INTERNSHIP REPORT

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I am very thankful to my college through which I could get this internship.
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IIRS/ISRO

The Indian Institute of Remote Sensing is a premier institute for research, higher education and training in the field of Remote Sensing, Geoinformatics and GPS Technology for Natural Resources, Environmental and Disaster Management under the Indian Department of Space, which was established in the year 1966. It is located in the city of Dehradun, Uttarakhand.

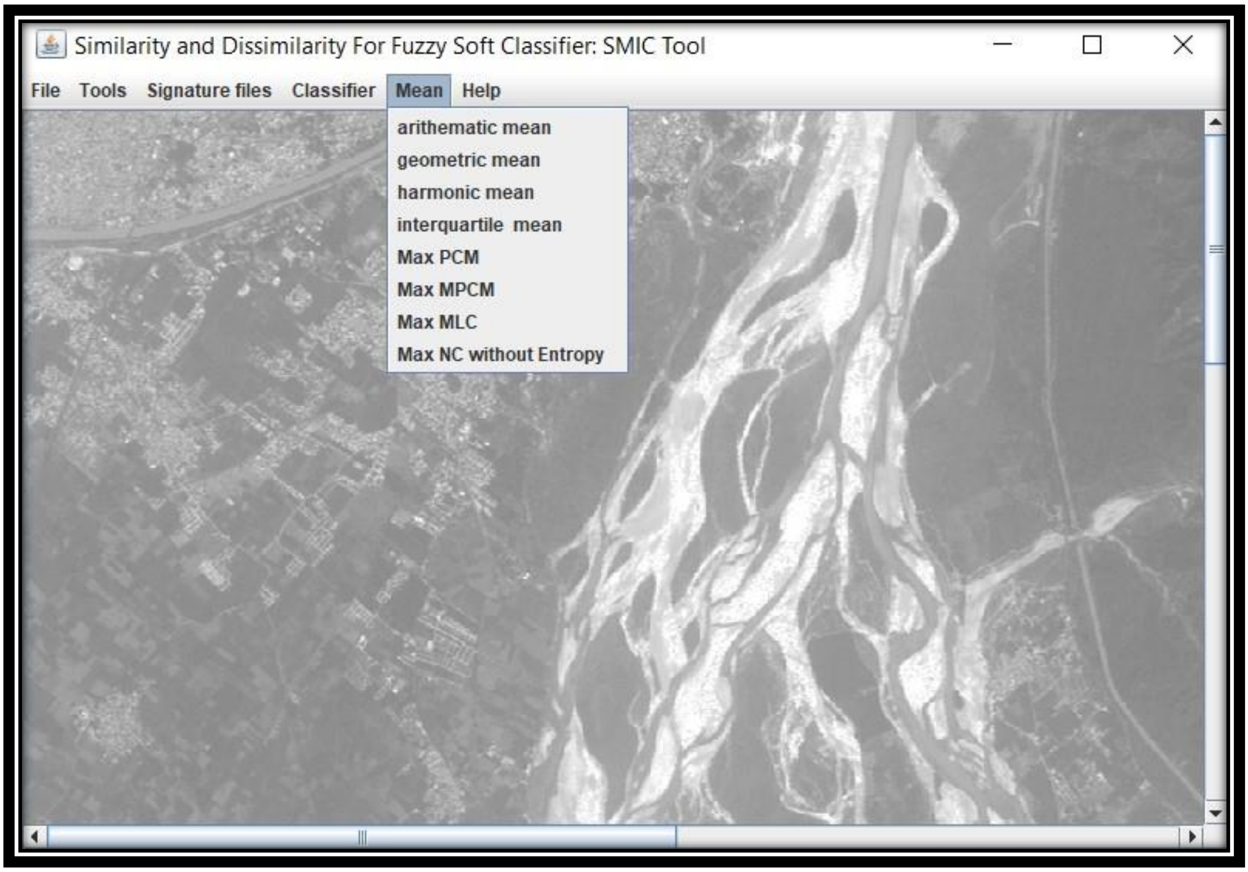
Indian Institute of Remote Sensing, Dehradun has been the premier institute responsible for capacity building in the field of Remote Sensing and GIS applications. It has grown manifolds and established itself as an institute of repute both nationally and internationally. Realising the potential of Earth Observation System and ISRO's forthcoming initiatives in the areas of Natural Resource Survey, Earth and Atmospheric Sciences and Oceanography, Dr. K. Radhakrishnan, Chairman ISRO has reorganised IIRS as a separate entity of ISRO w.e.f. 30 April 2011. IIRS will continue its Training, Education and Research programmes with enhanced focus on Microwave Remote Sensing, Hyperspectral Remote Sensing and Climate studies.

INTRODUCTION

Remote Sensing is defined as an art and science of gathering useful information about the earth’s surface from a distance. It is an important data source for providing effective Land Use/ Land Cover information which is retrieved by digital image classification.

In general, classification algorithms are statistical in nature and assign a single Land Use/ Land Cover class to each pixel which is known as Hard Classification. However, a pixel may contain more than one class which is known as mixed pixel. Mixed pixels can’t be handled by a hard classifier. Coarser is the spatial resolution, the problem of mixed pixel increases causing erroneous classification. For retrieving the classes from mixed pixel information, a soft classification approach may be required.

SMIC (Subpixel Multispectral Image Classifier) tool has been developed to handle the multi-spectral images. The components in a SMIC tool are shown below-



Original Image:

The Mean menu contains the following types options:

1. **Different types of statistical means:** In FCM(Fuzzy C-Means) and other classifiers too, you need to consider the mean of the values in the signature file. Depending upon the requirement, we can use different types of means.
    a. **Arithmetic mean**: It is the average of all the values which is computed by taking the sum of all the values and dividing by the total number of values.
    b. **Geometric mean**: It is defined as the arithmetic mean of the values taken on a log scale. It is expressed as the nth root of the product of all the values
    c. **Harmonic mean**: It is the reciprocal of the arithmetic mean of the reciprocal of the values.
    d. **Interquartile mean**: It is the mean of the middle 50 percent of data in a data set. It is resistant to outliers.

2. **Maximum classifiers:** PCM(Possibilistic C-Means), MPCM(Modified PCM), MLC(Maximum Likelihood classifier), Noise Clustering work on the mean of different classes. The maximum variant of these classifiers treats each sample of the signature file of a class as the mean one by one, and takes the best result.

Classification done for **water class** by Max classifiers:

1. **Max PCM:**

$$J_{\text{pcm}}(U,V)=\sum_{i=1}^{c}\sum_{k=1}^{N}(\mu_{ki})^{m}D(x_k,v_i)+\sum_{i=1}^{c}\eta_i\sum_{k=1}^{N}(1-\mu_{ki})^{m}$$

It is subject to following constraints Equations (3.14–3.16):

$$\max_i \mu_{ki} > 0 \quad \text{for all } k$$

$$\mathrm{N} < \sum_{k=1}^{N}\mu_{ki} > 0 \quad \text{for}$$

$$0 \le \mu_{ki} \le 1 \quad \text{for all } k, i$$

where,

η_i is a suitable positive number,

m is a weighting exponent (or fuzzif er) such as $1 < m < \infty$.

$$\overline{\mu}_{ki}=\frac{1}{1+\left(D(x_k,\overline{v}_i)/\eta_i\right)^{\frac{1}{(m-1)}}}$$

η_i can be computed as Equation (3.18):

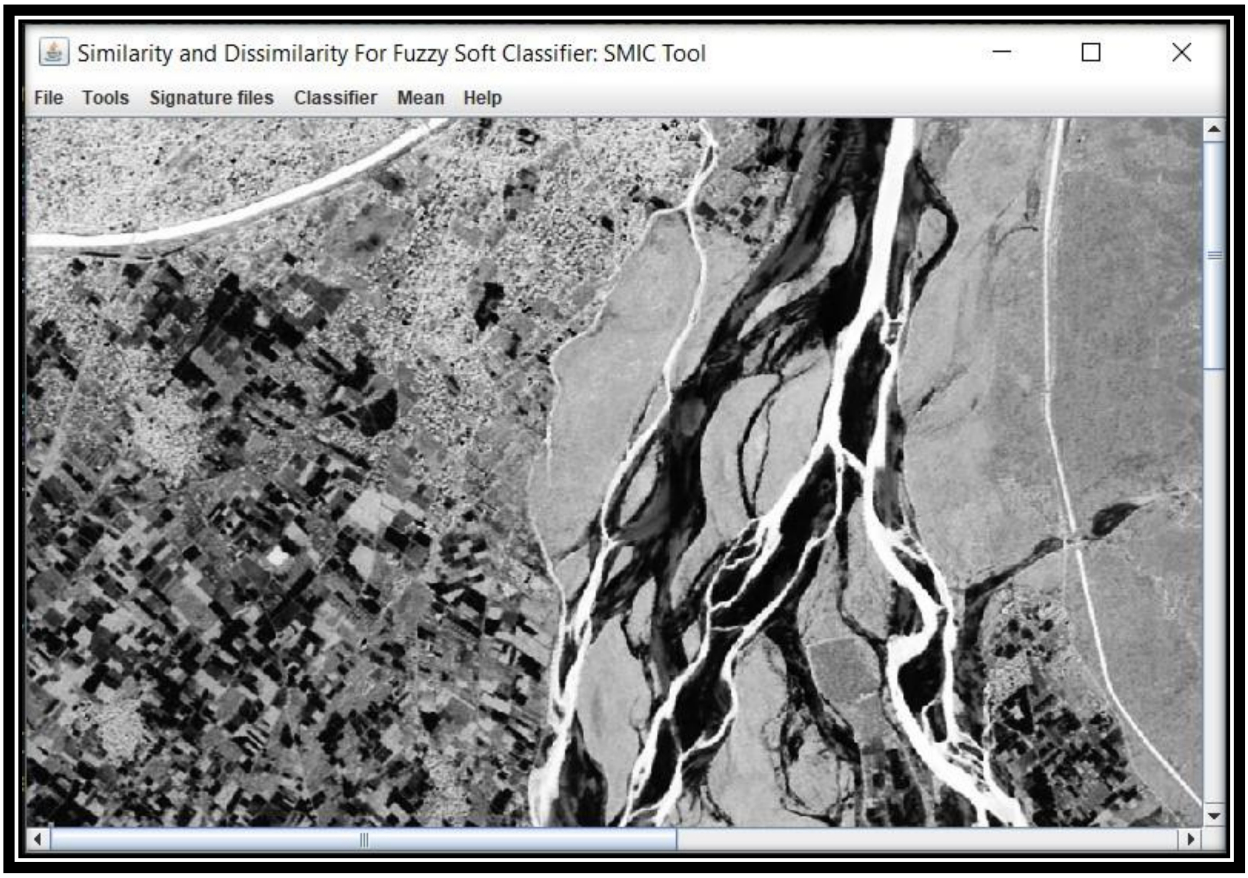
$$\eta_i = K\times\sum_{k=1}^{N}\mu_{ki}^{m}D\left(x_k,\overline{v}_i\right)\Big/\sum_{k=1}^{N}\mu_{ki}^{m}$$

2. Max MPCM:

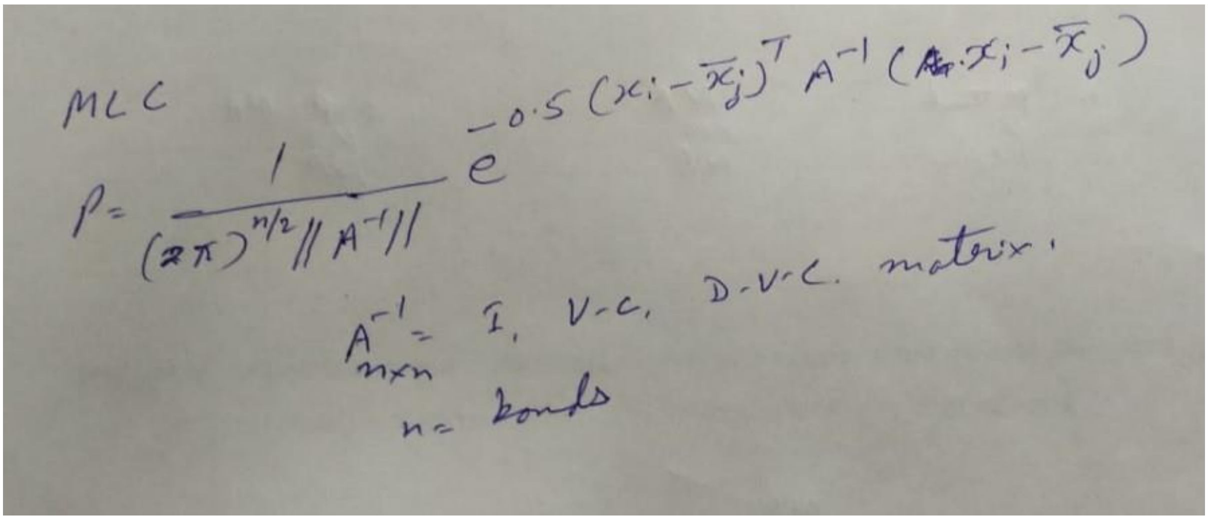
$$J_{mpcm}(U,V)=\sum_{i=1}^{c}\sum_{k=1}^{N}\mu_{ki}\,D_{ki}^{\;2}+\eta_i\sum_{k=1}^{N}\left(\mu_{ki}\log\mu_{ki}-\mu_{ki}\right)$$

$$\eta_i=\frac{\sum_{k=1}^{N}\mu_{ki,\,fcm}{}^{m}\,D^2{}_{ki}}{\sum_{k=1}^{N}\mu_{ki,\,fcm}{}^{m}}$$

$$\mu_{ki}=\exp\left(-\frac{D_{ki}{}^{2}}{\eta_i}\right)\;,\;\forall i,k\;;\quad(\text{Typicality values for MPCM})$$



3. Max MLC:



MLC

$$p = \frac{1}{(2\pi)^{n/2} \| A^{-1} \|} e^{-0.5 (x_i - \bar{x}_j)^T A^{-1} (\cancel{A} \cdot x_i - \bar{x}_j)}$$

$A^{-1}_{n \times n}$ = I, V-C, D-V-C. matrix.

n = bands

Where

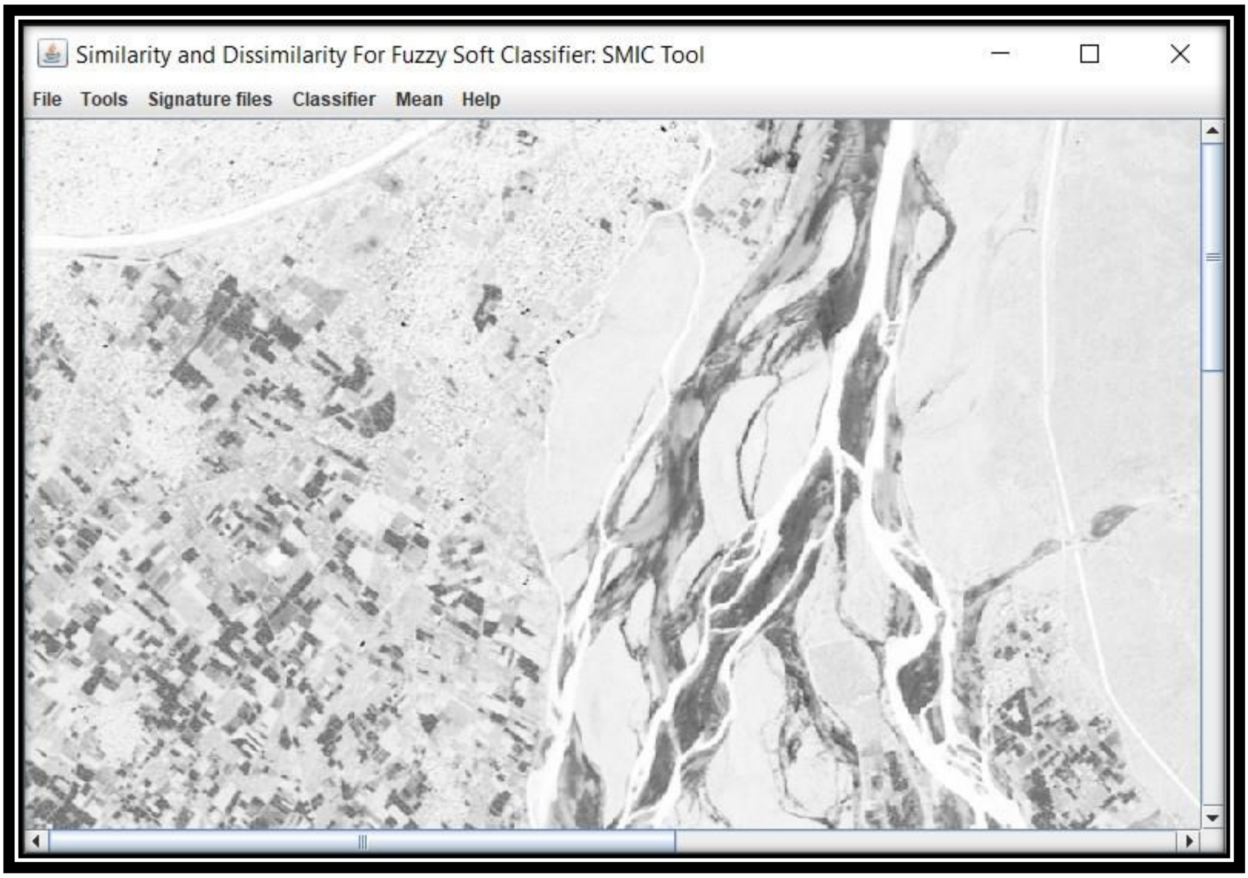
'p': probability of a pixel belonging to particular class

For single class, A is an identity matrix and |A| = 1

Distance: Euclidean distance.

μ*: 0 – 255*

(Normalized) x = (x - min(xi)) / (max(xi) - min(xi))



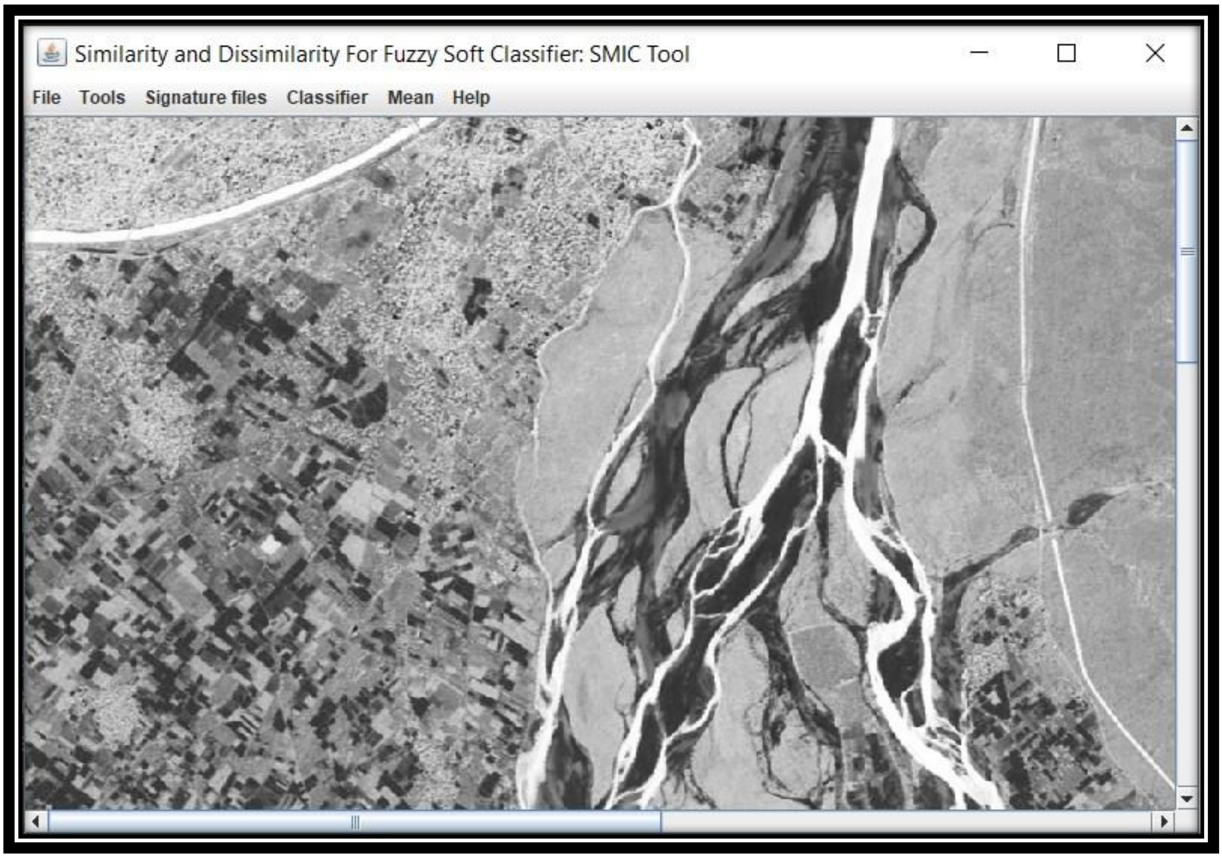
4. Max NC:

$$J_{nc}(U,V) = \sum_{i=1}^{c}\sum_{k=1}^{N}(\mu_{ki})^m D(x_k, v_i) + \sum_{k=1}^{N}(\mu_{k,c+1})^m \delta$$

where $U = N \times (c+1)$ matrix and $V = (v_1 \ldots v_c)$.

here μ is

$$\overline{\mu}_{ki} = \left[\sum_{j=1}^{c}\left(\frac{D(x_k,\overline{v}_i)}{D(x_k,\overline{v}_j)}\right)^{\frac{1}{m-1}} + \left(\frac{D(x_k,\overline{v}_i)}{\delta}\right)^{\frac{1}{m-1}}\right]^{-1}$$



(For Noise μ is)

$$\bar{\mu}_{k,c+1} = \left[\sum_{j=1}^{c} \left(\frac{\delta}{D\left(x_k, \bar{v}_i\right)} \right)^{\frac{1}{m-1}} + 1 \right]^{-1}$$

HARD AND SOFT CLUSTERING

Clustering is the task of dividing the population or data points into a number of groups such that data points in the same groups are more similar to other data points in the same group than those in other groups.

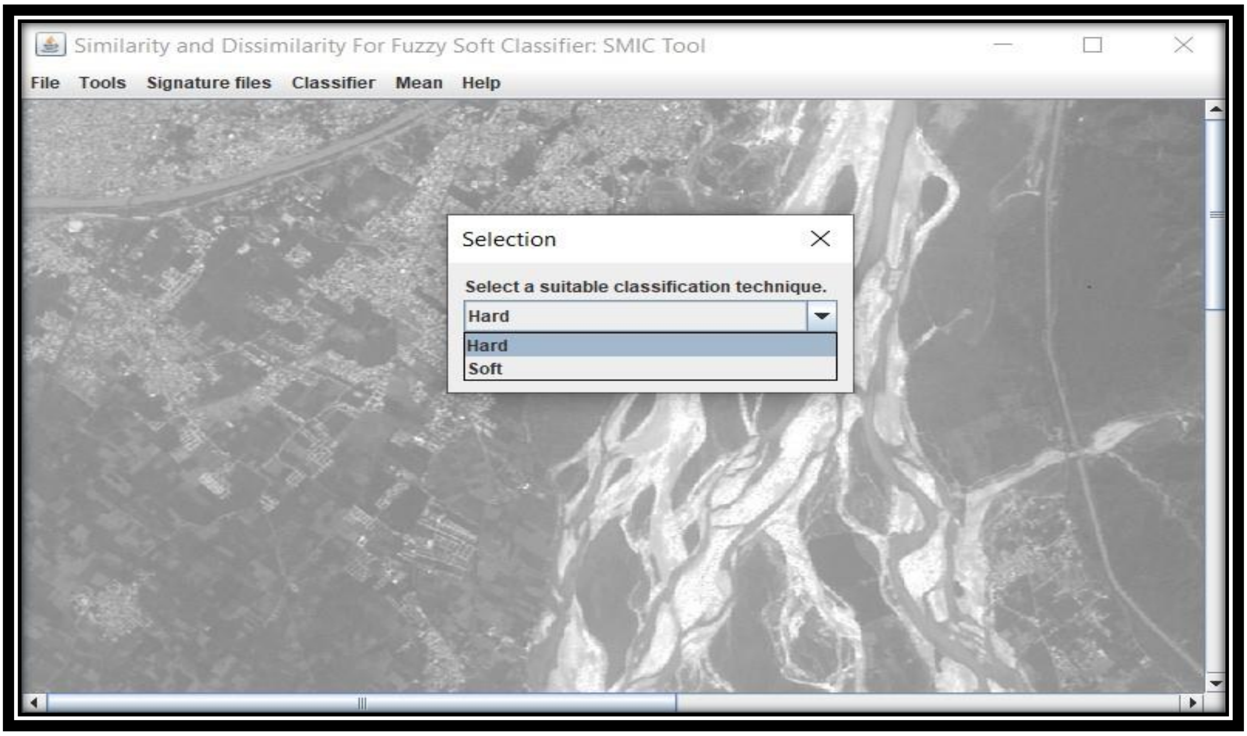
Hard Clustering: In hard clustering, each data point either belongs to a cluster completely or not.

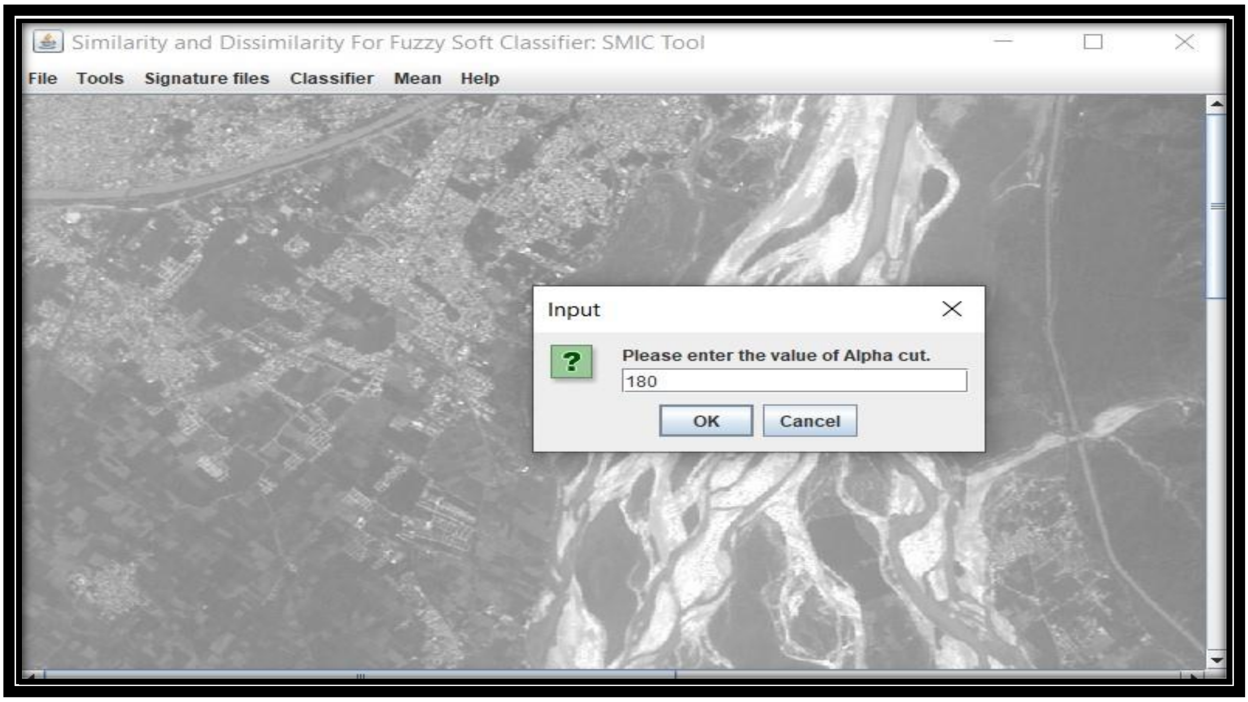
Soft Clustering: In soft clustering, instead of putting each data point into a separate cluster, a probability or likelihood of that data point to be in those clusters is assigned.

Alpha-cut : Let $\mu \in F(X)$ and $\alpha \in [0, 1]$.

Then the sets [μ]α = {x ∈ X | μ(x) ≥ α} , [μ]α = {x ∈ X | μ(x) > α} are called the α-cut and strict α-cut of μ.

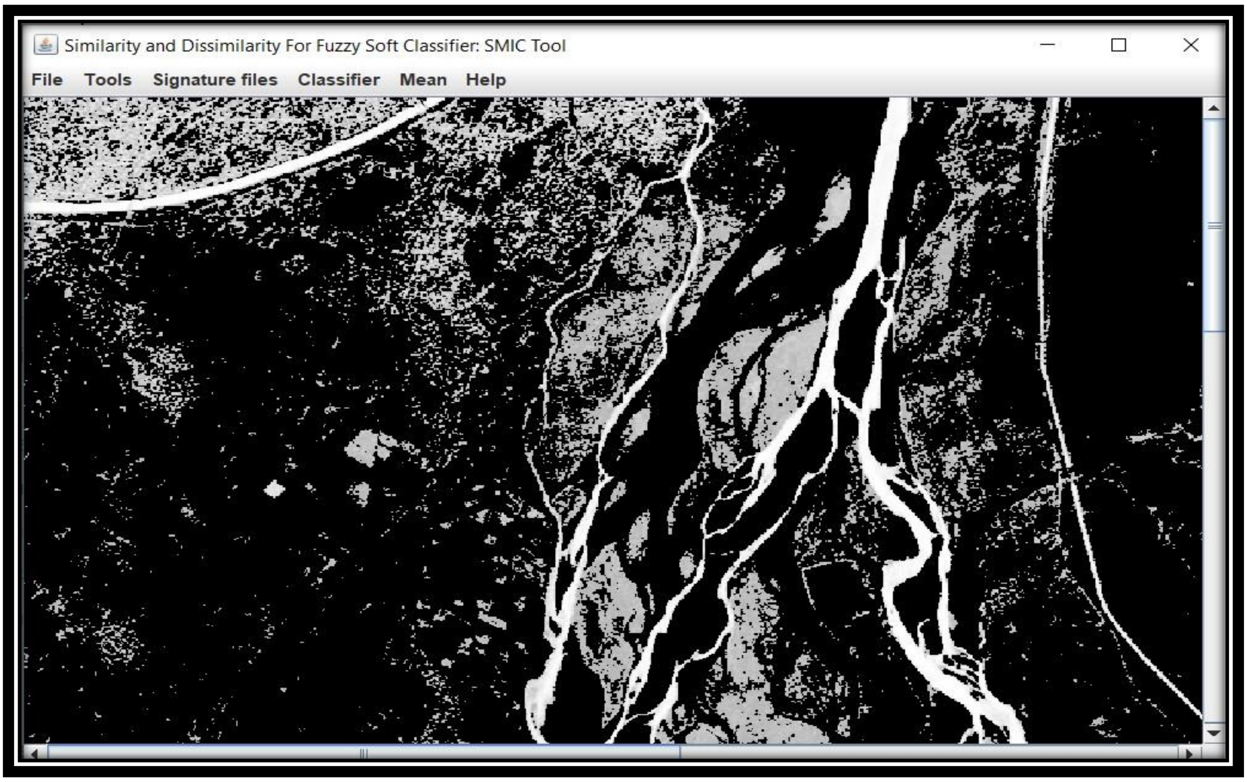
Using the concept of alpha cut, soft and hard clustering has been implemented as follows:





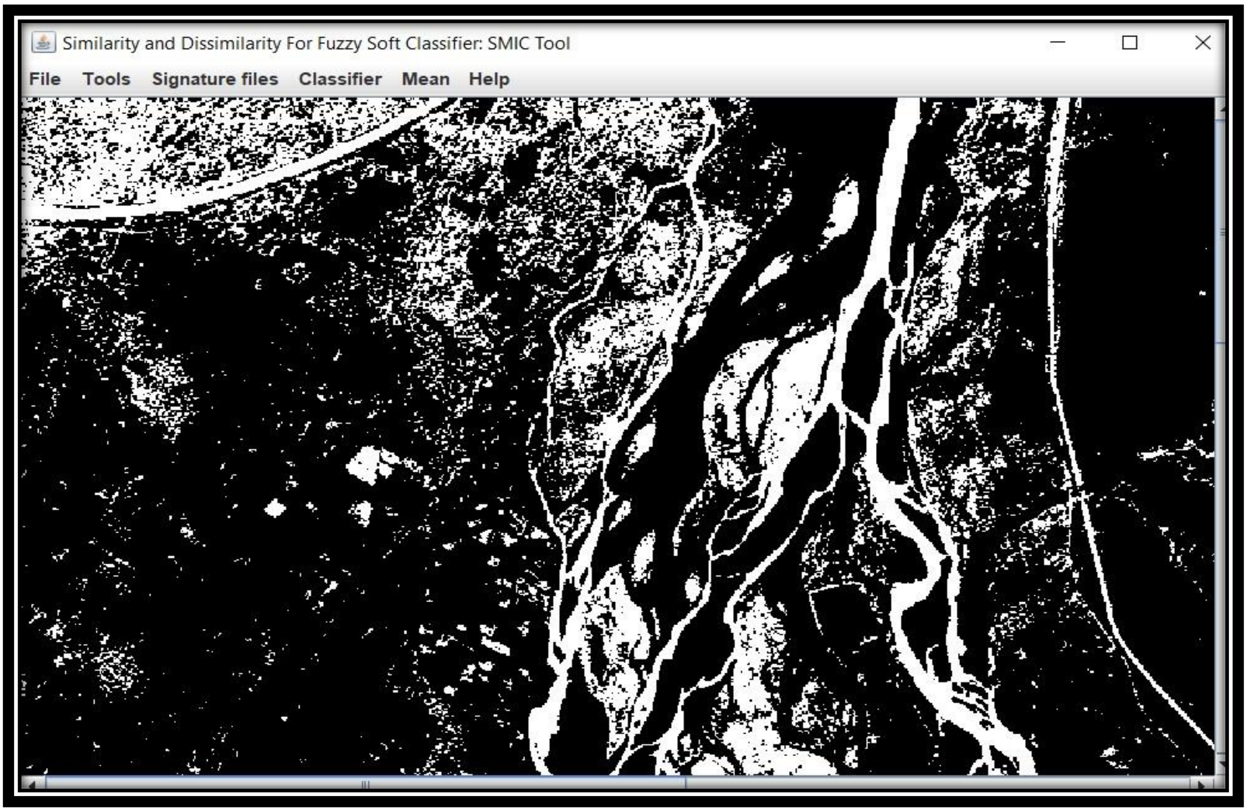
SOFT

If value < alpha cut
    then value = 0



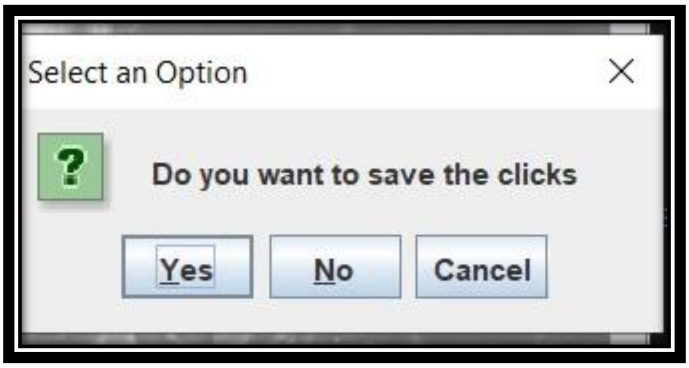
HARD

If value < alpha cut
    then value = 0
else
    value=255

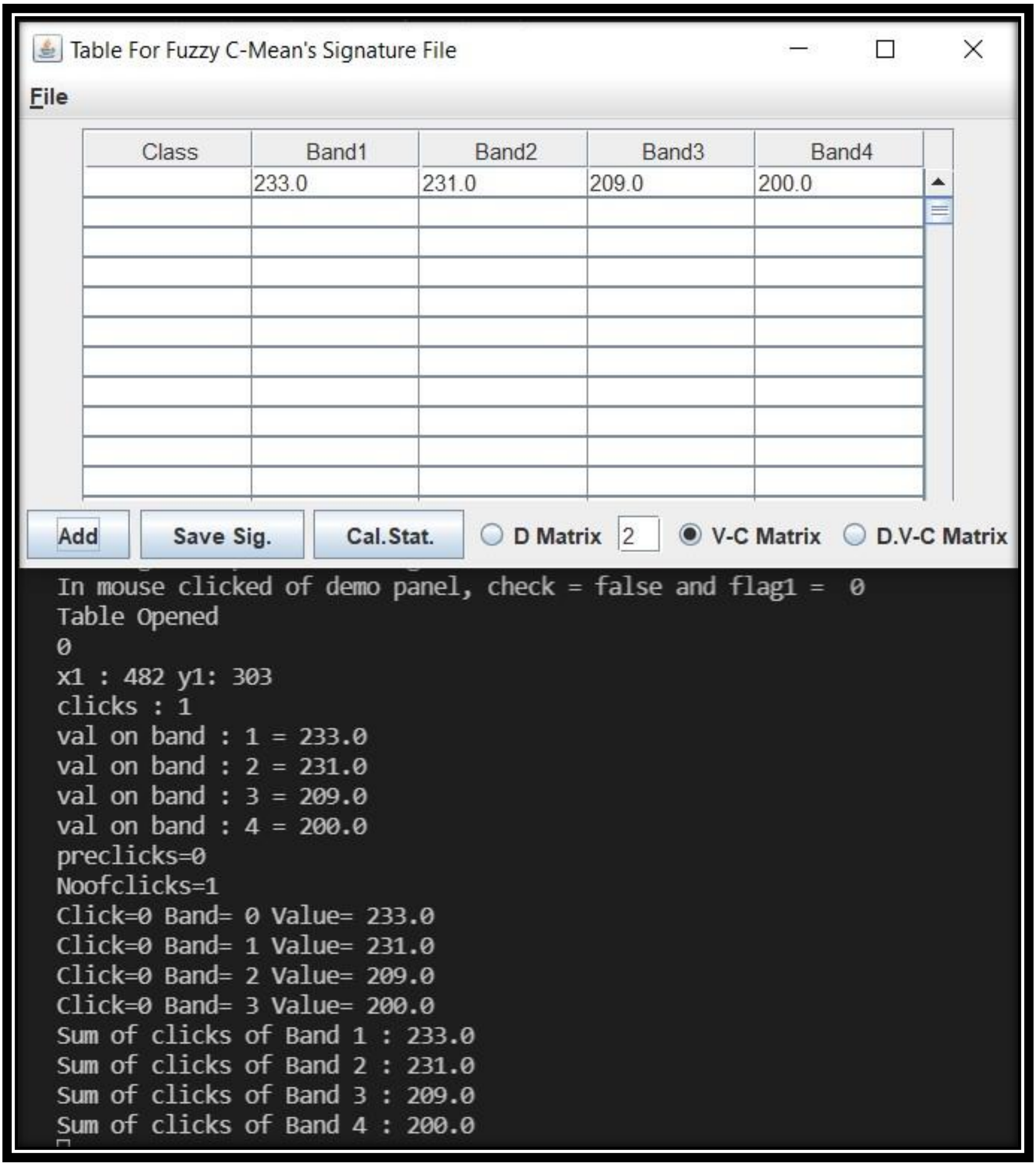


Appending clicks in existing signature file

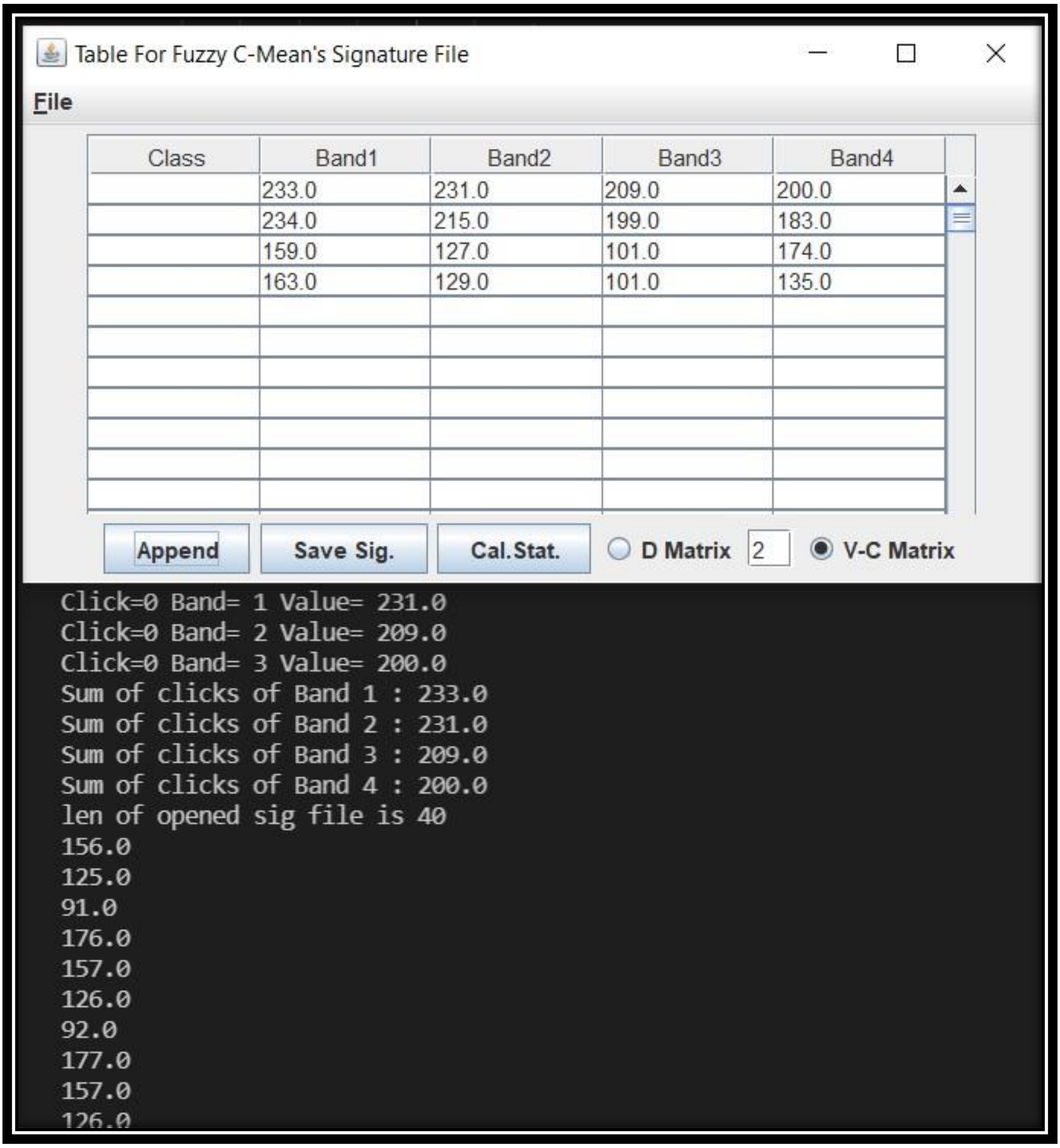
1.OnClick



2. After 'Yes':



3. After opening the signature file:



Here, length of file = 40 (4 bands * 10 clicks)

4. After Save:

```
len of old file  for new save is 40
len of  new clicks for save is 12
len of opened sig file is 52
156.0
125.0
91.0
176.0
157.0
126.0
92.0
```

Length of file = 52 (10+3 * 4)

CONCLUSION

There are different classifiers/algorithms for classifying remotely sensed images. This report presents the performance of variants of standard classifiers. Most of them give good results. Along with advancements in technology and faster computational techniques, other improvements or variations in existing algorithms or new algorithms can be experimented to give more accurate results.