Model 1

Layer (type) Output Shape Param #

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dense\_1 (Dense) (None, 32, 32, 32) 128

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activation\_1 (Activation) (None, 32, 32, 32) 0

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max\_pooling2d\_1 (MaxPooling2 (None, 16, 16, 32) 0

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dropout\_1 (Dropout) (None, 16, 16, 32) 0

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dense\_2 (Dense) (None, 16, 16, 64) 2112

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activation\_2 (Activation) (None, 16, 16, 64) 0

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max\_pooling2d\_2 (MaxPooling2 (None, 8, 8, 64) 0

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dropout\_2 (Dropout) (None, 8, 8, 64) 0

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dense\_3 (Dense) (None, 8, 8, 128) 8320

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activation\_3 (Activation) (None, 8, 8, 128) 0

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max\_pooling2d\_3 (MaxPooling2 (None, 4, 4, 128) 0

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dropout\_3 (Dropout) (None, 4, 4, 128) 0

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dense\_4 (Dense) (None, 4, 4, 512) 66048

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dropout\_4 (Dropout) (None, 4, 4, 512) 0

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flatten\_1 (Flatten) (None, 8192) 0

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dense\_5 (Dense) (None, 10) 81930

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activation\_4 (Activation) (None, 10) 0

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Total params: 158,538

Trainable params: 158,538

Non-trainable params: 0

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Train on 50000 samples, validate on 10000 samples

Epoch 1/20

50000/50000 [==============================] - 11s 213us/step - loss: 1.9623 - acc: 0.2934 - val\_loss: 1.8921 - val\_acc: 0.3213

Epoch 2/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.6995 - acc: 0.3954 - val\_loss: 1.6959 - val\_acc: 0.4019

Epoch 3/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.6181 - acc: 0.4205 - val\_loss: 1.6494 - val\_acc: 0.4139

Epoch 4/20

50000/50000 [==============================] - 6s 128us/step - loss: 1.5701 - acc: 0.4398 - val\_loss: 1.6681 - val\_acc: 0.3989

Epoch 5/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.5350 - acc: 0.4532 - val\_loss: 1.6816 - val\_acc: 0.3890

Epoch 6/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.5065 - acc: 0.4621 - val\_loss: 1.6232 - val\_acc: 0.4184

Epoch 7/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.4862 - acc: 0.4700 - val\_loss: 1.6972 - val\_acc: 0.3835

Epoch 8/20

50000/50000 [==============================] - 6s 128us/step - loss: 1.4657 - acc: 0.4786 - val\_loss: 1.6352 - val\_acc: 0.4114

Epoch 9/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.4502 - acc: 0.4840 - val\_loss: 1.5795 - val\_acc: 0.4241

Epoch 10/20

50000/50000 [==============================] - 6s 128us/step - loss: 1.4385 - acc: 0.4869 - val\_loss: 1.6770 - val\_acc: 0.3912

Epoch 11/20

50000/50000 [==============================] - 6s 126us/step - loss: 1.4242 - acc: 0.4905 - val\_loss: 1.6364 - val\_acc: 0.4030

Epoch 12/20

50000/50000 [==============================] - 6s 128us/step - loss: 1.4150 - acc: 0.4956 - val\_loss: 1.6135 - val\_acc: 0.4101

Epoch 13/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.4081 - acc: 0.4976 - val\_loss: 1.6159 - val\_acc: 0.4204

Epoch 14/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.4024 - acc: 0.5024 - val\_loss: 1.6964 - val\_acc: 0.3977

Epoch 15/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.3910 - acc: 0.5067 - val\_loss: 1.7219 - val\_acc: 0.3823

Epoch 16/20

50000/50000 [==============================] - 6s 126us/step - loss: 1.3855 - acc: 0.5079 - val\_loss: 1.6748 - val\_acc: 0.4071

Epoch 17/20

50000/50000 [==============================] - 6s 128us/step - loss: 1.3823 - acc: 0.5076 - val\_loss: 1.6424 - val\_acc: 0.4170

Epoch 18/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.3716 - acc: 0.5112 - val\_loss: 1.6512 - val\_acc: 0.4002

Epoch 19/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.3671 - acc: 0.5135 - val\_loss: 1.6776 - val\_acc: 0.4089

Epoch 20/20

50000/50000 [==============================] - 6s 127us/step - loss: 1.3636 - acc: 0.5126 - val\_loss: 1.7206 - val\_acc: 0.3830

Model 2

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Layer (type) Output Shape Param #

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dense\_24 (Dense) (None, 32, 32, 128) 512

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activation\_19 (Activation) (None, 32, 32, 128) 0

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max\_pooling2d\_11 (MaxPooling (None, 16, 16, 128) 0

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dropout\_19 (Dropout) (None, 16, 16, 128) 0

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dense\_25 (Dense) (None, 16, 16, 256) 33024

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activation\_20 (Activation) (None, 16, 16, 256) 0

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max\_pooling2d\_12 (MaxPooling (None, 8, 8, 256) 0

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dropout\_20 (Dropout) (None, 8, 8, 256) 0

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dense\_26 (Dense) (None, 8, 8, 512) 131584

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dropout\_21 (Dropout) (None, 8, 8, 512) 0

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flatten\_6 (Flatten) (None, 32768) 0

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dense\_27 (Dense) (None, 10) 327690

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activation\_21 (Activation) (None, 10) 0

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Total params: 492,810

Trainable params: 492,810

Non-trainable params: 0

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Train on 50000 samples, validate on 10000 samples

Epoch 1/20

50000/50000 [==============================] - 17s 336us/step - loss: 2.0610 - acc: 0.2581 - val\_loss: 1.9373 - val\_acc: 0.3380

Epoch 2/20

50000/50000 [==============================] - 16s 318us/step - loss: 1.8449 - acc: 0.3552 - val\_loss: 1.8319 - val\_acc: 0.3573

Epoch 3/20

50000/50000 [==============================] - 16s 320us/step - loss: 1.7492 - acc: 0.3895 - val\_loss: 1.8106 - val\_acc: 0.3630

Epoch 4/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.6829 - acc: 0.4139 - val\_loss: 1.7912 - val\_acc: 0.3755

Epoch 5/20

50000/50000 [==============================] - 16s 318us/step - loss: 1.6282 - acc: 0.4309 - val\_loss: 1.8006 - val\_acc: 0.3819

Epoch 6/20

50000/50000 [==============================] - 16s 318us/step - loss: 1.5854 - acc: 0.4452 - val\_loss: 1.7523 - val\_acc: 0.3938

Epoch 7/20

50000/50000 [==============================] - 16s 316us/step - loss: 1.5538 - acc: 0.4576 - val\_loss: 1.7853 - val\_acc: 0.3894

Epoch 8/20

50000/50000 [==============================] - 16s 318us/step - loss: 1.5251 - acc: 0.4659 - val\_loss: 1.8102 - val\_acc: 0.3859

Epoch 9/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.4989 - acc: 0.4757 - val\_loss: 1.8048 - val\_acc: 0.3889

Epoch 10/20

50000/50000 [==============================] - 16s 316us/step - loss: 1.4809 - acc: 0.4820 - val\_loss: 1.9155 - val\_acc: 0.3665

Epoch 11/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.4581 - acc: 0.4882 - val\_loss: 1.8835 - val\_acc: 0.3804

Epoch 12/20

50000/50000 [==============================] - 16s 316us/step - loss: 1.4441 - acc: 0.4930 - val\_loss: 1.9163 - val\_acc: 0.3704

Epoch 13/20

50000/50000 [==============================] - 16s 316us/step - loss: 1.4318 - acc: 0.4972 - val\_loss: 1.8880 - val\_acc: 0.3787

Epoch 14/20

50000/50000 [==============================] - 16s 316us/step - loss: 1.4180 - acc: 0.5011 - val\_loss: 1.8124 - val\_acc: 0.3926

Epoch 15/20

50000/50000 [==============================] - 16s 318us/step - loss: 1.4090 - acc: 0.5043 - val\_loss: 1.8351 - val\_acc: 0.3904

Epoch 16/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.4004 - acc: 0.5091 - val\_loss: 1.8092 - val\_acc: 0.3933

Epoch 17/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.3898 - acc: 0.5100 - val\_loss: 1.7469 - val\_acc: 0.4059

Epoch 18/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.3854 - acc: 0.5120 - val\_loss: 1.7678 - val\_acc: 0.3993

Epoch 19/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.3808 - acc: 0.5134 - val\_loss: 1.7367 - val\_acc: 0.4115

Epoch 20/20

50000/50000 [==============================] - 16s 318us/step - loss: 1.3715 - acc: 0.5191 - val\_loss: 1.7148 - val\_acc: 0.4129

Model 3

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Layer (type) Output Shape Param #

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dense\_28 (Dense) (None, 32, 32, 128) 512

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activation\_22 (Activation) (None, 32, 32, 128) 0

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max\_pooling2d\_13 (MaxPooling (None, 16, 16, 128) 0

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dropout\_22 (Dropout) (None, 16, 16, 128) 0

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dense\_29 (Dense) (None, 16, 16, 256) 33024

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activation\_23 (Activation) (None, 16, 16, 256) 0

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max\_pooling2d\_14 (MaxPooling (None, 8, 8, 256) 0

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dropout\_23 (Dropout) (None, 8, 8, 256) 0

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dense\_30 (Dense) (None, 8, 8, 512) 131584

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dropout\_24 (Dropout) (None, 8, 8, 512) 0

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flatten\_7 (Flatten) (None, 32768) 0

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dense\_31 (Dense) (None, 10) 327690

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activation\_24 (Activation) (None, 10) 0

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Total params: 492,810

Trainable params: 492,810

Non-trainable params: 0

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Train on 50000 samples, validate on 10000 samples

Epoch 1/30

50000/50000 [==============================] - 17s 339us/step - loss: 2.0847 - acc: 0.2469 - val\_loss: 1.9656 - val\_acc: 0.3168

Epoch 2/30

50000/50000 [==============================] - 16s 318us/step - loss: 1.8635 - acc: 0.3469 - val\_loss: 1.8454 - val\_acc: 0.3594

Epoch 3/30

50000/50000 [==============================] - 16s 318us/step - loss: 1.7594 - acc: 0.3867 - val\_loss: 1.8162 - val\_acc: 0.3602

Epoch 4/30

50000/50000 [==============================] - 16s 318us/step - loss: 1.6906 - acc: 0.4117 - val\_loss: 1.7935 - val\_acc: 0.3788

Epoch 5/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.6344 - acc: 0.4286 - val\_loss: 1.8107 - val\_acc: 0.3726

Epoch 6/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.5939 - acc: 0.4414 - val\_loss: 1.8303 - val\_acc: 0.3696

Epoch 7/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.5599 - acc: 0.4547 - val\_loss: 1.8327 - val\_acc: 0.3772

Epoch 8/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.5293 - acc: 0.4650 - val\_loss: 1.8710 - val\_acc: 0.3689

Epoch 9/30

50000/50000 [==============================] - 16s 316us/step - loss: 1.5048 - acc: 0.4729 - val\_loss: 1.8586 - val\_acc: 0.3807

Epoch 10/30

50000/50000 [==============================] - 16s 316us/step - loss: 1.4833 - acc: 0.4796 - val\_loss: 1.9621 - val\_acc: 0.3571

Epoch 11/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.4637 - acc: 0.4866 - val\_loss: 1.8912 - val\_acc: 0.3747

Epoch 12/30

50000/50000 [==============================] - 16s 316us/step - loss: 1.4477 - acc: 0.4928 - val\_loss: 1.9505 - val\_acc: 0.3692

Epoch 13/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.4362 - acc: 0.4958 - val\_loss: 1.8417 - val\_acc: 0.3851

Epoch 14/30

50000/50000 [==============================] - 16s 316us/step - loss: 1.4257 - acc: 0.5001 - val\_loss: 1.8720 - val\_acc: 0.3762

Epoch 15/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.4147 - acc: 0.5041 - val\_loss: 1.8107 - val\_acc: 0.3884

Epoch 16/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.4063 - acc: 0.5064 - val\_loss: 1.7727 - val\_acc: 0.4001

Epoch 17/30

50000/50000 [==============================] - 16s 318us/step - loss: 1.3994 - acc: 0.5086 - val\_loss: 1.7213 - val\_acc: 0.4123

Epoch 18/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3931 - acc: 0.5120 - val\_loss: 1.6919 - val\_acc: 0.4209

Epoch 19/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3885 - acc: 0.5125 - val\_loss: 1.6463 - val\_acc: 0.4272

Epoch 20/30

50000/50000 [==============================] - 16s 319us/step - loss: 1.3809 - acc: 0.5126 - val\_loss: 1.6306 - val\_acc: 0.4339

Epoch 21/30

50000/50000 [==============================] - 16s 316us/step - loss: 1.3745 - acc: 0.5156 - val\_loss: 1.5805 - val\_acc: 0.4486

Epoch 22/30

50000/50000 [==============================] - 16s 318us/step - loss: 1.3668 - acc: 0.5199 - val\_loss: 1.5915 - val\_acc: 0.4425

Epoch 23/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3625 - acc: 0.5221 - val\_loss: 1.5840 - val\_acc: 0.4440

Epoch 24/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3613 - acc: 0.5230 - val\_loss: 1.5261 - val\_acc: 0.4629

Epoch 25/30

50000/50000 [==============================] - 16s 319us/step - loss: 1.3567 - acc: 0.5249 - val\_loss: 1.5323 - val\_acc: 0.4587

Epoch 26/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3501 - acc: 0.5258 - val\_loss: 1.4850 - val\_acc: 0.4796

Epoch 27/30

50000/50000 [==============================] - 16s 318us/step - loss: 1.3461 - acc: 0.5276 - val\_loss: 1.4483 - val\_acc: 0.4875

Epoch 28/30

50000/50000 [==============================] - 16s 316us/step - loss: 1.3431 - acc: 0.5277 - val\_loss: 1.4997 - val\_acc: 0.4696

Epoch 29/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3392 - acc: 0.5277 - val\_loss: 1.4620 - val\_acc: 0.4814

Epoch 30/30

50000/50000 [==============================] - 16s 317us/step - loss: 1.3344 - acc: 0.5321 - val\_loss: 1.4660 - val\_acc: 0.4806

Model 4

Layer (type) Output Shape Param #

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conv2d\_13 (Conv2D) (None, 32, 32, 64) 1792

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activation\_38 (Activation) (None, 32, 32, 64) 0

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conv2d\_14 (Conv2D) (None, 30, 30, 64) 36928

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activation\_39 (Activation) (None, 30, 30, 64) 0

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max\_pooling2d\_20 (MaxPooling (None, 10, 10, 64) 0

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dropout\_31 (Dropout) (None, 10, 10, 64) 0

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conv2d\_15 (Conv2D) (None, 10, 10, 128) 73856

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activation\_40 (Activation) (None, 10, 10, 128) 0

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conv2d\_16 (Conv2D) (None, 8, 8, 128) 147584

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activation\_41 (Activation) (None, 8, 8, 128) 0

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max\_pooling2d\_21 (MaxPooling (None, 2, 2, 128) 0

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dropout\_32 (Dropout) (None, 2, 2, 128) 0

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flatten\_9 (Flatten) (None, 512) 0

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dense\_34 (Dense) (None, 512) 262656

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activation\_42 (Activation) (None, 512) 0

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dropout\_33 (Dropout) (None, 512) 0

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dense\_35 (Dense) (None, 10) 5130

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activation\_43 (Activation) (None, 10) 0

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Total params: 527,946

Trainable params: 527,946

Non-trainable params: 0

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Train on 50000 samples, validate on 10000 samples

Epoch 1/30

50000/50000 [==============================] - 15s 308us/step - loss: 2.1019 - acc: 0.2078 - val\_loss: 1.8334 - val\_acc: 0.3375

Epoch 2/30

50000/50000 [==============================] - 14s 271us/step - loss: 1.7844 - acc: 0.3273 - val\_loss: 1.6199 - val\_acc: 0.4064

Epoch 3/30

50000/50000 [==============================] - 14s 272us/step - loss: 1.6372 - acc: 0.3864 - val\_loss: 1.5121 - val\_acc: 0.4499

Epoch 4/30

50000/50000 [==============================] - 13s 270us/step - loss: 1.5510 - acc: 0.4234 - val\_loss: 1.4313 - val\_acc: 0.4838

Epoch 5/30

50000/50000 [==============================] - 13s 270us/step - loss: 1.4781 - acc: 0.4573 - val\_loss: 1.3599 - val\_acc: 0.5103

Epoch 6/30

50000/50000 [==============================] - 14s 271us/step - loss: 1.4141 - acc: 0.4828 - val\_loss: 1.2898 - val\_acc: 0.5371

Epoch 7/30

50000/50000 [==============================] - 14s 271us/step - loss: 1.3598 - acc: 0.5068 - val\_loss: 1.2407 - val\_acc: 0.5594

Epoch 8/30

50000/50000 [==============================] - 14s 271us/step - loss: 1.3177 - acc: 0.5231 - val\_loss: 1.2072 - val\_acc: 0.5728

Epoch 9/30

50000/50000 [==============================] - 14s 272us/step - loss: 1.2773 - acc: 0.5388 - val\_loss: 1.1766 - val\_acc: 0.5853

Epoch 10/30

50000/50000 [==============================] - 14s 271us/step - loss: 1.2414 - acc: 0.5533 - val\_loss: 1.1459 - val\_acc: 0.5969

Epoch 11/30

50000/50000 [==============================] - 14s 270us/step - loss: 1.2101 - acc: 0.5676 - val\_loss: 1.1040 - val\_acc: 0.6140

Epoch 12/30

50000/50000 [==============================] - 14s 270us/step - loss: 1.1866 - acc: 0.5782 - val\_loss: 1.0770 - val\_acc: 0.6239

Epoch 13/30

50000/50000 [==============================] - 14s 270us/step - loss: 1.1559 - acc: 0.5900 - val\_loss: 1.0600 - val\_acc: 0.6295

Epoch 14/30

50000/50000 [==============================] - 13s 269us/step - loss: 1.1321 - acc: 0.5974 - val\_loss: 1.0398 - val\_acc: 0.6388

Epoch 15/30

50000/50000 [==============================] - 14s 271us/step - loss: 1.1087 - acc: 0.6062 - val\_loss: 1.0119 - val\_acc: 0.6480

Epoch 16/30

50000/50000 [==============================] - 14s 270us/step - loss: 1.0889 - acc: 0.6180 - val\_loss: 0.9961 - val\_acc: 0.6559

Epoch 17/30

50000/50000 [==============================] - 13s 269us/step - loss: 1.0711 - acc: 0.6226 - val\_loss: 0.9967 - val\_acc: 0.6509

Epoch 18/30

50000/50000 [==============================] - 13s 269us/step - loss: 1.0572 - acc: 0.6278 - val\_loss: 0.9987 - val\_acc: 0.6508

Epoch 19/30

50000/50000 [==============================] - 14s 272us/step - loss: 1.0402 - acc: 0.6365 - val\_loss: 0.9577 - val\_acc: 0.6708

Epoch 20/30

50000/50000 [==============================] - 13s 269us/step - loss: 1.0186 - acc: 0.6437 - val\_loss: 0.9370 - val\_acc: 0.6733

Epoch 21/30

50000/50000 [==============================] - 13s 269us/step - loss: 1.0052 - acc: 0.6481 - val\_loss: 0.9188 - val\_acc: 0.6813

Epoch 22/30

50000/50000 [==============================] - 14s 272us/step - loss: 0.9918 - acc: 0.6510 - val\_loss: 0.9333 - val\_acc: 0.6758

Epoch 23/30

50000/50000 [==============================] - 13s 269us/step - loss: 0.9826 - acc: 0.6557 - val\_loss: 0.8982 - val\_acc: 0.6896

Epoch 24/30

50000/50000 [==============================] - 13s 270us/step - loss: 0.9613 - acc: 0.6624 - val\_loss: 0.8838 - val\_acc: 0.6933

Epoch 25/30

50000/50000 [==============================] - 14s 270us/step - loss: 0.9503 - acc: 0.6688 - val\_loss: 0.8793 - val\_acc: 0.6957

Epoch 26/30

50000/50000 [==============================] - 13s 270us/step - loss: 0.9359 - acc: 0.6712 - val\_loss: 0.8536 - val\_acc: 0.7048

Epoch 27/30

50000/50000 [==============================] - 13s 269us/step - loss: 0.9261 - acc: 0.6757 - val\_loss: 0.8491 - val\_acc: 0.7068

Epoch 28/30

50000/50000 [==============================] - 13s 270us/step - loss: 0.9116 - acc: 0.6794 - val\_loss: 0.8582 - val\_acc: 0.7071

Epoch 29/30

50000/50000 [==============================] - 13s 269us/step - loss: 0.8993 - acc: 0.6823 - val\_loss: 0.8330 - val\_acc: 0.7128

Epoch 30/30

50000/50000 [==============================] - 13s 269us/step - loss: 0.8910 - acc: 0.6890 - val\_loss: 0.8189 - val\_acc: 0.7179

Model 5

Train on 50000 samples, validate on 10000 samples

Epoch 1/90

50000/50000 [==============================] - 16s 316us/step - loss: 1.8493 - acc: 0.3077 - val\_loss: 1.5548 - val\_acc: 0.4329

Epoch 2/90

50000/50000 [==============================] - 14s 272us/step - loss: 1.4449 - acc: 0.4696 - val\_loss: 1.2517 - val\_acc: 0.5438

Epoch 3/90

50000/50000 [==============================] - 14s 270us/step - loss: 1.2480 - acc: 0.5509 - val\_loss: 1.1361 - val\_acc: 0.6006

Epoch 4/90

50000/50000 [==============================] - 14s 273us/step - loss: 1.1141 - acc: 0.6051 - val\_loss: 1.0064 - val\_acc: 0.6467

Epoch 5/90

50000/50000 [==============================] - 14s 272us/step - loss: 1.0280 - acc: 0.6376 - val\_loss: 0.9287 - val\_acc: 0.6782

Epoch 6/90

50000/50000 [==============================] - 13s 269us/step - loss: 0.9508 - acc: 0.6684 - val\_loss: 0.8622 - val\_acc: 0.7017

Epoch 7/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.8900 - acc: 0.6884 - val\_loss: 0.8624 - val\_acc: 0.7062

Epoch 8/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.8366 - acc: 0.7068 - val\_loss: 0.7896 - val\_acc: 0.7279

Epoch 9/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.7992 - acc: 0.7219 - val\_loss: 0.7662 - val\_acc: 0.7385

Epoch 10/90

50000/50000 [==============================] - 14s 272us/step - loss: 0.7616 - acc: 0.7339 - val\_loss: 0.7124 - val\_acc: 0.7550

Epoch 11/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.7278 - acc: 0.7462 - val\_loss: 0.7093 - val\_acc: 0.7602

Epoch 12/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.6961 - acc: 0.7580 - val\_loss: 0.6872 - val\_acc: 0.7637

Epoch 13/90

50000/50000 [==============================] - 14s 272us/step - loss: 0.6633 - acc: 0.7676 - val\_loss: 0.6623 - val\_acc: 0.7730

Epoch 14/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.6499 - acc: 0.7739 - val\_loss: 0.6474 - val\_acc: 0.7765

Epoch 15/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.6268 - acc: 0.7821 - val\_loss: 0.6358 - val\_acc: 0.7809

Epoch 16/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.6039 - acc: 0.7893 - val\_loss: 0.6216 - val\_acc: 0.7855

Epoch 17/90

50000/50000 [==============================] - 14s 272us/step - loss: 0.5789 - acc: 0.7998 - val\_loss: 0.6129 - val\_acc: 0.7904

Epoch 18/90

50000/50000 [==============================] - 13s 269us/step - loss: 0.5678 - acc: 0.8012 - val\_loss: 0.6342 - val\_acc: 0.7838

Epoch 19/90

50000/50000 [==============================] - 14s 272us/step - loss: 0.5494 - acc: 0.8078 - val\_loss: 0.5975 - val\_acc: 0.7979

Epoch 20/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.5277 - acc: 0.8154 - val\_loss: 0.5827 - val\_acc: 0.8008

Epoch 21/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.5145 - acc: 0.8186 - val\_loss: 0.5994 - val\_acc: 0.7957

Epoch 22/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.4975 - acc: 0.8248 - val\_loss: 0.5713 - val\_acc: 0.8033

Epoch 23/90

50000/50000 [==============================] - 14s 272us/step - loss: 0.4787 - acc: 0.8317 - val\_loss: 0.5739 - val\_acc: 0.8059

Epoch 24/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.4668 - acc: 0.8351 - val\_loss: 0.5746 - val\_acc: 0.8037

Epoch 25/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.4555 - acc: 0.8385 - val\_loss: 0.5645 - val\_acc: 0.8047

Epoch 26/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.4424 - acc: 0.8438 - val\_loss: 0.5687 - val\_acc: 0.8072

Epoch 27/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.4302 - acc: 0.8482 - val\_loss: 0.5488 - val\_acc: 0.8141

Epoch 28/90

50000/50000 [==============================] - 14s 273us/step - loss: 0.4165 - acc: 0.8512 - val\_loss: 0.5628 - val\_acc: 0.8134

Epoch 29/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.4069 - acc: 0.8558 - val\_loss: 0.5636 - val\_acc: 0.8123

Epoch 30/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.3964 - acc: 0.8598 - val\_loss: 0.5499 - val\_acc: 0.8170

Epoch 31/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.3794 - acc: 0.8663 - val\_loss: 0.5513 - val\_acc: 0.8192

Epoch 32/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.3746 - acc: 0.8682 - val\_loss: 0.5625 - val\_acc: 0.8170

Epoch 33/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.3673 - acc: 0.8690 - val\_loss: 0.5599 - val\_acc: 0.8180

Epoch 34/90

50000/50000 [==============================] - 14s 272us/step - loss: 0.3547 - acc: 0.8735 - val\_loss: 0.5518 - val\_acc: 0.8184

Epoch 35/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.3447 - acc: 0.8779 - val\_loss: 0.5604 - val\_acc: 0.8179

Epoch 36/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.3372 - acc: 0.8791 - val\_loss: 0.5535 - val\_acc: 0.8203

Epoch 37/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.3315 - acc: 0.8823 - val\_loss: 0.5520 - val\_acc: 0.8207

Epoch 38/90

50000/50000 [==============================] - 13s 269us/step - loss: 0.3182 - acc: 0.8872 - val\_loss: 0.5736 - val\_acc: 0.8171

Epoch 39/90

50000/50000 [==============================] - 13s 268us/step - loss: 0.3157 - acc: 0.8866 - val\_loss: 0.5578 - val\_acc: 0.8178

Epoch 40/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.3107 - acc: 0.8884 - val\_loss: 0.5793 - val\_acc: 0.8176

tep - loss: 0.1927 - acc: 0.9294 - val\_loss: 0.5970 - val\_acc: 0.8217

0.1655 - acc: 0.9416 - val\_loss: 0.6512 - val\_acc: 0.8230

Epoch 83/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.1647 - acc: 0.9417 - val\_loss: 0.6388 - val\_acc: 0.8248

Epoch 84/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.1590 - acc: 0.9433 - val\_loss: 0.6614 - val\_acc: 0.8238

Epoch 85/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.1593 - acc: 0.9435 - val\_loss: 0.6476 - val\_acc: 0.8216

Epoch 86/90

50000/50000 [==============================] - 14s 270us/step - loss: 0.1530 - acc: 0.9456 - val\_loss: 0.6510 - val\_acc: 0.8255

Epoch 87/90

50000/50000 [==============================] - 14s 271us/step - loss: 0.1535 - acc: 0.9453 - val\_loss: 0.6383 - val\_acc: 0.8236

Epoch 88/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.1466 - acc: 0.9483 - val\_loss: 0.6702 - val\_acc: 0.8202

Epoch 89/90

50000/50000 [==============================] - 13s 269us/step - loss: 0.1491 - acc: 0.9468 - val\_loss: 0.6482 - val\_acc: 0.8232

Epoch 90/90

50000/50000 [==============================] - 13s 270us/step - loss: 0.1451 - acc: 0.9485 - val\_loss: 0.6666 - val\_acc: 0.8274

Model 6

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Layer (type) Output Shape Param #

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conv2d\_61 (Conv2D) (None, 32, 32, 64) 1792

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activation\_101 (Activation) (None, 32, 32, 64) 0

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conv2d\_62 (Conv2D) (None, 30, 30, 64) 36928

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activation\_102 (Activation) (None, 30, 30, 64) 0

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max\_pooling2d\_44 (MaxPooling (None, 10, 10, 64) 0

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dropout\_61 (Dropout) (None, 10, 10, 64) 0

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conv2d\_63 (Conv2D) (None, 10, 10, 128) 73856

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activation\_103 (Activation) (None, 10, 10, 128) 0

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conv2d\_64 (Conv2D) (None, 8, 8, 128) 147584

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activation\_104 (Activation) (None, 8, 8, 128) 0

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max\_pooling2d\_45 (MaxPooling (None, 2, 2, 128) 0

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dropout\_62 (Dropout) (None, 2, 2, 128) 0

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flatten\_17 (Flatten) (None, 512) 0

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dense\_50 (Dense) (None, 512) 262656

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activation\_105 (Activation) (None, 512) 0

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dropout\_63 (Dropout) (None, 512) 0

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dense\_51 (Dense) (None, 10) 5130

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activation\_106 (Activation) (None, 10) 0

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Total params: 527,946

Trainable params: 527,946

Non-trainable params: 0

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Train on 50000 samples, validate on 10000 samples

Epoch 1/20

50000/50000 [==============================] - 16s 317us/step - loss: 1.8315 - acc: 0.3118 - val\_loss: 1.4680 - val\_acc: 0.4625

Epoch 2/20

50000/50000 [==============================] - 14s 270us/step - loss: 1.4189 - acc: 0.4801 - val\_loss: 1.2693 - val\_acc: 0.5514

Epoch 3/20

50000/50000 [==============================] - 14s 271us/step - loss: 1.2399 - acc: 0.5588 - val\_loss: 1.1206 - val\_acc: 0.6084

Epoch 4/20

50000/50000 [==============================] - 13s 269us/step - loss: 1.1268 - acc: 0.5975 - val\_loss: 1.0056 - val\_acc: 0.6426

Epoch 5/20

50000/50000 [==============================] - 14s 272us/step - loss: 1.0283 - acc: 0.6388 - val\_loss: 0.9145 - val\_acc: 0.6840

Epoch 6/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.9556 - acc: 0.6637 - val\_loss: 0.8693 - val\_acc: 0.6981

Epoch 7/20

50000/50000 [==============================] - 13s 270us/step - loss: 0.8975 - acc: 0.6875 - val\_loss: 0.8597 - val\_acc: 0.7027

Epoch 8/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.8464 - acc: 0.7028 - val\_loss: 0.7984 - val\_acc: 0.7233

Epoch 9/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.8034 - acc: 0.7206 - val\_loss: 0.8054 - val\_acc: 0.7186

Epoch 10/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.7688 - acc: 0.7305 - val\_loss: 0.7393 - val\_acc: 0.7426

Epoch 11/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.7364 - acc: 0.7445 - val\_loss: 0.7141 - val\_acc: 0.7529

Epoch 12/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.6979 - acc: 0.7563 - val\_loss: 0.6903 - val\_acc: 0.7592

Epoch 13/20

50000/50000 [==============================] - 13s 269us/step - loss: 0.6771 - acc: 0.7638 - val\_loss: 0.6732 - val\_acc: 0.7678

Epoch 14/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.6505 - acc: 0.7735 - val\_loss: 0.6761 - val\_acc: 0.7676

Epoch 15/20

50000/50000 [==============================] - 14s 272us/step - loss: 0.6219 - acc: 0.7832 - val\_loss: 0.6472 - val\_acc: 0.7776

Epoch 16/20

50000/50000 [==============================] - 14s 270us/step - loss: 0.6033 - acc: 0.7885 - val\_loss: 0.6297 - val\_acc: 0.7860

Epoch 17/20

50000/50000 [==============================] - 14s 271us/step - loss: 0.5849 - acc: 0.7955 - val\_loss: 0.6398 - val\_acc: 0.7815

Epoch 18/20

50000/50000 [==============================] - 14s 272us/step - loss: 0.5678 - acc: 0.8009 - val\_loss: 0.6418 - val\_acc: 0.7805

Epoch 19/20

50000/50000 [==============================] - 13s 270us/step - loss: 0.5500 - acc: 0.8073 - val\_loss: 0.5961 - val\_acc: 0.7931

Epoch 20/20

50000/50000 [==============================] - 14s 275us/step - loss: 0.5351 - acc: 0.8122 - val\_loss: 0.5944 - val\_acc: 0.7968