Image Classification

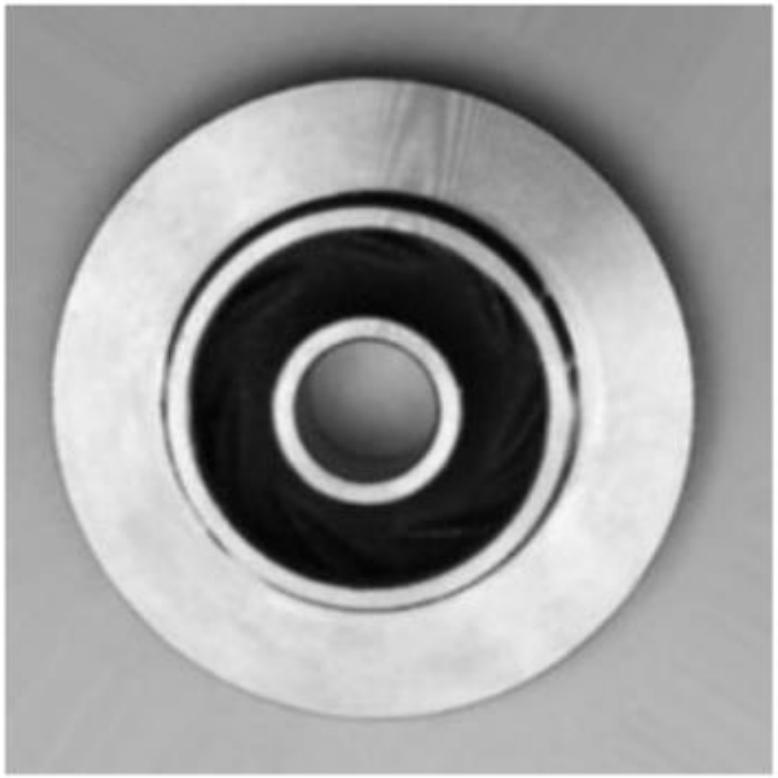
casting product image data for quality inspection

(Reference : casting product image data for quality inspection | Kaggle)

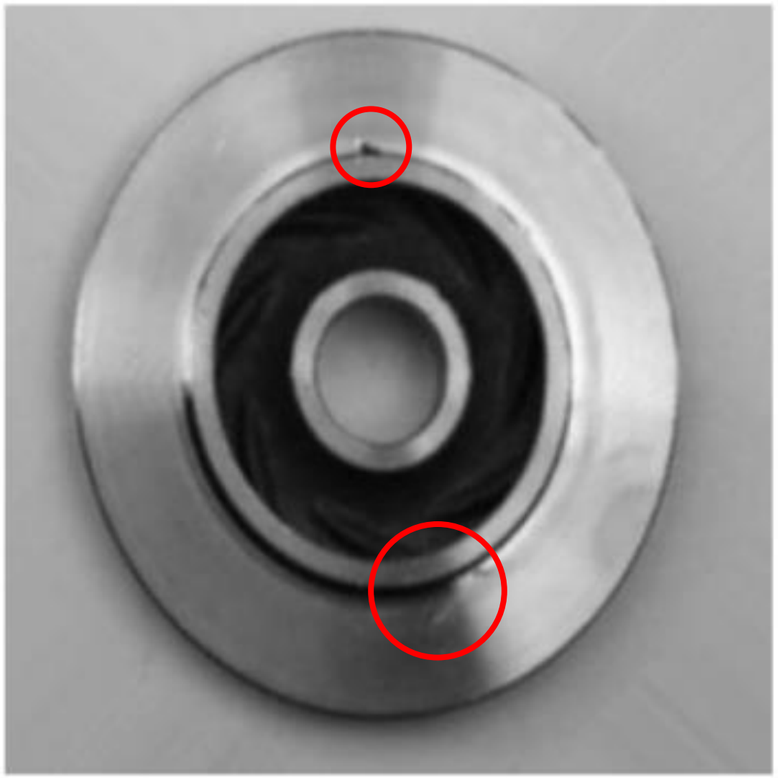
Information

Information

ok



def



Information

Explore Dataset...

Train dataset (6,633 pictures)

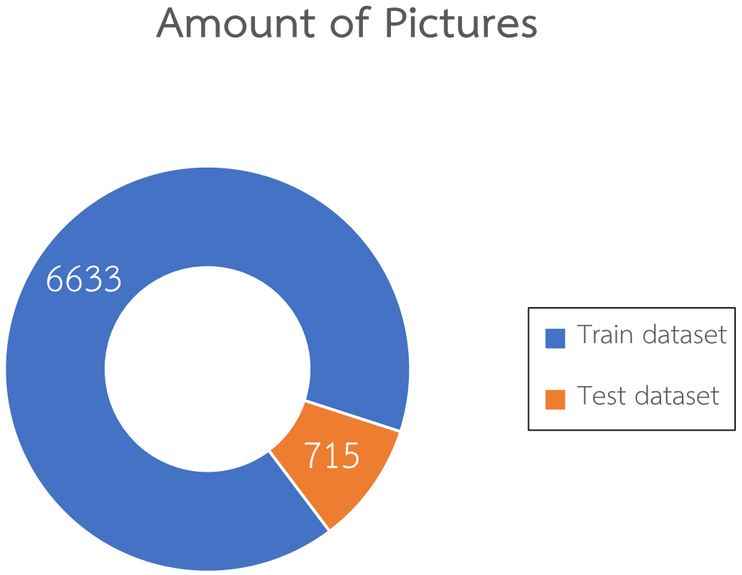
- def_front : 3,758 pictures
- ok_front : 2,875 pictures

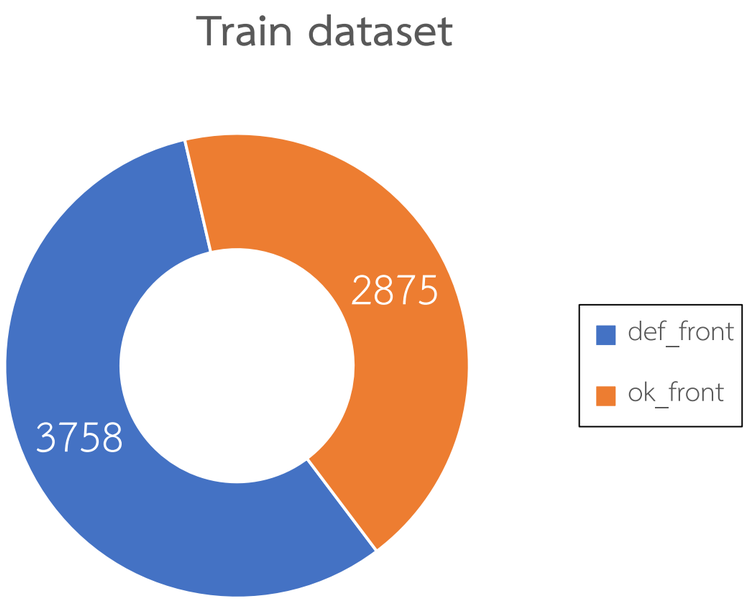
Test dataset (715 pictures)

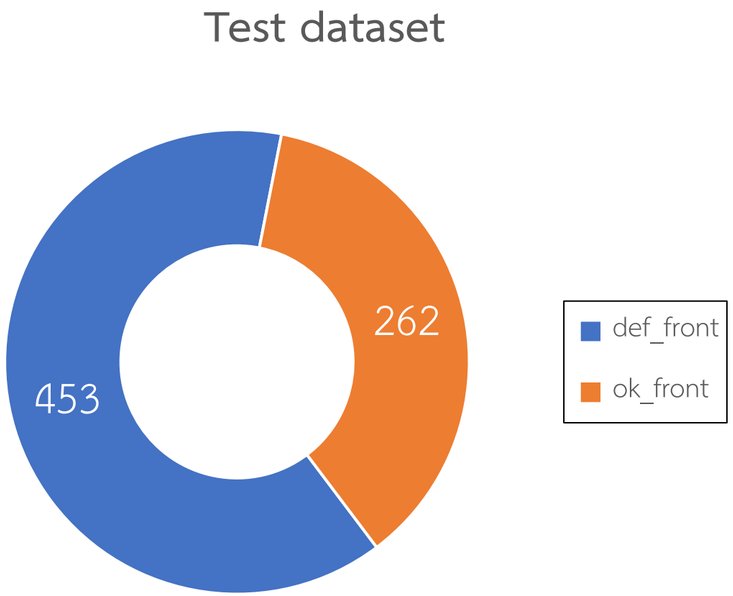
- def_front : 453 pictures
- ok_front : 262 pictures

Total = 7,348 pictures

** Augmentation are already applied.





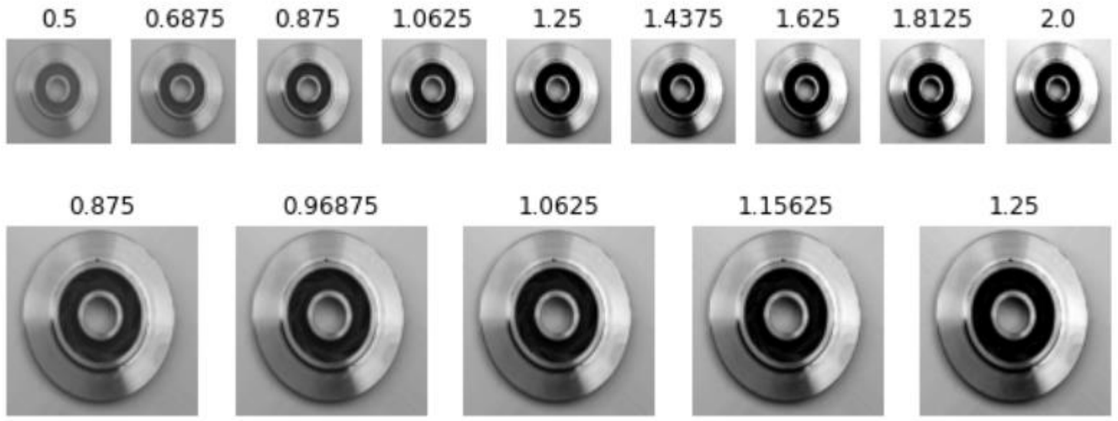


EDA

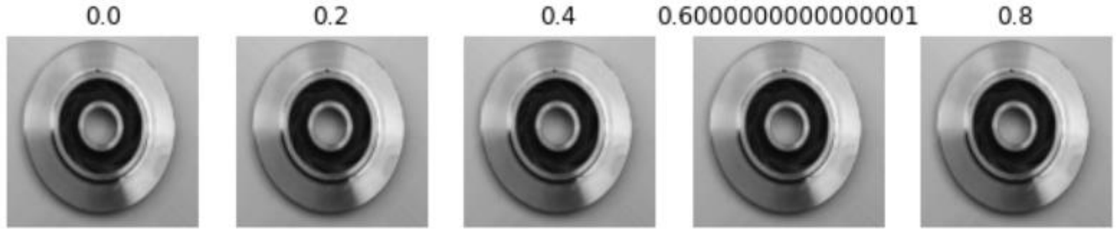
(Exploratory Data Analysis)

EDA

Adjust Brightness



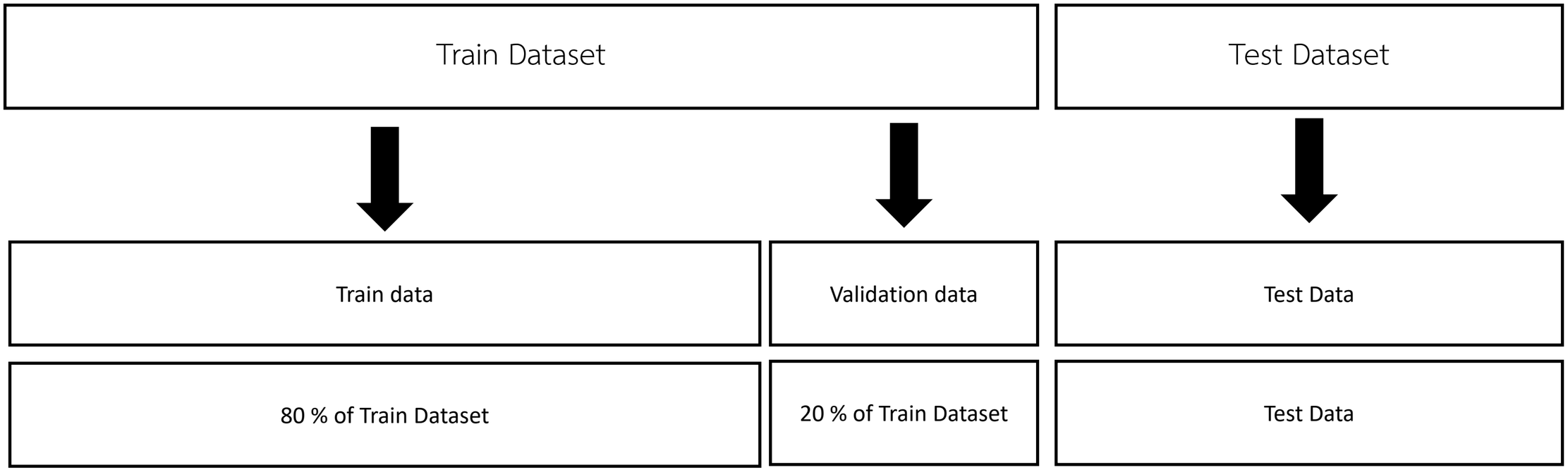
Adjust Hue



Adjust - Brighness : [0.875 - 1.25], Hue : [0 - 0.5]

Preprocessing

Preprocessing



Evaluation Tools

Evaluation Tools

1. Accuracy
2. Recall or Sensitivity

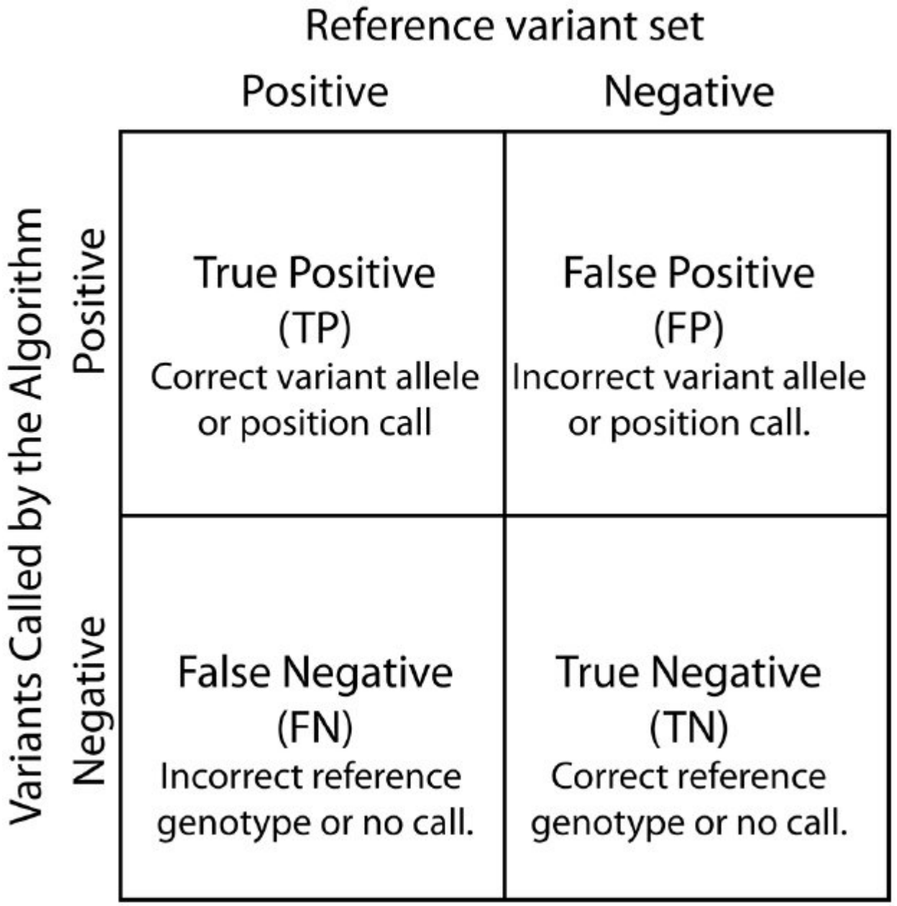
$$Recall = \frac{True\ Positive}{(True\ positive + False\ Negative)}$$

3. Precision

$$Precision = \frac{True\ Positive}{(True\ positive + False\ Positive)}$$

4. F1 – Score

$$\text{F1 – Score} = 2 \times \left[\frac{Precision \times Recall}{Precision + Recall}\right]$$



Part 1 : Fix Architecture

Fix Architecture

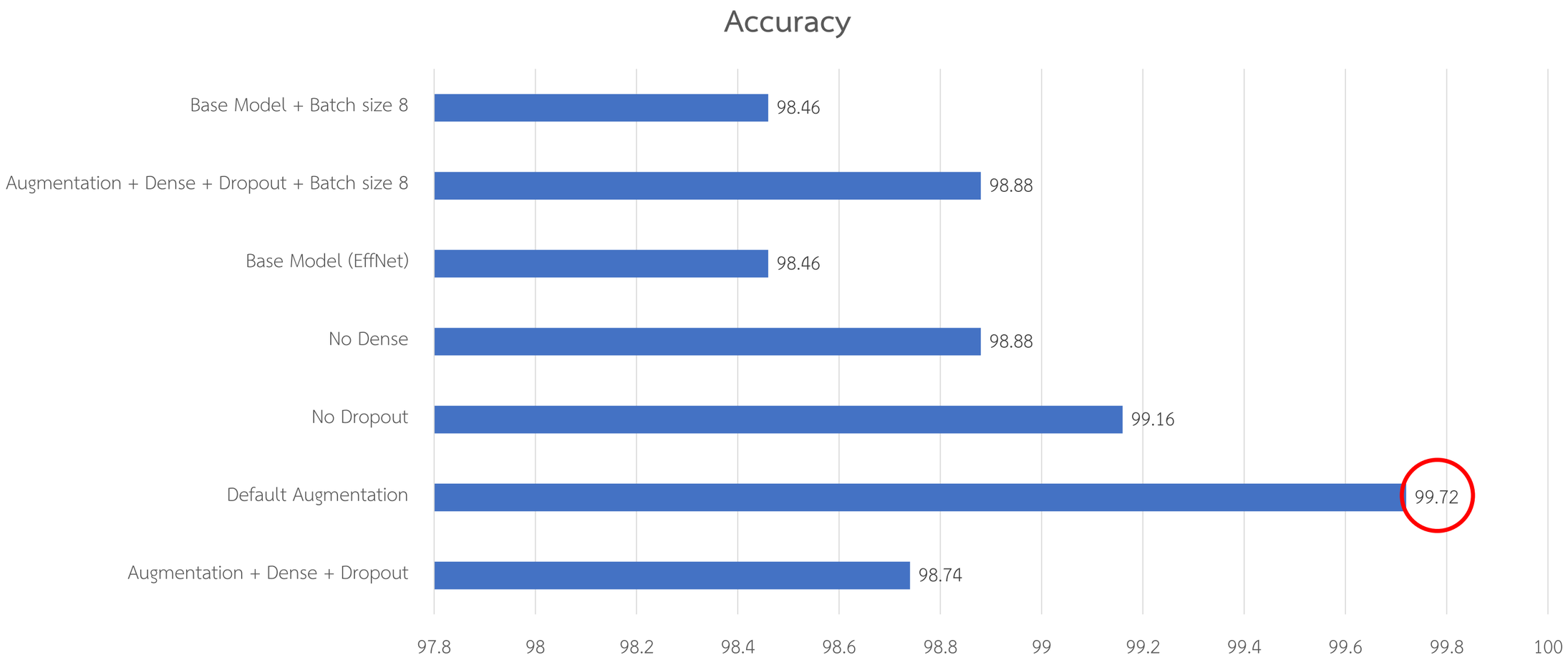
Augmentation	
preprocess_train function	random_hue
	random_contrast
ImageDataGenerator	Shift (width & height)
	Rotation
	Brightness
	Shear
	Zoom
	Fill_mode
	Flip (Horizontal & Vertical)
	Constant Parameter

Batch size	
size	4 or 8

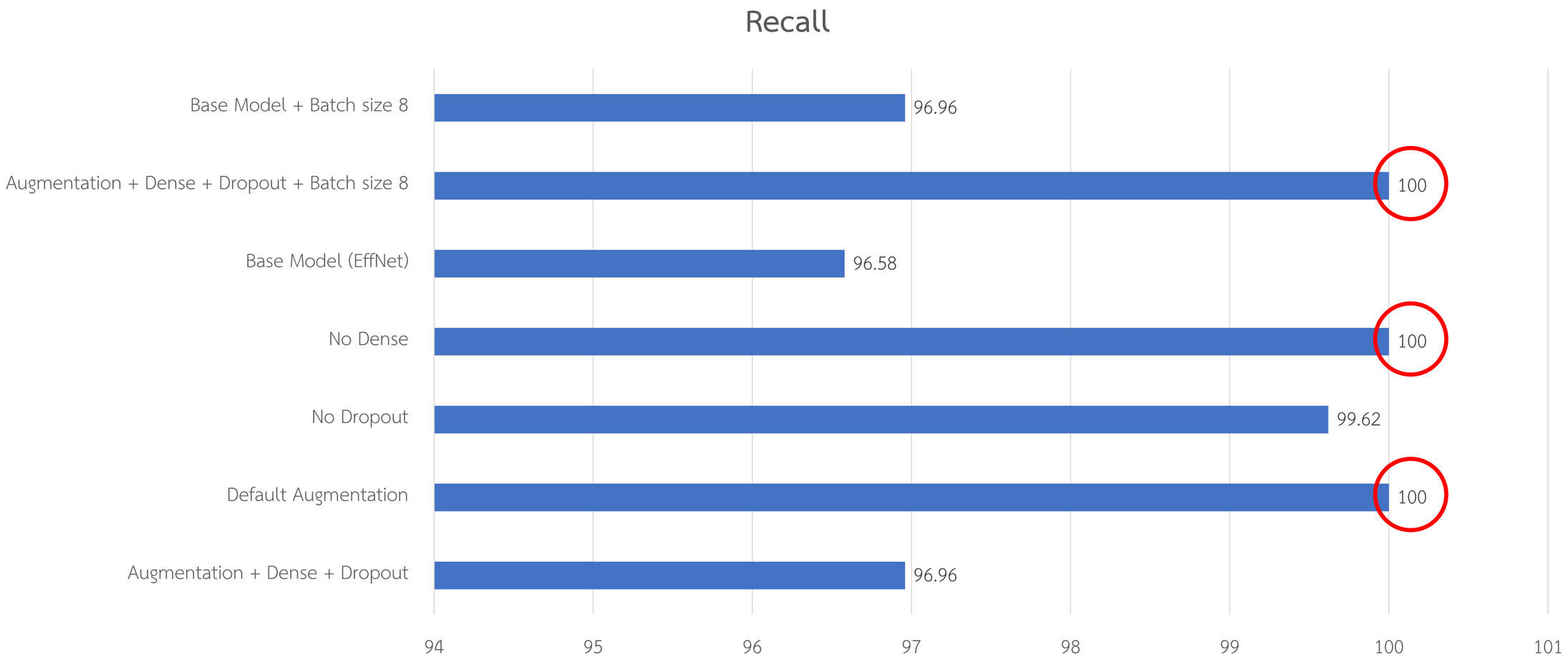
Model

```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         [(None, 512, 512, 3)]     0
_________________________________________________________________
efficientnetb4 (Functional)  (None, 16, 16, 1792)      17673823
_________________________________________________________________
global_average_pooling2d (Gl (None, 1792)              0
_________________________________________________________________
dense (Dense)                (None, 1024)              1836032
_________________________________________________________________
dropout (Dropout)            (None, 1024)              0
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 1025
=================================================================
Total params: 19,510,880
Trainable params: 19,385,673
Non-trainable params: 125,207
_________________________________________________________________
```

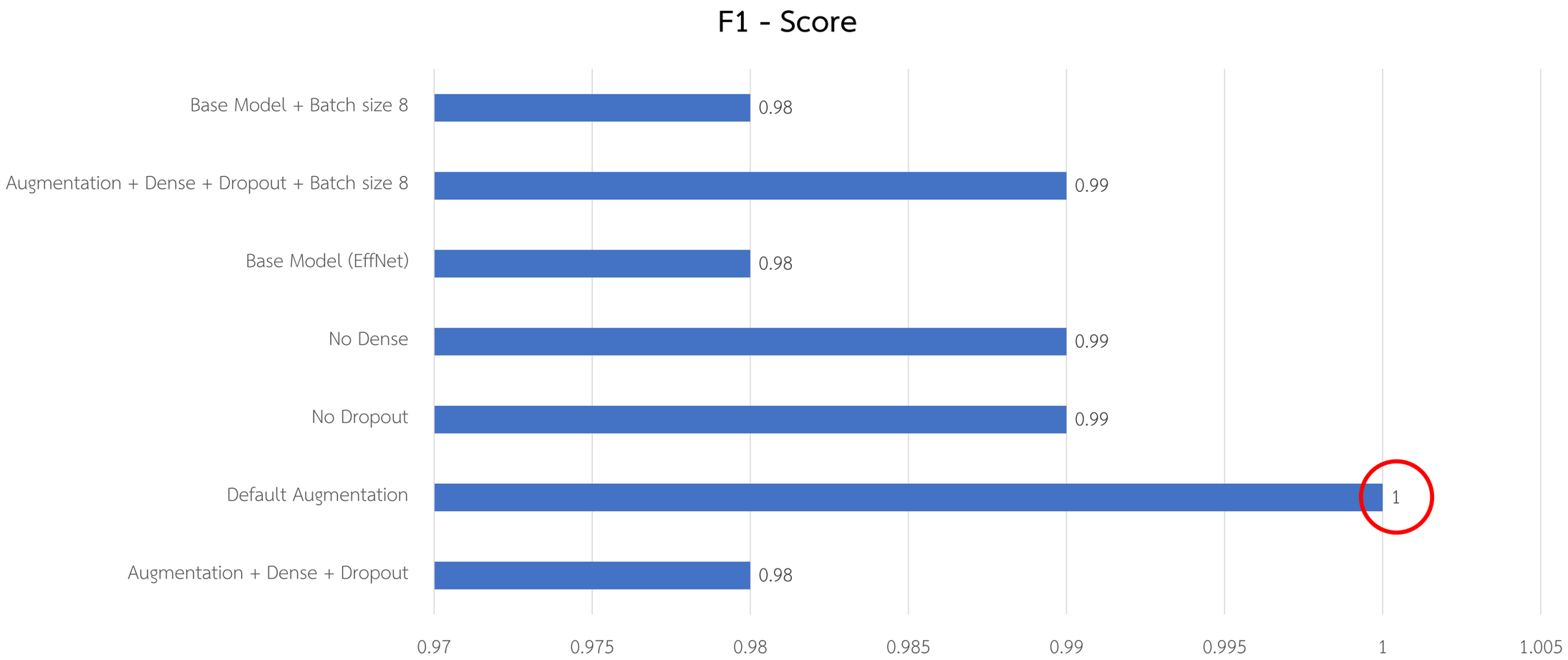
Fix Architecture (backbone : EffNet)



Fix Architecture (backbone : EffNet)



Fix Architecture (backbone : EffNet)



Fix Architecture (backbone : EffNet)

Test	Accuracy	Recall	F1 - Score
Base Model + Batch size 8	98.46	96.96	0.98
Augmentation + Dense + Dropout + Batch size 8	98.88	100	0.99
Base Model (EffNet)	98.46	96.58	0.98
No Dense	98.88	100	0.99
No Dropout	99.16	99.62	0.99
Default Augmentation	99.72	100	1
Augmentation + Dense + Dropout	98.74	96.96	0.98

Part 2 : Fix Augmentation

Base Model : EffNet + Dense + Dropout + Batch size = 4

Fix Augmentation

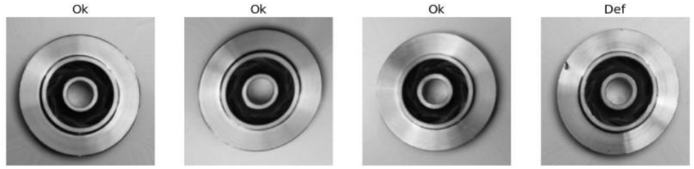
Additional Augmentation		
preprocess_train function	random_hue	tf.image.random_hue(img, max_delta = 0.5, seed = 404)
	random_contrast	tf.image.random_contrast(img, lower = 0.75, upper = 1.5, seed = 404)
ImageDataGenerator	Shift (width & height)	width_shift_range = 0.1, height_shift_range = 0.1
	Rotation	rotation_range = 45
	Brightness	brightness_range = [0.9, 1.1]
	Shear	shear_range = 5
	Zoom	zoom_range = 0.1
	Fill_mode	fill_mode = 'constant'
	Flip (Horizontal & Vertical)	horizontal_flip = True, vertical_flip = True
	Constant Parameter	dtype = tf.float32
		validation_split = validation_split
		preprocessing_function = preprocess_train

Fix Augmentation

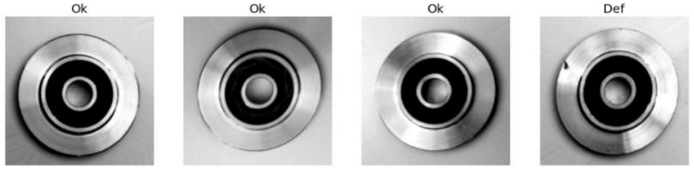
Default Augmentation	**Default Augmentation**
	Default Augmentation (random_hue & random_contrast only)
Additional Augmentation	**Additional Augmentation**
	Augmentation (No random_hue & No random_contrast only)
	No Shift (width & height)
	No Rotation
	No Brightness
	No Shear
	No Zoom
	No Fill_mode
	No Flip (Horizontal & Vertical)

Fix Augmentation (Compare Picture)

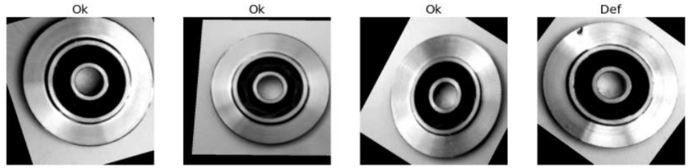
Default Augmentation



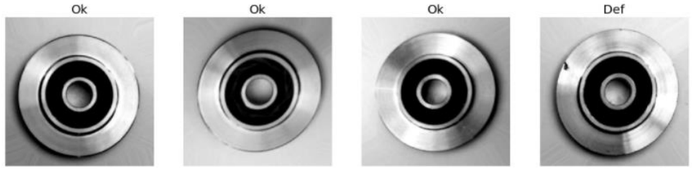
Default Augmentation
(random_hue & random_contrast only)



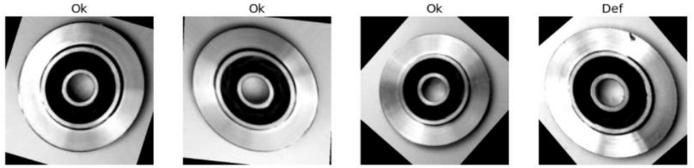
Additional Augmentation



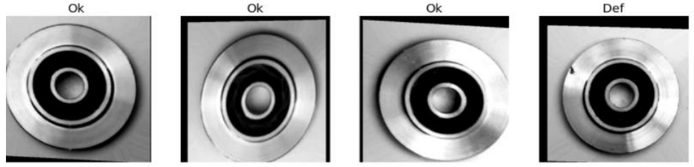
Augmentation
(No random_hue & No random_contrast only)



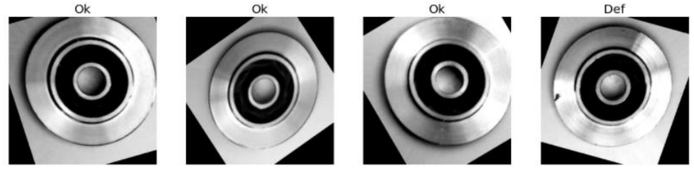
No Shift (width & height)



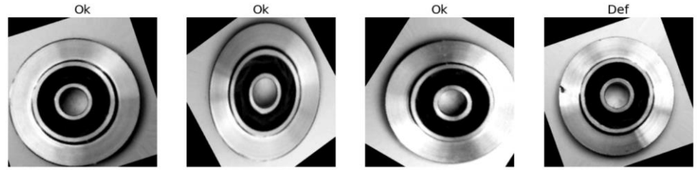
No Rotation



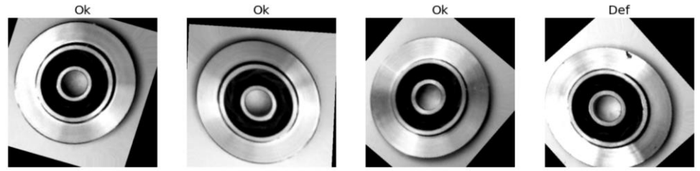
No Brightness



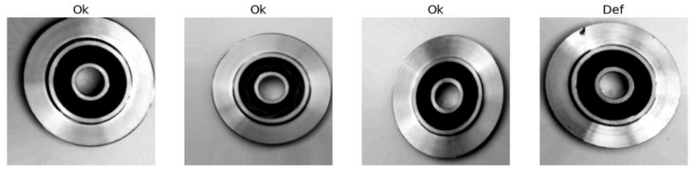
No Shear



No Zoom

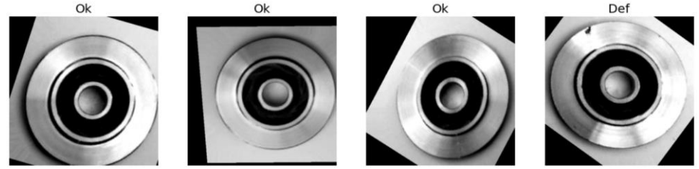


No Fill_mode

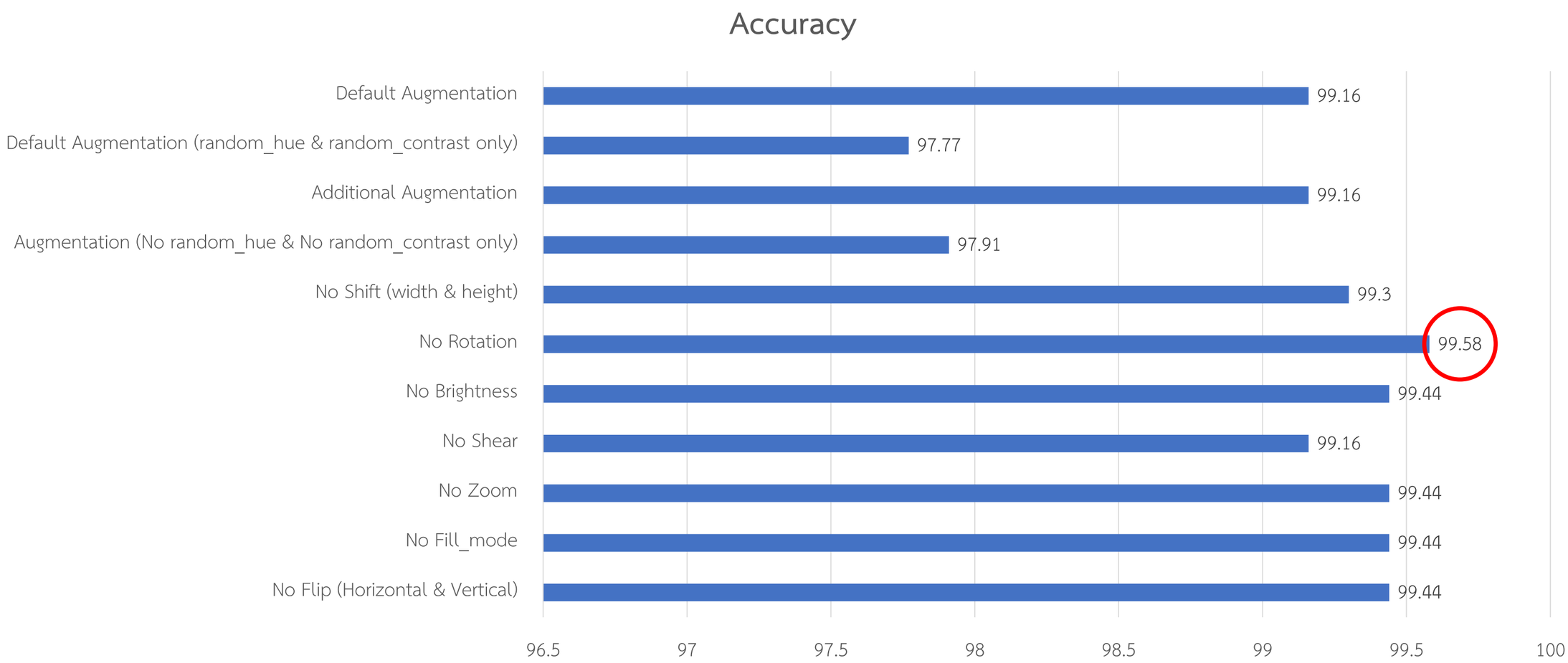


No Flip

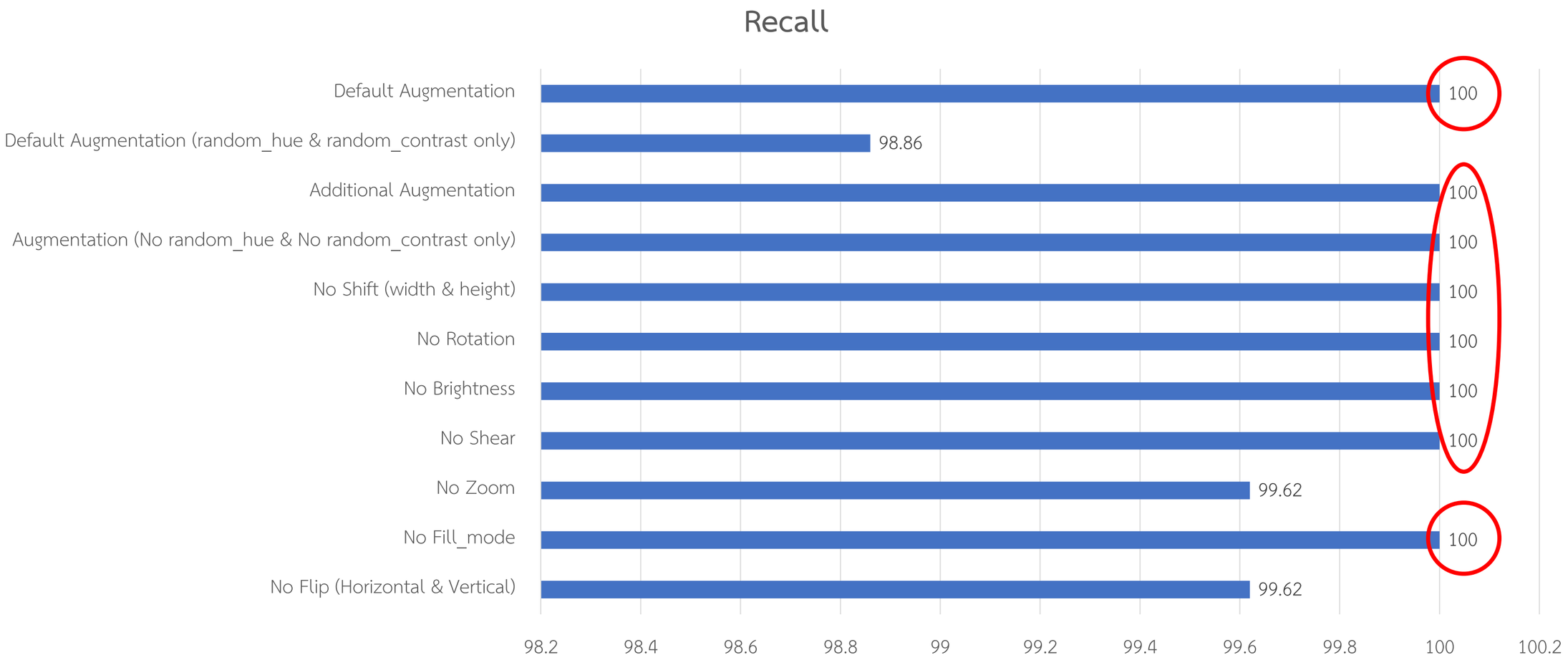
(Horizontal & Vertical)



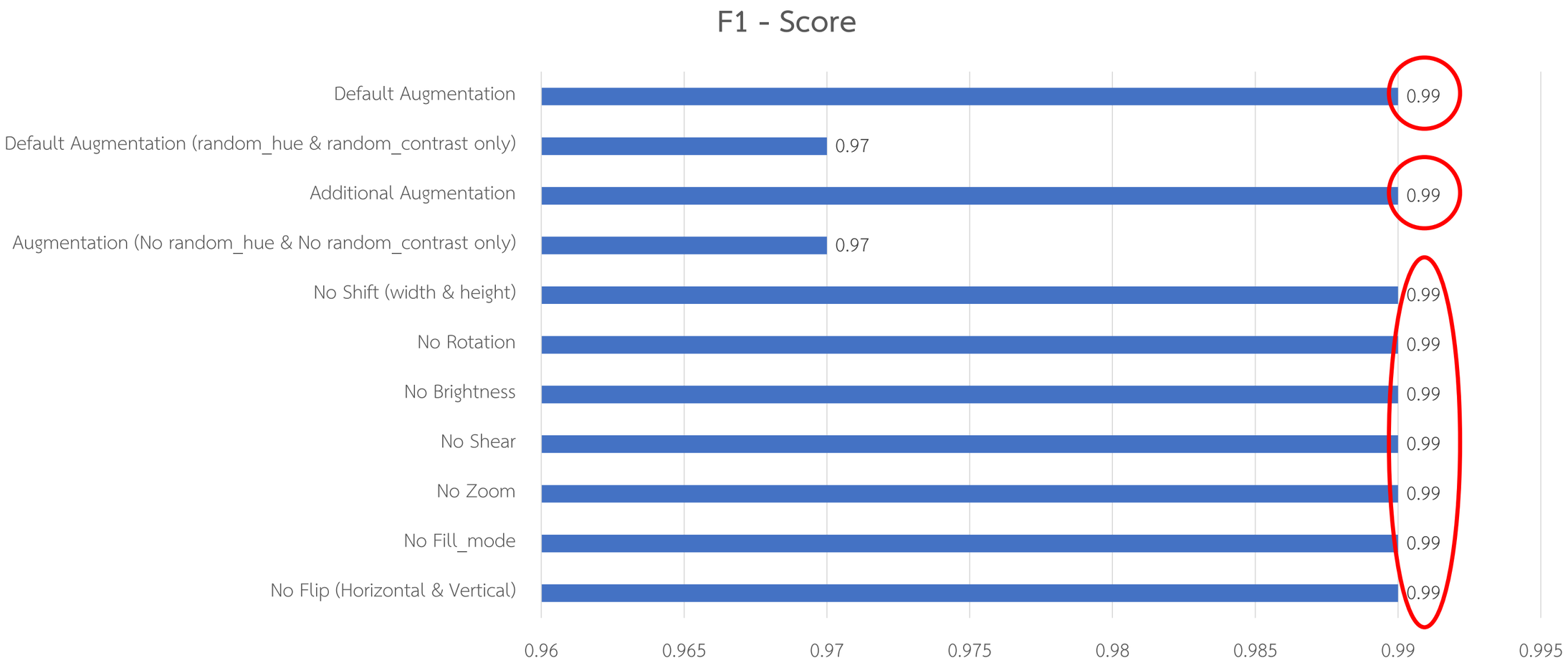
Fix Augmentation (backbone : EffNet)



Fix Augmentation (backbone : EffNet)



Fix Augmentation (backbone : EffNet)



Fix Augmentation (backbone : EffNet)

	Test	Accuracy	Recall	F1 - Score
Default Augmentation	**Default Augmentation**	99.16	100	0.99
	Default Augmentation (random_hue & random_contrast only)	97.77	98.86	0.97
Additional Augmentation	**Additional Augmentation**	99.16	100	0.99
	Augmentation (No random_hue & No random_contrast only)	97.91	100	0.97
	No Shift (width & height)	99.3	100	0.99
	No Rotation	99.58	100	0.99
	No Brightness	99.44	100	0.99
	No Shear	99.16	100	0.99
	No Zoom	99.44	99.62	0.99
	No Fill_mode	99.44	100	0.99
	No Flip (Horizontal & Vertical)	99.44	99.62	0.99

Part 3 : Fix Backbone

Fix Backbone

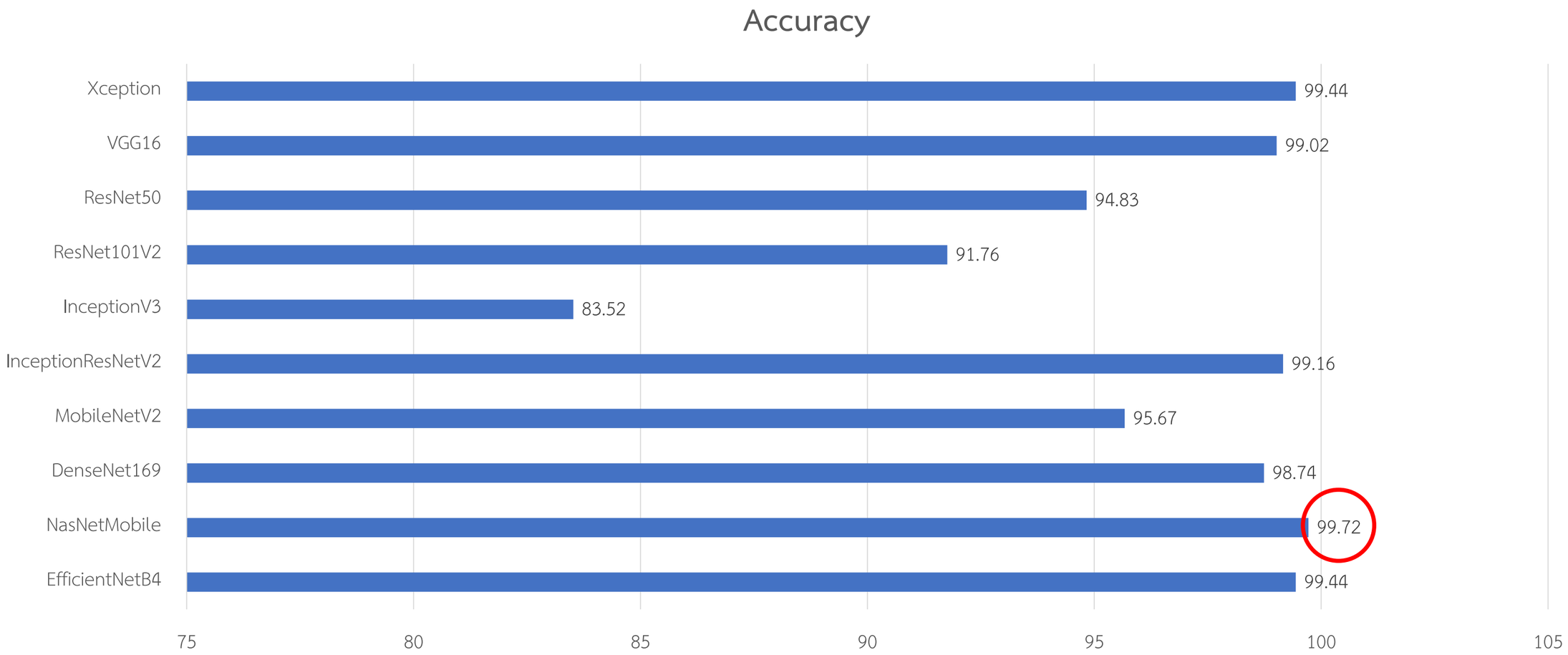
Backbone	Model
Xception	Xception
VGG	VGG16
ResNet	ResNet50
	ResNet101V2
Inception	InceptionV3
InceptionResNet	InceptionResNetV2
MobileNet	MobileNetV2
DenseNet	DenseNet169
NASNetMobile	NASNetMobile (image size : 224 * 224)
EfficientNet	EfficientNetB4

Fix Backbone (Default Augmentation)

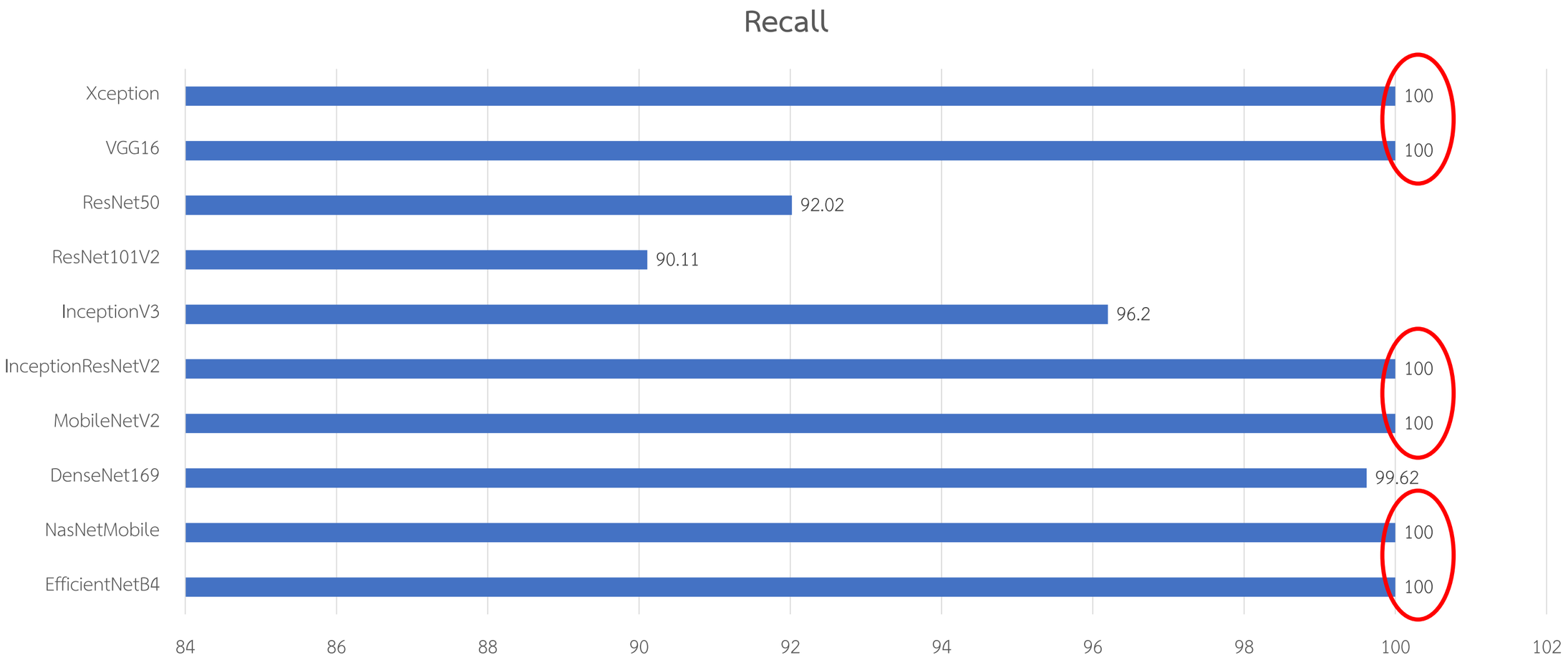
```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         [(None, 512, 512, 3)]     0
_________________________________________________________________
global_average_pooling2d (Gl (None, 1792)              0
_________________________________________________________________
dense (Dense)                (None, 1)                 1793
=================================================================
Total params: 17,675,616
Trainable params: 17,550,409
Non-trainable params: 125,207
_________________________________________________________________
```

Change the Backbone

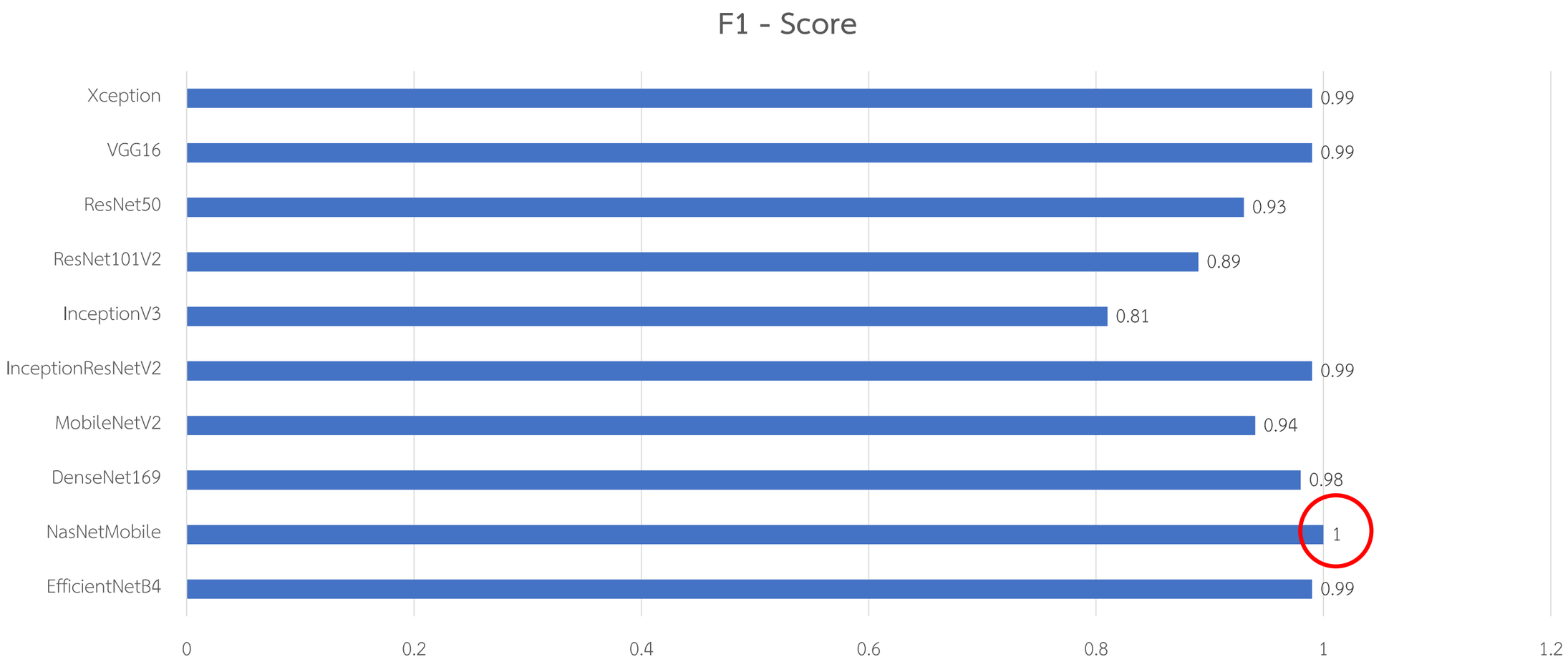
Fix Backbone (Default Augmentation)



Fix Backbone (Default Augmentation)



Fix Backbone (Default Augmentation)



Fix Backbone (Default Augmentation)

Test	Accuracy	Recall	F1 - Score
Xception	99.44	100	0.99
VGG16	99.02	100	0.99
ResNet50	94.83	92.02	0.93
ResNet101V2	91.76	90.11	0.89
InceptionV3	83.52	96.2	0.81
InceptionResNetV2	99.16	100	0.99
MobileNetV2	95.67	100	0.94
DenseNet169	98.74	99.62	0.98
NasNetMobile	99.72	100	1
EfficientNetB4	99.44	100	0.99

224 * 224

Fix Backbone (Default Augmentation)

Test	Accuracy	Recall	F1 - Score
Xception	99.44	100	0.99
VGG16	99.02	100	0.99
ResNet50	94.83	92.02	0.93
ResNet101V2	91.76	90.11	0.89
InceptionV3	83.52	96.2	0.81
InceptionResNetV2	99.16	100	0.99
MobileNetV2	95.67	100	0.94
DenseNet169	98.74	99.62	0.98
NasNetMobile	99.72	100	1
EfficientNetB4	99.44	100	0.99

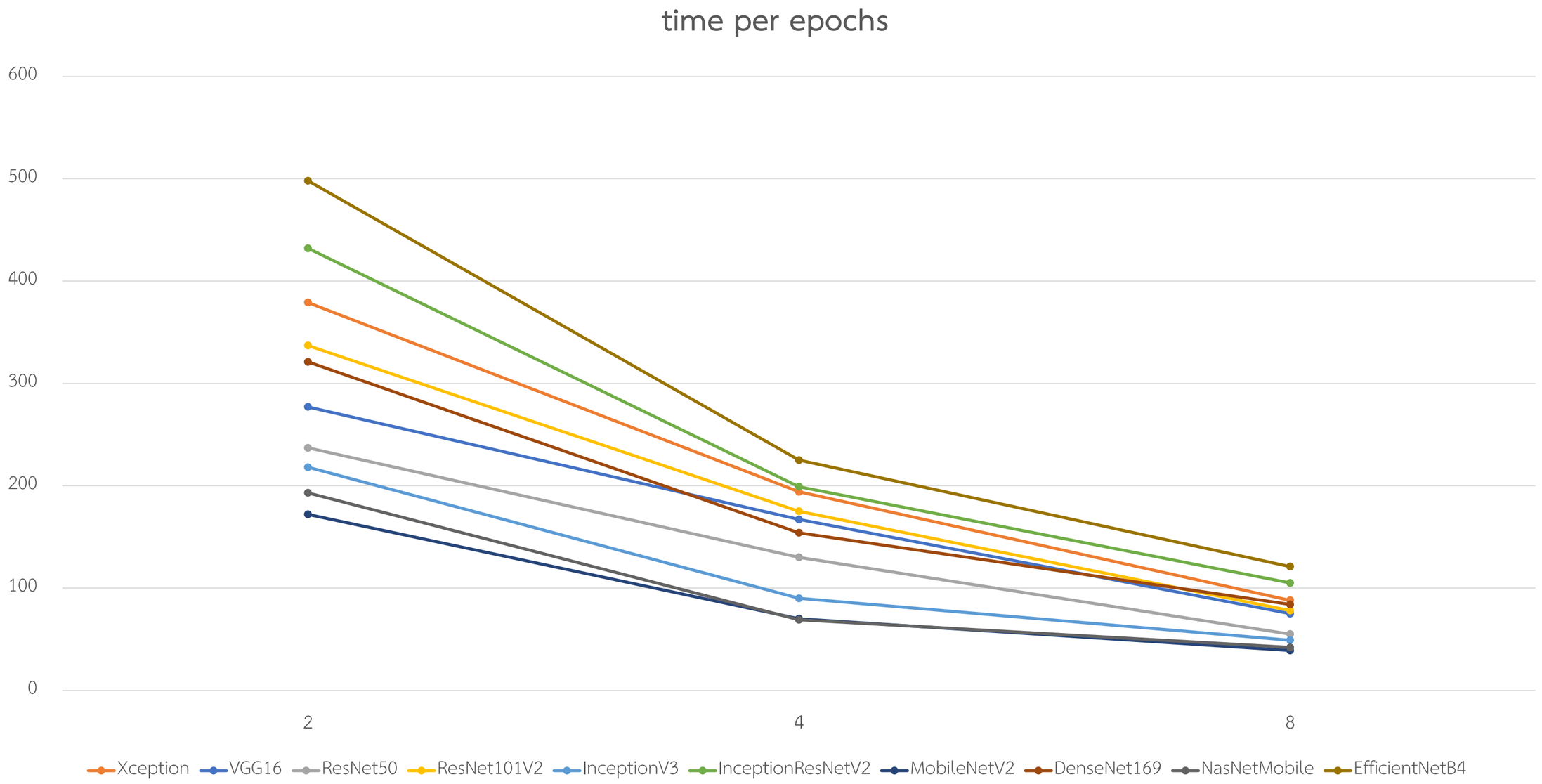
Part 4 : Interference time

Interference time

Time per epochs

batch size	2	4	8
Xception	379	194	88
VGG16	277	167	75
ResNet50	237	130	55
ResNet101V2	337	175	78
InceptionV3	218	90	49
InceptionResNetV2	432	199	105
MobileNetV2	172	70	39
DenseNet169	321	154	84
NasNetMobile	193	69	42
EfficientNetB4	498	225	121

Interference time

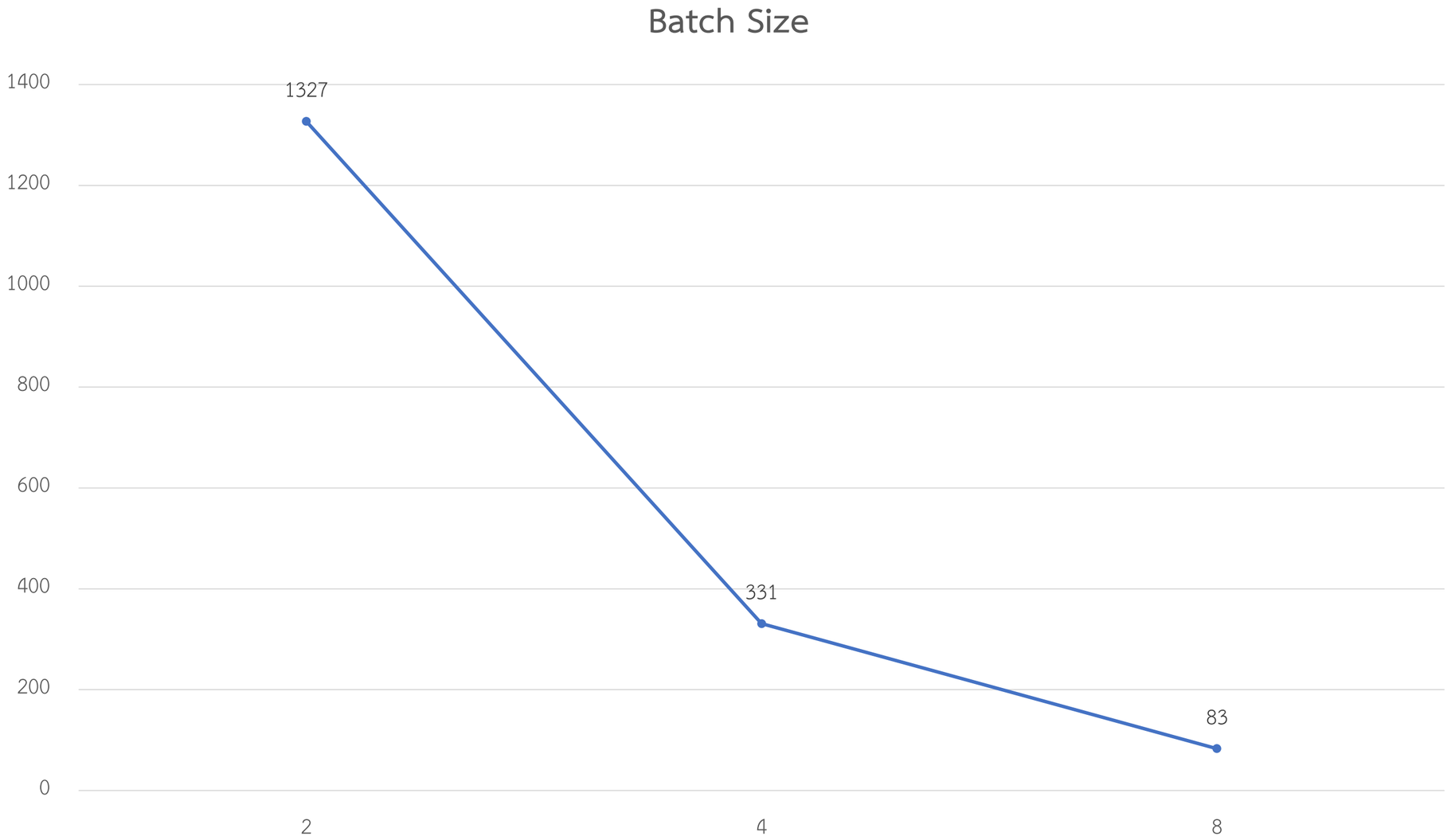


Interference time

Time per epochs

batch size	2	4	8
Xception	1327	331	83
VGG16	1327	331	83
ResNet50	1327	331	83
ResNet101V2	1327	331	83
InceptionV3	1327	331	83
InceptionResNetV2	1327	331	83
MobileNetV2	1327	331	83
DenseNet169	1327	331	83
NasNetMobile	1327	331	83
EfficientNetB4	1327	331	83

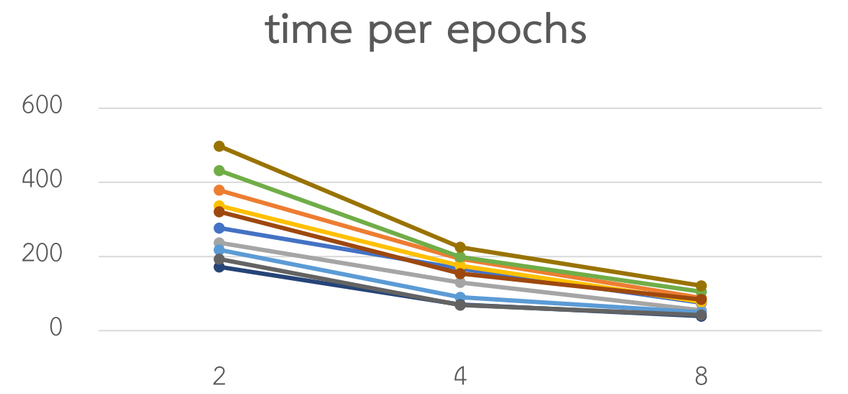
Interference time

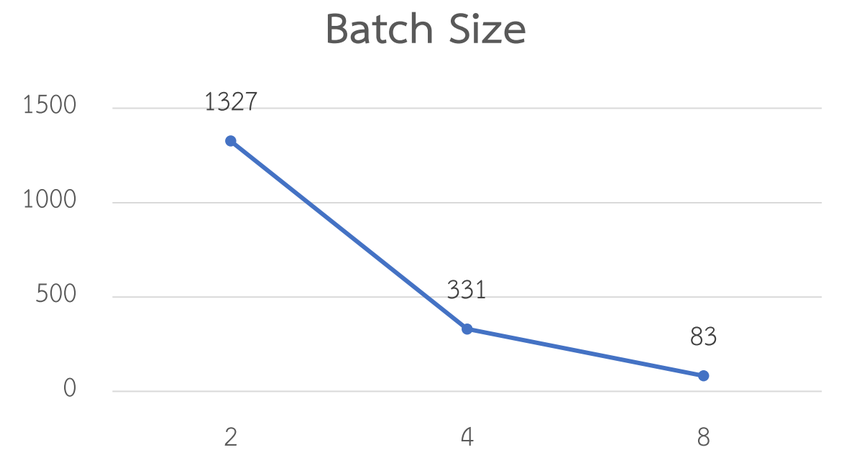


Interference time

$$\frac{\text{time per epochs}}{\text{Batch Size}} = \text{time per batch}$$

Interference time





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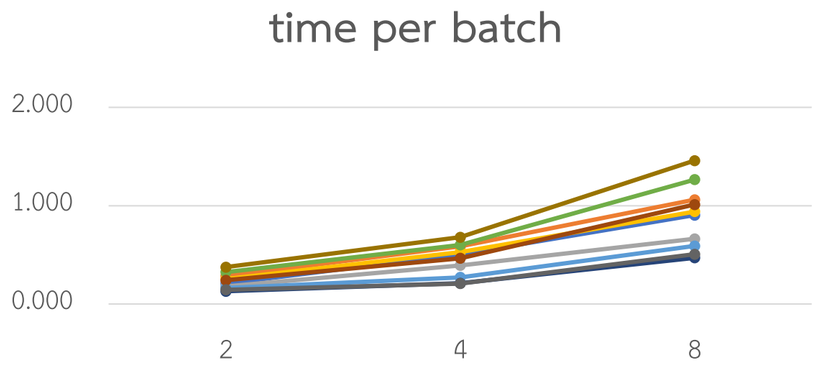
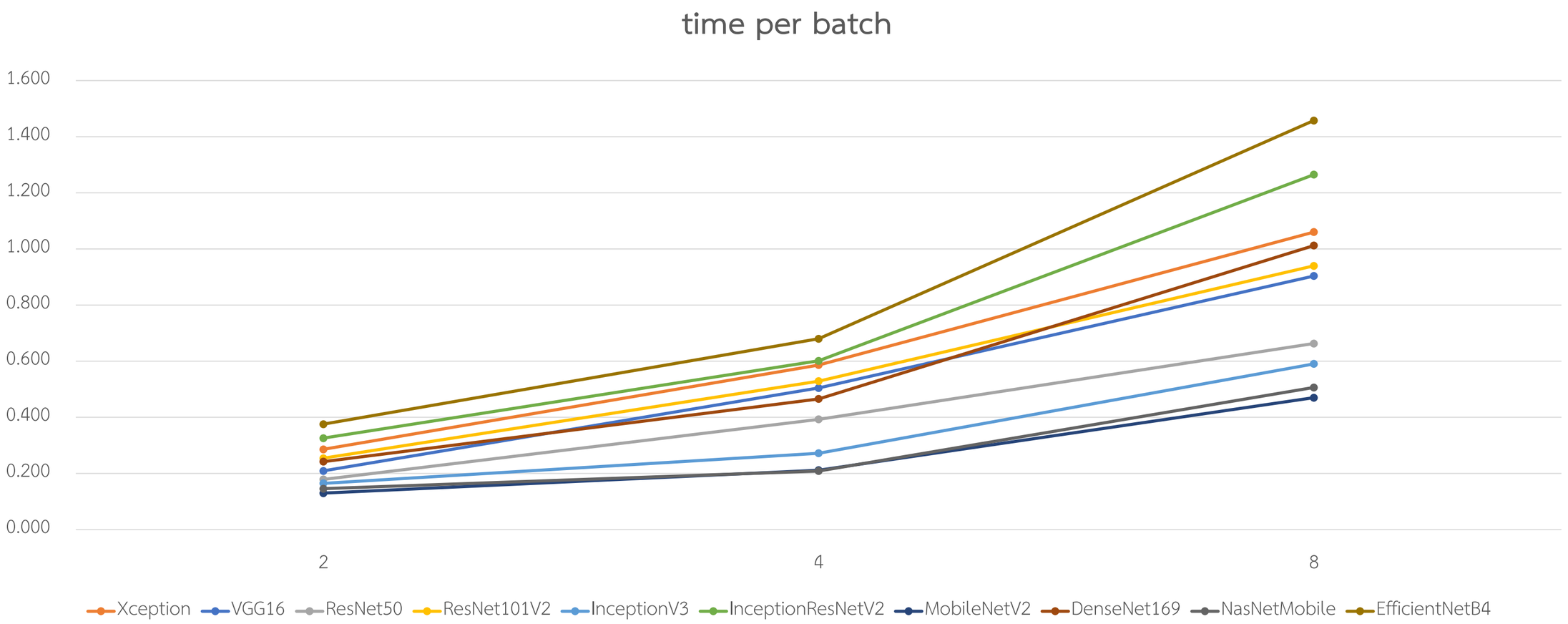


Interference time

Time per batch

batch size	2	4	8
Xception	0.285606631	0.586102719	1.060240964
VGG16	0.208741522	0.504531722	0.903614458
ResNet50	0.178598342	0.392749245	0.662650602
ResNet101V2	0.253956292	0.528700906	0.939759036
InceptionV3	0.164280332	0.271903323	0.590361446
InceptionResNetV2	0.325546345	0.601208459	1.265060241
MobileNetV2	0.129615674	0.211480363	0.469879518
DenseNet169	0.24189902	0.465256798	1.012048193
NasNetMobile	0.145440844	0.208459215	0.506024096
EfficientNetB4	0.375282592	0.679758308	1.457831325

Interference time



Summary Model

EfficientNetB4 + Additional Augmentation(no rotation) + Batch Size (4)

Summary Model

EffectiveNetB4

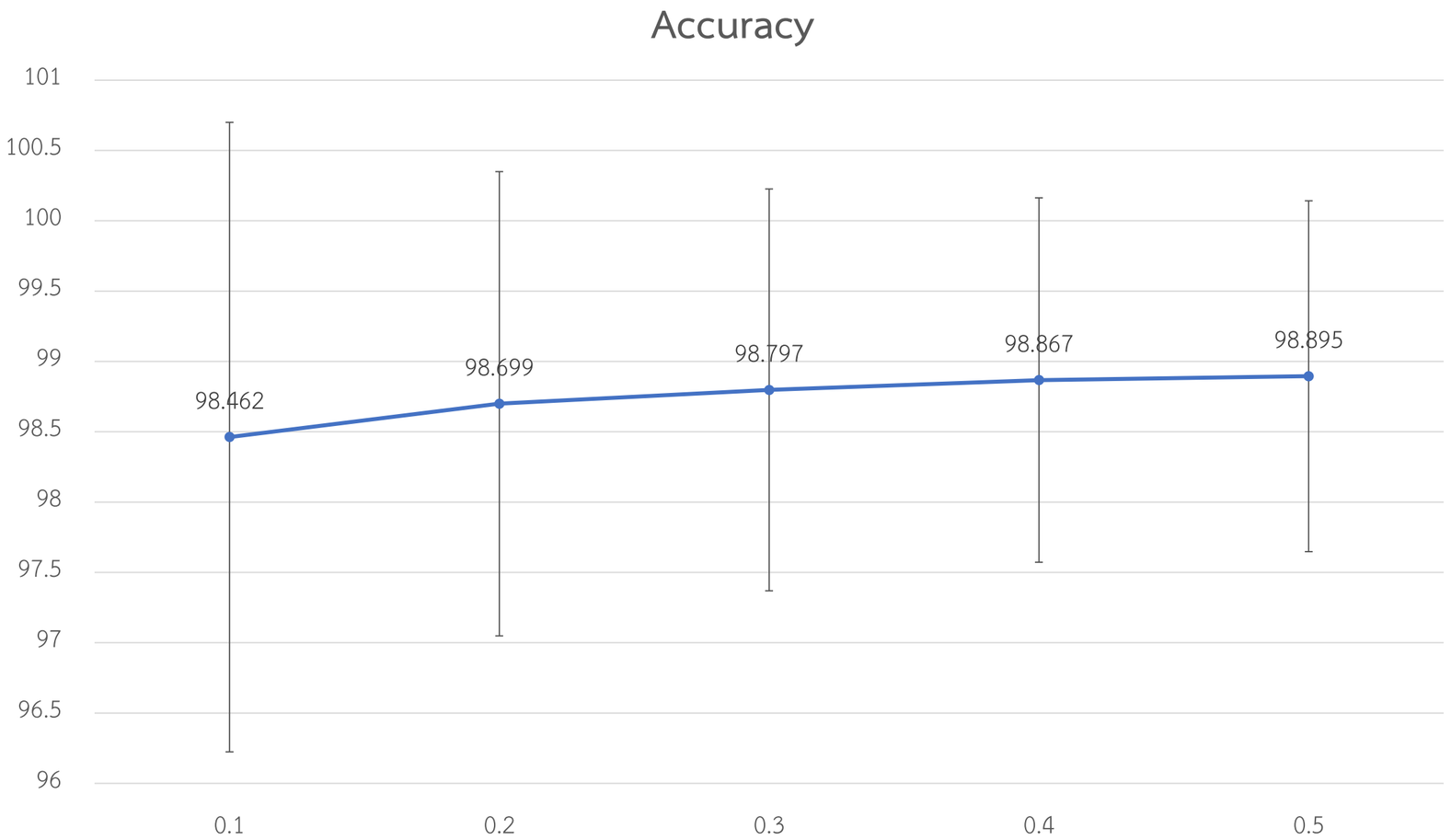
treshold	test	1	2	3	4	5	6	7	8	9	10	Avg	sd
0.1	Accuracy	99.44	98.74	99.3	98.32	99.44	99.3	99.3	92.46	99.3	99.02	98.46	2.24
	Recall	100	100	100	100	100	100	100	100	100	100	100.00	0.00
	F1-Score	0.99	0.98	0.99	0.98	0.99	0.99	0.99	0.91	0.99	0.99	0.98	0.03
0.2	Accuracy	99.44	98.88	99.3	98.6	99.44	99.3	99.3	94.27	99.3	99.16	98.70	1.65
	Recall	100	100	100	100	100	100	100	100	100	100	100.00	0.00
	F1-Score	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.93	0.99	0.99	0.98	0.02
0.3	Accuracy	99.44	99.16	99.3	98.6	99.44	99.3	99.3	94.97	99.3	99.16	98.80	1.43
	Recall	100	100	100	100	100	100	100	100	100	100	100.00	0.00
	F1-Score	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.94	0.99	0.99	0.98	0.02
0.4	Accuracy	99.44	99.3	99.3	98.74	99.44	99.3	99.3	95.39	99.3	99.16	98.87	1.30
	Recall	100	100	100	100	100	100	100	100	100	100	100.00	0.00
	F1-Score	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.94	0.99	0.99	0.98	0.02
0.5	Accuracy	99.58	99.3	99.3	98.74	99.3	99.3	99.3	95.53	99.3	99.3	98.90	1.25
	Recall	100	100	100	100	99.62	100	100	100	100	100	99.96	0.13
	F1-Score	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.94	0.99	0.99	0.98	0.02

Summary Model

EffectiveNetB4

Treshold	Accuracy	Recall	F1-Score
0.1	98.462 ± 2.24	100	0.98 ± 0.03
0.2	98.699 ± 1.65	100	0.983 ± 0.02
0.3	98.797 ± 1.43	100	0.984 ± 0.02
0.4	98.867 ± 1.30	100	0.984 ± 0.02
0.5	98.895 ± 1.25	99.962 ± 0.13	0.984 ± 0.02

Summary Model

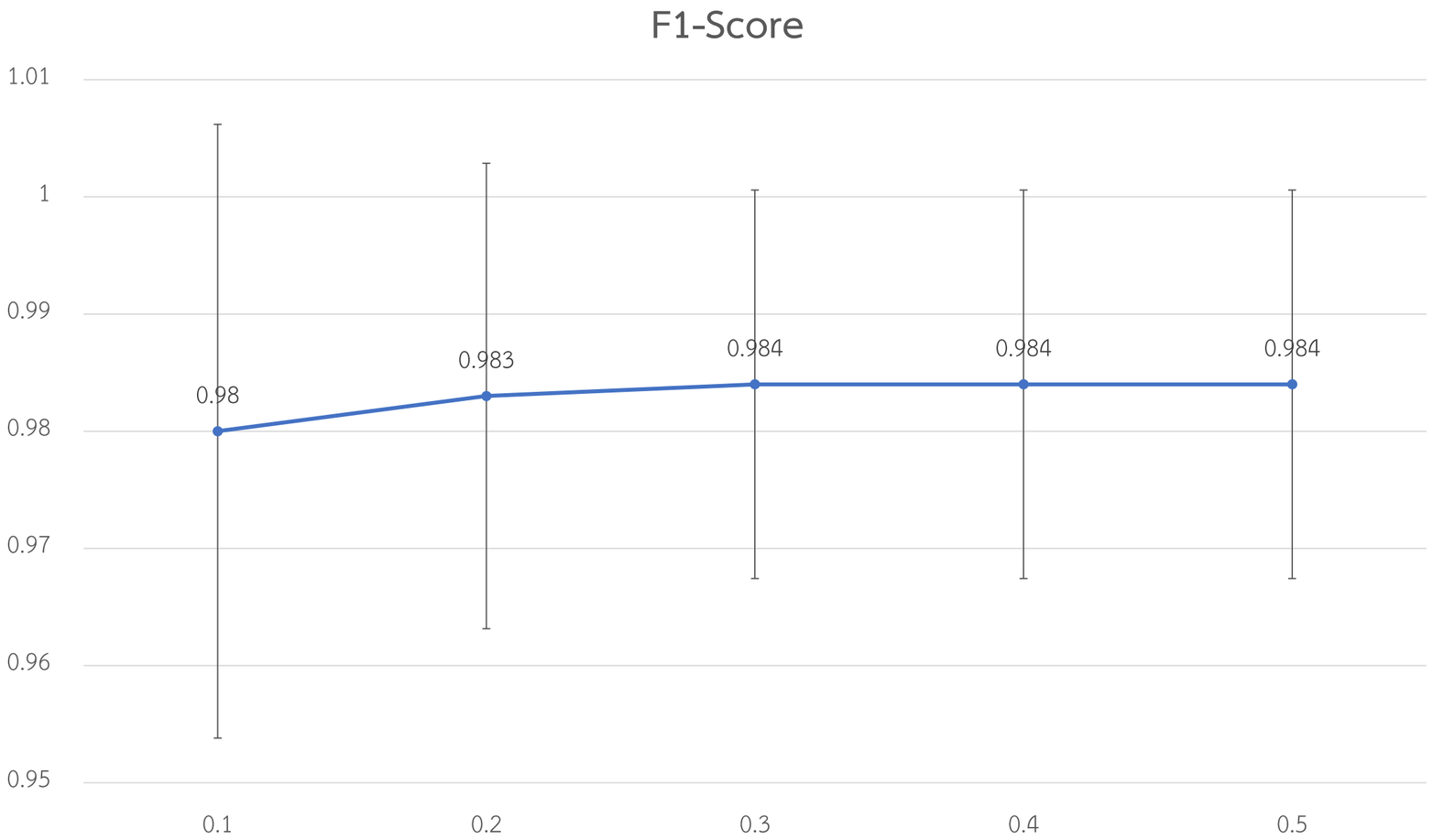


Treshold	Accuracy
0.1	98.462 ± 2.24
0.2	98.699 ± 1.65
0.3	98.797 ± 1.43
0.4	98.867 ± 1.30
0.5	98.895 ± 1.25

Summary Model

Treshold	Recall
0.1	100
0.2	100
0.3	100
0.4	100
0.5	99.962 ± 0.13

Summary Model



Treshold	F1-Score
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0.2	0.983 ± 0.02
0.3	0.984 ± 0.02
0.4	0.984 ± 0.02
0.5	0.984 ± 0.02