Age Estimation from Face Images: Human vs. Machine Performance

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Age Estimation from Face Images

- How old are these people?

True Age: 21

True Age: 23

Potential applications

- Age-specific access control
  - Vending machines that prevent minors from buying alcohol or cigarettes

Kraft's vending machine

Japanese cigarette vending machine

http://www.dailymail.co.uk/sciencetech/article-2079048/Kraft-unveils-adults-vending-machine-scans-faces-ensure-children-free-pudding.html

http://www.dvice.com/archives/2007/11/japanese-cigarette-machine-rea.php

Potential applications

- Targeted advertising
  - Explore the shopping habit of different groups of people

http://www.theblogismine.com/2010/11/22/vending-machine-recommends-drinks-based-on-facial-recognition/

Datasets

- FG-NET
  - Public dataset, personal photographs of subjects
  - Ages: 0-69,
  - 1,002 images

18

- MORPH Album 2
  - Public dataset, collection of mugshot images
  - Ages 15-77
  - 78,207 images total

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- Pinellas County Sherriff's Office (PCSO) data set
  - Database of mugshots
  - Ages: ~18-70
  - 1.5M images total, using a 10,036 image subset

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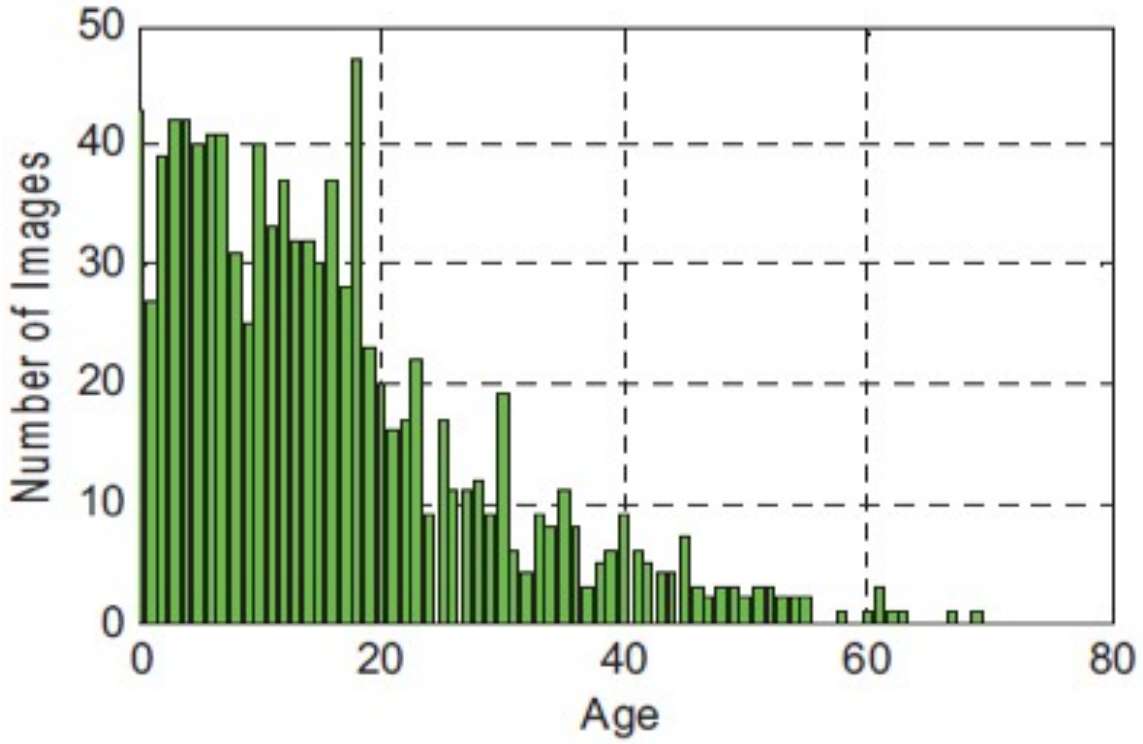
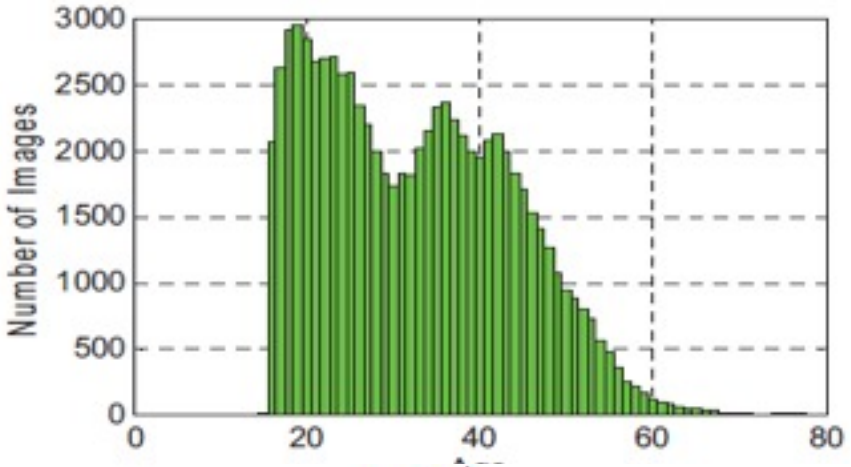
FG-NET Demographics

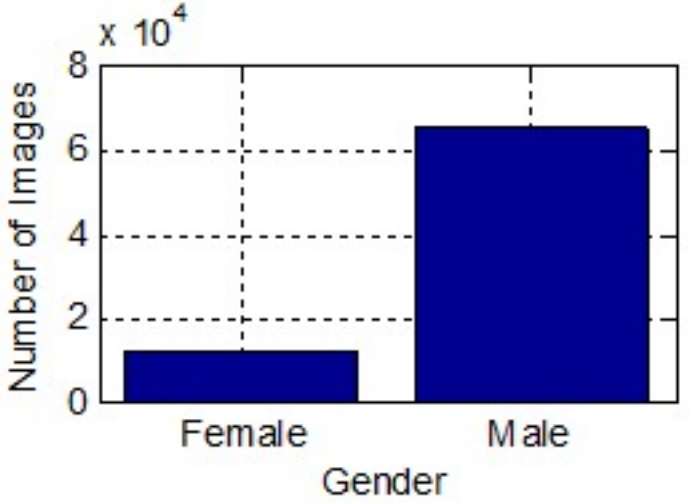
- 1002 images for 82 subjects
- Gender, ethnicity ground truth not provided

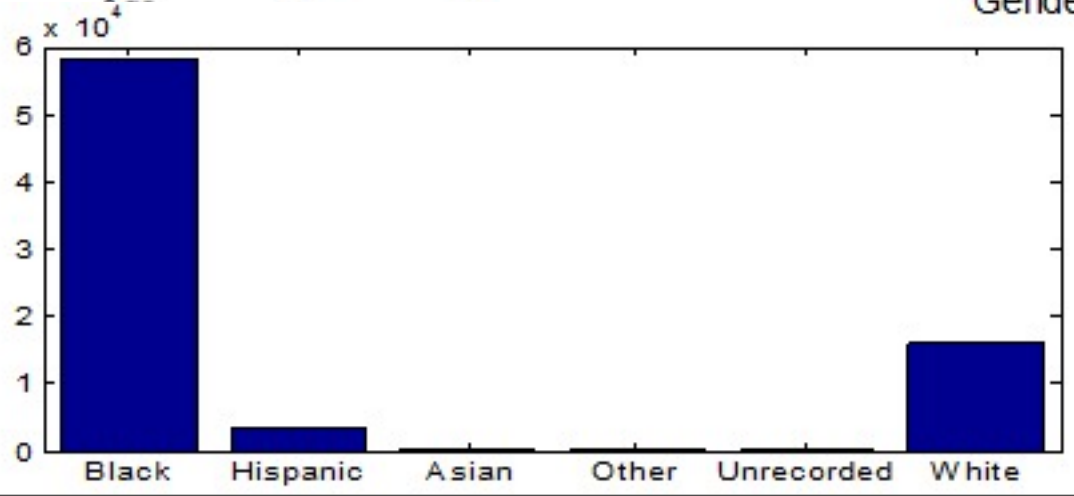


MORPH Demographics

- 78K images of 20K subjects

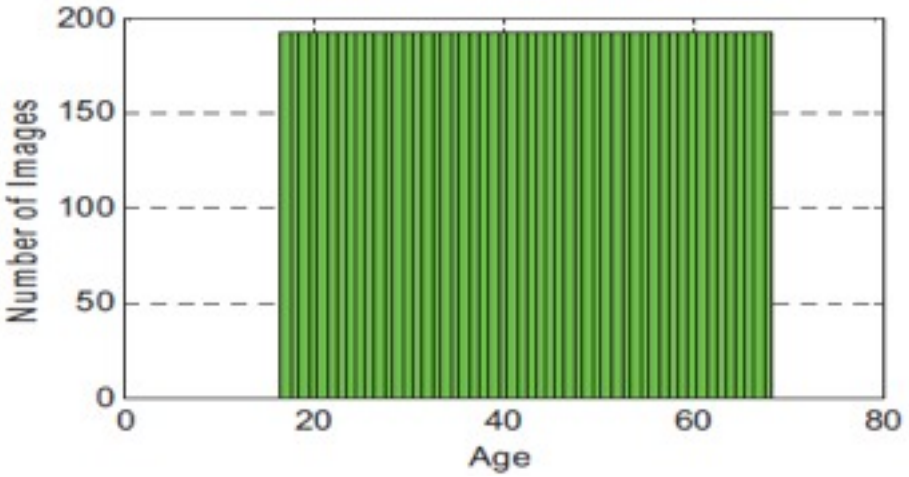


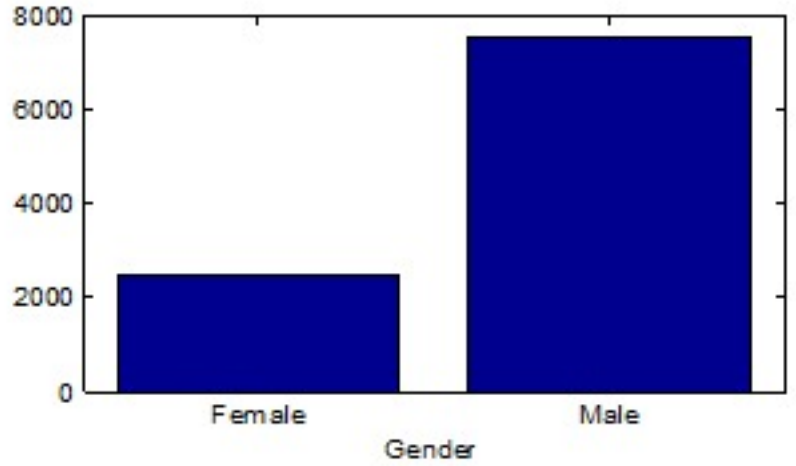


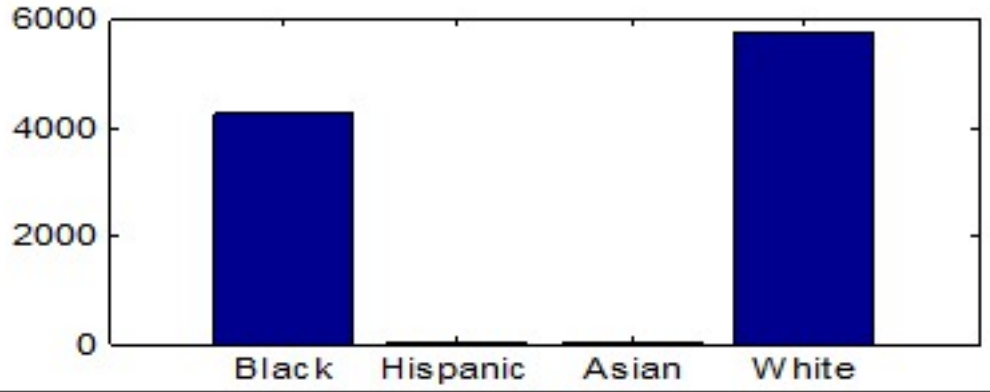


PCSO Demographics

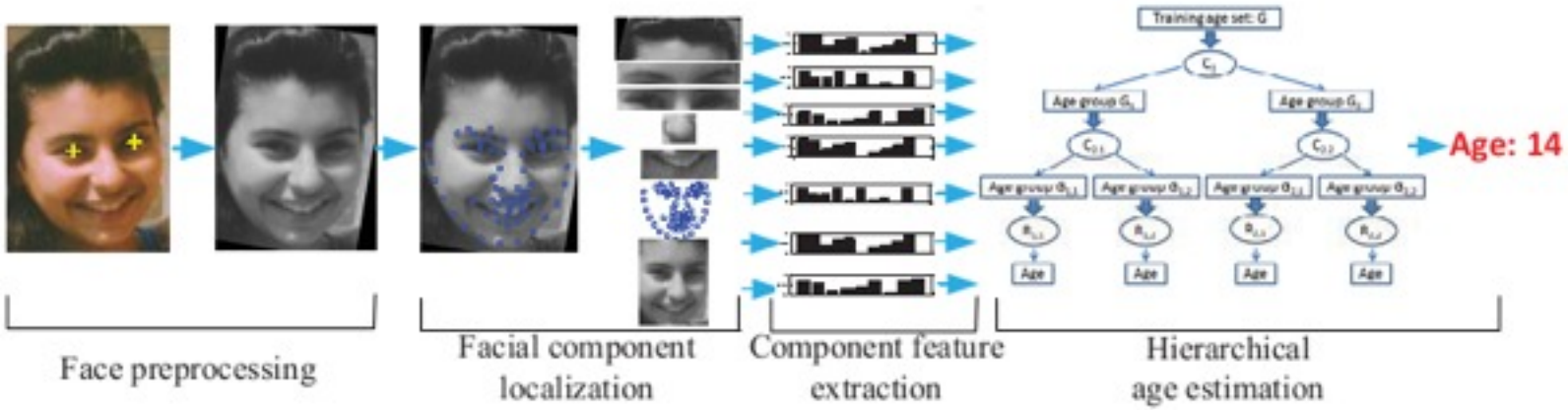
- 10,036 images of 1,802 subjects







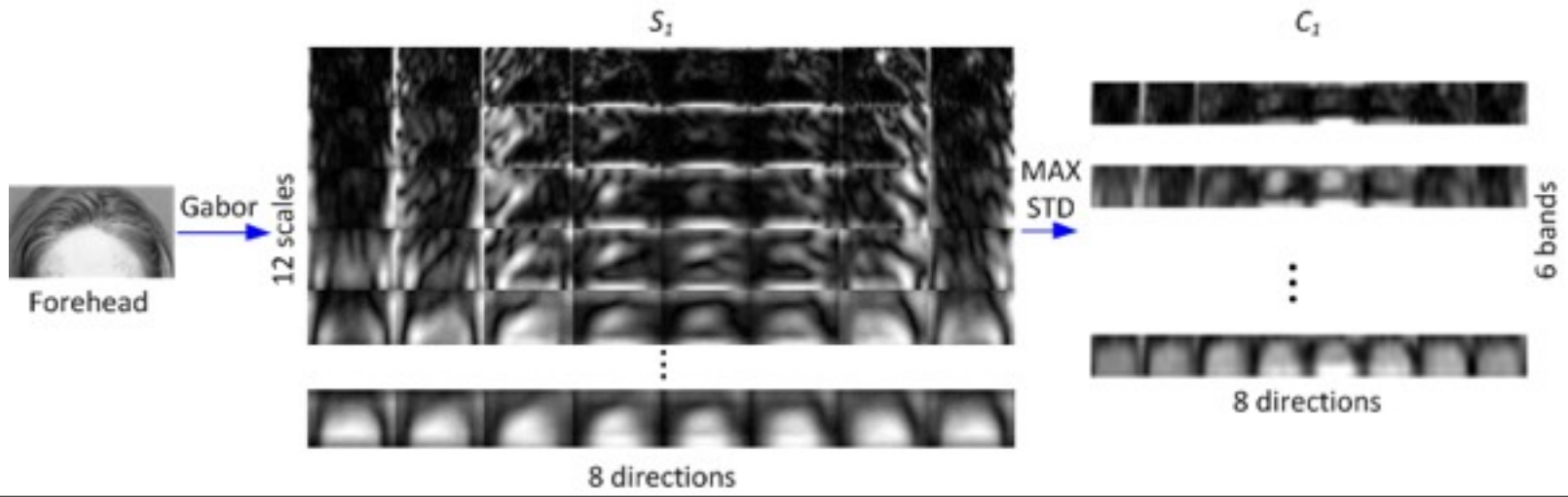
Automatic Age Estimation



- Localize 5 facial components, extract local texture features
- Extract global shape, and global texture features
- Combine global and local features
- Explicit component localization allows per-component performance analysis

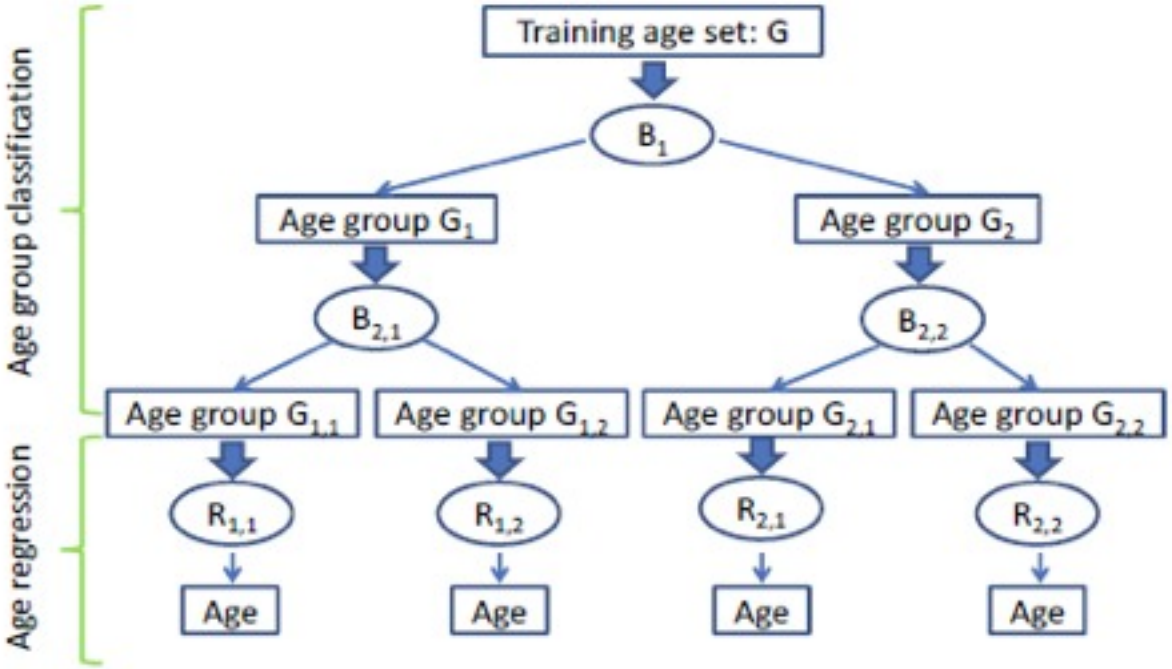
Feature Extraction

- Two-layer biologically inspired features (BIF), proposed for age estimation in [Guo'09]
- S_1 layer:
  - real component of the Gabor filter, parameters chosen to model visual component cells
  - 12 scales, 8 orientations for each scale
- C_1 layer:
  - Max between same orientation S_1 in adjacent pairs of scales, followed by standard deviation over local patches



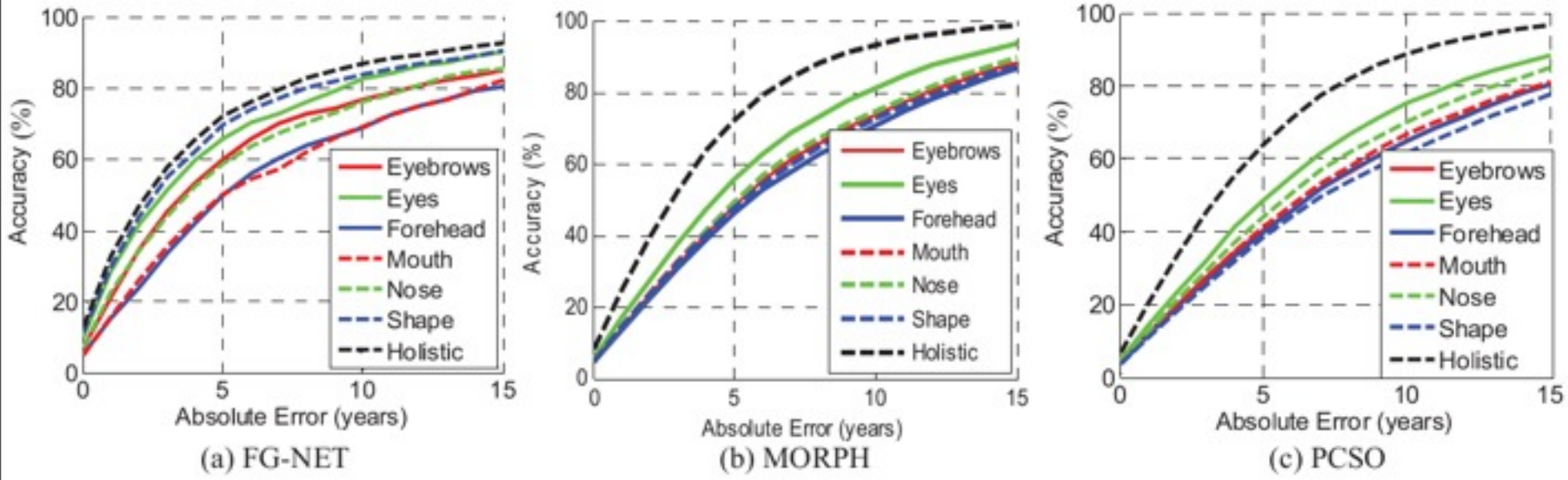
Hierarchical Age Estimation

- Age group classification (SVM) into explicit age ranges
  - FG-NET: [0-7, 8-17, 18-25, 26-70]
  - MORPH/PCSO: [16-27, 28-42, 43-55, 56-70]
- Within group regression (SVR) trained using overlapping age ranges (±5 years added to age group ranges)



Per-Component Performance

- Shape based features effective for FG-NET data
  - FG-NET results use manual landmarks
  - Shape based features most discriminative for young children
- For MORPH and PCSO datasets, holistic features significantly outperform per-component features
- Eyes give best individual component accuracy

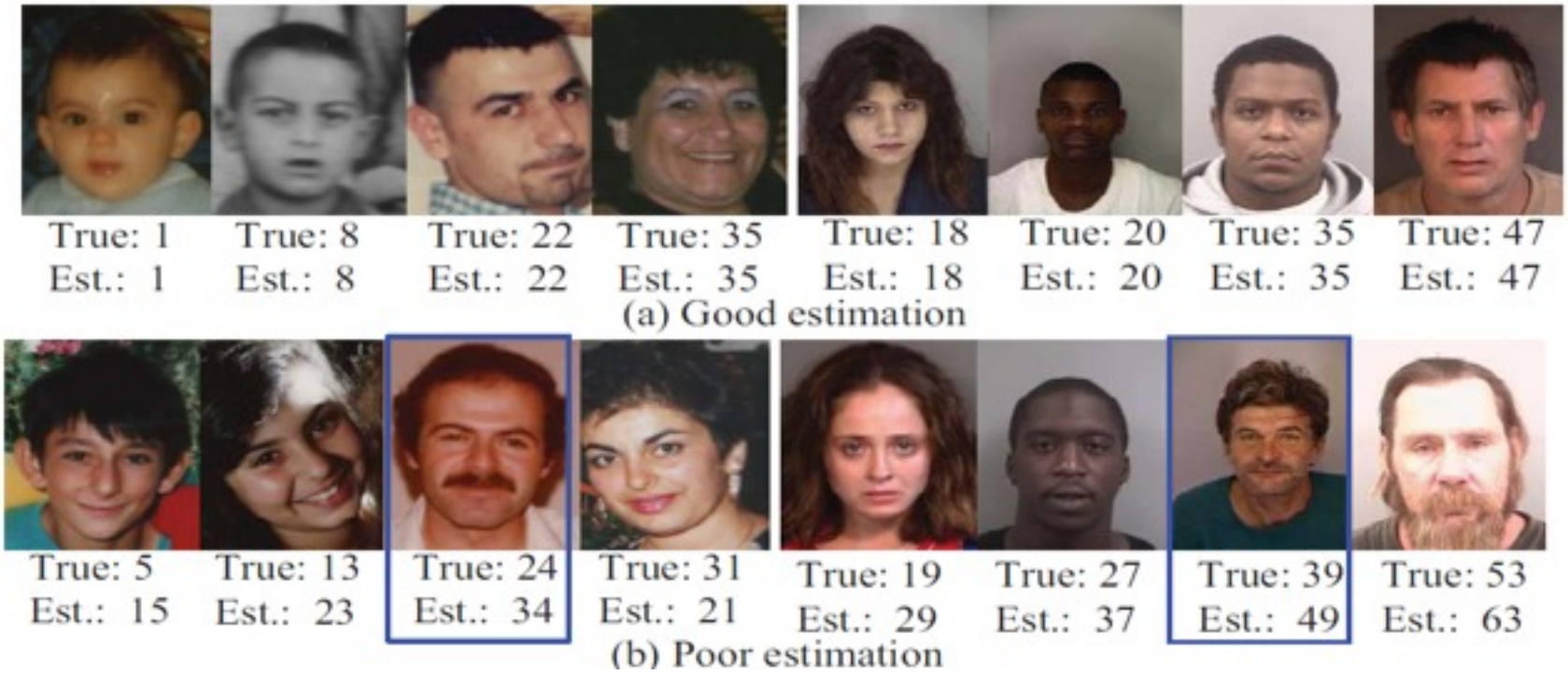


Automatic Age Estimation Performance

Age Estimation Method	FG-NET Accuracy	MORPH Accuracy	PCSO Accuracy	Per Image Estimation Time
Proposed Method	4.6/72%	4.21/72.4%	5.0/63.7%	~.3 seconds
CAM [Luu'11]	4.1/~73%			
OHRank [Chang'11]	4.5/74.7%	6.1/56.5%		
C-lsRCA+C-lsLPP [Chao'13]	4.4/~75%			
KCCA [Guo'13]		3.98		~1.62 seconds
rCCA [Guo'13]		4.42		~1.3 * 10^{-6} seconds

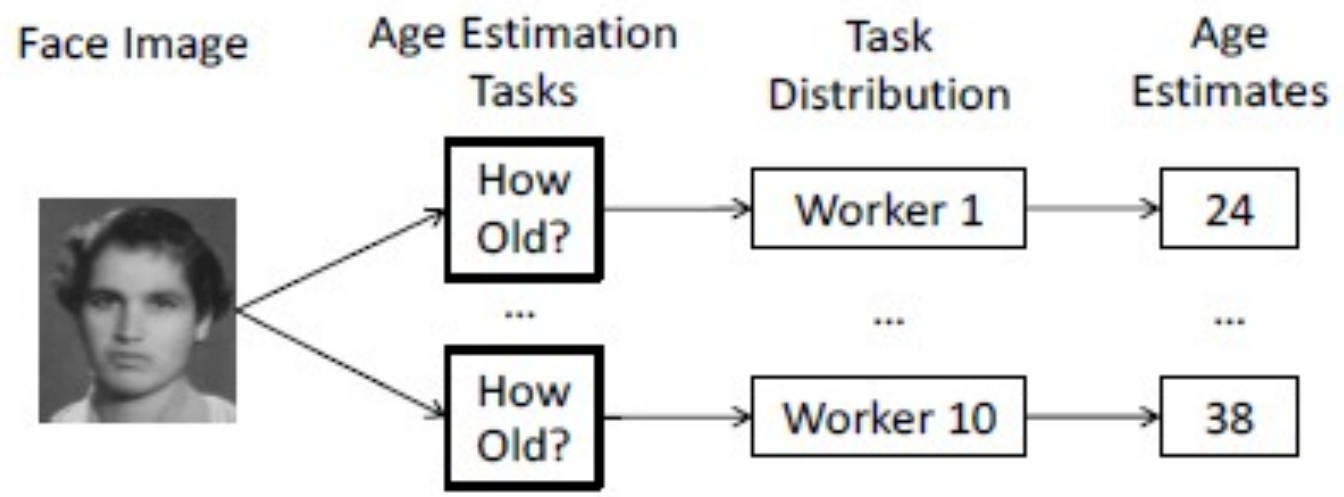
Accuracy: MAE/CS@5 years
Estimation time not including preprocessing/feature extraction

Age Estimation Examples

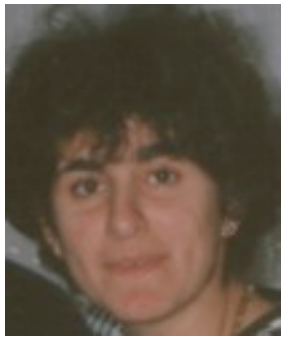


Human Age Estimation

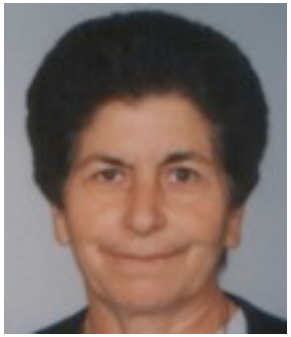
- How well can humans estimate age from the face?
- Collected 10 age estimates per image using Amazon Mechanical Turk
  - Estimates for complete FG-NET dataset, 2,200 image subset of PCSO
- Discarded high/low estimates of each image



Human Age Estimation Examples

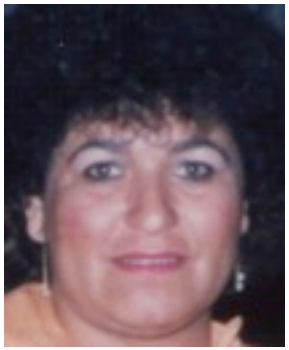


True: 19
Avg. Error: 21.6



True: 40
Avg. Error: 21.4

True: 35
Avg. Error: 23.6



True: 24
Avg. Error: 20.1

True: 28
Avg. Error: 20.7

True: 4
Avg. Error: .7

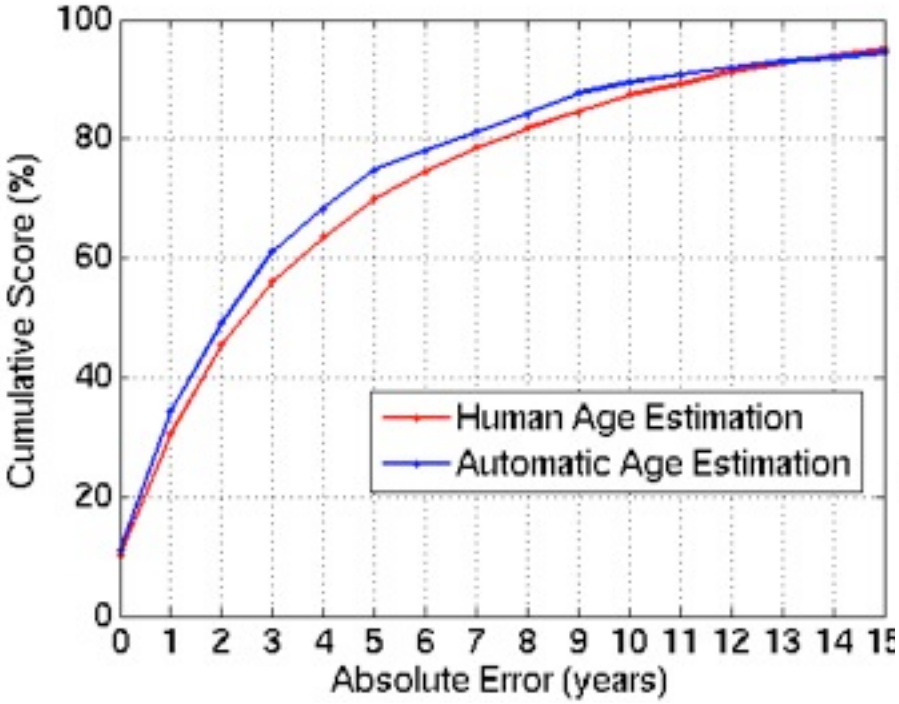
True: 6
Avg. Error: .7

True: 1
Avg. Error: .5

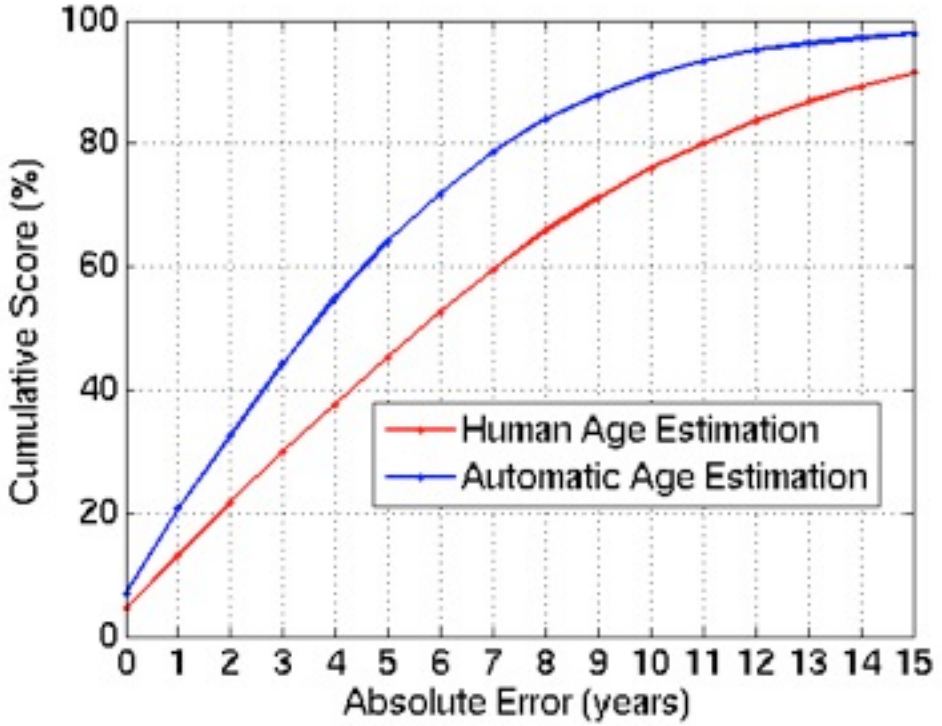
True: 2
Avg. Error: .7

True: 2
Avg. Error: .6

Human vs. Automatic Age Estimation



FG-NET



PCSO (2,200 image subset)

Summary

- Large scale evaluation on multiple datasets
- Automatic age estimation results comparable to or better than human results on FG-NET, PCSO
- Accuracy comparable to competing methods, without explicitly modeling demographic factors
- The approach makes gross errors in some cases, often due to keypoint detection errors
  - In cooperative scenarios, a reject option can improve system usability
- Prototype real time implementation

Thank You!