



# Forensic Intelligence Workshop

## Facial Age Estimation

DR. MARK SCANLON

OSLO, 24<sup>TH</sup> APRIL 2019



UCD Forensics and  
Security Research Group

# Agenda

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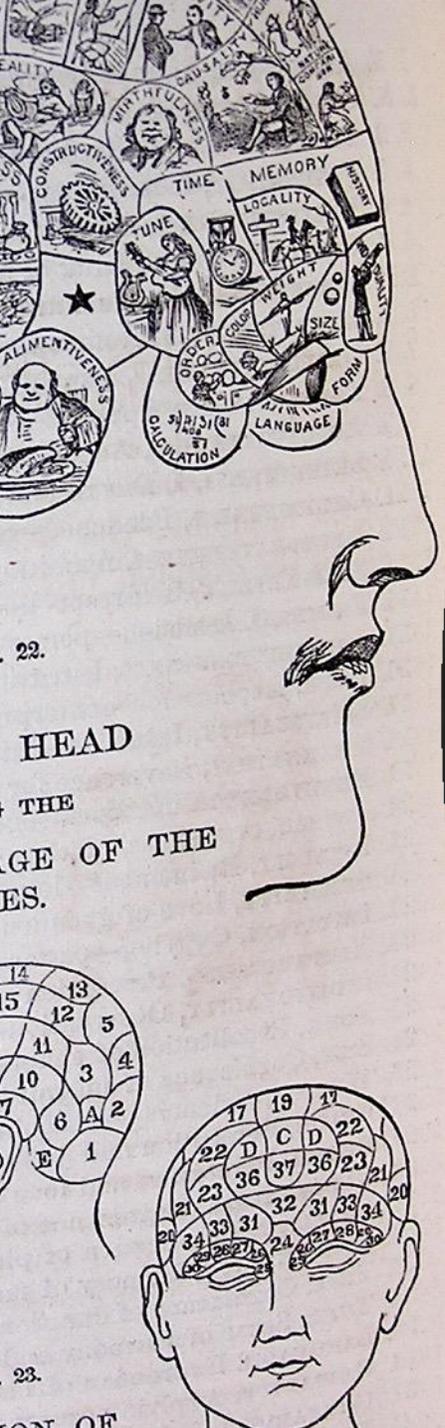
- ▶ Human Fascination with Facial/Cranial Measurement
- ▶ Human Facial Age Estimation
- ▶ Current Applications of AI Facial Analysis
- ▶ How Do AIs See Your Face?
- ▶ What Can They Detect?
- ▶ Your how old!?

[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.





# 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



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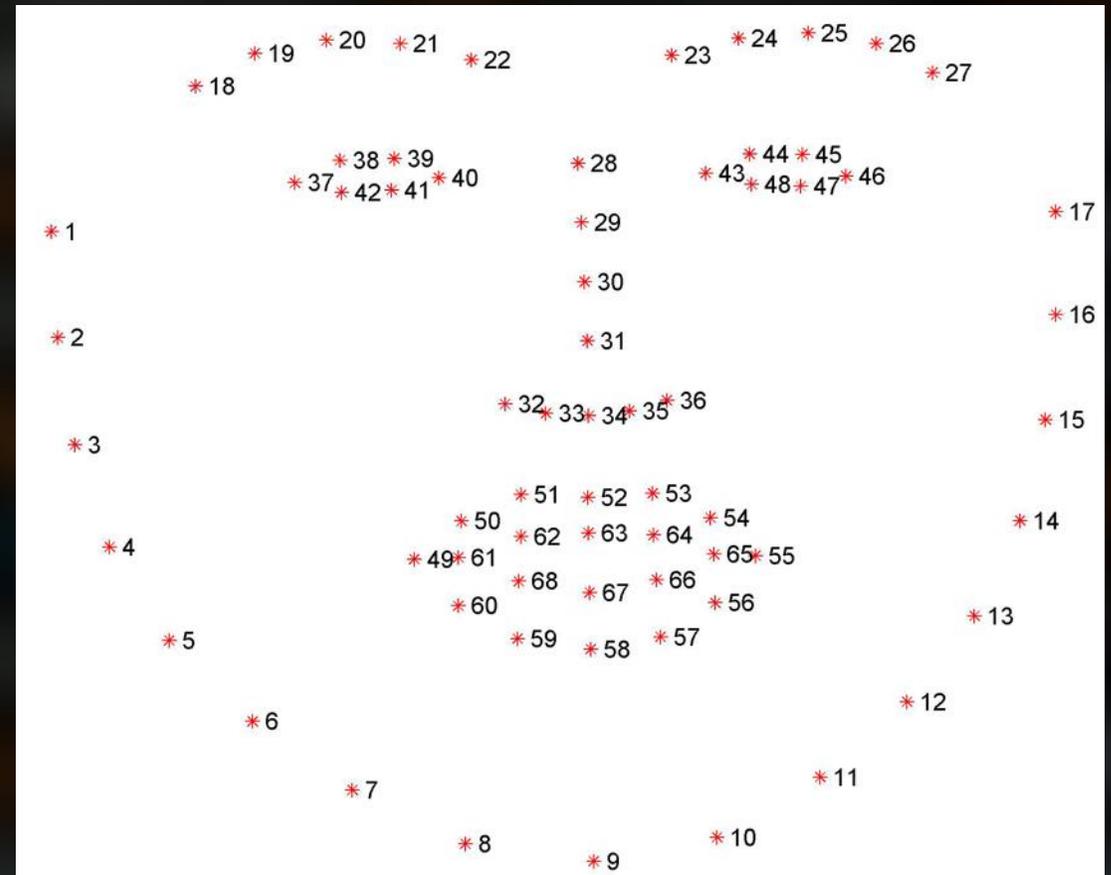
- ▶ Relies on facial landmarks and their relative position and distances
- ▶ Eye
  - ▶ Pupil Left/Right Edge
  - ▶ Left/Right Outer Edges
  - ▶ Left/Right Inner Edges
  - ▶ Left/Right Top/Bottom Edges
  - ▶ Eyebrow Left/Right Top/Bottom Edges
- ▶ Mouth
  - ▶ Left/Right Edges
  - ▶ Top/Bottom of each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



# dlib Facial Landmark Detection



- ▶ 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.

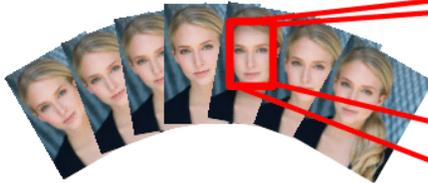


# Automated Age Estimation

1. Input image

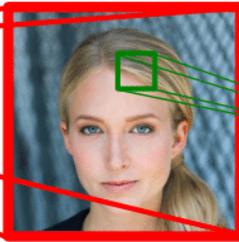


2. Face detection



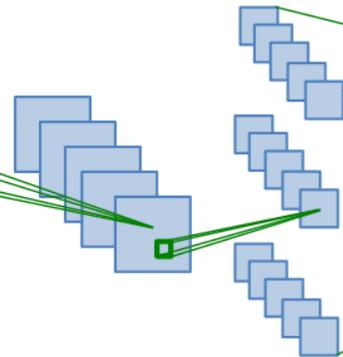
Mathias et al. detector

3. Cropped face



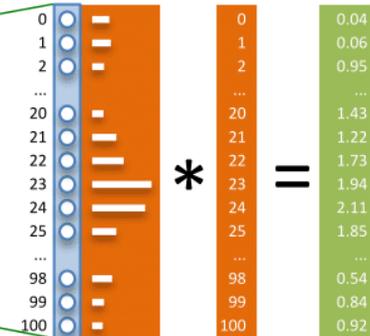
+ 40% margin

4. Feature extraction



VGG-16 architecture

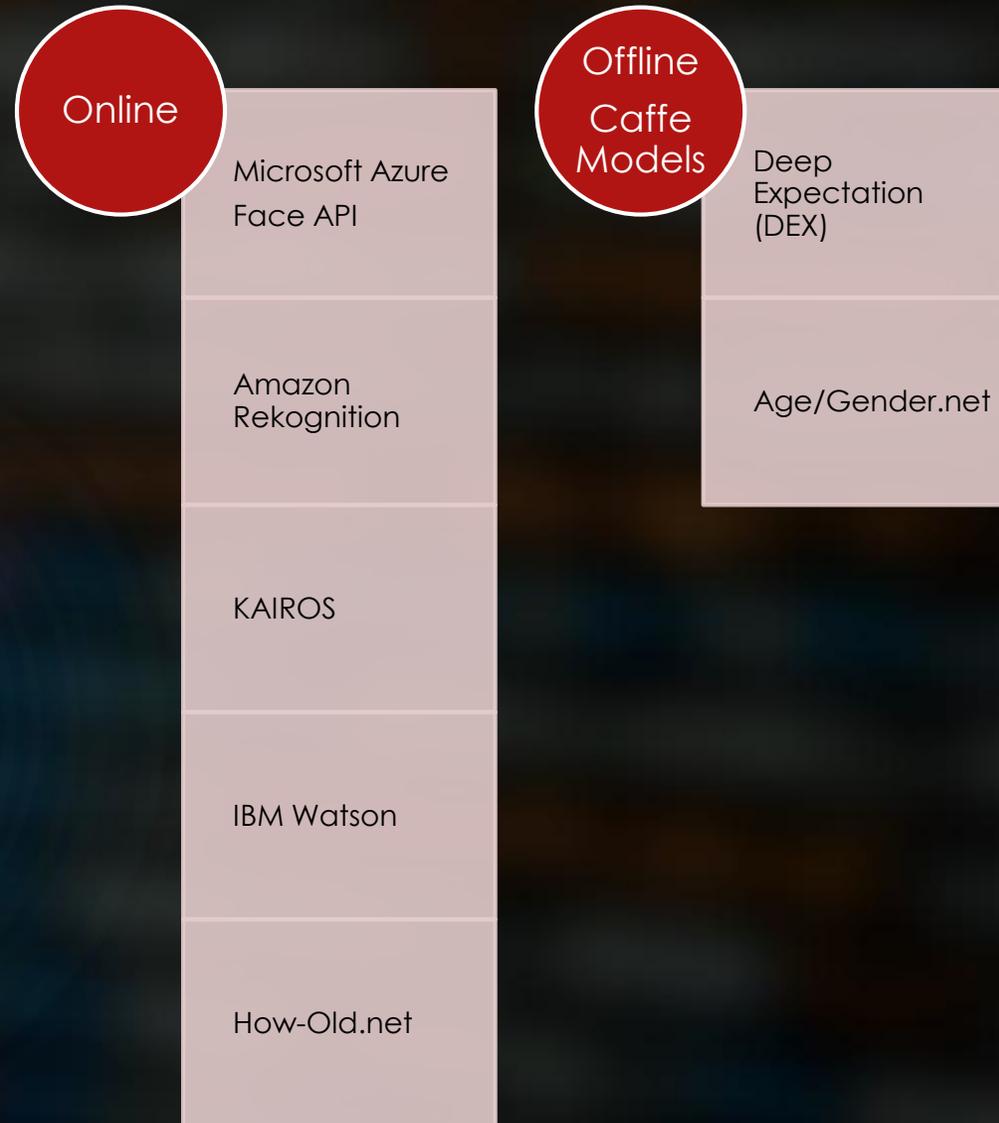
5. Prediction



Softmax expected value

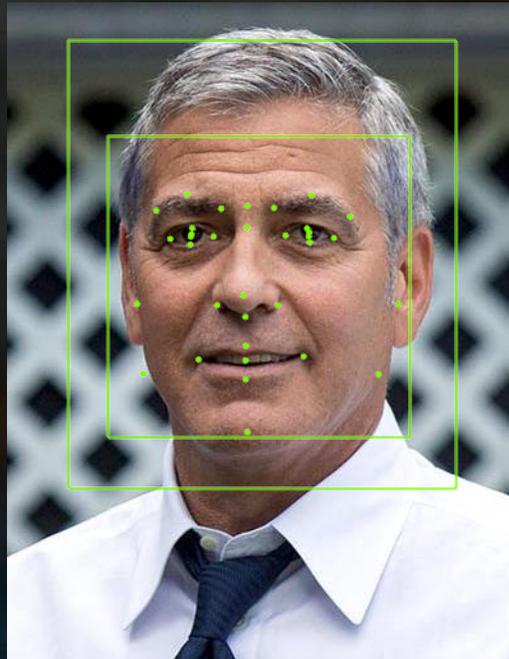
$$\sum = 23.4 \text{ years}$$

# Age Estimation Services



# George – Age 55

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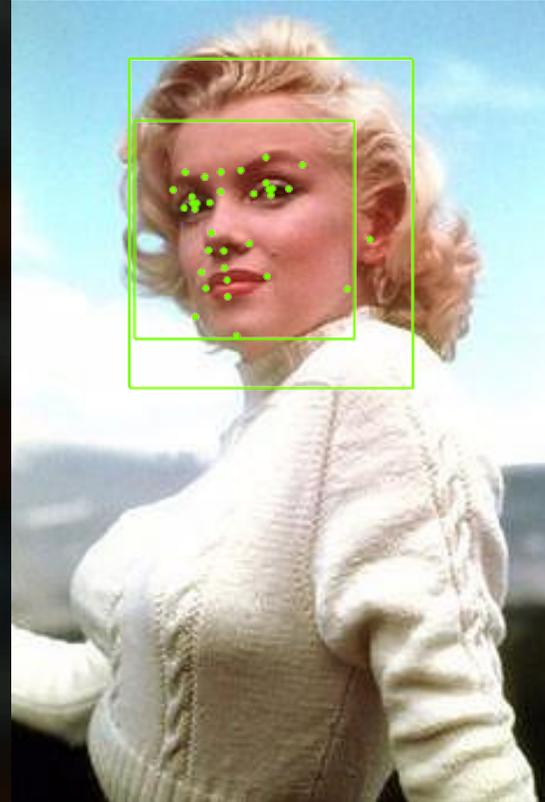


- ▶ Age: 59, 56-58, 60-90, or 31
- ▶ Gender: Male
- ▶ Grey: 1.0
- ▶ Smiling: 0.79
- ▶ Moustache: 0.1
- ▶ Bald: 0.07
- ▶ Contempt: 0.001



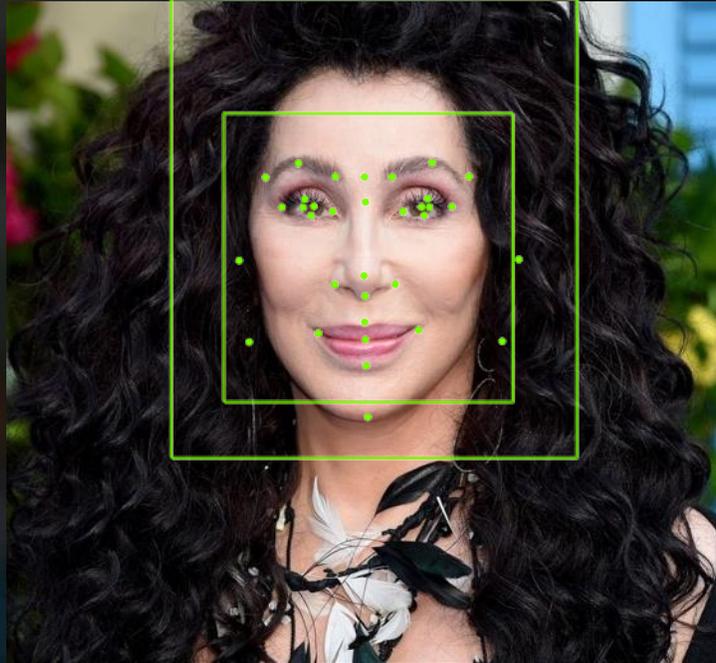
# Marilyn - Age 26

- ▶ 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

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- ▶ 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



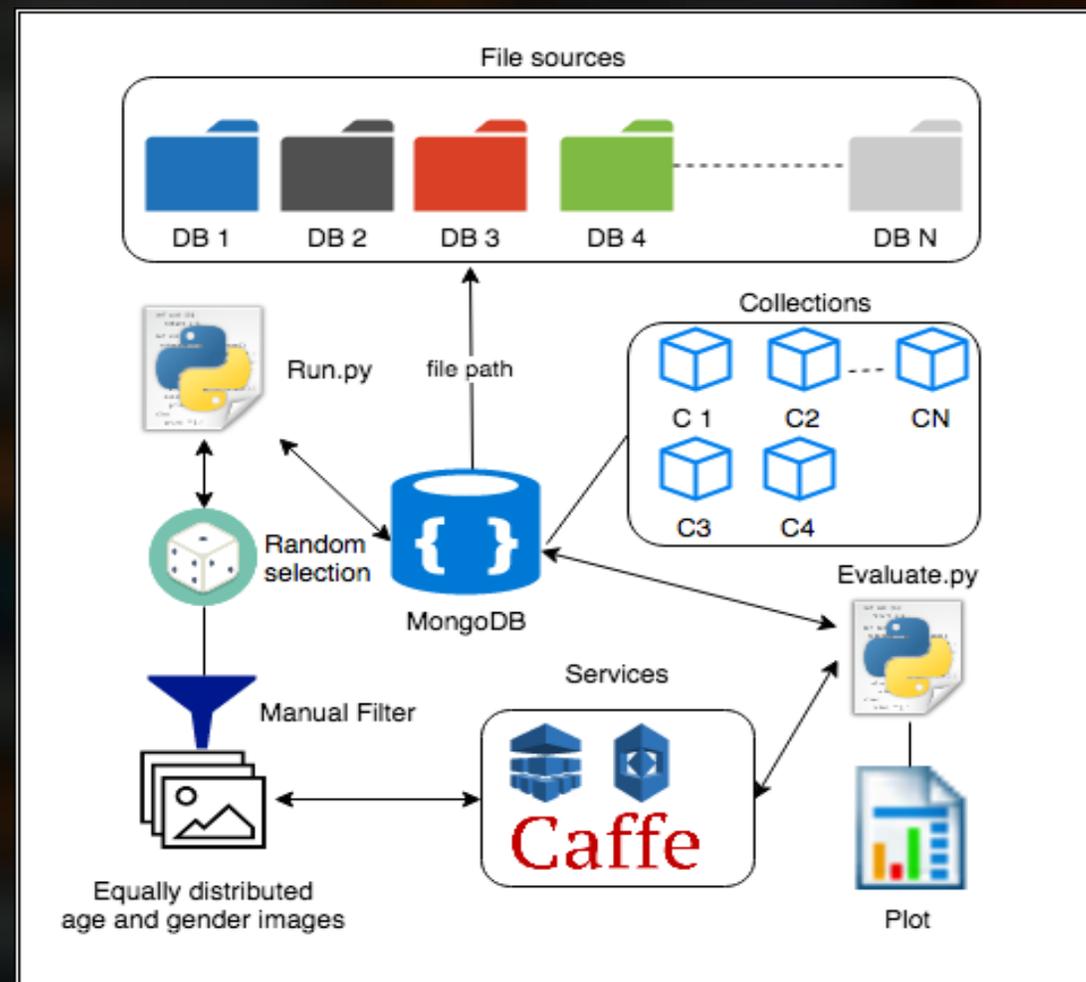
# Facial Age Estimation Datasets

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

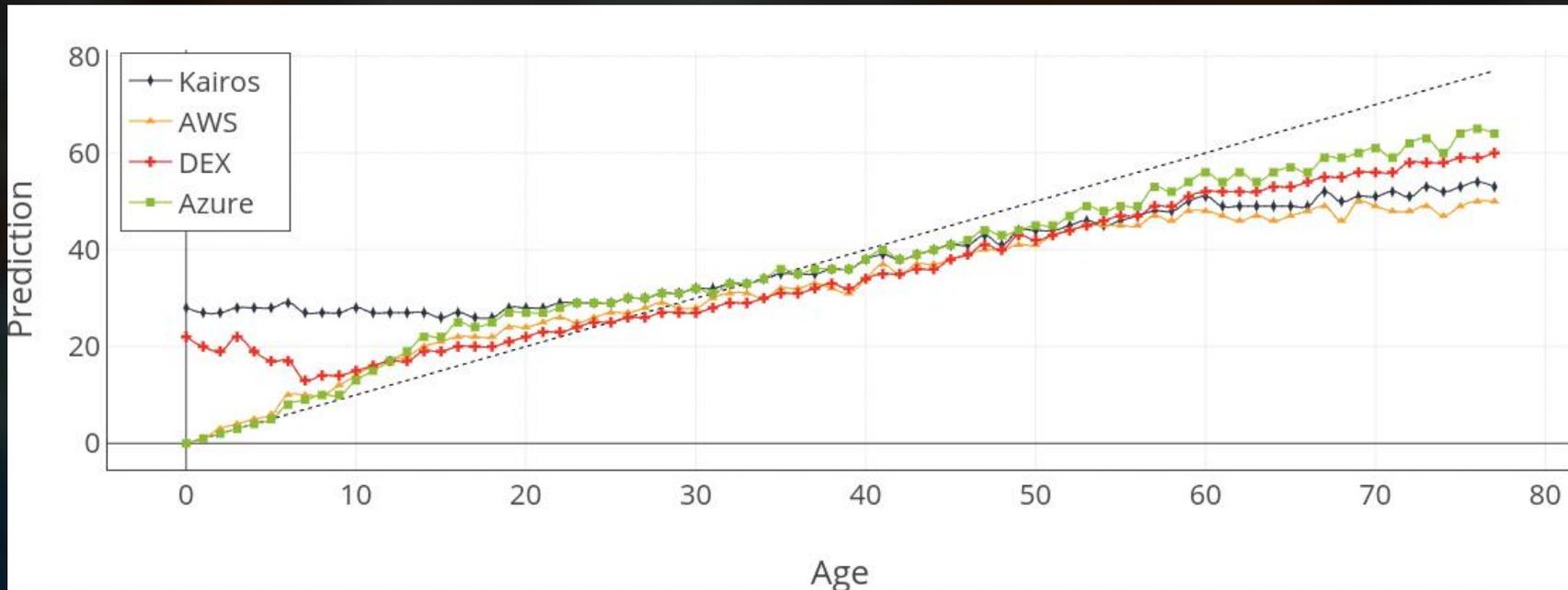
# Dataset Generator

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[https://bitbucket.org/4nd4/image\\_database.git](https://bitbucket.org/4nd4/image_database.git)

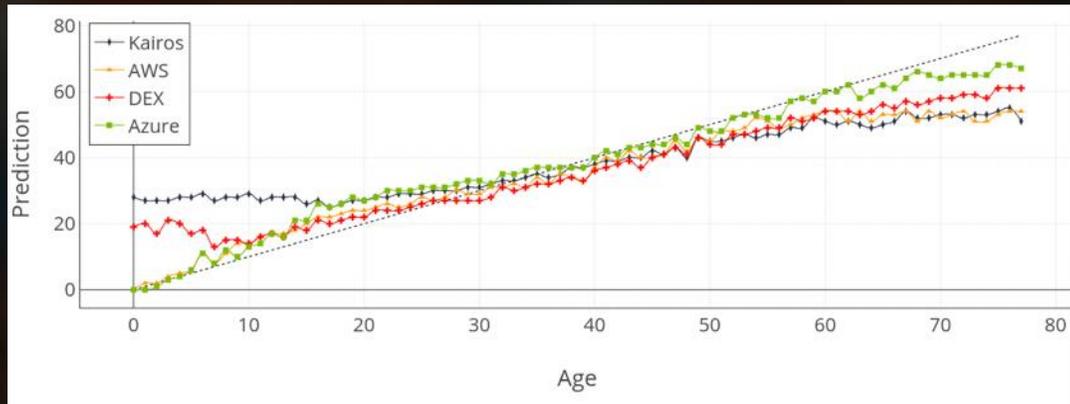
# Evaluation of Existing Services



Service	MAE
Kairos	11.236
AWS	9.286
DEX	8.079
Azure	7.614

Average Estimated Age Compared with Actual Age across Entire Dataset.

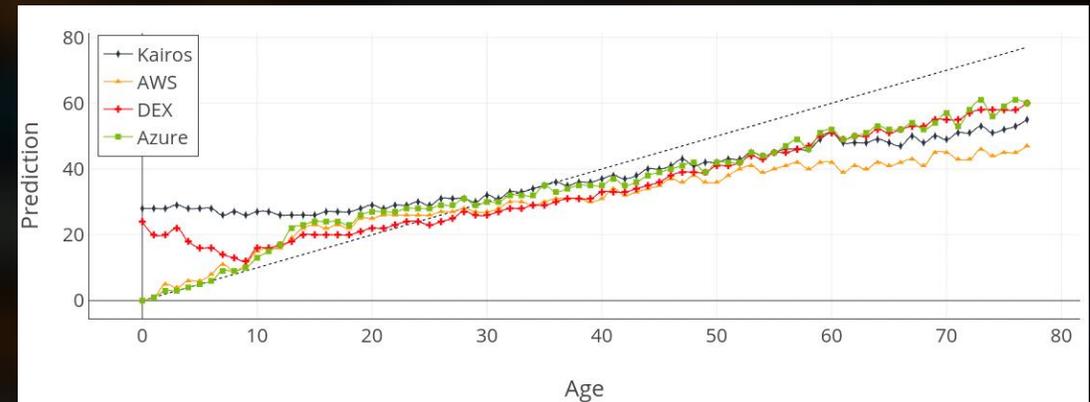
# Evaluation of Existing Services: Influence of Gender



Males

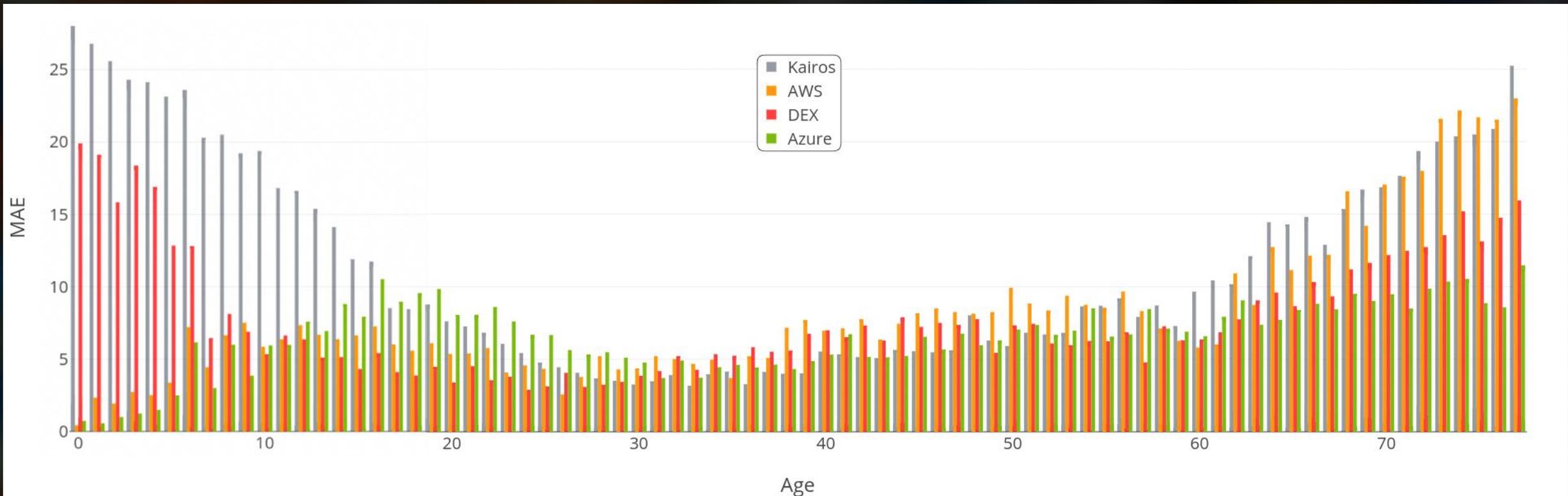
Service	Male	Female
Kairos	10.6838	11.7960
AWS	7.2192	11.4057
DEX	7.1975	8.9613
Azure	6.4205	8.8092

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
0	12	34
1	48	21
2	78	26
3	21	29
4	52	23
5	72	38
6	99	51
7	136	65
8	129	155
9	174	190

Age	Male	Female
10	223	258
11	481	409
12	453	480
13	783	415
14	738	482
15	1027	565
16	1300	1949
17	1637	2484
18	1961	2856
19	2516	3427





# Audience Participation Time



34, M

OFFRVS 2016 EUROPE

# Option 1 Setup (recommended)

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- ▶ 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](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”*



UCD Forensics and  
Security Research Group



**MARK.SCANLON@UCD.IE**



**WWW.FORENSICSANDSECURITY.COM**



**@MRKSCN / @FORSECRESEARCH**