User Manual for GeoQos

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1. About GeoQoS

1.1 Introduction

GeoQoS is tool for QoS-aware geoprocessing. It can evaluate the quality of geoprocessing services with users' feedback and other quality factors including availability and reliability. QoS for each geoprocessing services can be visualized in a Virtual Globe environment to facilitate service selection. Users can set QoS constraints for processing nodes in geoprocessing workflows, and then optimize workflows with constraints satisfaction. The tool has been implemented as an extension to an existing geoprocessing modeling tool—GeoJModelBuilder.

1.2 Copyright information

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1.3 License Agreement

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2. Basic Conception

2.1 Geoprocessing Service Chain

Geoprocessing operations offered via web services provide the means for building complex web-based geospatial applications. With the advent and evolution of OGC Web Service Program (OWS), more and more geoprocessing Web services are published under network environment available for spatial analysis, and workflow technology has been widely used to chain the scattered services. Geoprocessing services chained together can help solve complex geospatial problems.

2.2 Quality of Geoprocessing Service

When dealing with a geoprocessing task, we may meet the need that how to find

out the best feasible one among tens of thousands of geoprocessing services which have the same functionality but differ in their quality. To provide a better QoS (Quality of Service), it is primarily necessary to identify all possible QoS requirements for geoprocessing Web Services. Here we present a set of QoS attributes for geoprocessing services by complementing regular QoS factors with geospatial factors. Their definitions are provided in Figure 2.2.1.



Figure 2.2.1 QoS Factors

2.3 Geoprocessing Service Chain Optimization

The optimization of service chain is to composite the available services to gain a good performance under user's given constrains. There are two strategies of optimization: local selection strategy and global optimization strategy. Local strategy selects the concrete service by combining each optimal candidate of subservices. Global optimization can maximize the global QoS according to the global requirements the users given. Global optimization is the NP-hard problem often handled with heuristic optimization algorithm.

3. Basic Operation

3.1 Check QoS

Drag a concrete service form the left service list panel and drop it into the current working panel, as shown in Figure 3.1.1.



Figure 3.1.1 A Concrete Service

Select the service node, and then click menu *QoS Information* \rightarrow *Single Service*. We can check the QoS information related with this service from the popup dialog, as shown in Figure 3.1.2.





Click QoS factor on the left side panel, we can check the detail information of

each QoS factor on selected service.

3.2 Data Provenance

There are two types of data quality evaluation methods, direct and indirect. The direct evaluation methods determine data quality through the comparison of the data with reference information. Indirect evaluation methods infer or estimate data quality using provenance. The quality of geospatial data is generally measured by their completeness, logical consistency, positional accuracy, thematic accuracy, and temporal accuracy. If the geoprocessing service record data provenance, we can get the information to help us evaluate the data quality.

In the *Check Qos Panel*, expand *Data Quality* node, click *Provenance* node, click *Run* button to execute the service, and then we will get the provenance information of the data in the processing. As shown in Figure 3.2.1.

<u></u>	Detail Inform	nation of QoS –	□ ×
QoS factors — Performance — Availability — Reliability — Reputation • Data Quality	Run service to get its p	proveance information! Run Provenance Information List]
 Provenance Visualization 	InputData	http://202.114.114.71:8080/wp	
- Statistics	Width	150000 😑	
 Evaluation 	OutputFormat	application/x-zipped-shp	
	Service URL	http://geos.whu.edu.cn:8080/w	
	Service Name	GeoBufferProcess	
	V	alue of Data Quality Indicator	
	First Level:	Positional Accuracy	
	Second Level:	solute or external positional accuracy 💌	
	Value:		

Figure 3.2.1 Data Proveance

3.3 QoS Evaluation

In order to get the QoS evaluation value, there are two things we must to do: ① Choose the QoS factors you want to use in the evaluation process. ② Determine the weights for each QoS factors.

Select service model you want to get its evaluation QoS value in the working

panel. Click menu $QoS \rightarrow Service Evaluation$, open evaluation wizard, as shown in Figure 3.2.1. Choose factors we want to use in the service evaluation process.



Figure 3.2.1 Choose QoS factors

Then click *Next* button for third step, in this part we need to determine the weight of each QoS factors. There are two way to set the weights: Subjective Experience Method and Analytic Hierarchy Process (AHP). If we choose the former one, we need to give a number for each QoS factors according our own experience, as shown in Figure 3.2.2. If we choose the AHP, we should click the cell of Fuzzy Pairwise Comparison Table, and then select the importance degree for each two factors, the table cell will display the degree value automatically. As shown in Figure 3.2.3.

	QoS Evaluation Wizard	x
QoS Evaluation - Choose QoS factors - Determine Weights - Check QoS Information	Step 2: Determine the weights of each QoS factor	
	Subjective Experience Method Analytic Hierarchy Process(AHP)	
	Tip: Please input weight number ranged from 0 to 9	
	Performance: 1	
	Availability: 1	
	Reliability: 1	
	< Back Next > Finish Canc	el

Figure 3.2.2 Determine weights

QoS Evaluation Wizard					
QoS Evaluation - Choose QoS factors - Determine Weights - Check QoS Information	Step 2: Determine the weights of each QoS factor				
	 Subjective Experience Method Analytic Hierarchy Process(AHP) 			ess(AHP)	
	Performance				
	 Extremely Important 		Sumo Delevie		
	 Very Important 		Fuzzy Pairwis	e Comparison	
	 Quite Important 		Performance	Availability	Reliability
	 Weakly Important 	Performance	1	1/5	
	 Equally Important 	Availability	5	1	
	 Weakly Important 	Reliability			1
	Quite Important				
	 Very Important 				
	 Extremely Important 				
	Availability				
			< Back	Next > Finisl	Cancel

Figure 3.2.3 AHP

Next panel shows the QoS information of the service and other recommended service list. As shown in Figure 3.2.4. We can adjust the keywords to get candidate service which is similar in functionality. Click *Detail* button, we can check some QoS information of selected service, or we can click *Delete* button to delete the service

from candidate set.

	QoS Evaluation Wizard	×		
QoS Evaluation - Choose QoS factors	Step 3: Check QoS information and discover services			
- Determine Weights - Check QoS Information	QoS Information of GeoBufferProcess			
	Throughput:			
	Time: 844.4s			
	Availability 1.0			
	Reliability 0.9			
	Reputation 3 Star			
	Data Quality Excellent			
	Remmended Services List			
	Name Url Version HasQoSInfo			
	0 GeoBufferProcess http://geopw.whu.edu.cn:8080/wps/WebPr 0.4.0 🗸			
	1 GeoBufferProcess http://geos.whu.edu.cn:8080/wps/WebPro 0.4.0 🗸			
	GeoBufferProcess Search Do Test Detail Delete			
	< Back Next > Finish Canc	el		

Figure 3.2.4 Check QoS information

Finally, we click *Finish* button to get the final evaluation result as shown in Figure 3.2.4. The final QoS value normalizes between 0 and 1.

	Service Evaluation Result						
		QoS Evaluation Result List					
	Name	Url	Version	QoS			
0	GeoBufferProcess	http://geopw.whu.edu.cn:8080/wps/WebProcessingSer	0.4.0	0.952			
1	GeoBufferProcess	http://geos.whu.edu.cn:8080/wps/WebProcessingServi	0.4.0	0.952			
			[ОК			

Figure 3.2.4 Evaluation Result

If the Service Proxy does not have attached QoS data, we can do a QoS Test to

get partial information which includes execution time, availability, reliability about the service. Click *Do Test* button, input a number as the request times in the popup dialog, as shown in Figure 3.2.5.

	Qo	S Evaluation Wizard		×
QoS Evaluation Choose QoS factors Determine Weights Check QoS Information	Step 3: Check QoS infor QoS Information of (mation and discover services		
	Performance	Throughput: Time: 844.4s		
	Availability	1.0		
		Input	×	
	You will gu Please se 20	et the execution time, availability, t number of request times for do OK Car	and reliability of the service in the test. ing online test	
	GeoBufferProce GeoBufferProcess	ss http://geopw.whu.edu.cn:80	80/wps/WebPr 0.4.0 ,/	
		< Bac	k Next> Finish Can	cel

Figure 3.2.5 QoS Test

Click*OK* button to do this quality test, the progress bar on right bottom corner display the progress of the test. When the test is done, we can get the test result, as shown in Figure 3.2.6.

<u></u>	Qos	S Information	×
Name: GeoBufferProcess			
Url:	http://geopw.w	/hu.edu.cn:8080/wps/WebP	rocessing
QoS Inf	ormation		
Dorform		Throughput:	-
Penom	lance	Time: 821.0s	
Availabi	ility	1.0	_
Reliabil	lity	0.8	
Reputa	tion	3 Star	
Data Quality		Excellent	-

Figure 3.2.6 Test Result

3.4 Service Chain Optimization

First you should do is to build your own service chain. Click the Add Model button for toolbar to add an abstract service model, set parameters of model, as shown in Figure 3.3.1. Then click Add Flow button for the toolbar to chain the abstract models together, we can get an abstract service chain, as shown in Figure 3.3.2.

<u>\$</u>	Ad	d Model Dialog	×
Name: Abstract:			
	Param	eter List	
r	name	type	
RedBand		Complex Parameter	Add
NIRBand		Complex Parameter	
			Delete
C	ж	Cancel	

Figure 3.3.1 Create service model



Figure 3.3.2 Service chain model

Having built your service chain, it's time to do the optimization namely to select a best candidate service set to run the service chain. Click menu $QoS \rightarrow Chain$ *Evaluation*, open optimization wizard, as shown in Figure 3.3.3.

	Service Chain Optimization Wizard	×			
Service Chain Optimization Local Selection Global Optimization	Step 1: Set the keyword for each abstract service				
	Abstract Services: RasterMapcalcProcess				
	Keywords: RasterMapcalcProcess				
Step 2: Set the QoS filters for each abstract service (optional) QoS Factor The availability of the service ≥ 0.0 The reliability of the service ≥ 0.0 The reputation of the service ≥ 1 Star					
	Candidate Service List				
	Name Url Ver	sion			
	0 RasterMapcalcProcess http://geos.whu.e 0.4.0				
	1 RasterMapcalcProcess http://geopw.whu 0.4.0				
	2 RasterMapcalcProcess2 http://geopw.whu 0.4.0				
	Detail	Jelete			
	< Back Next > Finish	Cancel			

Figure 3.3.3 Local Selection

(1) First is Local Selection part. Step 1 is to set the keywords for each abstract service to get its candidate. Select item of Abstract Services combo box, adjust the keywords to get candidate services of this abstract service model. The candidate set will display in the Candidate Service List of bottom table. We can click on the table cell to select a candidate, then we can click *Detail* button to check its detail information, click *Delete* Button to delete the candidate form services set. Step 2 is optional, we can set the filters for each abstract service, and sometimes maybe we want the availability of all the candidate services is greater than 0.8, so the service which has availability less than 0.8 is passed by the filter.

(2) After get the candidate set of each abstract service model, click the *Next* button, we go into second part: Global Optimization, as shown in Figure 3.3.4. Step 3 is to choose the QoS factors which you will use in the optimization process. Next setp

is to determine the weight of each QoS factor and then set the constraints of whole service chain (this part metioned before, not tired in words here). Then we will do the global optimization using Genetic Algorithm, you can click *Settings* button to change the paramters of this optimization alorithm, or you can keep its default value.

	Service Chain Optimization Wizard	×		
Service Chain Optimization Local Selection Global Optimization	Step 3: Choose the QoS factor using in the global optimization process			
	Performance Image: Availability Image: Reliability Reputation Image: Data Quality			
	Step 4: Determine the weight of each QoS factor (optional)			
	Subject Experence Method			
	Analytic Hierarchy Process (AHP)			
	Step 5: Set the constraints of whole service chain (optional)			
	QoS Factor			
	The availability of the service chain \geq 0.0 \checkmark			
	The reliability of the service chain ≥ 0.0 ▼			
	The reputation of the service chain \ge 1 Star \checkmark			
	Optimization Method:			
	Settings			
	< Back Next > Finish Canc	:el		

Figure 3.3.4 Global Optimization

Click *Finish* button, we can get the optimization result, as shown in Figure 3.3.5. In the result dialog, we can see the model and its best candidate. Click OK button the selected candidate will be binded to abstract service model. If the checkbox of Show Chain in WorldWind is selected, the optimization result will visualize in the WorldWind, as shown in Figure 3.3.6.

<u>گ</u>	🚳 Service Chain Optimization Result						
Optimization Result							
Model Name	Service Name	Service Url					
RasterMapcalcProcess	RasterMapcalcProcess	http://geopw.whu.edu.cn:8080/wps/WebProcessingService					
RasterBinaryProcess	RasterBinaryProcess	http://geopw.whu.edu.cn:8080/wps/WebProcessingService					
RasterColorsProcess	RasterColorsProcess	http://geopw.whu.edu.cn:8080/wps/WebProcessingService					
	RasterColorsProcess RasterColorsProcess http://geopw.whu.edu.cn:8080/wps/WebProcessingService						
🗹 Show Chain QoS ir	✓ Show Chain QoS in WorldWind OK						

Figure 3.3.5 Optimization Result



Figure 3.3.6 QoS Visulization

What' more, you can bind other concrete service to you service mode. Click Bind Model button and select the service model, and then click Add button in the popup dialog. We should select concrete service in the following dialog, and then bind the model parameters to service parameters. As shown in Figure 3.3.7.

Add Binding to RasterMapcalcProcess								
Name:								
Process Set:	GeoF	GeoPW-WPS						
Process:	Build	BuildPolylinesProcess						
Model Parameters: FirstInput			Data		-			
Bind Parameters: InputData			l		-			
Model Pa	ramete	er	Bind	I Parameter	Bind			
					Delete			
ОК				Cancel				

Figure 3.3.7 Change service binding

After binding all the services in the service chain, click menu $QoS \rightarrow Chain QoS$, the bind result will display on the WorldWind. Move you mouse to the connecting lines you will get the QoS value of this service chain. Click on the service icon, you can get the QoS information about the service. As shown in Figure 3.3.8.



Figure 3.3.8

Now you can click menu Run \rightarrow Run to run the service and you will get your result you wanted.

4. Water Extract Case

Here we offer you a case to optimize service chain to get an optimal services composition. In this case, we use past MODIS images as our data. Red band and NIR band of each image go through the Normalized Difference Vegetation Index (NDVI) calculation binaryzation, and rendering processes to derive the water body from images.

4.1 Builder Service Chain

Click the Add Model button on toolbar to add an abstract service model, set

parameters of model, as shown in Figure 4.1.1. Then click Add Flow button on the toolbar to chain the abstract models together, we can get an abstract service chain, as shown in Figure 4.1.2.

<u>\$</u>	Add Model Dialog					
Name: Abstract:	NDVI					
n	ame	type	Add			
NIRBand		Complex Parameter Complex Parameter	Add			
			Delete			
0	К	Cancel	-			

Figure 4.1.1 New a service model



Figure 4.1.2 Build service chain

4.2 Service Chain Optimization

Having built your service chain, it's time to do the optimization namely to select a best candidate service set to run the service chain. Click menu $QoS \rightarrow Chain$ *Evaluation*, open optimization wizard, as shown in Figure 3.3.3.

	Service	Chain Optim	ization V	Vizard		×		
Service Chain Optimization Local Selection Global Optimization	Step 1: Set the keyword for each abstract service							
	Abs	Abstract Services: RasterMapcalcProcess						
	Key	words:	Ras	terMapcalcProces	apcalcProcess			
	Step 2: Set the QoS filters for each abstract service (optional) QoS Factor The availability of the service ≥ 0.0 The reliability of the service ≥ 0.0 The reputation of the service ≥ 1 Star							
	Candidate Service List							
		Name	;	Url	Version	ı		
	0	RasterMapcalcP	rocess	http://geos.whu.e	0.4.0			
	1	RasterMapcalcP	rocess	http://geopw.whu	0.4.0			
	2 RasterMapcalcProcess2 http://geopw.whu 0.4.0							
	Detail Delete							
	L	[< Back	Next >	Finish	Cancel		

Figure 3.3.3 Service Chain Optimization

According to the wizard we can finish optimization to select the optimal candidate service for each abstract service model.

4.3 Check QoS in the WorldWind

Click Finish button the QoS information will load to WorldWind, you can get an easy way to check some of the information, including each single service QoS and the total service chain QoS value. As shown in Figue 4.3.1.



Figure 4.3.1 Check QoS Information

4.4 Run the Service Chain

Run \rightarrow Run to run the service and you will get your result you wanted. The result can be added to the WorldWind, click $\boxed{100}$ button and then click Load in WorldWind in the popup dialog. As show in Figure 4.4.1.



Figure 4.4.1 Display Result Data