

# ETHICS & FAIRNESS IN AI-ENABLED SYSTEMS

Christian Kaestner

(with slides from Eunsuk Kang)

Required reading: R. Caplan, J. Donovan, L. Hanson, J. Matthews. "Algorithmic Accountability: A Primer", Data & Society (2018).



# LEARNING GOALS

- Review the importance of ethical considerations in designing AI-enabled systems
- Recall basic strategies to reason about ethical challenges
- Diagnose potential ethical issues in a given system
- Understand the types of harm that can be caused by ML
- Understand the sources of bias in ML
- Analyze a system for harmful feedback loops

# OVERVIEW

Many interrelated issues:

- Ethics
- Fairness
- Justice
- Discrimination
- Safety
- Privacy
- Security
- Transparency
- Accountability

*Each is a deep and nuanced research topic. We focus on survey of some key issues.*

# ETHICAL VS LEGAL



*In September 2015, Shkreli received widespread criticism when Turing obtained the manufacturing license for the antiparasitic drug Daraprim and raised its price by a factor of 56 (from USD 13.5 to 750 per pill), leading him to be referred to by the media as "the most hated man in America" and "Pharma Bro".*

-- [Wikipedia](#)

*"I could have raised it higher and made more profits for our shareholders. Which is my primary duty."* -- Martin Shkreli

## Speaker notes

Image source: [https://en.wikipedia.org/wiki/Martin\\_Shkreli#/media/File:Martin\\_Shkreli\\_2016.jpg](https://en.wikipedia.org/wiki/Martin_Shkreli#/media/File:Martin_Shkreli_2016.jpg)



# TERMINOLOGY

- Legal = in accordance to societal laws
  - systematic body of rules governing society; set through government
  - punishment for violation
- Ethical = following moral principles of tradition, group, or individual
  - branch of philosophy, science of a standard human conduct
  - professional ethics = rules codified by professional organization
  - no legal binding, no enforcement beyond "shame"
  - high ethical standards may yield long term benefits through image and staff loyalty

# WITH A FEW LINES OF CODE...



# Some airlines may be using algorithms to split up families during flights

Your random airplane seat assignment might not be random at all.

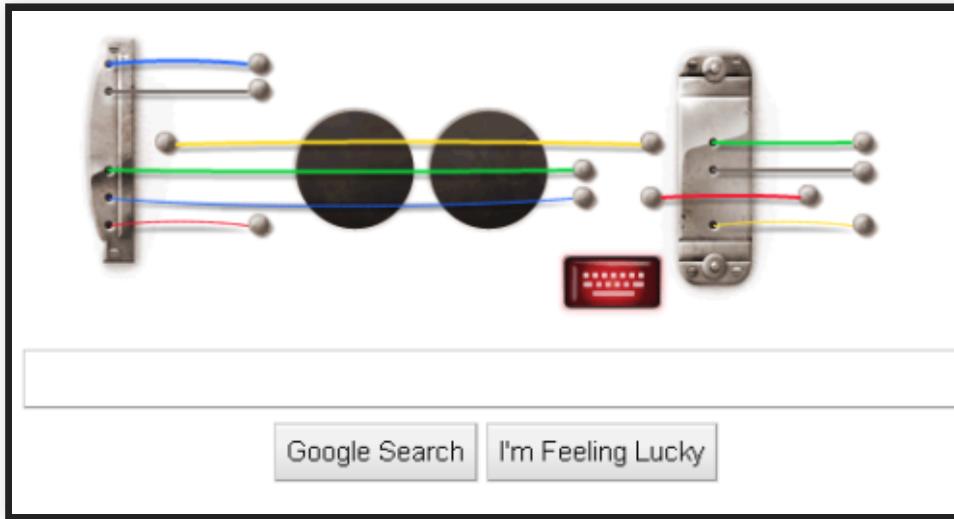
By Aditi Shrikant | [aditi@vox.com](mailto:aditi@vox.com) | Nov 27, 2018, 6:10pm EST



SHARE



# THE IMPLICATIONS OF OUR CHOICES



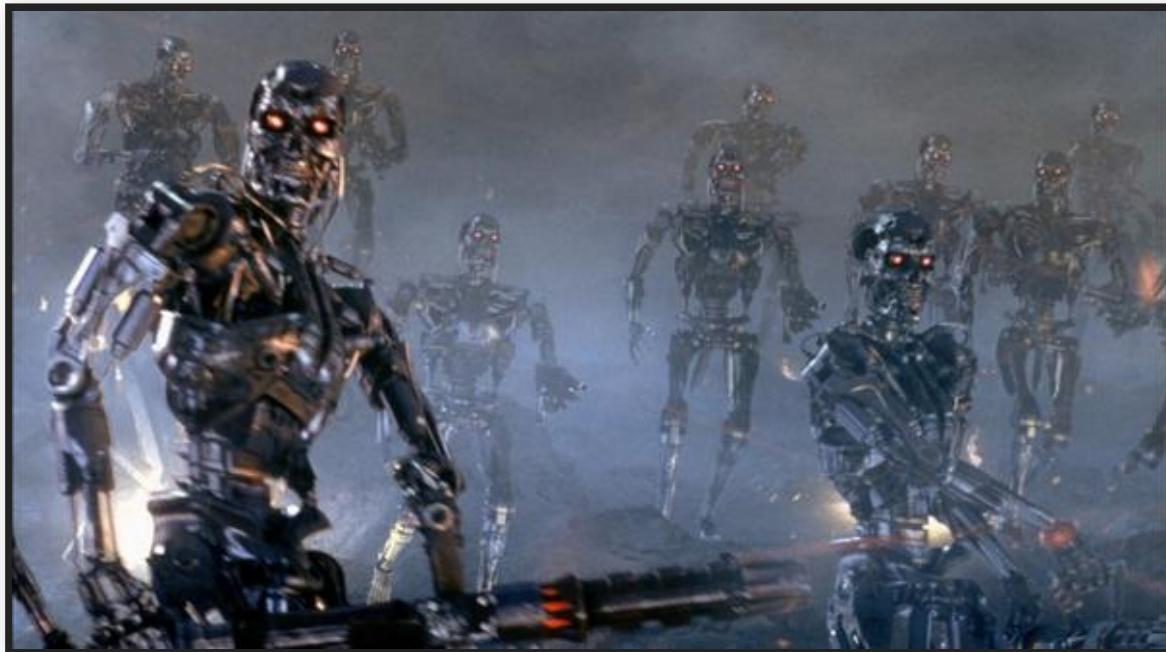
*“Update Jun 17: Wow—in just 48 hours in the U.S., you recorded 5.1 years worth of music—40 million songs—using our doodle guitar. And those songs were played back 870,000 times!“*



# CONCERNS ABOUT AN AI FUTURE



# SAFETY



# SAFETY

**skoops** 😊👤  
@skoops

The [@netatmo](#) servers are down and twitter is already full of freezing people not able to control their heating :D (via [protected]) / cc [@internetofshit](#)

Kieran @DivemasterK  
netatmo Are your servers down ? I can't connect to my app to turn on heating !!  
11.18, 21:02 from Wicklow, Ireland

@netatmo hi my manual override on my thermostat is not working and when i try using the app it comes up with an error with servers down. Can i override at boiler end?  
22.11.18, 20:58

Andy Mc @TakeSugar  
Replies to @levisiedaniel and @netatmo  
Is there a way to control the boiler even if the servers are down, it's freezing at the moment  
22.11.18, 20:38

James Brown @jamesbrun · 1h  
Replies to @tyrestighe @levis  
@netatmo same issue. Can't control heat cannot login to netatmo.com to control from there. What is @netatmo ?  
22.11.18, 20:58

8:15 PM · Nov 22, 2018

2.2K 1.6K people ...

# SAFETY



**Emily Slackerman**   
@EmilyEAckerman

i (in a wheelchair) was just trapped \*on\* forbes ave by one of these robots, only days after their independent roll out. i can tell that as long as they continue to operate, they are going to be a major accessibility and safety issue. [thread]



Everything we know about the Starship food delivery ...  
 [pittnews.com](https://pittnews.com)

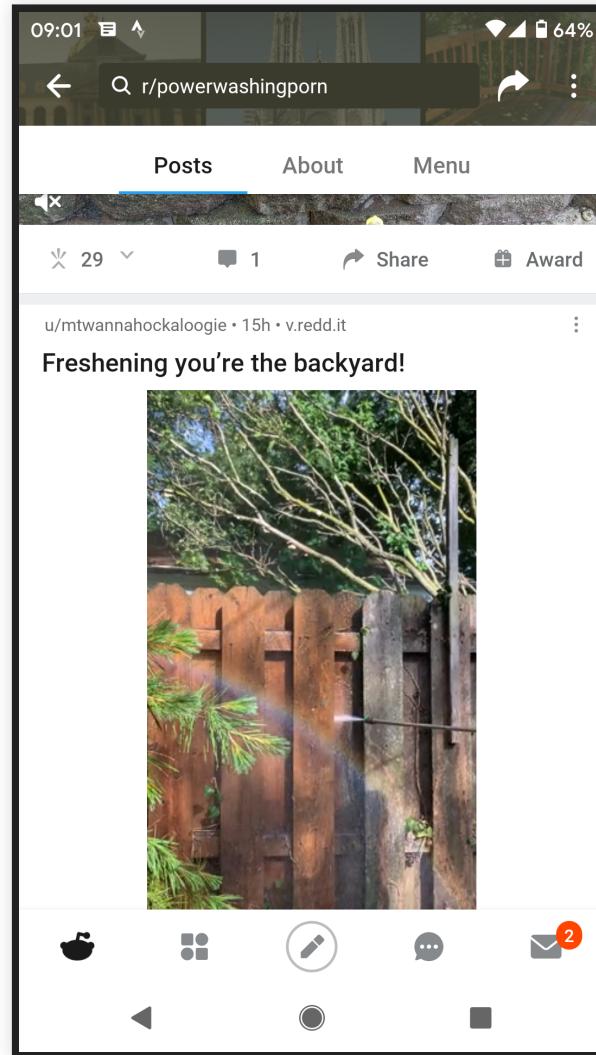
7:27 PM · Oct 21, 2019



 4.3K  3.2K people ...



# ADDICTION



## Speaker notes

Infinite scroll in applications removes the natural breaking point at pagination where one might reflect and stop use.



# ADDICTION



NO MERCY NO MALICE

# Robinhood Has Gamified Online Trading Into an Addiction

Tech's obsession with addiction will hurt us all



Scott Galloway [Follow](#)

Jun 23 · 7 min read ★



*Warning: This post contains a discussion of suicide.*

**A**ddiction is the inability to stop consuming a chemical or pursuing an activity although it's causing harm.

I engage with almost every substance or behavior associated with addiction: alcohol, drugs, coffee, porn, sex, gambling, work, spending,

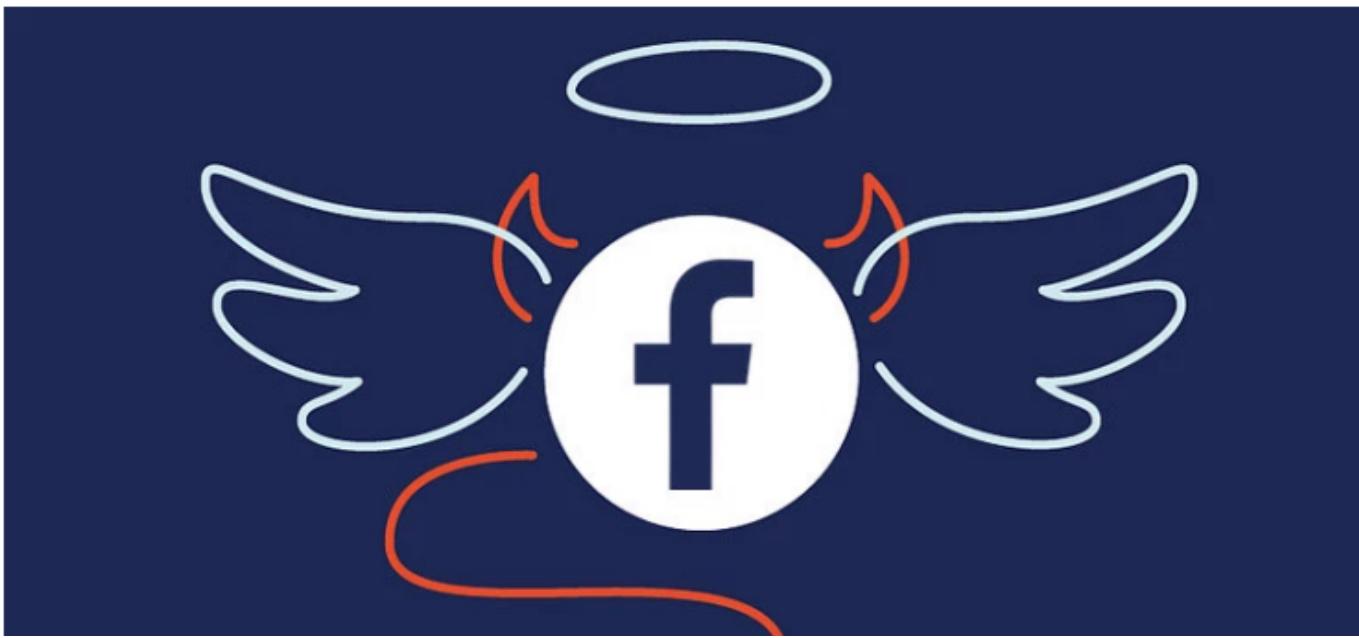
X

# The Morality Of A/B Testing

**Josh Constine** @joshconstine / 4 years ago



Comment





# MENTAL HEALTH



healthline

SUBSCRIBE

HEALTH NEWS

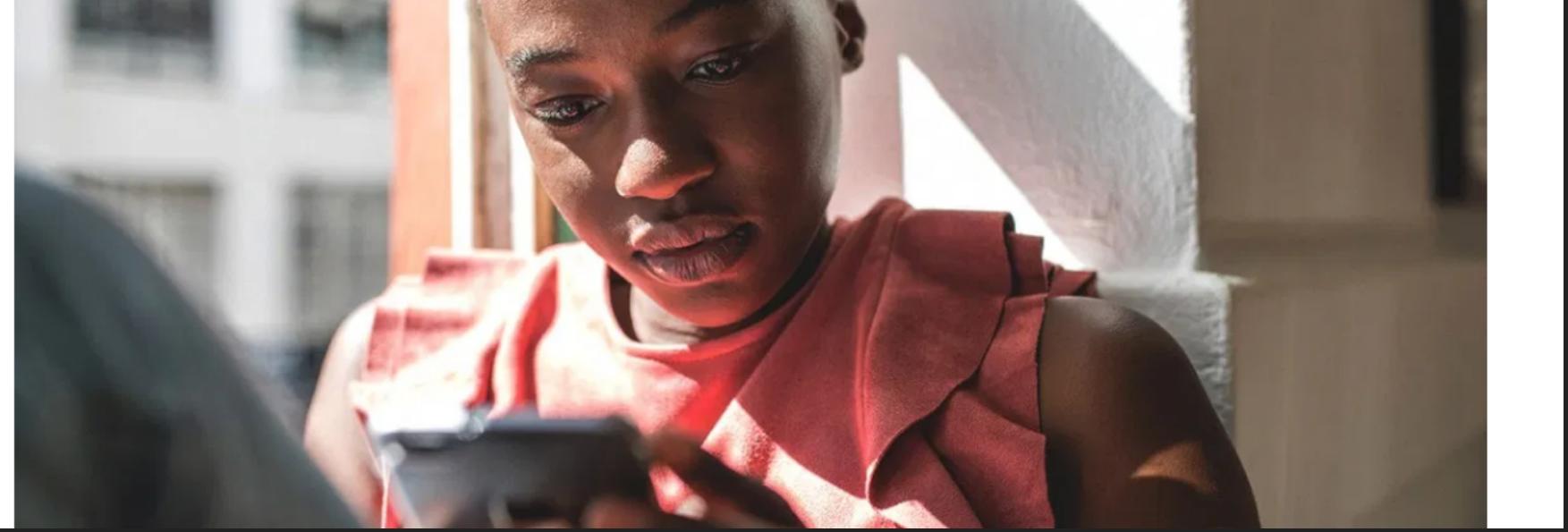
✓ Fact Checked

## The FOMO Is Real: How Social Media Increases Depression and Loneliness

Written by [Gigen Mammoser](#) on December 10, 2018

New research reveals how social media platforms like Facebook can greatly affect your mental health.





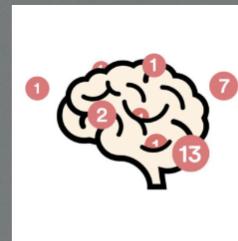
## The extractive attention economy is tearing apart our shared social fabric.

The companies that created social media and mobile tech have benefited our lives enormously. But even with the best intentions, they are under intense pressure to compete for attention, creating invisible harms for society:



### Digital Addiction

Digital slot machines occupy more and more space in our lives



### Mental Health

We constantly face a battle for our attention, social comparison, and bullying



### Breakdown of Truth

It's become harder than ever to separate fact from fiction

# SOCIETY: UNEMPLOYMENT ENGINEERING / DESKILLING



## Speaker notes

The dangers and risks of automating jobs.

Discuss issues around automated truck driving and the role of jobs.

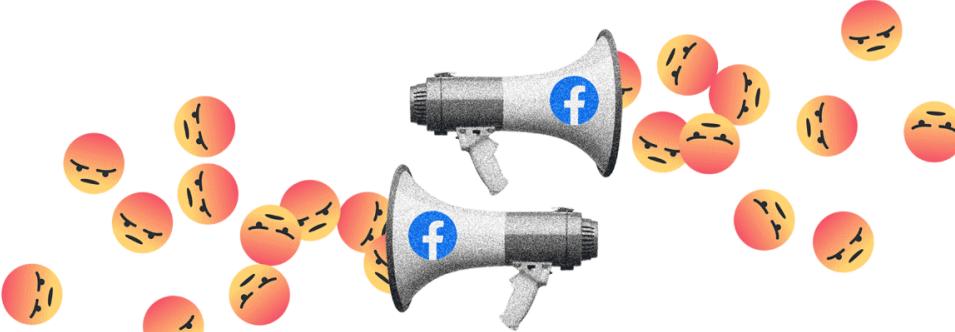
See for example: Andrew Yang. The War on Normal People. 2019



# SOCIETY: POLARIZATION

≡ THE WALL STREET JOURNAL. Ⓛ

SUBSCRIBE SIGN IN



TECH

## Facebook Executives Shut Down Efforts to Make the Site Less Divisive

The social-media giant internally studied how it polarizes users, then largely shelved the research

By [Jeff Horwitz](#) and [Deepa Seetharaman](#)  
May 26, 2020 11:38 am ET

## Speaker notes

Recommendations for further readings: <https://www.nytimes.com/column/kara-swisher>,  
<https://podcasts.apple.com/us/podcast/recode-decode/id1011668648>

Also isolation, Cambridge Analytica, collaboration with ICE, ...



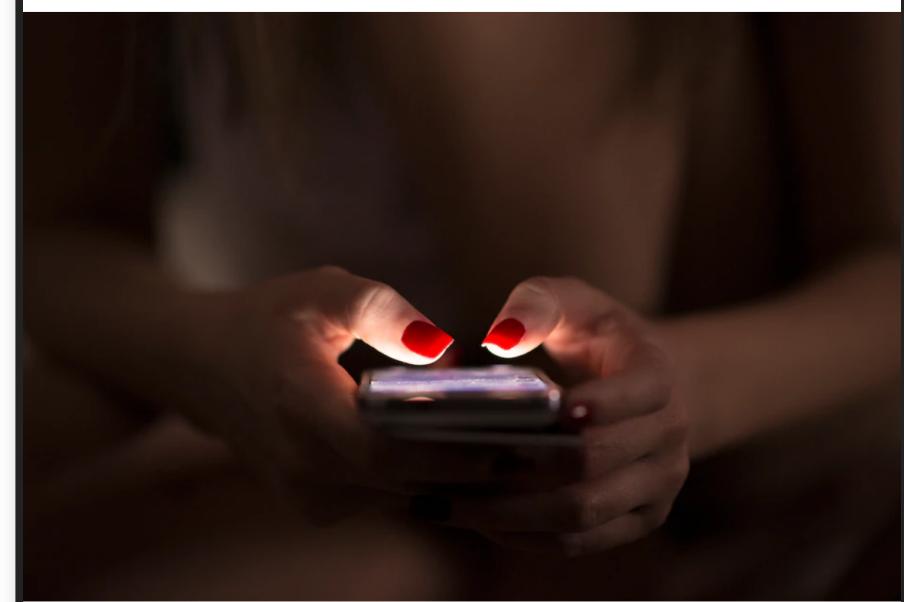
# WEAPONS, SURVEILLANCE, SUPPRESSION



The Washington Post  
*Democracy Dies in Darkness*

PostEverything • Perspective

## How U.S. surveillance technology is propping up authoritarian regimes



(iStock)

By **Robert Morgus** and **Justin Sherman**

Jan. 17, 2019 at 6:00 a.m. EST



# DISCRIMINATION



DHH

@dhh



The [@AppleCard](#) is such a fucking sexist program. My wife and I filed joint tax returns, live in a community-property state, and have been married for a long time. Yet Apple's black box algorithm thinks I deserve 20x the credit limit she does. No appeals work.

8:34 PM · Nov 7, 2019



28.6K 10.7K peo...

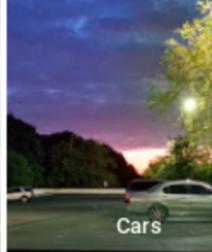
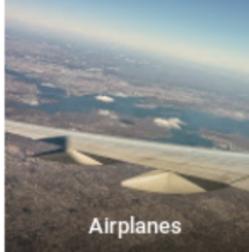
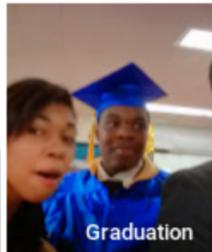


# DISCRIMINATION

 stop hoarding and work with your ...  
@jackyalcine

Follow ▾

Google Photos, y'all fucked up. My friend's not a gorilla.

6:22 PM - 28 Jun 2015

3,352 Retweets 2,767 Likes

 Kahuna

232 3.4K 2.8K

# DISCRIMINATION

- Unequal treatment in hiring, college admissions, credit rating, insurance, policing, sentencing, advertisement, ...
- Unequal outcomes in healthcare, accident prevention, ...
- Reinforcing patterns in predictive policing with feedback loops
- Technological redlining

# ANY OWN EXPERIENCES?



# SUMMARY -- SO FAR

- Safety issues
  - Addiction and mental health
  - Societal consequences: unemployment, polarization, monopolies
  - Weapons, surveillance, suppression
  - Discrimination, social equity
- 
- Many issues are ethically problematic, but some are legal. Consequences?
  - Intentional? Negligence? Unforeseeable?



# FAIRNESS



# LEGALLY PROTECTED CLASSES (US)

- Race (Civil Rights Act of 1964)
- Color (Civil Rights Act of 1964)
- Sex (Equal Pay Act of 1963; Civil Rights Act of 1964)
- Religion (Civil Rights Act of 1964)
- National origin (Civil Rights Act of 1964)
- Citizenship (Immigration Reform and Control Act)
- Age (Age Discrimination in Employment Act of 1967)
- Pregnancy (Pregnancy Discrimination Act)
- Familial status (Civil Rights Act of 1968)
- Disability status (Rehabilitation Act of 1973; Americans with Disabilities Act of 1990)
- Veteran status (Vietnam Era Veterans' Readjustment Assistance Act of 1974; Uniformed Services Employment and Reemployment Rights Act)
- Genetic information (Genetic Information Nondiscrimination Act)

Barocas, Solon and Moritz Hardt. "[Fairness in machine learning](#)." NIPS Tutorial 1 (2017).

# REGULATED DOMAINS (US)

- Credit (Equal Credit Opportunity Act)
- Education (Civil Rights Act of 1964; Education Amendments of 1972)
- Employment (Civil Rights Act of 1964)
- Housing (Fair Housing Act)
- ‘Public Accommodation’ (Civil Rights Act of 1964)

Extends to marketing and advertising; not limited to final decision

Barocas, Solon and Moritz Hardt. "[Fairness in machine learning](#)." NIPS Tutorial 1 (2017).

## Equality



The assumption is that **everyone benefits from the same supports**. This is equal treatment.

## Equity



**Everyone gets the supports they need**  
(this is the concept of "affirmative action"), thus producing equity.

## Justice

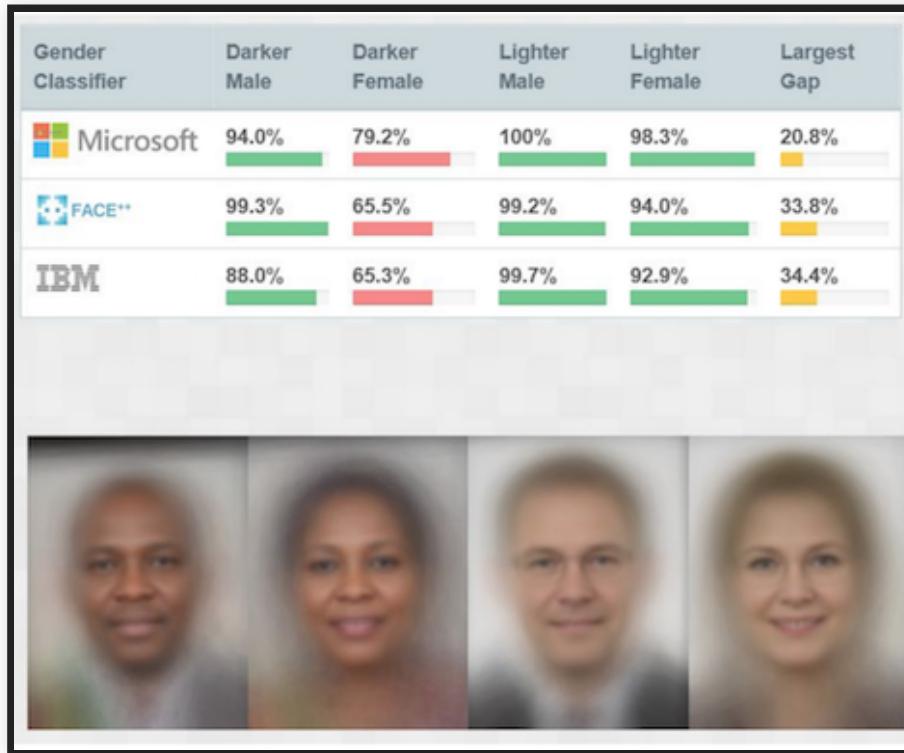


All 3 can see the game without supports or accommodations because **the cause(s) of the inequity was addressed**.  
The systemic barrier has been removed.



# HARMS OF ALLOCATION

- Withhold opportunities or resources
- Poor quality of service, degraded user experience for certain groups



Other examples?





# HARMS OF REPRESENTATION

- Reinforce stereotypes, subordination along the lines of identity

Ads by Google

[Latanya Sweeney, Arrested?](#)

1) Enter Name and State. 2) Access Full Background Checks Instantly.

[www.instantcheckmate.com/](http://www.instantcheckmate.com/)

[Latanya Sweeney](#)

Public Records Found For: Latanya Sweeney. View Now.

[www.publicrecords.com/](http://www.publicrecords.com/)

[La Tanya](#)

Search for La Tanya Look Up Fast Results now!

[www.ask.com/La+Tanya](http://www.ask.com/La+Tanya)

Other examples?

Latanya Sweeney. [Discrimination in Online Ad Delivery](#), SSRN (2013).





# IDENTIFYING HARMS

	Allocation of resources	Quality of Service	Stereotyping	Denigration	Over- / Under-Representation
Hiring system does not rank women as highly as men for technical jobs	x	x	x		x
Photo management program labels image of black people as “gorillas”		x		x	
Image searches for “CEO” yield only photos of white men on first page			x		x

- Multiple types of harms can be caused by a product!
- Think about your system objectives & identify potential harms.

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))

# THE ROLE OF REQUIREMENTS ENGINEERING

- Identify system goals
- Identify legal constraints
- Identify stakeholders and fairness concerns
- Analyze risks with regard to discrimination and fairness
- Analyze possible feedback loops (world vs machine)
- Negotiate tradeoffs with stakeholders
- Set requirements/constraints for data and model
- Plan mitigations in the system (beyond the model)
- Design incident response plan
- Set expectations for offline and online assurance and monitoring

# WHY CARE ABOUT FAIRNESS?

- Obey the law
- Better product, serving wider audiences
- Competition
- Responsibility
- PR

*Examples?*

*Which argument appeals to which stakeholders?*

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))



# CASE STUDY: COLLEGE ADMISSION



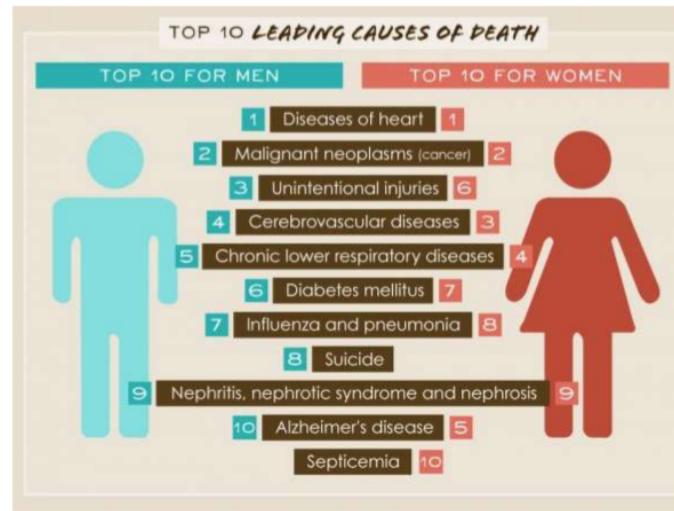
- Objective: Decide "Is this student likely to succeed"?
- Possible harms: Allocation of resources? Quality of service? Stereotyping? Denigration? Over-/Under-representation?

# NOT ALL DISCRIMINATION IS HARMFUL



FEDERAL TRADE COMMISSION

Mortgage discrimination is against the law.



- Loan lending: Gender discrimination is illegal.
- Medical diagnosis: Gender-specific diagnosis may be desirable.
- Discrimination is a **domain-specific** concept!

Other examples?

# SOURCES OF BIAS



# WHERE DOES THE BIAS COME FROM?

The image displays two side-by-side screenshots of the Google Translate interface, illustrating gender bias in machine translation.

**Top Screenshot (English to Turkish):**

- Input:** "He is a nurse  
She is a doctor" (English)
- Output:** "O bir hemşire  
O bir doktor" (Turkish)
- Note:** The output preserves the gender of the input, translating "he" as "O bir hemşire" and "she" as "O bir doktor".

**Bottom Screenshot (Turkish to English):**

- Input:** "O bir hemşire  
O bir doktor" (Turkish)
- Output:** "She is a nurse  
He is a doctor" (English)
- Note:** The output preserves the gender of the input, translating "she" as "She is a nurse" and "he" as "He is a doctor".

In both cases, the model has assigned a female gender to the first sentence and a male gender to the second sentence, reflecting a gender bias present in the training data.

Caliskan et al., *Semantics derived automatically from language corpora contain human-like biases*, Science (2017).

# ON TERMINOLOGY

- Bias and discrimination are technical terms in machine learning
  - selection bias, reporting bias, bias of an estimator, inductive/learning bias
  - discrimination refers to distinguishing outcomes (classification)
- The problem is *unjustified* differentiation, ethical issues
  - practical irrelevance
  - moral irrelevance

# SOURCES OF BIAS

- Skewed sample
- Tainted examples / historical bias
- Limited features
- Sample size disparity
- Proxies

Baracas, Solon, and Andrew D. Selbst. "Big data's disparate impact." Calif. L. Rev. 104 (2016): 671.

Mehrabi, Ninareh, Fred Morstatter, Nripsuta Saxena, Kristina Lerman, and Aram Galstyan. "] (<https://arxiv.org/pdf/1908.09635.pdf>.)" arXiv preprint arXiv:1908.09635 (2019).

# HISTORICAL BIAS

*Data reflects past biases, not intended outcomes*

A screenshot of a search results page for the query "ceo". The search bar at the top contains the text "ceo". Below the search bar are navigation links: All, Images (which is underlined), Videos, News, Maps, Meanings, and Settings. There are also dropdown menus for All Regions (set to "All Regions"), Safe Search (set to "Moderate"), All Sizes, All Types, All Layouts, and All Colors. The main content area displays five search results, each with a thumbnail image and a brief description. The first three results have full descriptions, while the fourth and fifth results are partially visible.

Thumbnail	Description	Source
	Cronos CEO: \$1.8 billion from Big Tob...	marketwatch.com
	Marriott CEO talks...	bizjournals.com
	Goldman Sachs may claw back milli...	nypost.com
	Coolest thing about Tesla's C...	businessinsider.com



1000 × 1000

Croatian Doctor To...  
croatiaweek.com



999 × 666

Lufthansa CEO Says Brit...  
skift.com



1000 × 750

'The ideal match': Lululemon...  
business.financialpost.com



750 × 999

Fairview names St...  
bizjournals.com



CEO pay: Top 10 highest  
usatoday.com

## Speaker notes

"An example of this type of bias can be found in a 2018 image search result where searching for women CEOs ultimately resulted in fewer female CEO images due to the fact that only 5% of Fortune 500 CEOs were woman—which would cause the search results to be biased towards male CEOs. These search results were of course reflecting the reality, but whether or not the search algorithms should reflect this reality is an issue worth considering."



# TAINTED EXAMPLES

*Samples or labels reflect human bias*

TECH \ AMAZON \ ARTIFICIAL INTELLIGENCE

## Amazon reportedly scraps internal AI recruiting tool that was biased against women

*The secret program penalized applications that contained the word “women’s”*

By James Vincent | Oct 10, 2018, 7:09am EDT

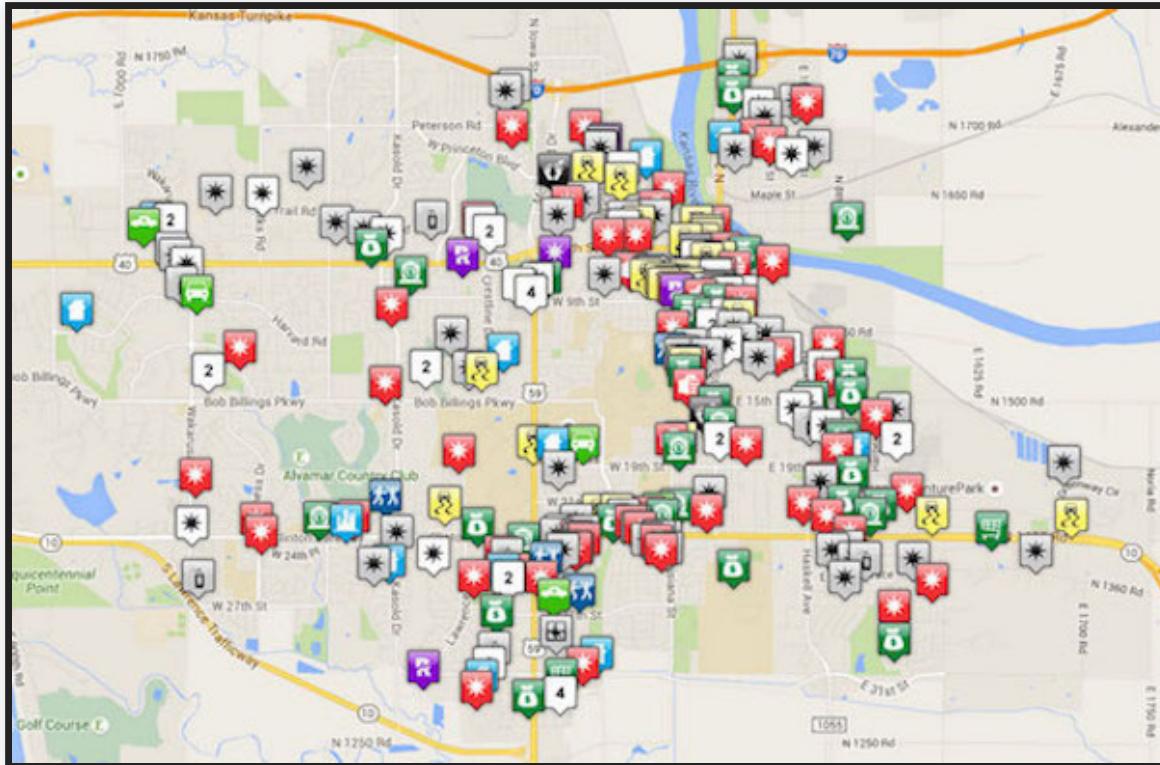
## Speaker notes

- Bias in the dataset caused by humans
- Some labels created manually by employers
- Dataset "tainted" by biased human judgement



# SKEWED SAMPLE

*Crime prediction for policing strategy*



## Speaker notes

Initial bias in the data set, amplified through feedback loop

Other example: Street Bump app in Boston (2012) to detect potholes while driving favors areas with higher smartphone adoption



# LIMITED FEATURES

*Features used are less informative/reliable for certain subpopulations*



Example: "Leave of absence" as feature in employee performance review

## Speaker notes

- Features are less informative or reliable for certain parts of the population
- Features that support accurate prediction for the majority may not do so for a minority group
- Example: Employee performance review
  - "Leave of absence" as a feature (an indicator of poor performance)
  - Unfair bias against employees on parental leave



# SAMPLE SIZE DISPARITY

*Less training data available for certain subpopulations*



Example: "Shirley Card" used for color calibration

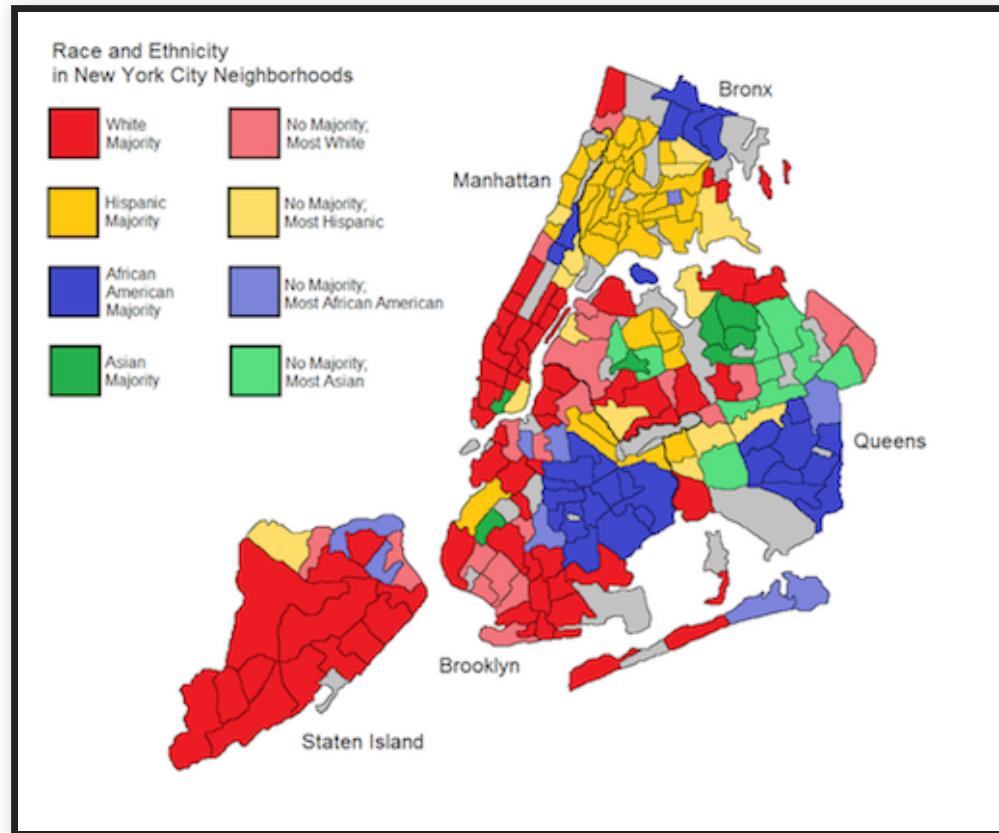
## Speaker notes

- Less data available for certain parts of the population
- Example: "Shirley Card"
  - Used by Kodak for color calibration in photo films
  - Most "Shirley Cards" used Caucasian models
  - Poor color quality for other skin tones



# PROXIES

*Features correlate with protected attributes*



## Speaker notes

- Certain features are correlated with class membership
- Example: Neighborhood as a proxy for race
- Even when sensitive attributes (e.g., race) are erased, bias may still occur

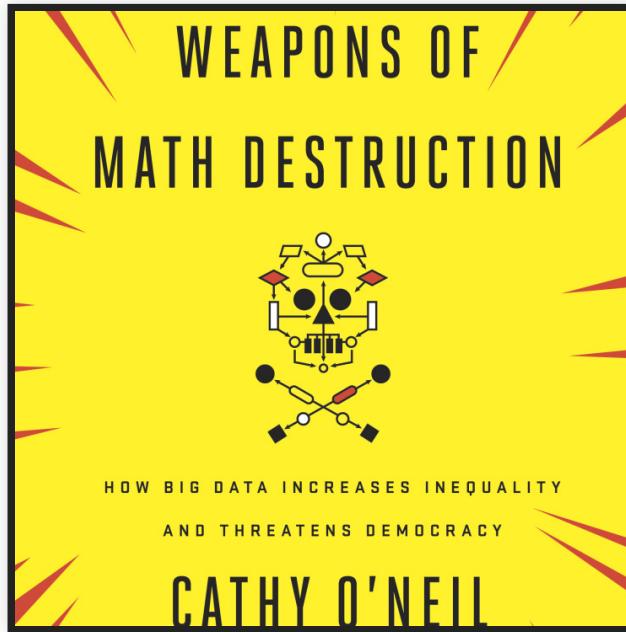


# CASE STUDY: COLLEGE ADMISSION



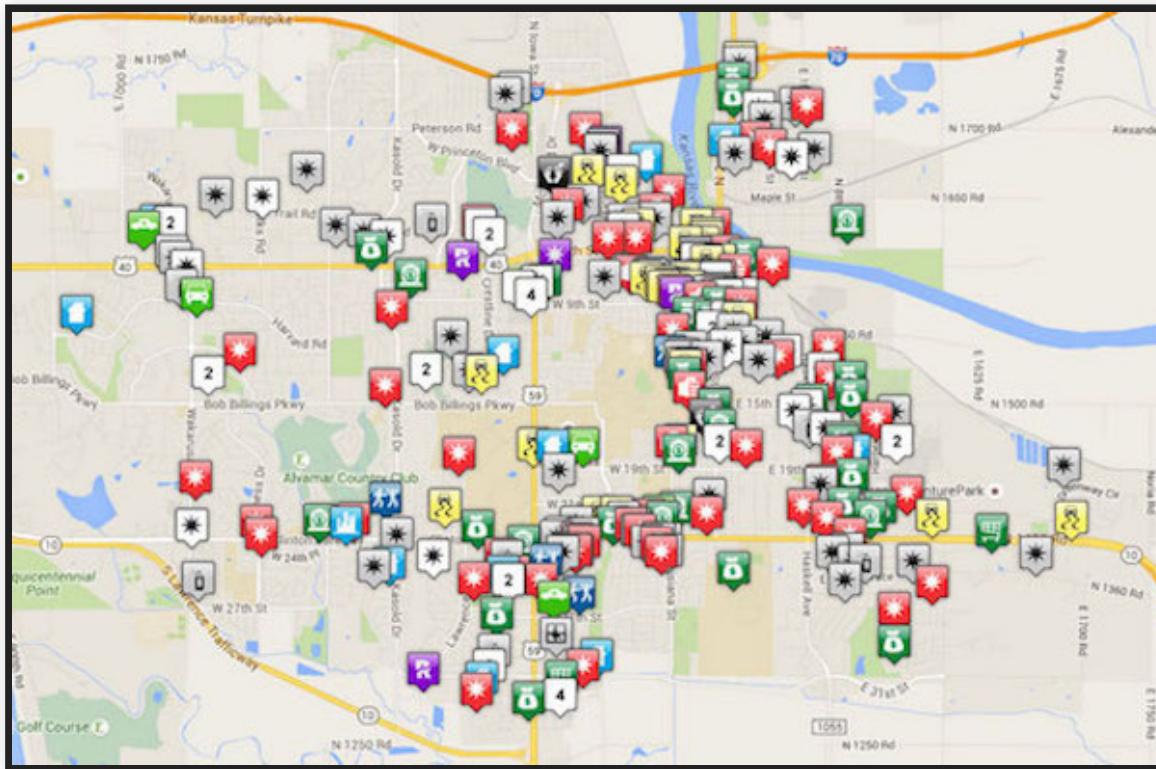
- Classification: Is this student likely to succeed?
- Features: GPA, SAT, race, gender, household income, city, etc.,
- **Discuss:** Historical bias? Skewed sample? Tainted examples? Limited features? Sample size disparity? Proxies?

# MASSIVE POTENTIAL DAMAGE



O'Neil, Cathy. [Weapons of math destruction: How big data increases inequality and threatens democracy](#). Broadway Books, 2016.

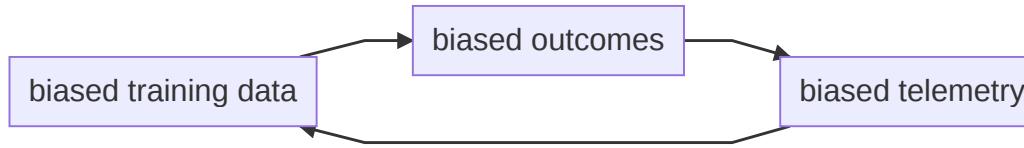
# EXAMPLE: PREDICTIVE POLICING



*with a few lines of code...*

*A person who scores as ‘high risk’ is likely to be unemployed and to come from a neighborhood where many of his friends and family have had run-ins with the law. Thanks in part to the resulting high score on the evaluation, he gets a longer sentence, locking him away for more years in a prison where he’s surrounded by fellow criminals—which raises the likelihood that he’ll return to prison. He is finally released into the same poor neighborhood, this time with a criminal record, which makes it that much harder to find a job. If he commits another crime, the recidivism model can claim another success. But in fact the model itself contributes to a toxic cycle and helps to sustain it.* -- Cathy O’Neil in [Weapons of Math Destruction](#)

# FEEDBACK LOOPS



*"Big Data processes codify the past. They do not invent the future. Doing that requires moral imagination, and that's something only humans can provide. " -- Cathy O'Neil in  
*Weapons of Math Destruction**

# KEY PROBLEMS

- We trust algorithms to be objective, may not question their predictions
- Often designed by and for privileged/majority group
- Algorithms often black box (technically opaque and kept secret from public)
- Predictions based on correlations, not causation; may depend on flawed statistics
- Potential for gaming/attacks
- Despite positive intent, feedback loops may undermine the original goals

O'Neil, Cathy. [Weapons of math destruction: How big data increases inequality and threatens democracy.](#)  
Broadway Books, 2016.

# "WEAPONS OF MATH DESTRUCTION"

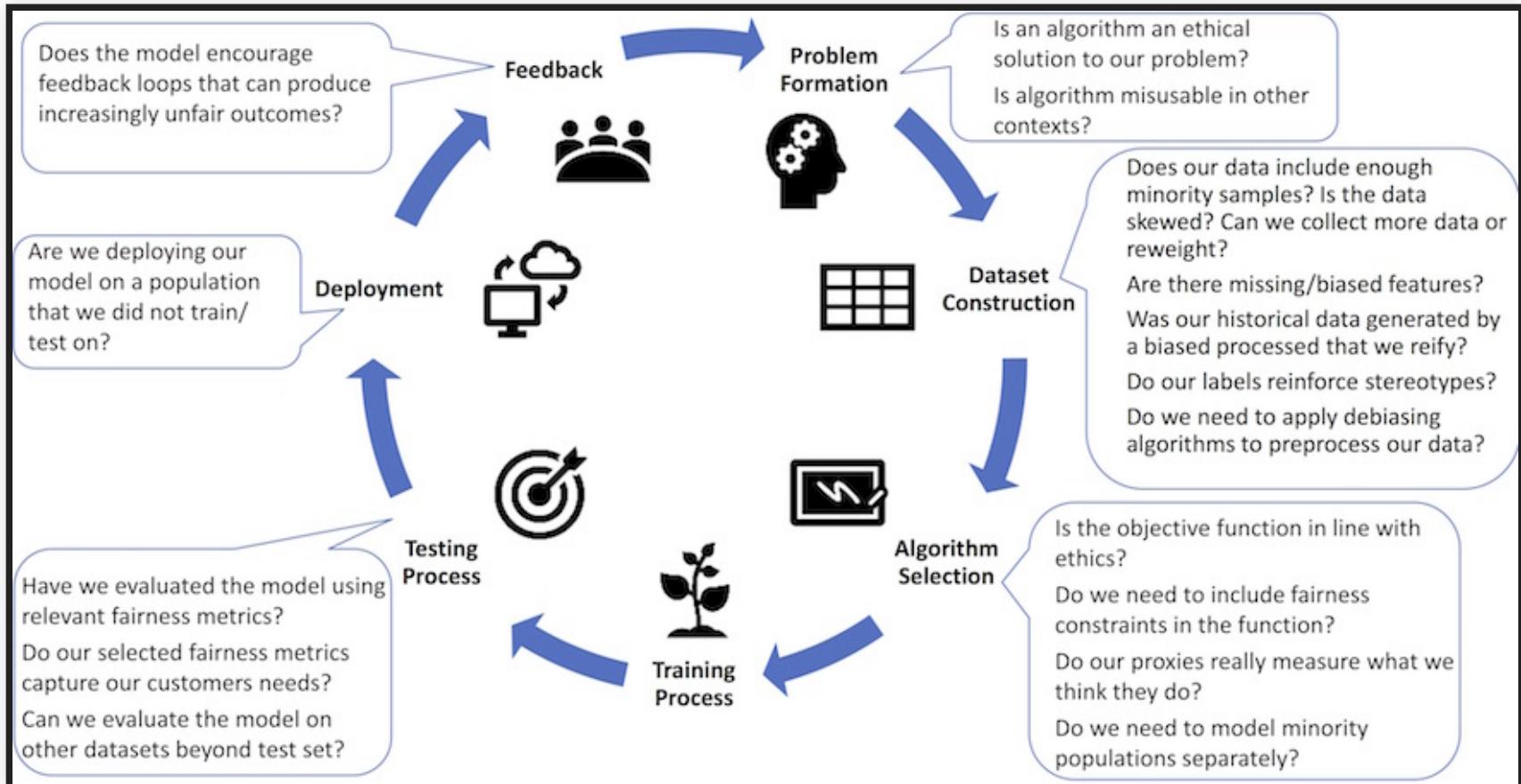
- Algorithm evaluates people
  - e.g., credit, hiring, admissions, recidivism, advertisement, insurance, healthcare
- Widely used for life-affecting decisions
- Opaque and not accountable, no path to complain
- Feedback loop

O'Neil, Cathy. [Weapons of math destruction: How big data increases inequality and threatens democracy.](#)  
Broadway Books, 2016.

# BUILDING FAIR ML SYSTEMS



# FAIRNESS MUST BE CONSIDERED THROUGHOUT THE ML LIFECYCLE!



Bennett et al., [Fairness-aware Machine Learning](#), WSDM Tutorial (2019).



# THE ROLE OF REQUIREMENTS ENGINEERING

- Identify system goals
- Identify legal constraints
- Identify stakeholders and fairness concerns
- Analyze risks with regard to discrimination and fairness
- Analyze possible feedback loops (world vs machine)
- Negotiate tradeoffs with stakeholders
- Set requirements/constraints for data and model
- Plan mitigations in the system (beyond the model)
- Design incident response plan
- Set expectations for offline and online assurance and monitoring

# THE ROLE OF SOFTWARE ENGINEERS

- Whole system perspective
- Requirements engineering, identifying stakeholders
- Tradeoff decisions among conflicting goals
- Interaction and interface design
- Infrastructure for evaluating model quality and fairness offline and in production
- Monitoring
- System-wide mitigations (in model and beyond model)

# BEST PRACTICES: TASK DEFINITION

- Clearly define the task & model's intended effects
- Try to identify and document unintended effects & biases
- Clearly define any fairness requirements
- *Involve diverse stakeholders & multiple perspectives*
- Refine the task definition & be willing to abort

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))



# BEST PRACTICES: CHOOSING A DATA SOURCE

- Think critically before collecting any data
- Check for biases in data source selection process
- Try to identify societal biases present in data source
- Check for biases in cultural context of data source
- Check that data source matches deployment context
- Check for biases in
  - technology used to collect the data
  - humans involved in collecting data
  - sampling strategy
- *Ensure sufficient representation of subpopulations*
- Check that collection process itself is fair & ethical

*How can we achieve fairness without putting a tax on already disadvantaged populations?*

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))





# BEST PRACTICES: LABELING AND PREPROCESSING

- Check for biases introduced by
  - discarding data
  - bucketing values
  - preprocessing software
  - labeling/annotation software
  - human labelers
- Data/concept drift?

*Auditing? Measuring bias?*

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))



# BEST PRACTICES: MODEL DEFINITION AND TRAINING

- Clearly define all assumptions about model
- Try to identify biases present in assumptions
- Check whether model structure introduces biases
- Check objective function for unintended effects
- Consider including “fairness” in objective function

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))



# BEST PRACTICES: TESTING & DEPLOYMENT

- Check that test data matches deployment context
- Ensure test data has sufficient representation
- Continue to involve diverse stakeholders
- Revisit all fairness requirements
- Use metrics to check that requirements are met
- Continually monitor
  - match between training data, test data, and instances you encounter in deployment
  - fairness metrics
  - population shifts
  - user reports & user complaints
- Invite diverse stakeholders to audit system for biases

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))

# **DATASET CONSTRUCTION FOR FAIRNESS**



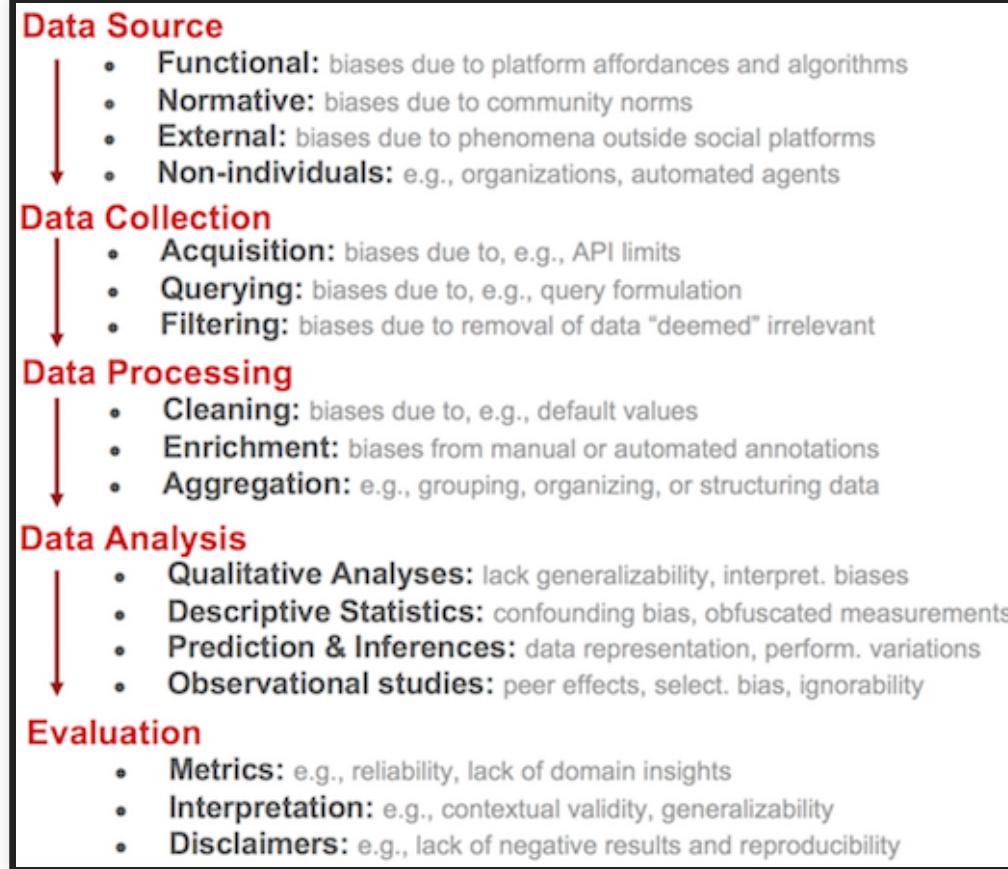
# FLEXIBILITY IN DATA COLLECTION

- Data science education often assumes data as given
- In industry most have control over data collection and curation (65%)
- Most address fairness issues by collecting more data (73%)

Swati Gupta, Henriette Cramer, Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miroslav Dudík, Hanna Wallach, Sravana Reddy, Jean GarciaGathright. [Challenges of incorporating algorithmic fairness into practice](#), FAT\* Tutorial, 2019. ([slides](#))



*Bias can be introduced at any stage of the data pipeline*



Bennett et al., [Fairness-aware Machine Learning](#), WSDM Tutorial (2019).

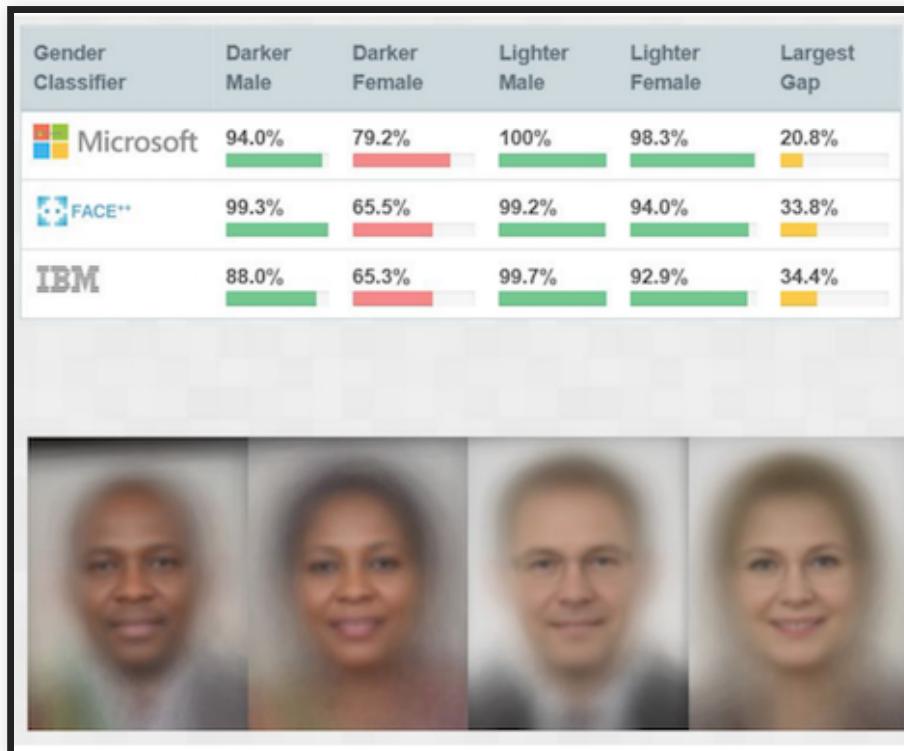
# **TYPES OF DATA BIAS**

- Population bias
- Behavioral bias
- Content production bias
- Linking bias
- Temporal bias

Olteanu et al., [Social Data: Biases, Methodological Pitfalls, and Ethical Boundaries](#), Olteanu et al., Frontiers in Big Data (2019).

# POPULATION BIAS

- Differences in demographics between a dataset vs a target population
- Example: Does the Twitter demographics represent the general population?
- In many tasks, datasets should match the target population
- But some tasks require equal representation for fairness



# BEHAVIORAL BIAS

- Differences in user behavior across platforms or social contexts

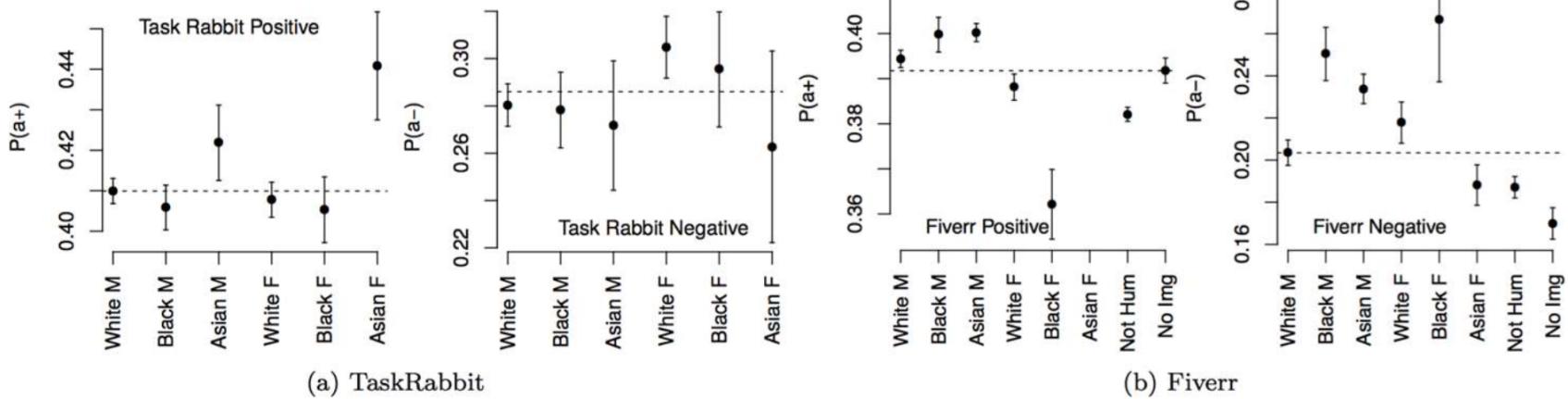


Figure 2: Fitted  $P(a_+)$  and  $P(a_-)$  depending on combinations of gender and race of the reviewed worker. Points show expected values and bars standard errors. In Fiverr, Black workers are less likely to be described with adjectives for positive words, and Black Male workers are more likely to be described with adjectives for negative words.

*Example: Freelancing platforms (Fiverr vs TaskRabbit): Bias against certain minority groups on different platforms*

*Bias in Online Freelance Marketplaces, Hannak et al., CSCW (2017).*



# FAIRENESS-AWARE DATA COLLECTION

- Address population bias
  - Does the dataset reflect the demographics in the target population?
- Address under- & over-representation issues
  - Ensure sufficient amount of data for all groups to avoid being treated as "outliers" by ML
  - But also avoid over-representation of certain groups (e.g., remove historical data)
- Data augmentation: Synthesize data for minority groups
  - Observed: "He is a doctor" -> synthesize "She is a doctor"
- Fairness-aware active learning
  - Collect more data for groups with highest error rates

Bennett et al., [Fairness-aware Machine Learning](#), WSDM Tutorial (2019).



# DATA SHEETS

Demographic Characteristic	Value
Percentage of female subjects	22.5%
Percentage of male subjects	77.5%
Percentage of White subjects	83.5%
Percentage of Black subjects	8.47%
Percentage of Asian subjects	8.03%
Percentage of people between 0-20 years old	1.57%
Percentage of people between 21-40 years old	31.63%
Percentage of people between 41-60 years old	45.58%
Percentage of people over 61 years old	21.2%

- A process for documenting datasets
- Based on common practice in the electronics industry, medicine
- Purpose, provenance, creation, composition, distribution: Does the dataset relate to people? Does the dataset identify any subpopulations?

*Datasheets for Dataset*, Gebru et al., (2019).

# MODEL CARDS

### Model Card - Toxicity in Text

**Model Details**

- The TOXICITY classifier provided by Perspective API [32], trained to predict the likelihood that a comment will be perceived as toxic.
- Convolutional Neural Network.
- Developed by Jigsaw in 2017.

**Intended Use**

- Intended to be used for a wide range of use cases such as supporting human moderation and providing feedback to comment authors.
- Not intended for fully automated moderation.
- Not intended to make judgments about specific individuals.

**Factors**

- Identity terms referencing frequently attacked groups, focusing on sexual orientation, gender identity, and race.

**Metrics**

- Pinned AUC, as presented in [11], which measures threshold-agnostic separability of toxic and non-toxic comments for each group, within the context of a background distribution of other groups.

**Ethical Considerations**

- Following [31], the Perspective API uses a set of values to guide their work. These values are Community, Transparency, Inclusivity, Privacy, and Topic-neutrality. Because

**Training Data**

- Proprietary from Perspective API. Following details in [11] and [32], this includes comments from online forums such as Wikipedia and New York Times, with crowdsourced labels of whether the comment is “toxic”.
- “Toxic” is defined as “a rude, disrespectful, or unreasonable comment that is likely to make you leave a discussion.”

**Evaluation Data**

- A synthetic test set generated using a template-based approach, as suggested in [11], where identity terms are swapped into a variety of template sentences.
- Synthetic data is valuable here because [11] shows that real data often has disproportionate amounts of toxicity directed at specific groups. Synthetic data ensures that we evaluate on data that represents both toxic and non-toxic statements referencing a variety of groups.

**Caveats and Recommendations**

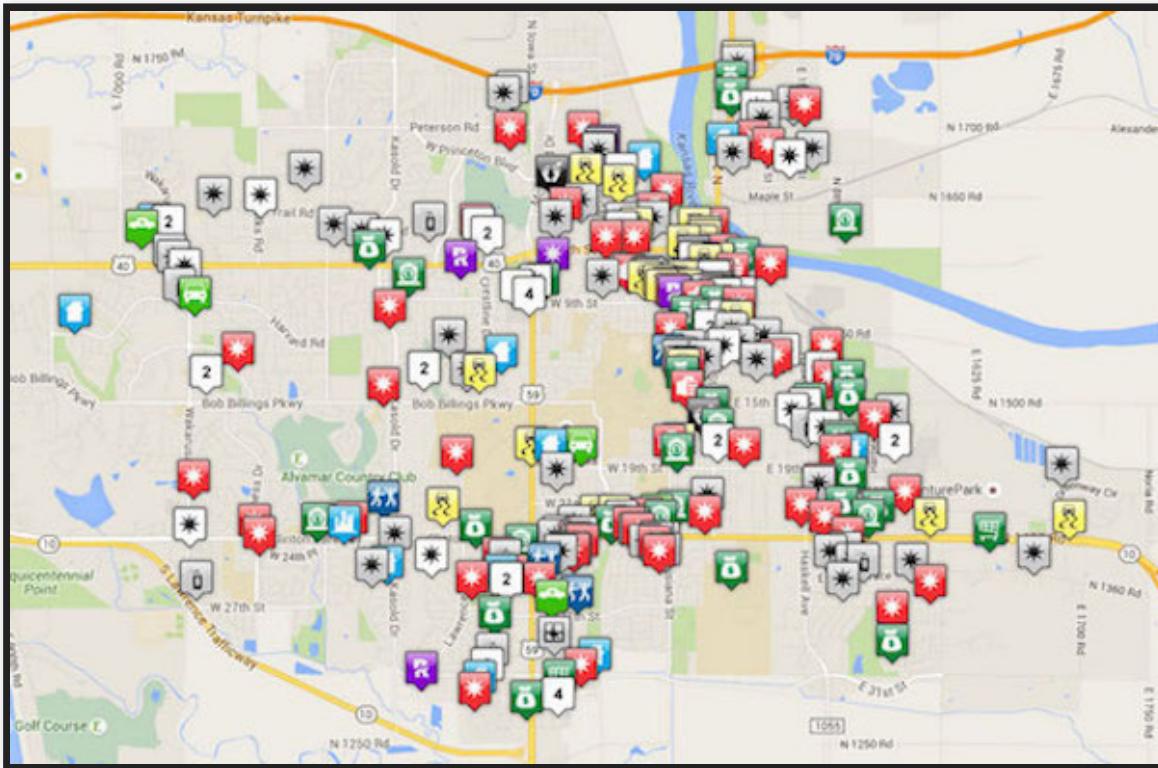
- Synthetic test data covers only a small set of very specific comments. While these are designed to be representative of common use cases and concerns, it is not comprehensive.

see also <https://modelcards.withgoogle.com/about>

Mitchell, Margaret, et al. "Model cards for model reporting." In Proceedings of the Conference on fairness, accountability, and transparency, pp. 220-229. 2019.



# EXERCISE: CRIME MAP



*How can we modify an existing dataset or change the data collection process to reduce the effects the feedback loop?*

# SUMMARY

- Many interrelated issues: ethics, fairness, justice, safety, security, ...
- Many many many potential issues
- Consider fairness when it's the law and because it's ethical
- Large potential for damage: Harm of allocation & harm of representation
- Sources of bias in ML: skewed sample, tainted examples, limited features, sample size, disparity, proxies
- Be aware of feedback loops
- Addressing fairness requirements engineering and throughout the entire ML pipeline
- Data bias & data collection for fairness
- Recommended readings: [Weapons of Math Destructions](#) and [several tutorials on ML fairness](#)
- **Next:** Definitions of fairness, measurement, testing for fairness