Università degli Studi di Brescia,
Dipartimento di Ingegneria dell'Informazione

Remote Sensing
(*Remote Sensing Data Analysis*)
Written Test 8 january 2021 - Online

Surname: _____ Name: _____ Matricola: _____ Voto: _____

Select your answers to the following close response questions (from 1 to 36) using the symbol 'X' (*Scores:* +1 *for each right answer;* 0 *for each no answer; up to* 0.5 *point less each wrong answer*),
For answers to open questions 37 and 38 use max one page for each answer (Scores for each answer range from 0 to 3 points),
The global score will be normalized in thirtieths.

[Question 1] The Ultraviolet range:

☐ is commonly used for remote-sensing.
☐ is not used because it gives useless informations.
☒ is not used because of the athmospheric absorption.

[Question 2] Visible range measurements:

☐ are usually made with active systems.
☒ are usually made with passive systems.
☐ are not made because of athmospheric absorption.

[Question 3] The radiometric resolution:

☒ is expressed in equivalent ground meters.
☐ is related to the number of bits used to represent the quantity measured by each element of an array of sensors.
☐ does not influence the data volume (in bits) generated from a sensor.

[Question 4] A rectangular detector array

☒ can be used to obtain multispectral or hyperspectral data.
☐ is exploited in radar acquisitions.
☐ allows to record images in a raster-scan fashion.

[Question 5] A synthetic aperture radar (SAR):

☐ is used for infrared wavebands.
☒ allows an acceptable azimuth resolution at spacecraft altitudes.
☐ allows a good radiometric resolution at aircraft altitudes.

[Question 6] A radiometric error can result:

☒ from the effect of the atmosphere.
☐ from the relative motion of the platform with respect to the earth.
☐ from the curvature of the earth.

[Question 7] Because of sky irradiance:

☒ a particular pixel will be irradiated by energy scattered downwards from atmospheric constituents or from surrounding pixels.
☐ radiation can be scattered towards and reach the sensor before it reaches the ground.
☐ image data can be affected from striping artifacts.

[Question 8] Mie scattering:

☐ is strongly wavelength dependent.
☒ accounts for the white color of the clouds.
☐ accounts for the blueness of the sky.

[Question 9] Haze removal:

☐ is a correction technique for geometric distortions.
☒ is a correction technique for radiometric distortions.
☐ is an interpolation technique.

[Question 10] The following matrix notation:

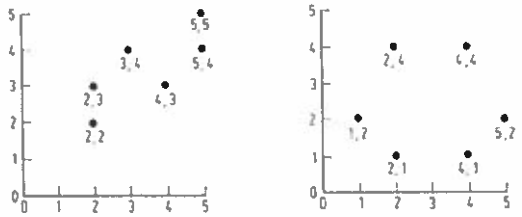
$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} cos\alpha & sin\alpha \\ -sin\alpha & cos\alpha \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix}$$

☐ represents the mathematical modeling for panoramic distortion correction.
☐ represents the mathematical expression for PC decomposition.
☒ represents the mathematical modeling for rotation correction.

[Question 11] Sequential similarity detection algorithm (SSDA):

☐ is a manual method for control point localization.
☐ is an automatic method for control point localization which make use of features (like SIFT).
☒ is an automatic method for control point localization which make use of correlation.

[Question 12] Considering the two following images:



☒ PCA is more useful in the left image data (for decorrelation).
☐ PCA is more useful in the right image data (for decorrelation).
☐ PCA is useless in both cases.

[Question 13] The following correlation matrix:

$$R = \begin{bmatrix} 1.000 & 0.377 & 1.000 \\ 0.377 & 1.000 & 0.377 \\ 1.000 & 0.377 & 1.000 \end{bmatrix}$$

☐ shows an high correlation between the second and third dimension.
☐ is impossible to obtain.
☒ shows that the real number of dimensions of our data is two.

[Question 14] Principal Components decomposition:
☐ is a method for geometric correction.
☒ can be used for bandwidth compression.
☐ is not useful if the data has too much spectral bands.

[Question 15] The human photointerpretation of an image:

☒ allows only a limited multispectral analysis.
☐ is characterized by decisions taken on an individual pixel resolution.
☐ requires a prior training stage.

[Question 16] In the Statistical Supervised Classification of the pixel in an image:

☒ each spectral class is modeled with a Gaussian distribution.
☐ each spectral class is modeled with a Uniform distribution.
☐ each spectral class is modeled with a Laplacian distribution.

[Question 17] Let the spectral classes for an image be represented by ω_i, i = 1,...,M where M is the total number of classes, and take a column of brightness values for one pixel $\mathbf{x}$. In the Bayes Classification process, the posterior probabilities are:

☒ $p(\omega_i|\mathbf{x})$.
☐ $p(\omega_i)$.
☐ $p(\mathbf{x}|\omega_i)$.

[Question 18] To avoid poor classifications, maximum likelihood classification can make use of thresholds that:

☐ are obtained using a χ^2 distribution.
☒ define regions where the discriminant functions for adjoining spectral classes are equal.
☐ are obtained by observing a mixture of Gaussian distributions.

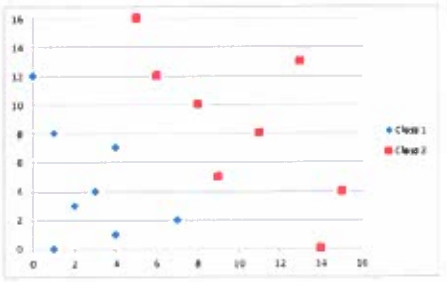
[Question 19] The kNN (Nearest Neighbour) Classifier:

☒ takes into account of the spatial context of the pixels.
☐ is a Supervised Classification process.
☐ is a faster technique than maximum likelihood classification.

[Question 20] The effect of spatial contexts can be incorporated into a classificator using:

☐ Markov Random Fields.
☐ Support Vector Machine.
☒ k-Nearest Neighbours.

[Question 21] The N-dimensional data illustrated in the figure:



☐ can be separated by an hyperplane of equation $\mathbf{w^T x} = \mathbf{0}$.
☑ can be separated by an hyperplane of equation $\mathbf{w^T x} + \mathbf{w_{N+1}} = \mathbf{0}$.
☐ can be separated by an hyperplane of equation $\mathbf{x} + \mathbf{w^T} = \mathbf{0}$.

[Question 22] The training operations during the linear discrimination of data:

☒ are nonparametric iterative procedures.
☐ are used to give an estimate of the stathistic of each class.
☐ take into account of the geometric spatial context of the pixels.

[Question 23] A Support Vector Classifier:

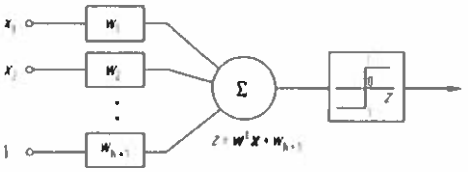
☐ provides a training approach that balances the contributions of all the training pixels.
☐ leads to a hyperplane position that is always suboptimal for the available training patterns.
☒ provides a training approach that depends only on those pixels in the vicinity of the separating hyperplane.

[Question 24] "Slack variables" in SVM:

☒ can be adopted when the training set is reliable but the data are affected by noise.
☐ must be estimated for every training data even if the data is on the correct side of the hyperplane.
☐ determines an encreased dimensionality of the data space thus improving class separability

[Question 25] A Threshold Logic Unit, as depicted in figure:

☐ is able to cope with a multiclass problem.
☒ usually consists of weighting elements, a summing device and an output element.
☐ does not need of a training stage.



[Question 26] The clustering algorithm referred to as k-means:

☐ requires only a single pass elaboration through the data.
☒ requires that the number of clusters must be specified beforehand by the user.
☐ is used to decide the set of natural groupings into which the data falls.

[Question 27] A Single Pass Clustering technique:

☐ requires that the number of clusters must be specified beforehand by the user.
☐ is slightly different from the Agglomerative Hierarchical Clustering.
☒ makes use of the first row of samples to obtain a starting set of cluster centres.

[Question 28] Clustering by Histogram Peak Selection:

☐ are more computationally expensive than Agglomerative Hierarchical Clustering.
☐ are applicable to hyperspectral data sets or to other dense data.
☒ are only useful when the dimensionality of the data is low.

[Question 29] The correlation matrix between the bands in Hyperspectral data:

☐ is typically roughly block diagonal.
☐ can be rectangular depending on the type of spectral and spatial sampling.
☐ is typically is sparse.

[Question 30] The Spectral Angle Mapper (SAM):

☐ attempt classification using just the magnitude and angular orientations of the pixel vectors in hyperspectral space.
☐ ignores the angular orientation of the pixel vectors in hyperspectral space.
☐ ignores the magnitudes of the pixel vectors in hyperspectral space.

[Question 31] In Library searching by spectral coding the nearest codeword, respect to the word 0110011011, is:

☐ 1110101011.
☐ 0110101011.
☒ 0110011100.

[Question 32] SIFT detector is based on a pyramidal scale space of

☐ Laplacian of Gaussian.
☒ Difference od Gaussian.
☐ Binary descriptors.

[Question 33] Consider the problem of cancer classification. Suppose that for each patient some features are extracted and these features well represent the clinical situation of the patient, so it is reasonable to think that it will be possible to infer if the patient has the cancer by looking at them. After that machine learning has been done, it is obtained an algorithm that classifies correctly the 99% of the examples in the test set, predicting every time "No cancer". If only the 1% of the population have cancer what is the Recall?

☒ 0
☐ 0.01
☐ 0.99

[Question 34] If we are experiencing high variance:

☐ we are in under-fitting.
☒ we are in over-fitting.
☐ we are "Just right".

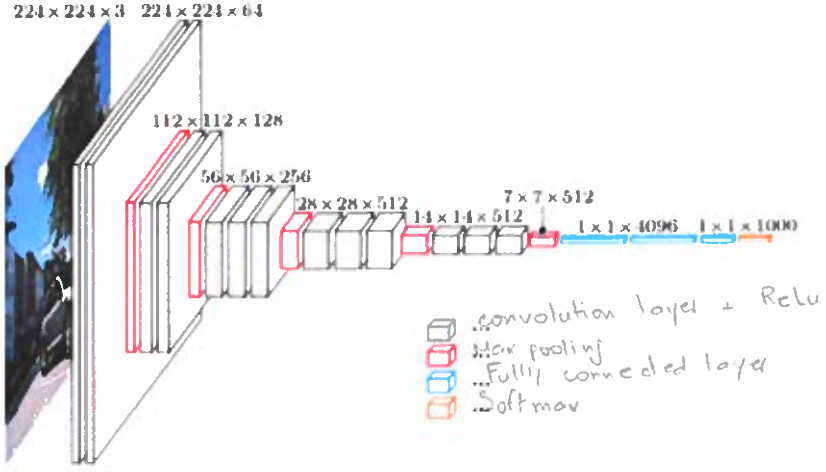
[Question 35] In CNNs, the convolutional layer reaches Shift Invariance by

☐ local receptive fields.
☒ shared weights.
☐ using GPU.

[Question 36] A MaxPooling layer in a deep neural network

☒ reduce activation by taking the max value with a certain stride.
☐ smooth the input activation.
☐ let the network be aware of geometrical relationships.

[Question 37] Consider the computational architecture depicted in the following picture, in particular describing (in max one page) the name, the function, the role and the parameters of the various blocks (in different colors) and exemplifying possible usages of this system in the domain of Remote Sensing (or beyond).



① Convolution layer:

→ It preserves the spatial structure

→ A small filter (patch) is used to perform convolution with the input image (by sliding it through the image), computing a dot product

→ convolutions are translation equivalent and are made

$$[A * H] = \sum A(\Delta x) \cdot H(x + \Delta x)$$

A: Kernal $K \times K$

H: feature map

② Max pooling → makes the representation smaller and more manageable.

→ operates over each activation map independently.

→ slides the filter along the image and takes the max value each time, which represent where the neuron fired the most

③ Fully connected : → are most memory intensive part of VGG architecture.

④ Softmax :

[Question 38] Describe (in max one page) and evidence pros and cons of different technological solutions for the acquisition of hyperspectral images.