**Model 1 Summary:**

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Layer (type) Output Shape Param #

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conv3d\_33 (Conv3D) (None, 30, 120, 120, 8) 656

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batch\_normalization\_25 (Batc (None, 30, 120, 120, 8) 32

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activation\_33 (Activation) (None, 30, 120, 120, 8) 0

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max\_pooling3d\_33 (MaxPooling (None, 15, 60, 60, 8) 0

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conv3d\_34 (Conv3D) (None, 15, 60, 60, 16) 3472

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batch\_normalization\_26 (Batc (None, 15, 60, 60, 16) 64

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activation\_34 (Activation) (None, 15, 60, 60, 16) 0

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max\_pooling3d\_34 (MaxPooling (None, 7, 30, 30, 16) 0

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conv3d\_35 (Conv3D) (None, 7, 30, 30, 32) 4640

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batch\_normalization\_27 (Batc (None, 7, 30, 30, 32) 128

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activation\_35 (Activation) (None, 7, 30, 30, 32) 0

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max\_pooling3d\_35 (MaxPooling (None, 3, 15, 15, 32) 0

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conv3d\_36 (Conv3D) (None, 3, 15, 15, 64) 18496

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activation\_36 (Activation) (None, 3, 15, 15, 64) 0

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dropout\_21 (Dropout) (None, 3, 15, 15, 64) 0

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max\_pooling3d\_36 (MaxPooling (None, 1, 7, 7, 64) 0

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flatten\_7 (Flatten) (None, 3136) 0

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dense\_19 (Dense) (None, 256) 803072

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dropout\_22 (Dropout) (None, 256) 0

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dense\_20 (Dense) (None, 128) 32896

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dropout\_23 (Dropout) (None, 128) 0

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dense\_21 (Dense) (None, 5) 645

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Total params: 864,101

Trainable params: 863,989

Non-trainable params: 112

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Input and Output layers:

- One Input layer with dimensions 30, 120, 120, 3

- Output layer with dimensions 5

**Convolutions :**

- Apply 4 Convolutional layer with increasing order of filter size (standard size : 8, 16, 32, 64) and fixed kernel size = (3, 3, 3)

- Apply 2 Max Pooling layers, one after 2nd convolutional layer and one after fourth convolutional layer.

**Model 2 Summary :**

**# epochs = 10**

**# training sequences = 663**

**# validation sequences = 100**

**# batch size = 90**

**# epochs = 10**

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Layer (type) Output Shape Param #

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conv3d\_1 (Conv3D) (None, 18, 118, 118, 8) 656

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max\_pooling3d\_1 (MaxPooling3 (None, 18, 59, 59, 8) 0

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conv3d\_2 (Conv3D) (None, 16, 57, 57, 16) 3472

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max\_pooling3d\_2 (MaxPooling3 (None, 16, 28, 28, 16) 0

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conv3d\_3 (Conv3D) (None, 14, 26, 26, 32) 13856

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conv3d\_4 (Conv3D) (None, 12, 24, 24, 32) 27680

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max\_pooling3d\_3 (MaxPooling3 (None, 12, 12, 12, 32) 0

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conv3d\_5 (Conv3D) (None, 11, 11, 11, 64) 16448

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conv3d\_6 (Conv3D) (None, 10, 10, 10, 64) 32832

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max\_pooling3d\_4 (MaxPooling3 (None, 10, 5, 5, 64) 0

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flatten\_1 (Flatten) (None, 16000) 0

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dense\_1 (Dense) (None, 512) 8192512

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dropout\_1 (Dropout) (None, 512) 0

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dense\_2 (Dense) (None, 256) 131328

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dropout\_2 (Dropout) (None, 256) 0

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dense\_3 (Dense) (None, 5) 1285

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Total params: 8,420,069

Trainable params: 8,420,069

Non-trainable params: 0

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- One Input layer with dimensions 20, 120, 120, 3

- Output layer with dimensions 5

**Convolutions :**

- Apply 4 Convolutional layer with increasing order of filter size (standard size : 8, 16, 32, 64) and fixed kernel size = (3, 3, 3)

- Apply 2 Max Pooling layers, one after 2nd convolutional layer and one after fourth convolutional layer

**Model 3 Summary:**

**# training sequences = 663**

**# validation sequences = 100**

**# batch size = 50**

**# epochs = 25**

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Layer (type) Output Shape Param #

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conv3d\_1 (Conv3D) (None, 20, 120, 120, 16) 1312

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activation\_1 (Activation) (None, 20, 120, 120, 16) 0

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conv3d\_2 (Conv3D) (None, 20, 120, 120, 16) 6928

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activation\_2 (Activation) (None, 20, 120, 120, 16) 0

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max\_pooling3d\_1 (MaxPooling3 (None, 7, 40, 40, 16) 0

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dropout\_1 (Dropout) (None, 7, 40, 40, 16) 0

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conv3d\_3 (Conv3D) (None, 7, 40, 40, 32) 13856

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activation\_3 (Activation) (None, 7, 40, 40, 32) 0

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conv3d\_4 (Conv3D) (None, 7, 40, 40, 32) 27680

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activation\_4 (Activation) (None, 7, 40, 40, 32) 0

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max\_pooling3d\_2 (MaxPooling3 (None, 3, 14, 14, 32) 0

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dropout\_2 (Dropout) (None, 3, 14, 14, 32) 0

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conv3d\_5 (Conv3D) (None, 3, 14, 14, 32) 27680

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activation\_5 (Activation) (None, 3, 14, 14, 32) 0

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conv3d\_6 (Conv3D) (None, 3, 14, 14, 32) 27680

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activation\_6 (Activation) (None, 3, 14, 14, 32) 0

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max\_pooling3d\_3 (MaxPooling3 (None, 1, 5, 5, 32) 0

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dropout\_3 (Dropout) (None, 1, 5, 5, 32) 0

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flatten\_1 (Flatten) (None, 800) 0

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dense\_1 (Dense) (None, 512) 410112

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batch\_normalization\_1 (Batch (None, 512) 2048

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dropout\_4 (Dropout) (None, 512) 0

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dense\_2 (Dense) (None, 5) 2565

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Total params: 519,861

Trainable params: 518,837

Non-trainable params: 1,024

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- One Input layer with dimensions 20, 120, 120, 3

- Output layer with dimensions 5

**Convolutions :**

- Apply 4 Convolutional layer with increasing order of filter size (standard size : 8, 16, 32, 64) and fixed kernel size = (3, 3, 3)

- Apply 2 Max Pooling layers, one after 2nd convolutional layer and one after fourth convolutional layer

**Model 4 Summary (CNN + LSTM)**

**# training sequences = 663**

**# validation sequences = 100**

**# batch size = 90**

**# epochs = 30**

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Layer (type) Output Shape Param #

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time\_distributed\_1 (TimeDist (None, 20, 60, 60, 16) 2368

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time\_distributed\_2 (TimeDist (None, 20, 58, 58, 16) 2320

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time\_distributed\_3 (TimeDist (None, 20, 29, 29, 16) 0

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time\_distributed\_4 (TimeDist (None, 20, 29, 29, 32) 4640

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time\_distributed\_5 (TimeDist (None, 20, 29, 29, 32) 9248

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time\_distributed\_6 (TimeDist (None, 20, 14, 14, 32) 0

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time\_distributed\_7 (TimeDist (None, 20, 14, 14, 64) 18496

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time\_distributed\_8 (TimeDist (None, 20, 14, 14, 64) 36928

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time\_distributed\_9 (TimeDist (None, 20, 7, 7, 64) 0

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time\_distributed\_10 (TimeDis (None, 20, 7, 7, 128) 73856

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time\_distributed\_11 (TimeDis (None, 20, 7, 7, 128) 147584

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time\_distributed\_12 (TimeDis (None, 20, 3, 3, 128) 0

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time\_distributed\_13 (TimeDis (None, 20, 1152) 0

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lstm\_1 (LSTM) (None, 256) 1442816

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dense\_1 (Dense) (None, 5) 1285

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Total params: 1,739,541

Trainable params: 1,739,541

Non-trainable params: 0

- One Input layer with dimensions 20, 120, 120, 3

- Output layer with dimensions 5

**Convolutions :**

- Apply 4 Convolutional layer + Long short term memory layer with increasing order of filter size (standard size : 16, 32, 64, 128) and fixed kernel size = (3, 3)

**Model 5 Summary (CNN + LSTM)**

**# training sequences = 663**

**# validation sequences = 100**

**# batch size = 50**

**# epochs = 30**

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Layer (type) Output Shape Param #

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time\_distributed\_1 (TimeDist (None, 20, 60, 60, 16) 2368

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time\_distributed\_2 (TimeDist (None, 20, 58, 58, 16) 2320

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time\_distributed\_3 (TimeDist (None, 20, 29, 29, 16) 0

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time\_distributed\_4 (TimeDist (None, 20, 29, 29, 32) 4640

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time\_distributed\_5 (TimeDist (None, 20, 29, 29, 32) 9248

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time\_distributed\_6 (TimeDist (None, 20, 14, 14, 32) 0

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time\_distributed\_7 (TimeDist (None, 20, 14, 14, 64) 18496

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time\_distributed\_8 (TimeDist (None, 20, 14, 14, 64) 36928

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time\_distributed\_9 (TimeDist (None, 20, 7, 7, 64) 0

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time\_distributed\_10 (TimeDis (None, 20, 7, 7, 128) 73856

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time\_distributed\_11 (TimeDis (None, 20, 7, 7, 128) 147584

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time\_distributed\_12 (TimeDis (None, 20, 3, 3, 128) 0

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time\_distributed\_13 (TimeDis (None, 20, 3, 3, 256) 295168

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time\_distributed\_14 (TimeDis (None, 20, 3, 3, 256) 590080

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time\_distributed\_15 (TimeDis (None, 20, 1, 1, 256) 0

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time\_distributed\_16 (TimeDis (None, 20, 256) 0

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lstm\_1 (LSTM) (None, 256) 525312

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dense\_1 (Dense) (None, 5) 1285

=================================================================

Total params: 1,707,285

Trainable params: 1,707,285

- One Input layer with dimensions 20, 120, 120, 3

- Output layer with dimensions 5

**Convolutions :**

- Apply 5 Convolutional layer + Long short term memory layer with increasing order of filter size (standard size : 16, 32, 64, 128, 256) and fixed kernel size = (3, 3)

- Apply 2 Max Pooling layers, one after 2nd convolutional layer and one after fourth convolutional layer

**Model 6 Summary**

# training sequences = 663

# validation sequences = 100

# batch size = 50

# epochs = 30

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Layer (type) Output Shape Param #

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conv3d\_5 (Conv3D) (None, 18, 118, 118, :sunglasses: 656

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max\_pooling3d\_5 (MaxPooling3 (None, 18, 59, 59, 8) 0

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conv3d\_6 (Conv3D) (None, 16, 57, 57, 16) 3472

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max\_pooling3d\_6 (MaxPooling3 (None, 16, 28, 28, 16) 0

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conv3d\_7 (Conv3D) (None, 14, 26, 26, 32) 13856

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max\_pooling3d\_7 (MaxPooling3 (None, 14, 13, 13, 32) 0

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conv3d\_8 (Conv3D) (None, 13, 12, 12, 64) 16448

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max\_pooling3d\_8 (MaxPooling3 (None, 13, 6, 6, 64) 0

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flatten\_2 (Flatten) (None, 29952) 0

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dense\_4 (Dense) (None, 512) 15335936

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dropout\_3 (Dropout) (None, 512) 0

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dense\_5 (Dense) (None, 256) 131328

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dropout\_4 (Dropout) (None, 256) 0

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dense\_6 (Dense) (None, 5) 1285

=================================================================

Total params: 15,502,981

Trainable params: 15,502,981

Non-trainable params: 0

- One Input layer with dimensions 20, 120, 120, 3

- Output layer with dimensions 5

**Convolutions :**

- Apply 4 Convolutional layer with increasing order of filter size (standard size : 8,16, 32, 64, 25) and fixed kernel size = (3, 3, 3)

- Each layer followed by max Pooling layers

|  |  |  |  |
| --- | --- | --- | --- |
| **Experiment Number** | **Model** | **Result** | **Decision + Explanation** |
| **1a** | **Conv3D** | **Vaildation: 0.84**  **Train: 0.8725** | **Batch Size: 20**  **Num Epochs: 20** |
| **1b** | **Conv3D** | **Vaildation:0.85**  **Train: 0.90** | **Batch Size: 30**  **Num Epochs: 30** |
| **1c** | **Conv3D** | **Vaildation:0.90**  **Train: 0.91** | **Batch Size: 50**  **Num Epochs: 30** |
| **1d** | **Conv3D** | **Vaildation:0.95**  **Train: 0.93** | **Batch Size: 90**  **Num Epochs: 30** |
| **1e** | **Conv3D** | **Vaildation:0.95**  **Train: 0.93** | **Batch Size: 90**  **Num Epochs: 20** |
| **2a** | **Conv3D** | **Validation:0.35**  **Train: 0.29** | **Batch Size: 90**  **Num Epochs: 10** |
| **2b** | **Conv3D** | **Validation:0.61**  **Train: 0.70** | **Batch Size: 50**  **Num Epochs: 20** |
| **2c** | **Conv3D** | **Validation :0.26**  **Train: 0.20** | **Batch Size: 30**  **Num Epochs: 20**  **Frames:15** |
| **3a** | **Conv3D** | **Validation:0.39**  **Train: 0.58** | **Batch Size: 50**  **Num Epochs: 25** |
| **3b** | **Conv3D** | **Validation:0.39**  **Train: 0.58** | **Batch Size: 90**  **Num Epochs: 30**  **Frames:30** |
| **3c** | **Conv3D** | **Validation:0.25**  **Train: 0.50** | **Batch Size: 90**  **Num Epochs: 30**  **Frames:20** |
| **4a** | **CNN + LSTM** | **Validation:0.25**  **Train: 0.50** | **Batch Size: 90**  **Num Epochs: 30**  **Frames:20** |
| **4b** | **CNN + LSTM** | **Validation:0.47**  **Train: 0.52** | **Batch Size: 50**  **Num Epochs: 30**  **Frames:20** |
| **5** | **CNN + LSTM** | **Validation:0.38**  **Train: 0. 4176** | **Batch Size: 50**  **Num Epochs: 30**  **Frames:20** |
| **6** | **CNN** | **Validation:0.67**  **Train: 0.82** | **Batch Size: 50**  **Num Epochs: 30**  **Frames:20** |
| **Final Model** |  |  |  |

Model 1 gave us \*\*test accuracy of 95% and validation accuracy of 93%\*\* using all the 30 frames. The same model is submitted for the review.

While we did try model lesser frames by using even frames but we felt more comfortable using full frame. Cropping and other preprocessing also did not affect much on the final accuracy. Same was with hybrid CNN + LSTM model