

Task 1 – Advanced Image Retrieval (multiple choices)

Select the correct answer for the following questions.

- 1) What is the kernel trick used for in SVM classification?
 - A. It is used to minimize the partitioning error
 - B. It is used to map data to a higher-dimensional space
 - C. It is used to calculate the inner product required for SVM
 - D. It is used to maximize the margin
- 2) What is the primary function of the hidden layers in a multilayer network?
 - A. To store input data
 - B. To provide binary outputs
 - C. To allow for more complex computations
 - D. To optimize the performance
- 3) What is the purpose of the backpropagation learning algorithm in a multilayer network?
 - A. To set input elements to zero with a certain probability
 - B. To calculate the state of each neuron
 - C. To adjust the weights of the network
 - D. To define the optimal state for all the network parameters
- 4) What is the primary advantage of using stochastic gradient descent (SGD) over traditional gradient descent?
 - A. SGD approximates the gradient using a sub-set of the data, minimizing storage requirements
 - B. SGD is faster than traditional gradient descent
 - C. SGD always converges to the global minimum
 - D. SGD requires less computational resources than traditional gradient descent
- 5) In machine learning, what issue arises when using the sigmoid activation function in neural networks?
 - A. Vanishing gradient problem
 - B. Exploding gradient problem
 - C. Slow convergence
 - D. Overfitting

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- 6) In machine learning, what issue arises when using the sigmoid activation function in neural networks?
 - A. Vanishing gradient problem
 - B. Exploding gradient problem
 - C. Slow convergence
 - D. Overfitting
- 7) What is the main advantage of using the ReLU activation function in neural networks?
 - A. Avoids the vanishing gradient problem
 - B. Provides a smooth gradient
 - C. Prevents overfitting
 - D. Allows for negative input values
- 8) What is overfitting in machine learning?
 - A. When the model is too simplistic
 - B. When the model has too few parameters
 - C. When the model becomes overly complex
 - D. When the model captures the underlying data trends
- 9) How is underfitting characterized during training?
 - A. Small losses on the training and validation sets
 - B. Large errors on the training data and poor prediction performance for new data points
 - C. Small errors on the training set and the validation set
 - D. High losses on the training and validation sets
- 10) What architectural enhancements have modern deep networks adopted to tackle vanishing and exploding gradient issues?
 - A. Fully connected layers
 - B. Increased number of hidden layers
 - C. Convolutional layers
 - D. Decreased number of input neurons

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- 11) What is the advantage of using the softmax function in deep learning?
 - A. It simplifies the process of normalizing the activations of each layer during training
 - B. It accelerates the vanishing and exploding gradients problem
 - C. It transforms output values into class probabilities
 - D. It limits weight adjustments in early layers
- 12) What is the purpose of L1/L2 Regularization in the cost function?
 - A. Reducing model complexity
 - B. Increasing model complexity
 - C. Minimizing the number of training samples
 - D. Penalizing large weights
- 13) What is the purpose of using strides in convolutional layers?
 - A. To increase the number of output neurons
 - B. To decrease the initial size of the network
 - C. To improve the accuracy of the classification task
 - D. To reduce the number of parameters
- 14) What is the purpose of using 1x1 convolution in a network structure?
 - A. To increase the size of the feature values
 - B. To add more parameters to the network
 - C. To decrease the size of the feature values and the number of parameters in the next layers
 - D. To improve the classification accuracy
- 15) What is the purpose of the Dropout technique in neural network training?
 - A. To increase the number of active nodes
 - B. To decrease the number of training steps
 - C. To prevent overfitting
 - D. To speed up the learning process

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Select the correct answer for the following questions.

- 16) What is the purpose of the stem in the GoogleLeNet architecture?
- A. Preparing images for feature extraction
 - B. Applying final convolutions
 - C. Reducing dimensionality of features
 - D. Adjusting dimensionality of incoming features
- 17) What is the main advantage of ResNet's residual block design?
- A. The block learns the function directly
 - B. The block avoids using the ReLU activation function
 - C. Gradients flow directly through the second path to previous layers
 - D. The block concatenates the two paths before applying the ReLU activation function
- 18) How does the architecture of DenseNet differ from the traditional ResNet architecture?
- A. DenseNet uses residual connections
 - B. ResNet has transition layers between blocks
 - C. DenseNet adds a residual connection to each layer
 - D. ResNet employs global average pooling

Task 2: MNIST Challenge (practical)

How well does your network perform for the MNIST Challenge, that is recognizing hand-written digits. You can use any framework such as TensorFlow or PyTorch to participate in the challenge. Use the training data to learn your model, then evaluate the model with the test set. Can you achieve 99%?

- **PyTorch** (<https://pytorch.org/>) is a machine learning framework developed by Meta AI for Python. It contains automated gradient computations and many building blocks discussed in this chapter to build deep learning models.
 - **TensorFlow** (<https://www.tensorflow.org>) is advanced machine learning and neural networking library with a front end for Python.
 - ...many other libraries, so pick your preferred option.
- a) Build your network model. You can either combine layers such as convolution and pooling to implement a model, or use higher level modules with building blocks to define the model. The MNIST data is relatively small with 28x28 grayscale images and 10 output categories. You should be able to train the model on your own equipment.