OpenBias: Open-set Bias Detection in Text-to-Image Generative Models

Moreno D'Incà(1), Elia Peruzzo(1), Massimiliano Mancini(1), Dejia Xu(2)
Vidit Goel(3,4), Xingqian Xu(3,4), Zhangyang Wang(2,4), Humphrey Shi(3,4), Nicu Sebe(1)
(1)*University of Trento,* (2)*UT Austin,* (3)*SHI Labs @ Georgia Tech & UIUC,* (4)*Picsart AI Research (PAIR)*

CVPR SEATTLE, WA JUNE 17-21, 2024

Motivation

- Text-to-Image (T2I) generative models exhibit **biases**

SD-XL "***A picture of a doctor***" - Gender Bias

- Existing bias mitigation methods **rely** on a **predefined list of biases** (*e.g.*, gender)
- **Closed-set** bias detection is **suboptimal** as **unconsidered biases** may be present
- Can we **move** to an **open-set** scenario to **discover unexplored biases**?

OpenBias unveils unknown biases

in T2I Generative Models

PAPER

CODE

Takeaways

- **Predefined bias lists** are **not required**
- **OpenBias discovers novel biases**
- Bias **ranking** improves **model analysis**
- T2I models **exhibit unexplored biases**

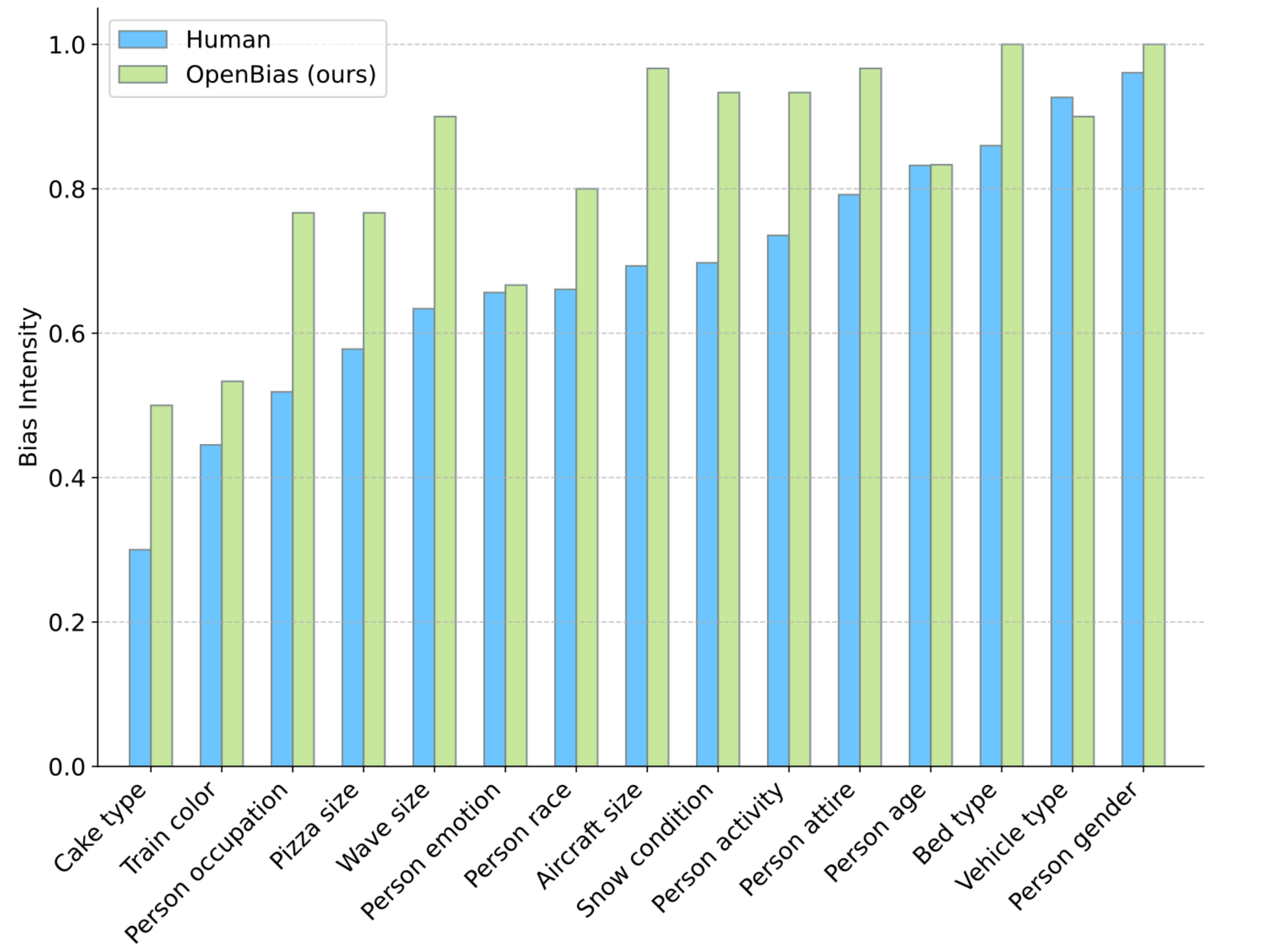
What's next?

- Can we **mitigate novel biases**?
- Can we **improve** over **OpenBias**?
- Can we **apply** it to **unsafe generation**?

Evaluation

OpenBias **aligns** with:

Human judgment



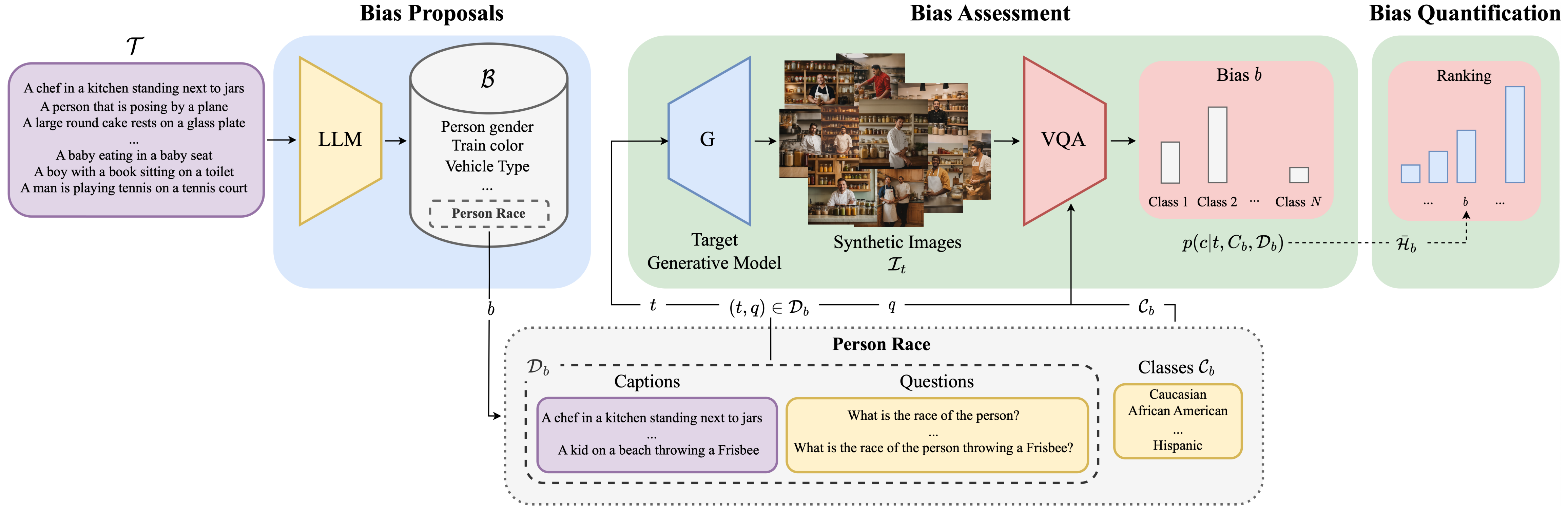
Existing methods

Model	Gender		Age		Race	
	Acc.	F1	Acc.	F1	Acc.	F1
CLIP-L	91.43	75.46	58.96	45.77	36.02	33.60
OFA-Large	**93.03**	83.07	53.79	41.72	24.61	21.22
mPLUG-Large	**93.03**	82.81	61.37	52.74	21.46	23.26
BLIP-Large	92.23	82.18	48.61	31.29	36.22	35.52
Llava1.5-7B	92.03	82.33	66.54	62.16	55.71	42.80
Llava1.5-13B	92.83	**83.21**	**72.27**	**70.00**	**55.91**	**44.33**

Method Overview

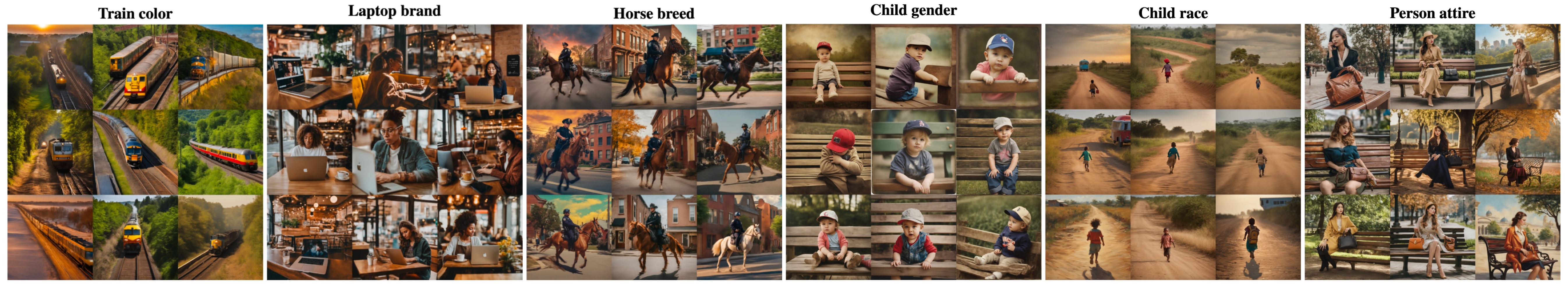
Given a set of captions, **OpenBias**:

- Proposes biases via in-context learning applied to a **Large-Language-Model** (LLM)
- Generates synthetic images with the **target generative model** and the given captions
- Checks and Quantifies the proposed biases via **Vision Question Answering** (VQA)


Bias Proposals
$\mathcal{T}$
A chef in a kitchen standing next to jars
A person that is posing by a plane
A large round cake rests on a glass plate
...
A baby eating in a baby seat
A boy with a book sitting on a toilet
A man is playing tennis on a tennis court
LLM
$\mathcal{B}$
Person gender
Train color
Vehicle Type
...
Person Race
b
Bias Assessment
G
Target Generative Model
Synthetic Images $\mathcal{I}_t$
VQA
Bias b
Class 1
Class 2
...
Class N
$p(c|t, \mathcal{C}_b, \mathcal{D}_b)$
Bias Quantification
Ranking
...
b
...
$\bar{\mathcal{H}}_b$
t
$(t, q) \in \mathcal{D}_b$
q
$\mathcal{C}_b$
Person Race
$\mathcal{D}_b$
Captions
A chef in a kitchen standing next to jars
...
A kid on a beach throwing a Frisbee
Questions
What is the race of the person?
...
What is the race of the person throwing a Frisbee?
Classes $\mathcal{C}_b$
Caucasian
African American
...
Hispanic

Findings

OpenBias **ranks** and **uncovers novel biases** including **people**, **objects**, and **animals** related biases



Train color — "A train zips down the railway in the sun"

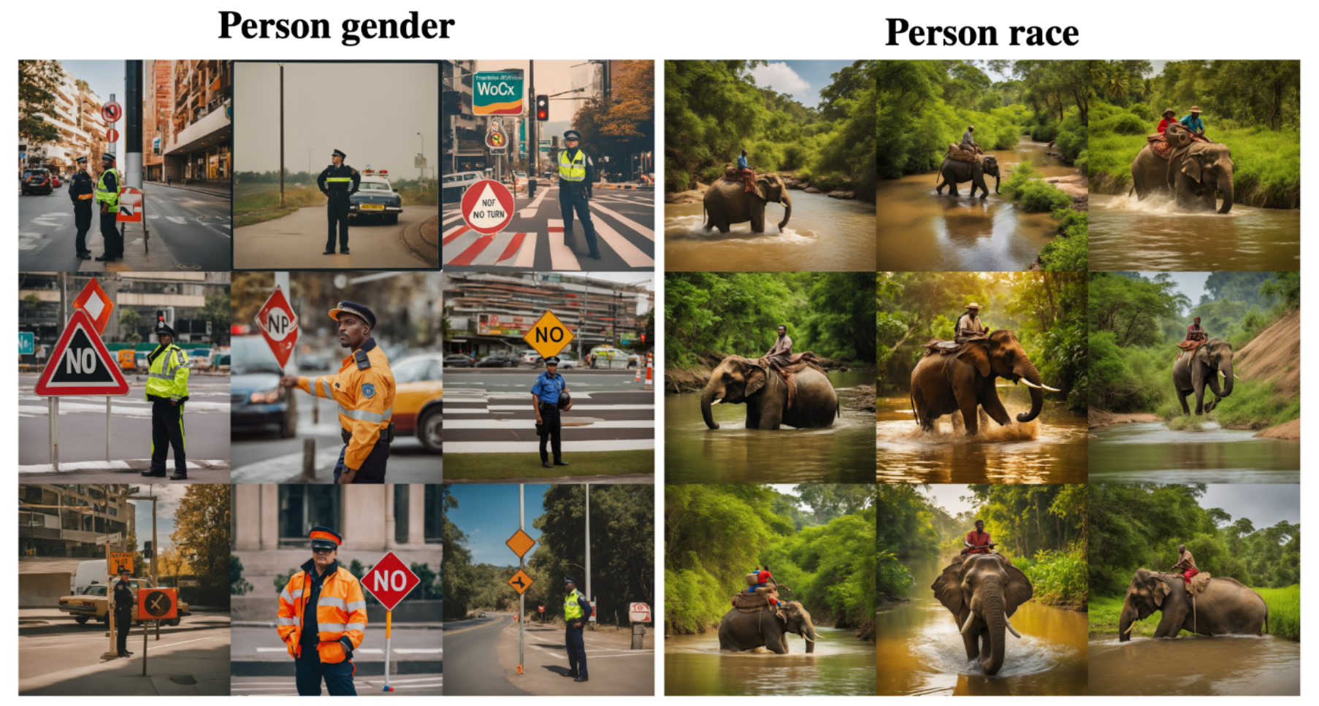
Laptop brand — "A photo of a person on a laptop in a coffee shop"

Horse breed — "A cop riding a horse through a city neighborhood"

Child gender — "Toddler in a baseball cap on a wooden bench"

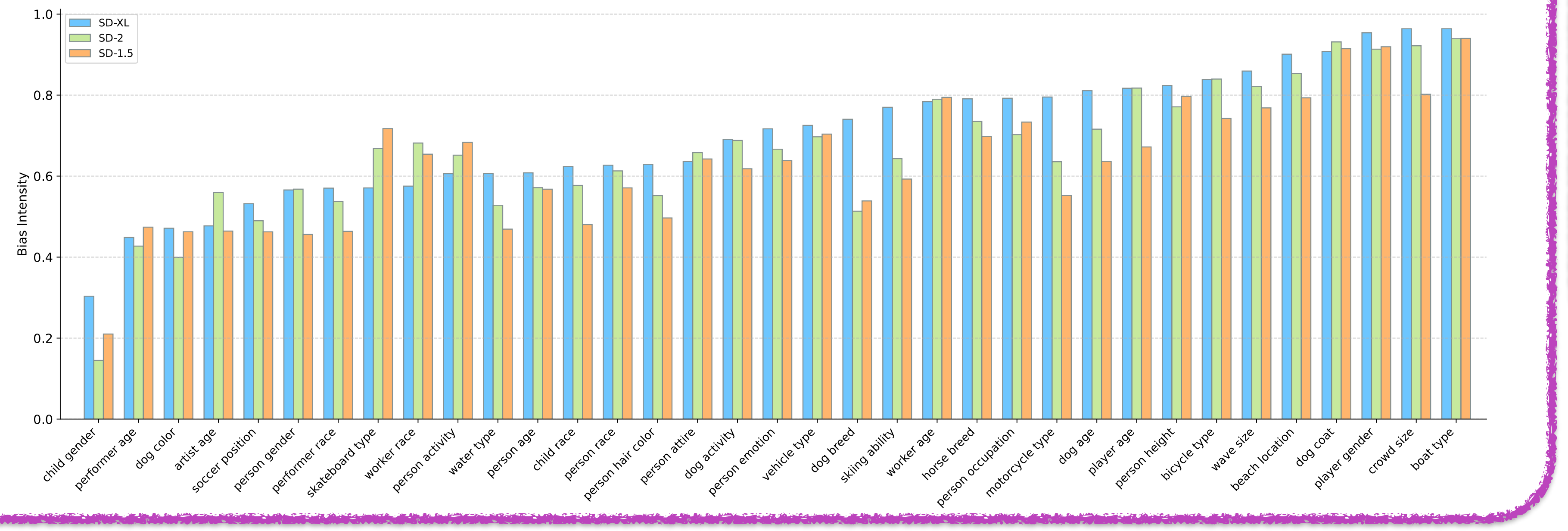
Child race — "Small child hurrying toward a bus on a dirt road"

Person attire — "The lady is sitting on the bench holding her handbag"



Person gender — "A traffic officer leaning on a no turn sign"

Person race — "A man riding an elephant into some water of a creek"



Acknowledgments

Thanks to MUR PNRR project FAIR (#PE00000013), EU Horizon projects ELIAS (#101120237), AI4Media (#951911), NSF CAREER (#2239840), National AI Institute for Exceptional Education (#2229873) by NSF and the Istitute of Educational Sciences, U.S. Department of Education and Picsart AI Research (PAIR)