

# Longitudinal Study of Child Face Recognition

**Debayan Deb, Neeta Nain, Anil K. Jain**  
February 22, 2018

# Trace Missing Children



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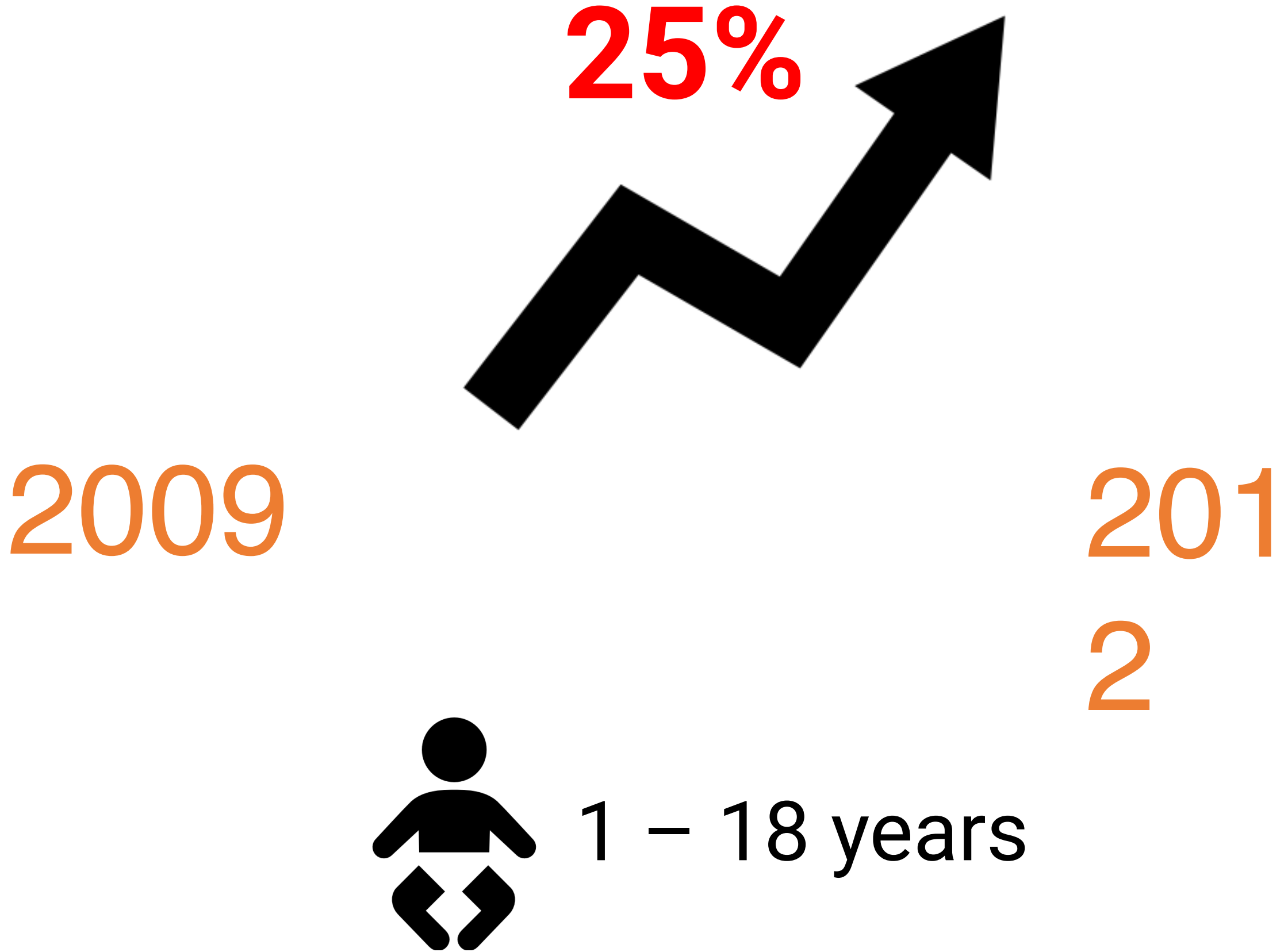




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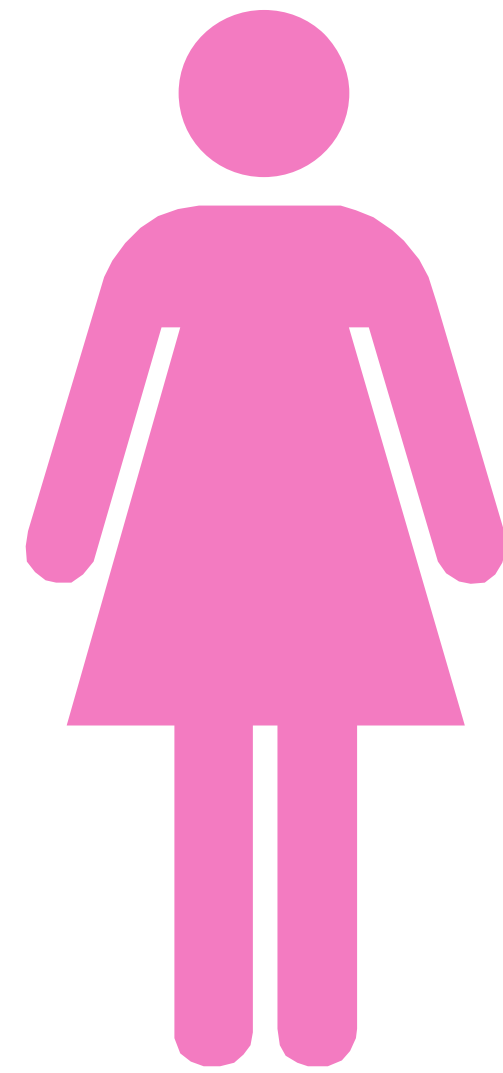
# Child Trafficking Victims<sup>1</sup>



1. [http://www.unodc.org/documents/data-and-analysis/glotip/Trafficking\\_in\\_Persons\\_2012\\_web.pdf](http://www.unodc.org/documents/data-and-analysis/glotip/Trafficking_in_Persons_2012_web.pdf)  
2. UNICEF

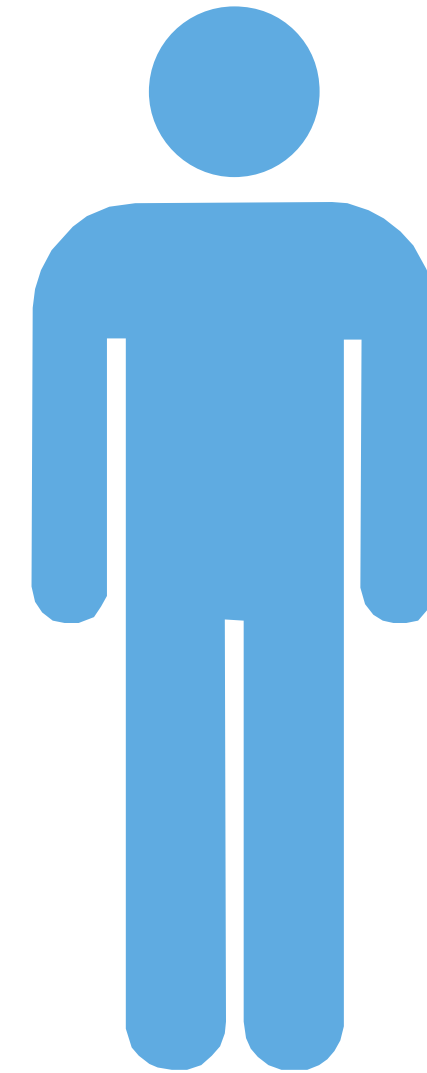
# Child Trafficking Victims<sup>1</sup>

Girl



67%

Boy



33%

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# Child Prostitution<sup>2</sup>

**2 million children < 20 years  
old**

1. [http://www.unodc.org/documents/data-and-analysis/glotip/Trafficking\\_in\\_Persons\\_2012\\_web.pdf](http://www.unodc.org/documents/data-and-analysis/glotip/Trafficking_in_Persons_2012_web.pdf)
2. UNICEF



# Child Face Recognition

## Primary Biometric Modality



Yesong Wang: missing 14 year old child traced by Microsoft's Face Recognition system [1]

1. <https://news.microsoft.com/features/lost-boy-fathers-search-microsoft-technology-helped-solve-four-year-mystery/>



# Longitudinal Study of Face Recognition

## Facial Aging

- 01.** Face recognition accuracy drops with an increase in time lapse between a subject's gallery and probe image acquisitions.
- 02.** Face recognition accuracies for older subjects are higher than younger ones.

# Longitudinal Study of Face Recognition

## Limited Prior Studies

- 01.** Lack of publicly available longitudinal face dataset of children in the age group 2 to 18 years.
- 02.** Low confidence in the accuracy of face recognition of children obtained by COTS face matchers (trained on adults).

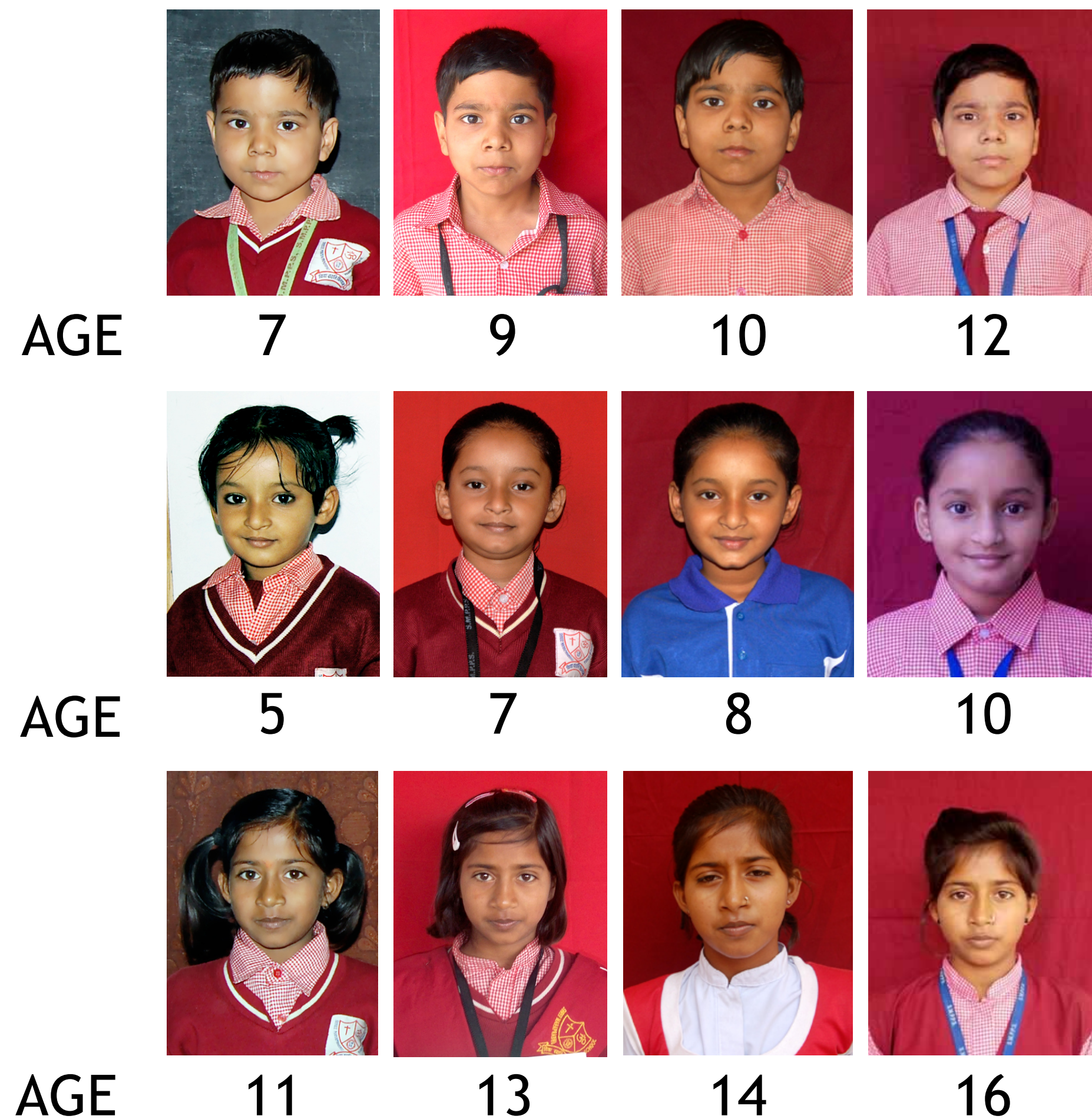
# Longitudinal Study of Face Recognition

## Objective

**Evaluate longitudinal face recognition performance for children in the age group of 2-18 years old.**



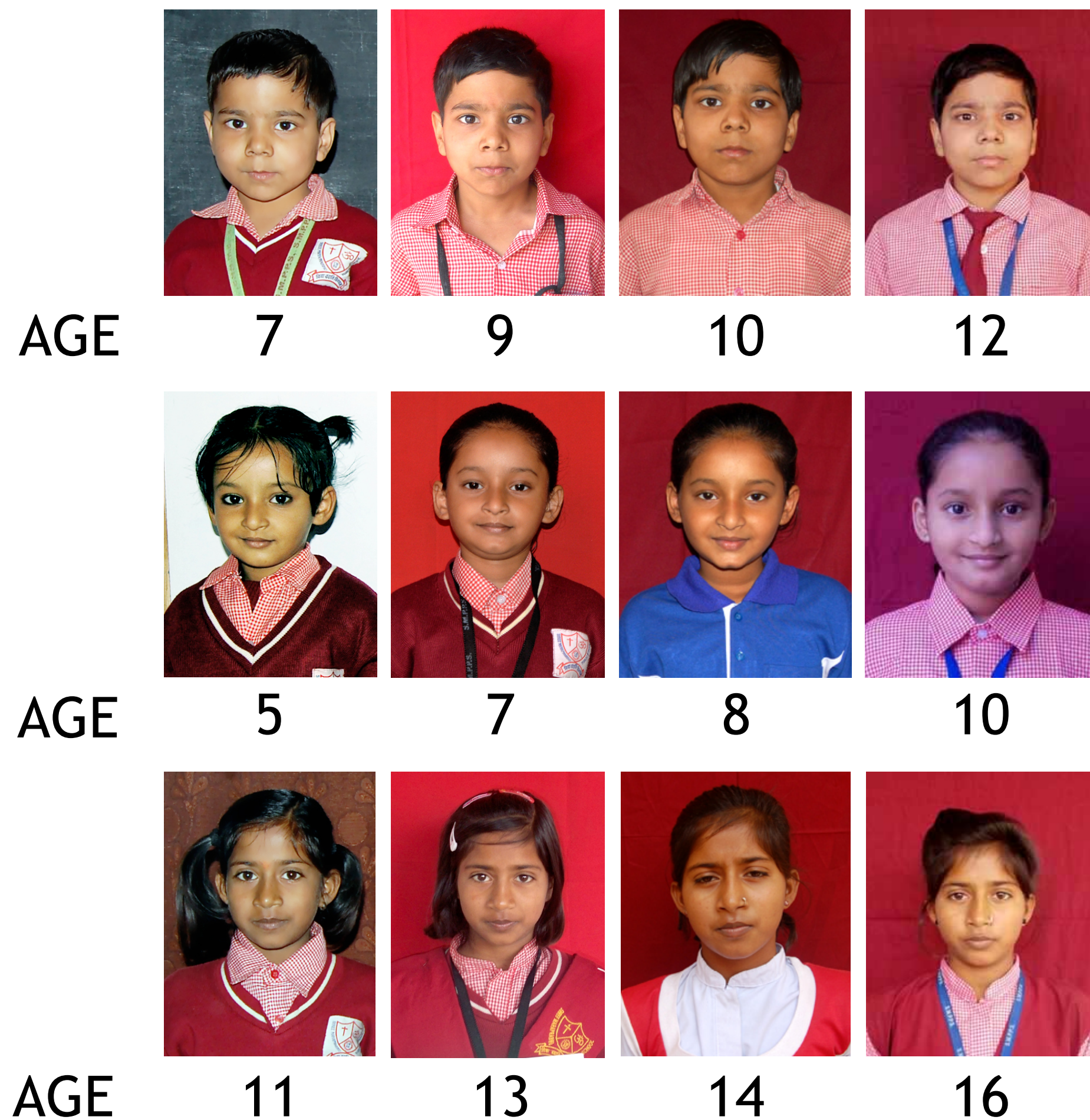
# Children Longitudinal Face (CLF) Dataset



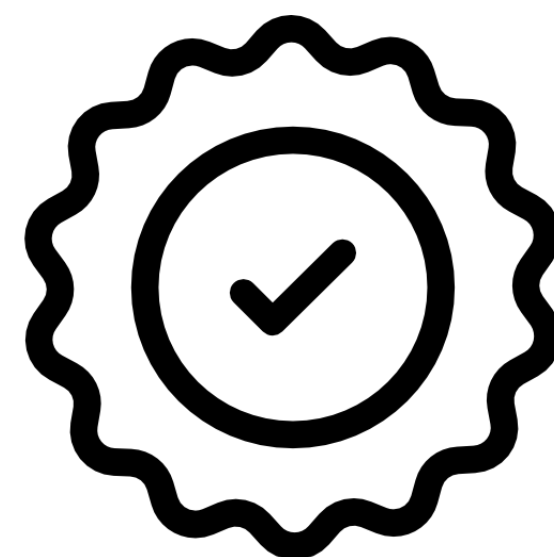
# Images	3,682
# Subjects	919
# Images / Subject	2 - 6 (avg. 4)
Age Group (yrs.)	2 - 18 (avg. 10)
Time Lapse (yrs.)	2 - 7 (avg. 4)
Boy / Girl (%)	66 / 34
Age at Enrollment (yrs.)	2 - 15 (avg. 8)



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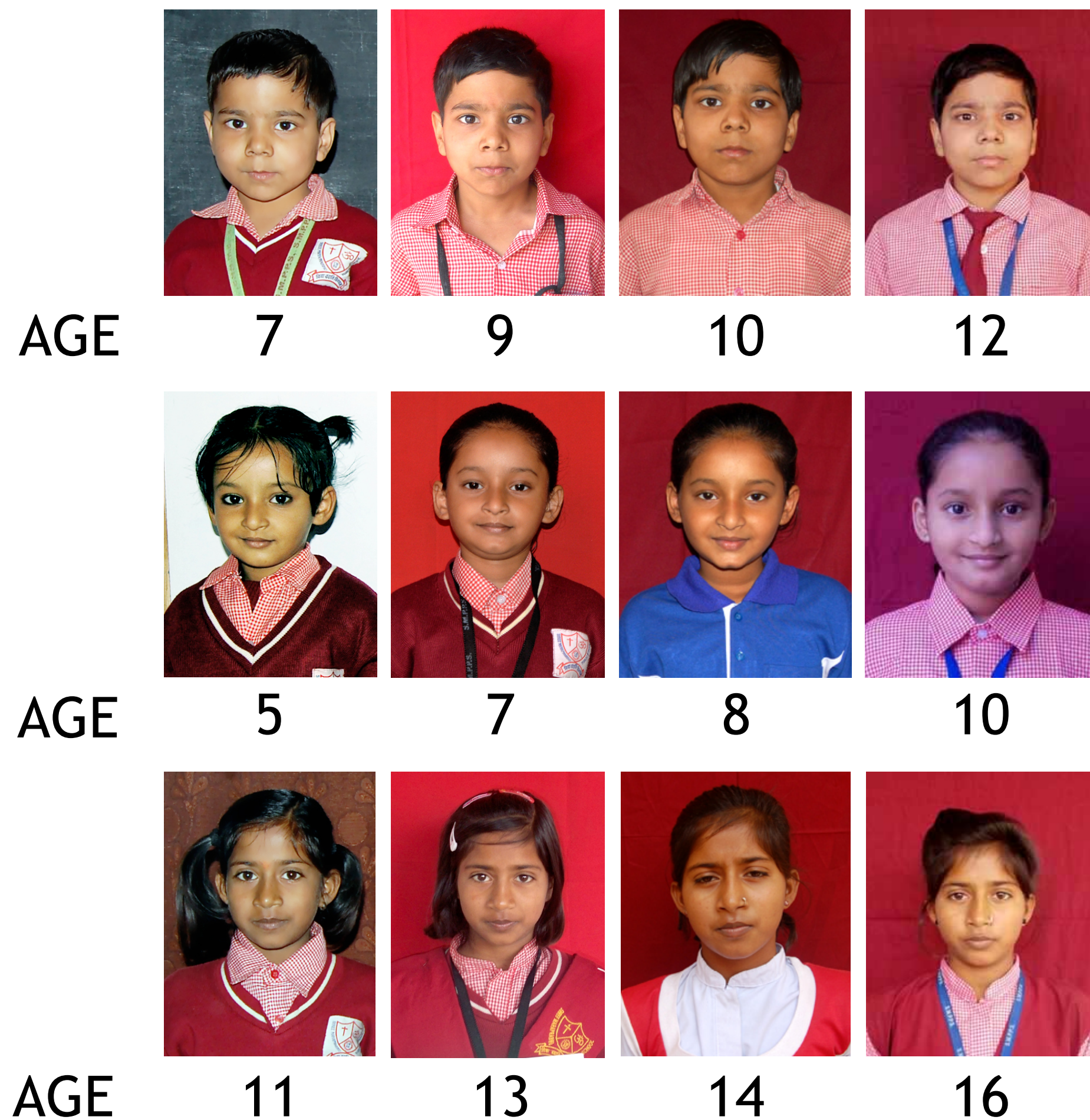


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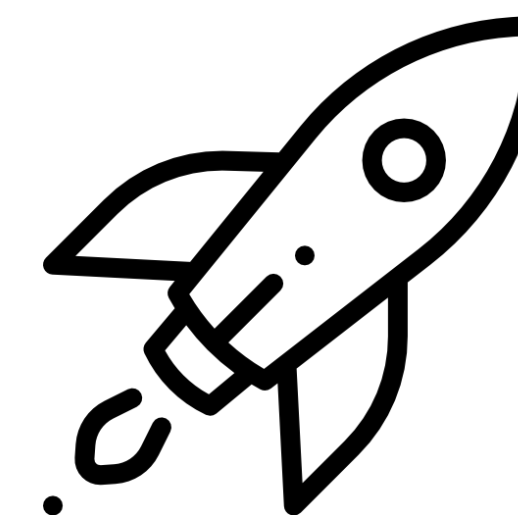
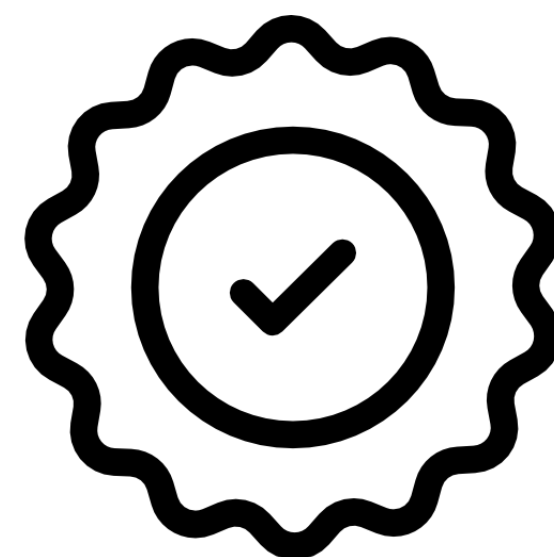




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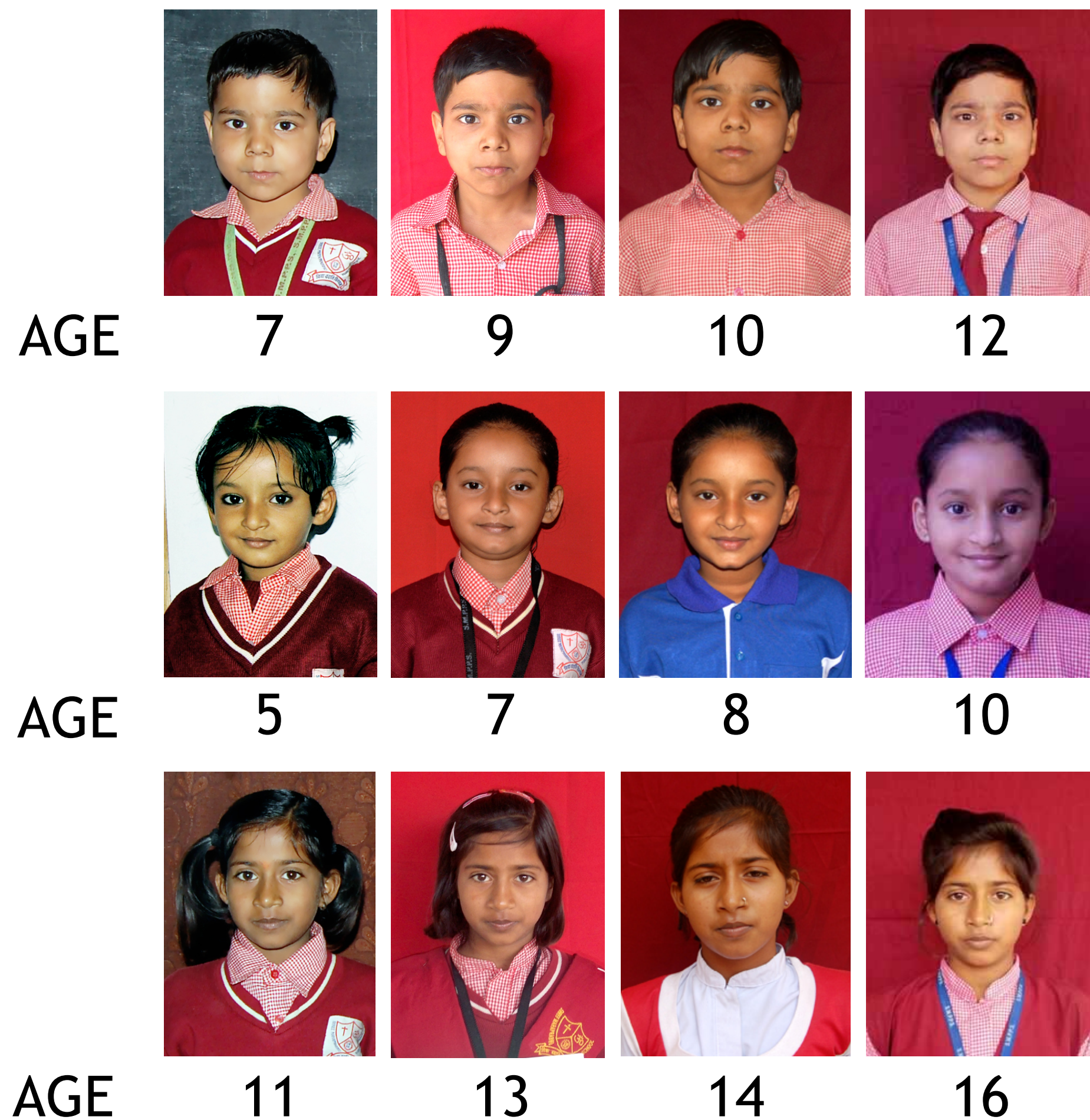


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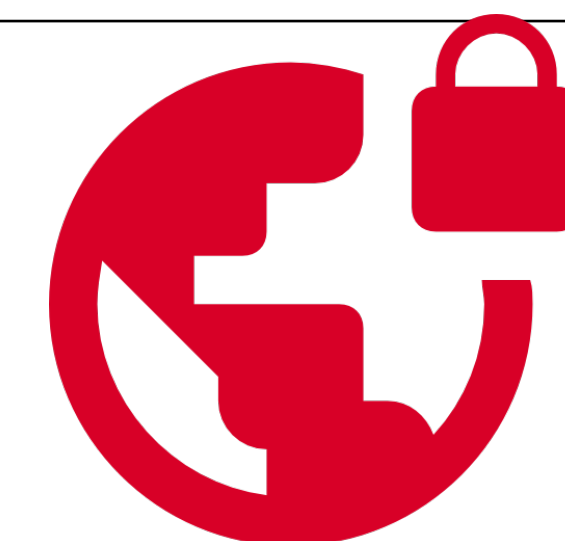
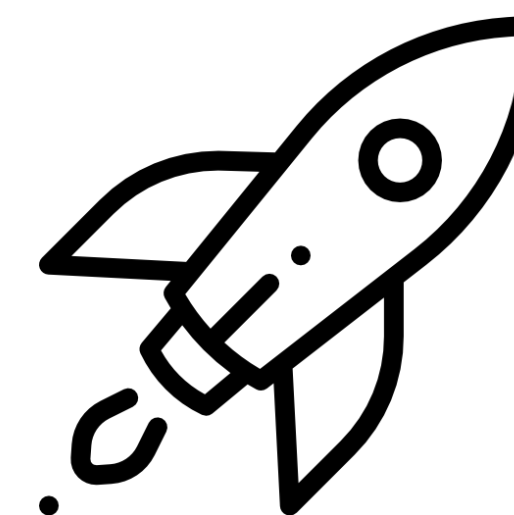
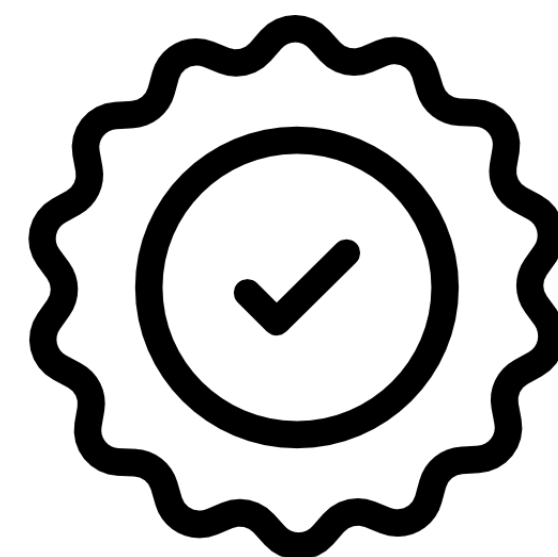




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# Fine-tuning FaceNet



CFT Training  
Dataset



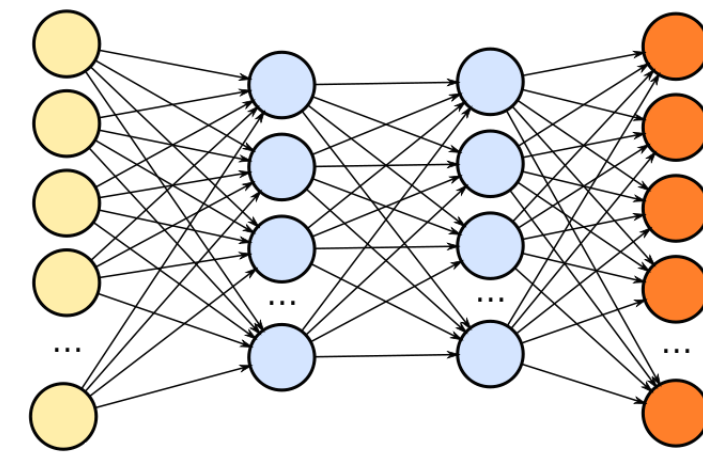
# of Subjects	1,119
# of Images	3,294
# Images / Subject	1-3
Age Group (yrs)	3-18

# Fine-tuning FaceNet



CFT Training  
Dataset

→  
Fine-  
tune



FaceNet [2]



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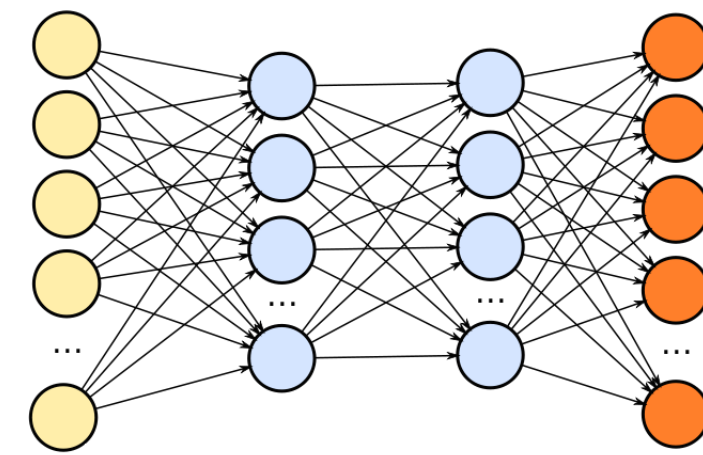


# Fine-tuning FaceNet



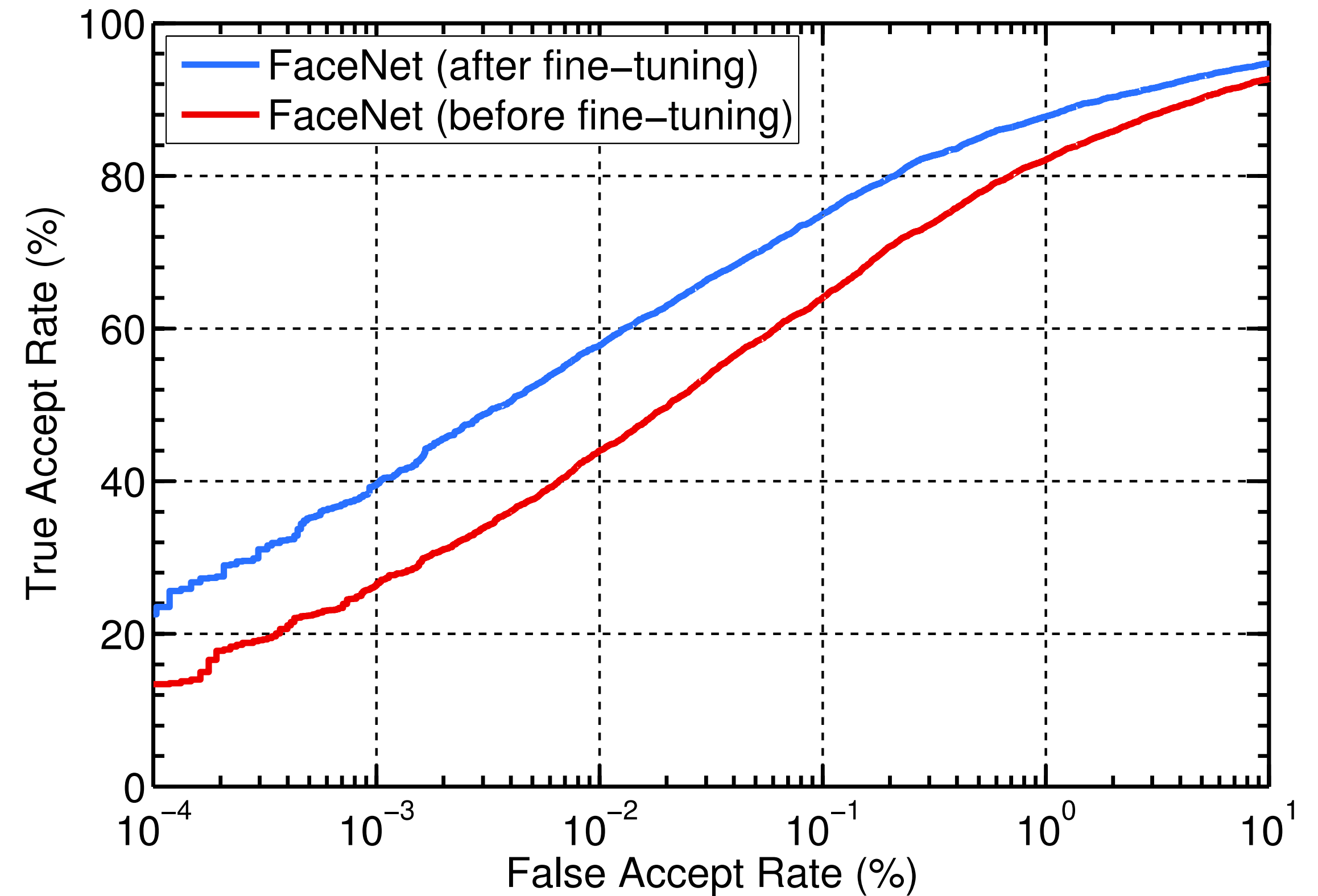
CFT Training Dataset

Fine-tune



FaceNet [2]

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# Face Matchers

**01. COTS** - state-of-the-art face matcher using a CNN for face recognition

**02. FaceNet** - fine-tuned on child face images

**03. Fused** - simple sum-score fusion of COTS and FaceNet

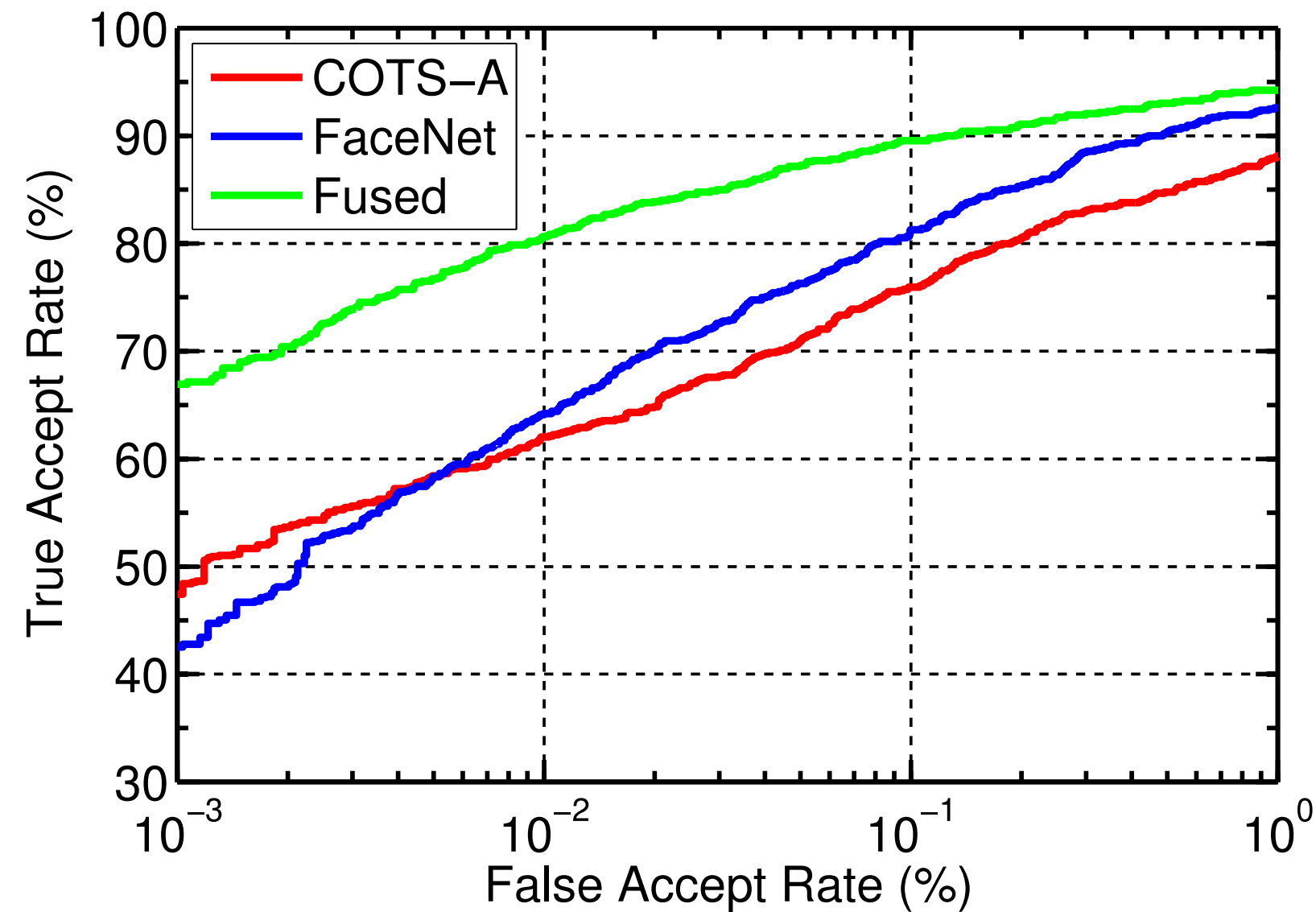


# Verification Scenario

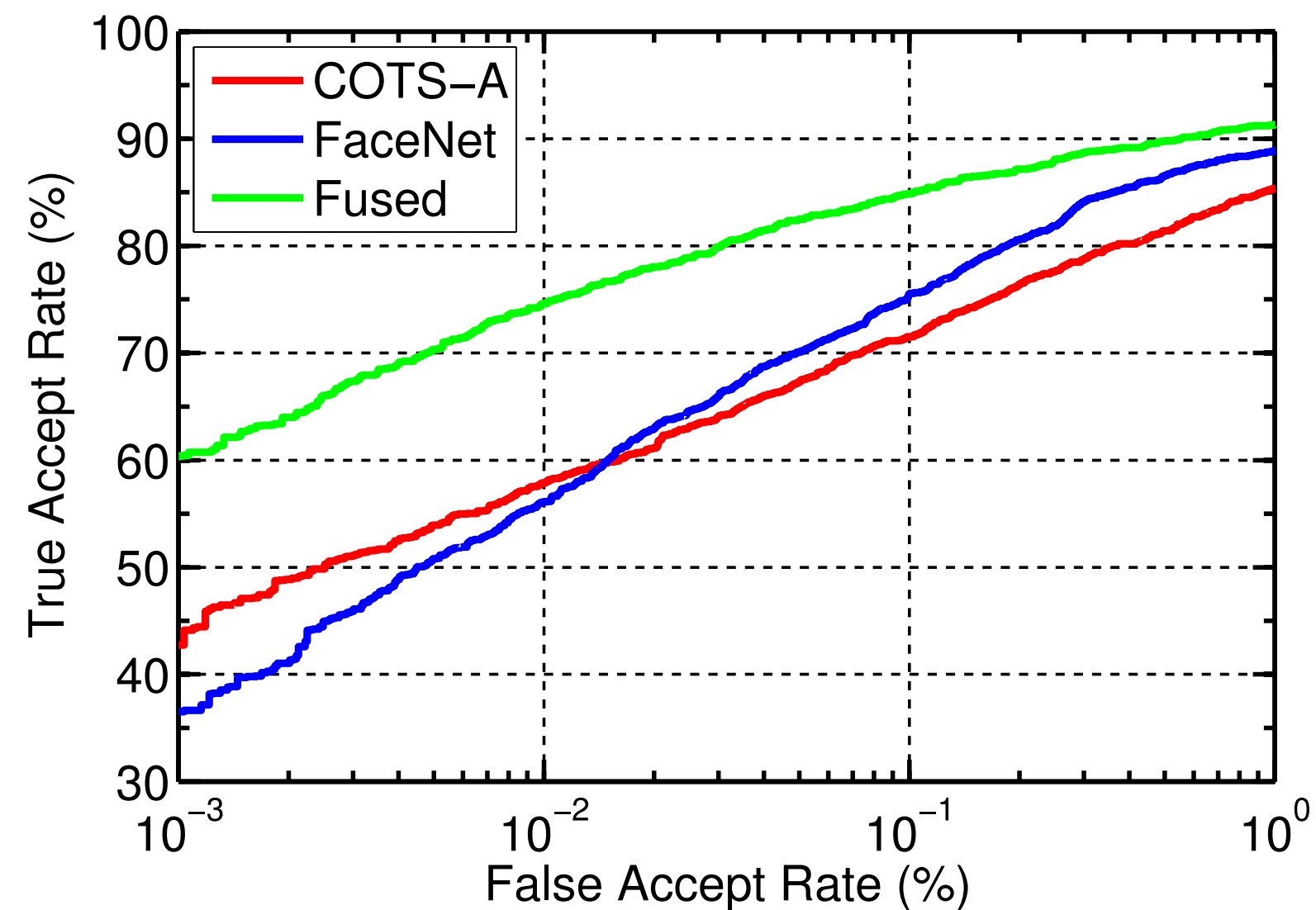
Enrollment (first image acquisition) vs. Subsequent face image acquisitions

Genuine: 2,763, Impostor: 3.38M

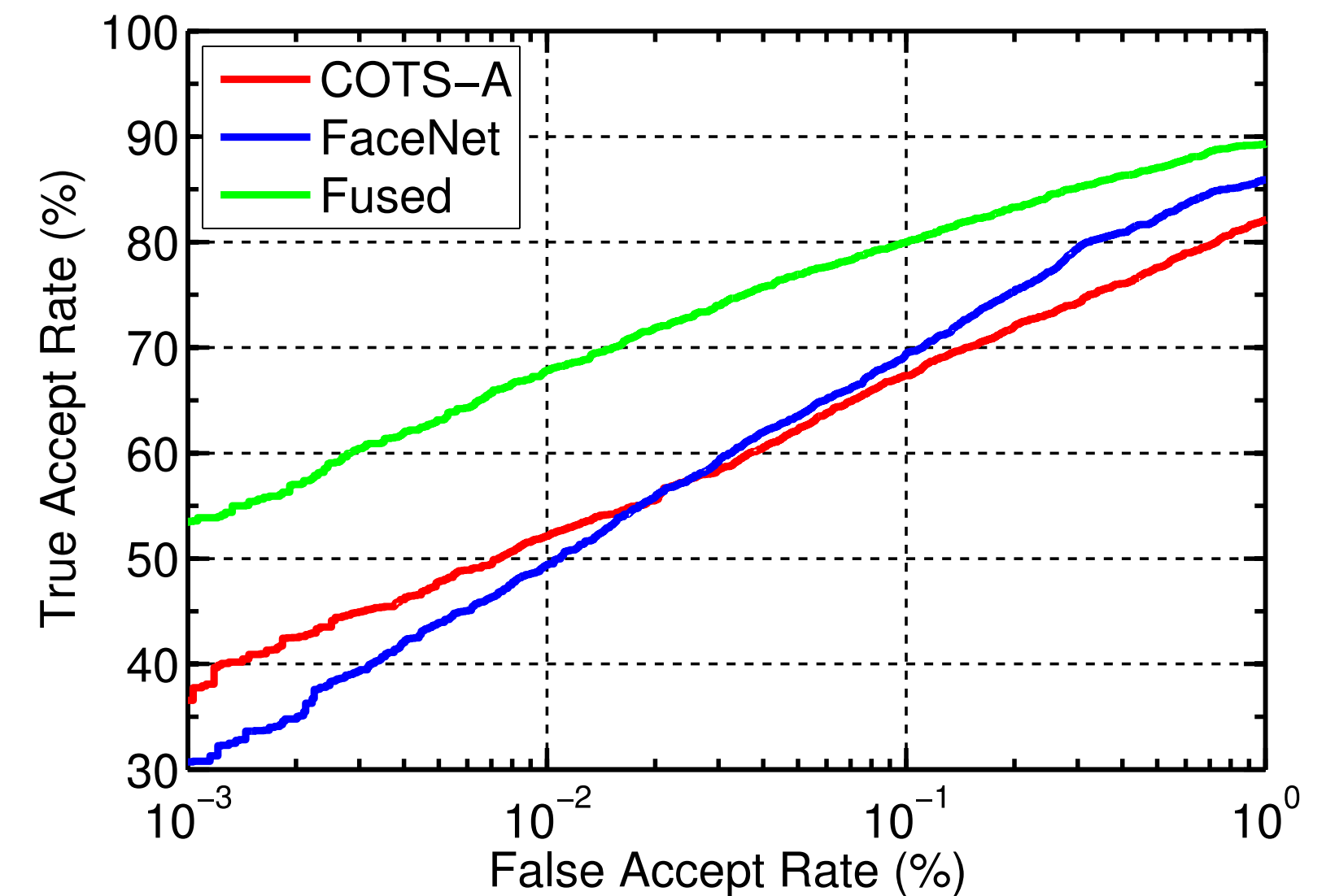
Longitudinal performance evaluated after  $\Delta T$  years.



$\Delta T = 1$  year



$\Delta T = 2$  years

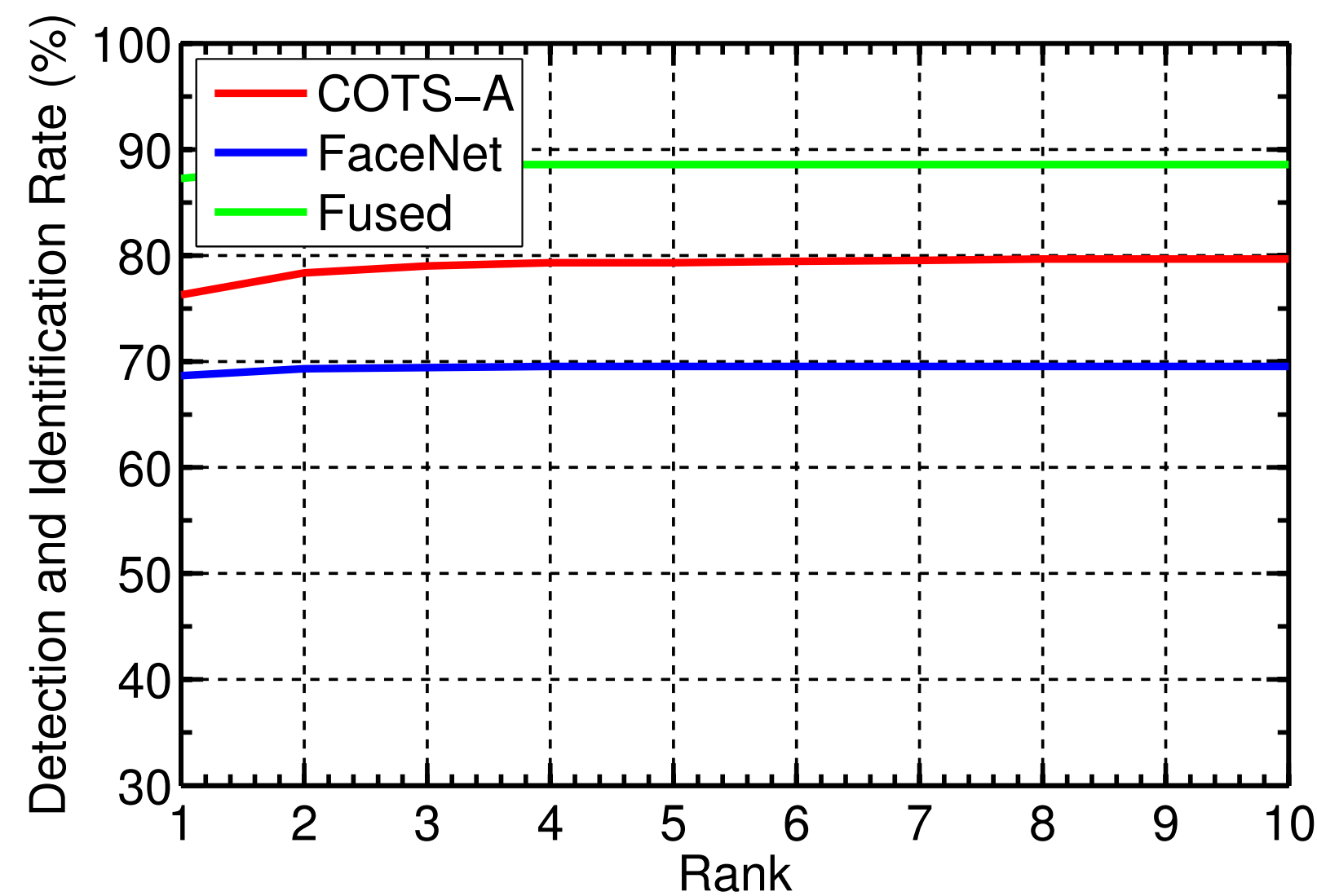


$\Delta T = 3$  years

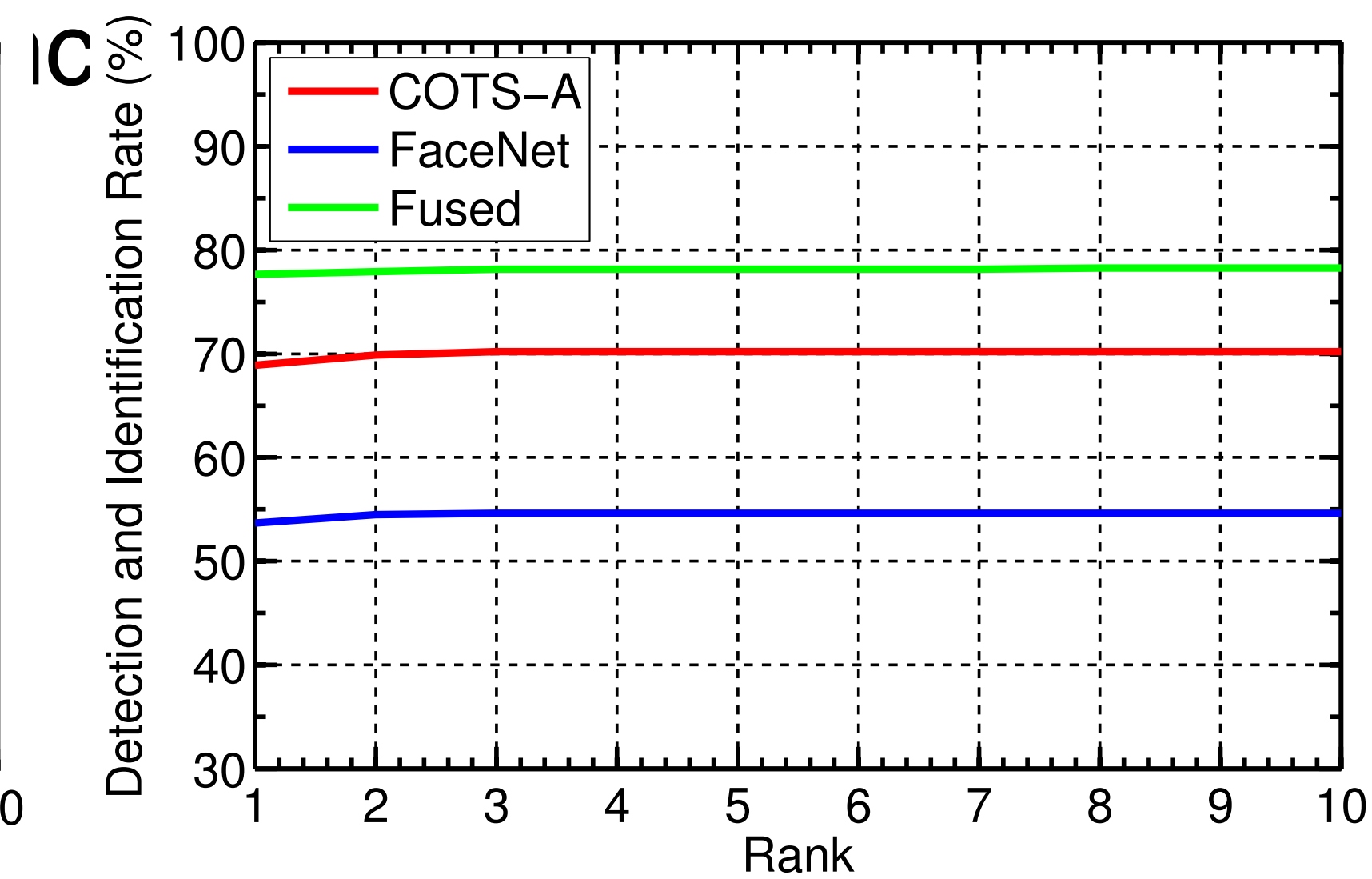
# Open-set Identification Scenario

Gallery (First image acquisition) vs. Probes (Non-enrollment + 756 images not in CLF)

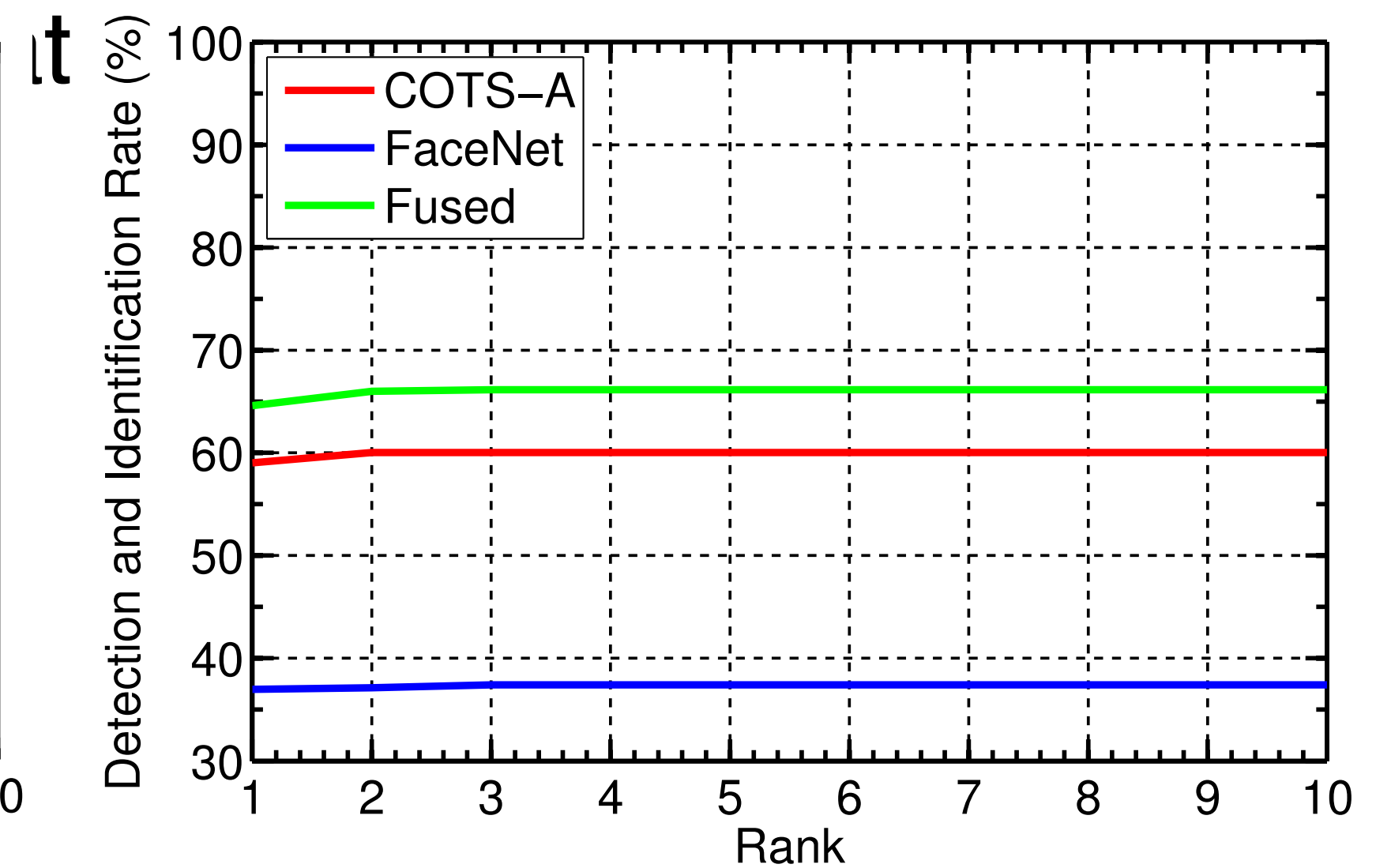
Gallery Size: 919, Probe Size: 3,520



$\Delta T = 1$  year



$\Delta T = 2$  years



$\Delta T = 3$  years



# Multilevel Statistical Models

*At what rate do genuine similarity scores change over time due to **Time Lapse** and **Gender**?*

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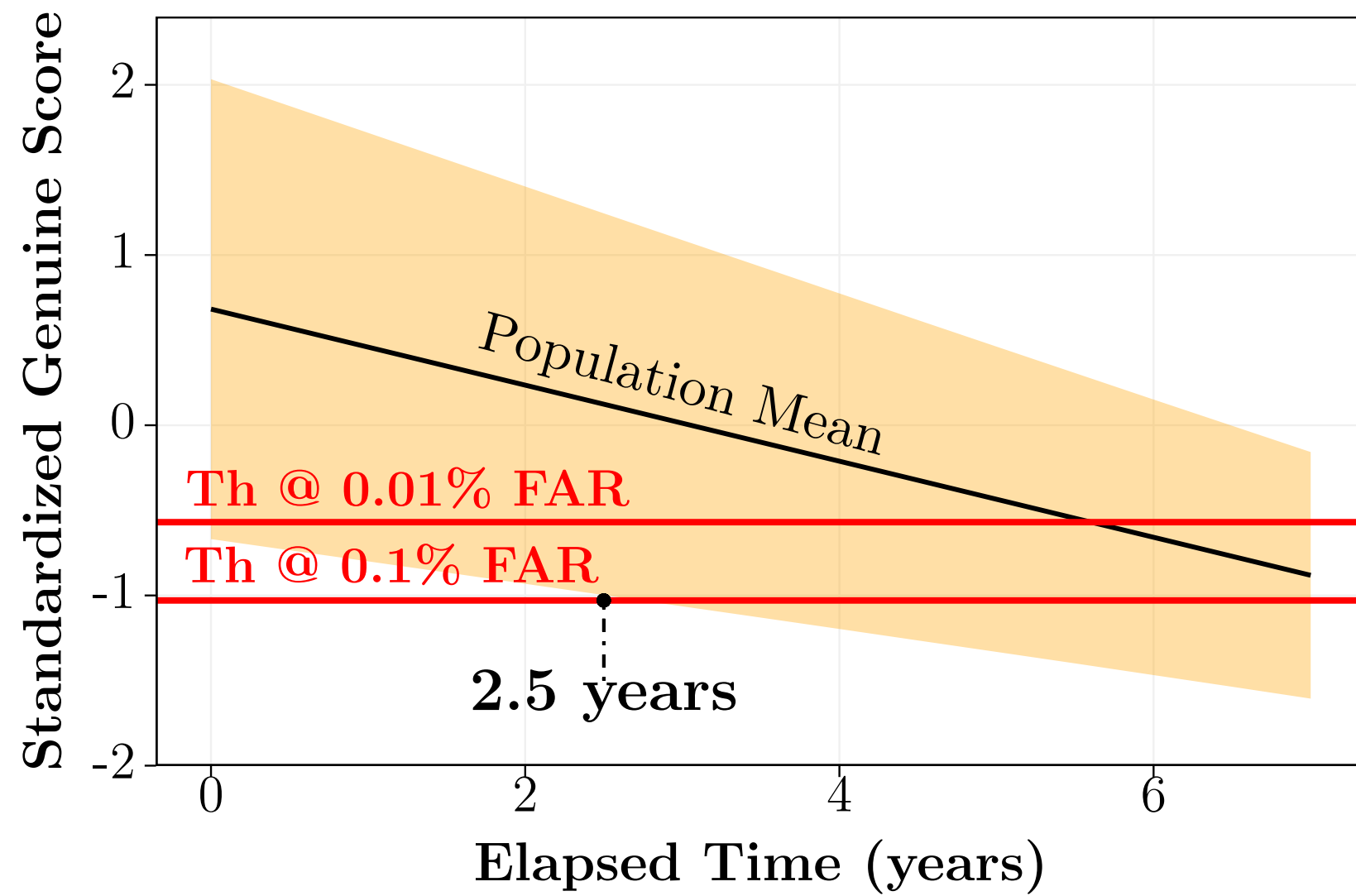
Level-1 Model: Subject-specific trend (within-subject variability)

Level-2 Model: Population-mean trend (between-subject variability)

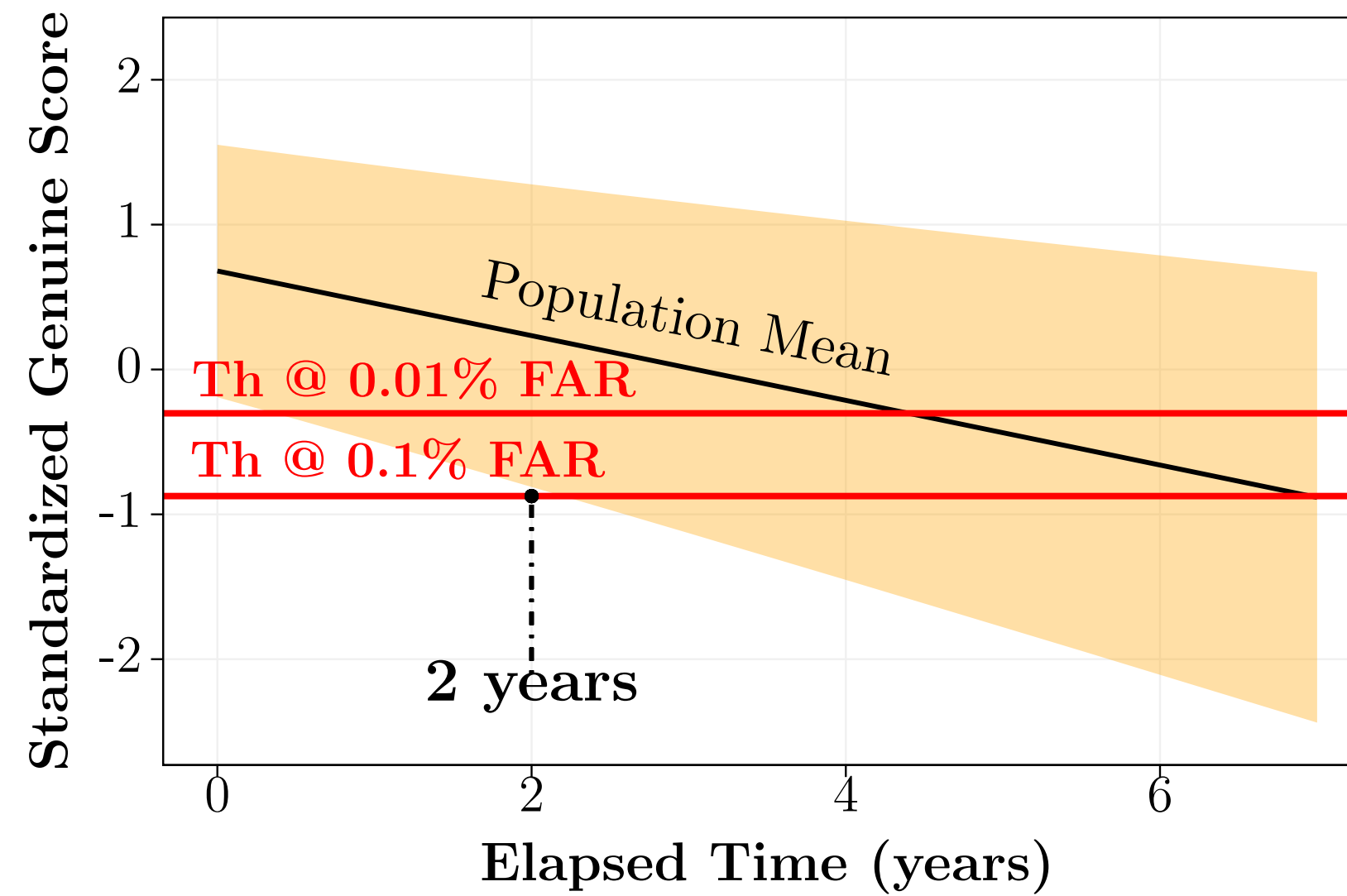


# Multilevel Statistical Models

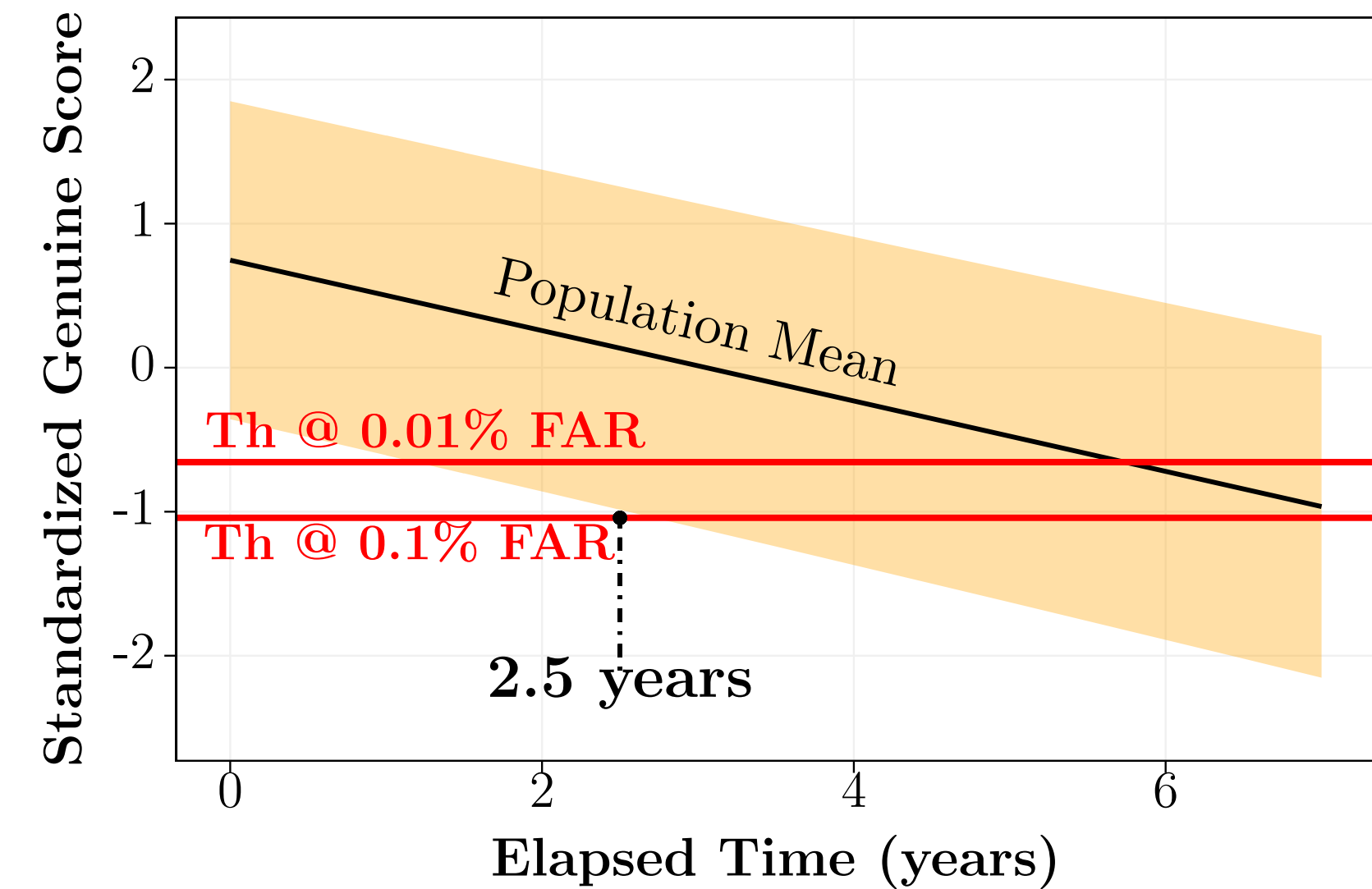
### COTS-A



### FaceNet



### Fused

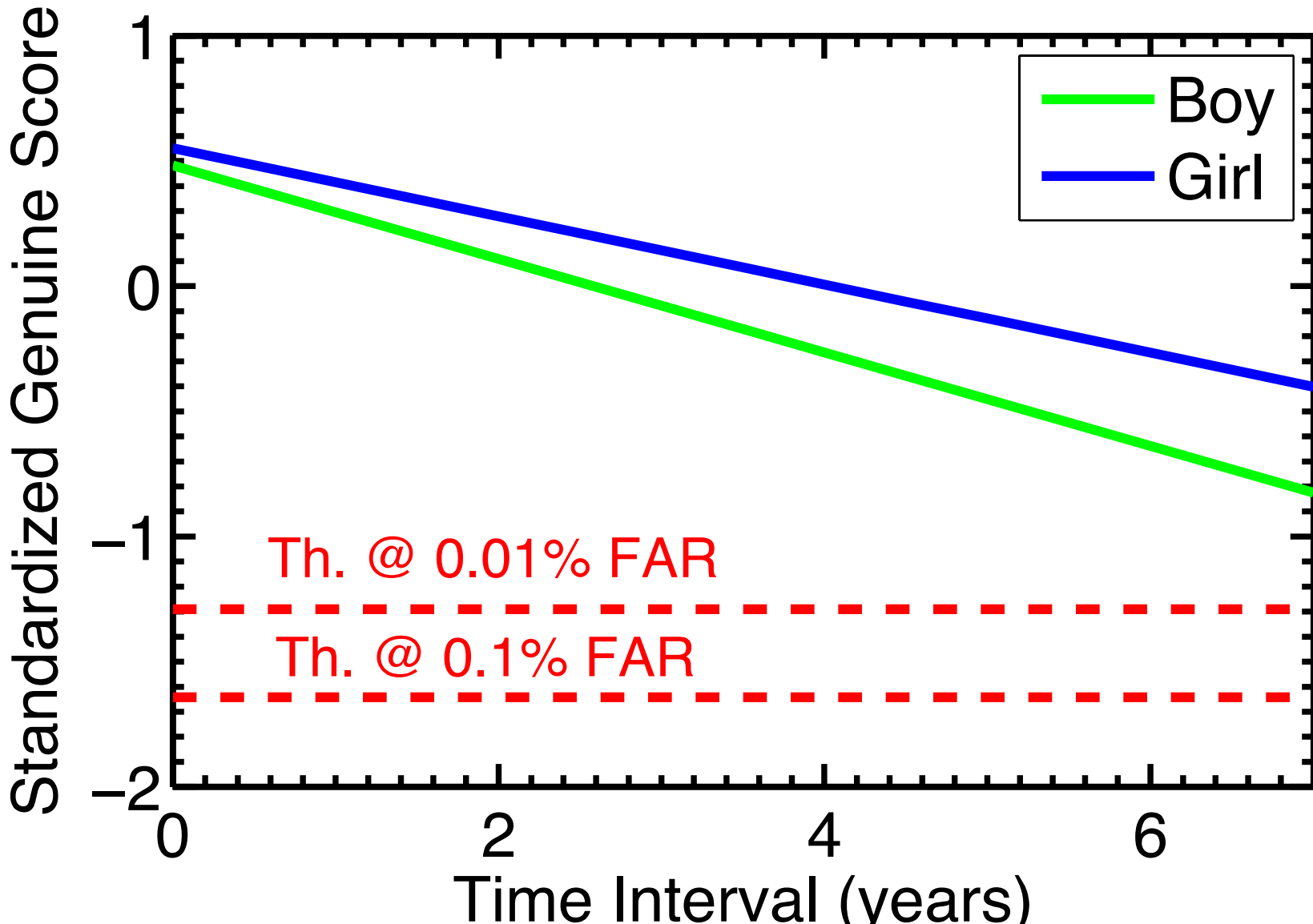


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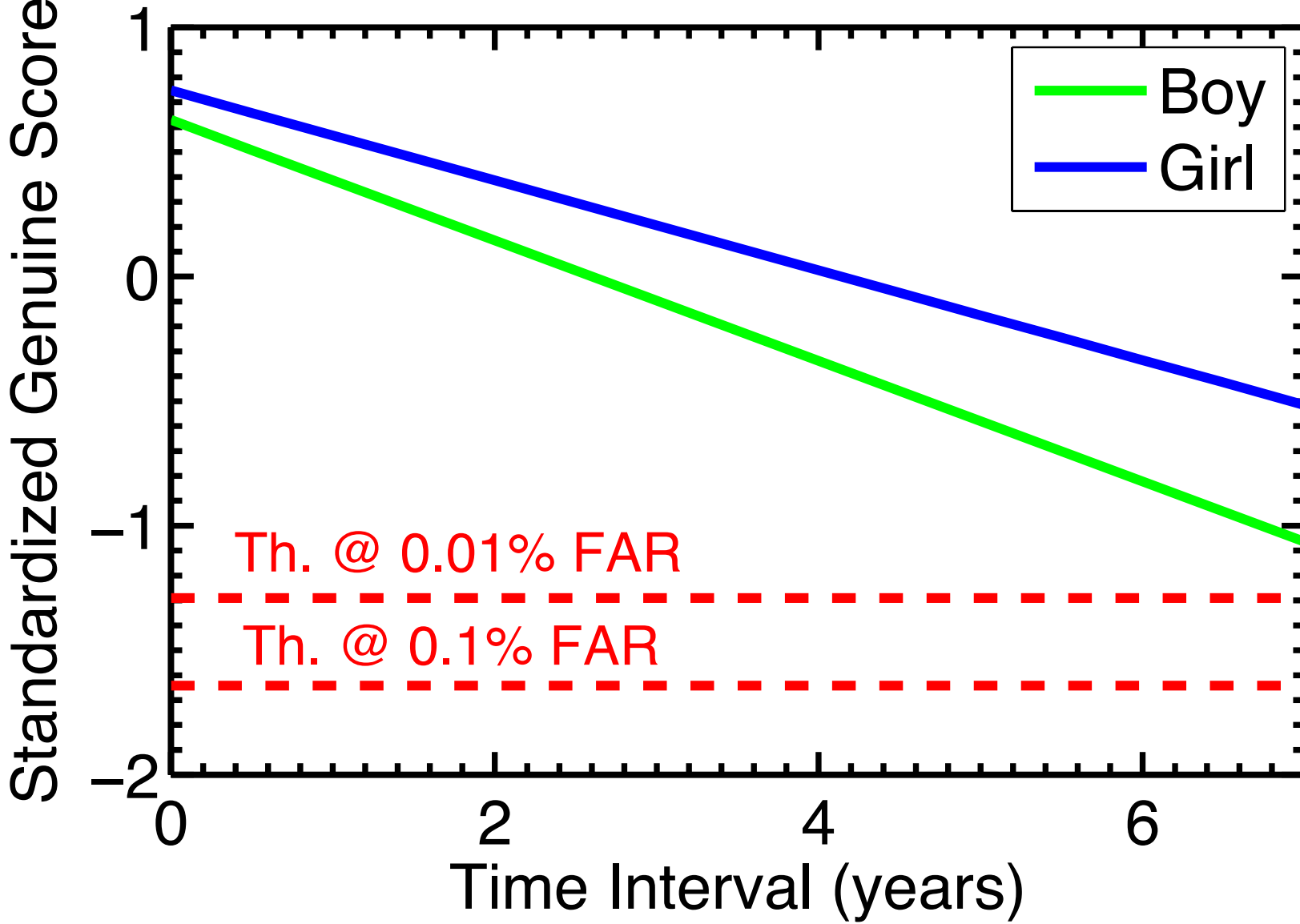


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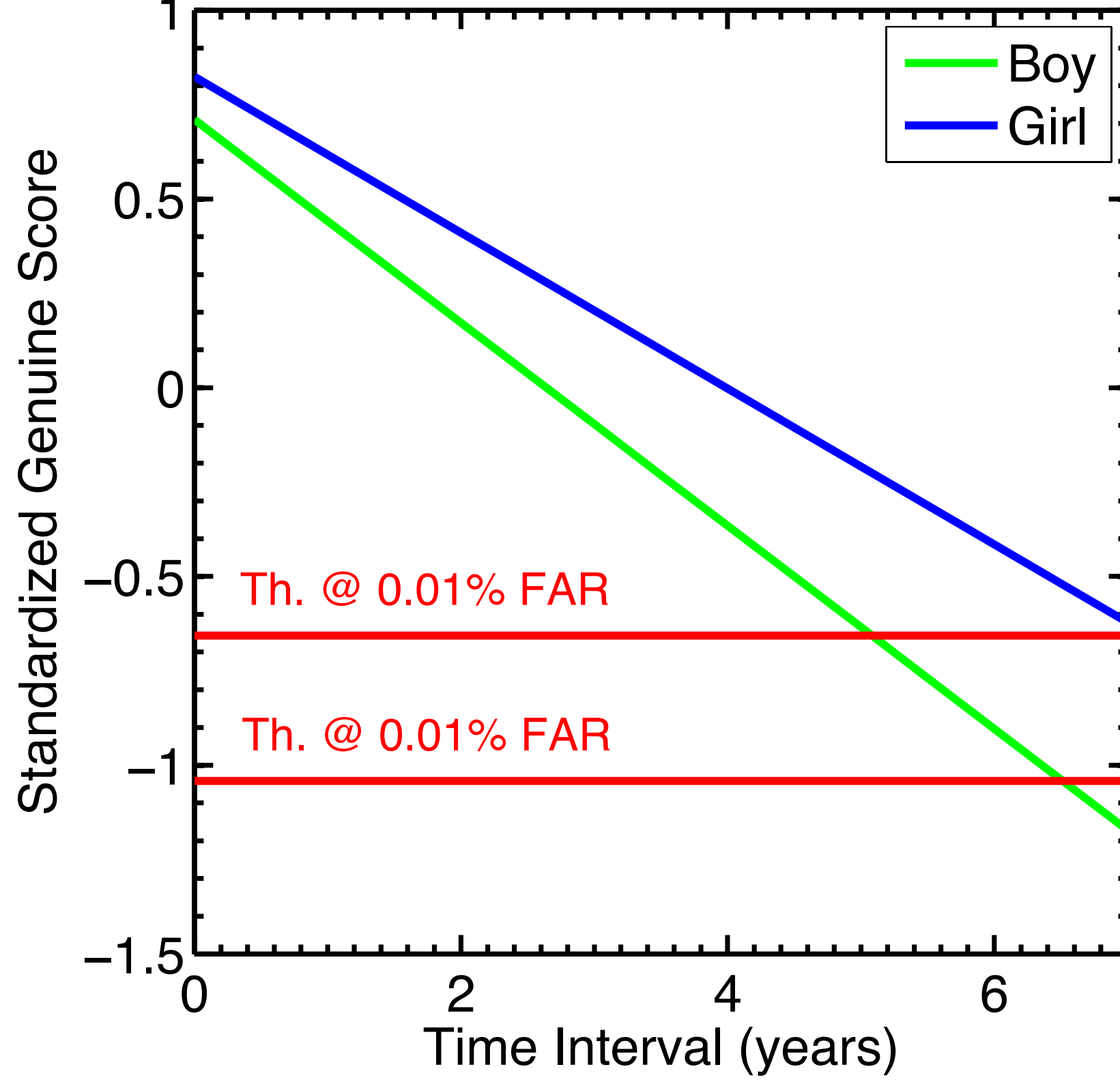
COTS-A



FaceNet



Fused

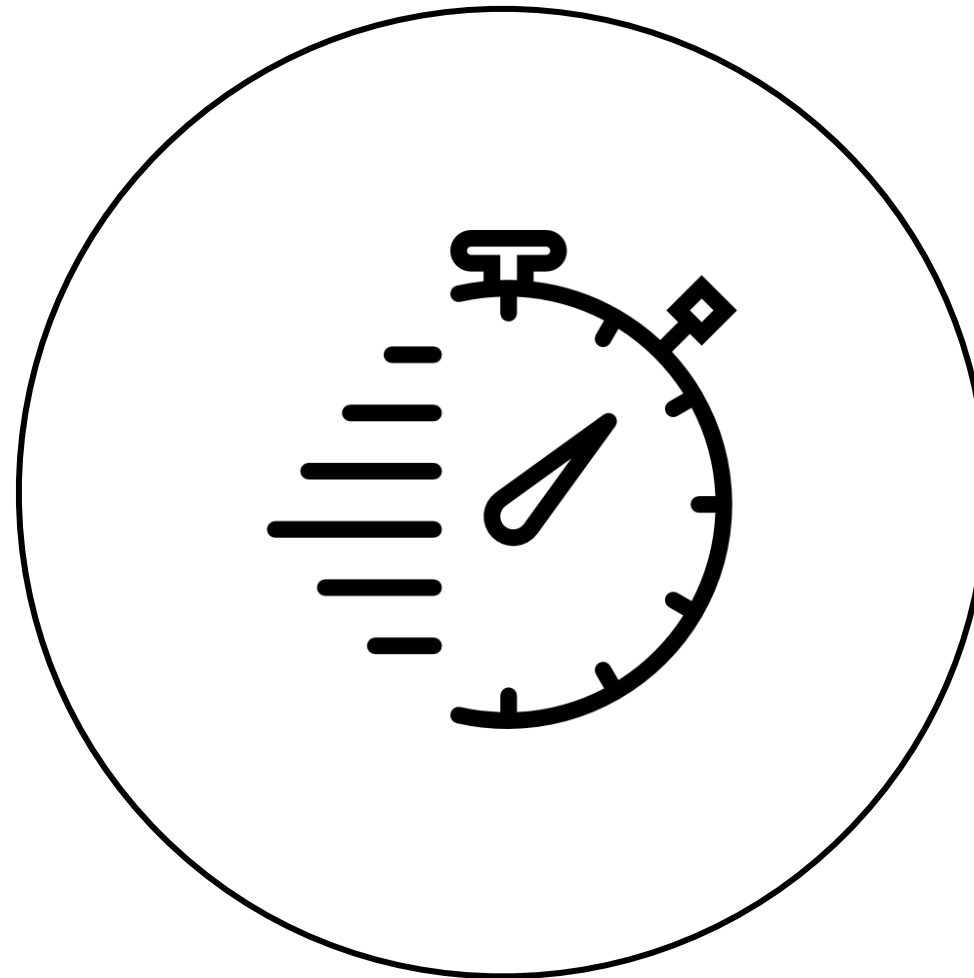


# Conclusions



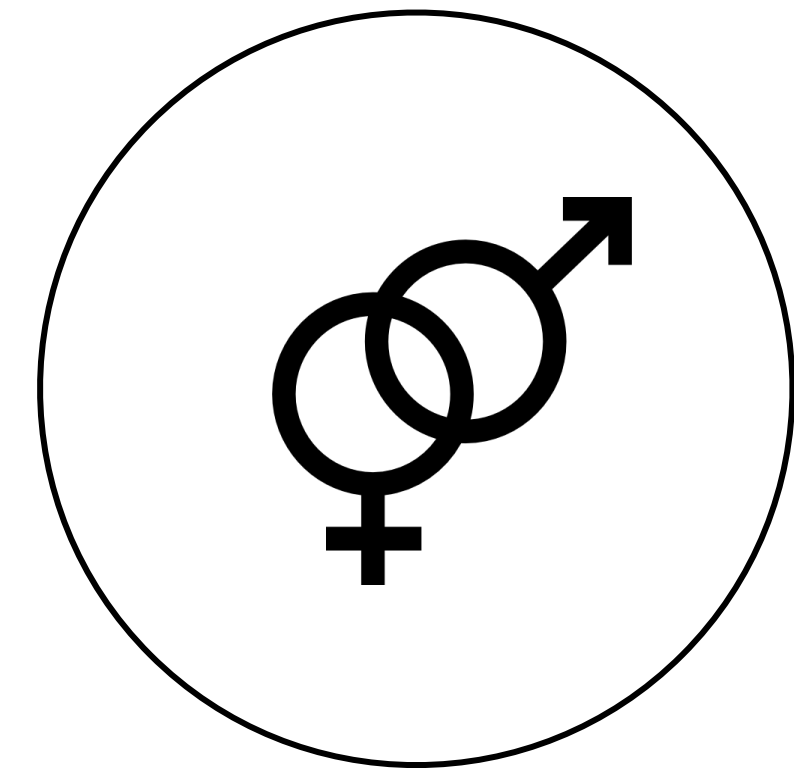
## Viability

**TAR 90.18%** at 0.1% FAR degrades to **80.12% TAR** at 0.1% FAR after 3 years.



## Time Lapse

80% of children in CLF can be successfully recognized at 0.1% FAR for an elapsed time of 2-3 years.



## Gender

Difference in performance due to gender is matcher-independent. Girls appear to be easier to recognize than boys.