Assignment 2B

Kritagya Nepal (kxn190007) Name of Group Member: None Number of free days used: 3

Face Expression Recognition using Convolution Neural Net

For image classification, the facial expression recognition is used. The dataset consists of seven different emotion which includes, 0 = Angry, 1 = Disgust, 2 = Fear, 3 = Happy, 4 = Sad, 5 = Surprise, 6 = Neutral. The dataset consists of 3 columns, which includes emotion, Usage and pixels respectively. There are total of 28709 training data and 7178 testing data. The pixel size for the image is 48*48 pixel. The link to the project can be found here:

Link

The training and testing data are in a csv file that looks like this:

emotion Usage	pixels												
0 Training	70 80 82 7	72 58 58 60 (53 54 58 60	48 89 115 1	21 119 115	110 98 91 8	4 84 90 99	110 126 14	3 153 158 1	71 169 172	169 165 129	110 113 10	07 95 79 66
0 Training	151 150 1	47 155 148	133 111 140	170 174 18	2 154 153 1	.64 173 178	185 185 18	89 187 186 1	193 194 185	183 186 18	0 173 166 1	.61 147 133	3 172 151 11
2 Training	231 212 1	56 164 174	138 161 17	3 182 200 10	6 38 39 74	138 161 164	1 179 190 20	01 210 216	220 224 22	2 218 216 2	13 217 220 :	220 218 217	7 212 174 16
4 Training	24 32 36 3	30 32 23 19	20 30 41 21	22 32 34 21	19 43 52 13	26 40 59 6	5 12 20 63 9	99 98 98 11	1 75 62 41	73 118 140 1	92 186 187	188 190 19	90 187 182 1
6 Training	400000	000000	3 15 23 28 4	8 50 58 84 :	115 127 137	142 151 15	6 155 149 1	153 152 157	7 160 162 1	59 145 121 8	3 58 48 38	21 17 7 5 2	5 27 24 25 1
2 Training	55 55 55 5	55 55 54 60 (58 54 85 15	1 163 170 17	79 181 185 1	188 188 191	196 189 19	94 198 197	195 194 190	193 195 18	34 175 172 1	161 159 158	8 159 147 13
4 Training	20 17 19 2	21 25 38 42	42 46 54 56	62 63 66 82	108 118 13	0 139 134 1	32 126 113	97 126 148	157 161 15	55 154 154 1	64 189 204	194 168 18	30 188 214 2
3 Training	77 78 79 7	79 78 75 60 5	55 47 48 58	73 77 79 57	50 37 44 56	70 80 82 8	7 91 86 80	73 66 54 57	68 69 68 68	3 49 46 75 7	1 69 70 70 7	72 72 71 72	74 77 76 83
3 Training	85 84 90 1	121 101 102	133 153 15	3 169 177 1	89 195 199	205 207 209	9 216 221 2	25 221 220	218 222 22	3 217 220 2	17 211 196	188 173 170	0 133 117 13
2 Training	255 254 2	55 254 254	179 122 107	7 95 124 149	150 169 17	78 179 179 I	181 181 184	190 191 19	91 193 190	190 195 194	192 193 19	6 193 192 1	188 182 173
0 Training	30 24 21 2	23 25 25 49 (57 84 103 1	20 125 130 1	139 140 139	148 171 17	78 175 176 1	174 180 180	178 178 1	32 185 183 1	86 186 178	180 172 17	75 171 155 1
6 Training	39 75 78 5	58 58 45 49	48 103 156	81 45 41 38	49 56 60 49	32 31 28 5	2 83 81 78 7	75 62 31 18	19 19 20 17	20 16 15 12	2 10 11 10 2	3 36 65 59 9	9 3 5 7 93 69
6 Training	219 213 2	06 202 209	217 216 215	219 218 22	23 230 227 2	27 233 235	234 236 23	7 238 234 2	226 219 212	208 201 19	0 183 176 1	.61 74 15 24	4 22 22 22 2
6 Training	148 144 1	30 129 119	122 129 13:	l 139 153 14	0 128 139 1	.44 146 143	132 133 13	34 130 140 1	142 150 152	150 134 12	8 149 142 1	.38 156 155	140 136 14
3 Training	4 2 13 41	56 62 67 87	95 62 65 70	80 107 127	149 153 15	0 165 168 1	77 187 176	167 152 12	8 130 149 1	149 146 130	139 139 14	3 134 105 7	78 56 36 50
5 Training	107 107 1	09 109 109	109 110 10	l 123 140 14	4 144 149 1	53 160 161	161 167 16	8 169 172 1	172 173 175	176 171 17	0 166 165 1	.62 162 157	7 150 149 14
3 Training	14 14 18 2	28 27 22 21	30 42 61 77	86 88 95 10	0 99 101 99	98 99 99 9	6 101 102 9	6 95 94 88 7	78 72 65 55	40 25 20 20	42 64 74 12	29 133 125	144 151 153
2 Training	255 255 2	55 255 255	255 255 255	255 255 25	5 255 255 2	55 255 255	255 255 25	5 255 255 2	255 255 255	255 255 25	5 255 255 2	55 255 255	255 255 25
6 Training	134 124 1	67 180 197	194 203 210	204 203 20	9 204 206 2	211 211 216	219 224 22	28 230 230 2	226 222 220	217 217 21	0 207 213 2	10 199 191	l 190 188 17
4 Training	219 192 1	79 148 208	254 192 98	121 103 145	185 83 58	114 227 225	5 220 203 20	02 168 154	157 164 18	2 211 164 94	1 122 155 1	76 238 240	242 192 87
4 Training	111111	1111111	2222712	23 45 38 35	14 43 27 31	L 24 18 20 2	9 18 6 2 4 2	011110	5 13 16 16	16 15 14 1 1	111111	1111003	3 7 9 27 44 4
2 Training	174 51 37	37 38 41 22	25 22 24 3	5 51 70 83 9	8 113 119 1	27 136 149	149 141 12	5 107 77 50	30 21 9 38	96 79 72 87	60 23 25 4	3 29 24 33 5	51 36 33 26
0 Training	123 125 1	24 142 209	226 234 236	5 231 232 23	5 223 211 1	96 184 181	182 186 18	35 193 208 2	211 208 201	196 192 19	1 192 194 2	01 207 216	5 225 225 22
0 Training	8 9 14 21	26 32 37 46	52 62 72 70	71 73 76 83	98 92 80 9	0 110 148 1	58 149 166	172 166 16	6 164 179 1	96 197 189	185 194 18	9 174 173 1	.77 179 186
3 Training	252 250 2	46 229 182	140 98 72 5	3 44 67 95 9	5 89 89 90 9	90 93 94 89	88 88 83 82	2 81 73 74 6	9 69 64 58	49 46 49 35	32 27 25 24	21 13 9 11	15 15 15 21
3 Training	224 227 2	19 217 215	210 187 17	7 189 200 20	6 212 210 2	08 204 207	206 207 20	5 203 203 2	206 206 201	204 199 19	6 189 187 1	.87 186 185	184 186 18
5 Training	162 200 1	87 180 197	198 196 192	2 176 152 13	6 114 109 1	17 124 133	162 182 19	5 200 202 2	203 204 200	201 202 20	0 200 200 2	00 198 195	192 189 18
0 Training	236 230 2	25 226 228	209 199 193	3 196 211 19	9 198 194 1	99 214 209	202 207 17	79 156 154 1	152 157 156	151 144 13	6 138 140 1	.48 183 209	9 192 177 15
3 Training	210 210 2	10 210 211	207 147 103	8 68 60 47 7	0 124 118 1	19 123 124	131 136 13	8 146 144 1	47 152 157	159 162 163	5 165 164 1	53 161 159	159 159 162
5 Training	50 44 74 1	141 187 187	169 113 80	128 181 17	2 76 62 37 4	1 40 37 55	44 37 36 48	45 40 48 8	2 82 78 69 5	6 60 50 42 5	52 69 125 1	54 128 68 5	7 46 50 51 4
3 Training	234 233 2	28 231 234	233 236 230	236 196 11	2 85 100 11	4 129 133 1	132 132 147	7 164 180 15	66 161 156	151 150 137	117 139 15	7 138 145 1	137 132 114
6 Training	244 214 1	98 187 105	89 47 38 40	28 26 29 42	39 33 48 35	5 22 28 31 4	12 46 42 58	61 54 42 46	54 43 38 4	9 50 86 100	101 93 65 6	9 71 61 114	4 161 211 23
3 Training		8 66 61 52 5											
2 Training	59 63 70 6	57 67 72 69 8	80 95 105 1	25 141 149 :	155 164 168	168 174 18	80 181 184 1	187 190 194	194 196 20	00 201 201 2	200 200 196	193 191 18	36 181 179 1

Testing Data:

0 PublicTes 31 24 29 29 39 44 28 20 17 20 23 28 24 29 37 33 22 20 25 28 24 22 23 28 29 25 27 30 38 44 47 49 53 55 53 45 40 43 54 52 50 47 44 45 46 47 43 54 32 26 33 35 34 3 PublicTes 35 48 70 75 58 44 45 44 42 54 78 70 59 83 120 87 79 138 155 173 171 171 172 170 167 155 134 115 115 127 147 160 166 165 160 157 152 147 142 77 22 43 66 6 5 PublicTes 91 146 230 198 196 206 175 214 215 227 223 208 211 208 196 202 180 173 176 196 179 160 166 167 170 174 162 153 146 157 151 135 140 120 98 106 83 109 98 5 PublicTes 229 222 208 196 200 209 207 181 156 141 136 130 129 129 128 129 131 132 134 134 134 134 134 135 137 139 139 139 139 140 139 140 141 140 141 140 141 142 145 6 PublicTes 113 71 18 31 31 30 31 64 90 58 67 79 71 38 15 18 49 86 70 97 126 121 122 124 129 124 122 127 121 110 128 128 127 103 69 83 58 23 28 27 40 83 93 98 82 53 54 4 PublicTes 20 15 24 26 26 22 15 20 32 60 88 112 135 143 146 150 155 154 156 159 158 157 153 149 153 154 150 157 157 158 156 157 158 156 152 140 141 147 135 120 71 46 4 3 PublicTes 166 66 8 8 13 18 16 18 13 19 13 6 16 25 27 26 31 35 44 61 57 45 93 109 145 169 159 167 195 195 212 210 203 208 210 205 192 164 120 69 57 94 107 73 153 4 PublicTes 108 116 135 133 135 146 147 147 160 158 164 166 150 150 140 138 142 128 120 111 110 106 100 94 93 104 115 127 143 150 160 168 163 151 153 150 136 109 1 PublicTes 136 83 25 126 135 134 134 133 134 65 91 106 112 94 45 126 194 204 188 117 54 107 77 132 129 134 46 83 133 132 124 41 90 132 131 131 29 73 135 133 136 29 PublicTes 9 22 40 18 8 6 17 15 32 58 65 75 81 87 90 97 100 105 109 116 122 126 131 128 126 125 119 119 118 112 104 87 72 93 94 85 82 77 64 48 43 17 12 13 10 10 11 74 3 PublicTes 10 18 18 11 18 46 39 37 24 24 36 32 31 37 33 32 25 25 38 29 33 33 25 29 37 34 24 30 30 30 37 36 31 31 30 34 38 36 33 26 34 32 16 19 30 46 43 44 69 56 41 16 3 PublicTes 0 0 0 0 0 0 0 1 0 0 0 1 1 1 1 3 4 21 40 53 65 69 72 70 67 70 67 67 67 67 55 44 41 33 21 13 9 9 9 16 12 13 18 28 56 73 70 106 1 1 0 1 0 0 0 0 0 0 0 1 2 2 3 11 37 56 7 4 PublicTes 178 176 172 173 173 174 176 173 166 166 206 226 228 215 195 174 146 118 95 99 110 126 132 141 157 164 154 151 158 167 170 172 182 183 180 192 196 207 3 PublicTes 25 34 42 44 42 47 57 59 59 58 54 51 50 56 63 60 63 66 67 74 87 95 93 87 79 69 68 66 63 63 54 49 58 76 113 153 176 184 196 212 214 211 216 219 218 219 217 21 4 PublicTes 33 25 31 36 36 42 69 103 132 163 175 183 187 190 194 197 197 196 200 200 201 203 200 198 199 197 192 190 185 183 180 158 85 39 27 21 11 35 69 38 30 28 27 4 PublicTes 61 63 59 75 151 159 166 161 143 170 127 131 184 216 222 52 70 89 83 97 93 92 88 85 89 83 85 76 67 60 60 57 31 90 136 100 122 111 71 50 92 86 88 94 82 88 81 0 Private Te: 170 118 101 88 88 75 78 82 66 74 68 59 63 64 65 90 89 73 80 80 85 88 95 117 132 146 139 152 164 181 182 194 195 162 142 147 151 148 158 127 113 112 97 11 5 PrivateTe: 7586732654457555677710108681112159716219813182320232724262847541810157586310971246667798789858141 6 PrivateTe: 232 240 241 239 237 235 246 117 24 24 22 13 12 14 9 8 5 6 8 9 9 7 7 6 4 4 4 5 7 4 10 12 12 15 20 14 17 36 206 243 234 236 236 237 235 235 233 235 230 238 242 4 Private Te: 200 197 149 139 156 89 111 58 62 95 113 117 116 116 112 111 96 86 99 113 120 117 116 109 114 125 132 136 136 132 128 128 134 132 132 136 138 137 134 13 2 PrivateTe: 40 28 33 56 45 33 31 78 152 194 200 186 196 207 194 185 197 185 176 167 166 162 160 151 145 142 135 134 134 131 125 122 101 72 48 32 27 22 23 24 22 25 0 PrivateTe: 138 142 66 80 87 92 97 99 88 73 72 83 92 102 113 121 122 175 159 136 159 141 141 136 152 167 149 153 162 152 145 130 122 115 111 109 116 144 154 148 142 4 Private Te 72 66 66 69 62 51 57 60 56 66 63 70 68 68 81 95 106 122 130 133 139 143 138 131 134 142 136 124 110 109 109 106 108 98 94 60 81 98 97 95 98 100 101 98 98 98 3 PrivateTe: 4 4 7 12 14 18 26 31 33 38 44 49 59 68 80 86 94 103 110 122 135 149 159 168 175 182 190 199 207 215 222 227 228 227 226 222 218 214 206 191 170 148 107 6 0 PrivateTe: 245 245 239 122 144 101 33 37 84 137 143 130 135 146 148 149 143 135 138 127 129 137 146 140 144 152 164 163 165 165 171 170 160 153 135 110 54 29 54 6 3 PrivateTe: 20 31 65 81 79 63 61 51 61 97 114 121 140 200 158 137 148 174 177 184 177 156 150 159 182 183 180 170 157 146 137 122 82 87 108 74 73 84 120 143 131 126 5 PrivateTe: 255 255 255 252 255 212 122 107 137 178 196 211 219 223 228 232 236 238 239 238 237 237 238 239 240 241 241 240 239 239 238 236 232 227 219 203 169 13 3 PrivateTe: 245 247 243 242 233 229 213 190 173 141 109 138 175 187 195 204 206 206 207 206 211 208 207 205 201 201 202 202 196 188 164 128 86 45 28 25 26 30 41 52 4 PrivateTe 60 41 21 35 43 50 49 54 56 62 68 75 82 87 93 99 106 113 115 114 105 92 80 83 81 77 83 63 40 30 24 30 43 37 35 53 56 34 55 53 69 72 65 68 70 65 67 65 64 44 23 4 PrivateTe: 190 192 198 197 189 184 168 142 105 107 156 160 144 119 108 106 85 84 97 114 121 127 128 128 125 126 141 146 151 160 161 164 161 162 164 164 163 162 10 0 PrivateTe: 215 218 222 220 221 226 218 215 216 218 215 216 212 207 204 205 203 204 205 203 205 206 208 211 208 207 207 204 202 181 155 165 188 218 221 223 208 18 2 PrivateTe: 133 140 138 137 136 133 130 124 114 105 115 117 111 114 105 88 66 75 86 85 83 75 69 60 45 63 65 64 59 56 42 59 85 79 78 82 97 120 150 231 244 241 242 241 5 PrivateTe: 124 141 120 113 105 106 114 103 91 109 105 105 89 94 107 112 100 88 94 96 101 113 108 107 143 151 137 131 135 140 132 143 158 156 145 143 148 129 121 1 4 PrivateTe: 253 253 253 252 253 252 254 253 252 248 244 248 230 180 175 169 148 147 154 160 163 171 186 203 228 252 255 254 251 253 252 251 251 249 250 251 244 24 2 PrivateTe: 102 102 103 102 102 103 103 103 103 103 103 103 102 110 108 103 104 106 94 40 34 35 27 21 24 30 39 24 28 42 43 57 51 30 48 50 65 82 83 111 102 105 93 95 89 85 64 82 8: 3 PrivateTe: 221 177 138 120 110 90 84 82 86 101 104 91 79 95 98 79 80 82 89 84 78 80 73 71 73 71 76 73 70 69 65 64 59 57 54 65 93 101 124 215 247 253 254 255 254 255 2 6 PrivateTe: 22 18 17 17 26 35 26 18 22 22 18 19 14 22 24 23 23 19 18 21 19 21 22 17 14 16 75 108 125 140 158 175 188 196 202 210 212 213 215 217 218 218 217 216 216 22 0 PrivateTe: 58 52 55 62 59 42 40 45 43 39 40 43 46 46 56 77 83 78 74 68 77 74 78 78 76 80 94 110 109 108 116 123 126 115 96 92 77 69 65 59 47 49 46 47 54 56 61 48 69 64

Model: The model consists of three convolutional and two Maxpolling layers which is then passed to four dense layer.

[74] model.summary()

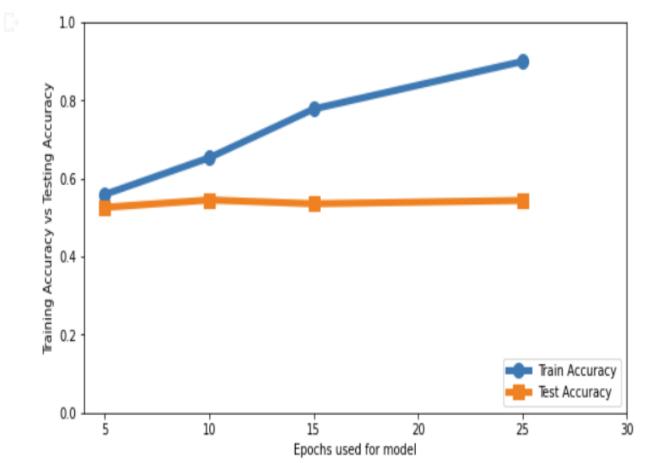
Model: "sequential_10"

Layer (type)	Output	Shape	Param #
conv2d_30 (Conv2D)	(None,	46, 46, 32)	320
max_pooling2d_20 (MaxPooling	(None,	23, 23, 32)	0
conv2d_31 (Conv2D)	(None,	21, 21, 64)	18496
max_pooling2d_21 (MaxPooling	(None,	10, 10, 64)	0
conv2d_32 (Conv2D)	(None,	8, 8, 64)	36928
flatten_10 (Flatten)	(None,	4096)	0
dense_39 (Dense)	(None,	32)	131104
dense_40 (Dense)	(None,	32)	1056
dense_41 (Dense)	(None,	32)	1056
dense_42 (Dense)	(None,	7)	231

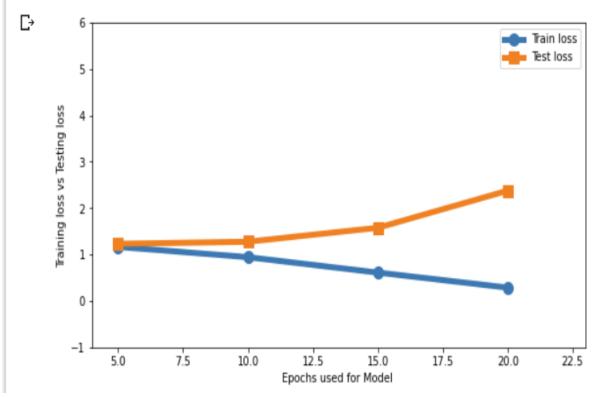
Total params: 189,191 Trainable params: 189,191 Non-trainable params: 0 The training data is fitted into the model with an epoch of 10 and the training accuracy obtained is 63% while the loss is 9.6%. This model is tested with the test data, which yields the accuracy of 53% and loss of 12%.

The plot for training accuracy and test accuracy is show below:

```
plt.figure(figsize=(9,5))
plt.plot([5,10,15,25], train_acc, linewidth=5, marker='o', markersize=10)
plt.plot([5,10,15,25], test_acc, linewidth=5, marker='s', markersize=10)
plt.xlabel('Epochs used for model', fontsize=10)
plt.ylabel('Training Accuracy vs Testing Accuracy', fontsize=10)
plt.legend(['Train Accuracy','Test Accuracy'], fontsize=10, loc='lower right')
plt.axis([4, 30, 0, 1])
plt.show()
```



```
plt.figure(figsize=(9,5))
plt.plot([5,10,15,20], train_loss, linewidth=5, marker='o', markersize=10)
plt.plot([5,10,15,20], test_loss, linewidth=5, marker='s', markersize=10)
plt.xlabel('Epochs used for Model ', fontsize=10)
plt.ylabel('Training loss vs Testing loss', fontsize=10)
plt.legend(['Train loss','Test loss'], fontsize=10, loc='upper right')
plt.axis([4, 23, -1, 6])
plt.show()
```



Iteration	Parameters	Training and	
		Test Accuracy	
1	No. of layers: 3 Conv 2D layers,2 Maxpolling layers and 4	Train: 53%	
	dense layers	Test: 52%	
	Number of kernels: 32, 64, 64		
	No. of neuron in last dense layer: 7		
	Activation function: ReLu, Last Layer: Softmax		
	Error function: Categorical cross entropy		
	Batch Size: 64		
	No. of epochs: 5		

2	No. of layers: 3 Conv 2D layers,2 Maxpolling layers and 4	Train: 54.5%
	dense layers	Test: 54.4%
	Number of kernels: 32,64,64	
	No. of neuron in last dense layer: 7	
	Activation function: Relu, Last Layer: softmax	
	Error function: Categorical cross entropy	
	Batch Size: 64	
	No. of epochs: 10	
3	No. of layers: 3 Conv 2D layers,2 Maxpolling layers and 4	Train: 70%
	dense layers	Test: 53.3%
	Number of kernels: 32,64,64	
	No. of neuron in last dense layer: 7	
	Activation function: Relu, Last Layer: softmax	
	Error function: Categorical cross entropy	
	Batch Size: 64	
	No. of epochs: 15	
4	No. of layers: 3 Conv 2D layers,2 Maxpolling layers and 4	Train:
	dense layers	Test: 54%
	Number of kernels: 32,64,64	
	No. of neuron in last dense layer: 7	
	Activation function: Relu, Last Layer: softmax	
	Error function: Categorical cross entropy	
	Batch Size: 64	
	No. of epochs: 20	

Out of the three methods, Convolutional layers performed the based. The accuracy of this model is much higher than the other two. Since the accuracy for this model is still less than optimal accuracy, we can perform fine tuning and image augmentation to increase the accuracy.