY_M	GENERAL_N	GENERAL_N	PRIMARY_M	GENERAL_N				
#	CNCON1	SESE09	HSHD24	JDMC07	SCCISD			1/28/16										P-NON				
#	CNCON1	SESE09	HSHD24	JDMC07	SCCISD			5/29/19														
#	CNCON1	SESE09	HSHD24	JDMC07	SCCISD			10/4/21														
#	CNCON8	SESE09	HSHD26	JDMC03	SCWWSD	VDGOS		6/9/22														
#	CNCON8	SESE09	HSHD26	JDMC03	SCWWSD	VDGOS		8/4/20		P-DEM		P-NON		A-NON								
#	CNCON1	SESE07	HSHD27	JDMC04	LSFOSD	CS	VDGOS	8/9/16										P-NON				
#	CNCON1	SESE07	HSHD27	JDMC04	LSFOSD	CS	VDGOS	1/6/11						A-NON								
#	CNCON1	SESE08	HSHD28	JDMC05	SCSYSD	VDGOS		8/2/16				P-NON		A-NON		A-DEM		P-NON		P-NON	P-DEM	P-NON
#	CNCON1	SESE08	HSHD28	JDMC05	SCSYSD	VDGOS		8/27/08				P-NON		A-NON		A-DEM		P-NON		P-NON		
#	CNCON1	SESE07	HSHD27	JDMC04	SCCISD			8/11/16						A-NON								

- 595,158 registered voters in Hamilton County

- Address
- Phone number
- Party Affiliation
- Active/Inactive
- Birth year
- Voting precinct
- Date registered
- Elections voted in
- School district

Most voters have no party affiliation

	M	N	O
	A	NON	1995
508	A	NON	1955
	A	NON	1992
	A	NON	1980
	I	NON	1988
	A	NON	1992
	I	NON	1999
170	A	DEM	1951
	A	DEM	1983
	A	NON	1966
	A	NON	1962
	A	NON	1982
	A	NON	1965
562	A	NON	1960
	A	REP	1942
387	A	REP	1956
	A	NON	1960
387	A	REP	1951
	I	NON	1944
	I	NON	1995
	A	DEM	1989
	A	NON	1980
	A	REP	1941
	A	REP	1936
387	A	NON	1958
527	A	REP	1945
	A	REP	1990
	A	NON	1970
	I	NON	1970
	A	DEM	1993
	A	NON	1985

- Would be valuable if we could predict which 'NON' voters will vote for Democrats/Republicans

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	A	NON	1970
	I	NON	1970
	A	DEM	1993
	A	NON	1995

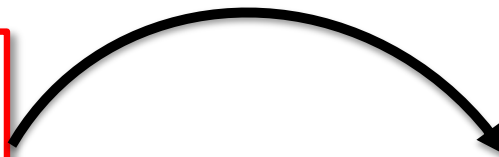
- Would be valuable if we could predict which 'NON' voters will vote for Democrats/Republicans

– Data includes:

- Age, residence location, year registered to vote, gender, etc.
- Must be some patterns that could help us make an educated guess

Have lots of data

Want to identify patterns



Most voters have no party affiliation

	M	N	O
	A	NON	1995
508	A	NON	1955
	A	NON	1992
	A	NON	1980
	I	NON	1988
	A	NON	1992
	I	NON	1999
170	A	DEM	1951
	A	DEM	1983
	A	NON	1966
	A	NON	1962
	A	NON	1982
	A	NON	1965
562	A	NON	1960
	A	REP	1942
387	A	REP	1956
	A	NON	1960
387	A	REP	1951
	I	NON	1944
	I	NON	1995
	A	DEM	1989
	A	NON	1980
	A	REP	1941
	A	REP	1936
387	A	NON	1958
527	A	REP	1945
	A	REP	1990
	A	NON	1970
	I	NON	1970
	A	DEM	1993
	A	NON	1995

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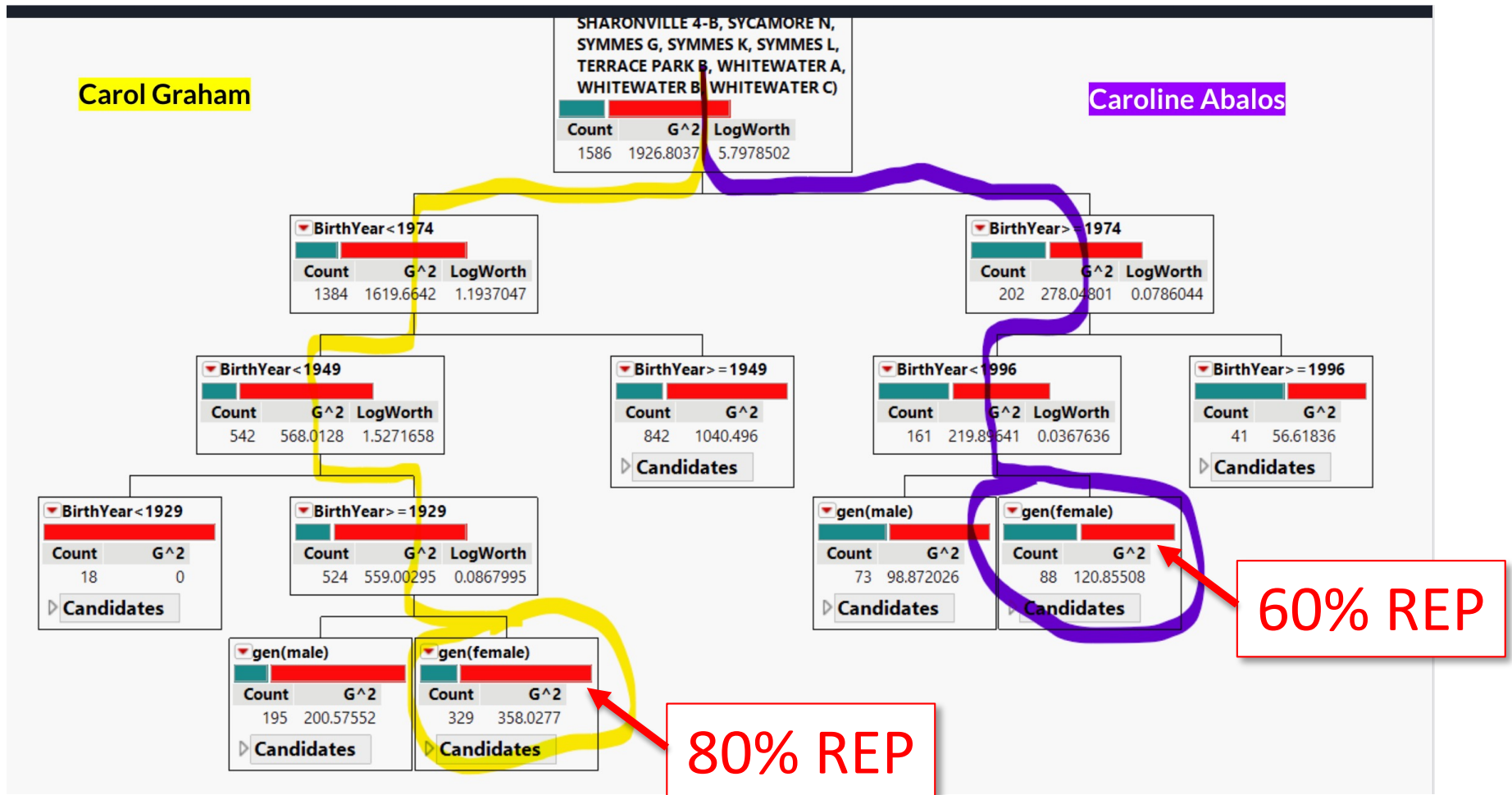
Have lots of data

Machine Learning / Artificial Intelligence

Want to identify patterns

Decision Trees

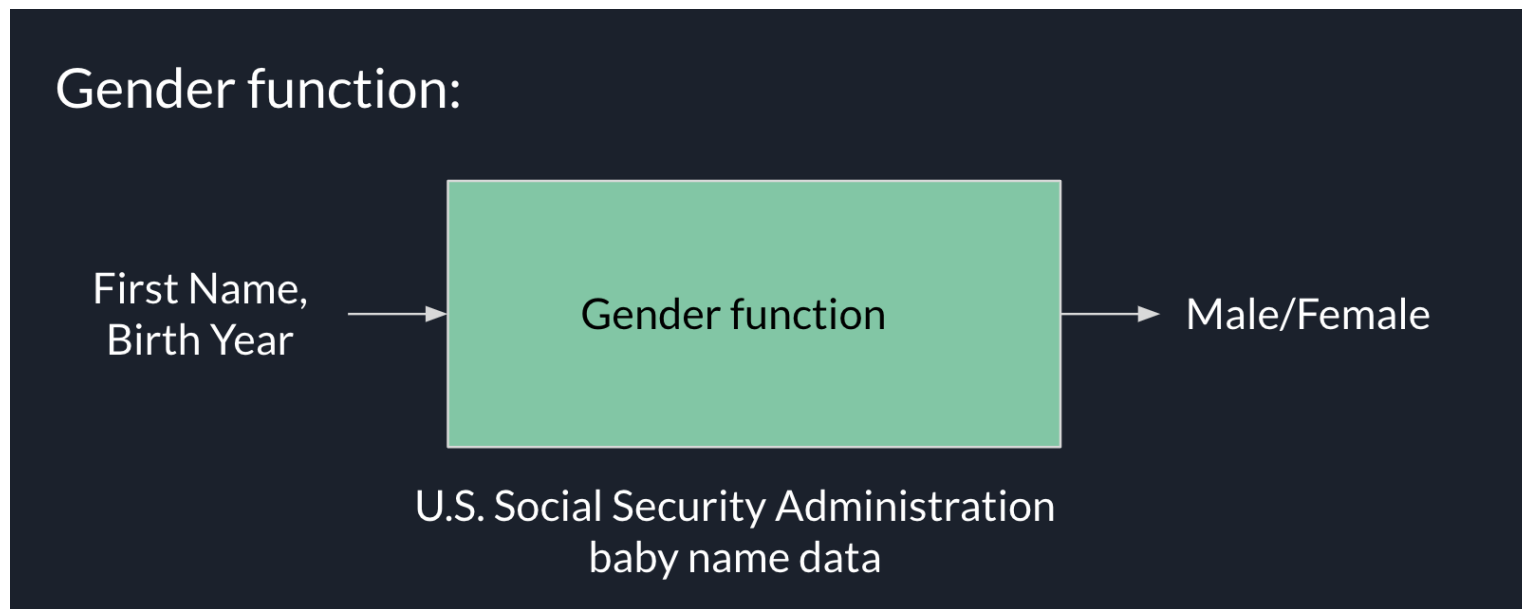
Is this person a DEM or a REP?



Fun fact: Gender isn't in voter list data

Gender package in R

Created by Lincoln Mullen, historian at George Mason University
Studies religion and the 19th century United States, often using computational methods for texts and maps.



Could probably do this same thing for race... but should we?

Election Night Coverage

Live CitiCable broadcast from the Hamilton County Board of Elections

- Programming/math skills can lead to unexpected places
- DSCI 210: Data and American Democracy



Conclusion

Getting at those “soft skills”

- successfully collaborate with individuals that lack necessary quantitative skills
- communicate well enough to understand the question at hand in the client’s domain
- communicate the results so that appropriate actions can be taken

Motivation for future technical skills

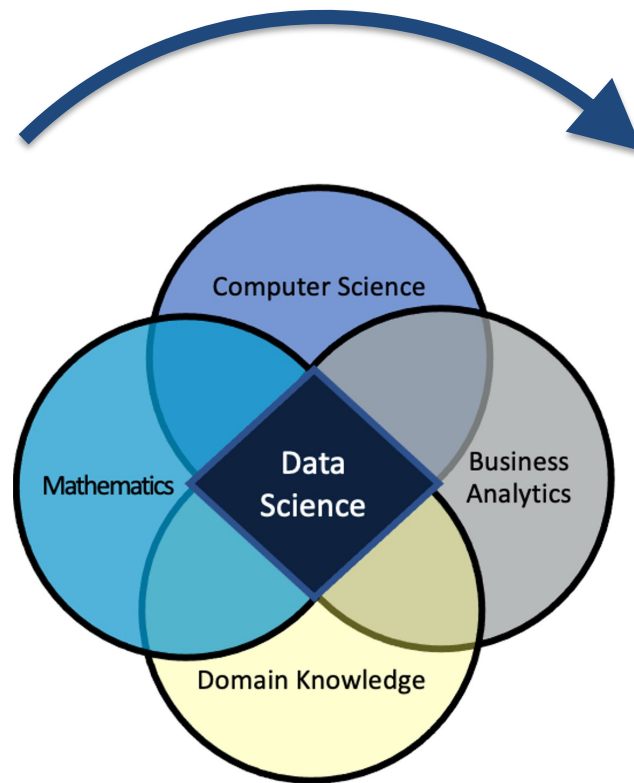
- doing this in fall of sophomore year
- before students learn most technical skills.

Wrapping things up

1. Introduce you to the field of Data Science
2. Show you how quantitative skills and programming can be useful in surprising ways.

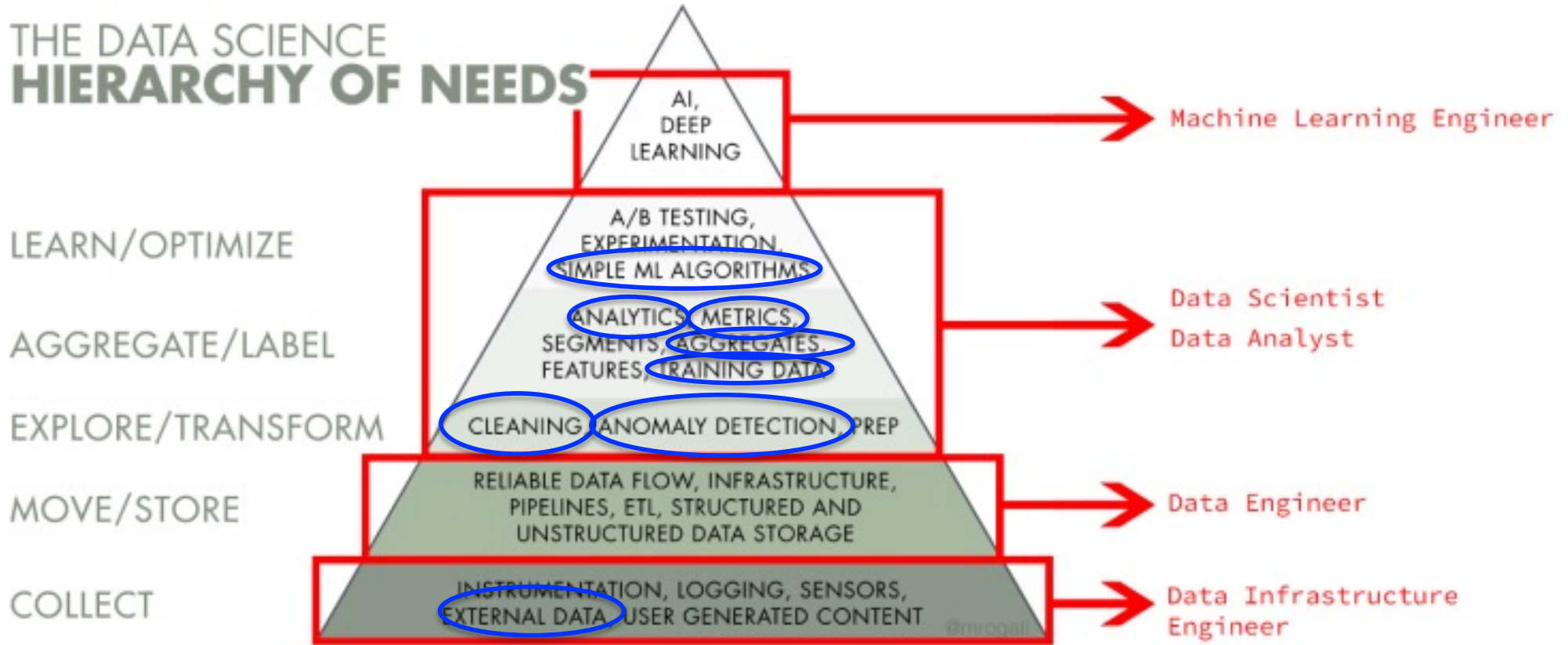
Introduce you to Data Science

Large,
messy
data



Insights
to make
decisions

Introduce you to Data Science



★ Aspects of the Political Campaigns collaboration

Math and programming can be useful in surprising ways

- Sophomores contribute to political campaigns
 - Nothing special about politics!
 - **Health**: replace DEM/REP with Cancer/No Cancer
 - **Business**: replace DEM/REP with GM/Ford/Tesla/Honda/etc
 - **History/Religion**: where gender R package came from
 - **Music**: Spotify API gives genres, keys, plays, etc.
 - **Psychology/Sociology**: Social media data and network information
 - **Sports**: advanced analytics
 - **Fashion**: can historical data predict trends?



Honor's B.S. in Data Science

PROGRAM CONTACT: David Gerberry, PhD,

Director of Data Science

david.gerberry@xavier.edu



TechOlympics 2023

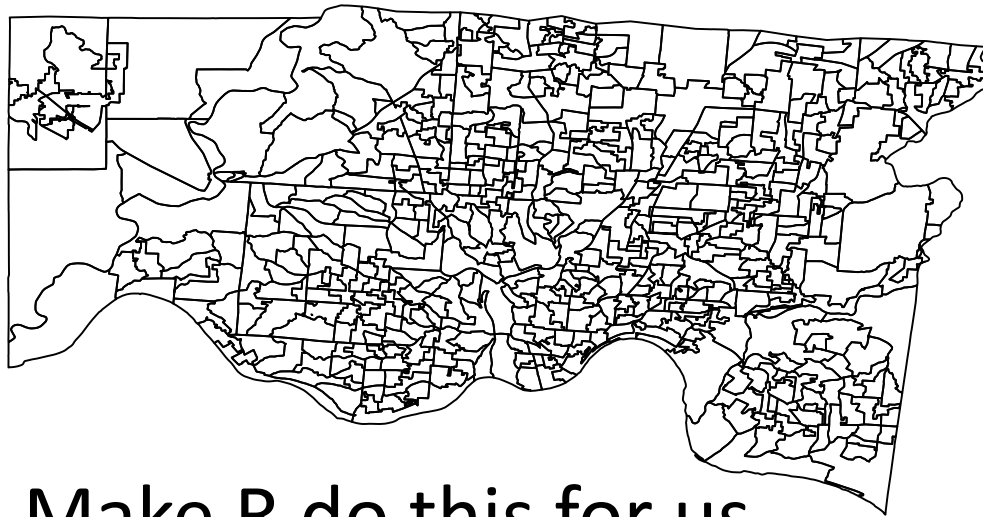


**February 18-19, 2023 at the
Great American Ball Park**

Thank you!

Fall 2012: Old way and new way

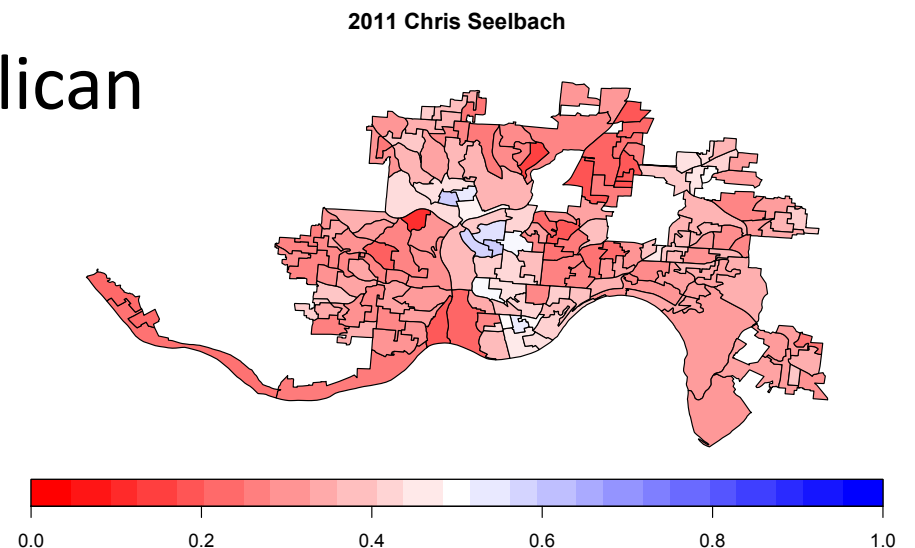
- Groups of PPP students are inserted into city/county campaigns
- 545 voting precincts in Hamilton County
 - Use Board of Election spreadsheet, point click, color



- New way: Make R do this for us
 - Mapping is part of the analysis rather than just a visualization of the conclusions

Fall 2013: more time → better results

- Two full class periods for mapping
 - All groups have made their own maps
 - Sophomore Math/CS double major involved
- City Council election (21 candidates, 9 winners)
 - Not head-to-head elections
 - Not Democrat vs. Republican

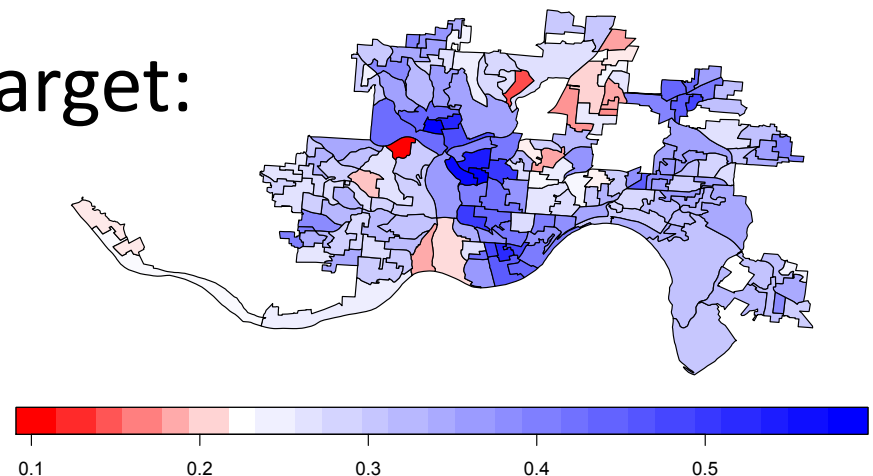


Fall 2013: Deeper Analysis

- What is base/swing in a City Council election?
- New metrics to decide where to target resources
 - Averaging previous results of similar candidates
 - Looking at results for non-similar candidates
 - Combining candidates/voter turnout/ballot issues/etc.

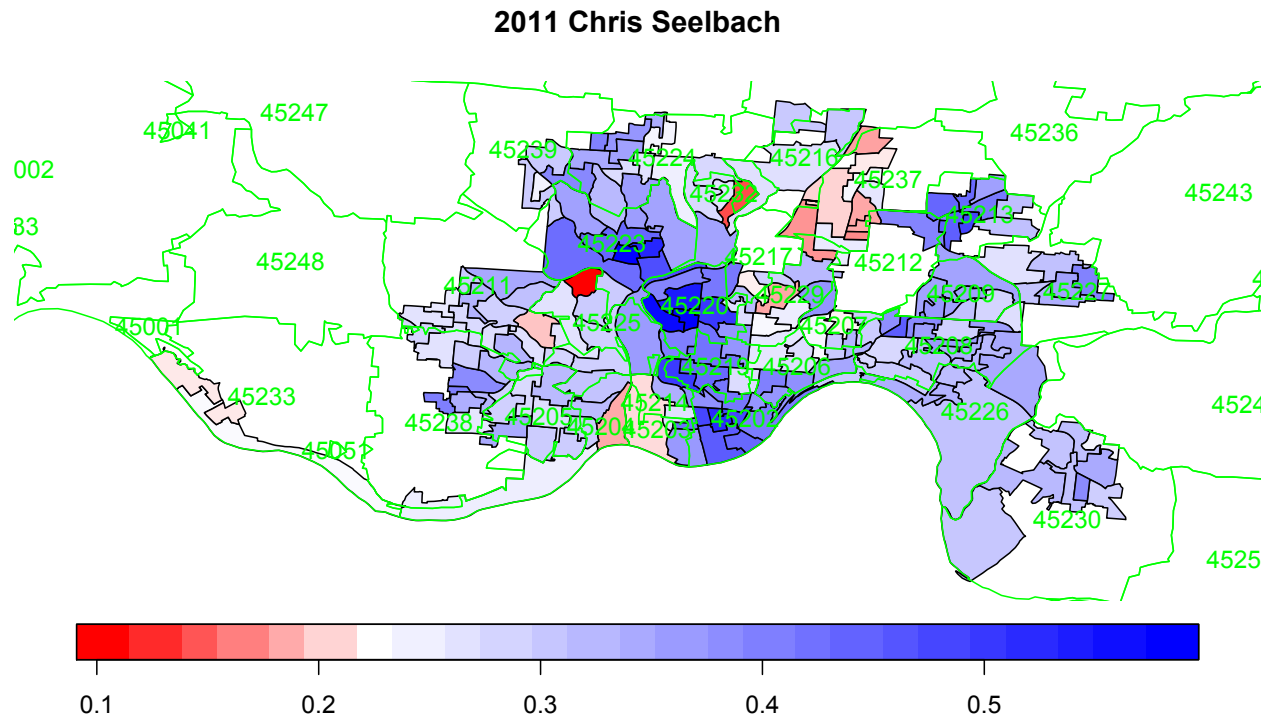
- Once we know where to target:
 - What type of messaging?
 - “Strong on crime”
 - Economic development

2011 Chris Seelbach



“What type of messaging?” \cong
“What are the demographics?”

- Answer: Census Data

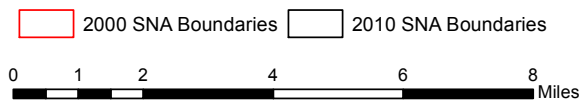


- websites like <http://www.city-data.com> turn a zipcode into demographic data

Statistical Neighborhoods: A better idea!



Prepared by:
City of Cincinnati
Department of City Planning & Buildings
Charles C. Graves, III, Director
May 24, 2012



What I Don't Know about this Project?

- What does this project do for my career?
 - Tenure process (Research, Teaching, Service) → Service
 - Worst Case Interpretation:
 - “Why are you spending so much time helping someone else teach their political science class?”
 - Just “programmers” for the PPP program
 - Better to spend this time on my own research instead?
- What does this project do for the Math student?
 - Does it qualify as undergraduate research?
 - Does it matter if it doesn't?
 - Better off working on a more “mathy” research project?
 - Applied Math vs. Pure Math Guilt
 - Same issues as applying for jobs
- Questions of value are all at the Departmental level.

What I Do Know about this Project

- People around Xavier seem happy about it
 - Provost is impressed
 - Beaupre (PPP): “I am pretty sure you can’t fully appreciate how much you’ve added to our program... You’ve taken us farther than we have been in the history of the program.”
- Valuable experience for Math/CS and PPP students
 - Consultant-like experience that exists in the “real world”
 - Math student sees that she already has very valuable skills
 - PPP students seeing the value of quantitative skills.
 - More Math/CS classes?
 - Ideal way to foster truly interdisciplinary collaboration
 - Barriers between Math/PPP students haven’t formed yet

Non-academic Considerations

- Gaining valuable connections
 - People that get things done
 - Hamilton County Board of Elections
 - City of Cincinnati officials
 - Helpful in the future?
- Considerations at the University
 - PPP is a flagship program at Xavier

Bottom Line

- It is fun and I enjoy it
 - Could be just “Non-departmental Service”
 - Much better than “Parking Committee”
- Unique experience for a mathematician



Election Night 2012
Hamilton County
Board of Elections