Applied digital platform for remote sensing data processing

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Abstract. New methods and techniques developed small research teams for processing remote sensing that are rarely available to other teams. For the exchange of new methods among users, it is necessary to develop an applied digital platform that will allow publishing new methods, applying and comparing the results obtained to choose the best one in solving their problems. This article presents an applied digital platform being developed at the IDSCT SB RAS, which allows the user to quickly receive and process remote sensing data for the region of interest. The goals and requirements of creating an applied digital platform are considered, a general architecture, individual components and examples of its application are considered.

Keywords: Remote Sensing, WPS, Landsat, Sentinel, Digital platforms.

1 Introduction

Since the data of remote sensing of the Earth appeared in the public domain, many researchers began to use them to solve problems of thematic processing. In particular, satellite images are widely used [1-2] for updating topographic and navigation maps, agricultural monitoring, tracking the dynamics and state of forest felling, observation of ice conditions and ets. It is difficult for users to choose an appropriate method or technique among the well-known ones, since the result of their application depends on the studied area. Often, in order to achieve a research goal, it is required to sort out various combinations of processing methods and choose the most suitable one. The traditional approach to processing remote sensing data is to apply a desktop application which takes a lot of time. Desktop applications offer a limited set of methods, which are sometimes not enough to solve the current task. Existing remote sensing data processing systems, such as Google Earth Engine [3], ArcGIS Online [4], allow you to create your own methods with limited development tools, and are not focused on sharing them. New methods or techniques developed by research teams are rarely used due to the complexity of distribution among users.

Therefore, it is promising to create an applied digital platform (ADP), within which researchers could apply existing methods and techniques for processing remote sens-

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ing data, distribute their own methods, and compare the results. The goal of creating an applied digital platform is to simplify the full cycle of remote sensing data processing (see Fig. 1), i.e. automation of receiving, processing and publishing processes. The ADP should provide tools for creating new methods based on software systems or existing services.



Fig. 1. Workflow for remote data.

2 Applied digital platform

At the Matrosov Institute for System Dynamics and Control Theory SB RAS an applied digital platform is being developed for processing remote sensing data. The ADP architecture is shown in the figure (see Fig. 2). ADP has a web user interface accessible via a browser. Data processing is based on WPS services, which show good results in standardization, software support [5], which makes it possible to create and integrate custom services for each step of the remote sensing data processing cycle. Let's consider the functions of the main components of the ADP.

The catalog allows the user to search for remote sensing data for the region of interest. While searching users can specify the time interval, limit the cloudiness value, select the sensor, etc. For each sensor the catalog offers a corresponding set of services, processing and publishing.

The data storage system is designed for loading remote sensing data, storing intermediate results, processing results.

The service scheduling and execution system performs service execution, monitors the state of execution, balances the load between computing nodes, determines the schedule and sequence of service calls. The system has the ability to scale service execution, authorize users for services, interact with the storage system, etc.

Relational data editing services are designed to create training dataset for some supervised classification methods. The user through the browser can manually mark the remote sensing data and specify the classes of objects. The results of the work are saved in the form of relational tables with spatial attributes in the PostgreSQL DBMS with the PostGIS module for working with spatial data.



Fig. 2. Application digital platform architecture.

3 Remote sensing data catalog

The catalog contains data from Landsat 7, Landsat 8, Sentinel-2 sensors from the United States Geological Survey (USGS). Remote sensing data is updating every 5 - 16 days, depending on the sensors. Remote sensing data required for users is loaded via the Google Cloud API using the developed script. The catalog stores meta information about remote sensing data and allows users to search for remote sensing data on the region of interest. While searching users can specify the time interval, cloudiness, sensors (see Fig. 3).



Fig. 3. Remote sensing data catalog.

For each image, users can apply a set of service compositions that define the sequence of service execution. The composition should contain a service for publishing data, which will allow showing the processing result on the map. If the user needs to get data that is not in the catalog, the user can start the WPS service for downloading images.

4 Remote sensing data processing services

ADP allows publishing remote sensing methods in the form of WPS services. the standard WPS implementation provides the following advantages:

- allows expanding the set of methods, ranging from simple spectral indices to complex combinations of methods developed on different software platforms and distributed around the world;
- unifies the application of methods through standardization;
- simplifies technical support (the service can be located on any geographically remote server and is available to the author-developer);
- significantly speeds up method applying due to the absence of the need to install software;
- services can be scaled to multiple servers when implemented in a cloud ADP.

Remote sensing data processing techniques can be implemented using service compositions that define the sequence of calls and parameters. Let's consider the remote sensing data processing services implemented in the ADP and their features.

Spectral index calculation service: NDVI, NDWI, NDSI, NDGI, NDMI, NPCRI, PSRI, NBR, CMR, FMR, IOR, NDBI, AVI, BSI, SI (see Fig. 4). They are used for monitoring large areas.

Clustering service based on calls to GRASS GIS and GDAL functions. Unlike the desktop version, it was possible to reduce the number of steps required to get the result from 11 to 3 (see Fig. 5).

Image segmentation service based on neural networks of well-known architectures (Unet, FPN, Linknet, PSPNet), which allow for binary and multi-class segmentation (see Fig. 6).

Service for creating a training dataset. Data preparation for the training dataset is performed using manual image marking. The user through the browser creates polygonal objects with the class label, and at the output he receives a directory from two subdirectories (images, ground_trust), if required, the training dataset can be packed into a CSV file.

More details about these and other services can be found in [7].



Fig. 4. On the left - NDVI, on the right – NDSI.



Fig. 5. Monitoring changes. On the left - 2018, on the right – 2020 years.



Fig. 6. On the left - original image, on the right - segmentation result.

5 Data display services

Displaying data allows you to better evaluate the initial data and results, such tools are developing in ADP [6]. Data display services allow users to view remote sensing data in a browser on a map. For this, the Map service has been developed. The Map publishes the one image to the map, with styles passed as a parameter. The display of remote sensing data is supported by a combination of channels, which allows you to quickly obtain information, and can also be used to solve more complex problems. Various combinations of channels are used to search for some objects in a satellite image, for example, vegetation, urban areas, open soil, sandy areas and others. For example, the 5-4-3 channel combination mainly for studying the condition of the vegetation cover. The 4-3-2 channel combination "natural colors" corresponds to the RGB color model (see Fig. 7). Other combinations are listed as channel numbers: 7-5-3, 5-6-2, 5-6-4, 7-6-4, 7-6-5. To make the combination the WPS_visualize service has been developed.



Fig. 7. Combination of channels. On the left "natural colors", on the right "artificial colors"...

6 Planning and Executing Service Composition

Processing and publishing services can be launched separately in a special form that is generated based on the service metadata. In the remote sensing data catalog, images are associated with service compositions leading to a finished result, i.e. the service compositions must have publication service. Service composition is described in JSON format. Each service of the composition has its parameter values. As a parameter value, the user can define a value obtained from another service call. While starting a service composition one image or a directory as a parameter value is attached to the services composition, and then it is executed (see Fig. 8). JSON description of the service composition is sent to the geoportal. The geoportal processes parameters, converts them into link URLs, sets additional information, for example, access parameters, the address of the REST service to return the result, etc. Then the geoportal transmits JSON to the service planning and execution system. The results of the work are transferred to the catalog through the geoportal. The catalog displays the processing results on a map.



Fig. 8. Executing service composition.

7 Conclusion

The developed applied digital platform allows the user to quickly receive and process data on the region of interest. The use of the WPS standard makes it easier to incorporate new methods implemented for different operating systems using various development environments. The use of service compositions, including receiving, processing and displaying data, greatly simplifies the use of methods for processing and analyzing remote sensing data.

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