Technical University of Denmark
2 hours written examination: 24 June 2021, 9-11.
Course: 02514 Deep Learning in Computer Vision.
Aids allowed: All aids permitted (no internet access).
Weighting: All questions are weighted equally.

The exam is multiple choice. All questions have five possible answers marked by the letters A, B, C, D and E.
A correct answer gives 4 points, a wrong answer gives -1 points.
The individual questions are answered by filling in the answer fields in the table below with one of the letters A, B, C, D or E.
Please write your name and student number clearly and hand in the present page (page 1) as your answer of the written test. Other pages will not be considered.

Question 1

You are asked to solve a segmentation task where each training image has 10 annotations, one by each of 10 experts. You train a segmentation CNN using Monte Carlo dropout to quantify uncertainty, by randomly sampling an annotator every time you select an image as part of a training batch. What type of uncertainty have you quantified?

A. Aleatoric uncertainty

B. Epistemic uncertainty

C. Both aleatoric and epistemic uncertainty

D. Neither aleatoric nor epistemic uncertainty

E. Don't know

Question 2

You have ran a 514×514 image through the U-net shown in Fig. 2.1. Which pixels in the input image should get the foreground/background label indicated by pixel $[5, 6]$ in the output image?

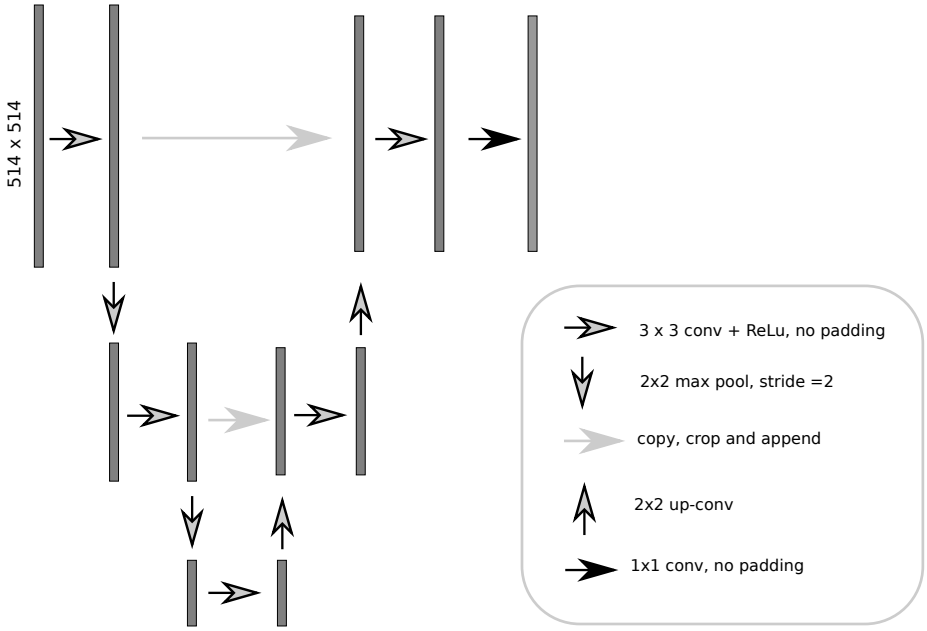


Figure 2.1: A U-net.

A. $[4 : 24, 4 : 29]$

B. **$[15, 16]$**

C. $[5, 6]$

D. $[10, 11]$

E. Don't know

Question 3

Consider the U-net shown in Fig. 3.1, trained on input images of size 514×514. What sort of spatial information is the network able to learn?

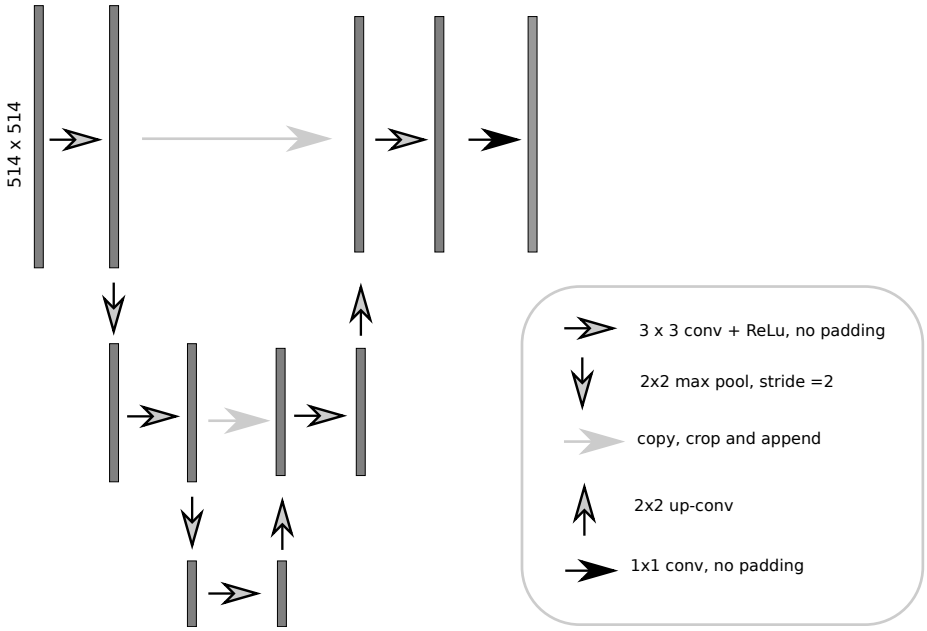


Figure 3.1: A U-net.

A. (X, Y)-coordinates

B. Proximity to boundaries

C. Proximity to center

D. It will not be able to learn any spatial information

E. Don't know

Question 4

Consider a CycleGAN with two generators, $A2B$, $B2A$, two real images, a_r, b_r and two discriminators, D_a, D_b. Now let

$$b_f = A2B(a_r)$$

$$a_c = B2A(b_f)$$

$$a_f = B2A(b_r)$$

$$b_c = A2B(a_f)$$

For this specific CycleGAN one or more losses have been removed before training it. An example of the images generated by the model are as follows:

Let vec be a function that reshapes a matrix into a vector.
Which losses has this CycleGAN been trained without?

A. Generator update: $||D_b(b_f) - 1||_2^2$
Generator update: $||D_a(a_f) - 1||_2^2$

B. **Generator update: $||\mathbf{vec}(a_c - a_r)||_1$**
Generator update: $||\mathbf{vec}(a_c - a_r)||_1$

C. Generator update: $||\text{vec}(B2A(a_r) - a_r)||_1$
Generator update: $||\text{vec}(A2B(b_r) - b_r)||_1$

D. Discriminator update: $||D_a(a_r) - 1||_2^2 + ||D_a(a_f) - 0||_2^2$
Discriminator update: $||D_b(b_r) - 1||_2^2 + ||D_b(b_f) - 0||_2^2$

E. Don't know

Question 5

You are training a generative adversarial network with a minimax loss and the following discriminator:

```
class Discriminator(nn.Module):
    def __init__(self):
        super(Discriminator, self).__init__()
        self.fc = nn.Sequential(nn.linear(28*28, 512),
                                nn.linear(512, 1))

    def forward(self, x):
        x = x.view(x.size(0), -1)
        return self.fc(x)
```

The minibatch size is 2. In one minibatch the discriminator above outputs [0.1, 0.5] for the generated images and [0.5, 0.9] for the real images.
What is the discriminator loss for this minibatch?

A. 1.267

B. 0.815

C. 0.799

D. 1.258

E. Don't know

Question 6

Which of the following tools does not help you avoid overfitting to small datasets?

A. Dropout

B. Batch normalization

C. Data augmentation

D. None of the above

E. Don't know

Question 7

Consider a generative adversarial network with Wasserstein loss, where the critic C is not Lipschitz continuous. Let $\mathbf{x}$ be real images and $G(\mathbf{z})$ images from the generator. As we train our model, $\mathbb{E}(C(\mathbf{x}))$ will tend towards

A. 0

B. 1

C. $\mathbb{E}(C(G(\mathbf{z})))$

D. ∞

E. Don't know

Question 8

Consider the neural network shown in Fig. 8.1. What is the receptive field of pixel $(1, 2)$ in the output, using Python zero indexing convention?

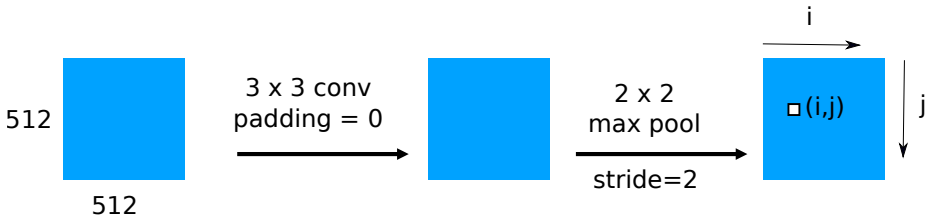


Figure 8.1: A CNN.

A. $[1:4, 3:6]$

B. $[2:5, 3:6]$

C. $\mathbf{[2:5, 4:7]}$

D. $[0:3, 2:5]$

E. Don't know

Question 9

Consider the neural network shown in Fig. 9.1. If you feed it an image of size 512×512, what is the size of its output?

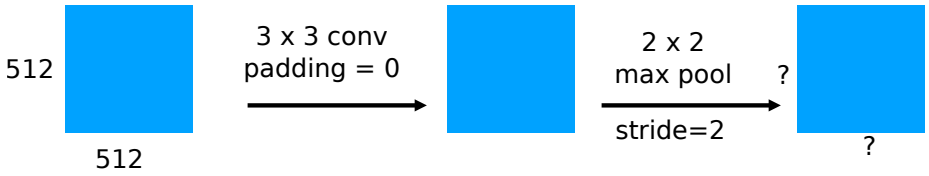


Figure 9.1: A CNN.

A. 256×256

B. 508×508

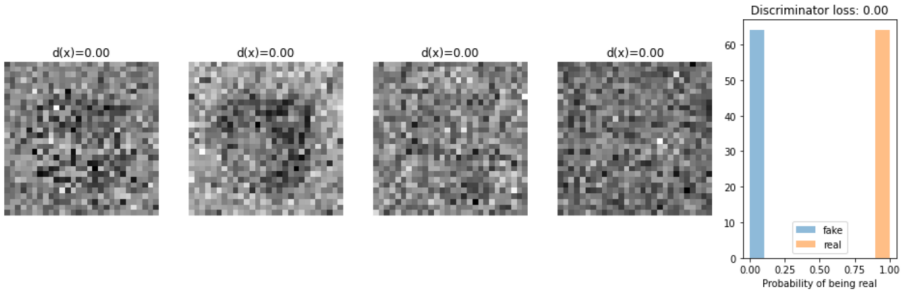
C. $\mathbf{255 \times 255}$

D. 128×128

E. Don't know

Question 10

You are training a generative adversarial network to generate MNIST digits, and you have generated the following images. The graph to the right is the output from the discriminator.



Which of the following actions would be the most important to do in order to make the generated images look more like the real ones.

A. Increase the capacity of generator

B. Train the discriminator on previously generated images as well

C. Increase the capacity of discriminator

D. Use data augmentation on the generated images

E. Don't know

Question 11

Consider a network where the gradient of loss function with respect to a parameter w follows a very specific pattern. For the i^{th} minibatch the gradient is

$$\frac{\partial l}{\partial w}(i) = \begin{cases} -2 & i \text{ is odd} \\ 2 & i \text{ is even} \end{cases}$$

When using the RMSProp optimizer with a learning rate of 1, what will be the correct weight update each iteration?

A. $w \leftarrow w - \begin{cases} -4 & i \text{ is odd} \\ 4 & i \text{ is even} \end{cases}$

B. $w \leftarrow w - \begin{cases} -2 & i \text{ is odd} \\ 2 & i \text{ is even} \end{cases}$

C. $\boldsymbol{w \leftarrow w - \begin{cases} -1 & i \text{ is odd} \\ 1 & i \text{ is even} \end{cases}}$

D. $w \leftarrow w$

E. Don't know

Question 12

Consider the following layer in PyTorch:

```
torch.nn.Conv2d(in_channels=16,
                out_channels=32,
                kernel_size=(3, 3),
                stride=2,
                padding=0,
                bias=True)
```

How many learnable parameters does this convolution have?

A. 4608

B. 4609

C. 4624

D. 4640

E. Don't know

Question 13

Which of the following statements is true

A. Adam divides the gradients by their variance

B. Adam introduces two additional learnable parameters

C. Adam makes learning rate annealing unnecessary

D. The above three statements are wrong

E. Don't know

Question 14

Which of the following losses for a generative adversarial network is the most susceptible to the vanishing gradient problem?

A. minimax

B. WGAN

C. WGAN-GP

D. LSGAN

E. Don't know

Question 15

Consider the neural network shown in Fig. 15.1. If you feed it an image of size 512×512, what is the size of its output?

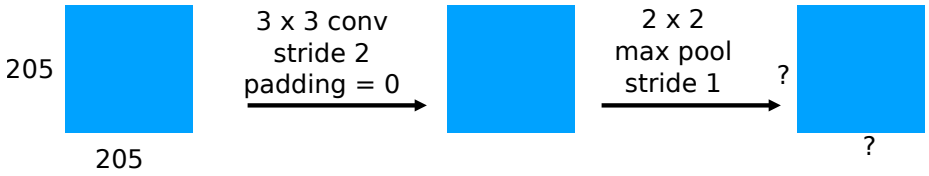


Figure 15.1: A CNN.

A. 51×51

B. 100×100

C. $\mathbf{101 \times 101}$

D. 102×102

E. Don't know

Question 16

Consider the neural network shown in Fig. 16.1. What is the receptive field of pixel $(2, 1)$ in the output image, using Python zero indexing convention?

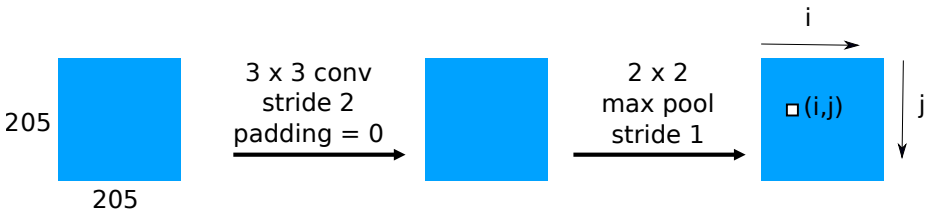


Figure 16.1: A CNN.

A. $[6 : 11, 3 : 8]$

B. $[8 : 12, 4 : 8]$

C. $[2 : 5, 1 : 4]$

D. $\mathbf{[4 : 8, 2 : 6]}$

E. Don't know