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# Algorithm to Predict Crime, or Criminal Algorithm?

Pablo Boix - Sarah Jacobs - Nazrath Palliparambil





In the aftermath of the death of George Floyd in Minneapolis, MN on May 25th, 2020, policing and the criminal justice system as a whole are under unprecedented scrutiny.



It is more important now than ever before to examine the processes used within that system.

The goal is to study one part of the system to determine whether or not it is impartial and therefore fair to all Americans.



## BY HER NAME

The Life and Death of Sandra Bland

MARVEL FILMS PRESENTS BY HER NAME: THE LIFE AND DEATH OF SANDRA BLAND DIRECTED BY DALE HARRISON  
PRODUCED BY KATE DAVIS, TOM BERGMAN AND REBECCA WALKER PRODUCTION DESIGN BY KAREN SANDA FALCOTT  
DIRECTOR OF PHOTOGRAPHY SHEILA NEVINS EDITORS JESSICA DAVIS, DAVID HELM RODRIGUEZ



# Pablo J. Boix

- Pablo has earned his Bachelor of Telecommunications Engineering at Universidad ORT Uruguay, as well as an MBA at IE Business School in Madrid, Spain
- He has experience managing indirect distribution channels in the Product Identification Industry in Latin America for more than 15 years
- He fluently speaks English, Portuguese and Spanish
- Additionally, he has worked as a QMS Auditor for many companies in S. America and Caribbean region (ISO 9001, 14001, 27001, OHSAS 18001)



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# Sarah Jacobs

- Sarah graduated from The College of Charleston with a bachelor's degree in Corporate and Organizational Communication
- She's worked as a project manager in construction since 2010
- In that position she coordinated between project owners, contractors and fabricators to maximize efficiency and quality of work from the project planning stages to move-in day
- Additionally, she's worked in product development, marketing, sales and human resources
- A college internship at the Polynesian Resort in Walt Disney World taught her excellent customer service and not to pursue a career in hospitality.



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# Nazrath Palliparambil

- Nazrath has completed her Bachelor of Technology in Electrical and Electronics Engineering from Calicut University, India
- She has experience maintaining large electrical systems by working at the State Electricity Board in her home state of Kerala, India
- She completed her internship at BPCL (Bharat Petroleum Corporation Limited) where she designed an electrical control system to monitor and alert critical operational issues.





# COMPAS Recidivism Bias Study

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**COMPAS** (*Correctional Offender Management Profiling for Alternative Sanctions*)

- Algorithm used in the American criminal justice system for judges and parole officers to make judgements on a defendant's likelihood of reoffending - risk of recidivism.

ProPublica set about to determine if the COMPAS algorithm is biased specifically against minorities. The resulting article concluded that there is significant bias against African Americans.

Since its publication, there have been many other studies done with some confirming ProPublica's conclusions while others hotly contest them.





# The Data

The screenshot shows a Kaggle competition page for "COMPAS Recidivism Racial Bias". The main title is "COMPAS Recidivism Racial Bias" with a subtitle "Racial Bias in inmate COMPAS reoffense risk scores for Florida (ProPublica)". Below the title is a profile picture of Dan Ofer and the text "updated 3 years ago (Version 1)". The page includes navigation links for "Data", "Tasks (2)", "Kernels (1)", "Discussion (3)", "Activity", and "Metadata". There is a "Download (23 MB)" button and a "New Notebook" button. At the bottom, there are sections for "Usability" (9.7), "License" (Database: Open Database, Contents: Database Contents), and "Tags" (natural and physical sciences, sensitive subjects, law, crime, social issues and advocacy, and 2 more).

Due to proprietary reasons, it is not possible to analyze the algorithm itself.

All of the data used for this project was obtained from ProPublica's github repository as linked from a Kaggle competition page:

<https://github.com/propublica/compas-analysis>

There are five .csv files available for analysis though not all were used.

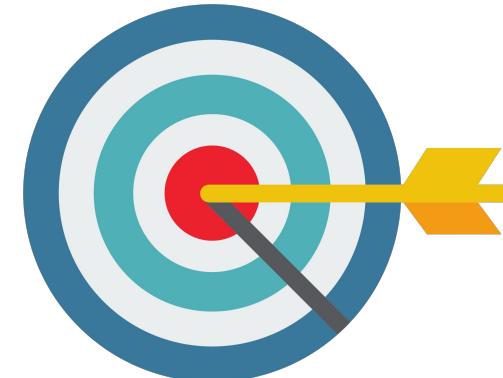
# Manipulation and Data Wrangling

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The team decided to work on this data in 4 different ways:

- Logistic Regression in R
- Descriptive Analysis Using Python
- Machine Learning with Python
- Visualization done in Tableau

*'Decile Score'* is the primary Dependant Variable (DV), or target. It is the resulting recidivism risk score generated by the mysterious COMPAS survey. Some version of it was included in all available datasets.



# Relevant Variables

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- COMPAS Score (entered as variations of “decile score”)
- 2 yr Recidivism
- Race
- Age

“Missing” variables:

- Input variables to “black box” COMPAS algorithm (137 questions)

Summary:

- The COMPAS system is owned by a for-profit company and is therefore proprietary. The data used came from a Kaggle project and included intake records on over 18,000 people arrested in Broward County Florida. This information came from freedom of information requests filed by ProPublica.
- Original technical paper by algorithm developer “Northpointe” was based on 2328 cases, ProPublica original study based on 11757 cases (prior wrangling)
- The sample used here was derived from the datasets released by ProPublica: 7214 cases



# Logit Regression:

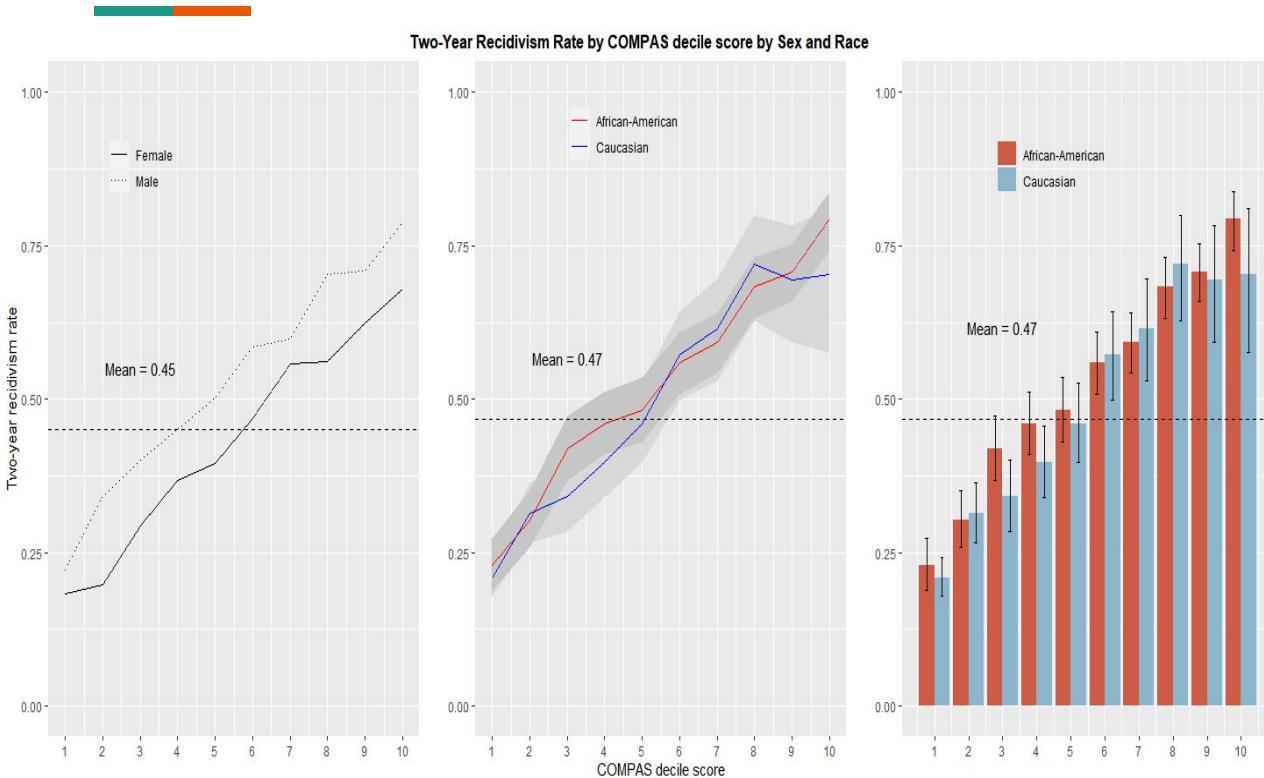
- COMPAS **score** shows a relationship with both **race** and **age** (Chi-square test)
- The logit regression also shows a relationship between COMPAS (DV) with **race** and **age**

LOGIT REGRESSION					
N (relevant factors)	DV	SCORE_FACTOR		DV	RECIDIVISM
	GENDER	**		GENDER	***
	AGE	***		AGE	***
	RACE	***		RACE	
	PRIORS COUNT	***		PRIORS COUNT	***

p< 0.05

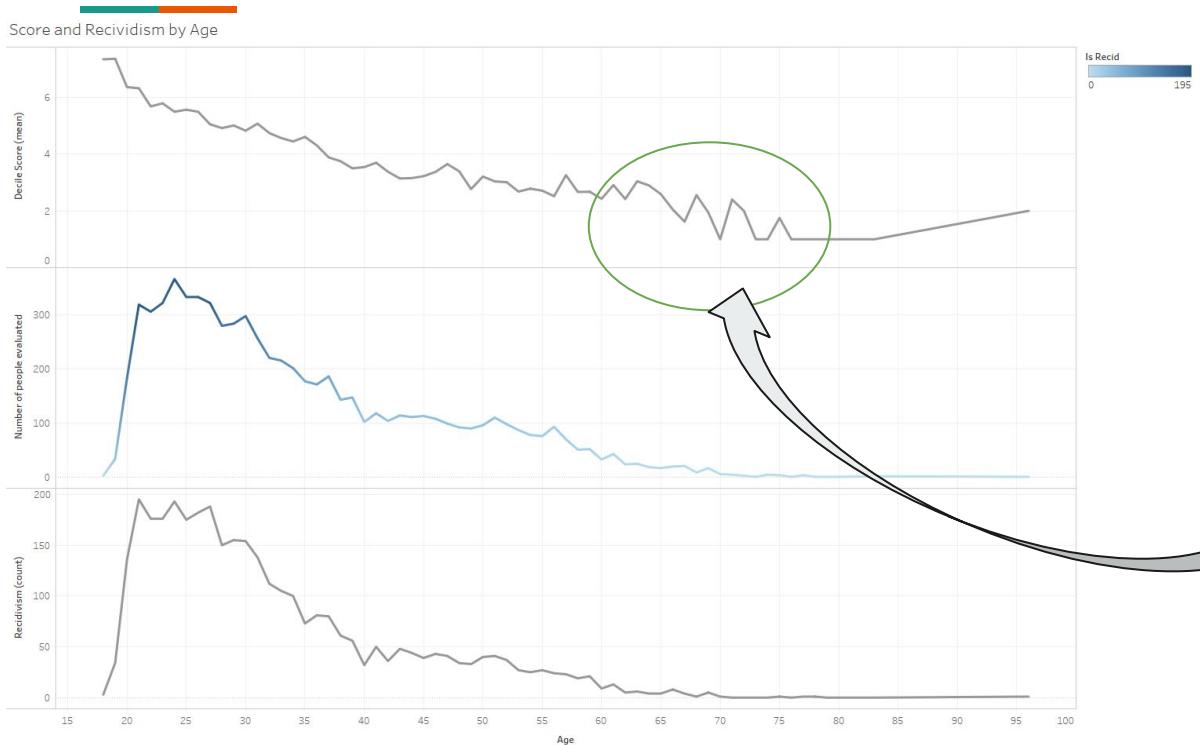
COMPAS score had been recoded into a binomial variable (high low) for logit regression purposes.

# Recidivism Rate vs COMPAS Score



- Recidivism rate is higher for male for any score, so we see a bias against females.
- Race, for low scores the bias seems to favour african-american, however for higher risk scores it seems to favour Caucasians.
- The right graph shows same data as middle graph but using bars and confidence intervals as lines.

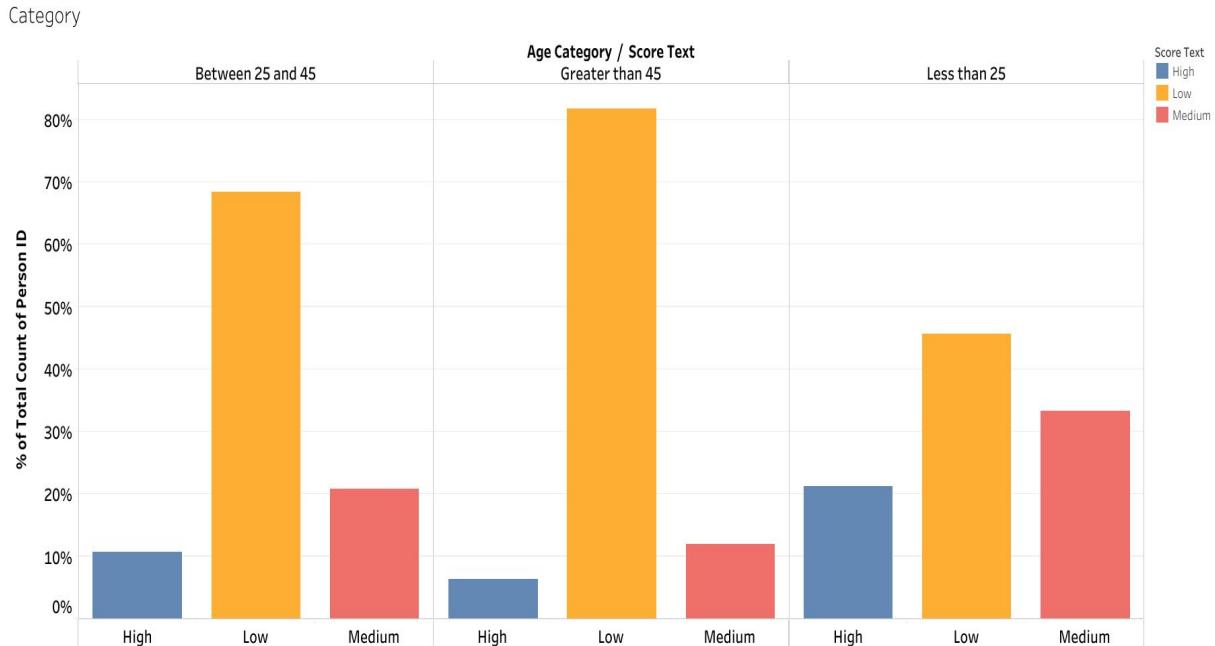
# COMPAS Score and Recidivism by Age



- Inmate population is concentrated mostly on the 18-40 years old age segment
- Higher recidivism count and average decile score is predominant in lower age range
- The “ripple” of average decile score above 70 years old is linked to a reduced number of cases

The trends of average of Decile Score, count of Decile Score and sum of Is Recid for Age. For pane Count of Decile Score: Color shows sum of Is Recid.

# Compas Score By Age Category



# ML Analysis

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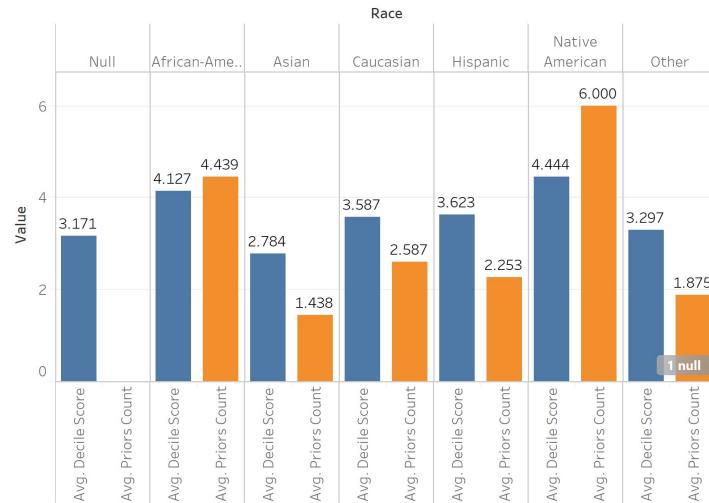
Both the raw COMPAS score and the two year COMPAS score datasets were cleaned, wrangled and prepared for random forest analysis.

Unfortunately, the data was never able to yield high enough accuracy scores to be used for drawing any conclusions.

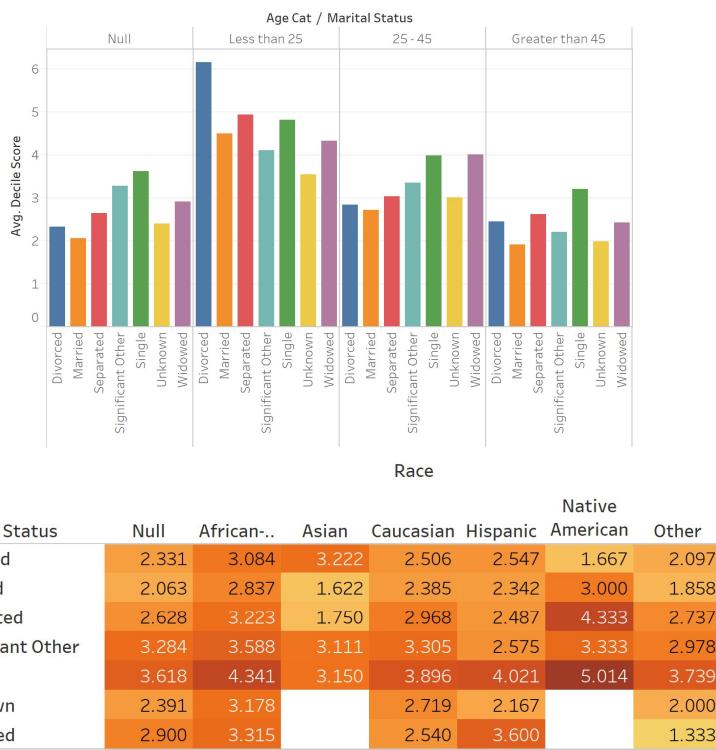
	precision	recall	f1-score	support
1	0.63	0.83	0.72	429
2	0.35	0.34	0.34	290
3	0.25	0.16	0.20	215
4	0.49	0.38	0.43	250
5	0.45	0.49	0.47	204
6	0.35	0.32	0.33	184
7	0.37	0.36	0.36	168
8	0.39	0.52	0.45	136
9	0.33	0.29	0.31	160
10	0.45	0.36	0.40	129
accuracy			0.45	2165
macro avg	0.40	0.40	0.40	2165
weighted avg	0.43	0.45	0.43	2165

This could be due to too much noise in the data, however in the process of preparing the data, other observations could be made.

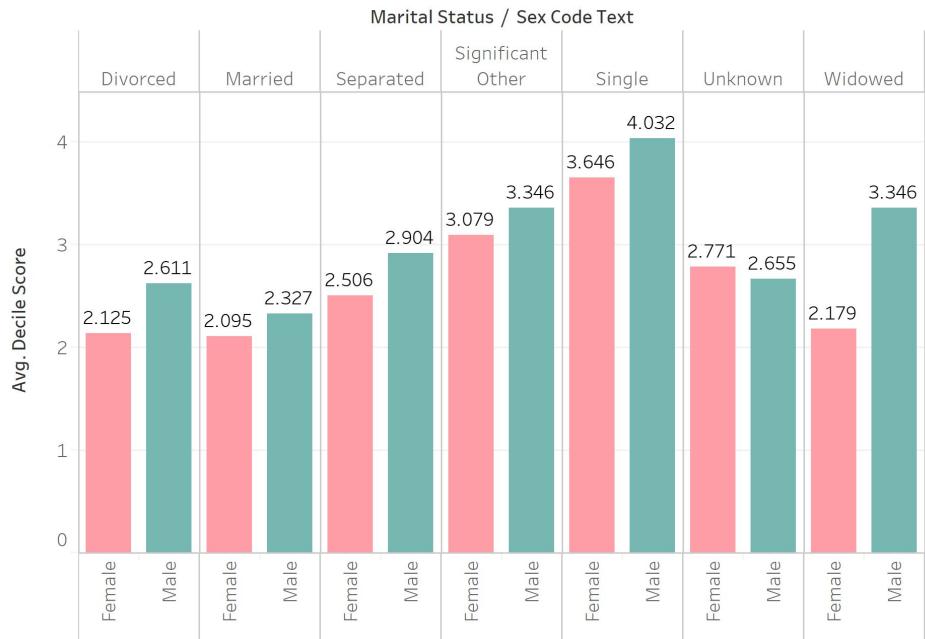
The relationship between the average score for a person of a specific race and the number of prior convictions they have.



# Examining Marital Status



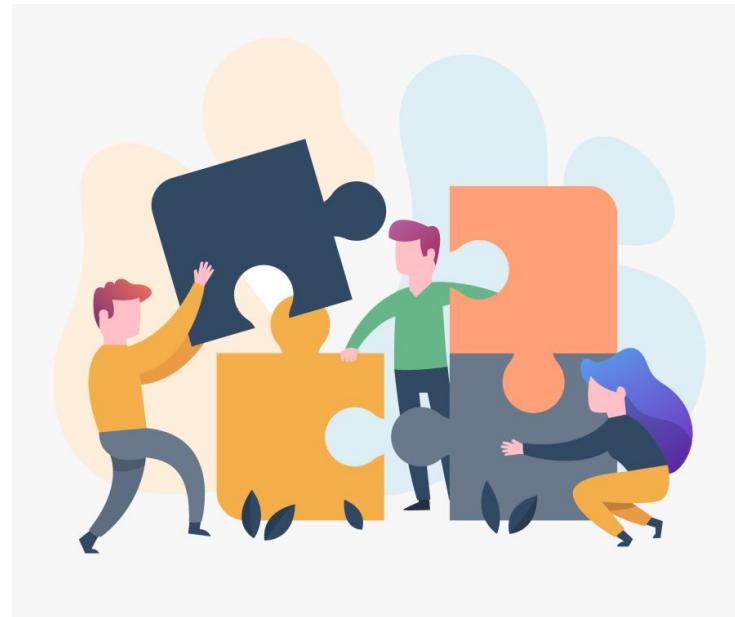
Being single appears to be a significantly higher risk category within the COMPAS system across race, age categories and gender. Those who report as single, separated or divorced have higher scores on average.



# Summary:

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- When determining COMPAS score, the following variables appear to have an influence:
  - Age** - younger people tend to have higher scores on average
  - Race** - African Americans specifically, and minorities in general, have higher average scores
  - Marital status** - (or relationship status) people who are single have higher average scores
  - Prior Convictions** - in general, the more prior convictions someone has, the higher their score



# The Case for Transparency

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- The available data does not really allow for adequate bias testing of the COMPAS algorithm
- All algorithms will have some bias because they are based on generalized statistics
- Whether an algorithm is “fair” depends on the “fairness” of the measures used
- Data Gathering from a disperse number of record is not easy (in cases legal action is needed).
- Algorithms for risk assessment are obscure in the best scenario (black-box)



Copyright by Matt Wuerker.



"The ability to argue with an algorithm requires confronting the base assumption that an algorithmically-derived assessment is objectively true, distant, and fixed"

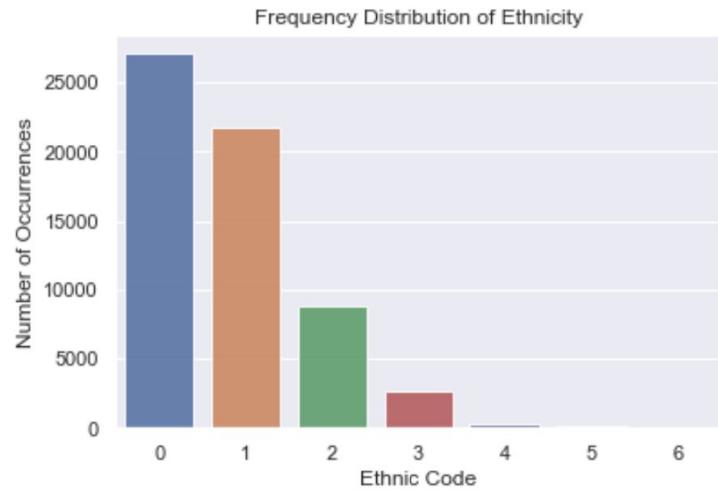
"However, it can be **difficult to assess the validity of information generated through proprietary algorithms** because vendors often claim that their algorithms are trade secrets that cannot be shared"

- Anne L. Washington PhD



# Conclusions

- One observation is clear, African Americans are arrested at a higher rate in general, regardless of other variables
- This points to the need to examine the racial bias of the system beyond the COMPAS algorithm
- If the criminal justice system is, itself, biased against minorities then the variables used by the algorithm would be corrupted by that bias and without access to the algorithm it is impossible to know if that baseline bias is accounted for when assigning COMPAS scores to defendants.





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# Questions?





## Limitations:

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- Between May 2016 and December 2017, the ProPublica “Machine Bias” article was cited by at least 578 scholars and researchers
- No clear consensus has ever been achieved as to whether the COMPAS risk system is biased beyond the results evaluated here
- The ProPublica research is still subject of passionate and heated discussions
- The lack of agreement could be attributed to, among other things:
  - Legal challenges linked to due process (i.e: State vs Loomis)
  - Lack of transparency on what variables the algorithm uses (137 questions serve as IV input)
  - “Chicken or the egg” mentality - in other words the mindset that higher numbers of minorities are in the justice system because they commit more crimes rather than the system targeting them disproportionately
- Anne L Washington (PhD) grouped all discussion related this subject in three general themes:
  - Mathematical definitions of fairness
  - Explainable interpretation of models
  - Importance of population comparison groups





## Ethical and Legal Issues

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“The question presented for review by the Court was whether the proprietary nature of the COMPAS violate a defendant’s constitutional right to due process because a defendant cannot challenge the algorithm’s accuracy or scientific validity. The United States Supreme Court declined to hear the case...”

“A research led by Jon Kleinberg presents three conditions that could denote fairness: (1) calibration; (2) balancing negative impact; and (3) balancing positive impact. Kleinberg includes mathematical proofs that show that it is not possible to simultaneously have all three conditions at once”

The factors that are the input for COMPAS Score could have a different influence on future behaviour on different groups.





# References, Bibliography and Acknowledgements:

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- EVALUATING THE PREDICTIVE VALIDITY OF THE COMPAS RISK AND NEEDS ASSESSMENT SYSTEM  
Tim Brennan, William Dieterich, Beate Ehret - Northpointe Institute for Public Management Inc.
- Data & original analysis gathered by ProPublica.  
Original Data methodology article: [How We Analyzed the COMPAS Recidivism Algorithm](#)
- [ProPublica Responds to Company's Critique of Machine Bias Story](#)
- [HOW TO ARGUE WITH AN ALGORITHM: LESSONS FROM THE COMPAS- PROPUBLICA DEBATE - Anne L. Washington](#)
- [ProPublica's COMPAS Data Revisited -2019 - Matias Barenstein](#)
  - [https://github.com/mbarenstein/ProPublica\\_COMPAS\\_Data\\_Revisited](https://github.com/mbarenstein/ProPublica_COMPAS_Data_Revisited)
- [FairML: Auditing Black-Box Predictive Models](#)
- <https://www.districtdatalabs.com/fairness-and-bias-in-algorithms>