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This

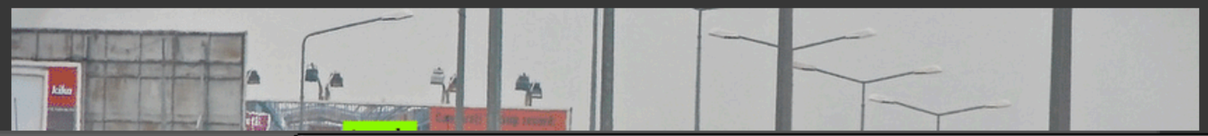
In This Lecture, We Will Cover:

- A brief introduction to Computer Vision field.
- Why Vanilla NN is **NOT** suited for Image Data? Explained with a real-world example!
- Taking motivations for a new architecture from **Human Visual Cortex System**.
- Defining the new architecture, aka **CNNs** and its components!

Q. **What is Computer Vision (CV)?**

Simply put, Computer Vision is a field of AI that enables machine to derive **Meaningful Information from Images**, Some Examples:

- Detect all the **Objects** in the Image -



1 / 1

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Search Google or type a URL

convolution

Computer vision - 2 (CNN)

- → Pooling → MaxPooling, ...
- → Apparel → 10 class classifier
  - → MLP
  - → CNN - Simplistic
  - → improve - CNN (GAP)

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Recap:

Conv

- → Spatial data
- → Biology inspired
- → Simple + ReLu
- → Padding
- → strides

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```
[ ] num_classes = 10
    hidden_size = 256

    model = keras.Sequential(
        name="model_cnn",
        layers=[
            layers.Conv2D(filters=16, kernel_size=3, strides=1, padding="same", activat
            layers.MaxPooling2D(),
            layers.Flatten(),
            layers.Dense(units=hidden_size, activation='relu'),
            layers.Dense(units=num_classes, activation='softmax')
        ]
    )
```

30 min

```
[ ] tf.keras.utils.plot_model(model, to_file="model_cnn.png", show_shapes=True)
```

conv2d_input	input:	[(None, 128, 128, 3)]	[(None, 128, 128, 3)]

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Conv: → cell-wise mul + addition ✓

↳ ✓ padding & strides *** (suggested) (code as post read)

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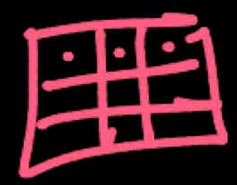

$$\mathrm{Relu}\left(\underbrace{I_m \odot K_1}_{\text{add}+\underline{\text{mul}}}\right)$$

$\longrightarrow$ FP

$\longleftarrow$ BP

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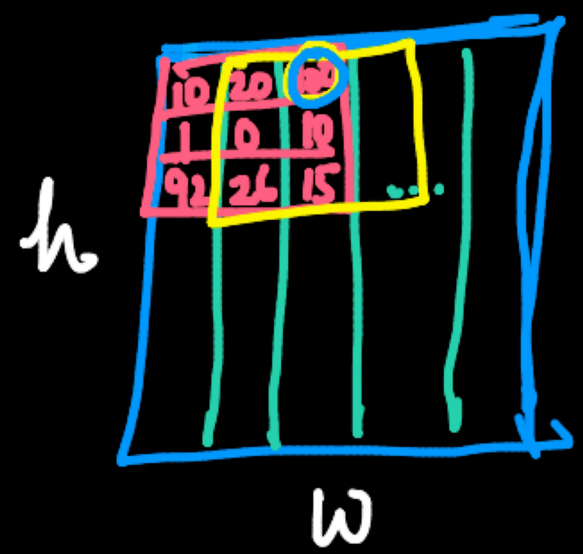
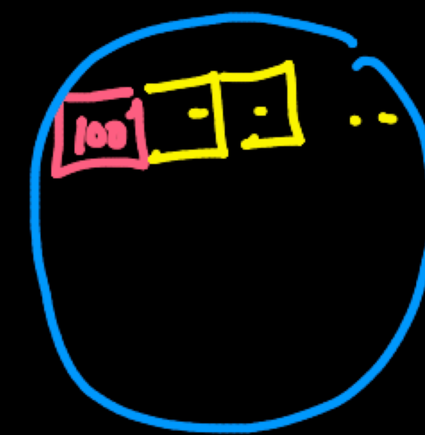
Max Pooling:

→ no params (most popular)





✓ edge/object /shape detector

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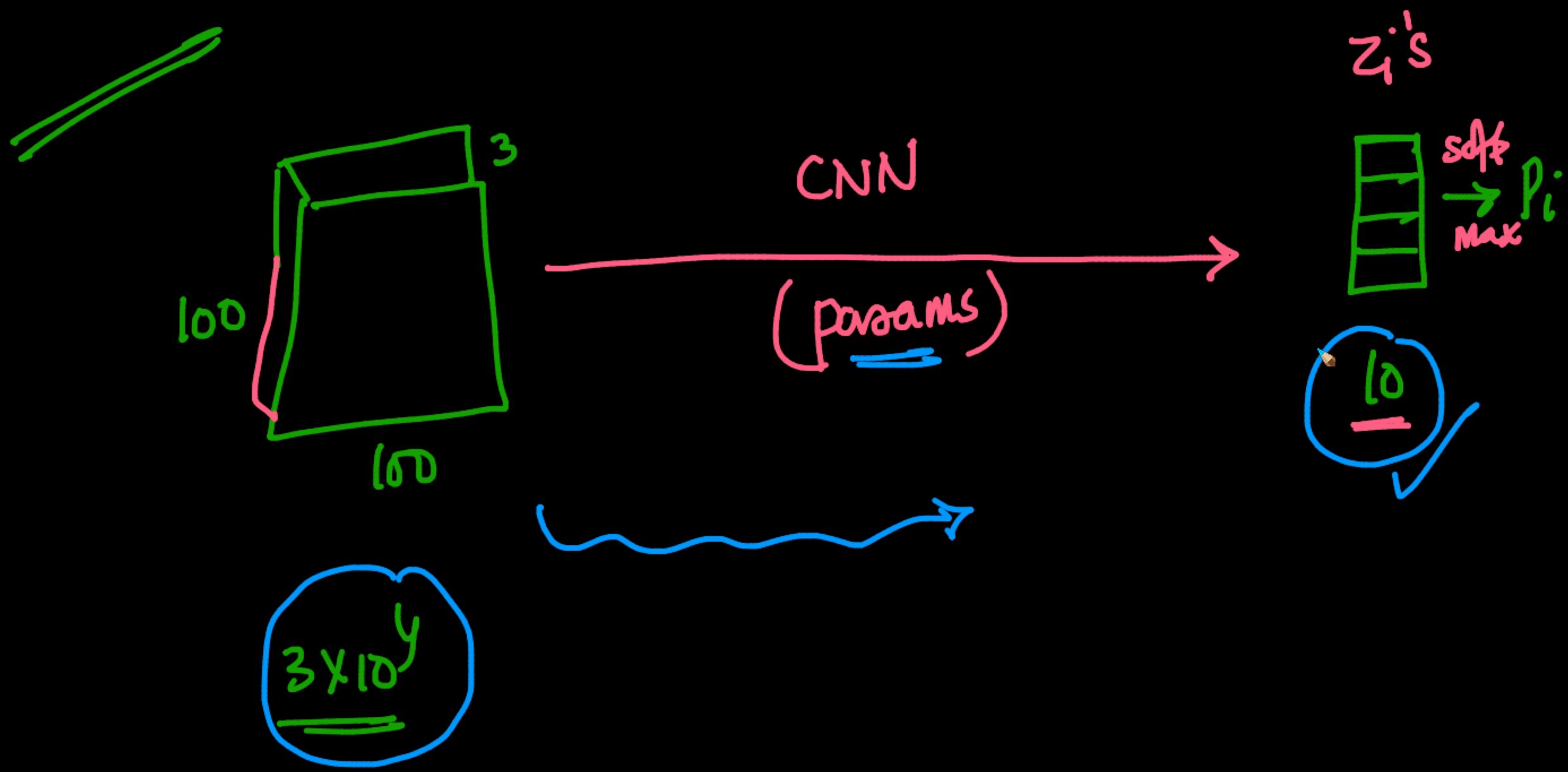
Max pooling → intuitively Max. Kernel 3x3

↳ no padding (often)

→ strides

Average/Mean pooling → [less often used]

↳ Mean instead of max


3
100
100
CNN
(params)
z_i's
softmax
p_i
10
3×10^4

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Max-pooling

Kernel size

3x3

5x5

7x7

hyper-param

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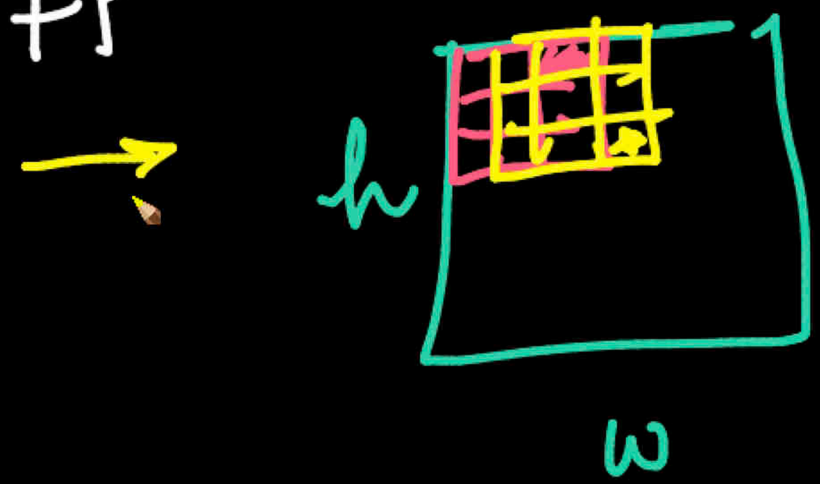
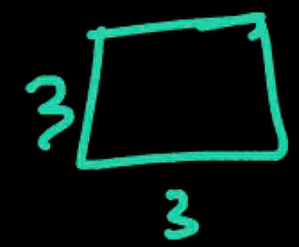
Max pooling

FP





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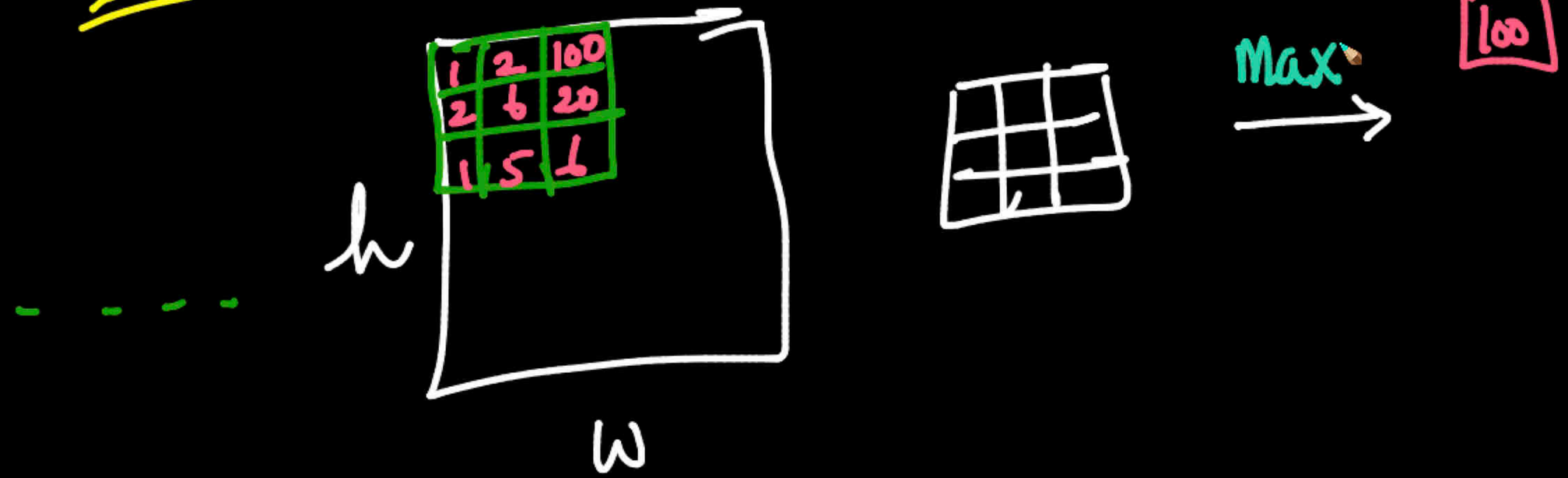
BP

Max pooling



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$$\frac{\partial \max(a, b, c, d)}{\partial a} = 0$$

Let $a < b < c < d$

$$= \lim_{\delta \to 0} \frac{\max(a+\delta, b, c, \boxed{d}) - \max(a, b, c, \boxed{d})}{\delta}$$

$= 0$

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$$\frac{\partial \max(a, b, c, d)}{\partial b} = 0$$

$$\frac{\partial \max(a, b, c, d)}{\partial d} = ?$$

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$$\frac{\partial \max(a, b, c, d)}{\partial d} = 1$$

$$= \lim_{\delta \to 0} \frac{\max(a, b, c, d+\delta) - \max(a, b, c, d)}{\delta}$$

$$= \frac{d+\delta-d}{\delta} = 1$$

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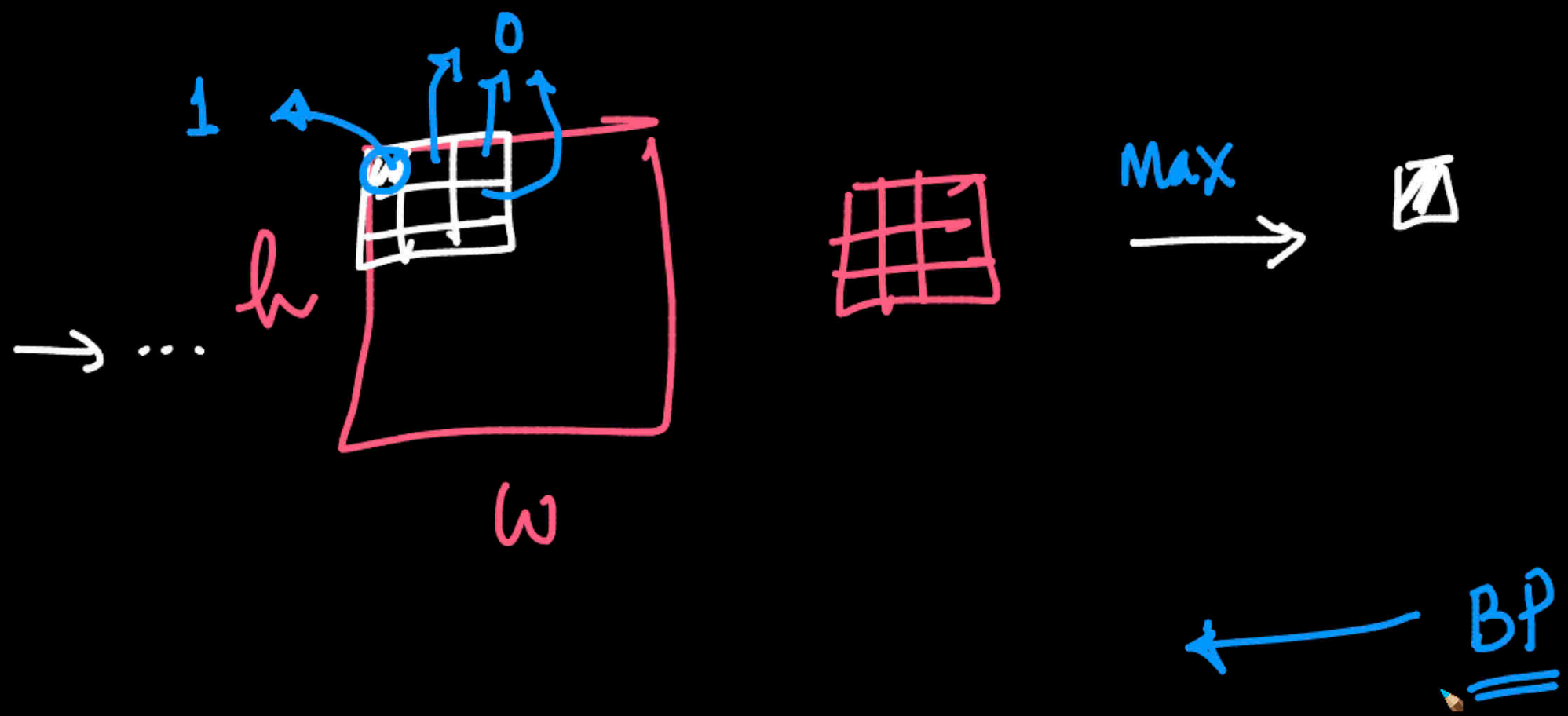

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NOTE

layer

FP →

BP ←

why ?

where

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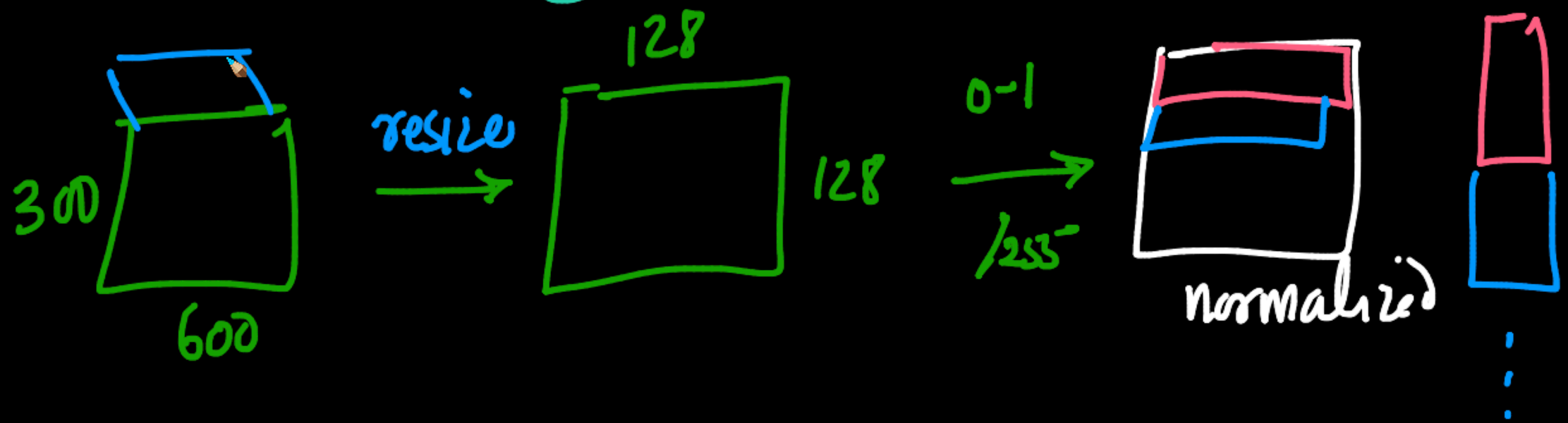
M1:

Pre-processing:

MLP ✓

1



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M1: MLP

128 X 128 X 3 → →

Tensor

(128 X 128 X 3)

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+ Code + Text Changes will not be saved Connect

```
[ ] num_classes = 10
    hidden_size_1 = 1024
    hidden_size_2 = 256

    model = keras.Sequential(
        name="model_ann",
        layers=[
            layers.Flatten(input_shape=(height, width, 3)), # alternatively, input_shap
            layers.Dense(units=hidden_size_1, activation='relu'), # hidden layer 1
            layers.Dense(units=hidden_size_2, activation='relu'), # hidden layer 2
            layers.Dense(units=num_classes, activation='softmax'), # output layer
        ]
    )
```

128X128X3 → [ ] → 1024 → 256 → 10

- So now that we have created the model,
  Lets Visualize **the structure of the model and the number of parameters,** using `.summary()` method.

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colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=kTN6F8ZUQT4F
+ Code + Text Changes will not be saved Connect

```
[ ] model.summary()
```

```
Model: "model_ann"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 flatten_1 (Flatten)         (None, 49152)             0

 dense (Dense)               (None, 1024)              50332672

 dense_1 (Dense)             (None, 256)               262400

 dense_2 (Dense)             (None, 10)                2570

=================================================================
Total params: 50,597,642
Trainable params: 50,597,642
Non-trainable params: 0
_________________________________________________________________
```

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+ Code + Text Changes will not be saved Connect

```
[ ] model.summary()
```

```
Model: "model_ann"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 flatten_1 (Flatten)         (None, 49152)             0

 dense (Dense)               (None, 1024)              50332672

 dense_1 (Dense)             (None, 256)               262400

 dense_2 (Dense)             (None, 10)                2570

=================================================================
Total params: 50,597,642
Trainable params: 50,597,642
Non-trainable params: 0
_________________________________________________________________
```

23 / 23

Chrome File Edit View History Bookmarks Profiles Tab Window Help 9:53
L1 : Intro to ComputerVis | GitHub - alexeygrigorev/ | L2 : Revisiting CNN Deal | Conv2D layer | Amazon.in : t shirts | 49152*1024+1024 - Goo
colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=o253WfkcZAJF
+ Code + Text Changes will not be saved Connect

128 X 128 X 3

~ 3000 images → 10 class classfn

```
model.summary()
```

```
Model: "model_ann"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 flatten_1 (Flatten)         (None, 49152)             0

 dense (Dense)               (None, 1024)              50332672

 dense_1 (Dense)             (None, 256)               262400

 dense_2 (Dense)             (None, 10)                2570

=================================================================
Total params: 50,597,642
Trainable params: 50,597,642
Non-trainable params: 0
_________________________________________________________________
```

Gut feel overfit

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Chrome File Edit View History Bookmarks Profiles Tab Window Help 9:57
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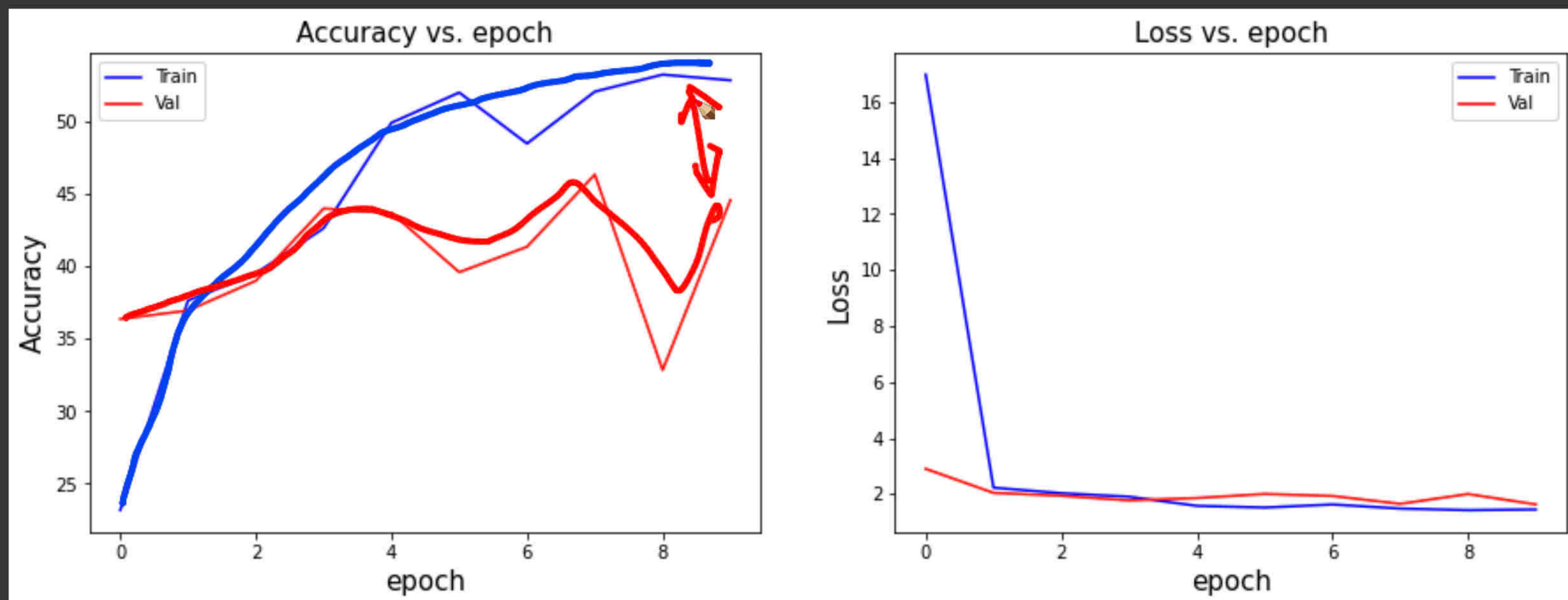
colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=Qn0Sqs9eZklM
+ Code + Text Changes will not be saved Connect

```
ax[1].legend()

#display the graph
plt.show()
```



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colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=HEjRmxNBd7bQ
+ Code + Text Changes will not be saved Connect

```
class_names = test_data.class_names

# create list of all "y"s labels, by iterating over test dataset
true_categories = tf.concat([y for x, y in test_ds], axis=0)

# calculate accuracy
test_acc = metrics.accuracy_score(true_categories, predicted_categories) * 100
print(f'\nTest Accuracy: {test_acc:.2f}%\n')
```

```
Test Accuracy: 36.56%
```

~1/3 rd → ✓

```
[ ] def ConfusionMatrix(model, ds, label_list):
    # Note: This logic doesn't work with shuffled datasets
        # run model prediction and obtain probabilities
        y_pred = model.predict(ds)
        # get list of predicted classes by taking argmax of the probabilities(y_pred)
        predicted_categories = tf.argmax(y_pred, axis=1)
        # create list of all "y"s labels, by iterating over test dataset
```

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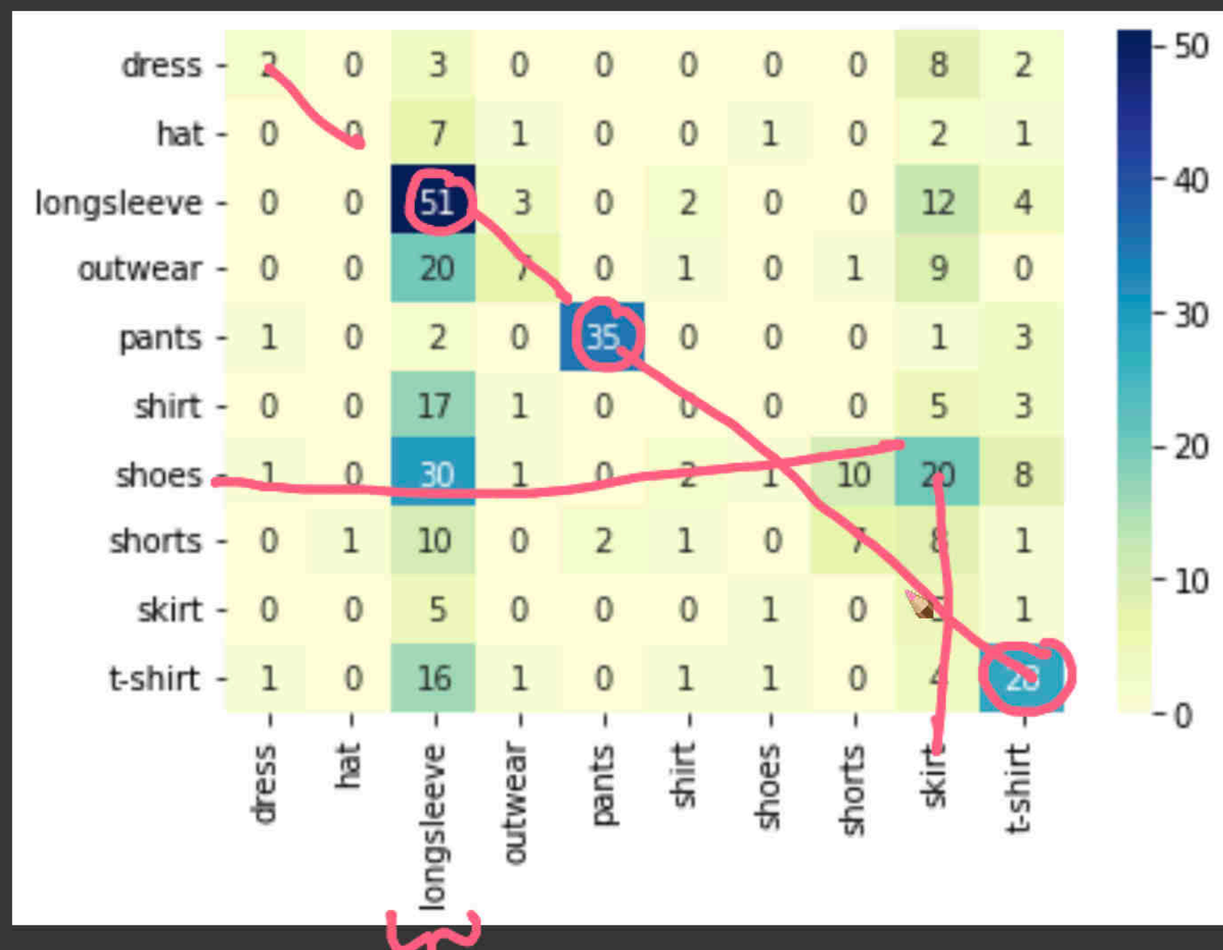
```
ConfusionMatrix(model, test_ds, test_data.class_names)
```



c. Let's also plot few samples from test set along with their predicted softmax probabilities.

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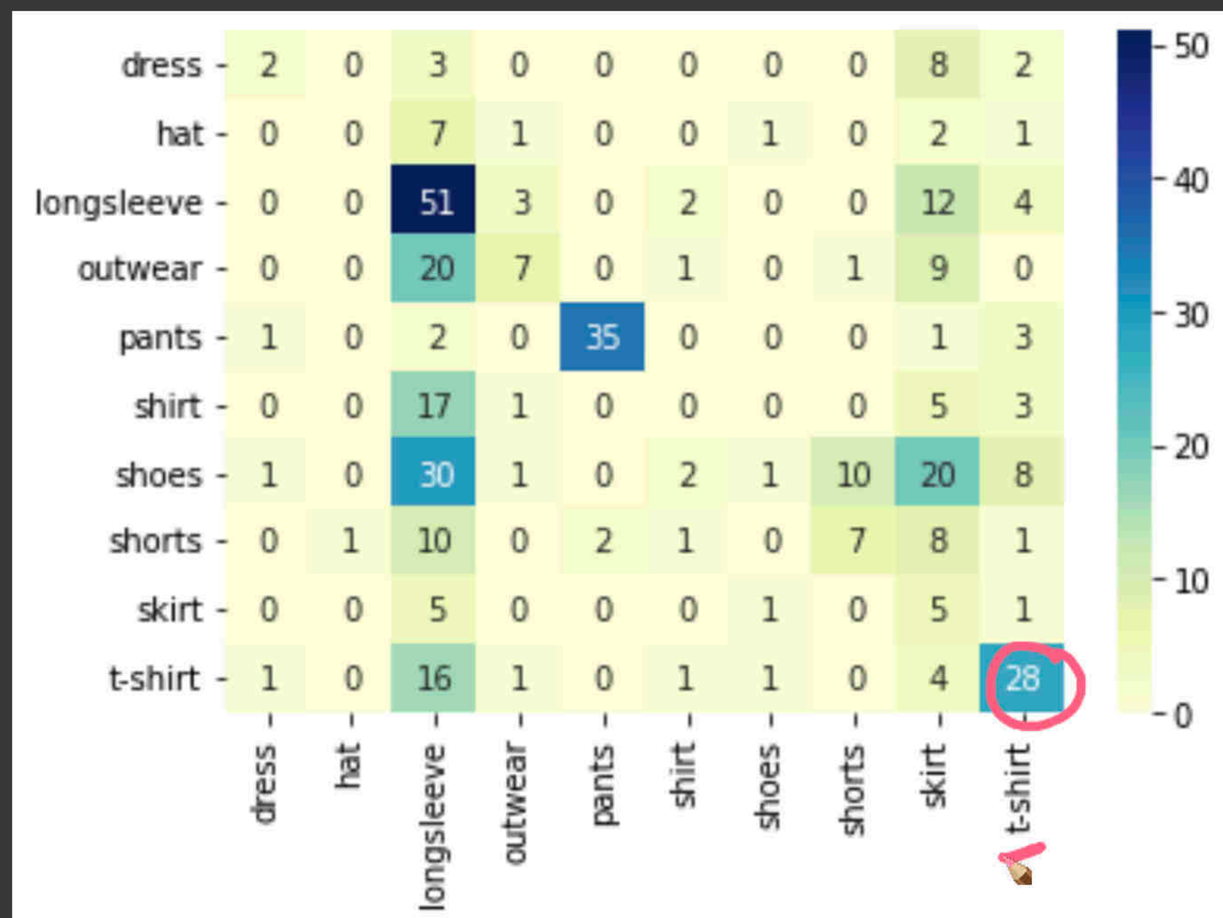
```
ConfusionMatrix(model, test_ds, test_data.class_names)
```



c. Let's also plot few samples from test set along with their predicted softmax probabilities.

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colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=HEjRmxNBd7bQ
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(Don't worry if you don't understand what all of this means, it will be explained in detail in later sections)

a. Model Architecture

128x128 x3 → 16 kernels 3x3x3

```
[ ] num_classes = 10
    hidden_size = 256

    model = keras.Sequential(
        name="model_cnn",
        layers=[
            layers.Conv2D(filters=16, kernel_size=3, strides=1, padding="same", activat
            layers.MaxPooling2D(),
            layers.Flatten(),
            layers.Dense(units=hidden_size, activation='relu'),
            layers.Dense(units=num_classes, activation='softmax')
        ]
    )
```

```
[ ] tf.keras.utils.plot_model(model, to_file="model_cnn.png", show_shapes=True)
```

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+ Code + Text Cannot save changes Connect

```
[ ] model.summary()
```

```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
```

27x16
432

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$$\text{Relu}\left(w^T x_i + b\right) \rightarrow \text{MLP}$$

$$\text{Relu}\left(I_m \odot K_1 + b\right) \rightarrow \text{CNN}$$

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```
[ ] model.summary()
```

```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
```

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+ Code + Text Cannot save changes Connect

```
[ ] model.summary()
```

128X128X3

1m

```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
```

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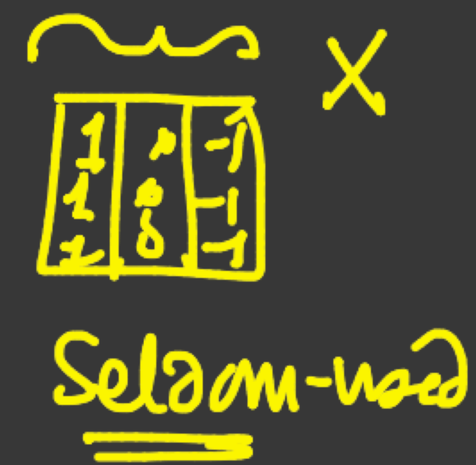
```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
_________________________________________________________________
```



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```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
_________________________________________________________________
```

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colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=r0qK_UFZfRpK
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128x128x3

```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )
```

(2x2)

```
 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
_________________________________________________________________
```

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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | 16*27 - Google Sea | MaxPooling2D layer
colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=r0qK_UFZfRpK
+ Code + Text Cannot save changes Connect

Images (Pixel)

```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
_________________________________________________________________
```

Dense

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Chrome File Edit View History Bookmarks Profiles Tab Window Help 10:17
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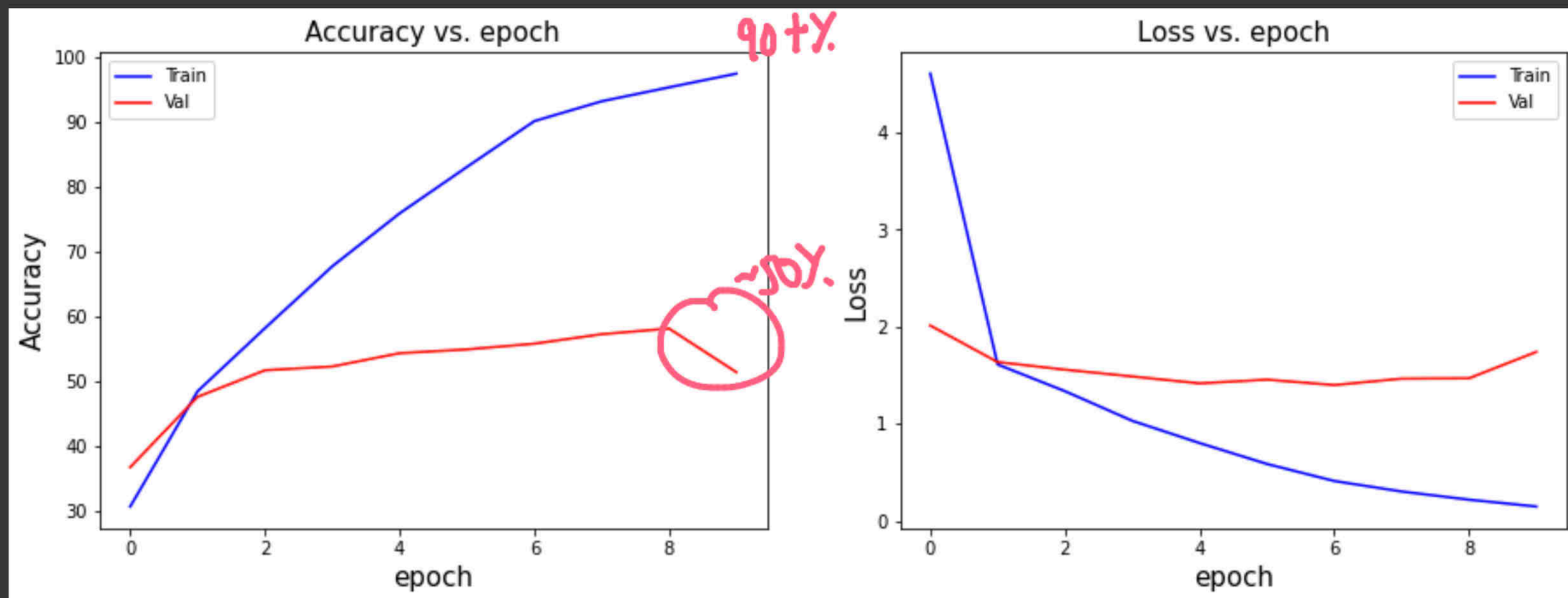
colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=HEjRmxNBd7bQ
+ Code + Text Cannot save changes Connect

```
#display the graph
plt.show()
```

36%. ~50%.



c. Evaluation on Test Dataset

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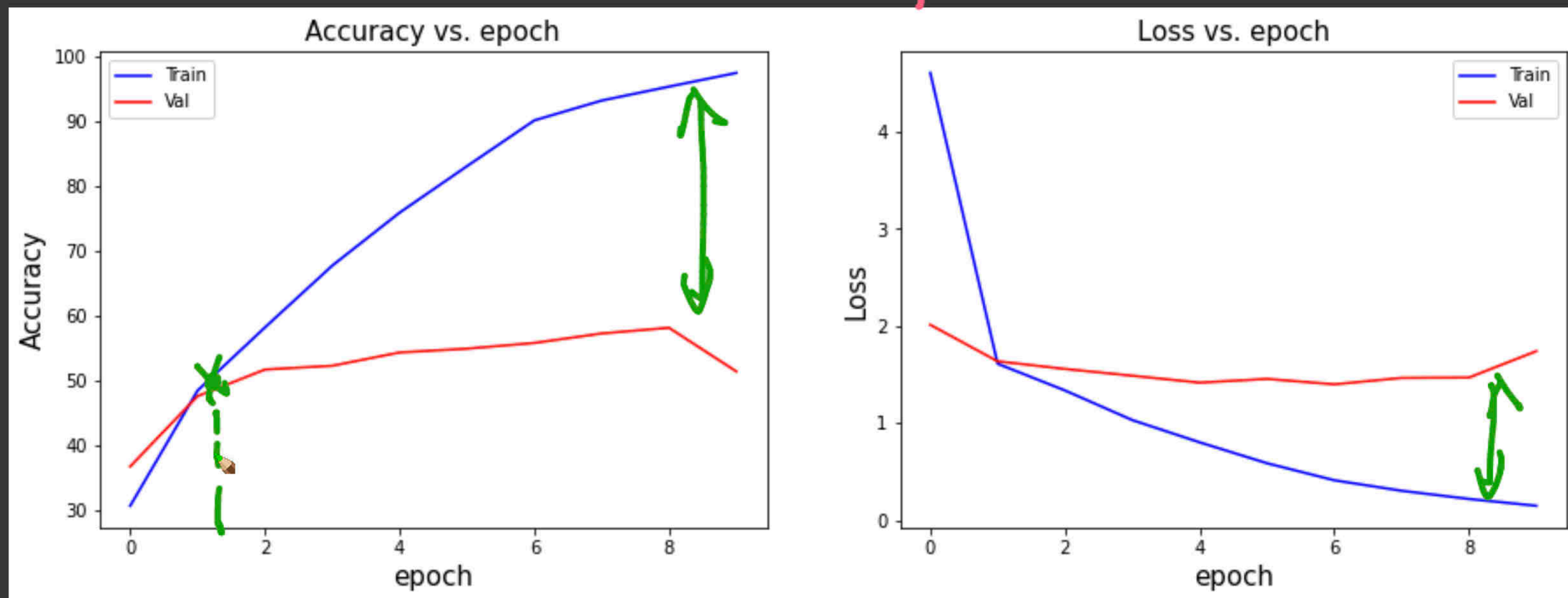
colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=HEjRmxNBd7bQ
+ Code + Text Cannot save changes Connect

```
plt.show()
```

simple-CNN



c. Evaluation on Test Dataset

Print Classification Report, Confusion Matrix and plot a few samples (with their probabilities)!

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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | 16*27 - Google Sea | MaxPooling2D layer

colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=C426sOJwydHC

+ Code + Text Changes will not be saved Connect

128 X128 X3

```
model = keras.Sequential(
    name="model_cnn_1",
    layers=[
        layers.Conv2D(filters=16, kernel_size=3, padding="same", activation='re
        layers.MaxPooling2D(),
        layers.Conv2D(filters=32, kernel_size=3, padding="same", activation='re
        layers.MaxPooling2D(),
        layers.Conv2D(filters=64, kernel_size=3, padding="same", activation='re
        layers.MaxPooling2D(),
        layers.Conv2D(filters=128, kernel_size=3, padding="same", activation='r
        layers.MaxPooling2D(),
        layers.Conv2D(filters=256, kernel_size=3, padding="same", activation='r
        # layers.MaxPooling2D(),
        # layers.Flatten(),
        layers.GlobalAveragePooling2D(),
        layers.Dense(units=hidden_size, activation='relu'),
        layers.Dense(units=num_classes, activation='softmax')
    ]
)
```

x(?)

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+ Code + Text Changes will not be saved Connect

```
model = keras.Sequential(
    name="model_cnn_1",
    layers=[
        layers.Conv2D(filters=16, kernel_size=3, padding="same", activation='re
        layers.MaxPooling2D(),
        layers.Conv2D(filters=32, kernel_size=3, padding="same", activation='re
        layers.MaxPooling2D(),
        layers.Conv2D(filters=64, kernel_size=3, padding="same", activation='re
        layers.MaxPooling2D(),
        layers.Conv2D(filters=128, kernel_size=3, padding="same", activation='r
        layers.MaxPooling2D(),
        layers.Conv2D(filters=256, kernel_size=3, padding="same", activation='r
        # layers.MaxPooling2D(),
        # layers.Flatten(),
        layers.GlobalAveragePooling2D(),
        layers.Dense(units=hidden_size, activation='relu'),
        layers.Dense(units=num_classes, activation='softmax')
    ]
)
```

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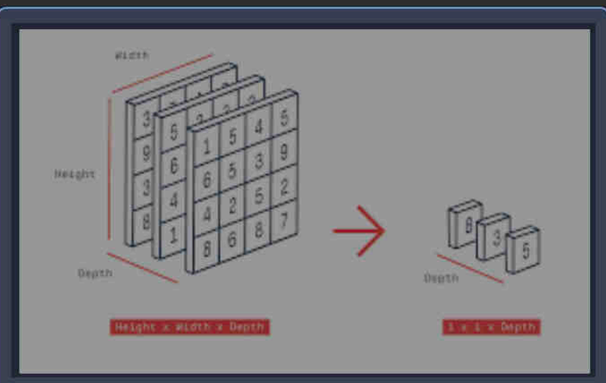
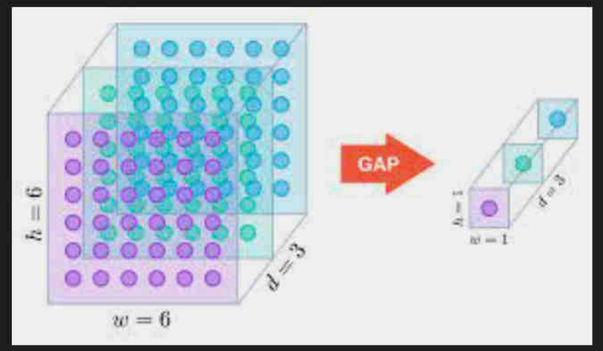
L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | global average pool

google.com/search?q=global+average+pooling&rlz=1C5CHFA_enIN958IN958&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj90b7b-bf6AhVBRmwGHYI...

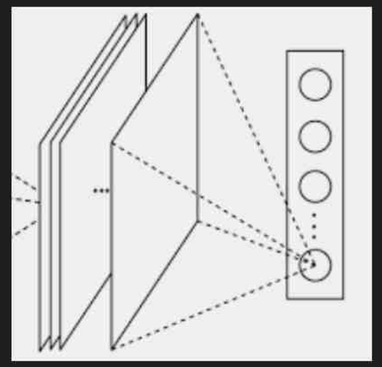
Google global average pooling



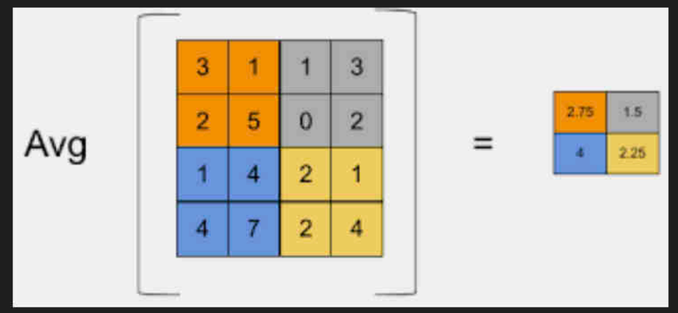
2D Global average pooling | Peltarion ...
peltarion.com



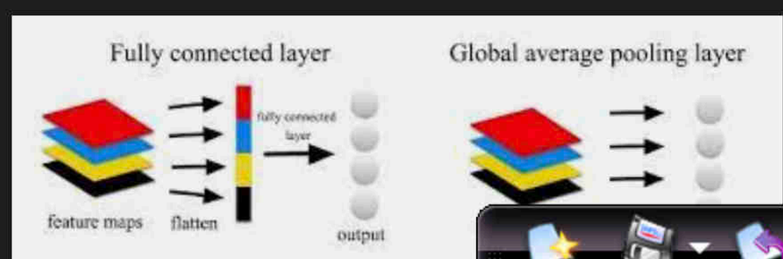
Global Average Pooling Layers for ...
alexisbcook.github.io

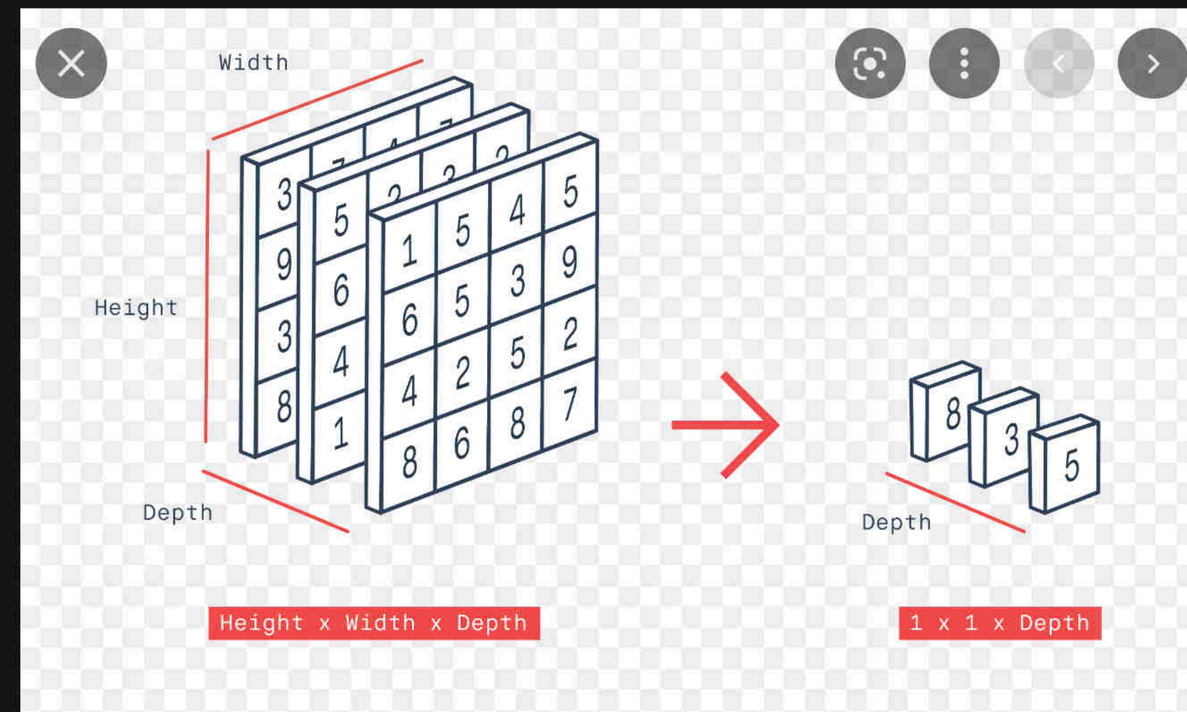


Global Average Pooling Explained ...
paperswithcode.com



Explain Pooling layers: Max Pooling ...
androidkt.com





Peltarion

2D Global average pooling | Peltarion Platform

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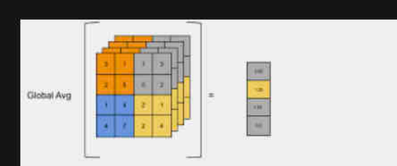
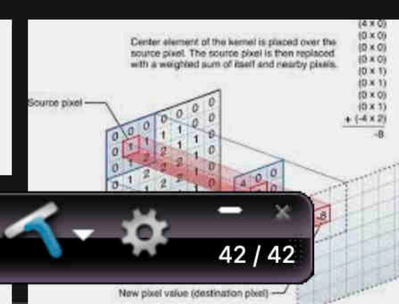
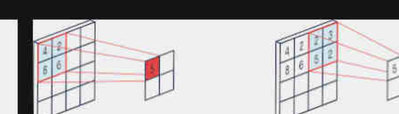
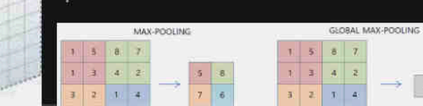






2D Average pooling block | Pelta...
peltarion.com



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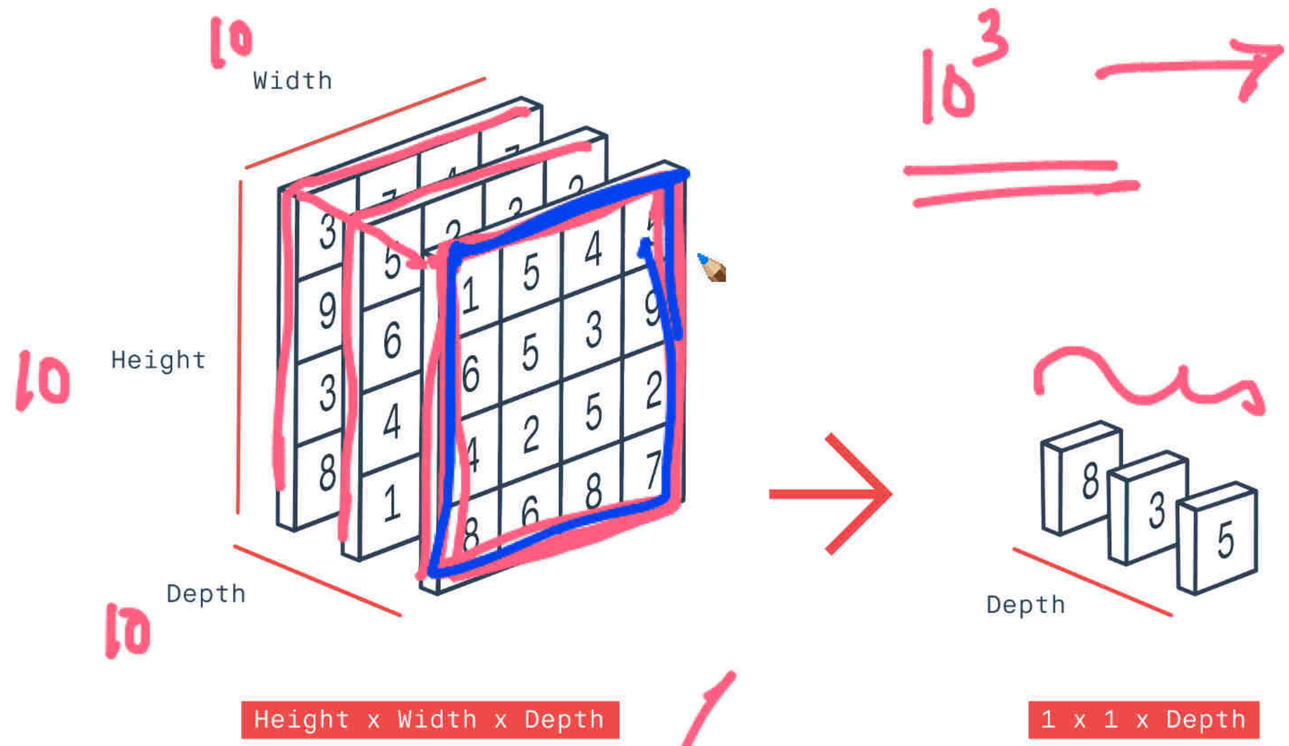
peltarion.com/knowledge-center/modeling-view/build-an-ai-model/blocks/global-average-pooling-2d
Platform closure - 30 September 2022 For questions on this please refer to the Peltarion Community. Read more

Universal sentence encoder
XLM-R Encoder
Input
Target
Output
Dense
Activation
Scaling
Dropout
Batch normalization
Random transformation
Random crop
2D Convolution
2D Deconvolution block
2D Depthwise convolution
Max pooling 2D
2D Average pooling

The output is thus a 1-dimensional tensor of size (input channels). Flatten

$10^3 \rightarrow 128$



128 dense

Figure 1. 2D Global average pooling operation. Here 'Depth' = 'Filters'

Input
Output
When to use global average pooling

128,000 +128

3x128 +128

When to use global average pooling

Use global average pooling blocks as an alternative to the Flattening block after the last pooling block of your convolutional neural network. Using 2D Global average pooling block can replace the fully connected

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+ Code + Text Changes will not be saved Connect

128 x 128 x 3

```
Model: "model_cnn_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_1 (Conv2D)           (None, 128, 128, 16)      448

 max_pooling2d_1 (MaxPooling  (None, 64, 64, 16)       0
 2D)

 conv2d_2 (Conv2D)           (None, 64, 64, 32)        4640

 max_pooling2d_2 (MaxPooling  (None, 32, 32, 32)       0
 2D)

 conv2d_3 (Conv2D)           (None, 32, 32, 64)        18496

 max_pooling2d_3 (MaxPooling  (None, 16, 16, 64)       0
 2D)

 conv2d_4 (Conv2D)           (None, 16, 16, 128)       73856

 max_pooling2d_4 (MaxPooling  (None, 8, 8, 128)        0
```

2x2

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+ Code + Text Changes will not be saved Connect

128 X 128 X 3

```
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_1 (Conv2D)           (None, 128, 128, 16)      448

 max_pooling2d_1 (MaxPooling  (None, 64, 64, 16)       0
 2D)
```

2X2

```
 conv2d_2 (Conv2D)           (None, 64, 64, 32)        4640

 max_pooling2d_2 (MaxPooling  (None, 32, 32, 32)       0
 2D)

 conv2d_3 (Conv2D)           (None, 32, 32, 64)        18496

 max_pooling2d_3 (MaxPooling  (None, 16, 16, 64)       0
 2D)

 conv2d_4 (Conv2D)           (None, 16, 16, 128)       73856

 max_pooling2d_4 (MaxPooling  (None, 8, 8, 128)        0
 2D)
```

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```
max_pooling2d_2 (MaxPooling  (None, 32, 32, 32)        0
2D)

conv2d_3 (Conv2D)            (None, 32, 32, 64)        18496

max_pooling2d_3 (MaxPooling  (None, 16, 16, 64)        0
2D)

conv2d_4 (Conv2D)            (None, 16, 16, 128)       73856

max_pooling2d_4 (MaxPooling  (None, 8, 8, 128)         0
2D)

conv2d_5 (Conv2D)            (None, 8, 8, 256)         295168

global_average_pooling2d (G  (None, 256)               0
lobalAveragePooling2D)

dense_2 (Dense)              (None, 256)               65792

dense_3 (Dense)              (None, 10)                2570

=================================================================
```

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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average
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+ Code + Text Changes will not be saved Connect

```
max_pooling2d_2 (MaxPooling  (None, 32, 32, 32)        0
2D)

conv2d_3 (Conv2D)            (None, 32, 32, 64)        18496

max_pooling2d_3 (MaxPooling  (None, 16, 16, 64)        0
2D)

conv2d_4 (Conv2D)            (None, 16, 16, 128)       73856

max_pooling2d_4 (MaxPooling  (None, 8, 8, 128)         0
2D)

conv2d_5 (Conv2D)            (None, 8, 8, 256)         295168

global_average_pooling2d (G  (None, 256)               0
lobalAveragePooling2D)

dense_2 (Dense)              (None, 256)               65792

dense_3 (Dense)              (None, 10)                2570
```

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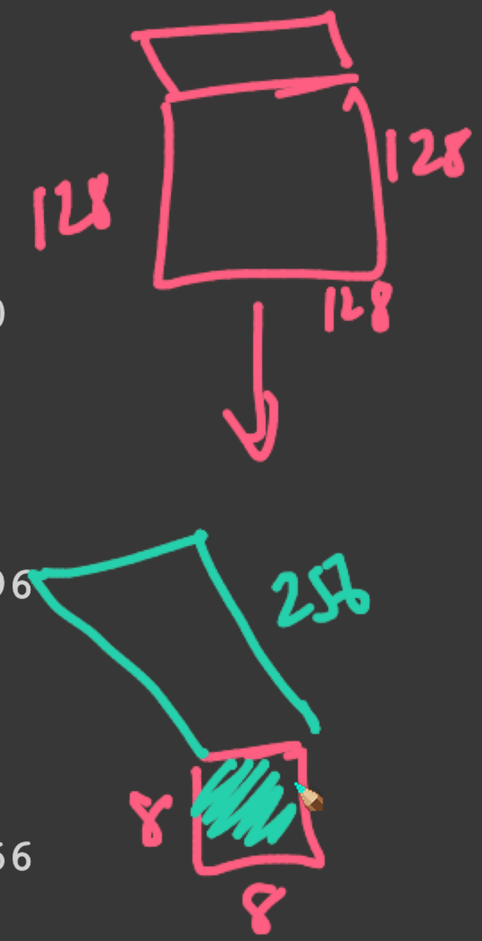
+ Code + Text Changes will not be saved Connect

128 x 128 x 3

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 128, 128, 16)      448

max_pooling2d_1 (MaxPooling  (None, 64, 64, 16)        0
2D)

conv2d_2 (Conv2D)            (None, 64, 64, 32)        4640

max_pooling2d_2 (MaxPooling  (None, 32, 32, 32)        0
2D)

conv2d_3 (Conv2D)            (None, 32, 32, 64)        18496

max_pooling2d_3 (MaxPooling  (None, 16, 16, 64)        0
2D)

conv2d_4 (Conv2D)            (None, 16, 16, 128)       73856

max_pooling2d_4 (MaxPooling  (None, 8, 8, 128)         0
2D)
```



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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average

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+ Code + Text Changes will not be saved Connect

```
 global_average_pooling2d (G   (None, 256)                0
 lobalAveragePooling2D)

 dense_2 (Dense)               (None, 256)                65792

 dense_3 (Dense)               (None, 10)                 2570

=================================================================
Total params: 460,970
Trainable params: 460,970
Non-trainable params: 0
_________________________________________________________________
```

460K

~50MM MLP → ~16MM SimpleCNN

```
[ ] def compile_train_v1(model, train_ds, val_ds, epochs=10, ckpt_path="/tmp/checkpoint
        model.compile(optimizer='adam',
                      loss='categorical_crossentropy',
                      metrics=['accuracy'])

        model_fit = model.fit(train_ds, validation_data=val_ds, epochs=epochs, callback
            keras.callbacks.ModelCheckpoint(ckpt_path, save_weights_only=True, monitor=
```

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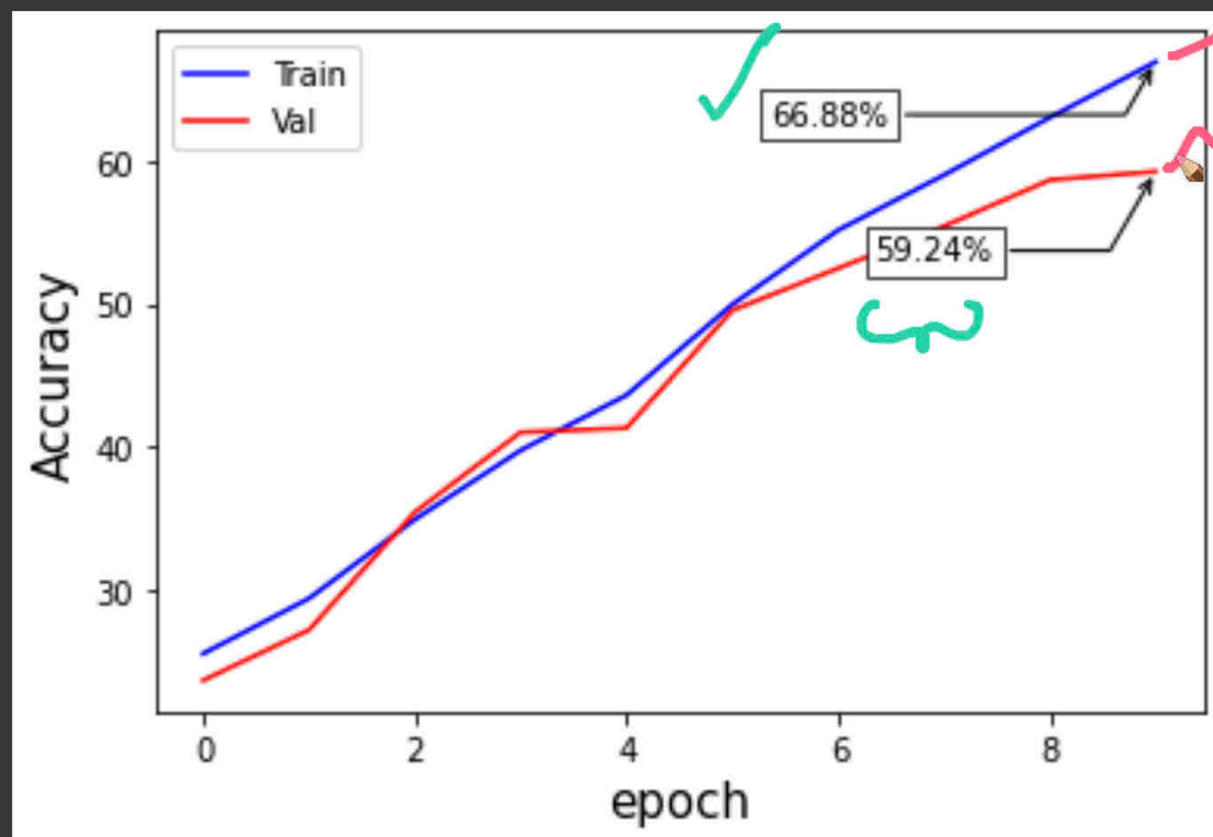
```
Epoch 10/10
96/96 [==============================] - 7s 67ms/step - loss: 0.9776 - accuracy: 0.6
```

```
[ ] plot_accuracy(model_fit)
```



(?)

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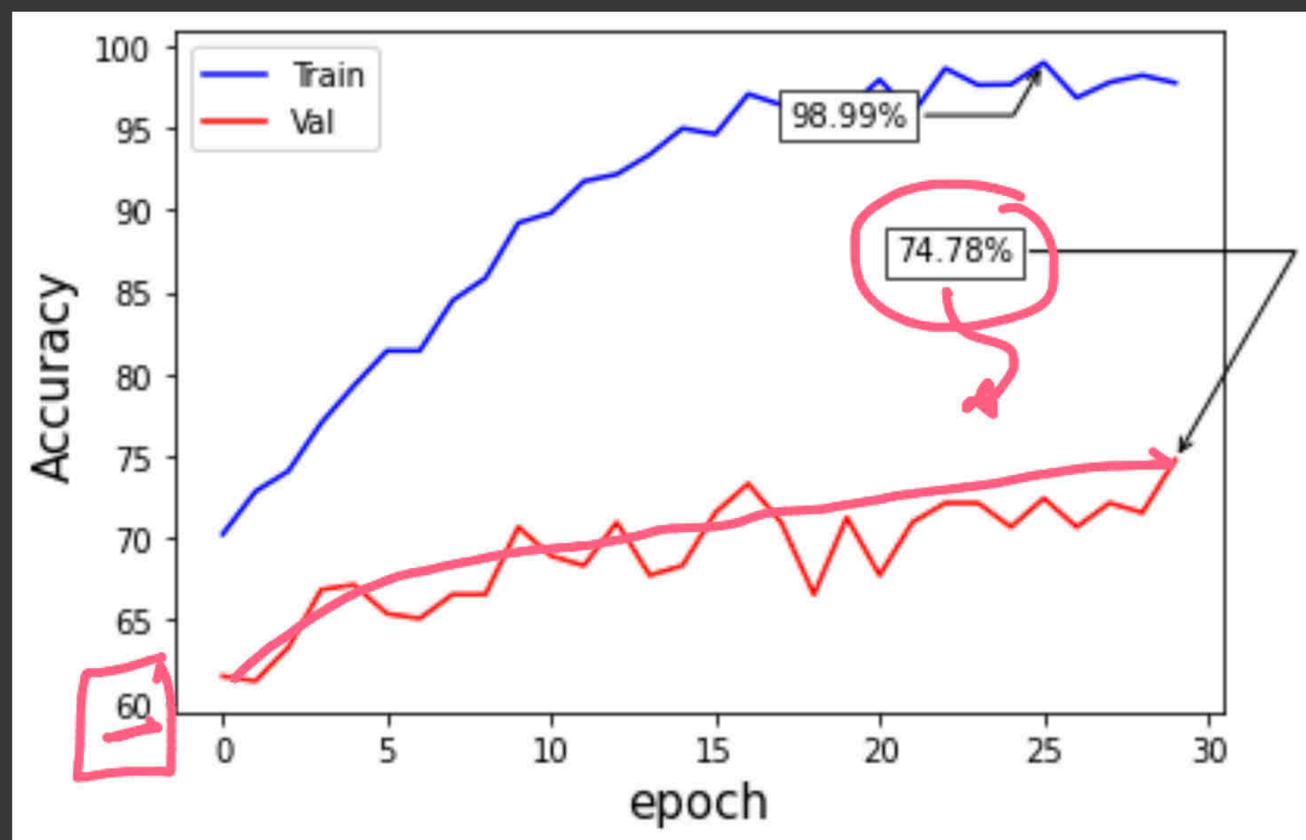
+ Code + Text Changes will not be saved Connect

```
Epoch 29/30
96/96 [==============================] - 7s 66ms/step - loss: 0.0536 - accuracy: 0.9
```

```
[ ] plot_accuracy(model_fit)
```



~36% → ~50%

~75%

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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average

colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=qw7E5484ydHC

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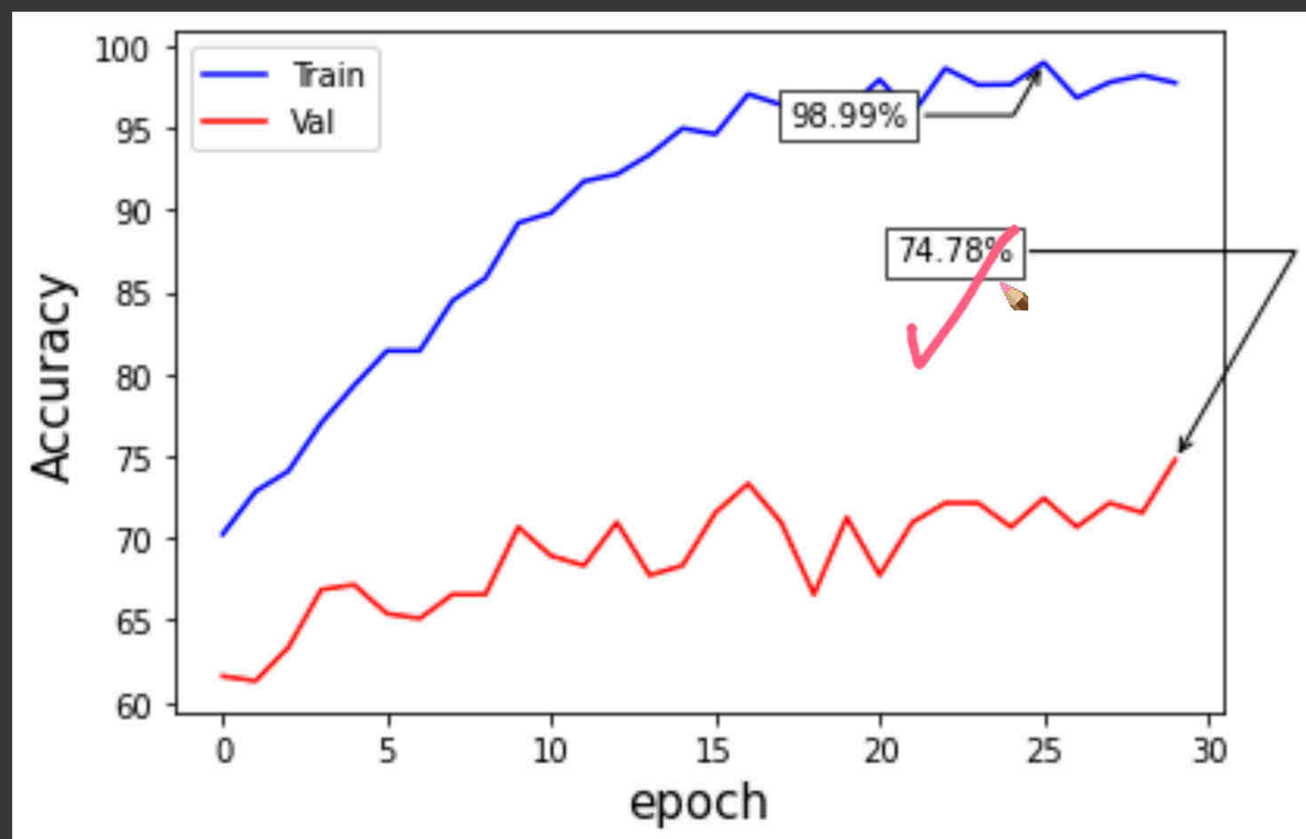
```
Epoch 29/30
96/96 [==============================] - 7s 66ms/step - loss: 0.0536 - accuracy: 0.9
```

```
[ ] plot_accuracy(model_fit)
```



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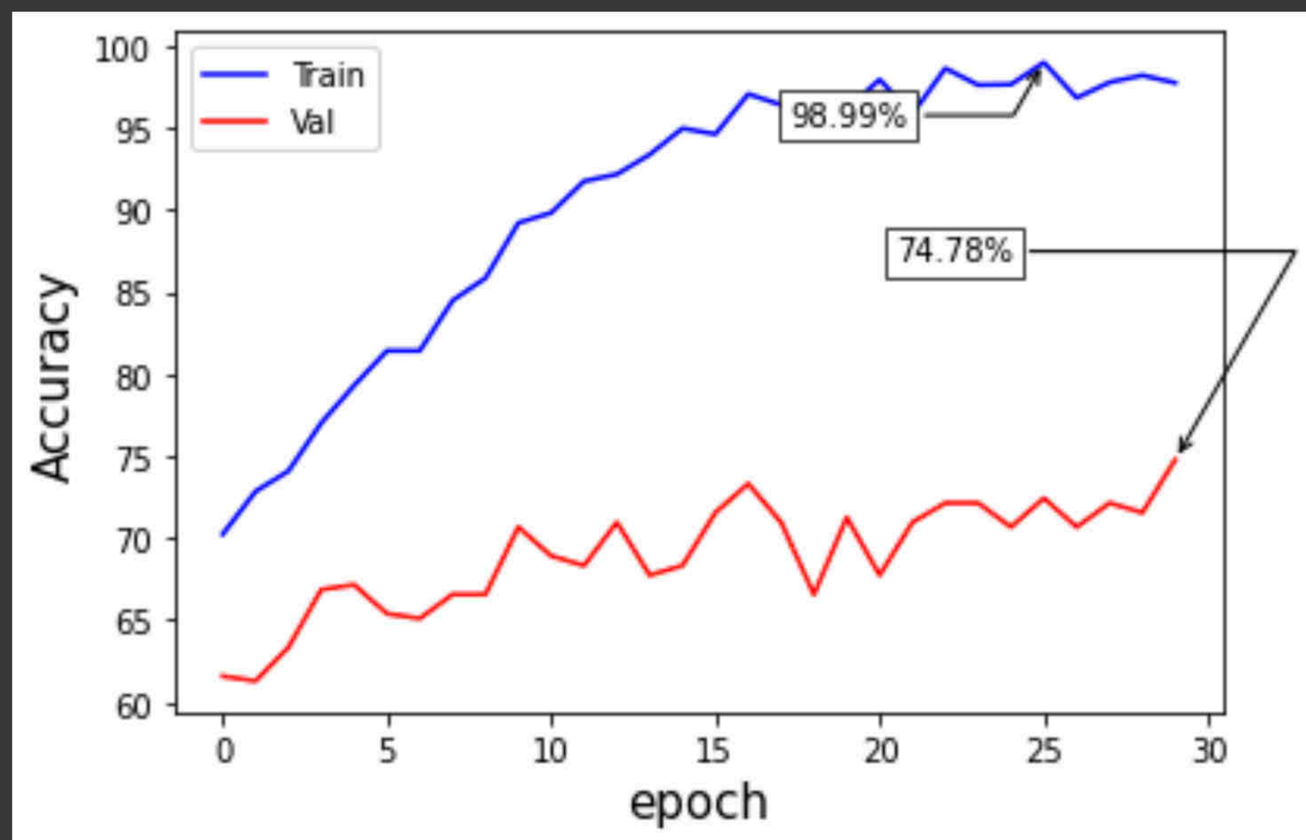
colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=qw7E5484ydHC
+ Code + Text Changes will not be saved Connect

```
Epoch 29/30
96/96 [==============================] - 7s 66ms/step - loss: 0.0536 - accuracy: 0.9
```

```
[ ] plot_accuracy(model_fit)
```



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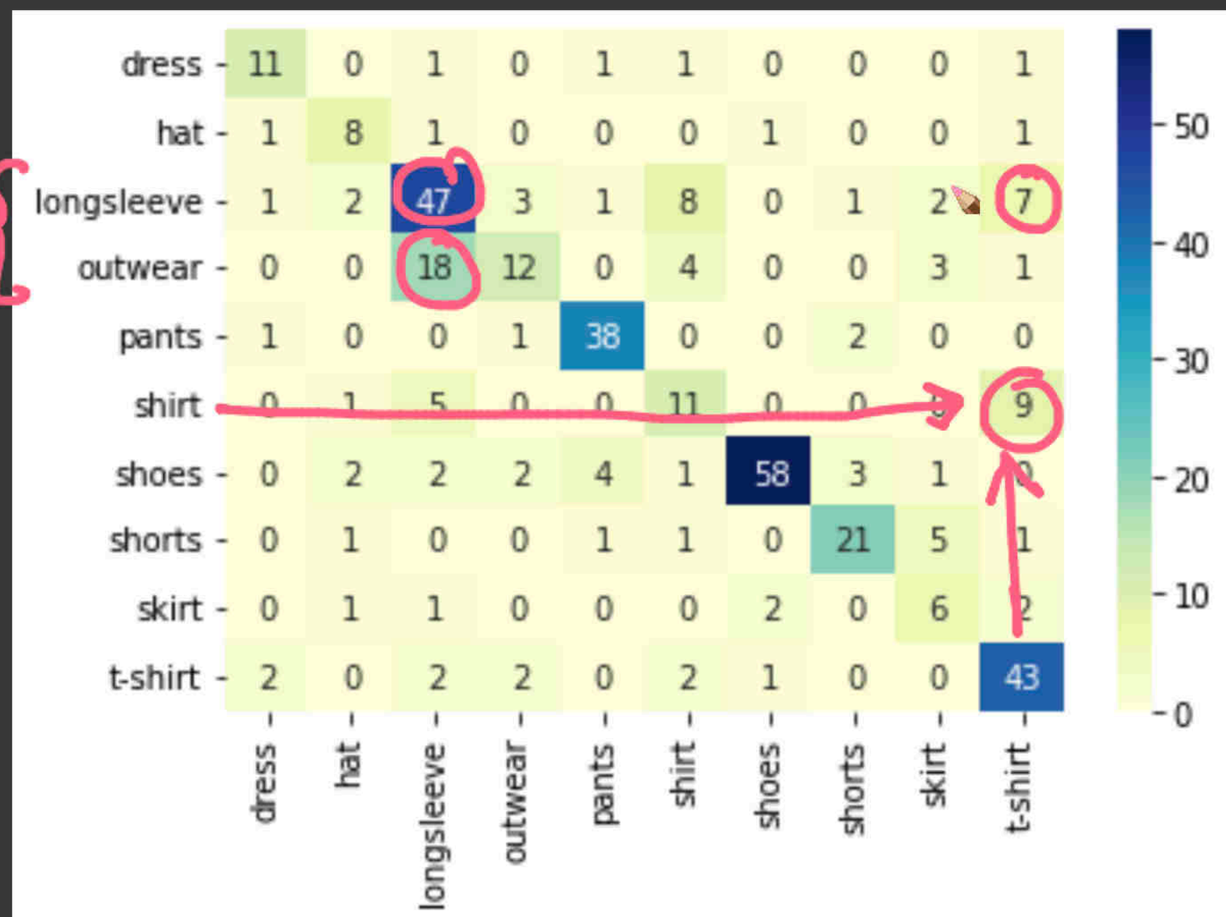
```
Test Accuracy: 68.55%
```



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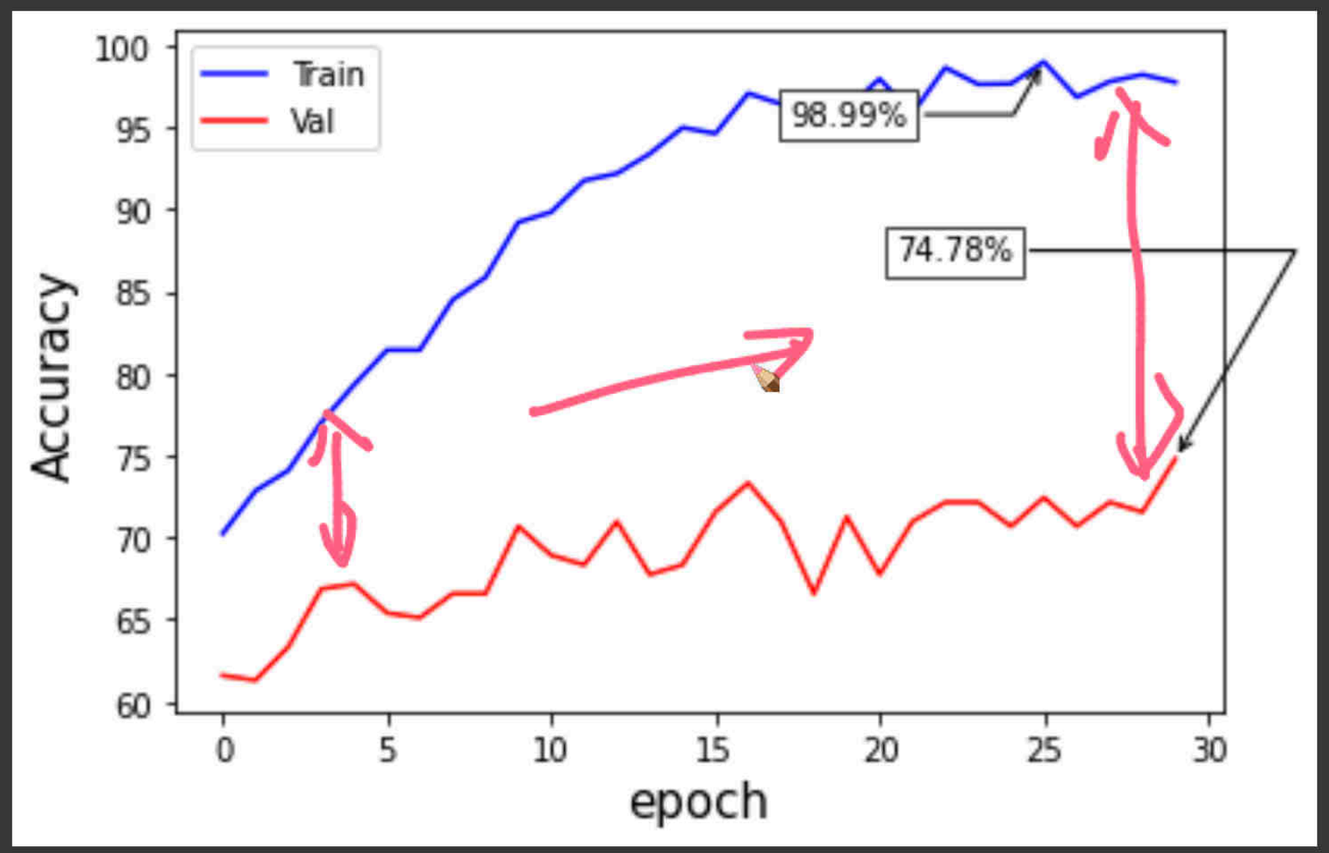
L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average
colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=iC-4mkFjydHD
+ Code + Text Changes will not be saved Connect

```
plot_accuracy(model_fit)
```




```
print_accuracy_stats(model, test_ds, class_names)
plot_confusion_matrix(model, test_ds, class_names)
```

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colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=cRJ929PHydHD
+ Code + Text Changes will not be saved Connect

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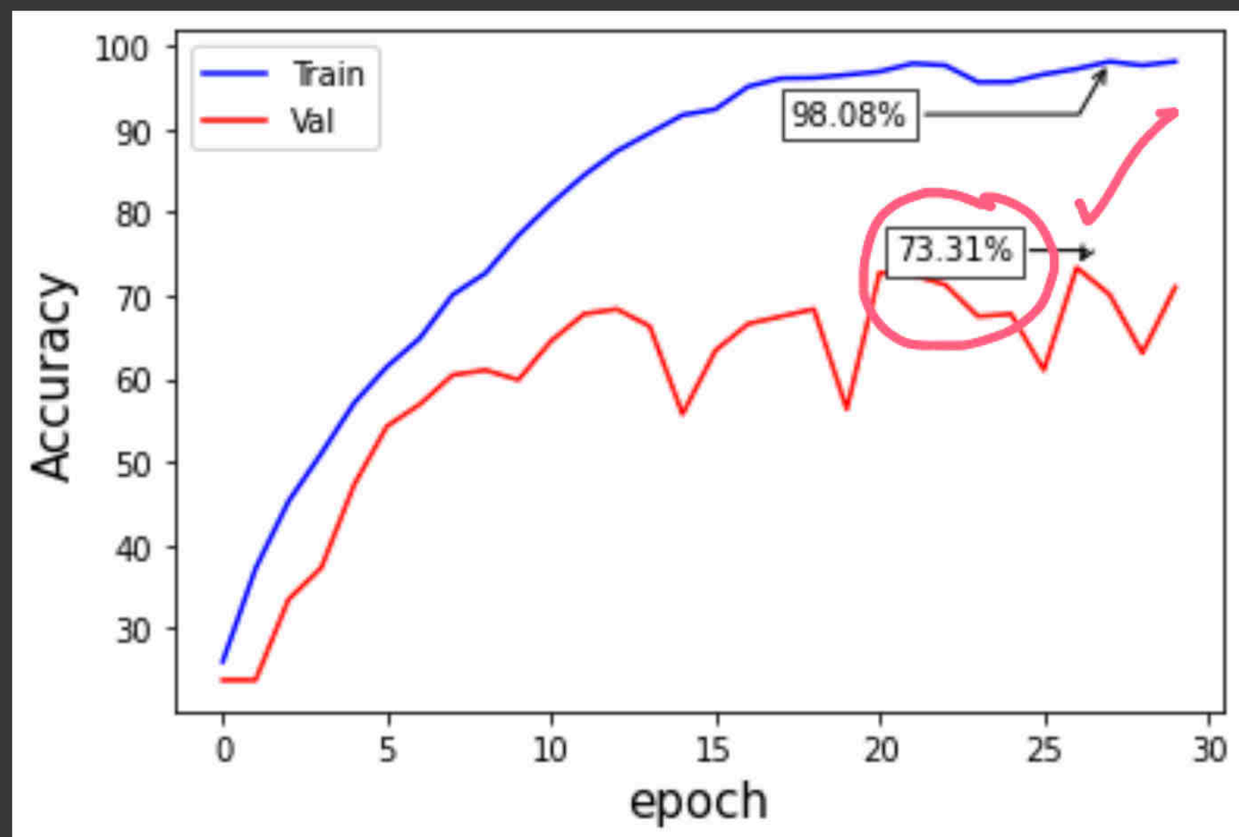
```



Pooling

WAIT, WAIT..SOMETHING AIN'T RIGHT HERE...

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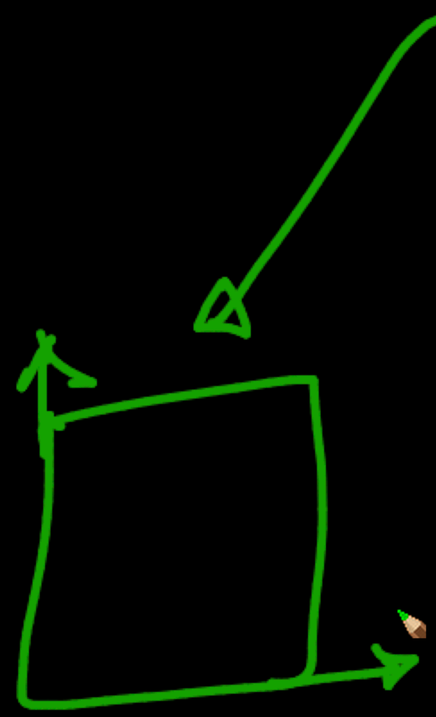
Q

Grid Search CV

brute force - like



Random Search CV

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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average
colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=S5IjrlpPydHE
+ Code + Text Changes will not be saved Connect

2. Modifications in Data Pipeline (Data Augmentation)

3000 → 30K

What is Augmentation?

- Augmentation is a technique to `artificially increase` the amount of data by generating new data points from `existing data`.

How can we increase the data from existing data?

- By making Minor changes such as `flips, translations,brigntness,coloring, rotations etc`.

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Preview File Edit View Go Tools Window Help 10:45

sample.jpg

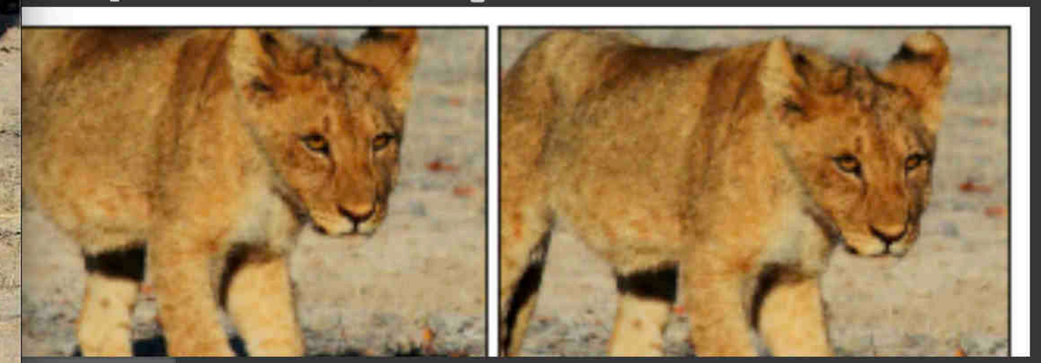
Amazon.in : t shirts | MaxPooling2D layer | 2D Global average

Connect

ickup-attachments.com/t3638486/a0a4f633-

==] - 0s 0us/step

===] - 0s 0us/step



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sample.jpg

Show all

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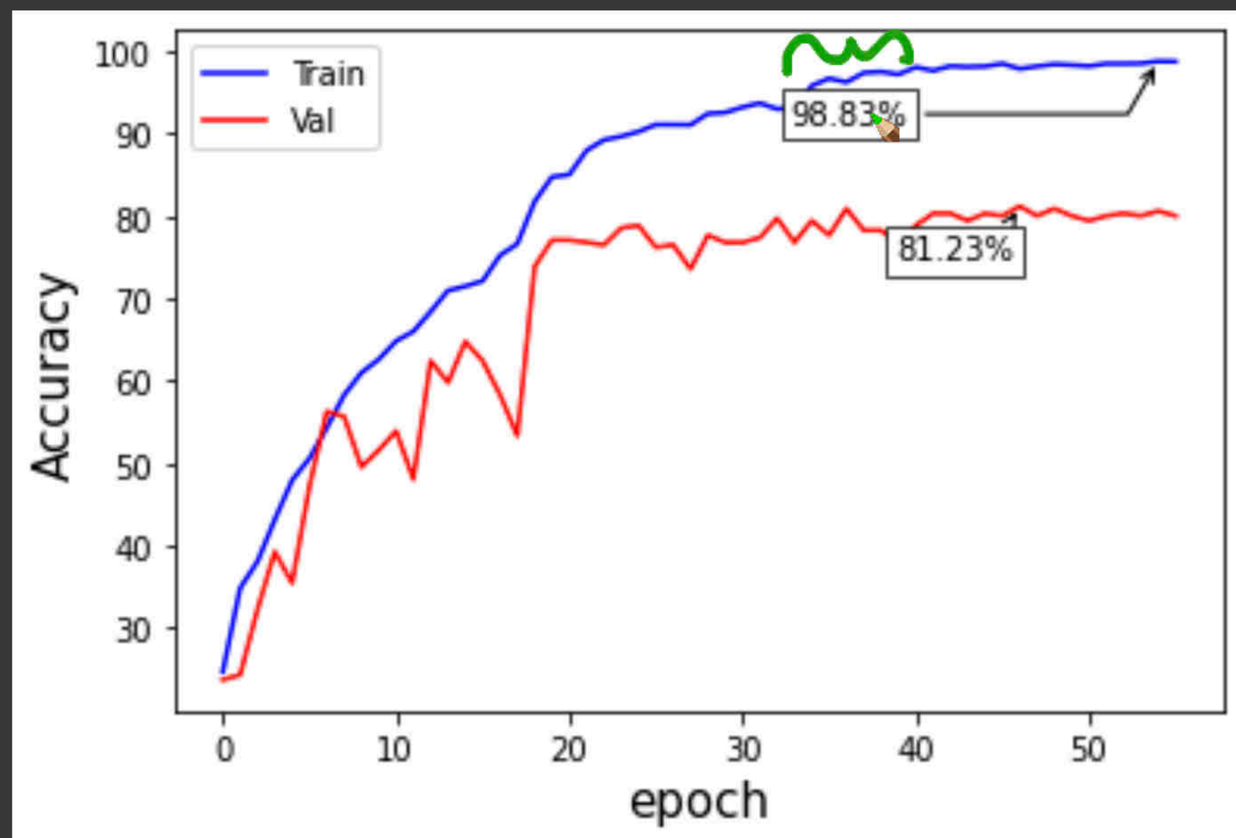
L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average
colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=m8o6FcWBydHF
+ Code + Text Changes will not be saved Connect

```
Epoch 29/100
96/96 [==============================] - 7s 70ms/step - loss: 0.6334 - accuracy: 0.9
```

```
[ ] plot_accuracy(model_fit)
```



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L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average
colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=m8o6FcWBydHF
+ Code + Text Changes will not be saved Connect

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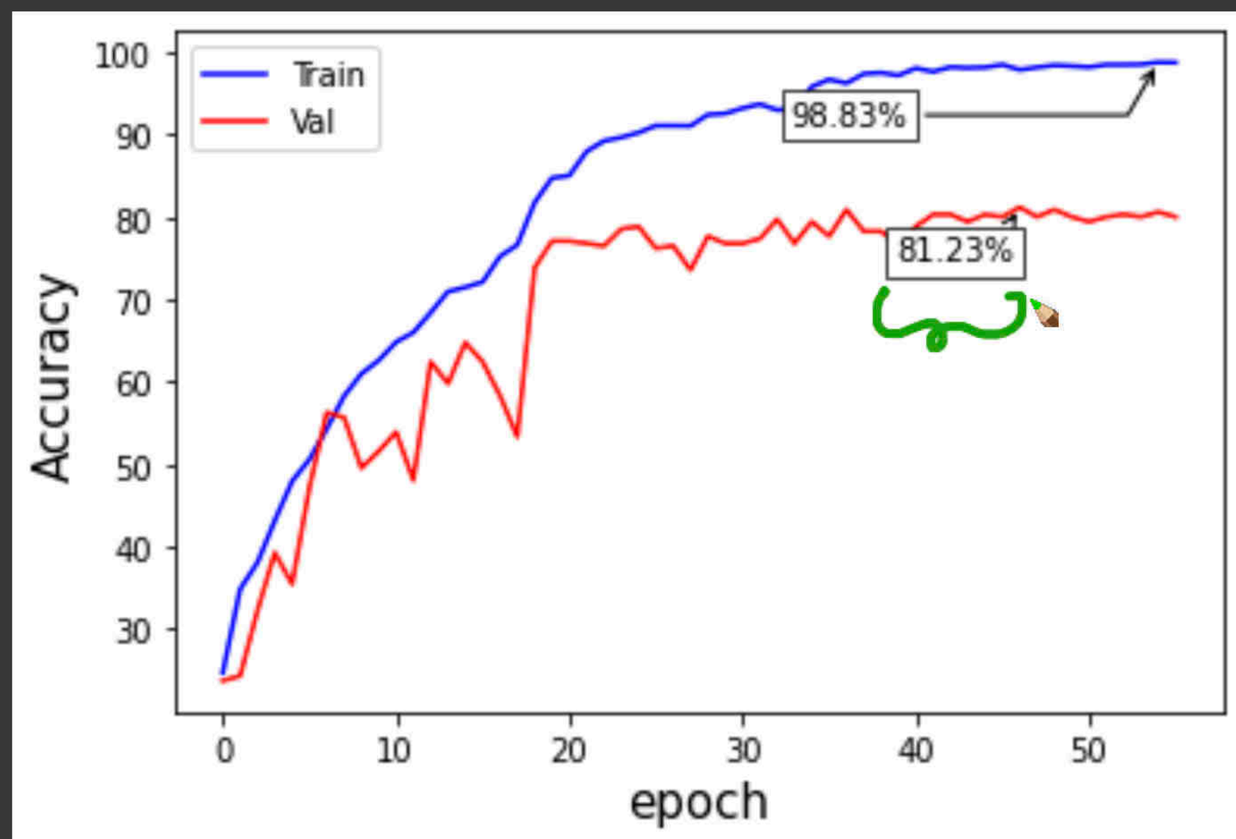

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Chrome File Edit View History Bookmarks Profiles Tab Window Help 10:51
L1 : Intro to Comput | GitHub - alexeygrig | L2 : Revisiting CNN | Conv2D layer | Amazon.in : t shirts | MaxPooling2D layer | 2D Global average
colab.research.google.com/drive/1ePCFjfU6puitK-tqX5ZJDPmFeXCj1RoG#scrollTo=m8o6FcWBydHF
+ Code + Text Changes will not be saved Connect

```
Epoch 29/100
96/96 [==============================] - 7s 70ms/step - loss: 0.6334 - accuracy: 0.9
```

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[ ] plot_accuracy(model_fit)
```
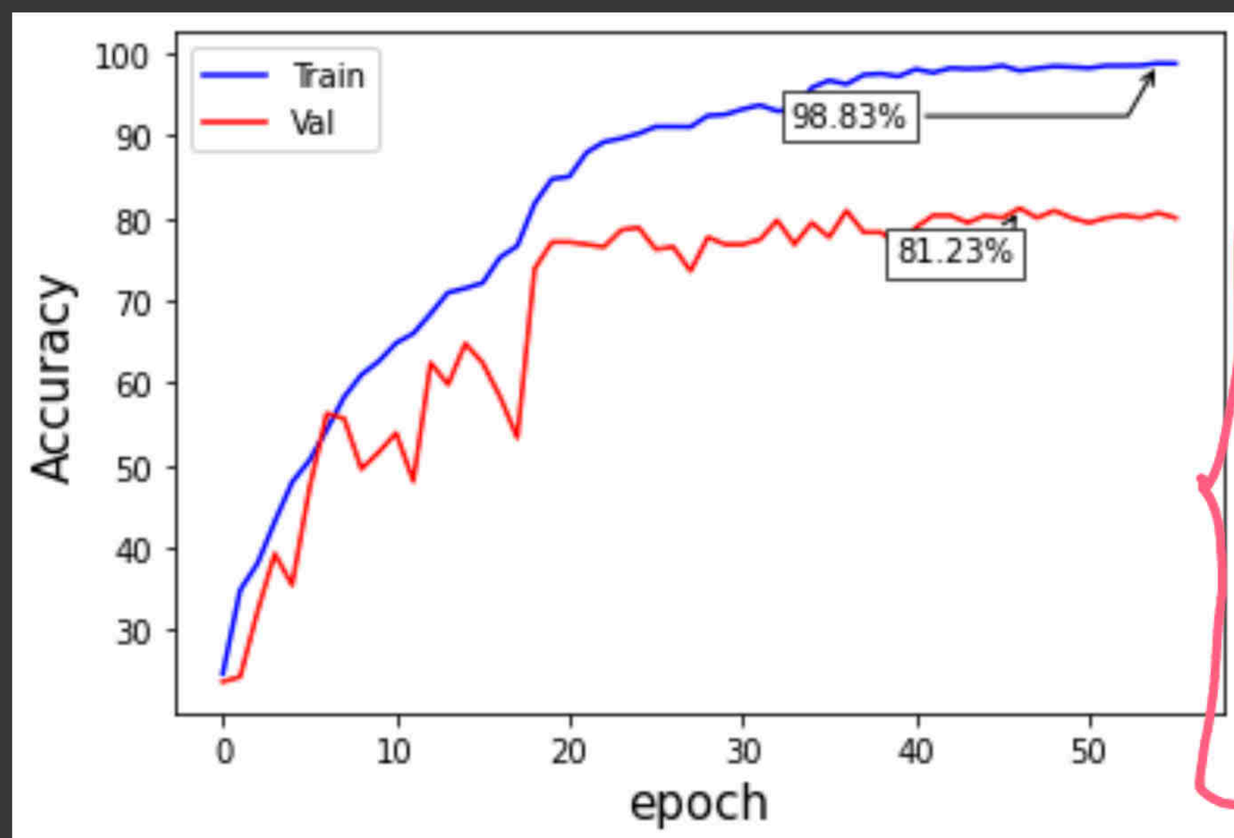

~50%



lols

→ Conv+Maxpoling

→ Global Avg poling

→ dropout + BatchNorm

→ 100 epochs

→ data aug

81.23%

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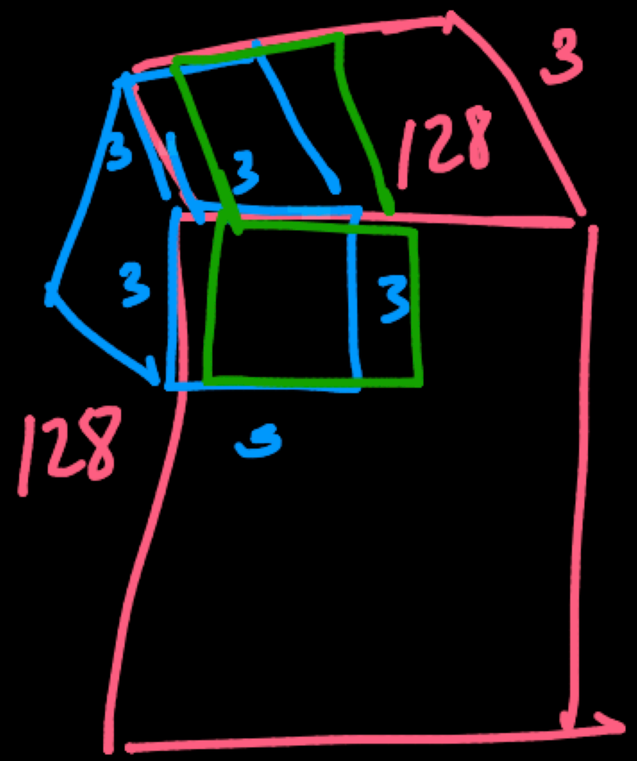

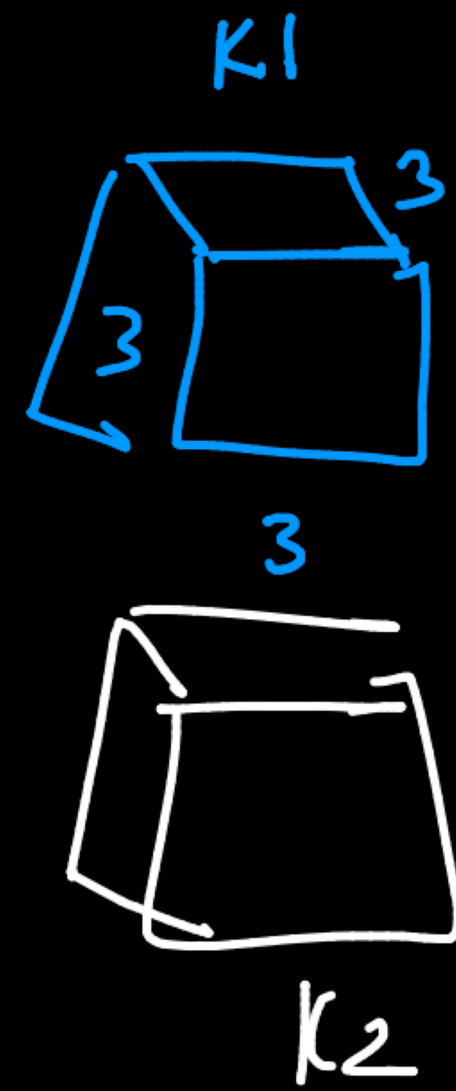

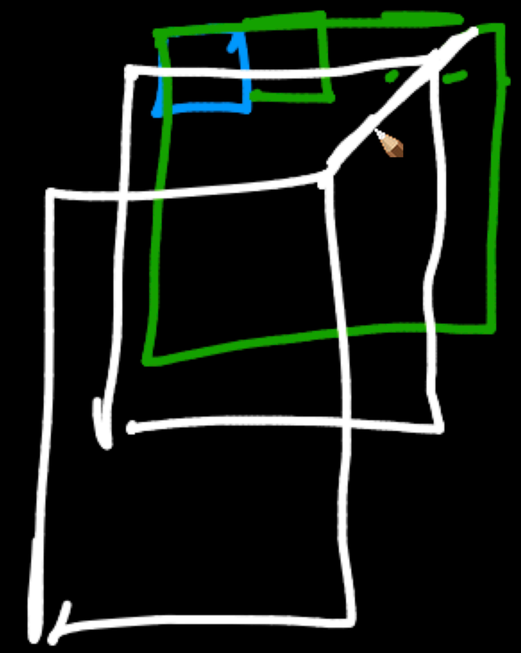

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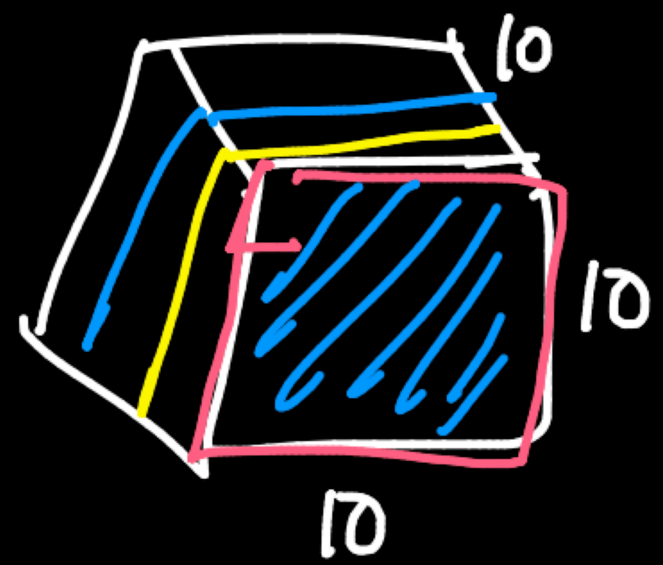
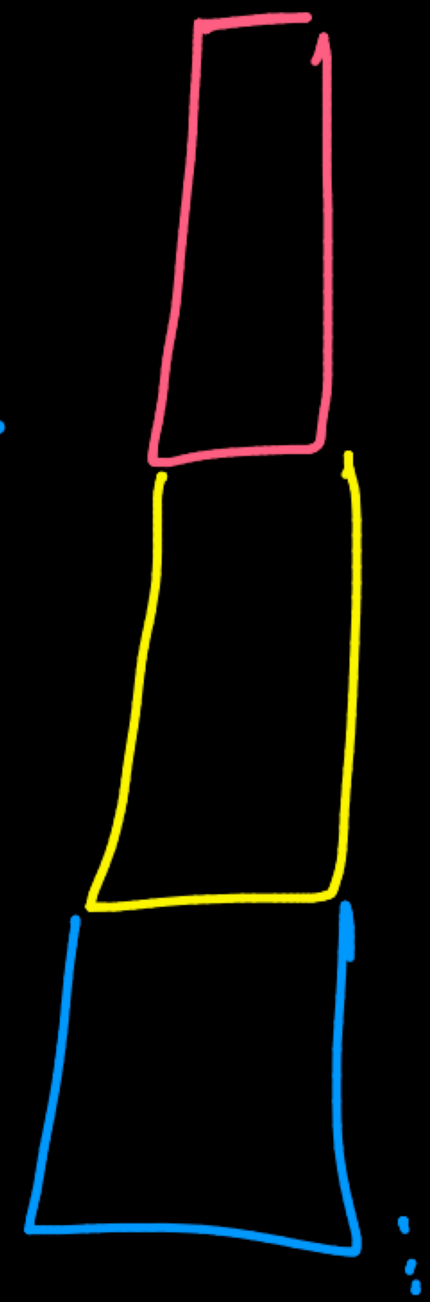
Q





GAP > flattening
(often)

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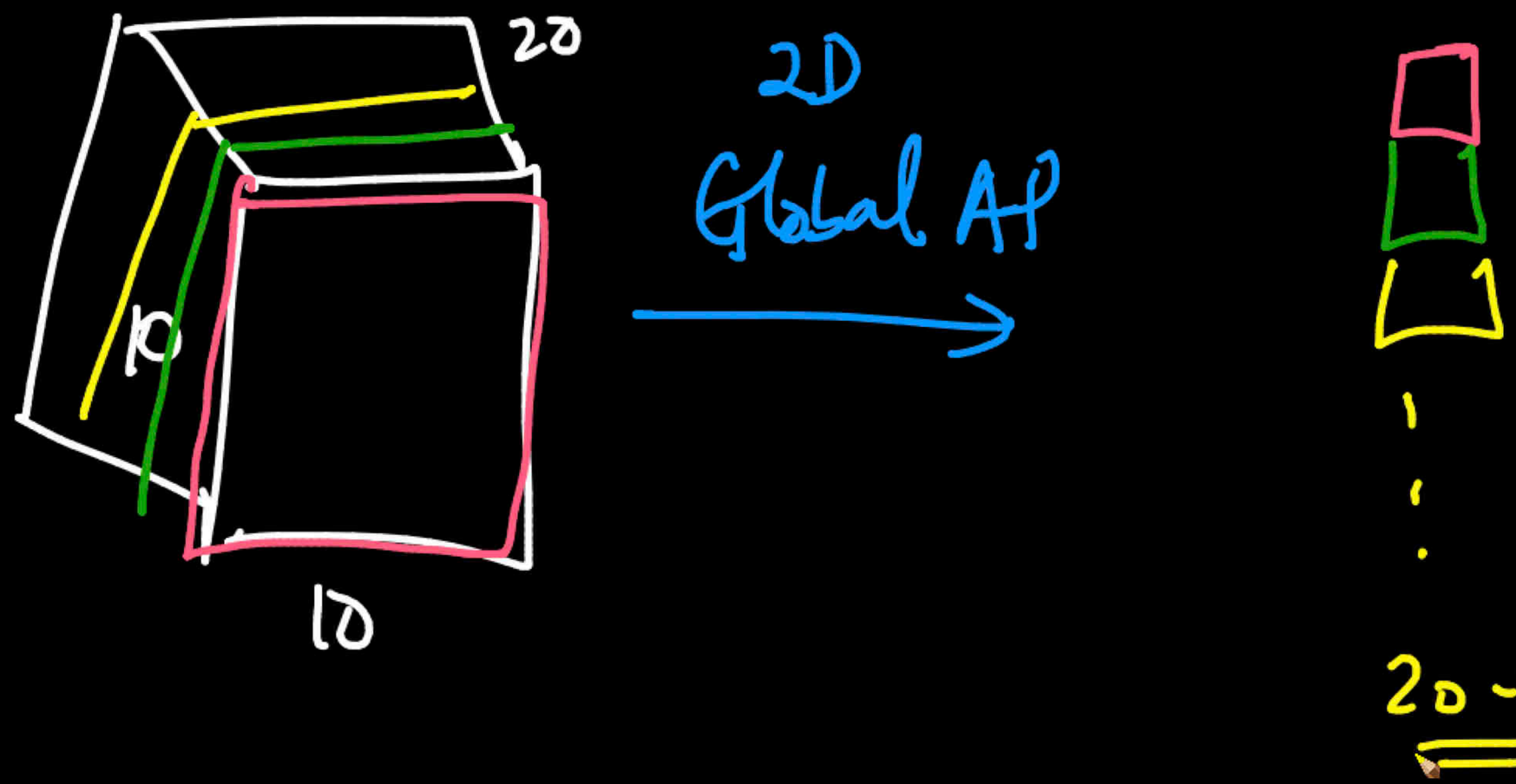

Chrome File Edit View History Bookmarks Profiles Tab Window Help
10:57
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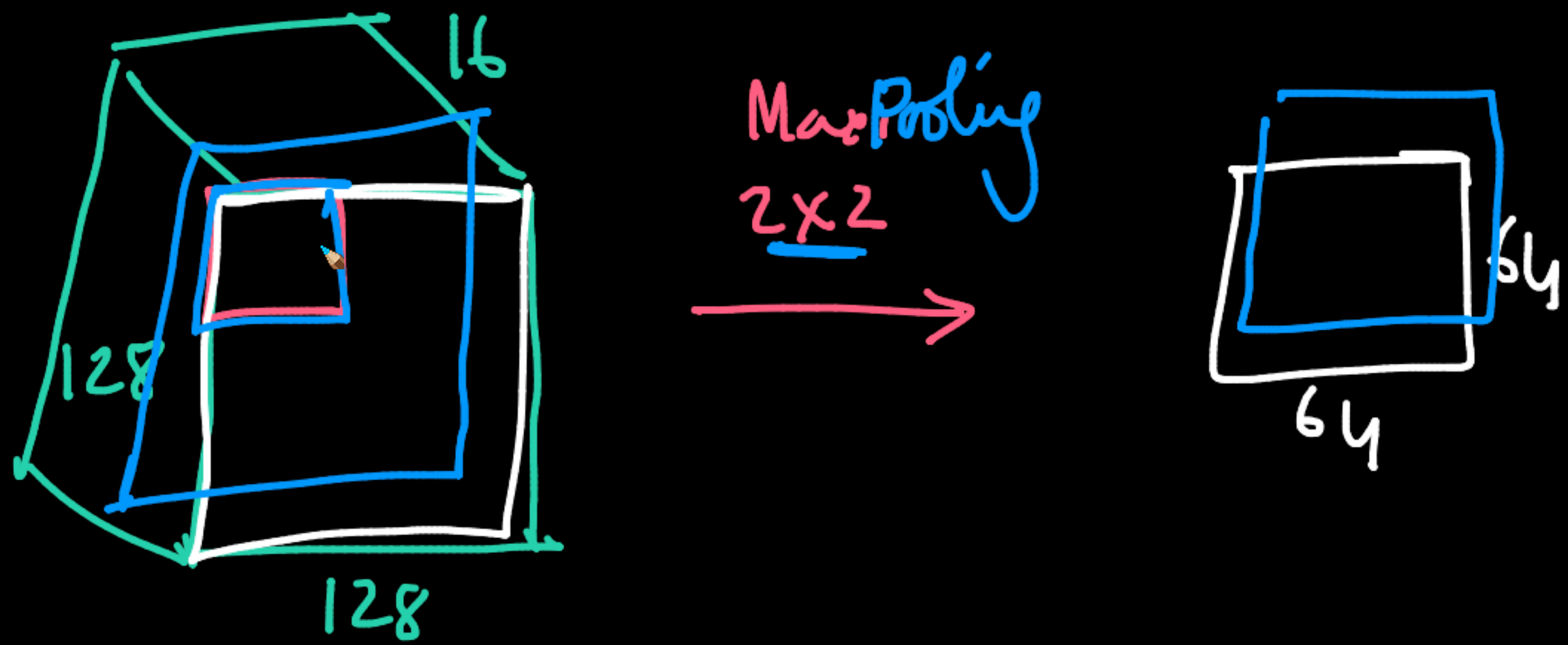
Q



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L1 : Intro to ComputerVis | GitHub - alexeygrigorev/ | L2 : Revisiting CNN Deal | Conv2D layer | MaxPooling2D layer | 2D Global average poolir

colab.research.google.com/drive/1kTOlDTKBF40RMxjCPauCgMkq_OHE8xoS#scrollTo=-MgJ9MCnfWe9

+ Code + Text Cannot save changes Connect

```
model.summary()
```

```
Model: "model_cnn"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 128, 128, 16)      448

 max_pooling2d (MaxPooling2D  (None, 64, 64, 16)       0
 )

 flatten_2 (Flatten)         (None, 65536)             0

 dense_3 (Dense)             (None, 256)               16777472

 dense_4 (Dense)             (None, 10)                2570

=================================================================
Total params: 16,780,490
Trainable params: 16,780,490
Non-trainable params: 0
```

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