Siamese Neural Networks for Access Control
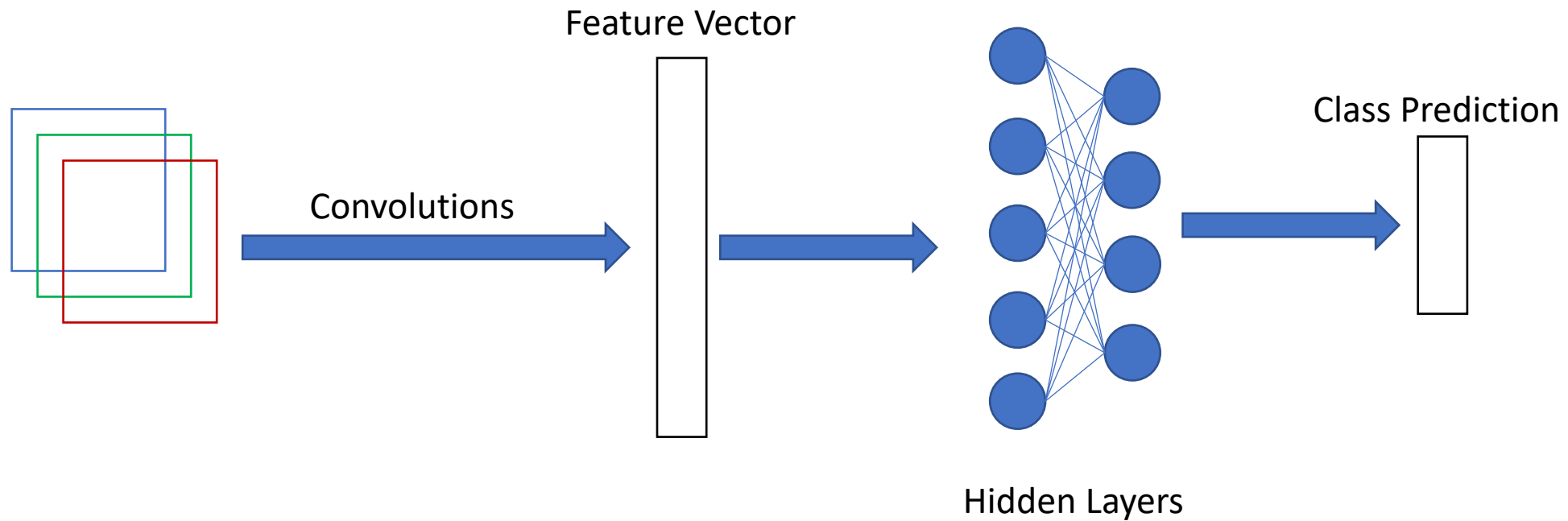
Ari Barnett

Mathematical Modeling Project 4
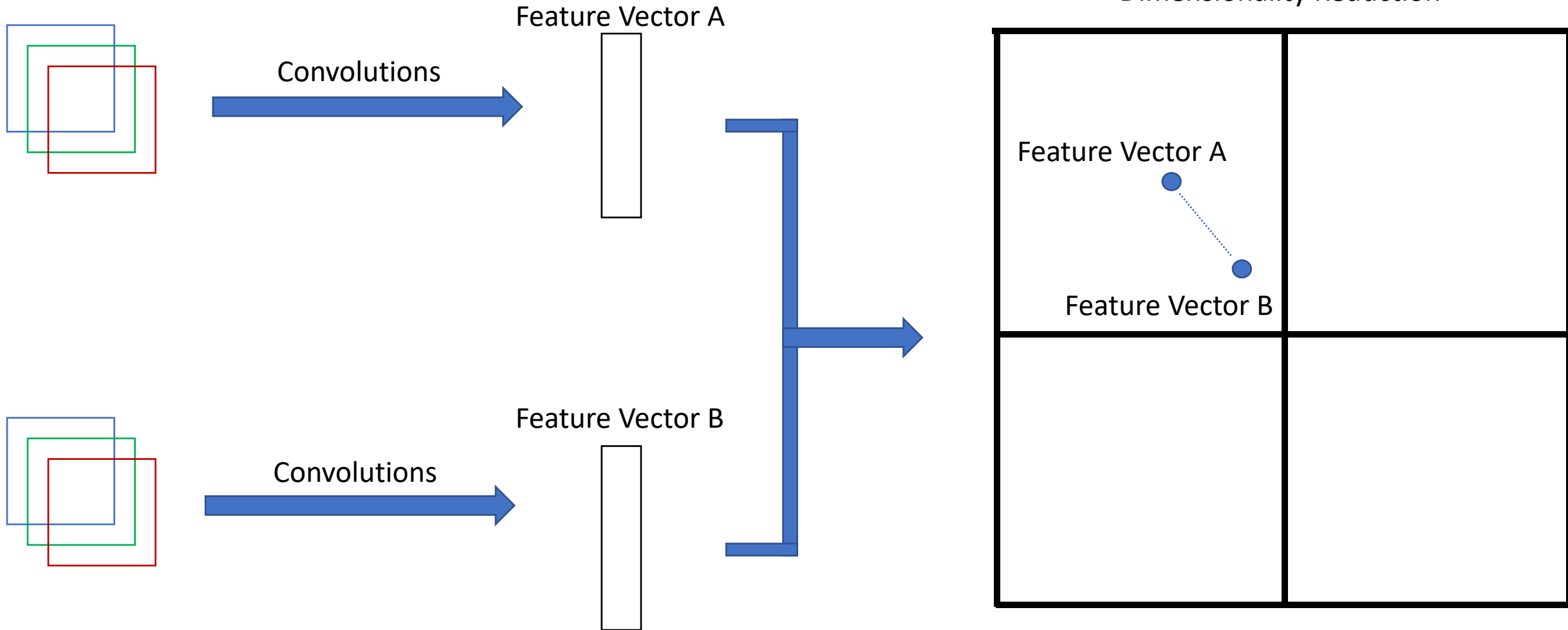
Overview

- CNN Basics
- SNN Basics
- Data overview / methods
- CNN Displayed
- Example Cases
- Conclusions

Basics of Convolutional Neural Networks

Feature Vector

Convolutions

Class Prediction

Hidden Layers

Siamese Neural Network

Dataset Used / Approaches Tried

- Kaggle Celebrity Image Dataset
  - N = 1800, Classes = 18, Both Actors and Actress, Multiracial, Varying presentations (glasses, facial hair, etc)

- Additional Cat Images
  - Utilize drastic image difference to demonstrate effectiveness or lack of

- Approaches
  - Cosine Similarity Score
  - Distance (Euclidean, L1)
  - Classification (K-means clustering, ML approach**)

**Discussed Not Shown

CNN Overview (Resnet18 using ImageNet)
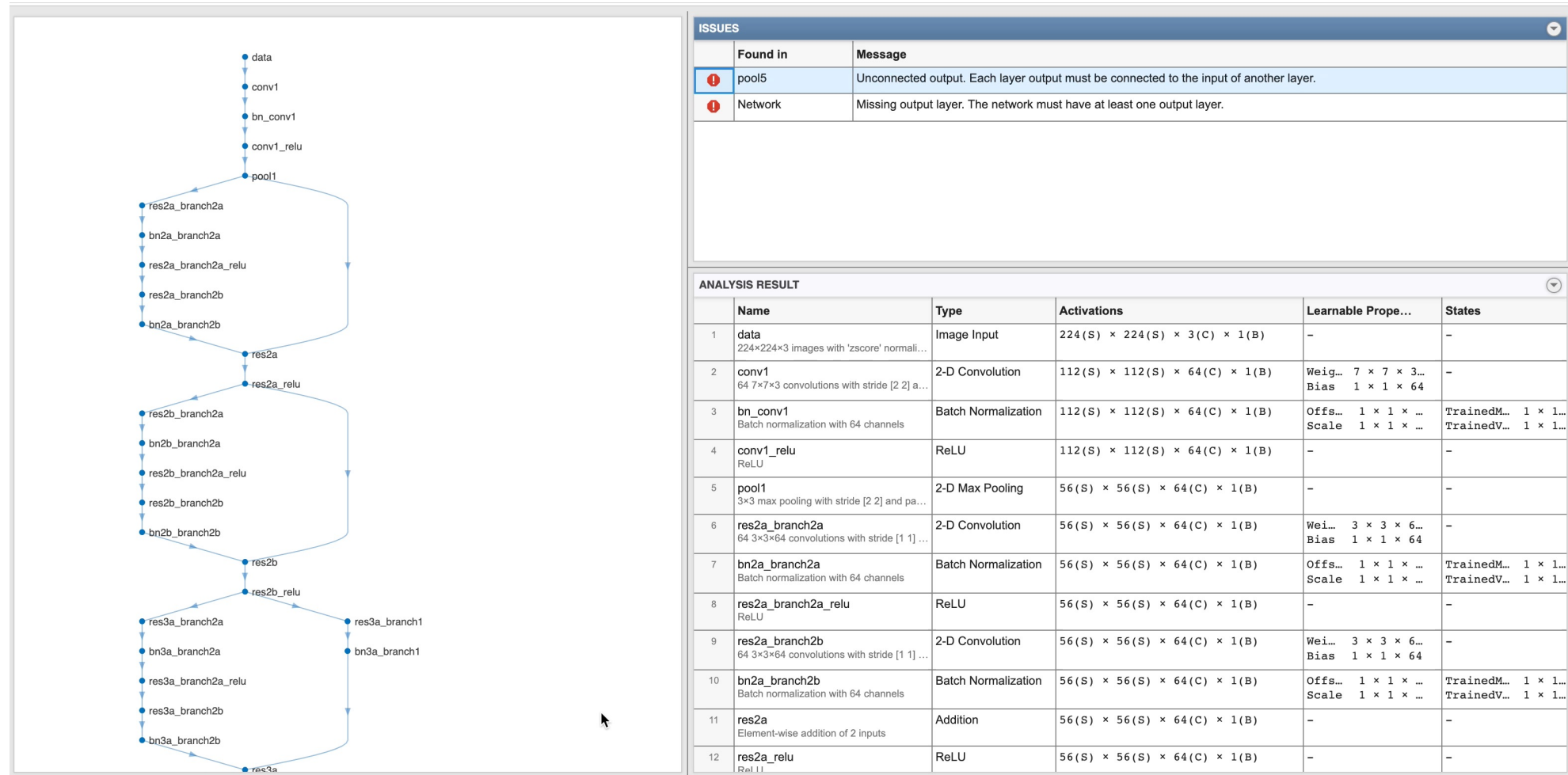
Example Case 1

Metrics from Feature Matrix:

Euclidean Distance = 1.2394
L1 Distance = 21.8296
Cosine Similarity = 0.9983

Metrics from Dimension Reduction (TSNE):

Euclidean Distance = 3.59e-05
L1 Distance = 4.99e-05
Cosine Similarity = 0.8853

Angelina Jolie

Due to the stochastic nature of TSNE without fixing RNG – can produce varying results.
Likewise, adjust perplexity hyperparameter to prevent point mirroring

Example Case 2

Metrics from Feature Matrix:

Euclidean Distance = 1.2938
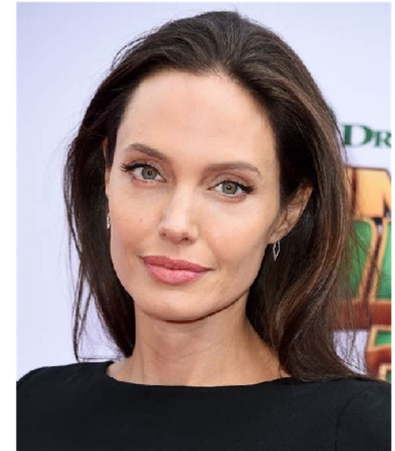L1 Distance = 22.5892
Cosine Similarity = 0.9982

Metrics from Dimension Reduction (TSNE):

Euclidean Distance = 1.44e-04
L1 Distance = 1.6657e-04
Cosine Similarity = -0.1674

Cartoon Cat vs Angelina Jolie

Example Case 2

Metrics from Feature Matrix:

Euclidean Distance = 1.2002
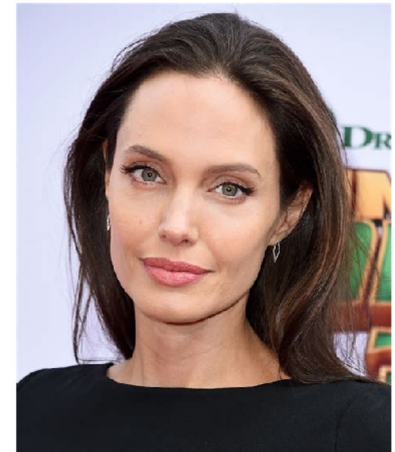L1 Distance = 21.6547
Cosine Similarity = 0.9984

Metrics from Dimension Reduction (TSNE):

Euclidean Distance = 1.545e-04
L1 Distance = 2.0414e-04
Cosine Similarity = 0.1752

Will Smith vs Angelina Jolie

Threshold / Rapid Testing

- Of the metrics utilized – cosine similarity yields the most effective and likely consistent method to be utilized.

- Therefore, we evaluate this approach for entry control via running 1000 iterations and comparing the method to standard clustering approaches to determine an effective method to maintain security.

Staff Employee Photo

Would I trust the security system as is?

Would I trust the security system as is?

- NOPE!

KMEAN APPROACH
Correctly identified employee = 45.6% of the time

COSINE SIM. APPROACH
Specifity = 0.667 Sensitivty = 0.358
Accuracy = 0.5125

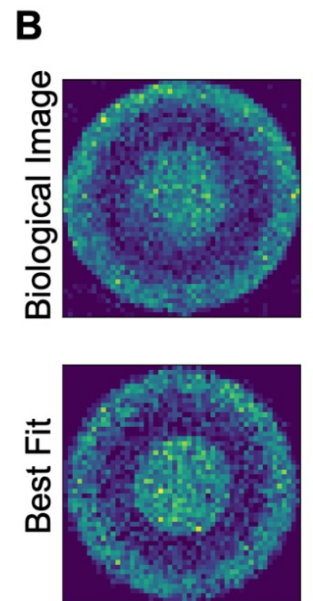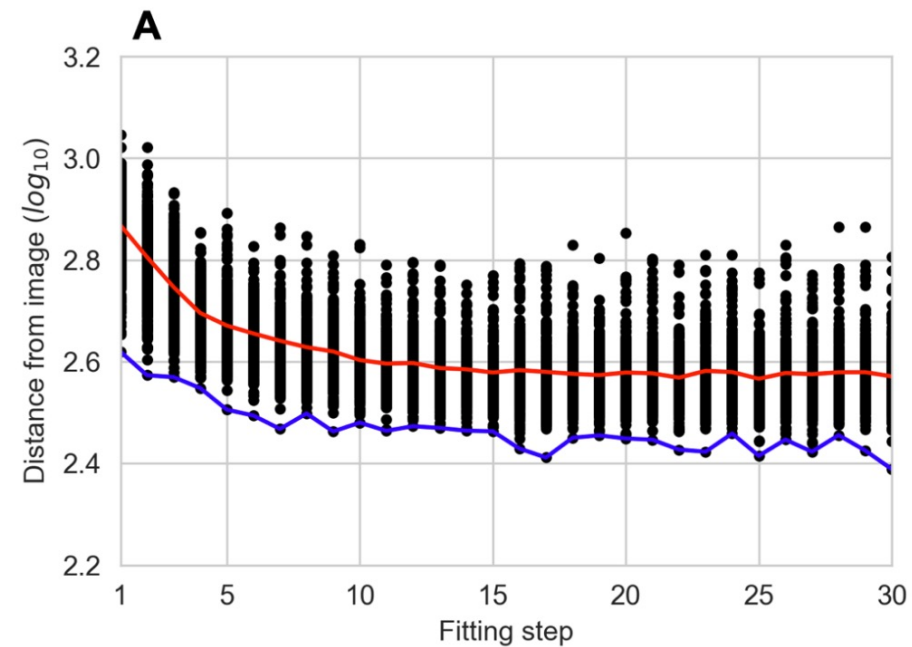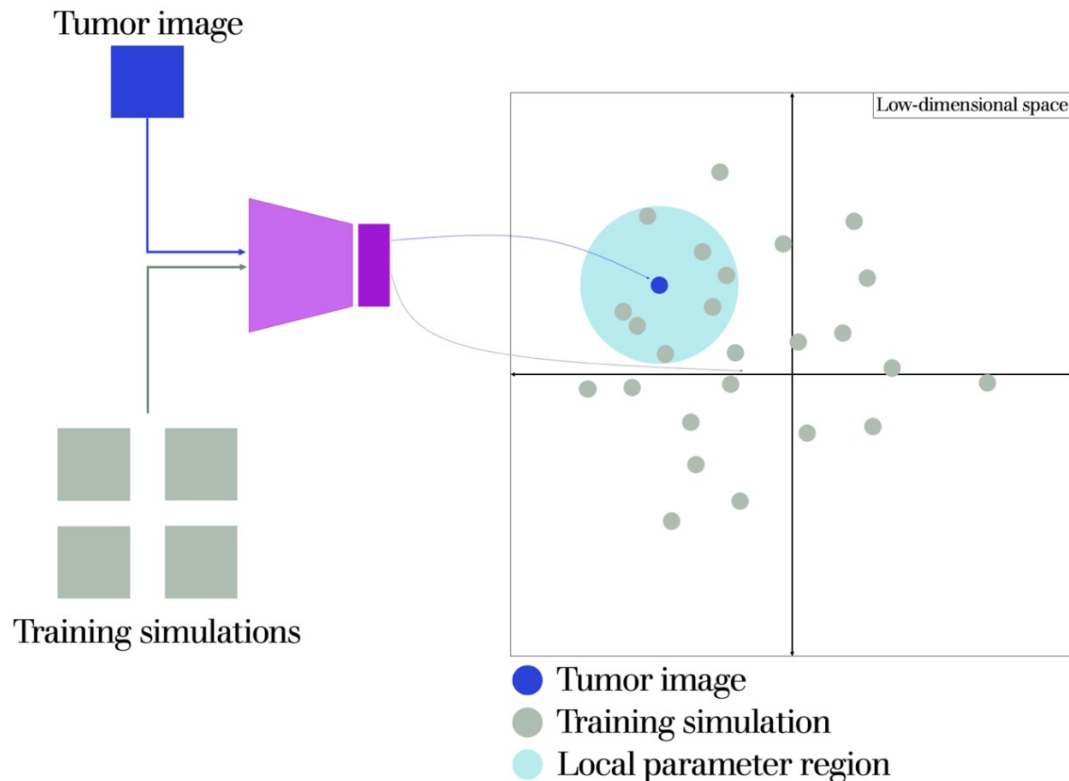MEDIAN COSINE SIMILARITY
Similarity Average (True) = 0.034019
Similarity Average (False) = –0.030293

Things to do different / Conclusion

- Ideally in a real-world situation more accurate weights from similar dataset could be used for transfer learning approach (freeze layers, retrain classification task)

- Evaluating initial classification labels given to the images – many times the predicted class referred to articles of clothing the celebrity was wearing therefore making the distinction difficult

- Potential need for further data augmentation or deeper network

Other Applications of SCNN

- Parameter estimation for Stochastic Models (ABM's)

QUESTIONS?