Vec2UAge: Enhancing Underage Age Estimation Performance through Facial Embeddings

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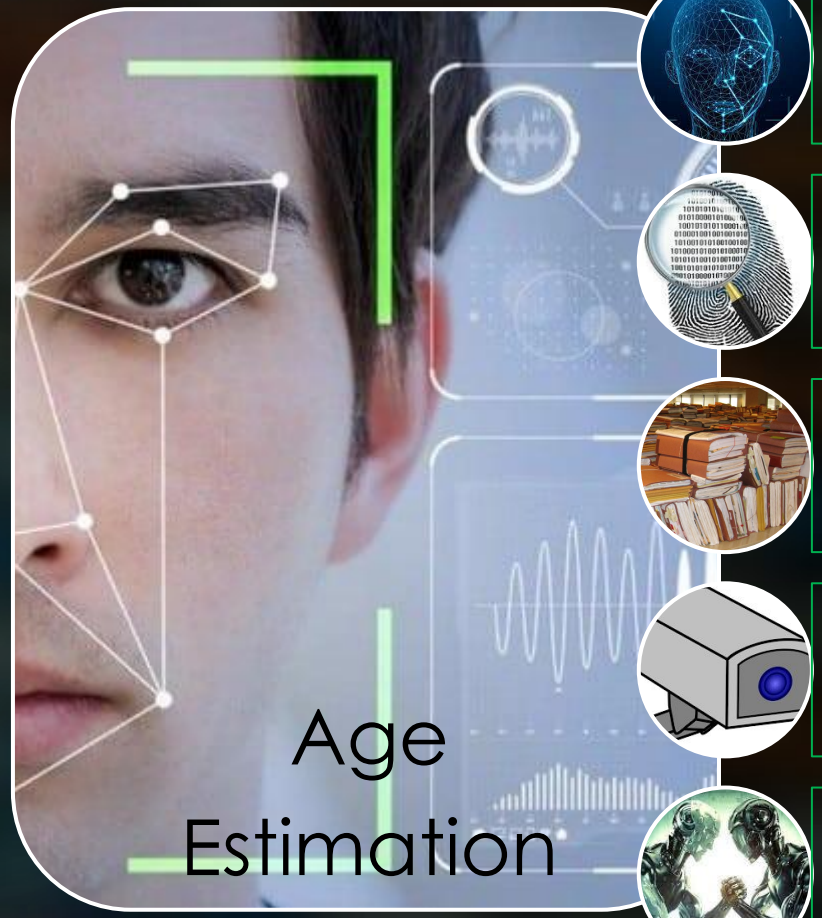
DFRWS 2021 VIRTUAL EUROPE

UCD DUBLIN

UCD Forensics and Security Research Group

Background



Facial Recognition

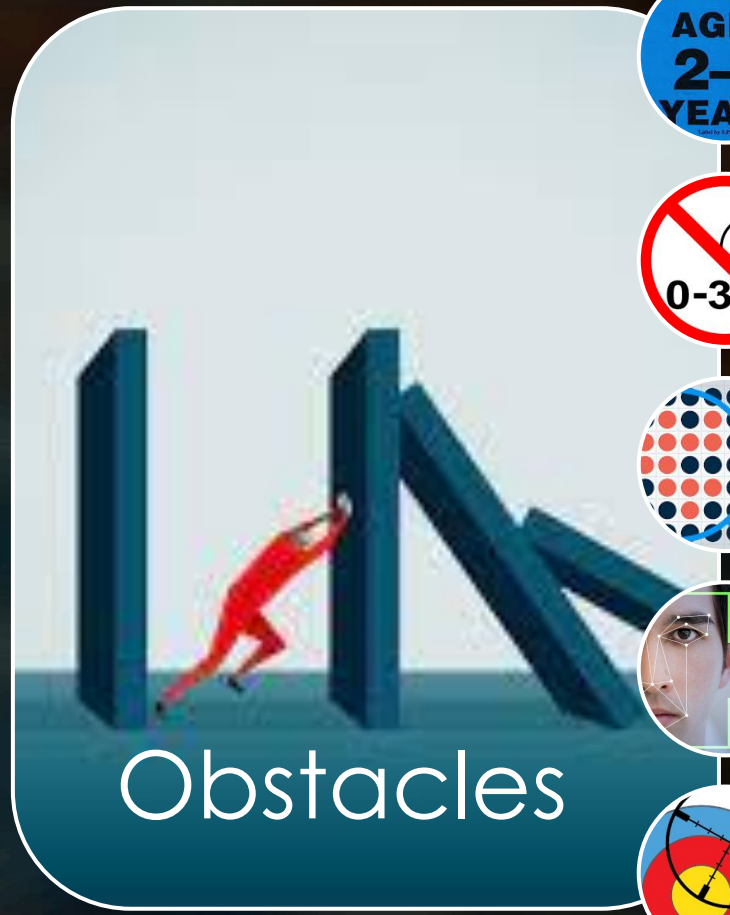
Evidence

DF Backlog

Victims/ Suspects

GAN

Challenges for Age Estimation Models



Age Labels

Age Ranges

Bias

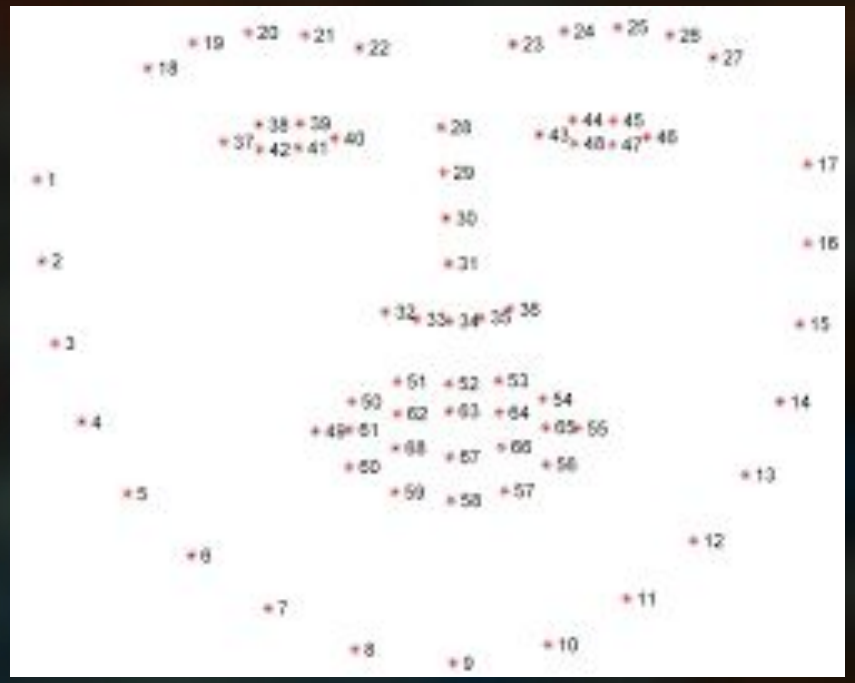
Age

Accuracy

Proposed Solution

- Facial Embeddings
  - Facial Recognition
    - Euclidean distance
  - FaceNet
    - Vector representation of 512 points
- Proposed Dataset
  - VisAGe
  - Selfie-FV
- Facial Image Pre-processing
  - Dlib HOG
  - Dlib CNN
- Data augmentation
  - Flip, Rotation, Zoom, Distortion, Colour, Contrast, Erasure
- Neural Network
  - 4L NN
- Optimisers
  - ADAM, ADAGRAD, SGD, SWA
- Experiments
  - D1 (Fixed LR), E1 (Initial LR Finder)

Facial Embeddings

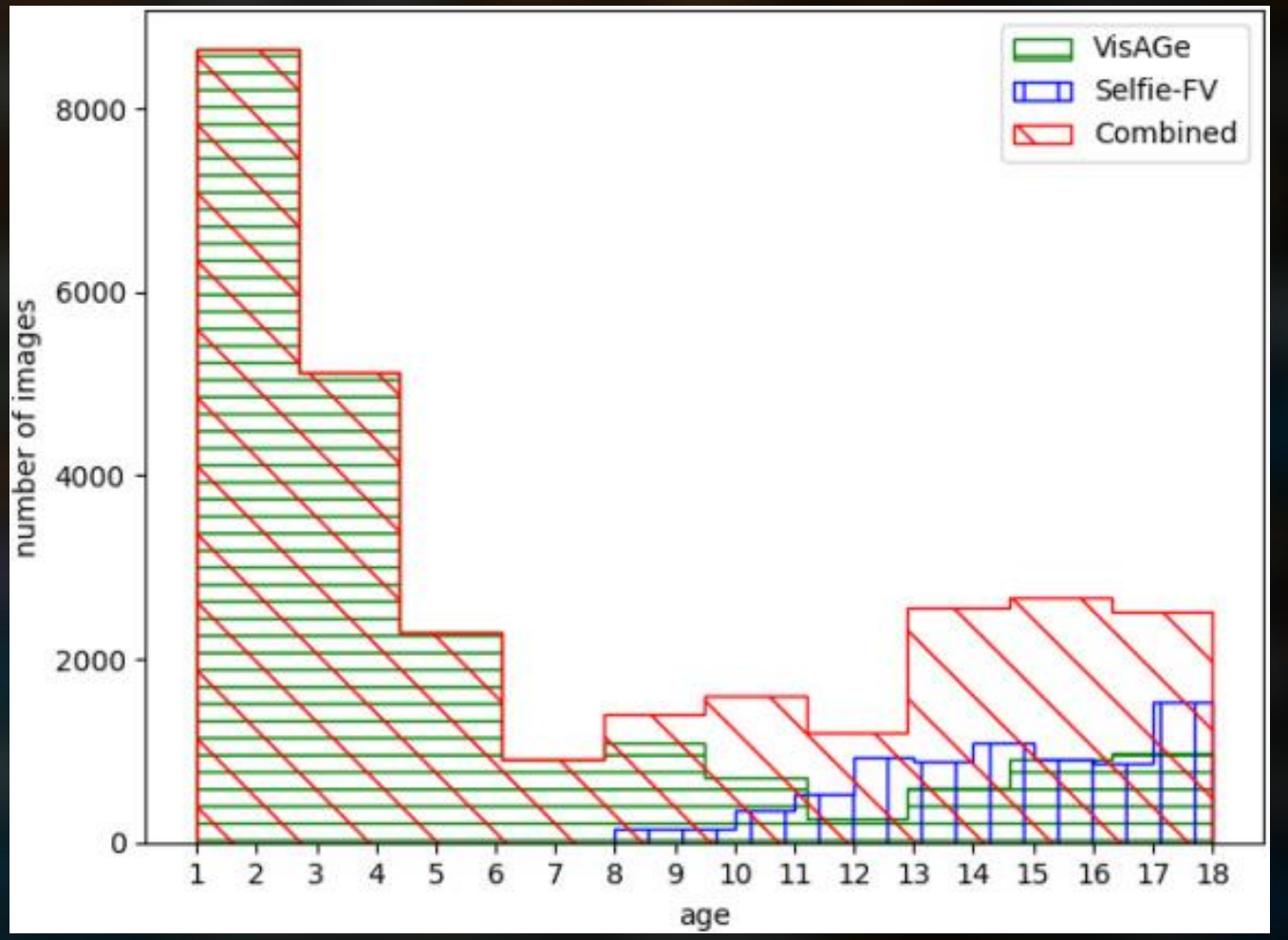


68 facial landmarks (DLIB)

```
array([ 1.07725732e-01,  3.16731818e-02,  4.08499762e-02, -1.07115060e-02,
       -2.28198152e-02,  5.57706365e-03,  9.75179765e-03, -5.36692515e-03,
       -1.83711771e-03,  4.57513779e-02,  4.33594622e-02, -5.81207611e-02,
       -4.79136780e-02,  4.68462817e-02, -7.73332566e-02, -2.13857740e-02,
       -1.40897382e-05, -2.62422096e-02,  2.23129615e-02,  1.30732255e-02,
       -8.95220116e-02,  5.93802631e-02, -1.43265515e-03, -1.23955412e-02,
       -2.54089199e-02, -1.01764537e-02, -5.63222275e-04,  2.59382073e-02,
        5.60861342e-02, -7.53680170e-02, -2.06493735e-02,  1.93569844e-03,
       -9.14568547e-03,  2.52238307e-02,  4.63761799e-02,  4.53585312e-02,
        2.17659567e-02,  3.04010827e-02, -6.05291091e-02, -1.58773060e-03,
        5.79611920e-02, -2.31141243e-02, -4.07206855e-04,  1.27771208e-02,
        3.00279595e-02,  1.83317810e-02,  1.00539085e-02, -6.57471735e-03,
        5.60290320e-03, -1.01998821e-02, -1.03056151e-02, -3.28540318e-02,
       -5.97769171e-02,  2.61105653e-02,  4.17980477e-02,  4.40444099e-03,
        2.04454679e-02, -6.01841230e-03,  2.84538660e-02, -8.39831904e-02,
       -2.42075697e-02, -1.02294264e-02,  5.55154718e-02, -7.41940066e-02,
        7.96858221e-02, -5.80874942e-02, -1.19266091e-02, -1.93555057e-02,
        6.20435067e-02,  3.60363885e-03,  2.44962275e-02,  9.92874056e-03,
       -5.46858311e-02,  3.86504829e-02, -3.05651929e-02,  2.09042095e-02,
```

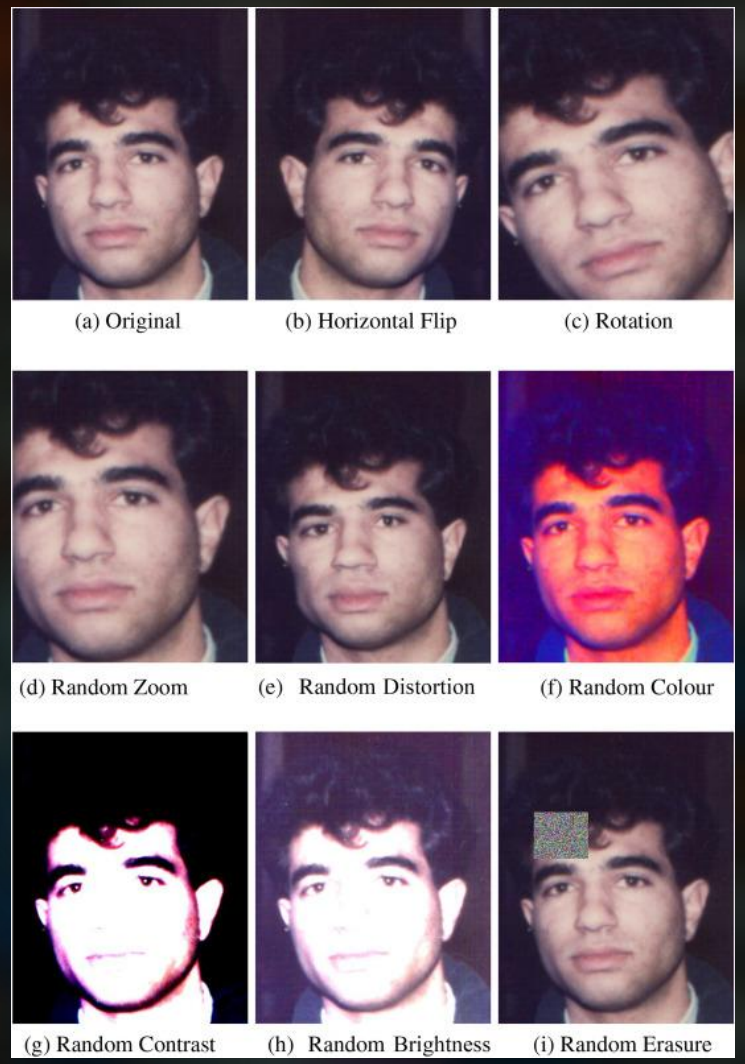
512 facial vector representations (FaceNet)

Proposed Dataset



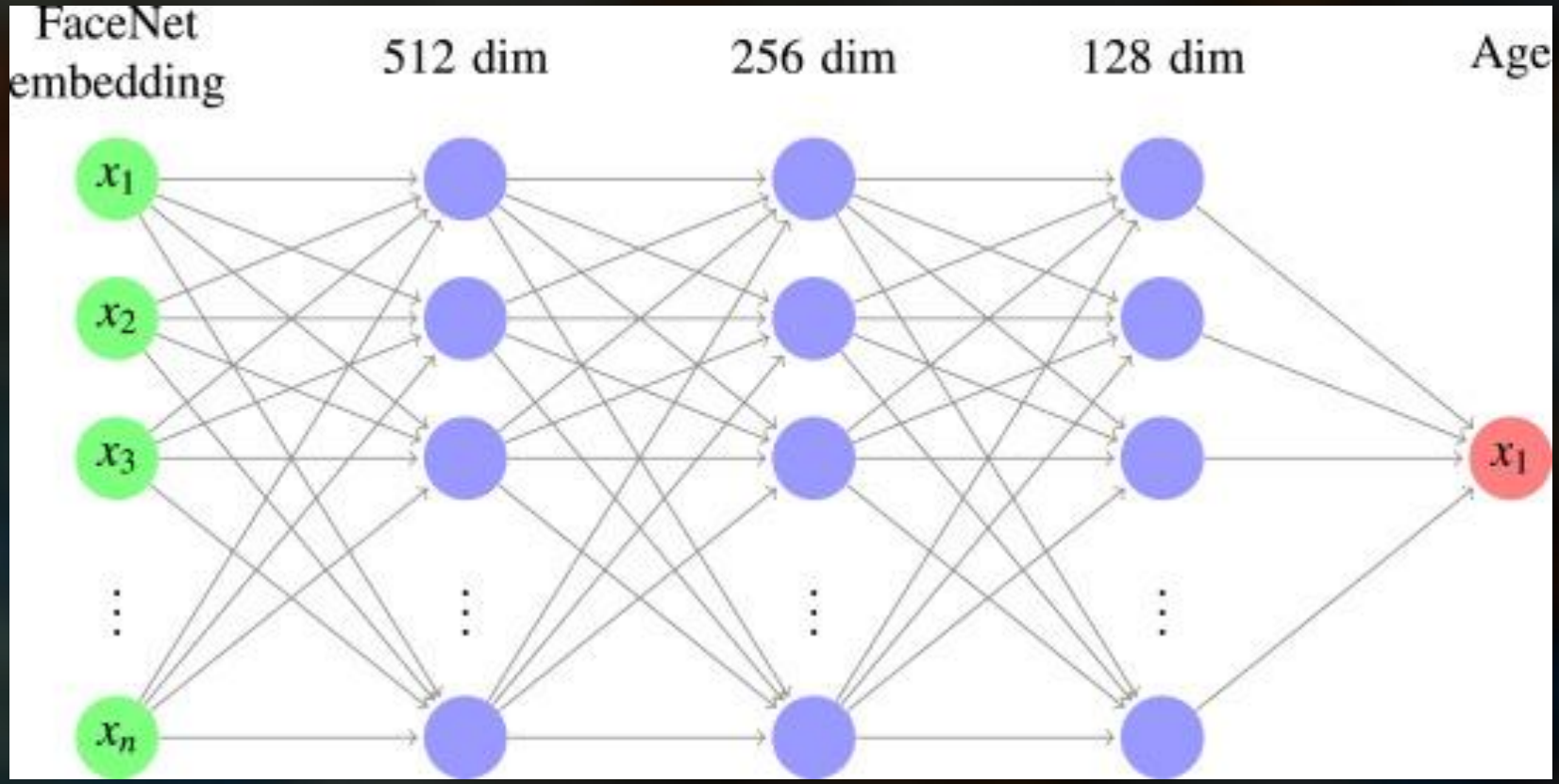
- https://www.forensicsandsecurity.com/visage
- https://github.com/EdwardDixon/selfie-fv

Data Augmentation



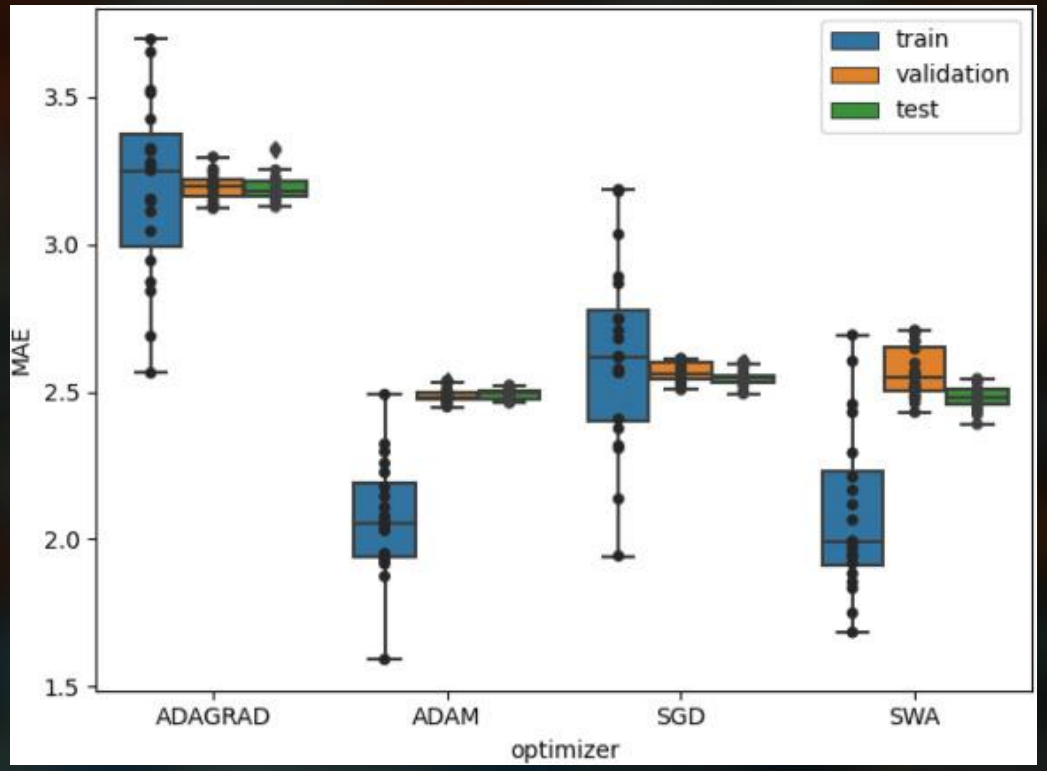
Augmentation	Cosine Similarity	Settings
Flip	0.8599	Horizontal
Brightness	0.6845	Factor: 2
Rotation	0.6656	Angle: 25
Random Zoom	0.7856	Factor: 2
Random Distortion	0.8728	Grid width: 10 Grid height: 10 Magnitude: 8
Random Colour	0.5609	Factor: 2
Random Contrast	0.3341	Factor: 5
Random Erasure	0.9837	Rectangle: 0.2

Neural Network



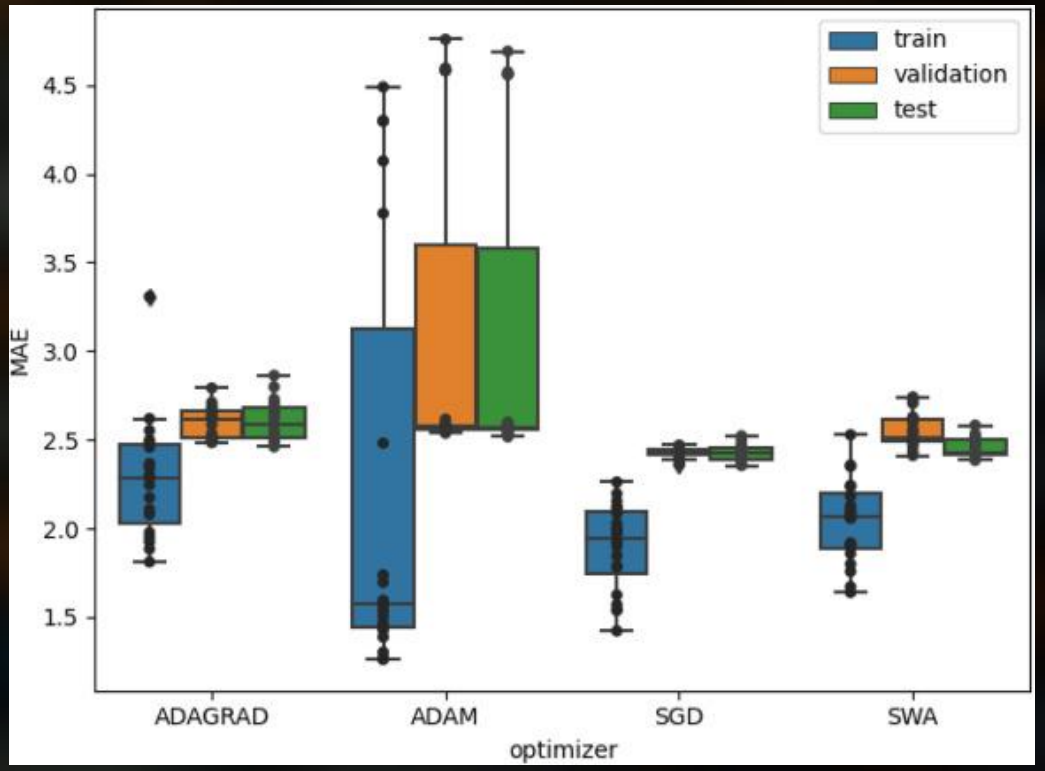
Results

Fixed Initial LR (D1)



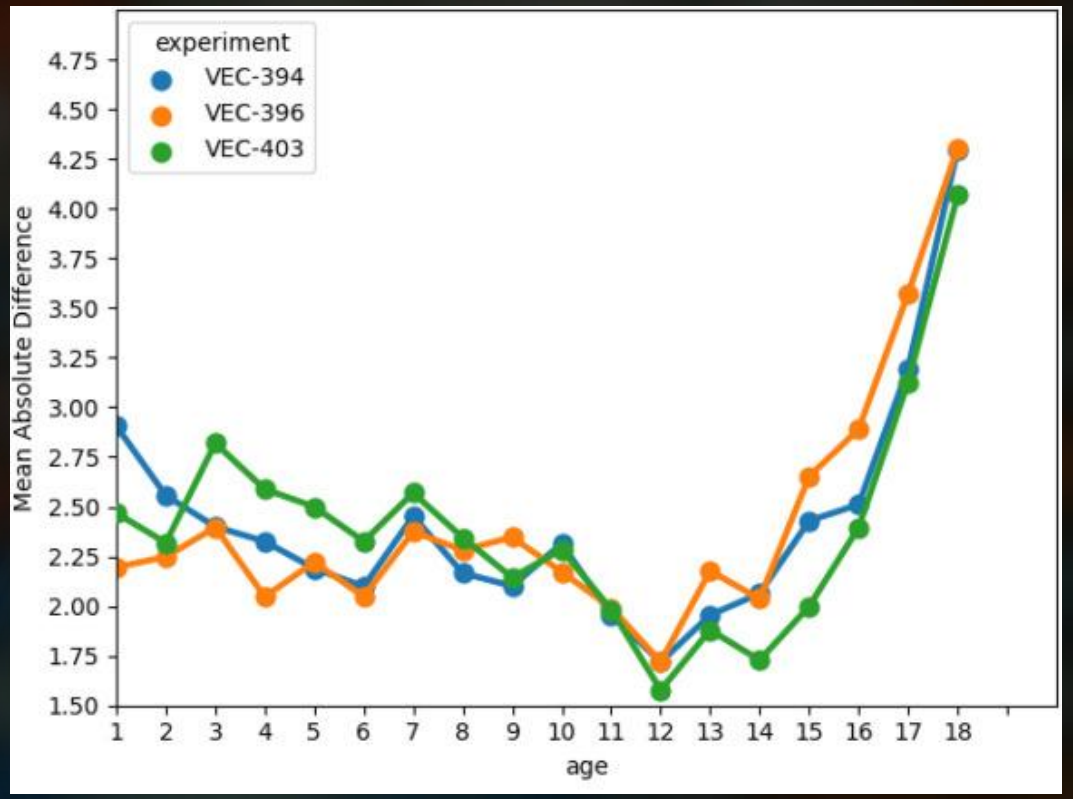
	mae			val_mae			test_mae		
optimiser	*min*	*mean*	*std*	*min*	*mean*	*std*	*min*	*mean*	*std*
ADAGRAD	2.56	3.19	0.31	3.12	3.20	0.05	3.13	3.19	0.05
ADAM	1.59	2.07	0.20	2.45	2.49	0.02	2.46	2.49	0.02
SGD	1.94	2.62	0.32	2.51	2.56	0.03	2.49	2.55	0.03
SWA	1.68	2.09	0.28	2.43	2.57	0.09	2.39	2.48	0.04

Initial LR Finder (E1)

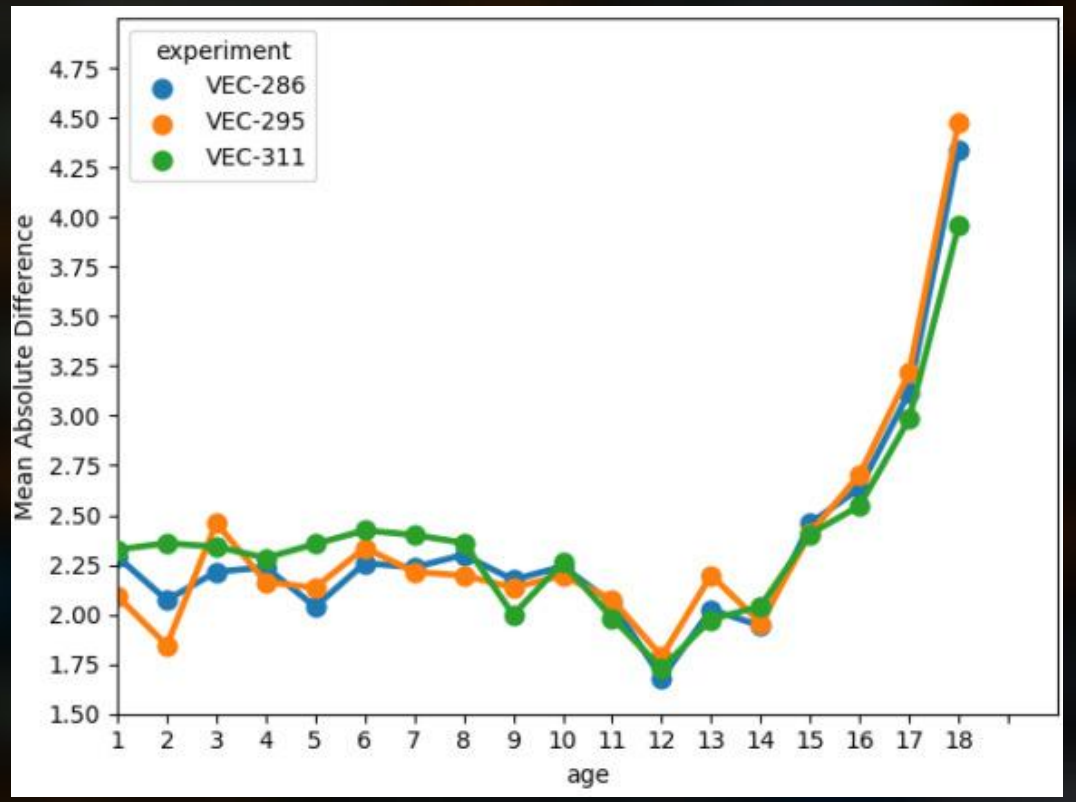


	mae			val_mae			test_mae		
optimiser	*min*	*mean*	*std*	*min*	*mean*	*std*	*min*	*mean*	*std*
ADAGRAD	1.81	2.28	0.35	2.48	2.60	0.09	2.46	2.61	0.12
ADAM	1.26	2.24	1.23	2.54	3.11	0.93	2.52	3.09	0.92
SGD	1.42	1.89	0.25	2.36	2.43	0.03	2.36	2.43	0.05
SWA	1.64	2.04	0.24	2.41	2.55	0.09	2.38	2.46	0.05

Results

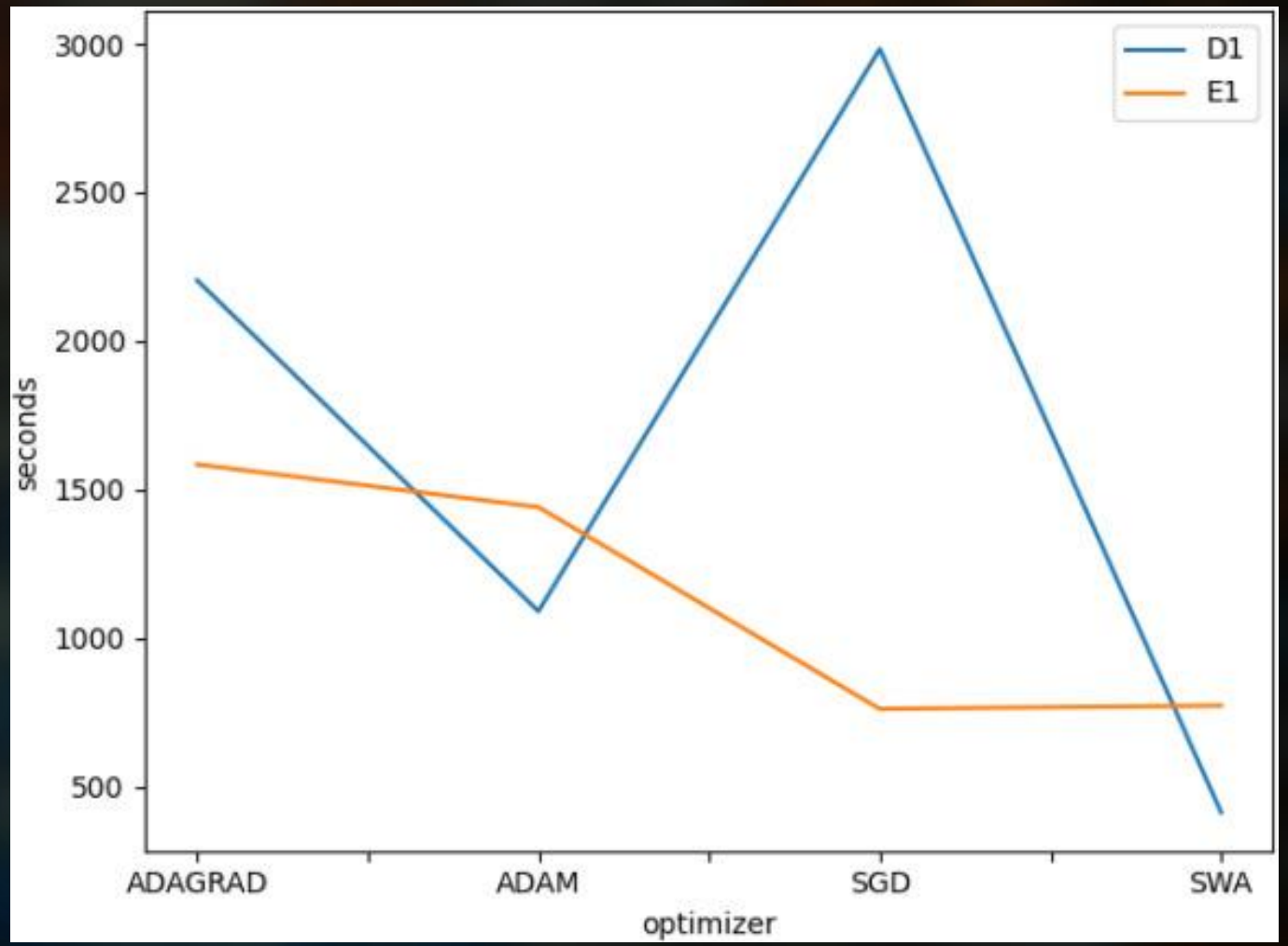


(a) Experiment D1 – SWA fixed initial *lr* approach



(b) Experiment E1 – SGD *lr* finder approach

Results



- CPU 2.8 GHz
- Quad-Core Intel Core i7
- 16GB Ram
- Intel Iris Pro 1536 Graphics card

Conclusion

- AE is still challenging
- Underage AE for DF performance has improved
- Simpler challenge is addressed, better performance
- Distribution of evaluation model metric, choose model more confidence
- Dataset and Optimal Learning Rates key influence on performance
- Tracking and visualizing metrics is paramount for researchers

THANK YOU

https://github.com/4ND4/Vec2UAge

https://ui.neptune.ai/4nd4/Vec2UAge/

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