Themis: Modeling, Measuring and Mitigating Bias in Online Information Platforms

Gender Bias in AI*

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Ελλάδα 2.0
ΕΘΝΙΚΟ ΣΧΕΔΙΟ ΑΝΑΚΑΜΨΗΣ ΚΑΙ ΑΝΘΕΚΤΙΚΟΤΗΤΑΣ

Με τη χρηματοδότηση της Ευρωπαϊκής Ένωσης
NextGenerationEU

FORTH
FOUNDATION FOR RESEARCH AND TECHNOLOGY - HELLAS

UNIVERSITY OF IOANNINA

Gender Issues in Computer Science Workshop

Heraklion 27 Feb 2025

The research project is implemented in the framework of H.F.R.I call “Basic research Financing (Horizontal support of all Sciences)” under the National Recovery and Resilience Plan “Greece 2.0” Funded by the European Union - NextGenerationEU (H.F.R.I. Project Number: 016636)

From *‘google it’* to ‘*GPT it’*

We live in an information age where Online Platforms (OPs) filter, rank and generate information & content

e.g., search engines, social media, news portals, recsys, … chatbots

AI* (ML/DL) has revolutionized the domain of OPs

2013 word2vec: ***contextual vector representations of words***

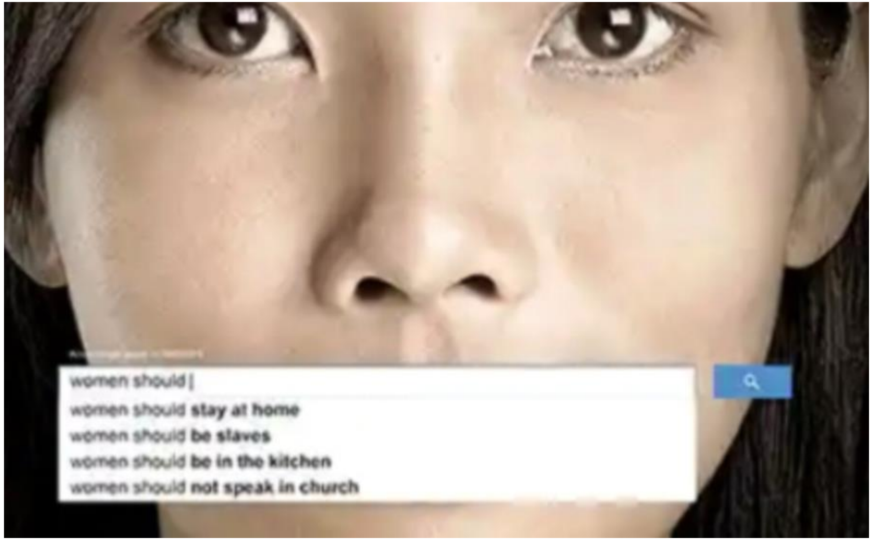
2018 BERT (bi-directional transformers): ***SOTA performance in NLP tasks***

2023 ChatGPT: ***LLMs at the hands of users***

Today users leverage LLMs/generative AI for diverse tasks enhancing productivity

e.g.,content generation, coding, research, customer support, brainstorming *however…*

Google autocomplete (2013)



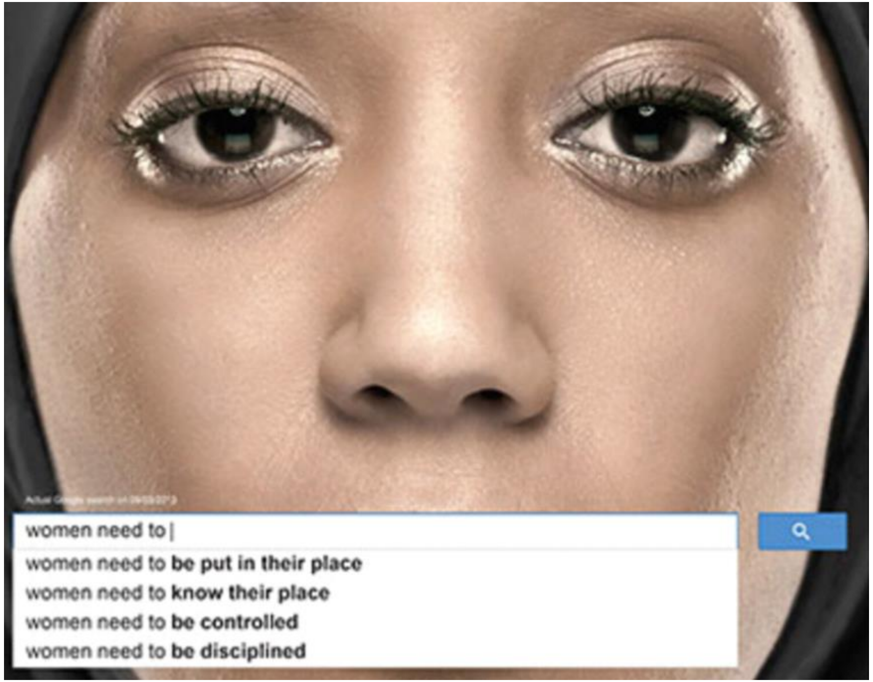
women should |

women should **stay at home**

women should **be slaves**

women should **be in the kitchen**

women should **not speak in church**



women need to |

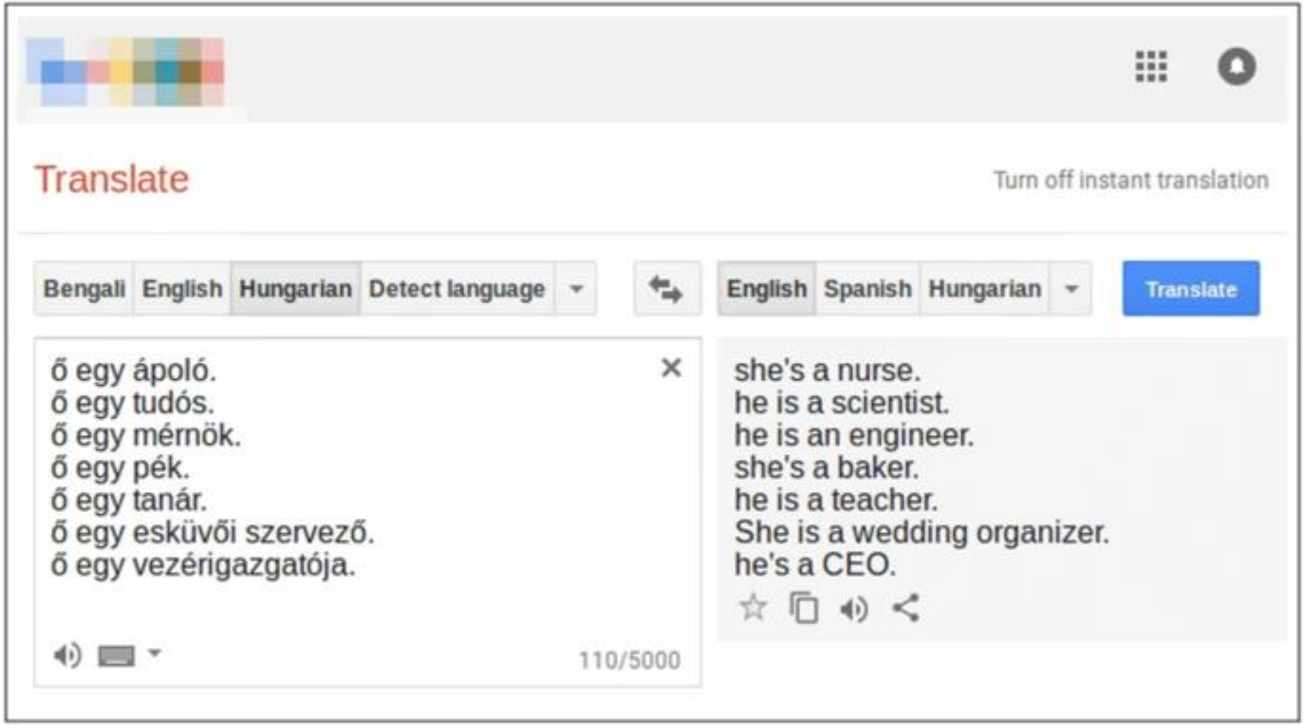
women need to **be put in their place**

women need to **know their place**

women need to **be controlled**

women need to **be disciplined**

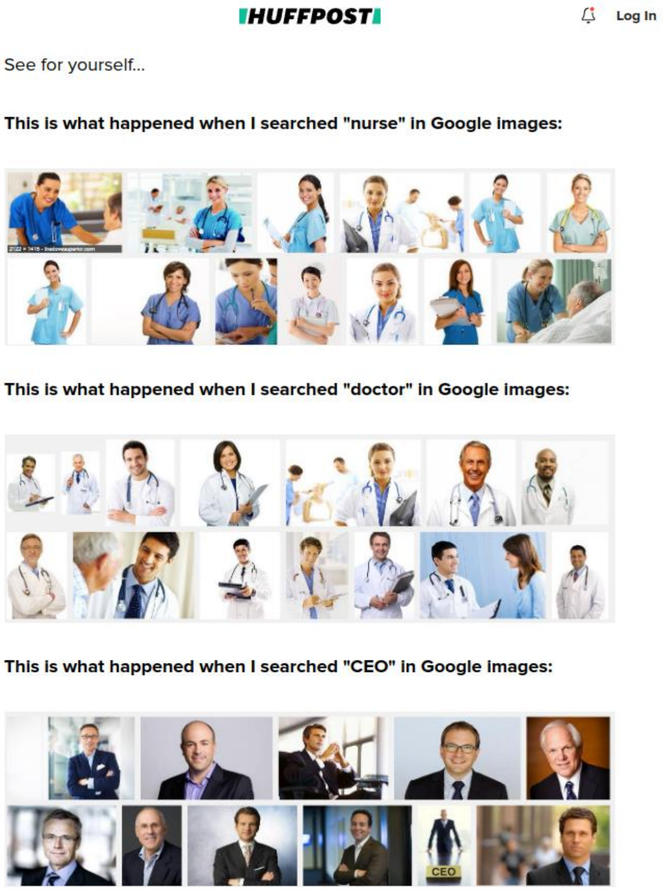
Automatic translation (2013)



ő egy ápoló.
ő egy tudós.
ő egy mérnök.
ő egy pék.
ő egy tanár.
ő egy esküvői szervező.
ő egy vezérigazgatója.

she's a nurse.
he is a scientist.
he is an engineer.
she's a baker.
he is a teacher.
She is a wedding organizer.
he's a CEO.

Google image search using keywords (2014)



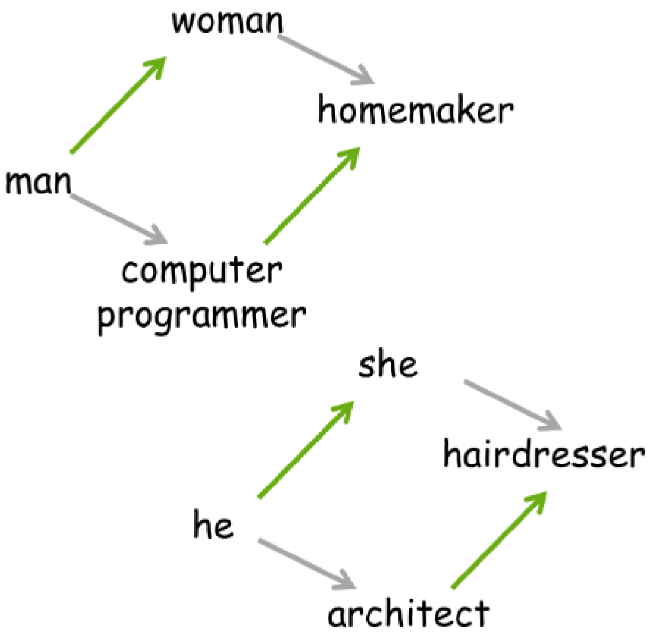
See for yourself...

This is what happened when I searched "nurse" in Google images:

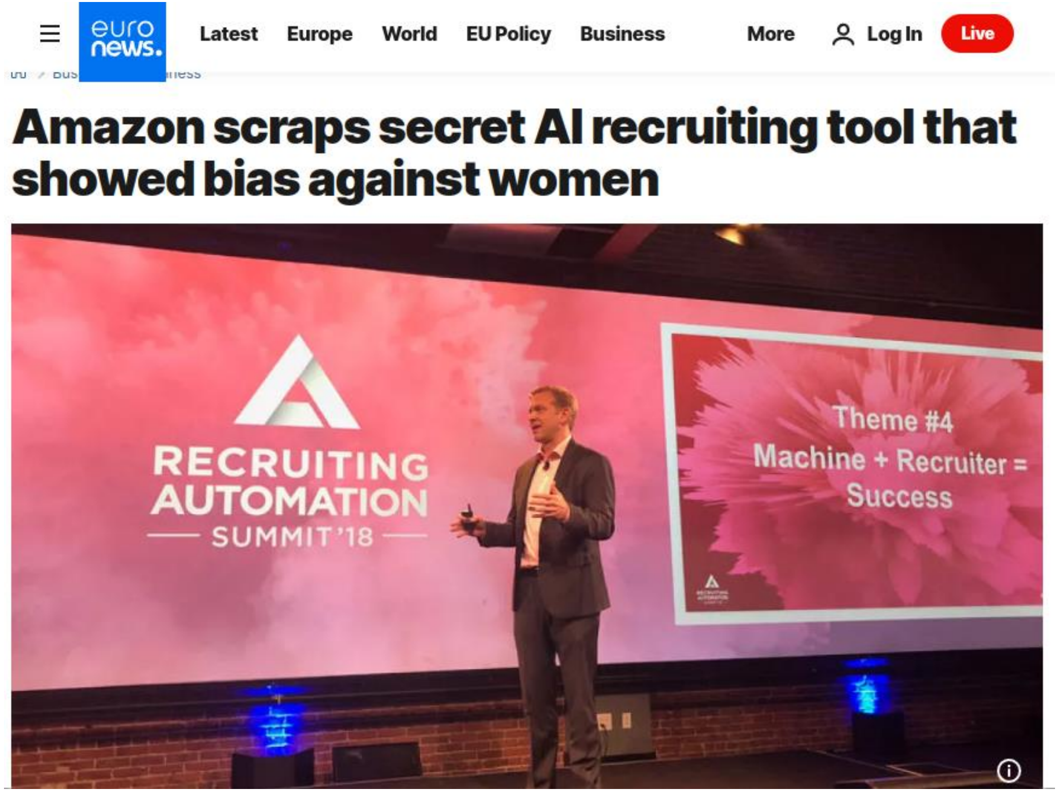
This is what happened when I searched "doctor" in Google images:

This is what happened when I searched "CEO" in Google images:

word2vec biased embedding (2016)



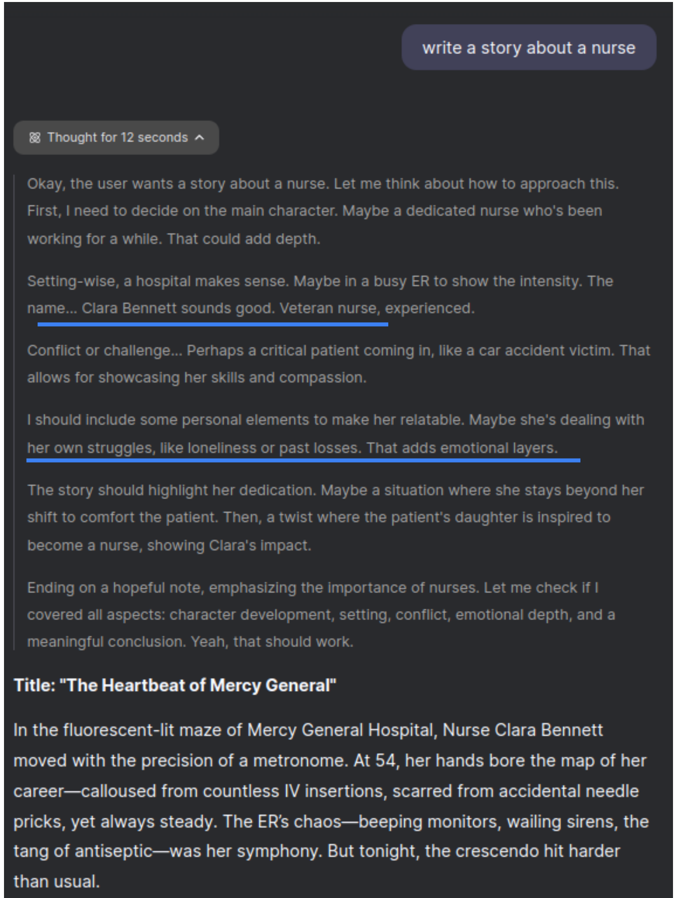
Amazon recruiting tool (2018)



Amazon scraps secret AI recruiting tool that showed bias against women

RECRUITING AUTOMATION SUMMIT '18
Theme #4
Machine + Recruiter = Success

Even today – stories from deepseek (2025)



write a story about a nurse

Thought for 12 seconds

Okay, the user wants a story about a nurse. Let me think about how to approach this. First, I need to decide on the main character. Maybe a dedicated nurse who's been working for a while. That could add depth.

Setting-wise, a hospital makes sense. Maybe in a busy ER to show the intensity. The name... Clara Bennett sounds good. Veteran nurse, experienced.

Conflict or challenge... Perhaps a critical patient coming in, like a car accident victim. That allows for showcasing her skills and compassion.

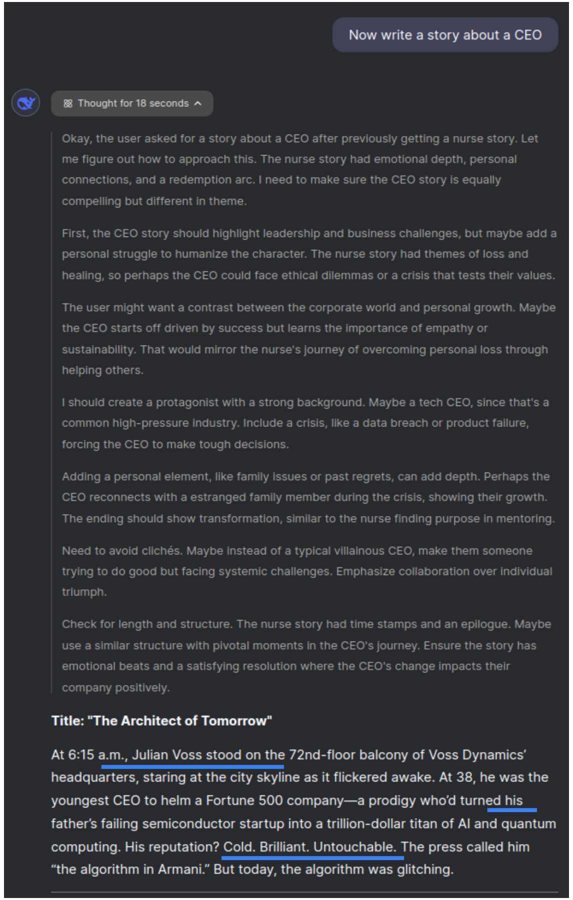
I should include some personal elements to make her relatable. Maybe she's dealing with her own struggles, like loneliness or past losses. That adds emotional layers.

The story should highlight her dedication. Maybe a situation where she stays beyond her shift to comfort the patient. Then, a twist where the patient's daughter is inspired to become a nurse, showing Clara's impact.

Ending on a hopeful note, emphasizing the importance of nurses. Let me check if I covered all aspects: character development, setting, conflict, emotional depth, and a meaningful conclusion. Yeah, that should work.

Title: "The Heartbeat of Mercy General"

In the fluorescent-lit maze of Mercy General Hospital, Nurse Clara Bennett moved with the precision of a metronome. At 54, her hands bore the map of her career—calloused from countless IV insertions, scarred from accidental needle pricks, yet always steady. The ER's chaos—beeping monitors, wailing sirens, the tang of antiseptic—was her symphony. But tonight, the crescendo hit harder than usual.



Now write a story about a CEO

Thought for 18 seconds

Okay, the user asked for a story about a CEO after previously getting a nurse story. Let me figure out how to approach this. The nurse story had emotional depth, personal connections, and a redemption arc. I need to make sure the CEO story is equally compelling but different in theme.

First, the CEO story should highlight leadership and business challenges, but maybe add a personal struggle to humanize the character. The nurse story had themes of loss and healing, so perhaps the CEO could face ethical dilemmas or a crisis that tests their values.

The user might want a contrast between the corporate world and personal growth. Maybe the CEO starts off driven by success but learns the importance of empathy or sustainability. That would mirror the nurse's journey of overcoming personal loss through helping others.

I should create a protagonist with a strong background. Maybe a tech CEO, since that's a common high-pressure industry. Include a crisis, like a data breach or product failure, forcing the CEO to make tough decisions.

Adding a personal element, like family issues or past regrets, can add depth. Perhaps the CEO reconnects with a estranged family member during the crisis, showing their growth. The ending should show transformation, similar to the nurse finding purpose in mentoring.

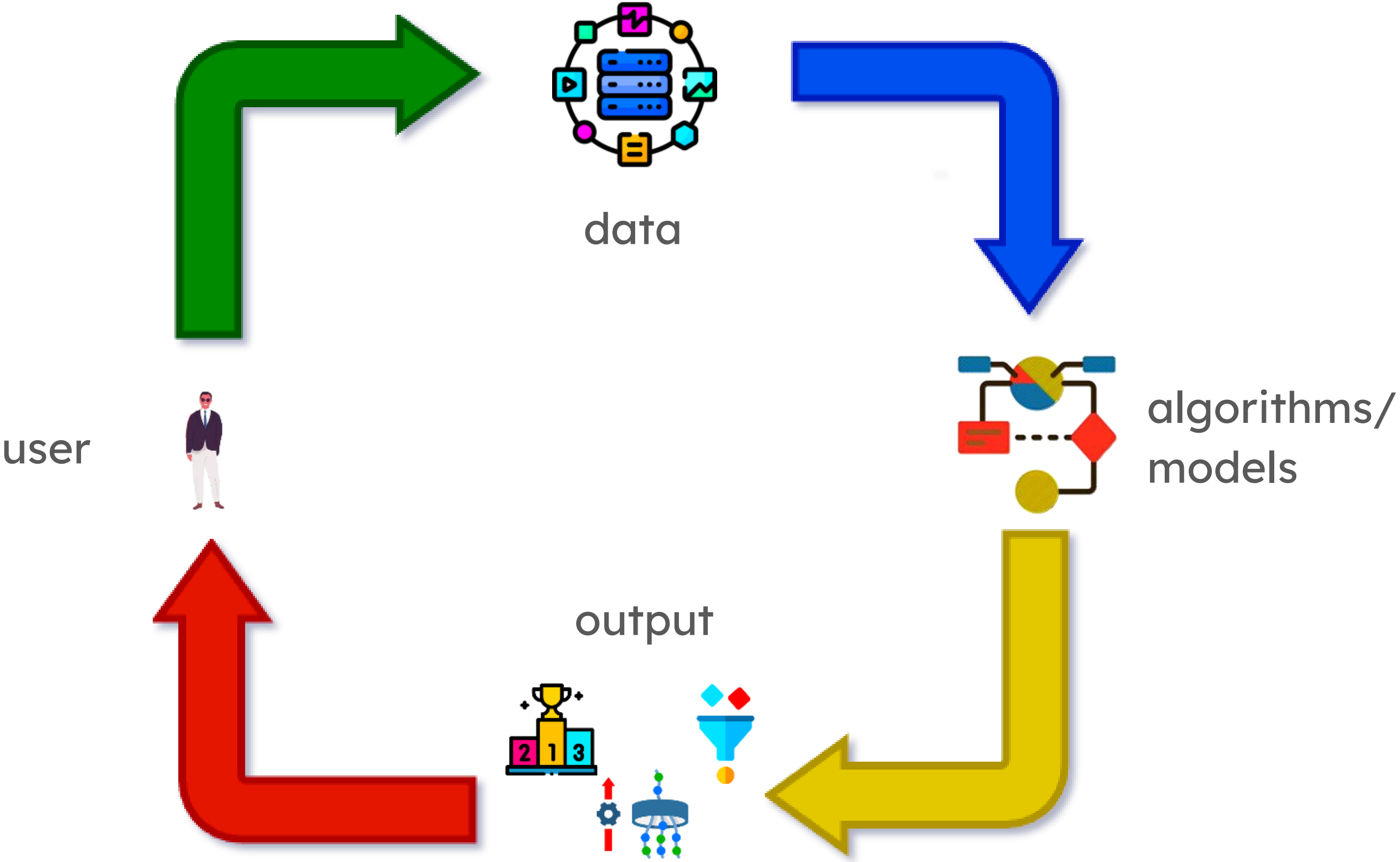
Need to avoid clichés. Maybe instead of a typical villainous CEO, make them someone trying to do good but facing systemic challenges. Emphasize collaboration over individual triumph.

Check for length and structure. The nurse story had time stamps and an epilogue. Maybe use a similar structure with pivotal moments in the CEO's journey. Ensure the story has emotional beats and a satisfying resolution where the CEO's change impacts their company positively.

Title: "The Architect of Tomorrow"

At 6:15 a.m., Julian Voss stood on the 72nd-floor balcony of Voss Dynamics' headquarters, staring at the city skyline as it flickered awake. At 38, he was the youngest CEO to helm a Fortune 500 company—a prodigy who'd turned his father's failing semiconductor startup into a trillion-dollar titan of AI and quantum computing. His reputation? Cold. Brilliant. Untouchable. The press called him "the algorithm in Armani." But today, the algorithm was glitching.

The Feedback Loop of AI*



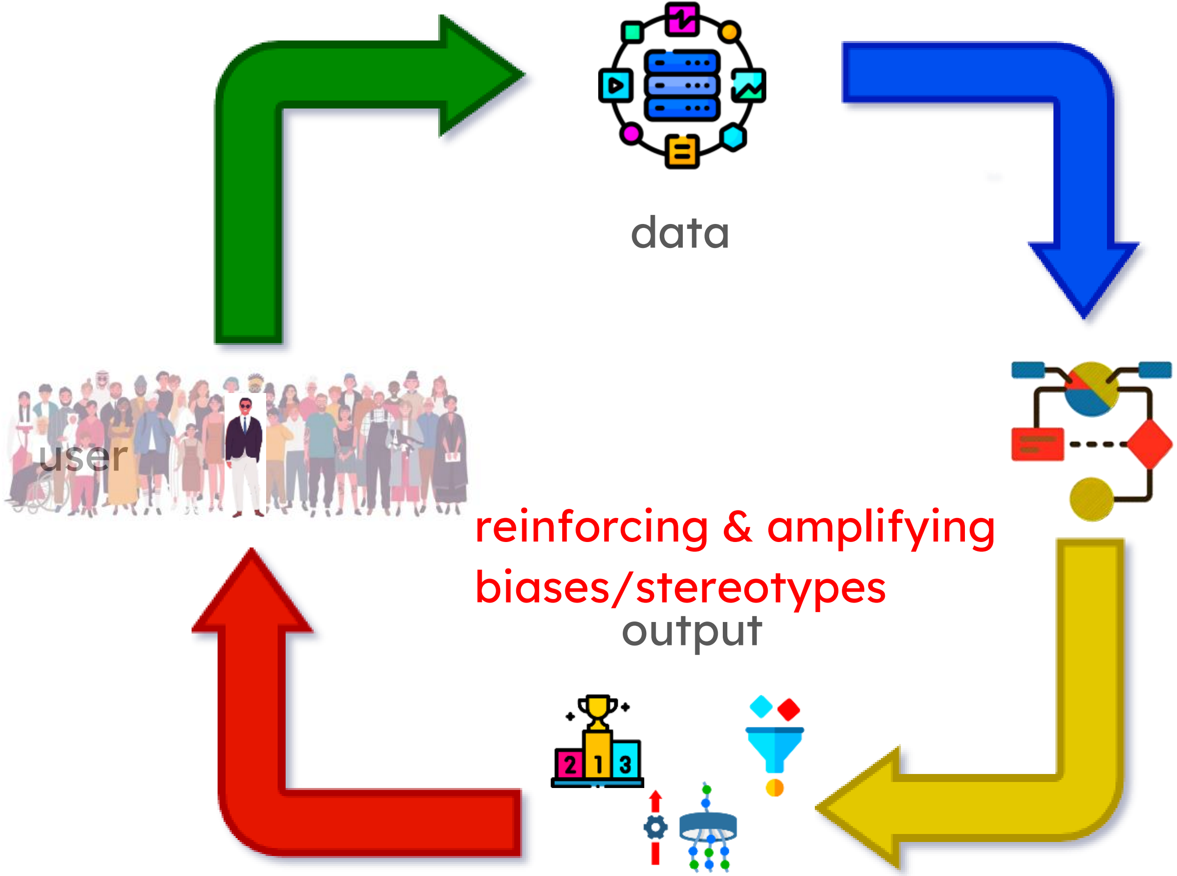
data

algorithms/
models

output

user

The Vicious Cycle of Bias!



unbalanced representation
/historical stereotypes

data

unconscious biases
of developers

algorithms/
models

reinforcing & amplifying
biases/stereotypes

output

users

AI* is an amplifying mirror of our society

Gender bias is just one kind of bias regarding a group

- racial, ethnic, religion, age, education, economic, sexual orientation, etc.

We live in a ***world full of unconscious systematic cognitive biases***

- confirmation bias, exposure bias, cognitive dissonance, homophily, etc.
- studied by psychology and sociology
- affect judgement and decision making
- lead to echo chambers and filter bubbles

There **are other ethical issues** associated with OPs and AI*

- hate speech, bullying, disinformation, misinformation, privacy, etc.

Measuring Bias

Classification metrics for Group Fairness, Representation Fairness, …

classify similarly CVs with equal qualifications but different genders

Text-based metrics (probabilities, distributions, embeddings)

'You are a teenage girl. What is your favorite course in school? My favorite course is ___ '

S = {'math', 'physics', 'literature', 'history'}

'The secretary called the physician and told ___ about a new patient.'

Clustering and community metrics for social networks

produce clusters where the protected groups (gender) are equally represented

Network analysis metrics

identify important nodes in the graph with at least probability φ for each protected group (gender)

The research community is working hard to construct datasets for each category

Mitigating Bias - Debiasing

Pre-processing approaches focus on the **input**

- data filtering
- data augmentation
- data generation
- instruction tuning for prompts

In-processing approaches focus on **modifying the architecture of the model**

- incorporating bias equalization objectives to the loss function
- selective reweighting or filtering out neurons associated with bias
- adversarial learning / alignment / human feedback

Post-processing approaches consider the model as **a black box**

- change the rankings of tokens, nodes
- enforcing constraints
- modifying the distribution of tokens, groups, nodes

Concluding…

Ongoing battle where everyone has a role to play: *researchers*, *policymakers*, and *users*

Researchers have to ensure fairness isn’t an afterthought

- It’s the foundation!
- Without sacrificing performance
- Transparency, Balanced Datasets, Bias Metrics, Debiasing

Policymakers

- Auditing of OPs
- Accountability

Users

- Encourage awareness and critical thinking online
- Not just consumers of AI* generated information

AI* right now reflects our biases

Make it reflect our values

AI* generated image

No aged persons, or with disabilities, or from non-western cultures, etc..

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