Deep Learning for Computer Vision (2021 Fall) HW1

R10942152 Ken Yu(游家權)

Problem 1: Image Classification

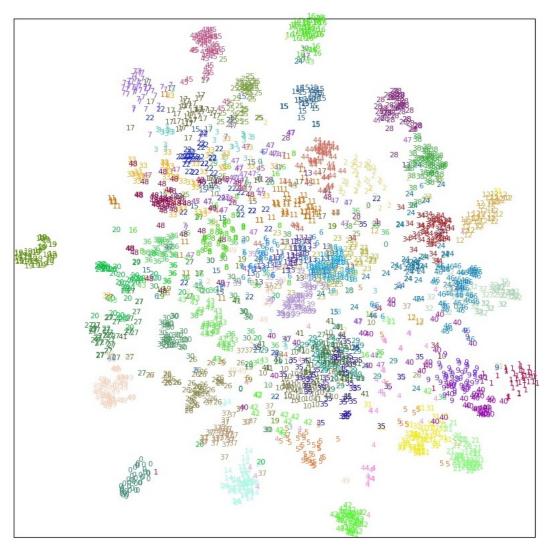
1. (2%) Print the network architecture of your model.

Conv2d-1 [-1, 64, 224, 224] 1,792 BatchNorm2d-2 [-1, 64, 224, 224] 128 ReLU-3 [-1, 64, 224, 224] 9 Conv2d-4 [-1, 64, 224, 224] 9 BatchNorm2d-5 [-1, 64, 224, 224] 36,928 BatchNorm2d-5 [-1, 64, 224, 224] 128 ReLU-6 [-1, 64, 224, 224] 9 MaxPool2d-7 [-1, 64, 112, 112] 9 Conv2d-8 [-1, 128, 112, 112] 73,856 BatchNorm2d-9 [-1, 128, 112, 112] 256 ReLU-10 [-1, 128, 112, 112] 9 Conv2d-11 [-1, 128, 112, 112] 147,584 BatchNorm2d-12 [-1, 128, 112, 112] 9 ReLU-13 [-1, 128, 112, 112] 9 MaxPool2d-14 [-1, 128, 112, 112] 9 MaxPool2d-14 [-1, 128, 112, 112] 9 Conv2d-15 [-1, 256, 56, 56] 9 Conv2d-16 [-1, 256, 56, 56] 90 ReLU-17 [-1, 256, 56, 56] 90 ReLU-18 [-1, 256, 56, 56] 90 ReLU-20 [-1, 256, 56, 56] 90 ReLU-21 [-1, 256, 56, 56] 90 ReLU-22 [-1, 256, 56, 56] 90 ReLU-23 [-1, 256, 56, 56] 90 ReLU-24 [-1, 256, 56, 56] 90 ReLU-25 [-1, 512, 28, 28] 1,180,160 BatchNorm2d-26 [-1, 512, 28, 28] 1,024 ReLU-27 [-1, 512, 28, 28] 1,024 ReLU-28 [-1, 512, 28, 28] 1,024 ReLU-29 [-1, 512, 28, 28] 1,024 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-31 [-1, 512, 28, 28] 1,024 ReLU-33 [-1, 512, 28, 28] 1,024 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-31 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 0 Conv2d-36 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14]	Layer (type)	Output Shape	Param #
BatchNorm2d-2 ReLU-3 ReLU-6 Conv2d-4 ReLU-6 ReLU-6 ReLU-6 ReLU-6 ReLU-7 ReLU-10 ReLU-10 ReLU-10 ReLU-10 ReLU-10 ReLU-10 ReLU-10 ReLU-10 ReLU-11 ReLU-11 ReLU-11 ReLU-12 ReLU-12 ReLU-13 ReLU-13 ReLU-14 ReLU-15 ReLU-15 ReLU-15 ReLU-16 ReLU-16 ReLU-17 ReLU-17 ReLU-17 ReLU-19 ReLU-20 ReLU-20 ReLU-20 ReLU-20 ReLU-20 ReLU-20 ReLU-17 ReLU-17 ReLU-18 ReLU-19 ReLU-19 ReLU-19 ReLU-19 ReLU-10 Relu-10 Relu-10 Relu-11 Relu-10 Relu-11 Relu-11 Relu-12 Relu-13 Relu-14 Relu-15 Relu-15 Relu-16 Relu-17 Relu-17 Relu-17 Relu-19 Relu-20 Relu-20 Relu-20 Relu-21 Relu-20 Relu-23 Relu-23 Relu-24 Relu-24 Relu-25 Relu-27 Relu-27 Relu-27 Relu-28 Relu-29 Relu-29 Relu-29 Relu-20 Relu-20 Relu-21 Relu-20 Relu-21 Relu-20 Relu-23 Relu-24 Relu-25 Relu-26 Relu-27 Relu-27 Relu-28 Relu-29 Relu-29 Relu-29 Relu-29 Relu-20 Relu-30 Relu-31 Relu-30 Relu-31 Relu-30 Relu-31 Relu-30 Relu-31 Relu-30 Relu-31 Relu-30 Relu-31 Relu-30 Relu-3	Conv2d-1	[-1. 64. 224. 224]	1.792
ReLU-3			
Conv2d-4	ReLU-3		0
BatchNorm2d-5	Conv2d-4		36,928
ReLU-6	BatchNorm2d-5		
MaxPool2d-7	ReLU-6		0
Conv2d-8	MaxPool2d-7		0
BatchNorm2d-9	Conv2d-8		73,856
ReLU-10 [-1, 128, 112, 112] 0 Conv2d-11 [-1, 128, 112, 112] 147,584 BatchNorm2d-12 [-1, 128, 112, 112] 256 ReLU-13 [-1, 128, 112, 112] 0 MaxPool2d-14 [-1, 128, 56, 56] 0 Conv2d-15 [-1, 256, 56, 56] 295, 168 BatchNorm2d-16 [-1, 256, 56, 56] 512 ReLU-17 [-1, 256, 56, 56] 0 Conv2d-18 [-1, 256, 56, 56] 0 Conv2d-18 [-1, 256, 56, 56] 590,080 BatchNorm2d-19 [-1, 256, 56, 56] 590,080 BatchNorm2d-19 [-1, 256, 56, 56] 590,080 BatchNorm2d-21 [-1, 256, 56, 56] 590,080 BatchNorm2d-22 [-1, 256, 56, 56] 590,080 BatchNorm2d-24 [-1, 256, 56, 56] 590,080 Conv2d-25 [-1, 512, 28, 28] 1,180,160 BatchNorm2d-26 [-1, 512, 28, 28] 1,180,160 BatchNorm2d-27 [-1, 512, 28, 28] 1,024 ReLU-27 [-1, 512, 28, 28] 1,024 ReLU-27 [-1, 512, 28, 28] 1,024 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-31 [-1, 512, 28, 28] 1,024 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-31 [-1, 512, 28, 28] 1,024 ReLU-33 [-1, 512, 28, 28] 1,024 ReLU-34 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-32 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 1,024 ReLU-38 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 1,024 ReLU-38 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-49 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-41 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14] 1,024 ReLU-41 [-1, 512, 14, 14] 1,024 ReLU-42 [-1, 512, 14, 14] 1,024 ReLU-43 [-1, 512, 14, 14] 1,024 ReLU-44 [-1, 512, 14, 14] 1,024 ReLU-46 [-1, 512, 14, 14] 1,024 ReLU-47 [-1, 4096] 102,764,544 ReLU-48 [-1, 512, 14, 14] 1,024 ReLU-49 [-1, 512, 14, 14] 1,024 ReLU-49 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14] 1,024 ReLU-4	BatchNorm2d-9	[-1, 128, 112, 112]	
Conv2d-11	ReLU-10		0
ReLU-13	Conv2d-11	[-1, 128, 112, 112]	147,584
ReLU-13	BatchNorm2d-12	[-1, 128, 112, 112]	
MaxPool2d-14 [-1, 128, 56, 56] 0 Conv2d-15 [-1, 256, 56, 56] 295,168 BatchNorm2d-16 [-1, 256, 56, 56] 512 ReLU-17 [-1, 256, 56, 56] 0 Conv2d-18 [-1, 256, 56, 56] 590,080 BatchNorm2d-19 [-1, 256, 56, 56] 512 ReLU-20 [-1, 256, 56, 56] 512 ReLU-21 [-1, 256, 56, 56] 590,080 BatchNorm2d-22 [-1, 256, 56, 56] 590,080 BatchNorm2d-22 [-1, 256, 56, 56] 512 ReLU-23 [-1, 256, 56, 56] 512 ReLU-23 [-1, 512, 28, 28] 1,180,160 BatchNorm2d-24 [-1, 512, 28, 28] 1,24 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-37 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-28 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-39 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-32 [-1, 512, 28, 28] 1,024 ReLU-30 [-1, 512, 28, 28] 1,024 ReLU-37	ReLU-13		0
BatchNorm2d-16	MaxPool2d-14		0
BatchNorm2d-16	Conv2d-15	[-1, 256, 56, 56]	295,168
ReLU-17 [-1, 256, 56, 56] 0 Conv2d-18 [-1, 256, 56, 56] 590,080 BatchNorm2d-19 [-1, 256, 56, 56] 590,080 Conv2d-21 [-1, 256, 56, 56] 0 Conv2d-21 [-1, 256, 56, 56] 590,080 BatchNorm2d-22 [-1, 256, 56, 56] 590,080 BatchNorm2d-22 [-1, 256, 56, 56] 590,080 BatchNorm2d-24 [-1, 256, 56, 56] 512 ReLU-23 [-1, 256, 56, 56] 512 ReLU-23 [-1, 256, 56, 56] 61 MaxPool2d-24 [-1, 256, 28, 28] 0 Conv2d-25 [-1, 512, 28, 28] 1,180,160 BatchNorm2d-26 [-1, 512, 28, 28] 1,024 ReLU-27 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-29 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-29 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-32 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-32 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-34 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-36 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-36 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-36 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 1,024 ReLU-48 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-49 [-1, 512, 14, 14] 0 Conv2d-41 [-1, 512, 14, 14] 0 Conv2d-41 [-1, 512, 14, 14] 0 AmaxPool2d-44 [-1, 512, 14, 14] 0 AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-45 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Dropout-51 [-1, 4096] 0	BatchNorm2d-16		
Conv2d-18	ReLU-17		0
BatchNorm2d-19 [-1, 256, 56, 56] 512 ReLU-20 [-1, 256, 56, 56] 0 Conv2d-21 [-1, 256, 56, 56] 590,080 BatchNorm2d-22 [-1, 256, 56, 56] 512 ReLU-23 [-1, 256, 56, 56] 0 MaxPool2d-24 [-1, 256, 28, 28] 0 Conv2d-25 [-1, 512, 28, 28] 1,024 BatchNorm2d-26 [-1, 512, 28, 28] 1,024 ReLU-27 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-29 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-29 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-31 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-32 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-33 [-1, 512, 28, 28] 1,024 ReLU-33 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-34 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 0 Conv2d-36 [-1, 512, 14, 14] 0 Conv2d-38 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 0 Conv2d-41 <th></th> <td></td> <td>590,080</td>			590,080
ReLU-20	BatchNorm2d-19	[-1, 256, 56, 56]	
Conv2d-21	ReLU-20		0
BatchNorm2d-22	Conv2d-21		590,080
ReLU-23	BatchNorm2d-22	[-1, 256, 56, 56]	
MaxPool2d-24	ReLU-23	[-1, 256, 56, 56]	0
Conv2d-25	MaxPool2d-24	[-1, 256, 28, 28]	0
BatchNorm2d-26 ReLU-27 ReLU-27 ReLU-27 ReLU-27 ReLU-30 ReLU-30 ReLU-30 ReLU-30 ReLU-33 ReLU-33 ReLU-34 ReLU-35 ReLU-35 ReLU-37 ReLU-37 ReLU-38 ReLU-38 ReLU-39 ReLU-37 ReLU-37 ReLU-37 ReLU-39 ReLU-40 ReLU-40 ReLU-40 ReLU-40 ReLU-40 ReLU-40 ReLU-43 ReLU-43 ReLU-43 ReLU-43 ReLU-43 ReLU-43 ReLU-43 ReLU-43 ReLU-44 ReLU-44 ReLU-45 ReLU-46 ReLU-47 ReLU-47 ReLU-47 ReLU-47 ReLU-47 ReLU-47 ReLU-48 ReLU-49 ReLU-49 ReLU-47 ReLU-47 ReLU-49 ReLU-47 ReLU-47 ReLU-47 ReLU-47 ReLU-47 ReLU-49 ReLU-47 ReLU-49 ReLU-49 ReLU-47 ReLU-47 ReLU-49 ReLU-49 ReLU-47 ReLU-47 ReLU-49 ReLU-50		[-1, 512, 28, 28]	1,180,160
ReLU-27			
Conv2d-28 BatchNorm2d-29 ReLU-30 Conv2d-31 ReLU-32 ReLU-33 BatchNorm2d-32 ReLU-33 BatchNorm2d-32 ReLU-33 BatchNorm2d-32 ReLU-33 BatchNorm2d-34 ReLU-33 BatchNorm2d-34 ReLU-35 Conv2d-35 BatchNorm2d-36 BatchNorm2d-36 BatchNorm2d-36 BatchNorm2d-38 BatchNorm2d-38 BatchNorm2d-39 BatchNorm2d-39 BatchNorm2d-39 BatchNorm2d-41 ReLU-40 Conv2d-41 BatchNorm2d-42 ReLU-43 BatchNorm2d-42 ReLU-43 BatchNorm2d-42 ReLU-43 BatchNorm2d-442 ReLU-43 BatchNorm2d-442 ReLU-43 BatchNorm2d-442 ReLU-43 BatchNorm2d-442 ReLU-43 BatchNorm2d-442 ReLU-43 BatchNorm2d-45 ReLU-43 BatchNorm2d-45 ReLU-45 ReLU-46 ReLU-47 BatchNorm2d-47 Conv2d-41 RelU-47 Conv2d-45 Conv2d-45 Conv2d-45 Conv2d-46 RelU-47 Conv2d-47 Conv2d-47 Conv2d-48 RelU-49 Conv2d-49 Conv2d-49 Conv2d-49 RelU-49 Conv2d-49 Conv2d-49 RelU-49 Conv2d-49 Con	ReLU-27		
BatchNorm2d-29			2,359,808
ReLU-30 [-1, 512, 28, 28] 0 Conv2d-31 [-1, 512, 28, 28] 2,359,808 BatchNorm2d-32 [-1, 512, 28, 28] 1,024 ReLU-33 [-1, 512, 28, 28] 0 MaxPool2d-34 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-36 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-38 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 0 Conv2d-41 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 0 AdaptiveAvgPool2d-45 [-1, 512, 14, 14] 0 Linear-46 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 0 Dropout-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	BatchNorm2d-29		1,024
Conv2d-31	ReLU-30		
ReLU-33	Conv2d-31	[-1, 512, 28, 28]	2,359,808
ReLU-33	BatchNorm2d-32	[-1, 512, 28, 28]	1,024
MaxPool2d-34 [-1, 512, 14, 14] 0 Conv2d-35 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-36 [-1, 512, 14, 14] 1,024 ReLU-37 [-1, 512, 14, 14] 0 Conv2d-38 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-41 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 1,024 ReLU-43 [-1, 512, 14, 14] 0 MaxPool2d-44 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-445 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 0 Linear-49 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	ReLU-33	[-1, 512, 28, 28]	0
BatchNorm2d-36 ReLU-37 ReLU-37 ReLU-38 ReLU-38 ReLU-49 ReLU-40 ReLU-40 ReLU-40 ReLU-41 ReLU-41 ReLU-42 ReLU-43 ReLU-43 ReLU-43 ReLU-43 ReLU-44 ReLU-44 Relu-44 Relu-45 Relu-45 Relu-45 Relu-47 Relu-46 Relu-47 Relu-47 Relu-47 Relu-47 Relu-47 Relu-47 Relu-48 Relu-49 Relu-49 Relu-49 Relu-47 Relu-47 Relu-47 Relu-47 Relu-47 Relu-47 Relu-48 Relu-50	MaxPool2d-34		0
ReLU-37 [-1, 512, 14, 14] 0 Conv2d-38 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-39 [-1, 512, 14, 14] 1,024 ReLU-40 [-1, 512, 14, 14] 0 Conv2d-41 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 1,024 ReLU-43 [-1, 512, 14, 14] 1,024 ReLU-43 [-1, 512, 14, 14] 0 MaxPool2d-44 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 0 Linear-49 [-1, 4096] 0 Dropout-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 4096] 0	Conv2d-35	[-1, 512, 14, 14]	2,359,808
Conv2d-38	BatchNorm2d-36	[-1, 512, 14, 14]	1,024
BatchNorm2d-39	ReLU-37	[-1, 512, 14, 14]	0
ReLU-40 [-1, 512, 14, 14] 0 Conv2d-41 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 1,024 ReLU-43 [-1, 512, 14, 14] 0 MaxPool2d-44 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	Conv2d-38		2,359,808
Conv2d-41 [-1, 512, 14, 14] 2,359,808 BatchNorm2d-42 [-1, 512, 14, 14] 1,024 ReLU-43 [-1, 512, 14, 14] 0 MaxPool2d-44 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	BatchNorm2d-39	[-1, 512, 14, 14]	1,024
BatchNorm2d-42	ReLU-40	[-1, 512, 14, 14]	0
ReLU-43 [-1, 512, 14, 14] 0 MaxPool2d-44 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	Conv2d-41	[-1, 512, 14, 14]	2,359,808
MaxPool2d-44 [-1, 512, 7, 7] 0 AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	BatchNorm2d-42	[-1, 512, 14, 14]	1,024
AdaptiveAvgPool2d-45 [-1, 512, 7, 7] 0 Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850			
Linear-46 [-1, 4096] 102,764,544 ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850		[-1, 512, 7, 7]	0
ReLU-47 [-1, 4096] 0 Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850	AdaptiveAvgPool2d-45		0
Dropout-48 [-1, 4096] 0 Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850			
Linear-49 [-1, 4096] 16,781,312 ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850		[-1, 4096]	
ReLU-50 [-1, 4096] 0 Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850			
Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850		[-1, 4096]	
Dropout-51 [-1, 4096] 0 Linear-52 [-1, 50] 204,850		[-1, 4096]	
Linear-52 [-1, 50] 204,850		[-1, 4096]	
VGG-53 [-1, 50] 0		[-1, 50]	
	VGG-53	[-1, 50]	0
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2. (2%) Report accuracy of model on the validation set. (TA will reproduce your results, error $\pm 0.5\%$)

Ans: Accuracy on validation set is **0.8356**

3. (6%) Visualize the classification result on validation set by implementing t-SNE on output features of the second last layer. Briefly explain your result of the tSNE visualization.



Ans: We can tell from tSNE plot that some classes are far from others, while some overlap with other classes. If the class is far from others, it means it has some distinct feature that make it easier to classify. If the class is overlapped

with others, it means their features can easily confuse detector, hence harder to classify.

For instance, class 0 is bicycle which has lots of features to recognize, making it stay far from other classes on tSNE plot. On the other hand, class 29 and class 35 are adult and child; due to the similarity of these features, these two classes are almost inseparable on tSNE plot.

Problem 2: Segmentation

1. (5%) Print the network architecture of your VGG16-FCN32s model.

Layer (type)	Output Shape	Param #			
Conv2d-1	[-1, 64, 512, 512]	1,792			
ReLU-2	[-1, 64, 512, 512]	-,			
Conv2d-3	[-1, 64, 512, 512]	36,928			
ReLU-4	[-1, 64, 512, 512]	0			
MaxPool2d-5	[-1, 64, 256, 256]	0			
Conv2d-6	[-1, 128, 256, 256]	73,856			
ReLU-7	[-1, 128, 256, 256]	0			
Conv2d-8	[-1, 128, 256, 256]	147,584			
ReLU-9	[-1, 128, 256, 256]	0			
MaxPool2d-10	[-1, 128, 128, 128]	0			
Conv2d-11	[-1, 256, 128, 128]	295,168			
ReLU-12	[-1, 256, 128, 128]	. 0			
Conv2d-13	[-1, 256, 128, 128]	590,080			
ReLU-14	[-1, 256, 128, 128]	. 0			
Conv2d-15	[-1, 256, 128, 128]	590,080			
ReLU-16	[-1, 256, 128, 128]	' o			
MaxPool2d-17	[-1, 256, 64, 64]	0			
Conv2d-18	[-1, 512, 64, 64]	1,180,160			
ReLU-19	[-1, 512, 64, 64]	0			
Conv2d-20	[-1, 512, 64, 64]	2,359,808			
ReLU-21	[-1, 512, 64, 64]	0			
Conv2d-22	[-1, 512, 64, 64]	2,359,808			
ReLU-23	[-1, 512, 64, 64]	. 0			
MaxPool2d-24	[-1, 512, 32, 32]	0			
Conv2d-25	[-1, 512, 32, 32]	2,359,808			
ReLU-26	[-1, 512, 32, 32]	0			
Conv2d-27	[-1, 512, 32, 32]	2,359,808			
ReLU-28	[-1, 512, 32, 32]	0			
Conv2d-29	[-1, 512, 32, 32]	2,359,808			
ReLU-30	[-1, 512, 32, 32]	0			
MaxPool2d-31	[-1, 512, 16, 16]	0			
Conv2d-32	[-1, 4096, 16, 16]	2,101,248			
ReLU-33	[-1, 4096, 16, 16]	0			
Dropout2d-34	[-1, 4096, 16, 16]	0			
Conv2d-35	[-1, 4096, 16, 16]	16,781,312			
ReLU-36	[-1, 4096, 16, 16]	0			
Dropout2d-37	[-1, 4096, 16, 16]				
Conv2d-38	[-1, 7, 16, 16]	28,679			
ConvTranspose2d-39	[-1, 7, 512, 512]	200,704			
T + 1					
Total params: 33,826,631					
Trainable params: 33,826,631 Non-trainable params: 0					
Input size (MB): 3.00					
Forward/backward pass size	(MB): 1203.01				
Params size (MB): 129.04					
Estimated Total Size (MB):	1335.05				

2. (5%) Implement an improved model which performs better than your baseline model. Print the network architecture of this model.

Layer (type)	Output Shape	Param #				
 Conv2d-1	[-1, 64, 512, 512]	1,792				
ReLU−2	[-1, 64, 512, 512]	. 0				
Conv2d-3	[-1, 64, 512, 512]	36,928				
ReLU-4	[-1, 64, 512, 512]	. 0				
MaxPool2d-5	[-1, 64, 256, 256]	Θ				
Conv2d-6	[-1, 128, 256, 256]	73,856				
ReLU-7	[-1, 128, 256, 256]	0				
Conv2d-8	[-1, 128, 256, 256]	147,584				
ReLU-9	[-1, 128, 256, 256]	9				
MaxPool2d-10	[-1, 128, 128, 128]	Θ				
Conv2d-11	[-1, 256, 128, 128]	295,168				
ReLU-12	[-1, 256, 128, 128]	0				
Conv2d-13	[-1, 256, 128, 128]	590,080				
ReLU-14	[-1, 256, 128, 128]	9				
Conv2d-15	[-1, 256, 128, 128]	590,080				
ReLU-16	[-1, 256, 128, 128]	0				
MaxPool2d-17	[-1, 256, 64, 64]	1 180 160				
Conv2d-18	[-1, 512, 64, 64]	1,180,160				
ReLU-19	[-1, 512, 64, 64]	2 350 808				
Conv2d-20	[-1, 512, 64, 64]	2,359,808				
ReLU-21	[-1, 512, 64, 64]	3 350 888				
Conv2d-22	[-1, 512, 64, 64]	2,359,808				
ReLU-23 MaxPool2d-24	[-1, 512, 64, 64]	0 0				
MaxP0012d-24 Conv2d-25	[-1, 512, 32, 32]					
ReLU-26	[-1, 512, 32, 32] [-1, 512, 32, 32]	2,359,808 0				
Conv2d-27	[-1, 512, 32, 32]	2,359,808				
ReLU-28	[-1, 512, 32, 32]	2,555,600				
Conv2d-29	[-1, 512, 32, 32]	2,359,808				
ReLU-30	[-1, 512, 32, 32]	2,555,555				
MaxPool2d-31	[-1, 512, 16, 16]	0				
ConvTranspose2d-32	[-1, 512, 32, 32]	2,359,808				
ReLU-33	[-1, 512, 32, 32]	9				
BatchNorm2d-34	[-1, 512, 32, 32]	1,024				
ConvTranspose2d-35	[-1, 256, 64, 64]	1,179,904				
ReLU-36	[-1, 256, 64, 64]					
BatchNorm2d-37	[-1, 256, 64, 64]	512				
ConvTranspose2d-38	[-1, 128, 128, 128]	295,040				
ReLU-39	[-1, 128, 128, 128]	9				
BatchNorm2d-40	[-1, 128, 128, 128]	256				
ConvTranspose2d-41	[-1, 64, 256, 256]	73,792				
ReLU-42	[-1, 64, 256, 256]	0				
BatchNorm2d-43	[-1, 64, 256, 256]	128				
ConvTranspose2d-44	[-1, 32, 512, 512]	18,464				
ReLU-45	[-1, 32, 512, 512]	0				
BatchNorm2d-46	[-1, 32, 512, 512]	64				
Conv2d-47	[-1, 7, 512, 512]	231				
Total params: 18,643,911						
Trainable params: 18,643,911						
Non-trainable params: 0						
Input size (MB): 3.00						
Forward/backward pass siz	e (MB): 1527.00					
Params size (MB): 71.12						
Estimated Total Size (MB): 1601.12						

3. (5%) Report mIoU of the improved model on the validation set. (TA will reproduce your results, error $\pm 0.5\%$)

Ans: My improved model is **FCN8s**, which produce **0.7247** mean_iou on validation dataset. By the way, my baseline model only produce 0.68 mean_iou in the same experiment.

4. (5%) Show the predicted segmentation mask of "validation/0010_sat.jpg", "validation/0097_sat.jpg", "validation/0107_sat.jpg" during the early, middle, and the final stage during the training process of this improved model

Early	Stage	Middle Stage	Final Stage	Label
(5 ep	och)	(20 epoch)	(40 epoch)	

Reference

[1] How to get intermediate layer's output.

https://discuss.pytorch.org/t/how-can-l-load-my-best-model-as-a-feature-extractor-evaluator/17254/6

[2] FNC8s

https://zhuanlan.zhihu.com/p/73965733

[3] Adam Optimizer

https://zhuanlan.zhihu.com/p/32626442

[4] UNet

https://github.com/milesial/Pytorch-UNet