Experiment/ Model Number 1:

Model Architecture

Model Name	Conv3D
Total Conv Layers	4
Batch Size	32
Image Dimensions	(102,102)
Activation Function	Exponential Linear Unit (ELU)
Optimizer	SGD
Learning Rate	Adaptive (3e-4) Momentum 0.75
Total Trainable Parameter	12,322,949
Model Checkpoint	Saved on minimum total loss
Trained Epochs	47
Loss Function	categorical_crossentropy
Training Accuracy	92.94%
Validation Accuracy	84.09%

Observations:

- Model has good accuracy on training data however the validation accuracy is low as compared to training accuracy. (slight overfitting)
- We have used image size 102*102; can experiment with different values.
- The model has a large number of parameters that can be reduced further in the next experiments.
- We have tried different batch sizes more than 32 but received the OOM error hence settled for 32.

Experiment/ Model Number 2:

Model Architecture

Model Name	Conv3D
Total Conv Layers	4 (feature maps: 32-64-128-256)
Batch Size	48
Image Dimensions	(102,102)
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-4)
Total Trainable Parameter	10,605,509
Model Checkpoint	Saved on minimum loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	97.91%
Validation Accuracy	83.00%

Observations:

- We have done following changes wrt previous model
    - Increase batch size to 48
    - Used Adam instead of SGD
    - Changes done in Conv3d model wrt feature size
    - Activation function used RELU
- Model training accuracy went up to 97% however validation accuracy did not improve and remains at 83%.
- We have reduced the number of parameters from what we had before.We could reduce it further by using large stride and small image size.

Experiment/ Model Number 3:

Model Architecture

Model Name	Conv3D
Total Conv Layers	3 (feature maps: 32-64-128)
Batch Size	48
Image Dimensions	(96,96)
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-4)
Total Trainable Parameter	38,031,557
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	55.91%
Validation Accuracy	60.00%

Observations:

- We have done following changes wrt previous model
    - Reduced one Conv3D layer
    - Monitored on validation loss instead of loss
    - Introduced the dropout layers
    - Reduced image dimensions
    - All other things were kept similar
- Model training accuracy went down to 55% and validation accuracy received was 60%.
- This model is underfitting as we have introduced the dropout and reduced model layer at same time.

Experiment/ Model Number 4:

Model Architecture

Model Name	Conv3D
Total Conv Layers	4 (feature maps:16- 32-64-128) + 2 Dense
Batch Size	48
Image Dimensions	(96,96) / Frame indexing also changed
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	1,481,061
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	98.95%
Validation Accuracy	94.00%

Observations:

- We have done following changes wrt the previous model
    - We have done some changes in the generator this time.
        - Changed Indexing
        - Changed the normalization method. Now we have divided pixels with max value rather than 255.0
    - Model has also been changed significantly
        - We restored one more Conv3D layer and changed feature maps size
        - Reduced the number of parameters by reducing numbers of neurons in dense layer
        - Removed the drop-out layers in Conv3D for now.
- Model training accuracy went up to 99% and validation accuracy received was 94%.
- This model is looking perfect but it may be overfitting hence will introduce dropout layers in the next iterations.

Experiment/ Model Number 5:

Model Architecture

Model Name	Conv3D
Total Conv Layers	4 (feature maps:16- 32-64-128) + 2 Dense
Batch Size	48
Image Dimensions	(96,96) / Frame indexing also changed
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	1,431,509
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	93.19%
Validation Accuracy	68.00%

Observations:

- We have done following changes wrt the previous model
    - We kept the model same but this time we have reduced the filter size to 2*2*2

- Model training accuracy was 94% and validation accuracy received was 68%.
- Given the more epochs to train model might have converged better.
- This model is not looking great we might explore CNN+LSTM/GRU further or else model 4 has better matrices.

Experiment/ Model Number 6:

Model Architecture

Model Name	Conv2D with LSTM
Total Conv Layers	4 (feature maps:32- 64-128-128) + 2 Dense
Batch Size	32
Image Dimensions	(84,84) / Frame indexing also changed
Activation Function	ELU
Optimizer	Adam
Learning Rate	Adaptive
Total Trainable Parameter	1,133,125
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	30
Loss Function	categorical_crossentropy
Training Accuracy	100%
Validation Accuracy	87.50%

Observations:

- The accuracy of the training model reached 100%, while the validation accuracy received was 94%.
- The model is clearly overfitted, so we changed the optimizer from ADAM to SGD in our next model.

Experiment/ Model Number 7:

Model Architecture

Model Name	Conv2D with LSTM
Total Conv Layers	4 (feature maps:32- 64-256-512) + 2 Dense
Batch Size	32
Image Dimensions	(84,84) / Frame indexing also changed
Activation Function	RELU
Optimizer	SGD
Learning Rate	Adaptive
Total Trainable Parameter	6,817,829
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	30
Loss Function	categorical_crossentropy
Training Accuracy	21.96%
Validation Accuracy	34.09%

Observations:

- The model is under fitted. Therefore, we have taken 5 layers + 2 dense layers in the next model.
- Note that the results here are trained up to 30 epochs only and hence the accuracy is below par.
- We have kept all other hyperparameters constant as per the last model.

Experiment/ Model Number 8:

Model Architecture

Model Name	Conv2D with LSTM
Total Conv Layers	5 (feature maps:16-32-64-128-256) + 2 Dense
Batch Size	32
Image Dimensions	(84,84) / Frame indexing also changed
Activation Function	RELU
Optimizer	ADAM
Learning Rate	Adaptive
Total Trainable Parameter	482,181
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	30
Loss Function	categorical_crossentropy
Training Accuracy	98.87%
Validation Accuracy	76.00%

Observations:

- Overfitting is a significant problem with the Training Model. We will include a learning rate of 1e-2 in our next model and also introduce more dropout layers to deal with overfitting.

Experiment/ Model Number 9:

Model Architecture

Model Name	Conv2D with LSTM
Total Conv Layers	5 (feature maps:16- 32-64-128-256) + 2 Dense
Batch Size	32
Image Dimensions	(84,84)
Activation Function	ELU
Optimizer	ADAM
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	482,181
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	91.55%
Validation Accuracy	75.00%

Observations:

- We have change dropout in our next model from 0.25 to 0.5 as previous model was also overfitting.
- Here we tried the ELU activation to check if any changes are happening rest all the parameters are kept constant.
- The model didn't gain perfection and still overfitting hence further we will experiment with different parameters set

Experiment/ Model Number 10:

Model Architecture

Model Name	Conv2D with GRU
Total Conv Layers	5 (feature maps:16- 32-64-128-256) + 2 Dense
Batch Size	48
Image Dimensions	(96,96)
Activation Function	RELU
Optimizer	ADAM
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	461,829
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	91.76%
Validation Accuracy	85.67%

Observations:

- We have done following changes wrt the previous model
    - Changes done in hyperparameters
    - Batch size changed to 48 and image size also changed to 96*96
    - LR is reduced to 0.01
- The model gave decent result on both training and validation.
- Next, we will explore transfer learning with LSTM/GRU.

Experiment/ Model Number 11:

Model Architecture

Model Name	ImageNet with LSTM With Train = False
Total Conv Layers	-
Batch Size	48
Image Dimensions	(96,96) / Frame indexing also changed
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	285,317
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	98.08%
Validation Accuracy	85.00%

Observations:

- We have done following changes wrt the previous model
    - We have used the pre-trained weights of Imagenet model along with LSTM.
    - The weights are kept as non-trainable.
    - Batch size and image size are the same as previous models

- Model training accuracy was 98.08% and validation accuracy received was 85%.
- This model is looking great wrt training however the validation accuracy is still 85 hence model is underfitting.

Experiment/ Model Number 12:

Model Architecture

Model Name	ImageNet with GRU With Train = False
Total Conv Layers	-
Batch Size	48
Image Dimensions	(96,96) / Frame indexing also changed
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	215,813
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	94.78%
Validation Accuracy	74.00%

Observations:

- We have done following changes wrt the previous model
    - We have used the pre-trained weights of Imagenet model along with GRU.
    - The weights are kept as non-trainable.
    - Batch size and image size are the same as previous models

- Model training accuracy was 94.08% and validation accuracy received was 74%.
- This model is looking great wrt training however the validation accuracy is still 85 hence model is underfitting.

We will try to keep the weights trainable now.

Experiment/ Model Number 13:

Model Architecture

Model Name	ImageNet with LSTM With Train = True
Total Conv Layers	Transfer learning is used
Batch Size	52
Image Dimensions	(96,96)
Activation Function	Rectified Linear Unit (RELU)
Optimizer	Adam
Learning Rate	Adaptive (1e-2)
Total Trainable Parameter	3,492,293
Model Checkpoint	Saved on minimum validation loss
Trained Epochs	50
Loss Function	categorical_crossentropy
Training Accuracy	95.02%
Validation Accuracy	93.00%

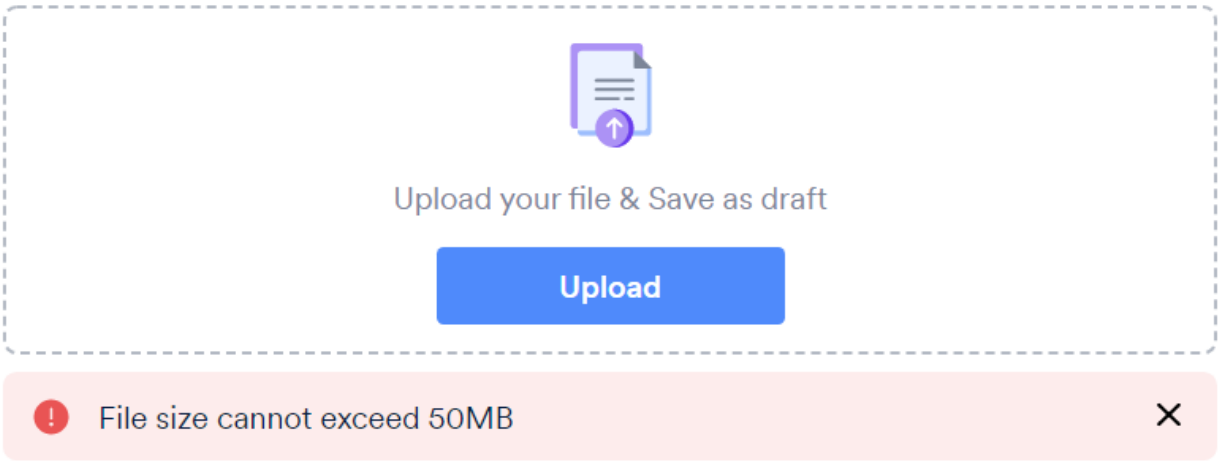
Observations:

- We have done following changes wrt the previous model
    - We have used the pre-trained weights of Imagenet model along with GRU.
    - The weights are kept as trainable.
    - The batch size changed to 52 and the image size is the same as previous models

- Model training accuracy was 95.02% and validation accuracy received was 93%.
- This model is looking great wrt training and validation accuracy. The model is the best one till now wrt to training and validation results.

We now have model 4 and model 13 which are equally good and hence ready to submit.

NOTE: The model weight (h5) file for Model 13 cannot be submitted because we got an issue while submitting it. Hence we have compressed it further.



Please reach out to devashishpkhairnar@gmail.com in case an h5 file is required.
Due to size constraints submitting the second-best model.