Evaluating Automated Facial Age Estimation Techniques for Digital Forensics

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Who am I?

- UCD Forensics and Security Research Group https://forensicsandsecurity.com/
- PhD Student University College Dublin
  - School of Computer Science
  - Digital Forensics
- MSc. Computing & Security, King's College London
  - Forensic Data Recovery from Android Smart Watches (Metropolitan Police)
- Systems and Computing Engineer, Pontifical Catholic University of Ecuador

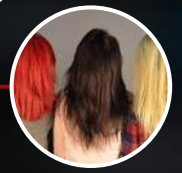
https://github.com/4nd4

Agenda

- Digital Forensics Backlog
- Age Estimation Applications
- Evaluation of Cloud and Offline age prediction services
- Datasets for Researchers
- Dataset generator Software
- Results
- Conclusions

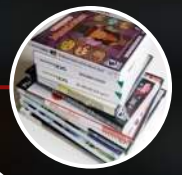
Digital Forensic Backlog

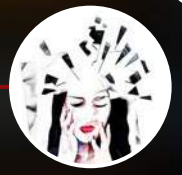
Human Characteristics

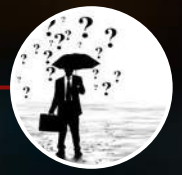


Age estimation applications

Age estimation in Digital Forensics







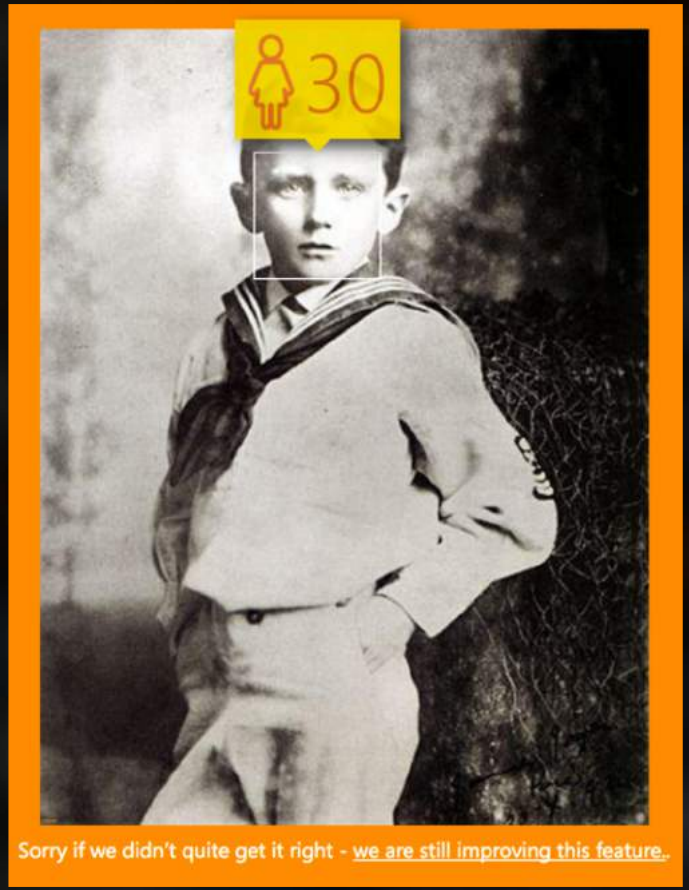
Medical Expert

Age estimation Accuracy

- Mean Absolute Error (MAE)

$$|Inferred_{age} - Ground_{truth}|$$

- Machine Age Perception
  - 1 to 5 years
  - Limited private datasets
  - Lack of datasets for underage



Joyce aged six, 1888

Age estimation Accuracy

- Human Facial Age Perception
  - 2 to 8 years
  - Overestimation on young people
  - Own age bias
  - Range of factors
    - Gender
    - Facial Expressions
      - Neutral Highest accuracy

Face Age Datasets

Dataset	Image	Description
FGNET	1K	- Subject timeline - Ages 0 to 69
MEDS	1.3K	- Deceased persons - Ages 17 to 70
FERET	14K	- Multiple subject poses - Ground truth
MORPH	55K	- Ages 16 to 77
IMDB-WIKI	500K	- Crawled images - Ages 0 to 100
OUI-ADIENCE	26K	- Flickr in the wild - Age label groups
YFCC100M	100M	Flickr Images and Videos

Face Datasets

FERET Observations	FGNET	MORPH
MEDS	IMDB-WIKI	OUI-ADIENCE CC 89.55%
Flickr API Birthday Tags	YFCC100M Static metadata	

Age estimation Services

Online

- Microsoft Azure
- Amazon Rekognition
- KAIROS
- IBM Watson
- How-Old.net

Offline Caffe Models

- Deep Expectation (DEX)
- Age/Gender.net

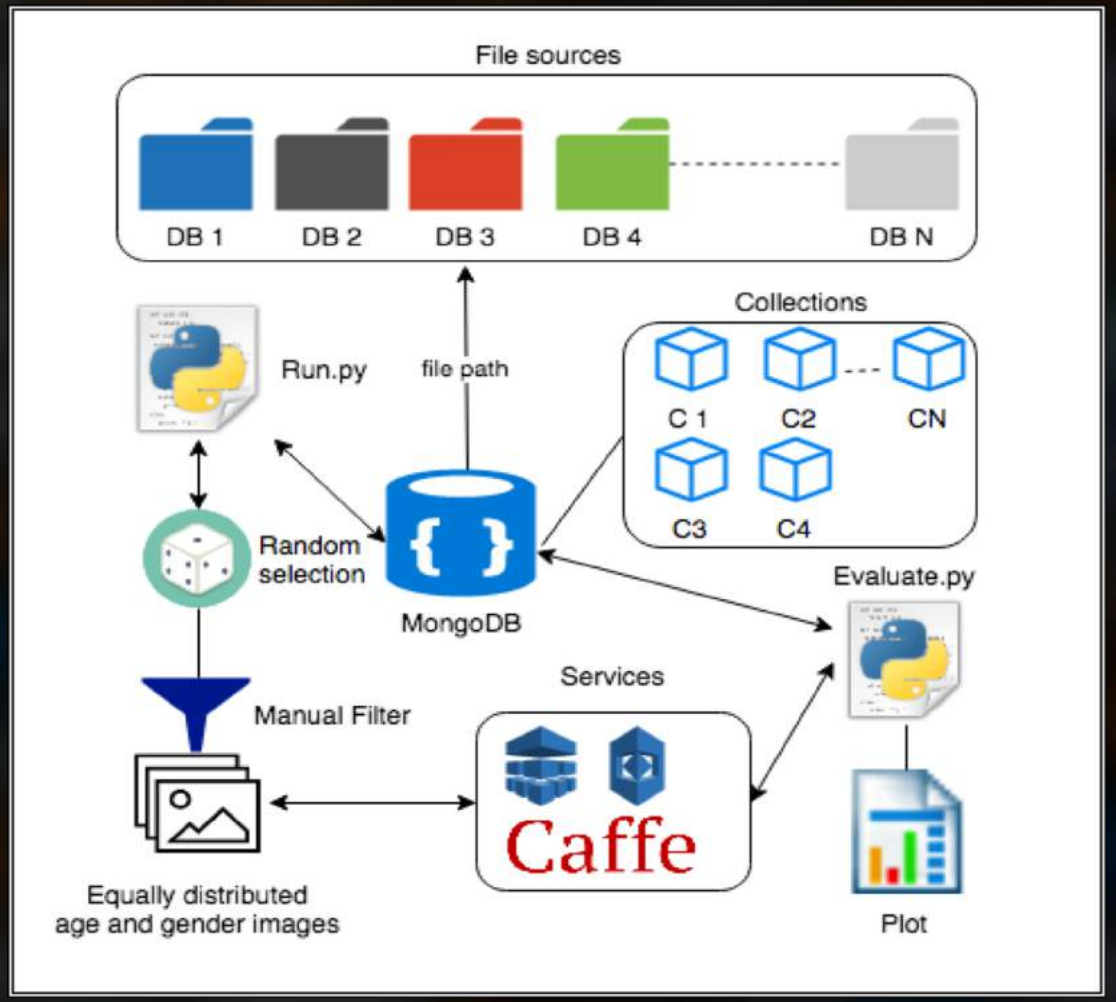
Age Estimation Services

Microsoft Azure	Amazon Rekognition	KAIROS
IBM Watson	How-Old.net	Deep Expectation (DEX)
Age/Gender.net		

Dataset Generator Software

System Architecture

- Imbalanced datasets
- Generate balanced dataset
- Evaluate dataset
- Plot data



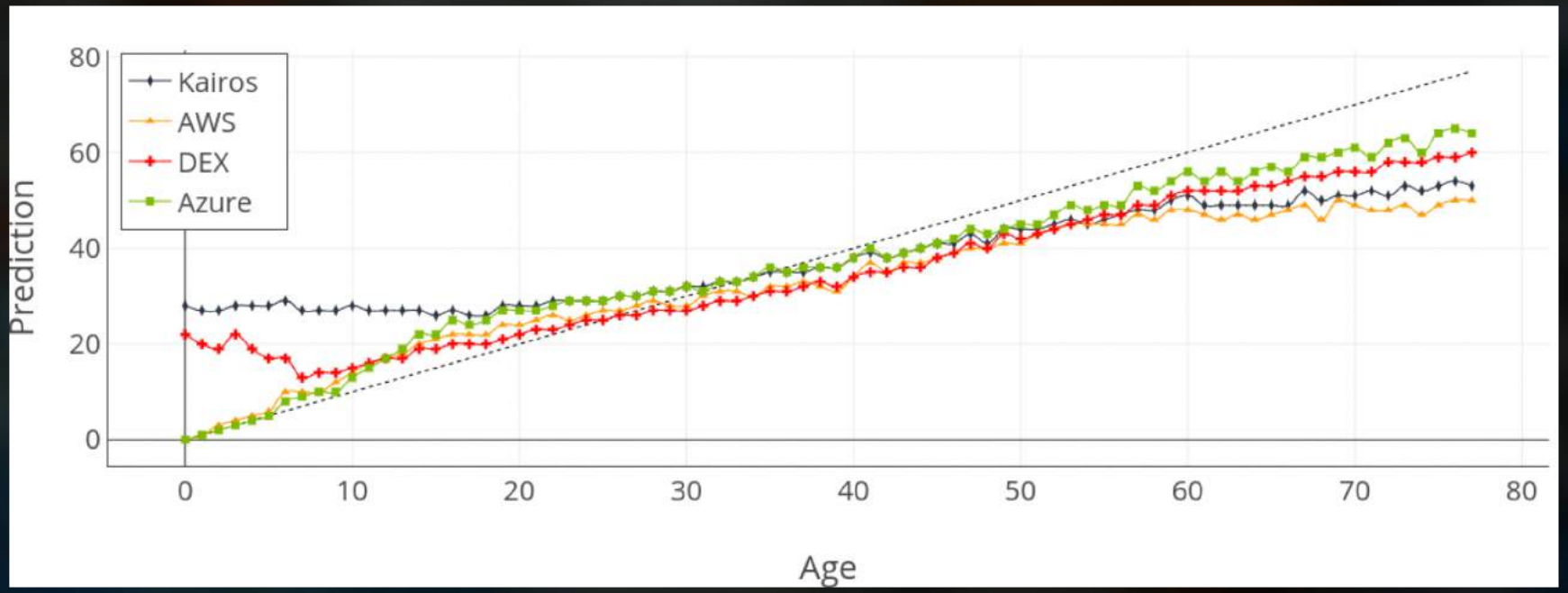
https://bitbucket.org/4nd4/image_database.git

Issues encountered

- Data curation lessened the amount of images available
- Although the different databases were mixed, there wasn't enough images for certain age groups (Children/ Elders)
  - Change original experiment to the 0 -> 77 range.
    - 10k Male & Female

Results

Evaluation on entire age range

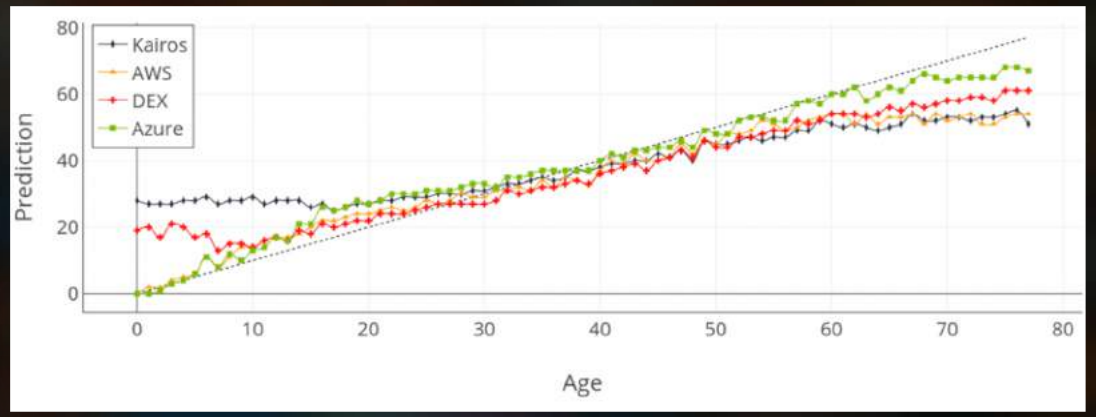


Service	MAE
Kairos	11.236
AWS	9.286
DEX	8.079
Azure	7.614

Average Estimated Age Compared with Actual Age across Entire Dataset.

Results

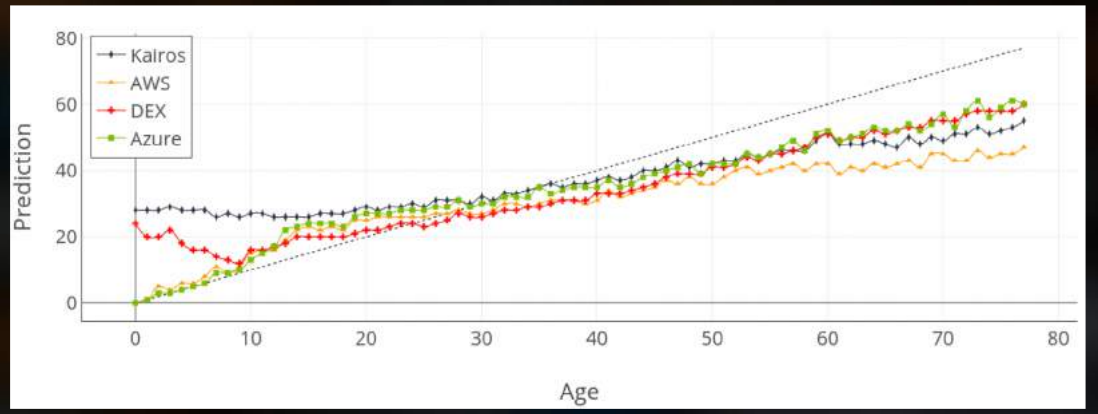
Influence of gender



Males

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

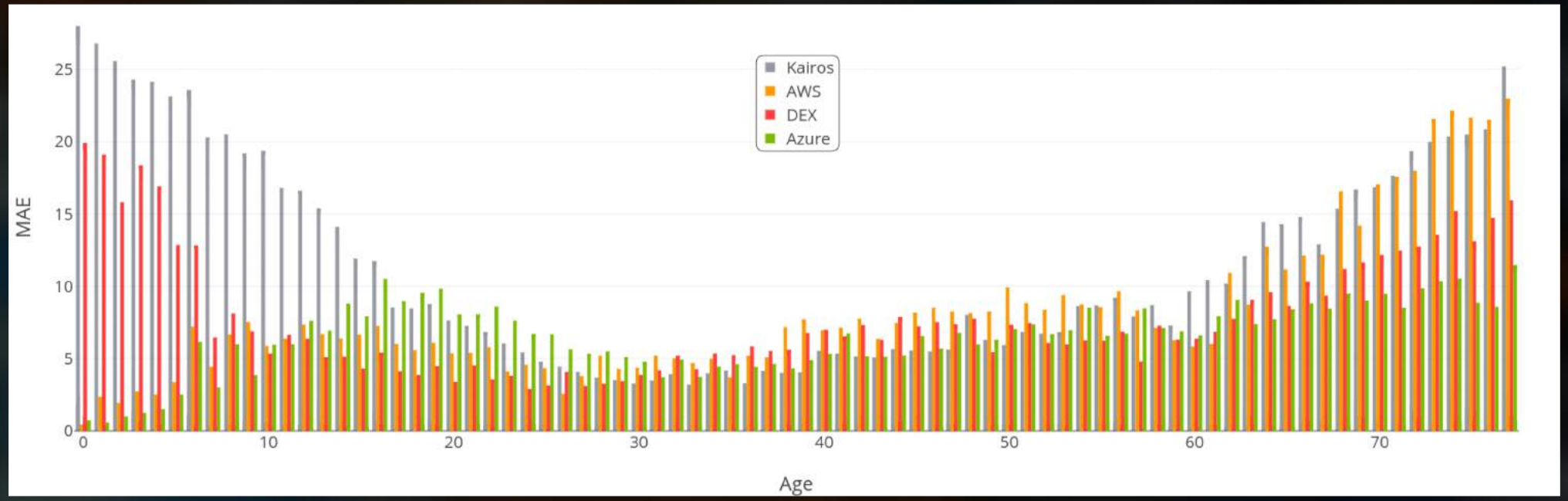
Females



Average Estimated Age Compared with Actual Age

Results

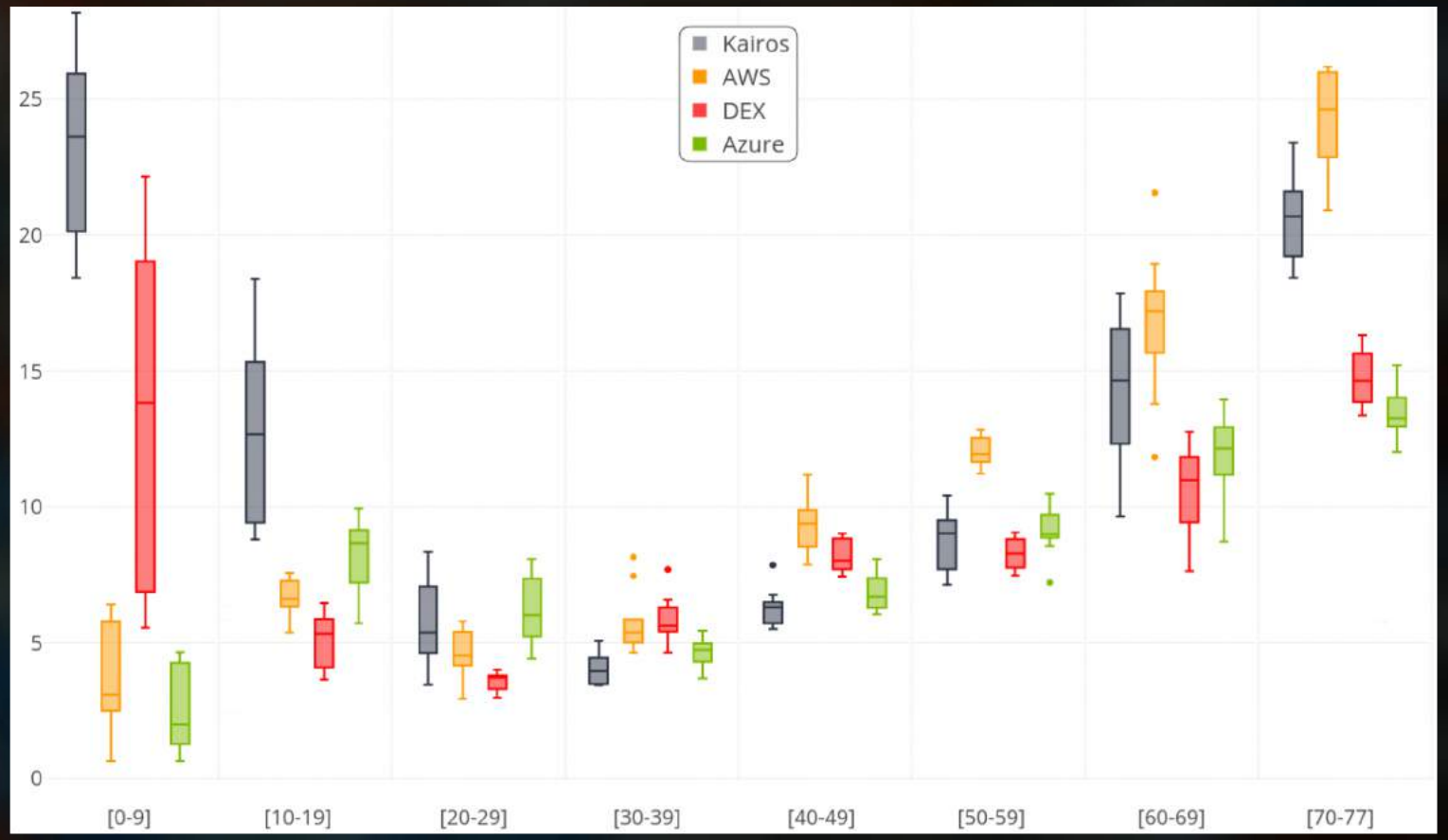
Influence of Gender (Female)



Mean Average Error Rate for Females

Results

Experiment 3 – Age Range Analysis



Age Range	Lowest Mean Absolute Error
0-9	Azure
10-19	DEX
20-29	DEX
30-39	Kairos
40-49	Kairos
50-59	DEX
60-69	DEX
70-77	Azure

Conclusion

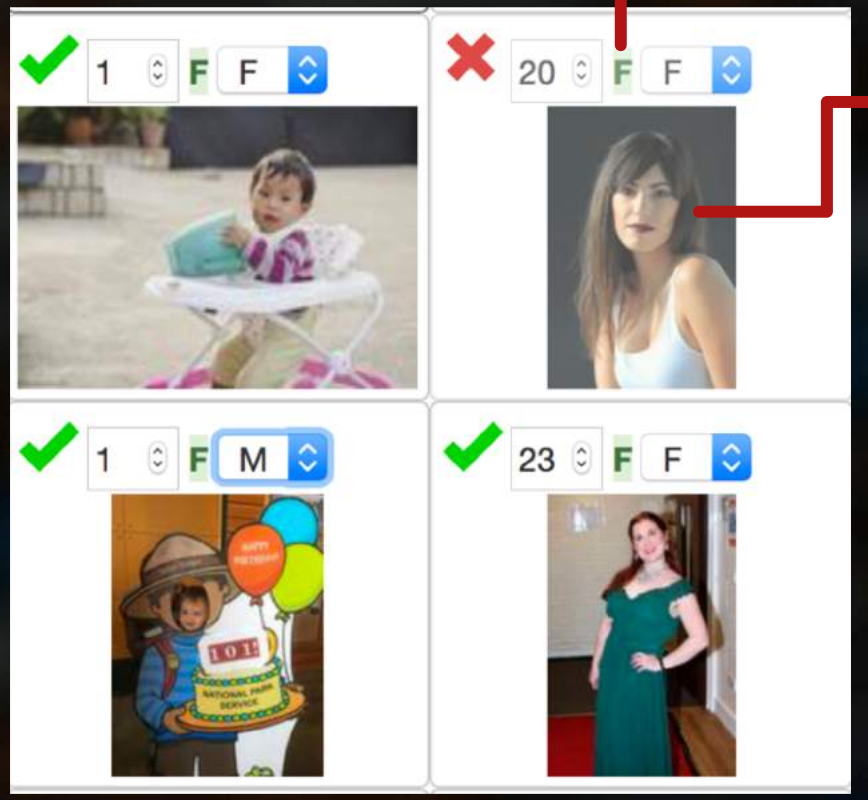
- Limited images on certain age factions
- Higher error rate for female subjects
- Although Microsoft Azure performed better then the other estimators, an age range analyze proved that other services performed better on certain ranges.

Future Work

- Weakness of current tools is predominant
- Expand this study further through different services
- Create a facial age dataset of underage subjects and create a model relevant to digital forensics.

Project Visage

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



CNN, HOG
(DLIB)

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

THANK YOU

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