

## Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

<b>Number of Filters</b>	128		128			512		512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)						
<b>Padding</b>	valid		valid							
<b>activation</b>	relu		relu			relu		relu		softmax

Epoch 1/30

2017-11-25 22:29:11.195056: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-11-25 22:29:11.195673: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0 totalMemory: 11.17GiB freeMemory: 11.03GiB

2017-11-25 22:29:11.195697: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 251s - loss: 1.3899 - acc: 0.2665 - val\_loss: 1.3888 - val\_acc: 0.2500

Epoch 2/30

250/250 [=====] - 239s - loss: 1.1286 - acc: 0.4250 - val\_loss: 0.7277 - val\_acc: 0.6020

Epoch 3/30

250/250 [=====] - 235s - loss: 0.7380 - acc: 0.6116 - val\_loss: 0.6064 - val\_acc: 0.6533

Epoch 4/30

250/250 [=====] - 233s - loss: 0.6735 - acc: 0.6252 - val\_loss: 0.5630 - val\_acc: 0.6756

Epoch 5/30

250/250 [=====] - 234s - loss: 0.6311 - acc: 0.6492 - val\_loss: 0.5086 - val\_acc: 0.6916

Epoch 6/30

250/250 [=====] - 232s - loss: 0.5868 - acc: 0.6685 - val\_loss: 0.5606 - val\_acc: 0.6624

Epoch 7/30

250/250 [=====] - 232s - loss: 0.5775 - acc: 0.6798 - val\_loss: 0.4881 - val\_acc: 0.6953

Epoch 8/30

250/250 [=====] - 232s - loss: 0.5472 - acc: 0.6957 - val\_loss: 0.4822 - val\_acc: 0.7172

Epoch 9/30

250/250 [=====] - 233s - loss: 0.5395 - acc: 0.7001 - val\_loss: 0.4812 - val\_acc: 0.7150

Epoch 10/30

250/250 [=====] - 239s - loss: 0.5285 - acc: 0.6961 - val\_loss: 0.4548 - val\_acc: 0.7152

Epoch 11/30

250/250 [=====] - 235s - loss: 0.5067 - acc: 0.7096 - val\_loss: 0.4570 - val\_acc: 0.7095

Epoch 12/30

250/250 [=====] - 244s - loss: 0.5090 - acc: 0.7089 - val\_loss: 0.4251 - val\_acc: 0.7231

Epoch 13/30

250/250 [=====] - 235s - loss: 0.4970 - acc: 0.7154 - val\_loss: 0.4288 - val\_acc: 0.7334

Epoch 14/30

250/250 [=====] - 235s - loss: 0.5101 - acc: 0.7154 - val\_loss: 0.4270 - val\_acc: 0.7353

Epoch 15/30

250/250 [=====] - 234s - loss: 0.4734 - acc: 0.7200 - val\_loss: 0.4086 - val\_acc: 0.7357

Epoch 16/30

250/250 [=====] - 232s - loss: 0.4809 - acc: 0.7180 - val\_loss: 0.4103 - val\_acc: 0.7418

Epoch 17/30

250/250 [=====] - 229s - loss: 0.4771 - acc: 0.7288 - val\_loss: 0.4569 - val\_acc: 0.7269

Epoch 18/30

250/250 [=====] - 231s - loss: 0.4677 - acc: 0.7245 - val\_loss: 0.4155 - val\_acc: 0.7424

Epoch 19/30

250/250 [=====] - 231s - loss: 0.4614 - acc: 0.7328 - val\_loss: 0.4409 - val\_acc: 0.7229

Epoch 20/30

250/250 [=====] - 233s - loss: 0.4654 - acc: 0.7306 - val\_loss: 0.4133 - val\_acc: 0.7472

Epoch 21/30

250/250 [=====] - 233s - loss: 0.4677 - acc: 0.7271 - val\_loss: 0.4272 - val\_acc: 0.7264

Test loss: 4.9933286047

# Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

Test accuracy 0.66375

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 300, 300, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 50, 50, 128)	0
conv2d_2 (Conv2D)	(None, 50, 50, 128)	589952
max_pooling2d_2 (MaxPooling2)	(None, 8, 8, 128)	0
flatten_1 (Flatten)	(None, 8192)	0
dense_1 (Dense)	(None, 512)	4194816
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052

Total params: 5,063,428

Trainable params: 5,063,428

Non-trainable params: 0

<b>Number of Filters</b>	128		250			512		512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)						
<b>Padding</b>	same		same							
<b>activation</b>	relu		relu			relu		relu		softmax

Epoch 1/30

2017-11-29 14:20:43.752113: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-11-29 14:20:43.752793: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.03GiB 128, 250, 512, 512

2017-11-29 14:20:43.752822: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 258s - loss: 1.3673 - acc: 0.3084 - val\_loss: 1.2138 - val\_acc: 0.4500

Epoch 2/30

250/250 [=====] - 249s - loss: 0.9916 - acc: 0.5166 - val\_loss: 0.6953 - val\_acc: 0.6129

Epoch 3/30

250/250 [=====] - 249s - loss: 0.7244 - acc: 0.6158 - val\_loss: 0.5993 - val\_acc: 0.6610

Epoch 4/30

250/250 [=====] - 249s - loss: 0.6868 - acc: 0.6315 - val\_loss: 0.5539 - val\_acc: 0.6814

Epoch 5/30

250/250 [=====] - 248s - loss: 0.6293 - acc: 0.6496 - val\_loss: 0.5570 - val\_acc: 0.6839

Epoch 6/30

250/250 [=====] - 248s - loss: 0.6124 - acc: 0.6615 - val\_loss: 0.5166 - val\_acc: 0.7008

Epoch 7/30

250/250 [=====] - 248s - loss: 0.5984 - acc: 0.6649 - val\_loss: 0.5135 - val\_acc: 0.7039

Epoch 8/30

250/250 [=====] - 248s - loss: 0.5678 - acc: 0.6842 - val\_loss: 0.4847 - val\_acc: 0.7107

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Epoch 9/30  
250/250 [=====] - 248s - loss: 0.5547 - acc: 0.6837 - val\_loss: 0.4642 - val\_acc: 0.7163

Epoch 10/30  
250/250 [=====] - 247s - loss: 0.5497 - acc: 0.6914 - val\_loss: 0.4707 - val\_acc: 0.7219

Epoch 11/30  
250/250 [=====] - 249s - loss: 0.5354 - acc: 0.6930 - val\_loss: 0.4615 - val\_acc: 0.7161

Epoch 12/30  
250/250 [=====] - 248s - loss: 0.5203 - acc: 0.6989 - val\_loss: 0.4595 - val\_acc: 0.7168

Epoch 13/30  
250/250 [=====] - 247s - loss: 0.5129 - acc: 0.7022 - val\_loss: 0.4721 - val\_acc: 0.7277

Epoch 14/30  
250/250 [=====] - 250s - loss: 0.5127 - acc: 0.7066 - val\_loss: 0.4289 - val\_acc: 0.7357

Epoch 15/30  
250/250 [=====] - 248s - loss: 0.4982 - acc: 0.7176 - val\_loss: 0.4338 - val\_acc: 0.7412

Epoch 16/30  
250/250 [=====] - 247s - loss: 0.4892 - acc: 0.7217 - val\_loss: 0.4404 - val\_acc: 0.7366

Epoch 17/30  
250/250 [=====] - 248s - loss: 0.4812 - acc: 0.7234 - val\_loss: 0.4357 - val\_acc: 0.7448

Epoch 18/30  
250/250 [=====] - 247s - loss: 0.4889 - acc: 0.7245 - val\_loss: 0.4627 - val\_acc: 0.7320

Epoch 19/30  
250/250 [=====] - 247s - loss: 0.4715 - acc: 0.7344 - val\_loss: 0.4128 - val\_acc: 0.7608

Epoch 20/30  
250/250 [=====] - 248s - loss: 0.4676 - acc: 0.7295 - val\_loss: 0.4399 - val\_acc: 0.7484

Epoch 21/30  
250/250 [=====] - 247s - loss: 0.4742 - acc: 0.7322 - val\_loss: 0.5086 - val\_acc: 0.7316

Epoch 22/30  
250/250 [=====] - 247s - loss: 0.4559 - acc: 0.7415 - val\_loss: 0.4207 - val\_acc: 0.7291

Epoch 23/30  
250/250 [=====] - 247s - loss: 0.4630 - acc: 0.7359 - val\_loss: 0.4181 - val\_acc: 0.7605

Epoch 24/30  
250/250 [=====] - 248s - loss: 0.4560 - acc: 0.7436 - val\_loss: 0.4040 - val\_acc: 0.7397

Epoch 25/30  
250/250 [=====] - 249s - loss: 0.4527 - acc: 0.7414 - val\_loss: 0.4063 - val\_acc: 0.7520

Epoch 26/30  
61/250 [=====>.....] - ETA: 114s - loss: 0.4510 - acc: 0.744  
62/250 [=====>.....] - ETA: 114s - loss: 0.4510 - acc: 0.744  
63/250 [=====>.....] - ETA: 113s - loss: 0.4510 - acc: 0.744  
64/250 [=====>.....] - ETA: 113s - loss: 0.4514 - acc: 0.741  
65/250 [=====>.....] - ETA: 113s - loss: 0.4526 - acc: 0.739  
66/250 [=====>.....] - ETA: 112s - loss: 0.4524 - acc: 0.740  
67/250 [=====>.....] - ETA: 112s - loss: 0.4507 - acc: 0.741  
68/250 [=====>.....] - ETA: 111s - loss: 0.4510 - acc: 0.740  
69/250 [=====>.....] - ETA: 111s - loss: 0.4511 - acc: 0.739  
70/250 [=====>.....] - ETA: 111s - loss: 0.4514 - acc: 0.738  
71/250 [=====>.....] - ETA: 110s - loss: 0.4542 - acc: 0.736  
250/250 [=====] - 249s - loss: 0.4526 - acc: 0.7418 - val\_loss: 0.3967 - val\_acc: 0.7418

Epoch 27/30  
250/250 [=====] - 248s - loss: 0.4521 - acc: 0.7460 - val\_loss: 0.4216 - val\_acc: 0.7593

Epoch 28/30  
250/250 [=====] - 248s - loss: 0.4551 - acc: 0.7425 - val\_loss: 0.4052 - val\_acc: 0.7486

Epoch 29/30  
250/250 [=====] - 248s - loss: 0.4412 - acc: 0.7514 - val\_loss: 0.4146 - val\_acc: 0.7625

Epoch 30/30  
250/250 [=====] - 248s - loss: 0.4430 - acc: 0.7479 - val\_loss: 0.4323 - val\_acc: 0.7445

## Convolutional Neural Network Architecture: Training and Validating

Test loss: 4.93330636978

Test accuracy 0.659375

## Single-Label Output, Multiclass Classification

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 300, 300, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 50, 50, 128)	0
conv2d_2 (Conv2D)	(None, 50, 50, 250)	1152250
max_pooling2d_2 (MaxPooling2)	(None, 8, 8, 250)	0
flatten_1 (Flatten)	(None, 16000)	0
dense_1 (Dense)	(None, 512)	8192512
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052

Total params: 9,623,422

Trainable params: 9,623,422

Non-trainable params: 0

<b>Number of Filters</b>	128		256			512		512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)						
<b>Padding</b>	valid		valid							
<b>activation</b>	relu		relu			relu		relu		softmax

Epoch 1/30

2017-11-30 00:42:50.282025: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-11-30 00:42:50.282631: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.03GiB

2017-11-30 00:42:50.282656: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 242s - loss: 1.3626 - acc: 0.2908 - val\_loss: 1.2037 - val\_acc: 0.4106

Epoch 2/30

250/250 [=====] - 226s - loss: 0.9322 - acc: 0.5236 - val\_loss: 0.8404 - val\_acc: 0.5610

Epoch 3/30

250/250 [=====] - 232s - loss: 0.7368 - acc: 0.6131 - val\_loss: 0.7779 - val\_acc: 0.5932

Epoch 4/30

250/250 [=====] - 232s - loss: 0.6681 - acc: 0.6440 - val\_loss: 0.5737 - val\_acc: 0.6669

Epoch 5/30

250/250 [=====] - 236s - loss: 0.6092 - acc: 0.6637 - val\_loss: 0.5412 - val\_acc: 0.6883

Epoch 6/30

250/250 [=====] - 231s - loss: 0.6295 - acc: 0.6673 - val\_loss: 0.5864 - val\_acc: 0.6687

Epoch 7/30

250/250 [=====] - 234s - loss: 0.5684 - acc: 0.6926 - val\_loss: 0.5177 - val\_acc: 0.6911

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Epoch 8/30  
250/250 [=====] - 229s - loss: 0.5420 - acc: 0.6946 - val\_loss: 0.5117 - val\_acc: 0.6834  
Epoch 9/30  
250/250 [=====] - 238s - loss: 0.5298 - acc: 0.7019 - val\_loss: 0.5094 - val\_acc: 0.7054  
Epoch 10/30  
250/250 [=====] - 239s - loss: 0.5409 - acc: 0.6969 - val\_loss: 0.4709 - val\_acc: 0.7172  
Epoch 11/30  
250/250 [=====] - 237s - loss: 0.5132 - acc: 0.7105 - val\_loss: 0.4557 - val\_acc: 0.7215  
Epoch 12/30  
250/250 [=====] - 235s - loss: 0.4910 - acc: 0.7160 - val\_loss: 0.4366 - val\_acc: 0.7431  
Epoch 13/30  
250/250 [=====] - 239s - loss: 0.4889 - acc: 0.7233 - val\_loss: 0.4758 - val\_acc: 0.7209  
Epoch 14/30  
250/250 [=====] - 237s - loss: 0.4693 - acc: 0.7290 - val\_loss: 0.4307 - val\_acc: 0.7420  
Epoch 15/30  
250/250 [=====] - 236s - loss: 0.4703 - acc: 0.7312 - val\_loss: 0.5957 - val\_acc: 0.7151  
Epoch 16/30  
250/250 [=====] - 237s - loss: 0.4747 - acc: 0.7365 - val\_loss: 0.4208 - val\_acc: 0.7427  
Epoch 17/30  
250/250 [=====] - 225s - loss: 0.4562 - acc: 0.7365 - val\_loss: 0.4319 - val\_acc: 0.7360  
Epoch 18/30  
250/250 [=====] - 239s - loss: 0.4791 - acc: 0.7250 - val\_loss: 0.4197 - val\_acc: 0.7428  
Epoch 19/30  
250/250 [=====] - 232s - loss: 0.4481 - acc: 0.7509 - val\_loss: 0.4059 - val\_acc: 0.7465  
Epoch 20/30  
250/250 [=====] - 233s - loss: 0.4573 - acc: 0.7438 - val\_loss: 0.4007 - val\_acc: 0.7430  
Epoch 21/30  
250/250 [=====] - 228s - loss: 0.4425 - acc: 0.7519 - val\_loss: 0.4119 - val\_acc: 0.7510  
Epoch 22/30  
250/250 [=====] - 226s - loss: 0.4574 - acc: 0.7428 - val\_loss: 0.4036 - val\_acc: 0.7389  
Epoch 23/30  
250/250 [=====] - 232s - loss: 0.4464 - acc: 0.7541 - val\_loss: 0.4049 - val\_acc: 0.7446  
Epoch 24/30  
250/250 [=====] - 234s - loss: 0.4362 - acc: 0.7457 - val\_loss: 0.4289 - val\_acc: 0.7389  
Epoch 25/30  
250/250 [=====] - 232s - loss: 0.4306 - acc: 0.7584 - val\_loss: 0.4086 - val\_acc: 0.7455  
Epoch 26/30  
250/250 [=====] - 231s - loss: 0.4266 - acc: 0.7533 - val\_loss: 0.4128 - val\_acc: 0.7457  
Test loss: 4.32757368922  
Test accuracy 0.68

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040

# Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052

Total params: 7,881,604  
 Trainable params: 7,881,604  
 Non-trainable params: 0

<b>Number of Filters</b>	128		256			512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)				
<b>Padding</b>	valid		valid					
<b>activation</b>	relu		relu			relu		softmax

Epoch 1/30  
 2017-11-30 02:27:51.363572: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-11-30 02:27:51.364193: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-11-30 02:27:51.364219: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 250/250 [=====] - 238s - loss: 1.3246 - acc: 0.3282 - val\_loss: 1.0460 - val\_acc: 0.4850  
 Epoch 2/30  
 250/250 [=====] - 235s - loss: 0.8516 - acc: 0.5650 - val\_loss: 0.6637 - val\_acc: 0.6277  
 Epoch 3/30  
 250/250 [=====] - 237s - loss: 0.6826 - acc: 0.6266 - val\_loss: 0.5605 - val\_acc: 0.6815  
 Epoch 4/30  
 250/250 [=====] - 236s - loss: 0.6195 - acc: 0.6569 - val\_loss: 0.5359 - val\_acc: 0.6952  
 Epoch 5/30  
 250/250 [=====] - 231s - loss: 0.5806 - acc: 0.6834 - val\_loss: 0.5041 - val\_acc: 0.7148  
 Epoch 6/30  
 250/250 [=====] - 233s - loss: 0.5506 - acc: 0.6941 - val\_loss: 0.4966 - val\_acc: 0.7168  
 Epoch 7/30  
 250/250 [=====] - 231s - loss: 0.5300 - acc: 0.7084 - val\_loss: 0.4617 - val\_acc: 0.7259  
 Epoch 8/30  
 250/250 [=====] - 224s - loss: 0.5059 - acc: 0.7200 - val\_loss: 0.4597 - val\_acc: 0.7190  
 Epoch 9/30  
 250/250 [=====] - 224s - loss: 0.5116 - acc: 0.7151 - val\_loss: 0.4726 - val\_acc: 0.7267  
 Epoch 10/30  
 250/250 [=====] - 225s - loss: 0.4835 - acc: 0.7284 - val\_loss: 0.4553 - val\_acc: 0.7318  
 Epoch 11/30  
 250/250 [=====] - 235s - loss: 0.4624 - acc: 0.7415 - val\_loss: 0.4775 - val\_acc: 0.7307  
 Epoch 12/30  
 250/250 [=====] - 234s - loss: 0.4554 - acc: 0.7464 - val\_loss: 0.4291 - val\_acc: 0.7369  
 Epoch 13/30  
 250/250 [=====] - 225s - loss: 0.4379 - acc: 0.7459 - val\_loss: 0.4167 - val\_acc: 0.7512  
 Epoch 14/30  
 250/250 [=====] - 229s - loss: 0.4339 - acc: 0.7594 - val\_loss: 0.3994 - val\_acc: 0.7698  
 Epoch 15/30  
 250/250 [=====] - 226s - loss: 0.4348 - acc: 0.7525 - val\_loss: 0.4052 - val\_acc: 0.7582  
 Epoch 16/30  
 250/250 [=====] - 230s - loss: 0.4275 - acc: 0.7575 - val\_loss: 0.4049 - val\_acc: 0.7509

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Epoch 17/30  
 250/250 [=====] - 231s - loss: 0.4300 - acc: 0.7572 - val\_loss: 0.4288 - val\_acc: 0.7477  
 Epoch 18/30  
 250/250 [=====] - 229s - loss: 0.4214 - acc: 0.7586 - val\_loss: 0.4059 - val\_acc: 0.7485  
 Test loss: 5.06435893536  
 Test accuracy 0.660625

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 4)	2052

Total params: 7,618,948  
 Trainable params: 7,618,948  
 Non-trainable params: 0  
 adamax = Adamax(lr=0.003, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0)

<b>Number of Filters</b>	128		256			512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)				
<b>Padding</b>	valid		valid					
<b>activation</b>	relu		relu			relu		softmax

Epoch 1/30  
 2017-12-01 23:26:50.672250: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-01 23:26:50.672978: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-12-01 23:26:50.673009: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 250/250 [=====] - 251s - loss: 1.3990 - acc: 0.2666 - val\_loss: 1.3470 - val\_acc: 0.3381  
 Epoch 2/30  
 250/250 [=====] - 244s - loss: 1.2290 - acc: 0.4011 - val\_loss: 0.9368 - val\_acc: 0.5640  
 Epoch 3/30  
 250/250 [=====] - 245s - loss: 0.8468 - acc: 0.5615 - val\_loss: 0.6607 - val\_acc: 0.6345  
 Epoch 4/30  
 250/250 [=====] - 241s - loss: 0.6966 - acc: 0.6179 - val\_loss: 0.6149 - val\_acc: 0.6449  
 Epoch 5/30  
 250/250 [=====] - 238s - loss: 0.6335 - acc: 0.6501 - val\_loss: 0.5840 - val\_acc: 0.6584  
 Epoch 6/30  
 250/250 [=====] - 239s - loss: 0.5883 - acc: 0.6704 - val\_loss: 0.5251 - val\_acc: 0.6945  
 Epoch 7/30  
 250/250 [=====] - 236s - loss: 0.5509 - acc: 0.6926 - val\_loss: 0.5091 - val\_acc: 0.7066

# Convolutional Neural Network Architecture: Training and Validating

# Single-Label Output, Multiclass Classification

Epoch 8/30  
 250/250 [=====] - 233s - loss: 0.5241 - acc: 0.7050 - val\_loss: 0.4651 - val\_acc: 0.7243  
 Epoch 9/30  
 250/250 [=====] - 237s - loss: 0.4917 - acc: 0.7246 - val\_loss: 0.4591 - val\_acc: 0.7286  
 Epoch 10/30  
 250/250 [=====] - 242s - loss: 0.4842 - acc: 0.7221 - val\_loss: 0.4667 - val\_acc: 0.7154  
 Epoch 11/30  
 250/250 [=====] - 233s - loss: 0.4655 - acc: 0.7308 - val\_loss: 0.4525 - val\_acc: 0.7339  
 Epoch 12/30  
 250/250 [=====] - 233s - loss: 0.4590 - acc: 0.7397 - val\_loss: 0.4183 - val\_acc: 0.7440  
 Epoch 13/30  
 250/250 [=====] - 232s - loss: 0.4391 - acc: 0.7501 - val\_loss: 0.4074 - val\_acc: 0.7495  
 Epoch 14/30  
 250/250 [=====] - 235s - loss: 0.4364 - acc: 0.7508 - val\_loss: 0.4289 - val\_acc: 0.7356  
 Epoch 15/30  
 250/250 [=====] - 235s - loss: 0.4342 - acc: 0.7550 - val\_loss: 0.4189 - val\_acc: 0.7529  
 Epoch 16/30  
 250/250 [=====] - 236s - loss: 0.4241 - acc: 0.7603 - val\_loss: 0.3860 - val\_acc: 0.7662  
 Epoch 17/30  
 250/250 [=====] - 236s - loss: 0.4129 - acc: 0.7675 - val\_loss: 0.3934 - val\_acc: 0.7665  
 Epoch 18/30  
 250/250 [=====] - 233s - loss: 0.3979 - acc: 0.7789 - val\_loss: 0.4239 - val\_acc: 0.7489  
 Epoch 19/30  
 250/250 [=====] - 237s - loss: 0.3980 - acc: 0.7699 - val\_loss: 0.3643 - val\_acc: 0.7658  
 Epoch 20/30  
 250/250 [=====] - 239s - loss: 0.3929 - acc: 0.7754 - val\_loss: 0.3818 - val\_acc: 0.7674  
 Epoch 21/30  
 250/250 [=====] - 243s - loss: 0.3905 - acc: 0.7776 - val\_loss: 0.3783 - val\_acc: 0.7702  
 Epoch 22/30  
 250/250 [=====] - 237s - loss: 0.3861 - acc: 0.7792 - val\_loss: 0.3686 - val\_acc: 0.7694  
 Epoch 23/30  
 250/250 [=====] - 241s - loss: 0.3806 - acc: 0.7873 - val\_loss: 0.3871 - val\_acc: 0.7597

adadelata = Adadelata(lr=1.0, rho=0.95, epsilon=1e-08, decay=0.0)

<b>Number of Filters</b>	128		256			512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)				
<b>Padding</b>	valid		valid					
<b>activation</b>	relu		relu			relu		softmax

Epoch 1/30  
 2017-12-02 03:17:23.429044: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-02 03:17:23.429690: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235  
 pciBusID: 0000:00:04.0

Test loss: 4.85898687363

Test accuracy 0.679375

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052

Total params: 7,881,604

Trainable params: 7,881,604

Non-trainable params: 0



## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

totalMemory: 11.17GiB freeMemory: 11.03GiB

2017-12-02 03:17:23.429717: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 260s - loss: 1.3155 - acc: 0.3409 - val\_loss: 0.9900 - val\_acc: 0.5169

Epoch 2/30

250/250 [=====] - 252s - loss: 0.8535 - acc: 0.5711 - val\_loss: 0.6104 - val\_acc: 0.6616

Epoch 3/30

250/250 [=====] - 252s - loss: 0.6455 - acc: 0.6512 - val\_loss: 0.5596 - val\_acc: 0.6785

Epoch 4/30

250/250 [=====] - 250s - loss: 0.5791 - acc: 0.6807 - val\_loss: 0.4732 - val\_acc: 0.7178

Epoch 5/30

250/250 [=====] - 236s - loss: 0.5162 - acc: 0.7116 - val\_loss: 0.5014 - val\_acc: 0.7109

Epoch 6/30

250/250 [=====] - 238s - loss: 0.4792 - acc: 0.7281 - val\_loss: 0.4227 - val\_acc: 0.7444

Epoch 7/30

250/250 [=====] - 246s - loss: 0.4617 - acc: 0.7372 - val\_loss: 0.4179 - val\_acc: 0.7572

Epoch 8/30

250/250 [=====] - 234s - loss: 0.4440 - acc: 0.7499 - val\_loss: 0.4147 - val\_acc: 0.7619

Epoch 9/30

250/250 [=====] - 239s - loss: 0.4413 - acc: 0.7524 - val\_loss: 0.4012 - val\_acc: 0.7560

Epoch 10/30

250/250 [=====] - 241s - loss: 0.4247 - acc: 0.7640 - val\_loss: 0.4368 - val\_acc: 0.7434

Epoch 11/30

250/250 [=====] - 243s - loss: 0.4132 - acc: 0.7659 - val\_loss: 0.3817 - val\_acc: 0.7679

Epoch 12/30

250/250 [=====] - 242s - loss: 0.4104 - acc: 0.7714 - val\_loss: 0.4098 - val\_acc: 0.7555

Epoch 13/30

250/250 [=====] - 241s - loss: 0.3996 - acc: 0.7759 - val\_loss: 0.3892 - val\_acc: 0.7603

Epoch 14/30

250/250 [=====] - 241s - loss: 0.3961 - acc: 0.7777 - val\_loss: 0.3868 - val\_acc: 0.7622

Epoch 15/30

250/250 [=====] - 240s - loss: 0.3876 - acc: 0.7812 - val\_loss: 0.3771 - val\_acc: 0.7815

Epoch 16/30

250/250 [=====] - 241s - loss: 0.3856 - acc: 0.7864 - val\_loss: 0.4035 - val\_acc: 0.7573

Epoch 17/30

250/250 [=====] - 241s - loss: 0.3779 - acc: 0.7869 - val\_loss: 0.3591 - val\_acc: 0.7932

Epoch 18/30

250/250 [=====] - 240s - loss: 0.3729 - acc: 0.7943 - val\_loss: 0.3697 - val\_acc:  
0.7706

Epoch 19/30

250/250 [=====] - 250s - loss: 0.3672 - acc: 0.7988 - val\_loss: 0.3628 - val\_acc:  
0.7833

Epoch 20/30

250/250 [=====] - 253s - loss: 0.3706 - acc: 0.7979 - val\_loss: 0.3579 - val\_acc:  
0.7868

Epoch 21/30

250/250 [=====] - 247s - loss: 0.3634 - acc: 0.7999 - val\_loss: 0.3624 - val\_acc:  
0.7799

Epoch 22/30

250/250 [=====] - 252s - loss: 0.3575 - acc: 0.8011 - val\_loss: 0.3575 - val\_acc:  
0.7930

Epoch 23/30

250/250 [=====] - 245s - loss: 0.3610 - acc: 0.7996 - val\_loss: 0.4038 - val\_acc:  
0.7531

Epoch 24/30

250/250 [=====] - 241s - loss: 0.3601 - acc: 0.8035 - val\_loss: 0.3611 - val\_acc:  
0.7841

Epoch 25/30

250/250 [=====] - 239s - loss: 0.3560 - acc: 0.8067 - val\_loss: 0.3613 - val\_acc:  
0.7829

Epoch 26/30

250/250 [=====] - 244s - loss: 0.3582 - acc: 0.8084 - val\_loss: 0.3562 - val\_acc:  
0.7880

Epoch 27/30

250/250 [=====] - 250s - loss: 0.3493 - acc: 0.8099 - val\_loss: 0.3908 - val\_acc:  
0.7723

Epoch 28/30

250/250 [=====] - 249s - loss: 0.3512 - acc: 0.8096 - val\_loss: 0.3550 - val\_acc:  
0.7905

Epoch 29/30

250/250 [=====] - 250s - loss: 0.3554 - acc: 0.8101 - val\_loss: 0.3579 - val\_acc:  
0.7825

Epoch 30/30

250/250 [=====] - 249s - loss: 0.3486 - acc: 0.8160 - val\_loss: 0.3526 - val\_acc:  
0.7875

# Convolutional Neural Network Architecture: Training and Validating

Test loss: 5.13014283419  
 Test accuracy 0.67125

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0

adamax = Adamax(lr=0.002, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0)

Number of Filters	64		128			512		512		512		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
Conv. Size	(3,3)	(3,3)	(3,3)	(3,3)								
Padding	valid		valid									
activation	relu		relu			relu		relu		relu		softmax

Epoch 1/50  
 2017-12-05 18:25:24.690074: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-05 18:25:24.690469: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235  
 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-12-05 18:25:24.690522: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 250/250 [=====] - 233s - loss: 1.4209 - acc: 0.2648 - val\_loss: 1.3671 - val\_acc: 0.3450  
 Epoch 2/50  
 250/250 [=====] - 229s - loss: 1.2518 - acc: 0.4030 - val\_loss: 1.0484 - val\_acc: 0.5186  
 Epoch 3/50  
 250/250 [=====] - 228s - loss: 1.0857 - acc: 0.4919 - val\_loss: 1.0083 - val\_acc: 0.5290  
 Epoch 4/50  
 250/250 [=====] - 229s - loss: 0.9704 - acc: 0.5447 - val\_loss: 0.8255 - val\_acc: 0.6097  
 Epoch 5/50  
 250/250 [=====] - 228s - loss: 0.8427 - acc: 0.5895 - val\_loss: 0.7768 - val\_acc: 0.6259  
 Epoch 6/50  
 250/250 [=====] - 228s - loss: 0.7748 - acc: 0.6121 - val\_loss: 0.6593 - val\_acc: 0.6574  
 Epoch 7/50  
 250/250 [=====] - 227s - loss: 0.7397 - acc: 0.6185 - val\_loss: 0.7439 - val\_acc: 0.6244  
 Epoch 8/50  
 250/250 [=====] - 229s - loss: 0.6681 - acc: 0.6531 - val\_loss: 0.7058 - val\_acc: 0.6352  
 Epoch 9/50  
 250/250 [=====] - 228s - loss: 0.6566 - acc: 0.6539 - val\_loss: 0.5734 - val\_acc: 0.6953  
 Epoch 10/50  
 250/250 [=====] - 228s - loss: 0.6312 - acc: 0.6630 - val\_loss: 0.5874 - val\_acc: 0.6748  
 Epoch 11/50  
 250/250 [=====] - 224s - loss: 0.6121 - acc: 0.6679 - val\_loss: 0.6362 - val\_acc: 0.6511  
 Epoch 12/50  
 250/250 [=====] - 220s - loss: 0.5787 - acc: 0.6806 - val\_loss: 0.6208 - val\_acc: 0.6733  
 Epoch 13/50  
 250/250 [=====] - 227s - loss: 0.5750 - acc: 0.6919 - val\_loss: 0.5509 - val\_acc: 0.6809  
 Epoch 14/50

# Single-Label Output, Multiclass Classification

dense_1 (Dense)	(None, 512)	6423040
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052
Total params: 7,881,604		
Trainable params: 7,881,604		
Non-trainable params: 0		

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

250/250 [=====] - 232s - loss: 0.5401 - acc: 0.7019 - val\_loss: 0.5490 - val\_acc: 0.6905  
Epoch 15/50  
250/250 [=====] - 230s - loss: 0.5405 - acc: 0.7041 - val\_loss: 0.4944 - val\_acc: 0.7266  
Epoch 16/50  
250/250 [=====] - 230s - loss: 0.5302 - acc: 0.6975 - val\_loss: 0.4957 - val\_acc: 0.7159  
Epoch 17/50  
250/250 [=====] - 231s - loss: 0.5077 - acc: 0.7189 - val\_loss: 0.5592 - val\_acc: 0.6980  
Epoch 18/50  
250/250 [=====] - 232s - loss: 0.5048 - acc: 0.7169 - val\_loss: 0.4981 - val\_acc: 0.7199  
Epoch 19/50  
250/250 [=====] - 237s - loss: 0.4900 - acc: 0.7194 - val\_loss: 0.4747 - val\_acc: 0.7180  
Epoch 20/50  
250/250 [=====] - 236s - loss: 0.4871 - acc: 0.7194 - val\_loss: 0.4742 - val\_acc: 0.7273  
Epoch 21/50  
250/250 [=====] - 230s - loss: 0.4748 - acc: 0.7370 - val\_loss: 0.4687 - val\_acc: 0.7315  
Epoch 22/50  
250/250 [=====] - 232s - loss: 0.4740 - acc: 0.7380 - val\_loss: 0.4482 - val\_acc: 0.7334  
Epoch 23/50  
250/250 [=====] - 231s - loss: 0.4506 - acc: 0.7430 - val\_loss: 0.4813 - val\_acc: 0.7236  
Epoch 24/50  
250/250 [=====] - 232s - loss: 0.4697 - acc: 0.7392 - val\_loss: 0.4661 - val\_acc: 0.7349  
Epoch 25/50  
250/250 [=====] - 232s - loss: 0.4555 - acc: 0.7385 - val\_loss: 0.4627 - val\_acc:  
0.7286  
Epoch 26/50  
250/250 [=====] - 232s - loss: 0.4403 - acc: 0.7464 - val\_loss: 0.4467 - val\_acc:  
0.7404  
Epoch 27/50  
250/250 [=====] - 235s - loss: 0.4338 - acc: 0.7572 - val\_loss: 0.4377 - val\_acc:  
0.7429  
Epoch 28/50  
250/250 [=====] - 235s - loss: 0.4420 - acc: 0.7494 - val\_loss: 0.4439 - val\_acc:  
0.7433  
Epoch 29/50  
250/250 [=====] - 234s - loss: 0.4249 - acc: 0.7572 - val\_loss: 0.4814 - val\_acc:  
0.7276  
Epoch 30/50  
250/250 [=====] - 233s - loss: 0.4286 - acc: 0.7656 - val\_loss: 0.4353 - val\_acc:  
0.7567  
Epoch 31/50  
250/250 [=====] - 234s - loss: 0.4133 - acc: 0.7740 - val\_loss: 0.5269 - val\_acc:  
0.7151  
Epoch 32/50  
250/250 [=====] - 234s - loss: 0.4155 - acc: 0.7676 - val\_loss: 0.4291 - val\_acc:  
0.7512  
Epoch 33/50  
250/250 [=====] - 233s - loss: 0.3999 - acc: 0.7735 - val\_loss: 0.4439 - val\_acc:  
0.7567  
Epoch 34/50  
250/250 [=====] - 234s - loss: 0.4072 - acc: 0.7650 - val\_loss: 0.4170 - val\_acc:  
0.7606  
Epoch 35/50  
250/250 [=====] - 235s - loss: 0.4029 - acc: 0.7755 - val\_loss: 0.4342 - val\_acc:  
0.7495  
Epoch 36/50

250/250 [=====] - 233s - loss: 0.3853 - acc: 0.7845 - val\_loss: 0.4229 - val\_acc:  
0.7549  
Epoch 37/50  
250/250 [=====] - 230s - loss: 0.3887 - acc: 0.7876 - val\_loss: 0.4252 - val\_acc:  
0.7620  
Epoch 38/50  
250/250 [=====] - 233s - loss: 0.3891 - acc: 0.7868 - val\_loss: 0.4481 - val\_acc:  
0.7453  
Test loss: 5.97175711632  
Test accuracy 0.6175

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 298, 298, 64)	1792
max_pooling2d_1 (MaxPooling2)	(None, 99, 99, 64)	0
conv2d_2 (Conv2D)	(None, 97, 97, 128)	73856
max_pooling2d_2 (MaxPooling2)	(None, 32, 32, 128)	0
flatten_1 (Flatten)	(None, 131072)	0
dense_1 (Dense)	(None, 512)	67109376
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656
dropout_3 (Dropout)	(None, 512)	0

# Convolutional Neural Network Architecture: Training and Validating

# Single-Label Output, Multiclass Classification

dense\_4 (Dense) (None, 4) 2052  
 =====  
 adamax = Adamax(lr=0.002, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0)

Total params: 67,712,388  
 Trainable params: 67,712,388  
 Non-trainable params: 0

<b>Number of Filters</b>	64		128			512		512		512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)								
<b>Padding</b>	valid		valid									
<b>activation</b>	relu		relu			relu		relu		relu		softmax

2017-12-05 16:51:17.494322: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 237s - loss: 1.3806 - acc: 0.2675 - val\_loss: 1.2822 - val\_acc: 0.3756

Epoch 2/50

250/250 [=====] - 226s - loss: 1.0326 - acc: 0.4754 - val\_loss: 0.7974 - val\_acc: 0.5679

Epoch 3/50

250/250 [=====] - 223s - loss: 0.7488 - acc: 0.5851 - val\_loss: 0.6621 - val\_acc: 0.6257

Epoch 4/50

250/250 [=====] - 221s - loss: 0.6509 - acc: 0.6456 - val\_loss: 0.5950 - val\_acc: 0.6697

Epoch 5/50

250/250 [=====] - 221s - loss: 0.6033 - acc: 0.6592 - val\_loss: 0.5861 - val\_acc: 0.6709

Epoch 6/50

250/250 [=====] - 218s - loss: 0.5606 - acc: 0.6899 - val\_loss: 0.4838 - val\_acc: 0.7056

Epoch 7/50

250/250 [=====] - 218s - loss: 0.5256 - acc: 0.6931 - val\_loss: 0.4763 - val\_acc: 0.7208

Epoch 8/50

250/250 [=====] - 217s - loss: 0.5146 - acc: 0.7098 - val\_loss: 0.4598 - val\_acc: 0.7192

Epoch 9/50

250/250 [=====] - 218s - loss: 0.4953 - acc: 0.7212 - val\_loss: 0.4508 - val\_acc: 0.7407

Epoch 10/50

250/250 [=====] - 218s - loss: 0.4644 - acc: 0.7314 - val\_loss: 0.4624 - val\_acc: 0.7142

Epoch 11/50

250/250 [=====] - 215s - loss: 0.4513 - acc: 0.7382 - val\_loss: 0.4298 - val\_acc: 0.7545

Epoch 12/50

250/250 [=====] - 214s - loss: 0.4568 - acc: 0.7386 - val\_loss: 0.4232 - val\_acc: 0.7551

Epoch 13/50

250/250 [=====] - 215s - loss: 0.4376 - acc: 0.7465 - val\_loss: 0.4207 - val\_acc: 0.7448

Epoch 14/50

250/250 [=====] - 211s - loss: 0.4305 - acc: 0.7509 - val\_loss: 0.3954 - val\_acc: 0.7749

Epoch 15/50

250/250 [=====] - 212s - loss: 0.4258 - acc: 0.7484 - val\_loss: 0.4669 - val\_acc: 0.7412

Epoch 16/50

250/250 [=====] - 211s - loss: 0.4196 - acc: 0.7610 - val\_loss: 0.3986 - val\_acc: 0.7516

Epoch 17/50

250/250 [=====] - 218s - loss: 0.4095 - acc: 0.7576 - val\_loss: 0.3861 - val\_acc: 0.7693

Epoch 18/50

250/250 [=====] - 249s - loss: 0.4028 - acc: 0.7676 - val\_loss: 0.3932 - val\_acc: 0.7593

Epoch 19/50

250/250 [=====] - 230s - loss: 0.4001 - acc: 0.7686 - val\_loss: 0.3706 - val\_acc: 0.7841

Epoch 20/50

250/250 [=====] - 227s - loss: 0.3929 - acc: 0.7746 - val\_loss: 0.3736 - val\_acc: 0.7771

Epoch 21/50

250/250 [=====] - 222s - loss: 0.3882 - acc: 0.7764 - val\_loss: 0.3736 - val\_acc: 0.7670

Epoch 22/50

250/250 [=====] - 223s - loss: 0.3877 - acc: 0.7757 - val\_loss: 0.3751 - val\_acc: 0.7797

Epoch 23/50

250/250 [=====] - 220s - loss: 0.3856 - acc: 0.7742 - val\_loss: 0.3724 - val\_acc: 0.7694

Test loss: 4.66581215262

Test accuracy 0.683125

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 64)	147520
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 64)	0
flatten_1 (Flatten)	(None, 3136)	0

## Convolutional Neural Network Architecture: Training and Validating

dense_1 (Dense)	(None, 512)	1606144
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656

adamax = Adamax(lr=0.001, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #prev 0.002

<b>Number of Filters</b>	64		128			512		512		512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)								
<b>Padding</b>	valid		valid									
<b>activation</b>	relu		relu			relu		relu		relu		softmax

## Single-Label Output, Multiclass Classification

dropout_3 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 4)	2052
=====		
Total params: 2,288,004		
Trainable params: 2,288,004		
Non-trainable params: 0		

2017-12-05 20:54:53.786076: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 239s - loss: 1.2902 - acc: 0.3396 - val\_loss: 1.0074 - val\_acc: 0.4975

Epoch 2/50

250/250 [=====] - 233s - loss: 0.8306 - acc: 0.5554 - val\_loss: 0.6689 - val\_acc: 0.6238

Epoch 3/50

250/250 [=====] - 234s - loss: 0.6772 - acc: 0.6182 - val\_loss: 0.6030 - val\_acc: 0.6522

Epoch 4/50

250/250 [=====] - 237s - loss: 0.6066 - acc: 0.6525 - val\_loss: 0.5645 - val\_acc: 0.6641

Epoch 5/50

250/250 [=====] - 231s - loss: 0.5473 - acc: 0.6908 - val\_loss: 0.4911 - val\_acc: 0.7031

Epoch 6/50

250/250 [=====] - 234s - loss: 0.5156 - acc: 0.6983 - val\_loss: 0.4654 - val\_acc: 0.7113

Epoch 7/50

250/250 [=====] - 234s - loss: 0.4865 - acc: 0.7120 - val\_loss: 0.4488 - val\_acc: 0.7176

Epoch 8/50

250/250 [=====] - 232s - loss: 0.4759 - acc: 0.7204 - val\_loss: 0.4219 - val\_acc: 0.7428

Epoch 9/50

250/250 [=====] - 230s - loss: 0.4603 - acc: 0.7341 - val\_loss: 0.4190 - val\_acc: 0.7361

Epoch 10/50

250/250 [=====] - 235s - loss: 0.4435 - acc: 0.7355 - val\_loss: 0.4072 - val\_acc: 0.7444

Epoch 11/50

250/250 [=====] - 234s - loss: 0.4243 - acc: 0.7512 - val\_loss: 0.4305 - val\_acc: 0.7560

Epoch 12/50

250/250 [=====] - 234s - loss: 0.4111 - acc: 0.7509 - val\_loss: 0.3996 - val\_acc: 0.7667

Epoch 13/50

250/250 [=====] - 235s - loss: 0.4065 - acc: 0.7681 - val\_loss: 0.4238 - val\_acc: 0.7500

Epoch 14/50

250/250 [=====] - 236s - loss: 0.4034 - acc: 0.7592 - val\_loss: 0.4195 - val\_acc: 0.7403

Epoch 15/50

250/250 [=====] - 236s - loss: 0.4014 - acc: 0.7676 - val\_loss: 0.3814 - val\_acc: 0.7701

Epoch 16/50

250/250 [=====] - 237s - loss: 0.3999 - acc: 0.7692 - val\_loss: 0.4275 - val\_acc: 0.7476

Epoch 17/50

250/250 [=====] - 236s - loss: 0.3914 - acc: 0.7712 - val\_loss: 0.3851 - val\_acc: 0.7719

Epoch 18/50

250/250 [=====] - 236s - loss: 0.3859 - acc: 0.7696 - val\_loss: 0.3792 - val\_acc: 0.7712

Epoch 19/50

250/250 [=====] - 234s - loss: 0.3769 - acc: 0.7771 - val\_loss: 0.4121 - val\_acc: 0.7632

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Epoch 20/50  
 250/250 [=====] - 234s - loss: 0.3699 - acc: 0.7856 - val\_loss: 0.3736 - val\_acc: 0.7797  
 Epoch 21/50  
 250/250 [=====] - 235s - loss: 0.3721 - acc: 0.7869 - val\_loss: 0.3771 - val\_acc: 0.7829  
 Epoch 22/50  
 250/250 [=====] - 236s - loss: 0.3813 - acc: 0.7864 - val\_loss: 0.3658 - val\_acc: 0.7891  
 Epoch 23/50  
 250/250 [=====] - 236s - loss: 0.3623 - acc: 0.7929 - val\_loss: 0.3630 - val\_acc: 0.7815  
 Epoch 24/50  
 250/250 [=====] - 235s - loss: 0.3702 - acc: 0.7868 - val\_loss: 0.3681 - val\_acc: 0.7710  
 Epoch 25/50  
 250/250 [=====] - 232s - loss: 0.3658 - acc: 0.7910 - val\_loss: 0.3764 - val\_acc: 0.7794  
 Epoch 26/50  
 250/250 [=====] - 233s - loss: 0.3606 - acc: 0.7935 - val\_loss: 0.3560 - val\_acc: 0.7836  
 Epoch 27/50  
 250/250 [=====] - 234s - loss: 0.3538 - acc: 0.7976 - val\_loss: 0.3786 - val\_acc: 0.7773  
 Epoch 28/50  
 250/250 [=====] - 236s - loss: 0.3622 - acc: 0.7980 - val\_loss: 0.3701 - val\_acc: 0.7736  
 Epoch 29/50  
 250/250 [=====] - 238s - loss: 0.3540 - acc: 0.8049 - val\_loss: 0.3709 - val\_acc: 0.7801  
 Epoch 30/50  
 250/250 [=====] - 233s - loss: 0.3466 - acc: 0.8096 - val\_loss: 0.3560 - val\_acc: 0.7869  
 Test loss: 4.95138476849  
 adam = Adam(lr=0.001, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0)

Test accuracy 0.673125

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 128)	0
flatten_1 (Flatten)	(None, 6272)	0
dense_1 (Dense)	(None, 512)	3211776
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656
dropout_3 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 4)	2052

Total params: 4,041,156  
 Trainable params: 4,041,156  
 Non-trainable params: 0

Number of Filters	128		256			512		512		512		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
Conv. Size	(6,6)	(6,6)	(6,6)	(6,6)								
Padding	valid		valid									
activation	relu		relu			relu		relu		relu		softmax

Epoch 1/50  
 2017-12-05 23:00:00.535254: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-05 23:00:00.535579: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-12-05 23:00:00.535620: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 250/250 [=====] - 241s - loss: 1.5961 - acc: 0.2725 - val\_loss: 1.5267 - val\_acc: 0.2600  
 Epoch 2/50  
 250/250 [=====] - 236s - loss: 1.4081 - acc: 0.2843 - val\_loss: 1.3664 - val\_acc: 0.2873  
 Epoch 3/50  
 250/250 [=====] - 234s - loss: 1.3704 - acc: 0.3036 - val\_loss: 1.9186 - val\_acc: 0.2571  
 Epoch 4/50  
 250/250 [=====] - 236s - loss: 1.3406 - acc: 0.3454 - val\_loss: 1.3055 - val\_acc: 0.3887

## Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

Epoch 5/50  
250/250 [=====] - 236s - loss: 1.2802 - acc: 0.3822 - val\_loss: 1.2641 - val\_acc: 0.3840  
Epoch 6/50  
250/250 [=====] - 236s - loss: 1.2075 - acc: 0.4173 - val\_loss: 1.2606 - val\_acc: 0.3869  
Epoch 7/50  
250/250 [=====] - 237s - loss: 1.1149 - acc: 0.4616 - val\_loss: 1.4246 - val\_acc: 0.3412  
Epoch 8/50  
250/250 [=====] - 236s - loss: 0.9870 - acc: 0.5191 - val\_loss: 1.6612 - val\_acc: 0.2826  
Epoch 9/50  
250/250 [=====] - 236s - loss: 0.8506 - acc: 0.5736 - val\_loss: 0.6999 - val\_acc: 0.6100  
Epoch 10/50  
250/250 [=====] - 235s - loss: 0.7357 - acc: 0.6074 - val\_loss: 0.7278 - val\_acc: 0.6138  
Epoch 11/50  
250/250 [=====] - 236s - loss: 0.7056 - acc: 0.6211 - val\_loss: 0.6625 - val\_acc: 0.6327  
Epoch 12/50  
250/250 [=====] - 235s - loss: 0.6758 - acc: 0.6202 - val\_loss: 0.6242 - val\_acc: 0.6632  
Epoch 13/50  
250/250 [=====] - 233s - loss: 0.6506 - acc: 0.6408 - val\_loss: 1.3711 - val\_acc: 0.5142  
Epoch 14/50  
250/250 [=====] - 234s - loss: 0.6356 - acc: 0.6571 - val\_loss: 0.6176 - val\_acc: 0.6457  
Epoch 15/50  
250/250 [=====] - 240s - loss: 0.6053 - acc: 0.6681 - val\_loss: 0.6441 - val\_acc: 0.6518  
Epoch 16/50  
250/250 [=====] - 238s - loss: 0.6278 - acc: 0.6538 - val\_loss: 0.7455 - val\_acc: 0.6235  
Epoch 17/50  
250/250 [=====] - 238s - loss: 0.5862 - acc: 0.6644 - val\_loss: 0.8550 - val\_acc: 0.6024  
Epoch 18/50  
250/250 [=====] - 239s - loss: 0.5855 - acc: 0.6665 - val\_loss: 0.5721 - val\_acc: 0.6574  
Epoch 19/50  
250/250 [=====] - 239s - loss: 0.5624 - acc: 0.6863 - val\_loss: 0.6592 - val\_acc: 0.6411  
Epoch 20/50  
250/250 [=====] - 239s - loss: 0.5556 - acc: 0.6875 - val\_loss: 0.5211 - val\_acc: 0.6953  
Epoch 21/50  
250/250 [=====] - 238s - loss: 0.5593 - acc: 0.6853 - val\_loss: 0.5537 - val\_acc: 0.6956  
Epoch 22/50  
250/250 [=====] - 239s - loss: 0.5386 - acc: 0.6883 - val\_loss: 0.5020 - val\_acc: 0.6984  
Epoch 23/50  
250/250 [=====] - 240s - loss: 0.5243 - acc: 0.6967 - val\_loss: 0.4772 - val\_acc: 0.7109  
Epoch 24/50  
250/250 [=====] - 239s - loss: 0.5392 - acc: 0.6945 - val\_loss: 0.5022 - val\_acc: 0.6967  
Epoch 25/50  
250/250 [=====] - 238s - loss: 0.5430 - acc: 0.6920 - val\_loss: 0.4945 - val\_acc: 0.7099  
Epoch 26/50  
250/250 [=====] - 239s - loss: 0.5188 - acc: 0.6962 - val\_loss: 0.4862 - val\_acc: 0.7099  
Epoch 27/50  
250/250 [=====] - 239s - loss: 0.5080 - acc: 0.7074 - val\_loss: 0.5287 - val\_acc: 0.7019  
Test loss: 3.69877340741  
Test accuracy 0.656875

---

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0

---

## Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
-----		
batch_normalization_1 (Batch Normalization)	(None, 44, 44, 256)	1024
-----		
max_pooling2d_2 (MaxPooling2D)	(None, 7, 7, 256)	0
-----		
flatten_1 (Flatten)	(None, 12544)	0
-----		
dense_1 (Dense)	(None, 512)	6423040
-----		
dropout_1 (Dropout)	(None, 512)	0
-----		
dense_2 (Dense)	(None, 512)	262656
-----		
dropout_2 (Dropout)	(None, 512)	0
-----		
dense_3 (Dense)	(None, 512)	262656
-----		
dropout_3 (Dropout)	(None, 512)	0
-----		
dense_4 (Dense)	(None, 4)	2052

=====  
 Total params: 8,145,284  
 Trainable params: 8,144,772  
 Non-trainable params: 512  
 adam = Adam(lr=0.0005, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

<b>Number of Filters</b>	128		256			512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)				
<b>Padding</b>	valid		valid					
<b>activation</b>	relu		relu			relu		softmax

Epoch 1/50  
 2017-12-06 20:24:26.383422: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-06 20:24:26.383730: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-12-06 20:24:26.383754: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 250/250 [=====] - 240s - loss: 1.2786 - acc: 0.3616 - val\_loss: 1.0405 - val\_acc: 0.4906  
 Epoch 2/50  
 250/250 [=====] - 236s - loss: 0.8380 - acc: 0.5733 - val\_loss: 0.6541 - val\_acc: 0.6428  
 Epoch 3/50  
 250/250 [=====] - 231s - loss: 0.6719 - acc: 0.6408 - val\_loss: 0.6153 - val\_acc: 0.6522  
 Epoch 4/50  
 250/250 [=====] - 225s - loss: 0.6128 - acc: 0.6730 - val\_loss: 0.5223 - val\_acc: 0.7055  
 Epoch 5/50  
 250/250 [=====] - 219s - loss: 0.5532 - acc: 0.7020 - val\_loss: 0.5041 - val\_acc: 0.7194  
 Epoch 6/50  
 250/250 [=====] - 219s - loss: 0.5138 - acc: 0.7100 - val\_loss: 0.5256 - val\_acc: 0.7093  
 Epoch 7/50  
 250/250 [=====] - 220s - loss: 0.4946 - acc: 0.7254 - val\_loss: 0.5014 - val\_acc: 0.7279  
 Epoch 8/50  
 250/250 [=====] - 225s - loss: 0.4787 - acc: 0.7390 - val\_loss: 0.4660 - val\_acc: 0.7168  
 Epoch 9/50



## Convolutional Neural Network Architecture: Training and Validating

```

250/250 [=====] - 232s - loss: 0.4619 - acc: 0.7478 - val_loss: 0.4370 - val_acc: 0.7534
Epoch 10/50
250/250 [=====] - 232s - loss: 0.4377 - acc: 0.7534 - val_loss: 0.4555 - val_acc: 0.7412
Epoch 11/50
250/250 [=====] - 232s - loss: 0.4326 - acc: 0.7612 - val_loss: 0.4338 - val_acc: 0.7560
Epoch 12/50
250/250 [=====] - 234s - loss: 0.4316 - acc: 0.7606 - val_loss: 0.4046 - val_acc: 0.7680
Epoch 13/50
250/250 [=====] - 234s - loss: 0.4097 - acc: 0.7671 - val_loss: 0.4043 - val_acc: 0.7758
Epoch 14/50
250/250 [=====] - 233s - loss: 0.4216 - acc: 0.7664 - val_loss: 0.4228 - val_acc: 0.7644
Epoch 15/50
250/250 [=====] - 234s - loss: 0.4036 - acc: 0.7796 - val_loss: 0.4043 - val_acc: 0.7710
Epoch 16/50
250/250 [=====] - 235s - loss: 0.3993 - acc: 0.7798 - val_loss: 0.4027 - val_acc: 0.7646
Epoch 17/50
250/250 [=====] - 236s - loss: 0.3941 - acc: 0.7784 - val_loss: 0.3965 - val_acc: 0.7726
Epoch 18/50
250/250 [=====] - 238s - loss: 0.3832 - acc: 0.7835 - val_loss: 0.3852 - val_acc: 0.7721
Epoch 19/50
250/250 [=====] - 234s - loss: 0.3760 - acc: 0.7869 - val_loss: 0.3858 - val_acc: 0.7834
Epoch 20/50
250/250 [=====] - 238s - loss: 0.3851 - acc: 0.7889 - val_loss: 0.3805 - val_acc: 0.7760
Epoch 21/50
250/250 [=====] - 235s - loss: 0.3678 - acc: 0.7969 - val_loss: 0.3744 - val_acc: 0.7778
Epoch 22/50
250/250 [=====] - 236s - loss: 0.3659 - acc: 0.7964 - val_loss: 0.3688 - val_acc: 0.7875
Epoch 23/50
250/250 [=====] - 235s - loss: 0.3686 - acc: 0.7911 - val_loss: 0.3846 - val_acc: 0.7724
Epoch 24/50
250/250 [=====] - 235s - loss: 0.3767 - acc: 0.7943 - val_loss: 0.3763 - val_acc: 0.7882
Epoch 25/50
250/250 [=====] - 237s - loss: 0.3691 - acc: 0.7955 - val_loss: 0.3738 - val_acc: 0.7775
Epoch 26/50
250/250 [=====] - 235s - loss: 0.3541 - acc: 0.8017 - val_loss: 0.3626 - val_acc: 0.7889
Epoch 27/50
250/250 [=====] - 235s - loss: 0.3456 - acc: 0.8147 - val_loss: 0.3685 - val_acc: 0.7886
Epoch 28/50
250/250 [=====] - 235s - loss: 0.3495 - acc: 0.8115 - val_loss: 0.4023 - val_acc: 0.7665
Epoch 29/50
250/250 [=====] - 236s - loss: 0.3510 - acc: 0.8075 - val_loss: 0.3693 - val_acc: 0.7884
Epoch 30/50
250/250 [=====] - 237s - loss: 0.3468 - acc: 0.8114 - val_loss: 0.3741 - val_acc: 0.7847
Test loss: 4.91565843821
Test accuracy 0.68625

```

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0

flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 4)	2052

=====  
 Total params: 7,618,948  
 Trainable params: 7,618,948  
 Non-trainable params: 0  
 adamax = Adamax(lr=0.002, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0)

<b>Number of Filters</b>	128		256			512		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)				
<b>Padding</b>	valid		valid					
<b>activation</b>	relu		relu			relu		softmax

Epoch 1/50  
 2017-12-06 22:52:14.879679: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-06 22:52:14.880030: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235  
 pciBusID: 0000:00:04.0 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-12-06 22:52:14.880057: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

1/250 [.....] - ETA: 853s - loss: 1.3844 - acc: 0.312  
 2/250 [.....] - ETA: 487s - loss: 1.9695 - acc: 0.250  
 3/250 [.....] - ETA: 365s - loss: 1.9597 - acc: 0.229  
 4/250 [.....] - ETA: 303s - loss: 1.8212 - acc: 0.234  
 5/250 [.....] - ETA: 266s - loss: 1.7404 - acc: 0.225  
 6/250 [.....] - ETA: 241s - loss: 1.6830 - acc: 0.218  
 7/250 [.....] - ETA: 223s - loss: 1.6473 - acc: 0.218  
 8/250 [.....] - ETA: 209s - loss: 1.6208 - acc: 0.210  
 9/250 [>.....] - ETA: 198s - loss: 1.5938 - acc: 0.218  
 10/250 [>.....] - ETA: 190s - loss: 1.5722 - acc: 0.228  
 11/250 [>.....] - ETA: 182s - loss: 1.5554 - acc: 0.230  
 12/250 [>.....] - ETA: 176s - loss: 1.5413 - acc: 0.229  
 13/250 [>.....] - ETA: 171s - loss: 1.5295 - acc: 0.223  
 14/250 [>.....] - ETA: 167s - loss: 1.5218 - acc: 0.218  
 15/250 [>.....] - ETA: 164s - loss: 1.5149 - acc: 0.210  
 16/250 [>.....] - ETA: 163s - loss: 1.5066 - acc: 0.218  
 17/250 [=>.....] - ETA: 162s - loss: 1.4996 - acc: 0.220  
 18/250 [=>.....] - ETA: 161s - loss: 1.4933 - acc: 0.225  
 19/250 [=>.....] - ETA: 161s - loss: 1.4876 - acc: 0.227  
 20/250 [=>.....] - ETA: 160s - loss: 1.4822 - acc: 0.235  
 21/250 [=>.....] - ETA: 159s - loss: 1.4784 - acc: 0.227  
 22/250 [=>.....] - ETA: 159s - loss: 1.4739 - acc: 0.231  
 23/250 [=>.....] - ETA: 158s - loss: 1.4700 - acc: 0.225  
 24/250 [=>.....] - ETA: 157s - loss: 1.4660 - acc: 0.230  
 25/250 [==>.....] - ETA: 156s - loss: 1.4626 - acc: 0.232  
 26/250 [==>.....] - ETA: 156s - loss: 1.4590 - acc: 0.240  
 27/250 [==>.....] - ETA: 155s - loss: 1.4573 - acc: 0.240  
 28/250 [==>.....] - ETA: 154s - loss: 1.4539 - acc: 0.244  
 29/250 [==>.....] - ETA: 153s - loss: 1.4508 - acc: 0.246

30/250 [==>.....] - ETA: 152s - loss: 1.4487 - acc: 0.247  
 31/250 [==>.....] - ETA: 152s - loss: 1.4466 - acc: 0.248  
 32/250 [==>.....] - ETA: 151s - loss: 1.4450 - acc: 0.247  
 33/250 [==>.....] - ETA: 150s - loss: 1.4441 - acc: 0.244  
 34/250 [===>.....] - ETA: 149s - loss: 1.4416 - acc: 0.247  
 35/250 [===>.....] - ETA: 149s - loss: 1.4403 - acc: 0.244  
 36/250 [===>.....] - ETA: 148s - loss: 1.4380 - acc: 0.249  
 37/250 [===>.....] - ETA: 147s - loss: 1.4362 - acc: 0.253  
 38/250 [===>.....] - ETA: 146s - loss: 1.4360 - acc: 0.252  
 39/250 [===>.....] - ETA: 146s - loss: 1.4350 - acc: 0.251  
 40/250 [===>.....] - ETA: 145s - loss: 1.4338 - acc: 0.253  
 41/250 [====>.....] - ETA: 144s - loss: 1.4326 - acc: 0.254  
 42/250 [====>.....] - ETA: 143s - loss: 1.4311 - acc: 0.256  
 43/250 [====>.....] - ETA: 142s - loss: 1.4305 - acc: 0.255  
 44/250 [====>.....] - ETA: 141s - loss: 1.4291 - acc: 0.257  
 45/250 [====>.....] - ETA: 140s - loss: 1.4281 - acc: 0.256  
 46/250 [====>.....] - ETA: 139s - loss: 1.4271 - acc: 0.258  
 47/250 [====>.....] - ETA: 138s - loss: 1.4263 - acc: 0.258  
 48/250 [====>.....] - ETA: 137s - loss: 1.4257 - acc: 0.257  
 49/250 [====>.....] - ETA: 137s - loss: 1.4250 - acc: 0.255  
 50/250 [====>.....] - ETA: 136s - loss: 1.4240 - acc: 0.256  
 51/250 [====>.....] - ETA: 135s - loss: 1.4231 - acc: 0.256  
 52/250 [====>.....] - ETA: 135s - loss: 1.4225 - acc: 0.256  
 53/250 [====>.....] - ETA: 134s - loss: 1.4214 - acc: 0.257  
 54/250 [====>.....] - ETA: 133s - loss: 1.4211 - acc: 0.254  
 55/250 [====>.....] - ETA: 132s - loss: 1.4208 - acc: 0.252  
 56/250 [====>.....] - ETA: 132s - loss: 1.4201 - acc: 0.253  
 57/250 [====>.....] - ETA: 131s - loss: 1.4195 - acc: 0.254  
 58/250 [====>.....] - ETA: 130s - loss: 1.4189 - acc: 0.254

## Convolutional Neural Network Architecture: Training and Validating

59/250 [=====>.....] - ETA: 130s - loss: 1.4179-acc: 0.255  
60/250 [=====>.....] - ETA: 129s - loss: 1.4174-acc: 0.255  
61/250 [=====>.....] - ETA: 128s - loss: 1.4168-acc: 0.255  
62/250 [=====>.....] - ETA: 128s - loss: 1.4157-acc: 0.257  
63/250 [=====>.....] - ETA: 127s - loss: 1.4149-acc: 0.258  
64/250 [=====>.....] - ETA: 126s - loss: 1.4139-acc: 0.259  
65/250 [=====>.....] - ETA: 126s - loss: 1.4130-acc: 0.258  
66/250 [=====>.....] - ETA: 125s - loss: 1.4139-acc: 0.259  
67/250 [=====>.....] - ETA: 124s - loss: 1.4140-acc:0.256  
68/250 [=====>.....] - ETA: 124s - loss: 1.4131-acc:0.256  
69/250 [=====>.....] - ETA: 123s - loss: 1.4127-acc:0.257  
70/250 [=====>.....] - ETA: 122s - loss: 1.4120-acc:0.258  
71/250 [=====>.....] - ETA: 121s - loss: 1.4116-acc:0.257  
72/250 [=====>.....] - ETA: 121s - loss: 1.4106-acc:0.260  
73/250 [=====>.....] - ETA: 120s - loss: 1.4105-acc:0.259  
250/250 [=====] - 247s - loss: 1.3464 - acc: 0.3126 - val\_loss: 1.2016 - val\_acc: 0.4119  
Epoch 2/50  
250/250 [=====] - 237s - loss: 1.0952 - acc: 0.4709 - val\_loss: 0.8154 - val\_acc: 0.5957  
Epoch 3/50  
250/250 [=====] - 241s - loss: 0.7729 - acc: 0.5994 - val\_loss: 0.6633 - val\_acc: 0.6383  
Epoch 4/50  
250/250 [=====] - 238s - loss: 0.6578 - acc: 0.6426 - val\_loss: 0.5693 - val\_acc: 0.6878  
Epoch 5/50  
250/250 [=====] - 238s - loss: 0.6067 - acc: 0.6678 - val\_loss: 0.5689 - val\_acc: 0.6906  
Epoch 6/50  
250/250 [=====] - 237s - loss: 0.5695 - acc: 0.6881 - val\_loss: 0.5346 - val\_acc: 0.6925  
Epoch 7/50  
250/250 [=====] - 235s - loss: 0.5391 - acc: 0.7053 - val\_loss: 0.4867 - val\_acc: 0.7289  
Epoch 8/50  
250/250 [=====] - 236s - loss: 0.5011 - acc: 0.7191 - val\_loss: 0.5041 - val\_acc: 0.7241  
Epoch 9/50  
250/250 [=====] - 235s - loss: 0.4863 - acc: 0.7342 - val\_loss: 0.4556 - val\_acc: 0.7302  
Epoch 10/50  
250/250 [=====] - 236s - loss: 0.4694 - acc: 0.7379 - val\_loss: 0.4496 - val\_acc: 0.7508  
Epoch 11/50  
250/250 [=====] - 234s - loss: 0.4475 - acc: 0.7489 - val\_loss: 0.4189 - val\_acc: 0.7552  
Epoch 12/50  
250/250 [=====] - 233s - loss: 0.4367 - acc: 0.7554 - val\_loss: 0.4015 - val\_acc: 0.7702  
Epoch 13/50  
250/250 [=====] - 230s - loss: 0.4279 - acc: 0.7641 - val\_loss: 0.4065 - val\_acc: 0.7677  
Epoch 14/50  
250/250 [=====] - 226s - loss: 0.4112 - acc: 0.7685 - val\_loss: 0.4050 - val\_acc: 0.7645  
Epoch 15/50  
250/250 [=====] - 229s - loss: 0.4108 - acc: 0.7700 - val\_loss: 0.4070 - val\_acc: 0.7664  
Epoch 16/50  
250/250 [=====] - 234s - loss: 0.4005 - acc: 0.7812 - val\_loss: 0.3775 - val\_acc: 0.7710  
Epoch 17/50  
250/250 [=====] - 235s - loss: 0.3881 - acc: 0.7858 - val\_loss: 0.3756 - val\_acc: 0.7725  
Epoch 18/50  
250/250 [=====] - 235s - loss: 0.3839 - acc: 0.7845 - val\_loss: 0.3762 - val\_acc: 0.7783  
Epoch 19/50  
250/250 [=====] - 236s - loss: 0.3823 - acc: 0.7833 - val\_loss: 0.3653 - val\_acc: 0.7910  
Epoch 20/50  
250/250 [=====] - 236s - loss: 0.3793 - acc: 0.7863 - val\_loss: 0.3866 - val\_acc: 0.7679  
Epoch 21/50

## Single-Label Output, Multiclass Classification

74/250 [=====>.....] - ETA: 119s - loss: 1.4099-acc:0.260  
75/250 [=====>.....] - ETA: 119s - loss: 1.4095-acc: 0.260  
76/250 [=====>.....] - ETA: 118s - loss: 1.4096-acc: 0.259  
77/250 [=====>.....] - ETA: 117s - loss: 1.4092-acc: 0.260  
78/250 [=====>.....] - ETA: 116s - loss: 1.4092-acc: 0.259  
79/250 [=====>.....] - ETA: 116s - loss: 1.4085-acc: 0.260  
80/250 [=====>.....] - ETA: 115s - loss: 1.4083-acc: 0.259  
81/250 [=====>.....] - ETA: 114s - loss: 1.4073-acc: 0.259  
82/250 [=====>.....] - ETA: 114s - loss: 1.4065-acc: 0.260  
83/250 [=====>.....] - ETA: 113s - loss: 1.4067-acc: 0.259  
84/250 [=====>.....] - ETA: 112s - loss: 1.4072-acc: 0.257  
85/250 [=====>.....] - ETA: 111s - loss: 1.4072-acc: 0.256  
86/250 [=====>.....] - ETA: 111s - loss: 1.4068-acc: 0.256  
87/250 [=====>.....] - ETA: 110s - loss: 1.4063-acc: 0.256

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

```

250/250 [=====] - 235s - loss: 0.3648 - acc: 0.7935 - val_loss: 0.3658 - val_acc: 0.7902
Epoch 22/50
250/250 [=====] - 235s - loss: 0.3667 - acc: 0.7991 - val_loss: 0.3692 - val_acc: 0.7816
Epoch 23/50
250/250 [=====] - 235s - loss: 0.3573 - acc: 0.7993 - val_loss: 0.3623 - val_acc: 0.7973
Epoch 24/50
250/250 [=====] - 234s - loss: 0.3599 - acc: 0.8041 - val_loss: 0.3844 - val_acc: 0.7624
Epoch 25/50
250/250 [=====] - 235s - loss: 0.3585 - acc: 0.7994 - val_loss: 0.3763 - val_acc: 0.7800
Epoch 26/50
250/250 [=====] - 237s - loss: 0.3557 - acc: 0.8010 - val_loss: 0.3735 - val_acc: 0.7794
Epoch 27/50
250/250 [=====] - 238s - loss: 0.3517 - acc: 0.8049 - val_loss: 0.3720 - val_acc: 0.7815
Test loss: 4.88308211803
Test accuracy 0.6825
    
```

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 128)	13952
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 128)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	1179904
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 4)	2052

```

Total params: 7,618,948
Trainable params: 7,618,948
Non-trainable params: 0
adam = Adam(lr=0.0005, beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001
    
```

Number of Filters	64		256			512		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
Conv. Size	(6,6)	(6,6)	(6,6)	(6,6)				
Padding	valid		valid					
activation	relu		relu			relu		softmax

```

Epoch 1/50
2017-12-07 16:21:54.876559: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2017-12-07 16:21:54.877290: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1064] Found device 0 with properties:
name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0
totalMemory: 11.17GiB freeMemory: 11.03GiB
2017-12-07 16:21:54.877320: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)
250/250 [=====] - 257s - loss: 1.1246 - acc: 0.4340 - val_loss: 0.7533 - val_acc: 0.6797
0.6081
Epoch 2/50
250/250 [=====] - 248s - loss: 0.7243 - acc: 0.6163 - val_loss: 0.5933 - val_acc: 0.6797
Epoch 3/50
    
```

## Convolutional Neural Network Architecture: Training and Validating

250/250 [=====] - 247s - loss: 0.6110 - acc: 0.6651 - val\_loss: 0.5569 - val\_acc: 0.6876  
 Epoch 4/50  
 250/250 [=====] - 246s - loss: 0.5743 - acc: 0.6841 - val\_loss: 0.5199 - val\_acc: 0.7151  
 Epoch 5/50  
 250/250 [=====] - 245s - loss: 0.5370 - acc: 0.7156 - val\_loss: 0.4837 - val\_acc: 0.7271  
 Epoch 6/50  
 250/250 [=====] - 247s - loss: 0.4895 - acc: 0.7305 - val\_loss: 0.4530 - val\_acc: 0.7243  
 Epoch 7/50  
 250/250 [=====] - 247s - loss: 0.4747 - acc: 0.7376 - val\_loss: 0.4562 - val\_acc: 0.7439  
 Epoch 8/50  
 250/250 [=====] - 245s - loss: 0.4529 - acc: 0.7519 - val\_loss: 0.4454 - val\_acc: 0.7339  
 Epoch 9/50  
 250/250 [=====] - 246s - loss: 0.4381 - acc: 0.7574 - val\_loss: 0.4005 - val\_acc: 0.7581  
 Epoch 10/50  
 250/250 [=====] - 246s - loss: 0.4319 - acc: 0.7590 - val\_loss: 0.4176 - val\_acc: 0.7473  
 Epoch 11/50  
 250/250 [=====] - 246s - loss: 0.4191 - acc: 0.7655 - val\_loss: 0.4011 - val\_acc: 0.7700  
 Epoch 12/50  
 250/250 [=====] - 248s - loss: 0.4096 - acc: 0.7729 - val\_loss: 0.4112 - val\_acc: 0.7640  
 Epoch 13/50  
 250/250 [=====] - 248s - loss: 0.3948 - acc: 0.7831 - val\_loss: 0.3947 - val\_acc: 0.7748  
 Epoch 14/50  
 250/250 [=====] - 245s - loss: 0.4085 - acc: 0.7704 - val\_loss: 0.3855 - val\_acc: 0.7752  
 Epoch 15/50  
 250/250 [=====] - 246s - loss: 0.3832 - acc: 0.7901 - val\_loss: 0.3760 - val\_acc: 0.7791  
 Epoch 16/50  
 250/250 [=====] - 248s - loss: 0.3814 - acc: 0.7871 - val\_loss: 0.3908 - val\_acc: 0.7705  
 Epoch 17/50  
 250/250 [=====] - 246s - loss: 0.3996 - acc: 0.7841 - val\_loss: 0.3755 - val\_acc: 0.7775  
 adam = Adam(lr=0.0005, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

<b>Number of Filters</b>	64		256			256		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)				
<b>Padding</b>	valid		valid					
<b>activation</b>	relu		relu			relu		softmax

## Single-Label Output, Multiclass Classification

Epoch 18/50  
 250/250 [=====] - 247s - loss: 0.3656 - acc: 0.7979 - val\_loss: 0.3818 - val\_acc: 0.7729  
 Epoch 19/50  
 250/250 [=====] - 247s - loss: 0.3671 - acc: 0.7918 - val\_loss: 0.3727 - val\_acc: 0.7944  
 Epoch 20/50  
 250/250 [=====] - 247s - loss: 0.3718 - acc: 0.7925 - val\_loss: 0.3921 - val\_acc: 0.7788  
 Epoch 21/50  
 250/250 [=====] - 246s - loss: 0.3599 - acc: 0.8019 - val\_loss: 0.3775 - val\_acc: 0.7884  
 Epoch 22/50  
 250/250 [=====] - 245s - loss: 0.3664 - acc: 0.7973 - val\_loss: 0.4196 - val\_acc: 0.7478  
 Epoch 23/50  
 250/250 [=====] - 245s - loss: 0.3473 - acc: 0.8060 - val\_loss: 0.3770 - val\_acc: 0.7841  
 Test loss: 4.94794062287  
 Test accuracy 0.68625

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	590080
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 4)	2052

Total params: 7,022,148  
 Trainable params: 7,022,148  
 Non-trainable params: 0

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235 pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.03GiB

2017-12-07 20:39:06.120599: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 258s - loss: 1.1554 - acc: 0.4215 - val\_loss: 0.7397 - val\_acc: 0.6144

Epoch 2/50

250/250 [=====] - 248s - loss: 0.7405 - acc: 0.6124 - val\_loss: 0.6412 - val\_acc: 0.6462

Epoch 3/50

250/250 [=====] - 247s - loss: 0.6454 - acc: 0.6580 - val\_loss: 0.5492 - val\_acc: 0.6895

Epoch 4/50

250/250 [=====] - 249s - loss: 0.5975 - acc: 0.6789 - val\_loss: 0.5221 - val\_acc:

0.7281

Epoch 5/50

250/250 [=====] - 248s - loss: 0.5424 - acc: 0.7004 - val\_loss: 0.4768 - val\_acc:

0.7397

Epoch 6/50

250/250 [=====] - 246s - loss: 0.5190 - acc: 0.7127 - val\_loss: 0.4785 - val\_acc:

0.7085

Epoch 7/50

250/250 [=====] - 246s - loss: 0.5044 - acc: 0.7220 - val\_loss: 0.4305 - val\_acc:

0.7574

Epoch 8/50

250/250 [=====] - 248s - loss: 0.4810 - acc: 0.7361 - val\_loss: 0.4371 - val\_acc:

0.7472

Epoch 9/50

250/250 [=====] - 247s - loss: 0.4608 - acc: 0.7489 - val\_loss: 0.4231 - val\_acc:

0.7445

Epoch 10/50

250/250 [=====] - 248s - loss: 0.4550 - acc: 0.7484 - val\_loss: 0.4162 - val\_acc:

0.7640

Epoch 11/50

250/250 [=====] - 248s - loss: 0.4401 - acc: 0.7575 - val\_loss: 0.4262 - val\_acc:

0.7614

Epoch 12/50

250/250 [=====] - 249s - loss: 0.4321 - acc: 0.7540 - val\_loss: 0.3978 - val\_acc:

0.7692

Epoch 13/50

250/250 [=====] - 247s - loss: 0.4347 - acc: 0.7596 - val\_loss: 0.4060 - val\_acc:

0.7525

Epoch 14/50

250/250 [=====] - 245s - loss: 0.4169 - acc: 0.7618 - val\_loss: 0.3932 - val\_acc:

0.7508

Epoch 15/50

250/250 [=====] - 250s - loss: 0.4248 - acc: 0.7616 - val\_loss: 0.4151 - val\_acc:

0.7555

adam = Adam(lr=0.0005, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

<b>Number of Filters</b>	64		256			256		256		4
<b>Layer Type</b>	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.25)	Dense()
<b>Conv. Size</b>	(6,6)	(6,6)	(6,6)	(6,6)						
<b>Padding</b>	valid		valid							
<b>activation</b>	relu		relu			relu		relu		softmax

Epoch 1/50

2017-12-07 22:14:39.314790: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-12-07 22:14:39.315598: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

Epoch 16/50

250/250 [=====] - 250s - loss: 0.4124 - acc: 0.7678 - val\_loss: 0.4064 - val\_acc:

0.7640

Epoch 17/50

250/250 [=====] - 246s - loss: 0.4152 - acc: 0.7715 - val\_loss: 0.3939 - val\_acc:

0.7724

Epoch 18/50

250/250 [=====] - 246s - loss: 0.3944 - acc: 0.7871 - val\_loss: 0.4318 - val\_acc:

0.7507

Test loss: 5.17871149302

Test accuracy 0.658125

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	590080
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 256)	3211520
dropout_1 (Dropout)	(None, 256)	0
dense_2 (Dense)	(None, 4)	1028
Total params: 3,809,604		
Trainable params: 3,809,604		
Non-trainable params: 0		

# Convolutional Neural Network Architecture: Training and Validating

# Single-Label Output, Multiclass Classification

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.03GiB

2017-12-07 22:14:39.315627: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

250/250 [=====] - 249s - loss: 1.3248 - acc: 0.3322 - val\_loss: 1.2087 - val\_acc: 0.4144

Epoch 2/50

250/250 [=====] - 238s - loss: 0.9903 - acc: 0.5050 - val\_loss: 0.7045 - val\_acc: 0.6117

Epoch 3/50

250/250 [=====] - 238s - loss: 0.7206 - acc: 0.6036 - val\_loss: 0.6625 - val\_acc: 0.6286

Epoch 4/50

250/250 [=====] - 237s - loss: 0.6510 - acc: 0.6361 - val\_loss: 0.5487 - val\_acc: 0.6671

Epoch 5/50

250/250 [=====] - 235s - loss: 0.5698 - acc: 0.6759 - val\_loss: 0.4944 - val\_acc: 0.6989

Epoch 6/50

250/250 [=====] - 235s - loss: 0.5465 - acc: 0.6925 - val\_loss: 0.5114 - val\_acc: 0.7195

Epoch 7/50

250/250 [=====] - 235s - loss: 0.5161 - acc: 0.7001 - val\_loss: 0.4594 - val\_acc: 0.7280

Epoch 8/50

250/250 [=====] - 235s - loss: 0.4948 - acc: 0.7137 - val\_loss: 0.4456 - val\_acc: 0.7417

Epoch 9/50

250/250 [=====] - 235s - loss: 0.4782 - acc: 0.7262 - val\_loss: 0.4128 - val\_acc: 0.7399

Epoch 10/50

250/250 [=====] - 234s - loss: 0.4636 - acc: 0.7272 - val\_loss: 0.4164 - val\_acc: 0.7591

Epoch 11/50

250/250 [=====] - 235s - loss: 0.4525 - acc: 0.7364 - val\_loss: 0.4124 - val\_acc: 0.7461

Epoch 12/50

250/250 [=====] - 236s - loss: 0.4376 - acc: 0.7481 - val\_loss: 0.4309 - val\_acc: 0.7564

Epoch 13/50

250/250 [=====] - 234s - loss: 0.4247 - acc: 0.7569 - val\_loss: 0.3844 - val\_acc: 0.7598

Epoch 14/50

250/250 [=====] - 235s - loss: 0.4188 - acc: 0.7541 - val\_loss: 0.3903 - val\_acc: 0.7586

Epoch 15/50

250/250 [=====] - 232s - loss: 0.4031 - acc: 0.7629 - val\_loss: 0.3875 - val\_acc: 0.7602

Epoch 16/50

250/250 [=====] - 231s - loss: 0.4056 - acc: 0.7736 - val\_loss: 0.3834 - val\_acc: 0.7534

Epoch 17/50

250/250 [=====] - 233s - loss: 0.4141 - acc: 0.7652 - val\_loss: 0.3777 - val\_acc:

0.7610

Epoch 18/50

250/250 [=====] - 233s - loss: 0.4108 - acc: 0.7710 - val\_loss: 0.4240 - val\_acc:

0.7569

Epoch 19/50

250/250 [=====] - 233s - loss: 0.4013 - acc: 0.7723 - val\_loss: 0.3943 - val\_acc:

0.7647

Epoch 20/50

250/250 [=====] - 234s - loss: 0.3883 - acc: 0.7755 - val\_loss: 0.3668 - val\_acc:

0.7797

Epoch 21/50

250/250 [=====] - 235s - loss: 0.3847 - acc: 0.7812 - val\_loss: 0.3768 - val\_acc:

0.7732

Epoch 22/50

250/250 [=====] - 235s - loss: 0.3856 - acc: 0.7784 - val\_loss: 0.3881 - val\_acc:

0.7661

Epoch 23/50

250/250 [=====] - 235s - loss: 0.4068 - acc: 0.7721 - val\_loss: 0.3870 - val\_acc: 0.7775

Epoch 24/50

250/250 [=====] - 235s - loss: 0.3744 - acc: 0.7946 - val\_loss: 0.3736 - val\_acc: 0.7750

Test loss: 4.62821881056

Test accuracy 0.6975

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	590080
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0

# Convolutional Neural Network Architecture: Training and Validating

# Single-Label Output, Multiclass Classification

dense_1 (Dense)	(None, 256)	3211520
dropout_1 (Dropout)	(None, 256)	0
dense_2 (Dense)	(None, 256)	65792
dropout_2 (Dropout)	(None, 256)	0

dense_3 (Dense)	(None, 4)	1028
Total params: 3,875,396		
Trainable params: 3,875,396		
Non-trainable params: 0		

dam = Adam(lr=0.0005, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

Num of Filters	64		256			512		256		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout Gaussian (0.35)	Dense()	Dropout Gaussian (0.15)	Dense()
Conv. Size	(6,6)	(6,6)	(6,6)	(6,6)						
Padding	valid		valid							
activation	relu		relu			relu		relu		softmax

Epoch 1/50  
 2017-12-09 05:12:32.899224: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-09 05:12:32.900016: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235  
 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.03GiB  
 2017-12-09 05:12:32.900059: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 250/250 [=====] - 256s - loss: 1.2635 - acc: 0.3641 - val\_loss: 0.9387 - val\_acc: 0.5350  
 Epoch 2/50  
 250/250 [=====] - 249s - loss: 0.8022 - acc: 0.5781 - val\_loss: 0.6272 - val\_acc: 0.6589  
 Epoch 3/50  
 250/250 [=====] - 248s - loss: 0.6434 - acc: 0.6444 - val\_loss: 0.5571 - val\_acc: 0.6789  
 Epoch 4/50  
 250/250 [=====] - 247s - loss: 0.5786 - acc: 0.6831 - val\_loss: 0.5369 - val\_acc: 0.6920  
 Epoch 5/50  
 250/250 [=====] - 246s - loss: 0.5442 - acc: 0.6920 - val\_loss: 0.5214 - val\_acc: 0.7066  
 Epoch 6/50  
 250/250 [=====] - 247s - loss: 0.5286 - acc: 0.7067 - val\_loss: 0.5141 - val\_acc: 0.6980  
 Epoch 7/50  
 250/250 [=====] - 248s - loss: 0.4264 - acc: 0.7614 - val\_loss: 0.4021 - val\_acc: 0.7609  
 Epoch 14/50  
 250/250 [=====] - 247s - loss: 0.4096 - acc: 0.7644 - val\_loss: 0.3961 - val\_acc: 0.7653  
 Epoch 15/50  
 250/250 [=====] - 247s - loss: 0.3960 - acc: 0.7738 - val\_loss: 0.3824 - val\_acc: 0.7698  
 Epoch 18/50  
 250/250 [=====] - 246s - loss: 0.3958 - acc: 0.7772 - val\_loss: 0.3929 - val\_acc: 0.7456  
 Epoch 19/50

250/250 [=====] - 247s - loss: 0.4953 - acc: 0.7171 - val\_loss: 0.4732 - val\_acc: 0.7194  
 Epoch 8/50  
 250/250 [=====] - 247s - loss: 0.4696 - acc: 0.7380 - val\_loss: 0.4296 - val\_acc: 0.7394  
 Epoch 9/50  
 250/250 [=====] - 246s - loss: 0.4495 - acc: 0.7379 - val\_loss: 0.4278 - val\_acc: 0.7308  
 Epoch 10/50  
 250/250 [=====] - 246s - loss: 0.4509 - acc: 0.7452 - val\_loss: 0.4218 - val\_acc: 0.7443  
 Epoch 11/50  
 250/250 [=====] - 247s - loss: 0.4245 - acc: 0.7654 - val\_loss: 0.4181 - val\_acc: 0.7582  
 Epoch 12/50  
 250/250 [=====] - 247s - loss: 0.4167 - acc: 0.7594 - val\_loss: 0.3937 - val\_acc: 0.7655  
 Epoch 13/50  
 250/250 [=====] - 247s - loss: 0.4082 - acc: 0.7711 - val\_loss: 0.3992 - val\_acc: 0.7700  
 Epoch 16/50  
 250/250 [=====] - 247s - loss: 0.3993 - acc: 0.7757 - val\_loss: 0.3824 - val\_acc: 0.7732  
 Epoch 17/50  
 250/250 [=====] - 248s - loss: 0.3817 - acc: 0.7827 - val\_loss: 0.3881 - val\_acc: 0.7662  
 Epoch 20/50  
 250/250 [=====] - 248s - loss: 0.3862 - acc: 0.7826 - val\_loss: 0.3930 - val\_acc: 0.7600  
 Epoch 21/50



## Convolutional Neural Network Architecture: Training and Validating

250/250 [=====] - 247s - loss: 0.3867 - acc: 0.7825 - val\_loss: 0.3788 - val\_acc: 0.7728  
 Epoch 22/50  
 250/250 [=====] - 247s - loss: 0.3784 - acc: 0.7776 - val\_loss: 0.3741 - val\_acc: 0.7733  
 Epoch 23/50  
 250/250 [=====] - 246s - loss: 0.3688 - acc: 0.7939 - val\_loss: 0.3846 - val\_acc: 0.7735  
 Epoch 24/50  
 250/250 [=====] - 246s - loss: 0.3769 - acc: 0.7871 - val\_loss: 0.3749 - val\_acc: 0.7776  
 Epoch 25/50  
 250/250 [=====] - 248s - loss: 0.3719 - acc: 0.7950 - val\_loss: 0.3814 - val\_acc: 0.7662  
 Epoch 26/50  
 250/250 [=====] - 252s - loss: 0.3698 - acc: 0.7959 - val\_loss: 0.3750 - val\_acc: 0.7695  
 Test loss: 4.73596389294  
 Test accuracy 0.685625

Layer (type)	Output Shape	Param #
=====		
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976

Png\_data

adam = Adam(lr=0.001, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

Num of Filters	64	128	512	4				
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()
Conv. Size	(6,6)	(6,6)	(6,6)	(6,6)				
Padding	valid		valid					
activation	relu		relu			relu		softmax

Epoch 1/50  
 2017-12-13 17:08:01.913355: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-13 17:08:01.913753: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235  
 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.09GiB  
 2017-12-13 17:08:01.913778: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 125/125 [=====] - 180s - loss: 1.2575 - acc: 0.3970 - val\_loss: 0.7540 - val\_acc: 0.6419  
 Epoch 2/50  
 125/125 [=====] - 168s - loss: 0.7125 - acc: 0.6474 - val\_loss: 0.5187 - val\_acc: 0.7214  
 Epoch 3/50  
 125/125 [=====] - 168s - loss: 0.5317 - acc: 0.7103 - val\_loss: 0.4899 - val\_acc: 0.7333  
 Epoch 4/50  
 125/125 [=====] - 166s - loss: 0.4867 - acc: 0.7365 - val\_loss: 0.6762 - val\_acc: 0.6989  
 Epoch 5/50  
 125/125 [=====] - 167s - loss: 0.4630 - acc: 0.7450 - val\_loss: 0.4546 - val\_acc: 0.7469  
 Epoch 6/50  
 125/125 [=====] - 170s - loss: 0.4275 - acc: 0.7600 - val\_loss: 0.4312 - val\_acc: 0.7525  
 Epoch 7/50  
 125/125 [=====] - 170s - loss: 0.4074 - acc: 0.7726 - val\_loss: 0.3794 - val\_acc: 0.7732  
 Epoch 8/50  
 125/125 [=====] - 170s - loss: 0.3999 - acc: 0.7760 - val\_loss: 0.5451 - val\_acc: 0.7249  
 Epoch 9/50

## Single-Label Output, Multiclass Classification

max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 256)	590080
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 256)	0
flatten_1 (Flatten)	(None, 12544)	0
dense_1 (Dense)	(None, 512)	6423040
gaussian_dropout_1 (Gaussian)	(None, 512)	0
dense_2 (Dense)	(None, 256)	131328
gaussian_dropout_2 (Gaussian)	(None, 256)	0
dense_3 (Dense)	(None, 4)	1028

=====  
 Total params: 7,152,452  
 Trainable params: 7,152,452  
 Non-trainable params: 0

## Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

```
125/125 [=====] - 169s - loss: 0.3801 - acc: 0.7893 - val_loss: 0.3699 - val_acc: 0.7883
Epoch 10/50
125/125 [=====] - 170s - loss: 0.3891 - acc: 0.7824 - val_loss: 0.3736 - val_acc: 0.7805
Epoch 11/50
125/125 [=====] - 170s - loss: 0.3879 - acc: 0.7897 - val_loss: 0.3685 - val_acc: 0.7887
Epoch 12/50
125/125 [=====] - 169s - loss: 0.3753 - acc: 0.7927 - val_loss: 0.4434 - val_acc: 0.7531
Epoch 13/50
125/125 [=====] - 171s - loss: 0.3707 - acc: 0.7957 - val_loss: 0.3872 - val_acc: 0.7842
Epoch 14/50
125/125 [=====] - 172s - loss: 0.3569 - acc: 0.8025 - val_loss: 0.3856 - val_acc: 0.7900
Epoch 15/50
125/125 [=====] - 175s - loss: 0.3572 - acc: 0.8054 - val_loss: 0.4148 - val_acc: 0.7624
Test loss: 3.65027219772
Test accuracy 0.755
```

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 295, 295, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 49, 49, 64)	0
conv2d_2 (Conv2D)	(None, 44, 44, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 7, 7, 128)	0
flatten_1 (Flatten)	(None, 6272)	0
dense_1 (Dense)	(None, 512)	3211776
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 4)	2052

Total params: 3,515,844

Trainable params: 3,515,844

Non-trainable params: 0

Png\_data 200 by 200 without preprocessing during training

adam = Adam(lr=0.001, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

Num of Filters	64		128			512		512		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
Conv. Size	(6,6)	(6,6)	(6,6)	(6,6)						
Padding	valid		valid							
activation	relu		relu			relu		relu		softmax

Epoch 1/50

2017-12-15 06:45:08.055877: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-12-15 06:45:08.056221: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.09GiB

2017-12-15 06:45:08.056248: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

208/207 [=====] - 55s - loss: 0.7097 - acc: 0.6957 - val\_loss: 0.4251 - val\_acc: 0.8447

Epoch 2/50

208/207 [=====] - 53s - loss: 0.3218 - acc: 0.8775 - val\_loss: 0.2393 - val\_acc: 0.9073

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Epoch 3/50  
208/207 [=====] - 53s - loss: 0.2573 - acc: 0.8991 - val\_loss: 0.2278 - val\_acc: 0.9078  
Epoch 4/50  
208/207 [=====] - 53s - loss: 0.2260 - acc: 0.9142 - val\_loss: 0.1951 - val\_acc: 0.9218  
Epoch 5/50  
208/207 [=====] - 52s - loss: 0.2293 - acc: 0.9134 - val\_loss: 0.2206 - val\_acc: 0.9160  
Epoch 6/50  
208/207 [=====] - 53s - loss: 0.2107 - acc: 0.9193 - val\_loss: 0.1795 - val\_acc: 0.9211  
Epoch 7/50  
208/207 [=====] - 51s - loss: 0.2064 - acc: 0.9230 - val\_loss: 0.1769 - val\_acc: 0.9266  
Epoch 8/50  
208/207 [=====] - 52s - loss: 0.1878 - acc: 0.9279 - val\_loss: 0.1726 - val\_acc: 0.9306  
Epoch 9/50  
208/207 [=====] - 52s - loss: 0.1942 - acc: 0.9276 - val\_loss: 0.1812 - val\_acc: 0.9222  
Epoch 10/50  
208/207 [=====] - 53s - loss: 0.2068 - acc: 0.9213 - val\_loss: 0.1648 - val\_acc: 0.9330  
Epoch 11/50  
208/207 [=====] - 52s - loss: 0.2067 - acc: 0.9215 - val\_loss: 0.1861 - val\_acc: 0.9193  
Epoch 12/50  
208/207 [=====] - 52s - loss: 0.1930 - acc: 0.9277 - val\_loss: 0.1587 - val\_acc: 0.9352  
Epoch 13/50  
208/207 [=====] - 52s - loss: 0.1819 - acc: 0.9280 - val\_loss: 0.1661 - val\_acc: 0.9271  
Epoch 14/50  
208/207 [=====] - 52s - loss: 0.1783 - acc: 0.9301 - val\_loss: 0.1742 - val\_acc: 0.9236  
Epoch 15/50  
208/207 [=====] - 52s - loss: 0.1825 - acc: 0.9340 - val\_loss: 0.1791 - val\_acc: 0.9248  
Test loss: 1.07142833689  
Test accuracy 0.932214765101

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 195, 195, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 32, 32, 64)	0
conv2d_2 (Conv2D)	(None, 27, 27, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 4, 4, 128)	0
flatten_1 (Flatten)	(None, 2048)	0
dense_1 (Dense)	(None, 512)	1049088
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052

Total params: 1,615,812  
Trainable params: 1,615,812  
Non-trainable params: 0

## Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

Png\_data 200 by 200 without preprocessing during training

adam = Adam(lr=0.001, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0) #previously 0.001

Num of Filters	64		128			512		512		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)	Dense()	Dropout (0.35)	Dense()
Conv. Size	(6,6)	(6,6)	(6,6)	(6,6)						
Padding	valid		valid							
activation	relu		relu			relu		relu		softmax

Epoch 1/50

2017-12-15 07:08:02.061940: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-12-15 07:08:02.062258: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.09GiB

2017-12-15 07:08:02.062283: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

208/207 [=====] - 54s - loss: 0.7417 - acc: 0.6750 - val\_loss: 0.2833 - val\_acc: 0.8854

Epoch 2/50

208/207 [=====] - 51s - loss: 0.2851 - acc: 0.8918 - val\_loss: 0.2341 - val\_acc: 0.9086

Epoch 3/50

208/207 [=====] - 52s - loss: 0.2365 - acc: 0.9128 - val\_loss: 0.1774 - val\_acc: 0.9279

Epoch 4/50

208/207 [=====] - 51s - loss: 0.2110 - acc: 0.9201 - val\_loss: 0.2078 - val\_acc: 0.9151

Epoch 5/50

208/207 [=====] - 52s - loss: 0.2059 - acc: 0.9247 - val\_loss: 0.1645 - val\_acc: 0.9331

Epoch 6/50

208/207 [=====] - 52s - loss: 0.1895 - acc: 0.9292 - val\_loss: 0.1846 - val\_acc: 0.9295

Epoch 7/50

208/207 [=====] - 52s - loss: 0.1880 - acc: 0.9292 - val\_loss: 0.1590 - val\_acc: 0.9374

Epoch 8/50

208/207 [=====] - 52s - loss: 0.1819 - acc: 0.9304 - val\_loss: 0.1443 - val\_acc: 0.9413

Epoch 9/50

208/207 [=====] - 52s - loss: 0.1778 - acc: 0.9336 - val\_loss: 0.1862 - val\_acc: 0.9239

Epoch 10/50

208/207 [=====] - 52s - loss: 0.1878 - acc: 0.9279 - val\_loss: 0.2013 - val\_acc: 0.9200

Epoch 11/50

208/207 [=====] - 51s - loss: 0.1742 - acc: 0.9351 - val\_loss: 0.1429 - val\_acc: 0.9447

Epoch 12/50

208/207 [=====] - 52s - loss: 0.1715 - acc: 0.9351 - val\_loss: 0.1607 - val\_acc: 0.9344

Epoch 13/50

208/207 [=====] - 51s - loss: 0.1628 - acc: 0.9398 - val\_loss: 0.1344 - val\_acc: 0.9485

Epoch 14/50

208/207 [=====] - 51s - loss: 0.1605 - acc: 0.9413 - val\_loss: 0.1642 - val\_acc: 0.9366

Epoch 15/50

208/207 [=====] - 51s - loss: 0.1557 - acc: 0.9407 - val\_loss: 0.1616 - val\_acc: 0.9350

Epoch 16/50

208/207 [=====] - 52s - loss: 0.1553 - acc: 0.9431 - val\_loss: 0.1299 - val\_acc: 0.9532

Epoch 17/50

208/207 [=====] - 52s - loss: 0.1720 - acc: 0.9372 - val\_loss: 0.1469 - val\_acc: 0.9384

Epoch 18/50

208/207 [=====] - 52s - loss: 0.1667 - acc: 0.9390 - val\_loss: 0.1591 - val\_acc: 0.9361

Epoch 19/50

208/207 [=====] - 52s - loss: 0.1613 - acc: 0.9393 - val\_loss: 0.1440 - val\_acc: 0.9431

Test loss: 0.796894465397

Test accuracy 0.94966442953

# Convolutional Neural Network Architecture: Training and Validating

# Single-Label Output, Multiclass Classification

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 195, 195, 64)	6976
max_pooling2d_1 (MaxPooling2)	(None, 32, 32, 64)	0
conv2d_2 (Conv2D)	(None, 27, 27, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 4, 4, 128)	0
flatten_1 (Flatten)	(None, 2048)	0
dense_1 (Dense)	(None, 512)	1049088
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 4)	2052

=====  
 Total params: 1,615,812  
 Trainable params: 1,615,812  
 Non-trainable params: 0

## Model Summary None

Png\_data 200 by 200 without preprocessing during training  
 Adadelta = Adadelta(lr=1.0, rho=0.95, epsilon=1e-08, decay=0.0)

	128		128		512		4
Num of Filters	128		128		512		4
Layer Type	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dropout (0.35)
Conv. Size	(6,6)	(6,6)	(3,3)	(3,3)			
Padding	valid		valid				
activation	relu		relu		relu		softmax

Epoch 1/50  
 2017-12-15 07:44:10.913172: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero  
 2017-12-15 07:44:10.913513: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:  
 name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235  
 pciBusID: 0000:00:04.0  
 totalMemory: 11.17GiB freeMemory: 11.09GiB  
 2017-12-15 07:44:10.913542: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)  
 208/207 [=====] - 62s - loss: 0.8218 - acc: 0.6593 - val\_loss: 0.4303 - val\_acc: 0.8694  
 Epoch 2/50  
 208/207 [=====] - 60s - loss: 0.3282 - acc: 0.8879 - val\_loss: 0.1684 - val\_acc: 0.9401  
 Epoch 3/50  
 208/207 [=====] - 59s - loss: 0.2384 - acc: 0.9163 - val\_loss: 0.1797 - val\_acc: 0.9414  
 Epoch 4/50  
 208/207 [=====] - 59s - loss: 0.2023 - acc: 0.9345 - val\_loss: 0.1542 - val\_acc: 0.9493  
 Epoch 5/50  
 208/207 [=====] - 59s - loss: 0.1809 - acc: 0.9355 - val\_loss: 0.1156 - val\_acc: 0.9645  
 Epoch 6/50  
 208/207 [=====] - 59s - loss: 0.1796 - acc: 0.9393 - val\_loss: 0.1239 - val\_acc: 0.9582  
 Epoch 7/50  
 208/207 [=====] - 60s - loss: 0.1635 - acc: 0.9441 - val\_loss: 0.1352 - val\_acc: 0.9550

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Epoch 8/50  
 208/207 [=====] - 59s - loss: 0.1559 - acc: 0.9468 - val\_loss: 0.1421 - val\_acc: 0.9425  
 Test loss: 1.02644992199  
 Test accuracy 0.935570469799

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 195, 195, 128)	13952
max_pooling2d_1 (MaxPooling2D)	(None, 32, 32, 128)	0
conv2d_2 (Conv2D)	(None, 30, 30, 128)	147584
max_pooling2d_2 (MaxPooling2D)	(None, 10, 10, 128)	0
flatten_1 (Flatten)	(None, 12800)	0
dense_1 (Dense)	(None, 512)	6554112
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 4)	2052

=====  
 Total params: 6,717,700  
 Trainable params: 6,717,700  
 Non-trainable params: 0

```

classifier.add(Conv2D(128, (3, 3), padding = 'valid', input_shape = (200, 200, 3), activation = 'relu'))
classifier.add(Conv2D(128, (6, 6), padding = 'valid', activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (6, 6)))
classifier.add(Conv2D(128, (6, 6), padding = 'valid', activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (6, 6)))
classifier.add(Conv2D(256, (2, 2), padding = 'valid', activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (2, 2)))
classifier.add(Flatten())
classifier.add(Dense(units = 512, activation = 'relu'))
classifier.add(Dropout(0.35))
classifier.add(Dense(units = 512, activation = 'relu'))
classifier.add(Dropout(0.15))
classifier.add(Dense(units = 512, activation = 'relu'))
classifier.add(Dropout(0.15))
classifier.add(Dense(units = 4, activation = 'softmax'))
adam = Adam(lr=0.0005, beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.0)
classifier.compile(optimizer = adam, loss = 'categorical_crossentropy', metrics = ['accuracy'])
adam = Adam(lr=0.0005, beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.0)
validation_steps = 300, saved in model.h5
    
```

Num of Filters	128	128		128		256			512	512	512	4
Layer Type	CONV_2D	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dense()	Dense()	Dense()
Conv. Size	(3,3)	(6,6)	(6,6)	(6,6)	(6,6)	(2,2)	(2,2)			Dropout (0.15)	Dropout (0.15)	
Padding	valid	valid		valid		valid						
activation	relu	relu		relu		relu			relu	relu	relu	softmax

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

```
Epoch 1/20
2017-12-19 00:06:35.963203: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2017-12-19 00:06:35.963541: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1064] Found device 0 with properties:
name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235
pciBusID: 0000:00:04.0
totalMemory: 11.17GiB freeMemory: 11.09GiB
2017-12-19 00:06:35.963567: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)
218/217 [=====] - 1347s - loss: 0.9309 - acc: 0.5354 - val_loss: 0.5693 - val_acc: 0.7405
Epoch 2/20
218/217 [=====] - 1325s - loss: 0.4233 - acc: 0.8105 - val_loss: 0.3020 - val_acc: 0.8483
Epoch 3/20
218/217 [=====] - 1321s - loss: 0.3101 - acc: 0.8769 - val_loss: 0.2263 - val_acc: 0.9123
Epoch 4/20
218/217 [=====] - 1320s - loss: 0.2774 - acc: 0.8918 - val_loss: 0.2254 - val_acc: 0.8913
Epoch 5/20
218/217 [=====] - 1319s - loss: 0.2573 - acc: 0.9014 - val_loss: 0.2055 - val_acc: 0.9156
Epoch 6/20
218/217 [=====] - 1322s - loss: 0.2357 - acc: 0.9120 - val_loss: 0.4404 - val_acc: 0.7872
Epoch 7/20
218/217 [=====] - 1322s - loss: 0.2338 - acc: 0.9132 - val_loss: 0.1898 - val_acc: 0.9304
Epoch 8/20
218/217 [=====] - 1323s - loss: 0.2205 - acc: 0.9190 - val_loss: 0.1504 - val_acc: 0.9467
Epoch 9/20
218/217 [=====] - 1319s - loss: 0.2062 - acc: 0.9250 - val_loss: 0.1489 - val_acc: 0.9456
Epoch 10/20
218/217 [=====] - 1320s - loss: 0.2018 - acc: 0.9255 - val_loss: 0.1497 - val_acc: 0.9451
Epoch 11/20
218/217 [=====] - 1320s - loss: 0.1975 - acc: 0.9299 - val_loss: 0.1455 - val_acc: 0.9413
Epoch 12/20
218/217 [=====] - 1315s - loss: 0.1971 - acc: 0.9295 - val_loss: 0.1562 - val_acc: 0.9403
Epoch 13/20
218/217 [=====] - 1316s - loss: 0.1890 - acc: 0.9313 - val_loss: 0.1330 - val_acc: 0.9521
Epoch 14/20
218/217 [=====] - 1315s - loss: 0.1916 - acc: 0.9318 - val_loss: 0.1794 - val_acc: 0.9359
Epoch 15/20
218/217 [=====] - 1315s - loss: 0.1890 - acc: 0.9332 - val_loss: 0.1433 - val_acc: 0.9477
Epoch 16/20
218/217 [=====] - 1311s - loss: 0.1772 - acc: 0.9361 - val_loss: 0.1571 - val_acc: 0.9416
Test loss: 1.0354661082
Test accuracy 0.925295508274
```

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 198, 198, 128)	3584
conv2d_2 (Conv2D)	(None, 193, 193, 128)	589952
max_pooling2d_1 (MaxPooling2)	(None, 32, 32, 128)	0
conv2d_3 (Conv2D)	(None, 27, 27, 128)	589952
max_pooling2d_2 (MaxPooling2)	(None, 4, 4, 128)	0
conv2d_4 (Conv2D)	(None, 3, 3, 256)	131328

## Convolutional Neural Network Architecture: Training and Validating

Single-Label Output, Multiclass Classification

max\_pooling2d\_3 (MaxPooling2 (None, 1, 1, 256) 0

flatten_1 (Flatten)	(None, 256)	0
dense_1 (Dense)	(None, 512)	131584
dense_2 (Dense)	(None, 512)	262656
dropout_1 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 4)	2052

=====  
 Total params: 1,973,764  
 Trainable params: 1,973,764  
 Non-trainable params: 0

adam = Adam(lr=0.001, beta\_1=0.9, beta\_2=0.999, epsilon=1e-08, decay=0.0)  
 rotation\_range = 30 for image\_generator  
 validation\_steps = 250

Num of Filters	128	128		128		256			512	512	512	4
Layer Type	CONV_2D	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dense()	Dense()	Dense()
Conv. Size	(3,3)	(6,6)	(6,6)	(6,6)	(6,6)	(2,2)	(2,2)		Dropout (0.25)	Dropout (0.15)	Dropout (0.15)	
Padding	valid	valid		valid		valid						
activation	relu	relu		relu		relu			relu	relu	relu	softmax

```

classifier.add(Conv2D(64, (3, 3), padding = 'valid', input_shape = (200, 200, 3), activation = 'relu'))
classifier.add(Conv2D(64, (6, 6), padding = 'valid', activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (6, 6)))
classifier.add(Conv2D(128, (6, 6), padding = 'valid', activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (6, 6)))
classifier.add(Conv2D(256, (2, 2), padding = 'valid', activation = 'relu'))
classifier.add(MaxPooling2D(pool_size = (2, 2)))
classifier.add(Flatten())
classifier.add(Dense(units = 512, activation = 'relu'))
classifier.add(Dropout(0.25))
classifier.add(Dense(units = 512, activation = 'relu'))
classifier.add(Dropout(0.15))
classifier.add(Dense(units = 512, activation = 'relu'))
classifier.add(Dropout(0.15))
classifier.add(Dense(units = 4, activation = 'softmax'))
adam = Adam(lr=0.001, beta_1=0.9, beta_2=0.999, epsilon=1e-08, decay=0.0)
classifier.compile(optimizer = adam, loss = 'categorical_crossentropy', metrics = ['accuracy'])
datagen = ImageDataGenerator(rescale = 1./255, rotation_range = 30, shear_range = 0.2, zoom_range = 0.2, horizontal_flip = True)
validate_datagen = ImageDataGenerator(rescale = 1./255)
validate_datagen.fit(validate_shape_dataset)
validate_generator = validate_datagen.flow(validate_shape_dataset, validate_y_dataset, batch_size = 64)
    
```



## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

Num of Filters	64	64		128		256			512	512	512	4
Layer Type	CONV_2D	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	CONV_2D	MAXPOOL	Flatten()	Dense()	Dense()	Dense()	Dense()
Conv. Size	(3,3)	(6,6)	(6,6)	(6,6)	(6,6)	(2,2)	(2,2)		Dropout (0.25)	Dropout (0.15)	Dropout (0.15)	
Padding	valid	valid		valid		valid						
activation	relu	relu		relu		relu			relu	relu	relu	softmax

438/437 [=====] - 865s - loss: 0.4552 - acc: 0.7777 - val\_loss: 0.3580 - val\_acc: 0.8077  
 Epoch 4/30  
 438/437 [=====] - 866s - loss: 0.4088 - acc: 0.8024 - val\_loss: 0.3060 - val\_acc: 0.8351  
 Epoch 5/30  
 438/437 [=====] - 866s - loss: 0.3752 - acc: 0.8206 - val\_loss: 0.2949 - val\_acc: 0.8464  
 Epoch 6/30  
 438/437 [=====] - 866s - loss: 0.3593 - acc: 0.8276 - val\_loss: 0.2940 - val\_acc: 0.8418  
 Epoch 7/30  
 438/437 [=====] - 866s - loss: 0.3446 - acc: 0.8347 - val\_loss: 0.2589 - val\_acc: 0.8607  
 Epoch 8/30  
 438/437 [=====] - 866s - loss: 0.3346 - acc: 0.8433 - val\_loss: 0.2719 - val\_acc: 0.8454  
 Epoch 9/30  
 438/437 [=====] - 865s - loss: 0.3216 - acc: 0.8483 - val\_loss: 0.2701 - val\_acc: 0.8592  
 Epoch 10/30  
 438/437 [=====] - 865s - loss: 0.3166 - acc: 0.8525 - val\_loss: 0.2504 - val\_acc: 0.8659  
 Epoch 11/30  
 438/437 [=====] - 866s - loss: 0.3091 - acc: 0.8567 - val\_loss: 0.2704 - val\_acc: 0.8520  
 Epoch 12/30  
 438/437 [=====] - 865s - loss: 0.3112 - acc: 0.8540 - val\_loss: 0.2395 - val\_acc: 0.8863  
 Epoch 13/30  
 438/437 [=====] - 866s - loss: 0.2985 - acc: 0.8632 - val\_loss: 0.2436 - val\_acc: 0.8706  
 Epoch 14/30  
 438/437 [=====] - 865s - loss: 0.2963 - acc: 0.8635 - val\_loss: 0.2401 - val\_acc: 0.8811  
 Epoch 15/30  
 438/437 [=====] - 865s - loss: 0.2887 - acc: 0.8667 - val\_loss: 0.2384 - val\_acc: 0.8747  
 Epoch 16/30  
 438/437 [=====] - 865s - loss: 0.2925 - acc: 0.8688 - val\_loss: 0.2654 - val\_acc: 0.8701  
 Epoch 17/30

438/437 [=====] - 865s - loss: 0.2885 - acc: 0.8693 - val\_loss: 0.2405 - val\_acc: 0.8735  
 Epoch 18/30  
 438/437 [=====] - 865s - loss: 0.2892 - acc: 0.8679 - val\_loss: 0.2464 - val\_acc: 0.8774  
 Test loss: 1.59995680253  
 Test accuracy 0.873462581003

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 198, 198, 64)	1792
conv2d_2 (Conv2D)	(None, 193, 193, 64)	147520
max_pooling2d_1 (MaxPooling2)	(None, 32, 32, 64)	0
conv2d_3 (Conv2D)	(None, 27, 27, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 4, 4, 128)	0
conv2d_4 (Conv2D)	(None, 3, 3, 256)	131328
max_pooling2d_3 (MaxPooling2)	(None, 1, 1, 256)	0
flatten_1 (Flatten)	(None, 256)	0
dense_1 (Dense)	(None, 512)	131584
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656
dropout_3 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 4)	2052

Total params: 1,234,628  
 Trainable params: 1,234,628  
 Non-trainable params: 0

## Convolutional Neural Network Architecture: Training and Validating

## Single-Label Output, Multiclass Classification

WARNING:tensorflow:From /home/maggie/py27/local/lib/python2.7/site-packages/keras/backend/tensorflow\_backend.py:1210: calling reduce\_prod (from tensorflow.python.ops.math\_ops) with keep\_dims is deprecated and will be removed in a future version.

Instructions for updating:

keep\_dims is deprecated, use keepdims instead

2017-12-22 19:07:11.914983: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-12-22 19:07:11.915353: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.09GiB

2017-12-22 19:07:11.915379: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

WARNING:tensorflow:From /home/maggie/py27/local/lib/python2.7/site-packages/keras/backend/tensorflow\_backend.py:2745: calling reduce\_sum (from tensorflow.python.ops.math\_ops) with keep\_dims is deprecated and will be removed in a future version.

Instructions for updating:

keep\_dims is deprecated, use keepdims instead

WARNING:tensorflow:From /home/maggie/py27/local/lib/python2.7/site-packages/keras/backend/tensorflow\_backend.py:1299: calling reduce\_mean (from tensorflow.python.ops.math\_ops) with keep\_dims is deprecated and will be removed in a future version.

Instructions for updating:

keep\_dims is deprecated, use keepdims instead

7280/7280 [=====] - 57s

Test loss: 1.34927178173

Test accuracy 0.909065934066

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 198, 198, 64)	1792
conv2d_2 (Conv2D)	(None, 193, 193, 64)	147520
max_pooling2d_1 (MaxPooling2)	(None, 32, 32, 64)	0
conv2d_3 (Conv2D)	(None, 27, 27, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 4, 4, 128)	0
conv2d_4 (Conv2D)	(None, 3, 3, 256)	131328
max_pooling2d_3 (MaxPooling2)	(None, 1, 1, 256)	0
flatten_1 (Flatten)	(None, 256)	0
dense_1 (Dense)	(None, 512)	131584
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656
dropout_3 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 4)	2052

=====  
Total params: 1,234,628

# Convolutional Neural Network Architecture: Training and Validating

# Single-Label Output, Multiclass Classification

Trainable params: 1,234,628

Non-trainable params: 0

Model Summary None

(py27) maggie@cnn-test-instance:~\$ python test\_model.py --job-dir ./ --train-file test\_resized\_images.pkl

Using TensorFlow backend.

Using logs\_path located at ./logs/2017-12-22T19:08:31.756936

WARNING:tensorflow:From /home/maggie/py27/local/lib/python2.7/site-packages/keras/backend/tensorflow\_backend.py:1210: calling reduce\_prod (from tensorflow.python.ops.math\_ops) with keep\_dims is deprecated and will be removed in a future version.

Instructions for updating:

keep\_dims is deprecated, use keepdims instead

2017-12-22 19:08:35.867503: I tensorflow/stream\_executor/cuda/cuda\_gpu\_executor.cc:900] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

2017-12-22 19:08:35.867844: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1064] Found device 0 with properties:

name: Tesla K80 major: 3 minor: 7 memoryClockRate(GHz): 0.8235

pciBusID: 0000:00:04.0

totalMemory: 11.17GiB freeMemory: 11.09GiB

2017-12-22 19:08:35.867894: I tensorflow/core/common\_runtime/gpu/gpu\_device.cc:1154] Creating TensorFlow device (/device:GPU:0) -> (device: 0, name: Tesla K80, pci bus id: 0000:00:04.0, compute capability: 3.7)

WARNING:tensorflow:From /home/maggie/py27/local/lib/python2.7/site-packages/keras/backend/tensorflow\_backend.py:2745: calling reduce\_sum (from tensorflow.python.ops.math\_ops) with keep\_dims is deprecated and will be removed in a future version.

Instructions for updating:

keep\_dims is deprecated, use keepdims instead

WARNING:tensorflow:From /home/maggie/py27/local/lib/python2.7/site-packages/keras/backend/tensorflow\_backend.py:1299: calling reduce\_mean (from tensorflow.python.ops.math\_ops) with keep\_dims is deprecated and will be removed in a future version.

Instructions for updating:

keep\_dims is deprecated, use keepdims instead

6976/6976 [=====] - 54s

Test loss: 3.0220900826

Test accuracy 0.777236238532

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 198, 198, 64)	1792
conv2d_2 (Conv2D)	(None, 193, 193, 64)	147520
max_pooling2d_1 (MaxPooling2)	(None, 32, 32, 64)	0
conv2d_3 (Conv2D)	(None, 27, 27, 128)	295040
max_pooling2d_2 (MaxPooling2)	(None, 4, 4, 128)	0
conv2d_4 (Conv2D)	(None, 3, 3, 256)	131328
max_pooling2d_3 (MaxPooling2)	(None, 1, 1, 256)	0
flatten_1 (Flatten)	(None, 256)	0
dense_1 (Dense)	(None, 512)	131584
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 512)	262656
dropout_2 (Dropout)	(None, 512)	0

## Convolutional Neural Network Architecture: Training and Validating

dense\_3 (Dense) (None, 512) 262656

---

dropout\_3 (Dropout) (None, 512) 0

---

dense\_4 (Dense) (None, 4) 2052

=====

Total params: 1,234,628

Trainable params: 1,234,628

Non-trainable params: 0

---

Model Summary None

Single-Label Output, Multiclass Classification