similarity between two regional features for all pairs of regions.

However, many regions on different images are very similar in terms of spectral and textural features. Therefore, GLA is used to classify the low-level features into a set of codes based on which a codebook will be generated (as Fig. 4).

Fig. 4 presents the principle of codebook extraction when image feature is 2-dimensional feature space. In Fig. 4, the blue point is a low-level feature, the black circle is a cluster, and the red point is the center of the cluster called code. $\text{Code}_j$ is the mean of all features in corresponding cluster. All codes form a codebook. Then, each region can be represented by a code. For an image $I$, its $i$-th region $R_i$ can be represented by $\text{Code}_j$.

3 Semantic feature extraction

In this step, a probabilistic method is used to mine the relationship among semantic features, regions, and images automatically. Then the EM method [28, 29] is used to analyze the relationship and extract the latent semantic concepts.

First, various parameters are defined as follows: