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# Master in Computer Vision Barcelona

UAB UOC UPC upf

**Module: M3. Machine learning for computer vision** **Final exam**

Date: February 17th, 2020

- Books, lecture notes, calculators, phones, etc. are not allowed.
- All sheets of paper should have your name.

**Question 1: 0.8**

**You are trying to fit a polynomial model to your data. Which of the following can help in preventing overfitting? Check all that apply.**

| | TRUE | FALSE |
|---|---|---|
| Fit small degree polynomials to the data. | X | |
| Constrain the coefficients of the polynomial to have small values. | X | |
| Get more data points. | X | |
| Fit the data with a polynomial of degree greater than the number of training points. | | X |

**Question 2: 0.4**

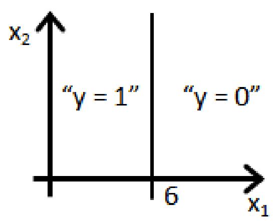
**Suppose you trained two logistic regression models, one using regularization parameter λ=0 and the other using λ=1. You have the results from both runs, but you have forgotten which one corresponds to which experiment. Can you tell which set of parameters corresponds to the run with λ=1? Circle your answer**

(a) $\theta = \begin{bmatrix} 15.52 \\ 78.34 \end{bmatrix}$

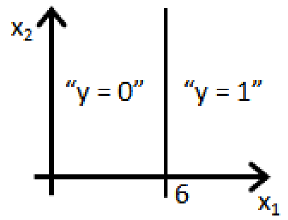
(b) $\theta = \begin{bmatrix} 0{,}96 \\ 10.52 \end{bmatrix}$

**Question 3: 0.8**

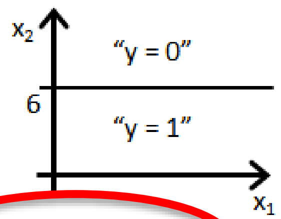
**Suppose you train a logistic classifier $h_\theta(x) = g(\theta_0 + \theta_1 x_1 + \theta_2 x_2)$. Suppose also that after a while you find the solution: $\theta_0 = 6, \theta_1 = 0, \theta_2 = -1$. Which of the following figures represents the decision boundary found by your classifier? (Circle your answer)**



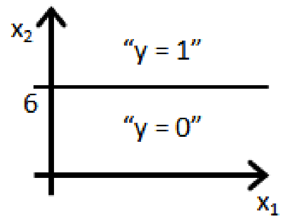

**(a)**




**(b)**




**(c)**




**(d)**

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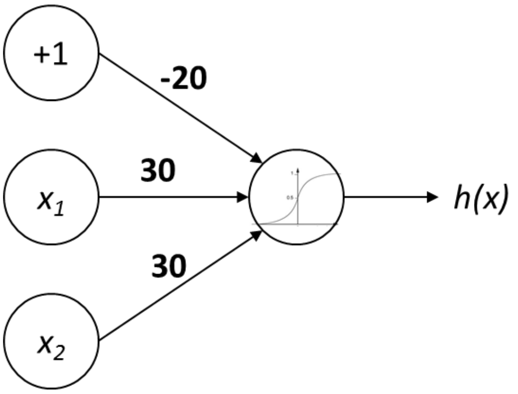
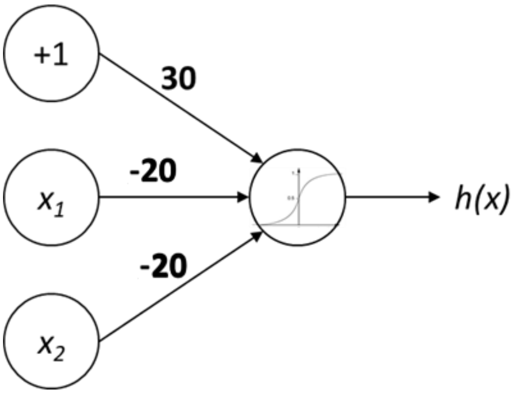
**Question 4: 1.0**

**You are training a classification model with logistic regression. Which of the following statements are true?**

| | TRUE | FALSE |
|---|---|---|
| Adding many new features to the model helps prevent overfitting on the training set | | X |
| Introducing regularization to the model always results in equal or better performance on the training set | | X |
| Adding a new feature to the model always results in equal or better performance on the training set | X | |
| Introducing regularization to the model always results in equal or better performance on examples not in the training set. | | X |
| Logistic regression's weights *w* should be initialized randomly rather than to all zeros, because if you initialize to all zeros, then logistic regression will fail to learn a useful decision boundary because it will fail to "break symmetry". | | X |

**Question 5: 1.0**

**Consider the following neural networks which take two binary-valued inputs $x_1, x_2 \in \{0, 1\}$ output $h(x)$ through a sigmoid output unit. Which of the following logical functions does each network (approximately) compute? Circle the correct answer.**

| | |
|---|---|
|  | **1. AND**<br>**2. NAND (NOT AND)**<br>**3. OR**<br>**4. XOR (exclusive OR)** |
|  | **1. AND**<br>**2. NAND (NOT AND)**<br>**3. OR**<br>**4. XOR (exclusive OR)** |

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**Question 7: 1.0**

**A ROC curve has the following behaviour:**

a) Cannot have a slope higher that 45 degrees, which corresponds to the 50% of classification accuracy.
b) It is monotonically growing and the maximum value of the area under the curve is 1.
c) The axis of the "Precision" cannot be negative.
d) None of the above.

Sol: 2. A ROC curve is always growing. The AUC is 1 when achieved a 100% of sensitivity with a 0% of FP-rate.

**Question 8: 1.0**

**For a given classification problem in a given feature space, the Bayesian error:**

a) Is always the same independently of the type of features used.
b) Provides us with an asymptotical value for the error.
c) Can by minimised by means of regularisation strategies.
d) None of the above.

Sol: 2. The Bayesian error provides the asymptotical error for the problem, fixing a value for the maximum accuracy that any classifier can provide for that particular feature space.

**Question 9: 1.0**

**A hypothesis test is run to compare the average results from two different classifiers, and the p-value obtained is p=0.03. What can we say about both classifiers?**

a) Nothing, the test did not provide enough information.
b) Both classifiers are indistinguishable in terms of performance.
c) One classifier gets better results than the other one.
d) None of the above.

Sol: 3. The null-hypothesis (both average values are equal) can be rejected, since such a situation would only statistically take place 3% of the times. Under the 5%, the scientific community accepts the results as statistically significant.

**Question 10: 1.0**

**The kernel trick in a SVM allows for:**

a) Explicitly calculate the features in a higher dimensional space, where the problem is linearly separable.
b) Allowing some of the samples to violate the maximal margin condition by introducing slack variables.
c) Classify non-linear problems without introducing any new parameter at all.
d) None of the above.

Sol: 4. None of the 3 first answers is correct: 1) The features in the higher space are not explicitly calculated; instead the kernel allows to avoid it by means of the use of dot products. 2) Slack variables introduce a regularisation parameter, independently of the use of kernels. 3) Some kernels, such as Radial Basis Functions, or Polynomial kernels, for instance, introduce new parameters which will have to be tuned.

**Question 11: 1.0**

**One of the advantages of the boosting algorithms is that:**

a) They allow bias reduction.
b) They allow variance reduction.
c) They allow both bias and variance reduction.
d) None of the above is a feature of bosting algorithms.

Sol: 3. Boosting algorithms allow for both bias and variance reduction.

**Question 12: 1.0**

**The XOR problem is well known due to the fact that:**

a) It can be solved with Fisher linear discriminant analysis.
b) It can be solved with a unique perceptron with a sigmoid activation function.
c) It can be solved with a one linear support vector machine with no kernel.
d) None of the above.

Solution: 4. The non-linear nature of the XOR-like problems makes it not feasible for the techniques mentioned above to provide a solution for the classification problem.

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**Question 13: 1.0**

**An overfitting during the training phase of a neural network can bring resulting learning curves which evolve through training epochs in the following way:**

a) The training data converges to zero loss while the validation data converges to zero loss too.
b) The training data converges to zero loss while the validation data does not converge to zero loss.
c) Neither the training data converges to zero loss nor the validation data converges to zero loss.
d) None of the above.

Sol: 2. The training data converges to zero error while the validation data does not converge to zero error, since the network learns the specifics of the training set without generalising properly.

**Question 14: 1.0**

**Select one case in which the use of softmax activation with cross-entropy loss functions is suitable.**

a) A value estimation for non-linear regression.
b) A performance estimate for cross-validation analysis.
c) A class-probability estimation for mutually exclusive classes.
d) None of the above cases will be suitable to use softmax activation with cross-entropy loss function.

Sol: 3. Softmax activation with cross-entropy loss functions provides a view of the class-probability, which is particularly suited for mutually exclusive classes.

**Question 15: 1.0**

**Which of the following operations, frequently used in CNNs, preserves spatial dimensions while reducing the depth?**

a) A one by one (1x1) convolution.
b) A drop-out.
c) A max pool.
d) Non of the above.

Sol: 1. 1x1 Convolutions preserve the spatial dimensions of the outputs, but reduces the final depth through a combination of the feature maps.

**Question 16: 1.0**

**The max pool operation...**

a) Disables a number of units of the CNN.
b) Introduces redundancy in the CNN.
c) Reduces the number of parameters of a CNN.
d) Non of the above.

Sol: 3. The max pool operation fundamentally reduces the number of parameters within the model by reducing the spatial dimensions through max functions applied locally.

**Question 17: 1.0**

**Explain the basic intuition of the method of momentum (Polyak, 1964) and how it modifies the standard algorithm of Stochastic Gradient Descent (SGD).**

**Question 18: 1.0**

**Explain why it is not a good idea to initialize all weights of a neural network to zero. In the context of weights initialization, what does the concept of "breaking symmetry" mean? How can we implement it?**

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**Question 19: 0.5**

**What are the similarities between Visualization of a network through activation maps or using top-scoring images?**

a) Both methods need input images to visualize the network
b) Both Methods focus on visualizing single neurons
c) Both Methods use activation Map information
d) All the above statements are true

**Question 20: 0.5**

**Which of the following methods allows to visualize individual neurons in a neural network.**

a) Visualizing the network through modification of the activations
b) Visualizing the network through weight comparison
c) Visualizing the network through ablation with the lottery ticket hypothesis
d) Visualizing the network through image generation.

**Question 21: 0.5**

**Why the method based on directly visualizing weights in the CNN is not very used to understand neural networks.**

a) It is the best method for representing the first layer of a model, but it is impossible to get an exact reconstruction into image space of the weights due to irreversible operations
b) It is useless for all the layers, since weights are giving information about intermediate representations which are not lying in the image space, and consequently they are not directly giving any understandable clue of the kind of image features that are activating that neuron
c) It needs a huge dataset to visualize each neuron and thus, it is not an optimal method
d) None of the above statements is true.

**Question 22: 0.5**

**In the frame of Convolutional Neural Networks, briefly define the following two concepts:**

**Receptive field of a neuron:**

***Image Patch/Window from the input image that provokes a specific activation of a neuron***

**Top-scoring images of a neuron:**

**Set of images patches (Receptive Fields) provoking the maximum activations of a neuron for a given dataset**

**Question 23: 0.5**

**Answer true or false**

| | TRUE | FALSE |
|---|---|---|
| Removing a layer in VGG reduces performance by less than 2.25% | | X |
| DARTS requires more computation than AMOEBA | | X |
| AMOEBA uses genetic algorithms | X | |
| Self-supervised learning requires labels during pre-training | | X |

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**Question 24: 0.5**

**Tell two differences between GoogleNet and previous architectures.**

**The use of concatenation, and the auxiliar loss function.**

**Question 25: 0.5**

**What is the main difference between a residual network and a highway network?.**

**Question 26: 0.5**

**Are stochastic depth networks faster than a traditional convnet during training time? Reason why.**

**Yes, because only a subset of the blocks are active at any time**

**Question 27: 0.5**

**From the ones explained in class, which techniques can reduce the size of the model?**

**Pruning, quantization, distillation, low-rank approximation**

**Question 28: 0.5**

**What is the difference between magnitude pruning and Optimal Brain Damage?**

**The use of the hessian**

**Question 29: 0.5**

**What is the difference between xnor networks and binary connect?**

**The binarization of the input**

**Question 30: 0.5**

| **Answer true or false** | **TRUE** | **FALSE** |
|---|---|---|
| Adaptive ResNet uses a cascade of models to classify an image | | **X** |
| Distillation transfers "dark knowledge" between models since it uses the relationships between classes | **X** | |
| Efficientnet was found by architecture search | **X** | |
| Trained quantization clusters weights by value and assigns binary codes to them. Huffman coding could be used to assign short codes to frequent weights, reducing the model size | **X** | |