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UNLOCKING THE SKY (Machine Learning Approaches for Satellite Image Classification)

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Abstract: Satellite imagery plays a crucial role in research and development, facilitating advancements in fields such as agriculture monitoring and disaster management. These images, captured through sophisticated systems, are processed using computers to extract valuable information. Machine Learning (ML), a fundamental aspect of artificial intelligence, involves constructing rules based on data. It revolves around creating software applications that access information and use it for self-guided learning. In the context of satellite imagery, Machine Learning algorithms have proven indispensable for analyzing images from various sources, yielding deeper insights. This article explores the utilization of Machine Learning-based image classification techniques to enhance the interpretation of Satellite Imagery. By employing these techniques, the process of classifying objects within satellite images can be improved, leading to more refined and detailed out comes window will be opened for the kids with specialized tools and description.

1 INTRODUCTION

The objective of our project “Satellite Image Classification” is to identify the images captured by satellite. Where we use smart technology to understand pictures taken from space. Imagine looking at Earth from above and figuring out what you see - whether it's forests, cities, or rivers. That's what we do. With special computer programs, we can teach computers to recognize and sort these pictures, helping us learn more about our planet. From finding the best places to grow crops to keeping an eye on the environment, our project makes studying Earth's pictures easy and fun. Join us in exploring the wonders of satellite images and uncovering the secrets they hold. These Satellites use cameras like superpowered cameras in space, orbiting our Earth. They capture pictures from way up above, covering vast areas. These pictures, often called satellite images, are incredibly detailed, showing everything on the Earth's surface. Satellite Image Classification transforms complicated satellite pictures into easy-to-understand information. It's like giving a voice to these pictures, allowing them to tell us stories about our planet.

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1.1 PROBLEM STATEMENT

In our innovative project, we prioritize accuracy to simplify the identification of various satellite images. The process begins with a crucial first step - determining whether the given image is indeed a satellite image. To achieve this, we utilize sophisticated techniques based on average intensity and threshold values. This initial assessment allows us to differentiate authentic satellite imagery from other types of pictures, ensuring the reliability of our classification process.Once the image is confirmed as a satellite image, our advanced classification system comes into play. Leveraging cutting- edge algorithms, we meticulously analyze the image to identify its specific category. Is it a dense forest canopy, an urban landscape, or a vast body of water? Our system provides precise and detailed classifications, allowing users to comprehend the content of the image accurately.

1.2 TECHNIQUES

Perceptron Class:

A perceptron is defined with the following components:

Initialization: Weights and bias are initialized randomly.

Activation Function (activate method): A step function is used here. If the weighted sum is greater than or equal to 0, it returns 1; otherwise, it returns 0.

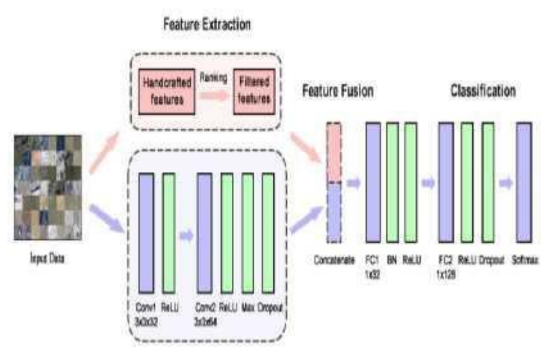
Prediction (predict method): Calculates the weighted sum of inputs and applies the activation function. Training (train method): Implements the perceptron learning algorithm to adjust weights and bias based on the error.

Image Loading and Preprocessing:

The code includes a function (load_and_preprocess_image) to open an image file, resize it, convert it to grayscale, and normalize pixel values. This function is used for loading and preprocessing images.

Image Classification: Another function (classify_image) is defined to classify images based on their average pixel intensity. It uses a threshold for classification.

1.3 ARCHITECTURE



1.4 DATASET DESCRIPTION

Data set we used for our project is “NWPU-RESISC45”

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Dataset Description:

The NWPU-RESISC45 dataset is a widely used benchmark dataset for satellite image classification tasks. It is specifically designed for remote sensing and includes 45 classes of land-use categories. Each class represents distinct land cover types commonly found in satellite imagery. The dataset provides a diverse range of challenges, making it suitable for testing and evaluating the performance of satellite image classification algorithms.

1.5 MODEL EVALUATION AND METRICS

Accuracy:Accuracy measures the overall correctness of the model.

Accuracy=Number of Correct Predictions/Total Number of Predictions

Accuracy= Total Number of Predictions/Number of Correct Predictions #code

total_predictions = len(test_data)

accuracy = correct_predictions / total_predictions
print(f'Accuracy: { accuracy:.2f}") Precision:

Precision measures the accuracy of the positive predictions.

Precision=True Positives/True Positives + False Positives

Precision= True Positives + False Positives/True Positives
#code

precision = correct_predictions / (correct_predictions + (total_predictions - correct_predictions))
print(f"Precision: {precision: .2f}")

2 LITERATURE REVIEW

Google Earth Engine:

Description: Google Earth Engine is a cloud-based platform for planetary-scale environmental data analysis. It provides access to a vast collection of satellite imagery and geospatial datasets, along with a powerful scripting environment for analysis and classification tasks.

Features: Offers pre-processed satellite imagery, extensive data catalog, and integration with Google Earth's visualization tools. It supports a wide range of geospatial analyses, including classification, time-series analysis, and change detection.

Sentinel Hub: Description: Sentinel Hub is a cloud-based service offering access to various satellite data sources, including Sentinel-2, Landsat, and others. It provides an intuitive interface for satellite image analysis and classification.

Features: Customizable processing pipelines, easy-to-use web interface, and integration with popular GIS tools. It supports tasks like image visualization, classification, and vegetation indices calculation.

Orfeo Toolbox:

Description: Orfeo Toolbox (OTB) is an open-source library for remote sensing image processing. It provides a set of high- performance algorithms for satellite image classification, feature extraction, and change detection.

Features: Extensive collection of image processing algorithms, support for large- scale data, and integration with QGIS and Monteverdi (a visualization tool).on, and vegetation indices calculation.

3 EXPERIMENTAL RESULTS

```
Target: 3, Prediction: 0
Target: 1, Prediction: 1
Accuracy: 100,00%
```

Figure 1: Finding Accuracy

```
print(f"Classification Result:

{classification Classification

Result: Satellite Image
```

Figure 1.2: Checking satellite image or not

```
Satellite Image Names:
bridge_601
basketball_court_601
basketball_court_601
```

Figure 1.3: Final Result

4 CONCLUSION

Satellite image classification stands as a pivotal technology, offering profound insights into our world from high above the Earth's surface. Through advanced algorithms and machine learning techniques, we have the power to unravel the intricate tapestry of our landscapes, accurately categorizing diverse terrains, vegetation, and human-made structures. As we navigate the realms of environmental conservation, urban planning, disaster management, and agricultural innovation, satellite image classification emerges as a indispensable tool, guiding our decisions and shaping our understanding of the planet's changing dynamics.

The ability to transform raw satellite data into actionable information signifies a monumental leap in the field of remote sensing. By harnessing the potential of sophisticated models, we can identify patterns, monitor changes, and predict trends with unprecedented precision. From detecting deforestation and tracking urban sprawl to aiding disaster response efforts, satellite image classification lends us a crucial lens through which we can comprehend the impact of human activities and natural phenomena on our environment.

5 FUTURE WORK

*High-Resolution Image Classification: With the availability of high-resolution satellite imagery from sources like WorldView-3 and Sentinel-2, there is a need for advanced algorithms capable of handling large-scale, high-resolution datasets. Developing efficient classification methods that can handle fine-grained details in these images is essential.

*Multi-Temporal Analysis: Leveraging time-series satellite data can provide valuable insights. Research can focus on classifying images over different time periods to monitor changes in land cover, crop health, and urban development. Long short-term memory (LSTM) networks and recurrent neural networks (RNNs) can be explored for modeling temporal dependencies in sequential satellite images.

*Multi-Sensor Fusion: Integrating data from different sensors, such as optical, radar, and LiDAR, can enhance classification accuracy. Fusion techniques, including data-level fusion, feature-level fusion, and decision- level fusion, can be explored to combine information from diverse sources.

*Semi-Supervised and Weakly Supervised Learning: Labeling large-scale satellite imagery datasets is time-consuming and expensive. Exploring techniques like semi- supervised learning and weakly supervised learning, where models can learn from a limited amount of labeled data and a large amount of unlabeled or weakly labeled data, can significantly reduce the annotation effort.

6 REFERENCES

*IEEE GRSS Data and Algorithm Standard Evaluation (DASE) Repository: Link

*USGS Earth Explorer: Link - Provides access to a vast collection of satellite imagery datasets.

*Ma, L., Liu, X., & Wu, Y. (2019). A Comprehensive Review on Remote Sensing Image Scene Classification: Evolutionary Taxonomies, Challenges, Benchmark Datasets, and Opportunities. Sensors.