Improving Fairness of Computer Graphics and Machine Learning at Microsoft

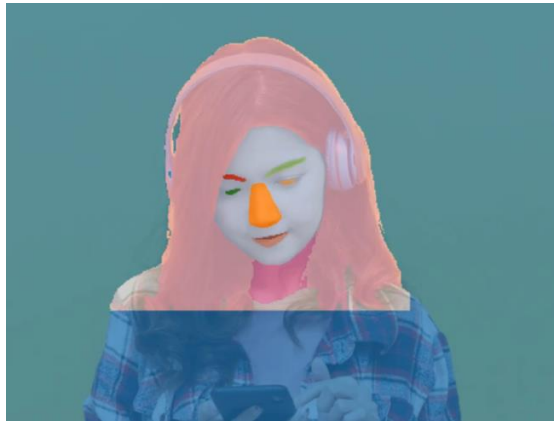
Microsoft Mixed Reality and AI Lab

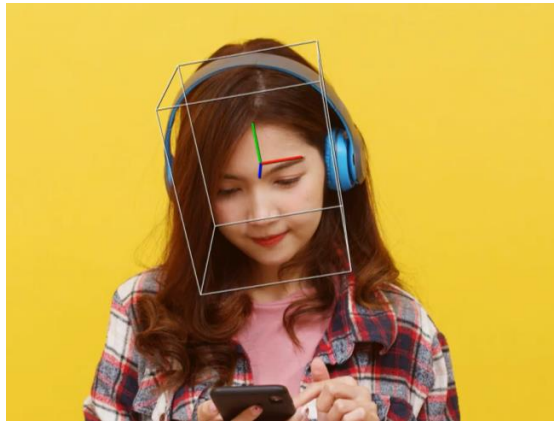
Cambridge, UK

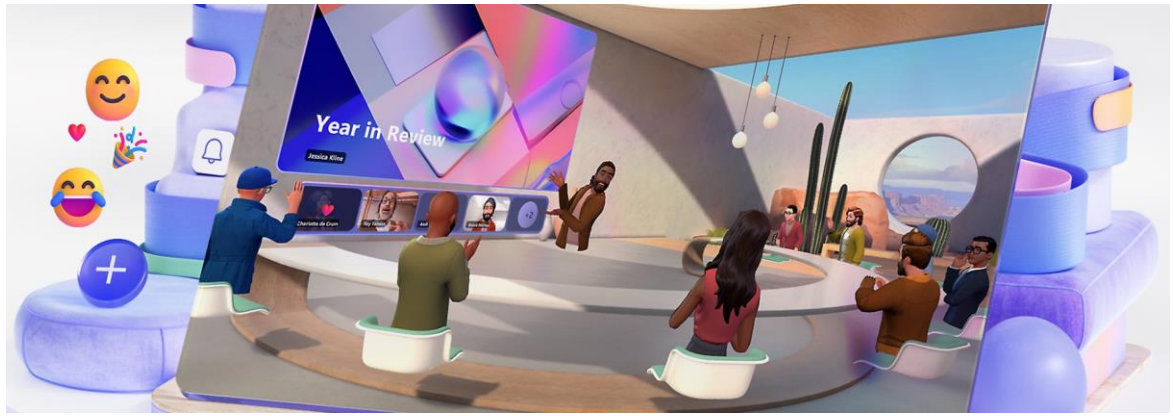
Zürich, Switzerland

Introduction

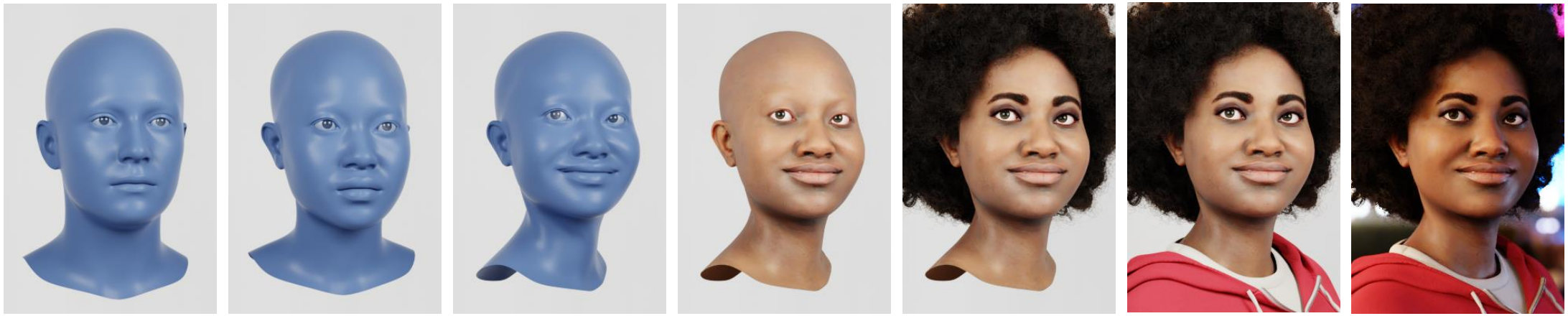
- Human understanding models for Microsoft Teams.
- Prioritise accommodation of diverse users.





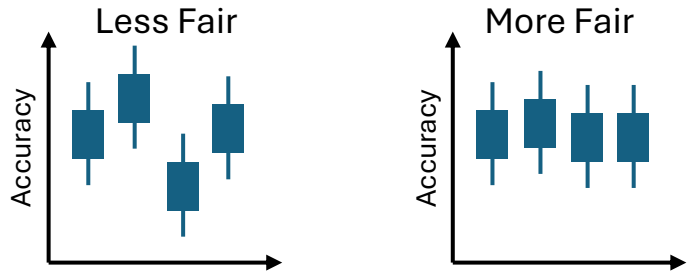


Backbone of our system: synthetic training data



Template face +identity +expression +texture +hair +clothes +environment

- Synthetic humans for diverse training data
- Test on real data, sliced by demographics
- Fairer AI through fairer computer graphics



In this talk…

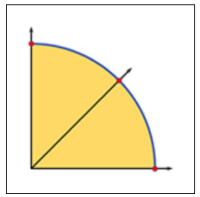
3 Examples where fairer CG lead to fairer AI.

Align with the work of this group (skin, hair, accurate appearance variables)

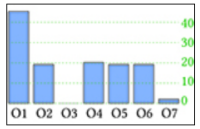
Our messages:

- Fairer AI in production: needs to work for users worldwide.
- Fairer CG leads to Fairer AI.
- Quality over quantity of data.

Reference:



Countering racial bias in computer graphics research.
T. Kim, Holly Rushmeier, Julie Dorsey, Derek Nowrouzezahrai, Raqi Syed, Wojciech Jarosz, and A.M. Darke
SIGGRAPH Talks 2022.
[Abstract] [PDF] [Supplement] [arXiv]



Sex and gender in the computer graphics research literature.
Ana Dodik*, Silvia Sellán*, T. Kim, and Amanda Phillips (* joint 1st authors)
SIGGRAPH Talks 2022.
[Abstract] [PDF] [Supplement] [arXiv]

Anti-racist graphics research.
T. Kim
SIGGRAPH Diversity Equity & Inclusion Summit 2021.
[Abstract] [YouTube]

Case study: Fairer Representation of Skin

Task: face normals prediction from image

❌ Problem: During development, normal prediction lower accuracy on some skin types.

Input real image

Predicted normals

Case study: Fairer Representation of Skin

- Proposed update: Try better match skin appearance to real photo and art references.

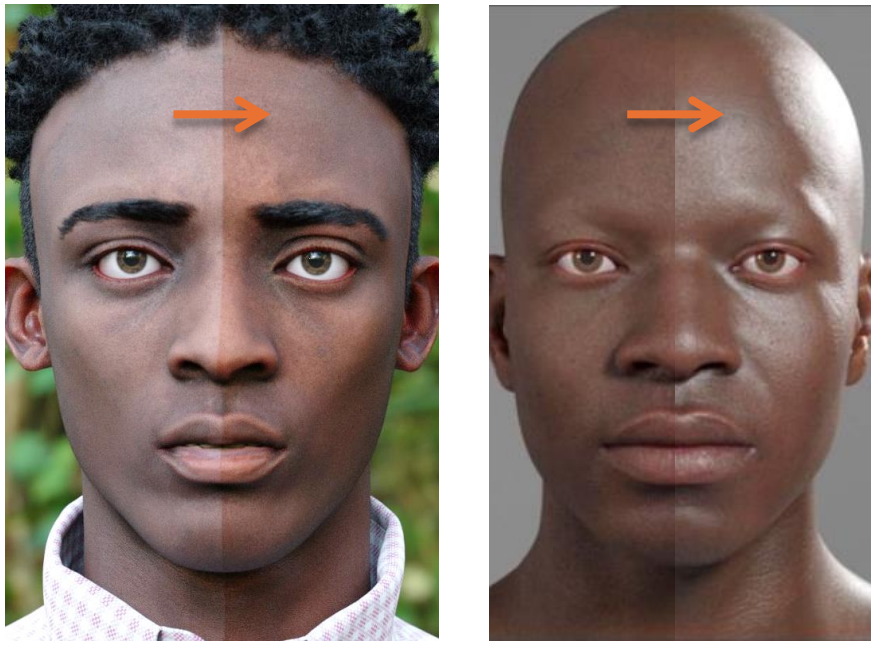
Photo

Scanned albedo texture

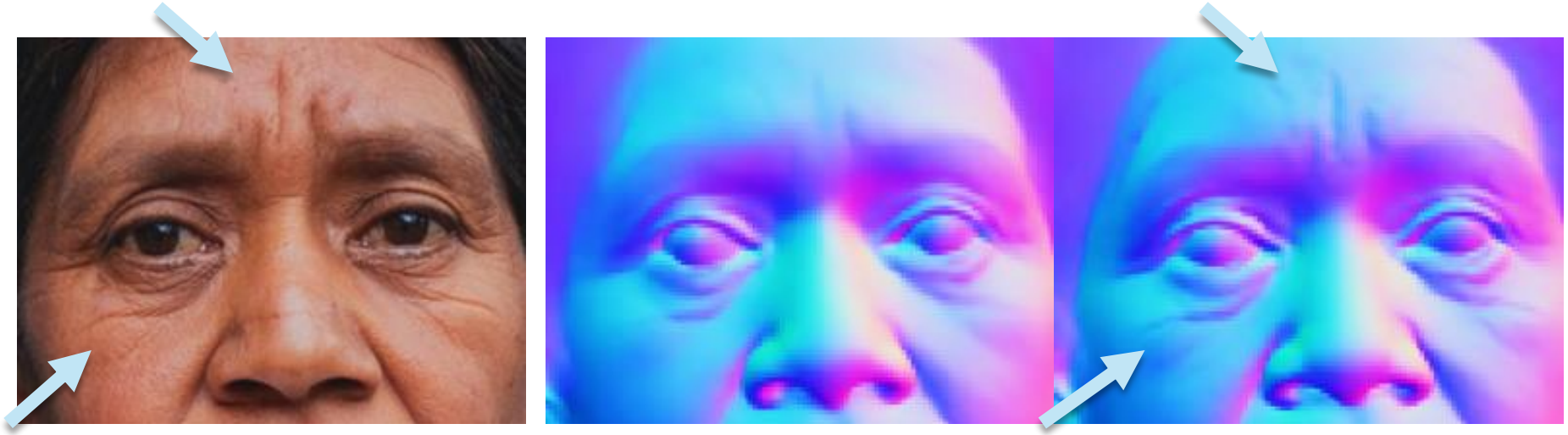
Artist-prepared albedo texture

Case study: Fairer Representation of Skin

- 🛠️ Implemented fairer synthetic albedo and specular appearance across skin tones.
- ✅ Improved model fairness on real images



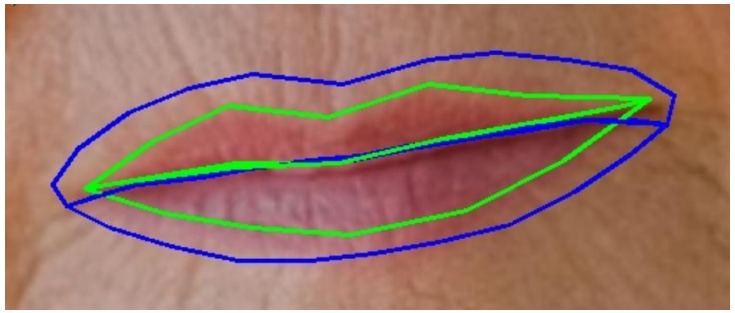
Synthetic skin improvements



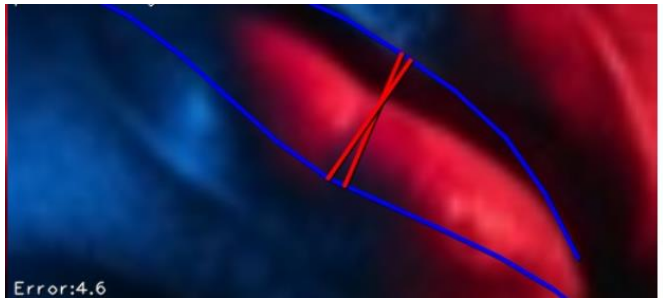
Input real image *Predicted normals before* *Predicted normals after*

Case Study: Fairer topological consistency

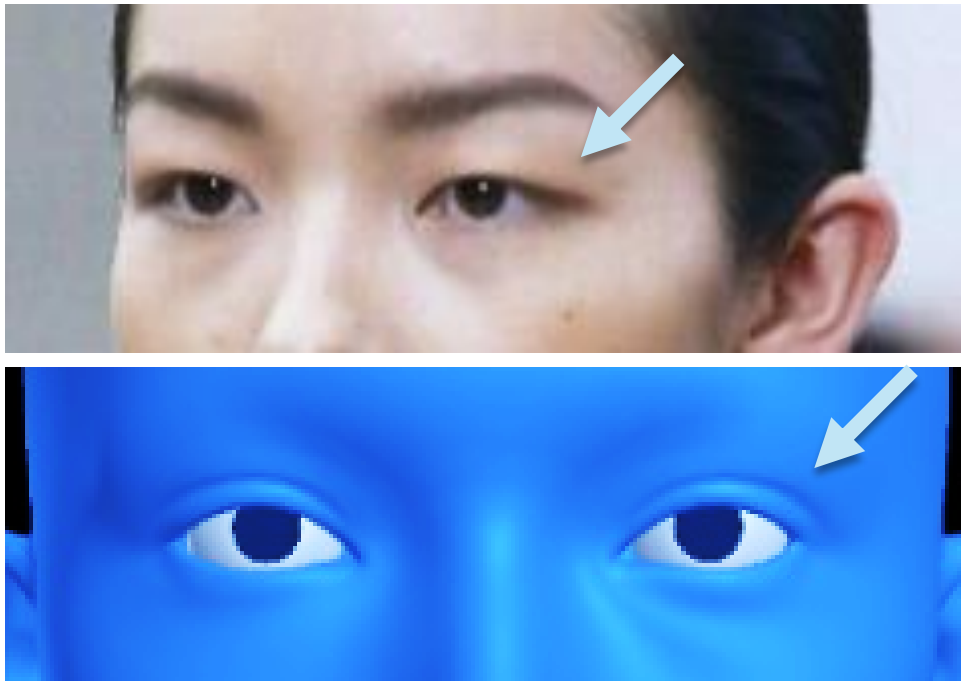
Task: facial tracking and reconstruction



❌ *Inaccurate thin-lip detection*



❌ *Inaccurate closed-lip detection*

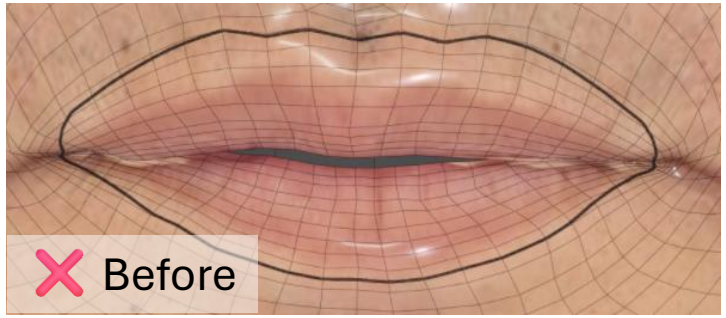


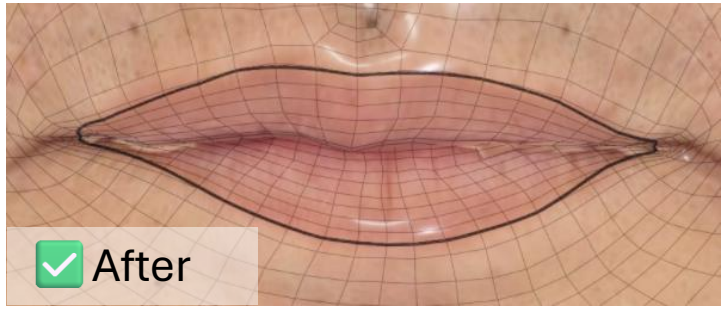
❌ *Inaccurate eyelid shape prediction*

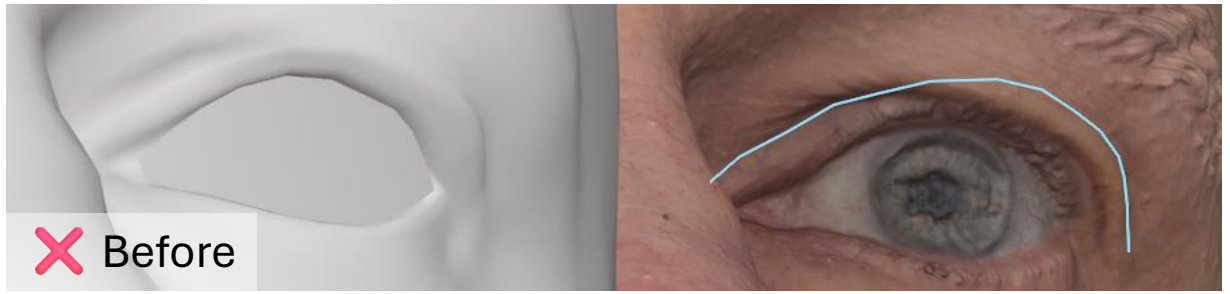
Case Study: Fairer topological consistency

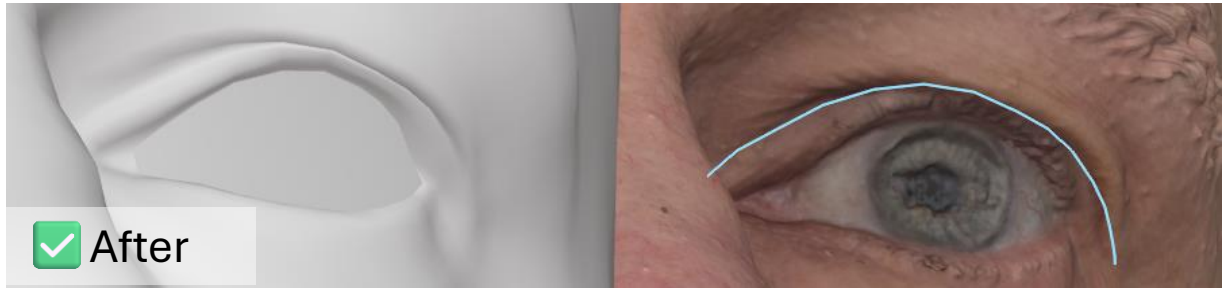
🛠️ Implement fair and consistent face topology.

- All lips and eyelids on shared edge loops.



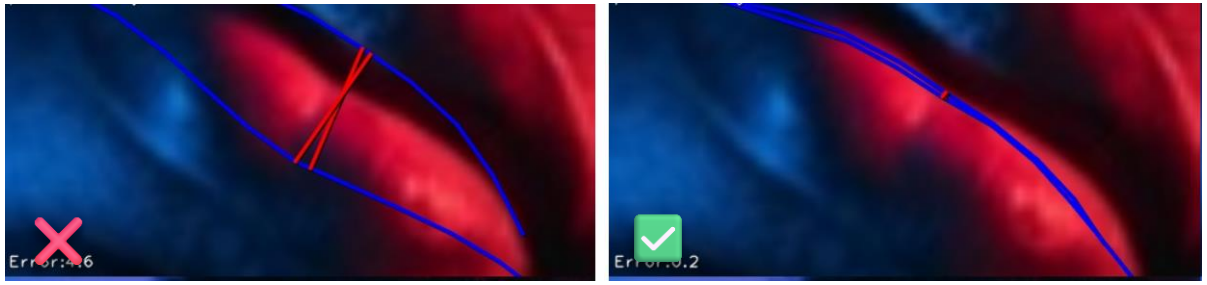




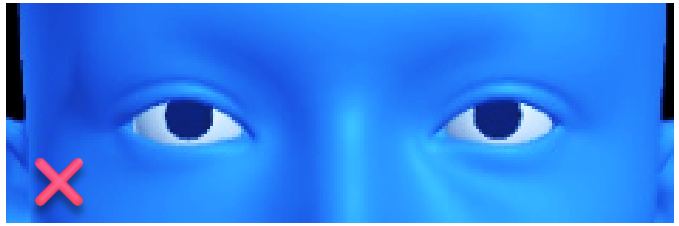


Case Study: Fairer topological consistency

✅ Resolved lip tracking and eyelid prediction failures.



Input



Face reconstruction before

Face reconstruction after

Case study: Hair sampling

Task: hairstyle classification

❌ Problem: during development, initial bias toward short, un-gathered hair.

Input *Predicted hair style*

Input *Predicted hair style*

💭 Proposed data update: Sample more long, gathered hair in synthetic training data.

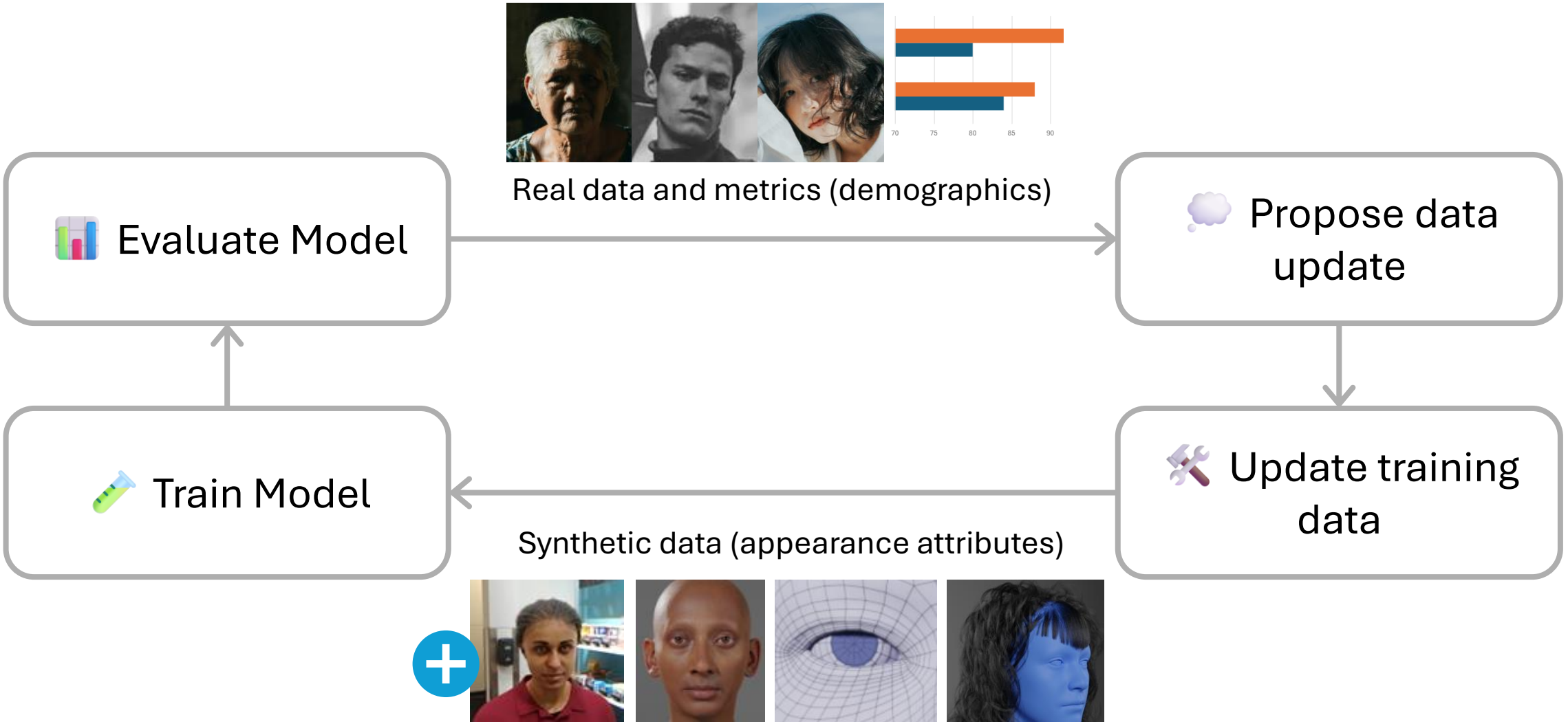
Case study: Hair Diversity

🛠️ We balanced the number of long, gathered hair with short, un-gathered hair in the training data.

- Harder to do with real training data

✅ This reduced the bias in hair prediction.

Model development loop

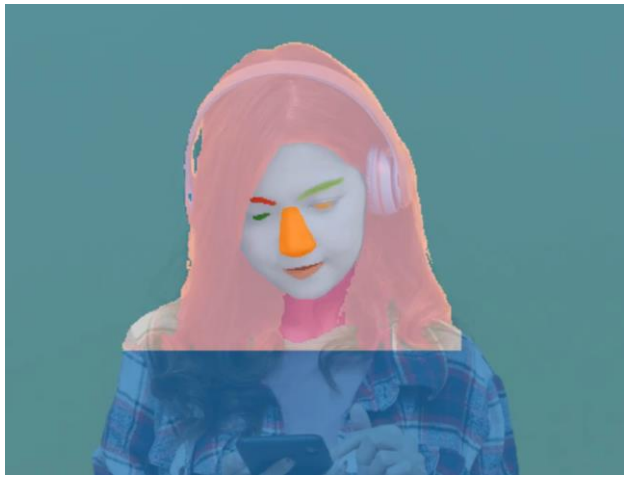


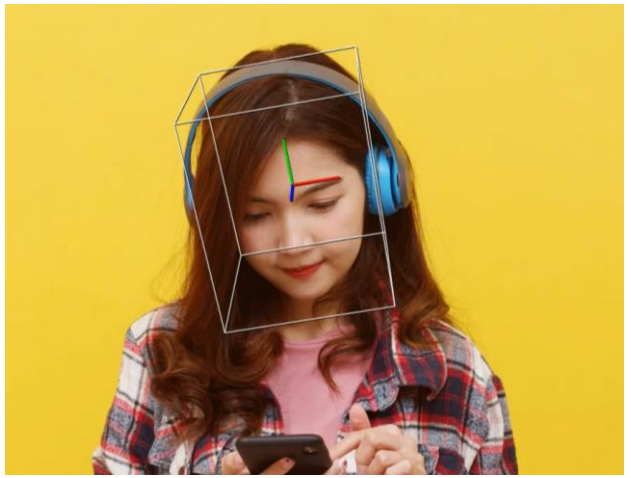
Conclusion

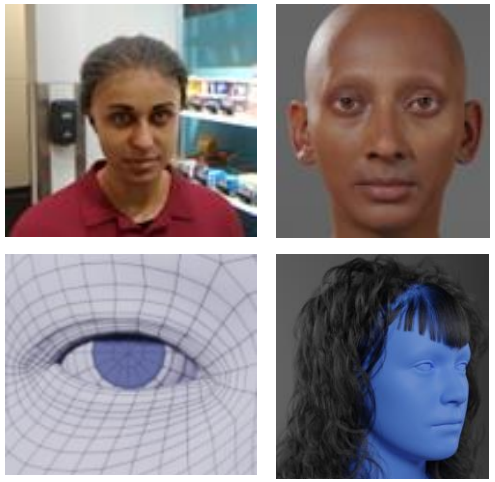
- AI in production: needs to work for users worldwide.
- Fairer CG leads to Fairer AI
- Quality over quantity of data
- Fair human representation is always a work in progress.

Acknowledgements

All work presented here is made possible by contributions from Mixed Reality & AI Lab and many partner teams across Microsoft.







Please see our related work at the poster sessions:

- *Scribble: Auto-Generated 2D Avatars with Diverse and Inclusive Art-Direction*