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# DATA ETHICS

PROF. DR. FLORIAN STAHL

# Overview – Data Ethics

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What are ethics?

Data ownership

Privacy

Anonymity

Data validity

Algorithmic fairness

# Ethics Are Not Religion

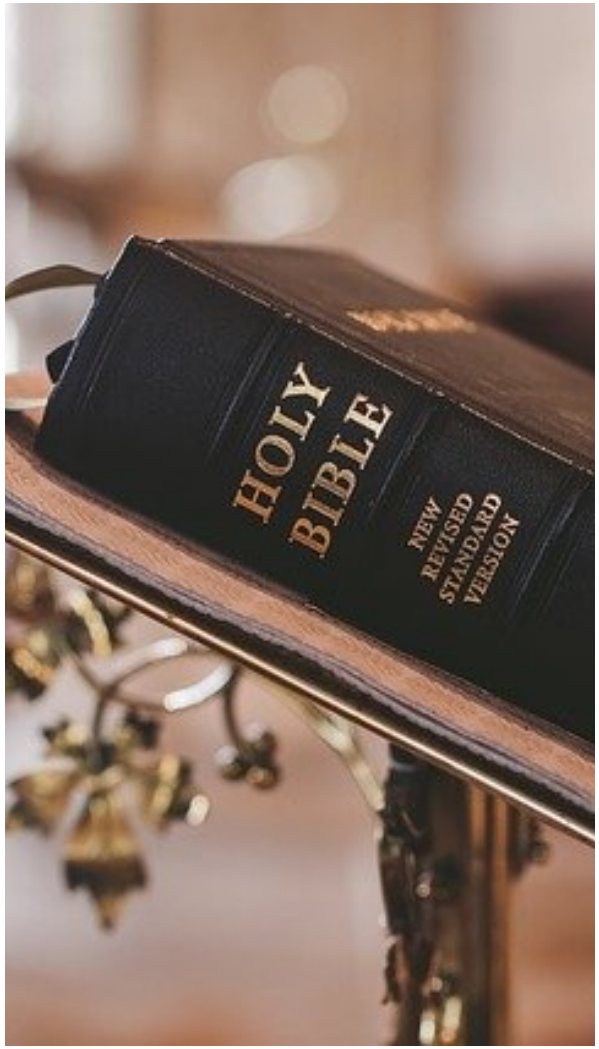


Most religions **promote** ethical behavior.

They contain **precepts** such as “You should not steal”.

But ethics do **not need to be religious**.

Ethics **originate from shared values**, which may or may not stem from religion.



# Ethics Are Not Laws



**Ethics guide the creation of laws**, such that the two often correspond.

**Laws** may be used to **enforce ethical behavior**.

Not everyone will act ethically, even if there are **shared values**. That is why people go to jail for theft.

# Economic Benefits



Mostly, society as a whole does best when **each individual works to maximize** their own **individual benefit**.

vs.

But there are situations where **the individual benefit comes at a cost to society**.

Shared societal value systems work to address these situations.

# Tragedy of the Commons
## *Example*



There is an open field, the commons, that is **shared across the village**. It is cheaper for a farmer to graze their sheep in the commons.

If every farmer in the village makes the **same judgement**, **the field gets overgrazed**, nobody takes care of it, and it ends up being a wasteland.

# Economic Value of Rules

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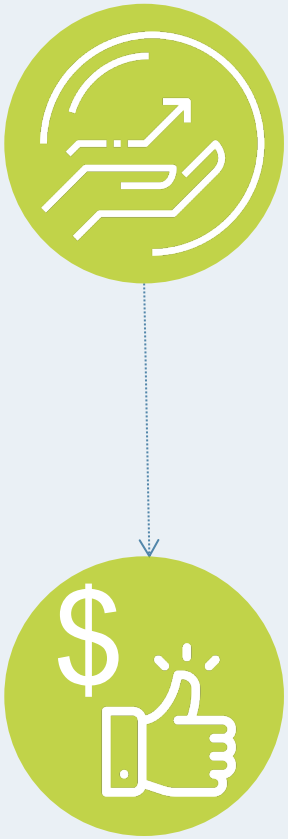
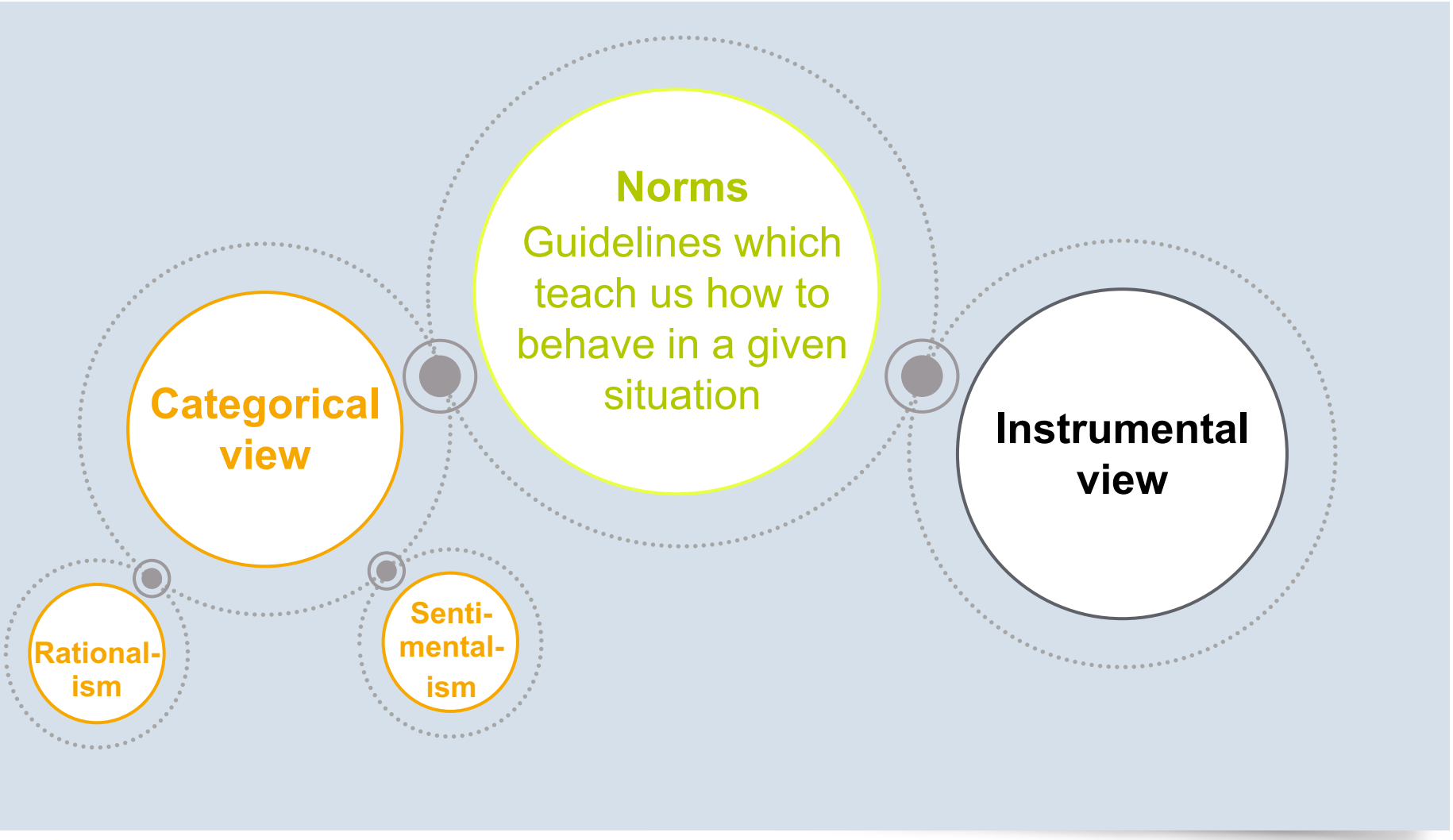
**If** the **cost** for me to follow a rule is **less than the benefit** to me from others following that same rule…

... then, this should make me **want the rule**, even if there is a cost to me.



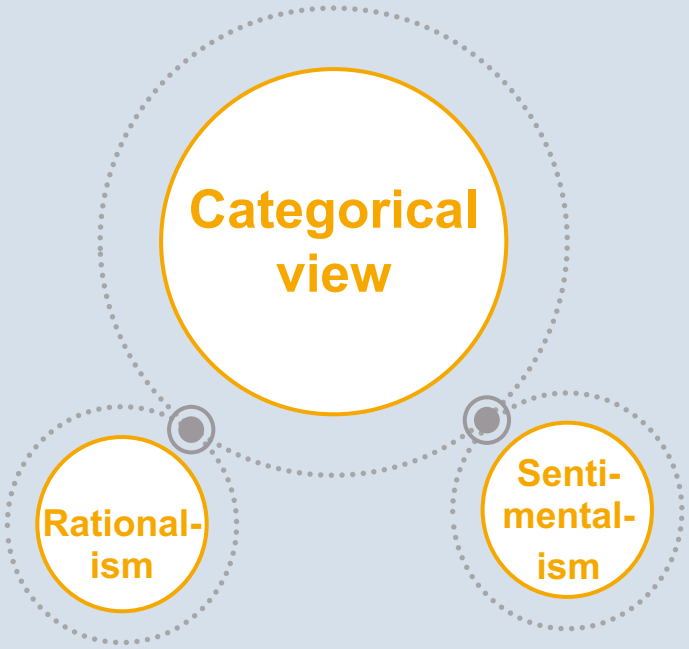
# Norm Relation





# Categorical Norm






see Kant

see Smith and Hume

**Independence** of individual objectives

Rationalism: based on **reason**

Sentimentalism: based on human **feelings**

# Instrumental Norm



**Involves individuals'** subjective view

Morality if it suits to one's **purpose**

Closer to **reality**

**Instrumental view**

# Summary: What Are Ethics?

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Ethics are shared rules we all agree to follow due to the resulting benefits.

They are infused with a sense of right and wrong.

We now know what ethics are, and why we are all better off with ethical behavior.

# The Possibilities Today



We have **unprecedented access** to data.

We have **unprecedented options** for analysis.

There is virtually **no limit to what Data Science could do**.

Should we **agree not to do some things** that are possible?

# Data Science Has an Impact



There is tremendous excitement about Data Science precisely because of the **many ways in which it provides us with a "better" way** to do something.

But there are possible **undesired consequences**, for privacy, fairness, etc.

How do we decide what is OK to do? Ethics give us a **rulebook** for these decisions.

# Unsolicited Commercial Mail

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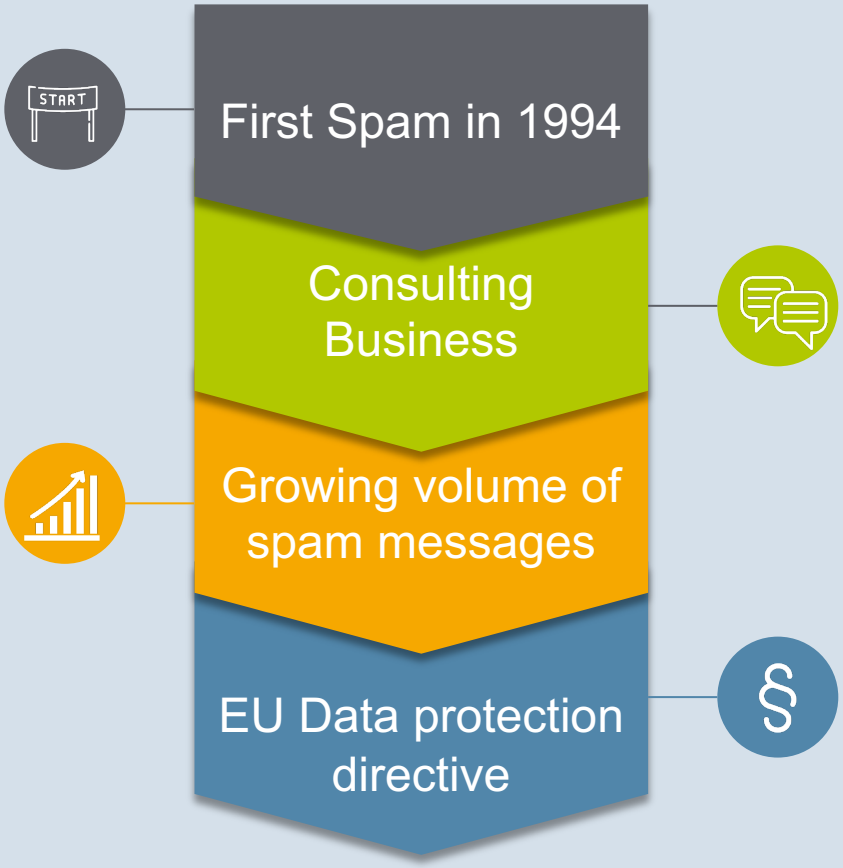
**First Spam**: Two immigration attorneys posted offers for immigrants over the internet in every place they knew

The **volume of spam messages** grew tremendously up to a point where it was considered to be unacceptable




Being **successful** with their "spam strategy", the two started a consulting business, helping other businesses to reach new customers through the internet

When sending commercial mail, companies **clearly state the sender** and offer a **visible unsubscribe** button

Today, no upstanding business will **own up to spamming intentionally**.

# Data Science Needs Ethics

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**Problem**

While Data Science can help in so many ways, it **can hurt, too**.

By **developing a shared sense of ethical values**, we can reap benefits while minimizing harms.

**Solution**

# A/B Testing

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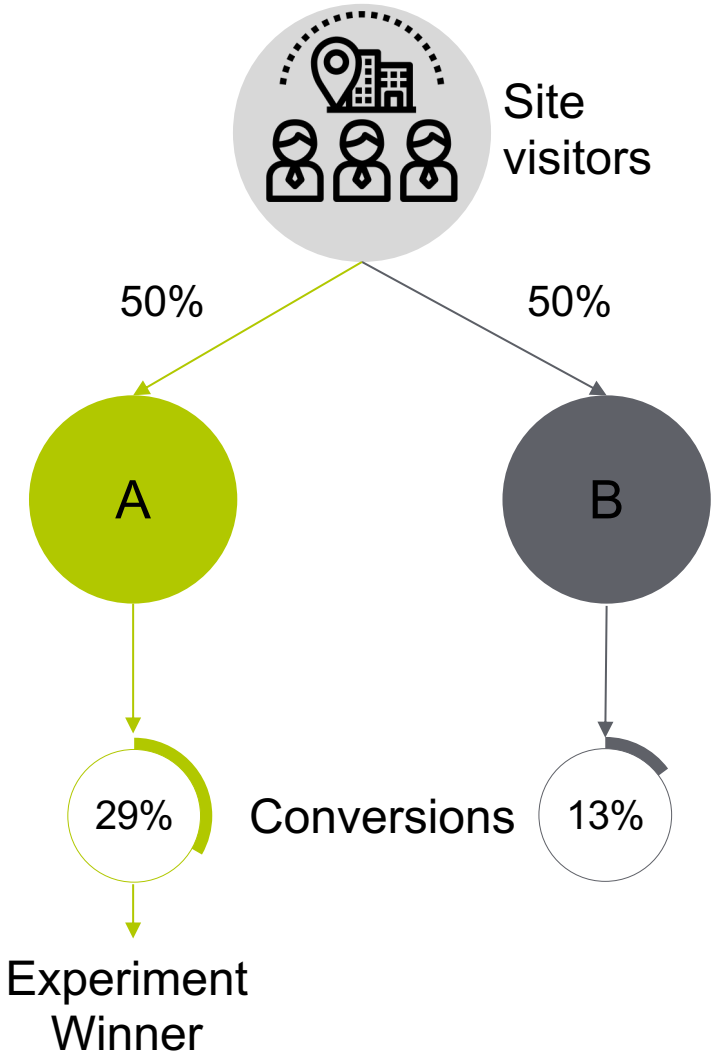
A/B testing is routinely used, particularly…

by companies with a **high customer volume.**

for **web-page design**.



# A/B Testing
## *Example: HelloFresh*

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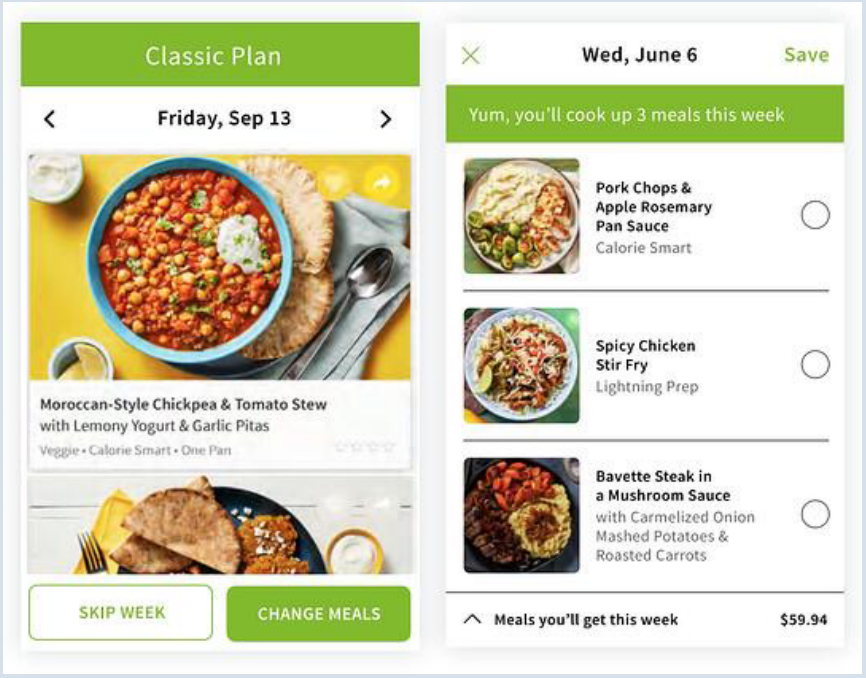


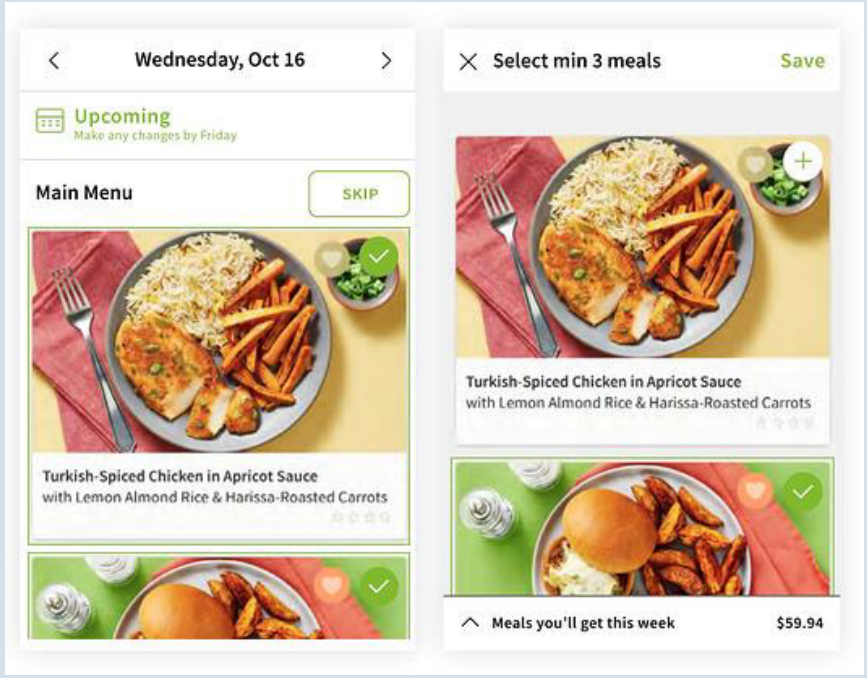


HELLO FRESH

# Human Subjects Research?

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**Web Companies do A/B testing**. Humans are impacted. With A/B testing , companies try to maximize their targets with both options offered.

Companies try to **"push buttons" to make consumers buy more**. This is considered good business practice

Companies can **have imperfect algorithms** that give us poor results.

These practices are just **best efforts** of companies and therefore they are not involved with human subjects research.

# Human Subjects Research?

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## Facebook/Cornell Experiment

**2012**
"Emotional contagion"

Experiment: Choose articles shown in newsfeed to **manipulate user mood** to demonstrate "emotional contagion".

**2014**
Results published

Results were **published** in the Proceedings of the National Academies of Science.

**Consequence**
Permit data use for research

Users **did not know** about newsfeed manipulation. Facebook **regularly tinkers the algorithm** to choose items for newsfeed.

- User agreement permits Facebook to use data for research

# Is It Informed and Voluntary?

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**"Informed"**
is based on **something hidden** in multiple pages of fine print.

- Unclear value in law
- E.g., liability waivers for sports activities

**"Voluntary"**
in spite of the requirement of **consent** to obtain a **desired action at the time of the action**.

- E.g., to use a software service
- E.g., to buy product

# Informed Consent: Facebook

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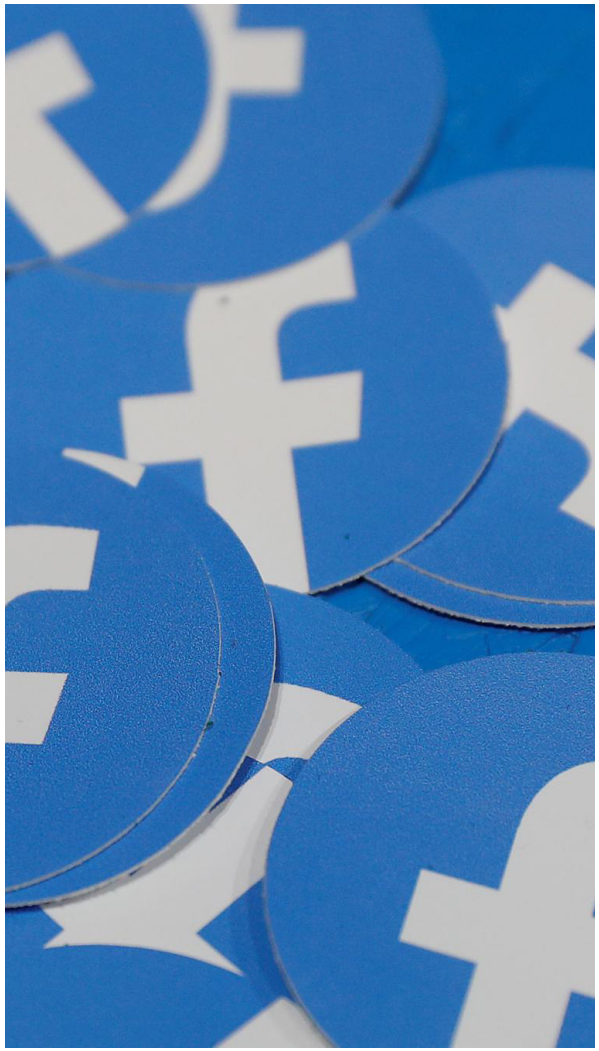
Facebook **explicitly tells** users in its agreement that it may **collect user data for research** purposes.

Facebook may have **stayed true to its user agreement**, even when it conducted the emotional contagion experiment.

But **received huge backlash** from its users, **nonetheless**.



# Repurposing Can Be Problematic

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I **give data** about myself to a merchant to **obtain a specific service**. I **do not want** the merchant to:

use this data for **other purposes,**

or **share** this data **with others.**

Consent can often be **limited to disallow repurposing**.

The "**context**" matters.

# Repurposing Can Be Problematic
## *Example: Cambridge Analytica*

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In 2014, US **Facebook users provided their personal data** to a quiz app in **exchange for personality tests**.

The app additionally **collected data of the users' Facebook friends**.

Allegedly, some of that data was **repurposed** by selling it to the firm **Cambridge Analytica** which used it to psychologically profile US voters.

Cambridge Analytica **denied to have broken any laws** and stated it had not used the data in the US election of 2016.

Facebook admitted a "**breach of trust**" and apologized to users.



https://www.bbc.com/news/world-us-canada-48972327

# Repurposing Is Not All Bad

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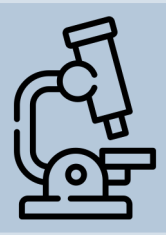
I understand that my credit card company **collects data about my purchases and payments**, and I am willing to **accept** that they also **share** some of this **with a credit reporting agency**, even if I don't particularly like it.

(Ideally) the card company **tells me about this intended sharing**, and I (maybe reluctantly) agree.

# Repurposing Is Often Necessary





I share **medical data** with my hospital to get better care, and I may gladly **support** its repurposed **use for medical research**.

However, the specific research questions may not be known at the time I receive my care. A **retrospective data analysis** is required.

Can we define a **consent agreement** broad enough to cover a range of possible medical research without being so broad as to cover “everything under the sun”?

# Humans and Data



Most **data of interest** is…

created by humans,

about humans, or

affecting humans.

We have to consider this impact as we practice Data Science.

# Overview – Data Ethics

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What are ethics?

Data ownership



Privacy



Anonymity



Data validity



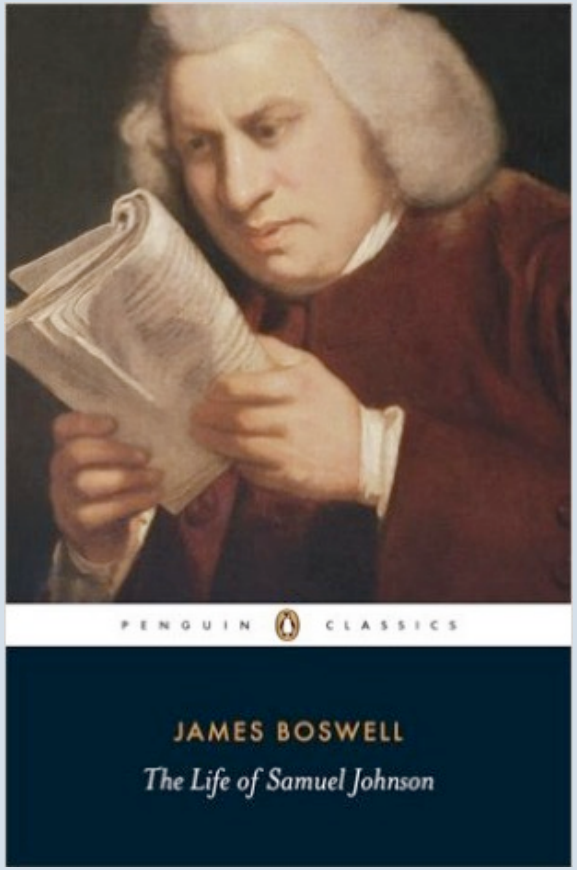
Algorithmic fairness

# Example: Biography Ownership



The biography **is about you**. But is it yours?

**If I write your biography, I own the copyright**. If you dislike what I say, there is not much you can do, except sue for libel where I am inaccurate.



# Example: „Nirvana Baby“

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„**Baby model**“ sued the band:

- No **consent**?
- Child pornography?
- **Emotional harm**?

- „Nirvana Baby“
- Did the baby model **benefit**?



https://i.pinimg.com/736x/b5/d3/74/b5d3748da964329878c200efb83ef157--final-fantasy-xv-splish-splash.jpg
https://3.bp.blogspot.com/-txPmj7Rk2oE/ToNEmNLuEjI/AAAAAAAACGE/iKQSIOHjvD0/s1600/nirvana-album-cover-20-years-later-01-480x329.jpg

# Data Ownership



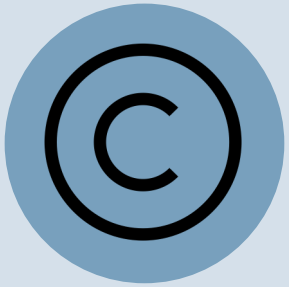
**Similar limits** on what data I can record about you and what I can do with it.

Free to record and free to use in other ways.

And we have done this forever: recommendation letters, gossip…

# Intellectual Property Basics





**Copyright**

Its an artistic expression. A rearrangement is a derivative work.

**Patent**

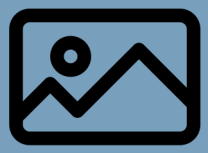
New idea for making or doing something, mostly of technical nature.


**Trade Secret**

I have it, but don't tell anyone.

# Use of Data





Source: XY

If I use an image, I display it, and can **credit the owner**.

If I use your data, I am almost always **taking some piece** of what you know, **merging** it with what I know, and **expressing something new**.

- At best I can say I used some data from you.
- It is not easy to say exactly what and exactly how much.

# Data Collection and Curation



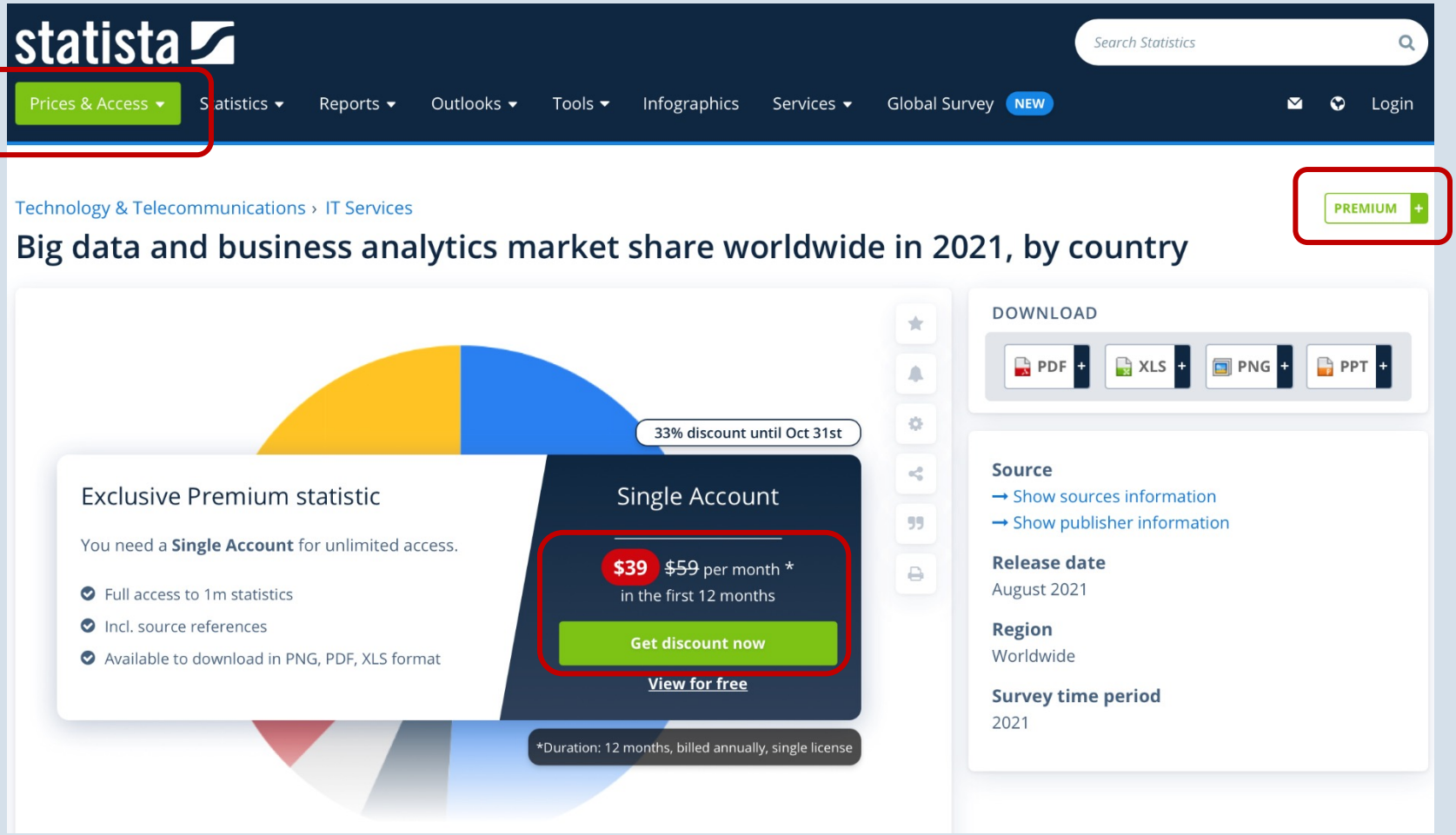
It can take a great deal of **effort to collect data** about something or someone.

Whoever does this work **deserves credit and has ownership** of the data "asset".

It can often take even more **effort to clean, validate and standardize the collected data** to place it into a form that is of immediate value.

# Data Collection and Curation
## *Example:* Statista








https://www.statista.com/statistics/1258046/worldwide-big-data-business-analytics-market-share-by-country/

# Crowd-Sourced Reputation Sites








# Limits on Recording



Recording is **wrong** when there is **reasonable expectation of privacy**, e.g., no cameras in clothing store fitting rooms.

**Similarly**: Phone companies must not record the (content of) phone calls.

# We Could Agree Otherwise



You could pose for a photograph under an agreement that I will give you **ownership of the photo**.

You could agree to participate in a research experiment under an agreement that has **informed consent**.

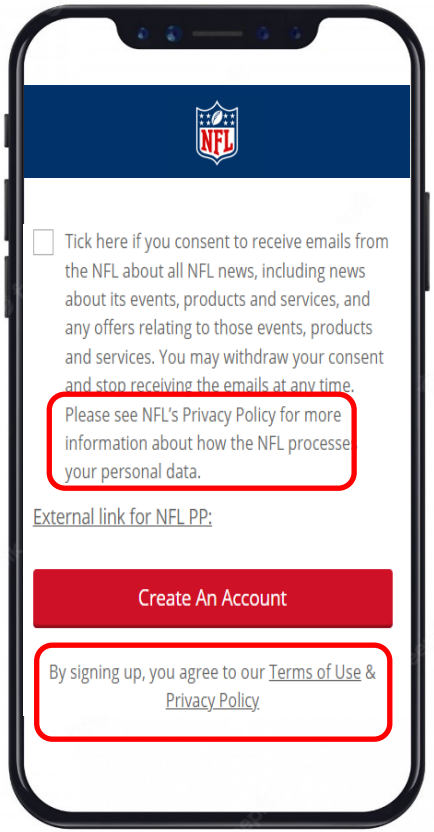
A funding agency could require that **data** collected from your funded research be **made public**.

# Example: Creating an Account



Your **choice/consent**.

**Contract-bound**.




Picture source: Sennco:

# Video Cameras in Stores



Can provide **security**.

Can even be used to **improve placement.**

Recordings should **not** be **published**.

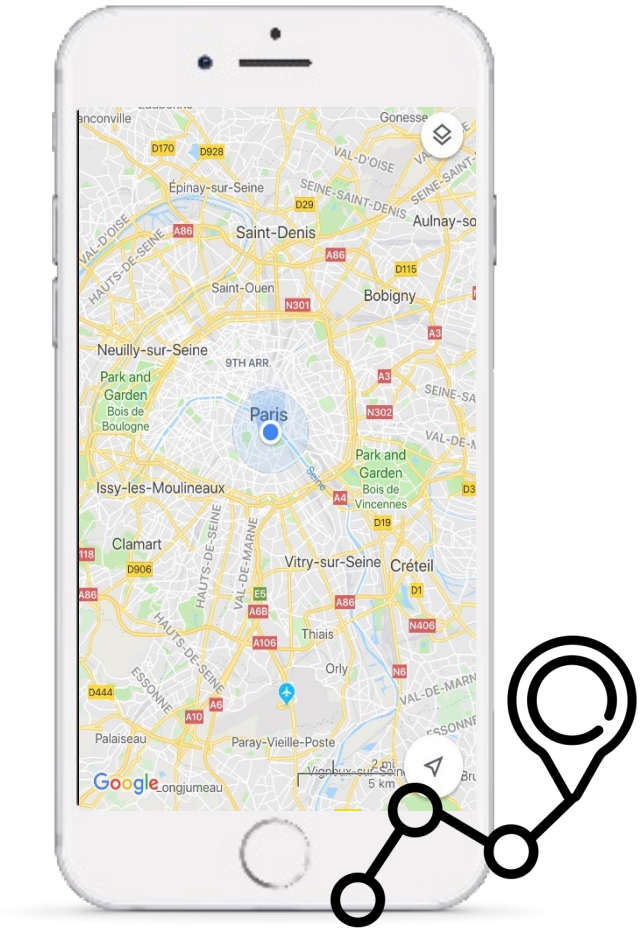
Picture source: Sennco:

# Cellphone Location Tracking



Necessary to **provide service**. Required for many valuable **applications**.

But can result in a **huge loss of privacy.**



# Limits on Use




Often, there is a **strong** reason to **record data**…

… but also **potential for misuse**.

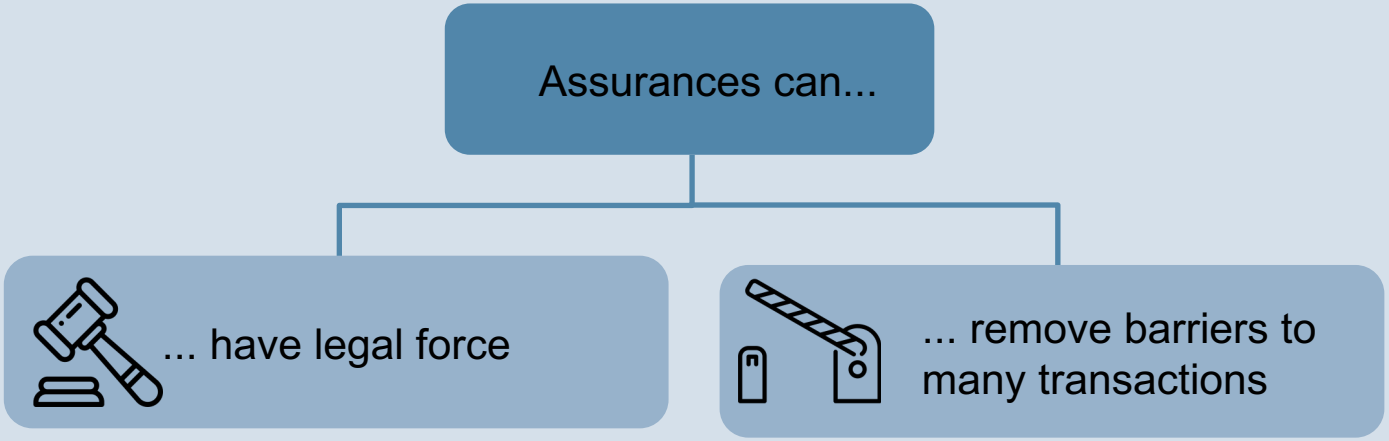
Prefer to **limit the use** rather than recording.

**Allow** desired **legitimate use** while disallowing other (undesirable) use.

# Voluntary Limits on Use



Police reassure citizens that body-cam video will not be posted on the web. In the same way, **businesses** can **reassure** customers that **data collected for one purpose** will **not be used for another**.



# Data Ownership Dispute Example: LinkedIn vs. hiQ Labs

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LinkedIn users enter their personal data into their profile. The company **believes that it owns this data**.

In 2017, the startup "**hiQ Labs**" used data on public LinkedIn profiles to **predict whether people were likely to leave their jobs**. According to LinkedIn, this **violates privacy**.

US **court ruled in favor of hiQ Labs** because it considered scraping of publicly available data a **lawful business purpose**.

In June 2021, the **US Supreme Court vacated the decision** for a later review based on the Computer Fraud and Abuse Act. The **final decision is still pending**.



https://www.forbes.com/sites/forbestechcouncil/2017/09/20/linkedin-vs-hiq-ruling-casts-a-long-shadow-over-the-tech-industry/?sh=8e5a96e5e6cf

# Data Destruction



Companies legitimately collect data as part of doing business.

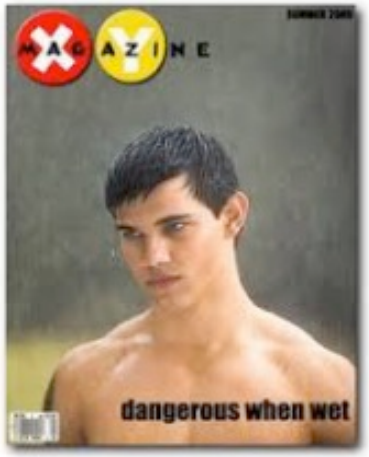
Companies need to retain goodwill of customers, and thus will try not to do shockingly bad things with the data.

Once the company ceases to do business (e.g., because of bankruptcy), this data is an asset that is likely sold to a third party who may intend to misuse it.

Collected data must be destroyed, not sold.

# Bankruptcy Law has Partial Protection



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# Data Ownership



Data ownership is **complex**, even for things you do want to share.

For the most part you do **not own data** about yourself. Therefore, there is a need to create **principles to control what isn't yours** and ensure the **rights to privacy**.

# Overview – Data Ethics

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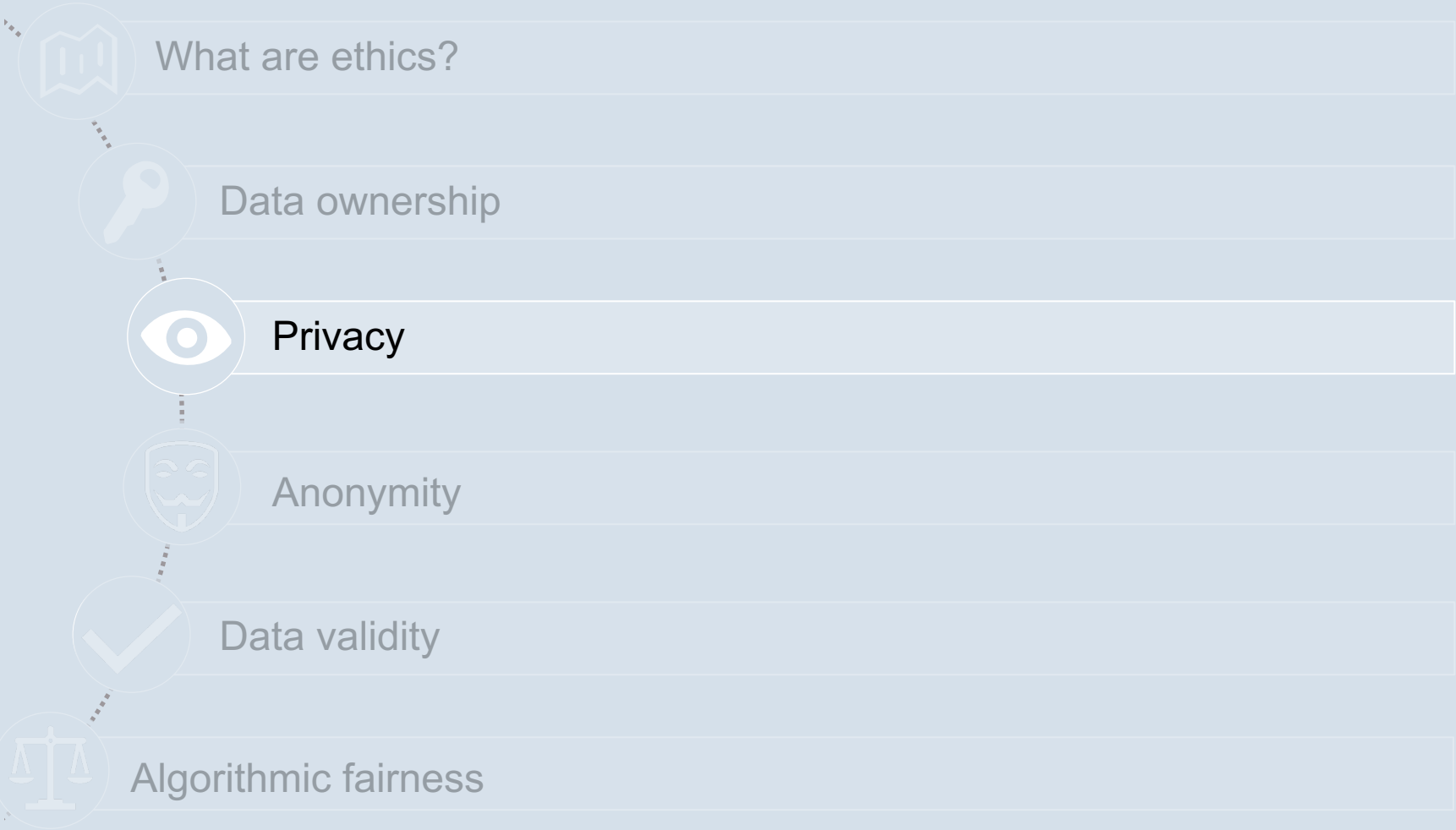


# What is Privacy?
# Argus Panoptes



Greek myth giant with
**“a hundred” eyes**
is **always watchful**.

Picture: Pinterest

# What is Privacy? Panopticon

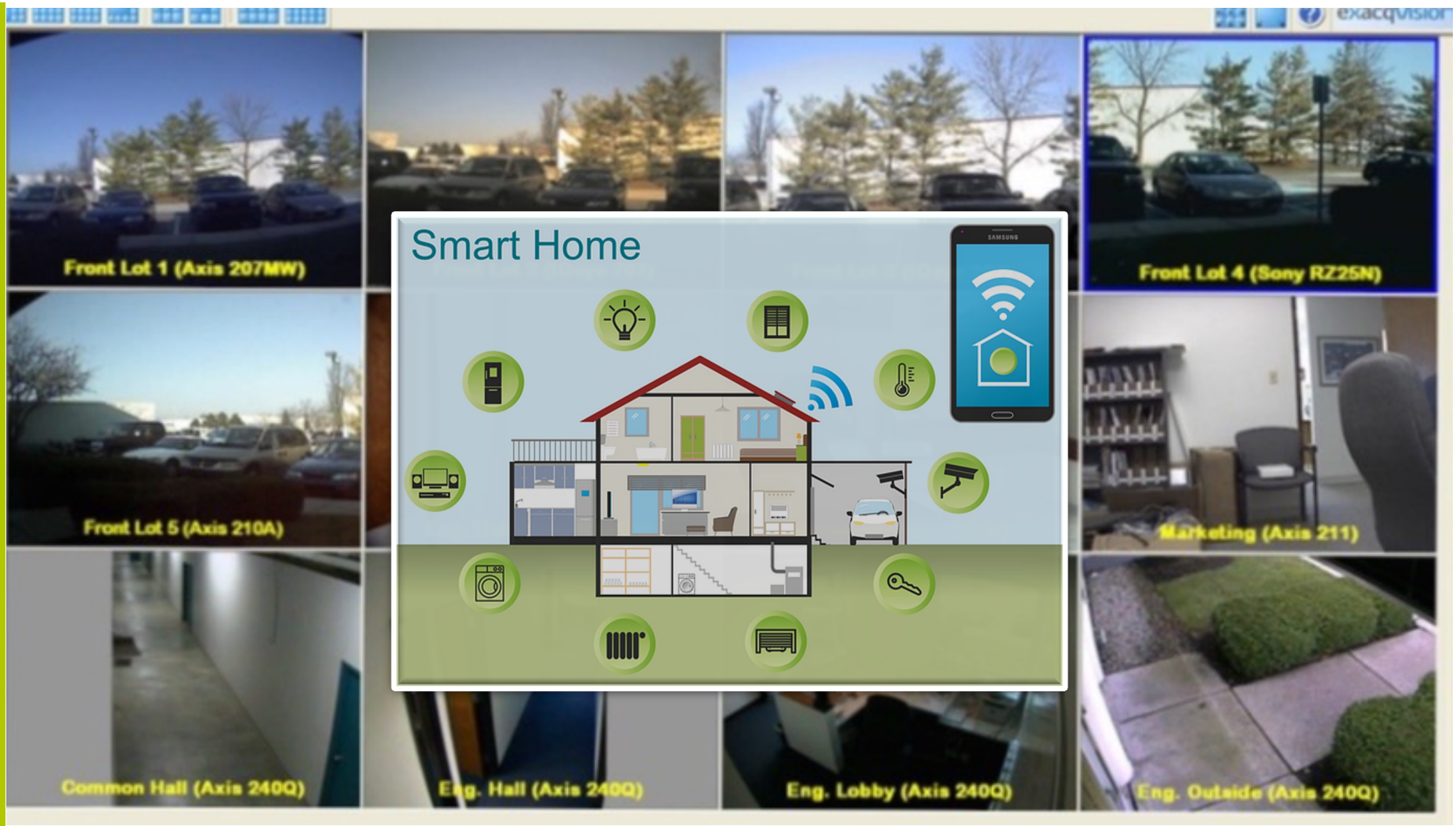


Jeremy Bentham designed a prison where a single guard could **observe all the prisoners**. Prisoners would not know when they were being watched, so they would "**behave**" all the time.

Picture: Mimisawhney

# Modern-Day Panopticon





# We Are Being Watched, Even if It Is Less Obvious

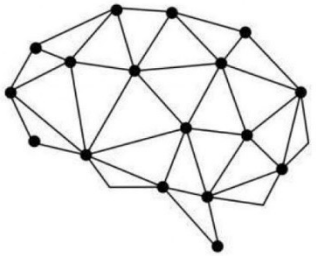



**Is there no no need to care just because you don‘t do anything wrong?**

# The Cambridge Analytica Scandal



- Huge amount of **data was stolen** from Facebook
- **Used by Cambridge Analytica** to target voters for Donald Trump
- Big drop in Facebook‘s share price plus **$5BN fine**
- **Responsibility** of Facebook?



Cambridge Analytica



https://www.google.com/url?sa=i&url=https%3A%2F%2Ffacebook.de.uptodown.com%2Fandroid&psig=AOvVaw28XMKbLOo4wBQX594_5MJG&ust=1643887757281000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCJCfi6P14PUCFQAAAAAdAAAAABAD

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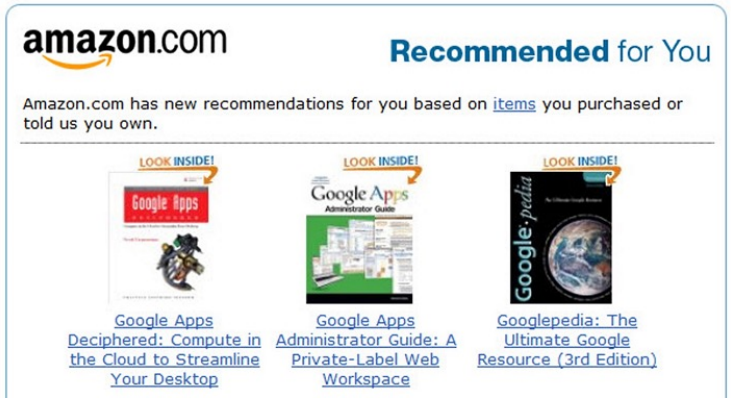
# Personalized Advertising







YouTube



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https://cdn.mageplaza.com/media/general/DdsQB2x.png
https://www.free-online-converters.com/blog/2020/08/3930-1.jpg

# Technology Is Eroding Privacy

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> You have zero privacy any way …
> Get over it.

Scott McNealy, CEO of SUN, 1999

➡ Then everybody needs to be completely **honest**, right?

# Changing Attitudes



As society adapts to new technologies, **attitudes will change**.

**Teenagers freely post facts** about their activities online that adults never would dream of doing. Their **privacy boundaries are different** from those of older people.

But **different boundaries** does **not mean no boundaries**

TikTok

YouTube

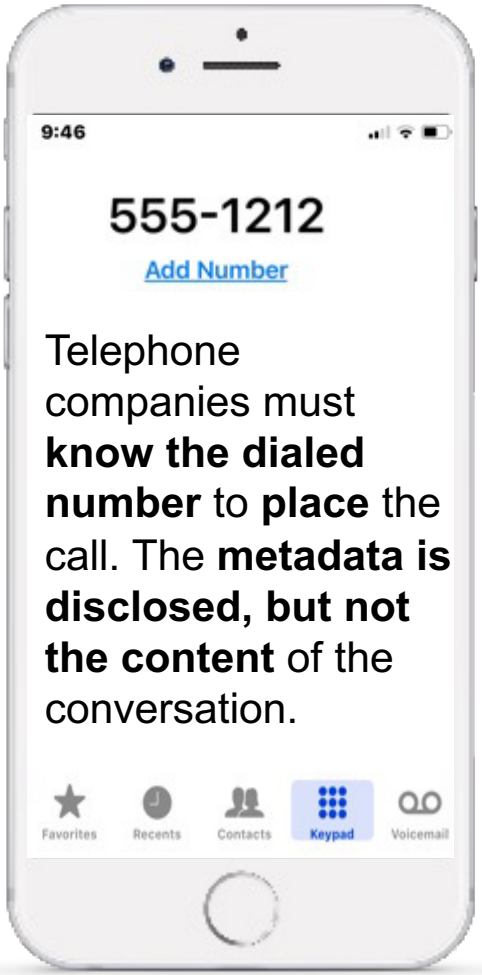
# Voluntary Disclosure



Anything you **voluntarily disclose** to others has much **less protection** than something you kept completely to yourself.

This quickly becomes problematic – due to **ubiquity**.

*Example:*



# It Takes a Village …



In small towns, there was **little privacy**. Everyone in town knew “everything” about everyone else.

Big cities provide **anonymity**.

Does **information technology** bring us **back** to the **“happy days”** in a small town?

# No Option to Exit



In the **past**, one could get a fresh start by **moving to a new place** or by waiting till **memory fades**. **Reputation** could be **rebuilt** over time.

Big Data is **universal** and **never forgets anything!**

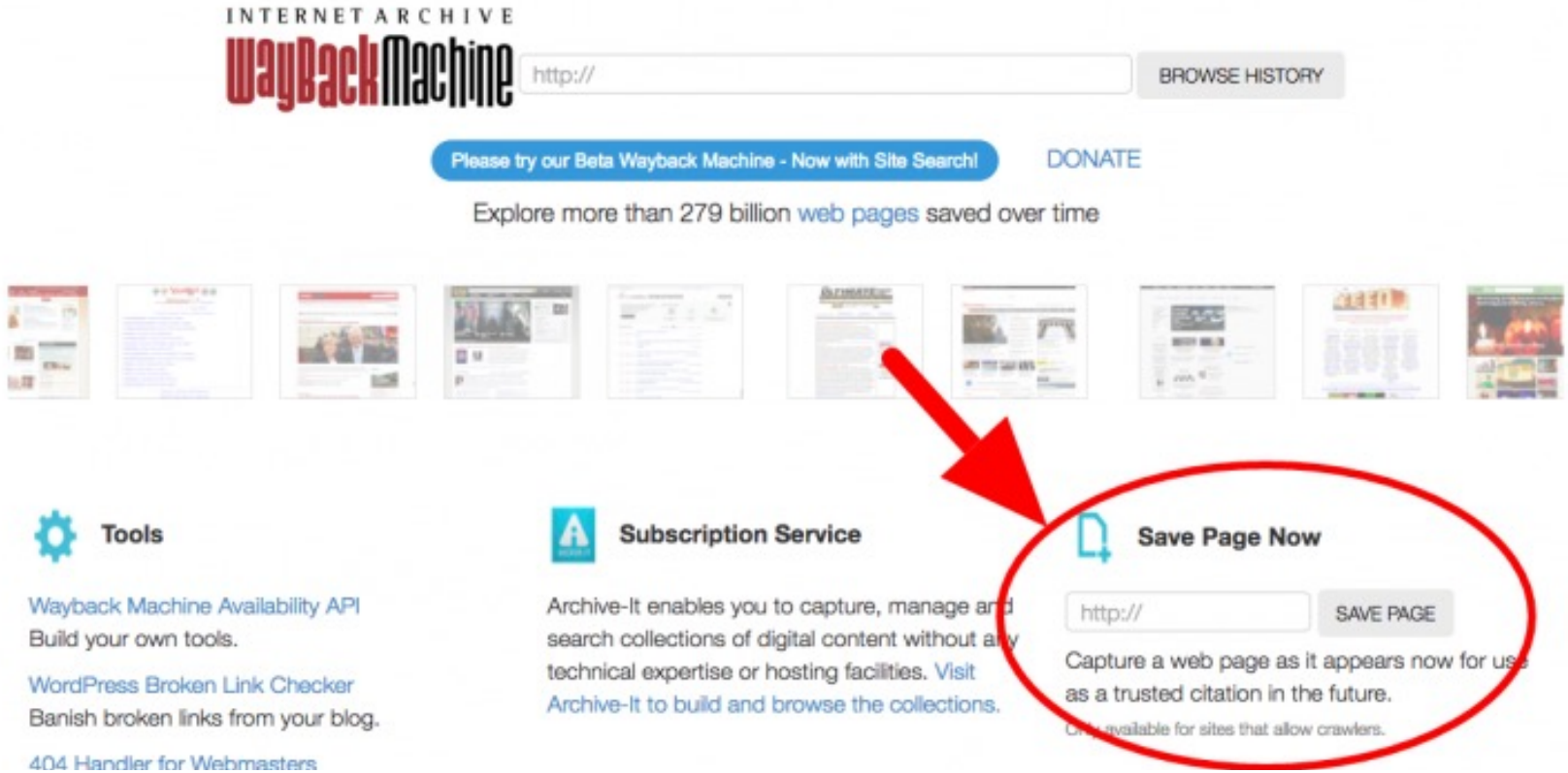
In a small town, **information** is (mostly) **symmetric**. You know as much about me as I know about you.

Data Science can result in **major asymmetries**.

# Wayback Machine



It **archives** almost every **page on the web** that is **accessible** and (intends to) **retain for ever**. If you have an unflattering page written about you, it will survive for ever in an archive, even if it was taken down!



# Right to be Forgotten



Laws are often written **to clear a person's record after some years**. For example, records about imprisonments or driving accidents are expunged after a defined number of years.

**But what if an individuals' record is on the web?**

**Individuals' record**

There are **laws in the EU and Argentina** since 2006. But in practice, these laws **primarily impact search engines**.

# The World of Data Today

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Every merchant, and many others, have **considerable data about me**. This includes at least my **interactions** with them, but often much more.

I am happy for them to **use** what they know to **serve my interests.**

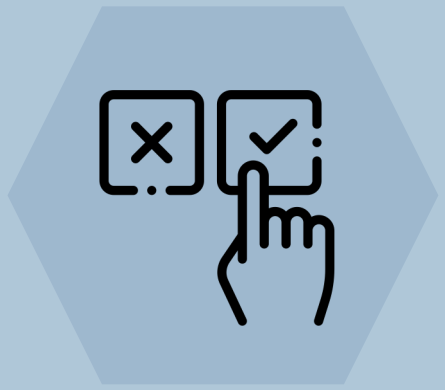
But I really do not want them to **share the data with others** or **use** it **in other ways**.

# All Or Nothing Agreements



Many user agreements are **“all-or-nothing”**. Users must completely give up control on shared data to get any service benefits at all.

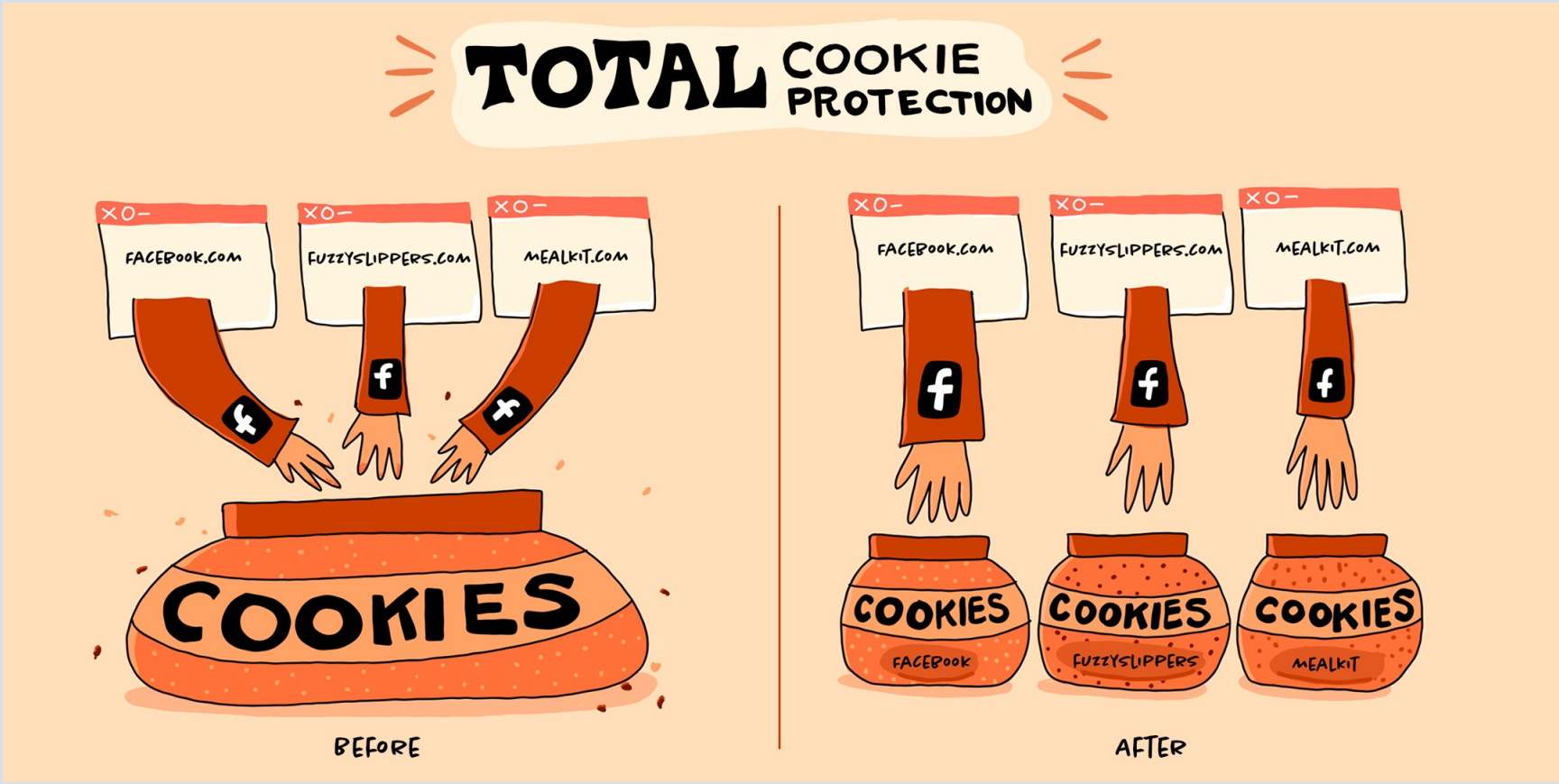
Users complain about **loss of privacy**.



It is better to **provide gradual choices**, so users can **make tradeoffs to their liking**, e.g., incognito browsing

# Privacy
## *Example:* Cookies



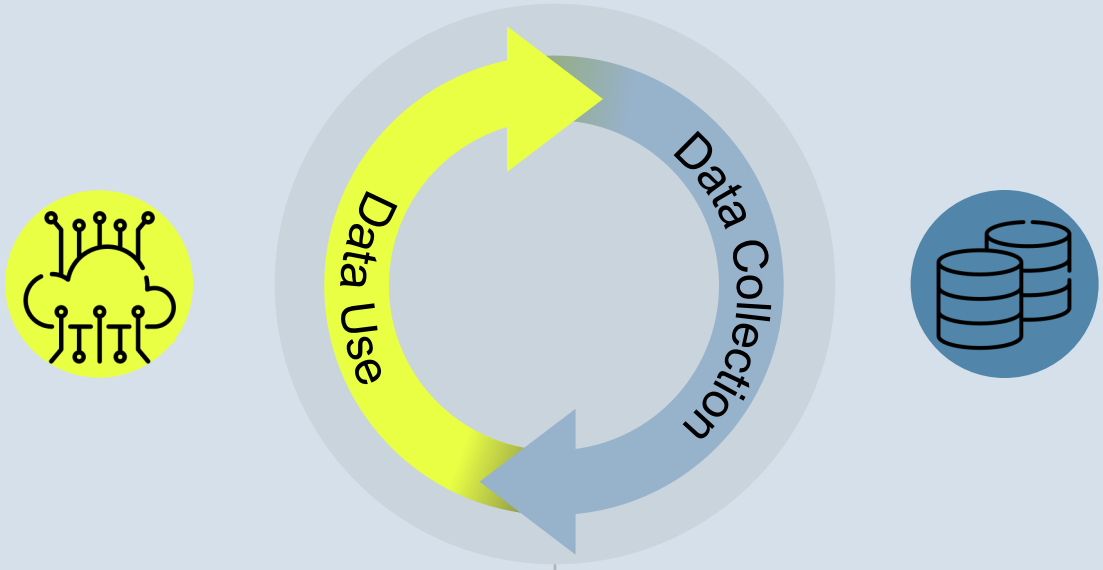





Picture: https://blog.mozilla.org/security/2021/06/01/total-cookie-protection-in-private-browsing/

# Collection versus Use






Privacy is usually harmed only **upon use of data**.

**Collection** is a **necessary** first step **before use**.

But **collection without use** may sometimes be **right**, e.g., surveillance

# Loss of Privacy



We have a **loss of privacy** due to a **loss of control over personal data.**

I am **OK** with there being **certain data** about me that I have chosen to share or that is public, but I really **do not want others to share** my data in ways that I **do not approve of**.

# Main Drivers of Privacy Violation

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Government agencies for national security, but also private enterprises, private investigators, …


**Advertising**

Prospective employee, prospective borrower, prospective date, …

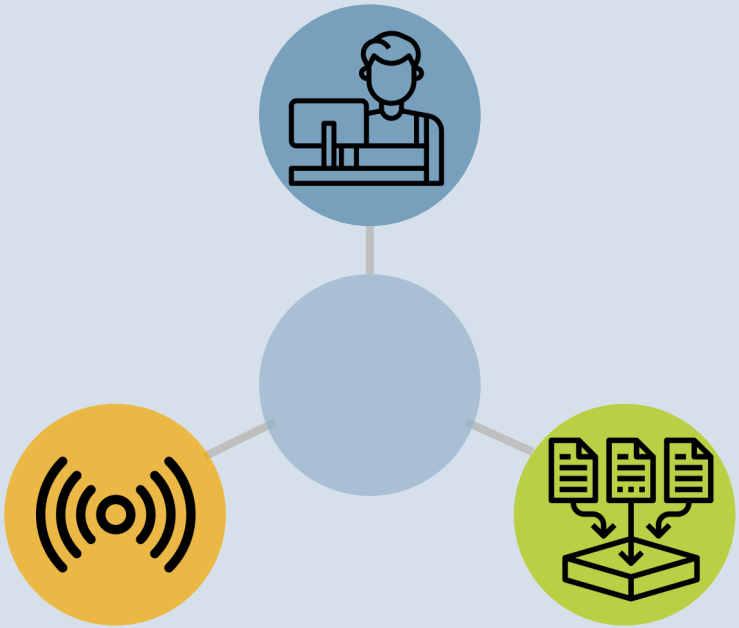
**Surveillance**

If a company can show you focused, person-alized, and relevant ads everyone wins.

**Introduction**

# Main Sources of Information





Data collected by **merchants** and **service providers.**

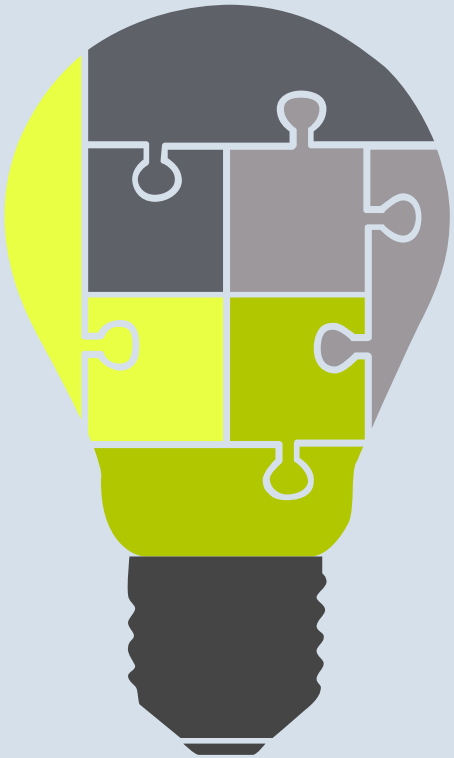
**Activity tracking** – on and off the web.

**Sensors** in devices around us

- Personal devices
- Infrastructure
- Third party devices

# Data Brokers





Companies that **aggregate and link information from multiple sources** to create more complete, and hence more valuable, information products.

Many don't realize **what can be learned about them** by linking multiple sources.

# “Waste” Data Collection

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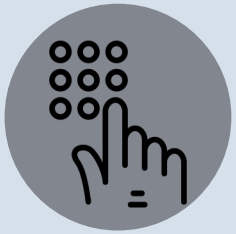
Your ID is scanned at the bar to confirm **proof of age**. The scanning computer at the bar captures your **name, address, date-of-birth**, etc.

# Metadata



Metadata is data about the data. It is often distinguished from data content.

E.g., for a phone call, metadata includes:



Caller

Callee

Time and date of call

Duration

# Metadata May Carry Much Information

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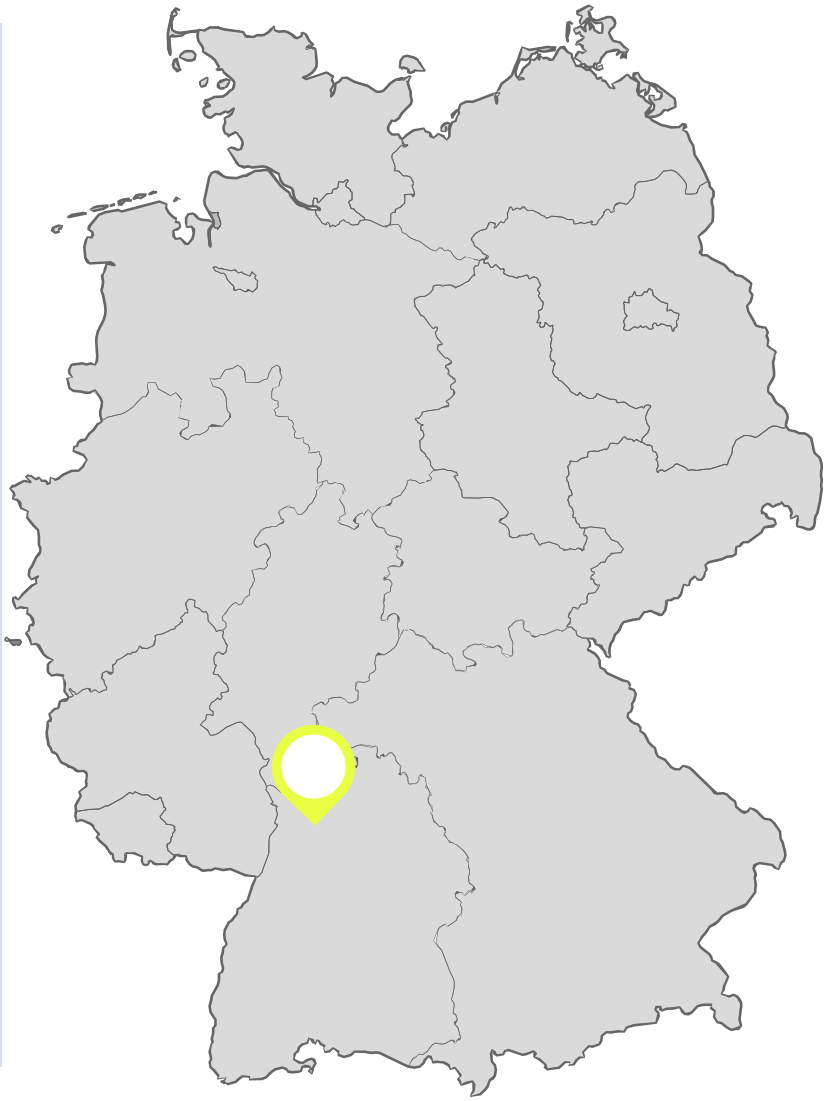
Location information may be metadata for a cellphone call.

Knowing the location does not reveal the content of a call.

But location tracking can reveal a great deal about the person.



# Trust ≥ Design

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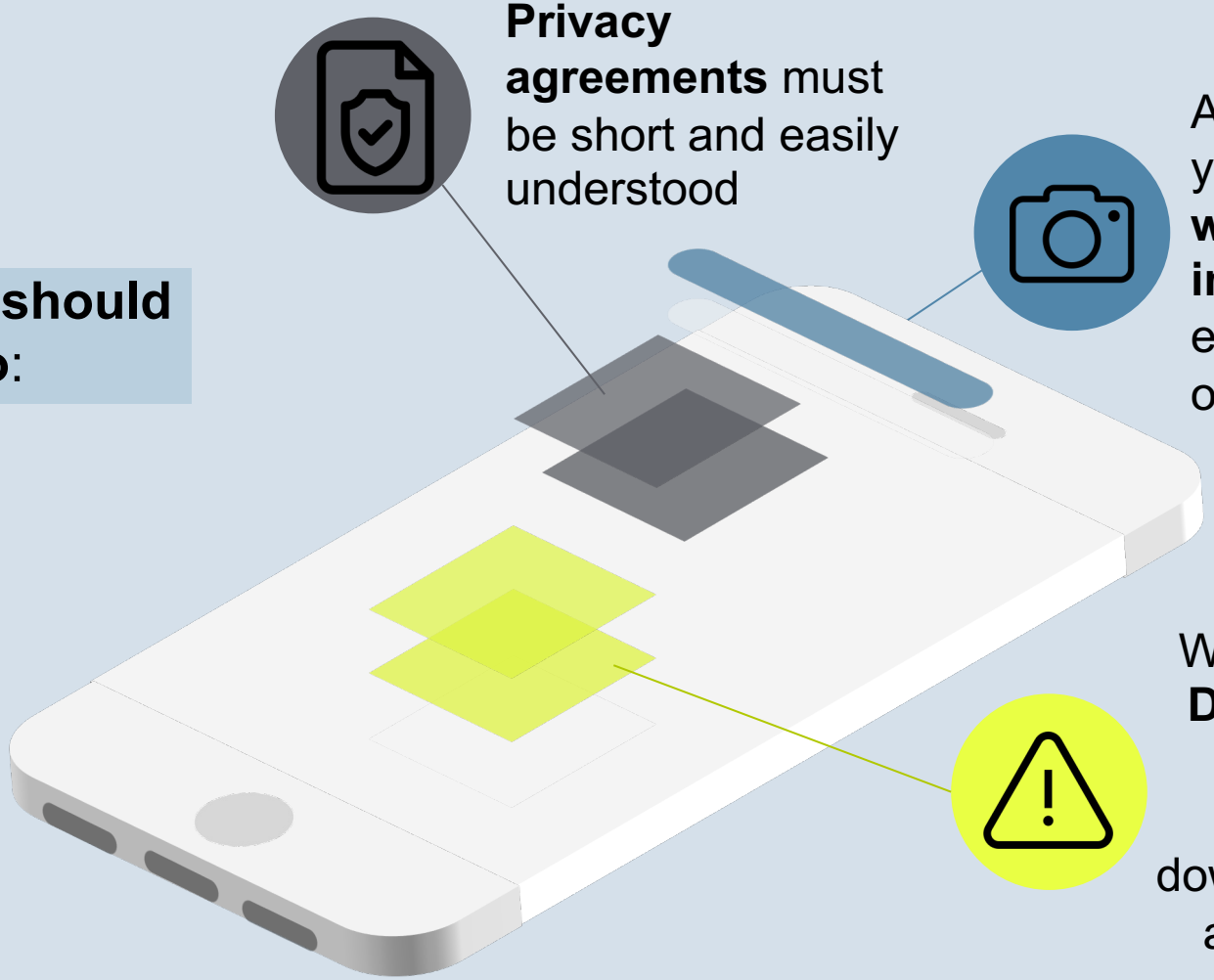
**Traditional social norms** dealt with **privacy by trust**: You tell me private things because you trust me not to use what you told me in ways you would not approve of.

**Modern data systems** must deal with **privacy by design**. There are too many players in a complex system. Data sharing is contractual and not based on trust.

# Sneaky Mobile App



What apps **should actually do**:



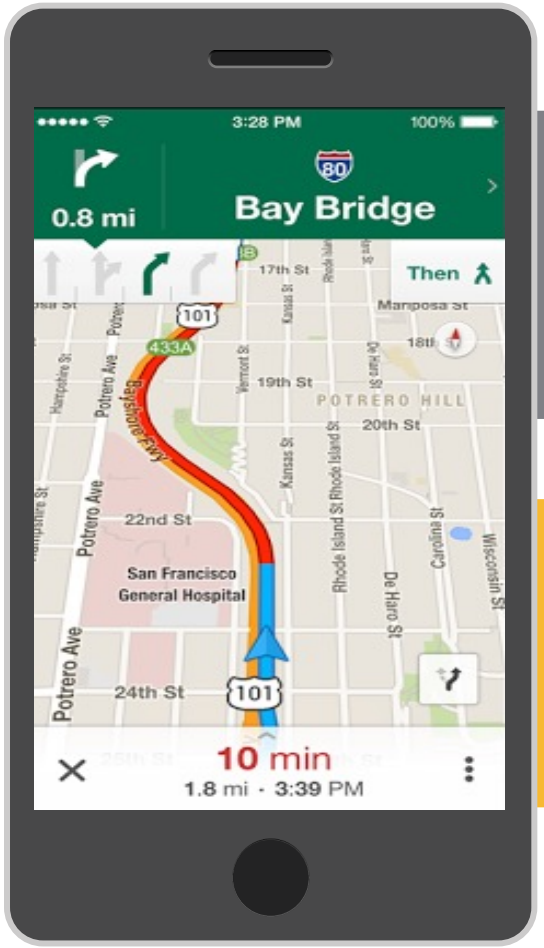
**Privacy agreements** must be short and easily understood

App will warn you about **what it is interested in**, e.g., camera or microphone

Warn about **Data it will collect** when downloading a new app

# “Map App”



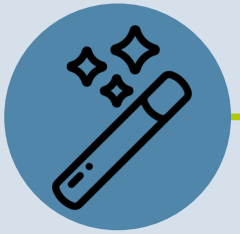



Will **still function** even if you **do not share all necessary data** with them.

If you do not share your location, it still gives you the **simple route** or a **map of the neighborhood**.

# Apps Ask For More Data Than Needed





Reasons why apps ask for more permissions than they actually need


Intentions for **future enhancements**

For **adware**

**Tradeoff** between getting an app for free and sharing the data with the app.

# Conclusion



Privacy is the **ability to control sharing of information about the self**. It is a **basic human need**, even for people who have “nothing to hide”.

Privacy is **easily eroded by thoughtless actions**, or in some cases, by intention.

**Stakeholders** have begun a **conversation around privacy**.

But there **is no consensus** on where the lines should be drawn just **yet**.

# Overview – Data Ethics

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What are ethics?

Data ownership



Privacy

Anonymity

Data validity

Algorithmic fairness

# “On the Internet Nobody Knows You’re a Dog”

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**Cartoon in the New Yorker**, July 5, 1993


*"On the Internet, nobody knows you're a dog."*

# Fake Profiles



- **Fake Profiles/accounts** are on the rise
- Facebook already deleted nearly **1.3 billion fake accounts**
- “Anonymous” posting is **exploited**



https://innewsweekly.com/wp-content/uploads/2019/02/How-to-Spot-a-Fake-Profile-on-Social-Media.jpg
https://www.dumblittleman.com/wp-content/uploads/2018/02/fake-social-media-account.jpg

# The Internet as a “Crime-Free Zone”



- **Hate speech**
- **Discrimination** and **Racism**
- **Crimes** such as the **denial of the Holocaust**
- **“Freedom of speech”?**



https://www.globalr2p.org/wp-content/uploads/2020/02/Screen-Shot-2020-02-21-at-9.46.30-AM.png
https://static.india.com/wp-content/uploads/2021/07/Bukayo-Saka-Racially-Abused.jpg?impolicy=Medium_Resize&w=1200&h=800

# Anonymous Transactions are Possible

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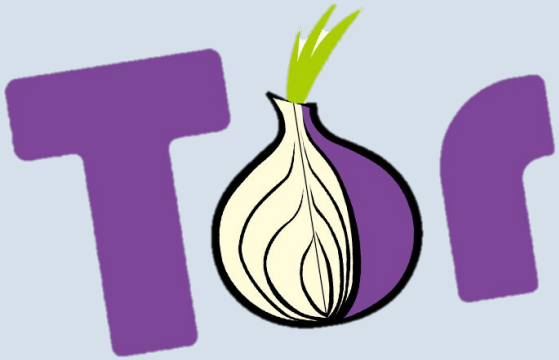
**Post** anonymously



**Pay** anonymously

# But Many Transactions Need ID

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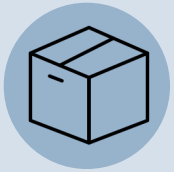


You must provide an **address** if **goods are to be shipped** to you.

You must provide your **name** for **travel bookings**.

You must reveal your **location** to get **cellular service**.

You must **disclose intimate details** of your **health** and lifestyle to get **effective medical care**.

# Enough History Tells All



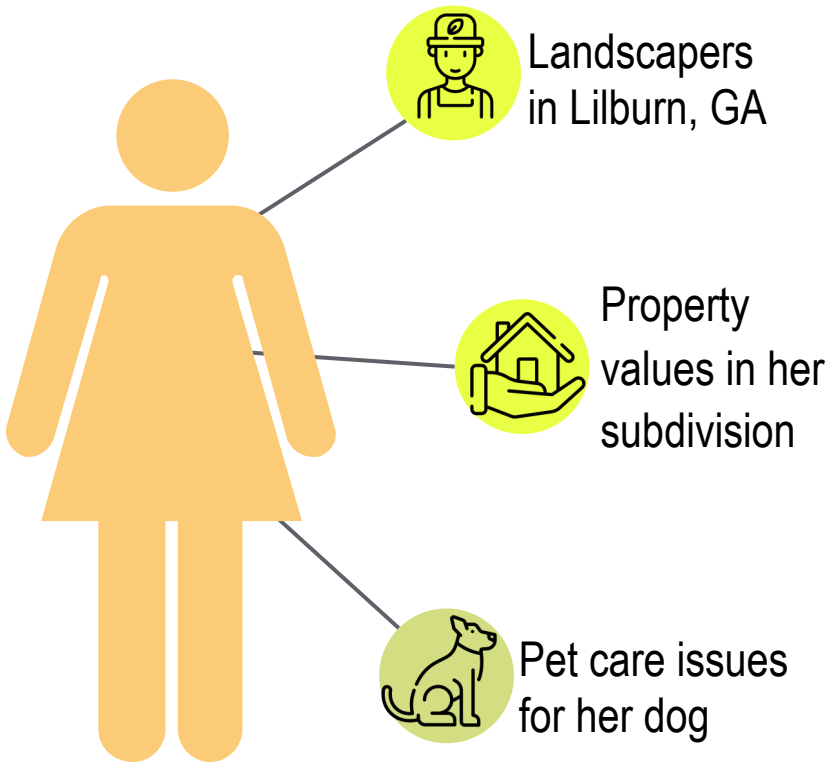
If we have a **log of all your web searches** over some period, we can form a very good **picture of who you are**, and quite likely **identify** you.

If we have a log of all your **credit card purchases** over some period, we can do the same.

# AOL Search Log Release



Web-based mail service AOL released **3 months of search logs for 650,000 users** for **research purposes**. The New York Times journalists Michael Barbaro and Tom Zeller were able to **use the data to identify several users**.




Thelma Arnold from Lilburn, GA

# What Exactly Is Personally Identifying?

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Given **zipcode, birth date, and sex**, about 87% of **Social Security Numbers** can be determined uniquely.

This is possible although that information is **not considered PII!**

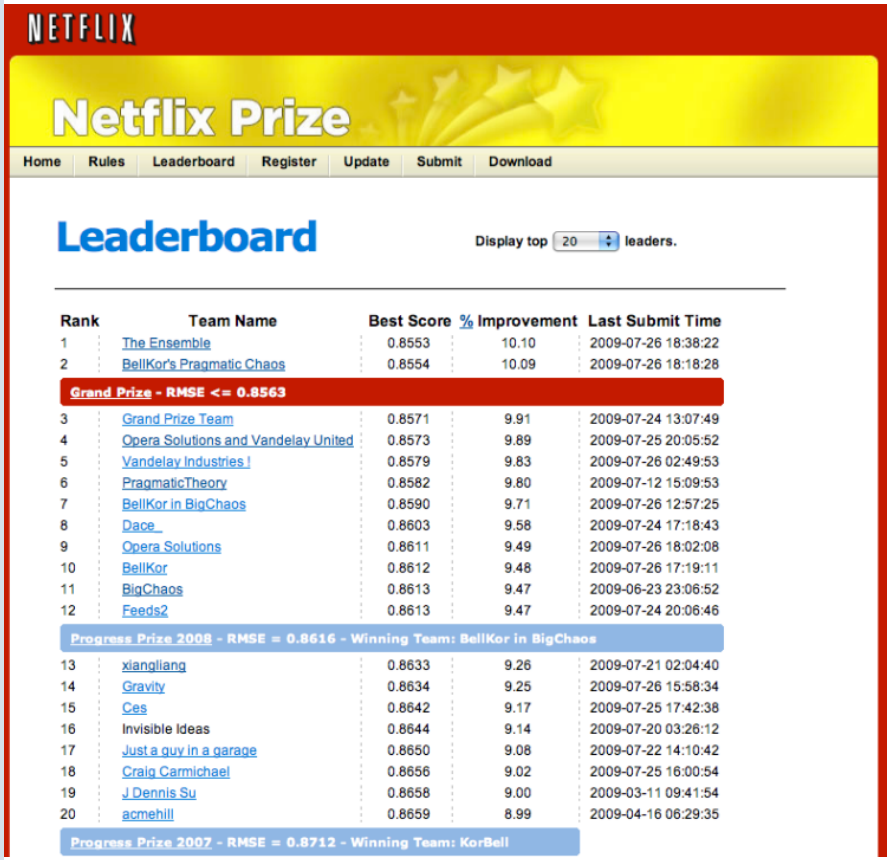
# Netflix Prize



Netflix offered a million dollars to the winning team that could **beat Netflix's own movie recommendation** algorithm by more than 10%.

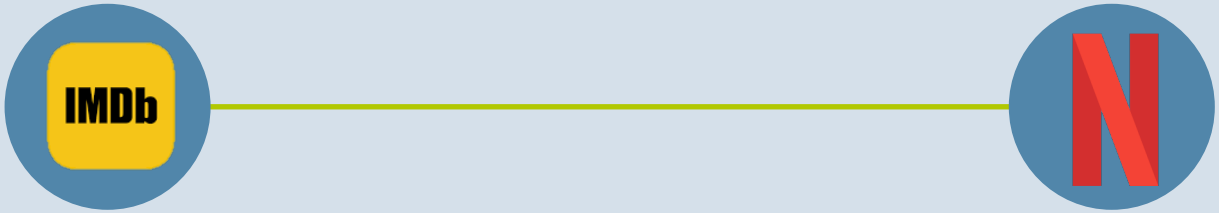
Released a **data set** comprising **user ID, date, movie name, rating**.

**"Completely de-identified"**



# Netflix Re-identification






Many users had posted **movie reviews on IMDb**…

…and at the same time they had **rated movies** on **Netflix**.

By **date of review**, users could be **linked across the two systems**, even if they only reviewed a few movies on IMDb. Their Netflix movie choices could be used to **determine sexual orientation**, even if all their IMDb reviews revealed no such information.

# Netflix Saga Conclusion



Netflix was **sued** by a lesbian mom, who had not (yet) come out, for "outing" her.

Case **settled** for $9m after 2+ years of litigation.

Netflix **canceled plans** for **additional rounds** of its prize challenge.

# Phone Data Re-identification

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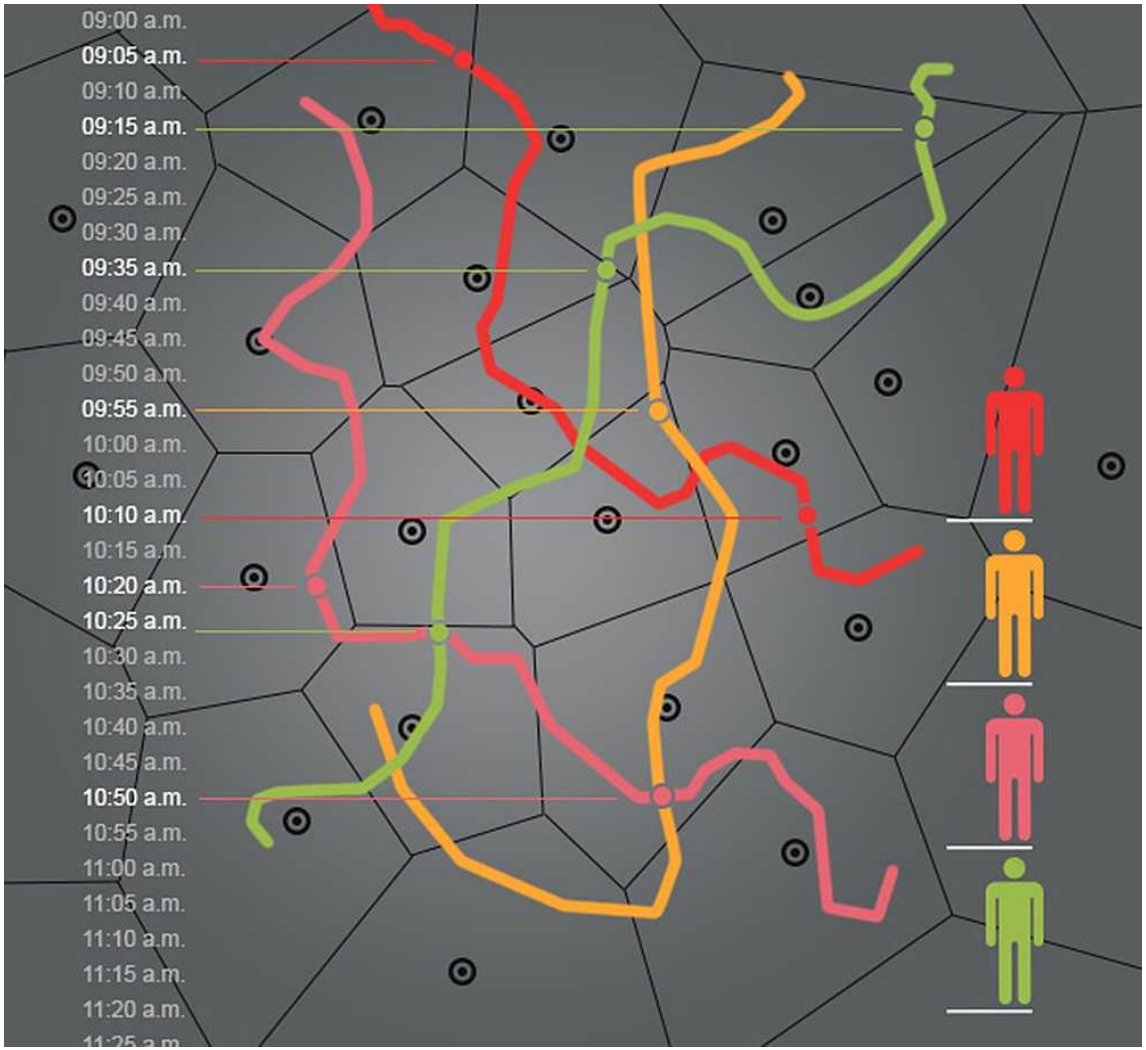
Analysis of **“anonymized” phone data** over 15 months.

Use of **only 4 points of reference** with slight differences in time and space.

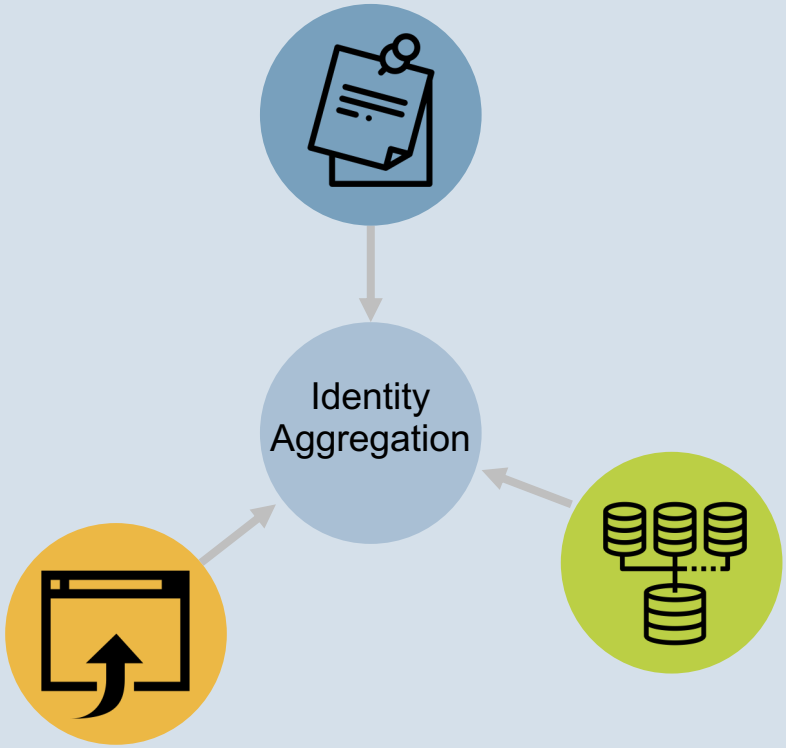
**Unique identification** of **95%** out of 1.5 m users.




Picture: https://news.mit.edu/2013/how-hard-it-de-anonymize-cellphone-data

# How Re-identification Works






Identifying **data in retained fields**, e.g., patient name mentioned in physician notes, a text field or graph structure match, even without labels

**Combination** of multiple **partial identification**, e.g., AOL search, Massachusetts health information

Using **external data sets**, e.g., Netflix

# Four Types of Leakage

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1. Reveal **identity**
2. Reveal **value of hidden attributes**
3. Reveal **link between two entities,** e.g., by phone call metadata
4. Reveal **group membership**, e.g., your religious denomination from your cellphone location

# Anonymity Is Impossible

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**Anonymity** is virtually **impossible**, with enough other data:

Diversity of entity sets can be eliminated through **joining external data.**

Random perturbation works only if we can **guarantee a one-time perturbation**.

Aggregation works only if there is **no known structure** among entities aggregated.

**Faces can be recognized in image data**. Increasingly even **under challenging conditions**, such as partial occlusion.

# Severe Lack of Anonymity
## *Example:* China's Facial Recognition

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Picture (L): https://image.cnbcfm.com/api/v1/image/105910971-1557804260825gettyimages-1124858078.jpeg?v=1582387062

Picture (R): https://www.cnet.com/news/in-china-facial-recognition-public-shaming-and-control-go-hand-in-hand/

# Limit Publication of Datasets As Solution?




If **anonymity is not possible**, the simplest way to **prevent misuse is not to publish** a dataset.

For example, **government** agencies should **not make potentially sensitive data public.**

Yet, access to **data is crucial for many desirable purposes**, including medical research and public watchdogs.

# License Data to Trusted Parties

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Need **simple licensing regime** for access to potentially sensitive data, including de-identified data.

Enforce through **contracts** in the **business world** or…

…through **professional standards** in the **research world**.

# Summary



Identity is very hard to manage online.

Anonymity is possible only in limited narrow situations.

De-identification is important to deter the merely curious but will not stop the truly determined.

# Overview – Data Ethics

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What are ethics?

Data ownership



Privacy



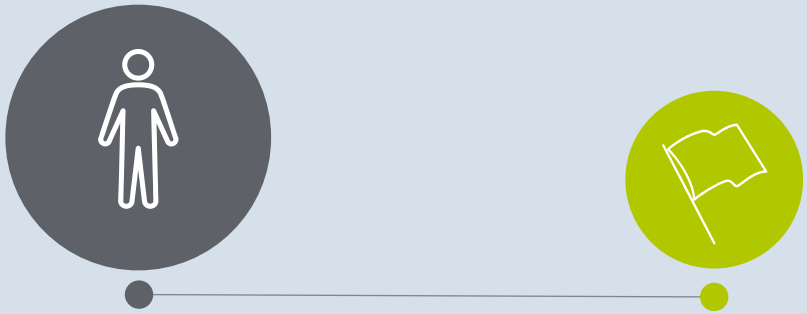
Anonymity

Data validity

Algorithmic fairness

# Validity





As there are a lot of possible interactions between two variables, we need to make sure that **validity** is given.

# Absence of Validity Leads to Data Error

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**Bad data** and **bad models** lead to **bad decisions**.

If **decision-making is non-transparent**, results can be bad on an aggregated level, and **catastrophic for an individual**.

What if someone **is denied a loan** because of an **error in the analyzed data?** Or in the analysis method design?

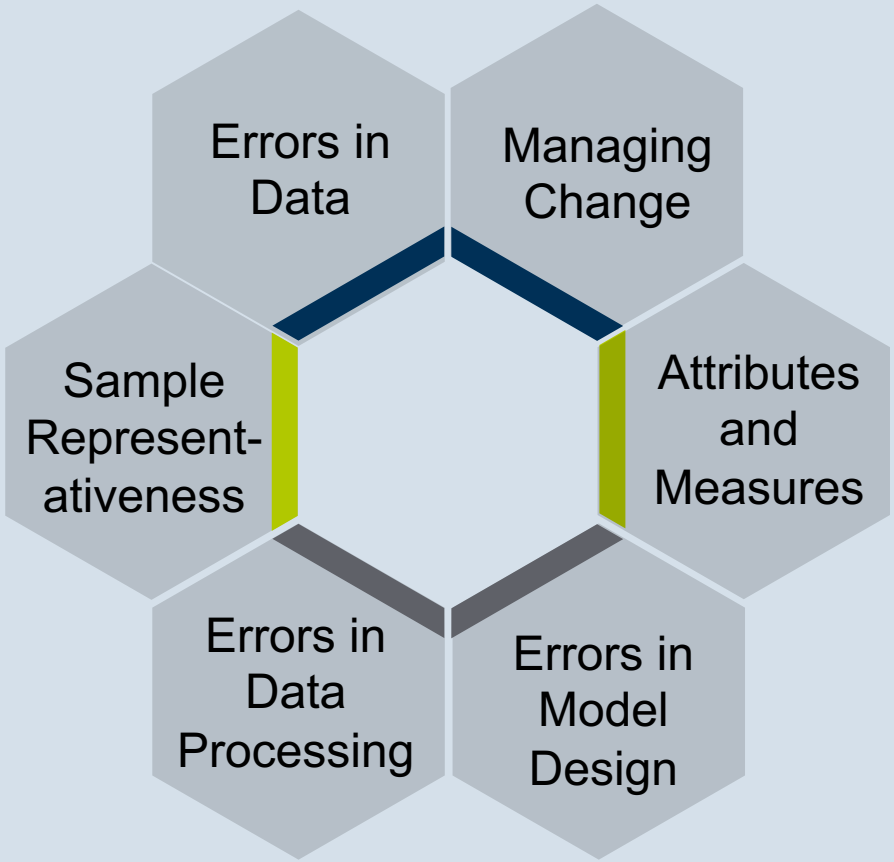
# Poor Data in Organizations




https://commence.com/blog/2021/01/16/bad-data-in-decision-making-process/

# Sources of Error





# Sample Representativeness

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## The Streetlight Effect

Drunk people look for their keys under a lamppost, because this is where they can see.

We are often limited by what data we have.

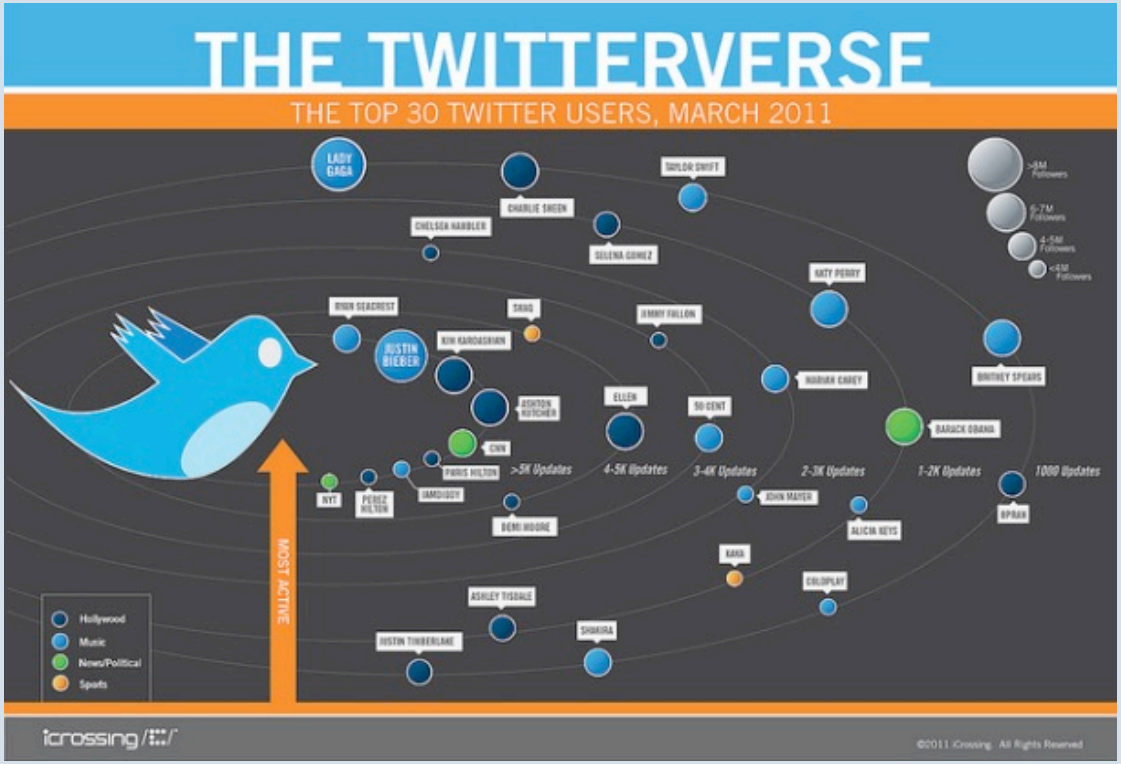
We just analyze what we have and hope for the best.

# Sample Representativeness
## *Example:* Twitterverse



Are twitter users **representative of the population** as a whole?

Are tweets **representative of the opinions** of twitter users?

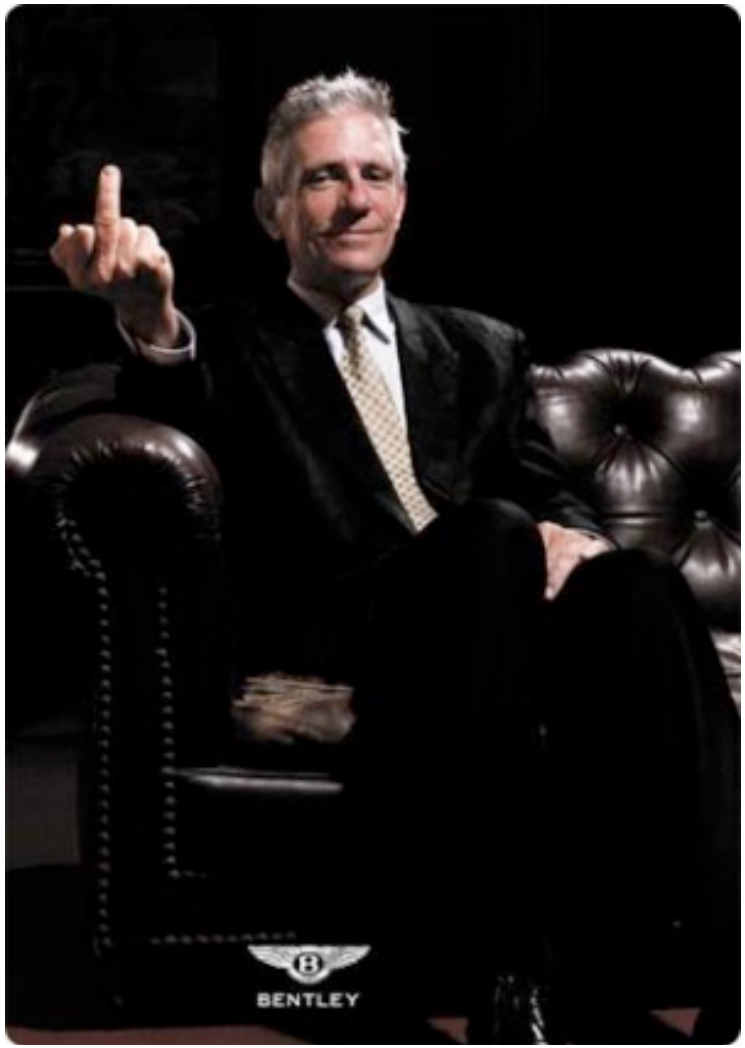


# Sample Representativeness: Opinionated Customers on Forums



Sometimes, it **may not matter** whether the **opinion is representative** of the population.

It may be **enough if it is representative of a segment** of the population.



# Sample Representativeness: Counting Variables

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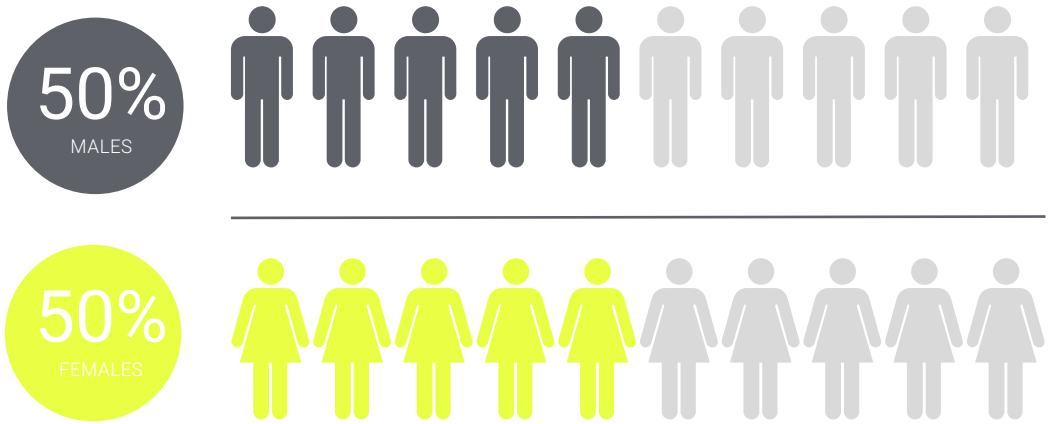
> “Not everything that can be counted counts, and not everything that counts can be counted.”

William Cameron, 1963

# Sample Representativeness: Balance Important Attributes



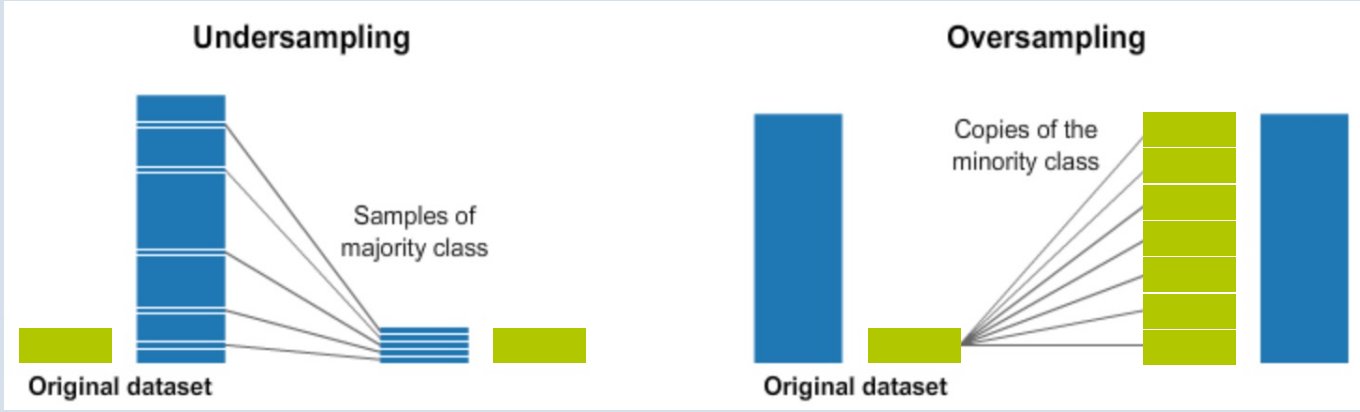
If a variable (e.g., race, gender, age) is likely to matter, you need to make sure **the sample is well balanced** in these **attributes**.



# Sample Representativeness: Accuracy Paradox as a Problem of Resampling



When working with data, you need samples of the **same** size, which you can achieve by **resampling**



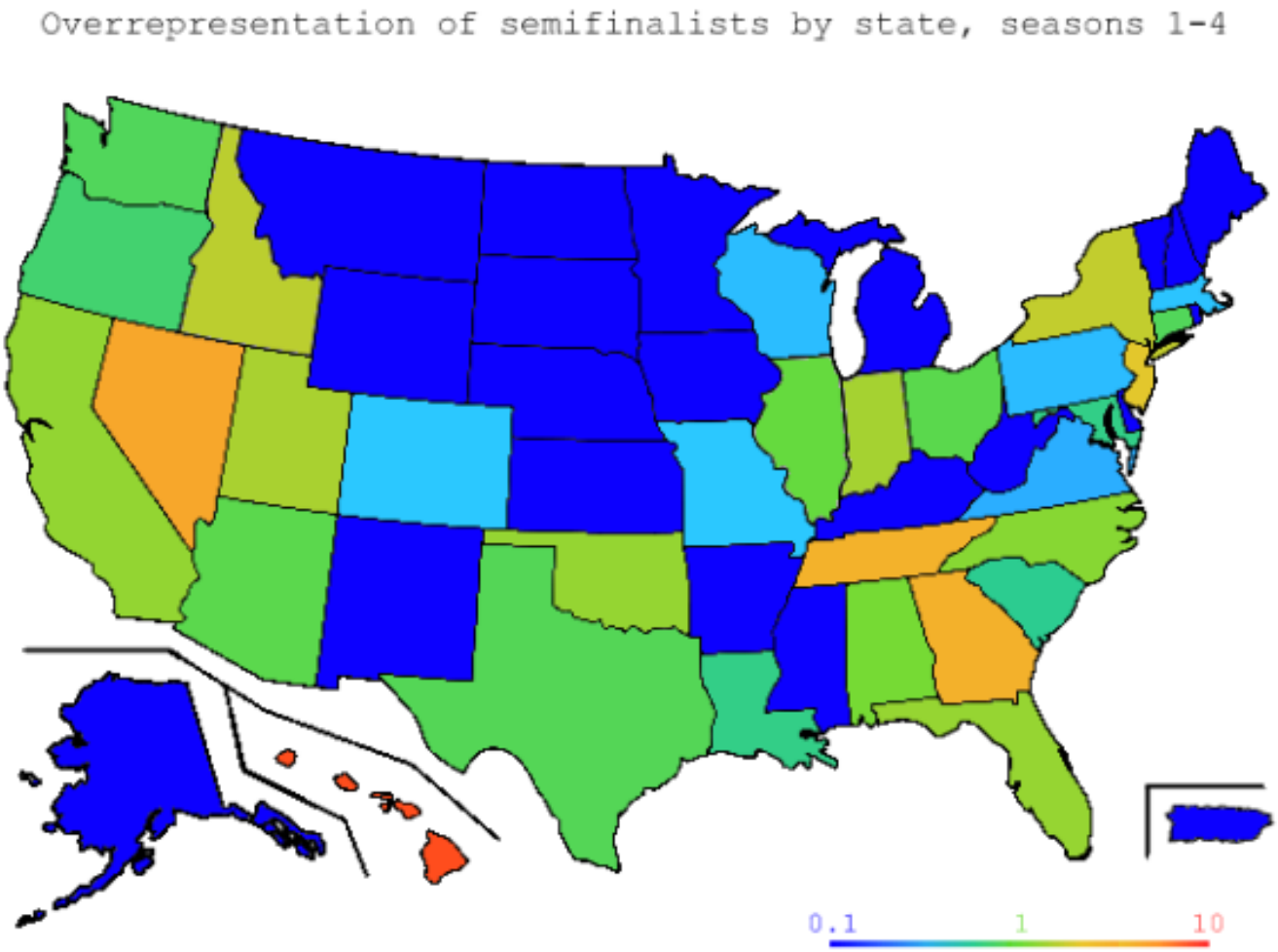

**But** this can lead to a **lack of accuracy** because it does **not clearly distinguish between the numbers of correctly classified examples**



https://www.analyticsvidhya.com/blog/2020/07/10-techniques-to-deal-with-class-imbalance-in-machine-learning/

# Sample Representativeness: American Idol Semi-finalists



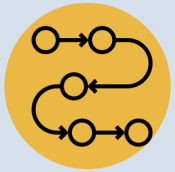


# Sample Representativeness: Project Future Population



Past population is not the same as the future population.

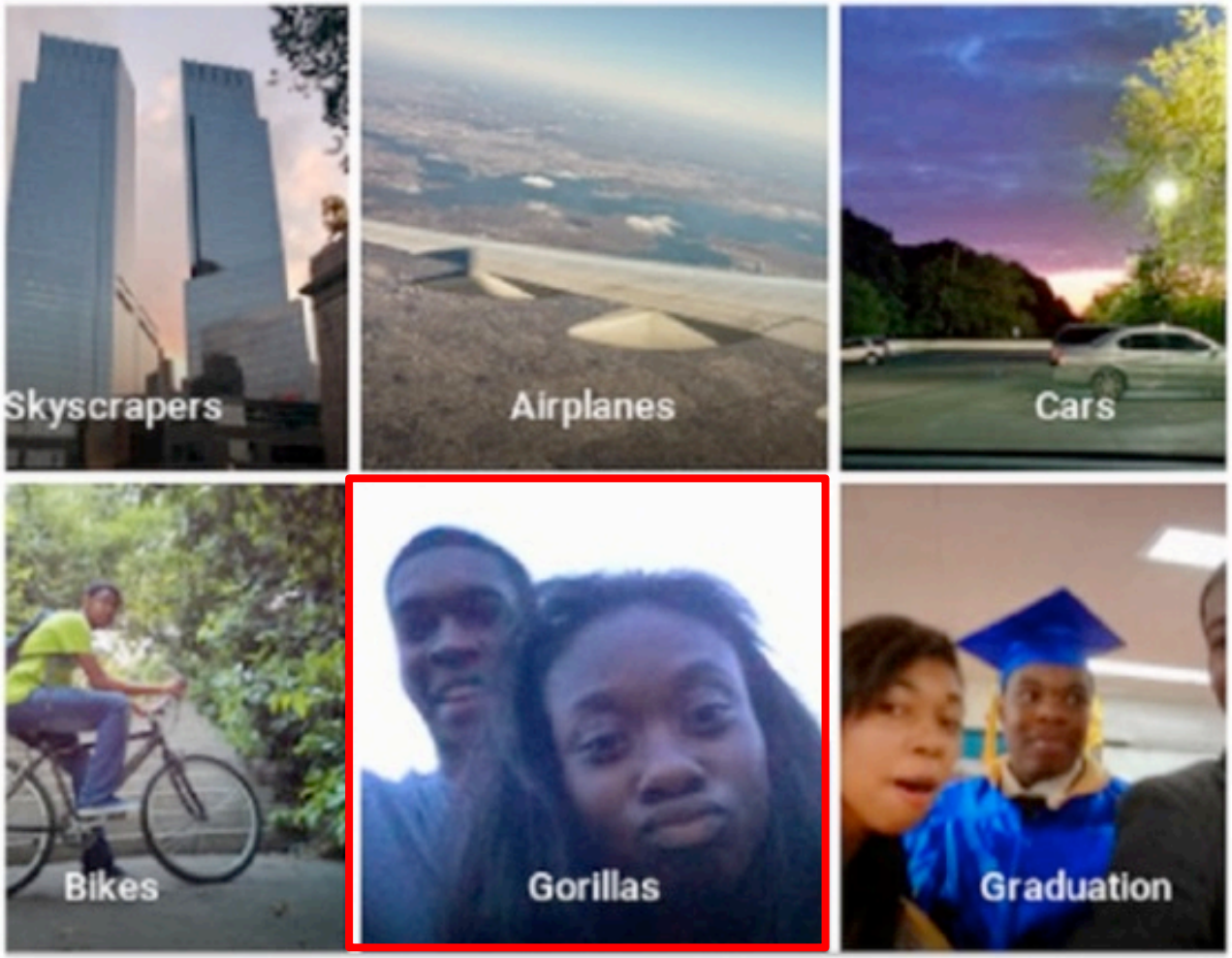
Analysis based on the past will work in the future only to the extent to which the future resembles the past.



Watch out for singularities, but also worry about gradual drift.

# Errors in Data
## *Example:* Google Labeling Error



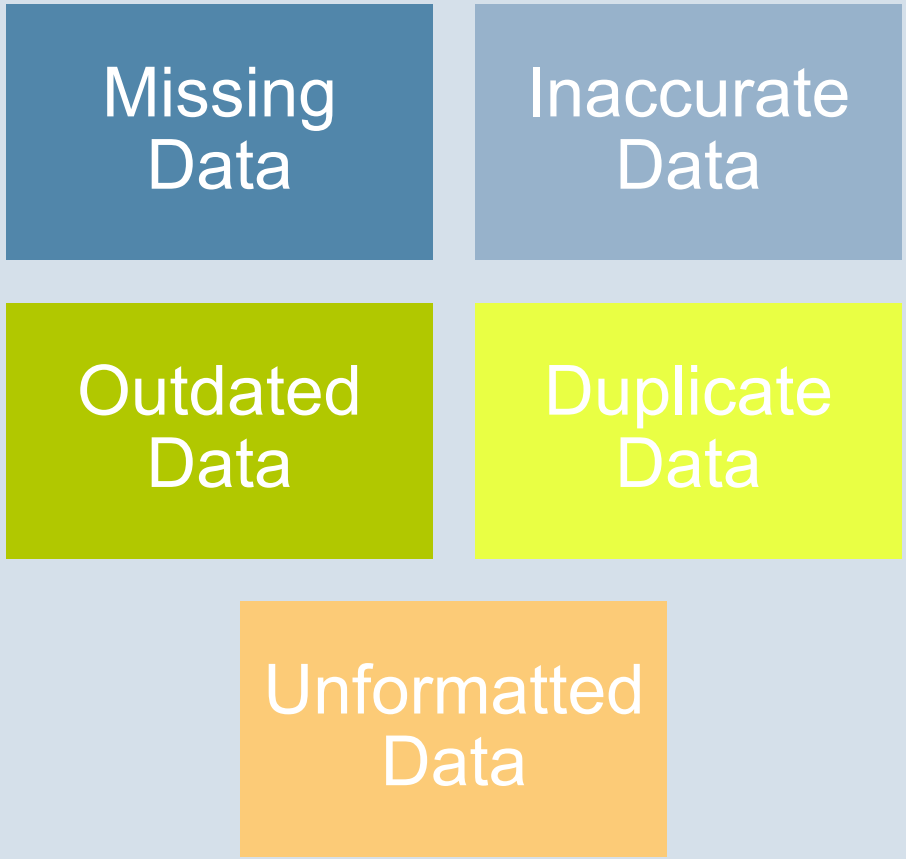


# Errors in Data: Algorithms and Race



# Errors in Data






https://commence.com/blog/2021/01/16/bad-data-in-decision-making-process/

# Errors in Data
## *Example:* Credit Reports




# Attributes and Measures: What Attributes to Choose

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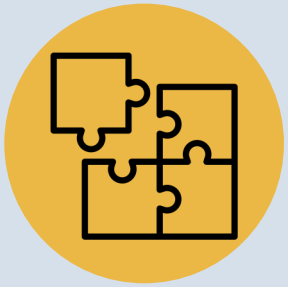
## Attributes decide on the research we can conduct

Usually **limited** by **what is available**.

**Additional attributes** can sometimes be **purchased** or **collected**.



Still, we need to think about **missing attributes.**

# Attributes and Measures: What Attributes to Leave Out



May be **limited by law.** For example, in many cases, race can and should **not** be considered.

# Attributes and Measures: Paid Ads Based on Followers



Kim Kardashian West has **70 million** followers on **Twitter**.

Company X paid her to **tweet about its products.**

- 50 million saw the tweet
- 2 million visited Company X's web site
- 30,000 orders ($30 each, on average)

→ **$900,000 in sales**

**Are these the sales based on this tweet?**

# Attributes and Measures: Paid Ads Based on Followers

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50 million saw the tweet.

At $0.003 per view = $150,000

Pay per view

Pay per new customer

2 million visited Company X's website.

At $0.05 per new visitor = $100,000

Associated sales of $900,000.

At 10% profit margin = $90,000

Pay profit margin

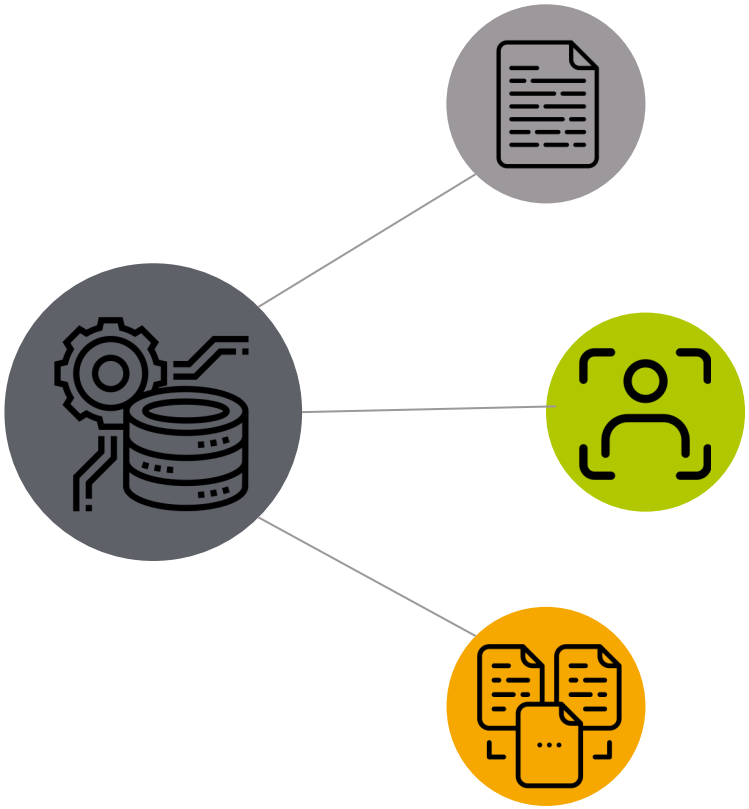
# Errors in Data Processing: “Fancy Data Processing”



Extracting sentiment from text.

Recognizing faces from photos.

Merging records for the “same” person.



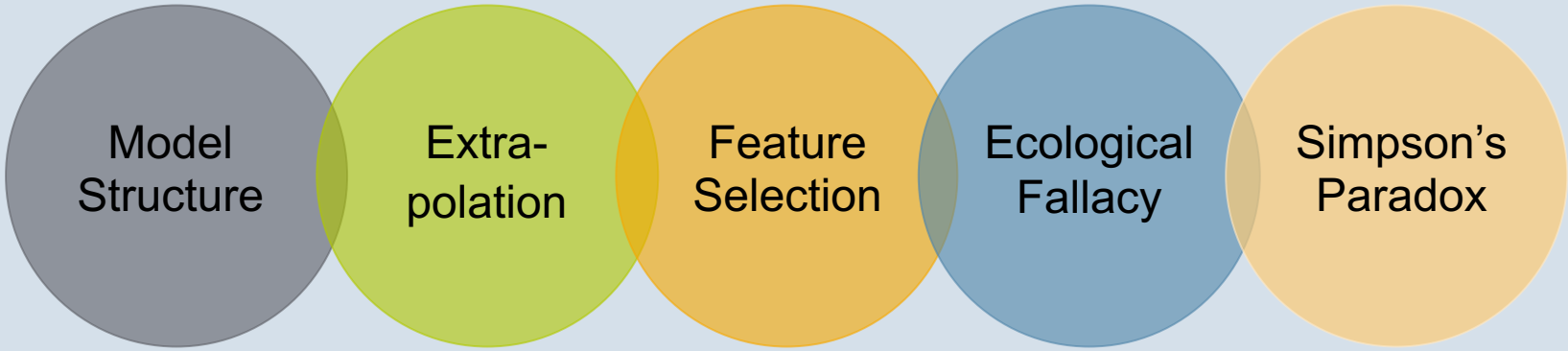
# Combination of Errors: Algorithms on Social Media




https://assets.deutschlandfunk.de/FILE_40d4b5c766050371d5ea859d130de380/512x384.jpg?t=1597525089324
https://i.computer-bild.de/imgs/5/1/8/3/8/5/6/Facebook-1024x576-e343b150b7305a53.jpg
https://news.stanford.edu/wp-content/uploads/2021/10/GettyImages-1298158450-555x370.jpg

# Errors in Model Design: Different Cases

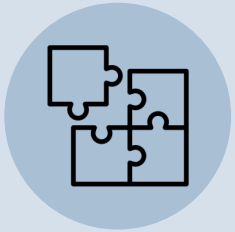




# Errors in Model Design: Model Structure



Most machine learning just **estimates parameters** to fit a **pre-determined model**.



Do you know the model is appropriate?

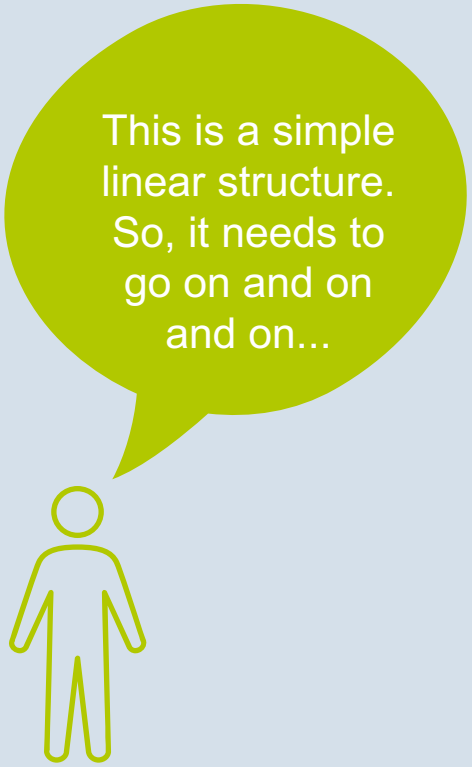
Are you trying to fit a linear model to a complex nonlinear reality?

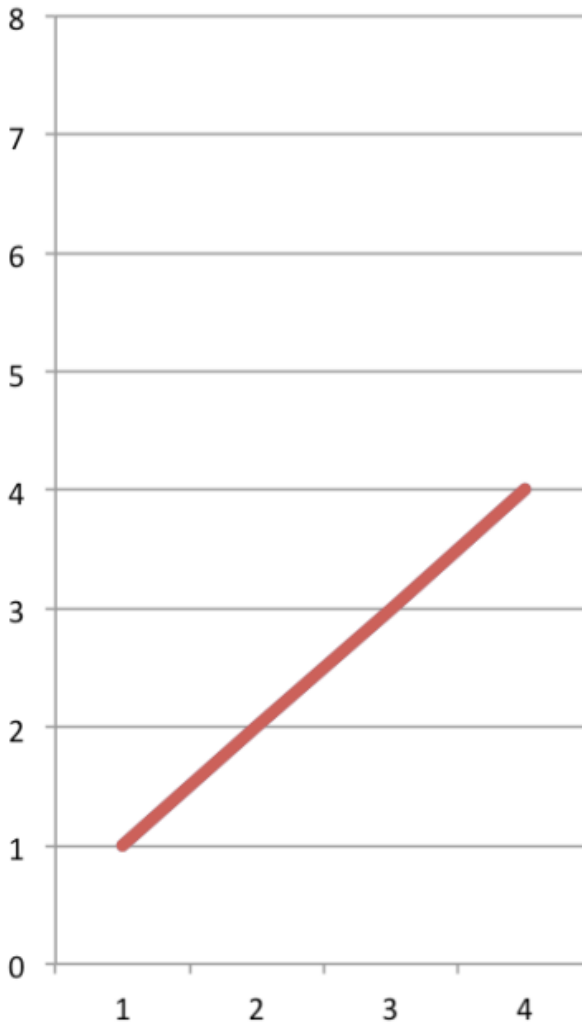
# Errors in Model Design: Extrapolation



We have a perfect linear graph in the range 1-4.

What can you say about X=7?



# Errors in Model Design: Feature Selection



Did you know that **taller people** are more likely to **grow beards**?

Women generally are shorter. Women don't grow beards. **This doesn't tell us anything about taller vs shorter men!**

# Errors in Model Design: Ecological Fallacy

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Analyzing results for a group and ascribing results to the individual.

*Example:*

# Errors in Model Design: Simpson's Paradox

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**Women** are **accepted more often** by both Easy U and Hard U. But they are **accepted less** often by the **two combined**. Because **more women than men apply to Hard U**.

| | Men | Women |
|---|---|---|
| Easy | 7/10 = 0.7 | 4/5 = 0.8 |
| Hard | 3/10 = 0.3 | 5/15 = 0.33 |
| All | 10/20 = 0.5 | 9/20 = 0.45 |

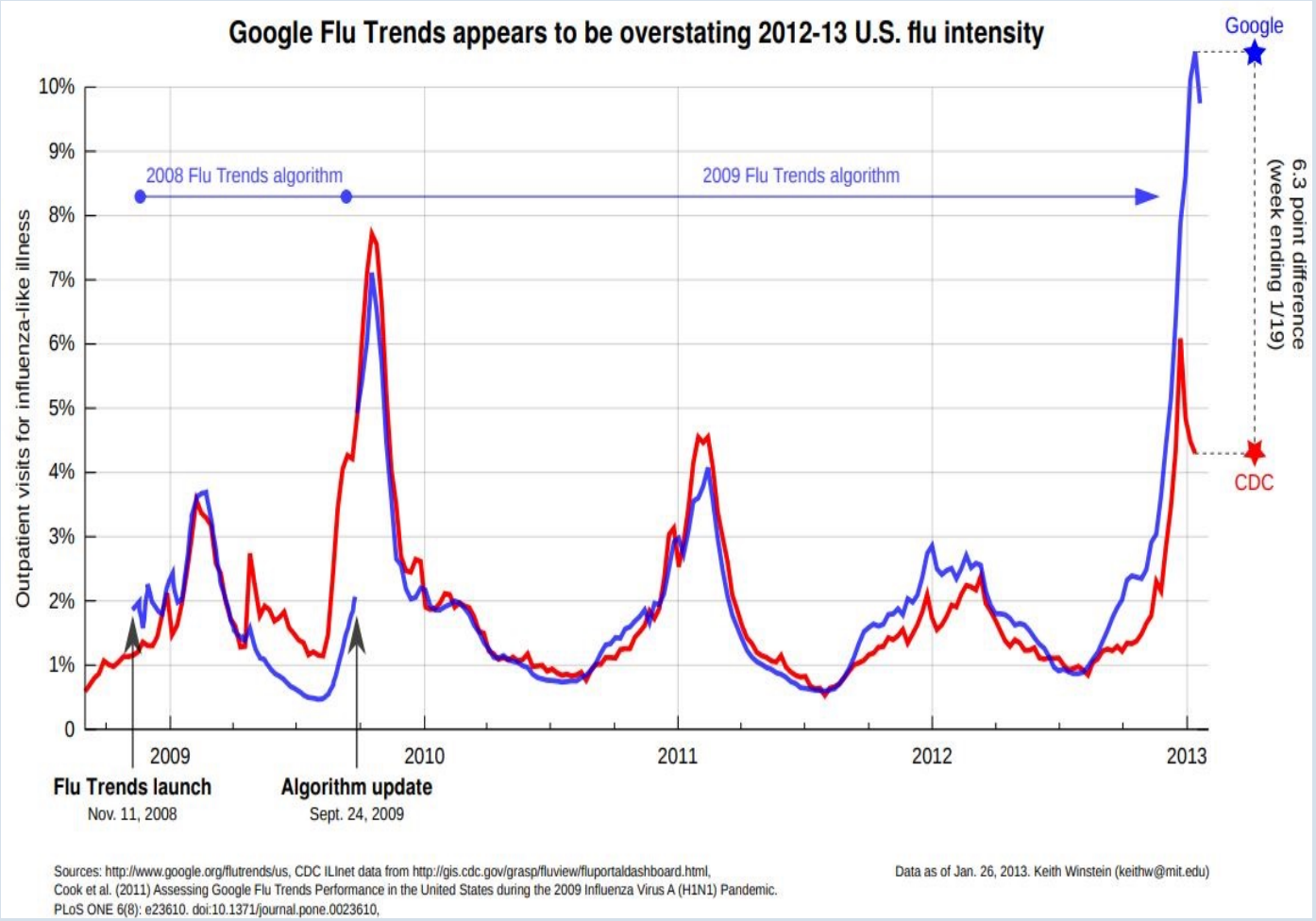
# Managing Change: Analysis of Complex System



- System **changes continuously**.
- Is the analysis **still valid** then? Most changes do not impact the analysis.
- But **some do**, and we may **not know which ones**!

# Managing Change
## *Example:* Google Flu Trends





# Managing Change: Campbell's Law

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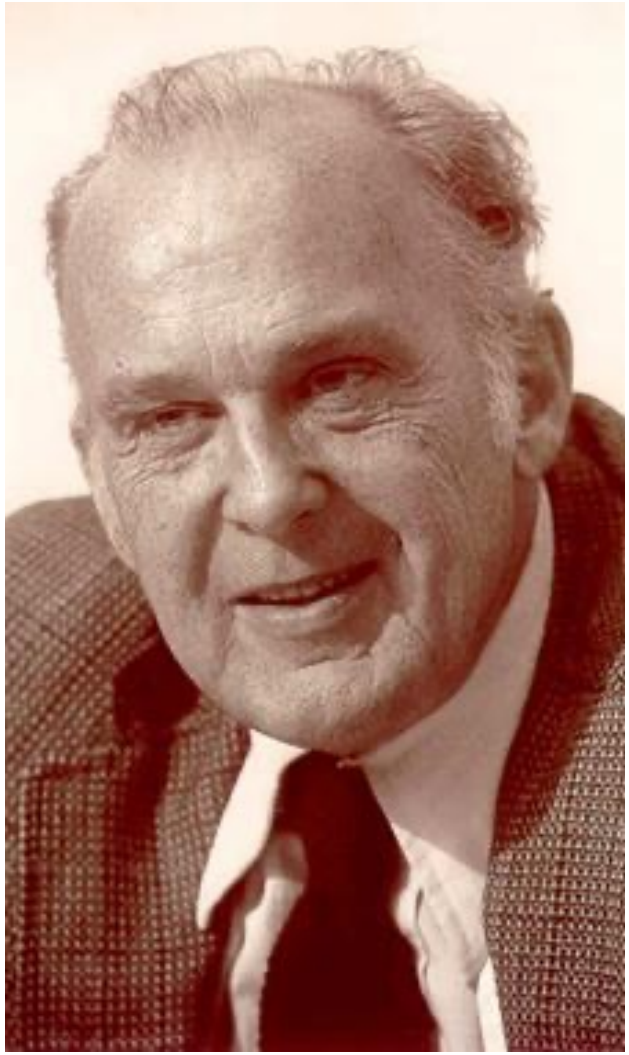
> The more any quantitative social indicator (or even some qualitative indicator) is used for social decision making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor.

Donald Campbell, 1979



# Managing Change: Campbell's Law
## *Example:* Crime Rate

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Assume there is a **decrease in a city's crime rate** (= social quant. indicator).

People likely attribute this to a **reduction in the actual number of crimes**.

However, it may reflect a **change in how the crime rate is recorded** or which police encounters are **classified as crimes**




https://searchbusinessanalytics.techtarget.com/definition/Campbells-Law

Picture: https://3er1viui9wo30pkxh1v2nh4w-wpengine.netdna-ssl.com/wp-content/uploads/sites/68/2017/09/GettyImages-93192527-1600x1067.jpg

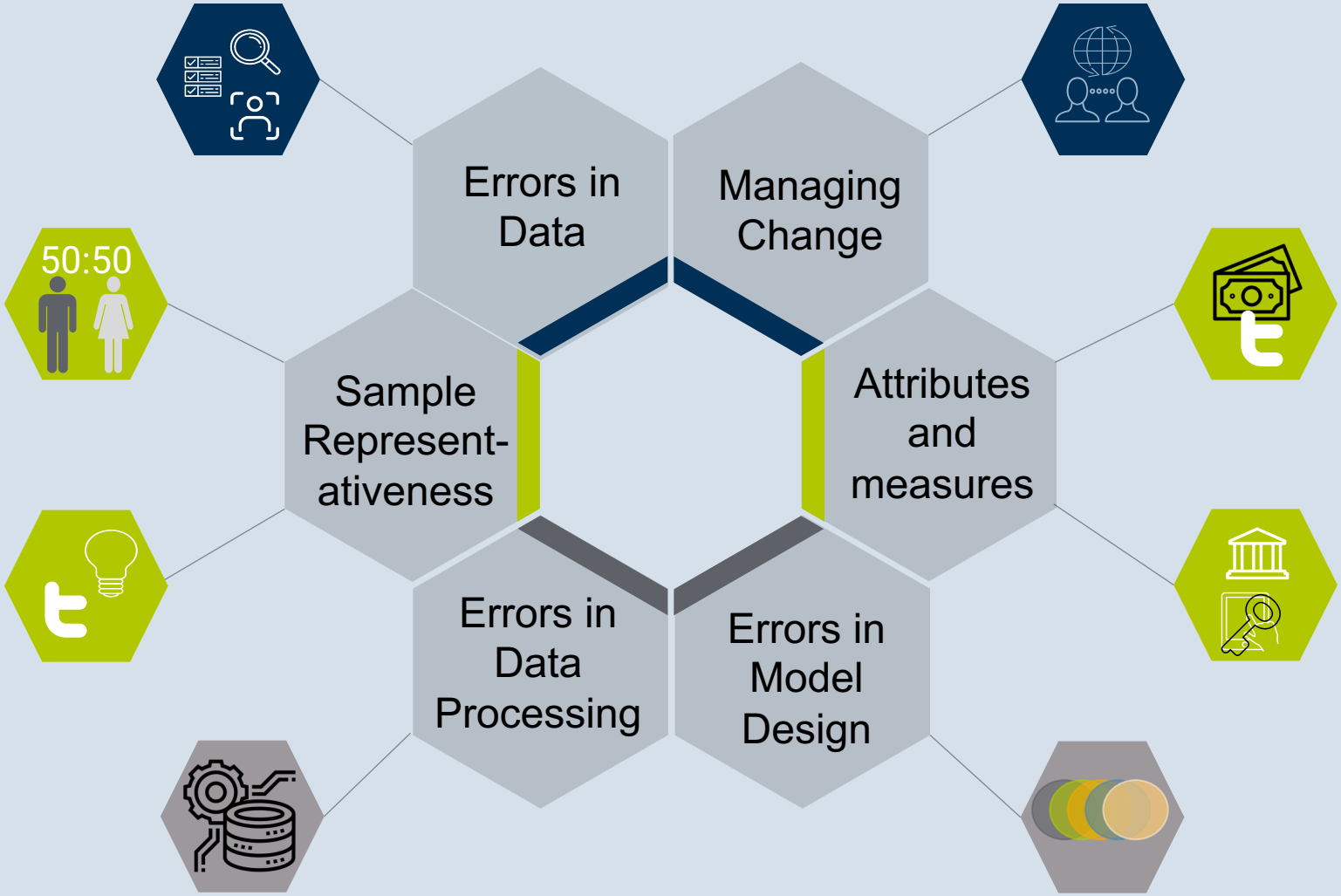
# Managing Change: Campbell's Law
## *Example:* The Facebook Case



### Metric Obsession Weakens UX: The Facebook Case

# Sources of Error





# Conclusion



It is crucial that we pay careful attention to the validity of our data, and of the model.

Otherwise, we will get bad results.


Which can cause real harm.

# Overview – Data Ethics

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# Algorithmic Fairness



- Do data “**speak for themselves**”?
- Can **algorithms** be **biased**?
- Can we **make algorithms unbiased**?

# What is “Discrimination”?

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How we view discrimination: **a single target group versus everyone else**. Individuals from that target group are **treated differently** from otherwise identical individuals outside the group.

Aggregate **outcome** (percent success) **of target group differs** from that of others, measured regarding:

Candidate population

Full universe population

# Algorithmic Fairness
## *Example:* Apple's Credit Limits



- Apple's credit card algorithm used to offer **different credit limits** for **men and women.**

- This occurred even when
  - men and women were **sharing a bank account** and
  - **women had a higher credit score.**


https://ichef.bbci.co.uk/news/976/cpsprodpb/3D53/production/_109599651_aaple.png

# Algorithmic Fairness
## *Example*: Amazon's Biased Recruiting Tool



- Review and rating of job applicants' resumes using AI-powered algorithms
- The AI model was trained with (biased) historical data from the past 10 years
- AI recruiting system was not rating candidates fairly and it showed biases against women, so that Amazon stopped using it

https://static.amazon.jobs/business_categories/8/thumbnails/Fulfillment_Ops_Hero_543.jpg?1557737773

# Bad Analysis from Good Data



# Correlated Attributes: Racial Discrimination



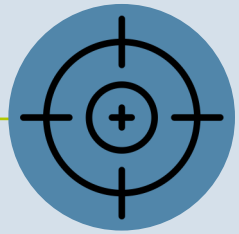
Universities are **prohibited** by law to **consider race** in admissions.

To **foster diversity**, they can **find surrogate features** that get them close, without violating the letter of the law.

# Correlated Attributes: Discriminatory Intent



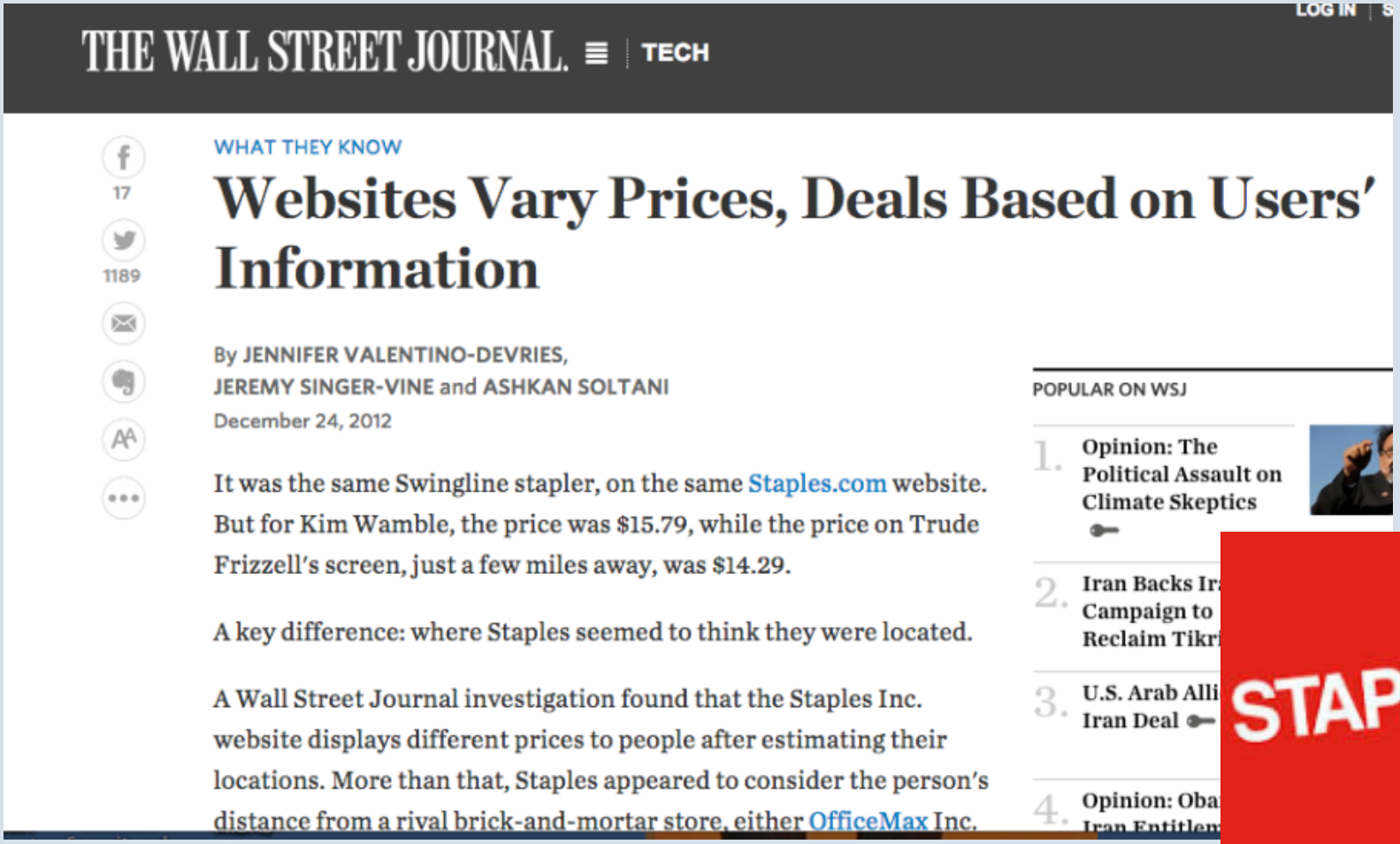
Big data provides technology to **facilitate proxy discrimination**, but….



… also provides technology to **detect and address discrimination**.

**How** this **technology is used** becomes a **matter of intent**!

# Correlated Attributes: Unintentional Discrimination



THE WALL STREET JOURNAL. | TECH

LOG IN

17
1189

WHAT THEY KNOW

## Websites Vary Prices, Deals Based on Users' Information

By JENNIFER VALENTINO-DEVRIES, JEREMY SINGER-VINE and ASHKAN SOLTANI
December 24, 2012

It was the same Swingline stapler, on the same Staples.com website. But for Kim Wamble, the price was $15.79, while the price on Trude Frizzell's screen, just a few miles away, was $14.29.

A key difference: where Staples seemed to think they were located.

A Wall Street Journal investigation found that the Staples Inc. website displays different prices to people after estimating their locations. More than that, Staples appeared to consider the person's distance from a rival brick-and-mortar store, either OfficeMax Inc.

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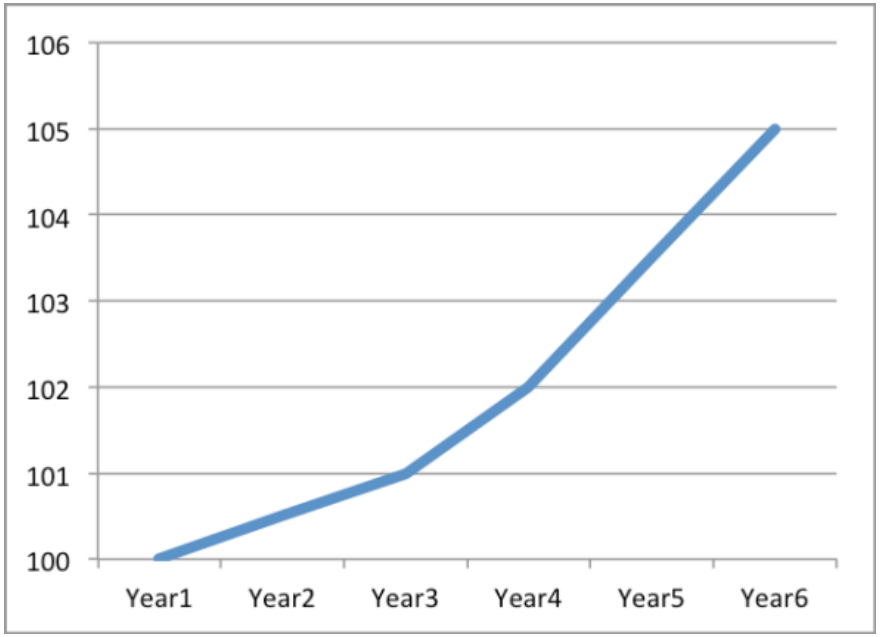
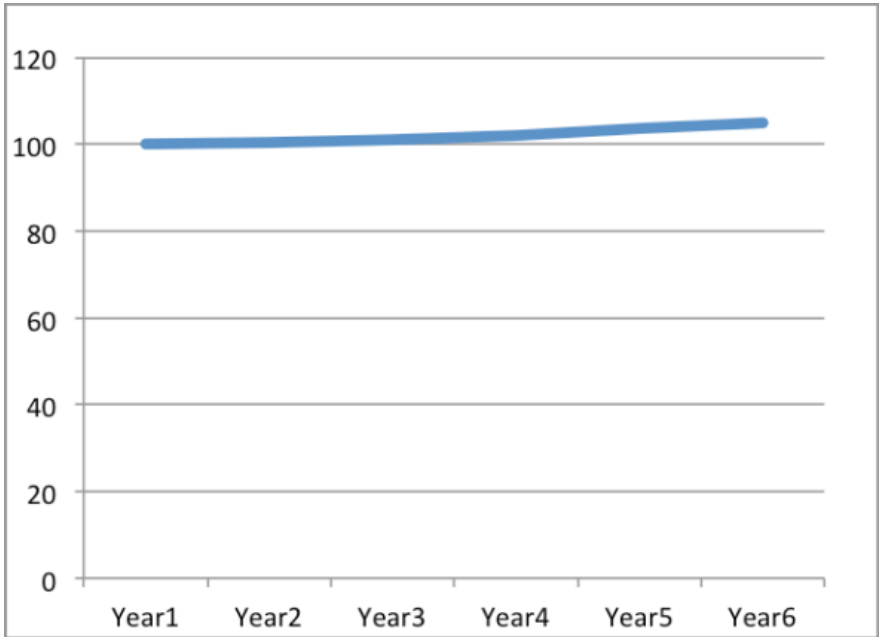
STAPLES

# Correct but Misleading Results: Unfair Visualization





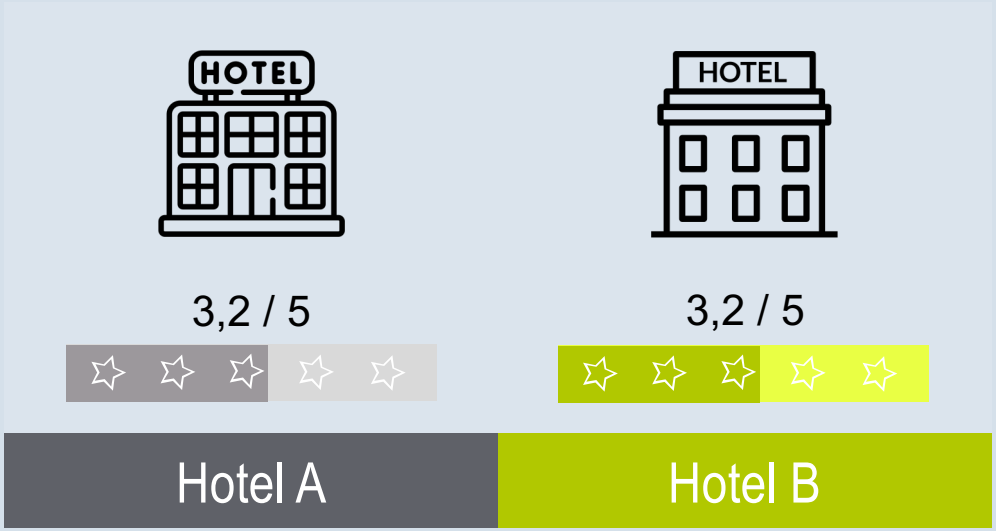

Sometimes, a company presents itself on an **atypical scale** just to appear in a better light.

# Correct but Misleading Results: Variance





mix of mostly 3 and 4 stars



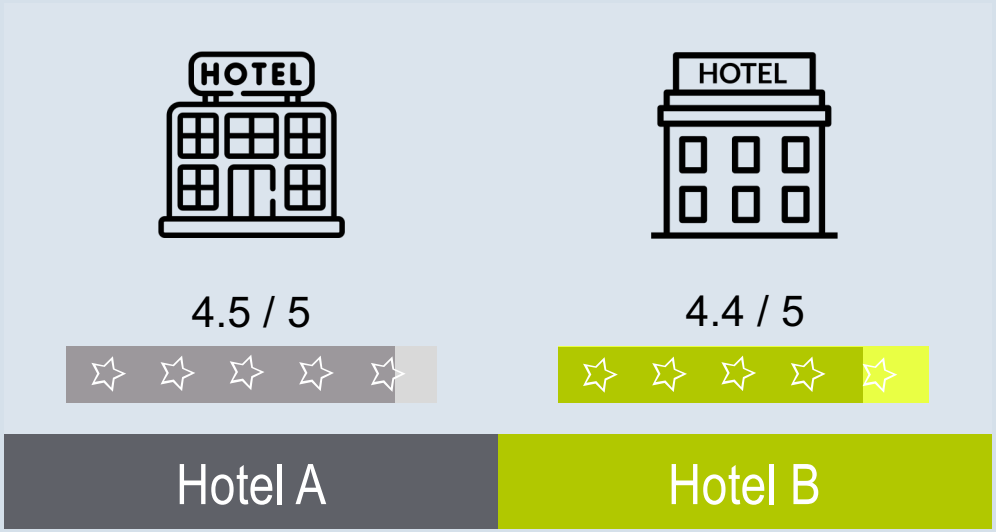

mix of mostly 1 and 5 stars

**Prefer Hotel B**, by a lot.

# Correct but Misleading Results: Support





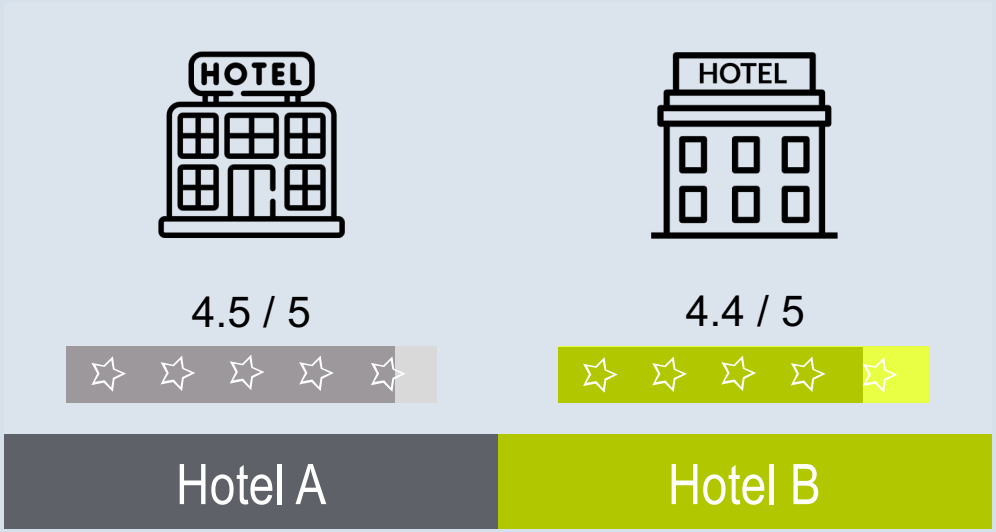



2 reviews

200 reviews

**Prefer Hotel B**, by a lot. It is too **easy** on most sites to **place** a few **false positive reviews**.

# Correct but Misleading Results: Scaling Support

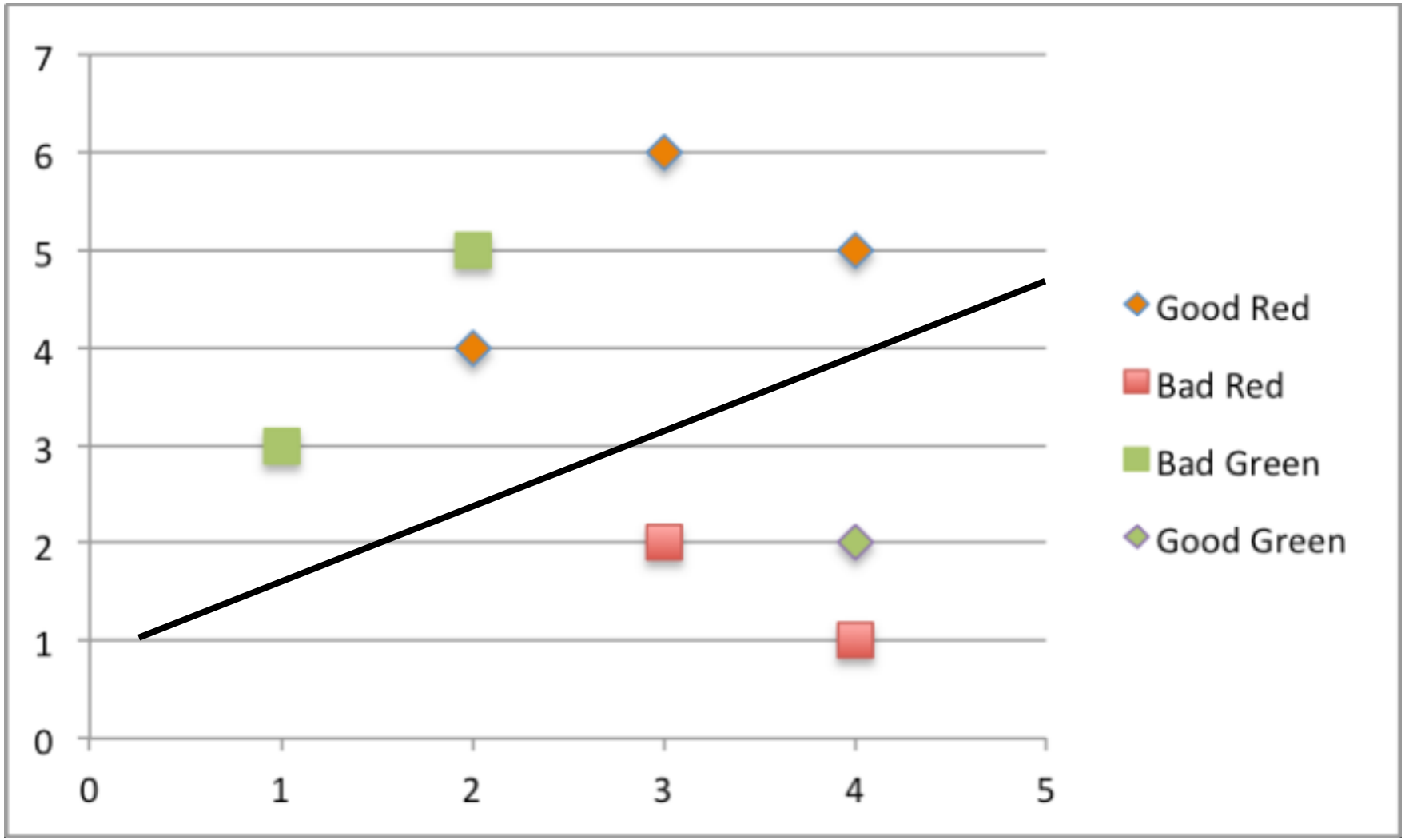



10 reviews
5 rooms

200 reviews
500 rooms

Quite possibly prefer **Hotel A**. It has far **fewer customers**, so you should expect it to have **fewer reviews**.

# Correct but Misleading Results: Minority Loses



# Correct but Misleading Results: Diversity Suppression





Use Data Science to find **promising prospects**.

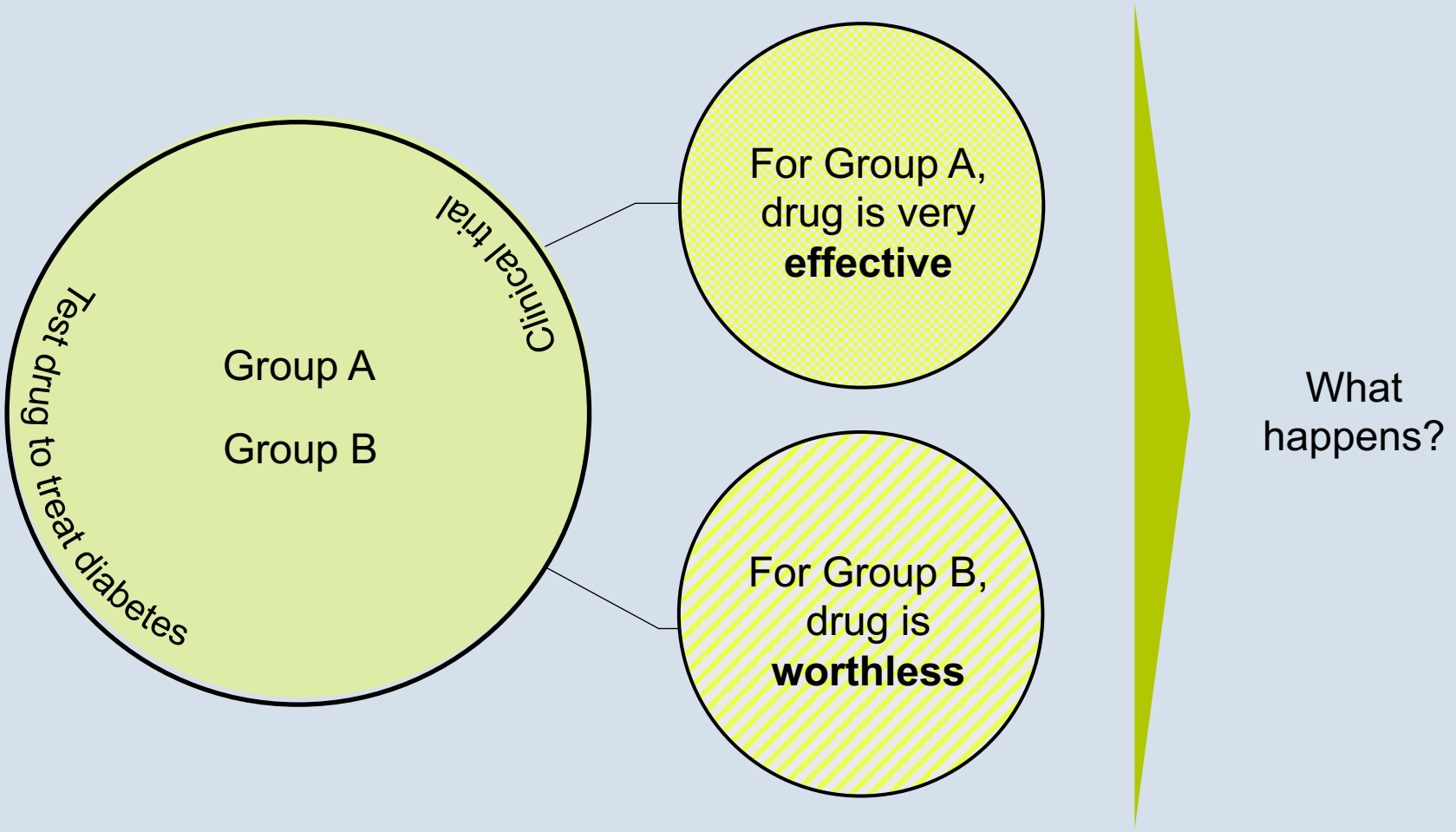
Criteria are tuned to **fit** the **majority**.

**Algorithm** performs **poorly** on (some) **minorities**.

**Best minority** applicants are **not hired** → unfair to them.

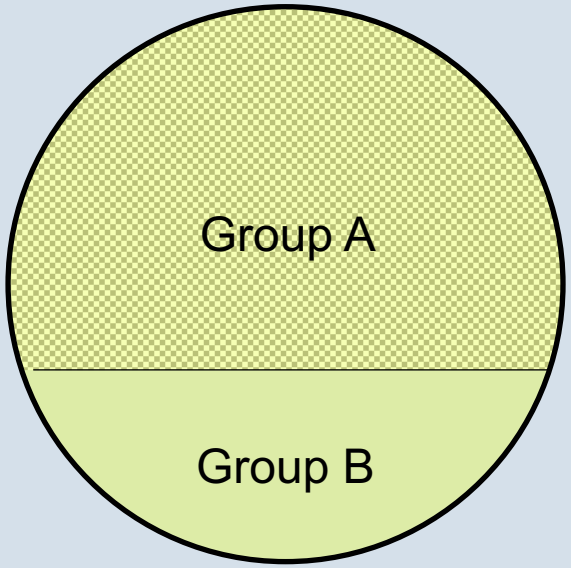
**Hired minority** employees are **not the best** and perform not well → unfairly besmirch others in minority.

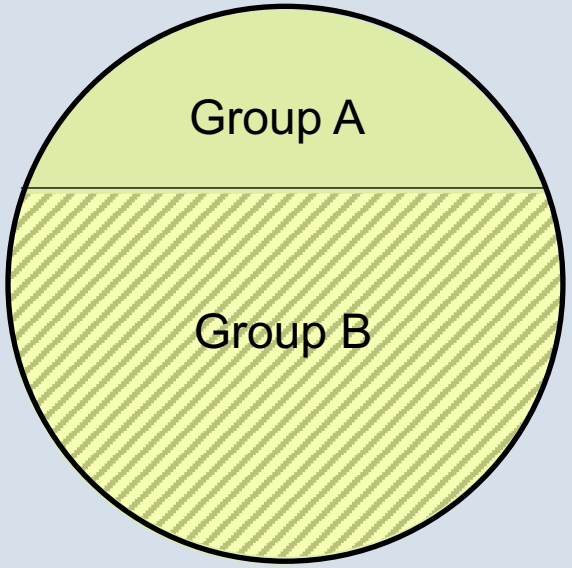
# Correct but Misleading Results: Diversity Suppression



# Correct but Misleading Results: Diversity Suppression






**Group A majority**: Drug is **found effective** with suitable significance level. Patients in group B are also given this drug.

**Group B majority**: Drug is **not approved**, even though minority (group A) patients could have benefitted from it.

# P-Hacking



To create “added value” without significance

Manipulation of research results

# P-Hacking
## *Slim by Chocolate*

Diese Studie schmeckt uns!

**Wer Schokolade isst, nimmt schneller ab**

**Mainz – Schokolade wirkt als Diät-Turbo! So lautet das überraschende Ergebnis einer Studie des „Institute of Diet and Health" in Mainz.**

Die Studienteilnehmer wurden in Diät-Gruppen aufgeteilt und aßen kohlehydratarm (Low Carb). Bei einer Gruppe standen zusätzlich 40 Gramm Bitterschokolade am Tag auf dem Speiseplan.

Das Ergebnis: Die Teilnehmer der Schoko-Gruppe nahmen deutlich schneller ab und konnten ihre Blutwerte wie z. B. Cholesterin verbessern. Die Mainzer Wissenschaftler vermuten, dass Schokolade mit hohem Kakaoanteil bei beliebigen Diäten als Beschleuniger dienen kann. Die Gründe dafür müssen jetzt genauer untersucht werden.

This is an excerpt of Europe's largest daily newspaper, Bild.
(from March 28, 2015)

The headline roughly states **"Those who eat chocolate lose weight faster"**.

Researchers wanted to **prove how easy** it is to **turn "bad science" into big headlines** in the dietary sphere.

**Study** on the **effects of chocolate consumption** during a low-carb diet.

**Intentionally "bad" study design** with 15 participants and 18 measurement items.

**Significant** but **meaningless** and **unfounded results**.

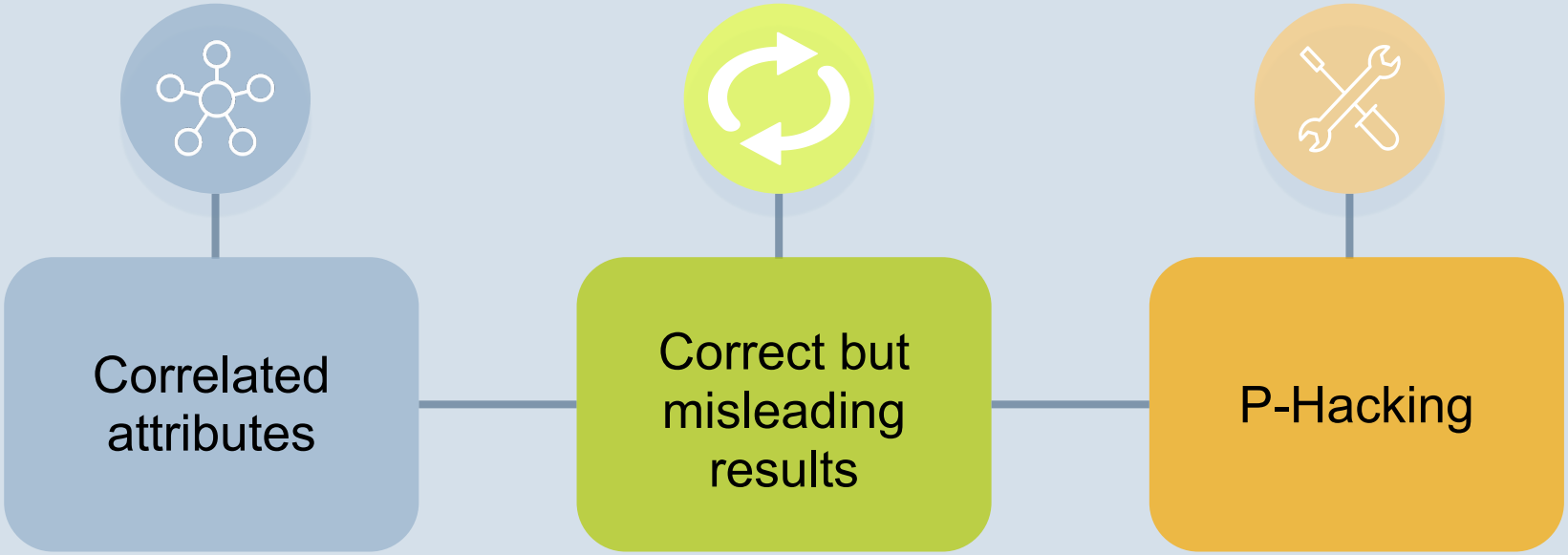


https://gizmodo.com/i-fooled-millions-into-thinking-chocolate-helps-weight-1707251800

Picture:
https://pbs.twimg.com/media/CGCFSFyWIAAKPXa.png

# Bad Analysis from Good Data






**Fair evaluation** of data and **correct handling** of algorithms is crucial in order to be able to work at **high quality** and also to be able to offer **added value** for oneself, one's environment, and society