DAYANANDA SAGAR UNIVERSITY

Department of Computer Science Engineering

School of Engineering

Workshop Report on

"IMAGE CLASSIFICATION TECHNIQUES USING QGIS"

Date: 21st September, 2023
Time: 9:30 am – 4.30pm

Resource Person:

Dr. P G Diwaker
ISRO Chair, Professor, NIAS

Patrons:

Dr. Uday Kumar Reddy K R
Dean, SOE

Dr. M. K. Banga
Dean, R & D

Dr. Girisha G S
Professor & Chairman, CSE

ORGANISERS:

Dr. Rajesh TM, Associate Professor, CSE

Dr. Gopal Sharma R Joshi, Professor of Practice, CSE

CO-ORDINATOR:

Srushti B Yalgudri, Student, CSE

Sumukh Sankarshana M, Student, CSE

Target Audience: Satellite Image processing inspired students.

Number of participants: 23

The Dept. of CSE has successfully organized a webinar on "**IMAGE CLASSIFICATION TECHNIQUES USING QGIS**". The targeted audience were 4th year students who chose their major project domain related to satellite image processing. The Workshop was organized in offline mode. Around 23 students attended the workshop. All students were trained on both theoretical and practical knowledge of the satellite image processing. At the end of the seminar feedback was taken from the students and it is found to be satisfactory.

Demonstration by the Speaker

The workshop covered theoretical and practical knowledge on **Image classification and its techniques using QGIS.** Detailed Information of the Session is given below

Introduction

Image classification is a fundamental process in remote sensing and GIS (Geographic Information System) that involves categorizing pixels or objects within an image into predefined classes or land cover categories. These classifications are crucial for various applications, including land use planning, environmental monitoring, and disaster management.

The workshop on Image Classification Techniques Using QGIS, conducted by **Dr. P G Diwakar** and **Varshini**, Research Associate (GIS) at PIXEL SOFTEK and also a former student of Dr. Diwakar, provided participants with a comprehensive understanding of both theoretical concepts and practical implementation using the Quantum Geographic Information System (QGIS). This report presents an overview of the key topics discussed during the workshop, divided into two parts: Theoretical Insights and Practical Hands-On Session.

Part I: Theoretical Insights

Feature Extraction:

- **Importance of Ground Truth**: Dr. Diwakar emphasized the critical role of ground truth data in image classification. Spectral signatures should be validated against real-world data, ensuring accurate classification results.
- **Training and Band Selection**: The image classification process starts with band selection, followed by training the system to recognize spectral signatures. It was emphasized that the quality of training datasets directly influences the accuracy of the classification.
- **Purity of Signatures**: Varshini Ma'am highlighted the importance of pure spectral signatures. These signatures, obtained from high-quality training data, are essential for reliable classification outcomes.

Types of Classification:

- **Parametric Classification**: Dr. Diwakar discussed techniques like Maximum Likelihood Analysis and the Mahalanobis Model, which rely on assumptions about underlying parameter distributions.
- **Non-Parametric Classification**: Varshini Ma'am introduced non-parametric approaches, including Artificial Neural Networks (ANN), Genetic Algorithms, Bayesian Rules, and more, which do not rely on specific parameter assumptions.

Seasonal Variations: Consideration of seasonal variations in land cover, such as leafy and leaf-shedding periods in forests or wet and dry seasons in agriculture, is vital for accurate classification.

Band Selection: The importance of selecting the right spectral bands was highlighted. Bands like shortwave infrared (SWIR) and near-infrared (NIR) were recommended for their unique information content.

Validation and Accuracy Assessment

- **Locational Accuracy**: Dr. Diwakar emphasized the need to validate satellite data with ground data using GPS coordinates. Orthorectified images were discussed as a means to eliminate distortions caused by sensor tilt and topographic relief.
- **Pre-defined Criteria**: Varshini Ma'am explained the importance of predefined criteria in data splitting. Reserving a portion of data for post-classification validation, with a typical split of 20 sets for training and 10 sets for testing and verification, ensures the reliability of the classification.
- **Thematic Accuracy**: It was discussed that thematic accuracy involves assessing the precision of classifying specific themes, such as water bodies, agriculture, or trees, based on the domain and specific objectives.
- **Quantitative Accuracy**: Dr. Diwakar emphasized the need to quantify biophysical parameters like biomass, biodiversity, and water quantity in lakes for accurate resource assessment.

Land Cover and Land Use

- **Land Cover vs. Land Use**: Participants learned **that land cover refers to the types of features present on Earth's surface**, while **land use relates to human activities associated with land**. The USGS Land Cover Categories were introduced as a standardized classification system.
- **Subjective Categorization**: Varshini Ma'am discussed the subjectivity involved in land cover and land use classification, including decisions on where to draw boundaries, the level of generalization, and assigning labels to specific classes.
- **Levels of Categorization**:
    - **Level I**: At this level, 55m, 30m, or 20m resolution data is used, providing a coarse overview.
    - **Level II**: 10m or 5m resolution data offers more details.
    - **Level III**: Quick bird (60 cm) and IKONOS (1m) data provide even finer details.
    - **Level IV**: Aerial sensors and drones can be used for the highest level of detail.
- **USGS Land Cover Categories**: Dr. Diwakar and Varshini Ma'am elaborated on the USGS Land Cover Categories, which include classes like:
    - **Open Water**
    - **Perennial Ice/Snow**
    - **Developed**
    - **Barren Land**
    - **Deciduous Forest**
    - **Evergreen Forest**
    - **Mixed Forest**
    - **Shrubland**
    - **Grassland**
    - **Pasture/Hay**
    - **Cultivated Crops**
    - **Woody Wetlands**
    - **Emergent Herbaceous Wetlands**

Image Classification

Types of Classification:

- **Unsupervised Classification**: Dr. Diwakar introduced unsupervised classification, where pixels are grouped into classes without prior labeling. The K-means clustering algorithm was discussed as a common technique.
- **Supervised Classification**: Varshini Ma'am explained supervised classification, which employs labeled training data to classify pixels based on predefined classes or categories. Methods like Maximum Likelihood and Mahalanobis distance were introduced.

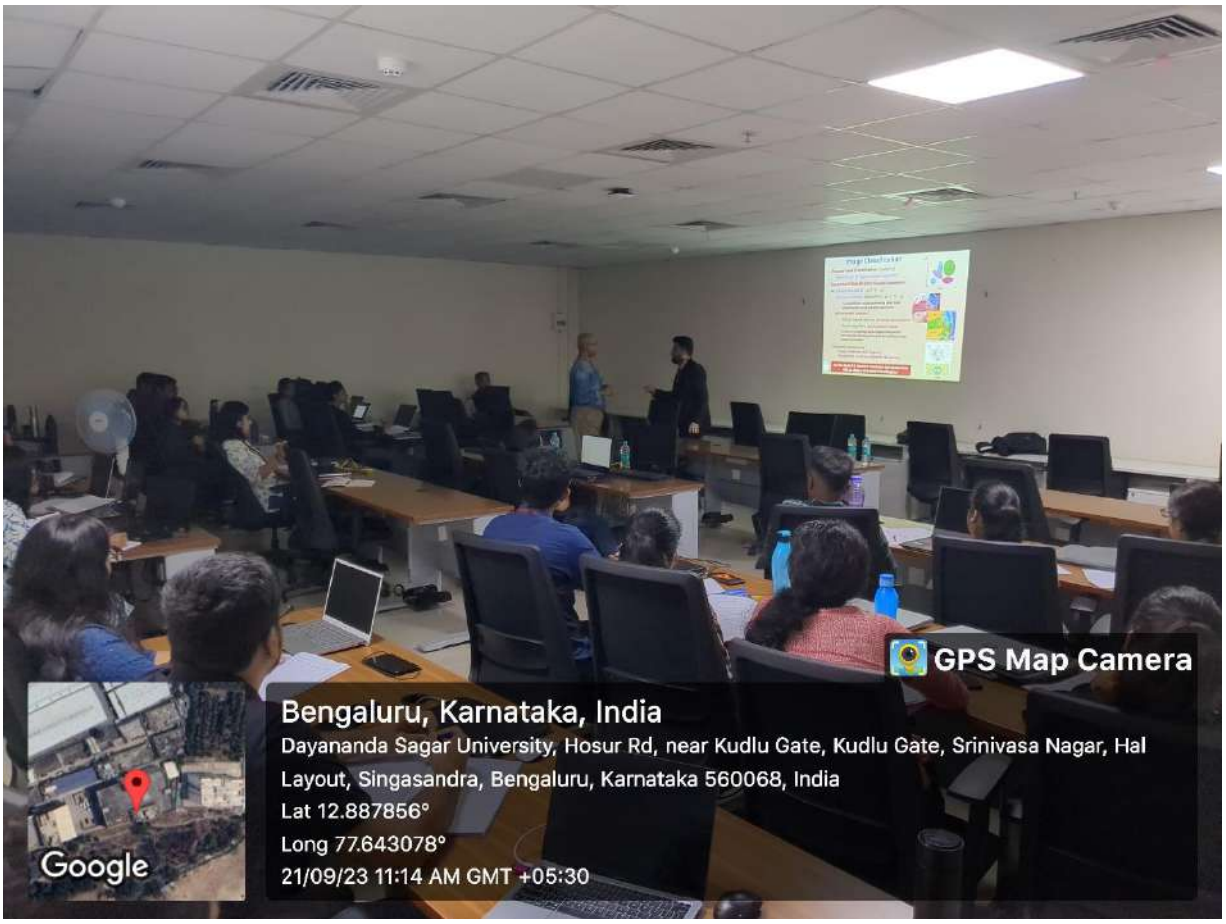
Non-parametric Approaches: Participants learned about non-parametric approaches like Artificial Neural Networks (ANN) and Genetic Algorithms, which do not rely on specific parameter assumptions.

Accuracy Assessment Methods: Dr. Diwakar discussed accuracy assessment methods such as Kappa Statistics (Chi-Square test) and Separability Analysis (Distance Measures) to evaluate classification results.

Pattern Recognition

The pattern recognition process, presented by Varshini Ma'am, was divided into several key steps:

1. **Understanding Ground Truth Collection**
2. **Training System to Recognize Typical Ground Features**
3. **Signature Computation for Each Feature**
4. **Signature Separability Analysis to Assess Purity of Classes**
5. **Classification of Ground Truth Areas for Validation**
6. **Classification of Entire Scene Data Based on Final Ground Truth**
7. **Post-classification Validation of Outputs**
8. **Post-classification Smoothing Using Low-pass Filters**
9. **Output as a Thematic Layer in GIS**



Practical Hands-On Session

Preparation

Participants were guided through the practical session, which involved the following steps:

1. **Install QGIS**: Ensure QGIS is installed on your computer from the official website.
2. **Load Remote Sensing Data**: Import remote sensing data, such as satellite imagery, into QGIS using the "Add Raster Layer" option.
3. **Enable the SCP Plugin**: Install and enable the Semi-Automatic Classification Plugin (SCP) through the QGIS Plugin Manager.

Practical Steps

1. Layer Stacking

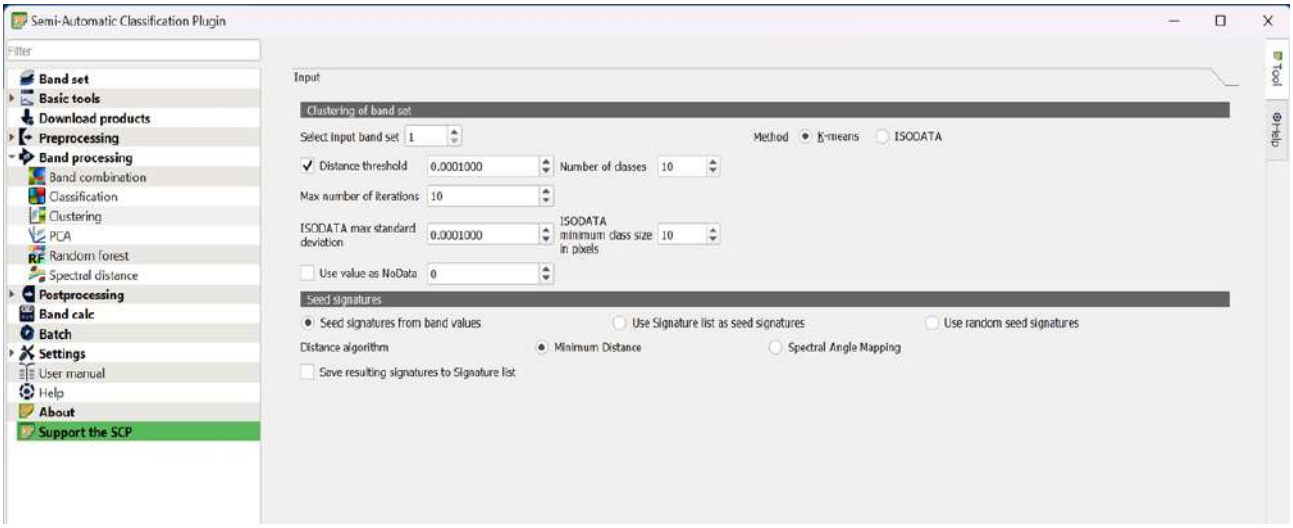
- Participants were introduced to layer stacking at the beginning of the practical session.
- Layer stacking involves combining multiple raster layers into a single composite image.
- This technique enhances the visual interpretation of remote sensing data by providing a comprehensive view of the landscape.

2. False Color Composite

- Following layer stacking, participants were instructed on how to create a false color composite.
- Dr. Diwakar and Varshini Ma'am explained how to generate a false color composite using different spectral bands.
- This composite can reveal unique information about land cover and land use by assigning specific spectral bands to different color channels.

3. Clustering

- Participants performed clustering using SCP: Band Processing -> Clustering.



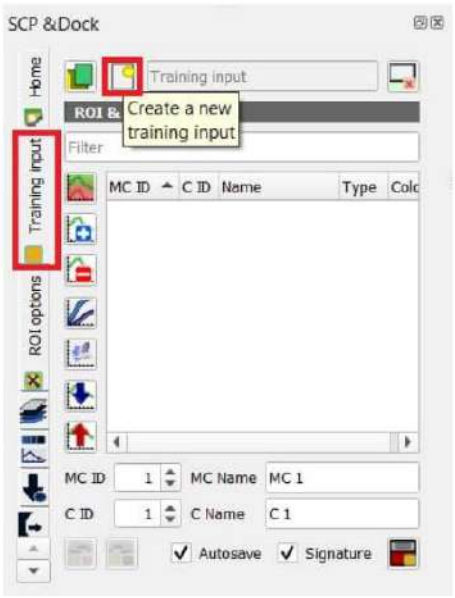
- They specified the number of classes and Max number of iterations, such as seed signatures and

Minimum distance algorithms.

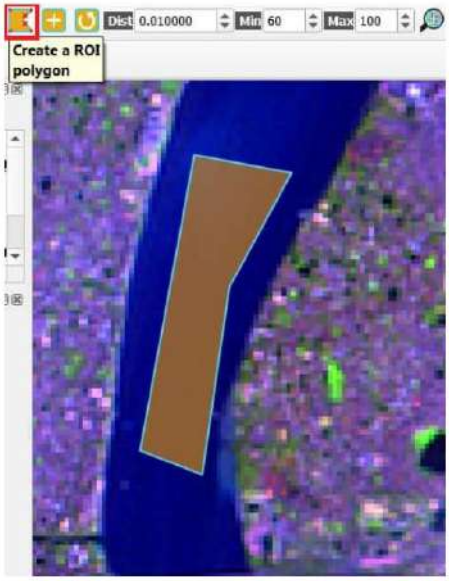
- Clustering was explained as an essential step for grouping similar spectral signatures.

4. Supervised Classification

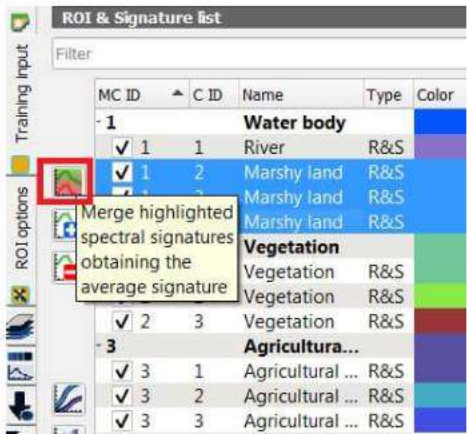
- Practical training included:
  - Preparing a training input to save spectral signatures.



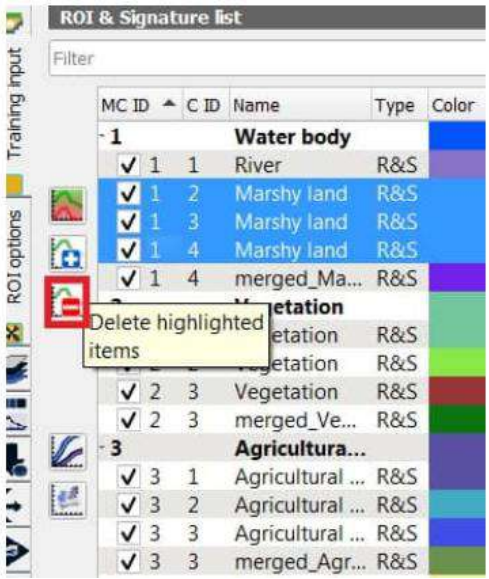
  - Creating Region of Interest (ROI) polygons to define training areas.



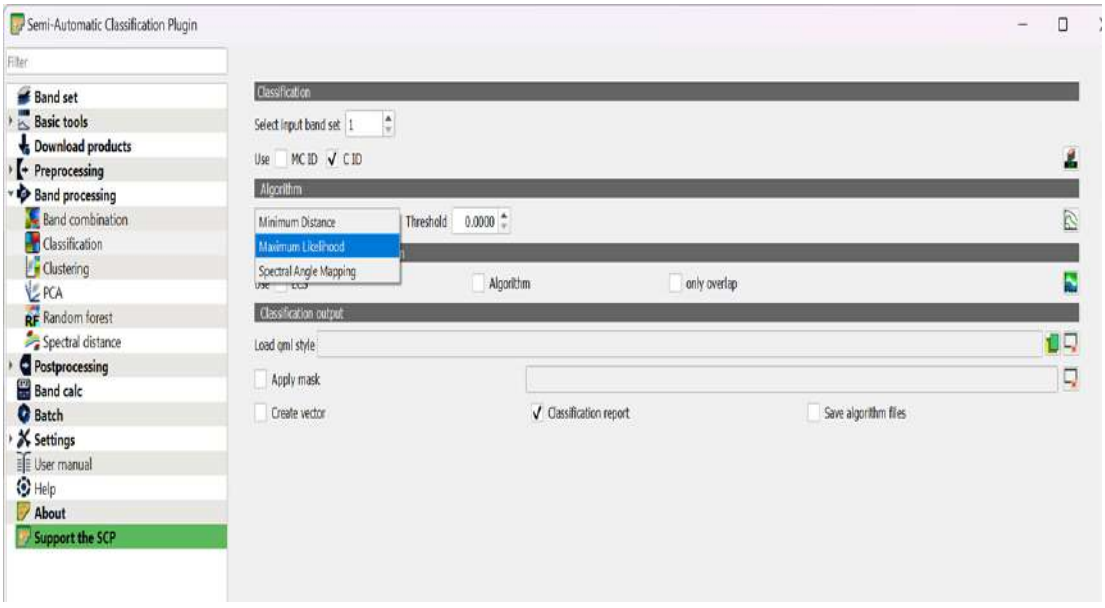
  - Merging signatures for similar classes.



- After obtaining the merged signature, delete the single classes



- Performing classification using SCP: Band Processing -> Classification. Select the Classification report to save the output.



5. Validation and Accuracy Assessment

- Participants learned about the importance of validation and accuracy assessment:
    - Locational accuracy was discussed, emphasizing the need for GPS coordinates for cross-verification.
    - Predefined criteria for data splitting (e.g., 20 sets for training, 10 sets for testing) were reinforced.
    - Thematic accuracy and quantitative estimation of biophysical parameters were demonstrated.

One-on-One Project Sessions (Post Lunch)

Following the morning's theoretical and practical sessions, the workshop featured valuable one-on-one project sessions. These personalized sessions, conducted after lunch, allowed participants to discuss their major projects and seek expert guidance from Dr. Diwakar and Varshini Ma'am.

In these interactive sessions, participants shared their project progress and challenges, receiving tailored advice and recommendations. These discussions fostered collaborative learning and equipped participants with the skills and confidence needed to excel in their projects.

The one-on-one sessions, held after lunch, enhanced the workshop's overall impact, ensuring participants left with a clear path to apply image classification techniques effectively to their research and projects in remote sensing and GIS.

Session Takeaways

- The workshop emphasized the significance of ground truth data and spectral signature validation.
- Feature extraction, band selection, and training were highlighted as critical steps in image classification.
- The quality of training datasets directly influences classification accuracy.
- Seasonal variations and thematic accuracy were recognized as essential considerations.
- Land cover and land use classification involve subjective categorization and depend on data resolution.
- Image classification methods include both parametric and non-parametric approaches.
- Accuracy assessment methods were introduced for evaluating classification results.
- Pattern recognition involves a series of steps for classification and validation.
- In the practical session, participants gained hands-on experience using the SCP plugin in QGIS for layer stacking, false color composite generation, clustering, supervised classification, accuracy assessment, and post-classification smoothing, as well as thematic layer creation.

Conclusion

The workshop on Image Classification Techniques Using QGIS, conducted by Dr. P G Diwakar and Varshini Ma'am, provided participants with valuable theoretical knowledge and practical skills. It equipped them to perform image classification, an essential task in remote sensing and GIS applications. The combination of theoretical insights and practical implementation using QGIS ensured a comprehensive learning experience for all participants. The detailed coverage of land cover, land use, and USGS categories added depth to the workshop's content.