Demographic Bias versus Fairness in Biometric Systems

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copy of slides available at:
https://christoph-busch.de/about-talks-slides.html

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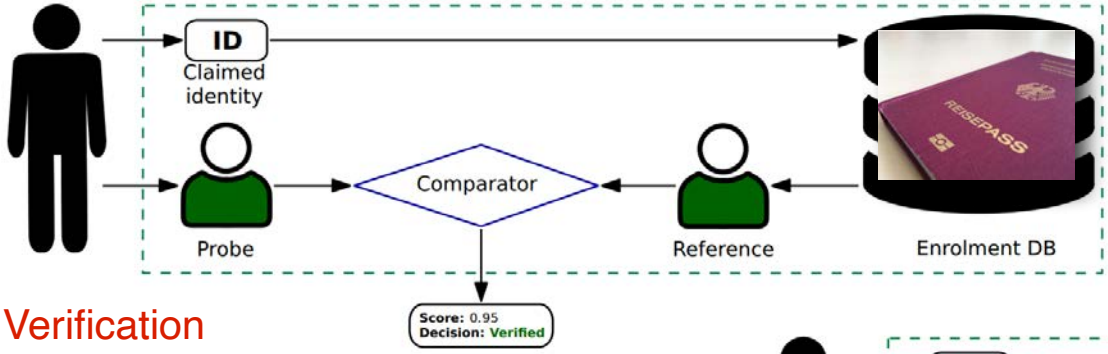
European Association for Biometrics
eab
Human Identity in Europe

NTNU

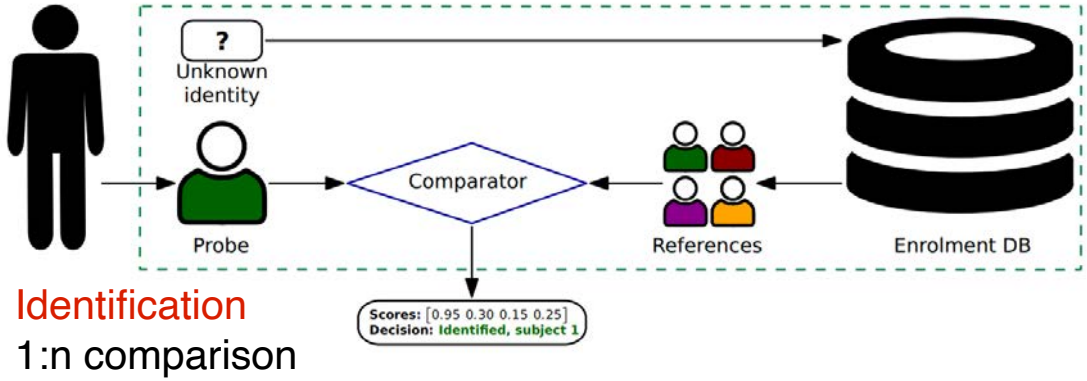
Relevant Operational Biometric Systems

Biometric recognition

- „*the automated recognition of individuals based on their behavioural and biological characteristics*“
- assisted border gates with biometric verification
- biometric reference data must be accessible in personal ID document or a central database



Verification
1:1 comparison



Identification
1:n comparison

Benefits and Disadvantages of Biometrics

Forensic applications

- re-active measure after terror attacks

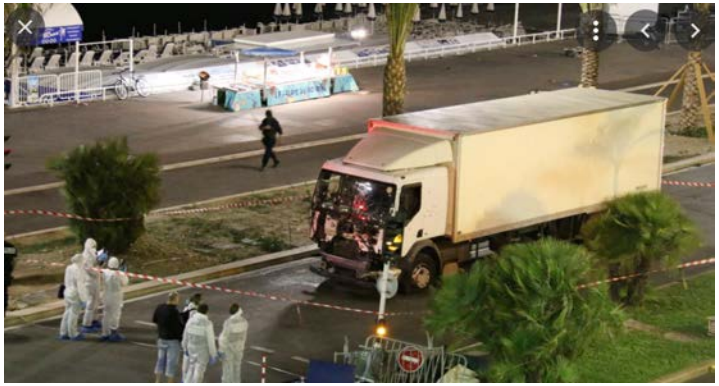


Image source: www.nytimes.com

Image source: www.rnd.de

- undisturbing and invisible control technology
  - continuous but with a very limited retention period

Risks and Disadvantages

What happens

- if a biometric recognition system is wrong?

Different consequences

- in different scenarios

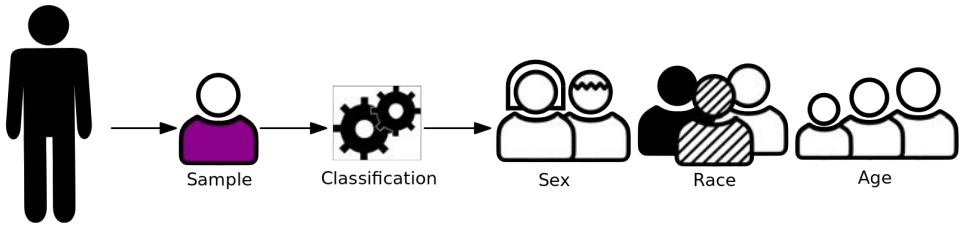
Table: Consequences of biometric errors

Error	Algorithm	
	Verification (1:1)	Identification (1:N)
False negative	Inconvenience	Missed lead
False positive	Security risk	False lead

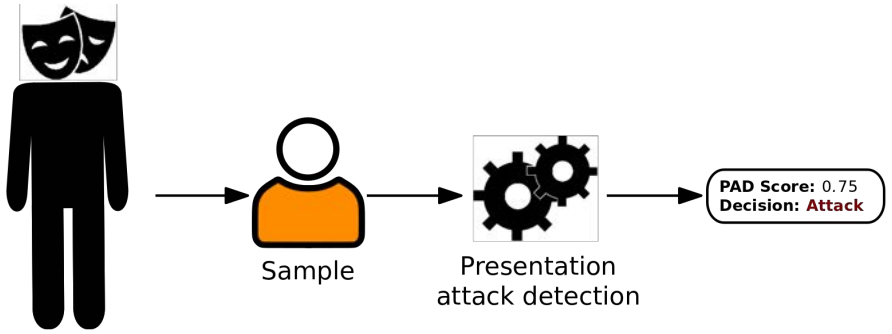
Other Biometric Systems and Scenarios

Which functionality beyond biometric recognition?

- classification



- presentation attack detection
- morphing attack detection



- image quality assessment

Bias in Biometric Artificial Intelligence

Reports that we find in the net

International Women's Day: how can algorithms be sexist?
Euronews - 8 Mar 2020
Even though the first person to write an **algorithm** was a woman in the 19th century artificial intelligence may now be **discriminating** against women. ... based on the use of AI was Amazon's ...

Study finds racial bias in Optum **algorithm**
Healthcare Finance News - 25 Oct 2019
The **algorithm** predicts healthcare costs, rather than illness, the study said. ... channels such as direct **discrimination** and changes to the doctor–patient relationship. ... Large health **systems** and payers rely on this **algorithm** to target patients for ... UPDATED: List of 2020 Medicare Advantage star **ratings**.

When Your Boss Is an **Algorithm**
New York Times (blog) - 12 Oct 2018
The **algorithmic** manager seems to watch everything you do. ... economists may call it price **discrimination**, but Uber explains it as an innovation ... Other tools, like the **rating system**, serve as automatic enforcers of the nudges ...

Who's to Blame When **Algorithms Discriminate**?
The New York Times - 20 Aug 2019
A proposed rule from HUD would make it harder to hold people accountable for subtler forms of **discrimination**.

AI **Bias** Could Put Women's Lives At Risk - A Challenge For ...
Forbes - 2 Mar 2020
Consider the example of face recognition **algorithms** which were studied by **Algorithmic** Justice League founder Joy Buolamwini. She found that ...

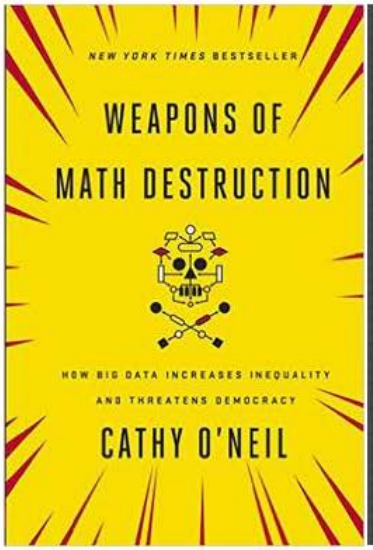
AI expert calls for end to UK use of 'racially **biased**' **algorithms**
The Guardian - 12 Dec 2019
Prof Noel Sharkey, who is also a leading figure in a global campaign against "killer robots", said **algorithms** were so "infected with **biases**" that ...

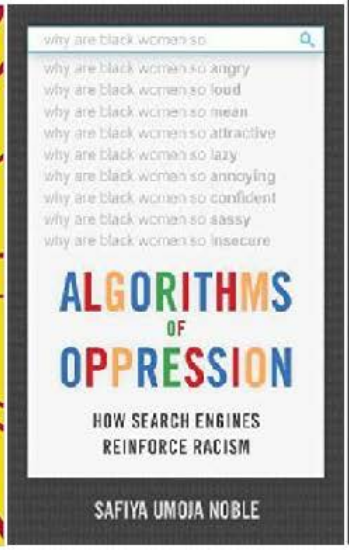
Machine Bias

There's software used across the country to predict future criminals. And it's biased against blacks.

Julia Angwin, Jeff Larson, Lauren Kirchner and Surya Mattu, May 23, 2016, 8 a.m. EDT

UN News
Urgent action needed over artificial intelligence risks to human ...





Demographic Factors

In the context of biometrics

- diversity
- balanced datasets

Challenges and limitations

- “demographic fairness”

Demographic Factors

What is fairness?

- dictionary:
  "*the quality of treating people equally or in a way that is right or reasonable*"

Image Source: https://www.flaticon.com (2020)

An inherently ethical and social concept

- influenced by cultural, historical, legal, religious, personal, and other factors
- challenging to develop mathematical definitions,
- no single, universal notion or definition of fairness in practice
- however, everyone wants to be treated "fairly"

Reaching out towards group fairness

Demographic Factors

Biased machines – fair human experts?

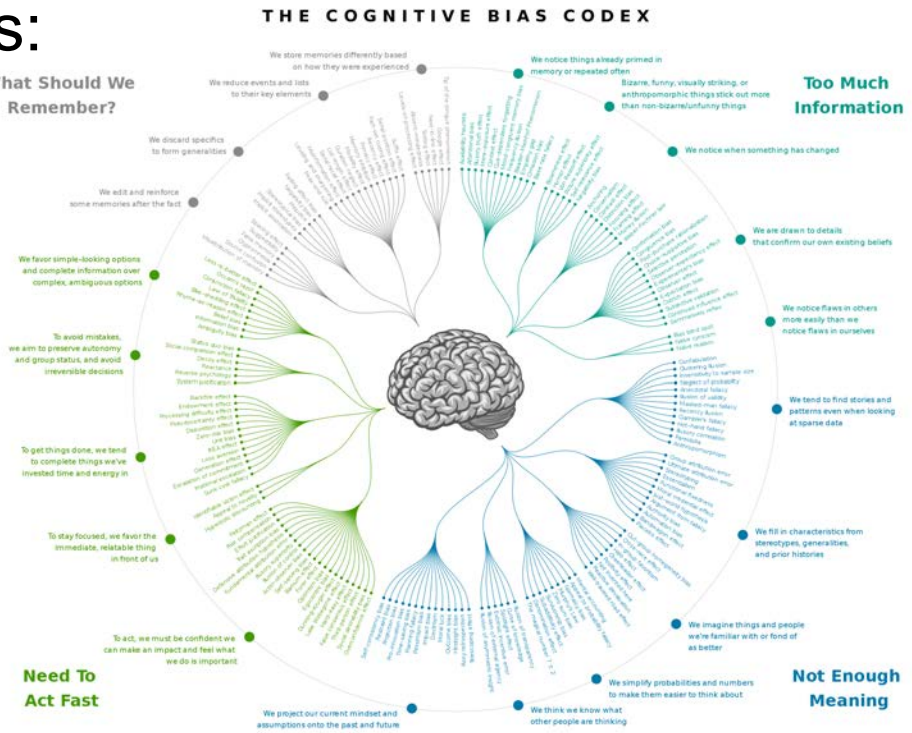
- cognitive biases
- examples in the field of biometrics: The other race effect

Advantages and disadvantages

- consistency over time (end-of-the-workday-effect)
- experience: Pass applications with morphed images

Hybrid systems

- not fully automated decision systems but assisting algorithms
- influence on expert opinions



Possible Consequences

of unfair algorithmic (and human) decision systems

- different accuracies/outcomes
  for different demographic groups
  and/or types of individuals
- unintentional discrimination
- individual and collective social harms
  - loss of opportunity
  - economic loss
  - social stigmatisation (e.g. Uigur people in China)

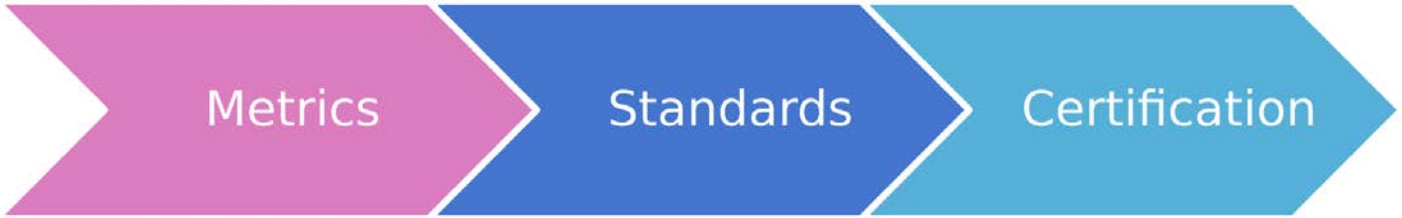
The Way out - Standardisation

The role of standards in biometrics

- common understanding, vocabulary, evaluation protocols and metrics
- benchmarks
- importance for tenders and deployments

New work-in-progress standards

- ISO/IEC 19795-10 – how to quantify demographic differentials? https://www.iso.org/standard/81223.html
- ISO/IEC 9868 – Remote biometric identification systems



Quality Metrics for Facial Images

Standard ISO/IEC 29794-5 to be aligned with both

- ISO/IEC 19794-5:2011
- ISO/IEC 39794-5:2019

Definitions

- 6.2 Unified quality score
  FaceQnet (JRC)
- 6.3 Capture-related
  quality elements
- 6.4. Subject-related
  quality elements

a) Compliant image **b) Low contrast**

source: ISO/IEC 39794-5:2019, Annex D
https://www.iso.org/standard/72156.html

images with +8 degrees (left) and -8 degrees (right) rotation in roll

Image Source: ISO/IEC 19794-5:2011

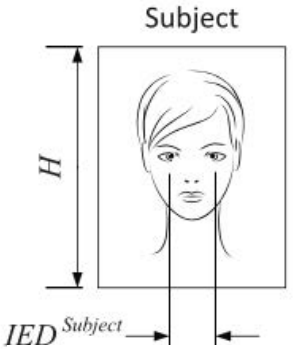


Image Source: ISO/IEC 39794-5

Quality Metrics for Facial Images

ISO/IEC 3rd WD 29794-5

#	Image quality aspect
1	Unified quality score
2	Background uniformity
3	Illumination uniformity
4	Illumination mean
5	Illumination variance
6	Illumination skewness
7	Illumination kurtsosis
8	Illumination under-exposure
9	Illumination over-exposure
10	Dynamic Range
11	De-focus
12	Image sharpness
13	Motion blur
14	Edge Density
15	Compression
16	Unnatural colour and colour balance
17	Camera lens focal length
18	Camera subject distance
19	Eyes visible
20	Inter-eye distance
21	Horizontal position of the face
22	Vertical position of the face
23	Pose
24	Expression neutrality
25	Mouth closed
26	Eyes open

Capture device related

Subject related

source: ISO/IEC 3rdWD 29794-5, Table 2
https://www.iso.org/standard/81005.html

a) Compliant image **b) Low contrast**

source: ISO/IEC 39794-5:2019, Annex D
https://www.iso.org/standard/72156.html

Image Source:
ISO/IEC 19794-5:2011

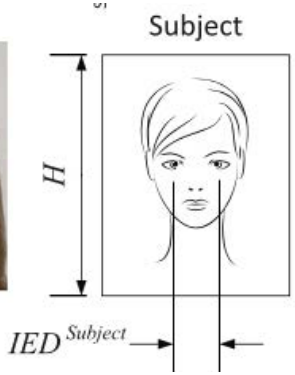
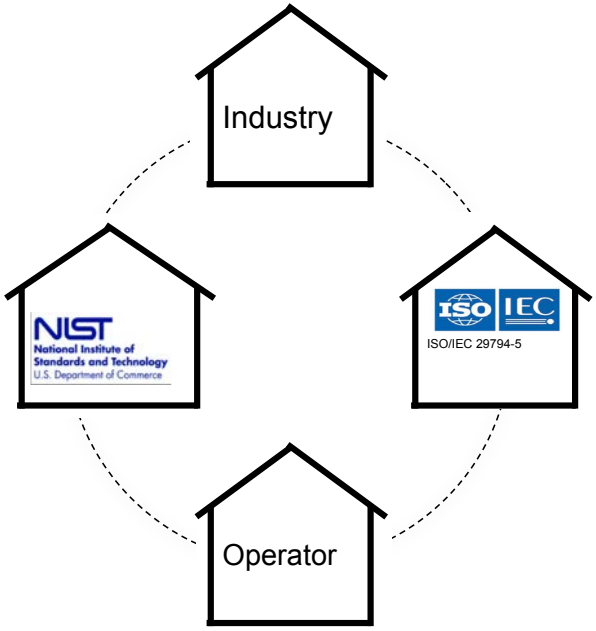


Image Source:
ISO/IEC 39794-5

Quality Metrics for Facial Images

How to develop face quality metrics? - Standardisation process

- for ISO/IEC 29794-5
- 2021 - 2024
  https://www.iso.org/standard/81005.html
- NIST FRVT Quality Assessment
  https://pages.nist.gov/frvt/html/frvt_quality.html
- workshop on face quality assessment
  https://eab.org/events/program/261



- Join the SC37 WG3 work!
  https://www.iso.org/members.html

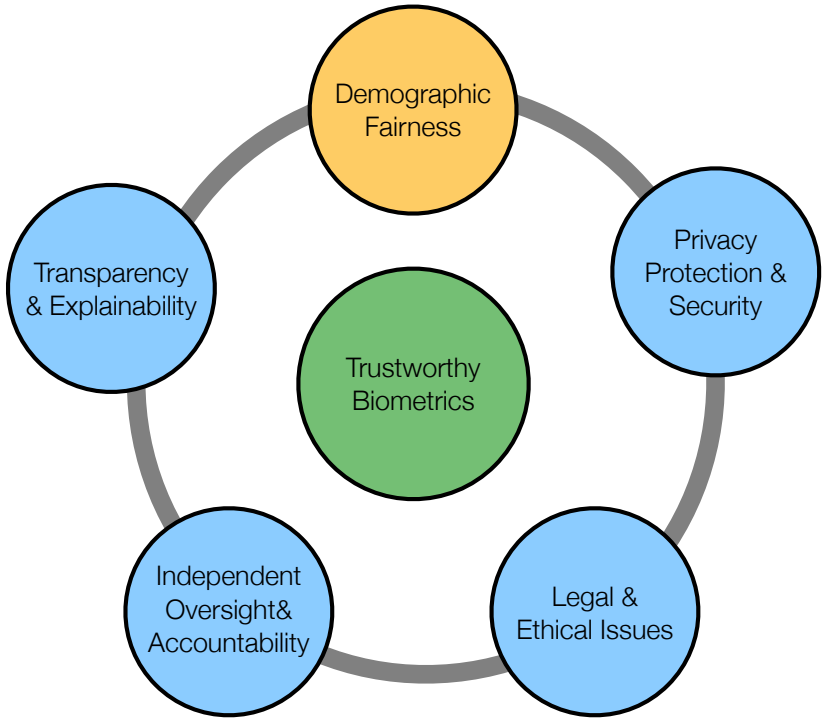
Trustworthy Biometrics

Acceptance of technology

- technology itself often considered as threat

Increase trust in technology can be achieved by

- security and privacy by design
- public consultations and information campaigns
- link to the broader debate on ethical AI
- need to examine implications for all stakeholders



European Association for Biometrics (EAB)

Objectives of the EAB

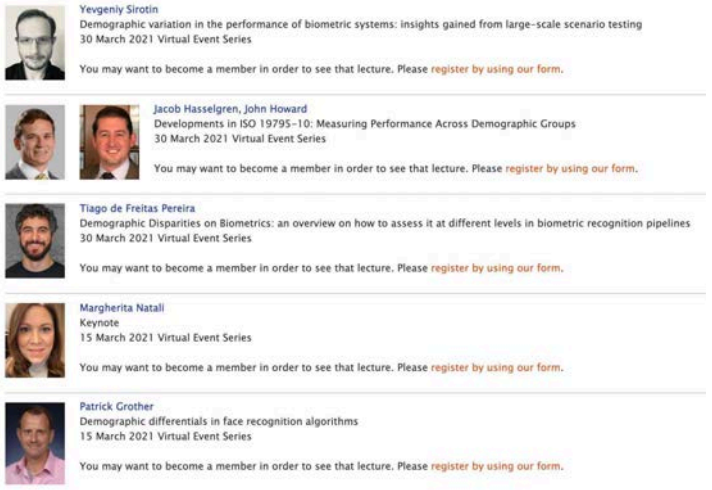
- the EAB is a non-profit, nonpartisan association https://eab.org/
- EAB supports all sections of the ID community across Europe, including governments, NGO's, industry, associations and special interest groups and academia.

- our role is to promote the responsible use and adoption of modern digital identity systems that enhance people's lives and drive economic growth.
- structure of membership fees is inclusive
  - Free membership for Bachelor, Master and PhD students! https://eab.org/membership/types_of_membership.html

European Association for Biometrics (EAB)

More Information

- Our initiatives are designed to foster networking
  - annual conference: EAB-RPC
    https://eab.org/events/program/219
  - biometric training event
    https://eab.org/events/program/224
  - workshops on relevant topics (e.g. Presentation Attack Detection, Morphing Attack Detection, Sample Quality, Bias in Biometric Systems)
    https://eab.org/events/
  - online Seminar every second week
    https://eab.org/events/program/268
  - recorded keynote talks
    https://eab.org/events/lectures.html
  - monthly newsletter
    https://eab.org/news/newsletter.html
  - annual academic graduation report
    https://eab.org/files/documents/2021-10-29_EAB-academic_graduation_monitoring_report-2020.pdf
  - open source repository
    https://eab.org/information/software.html



European Association for Biometrics (EAB)

The Artificial Intelligence Act workshop

- scope of the AI act and of the starting standardisation

Speakers


EUROPEAN COMMISSION

Brussels, 21.4.2021
COM(2021) 206 final

2021/0106 (COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

LAYING DOWN HARMONISED RULES ON ARTIFICIAL INTELLIGENCE (ARTIFICIAL INTELLIGENCE ACT) AND AMENDING CERTAIN UNION LEGISLATIVE ACTS

{SEC(2021) 167 final} - {SWD(2021) 84 final} - {SWD(2021) 85 final}

- Introduction to the AIA
  (Irina Orssich, DG Connect EC)
- Progress in International Standardization of AI
  (Thomas Zielke, DIN)
- The Interplay of AI and Biometrics and its Impact on IT-Security
  (Arndt von Twickel, BSI)
- Biometrics, data protection, and the new concepts introduced in the AIA
  (Catherine Jasserand, KUL)
- AI Aspects of Biometrics from the Consumer Point of View
  (Chiara Giovannini, ANEC)
- EDPS Stance on Remote Biometric Identification
  (Xabier Lareo, EDPS)

More information, slides and recordings at:

- https://eab.org/events/program/277
- https://eab.org/events/lectures.html

Further information

Harmonized Biometric Vocabulary

- https://www.iso.org/obp/ui/#iso:std:iso-iec:2382:-37:ed-2:v1:en

Recommended material

- P. Drozdowski, C. Rathgeb, A. Dantcheva, N. Damer, C. Busch, "Demographic Bias in Biometrics: A Survey on an Emerging Challenge", Transactions on Technology and Society (IEEE-TTS), vol. 1, no. 2, pp. 89-103, June 2020. https://doi.org/10.1109/TTS.2020.2992344
- P. Grother, M. Ngan, K. Hanaoka, "Ongoing Face Recognition Vendor Test (FRVT) Part 3: Demographic Effects", National Institute of Standards and Technology, NISTIR 8280, pp. 1-82, December 2019. https://nvlpubs.nist.gov/nistpubs/ir/2019/nist.ir.8280.pdf
- C. Garvie, "The perpetual line-up: Unregulated police face recognition in America", Georgetown Law, Center on Privacy & Technology, pp. 1–150, October 2016. https://www.perpetuallineup.org
- ISO/IEC TR 22116:2021 Information technology – A study of the differential impact of demographic factors in biometric recognition system performance, June 2021. https://www.iso.org/standard/72604.html
- “Coded Bias” Documentary, January 2020. https://www.codedbias.com/

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