



Forensic Intelligence Workshop

Facial Age Estimation

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OSLO, 24TH APRIL 2019



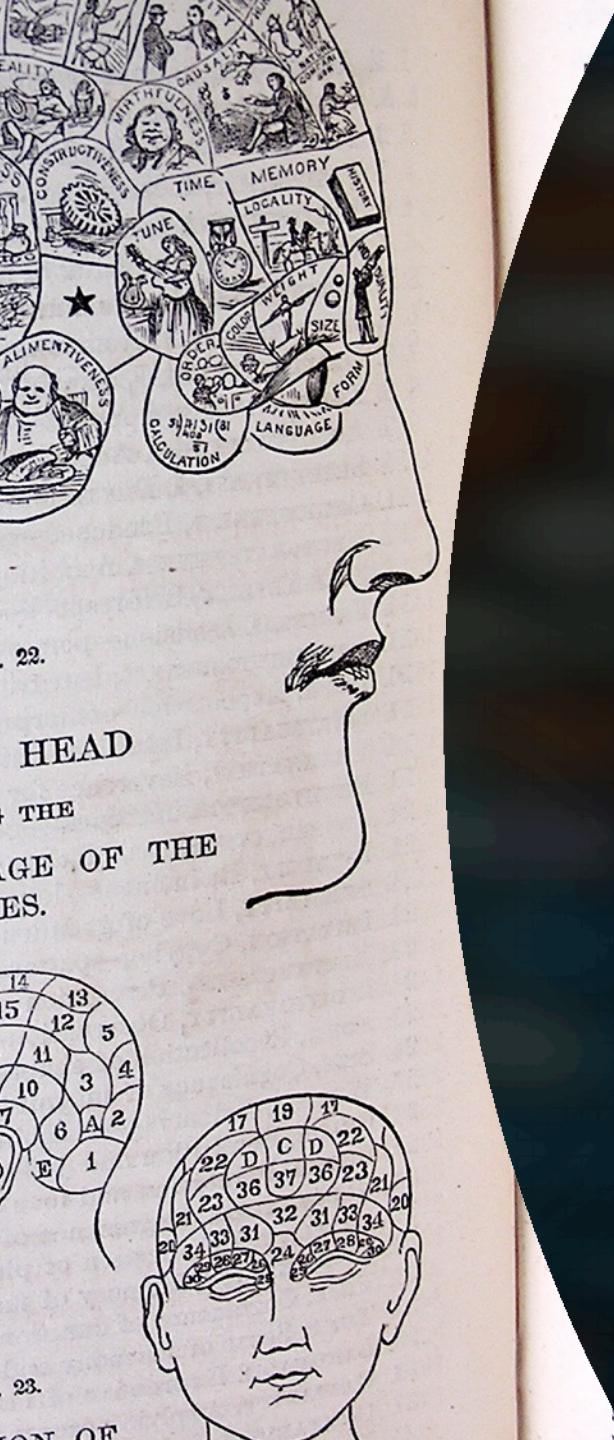
UCD Forensics and
Security Research Group

Agenda

- ▶ Human Fascination with Facial/Cranial Measurement
- ▶ Human Facial Age Estimation
- ▶ Current Applications of AI Facial Analysis
- ▶ How Do AIs See Your Face?
- ▶ What Can They Detect?
- ▶ Your how old!?

[and hopefully debunk some myths along the way]

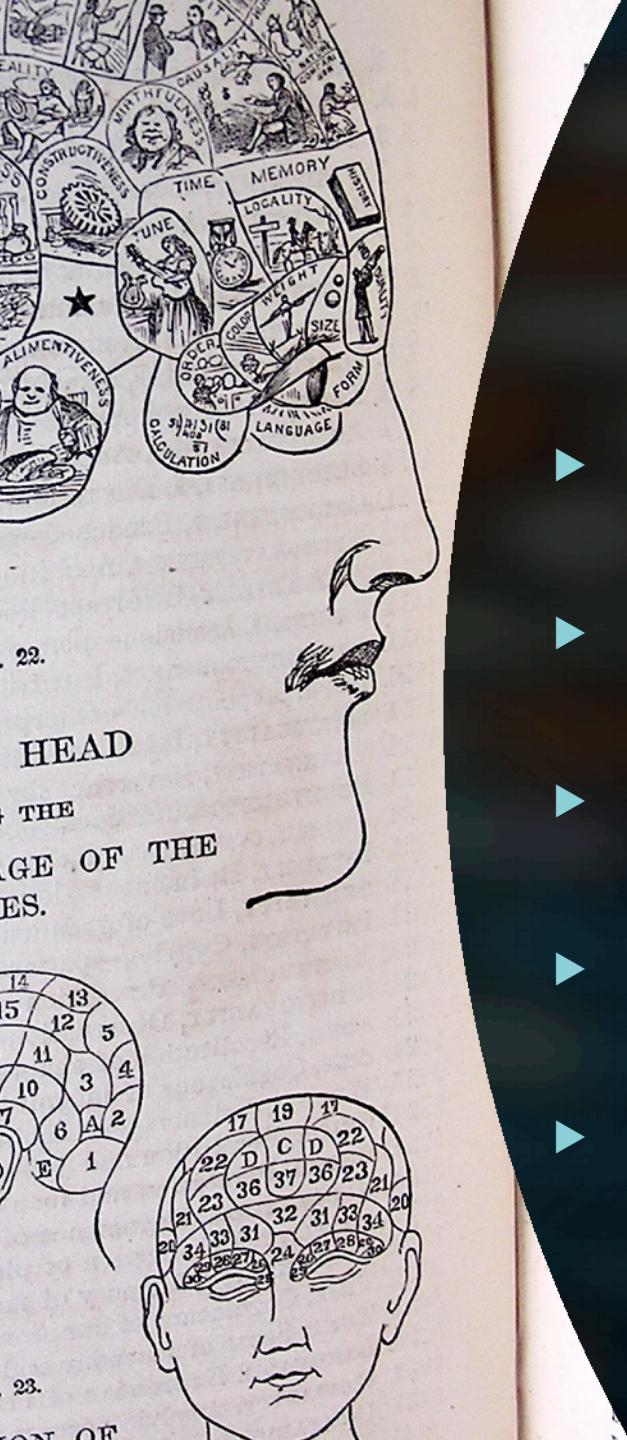




Phrenology

- ▶ Developed by German physician Franz Gall in 1796, phrenology is a pseudomedicine primarily focused on measurements of the human skull
 - ▶ Based on the concept that the brain is the organ of the mind, and that certain brain areas have localized, specific functions or modules.
 - ▶ Although both of those ideas have a basis in reality, phrenology extrapolated beyond empirical knowledge in a way that departed from science.
 - ▶ Phrenological thinking was influential in 19th-century psychiatry.
 - ▶ Gall's assumption that character, thoughts, and emotions are located in specific parts of the brain is considered an important historical advance toward neuropsychology.





Phrenology: Alleged Application Areas

- ▶ Education
 - ▶ Identify Slow Learners, Disorderly Children
 - ▶ Criminology
 - ▶ Determined predispositions and influenced sentencing
 - ▶ Psychiatry
 - ▶ An external view into the brain
 - ▶ Psychology
 - ▶ Used during hiring or finding suitable marriage partners
 - ▶ Racism
 - ▶ Europeans used it as a scientific basis for their perceived superiority



Examples Where AI Facial Analysis/Recognition is Being Used

- ▶ Security
 - ▶ Automated Boarding Gates at Airports
- ▶ Beijing's Social Rating System
- ▶ Targeted Real-World Advertising
- ▶ Restaurants
 - ▶ KFC in China is working in collaboration with Baidu to infer what a customer may be interested in ordering – based on their gender, facial expressions, and other visual features
 - ▶ Fast food restaurants in the USA are using facial recognition software to remember how you like your burger



A dark, moody profile photograph of a person's head and shoulders, facing right. The lighting is dramatic, highlighting the side of the face and the hair.

Human Facial Age Estimation

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- ▶ People are more accurate at estimating ages of those close to their own age/gender/ethnicity
- ▶ Tendency to assimilate age estimation with one's own
- ▶ Younger subjects tend to be consistently overestimated
- ▶ Accuracy is impacted by a range of factors including gender, ethnicity, facial hair and emotion/facial expressions
 - ▶ Smiling has been identified as shaving 3 years off your age



Expert Human Age Estimators (aka Bar Staff)

- ▶ Effectively experts at borderline adulthood determination
- ▶ Survey conducted in 2001 in the UK with bar staff
 - ▶ Staff were tested in their age estimation for several people aged 13, 16, 20 and 22, male and female
 - ▶ 18% of 13 year old females were judged to be of legal drinking age (3% for males)
 - ▶ 56% of 16 year old females were judged to be of legal drinking age (38% for males)
- ▶ Results confirmed in second study identifying a Mean Absolute Error rate of 3.26 years for the experts' 15-19 year olds age estimation (4.21 years for a control group)

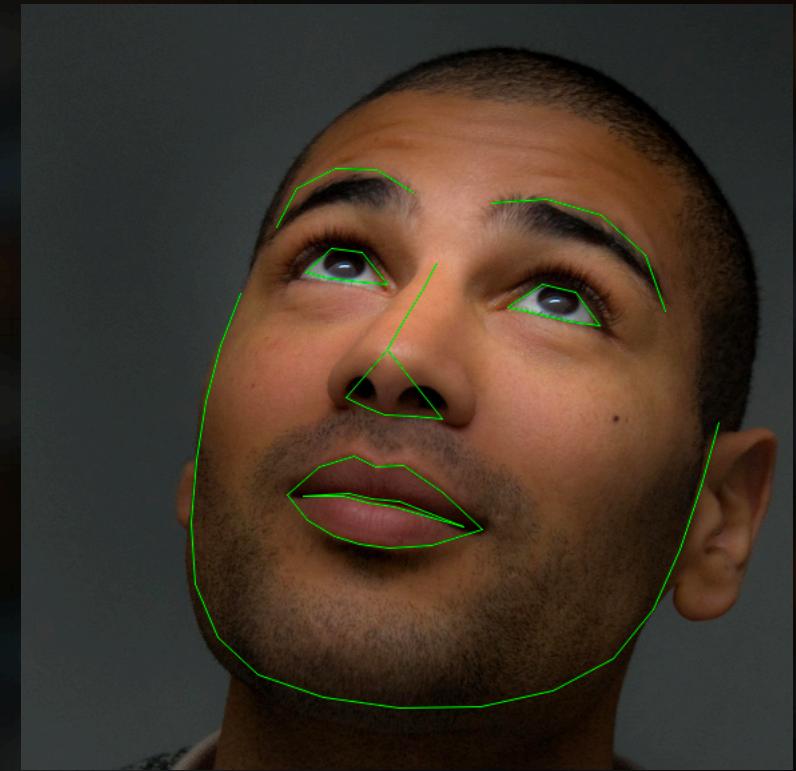




Automated Facial Recognition

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- ▶ Relies on facial landmarks and their relative position and distances
- ▶ Eye
 - ▶ Pupil Left/Right Edge
 - ▶ Left/Right Outer Edges
 - ▶ Left/Right Inner Edges
 - ▶ Left/Right Top/Bottom Edges
 - ▶ Eyebrow Left/Right Top/Bottom Edges
- ▶ Mouth
 - ▶ Left/Right Edges
 - ▶ Top/Bottom of each Lip
- ▶ Etc.

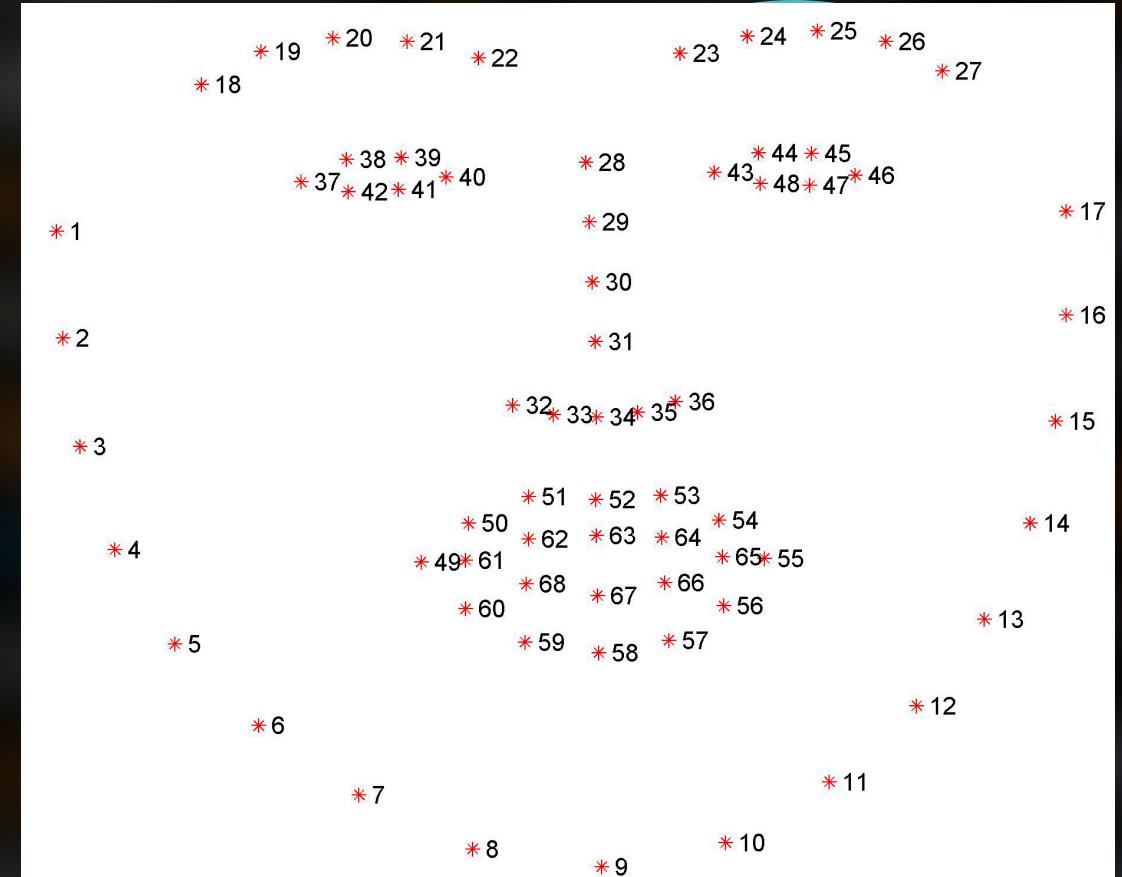


dlib Facial Landmark Detection

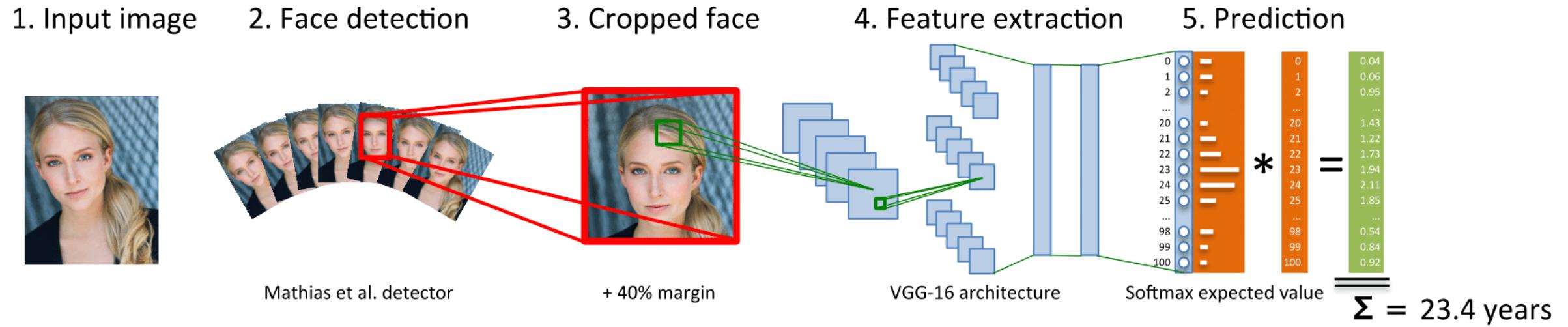


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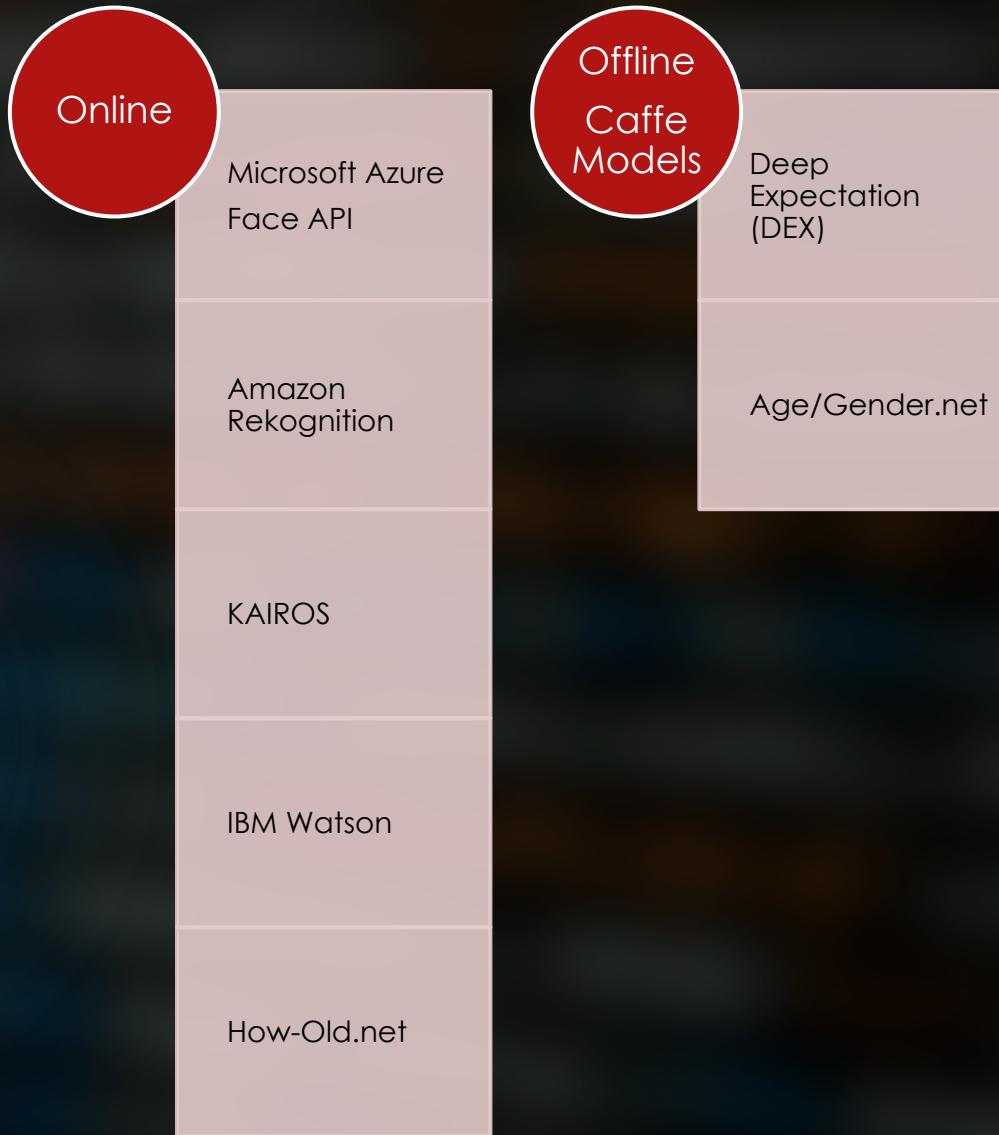
- ▶ The pose estimator was created by # using dlib's implementation of the paper:
 - ▶ One Millisecond Face Alignment with an Ensemble of Regression Trees by Vahid Kazemi and Josephine Sullivan, CVPR 2014
 - ▶ Trained on the iBUG 300-W face landmark dataset 300 faces In-the-wild challenge: Database and results. Image and Vision Computing (IMAVIS), Special Issue on Facial Landmark Localisation "In-The-Wild". 2016.



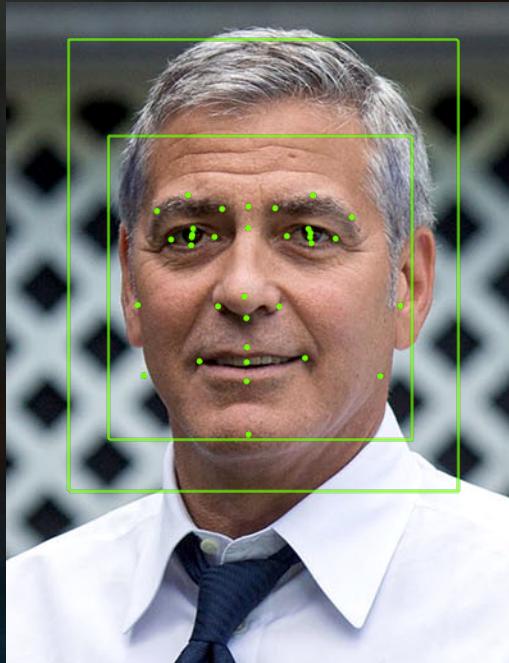
Automated Age Estimation



Age Estimation Services



George - Age 55

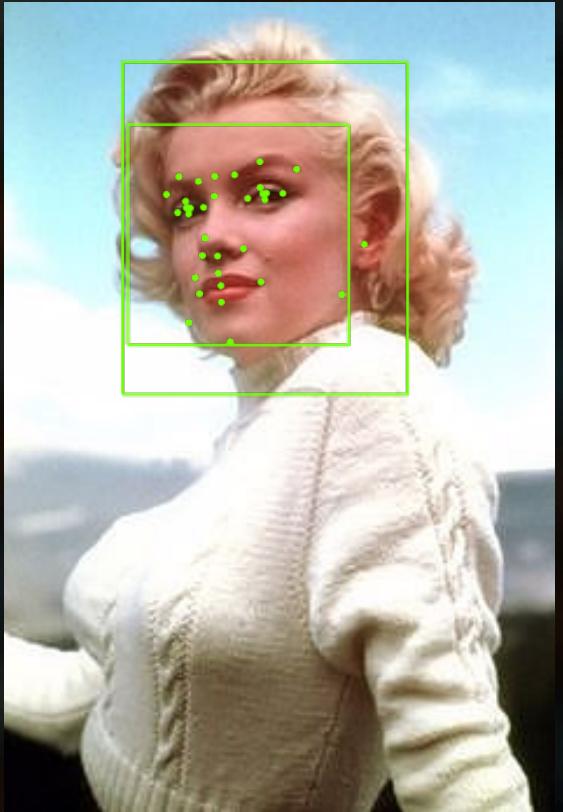


- ▶ Age: 59, 56-58, 60-90, or 31
- ▶ Gender: Male
- ▶ Grey: 1.0
- ▶ Smiling: 0.79
- ▶ Moustache: 0.1
- ▶ Bald: 0.07
- ▶ Contempt: 0.001

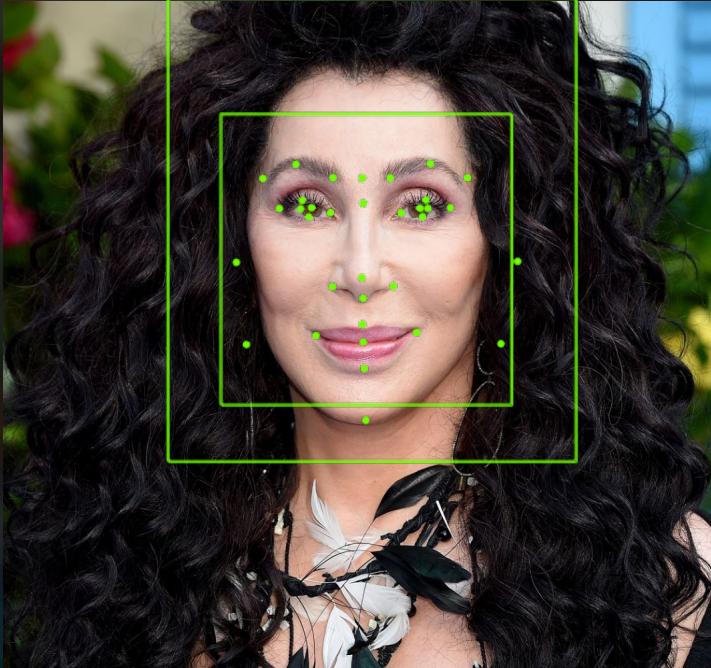


Marilyn - Age 26

- ▶ Age: 29, 18-22, 20-38, or 25
- ▶ Gender: Female
- ▶ Blond: 1.0
- ▶ Smiling: 0.75
- ▶ Bald: 0.00
- ▶ Eye Makeup: True
- ▶ Lip Makeup: True
- ▶ Contempt: 0.002



Cher – Age 72



- ▶ Age: 54, 53-57, 35-52, or 16
- ▶ Smiling: 0.99
- ▶ Hair:
 - ▶ Black: 0.99
 - ▶ Grey: 0.51
- ▶ Eye Makeup: True
- ▶ Lip Makeup: True
- ▶ Surprise: 0.001



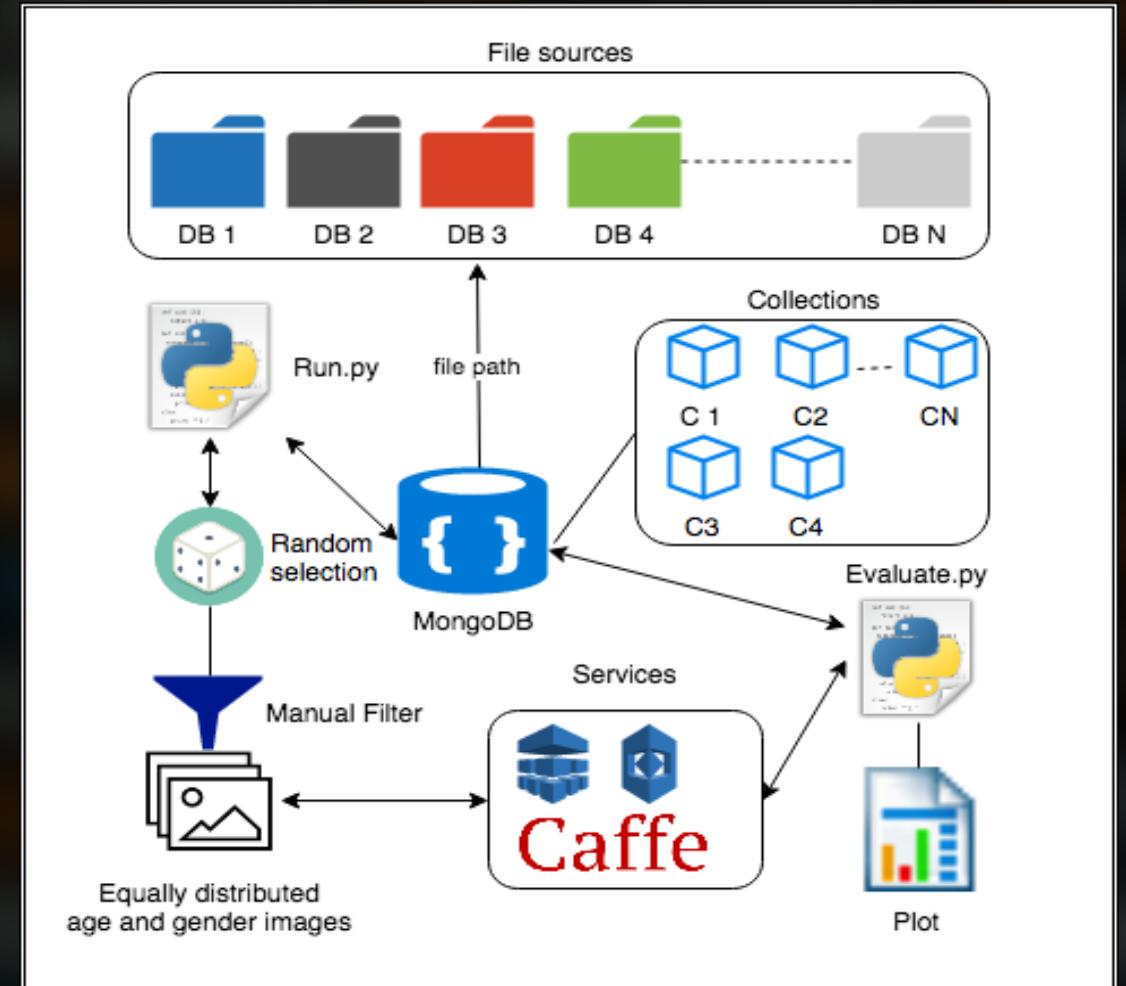
Facial Age Estimation Datasets

Dataset	Image	Description
FGNET	1K	<ul style="list-style-type: none">- Subject timeline- Ages 0 to 69
MEDS	1.3K	<ul style="list-style-type: none">- Deceased persons- Ages 17 to 70
FERET	14K	<ul style="list-style-type: none">- Multiple subject poses- Ground truth
MORPH	55K	<ul style="list-style-type: none">- Ages 16 to 77
IMDB-WIKI	500K	<ul style="list-style-type: none">- Crawled images- Ages 0 to 100
OUI-ADIENCE	26K	<ul style="list-style-type: none">- Flickr in the wild- Age label groups

Dataset Generator

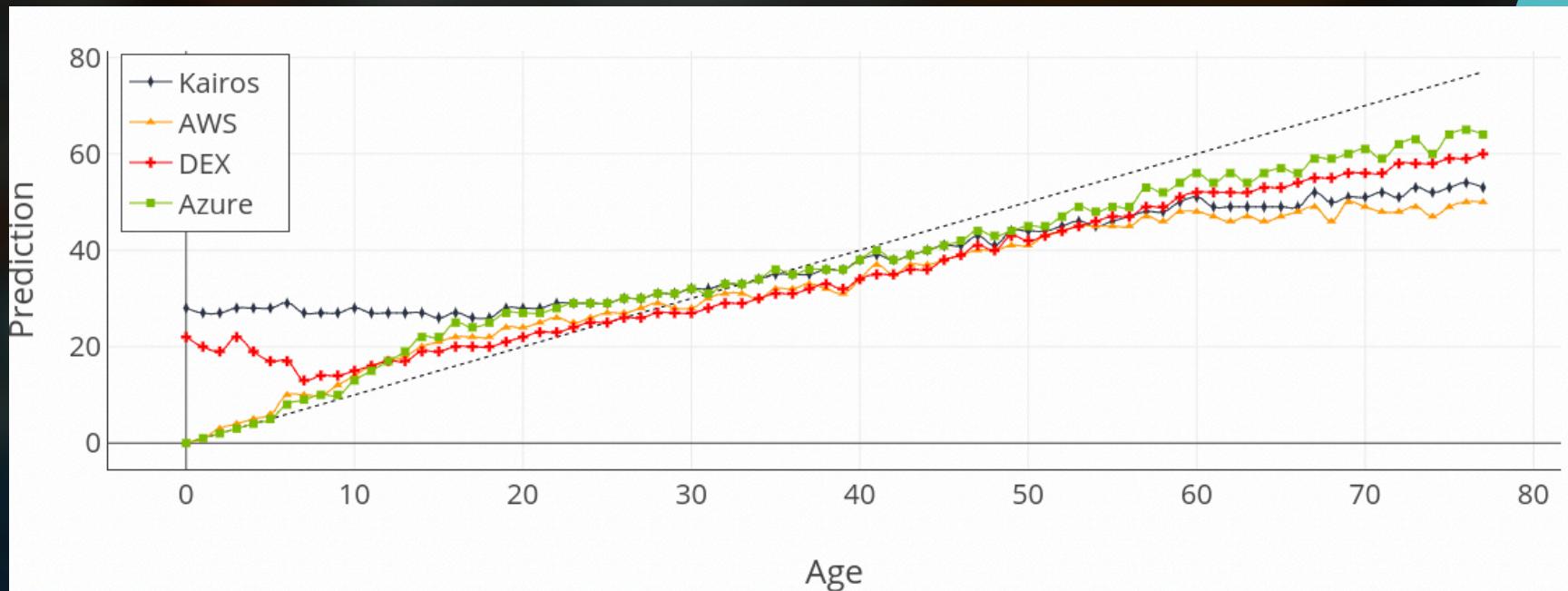


https://bitbucket.org/4nd4/image_database.git



Evaluation of Existing Services

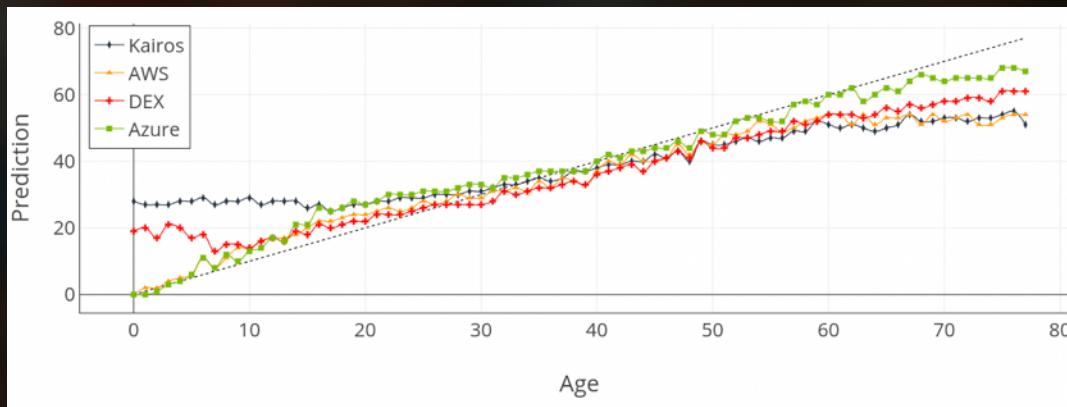
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Service	MAE
Kairos	11.236
AWS	9.286
DEX	8.079
Azure	7.614

Average Estimated Age Compared with Actual Age across Entire Dataset.

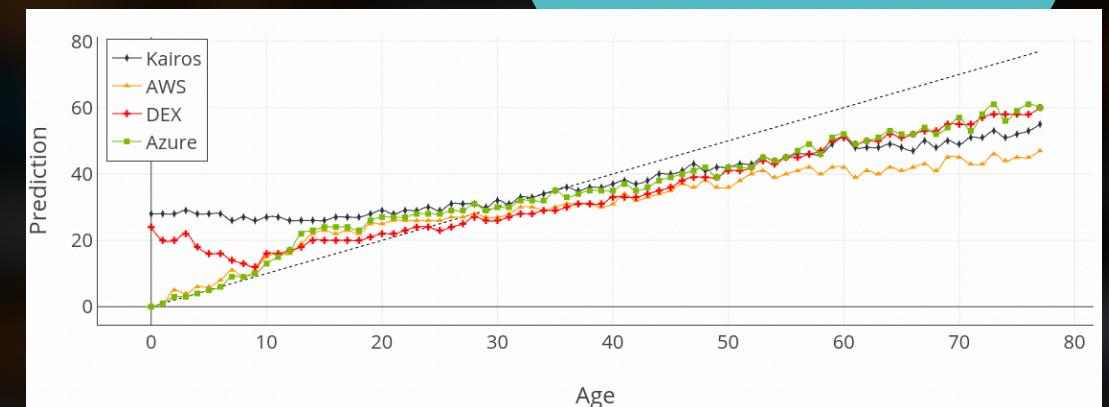
Evaluation of Existing Services: Influence of Gender



Males

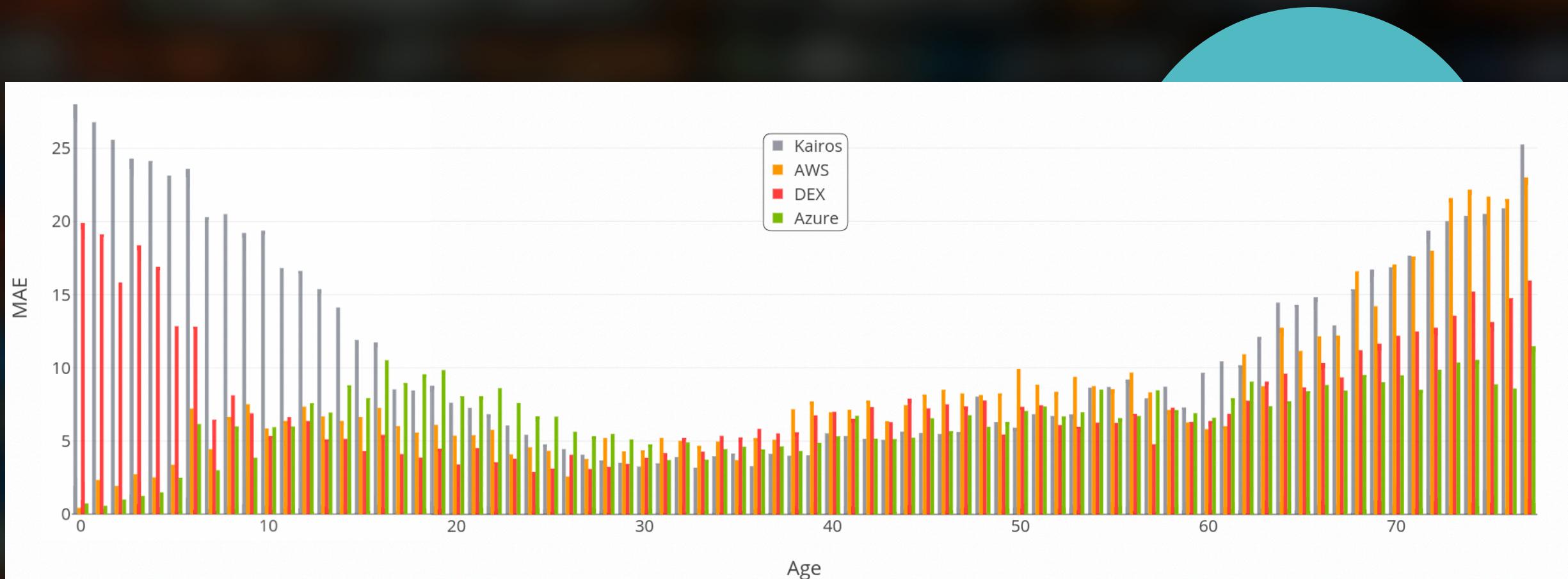
Service	Male	Female
Kairos	10.6838	11.7960
AWS	7.2192	11.4057
DEX	7.1975	8.9613
Azure	6.4205	8.8092

Females



Average Estimated Age Compared with Actual Age

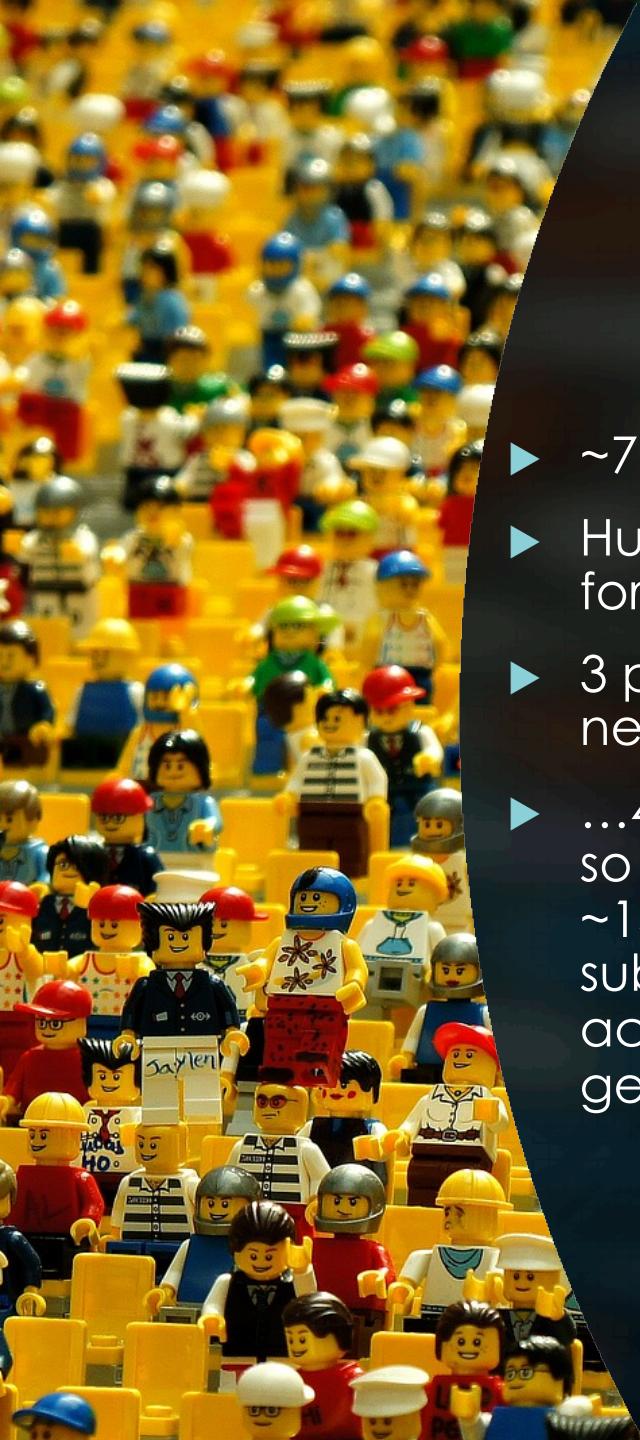
Mean Absolute Error Rates



Lack of Underage Training Data

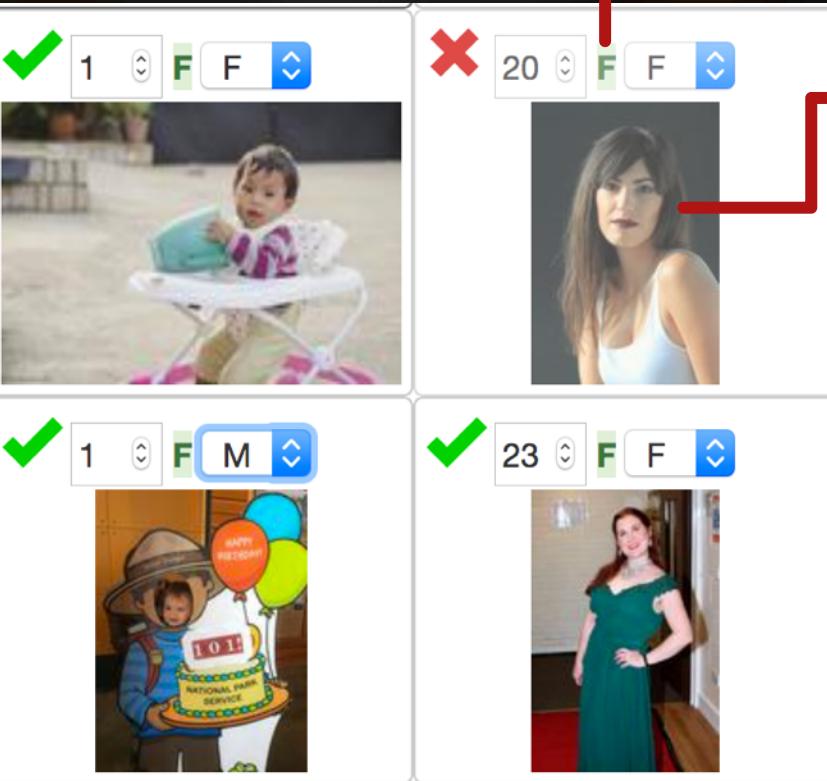
- ▶ Merging each of the existing facial age datasets results in a lack of underage subjects

Age	Male	Female	Age	Male	Female
0	12	34	10	223	258
1	48	21	11	481	409
2	78	26	12	453	480
3	21	29	13	783	415
4	52	23	14	738	482
5	72	38	15	1027	565
6	99	51	16	1300	1949
7	136	65	17	1637	2484
8	129	155	18	1961	2856
9	174	190	19	2516	3427



Project Visage

- ▶ ~750k images
- ▶ Human assessed for age & gender
- ▶ 3 positive votes needed
- ▶ ...40% processed so far netting ~14,000 underage subjects with accurate age and gender



DeepEXpectation (DEX)
Project Oxford (How-old.net)
Microsoft Azure

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CNN, HOG
(DLIB)



<https://www.forensicsandsecurity.com/visage.php>

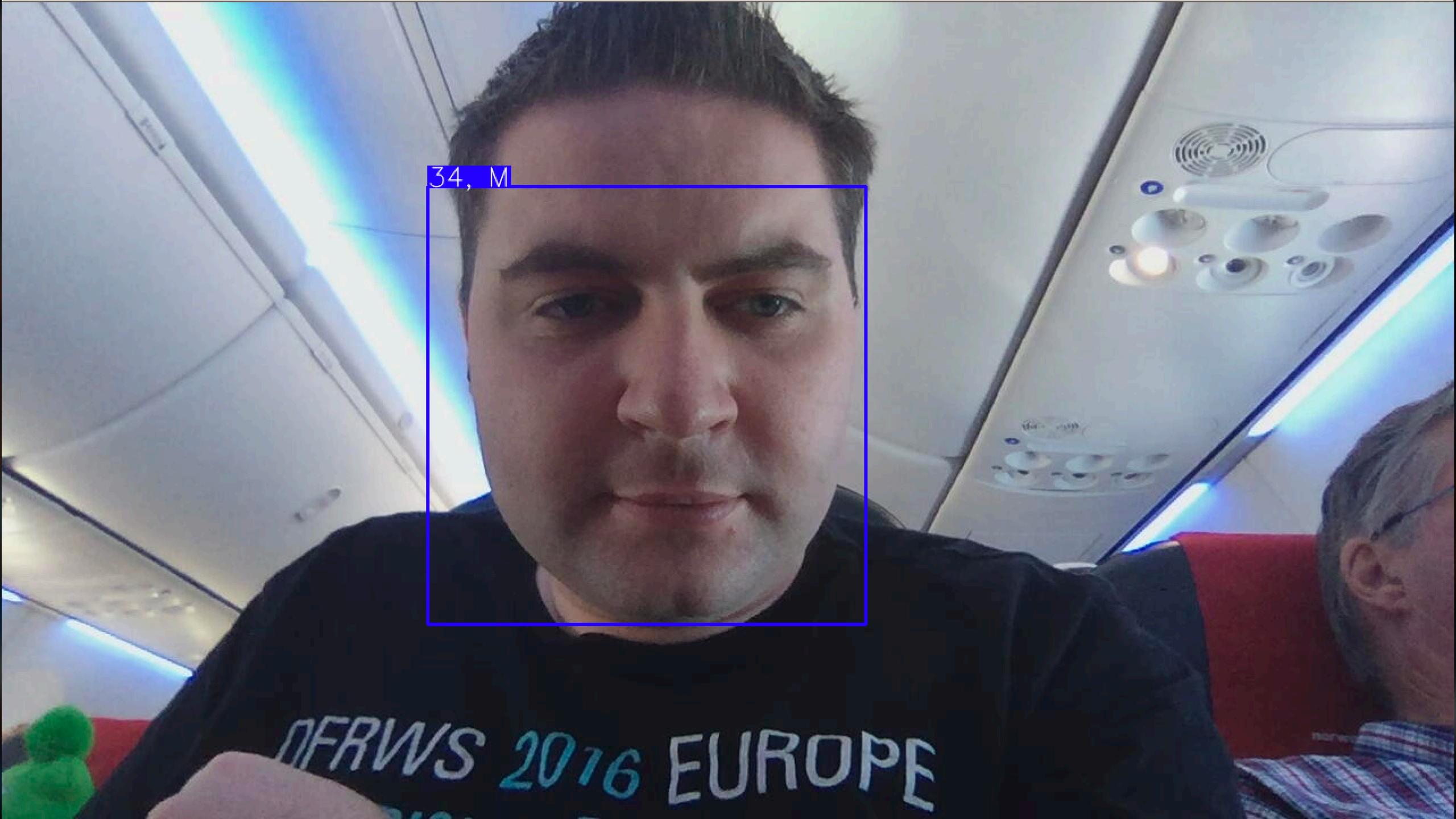




Audience Participation Time



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Option 1 Setup (recommended)

- ▶ The quickest and easiest option for facial age estimation demonstration part of the workshop is to use the latest version of VirtualBox platform and the VirtualBox Extension Pack (both available from here: <https://www.virtualbox.org/wiki/Downloads>). Then you can download a pre-prepared virtual machine (`dfrws.ova` ~1.4Gb) from either of the below links:
- ▶ Google Drive:
https://drive.google.com/open?id=1gJfO5GkGMrU9fW92WhAJkv8-kLbo4_xv
or
- ▶ My UCD server: <http://scanlon.ucd.ie/dfrws.ova>
 - ▶ MD5 hash: `aee02f23b2bed023b74b66885b9a787c`
 - ▶ SHA1 hash: `88d2c7fe5ec2d0639416f8c8b3d72687781fc61a`
- ▶ Lubuntu OS username and password: `lubuntu/lubuntu`

Option 2 Setup

- ▶ Manual installation instructions for Linux systems (requires python 2.7.x):
 1. `sudo apt install git python-pip`
 2. `git clone https://4nd4@bitbucket.org/4nd4/dfrws_demo.git`
 3. `cd dfrws_demo`
 4. `sudo apt-get install build-essential cmake libgtk-3-dev libboost-all-dev`
 5. `pip install -r requirements.txt`

Getting Started (Either VM or Manual Options)

- ▶ `python ~/Desktop/dfrws_demo/demo.py` in terminal
 - ▶ You may be prompted to grant python access to your webcam
 - ▶ The demo needs this access
- ▶ Note: It can take up to 10 minutes to download the weights file when launching `demo.py` for the first time (manual option) or if they've updated the weights file since I uploaded the VM.
- ▶ `Ctrl + C` on terminal command to quit

*“If you believe in
Phrenology, you need
your head examined”*



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