

I 202: INFORMATION ORGANIZATION & RETRIEVAL FALL 2025

Class 26: Fairness and Bias in Automated Systems

FINAL PROJECTS

- Updated Rubric Posted
- Pushed back the due date from Wed Dec 10 to Sat Dec 13!

Today's Outline

What is Fairness / Bias?

Focus: Dataset Creation

Focus: ML Algorithms

Fairness / Bias in Search Ranking

Two Readings

COMMUNICATIONS
OF THE ACM

Explore Topics ▾

PRACTICE [Artificial Intelligence and Machine Learning](#) Practice

Biases in AI Systems

A survey for practitioners.

By [Ramya Srinivasan](#) and [Ajay Chander](#)

Posted Aug 1 2021

Fairness and Machine Learning

— —

Limitations and Opportunities

Solon Barocas, Moritz Hardt, and Arvind Narayanan

WHAT IS FAIRNESS?

What does it mean for an algorithm/system to be “fair” or “unfair”?

MANY CLOSELY RELATED TOPICS

- Fairness in **ranking**
 - *(job applicants, political search results)*
- Search results **representativeness**
 - *(exposure of diverse information)*
- Fairness in **automated classification**
 - *(recognizing demographics of people in images)*
- Fairness in application of algorithms to **real-world tasks**
 - *(recidivism risk assessments, assessing teachers, recommending advertisements)*
- Bias in **generative** language models
 - *(story generation, image generation)*

SOME LEGAL DEFINITIONS

- **Protected groups:** Groups that are protected from discrimination by law, e.g., based on sex, race, age, disability, color, creed, national origin, or religion.
- **Disparate Treatment:** Intentional discrimination, where people in a protected class are deliberately treated differently.
- **Disparate Impact:** Unintentional discrimination, where the procedures are the same for everyone, but people in a protected class are negatively affected.

WHAT IS BIAS?

What does it mean for an algorithm/system to be “biased” or “unbiased”?

WHAT IS BIAS?

Bias: “computer systems that systematically and unfairly discriminate against certain individuals or groups of individuals in favor of others.”

- **Preexisting bias** (arising from biases present in individuals or society),
- **Technical bias** (arising from technical constraints), and
- **Emergent bias** (unforeseen discriminatory outcomes arising in real use, often arises when an algorithm is used by an audience or in a context for which it was not designed)

They argue: “freedom from bias should be counted among the select set of criteria – including reliability, accuracy, and efficiency -- according to which the quality of systems in use in society should be judged.”

TECHNICAL BIAS

- **Computer tools:**
 - e.g., in a database for matching organ donors with potential transplant recipients, certain individuals retrieved and displayed on initial screens are favored systematically for a match over individuals displayed on later screens
- **Decontextualized Algorithms Bias** that originates from the use of an algorithm that fails to treat all groups fairly under all significant conditions
 - e.g., a scheduling algorithm that schedules airplanes for take-off relies on the alphabetic listing of the airlines to rank order flights ready within a given period of time
- **Random Number Generation:**
 - e.g., an imperfection in a random-number generator used to select recipients for a scarce drug leads systematically to favoring individuals toward the end of the database.
- **Formalization of Human Constructs Bias** that originates from attempts to make human constructs such as discourse, judgments, or intuitions amenable to computers:
 - e.g., a legal expert system advises defendants on whether or not to plea bargain by assuming that law can be spelled out in an unambiguous manner that is not subject to human and humane interpretations in context

FAIRNESS AND MACHINE LEARNING

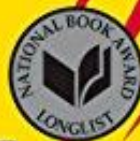
BOOK BY BAROCAS, HARDT, AND NARAYANAN

“Something ... is lost in moving to automated, predictive decision making. Human decision makers rarely try to maximize predictive accuracy at all costs; frequently, they might consider factors such as whether the attributes used for prediction are morally relevant.”

“For example, although younger defendants are statistically more likely to re-offend, judges are loath to take this into account in deciding sentence lengths, viewing younger defendants as less morally culpable.”

ADDRESSING BIAS IN REAL- WORLD APPLICATIONS

NEW YORK TIMES BESTSELLER



WEAPONS OF MATH DESTRUCTION



HOW BIG DATA INCREASES INEQUALITY
AND THREATENS DEMOCRACY

CATHY O'NEIL

A NEW YORK TIMES NOTABLE BOOK

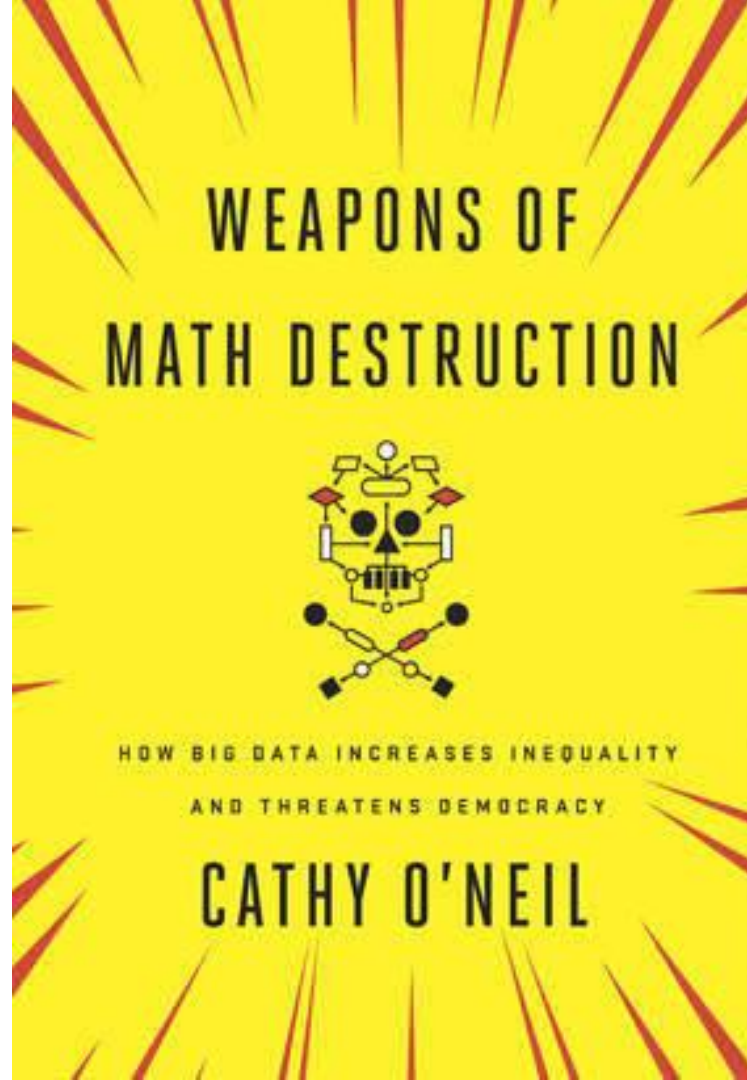
Sept 2016

WMDs:
Measure what they can, not
what they should

Do not adjust agilely to
error

Not answerable, secret
formula

Create their own reality



“Good” Model:
baseball stats

WMD: US News College
Rankings

BIAS IN AUTOMATED CLASSIFICATION

Facial recognition algorithms trained on biased datasets led to under-recognition of protected

C

Proceedings of Machine Learning Research 81:1–15, 2018

Conference on Fairness, Accountability, and Transparency

Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification*

Joy Buolamwini

MIT Media Lab 75 Amherst St. Cambridge, MA 02139

JOYAB@MIT.EDU

Timnit Gebru

Microsoft Research 641 Avenue of the Americas, New York, NY 10011

TIMNIT.GEBRU@MICROSOFT.COM

2018



Joy Buolamwini | TEDxBeaconStreet

How I'm fighting bias in algorithms

Details

About the talk

Transcript

22 languages

Reading List

Further learning

Footnotes

Notes + references

MIT grad student Joy Buolamwini was working with facial analysis software when she noticed a problem: the software didn't detect her face -- because the people who coded the algorithm hadn't taught it to identify a broad range of skin tones and facial structures. Now she's on a mission to fight bias in machine learning, a phenomenon she calls the "coded gaze." It's an eye-opening talk about the need for accountability in coding ... as algorithms take over more and more aspects of our lives.

This talk was presented to a local audience at TEDxBeaconStreet, an independent event. TED's editors chose to feature it for you.

1,475,724 views

TEDxBeaconStreet | November 2016

Related tags

[Activism](#)

Nov 2016

Biased, Differential Ad Delivery

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FOCUS POINT: DATASET COLLECTION

What kinds of biases can enter at this phase of machine learning?

DATASET BIASES

- Sampling Bias
 - *Ex: More images of homes with lawns than without*
- Measurement Bias
 - *Ex: Camera settings for creating images*
- Label Bias
 - *Ex: Cultural differences in naming (e.g., grass vs lawn)*
- Negative Set Bias
 - *Ex: Missing images from non-dominant culture*

Idea: Fix Bias in the Data Stage of the Pipeline

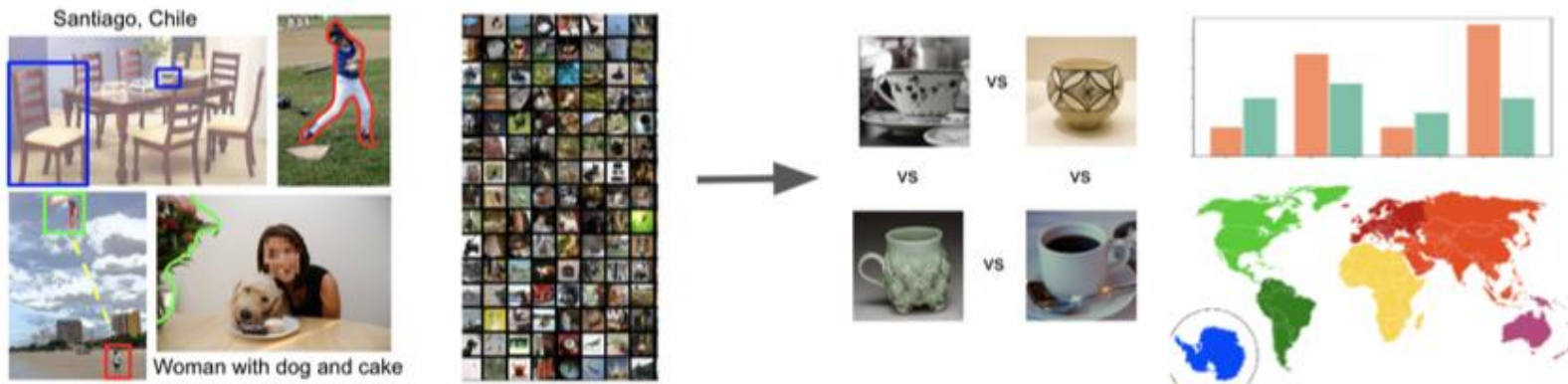


Fig. 1: Our tool takes in as input a visual dataset and its annotations, and outputs metrics, seeking to produce insights and possible actions.

Table 2: Gender-based summary: investigating representation of different genders

Metric	Example insight	Example action
Contextual representation	Males occur in more outdoors scenes and with sports objects. Females occur in more indoors scenes and with kitchen objects.	Collect more images of females in outdoors scenes with sports objects, and vice versa for males.
Interactions	In images with musical instrument organ , males are more likely to be actually playing the organ .	Collect more images of females playing organs .
Appearance differences	Males in sports uniforms tend to be playing outdoor sports, while females in sports uniforms are often indoors or in swimsuits.	Collect more images of each gender with sports uniform in their underrepresented scenes.
Gender label inference	When gender is unlikely to be identifiable, people in images are by default labeled as male.	Prune these gender labels from the dataset so as not to reinforce societal stereotypes.

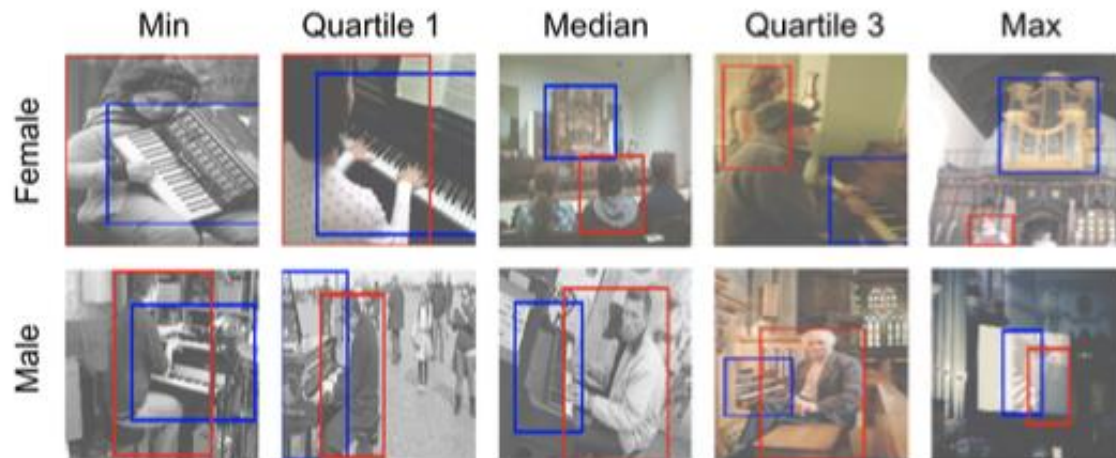


Fig. 4: 5 images from OpenImages for a person (red bounding box) of each gender pictured with an organ (blue bounding box) along the gradient of inferred 3D distances. Males tend to be featured as actually playing the instrument, whereas females are oftentimes merely in the same space as the instrument.

Table 3: Geography-based summary: looking into the geo-representation of a dataset, and how that differs between countries and subregions

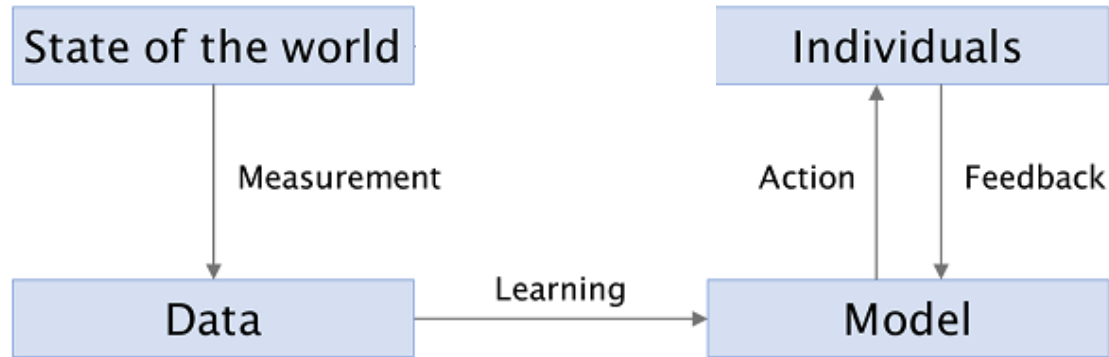
Metric	Example insight	Example action
Country distribution	Most images are from the USA, with very few from the countries of Africa	Collect more images from the countries of Africa
Local language analysis	Countries in Africa and Asia that are already underrepresented are frequently represented by non-locals rather than locals	Collect more images taken by locals rather than visitors in underrepresented countries
Tag counts, appearances	Wildlife is overrepresented in Kiribati, and mosque in Iran	Collect other kinds of images representing these countries

FAIRNESS AND MACHINE LEARNING

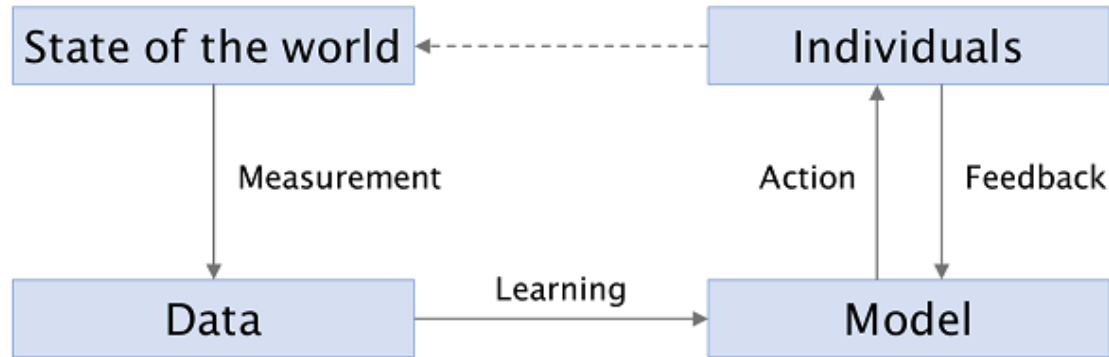
BAROCAS ET AL.

“Is our goal to **faithfully reflect the data**? Or do we have an obligation to **question the data**, and to design our systems to conform to some notion of **equitable behavior, regardless of whether or not that’s supported by the data** currently available to us?”

Machine Learning Feedback Loop



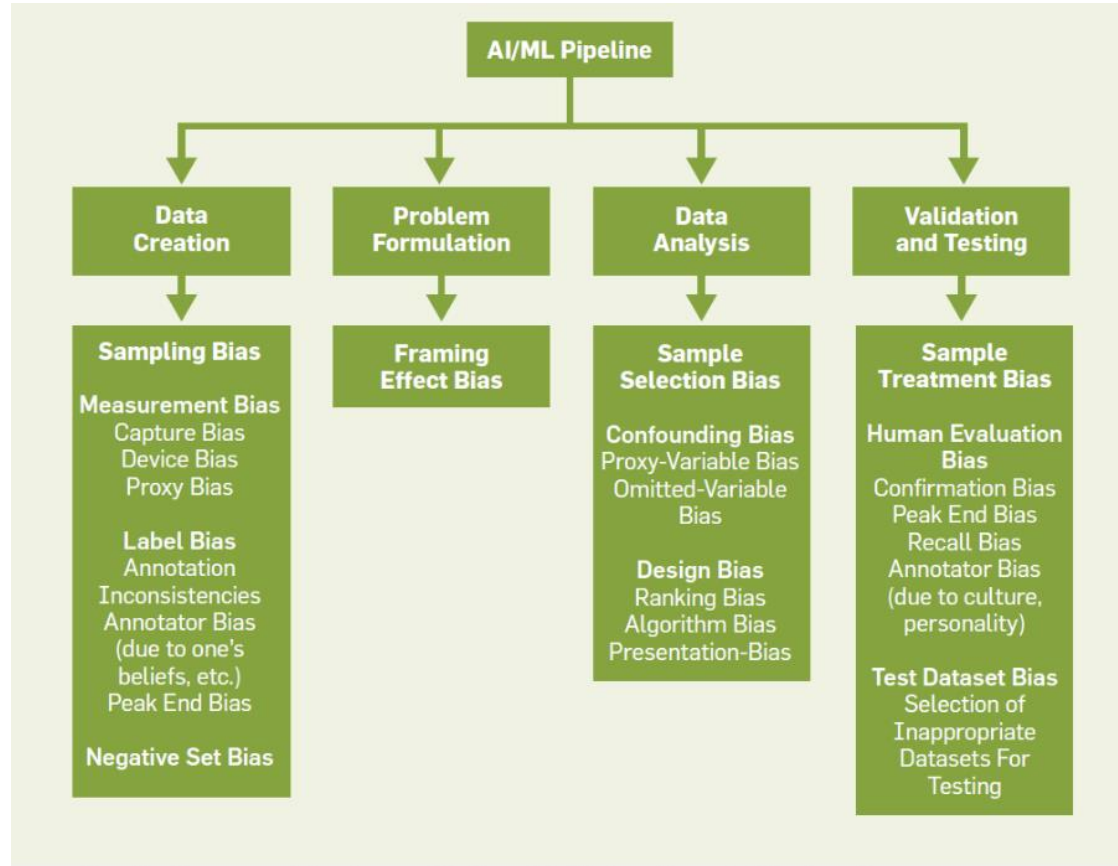
Machine Learning Feedback Loop



Do we have to learn from data? Why do we?

Do we have to learn from human's reactions to models? Why do we?

Taxonomy of Bias Types in AI Pipeline



DEBIASING (BORACAS ET AL.)

“Most attempts to “debias” machine learning in the current research literature assume simplistic mathematical systems, often ignoring the effect of algorithmic interventions on individuals and on the long-term state of society.”

Failed Diversification Attempt

Google Chatbot's A.I. Images Put People of Color in Nazi-Era Uniforms

The company has suspended Gemini's ability to generate human images while it vowed to fix the issue.



By **Nico Grant**

Nico Grant writes about Google and its related companies from San Francisco.

Published Feb. 22, 2024 Updated Feb. 26, 2024

“The company spent years assembling teams that tried to reduce any outputs from its technology that users might find offensive. Google also worked to improve representation, including showing more diverse pictures of professionals like doctors and businesspeople in Google Image search results. But now, social media users have blasted the company for going too far in its effort to showcase racial diversity.”

'We definitely messed up': why did Google AI tool make offensive historical images?



Dan Milmo and Alex Hern

Fri 8 Mar 2024 10.00 EST

“Prabhakar Raghavan, Google’s head of search, said in a [blog post last month](#): “So what went wrong? In short, two things. First, our tuning to ensure that Gemini showed a range of people failed to account for cases that should clearly *not* show a range. And second, over time, the model became way more cautious than we intended and refused to answer certain prompts entirely ... These two things led the model to overcompensate in some cases and be over-conservative in others, leading to images that were embarrassing and wrong.”

A REASON FOR OPTIMISM (BORACAS ET AL.)

“A reason for optimism is that the turn to automated decision-making and machine learning offers an opportunity to reconnect with the moral foundations of fairness. Algorithms force us to be explicit about what we want to achieve with decision-making.”

SOME ADVANCES

- Datasheets and Factsheets
- Intentional data collection
- Algorithms as aids, but not decision makers
- Transparency in algorithms
- Methods for appeal outside of algorithms

FAIRNESS IN SEARCH RANKING

KEYWORDS IN TITLES OF ACCEPTED PAPERS

(SIGIR IS A TRADITIONAL TECHNICAL CONFERENCE, CORE IR
RESEARCH)

- SIGIR'17: Fairness: 0 Bias: 0
- SIGIR'18: Fairness: 1 Bias: 2
- SIGIR'19: Fairness: 0 Bias: 1
- SIGIR'20: Fairness: 4 Bias: 1
- SIGIR'21: Fairness: 7 Bias: 4
- ...
- SIGIR'24: Fairness: 13 Bias: 9
- SIGIR'25: Fairness: 17 Bias: 13

TREC 2019 Fair Ranking Track

The TREC Fair Ranking track evaluates systems according to how well they *fairly* rank documents. The 2019 task focuses on re-ranking academic abstracts given a query. The objective is to fairly represent relevant authors from several, undisclosed group definitions. These groups can be defined in a variety of ways and the track emphasizes the development of systems which have robust performance across a variety of group definitions.

TREC 2020 Fair Ranking Track

The TREC Fair Ranking track evaluates systems according to how well they *fairly* rank documents. The 2020 focuses on scholarly search and fairly ranking academic abstracts and papers from authors belonging to different groups.

TREC 2021 Fair Ranking Track

The TREC Fair Ranking track evaluates systems according to how well they *fairly* rank documents. The 2021 track focuses on fairly prioritising Wikimedia articles for editing to provide a fair exposure to articles from different groups.

TREC 2022 Fair Ranking Track

The TREC Fair Ranking track evaluates systems according to how well they *fairly* rank documents.

DIVERSITY AND NOVELTY IN IR

(CLARKE ET AL.'08)

- “For a given query, an information retrieval system should respond with a ranked list that respects both the breadth of available information and any ambiguity inherent in the query.”
- “Ideally, the document ordering for this query would properly account for the interests of the overall user population.”
- Example: for “jaguar”, if cars are more popular than cats, it might make sense to have the first few result be the jaguar car, and the next few be the felines.
- Differentiate:
 - **Novelty**: the need to avoid redundancy
 - (near duplicates; find more deeper info on same topic)
 - **Diversity**: the need to resolve ambiguity



jaguar



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cat



car



black



f type



rainforest



animal



baby



f pace



wallpaper



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Jaguar - Wikipedia
en.wikipedia.org



Jaguar, facts and photos
nationalgeographic.com



2021 Jaguar XF Prices, Reviews ...
cars.usnews.com



Jaguar, facts and photos
nationalgeographic.com



Jaguar | Species | WWF
worldwildlife.org



Rebuild the U.S. Jaguar Population ...
scientificamerican.com



Habitat Area for Jaguars in Arizona ...
biologicaldiversity.org



How the Jaguar, King of the Forest ...
wired.com



Sports Cars | Jaguar
jaguar.com



The Jaguar King
thejaguarking.org



Jaguar New Boss Explains Why The XJ ...
motor1.com





Jaguar Cat



Wild Jaguar



Jaguar Animal



Snow Jaguar



Jaguar Big Cat



Jaguar the Car



Jungle Jaguar



Rare Jaguar



Jaguar Family



Jaguar Race Car



American Jaguar

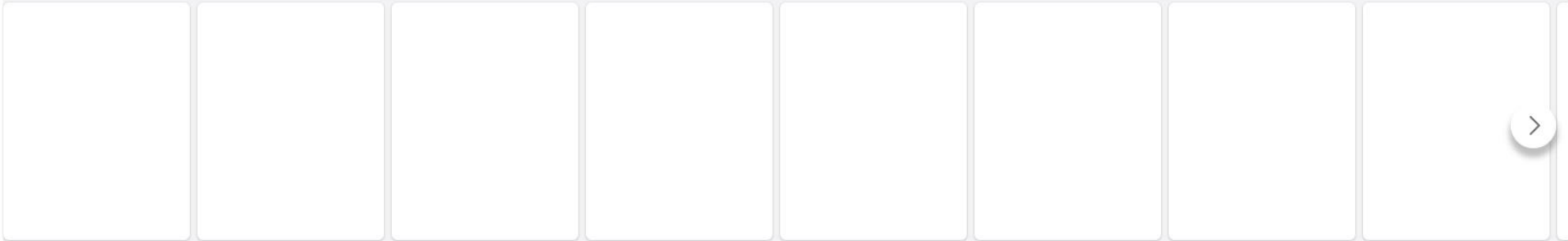


Jaguar Brand



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jaguar



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Jaguar Society | Brevard Zoo
brevardzoo.org



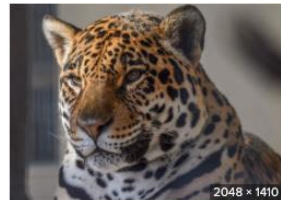
Jaguar, Wild, Cat, Carnivore, Language, W...
wallup.net



Trump's Wall Threatens Last Jaguars in th...
thedailybeast.com



Jaguar, Wild, Cat Wallpapers HD / Desktop...
wallup.net



Jaguar, Wild, Cat, Carnivore Wallpapers ...
wallup.net



Jaguar cub with burned legs rescued from...
theanimalreader.com



Two wild cubs mig...
revitalization.org



Adaptations - THE JAGUAR
themajesticjaguar.weebly.com



Jaguar Facts - Interesting Information ...
bigcatrescue.org



Jaguar Vs Leopard, Who Will Win? - Animals ...
animalscomparison.com



Jaguar, Panther, Wildcat, Predator Wallpaper...
wallup.net



Male jaguar walkin...
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Jaguar Animal Facts
buzzle.com



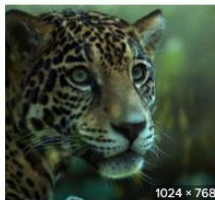
Wild Cat Jaguar HD Wallpapers | HD Wa...
hdwallpaperslife.com



17 Things You Sho...
buzzfeed.com



Male jaguar appro...
flickr.com



New Female Jaguar 1 | Woodla...
flickr.com



Jaguar HD Animals Wall...
hdwallpapers.in



Brazil | One Very C...
dailywildlifephoto.n...



Jaguar, Panthera onca, Belize - Stock...
sciencephoto.com



Why Should A Jaguar Be Displayed As A Mascot To ...
huffingtonpost.com



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All Models

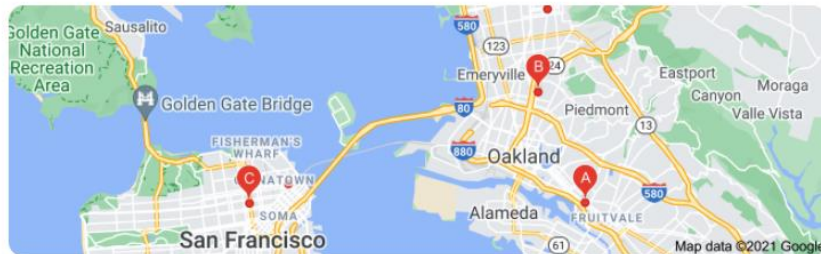
F-TYPE. Pulse-quickenning, pure Jaguar sports car. COUPE ...

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Please contact your local authorized Jaguar Retailer for ...

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Jaguar



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Closed · Opens 8AM Tue



Directions

Jaguar Cars



Luxury vehicles
company

Jaguar is the luxury vehicle brand of Jaguar Land Rover, a British multinational car manufacturer with its headquarters in Whitley, Coventry, England.

[Wikipedia](#)

Owner: [Jaguar Land Rover](#)

Founded: September 4, 1922, [Blackpool, United Kingdom](#)

Customer service: 1 (800) 452-4827

Headquarters: [Coventry, United Kingdom](#)

Parent organizations: [Tata Motors](#), [British Motor Holdings](#)

Founders: [William Lyons](#), [William Walmsley](#)

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Motto



Price range



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internet



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word



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phys.org



Deciphering the dark web: What it is ...
siliconrepublic.com



What is web design, how to do it right ...
rockcontent.com



Why Spiders Decorate Their Webs
thoughtco.com



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Chrome **Web** Store. Customize and Personalize Chrome on your desktop computer with Extensions, Themes and Apps. Power up your Chrome.

People also ask

What do you mean web?



What is web example?



What is App web?



Is Google a web?



World Wide Web



The World Wide Web, commonly known as the Web, is an information system where documents and other web resources are identified by Uniform Resource Locators, which may be interlinked by hyperlinks, and are accessible over the Internet. [Wikipedia](#)

Programming

Writer

Feedback

WEB VS IMAGE SEARCH

- Note the way the results differ for image vs web search
- One is more commercial, the other more visual
- Is this designed or accidental?

IMAGE DIVERSITY

People noted that querying on general terms like “CEO” on google image search returned undiverse images.



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heartofthecustomer.com



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as CEO to Help Your Business Grow ...
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4 Big Tech CEOs getting heat from ...
denverpost.com



Top C.E.O.s ...
nytimes.com



Why CEOs Get the Really Big Bucks, And ...
nbcnews.com



The 15 Richest CEOs of the USA (2021)
pakwired.com

WHAT DOES THE QUERY MEAN?

- “CEO” alone prototype: implies famous CEO of very big company
- ”CEOs” different than “CEO”
- Not the same for “custodian” or “software engineer”

THE PROBLEM WITH VAGUE QUERIES

Let's compare some queries that are single words, and others that make use of Russell's suggestion: refine your query with more specific words



young ceos



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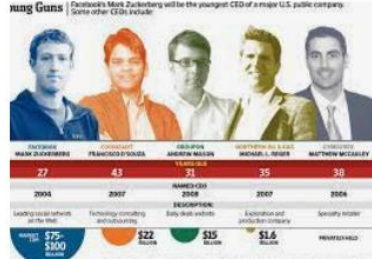
5 Self-Made Young CEOs Whose Su...
ikateclark.medium.com



Top 10 Young CEOs To Know Abo...
ceoworld.biz



Ten Youngest CEOs of Fortune 500 Co...
rttnews.com



Young CEOs: Are They Up to the Job? - WSJ
wsj.com



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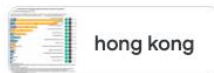
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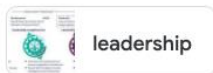
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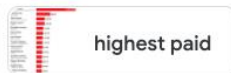
hong kong



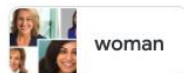
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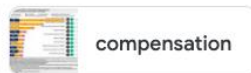
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highest paid



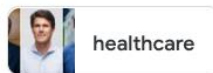
woman



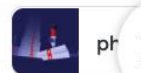
compensation



founder



healthcare



ph



The Top 25 Biotech CEOs of 2020 | The ...
thehealthcaretechnologyreport.com



The Top 25 Biotech CEOs of 2021 | The ...
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The Top 25 Biotech CEOs of 2020 | The ...
thehealthcaretechnologyreport.com



These biotech and life sciences CEOs ...
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10 Women Biotech CEOs Lead the Ch...



ceos of food and beverage companies



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foodprocessing.com



food industry ...
meatpoultry.com



Seven CEOs to Watch in ...
foodprocessing.com

Top 10 Food and Beverage Companies over the last 5 years

	2014	2015	2016	2017
1	Nestle	Nestle	Nestle	Nestle
2	Pfizer Inc.	Pfizer Inc.	Pfizer Inc.	Pfizer Inc.
3	Anheuser-Busch InBev	Anheuser-Busch InBev	Anheuser-Busch InBev	Anheuser-Busch InBev
4	Unilever	Unilever	Unilever	Unilever
5	Walmart	Walmart	Walmart	Walmart
6	Amazon	Amazon	Amazon	Amazon
7	Google	Google	Google	Google
8	Facebook	Facebook	Facebook	Facebook
9	Twitter	Twitter	Twitter	Twitter
10	LinkedIn	LinkedIn	LinkedIn	LinkedIn

The 2019 Top 100 Food & Beverage ...
foodengineeringmag.com



Food And Beverage Companies Play ...
forbes.com



The 2019 Top 100 Food & Beverage ...



food & beverage companies - 2015 ...



Top 100 Food and Beverage Companies ...

FOOD & BEVERAGE STOCKS

	Jan. 2017	Jan. 2018	March 1, 2019	July 30, 2020*
Anheuser-Busch InBev	\$105.93	\$114.74	\$81.96	\$57.86
Coca-Cola	41.74	46.07	45.38	47.40
General Mills	61.47	59.52	47.22	63.76
JBS S.A.	7.23	6.13	7.37	22.34
Kraft Heinz	86.31	77.84	32.40	34.88
Nestle	73.99	85.72	90.76	110.20
PepsiCo	104.56	110.67	116.18	137.50
Tyson Foods	63.22	80.83	62.19	60.58
TOTAL	\$544.45	\$589.52	\$483.46	\$534.34

*Price at opening 7/30/20

Food and Beverage Companies for 2020 ...



young ceos -zuckerberg



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Tools



handsome



korean



female



male



chinese



businessman



most handsome



at



Top 10 Young CEOs To Know Abo...
ceoworld.biz



Millionaire Fast Track: 27 CEOs Under 27
entrepreneur.com



Young CEOs - N2Growth
n2growth.com



These are the Three Youngest CEOs ...
inacademy.eu



Young CEOs On How They Got to Where ...
marieclaire.com



5 Young CEOs In Malaysia On The Perks ...
tatlerasia.com



Young Black CEOs and Business Leaders ...
blackbusiness.com



Young CEOs: Tips to become s...
economicstimes.indiatimes.com

Fairness of Exposure in Rankings

Singh & Joachims, KDD'18

“[I]t is no longer just books that are being ranked, but there is **hardly anything that is not being ranked today** – products, jobs, job seekers, opinions, potential romantic partners.

Nevertheless, one of the guiding technical principles behind the optimization of ranking systems still dates back to four decades ago – namely the **Probability Ranking Principle (PRP)** [Robertson'77].

It states that the **ideal ranking should order items in the decreasing order of their probability of relevance**, since this is the ranking that **maximizes utility of the retrieval system** to the user for a **broad range of common utility measures** in Information Retrieval.

But is this uncompromising focus on utility to the users still appropriate when we are not ranking books in a library, but people, products and opinions?”

FRAMING FAIRNESS IN RANKING

- There is no single definition of what constitutes a fair ranking
- Fairness depends on context and application.
- Different notions of fairness imply different trade-offs in utility, which may be acceptable in one situation but not in the other.
- For example, we may not want to convey strong rights to the books in a library when a user is trying to locate a book, but the situation is different when candidates are being ranked for a job opening.
- We are not limited to a single definition of fairness, since different application scenarios probably require different trade-offs between the rights of the items and what can be considered an acceptable loss in utility to the user

FORMULATIONS OF FAIRNESS FOR RANKING

- **Demographic Parity:**

- *Enforce that average exposure from documents in all groups is equal*

- **Disparate Treatment:**

- *Enforce that exposure of each group is **proportional to their average utility***
- *This takes relevance into account, but helps with “just-miss” cases, where the ranked values for members of groups are close to one another*

- **Disparate Impact:**

- *Enforce that the **expected clickthrough rate of each group is proportional to its average utility***
- *Goes beyond utility to take into account the impact of the exposure*

GENDER AND IMAGE SEARCH RANKINGS STUDY

- **Introduction:** Experimentally evaluated the effects of how gender is represented in image search results for occupations. Used very general queries like:
 - “bartender”, “custodian”
- **Findings:**
 - People have quite accurate estimates of the gender proportions of occupations
 - Gender proportions in search results are close to those in actual occupations.
 - However, there are slight exaggerations of gender ratios towards gender stereotypes for many
 - People rate search results quality higher when they are consistent with stereotypes for a career
 - Images matching the gender stereotype are rated more professional and less inappropriate
 - Manipulating the representation of gender in image search results can shift people’s perceptions about real-world distributions very slightly (by about 7%)
- **Conclusion:** There are tensions between desire for high-quality results and broader societal goals for equality of representation in this space.

LINKED-IN FAIRNESS RANKING APPROACH

- “For a given search or recommendation task, our algorithms seek to achieve a desired distribution of top ranked results with respect to one or more protected attributes.”
- “We show that such a framework can be tailored to achieve fairness criteria ... depending on the choice of the desired distribution.”

LINKED-IN FAIRNESS RANKING APPROACH

- Did A/B testing for representative ranking:
 - “For each search request, the desired gender distribution over the ranked candidate list is chosen to be the gender distribution over the set of candidates that meet (i.e., qualify for) the search criteria”
 - Hundreds of thousands of recruiters
 - Comparison was a model optimized to make a successful hire
- “Our approach resulted in tremendous improvement in the fairness metrics (nearly threefold increase in the number of search queries with representative results) without affecting the business metrics”
- “This paved the way for deployment to 100% of LinkedIn Recruiter users world-wide.”

SUMMARY

- Fairness is a **social construct**
- There are many different definitions of fairness; it is **contextual**
- For many applications, there is a tradeoff between **fairness and accuracy/relevance**; the two often can't be simultaneously optimized
- One potential remedy is to revisit the **assumptions behind the data and the original calculation** of accuracy/relevance

ACADEMIC WORKSHOPS AND CONFERENCES

- Workshop on Algorithmic Bias in Search and Recommendation: (BIAS, 2020-today)
- FATML.org: Fairness, Accountability, and Transparency in Machine Learning (2014-today)
- ACM Conference on Fairness, Accountability, and Transparency (FAccT, 2018-today)
- Symposium on the Foundations of Responsible Computing (math-y, 2020-today)

More Depth on These Topics: I 203 and I 205



Prof. Morgan Ames
UCB I School
Social Issues of Information



Prof. Deirdre Mulligan
UCB I School
Information Law & Policy

Designing Value-Based Technology: I 213: User Interface Design & Development



Prof. Niloufar Salehi
UCB I School

NEXT TIME

- Intellectual Property
- Course Wrap-up