Portrait Optimization Via Deep Learning Networks:

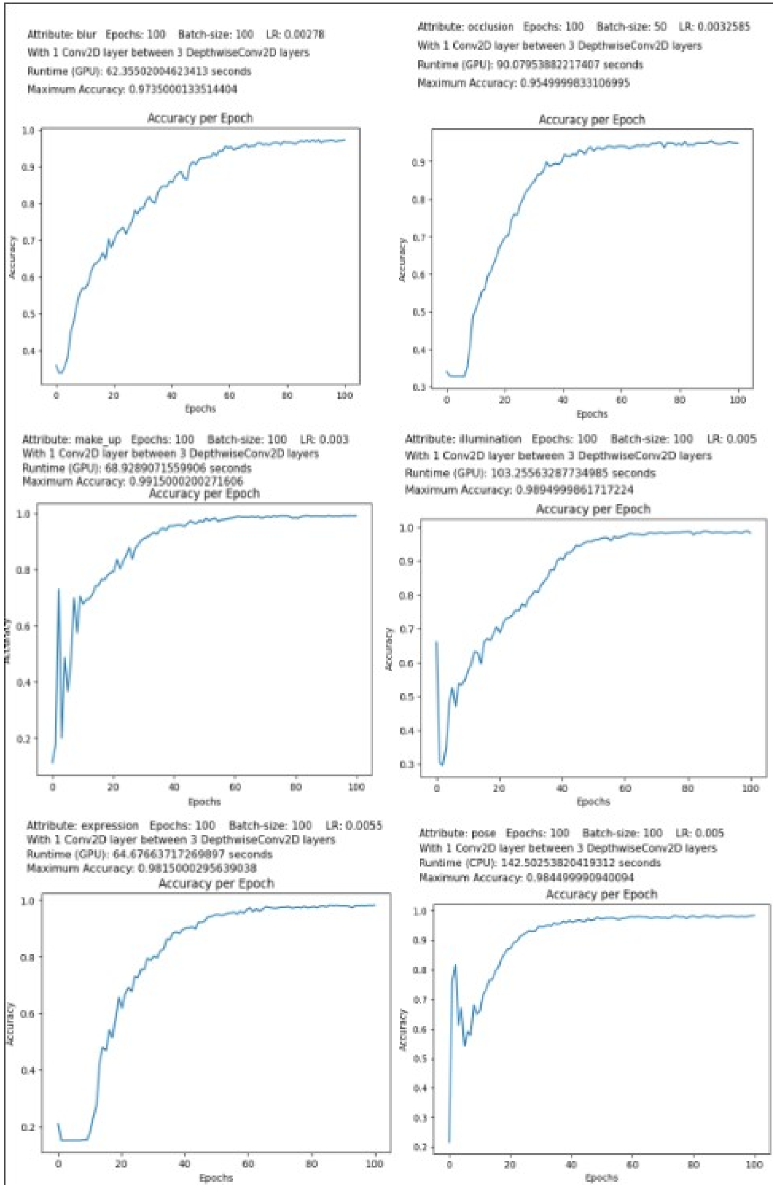
A Framework for Context-Aware Photography Recommendations

Shriya Nair & Bucky Hayes

Institute for Computing in Research Summer 2025

Photo-aid

Photo-aid



Attribute: blur   Epochs: 100   Batch-size: 100   LR: 0.00278
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 62.35502004623413 seconds
Maximum Accuracy: 0.9735000133514404

Attribute: occlusion   Epochs: 100   Batch-size: 50   LR: 0.0032585
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 90.07953882217407 seconds
Maximum Accuracy: 0.9549999833106995

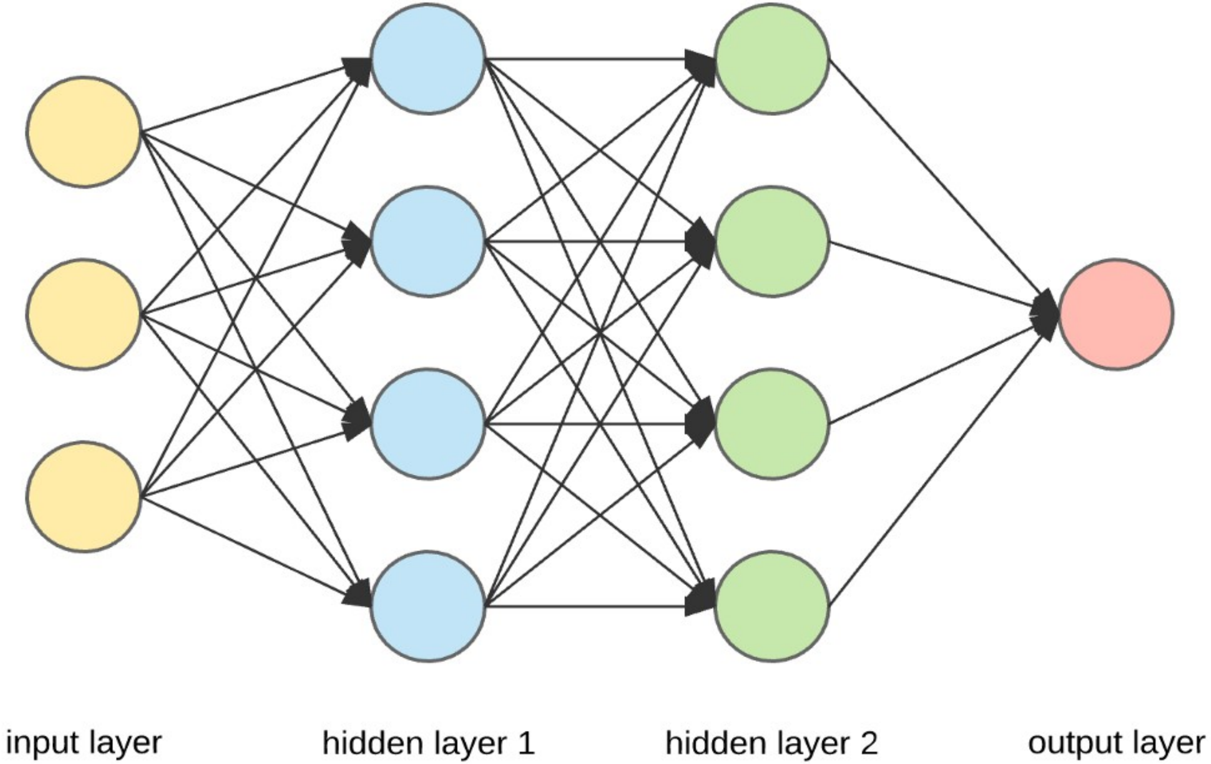
Attribute: make_up   Epochs: 100   Batch-size: 100   LR: 0.003
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 68.9289071559906 seconds
Maximum Accuracy: 0.9915000200271606

Attribute: illumination   Epochs: 100   Batch-size: 100   LR: 0.005
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 103.25563287734985 seconds
Maximum Accuracy: 0.9894999861717224

Attribute: expression   Epochs: 100   Batch-size: 100   LR: 0.0055
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 64.67663717269897 seconds
Maximum Accuracy: 0.9815000295639038

Attribute: pose   Epochs: 100   Batch-size: 100   LR: 0.005
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (CPU): 142.50253820419312 seconds
Maximum Accuracy: 0.984499990940094

What Is a Neural Network?

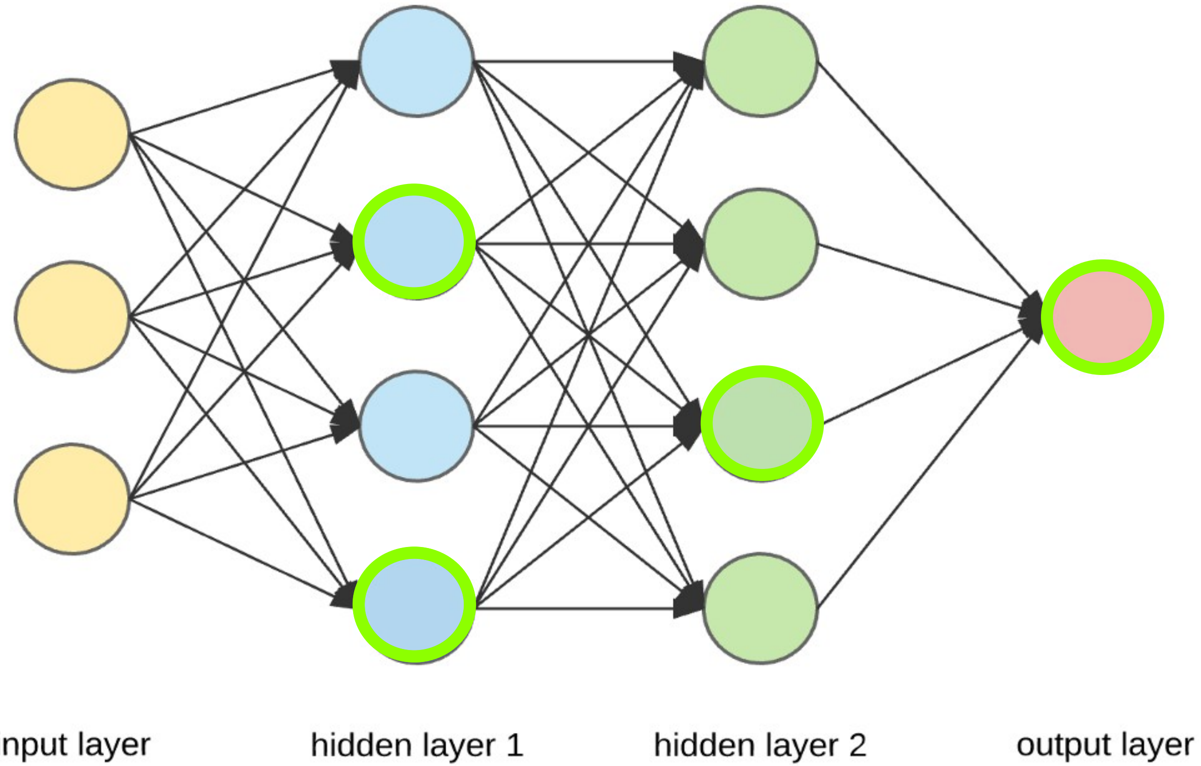


P., Petru. “What Is a Neural Network & How Does It Work? Ai Guide.” Roboflow Blog, Roboflow Blog, 14 Jan. 2025, blog.roboflow.com/what-is-a-neural-network/.

What Is a Neural Network?

Neurons

Activation



What Is a Neural Network?

Neurons

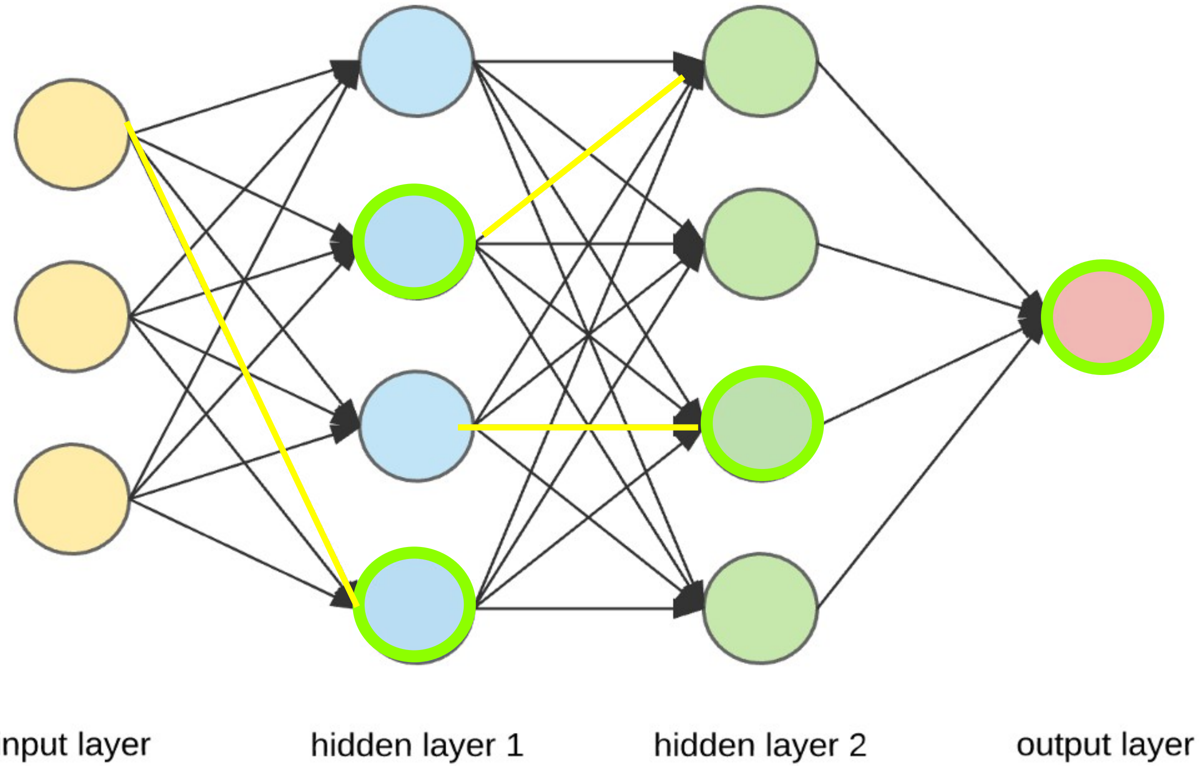
Activation

Normalization

Weights

Bias

Loss



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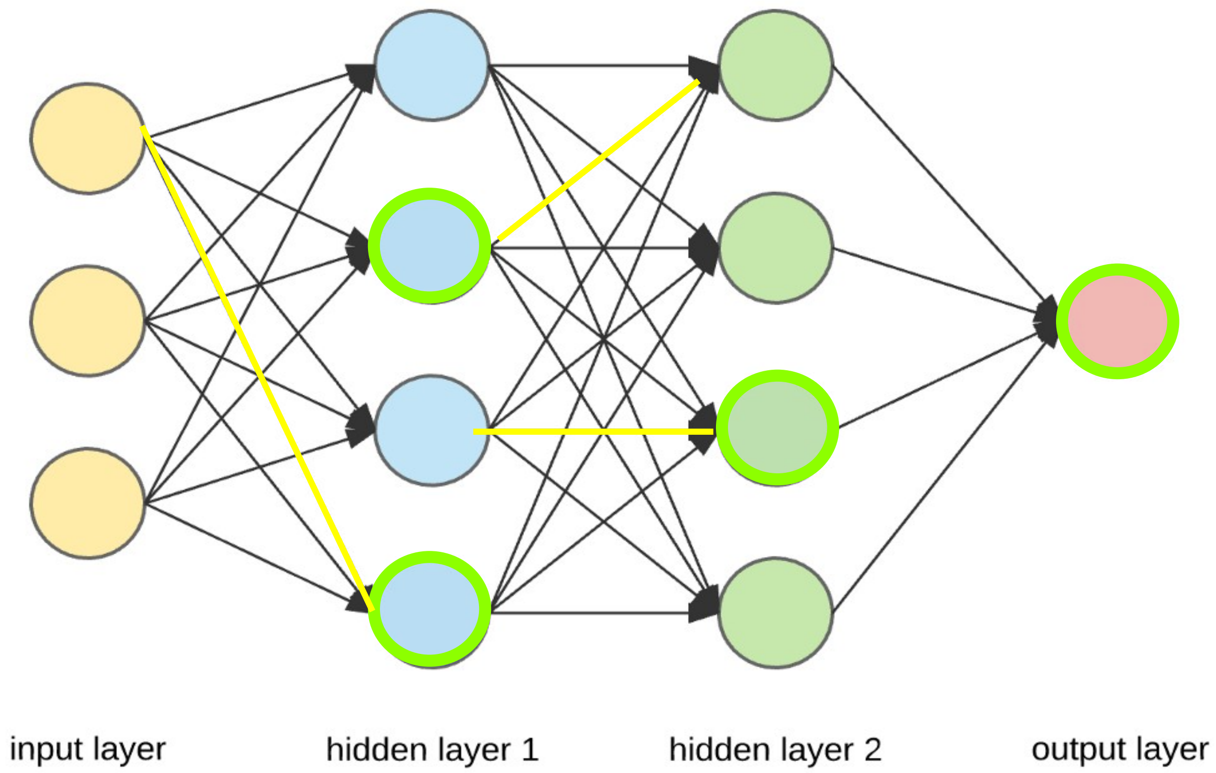


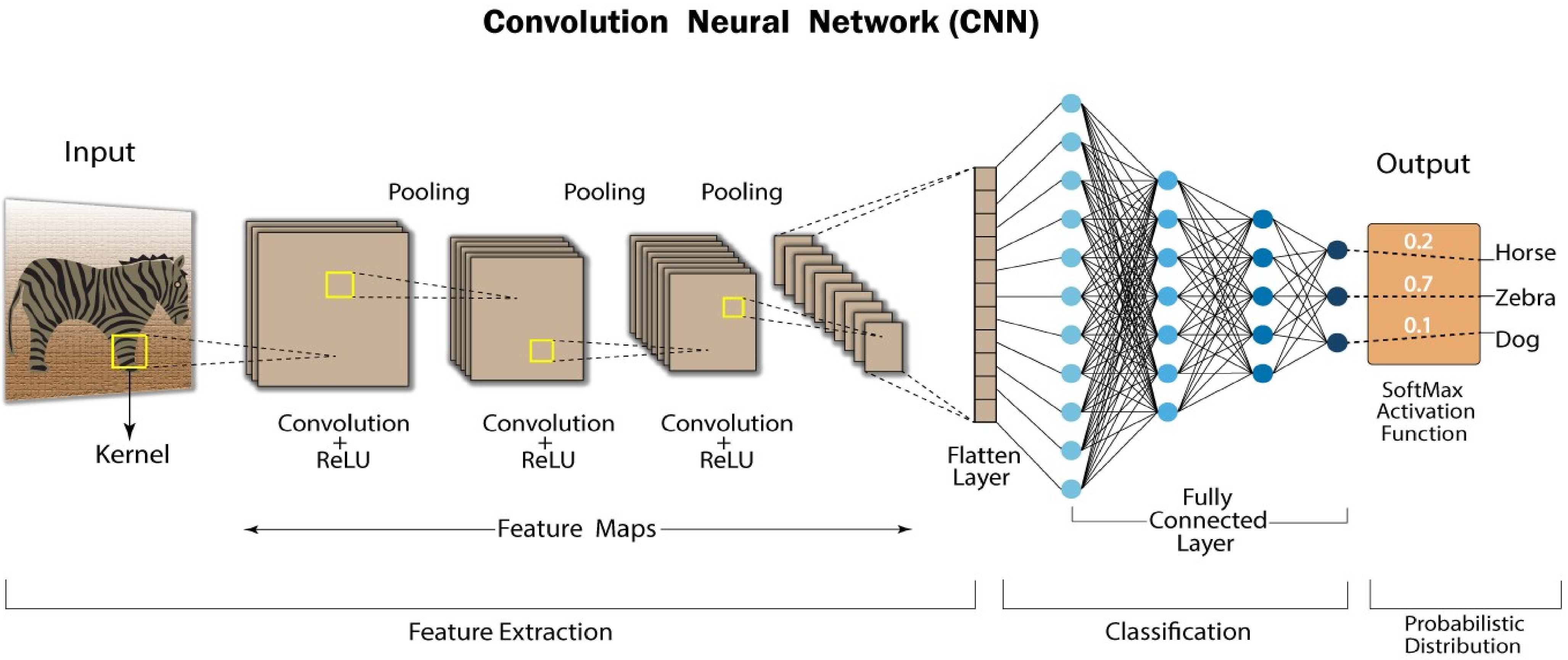
Back-propagation

Hyper-parameters:

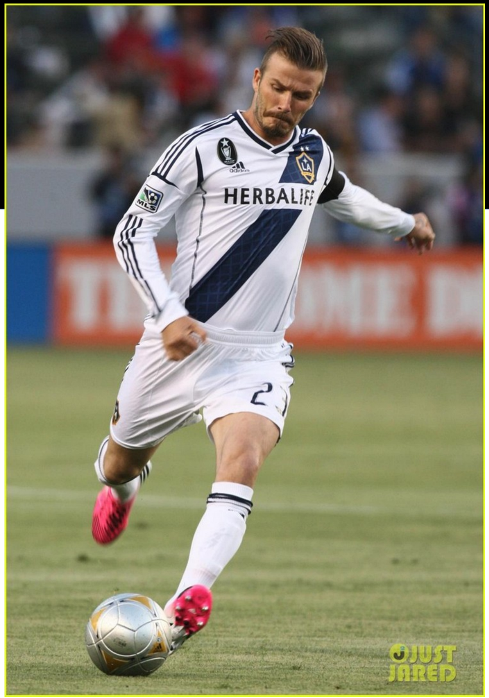
Epochs

Learning Rate

Batch-size

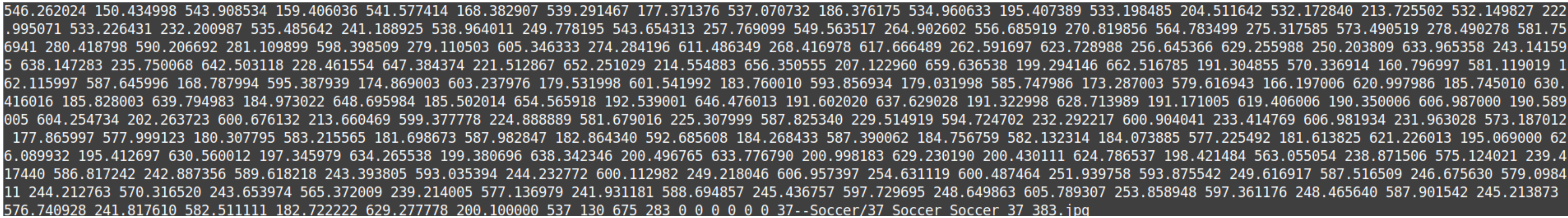


Swapna, & Sulthandudekula. (2025, February 8). Convolutional Neural Network: Deep learning. Developers Breach. https://developersbreach.com/convolution-neural-network-deep-learning/



Wider Facial Landmarks in the Wild (WFLW) Dataset

< image1, label1>



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.995071 533.226431 232.200987 535.485642 241.188925 538.964011 249.778195 543.654313 257.769099 549.563517 264.902602 556.685919 270.819856 564.783499 275.317585 573.490519 278.490278 581.75
6941 280.418798 590.206692 281.109899 598.398509 279.110503 605.346333 274.284196 611.486349 268.416978 617.666489 262.591697 623.728988 256.645366 629.255988 250.203809 633.965358 243.14159
5 638.147283 235.750068 642.503118 228.461554 647.384374 221.512867 652.251029 214.554883 656.350555 207.122960 659.636538 199.294146 662.516785 191.304855 570.336914 160.796997 581.119019 1
62.115997 587.645996 168.787994 595.387939 174.869003 603.237976 179.531998 601.541992 183.760010 593.856934 179.031998 585.747986 173.287003 579.616943 166.197006 620.997986 185.745010 630.
416016 185.828003 639.794983 184.973022 648.695984 185.502014 654.565918 192.539001 646.476013 191.602020 637.629028 191.322998 628.713989 191.171005 619.406006 190.350006 606.987000 190.589
005 604.254734 202.263723 600.676132 213.660469 599.377778 224.888889 581.679016 225.307999 587.825340 229.514919 594.724702 232.292217 600.904041 233.414769 606.981934 231.963028 573.187012
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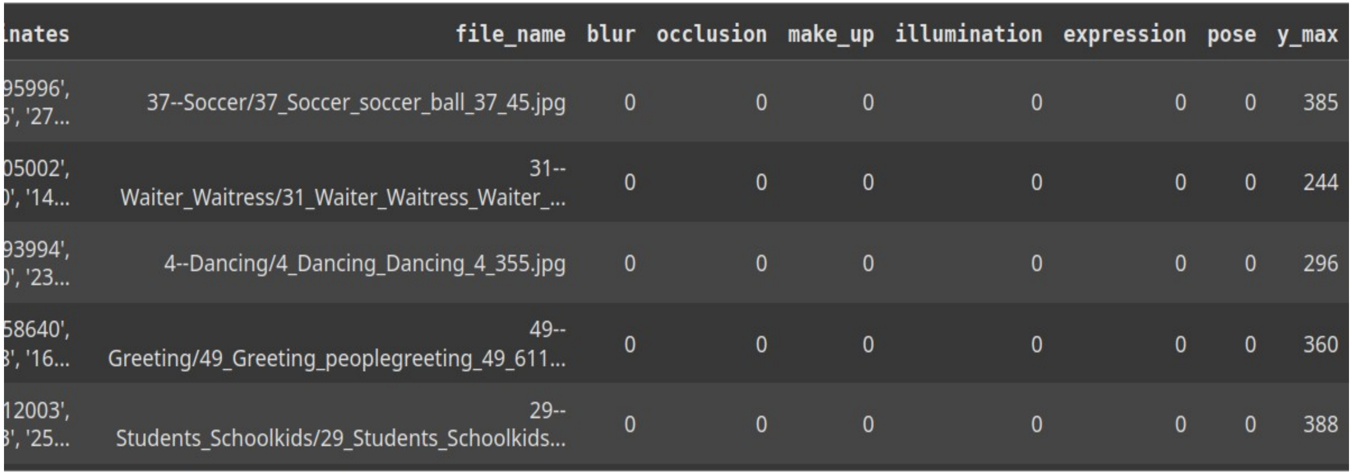
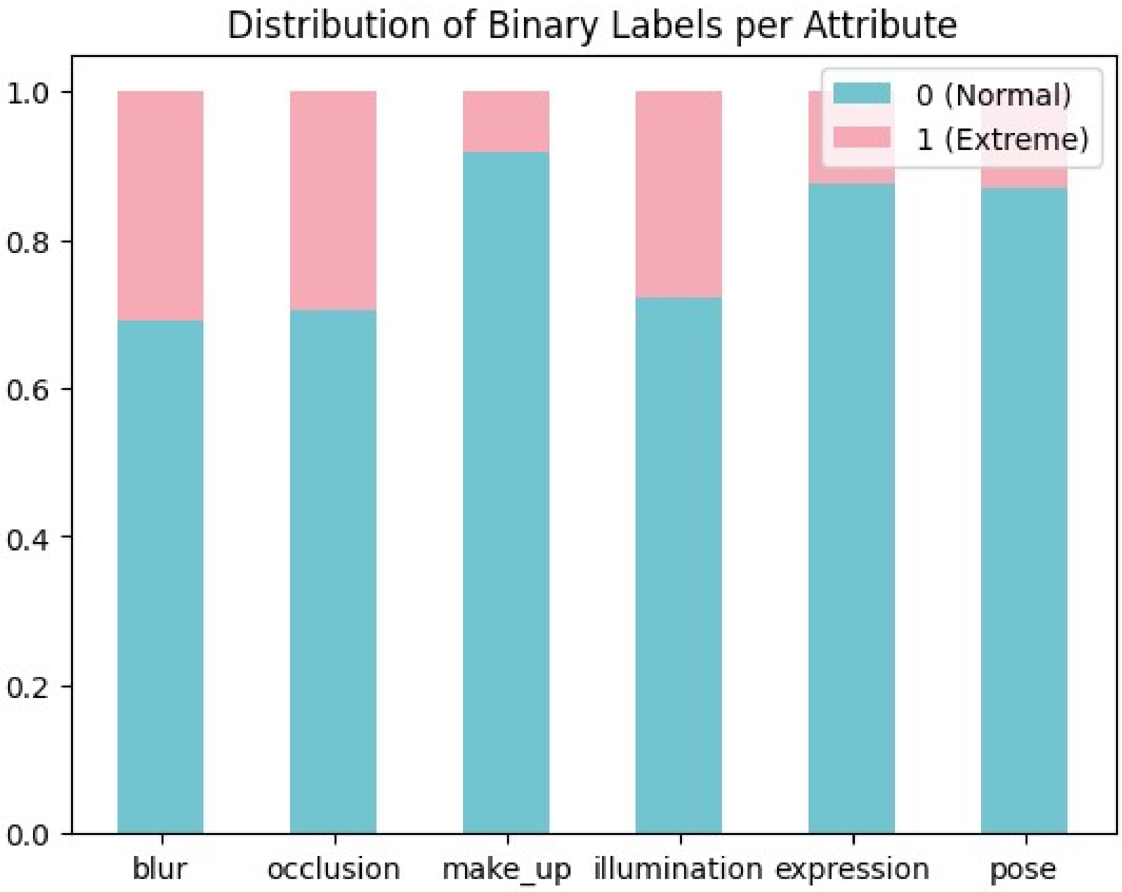
17440 586.817242 242.887356 589.618218 243.393805 593.035394 244.232772 600.112982 249.218046 606.957397 254.631119 600.487464 251.939758 593.875542 249.616917 587.516509 246.675630 579.0984
11 244.212763 570.316520 243.653974 565.372009 239.214005 577.136979 241.931181 588.694857 245.436757 597.729695 248.649863 605.789307 253.858948 597.361176 248.465640 587.901542 245.213873
576.740928 241.817610 582.511111 182.722222 629.277778 200.100000 537 130 675 283 0 0 0 0 0 0 37--Soccer/37_Soccer_Soccer_37_383.jpg
```

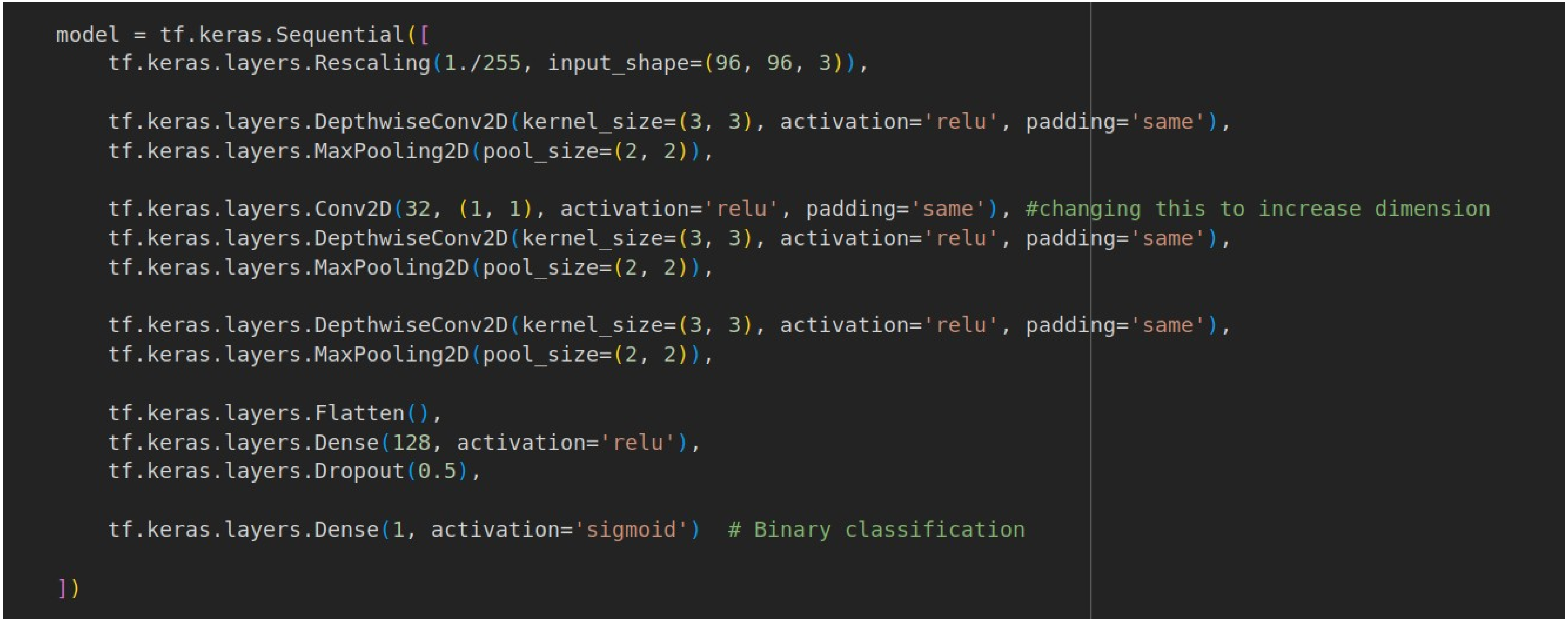
Wider Facial Landmarks in the Wild (WFLW) Dataset



inates	file_name	blur	occlusion	make_up	illumination	expression	pose	y_max
95996', 5', '27...	37--Soccer/37_Soccer_soccer_ball_37_45.jpg	0	0	0	0	0	0	385
05002', 0', '14...	31--Waiter_Waitress/31_Waiter_Waitress_Waiter_...	0	0	0	0	0	0	244
93994', 0', '23...	4--Dancing/4_Dancing_Dancing_4_355.jpg	0	0	0	0	0	0	296
58640', 3', '16...	49--Greeting/49_Greeting_peoplegreeting_49_611...	0	0	0	0	0	0	360
12003', 3', '25...	29--Students_Schoolkids/29_Students_Schoolkids...	0	0	0	0	0	0	388



Distribution of Binary Labels per Attribute



```python
model = tf.keras.Sequential([
    tf.keras.layers.Rescaling(1./255, input_shape=(96, 96, 3)),

    tf.keras.layers.DepthwiseConv2D(kernel_size=(3, 3), activation='relu', padding='same'),
    tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),

    tf.keras.layers.Conv2D(32, (1, 1), activation='relu', padding='same'), #changing this to increase dimension
    tf.keras.layers.DepthwiseConv2D(kernel_size=(3, 3), activation='relu', padding='same'),
    tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),

    tf.keras.layers.DepthwiseConv2D(kernel_size=(3, 3), activation='relu', padding='same'),
    tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),

    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dropout(0.5),

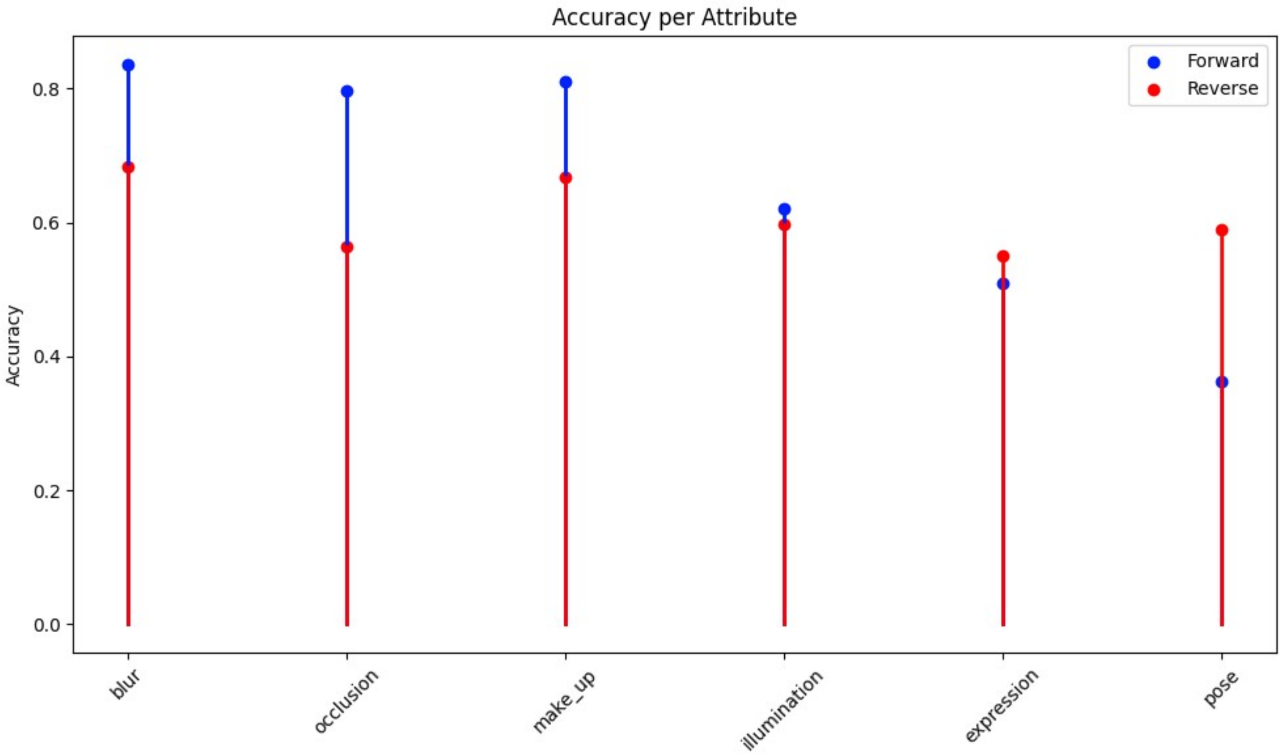
    tf.keras.layers.Dense(1, activation='sigmoid')  # Binary classification

])
```

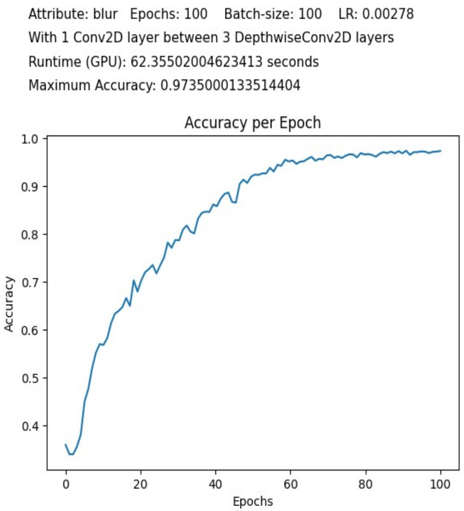
Epochs: 25 Batch-size: 100 Learning-rate: 0.0028

Using 2D Depthwise Convolutions

Runtime (CPU): 200.81493401527405 seconds



Accuracy per Epoch graph for each Attribute



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Attribute: blur   Epochs: 100    Batch-size: 100    LR: 0.00278
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 62.35502004623413 seconds
Maximum Accuracy: 0.9735000133514404
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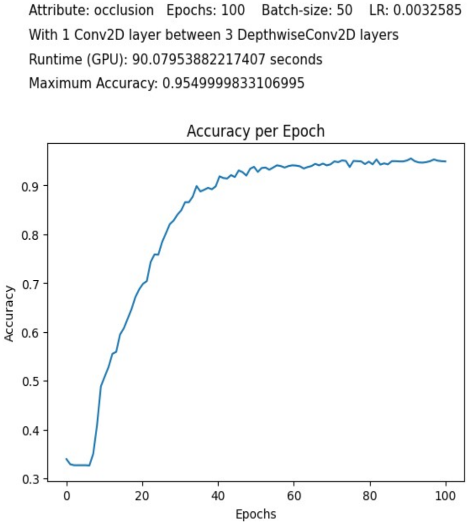

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Attribute: occlusion   Epochs: 100    Batch-size: 50    LR: 0.0032585
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 90.07953882217407 seconds
Maximum Accuracy: 0.9549999833106995
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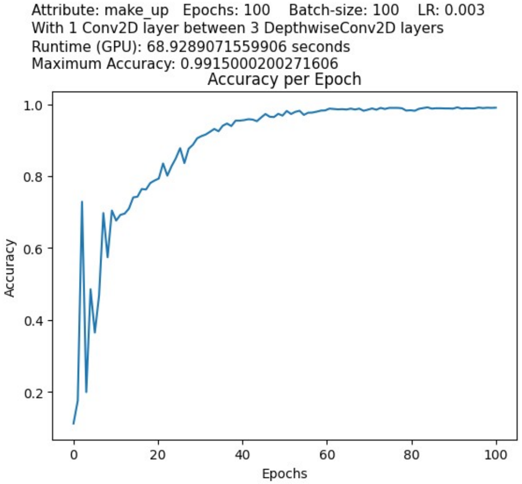

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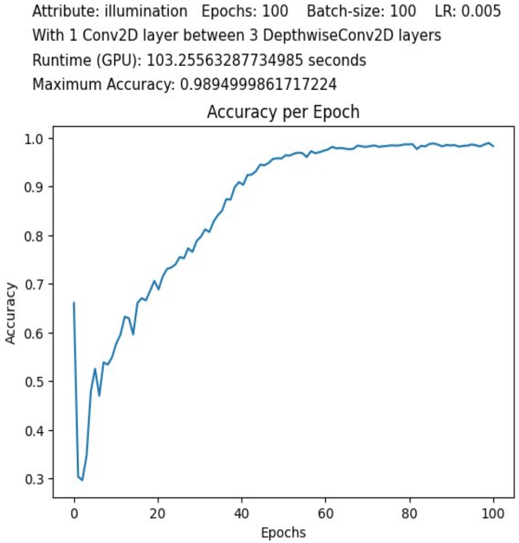

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Runtime (GPU): 103.25563287734985 seconds
Maximum Accuracy: 0.9894999861717224
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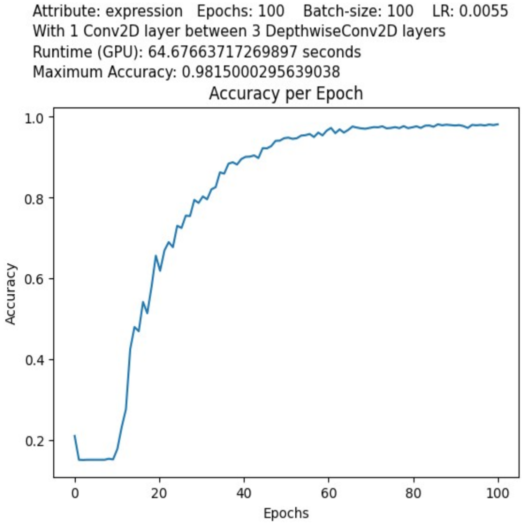

```
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With 1 Conv2D layer between 3 DepthwiseConv2D layers
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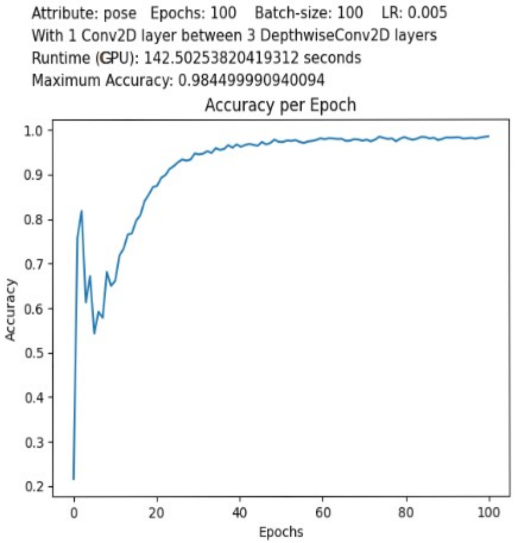
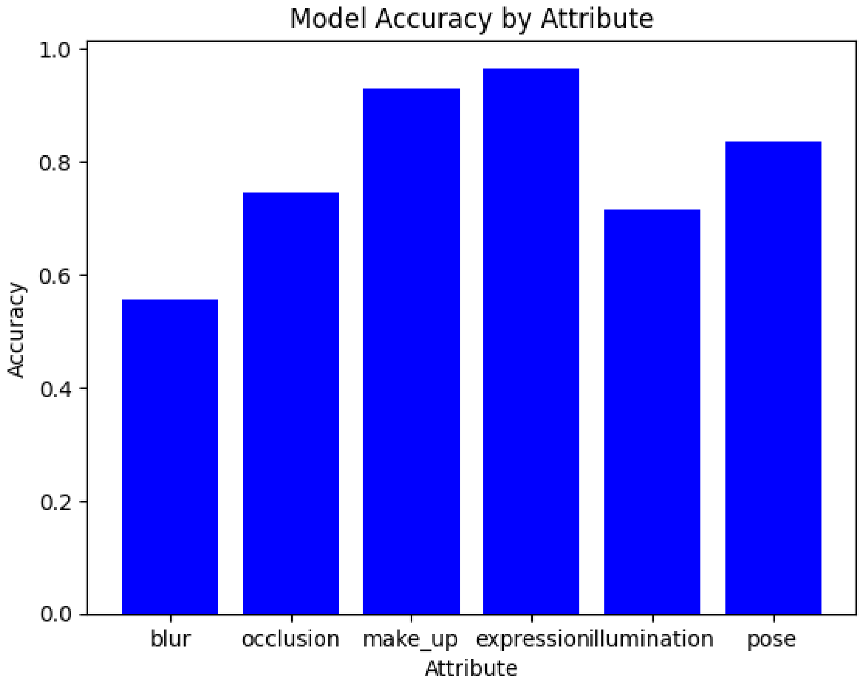


```
Attribute: pose   Epochs: 100    Batch-size: 100    LR: 0.005
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 142.50253820419312 seconds
Maximum Accuracy: 0.984499990940094
```

Training Results

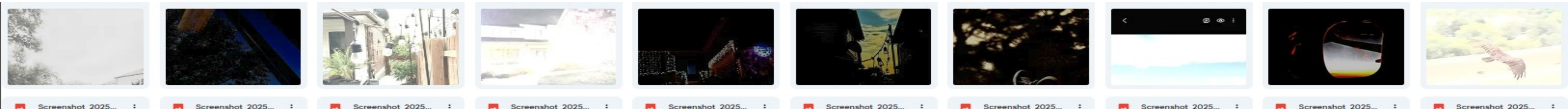
	Blur	Occlusion	Make Up	Expression	Illumination	Pose
Accuracy	97.3%	95.5%	99.1%	98.2%	98.9%	98.4%
Learning Rate	0.00278	0.003285	0.003	0.0055	0.005	0.005
Batch-size	100	50	100	100	100	100

Testing Results

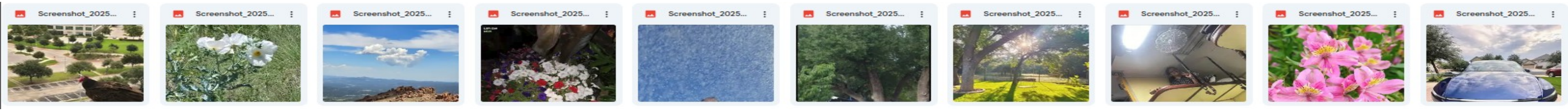


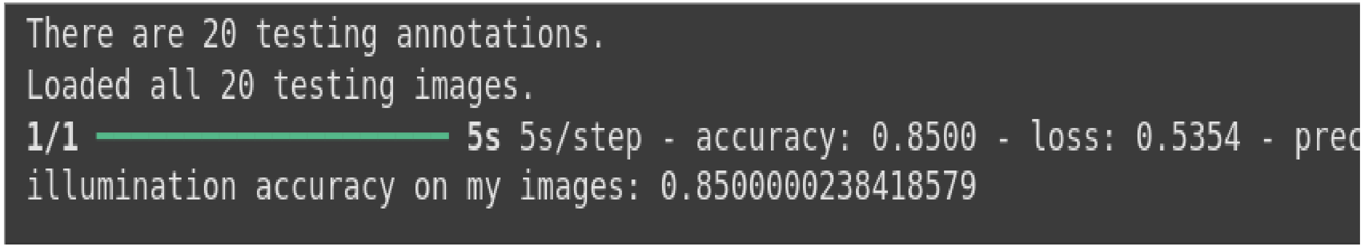
Testing Results

Extreme Illumination:



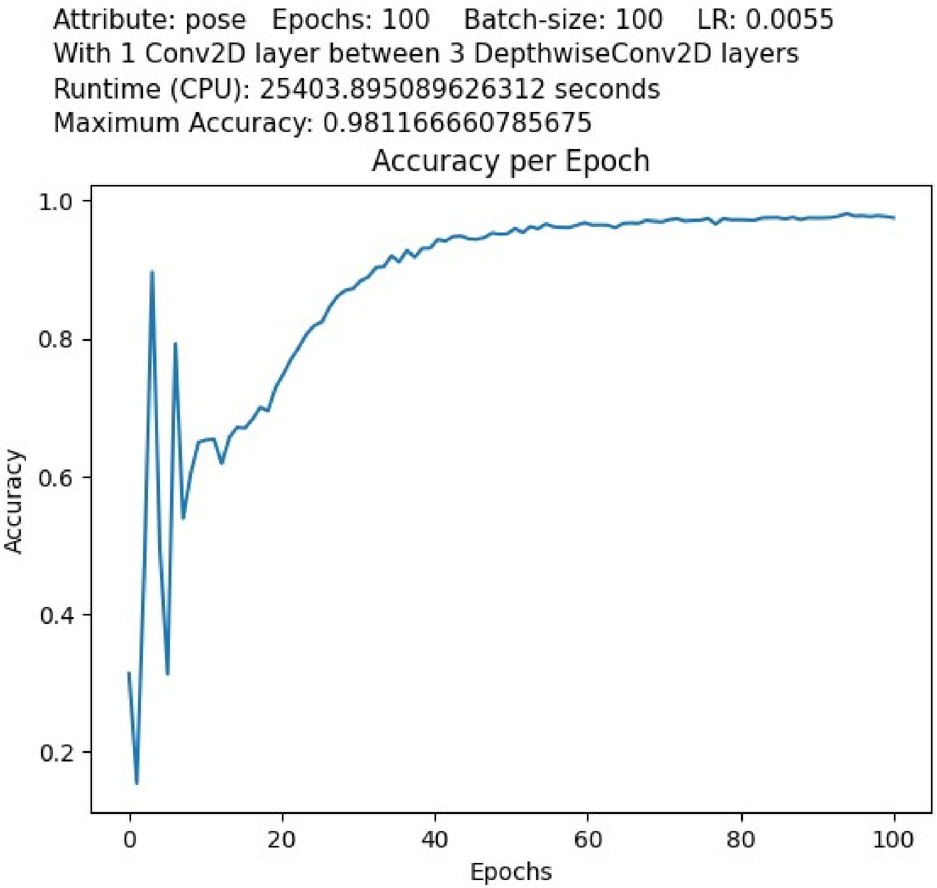
“Normal” Illumination:



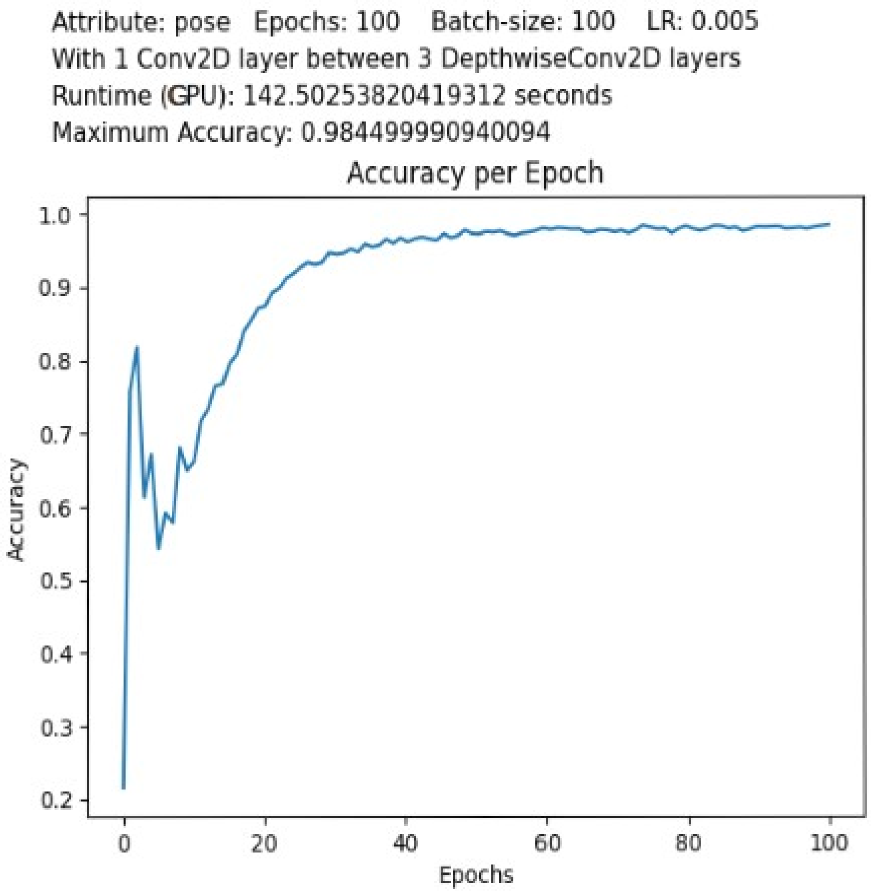


```
There are 20 testing annotations.
Loaded all 20 testing images.
1/1 ━━━━━━━━━━━━━━━━━━━━ 5s 5s/step - accuracy: 0.8500 - loss: 0.5354 - prec
illumination accuracy on my images: 0.8500000238418579
```

CPU vs GPU



Attribute: pose   Epochs: 100   Batch-size: 100   LR: 0.0055
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (CPU): 25403.895089626312 seconds
Maximum Accuracy: 0.981166660785675



Attribute: pose   Epochs: 100   Batch-size: 100   LR: 0.005
With 1 Conv2D layer between 3 DepthwiseConv2D layers
Runtime (GPU): 142.50253820419312 seconds
Maximum Accuracy: 0.984499990940094

What’s Next?

Photo-Aid Application

- Manipulate structure of models
- Diverse models
- CPU time complexity reduction

Similar Applications

- Deep Fake Recognition
- Modular AI vision system

Outcomes

- Used Tensorflow, Keras, Open-CV Libraries through Google Colab

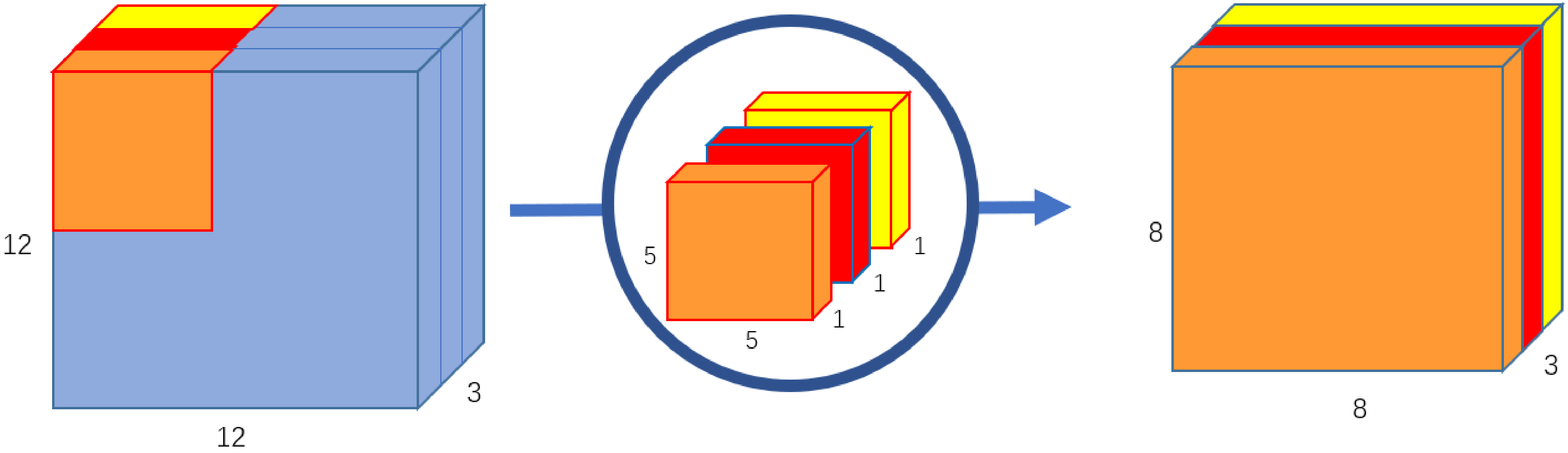
- Created Neural Networks to classify blur, occlusion, make up, illumination, expression, and pose into binary categories

- Experimented with different training conditions

- Tested using WFLW data and personal data

Thank you!

Depthwise Convolution Visual


12
12
3
5
5
1
1
1
8
8
3