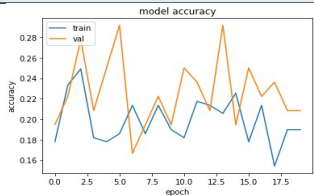
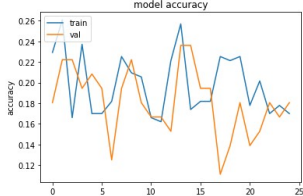
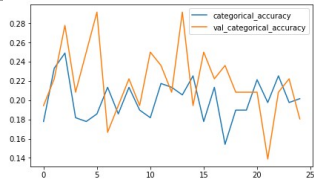
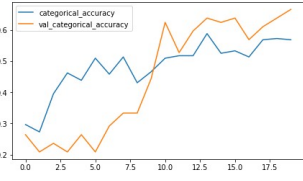
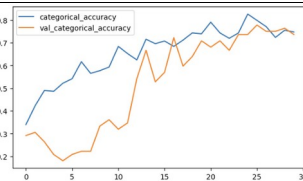
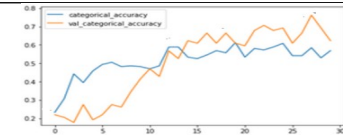



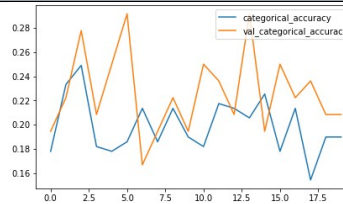
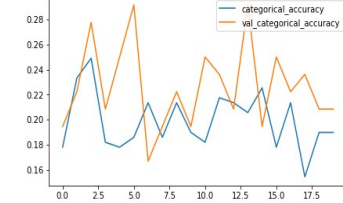
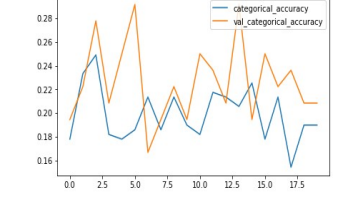
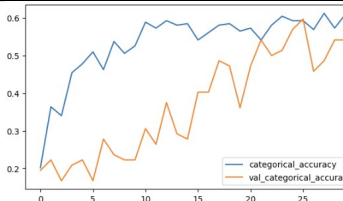
# Hand Gesture Recognition using Conv3D and CNN-RNN

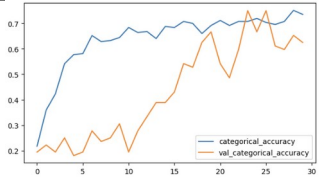
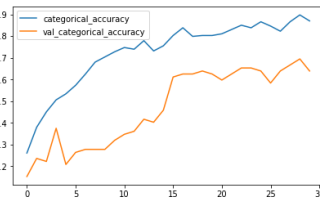
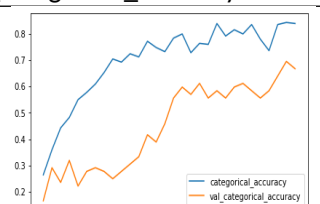
## Using Conv3D model:

Exp	Model	No. Of Parameters	Result	Comments
1	<b>Conv3D</b> -Batch_size=64 -Activation function = 'relu' -Kernel_size=(3,3,3) -Using last 18 image frames	8,958,629	 Accuracy: 0.1897 Val_Accuracy: 0.2083	Model under-fitting.
2	<b>Conv3D</b> - Batch_size=64 - Activation function = 'elu' - Kernel_size=(3,3,3) - Using last 18 image frames Using last 18 image frames	8,958,629	 categorical_accuracy: 0.1700 val_categorical_accuracy: 0.1806	Model is under-fitting. Changing the activation function did not improve accuracy,
3	<b>Conv3D</b> - Batch_size=64 - Activation function = 'relu' - Kernel_size=(2,2,2) Using last 18 image frames	9,856,901	 categorical_accuracy: 0.2016 val_categorical_accuracy: 0.1806	Model Under-fitting. Changing the kernel size did not improve accuracy,
4	<b>Conv3D</b> - Batch_size=64 - Activation function = 'elu' - Kernel_size=(3,3,3) - Using alternate frames	9,439,365	 categorical_accuracy: 0.5692 val_categorical_accuracy: 0.6667	Model Over-fitting. Using alternate frames improved model performance.
5	<b>Conv3D</b> - Using (84X84) image frames Updated momentum 0.7 to 0.9 in SGD optimizer	9,440,773	 categorical_accuracy: 0.7470 val_categorical_accuracy: 0.7361	No over-fitting or under-fitting. Updating momentum reduced the difference between train and validation accuracy.

6	<b>Conv3D</b> <ul style="list-style-type: none"> <li>- Batch size 80</li> <li>- Image frame (84,84)</li> <li>- filter(3,3,3)</li> </ul>	9,440,773	 <p>categorical_accuracy: 0.6852 val_categorical_accuracy: 0.6273</p>	Increasing batch size actually caused a drop in accuracy. Returning to batch size 64
7	<b>Conv3D</b> <ul style="list-style-type: none"> <li>-Using (84X84) images</li> <li>- Using all 30 frames.</li> </ul>	9,439,365	 <p>categorical_accuracy: 0.8024 val_categorical_accuracy: 0.6944</p>	Slightly over-fitting.

### Using CNN and RNN model:

Exp	Model	No. Of Parameters	Result	Comments
8	<b>Conv2D + GRU</b> <ul style="list-style-type: none"> <li>- Using last 18 (84X84) images per video</li> </ul> <p>Using momentum as 0.7 in SGD optimizer</p>	1,274,245	 <p>categorical_accuracy: 0.1897 val_categorical_accuracy: 0.2083</p>	Under-fitting
9	<b>Conv2D + GRU</b> <ul style="list-style-type: none"> <li>- Adding more layers</li> <li>- Using last 18 (84X84) images per video</li> </ul> <p>Using momentum as 0.7 in SGD optimizer</p>	733,957	 <p>categorical_accuracy: 0.1897 val_categorical_accuracy: 0.2083</p>	Under-fitting
10	<b>Conv2D + GRU</b> <ul style="list-style-type: none"> <li>- Using 18 last (100X100) images</li> </ul> <p>Using momentum as 0.7 in SGD optimizer</p>	1,004,293	 <p>categorical_accuracy: 0.1897 val_categorical_accuracy: 0.2083</p>	Under-fitting
11	<b>Conv2D + GRU</b> <ul style="list-style-type: none"> <li>- Using alternative 18 (84X84) images</li> <li>- momentum = 0.7</li> </ul>	1,274,469		Slightly over-fitting. Using alternative frames improved accuracy.

			categorical_accuracy: 0.6087 val_categorical_accuracy: 0.5417	
12	<b>Conv2D + GRU</b> - Using alternative 18 (84X84) images Updating momentum to 0.9	1,274,469	 categorical_accuracy: 0.7352 val_categorical_accuracy: 0.6250	Still Over-fitting
13	<b>Conv2D + GRU</b> - Using 18 alternative (100X100) images Using momentum as 0.9	1,004,293	 categorical_accuracy: 0.8696 val_categorical_accuracy: 0.6389	Over-fitting increased after increasing frame size.
14	<b>Conv2D + GRU</b> - Using 30 (100X100) images Using momentum as 0.9	1,004,293	 categorical_accuracy: 0.8379 val_categorical_accuracy: 0.6667	Over-fitting. Accuracy did not improve after using all frames.

## Conclusion:

The best model out of all the experiments conducted is experiment number 5 wherein we trained the model with: image frame 84X84, alternate images fed to the model, momentum of 0.9 in SGD optimizer. As can be seen, the accuracies are converging within a 5% range. There is no sign of the model under or over-fitting.

Experiments were also conducted using a CNN and RNN model. Apart from taking considerable time to train, the models also showed no sign of improved accuracy. The model always seems to either under-fit or over-fit.