Computers & Geosciences 47 (2012) 34–45

Contents lists available at SciVerse ScienceDirect

Computers & Geosciences

journal homepage: www.elsevier.com/locate/cageo

GeoPWTManager: a task-oriented web geoprocessing system

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ARTICLE INFO

Article history:
Received 20 March 2011
Received in revised form
29 November 2011
Accepted 30 November 2011
Available online 8 December 2011

Keywords:
Task
Geoprocessing
Web service
Workflow
SOA
GIS

ABSTRACT

Recent advancement of geospatial services has shown great promise to solve complex geoprocessing tasks in a distributed environment. Geoprocessing services are often chained as scientific workflows and executed in a workflow engine. This paper proposes a task-oriented architecture for Web geoprocessing systems, which leverages Web service and workflow technologies to design and execute tasks, and monitor and visualize the execution of tasks. The approach facilitates the expression of users' requirements, allows the monitoring of the task execution, and hides the complexity of technical details. A prototype system, named GeoPWTManager, is implemented to demonstrate the applicability of the approach.

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1. Introduction

Geoprocessing Web services aim to publish spatial analysis functions through Web service technologies, and workflow technology has been widely used to chain the scattered services (Kiehle, 2006). The Open Geospatial Consortium (OGC) has published a series of standards on geospatial Web services, including Web Map Service (WMS), Web Coverage Service (WCS), Web Feature Service (WFS), Web Processing Service (WPS), and Sensor Observation Service (OGC, 2007). There are already a number of investigations in developing and chaining geoprocessing services (Di, 2005a, 2005b; Brauner and Schaeffer, 2008; Yue et al., 2010).

The access to and chaining of geoprocessing services have shown great promise to solve complex geoprocessing tasks in a distributed environment (Jaeger et al., 2005; Yue et al., 2007; Allen et al., 2008; Chen et al., 2010). However, existing approaches are not task-oriented and expose too much technical details, for example the Kepler workflow system (Jaeger et al., 2005). To bridge the gap between users' requirement and distributed services, the concept of task is proposed (Vuong Xuan and Tsuji, 2009), which can facilitate the expression of users' requirements and hide the complexity of technical details.

This paper proposes a task-oriented architecture for Web geoprocessing systems, which leverages Web service and workflow technologies to design and execute tasks, and monitor and visualize the execution of geoprocessing tasks. It includes three functional components: task designer, task executor, and task monitor. A prototype system, named GeoPWTManager, is implemented to demonstrate the applicability of the approach.

The remainder of the paper is organized as follows. Section 2 describes the concept of task. One running example is introduced to help in understanding the concept. Related work is provided in Section 3. Section 4 describes a task-oriented architecture for Web geoprocessing systems, in particular how the three functional components work are described. Section 5 presents the implementation of the prototype system. Evaluation and discussion are provided in Section 6. Finally, conclusions and pointers to future work are given in Section 7.

2. The concept of task

The following example is used throughout the paper to help understand the role of task and how the task can be performed using distributed heterogeneous data and various geoprocessing services.

Supposing Mr. Li is a staff member in a disaster monitoring department in China, and he wants to know the situations of flood inundation in a region around the Poyang Lake in China in 2009 (Jiang et al., 2007; Sun and Yue, 2010). One satisfactory result would be a thematic image for the flood area, which renders regions that have different flood situations using different colors.

Mr. Li would like to formulate a geoprocessing task on the flood analysis, which can generate such an image. He finds that a geoprocessing model defined by Maathuis and Van Westen (2005) can perform the flood analysis and output the image (Fig. 1). The model uses six input images in three periods-before,

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doi:10.1016/j.cageo.2011.11.031

in, and after the flood. In each period, there are two images in the first and second wavelength bands of MODIS data respectively. Each group of images goes through Normalized Difference Vegetation Index (NDVI) calculation, binarization, and rendering processes to gain the range of the flood in the same place in each period. Then, the three resultant images are mixed by a blend process to generate the required flood thematic image.

The task in the context of this paper reflects a user's demand, which can be achieved by a service's operation or a composition of service operations. A task that satisfies the requirement of Mr. Li can be described using the following information (Fig. 2):

(1) Task type: the task type describes the classification of tasks based on their functional properties. The flood analysis in the example is a kind of geoprocessing tasks.
(2) Task priority: it denotes the execution priority of the task. The value of this property determines the order on the allocation of geoprocessing resources.

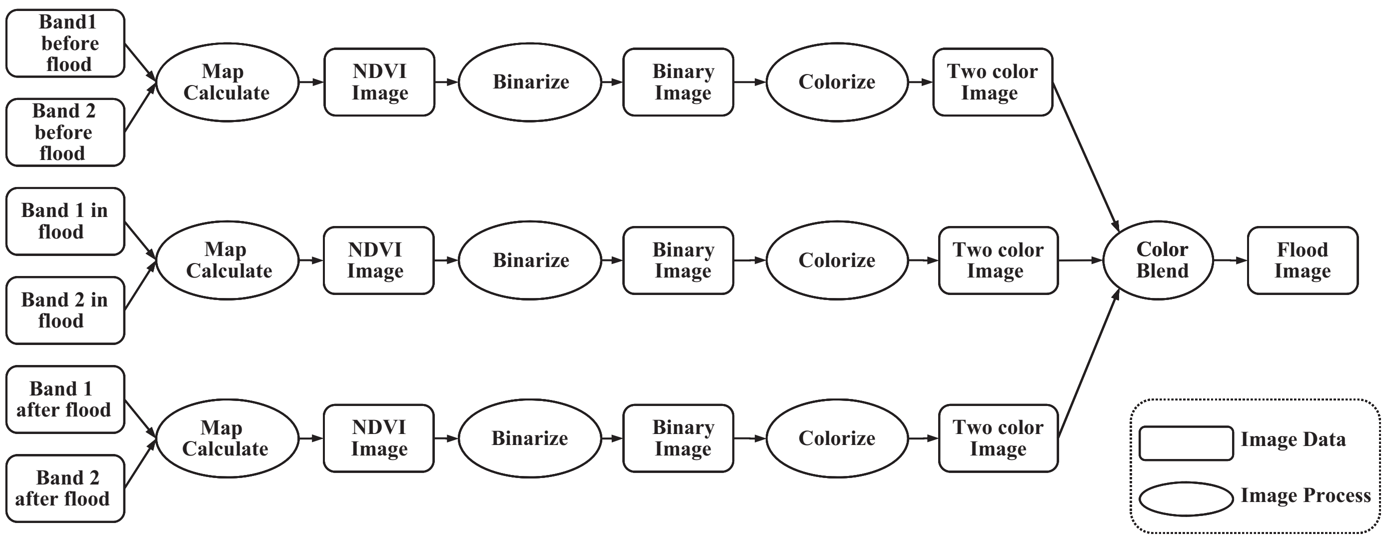

Fig. 1. The scientific model of the flood analysis.

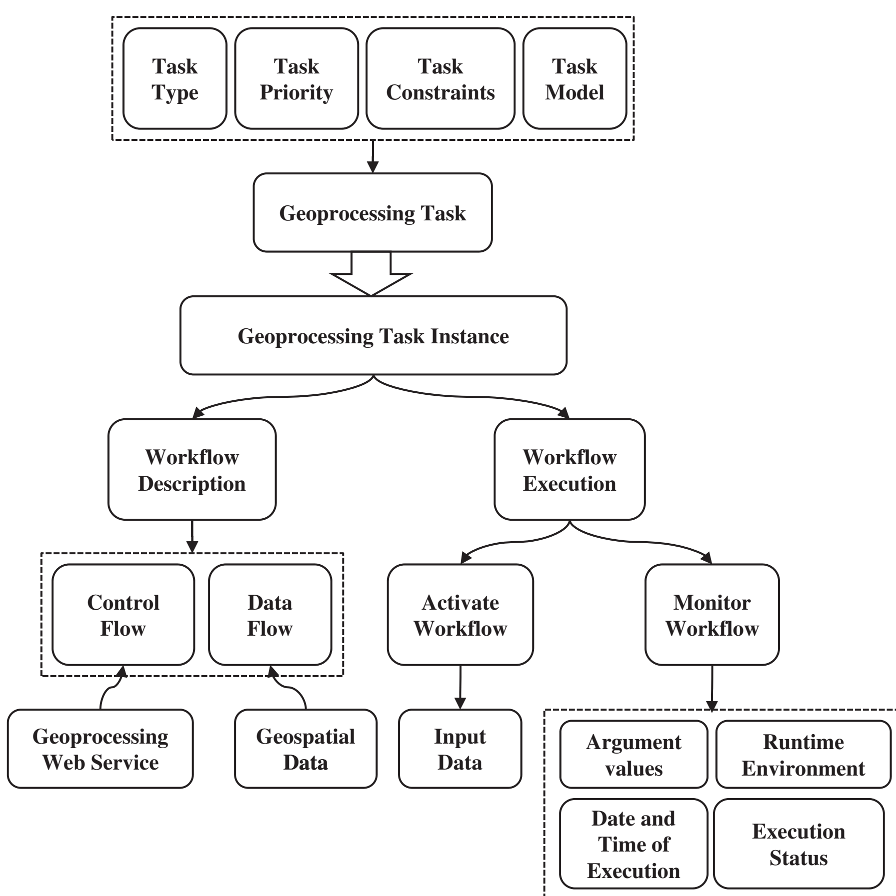

Fig. 2. The concept of the geoprocessing task.

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