Task 3 - Computer Vision

1. What is image preprocessing ?

Preprocessing refers to all the transformations on the raw data before it is fed to the machine learning or deep learning algorithm

2. Describe the preprocessing steps required on the image

a. Read image - In this step, we store the path to our image dataset into a variable then we created a function to load folders containing images into arrays.

b. Resize image - Some images captured by a camera and fed to our AI algorithm vary in size, therefore, we should establish a base size for all images fed into our AI algorithms

c. Remove noise(Denoise) - Gaussian blur (also known as Gaussian smoothing) is the result of blurring an image by a Gaussian function.

Noise removal algorithm is the process of removing or reducing the noise from the image. The noise removal algorithms reduce or remove the visibility of noise by smoothing the entire image leaving areas near contrast boundaries. But these methods can obscure fine, low contrast details

d. Segmentation & Morphology - In this step, we step we are going to segment the image, separating the background from foreground objects .

we apply another blur to improve the looks . Now, we separate different objects in the image with markers.

3. What is Image Classification?

Image classification is the task of categorizing and assigning labels to groups of pixels or vectors within an image dependent on particular rules.

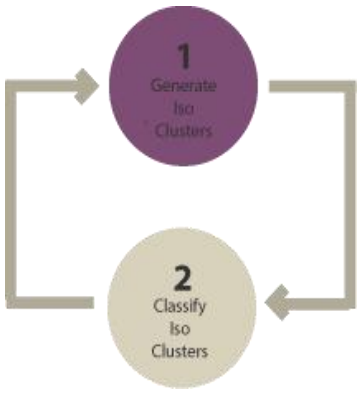
The categorization law can be applied through one or multiple spectral or textural characterizations. Image classification techniques are mainly divided into two categories: Supervised and unsupervised image classification techniques.

4. Describe techniques you would use for classification.

1. Unsupervised Classification -

In unsupervised classification, it first groups pixels into “clusters” based on their properties. Then, you classify each cluster with a land cover class.
Overall, unsupervised classification is the most basic technique. Because you don’t need samples for unsupervised classification, it’s an easy way to segment and understand an image.

The two basic steps for unsupervised classification are:
Generate clusters
Assign classes



Some of the common image clustering algorithms are:

- K-means
- ISODATA

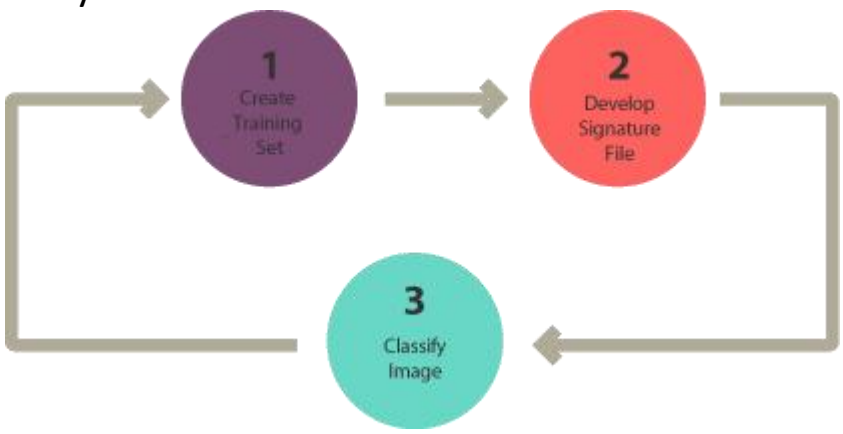
After picking a clustering algorithm, you identify the number of groups you want to generate. Fewer clusters have more resembling pixels within groups. But more clusters increase the variability within groups.

2. Supervised Classification

In supervised classification, you select representative samples for each land cover class. The software then uses these “training sites” and applies them to the entire image.

The three basic steps for supervised classification are:

- Select training areas
- Generate signature file
- Classify



For supervised image classification, you first create training samples. For example, you mark urban areas by marking them in the image. Then, you would continue adding training sites representative in the entire image.

For each land cover class, you continue creating training samples until you have representative samples for each class. In turn, this would generate a signature file, which stores all training samples' spectral information.

Finally, the last step would be to use the signature file to run a classification. From here, you would have to pick a classification algorithm such as:

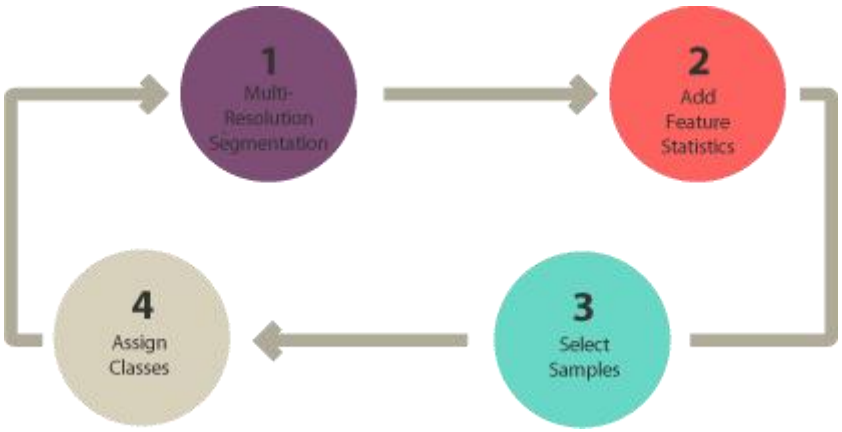
- Maximum likelihood
- Minimum-distance
- Principal components
- Support vector machine (SVM)
- Iso cluster.

3 . Object-Based Image Analysis (OBIA)

Supervised and unsupervised classification is pixel-based. In other words, it creates square pixels and each pixel has a class. But object-based image classification groups pixels into representative vector shapes with size and geometry.

Here are the steps to perform object-based image analysis classification:

- Perform multiresolution segmentation
- Select training areas
- Define statistics
- Classify



Object-based image analysis (OBIA) segments an image by grouping pixels. It doesn't create single pixels. Instead, it generates objects with different geometries. If you have the right image, objects can be so meaningful that it does the digitizing for you. For example, the segmentation results below highlight buildings.

The 2 most common segmentation algorithms are:

- Multi-resolution segmentation in eCognition
- The segment mean shift tool in ArcGIS

5. Most efficient algorithm according to me - CNN

CNN(Convolutional Neural Network) is a supervised type of Deep learning, most preferable used in image recognition and computer vision.

Image classification can be accomplished by any machine learning algorithms(logistic regression, random forest and SVM). But all the machine learning algorithms required proper features for doing the classification. If you feed the raw image into the classifier, it will fail to classify the images properly and the accuracy of the classifier would be less.

CNN (convolution neural network) extract the features from the images and it handles the entire feature engineering part. In normal CNN architecture, beginning layers are extracting the low-level features and end level layers extract high-level features from the image.

Before CNN, we need to spend time on selecting the proper features for classifying the image. There are so many handcrafted features available(local feature, global feature), but it will take so much time to select the proper features for a solution(image classification) and selecting the proper classification model. CNN handles all these problems and the accuracy of the CNN is higher compared with the normal classifier.
In some scenarios still, handcrafted based classification gives promising results.

We used the Euclidean distance. The Euclidean distance represents the minimum distance between two points in a plane, it's a straight line between them.

$$d(x, y) = \sqrt{\sum_{i=1}^{n} (y_i - x_i)^2}$$