7	11	51	16
54	48	32	21
52	70	22	43
58	62	60	33

+

51	60	21	62
43	62	83	73
32	24	32	60
60	88	21	49

=

29	36	36	39
49	55	58	47
42	47	27	52
59	75	41	41

Example: 1st Pixel (7 + 51)/2 = 29
(a) Image addition

22	25	24	26
23	26	27	28
26	27	29	25
28	30	26	28

–

27	26	23	22
23	25	28	29
26	30	29	23
28	26	22	27

=

–5	–1	1	4
0	1	–1	–1
0	–3	0	2
0	4	4	1

Example: 1st Pixel 22 – 27 = 5
(b) Image subtraction

7	8	5	7
5	6	8	7
3	7	6	5
2	4	3	5

×

7	8	5	7
5	6	8	7
3	7	6	5
2	4	3	5

=

49	64	25	49
25	36	64	49
9	49	36	25
4	16	9	25

Example: 1st Pixel 7 × 7 = 49
(c) Image multiplication

Fig. 7.21 *Image arithmetic operations*

7.6 IMAGE CLASSIFICATION

A major task after feature extraction is to classify the object into one of several categories. Classification of remotely sensed data is achieved by assigning levels with respect to groups with homogeneous characteristics so that multiple objects in a scene can be discriminated. The level is called *class*. Classification may, therefore, be defined as the process of assigning the pixels in an image into a finite number of individual classes based on their DN values. The classification is usually based on the patterns of their DN, spatial relationship with neighbouring pixels, and relationships between data acquired on different dates. The term *pattern* is not geometric in character; rather it refers to the set of radiance measurements obtained in the various wavelength bands for each pixel. The objectives of image classification are to detect different kinds of features in an image, discriminate the distinctive shapes and patterns, and to identify temporal changes in the image. Classification transforms the image data into information. Classification is considered as the most important technique to extract information from the digital images.

Spectral information is represented by digital numbers in spectral bands. Digital image classification attempts to classify each individual pixel based on this spectral information. The object is to assign all pixels in the image to particular classes or themes, e.g., water, wheat, etc. The resulting classified image will comprise of an array of pixels, each of which belongs to a particular theme. Classification generally comprises *image classification scheme*—usually classes such as agriculture, forest, etc., *image processing*—geometric correction, atmospheric correction, noise suppression, image enhancement, etc., *training signatures*—selection of the particular features which best describe the pattern; *decision*—choice of suitable method for comparing the image patterns with the target patterns; and *accuracy assessment*—comparing classification results with the field studies.

Different landcover types in an image can be discriminated using some image classification algorithms, using spectral features, i.e., the brightness and colour information contained in each pixel. The procedure can be supervised or unsupervised, depending upon whether or not a set of prototype is available. In the *supervised classification* system, also called *supervised learning*, each pixel is supervised for the categorisation of the data by specifying to the computer algorithm, numerical descriptors of various class types. The steps involved in typical supervised classification are *training stage*—identification of the training areas (representative sample sites of known landcover type) and development of a numerical description of the spectral attributes of the class or landcover type; *classification stage*—categorisation of each pixel, in the whole image, into landcover class to which it closely resembles; and *numerical mathematical approaches*—for application to spectral pattern recognition to form the class signature. These are shown in Fig. 7.22.

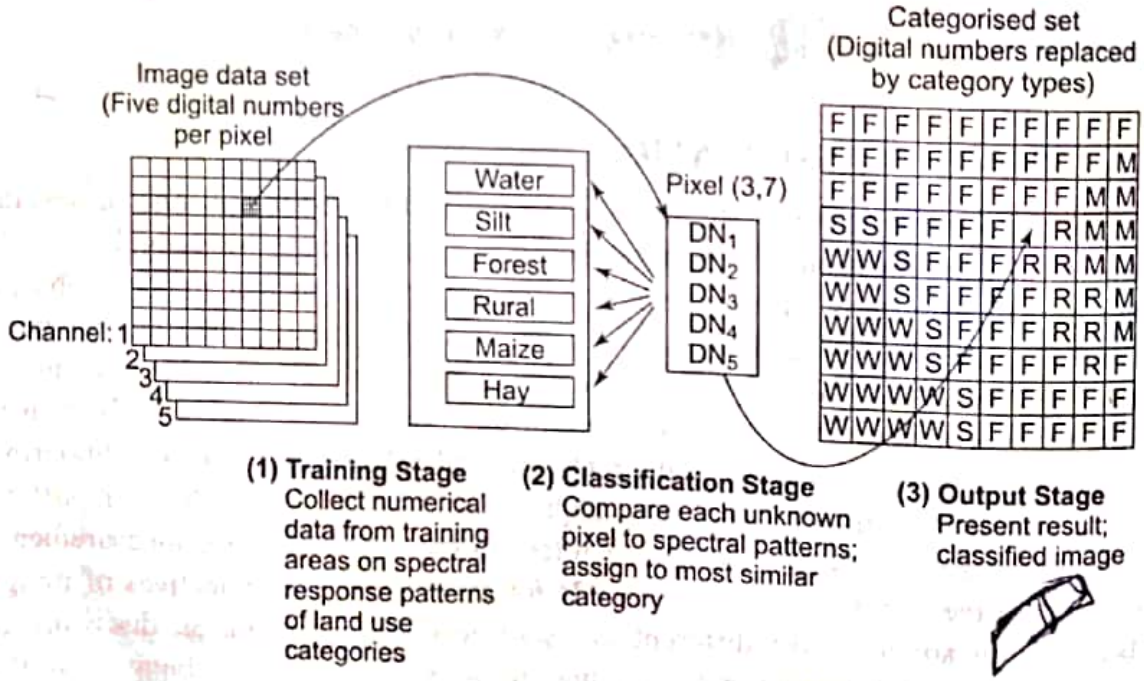

Fig. 7.22 *Steps in supervised classification*

The *unsupervised classification* (*unsupervised learning*) system does not utilise the training data as the basis of classification. It involves algorithms that examine

the unknown pixels in the image, and aggregate them into a number of classes based on the natural groupings (cluster) present in the image. The classes that result from this type of classification are spectral classes. Because they are based solely on the natural groupings in the image values, the identity of the spectral classes will not be initially known. Unsupervised classification consists in identification, labelling and mapping of these natural classes. The analyst then assigns a landcover type to each cluster. This method is used when less information about the data is available before classification.

Note *Each class of landcover is referred to as a theme and the product of classification as thematicmap.*

The utility of image classification depends on the requirement of the end user. The output product may contain the interpreted information in virtually unlimited forms; the commonly used forms are graphic, tabular, and digital information files.