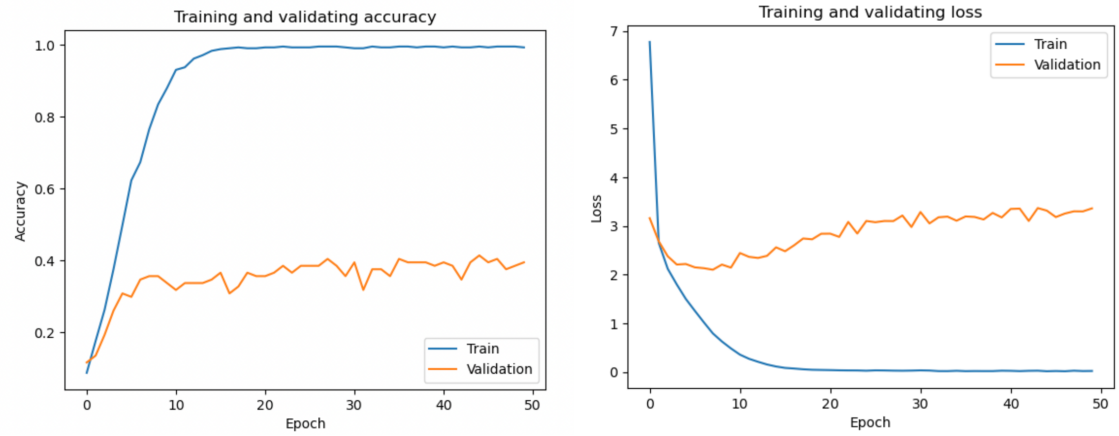
1.1



Based on these two graphs above, I observe that after training on the given dataset, train accuracy is almost close to 1 while validation accuracy is around 0.3 to 0.4, also, train loss is close to 0 while validation loss is slightly going up, which means that this model is overfitting. And this model needs more training data to get a better accuracy.

1.2

Data augmentation:

RandomFilp, RandomCrop and RandomZoom are used in my model to perform data augmentation to reduce underfitting since there is too little training data.

The reason to use RandomFlip is because many of the yoga pose is horizontal flipped, e.g.

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For the parameter of RandomFlip, I choose horizontal since it won't make sense to have yoga pose pictures flipped upside down which will generate lots of useless data. By performing RandomFlip, it will generate pictures flipped horizontally to provide more useful data to train the model.

For RandomCrop and RandomZoom, the reason to use these two methods is that after I observe the training dataset, I found that some of the pictures are just zooming in or zooming out of other pictures, e.g.  . By using RandomCrop and RandomZoom, it will generate pictures which is cropping, zooming in and out of the original dataset which will provide useful information to train.

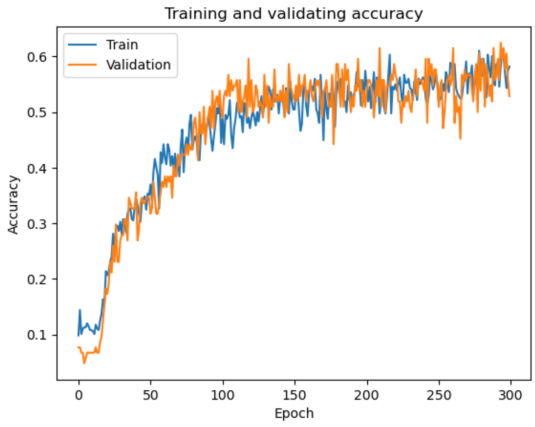
For RandomCrop, I use the parameter (28, 28) since the original image is 32 by 32 and it is more helpful not to lose too much information.

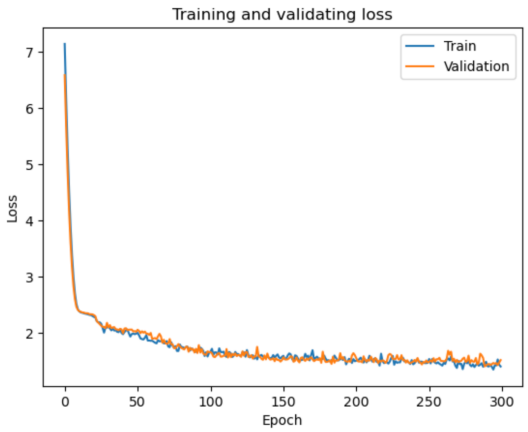
For RandomZoom, I use the parameter (-0.3, 0.3) since both zooming in and zooming out are needed and it is better to keep it in a small range otherwise will create some useless data.

These two methods may have the similar impact on the data since cropping the image is sort of zooming in the picture, but after my experiment, it is better to use both.

Regularisation:
I applied L2 regularizer at the last two convolutional layers, and l1_l2 regularizer which applies both L1 and L2 penalties at the last layer.
After I tried all L1, L2 and L1L2 regularizer, the combination above suits my model the best.

I also rescaled the data at the beginning of the model to have pixel value between 0 and 1 so that the computation becomes easier and faster. Normalizing the pixel values helps gradient calculations stay consistent and not get so large that they slow down or prevent the model from training.





After plotting the training and validation accuracy and loss, I observe that the validation line overlaps with the training line indicating that regularisation is working well. However, the accuracy is fluctuating around 0.6 which indicates that the data augmentation scheme is not good enough to provide enough useful data to train the model causing underfitting and it may provide lots of useless data, so the model is trained in a bad way.

2.

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The overall classification accuracy is 0.6571428571428571
bridge accuracy is 0.2857142857142857
childs accuracy is 0.5714285714285714
downwarddog accuracy is 0.8571428571428571
mountain accuracy is 1.0
plank accuracy is 0.2857142857142857
seatedforwardbend accuracy is 0.7142857142857143
tree accuracy is 0.5714285714285714
trianglepose accuracy is 0.7142857142857143
warrior1 accuracy is 0.7142857142857143
warrior2 accuracy is 0.8571428571428571
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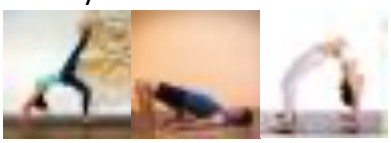
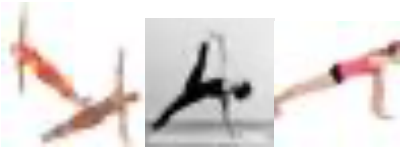
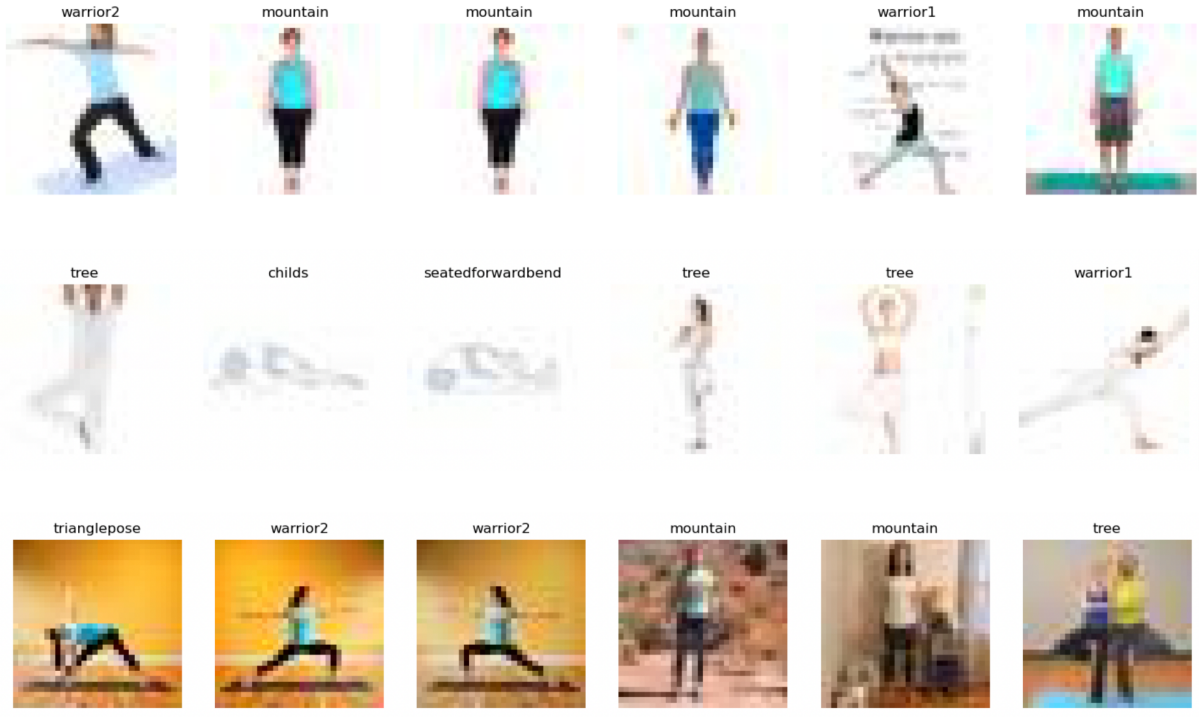
The performance of this model is good but can still be improved.
According to the accuracy for each class, bridge and plank are difficult for my model to classify. The reason is that bridge and plank can have many different transformations, e.g.


these three are all from bridge class but they look quite

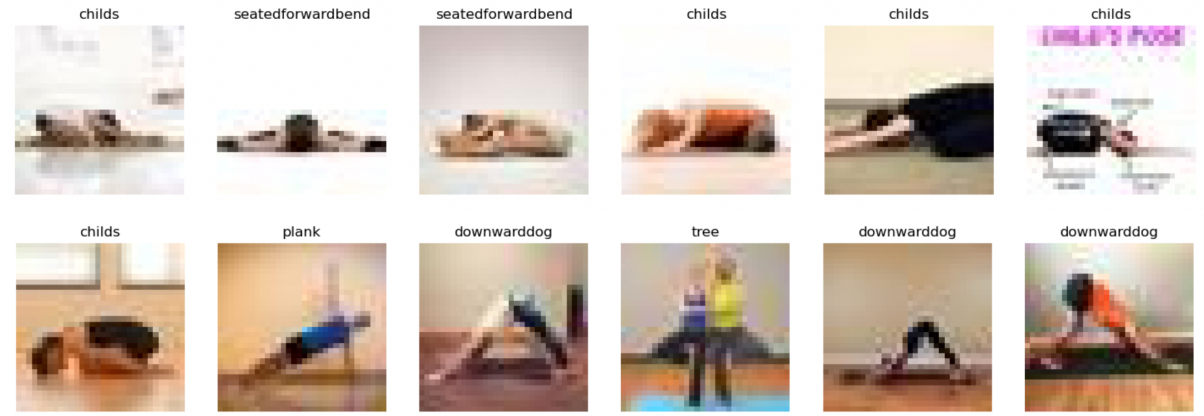
different.  these three also look very different but they are all from plank class.
Even human eyes cannot recognise that they are actually different transformations of the same yoga pose. With such limited amount of training data, the model may not classify some complicated pose very well. Also, the model has some randomness, so it may perform better on these two classes some time.
To improve the accuracy, the model needs more useful training data to train. I tried to use RandomRotation, RandomContrast and RandomTranslation in the data augmentation scheme, but they all seem to have some bugs on my system which gives me same statistic results every epoch. I couldn't fix it, so I didn't use them. However, I think these three data augmentation methods can definitely help to increase the accuracy of the model.

3.
The model has learned a relatively good result, but it is bad at classifying some classes like plank and bridge.
After I inspect the feature space, I found that my model emphasizes on the colour of the images too much.
For example, the pictures below show that similar colours will trick the model to think that they are from the same class. To improve this, I think converting them into greyscale images or change the background to the same colour will help the model to extract the pose feature better.



The model can recognise features like open arms.
The pictures below show that the model can identify poses which are stretched out very well.

But the model has problem recognising poses which are curled up, for example, the childs class. This class gives little information on the pose which makes it very difficult for the model to recognise.



To conclude, the main problem of my model is that it tends to be misled by the background of the image instead of looking at the pose of the human. It is easier for the model to identify poses like warrior2 which give more information than poses which are curled up. To improve the performance, it is important to preprocess the data to eliminate some noises like background colour. And also modify the data augmentation layer to generate more data like rotation and tilting the image which create different angles of a yoga pose.