African Wildlife Animal recognition

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Module 6 Project

by Michael Zbinden & Raphael Ziegler

- The Dataset
- Convolutional Neural Network
- Transfer Learning

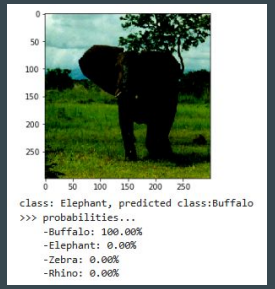
African Wildlife from kaggle.com

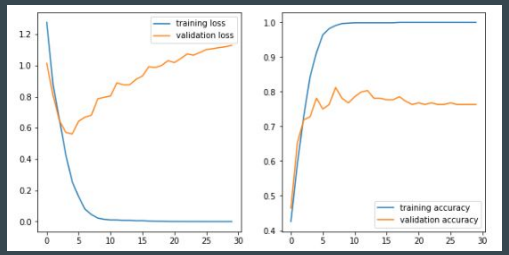
- Four animal classes (buffalo, elephant, rhino and zebra)
- 376 images for each animal class




Convolutional Neural Network

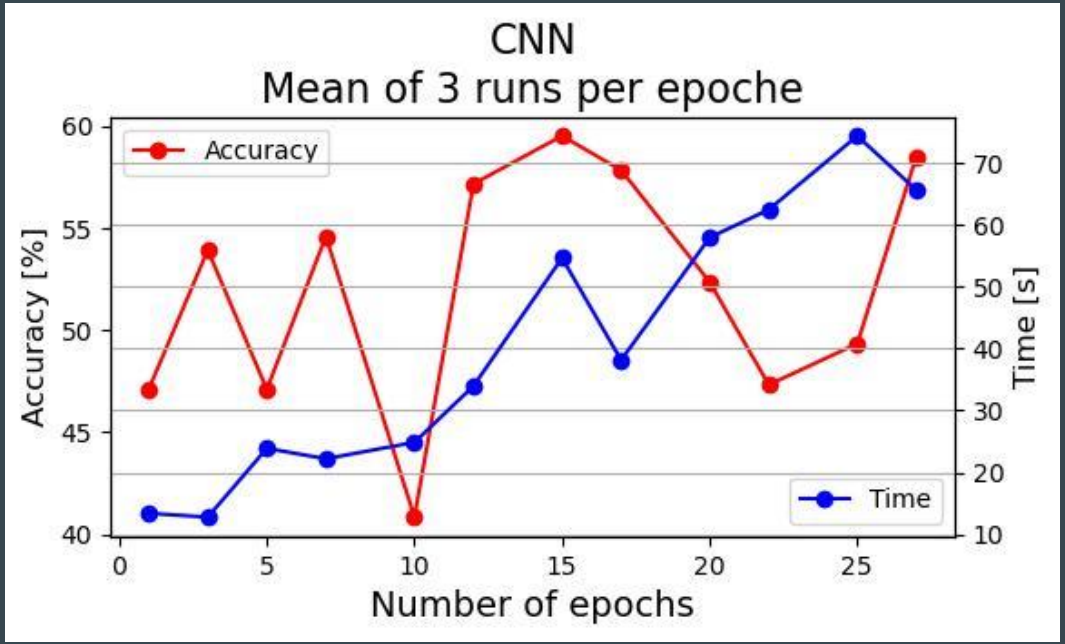
- Several variants were tested inkl. some with parallel streams
- No method delivers more than 65% validation Accuracy. Extreme overfitting.
- Most problems by recogn. elephants vs rhinos. Parallel variants do not help.
- With only 3 animals (no rhinos): valid. accuracy better (80%) but still overfitting:

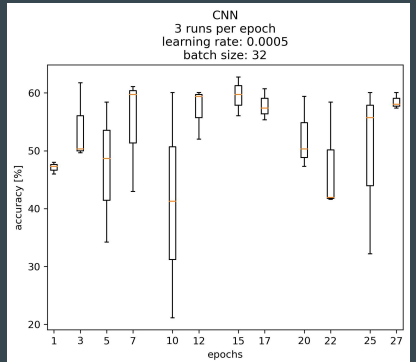


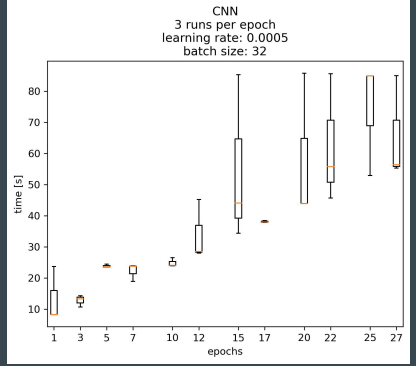


Convolutional Neural Network

3 runs per Epoch, learning rate: 0.0005, batch size: 32







Convolutional Neural Network

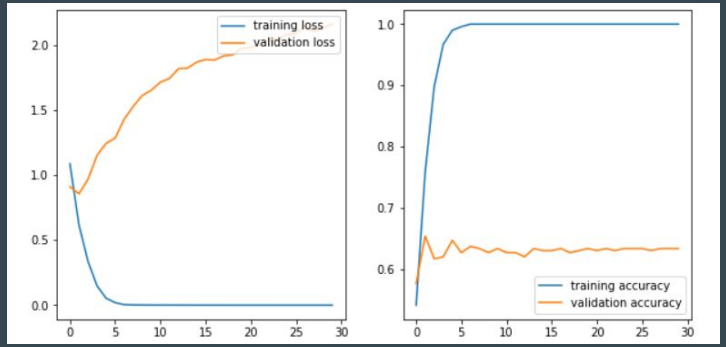
Model: "model_1"

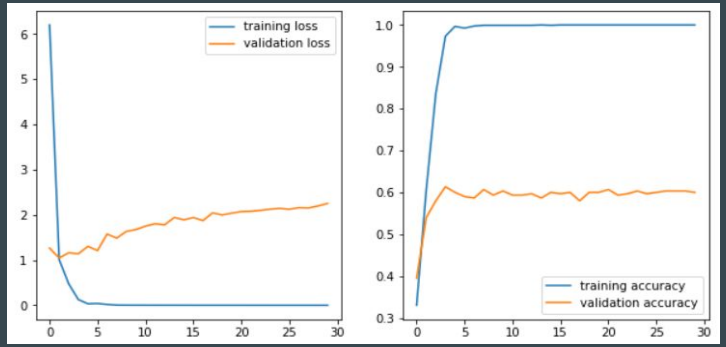
Layer (type)	Output Shape	Param #
input_2 (InputLayer)	[(None, 299, 299, 3)]	0
C1 (Conv2D)	(None, 297, 297, 8)	224
C2 (Conv2D)	(None, 148, 148, 32)	2336
C3 (Conv2D)	(None, 73, 73, 16)	4624
flatten_1 (Flatten)	(None, 85264)	0
l4 (Dense)	(None, 16)	1364240
l4a (Dense)	(None, 64)	1088
l5 (Dense)	(None, 4)	260

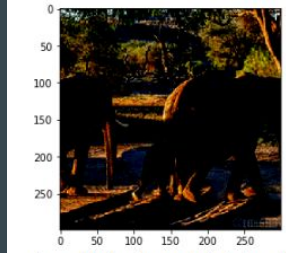
Total params: 1,372,772
Trainable params: 1,372,772

Layer (type)	Output Shape	Param #	Connected to
input_2 (InputLayer)	[(None, 299, 299, 3)]	0	[]
C1 (Conv2D)	(None, 297, 297, 32)	896	['input_2[0][0]']
D1 (Conv2D)	(None, 297, 297, 8)	224	['input_2[0][0]']
E1 (Conv2D)	(None, 297, 297, 16)	448	['input_2[0][0]']
C2 (Conv2D)	(None, 148, 148, 64)	18496	['C1[0][0]']
D2 (Conv2D)	(None, 99, 99, 8)	584	['D1[0][0]']
E2 (Conv2D)	(None, 295, 295, 32)	4640	['E1[0][0]']
C3 (Conv2D)	(None, 73, 73, 32)	18464	['C2[0][0]']
D3 (Conv2D)	(None, 97, 97, 8)	584	['D2[0][0]']
E3 (Conv2D)	(None, 293, 293, 16)	4624	['E2[0][0]']
flatten_3 (Flatten)	(None, 170528)	0	['C3[0][0]']
flatten_4 (Flatten)	(None, 75272)	0	['D3[0][0]']
flatten_5 (Flatten)	(None, 1373584)	0	['E3[0][0]']
concatenate_1 (Concatenate)	(None, 1619384)	0	['flatten_3[0][0]', 'flatten_4[0][0]', 'flatten_5[0][0]']
l4 (Dense)	(None, 32)	51820320	['concatenate_1[0][0]']
l4a (Dense)	(None, 32)	1056	['l4[0][0]']
l5 (Dense)	(None, 4)	132	['l4a[0][0]']

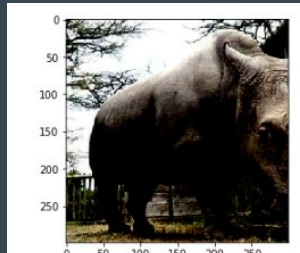
Total params: 51,870,468
Trainable params: 51,870,468
Non-trainable params: 0







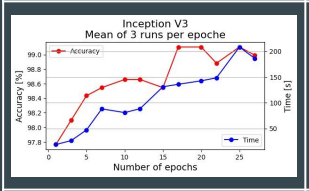
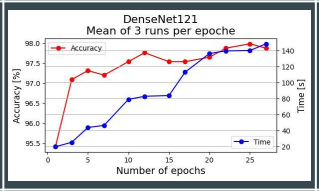
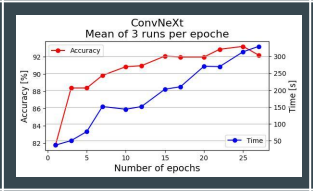
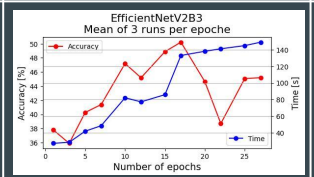
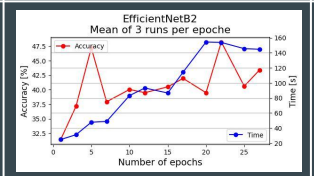
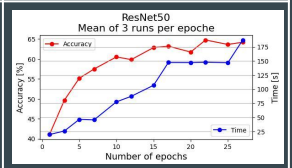
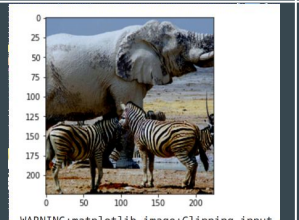
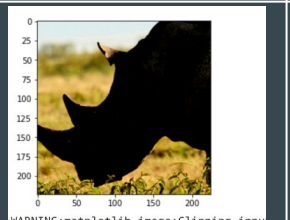
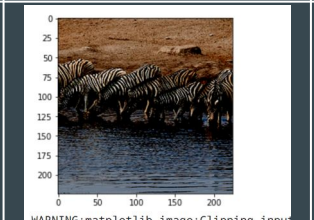
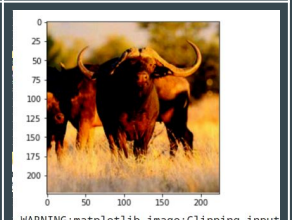
```
class: Elephant, predicted class:Rhino
>>> probabilities...
    -Buffalo: 21.70%
    -Elephant: 0.39%
    -Zebra: 0.00%
    -Rhino: 77.91%
```



```
class: Rhino, predicted class:Elephant
>>> probabilities...
    -Buffalo: 0.02%
    -Elephant: 98.01%
    -Zebra: 0.00%
    -Rhino: 1.97%
```

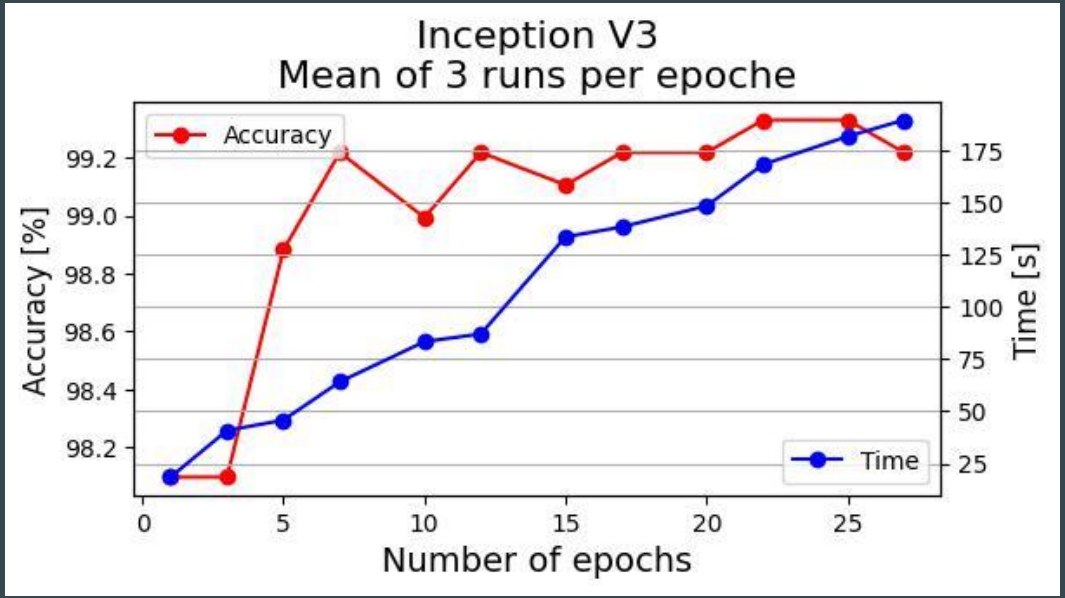
Transfer Learning overview

learning rate: 0.0005, batch size: 32

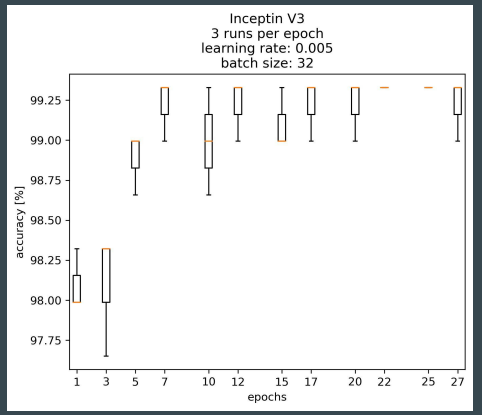
InceptionV3	DenseNet121	ConvNeXtTiny	EfficientNetV2B3	EfficientNetB2	ResNet50
Epoch 17, 111s, 99%	Epoch 25, 148s, 98%	Epoch 25, 331s, 93%	Epoch 17, 98s, 54%	Epoch 22, 153s, 49%	Epoch 22, 147s, 66%
Total params: 21,934,180 Trainable params: 131,396	Total params: 7,103,364 Trainable params: 65,860	Total params: 27,869,604 Trainable params: 49,476	Total params: 13,029,250 Trainable params: 98,628	Total params: 7,859,005 Trainable params: 90,436	Total params: 23,719,108 Trainable params: 131,396
					
 class: Buffalo, predicted class:Zebra >>> probabilities... -Buffalo: 44.87% -Elephant: 0.93% -Zebra: 50.87% -Rhino: 3.33%	 WARNING:matplotlib.image:Clipping input class: Elephant, predicted class:Zebra >>> probabilities... -Buffalo: 0.27% -Elephant: 1.63% -Zebra: 97.91% -Rhino: 0.19%	 class: Elephant, predicted class:Rhino >>> probabilities... -Buffalo: 19.95% -Elephant: 36.78% -Zebra: 1.26% -Rhino: 42.00%	 WARNING:matplotlib.image:Clipping input class: Rhino, predicted class:Buffalo >>> probabilities... -Buffalo: 36.52% -Elephant: 16.48% -Zebra: 11.06% -Rhino: 35.94%	 WARNING:matplotlib.image:Clipping input class: Zebra, predicted class:Buffalo >>> probabilities... -Buffalo: 30.19% -Elephant: 25.87% -Zebra: 21.27% -Rhino: 22.67%	 WARNING:matplotlib.image:Clipping input class: Buffalo, predicted class:Rhino >>> probabilities... -Buffalo: 26.01% -Elephant: 35.93% -Zebra: 1.36% -Rhino: 36.70%

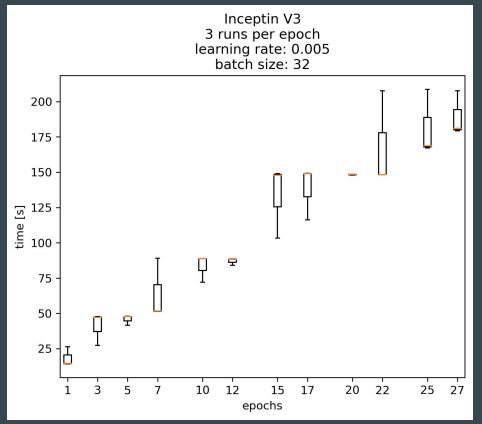
Inception V3

3 runs per Epoch, learning rate: 0.005, batch size: 32



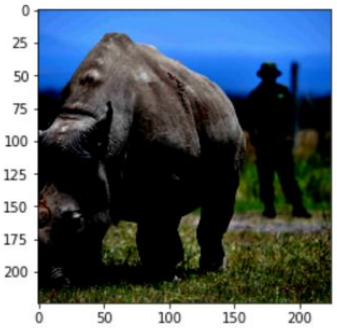

```
Total params: 21,934,180
Trainable params: 131,396
Non-trainable params: 21,802,784
```





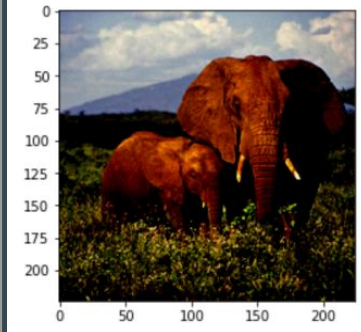
close but wrong predictions

EfficientNetV2B3



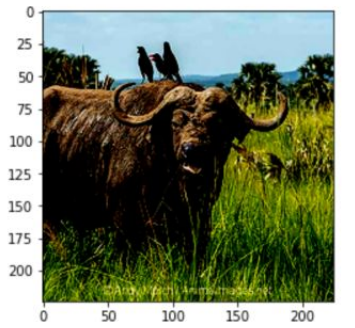
```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 33.31%
    -Elephant: 26.98%
    -Zebra: 10.01%
    -Rhino: 29.69%
```

ResNet50



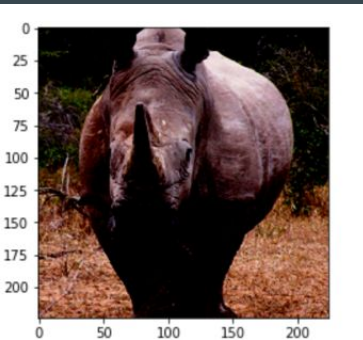
```
class: Elephant, predicted class:Rhino
>>> probabilities...
    -Buffalo: 28.72%
    -Elephant: 33.31%
    -Zebra: 1.70%
    -Rhino: 36.27%
```

EfficientNetV2B3



```
class: Buffalo, predicted class:Rhino
>>> probabilities...
    -Buffalo: 30.72%
    -Elephant: 21.91%
    -Zebra: 14.44%
    -Rhino: 32.93%
```

EfficientNetB2

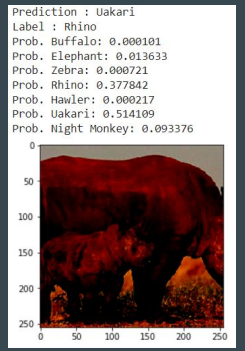


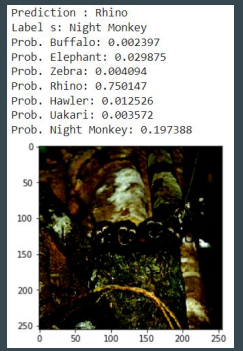
```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 32.32%
    -Elephant: 27.92%
    -Zebra: 8.28%
    -Rhino: 31.48%
```

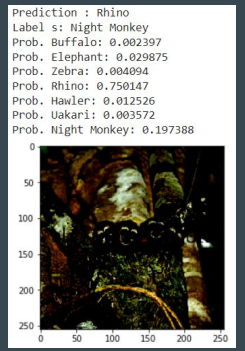
Transfer Learning additional checks

- Initial Transfer Model training sets with all animals but rhinos
- Check with a few additional animals from a separate set (3 monkey types) that rhino is not just recognised as “the fourth, unknown” animal.

  Not the case: InceptionV3 TRansf. also delivered 97% valid. accuracy with 7 anim.
- Wrong predictions (6 Epochs) with 7 animals:





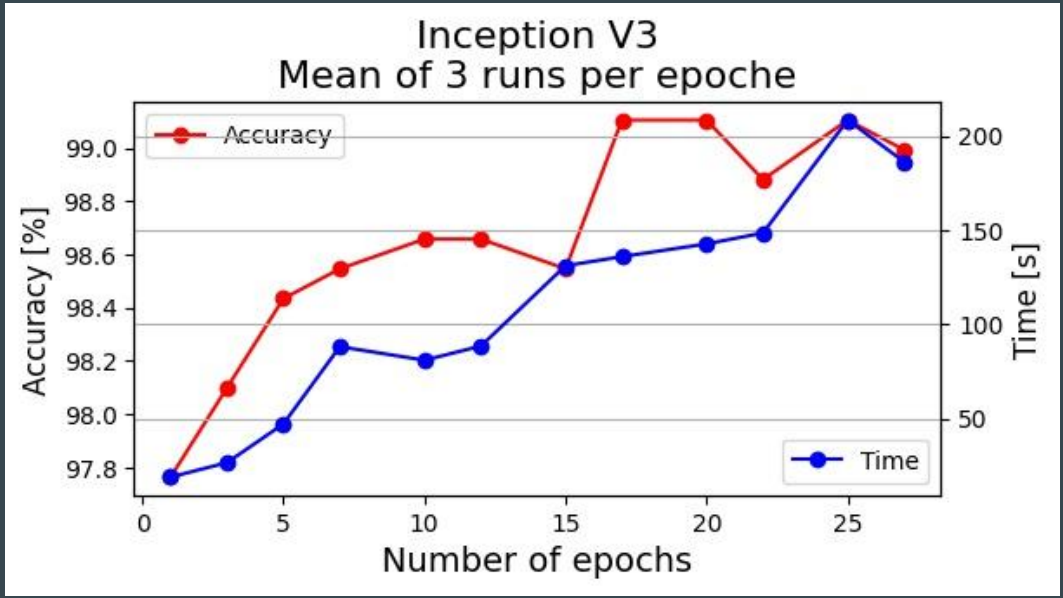


Discussion ...

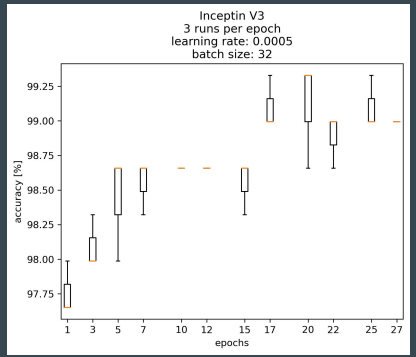
Appendix

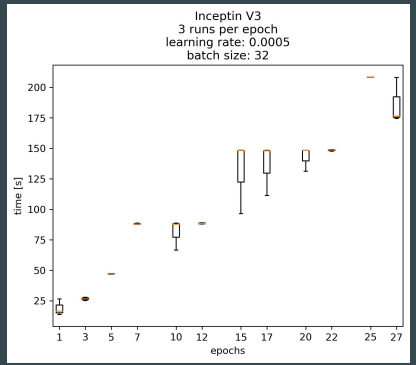
Inception V3

3 runs per Epoch, learning rate: 0.0005, batch size: 32



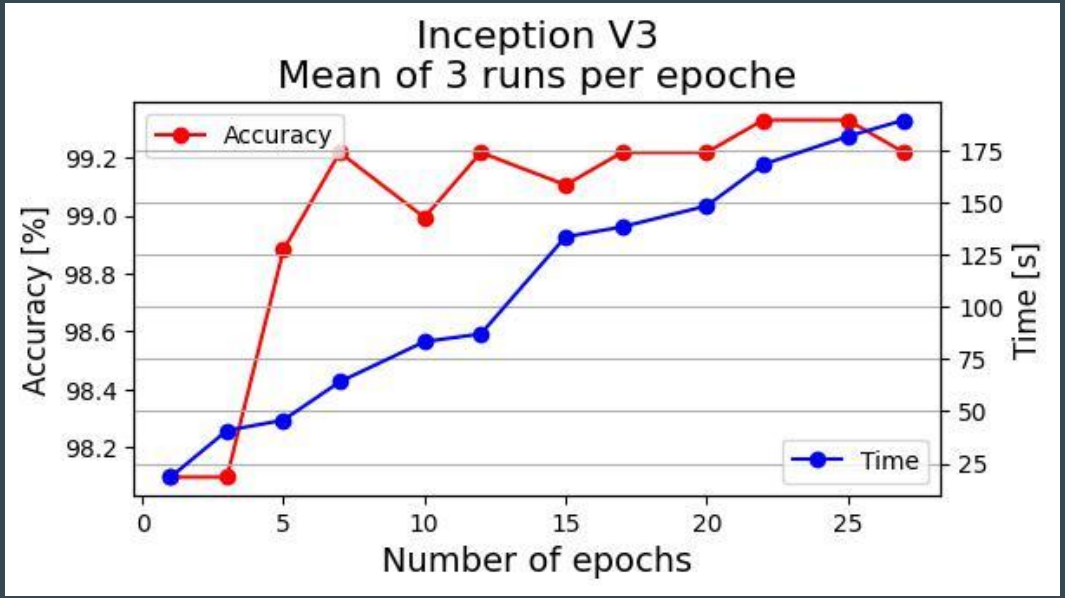

```
=================================================================
Total params: 21,934,180
Trainable params: 131,396
Non-trainable params: 21,802,784
_________________________________________________________________
```



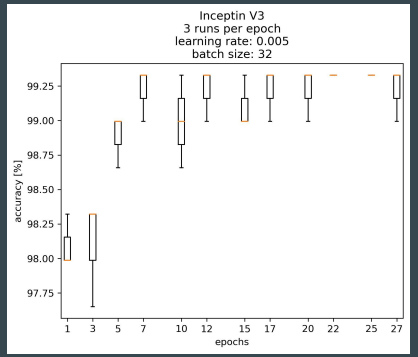


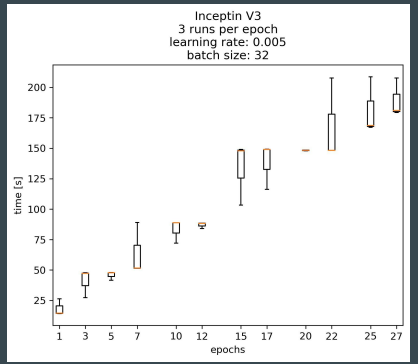
Inception V3

3 runs per Epoch, learning rate: 0.005, batch size: 32



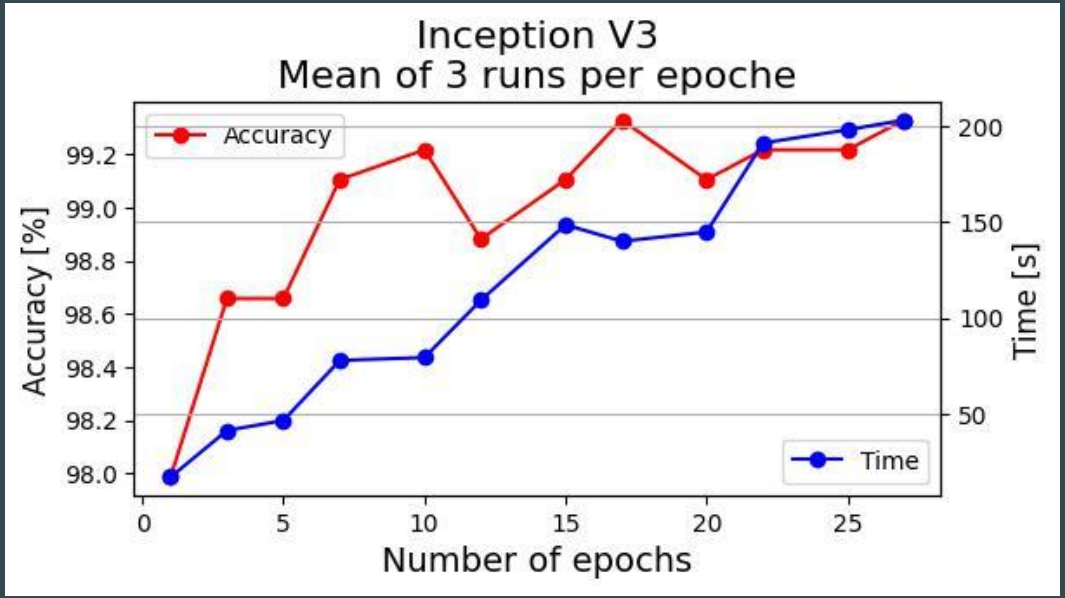

```
=================================================================
Total params: 21,934,180
Trainable params: 131,396
Non-trainable params: 21,802,784
_________________________________________________________________
```



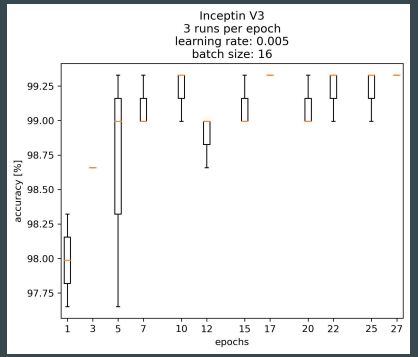


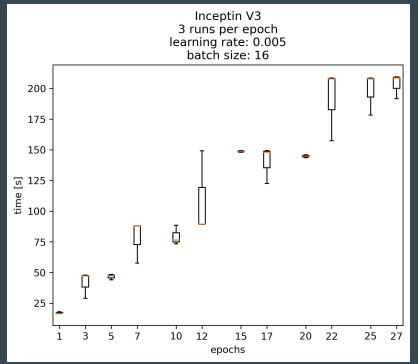
Inception V3

3 runs per Epoch, learning rate: 0.005, batch size: 16



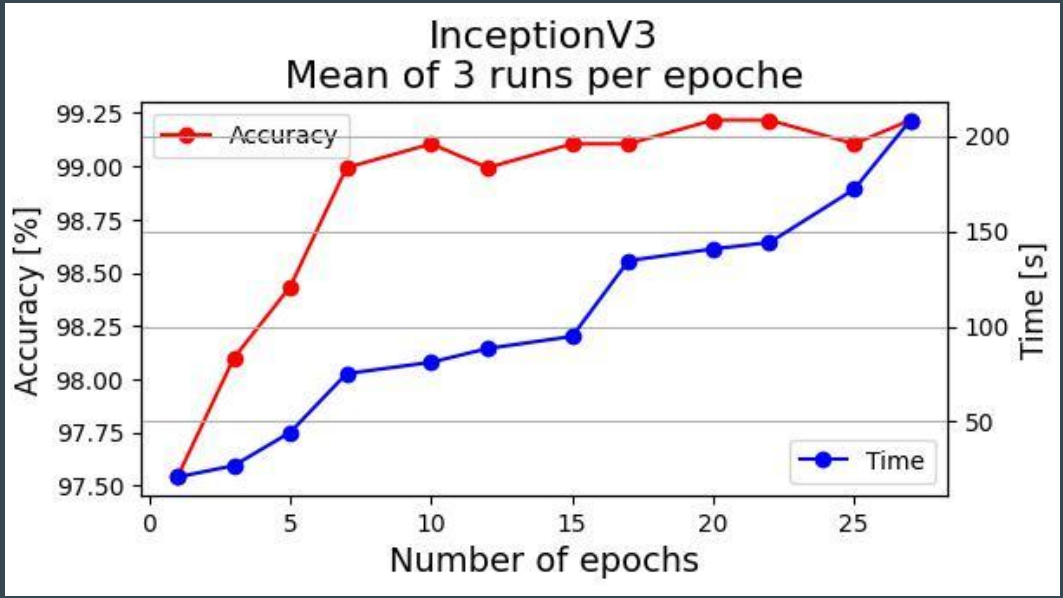

```
=================================
Total params: 21,934,180
Trainable params: 131,396
Non-trainable params: 21,802,784
_________________________________
```



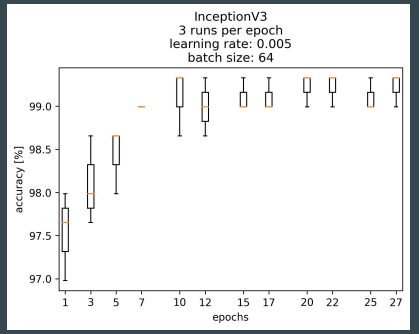


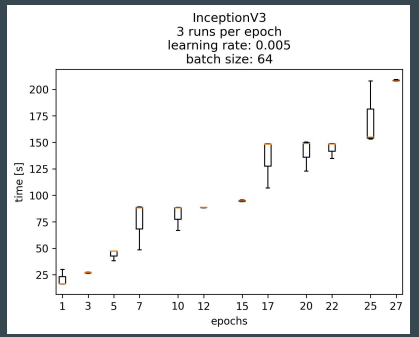
Inception V3

3 runs per Epoch, learning rate: 0.005, batch size: 64

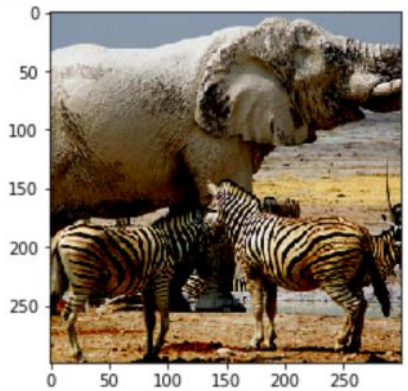



```
=================================================================
Total params: 21,934,180
Trainable params: 131,396
Non-trainable params: 21,802,784
_________________________________________________________________
```

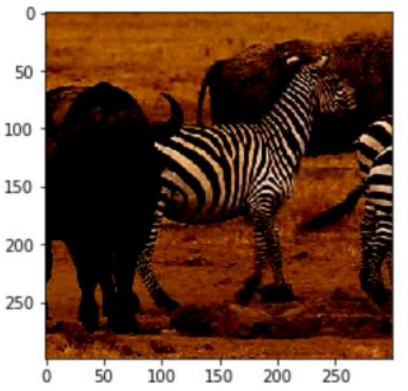




Inception V3



```
class: Elephant, predicted class:Zebra
>>> probabilities...
    -Buffalo: 0.23%
    -Elephant: 0.26%
    -Zebra: 99.43%
    -Rhino: 0.08%
-----------------------------------
```

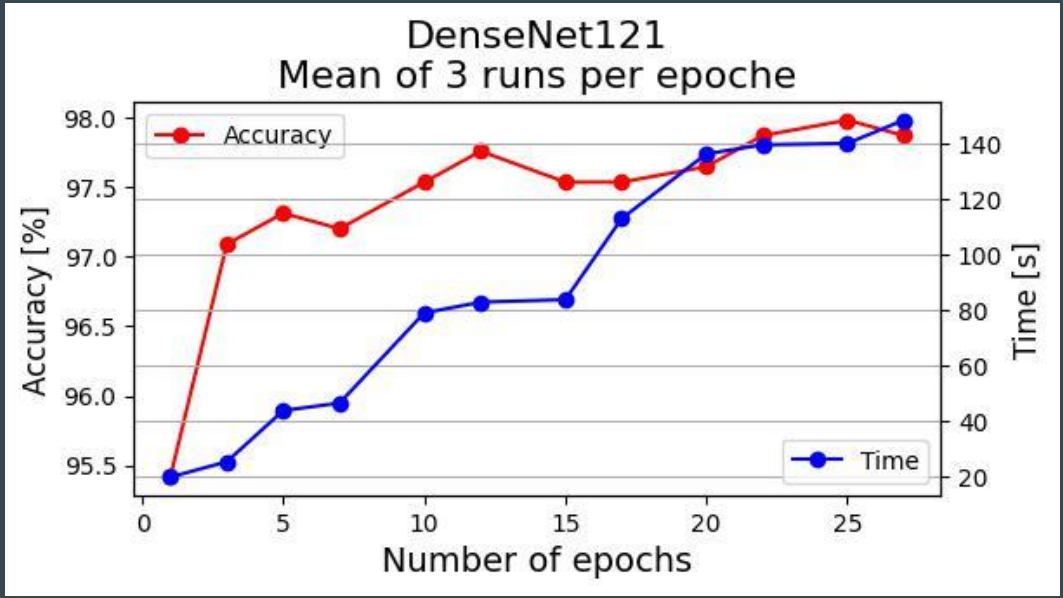


```
class: Buffalo, predicted class:Zebra
>>> probabilities...
    -Buffalo: 3.88%
    -Elephant: 0.26%
    -Zebra: 95.56%
    -Rhino: 0.30%
```

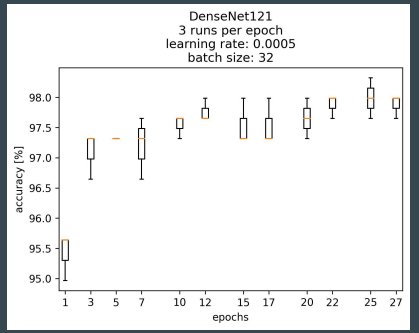
```
class: Buffalo, predicted class:Zebra
>>> probabilities...
    -Buffalo: 44.87%
    -Elephant: 0.93%
    -Zebra: 50.87%
    -Rhino: 3.33%
```

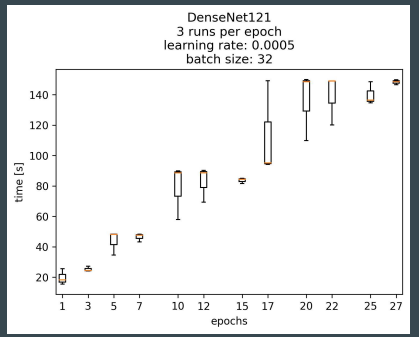
DenseNet 121

3 runs per Epoch, learning rate: 0.0005, batch size: 32

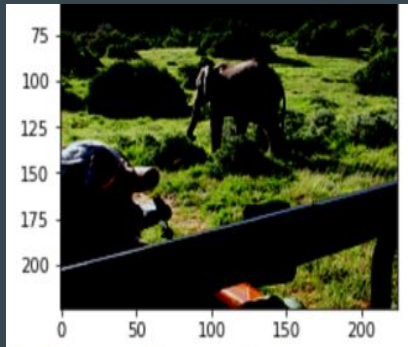



```
=================================================================
Total params: 7,103,364
Trainable params: 65,860
Non-trainable params: 7,037,504
_________________________________________________________________
```

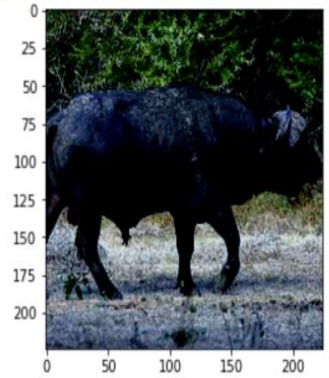




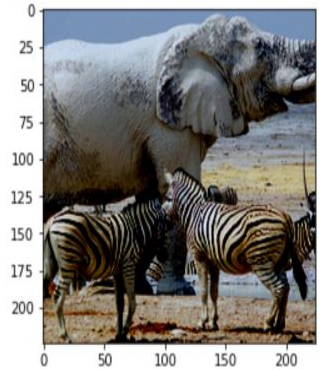
DenseNet 121



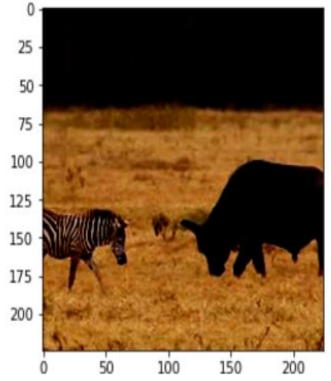
class: Elephant, predicted class:Rhino
>>> probabilities...
    -Buffalo: 2.23%
    -Elephant: 15.80%
    -Zebra: 0.37%
    -Rhino: 81.60%



class: Buffalo, predicted class:Rhino
>>> probabilities...
    -Buffalo: 37.31%
    -Elephant: 0.64%
    -Zebra: 0.51%
    -Rhino: 61.54%



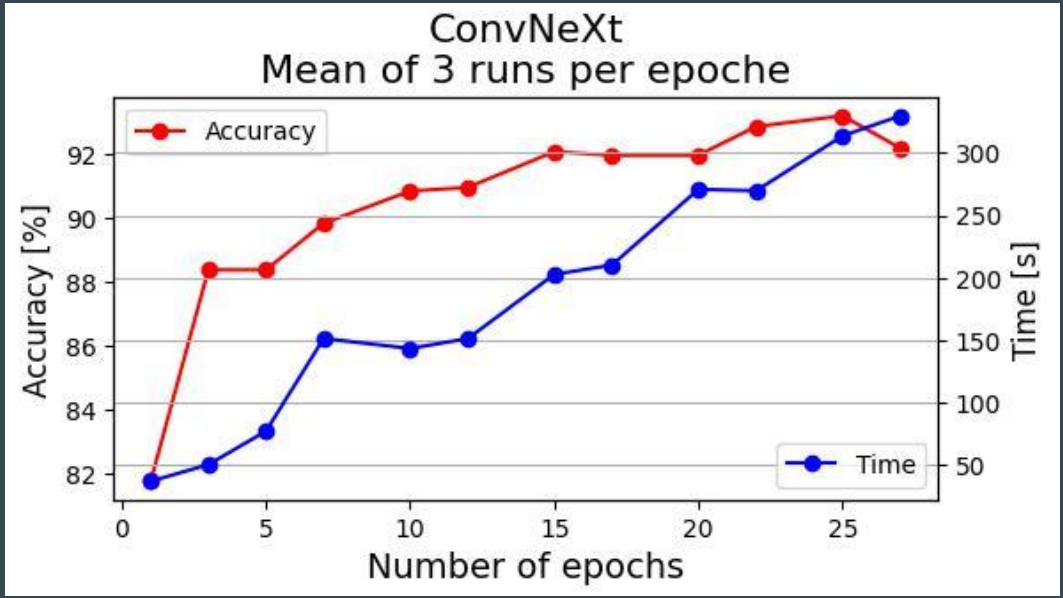
class: Elephant, predicted class:Zebra
>>> probabilities...
    -Buffalo: 0.27%
    -Elephant: 1.63%
    -Zebra: 97.91%
    -Rhino: 0.19%



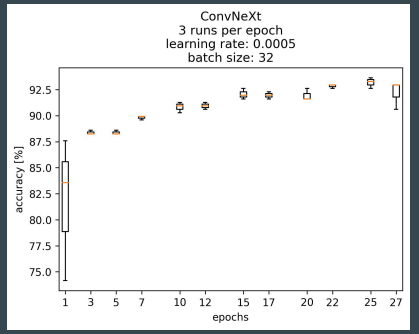
class: Buffalo, predicted class:Zebra
>>> probabilities...
    -Buffalo: 26.51%
    -Elephant: 1.04%
    -Zebra: 55.30%
    -Rhino: 17.16%

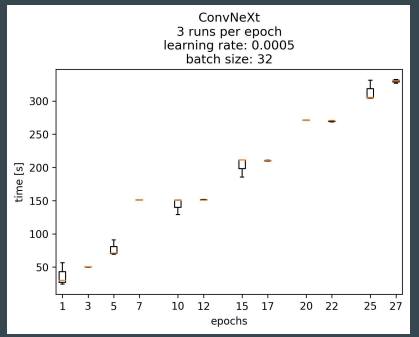
ConvNeXtTiny

3 runs per Epoch, learning rate: 0.0005, batch size: 32

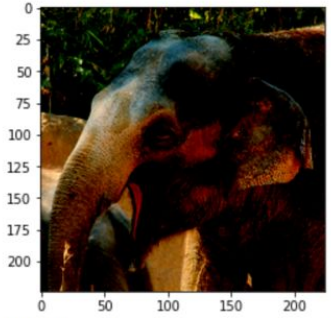



```
=================================================================
Total params: 27,869,604
Trainable params: 49,476
Non-trainable params: 27,820,128
```

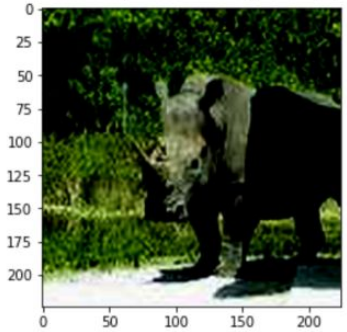




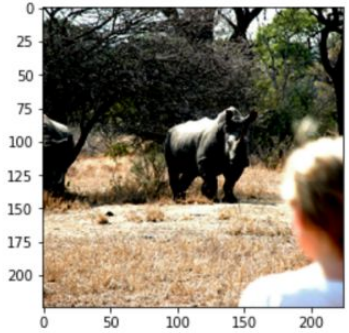
ConvNeXtTiny



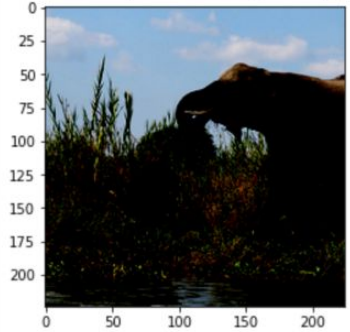
class: Elephant, predicted class:Rhino
>>> probabilities...
    -Buffalo: 6.82%
    -Elephant: 38.27%
    -Zebra: 1.32%
    -Rhino: 53.59%



class: Rhino, predicted class:Elephant
>>> probabilities...
    -Buffalo: 7.31%
    -Elephant: 47.28%
    -Zebra: 2.45%
    -Rhino: 42.95%



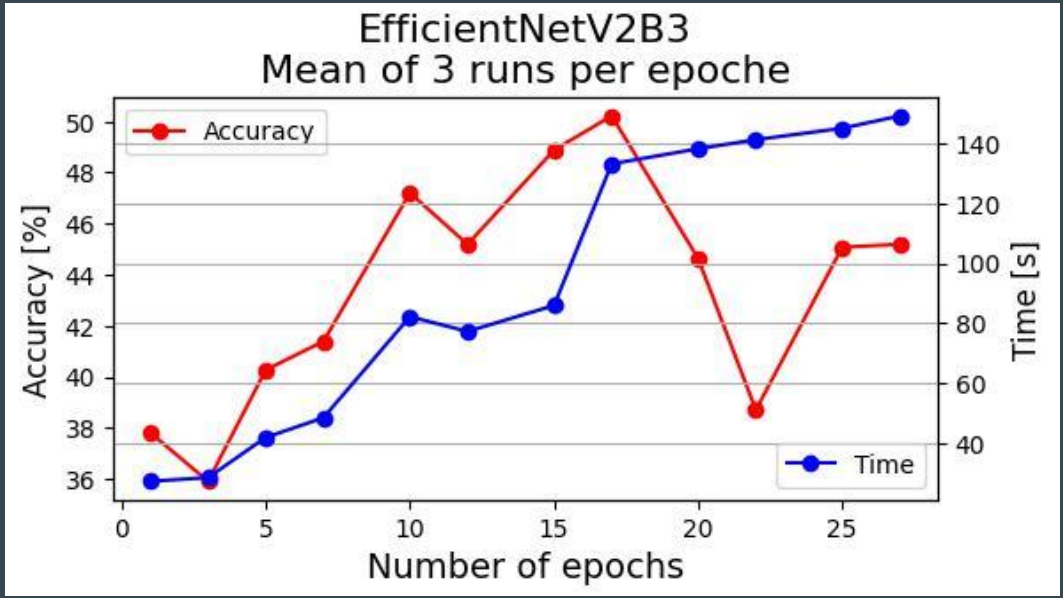
class: Rhino, predicted class:Elephant
>>> probabilities...
    -Buffalo: 3.90%
    -Elephant: 59.81%
    -Zebra: 0.65%
    -Rhino: 35.65%



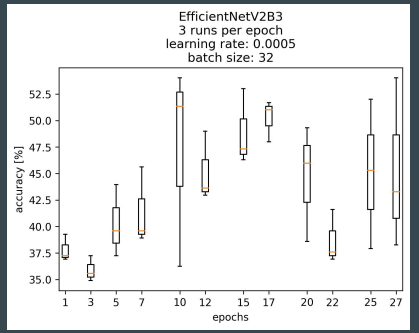
class: Elephant, predicted class:Rhino
>>> probabilities...
    -Buffalo: 19.95%
    -Elephant: 36.78%
    -Zebra: 1.26%
    -Rhino: 42.00%

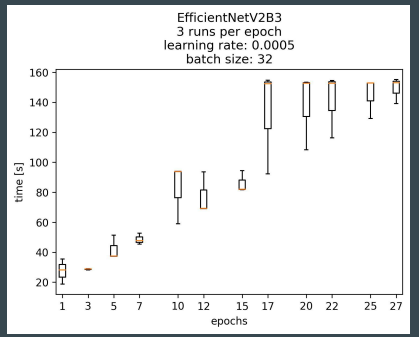
EfficientNetV2B3

3 runs per Epoch, learning rate: 0.0005, batch size: 32

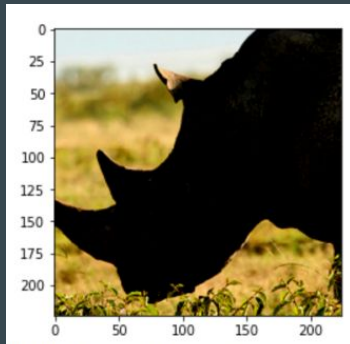



```
=================================================================
Total params: 13,029,250
Trainable params: 98,628
Non-trainable params: 12,930,622
_________________________________________________________________
```

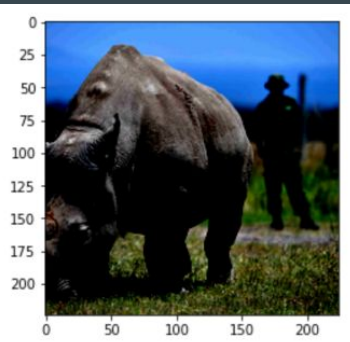




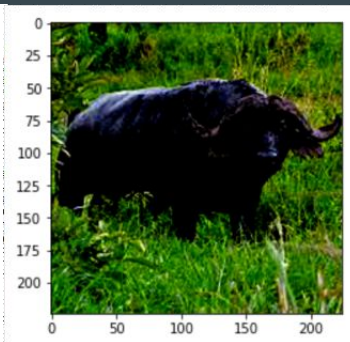
EfficientNetV2B3



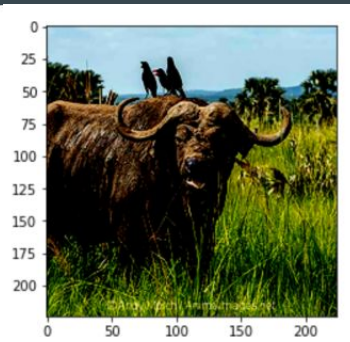
```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 36.52%
    -Elephant: 16.48%
    -Zebra: 11.06%
    -Rhino: 35.94%
----------------------------------
```



```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 33.31%
    -Elephant: 26.98%
    -Zebra: 10.01%
    -Rhino: 29.69%
----------------------------------
```



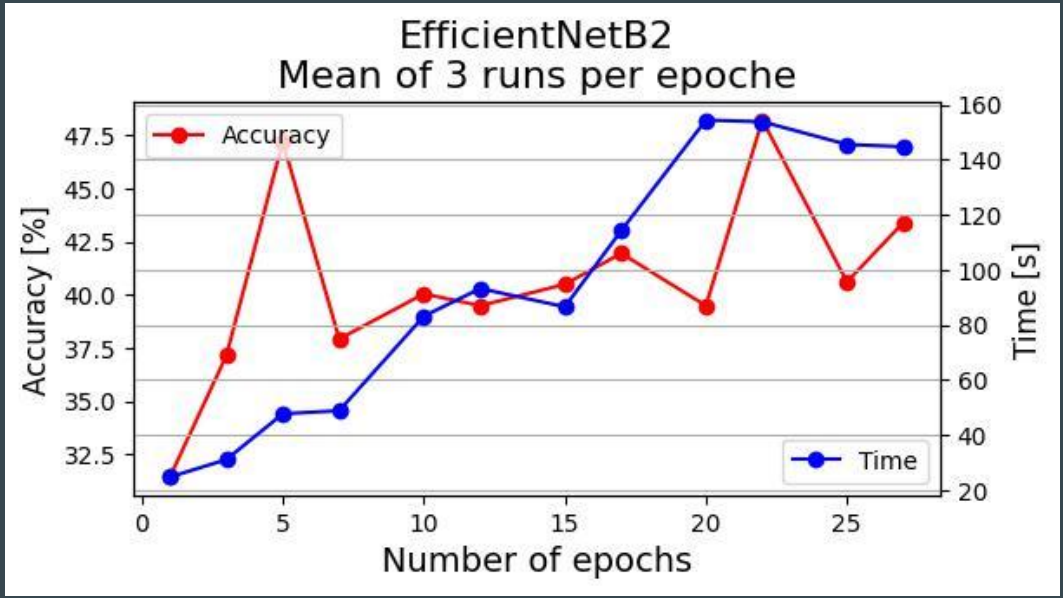
```
class: Buffalo, predicted class:Rhino
>>> probabilities...
    -Buffalo: 31.10%
    -Elephant: 20.42%
    -Zebra: 14.66%
    -Rhino: 33.82%
----------------------------------
```



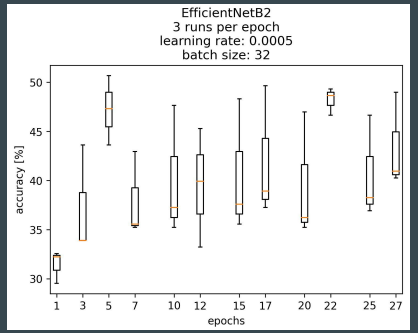
```
class: Buffalo, predicted class:Rhino
>>> probabilities...
    -Buffalo: 30.72%
    -Elephant: 21.91%
    -Zebra: 14.44%
    -Rhino: 32.93%
----------------------------------
```

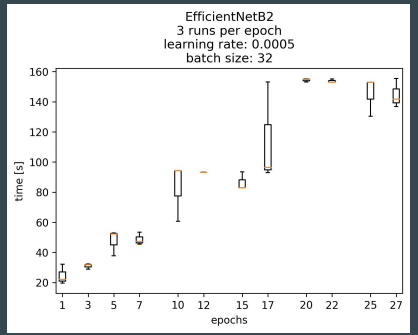
EfficientNetB2

3 runs per Epoch, learning rate: 0.0005, batch size: 32

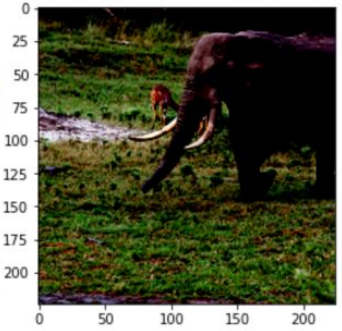



```
=================================
Total params: 7,859,005
Trainable params: 90,436
Non-trainable params: 7,768,569
_________________________________
```

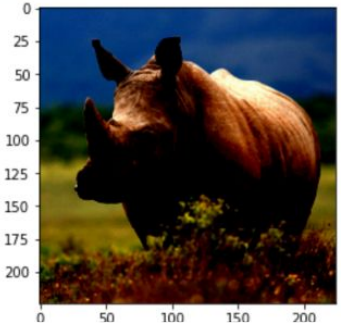




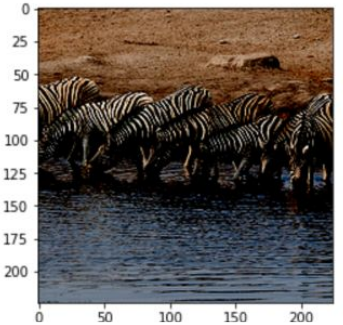
EfficientNetB2



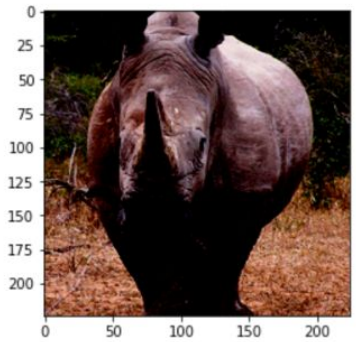
```
class: Elephant, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 32.13%
    -Elephant: 27.94%
    -Zebra: 9.68%
    -Rhino: 30.25%
-----------------------------------
```



```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 32.11%
    -Elephant: 27.84%
    -Zebra: 8.45%
    -Rhino: 31.60%
-----------------------------------
```



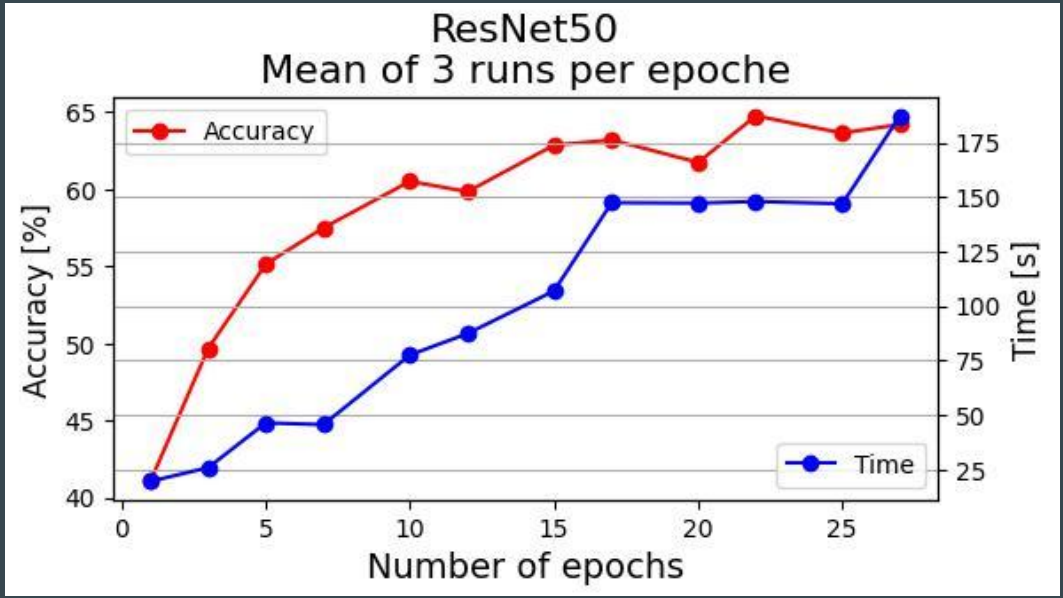
```
class: Zebra, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 30.19%
    -Elephant: 25.87%
    -Zebra: 21.27%
    -Rhino: 22.67%
-----------------------------------
```



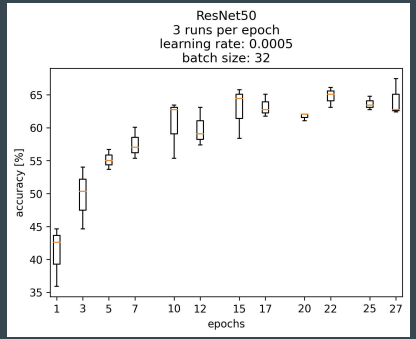
```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 32.32%
    -Elephant: 27.92%
    -Zebra: 8.28%
    -Rhino: 31.48%
-----------------------------------
```

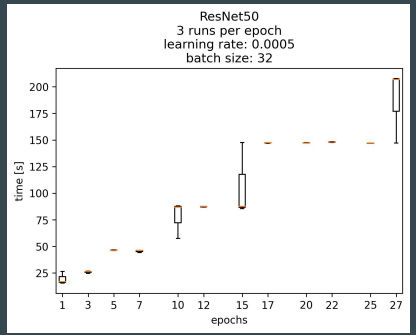
ResNet50

3 runs per Epoch, learning rate: 0.0005, batch size: 32

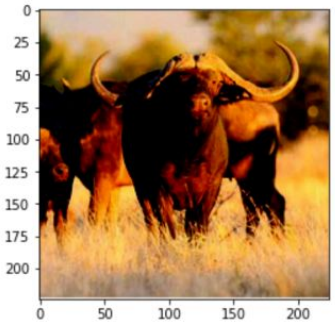



```
=================================================================
Total params: 23,719,108
Trainable params: 131,396
Non-trainable params: 23,587,712
_________________________________________________________________
```

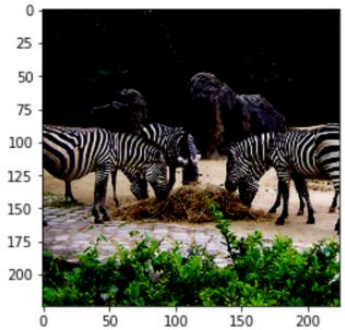




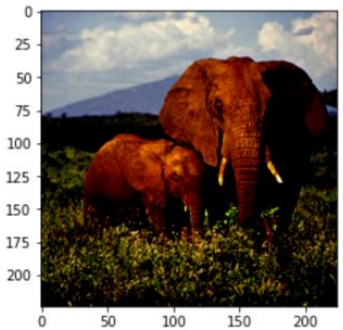
ResNet50



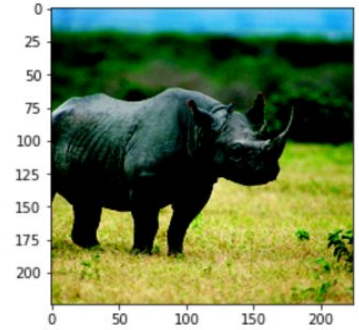
```
class: Buffalo, predicted class:Rhino
>>> probabilities...
    -Buffalo: 26.01%
    -Elephant: 35.93%
    -Zebra: 1.36%
    -Rhino: 36.70%
-----------------------------------
```



```
class: Zebra, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 39.79%
    -Elephant: 8.27%
    -Zebra: 37.90%
    -Rhino: 14.04%
-----------------------------------
```



```
class: Elephant, predicted class:Rhino
>>> probabilities...
    -Buffalo: 28.72%
    -Elephant: 33.31%
    -Zebra: 1.70%
    -Rhino: 36.27%
-----------------------------------
```



```
class: Rhino, predicted class:Buffalo
>>> probabilities...
    -Buffalo: 47.63%
    -Elephant: 18.04%
    -Zebra: 1.10%
    -Rhino: 33.23%
-----------------------------------
```