HLCV EXERCISE 2 REPORT

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3a) Data Augmentation

Experiment Setup:

Here we use different data transformations:
For Geometric augmentation, we use:

- Resize
- Crop
- HorizontalFlip
- Rotation

For color space data augmentation, we use:

- ColorJitter
- GrayScale

We check the performance of each transformation individually using some combinations of hyperparameters to get higher accuracy values.

```
input_size = 3
num_classes = 10
hidden_size = [128, 512, 512, 512, 512, 512]
num_epochs = 30 #Default: 20
batch_size = 200 #Default: 200
learning_rate = 2e-3 #Default: 2e-3
learning_rate_decay = 0.95 #Default: 0.95
reg=0.001 #Default: 0.001
num_training= 49000
num_validation = 1000
norm_layer = True ("batch")
use_dropout = False
```

Note: here we use epochs of size 30.

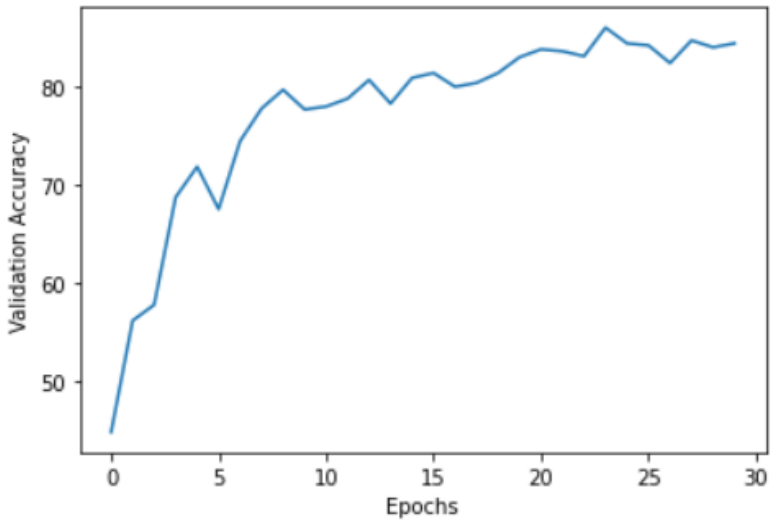
Results:

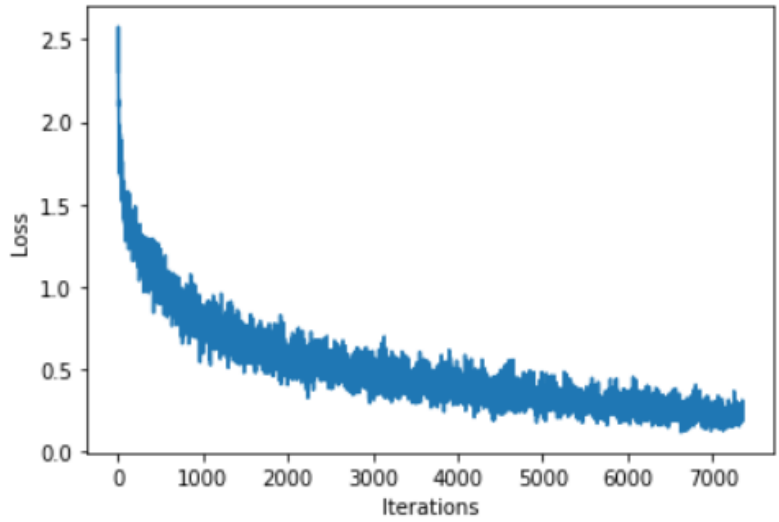
1. Using Resize and RandomCrop:

```
transforms.Resize((40, 40)),
transforms.RandomCrop((32, 32))
```

The original image is of size 32*32 so we first resize to 40*40 and then do a random crop to get image of 32*32.

We get.
Validation Accuracy: 85.9 %
Test Accuracy: 75.1 %



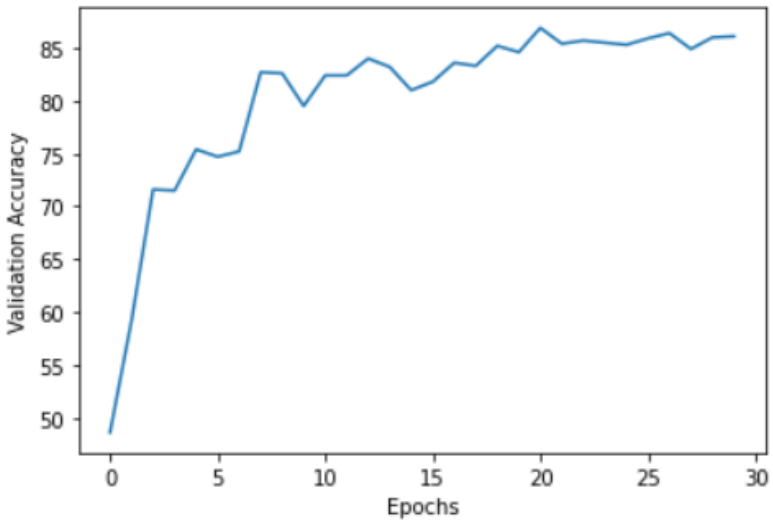


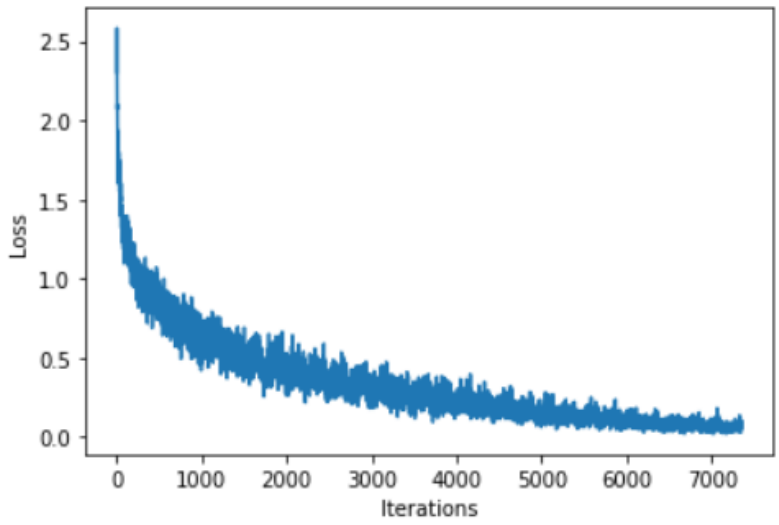
2. Using Horizontal Flip: (0.5)

```
transforms.RandomHorizontalFlip(),
```

Horizontally flip the given PIL Image randomly with a given probability.
Default = 0.5

We get.
Validation Accuracy: 86.9 %
Test Accuracy: 84.5 %



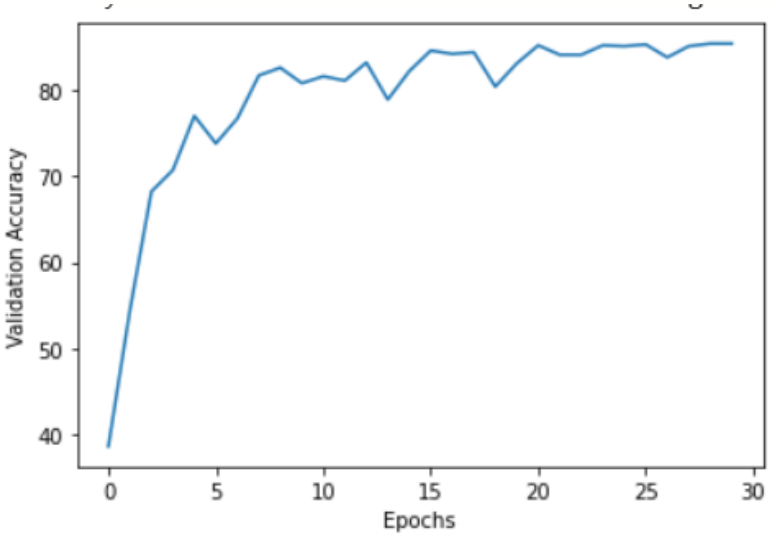


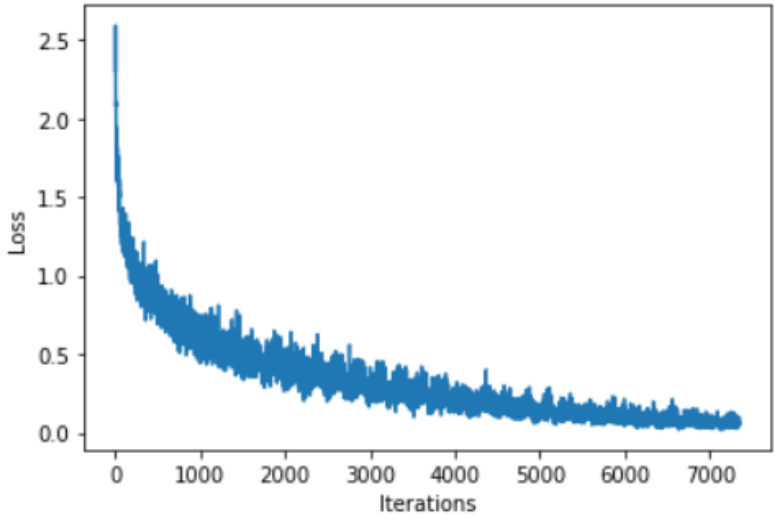
3. **Using Horizontal Flip:** (0.6)

```
transforms.RandomHorizontalFlip(0.6),
```

Horizontally flip the given PIL Image randomly with a given probability.
Default = 0.5

We get.
Validation Accuracy: 85.4 %
Test Accuracy: 86.0 %





4. Using Rotation: (degree = 15)

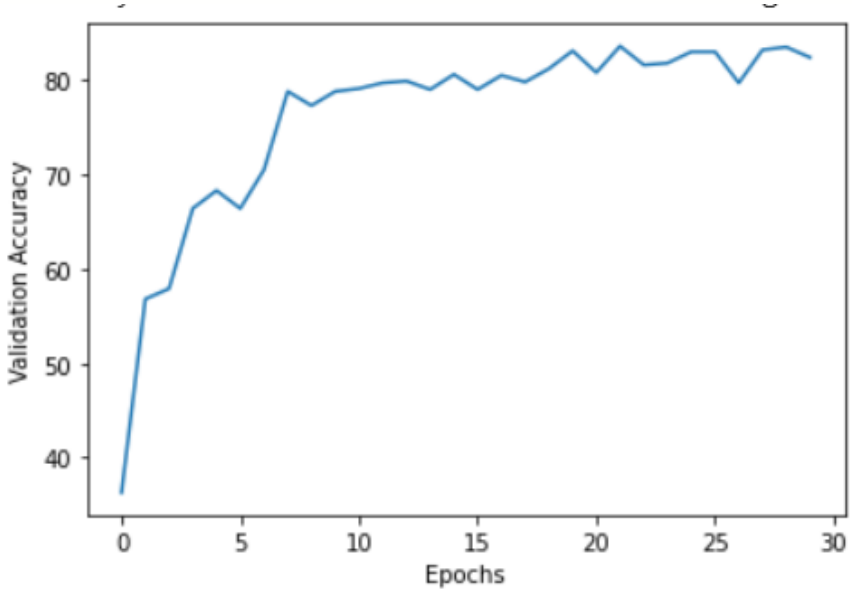
```
transforms.RandomRotation(degree = 15),
```

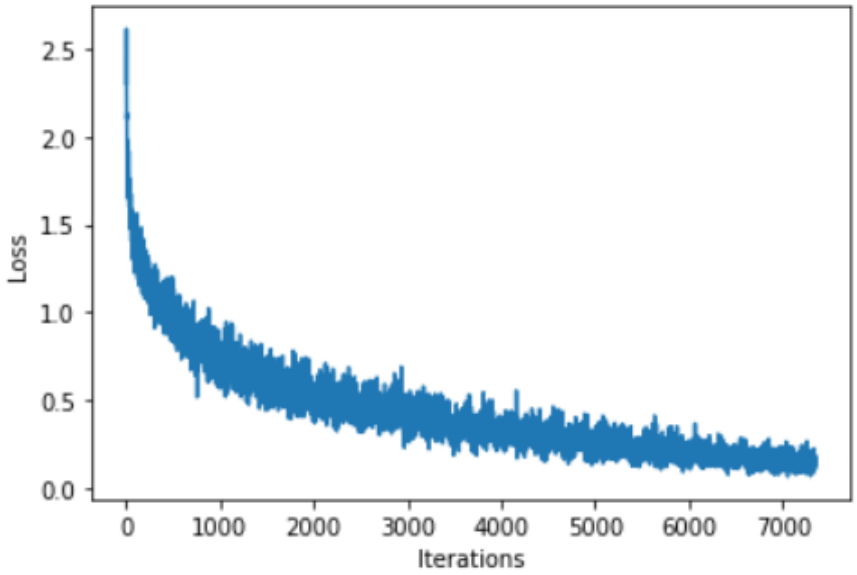
Rotate the image by angle. Here degree is the range of degree to select from, for above case it will be in the range of (-15, +15)

We get.

Validation Accuracy: 83.6 %

Test Accuracy: 83.3 %





5. Using Rotation: (degree = 25)

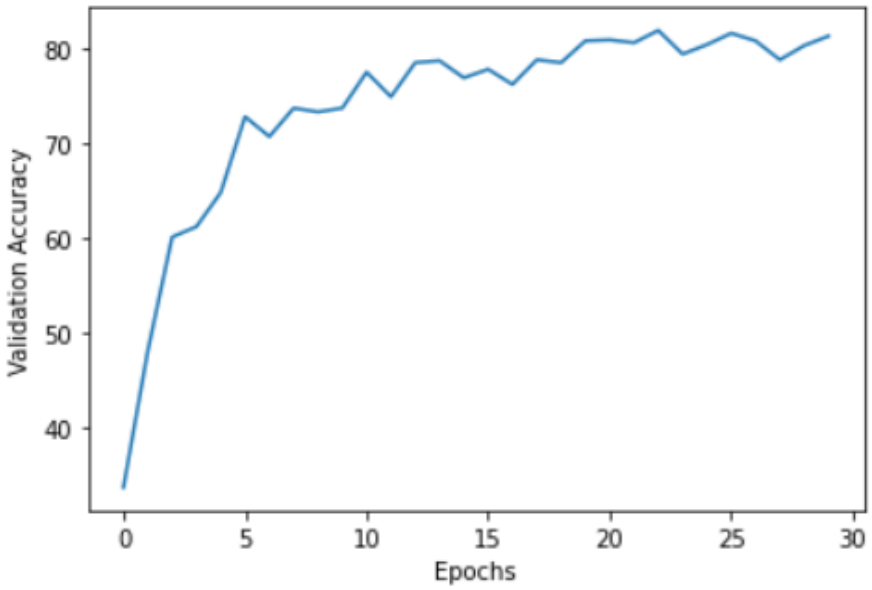
```
transforms.RandomRotation(degree = 25),
```

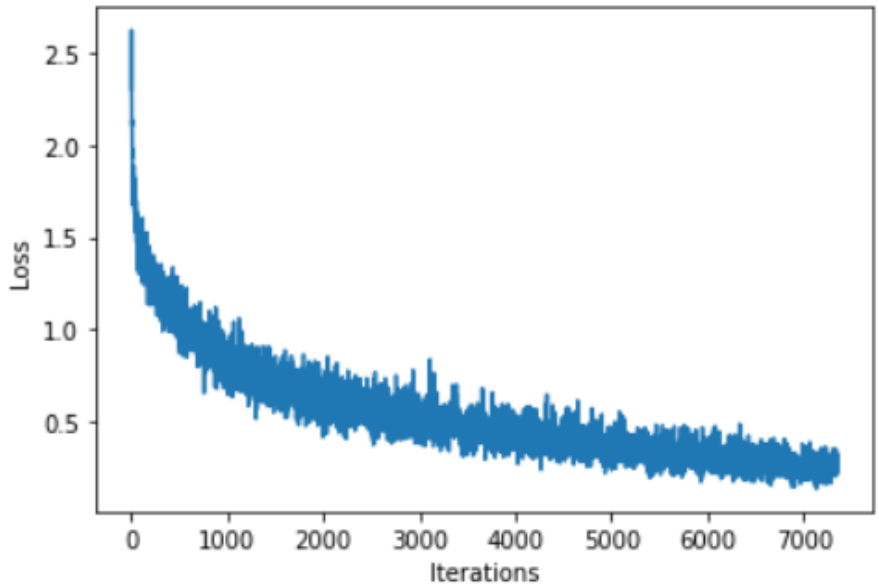
Rotate the image by angle. Here degree is the range of degree to select from, for above case it will be in the range of (-25, +25)

We get.

Validation Accuracy: 81.9 %

Test Accuracy: 83.3 %





6. Using colorJitter

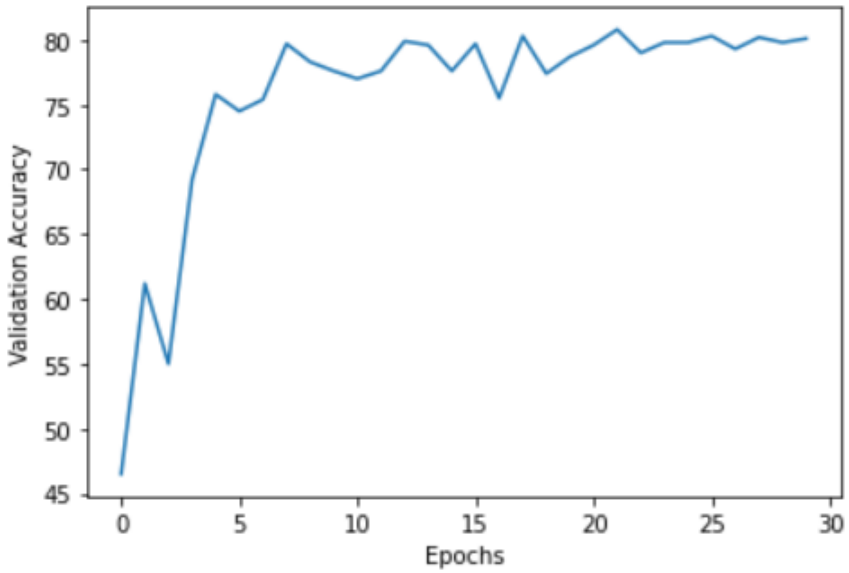
```
transforms.ColorJitter(brightness=0.4, contrast=0.4, saturation=0.4,
hue=0.1),
```

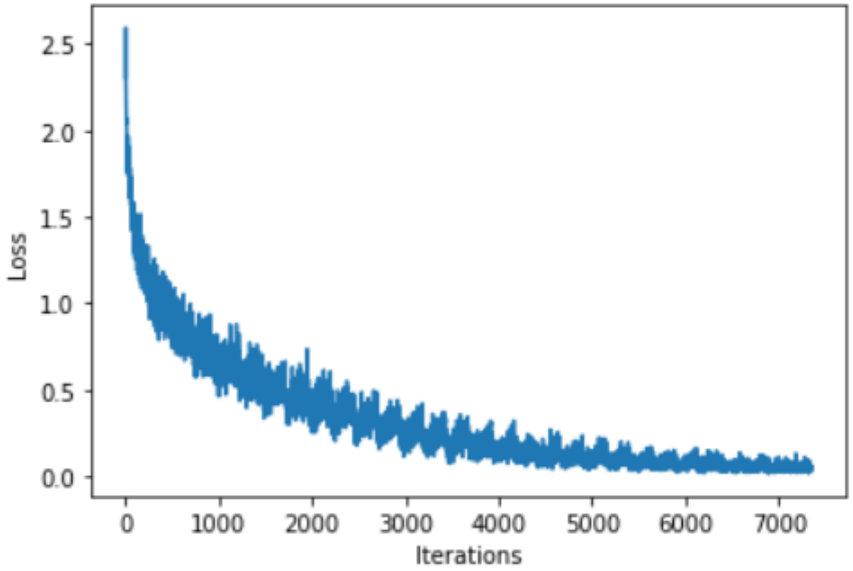
Randomly change the brightness, contrast, and saturation of an image.

We get.

Validation Accuracy: 80.8 %

Test Accuracy: 84.1 %





7. Using Grayscale:

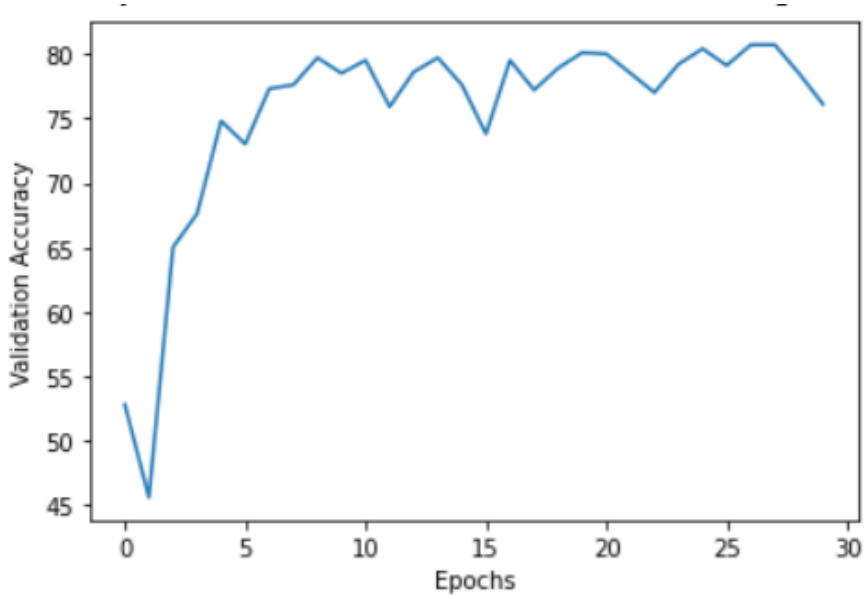
```
torchvision.transforms.Grayscale(num_output_channels=3)
```

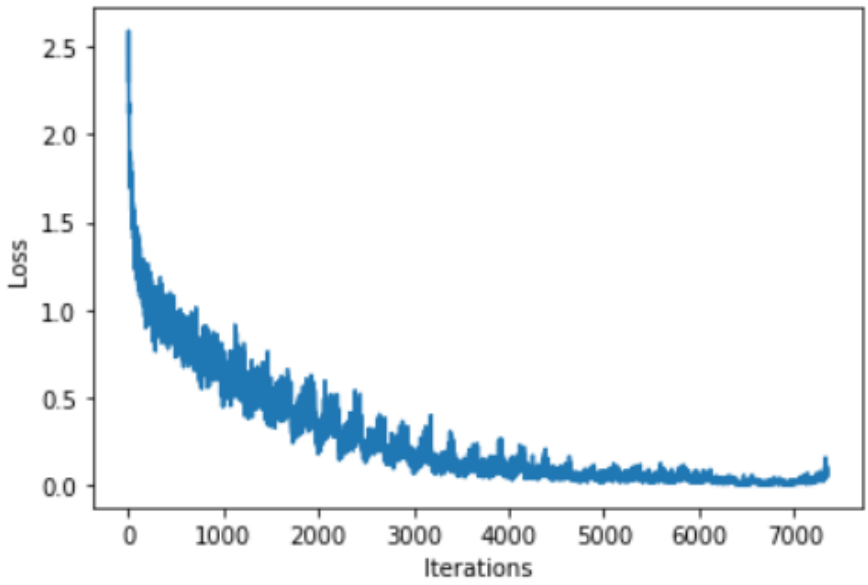
The original image is of size 32*32 so we first resize to 40*40 and then do a random crop to get image of 32*32.

We get.

Validation Accuracy: 80.4 %

Test Accuracy: 59.8 %





Observations:

We can see from using different data transformations:

The best accuracy is given by using HorizontalFlip(0.5) i.e. 86.9%

We also notice that **Geometric data transformation performs better than color space data augmentations.**

Among which GrayScale transformation performs the worst.

Question 3b (Dropout)

Experimental Setup :

```
input_size = 3
num_classes = 10
hidden_size = [128, 512, 512, 512, 512, 512]
num_epochs = 20 #Default: 20
batch_size = 200 #Default: 200
learning_rate = 2e-3 #Default: 2e-3
learning_rate_decay = 0.95 #Default: 0.95
reg=0.001 #Default: 0.001
dropout_value = [0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9]
num_training= 49000
num_validation =1000
norm_layer = True  # (Batch Normalization)
data_transform = False
```

We experiment for different values of p for dropout ranging from 0.1 to 0.9.

Results :

Test and validation accuracies have been reported for each value of p.

Model	p-value	Validation Accuracy	Test Accuracy
Model 1	0.1	84.40%	85.40%
Model 2	0.15	85.20%	84.10%
Model 3	0.2	85.80%	85.00%
Model 4	0.25	85.80%	84.30%
Model 5	0.3	85.80%	84.90%
Model 7	0.4	83.20%	81.10%
Model 8	0.5	79.90%	79.20%
Model 9	0.6	75.70%	76.10%
Model 10	0.7	68.10%	66.10%
Model 11	0.8	38.90%	37.00%
Model 12	0.9	11.20%	12.40%

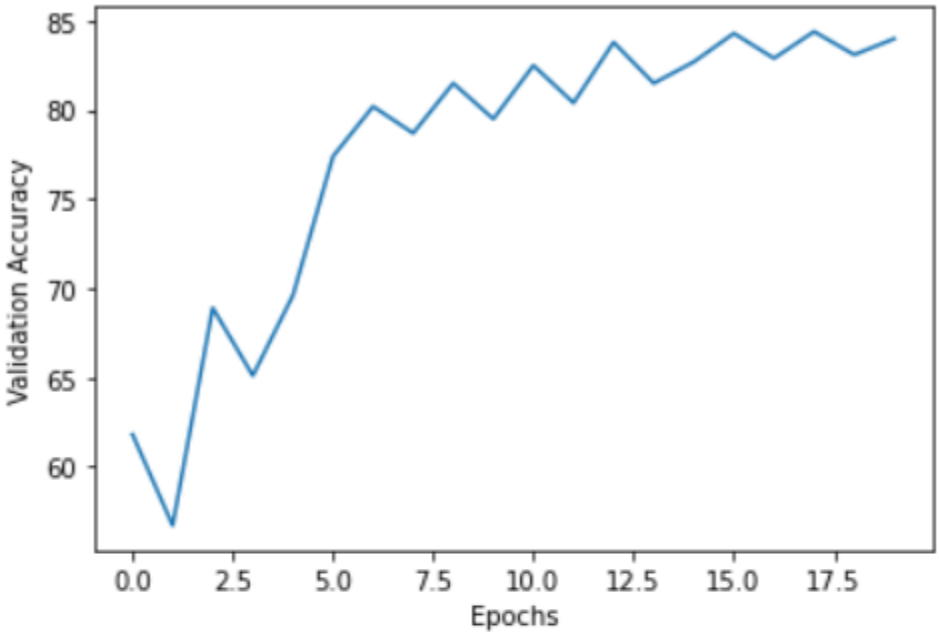
Observations:

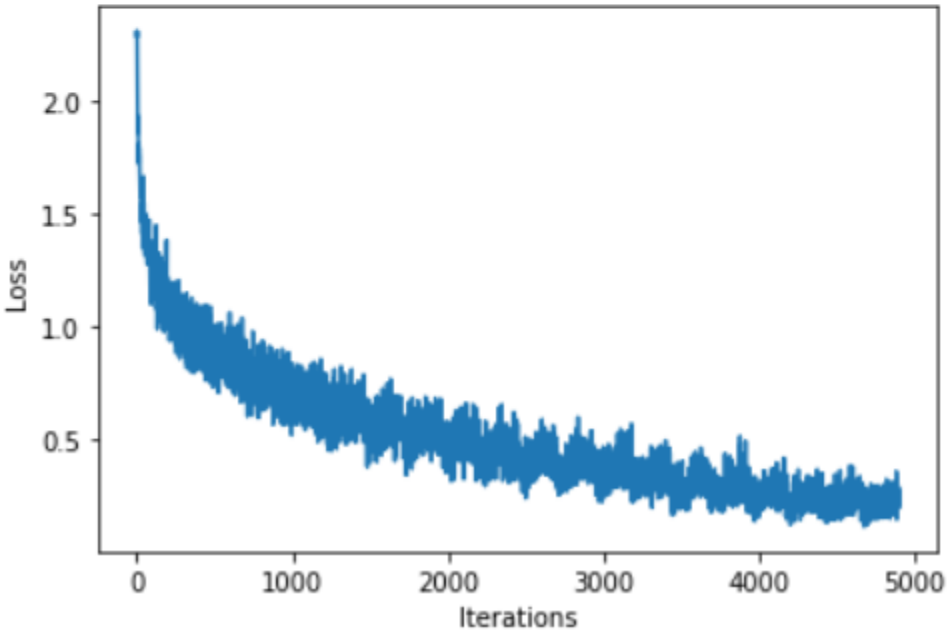
We get maximum validation accuracy for Model with Dropout probability(p) = 0.2
I.e. Validation Accuracy = 85.50%
And Test Accuracy = 85.00%

From the plots(below) we can also notice that high values of p regularize the model heavily and decrease model capacity, but with low values, the model overfits.

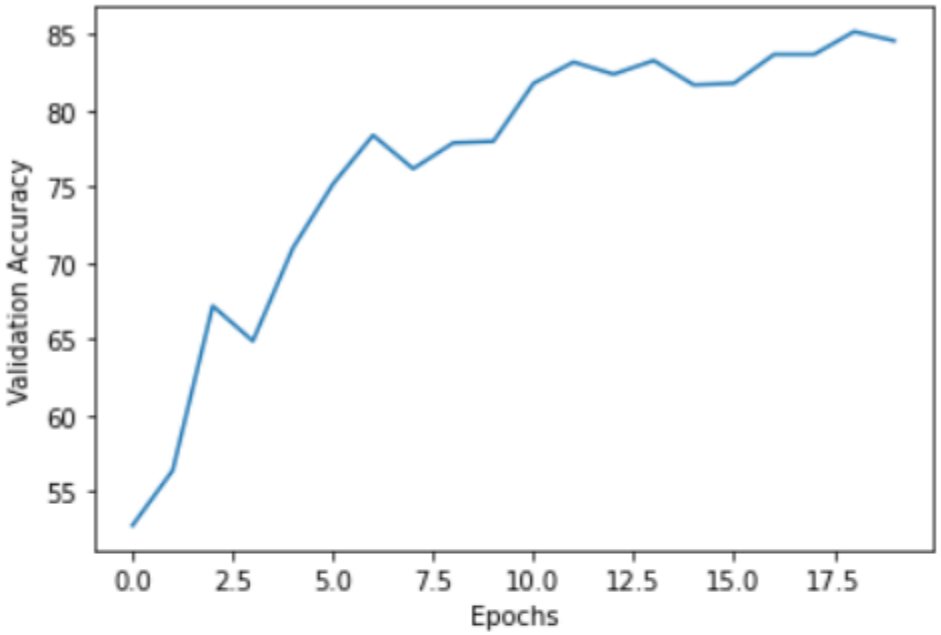
Plots for Accuracy and Loss for different values of p (Dropout probability):

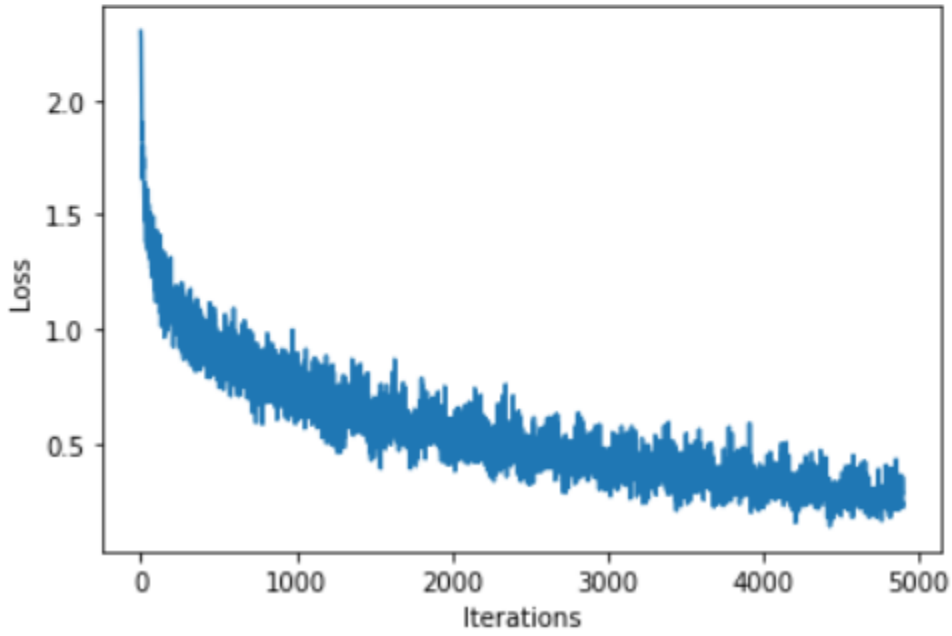
p = 0.1



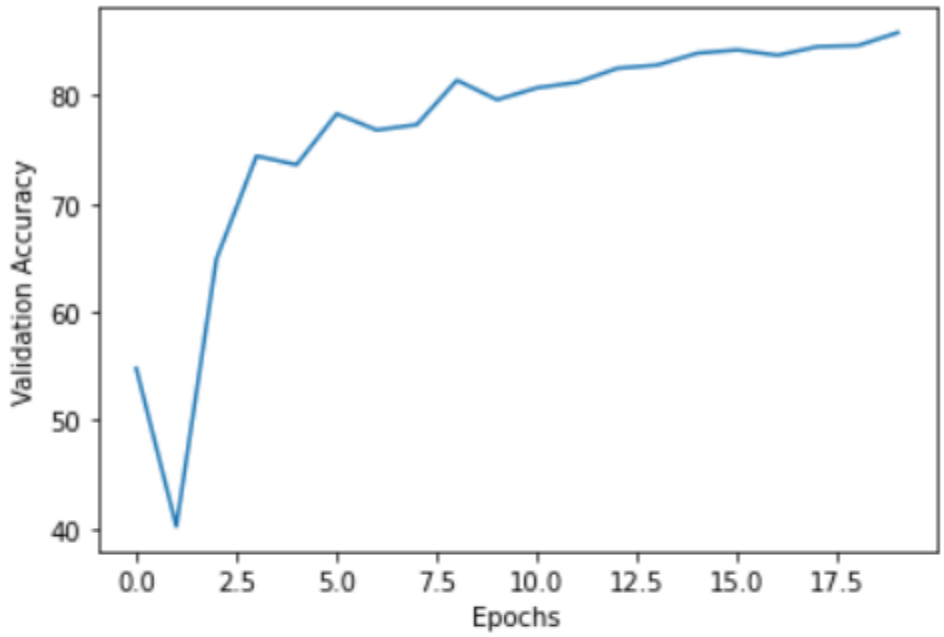


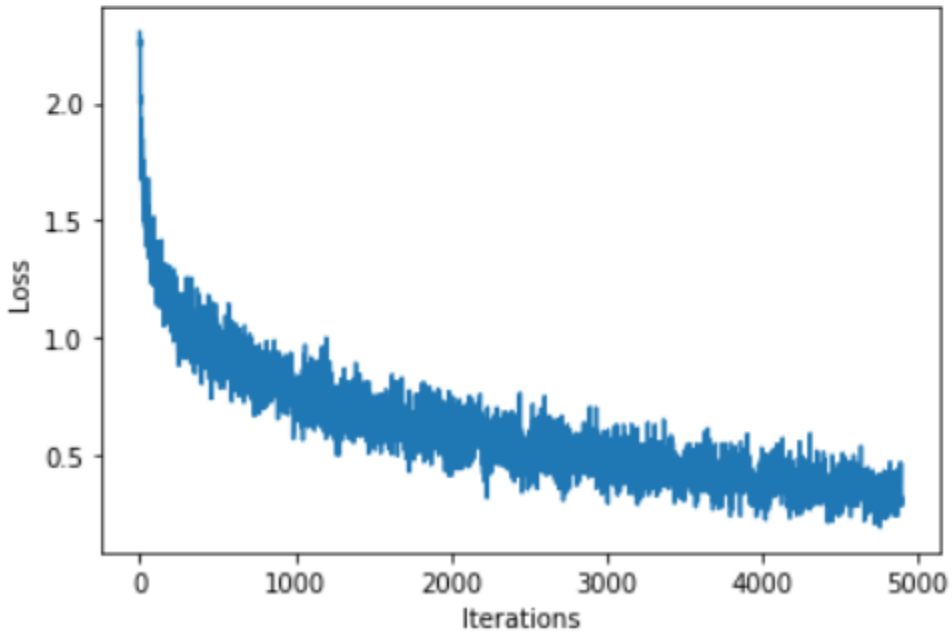
P = 0.15


Validation Accuracy
85
80
75
70
65
60
55
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

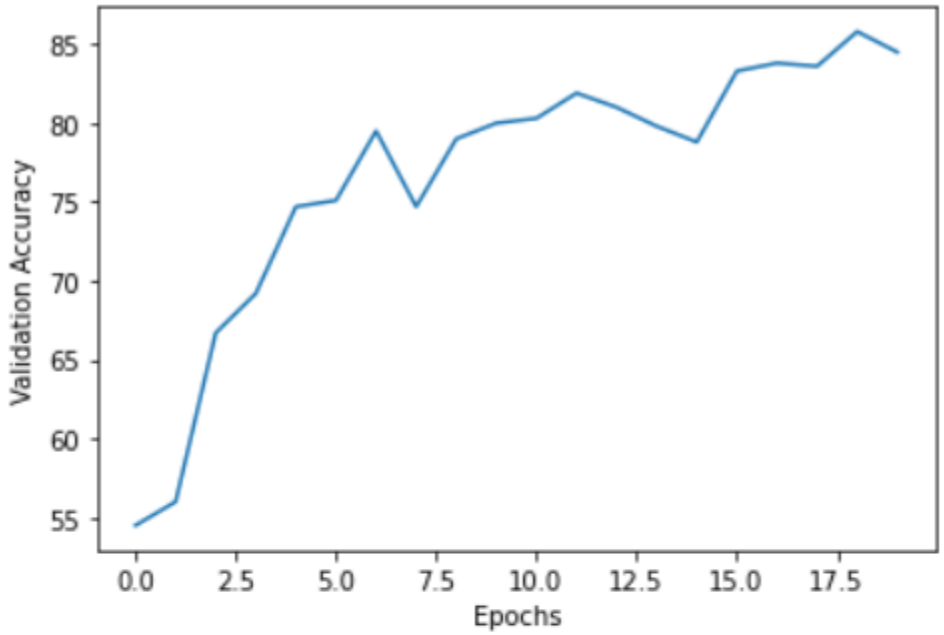

Loss
2.0
1.5
1.0
0.5
0
1000
2000
3000
4000
5000
Iterations

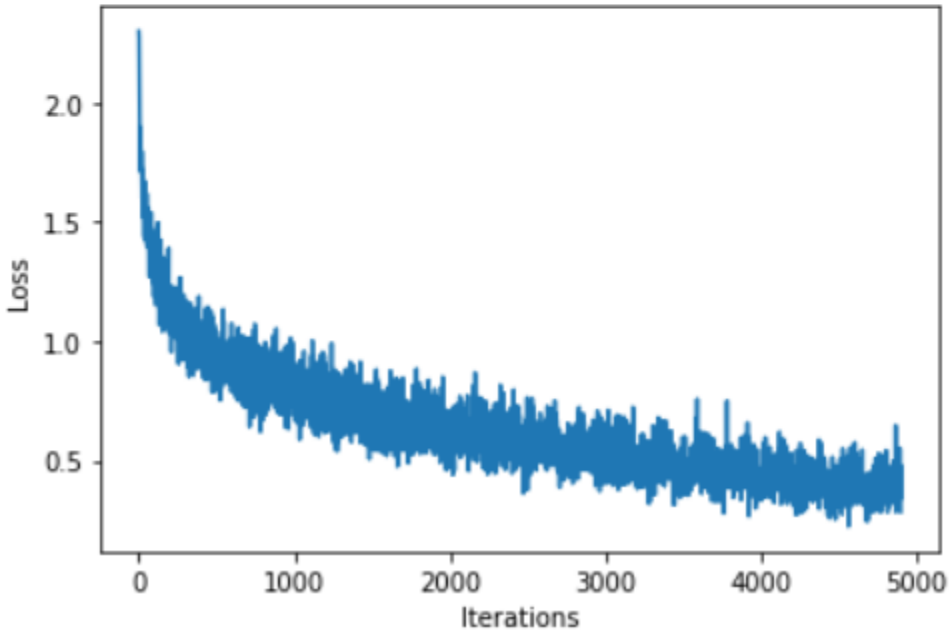
P = 0.2


Validation Accuracy
80
70
60
50
40
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

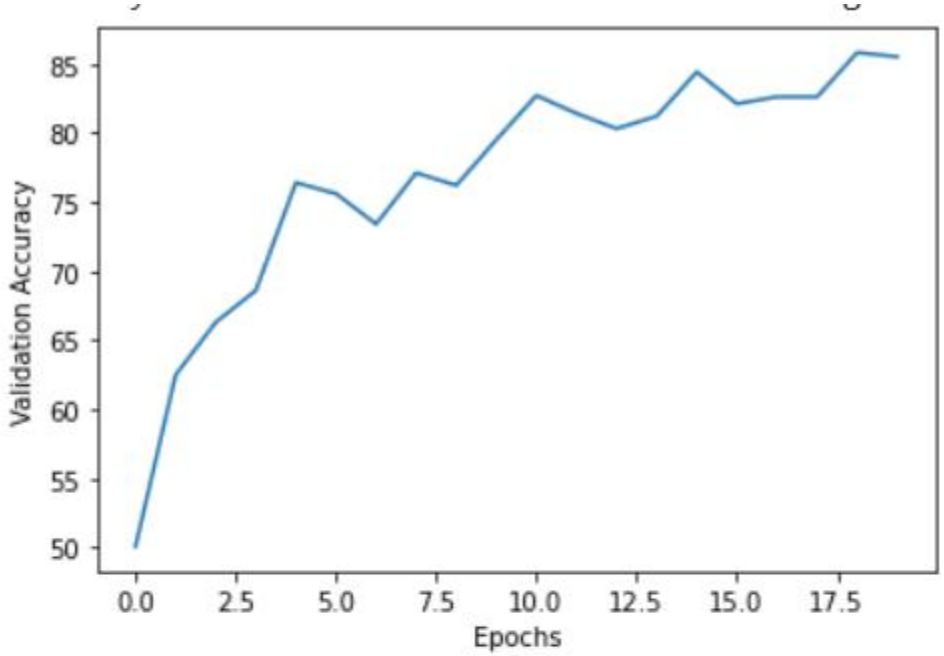

Loss
2.0
1.5
1.0
0.5
0
1000
2000
3000
4000
5000
Iterations

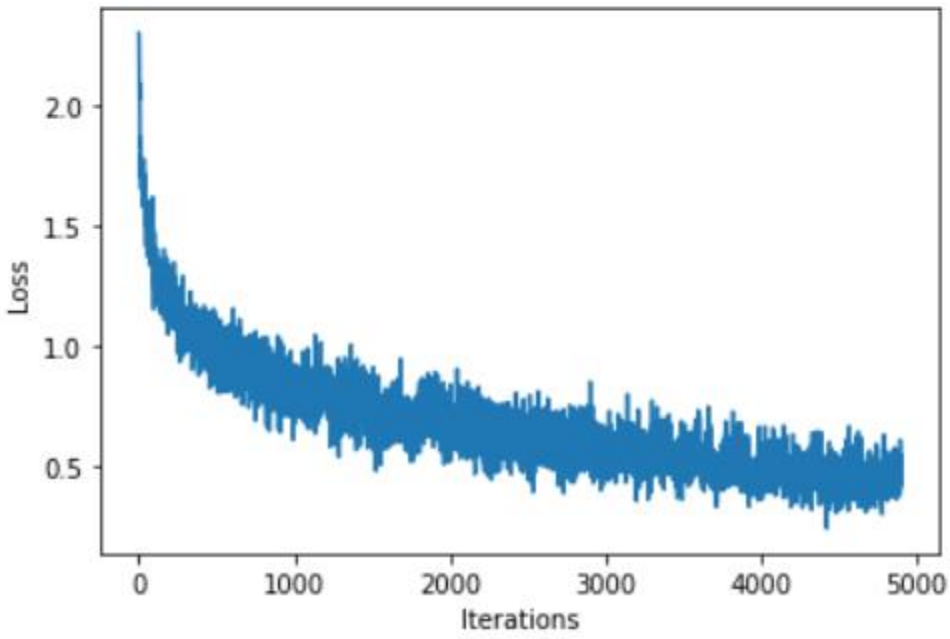
P = 0.25


Validation Accuracy
85
80
75
70
65
60
55
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

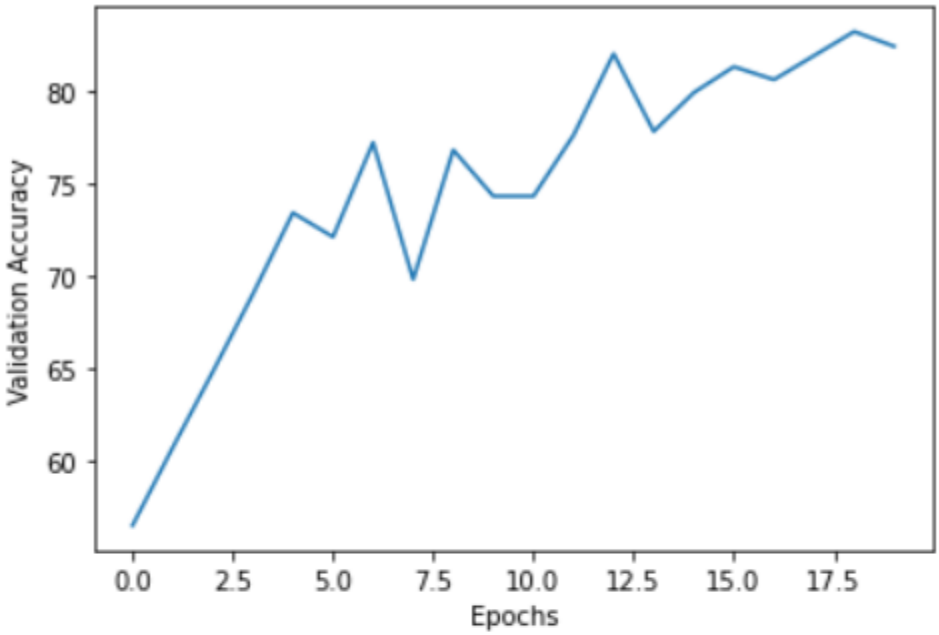

Loss
2.0
1.5
1.0
0.5
0
1000
2000
3000
4000
5000
Iterations

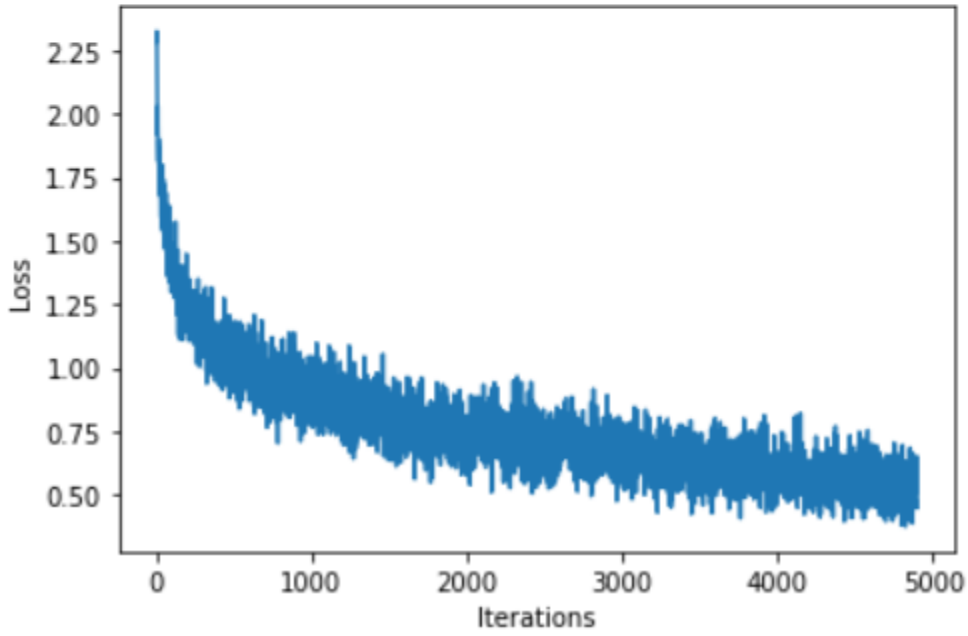
P = 0.3


Validation Accuracy
85
80
75
70
65
60
55
50
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

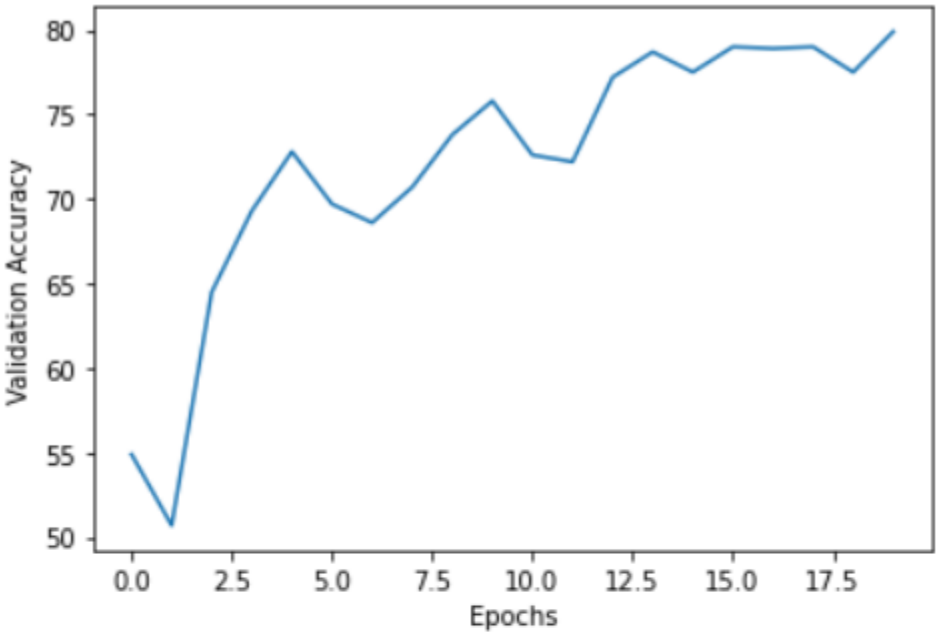

Loss
2.0
1.5
1.0
0.5
0
1000
2000
3000
4000
5000
Iterations

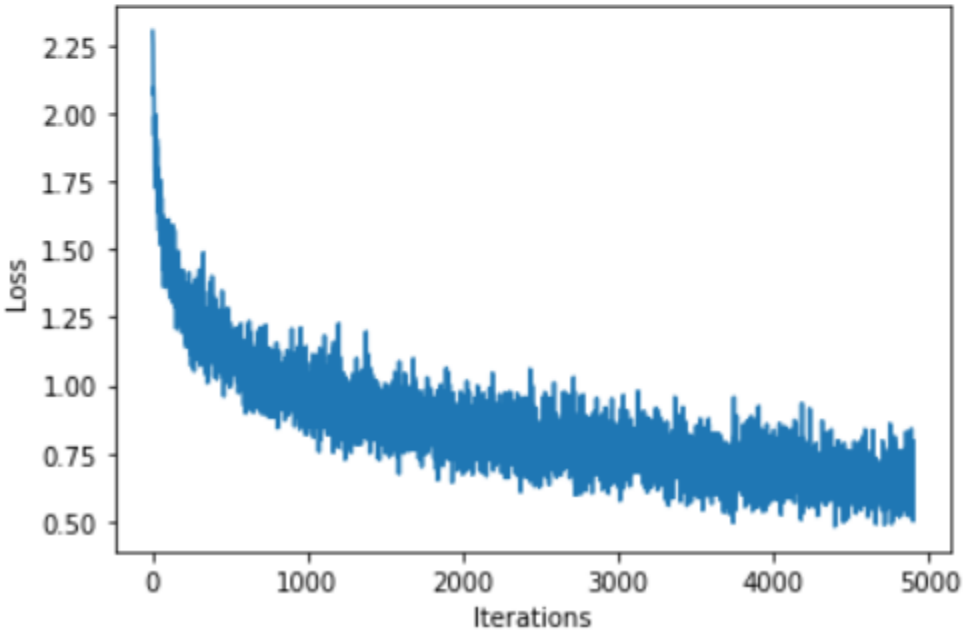
p = 0.4


Validation Accuracy
80
75
70
65
60
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

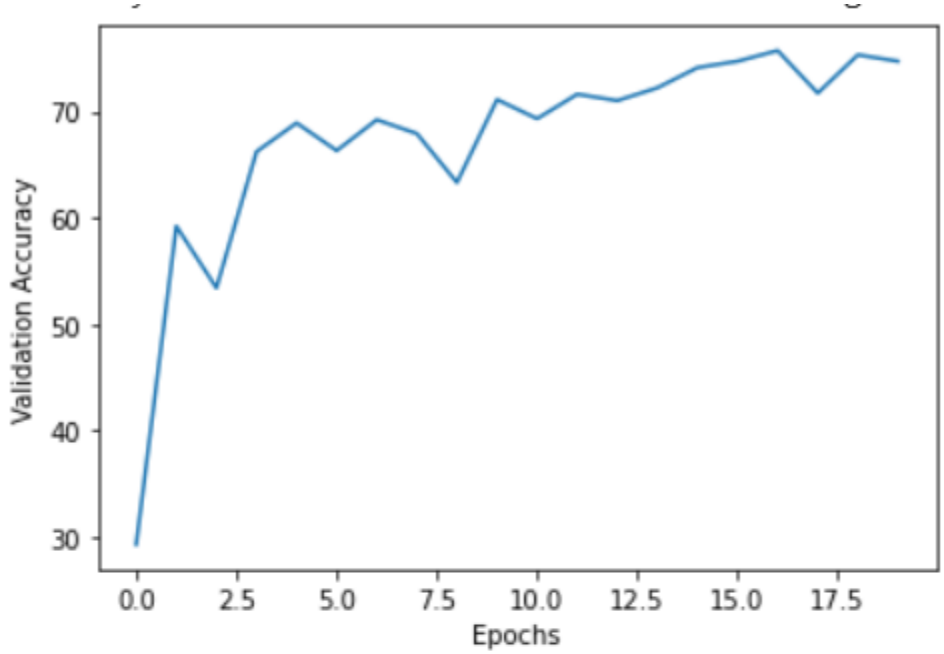

Loss
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
1000
2000
3000
4000
5000
Iterations

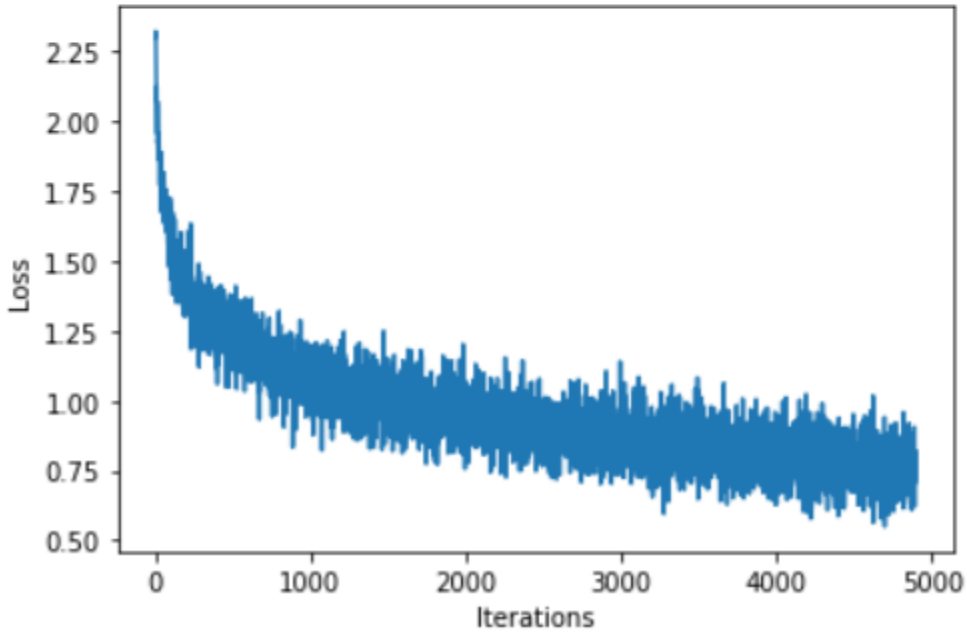
P = 0.5


Validation Accuracy
80
75
70
65
60
55
50
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

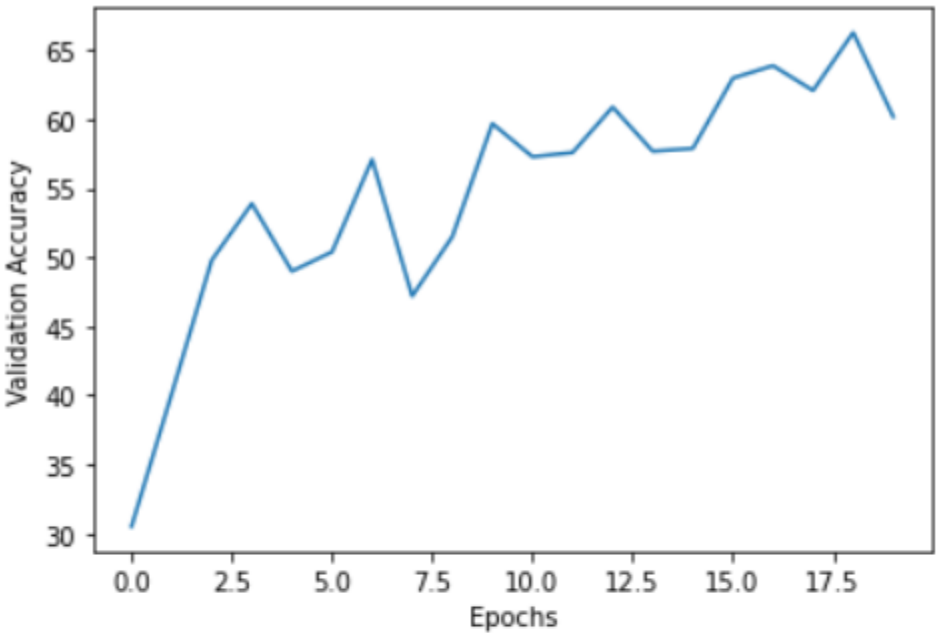

Loss
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
1000
2000
3000
4000
5000
Iterations

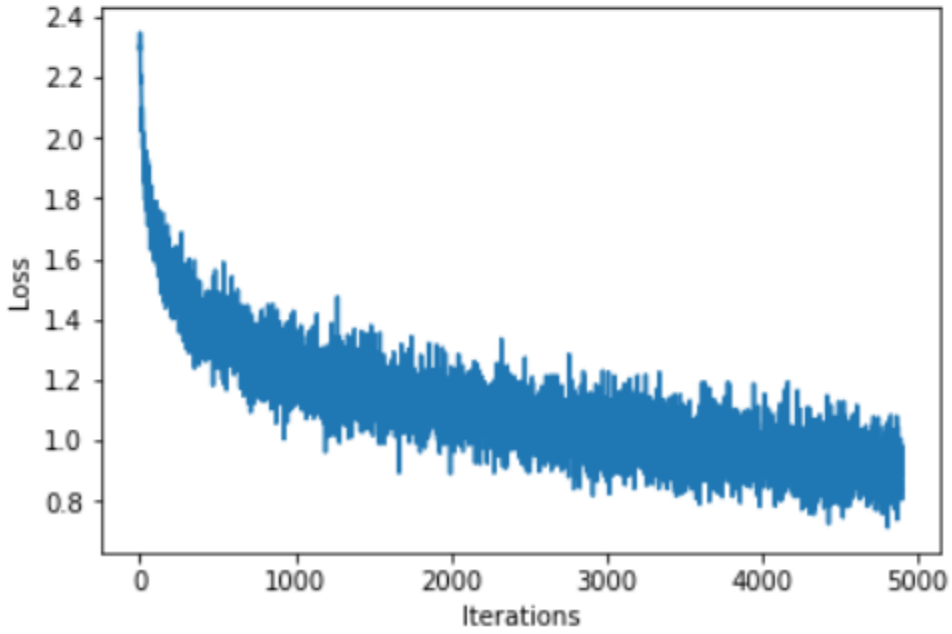
p = 0.6


Validation Accuracy
70
60
50
40
30
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

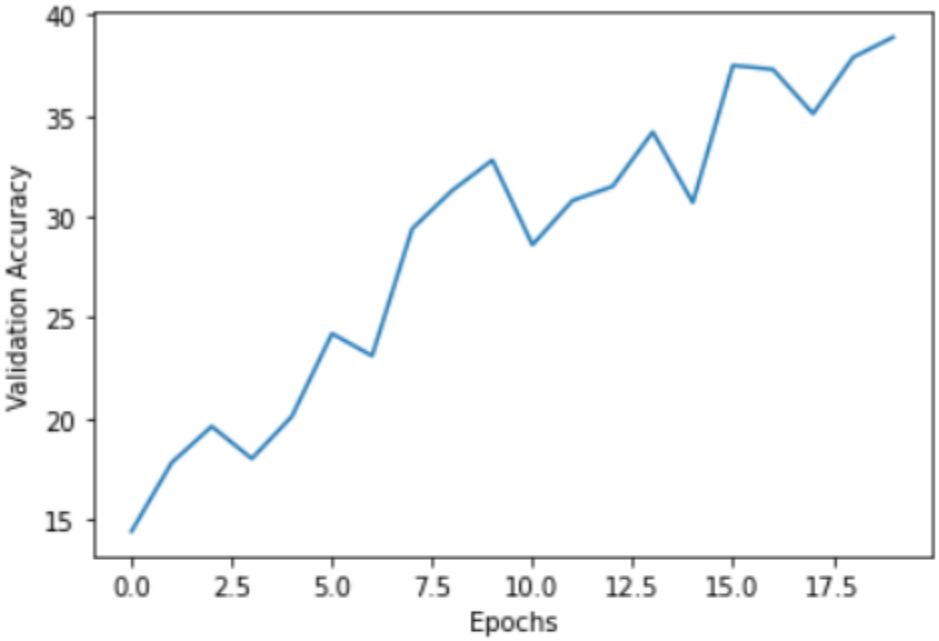

Loss
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
1000
2000
3000
4000
5000
Iterations

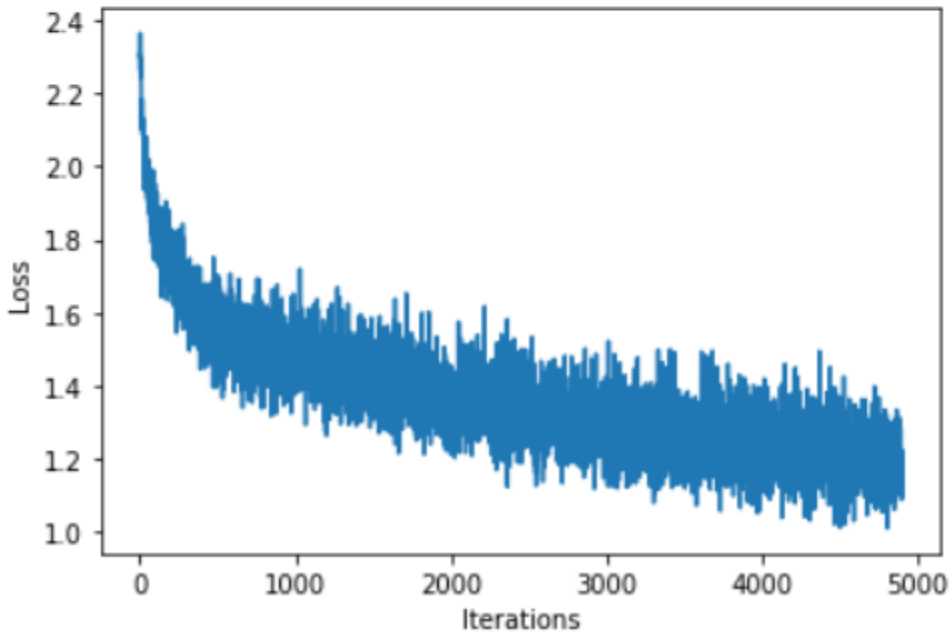
P = 0.7


Validation Accuracy
65
60
55
50
45
40
35
30
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs

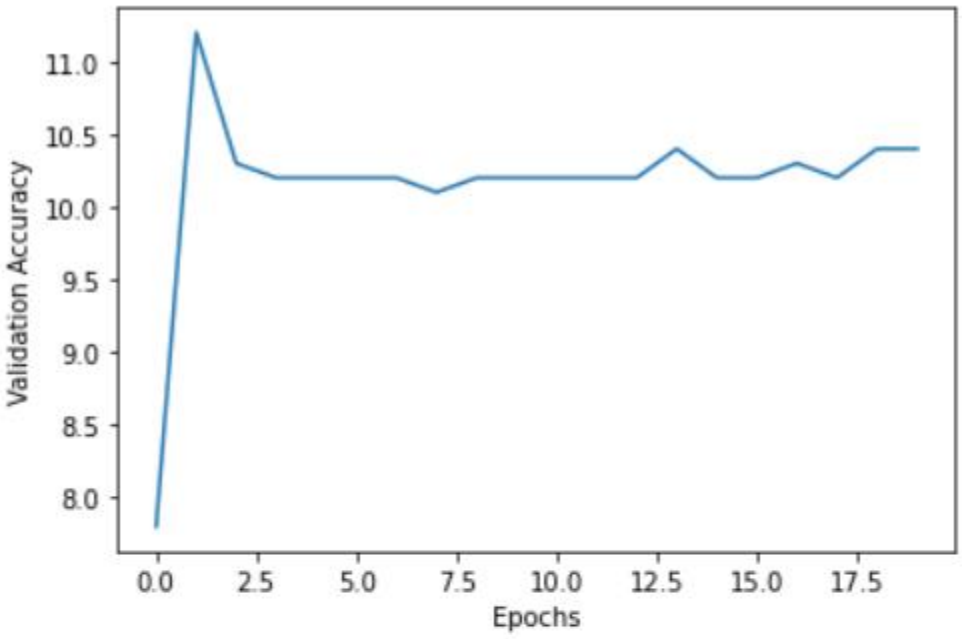

Loss
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0
1000
2000
3000
4000
5000
Iterations

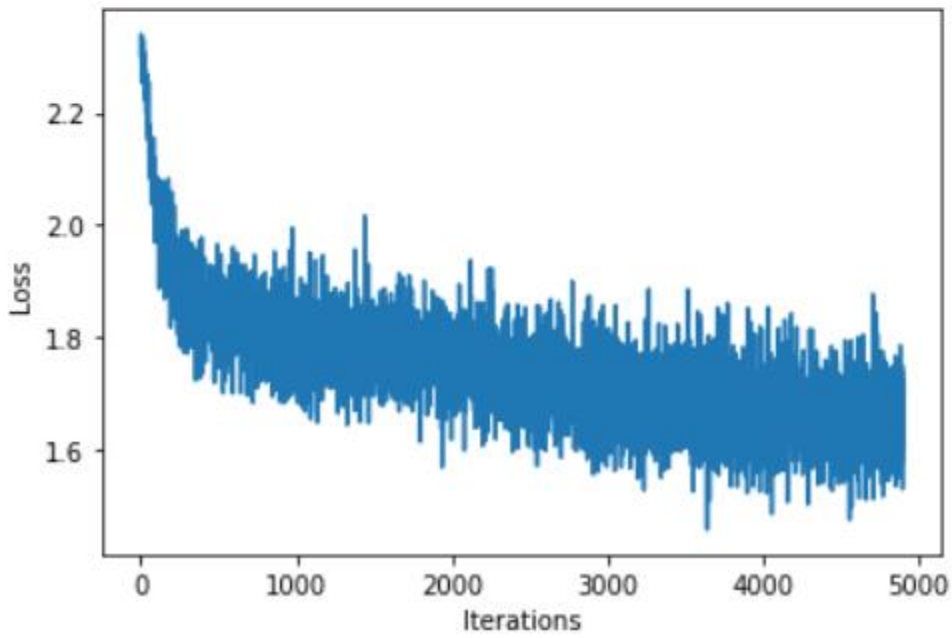
P = 0.8


Validation Accuracy
Epochs
40
35
30
25
20
15
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5


Loss
Iterations
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0
1000
2000
3000
4000
5000

P = 0.9


Validation Accuracy
11.0
10.5
10.0
9.5
9.0
8.5
8.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Epochs


Loss
2.2
2.0
1.8
1.6
0
1000
2000
3000
4000
5000
Iterations