MARS Network Services User Manual
Version 2.0

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Contents

Abstract

The purpose of this document is to provide an overview of MARS services, installation and usage.

1 Introduction

1.1 What is MARS?

MARS is a new network services and workflow system that supports structural network analyses and generalized network dynamics analyses. It is accessible through the internet and can serve multiple simultaneous users and software applications. In addition to managing various types of digital objects including networked data, MARS provides services that enable applications (and UIs) to add, interrogate, query, analyze, and process data.

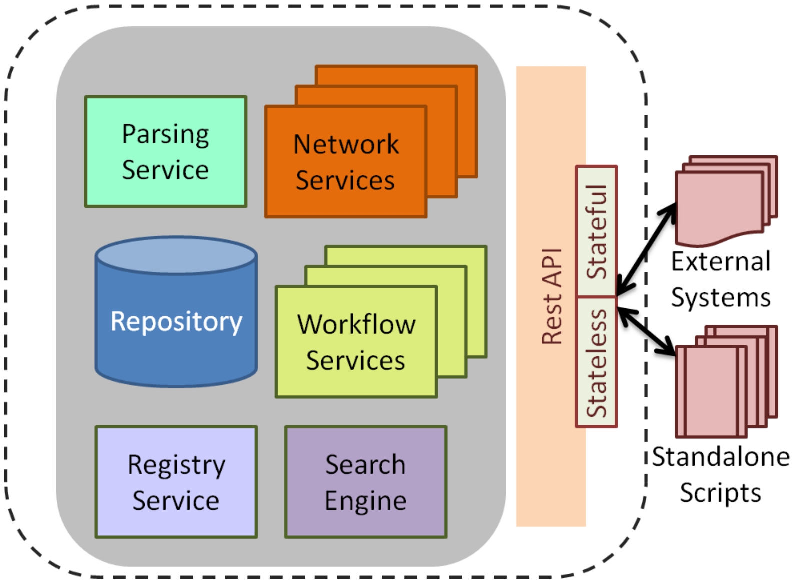


Figure 1: Overview of the MARS system.

1.2 Features

- Modular, interoperable categories of services, where each service can be a distinct, relocatable process.
- Stateless (REST-ful) and stateful (using session management) API.
- SQL-like query grammar with special features for network dynamics.
- Built-in search engine, for quey grouping, sharing and retrieval.
- Database for storing networked data along with metadata.
- **New in v2.0** Distributed architecture, multiple services run separately on different VMs. Services communicate using HTTP requests.
- **New in v2.0** Workflow service to execute a set of user-defined steps for analyzing networked data.
- **New in v2.0** Data plotting service. Integrated within the workflow service. Currently, is using matplotlib but can be extended to other 3rd party plotting tools (e.g. ggplot, D3).
- **New in v2.0** Network Measure service with a dedicated broker. The measure service has to be running on shadowfax.
- **New in v2.0** Extended database schema.

2 MARS Setup

2.1 Installation

Currently, MARS v2.0 is tested to run on Linux platform. To install MARS:

2.1.1 Python Installation

- wget https://www.python.org/ftp/python/2.7.9/Python-2.7.9.tgz
- tar -xzvf Python-2.7.9.tgz
- cd Python-2.7.9
- ./configure –prefix=[Python installation directory]
- make
- make test
- make install

2.1.2 Installing Required Packages

- Check if pip or easy_install are installed, if not do:
  - wget https://bootstrap.pypa.io/get-pip.py
  - python get-pip.py
  - wget https://bootstrap.pypa.io/ez_setup.py −o − | python
  - easy_install pip
- Use pip or easy_install to install the following packages (e.g. easy_install numpy or pip install whoosh):
  - Whoosh
  - Networkx
  - Bottle web framework
  - Pyparsing
  - multiprocessing
  - requests
  - numpy
  - pythonds
  - mpipe

2.1.3 Creating a mounted directory

- Currently, there is a mounted directory on shadowfax "/home/sipcinet/edison/graphservices" that is shared with edisondev VM. The same directory is accessed from edison VM at "/home/sip/edison/graphservices". The directory is needed for sharing files and codes between the measure service which is running on shadowfax and the rest of services running on other VMs. This setting relieve the services from handling large file transfers and share the same configuration setup (mars.config).
- To create a new mounted directory between shadowfax and a new VM, please contact the RT at VBI. Go to rt.vbi.vt.edu and create a new ticket.

2.1.4 Downloading MARS Code

Note: it is preferred to download the mars v2.0 code to any place within the mounted directory. This provides flexibility in starting and stopping the services.

- Ask Sherif Abdelhamid (sherief@vbi.vt.edu) or Chris Kuhlman(ckuhlman@vbi.vt.edu) to be added to git project (https://ndsslgit.vbi.vt.edu/software-contagion-services/network-services)
- git clone https://ndsslgit.vbi.vt.edu/software-contagion-services/network-services.git [code directory]
- cd mars
- check the main directories v1 and v2. Each directory has two sub-directories src (code) and doc (manual).
- v2.0 codes resides under v2/src sub-directory.
- Copy database file into a database directory of your choice (This is a database directory that you created or have access permission to it. Please make sure that it doesn't contain a database file with the same name).
  scp username@edisondev.vbi.vt.edu:/home/sipcinet/edison/graphservices/database/Edison2.db [database directory]

2.1.5 Starting Network Measure Service on shadowfax

Note: the measure service has to run on shadowfax to be able to submit a job using qsub. Shadowfax has a cluster management server running on the headnode (sfx1, sfx2, ..). This server monitors the status of the cluster and controls/monitors the various queues and job lists. qsub interacts with the server and lets it know that there is another job that has requested resources on the cluster.

- sudo su - sipcinet
- export PATH=[python installation directory on shadowfax]:$PATH
- go to [code directory]/v2/src/code
- to start the measure service enter python measure_service2.py &
- to start the measure broker used by the measure service (monitor the job submission status) enter measure_broker &. Note: the measure service is now running on shadowfax.

2.1.6 Starting MARS Services on edisondev

Note: the same steps can be done on other VMs, as long as the user has the required permissions and access rights. Since multiple services can run on the same machine, please make sure to assign different port for each service.

- sudo su - sipcinet
- export PATH=[python installation directory]:$PATH
- go to [code directory]/v2/src/code
- to start the query service enter python query_service2.py &
- to start the storage service enter python storage_service2.py &
- to start the workflow service enter python workflow_service2.py & Note: the storage, workflow, and query services are now started on edisondev. Each service has its own port that is defined in mars.config file.

2.1.7 configuring MARS services

- go to [code directory]/v1/src/code
- check and edit (if needed) the properties:
  - server: name of the python server used. Currently, set to cherrypy, a multithreaded server written python.
  - host: server IP address that will host MARS. It can be set to localhost.
  - port: list of port numbers that will be used. Each port number is in a separate line. Two services can not share the same port. Make sure when add port to the config file that only one service can use at a time.
  - database: the database directory.
  - index1: location where property queries are indexed on the file system.
  - index2: location where seed queries are indexed on the file system.
  - query: directory where query results are stored on the file system.
  - workflow: **New in v2.0** location where the plots generated by workflow services are stored. [need to be under the NEMO webapp directory]
  - uploadfile: **New in v2.0** directory where uploaded files by NEMO web-interface are stored. [need to be under the NEMO webapp directory]
  - qsub and output: **New in v2.0** two directories used by the measure service in MARS v2. Store information about qsub execution for network measures.
  - graph: directory for MARS graphs.
  - code: the directory that contains the services code and the stand-alone executable codes that compute measures on networks. These codes can be C, C++, Python, Perl, or codes written in any other language. These are called by the measure service in MARS v2.0.
  - **New in v2.0** A flag (True/False) to determine whether the measure service will notify the network storage service to store the computed measure or not.

2.1.8 Stopping MARS Services

Note: this steps can repeated for each process/service. A shell script be written to speed up the task.

- ps ax | grep python [Retrieve python process PID]
- kill −9 PID

2.1.9 Create index for Network Query Search Service

- go to [code directory]/v1/src/code
- enter python create_index.py [This will create two indexes, for the property and seed type queries]. The indexes directories are specified in the mars.config file as index1 and index2.

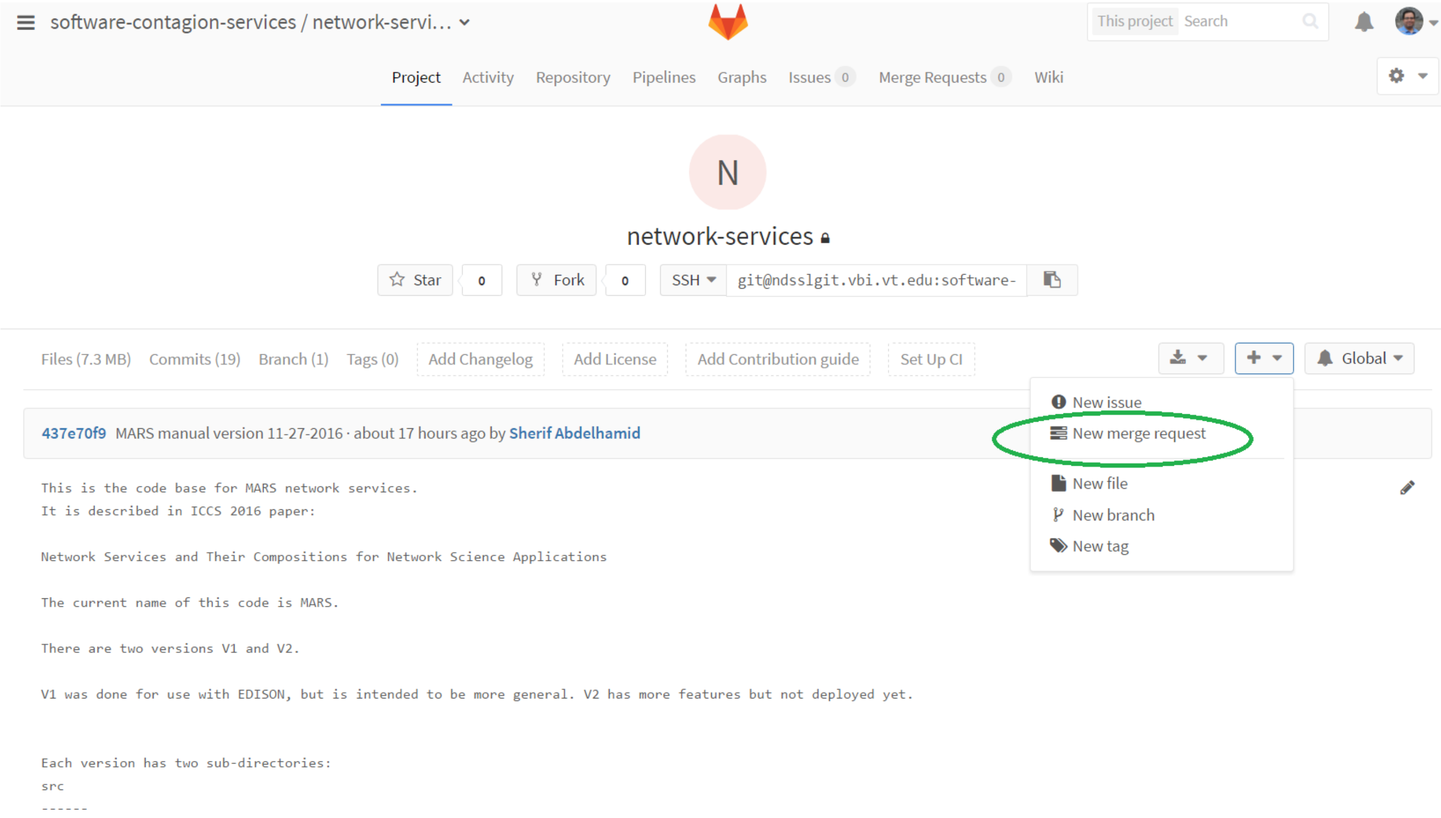
2.2 Contribution steps

To start contributing to MARS repository, please follow these steps:

- Create a new branch and switch to it [git checkout −b [name_of_your_new_branch]. Name of branch should begin with class type:
  - Feature, if user is adding a new feature for MARS.
  - Bug-fix, if user updating current code to fix a bug.

  - Enhancement, if user is updating current code for code optimization or performance enhancement.

- Commit the changes with a descriptive message. [git commit -m "Commit message"].
- Create a new remote for your branch [git remote add [name_of_your_remote]].
- Push the branch to the remote repository [git push [name_of_your_new_remote] [name_of_your_new_branch]].
- Create a merge request using https://ndsslgit.vbi.vt.edu, as shown in Figure 2. Notify other team members to review.
- Reviewer will check for merge conflicts.
- Reviewer merge the new branch with master.



437e70f9 MARS manual version 11-27-2016 · about 17 hours ago by Sherif Abdelhamid

```
This is the code base for MARS network services.
It is described in ICCS 2016 paper:

Network Services and Their Compositions for Network Science Applications

The current name of this code is MARS.

There are two versions V1 and V2.

V1 was done for use with EDISON, but is intended to be more general. V2 has more features but not deployed yet.


Each version has two sub-directories:
src
------
```

Figure 2: Creating a merge request using Web-based interface of ndsslgit.

3 Using MARS

Currently, MARS v2.0 is used with NEMO system. However, MARS is a general purpose network services that can be integrated with other systems through the REST API. In this section we describe all MARS endpoints grouped by each service. A sample network, see Figure 3, is used in the illustrative examples in the API document. Each node has eight attributes (id integer, degree integer, betweeness_centrality real, clustering real, load_centrality real, node_clique_number integer, closeness_centrality real, clustering_galib real).

Notes:

- All the possible responses are listed under 'Responses' for each method. Only one of them is issued per request server.
- All responses are in JSON format.
- Some of requests parameters are optional and have default value.
- Host name and port number can be changed in mars.config file.

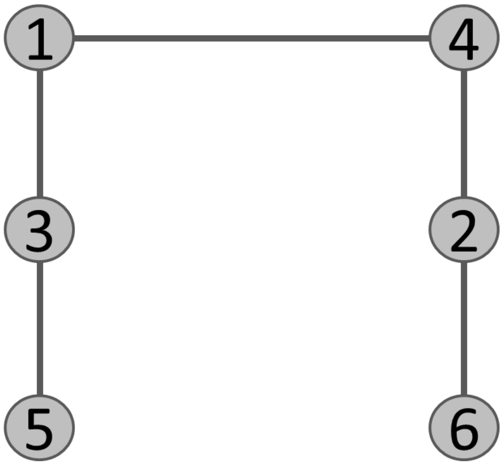


Figure 3: Sample network used in the illustrative examples. The network consists of six nodes. All the nodes have degree equals to two, except nodes 5 and 6 which have degree equals to one.

3.1 MARS API Document

Network Query Service

Methods

1. Query

Purpose

Submit queries to the Network Query Service.

Request

Method	URL
GET	http://<hostName>:<portNumber>/graphservice/query?content=value &graph=value&validate=value&view=value&parallel=value&nruns=value

Type	Params	Values	Examples	Required	Description
GET	content	string	• select nodes from netscience where degree > 20 • select edges from netscience where coauthorship> 3 • select sample(5,[3,8]) nodes from dolphins • select edges from sample where u.degree > 1 and v.kshell >1	Yes	Query sting: two forms simple (examples 1 and 2) and sampling (example 3). Example 3 is a new form added in MARS v2.0 which is called mixed queries. Users can query edges based on node attributes, and vice versa.
	graph	string	netscience	Yes	graph name
	validate	string	True/False	No (default False)	Valid entries are True or False only
	view	string	property/seed	Yes	Valid entries are either property (for simple queries) or seed (for sampling queries).
	parallel	string	True/False (Please always use False, feature not supported in the deployed version)	No (default False)	Valid entries are True or False only
	nruns	string	3	No (default0)	Used only if seed view is selected

Response

Status	Response

200	**Response for simple query will be an object containing the list of nodes or edges as well as the attributes.**
	Note **that the WHERE clause in queries is enabled in this version of MARS.**
	
	An example response returning all nodes (100% coverage):-
	`select nodes from sample where id < 2 and degree <2`
	
	{"node_sets": [{"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 1, "closeness_centrality": 0.333333333333, "clustering_galib": 0.0, "load_centrality": 0.0, "kshell": 1, "id": 5, "betweeness_centrality": 0.0}, {"clustering": 0.0, "node_clique_number": 2, "degree": 1, "closeness_centrality": 0.333333333333, "clustering_galib": 0.0, "load_centrality": 0.0, "kshell": 1, "id": 6, "betweeness_centrality": 0.0}], "coverage": 33.3}]}
	
	An example response returning all edges in sample network (100% coverage)
	
	`select edges from sample`
	
	{"qid": 2543, "result": {"edge_sets": [{"edges": [{"start": 2, "end": 4}, {"start": 3, "end": 1}, {"start": 3, "end": 5}, {"start": 2, "end": 6}, {"start": 1, "end": 4}], "coverage": 100.0}]}}
	
	New in v2.0: An example response returning all edges in sample network connecting nodes with degree > 1
	
	`select edges from sample where u.degree > 1 and v.degree >1`
	
	{"edge_sets": [{"edges": [{"start": 2, "end": 4}, {"start": 3, "end": 1}, {"start": 1, "end": 4}], "coverage": 60.0}]}

Response for sampling query.
This query returns three sets of nodes, this is identified by the number “2” after the “number =” keyword. Each set may contain any number of nodes from 1 up to 2, this is shown in “[1,2]” after the keyword “size =”.
Note here that we used a where clause that is acceptable in seed type queries only.

```
select sample(number = 2,size =[1,2])nodes from sample where degree > 1
```

{"node_sets": [{"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.454545454545, "clustering_galib": 0.0, "load_centrality": 0.4, "kshell": 1, "id": 3, "betweeness_centrality": 0.4}], "coverage": 16.7}, {"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.555555555556, "clustering_galib": 0.0, "load_centrality": 0.6, "kshell": 1, "id": 4, "betweeness_centrality": 0.6}], "coverage": 16.7}]}

This query returns three sets of nodes, this is identified by the number “3” after the “number =” keyword. Each set contains exactly one node, this is shown in “[1,1]” after the keyword “size =”. Note here that we didn’t use the where clause which is optional.

```
select sample(number = 3,size =[1,1])nodes from sample
```

{"node_sets": [{"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.555555555556, "clustering_galib": 0.0, "load_centrality": 0.6, "kshell": 1, "id": 1, "betweeness_centrality": 0.6}], "coverage": 16.7}, {"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 1, "closeness_centrality": 0.333333333333, "clustering_galib": 0.0, "load_centrality": 0.0, "kshell": 1, "id": 5, "betweeness_centrality": 0.0}], "coverage": 16.7}, {"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.555555555556, "clustering_galib": 0.0, "load_centrality": 0.6, "kshell": 1, "id": 4, "betweeness_centrality": 0.6}], "coverage": 16.7}]}

	New in v2.0 Response for a subgraph query. This query returns a subgraph of nodes, starting node is identified by the number "4". Number of levels is identified by the second number "1". This is a special form of subgraph using breadth-first search. Note: this approach is working with small-medium networks. Need to be optimized for better performance with large networks. Other algorithms like depth-first can be added. select subgraph(4,1) from sample {"node_sets": [{"nodes": [{"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.555555555556, "clustering_galib": 0.0, "load_centrality": 0.6, "kshell": 1, "id": 1, "betweeness_centrality": 0.6}, {"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.454545454545, "clustering_galib": 0.0, "load_centrality": 0.4, "kshell": 1, "id": 2, "betweeness_centrality": 0.4}, {"clustering": 0.0, "node_clique_number": 2, "degree": 2, "closeness_centrality": 0.555555555556, "clustering_galib": 0.0, "load_centrality": 0.6, "kshell": 1, "id": 4, "betweeness_centrality": 0.6}], "coverage": 50.0}]} New in v2.0 Response for a compound query. This query involves execution of multiple queries and the results are combined using union, intersect, or except. select nodes from sample where load_centrality < 0.4 intersect select nodes from sample where id > 5 {"node_sets": [{"nodes": [{"id": 6}], "coverage": 16.7}]}
200	**Response for query validation** {"check": "Valid"}
400	"Invalid Query"
300	"Do you mean degree" if user misspelled attribute name, service responds with the closest attribute suggestion

2. Set operations

Request

Method	URL	Description
GET	http://<hostName>:<portNumber>/graphservice/session/create?appid=value	This end point creates a session for an application with id identified by appid. The end point returns the session id.
GET	http://<hostName>:<portNumber>/grapservice/session/end?appid=value&sesionsid=value	This end point ends an existing session with id equals to sessionid for an application with id equals to appid.
GET	http://<hostName>:<portNumber>/graphservice/setoperation/delete?setid=value	This end point deletes an existing set identified by id equals to setid.
GET	http://<hostName>:<portNumber>/grapservice/setoperation/save?setname=vlue&sessionid=value&queryid=value	This end point saves a query (identified by queryid) result into a set with name setname. The set will belong to session with id equals to sessionid.

Network Query Search Service

1. Search

Purpose

Search for existing queries. For example, in the EDISON web application, this invocation is used to return all queries that have been executed, so that they may be displayed in the UI, to help users form their own queries or use pre-existing ones.

Request

Method	URL

GET	`http://<hostName>:<portNumber>/graphservice/search?keywords=value&metadata=value`
	`&view=value`

Type	Params	Values	Examples (Valid entries)	Required	Description
GET	keywords	String	sample NOT degree	yes	Keywords used for query searching. Users can use Boolean operators as an example AND, OR, NOT
	metadata	string	content/graph/query_id/target	No (Default content)	Type of metadata searching is based on. Valid entries are only content, graph, query_id or target. “query_id” is an integer number that uniquely identifies the query. “target” is the target type which can be node or edge. “graph” is the name of the network on which the query is executed.
	view	string	property/seed	yes	The type of queries. Valid entries are property or seed only.

Response

Status	Response
200	**Response will be an object containing the list of queries (array).**

	Using the keywords sample NOT degree which means search for all the queries that have the keyword sample but not degree. [{"content": "select edges from sample", "graph": "sample", "query_id": "2530", "results": "/home/sipcinet/edison/graphservices/query/sample_query2530.txt", "target": "edge"}, {"content": "select nodes from sample", "graph": "sample", "query_id": "2527", "results": "/home/sipcinet/edison/graphservices/query/sample_query2527.txt", "target": "node"}]
400	"Error"

2. Repository

Purpose

Repository keeps information about all queries. Categorize queries by node and edge.

Request

Method	URL
GET	`http://<hostName>:<portNumber>/graphservice/repository?type=value&view=value`

Type	Params	Values	Examples	Required	Description
GET	type	string	node/edge/ all	yes	Category of data to be retrieved. Valid entries are node, edge or all only
	view	string	property/seed	yes	Type of queries. Valid entries are property or seed only.

Response

Status	Response
200	**An example response for choosing type node and view seed queries. This will return all queries targeting nodes of type seed for sampling.** {"node_queries": [{"content": "select sample(number = 3,size =[1,1])nodes from sample", "graph": "sample", "query_id": "2532", "results":

	"/home/sipcinet/edison/graphservices/query/sample_query2532.txt", "target": "node"}, {"content": "select sample(number = 2,size =[1,2])nodes from sample where degree > 1", "graph": "sample", "query_id": "2531", "results": "/home/sipcinet/edison/graphservices/query/sample_query2531.txt", "target": "node"}]} **An example response for choosing type node and view property queries. This will return all queries targeting nodes of type simple.** {"node_queries": [{"content": "select nodes from sample where degree = 1", "graph": "sample", "query_id": "2529", "results": "/home/sipcinet/edison/graphservices/query/sample_query2529.txt", "target": "node"}, {"content": "select nodes from sample where degree >2" "graph": "sample", "query_id": "2528", "results": "/home/sipcinet/edison/graphservices/query/sample_query2528.txt", "target": "node"}, {"content": "select nodes from sample", "graph": "sample", "query_id": "2527", "results": "/home/sipcinet/edison/graphservices/query/sample_query2527.txt", "target": "node"}]}
400	"Error"

Network Storage Service

Methods

1. Graph

Purpose

List all stored graphs. Search a graph by name or filter graphs by attribute value

Request

ID	Method	URL	Description
1	GET	`http://<hostName>:<portNumber>/graphservice/storage/graph`	This end point returns all graphs marked as available
2	GET	`http://<hostName>:<portNumber>/graphservice/storage/graph/filter?attribute=value&operator=value&rval=value`	This end point returns all graphs marked as available and satisfy the given filter. Filter is defined by attribute, operator and value
3	GET	`http://<hostName>:<portNumber>/graphservice/storage/measure_notify?graph=value&measure=value`	This end point is used by the measure service to notify storage service that a requested measure computation is complete.

Type	Params	Values	Example	Description
`GET`	`attribute`	string	network attribute	Network attributed used for filtering. Network attributes are part of network metadata.
	`operator`	string	>,>=, <, <=, !=,=	Operator used for the comparison. Valid values are >,>=, <, <=, !=,=
	`rvalue`	string	500	Right-hand value. This can be sting or number. Has to be consistent with the attribute data type. For example, if the attribute on left-hand side is of type sting, the rvalue shall be sting too.

Response

Status	Response
200	**Response for method 1 and 2 will be a JSON object containing a single graph or a list of graphs with details, including title, description and other metadata. Here we sent a request using attribute nodes, operator <, and rvalue 40. This will return all graphs in repository that are marked available to public and has number of nodes < 40.** [{"directed": "false", "weighted": "false", "graph_id": 38, "name": "karate", "edge_attributes": {"degree_product": "integer", "betweenness_centrality": "real"}, "numberOfEdges": 78, "file_name": "karate", "original_format": "uel", "labeled": "true" "node_attributes": {"node_clique_number": "integer", "closeness_centrality": "real", "degree": "integer", "betweenness_centrality": "real", "load_centrality": "real", "id": "integer", "clustering": "real"}, "numberOfNodes": 34, "description": "Network of friendships between the 34 members of a karate club at a US university, as describe by Wayne Zachary in 1977"}]
400	“Error”

2. ADD Network

Note: **This feature is disabled for the current EDISON version. EDISON has no screen that enables users to upload networks. However, this feature can be called from Rest API directly by admin users.**

Request

Method	URL
GET	`http://<hostName>:<portNumber>/graphservice/storage/addnetwork`

Type	Params	Values	Example	Description
GET	name	string	karate, netscience	Name of graph to be added. Graph files (.uel, .nodes, and .md) need to be placed manually or uploaded (through UI) before calling this method. • .md: has the graph metadata • .uel: list of graph edges • .nodes: list of graph nodes

Response

Status	Response
200	OK - graph removed successfully
400	“Error”

Network Measure Service

Methods

1. Compute

Purpose

Submit measure computation requests to the measure service.

Request

Method	URL
GET	`http://<hostName>:<portNumber>/graphservice/measure/compute?graph=value &measure=value`

Type	Params	Values	Examples	Required	Description
GET	graph	string	karate, dolphins, lesmis	Yes	Graph name
	measure	string	measure id	Yes	A number that uniquely identify the measure. 1. degree 2. betweeness_centrality 3. clustering 4. load_centrality 5. node_clique_number 6. closeness_centrality 7. clustering_galib 8. kshell These are all the valid values. New measures/ids can be added in the future.

Response

Status	Response
200	OK - measure computed successfully
400	“Error”

User-defined Workflow Service

Methods

Purpose

Submit user-defined workflow execution requests to the workflow service.

Request

Method	URL
`GET`	`http://<hostName>:<portNumber>/workflowservice/execute?wf=value &input=value`

<table>
<tr><th>Type</th><th>Params</th><th>Values</th><th>Examples</th><th>Required</th><th>Description</th></tr>
<tr><td>GET</td><td>wf</td><td>string</td><td><ul><li>start,network_data,min_data,end</li><li>start,execute_query,query_data,sum_data,end</li></ul></td><td>Yes</td><td>Sequence of processes that to be executed. Processes names are separated by “,”. The expected input/output data type of consecutive processes shall be compatible.
<table>
<tr><th>Process</th><th>Functionality</th></tr>
<tr><td>network_data</td><td>Extracts node or edge attribute data. A filter can be applied.</td></tr>
<tr><td>start</td><td>Start the execution session of the workflow and prepare input data for each process</td></tr>
<tr><td>end</td><td>End the execution session of the workflow. Return the final results.</td></tr>
<tr><td>plot_data</td><td>Plot data (e.g. degree distribution, clustering distribution)</td></tr>
<tr><td>save_data</td><td>Saves output data from a process into a variable</td></tr>
<tr><td>execute_query</td><td>Send a network query request to query service.</td></tr>
<tr><td>query_data</td><td>Parse and extract output data (JSON response) of the execute_query process</td></tr>
</table></td></tr>
<tr><td></td><td>input</td><td>string</td><td><ul><li>degree,sample,node,no condition</li><li>select nodes from sample where degree =1 ,sample,node|clustering</li></ul></td><td>Yes</td><td>Input data for each process (if needed). Some processes don’t need input.</td></tr>
</table>

Response

Status	Response
200	OK - workflow executed successfully
400	“Error”

Model Information Service

Note: This service is in not use now, and will take over in the future all model-related processes from Edison front end.

Methods

Purpose

List all Edison models with information

Request

Method	URL
GET	`http://<hostName>:<portNumber>/graphservice/model`

Response

Status	Response
200	**Response will be a JSON object containing the a list of models with details, including description, parameters and other metadata** `[{"sub_model_id": 1, "model_id": 11, "model_name": "Progressive 2-state model", "parameters": [{"threshold": "integer", "model": "integer", "type": "int_node_trait", "sub_model": "integer"}, {"state": "integer", "is_fixed": "integer", "type": "int_node_state"}], "description": "Threshold model where nodes may transition from state 0 t`

1, but not from 1 to 0. The model supports blocking nodes:
nodes that do not change state."}, {"sub_model_id": 3,
"model_id": 11, "model_name": "Back-and-forth 2-state
model", "parameters": [{"type": "int_node_trait", "model":
"integer", "down_threshold": "integer", "sub_model":
"integer", "up_threshold": "integer"}, {"state": "integer"
"is_fixed": "integer", "type": "int_node_state"}],
"description": "Threshold model where nodes may transition
from state 0 to 1, and from 1 to 0. The model supports
blocking nodes: nodes that do not change state."},
{"sub_model_id": 4, "model_id": 11, "model_name": "Back-and-forth 2-state model with influence from distance-2
neighbors", "parameters": [{"type": "int_node_trait",
"model": "integer", "down_threshold": "integer",
"sub_model": "integer", "up_threshold": "integer"},
{"state": "integer", "is_fixed": "integer", "type":
"int_node_state"}], "description": "Threshold model where
nodes may transition from state 0 to 1, and from 1 to 0.
Neighboring nodes at distance 1 and distance 2 can
influence a node."}, {"sub_model_id": 1, "parameters":
[{"model": "integer", "duration_in_state_I": "integer",
"type": "int_node_trait", "sub_model": "integer"},
{"state": "integer", "type": "int_node_state"},
{"edge_weight": "double", "type": "double_edge_state"}],
"model_name": "SIR epidemic model", "model id": 22,
"description": "Classic susceptible-infected-recovered
epidemiological model."}, {"sub_model_id": 3, "model_id":
22, "model_name": "SIR epidemic model", "parameters":
[{"model": "integer", "type": "int_node_trait",
"sub_model": "integer", "duration_in_state I": "integer"},
{"threshold": "integer", "state": "integer", "type":
"int_node_state"}, {"edge weight": "double", "type":
"double_edge_state"}], "description": "Classic susceptible
infected-recovered epidemiological model, but a susceptibl
node may require multiple infecting neighbors to become
infected."}, {"sub_model_id": 0, "model_id": 37,
"model_name": "Linear Threshold model", "parameters":
[{"model": "integer", "type": "int_node_trait",
"sub_model": "integer"}, {"state": "integer", "type":
"int_node_state"}, {"threshold": "double", "type":
"double_node_state"}, {"type": "double_edge_state", "edge
influence": "double"}], "description": "This is the Linear
Threshold model of Kempe et. al (KDD 2003)."},
{"sub_model_id": 0, "parameters": [{"model": "integer",

	"type": "int_node_trait", "sub_model": "integer"}, {"state": "integer", "is_fixed": "integer", "type": "int_node_state", "down_threshold": "integer", "up_threshold": "integer"}], "model_name": "Connected Components Threshold Model", "model id": 38, "description" "This is an influence model that uses thresholds, but now each set of neighbors of a node that form a connected component collectively influence the node (Ugander, PNAS 2012)."}]

4 Adding New Networks Manually

MARS v2.0 has the capability to add networks automatically. However, users can still manually add networks as in v1.0. Manual approach can be useful with large networks.

Note: We will use network "sample" for demonstration.

Files needed:

File	Description
node_file_gen.py	Generates uel, del and nodes file from input file
gen_n_file.qsub	Executes node_file_gen.py on sfx
preparefiles.py	Generates uel and node files with attributes for database
preparefiles.qsub	Executes preparefiles.py on sfx
dataLoader.py	Loads network data from file into database
Loaddata.qsub	Executes dataLoader.py on sfx through qsub

Processing and generating data on shadowfax:

1. Go to you scripts directory under v1/doc/manu01
2. Edit   gen_n_file.qsub and replace graph name with sample2.
3. Execute qsub gen_n_file.qsub on sfx1, this will generate: sample.uel, sample.del and sample.nodes. These files are needed by InterSim.
4. Edit preparefiles.qsub and replace graph name with sample2. Note: make sure the path for the preparefiles.py is correct.
5. Edit preparefiles.py and replace all directories for .uel, .nodes, .uels, and .info files with the correct ones.
6. Execute preparefiles.qsub on sfx1, this will generate: sample2.info and sample2.uel2.

Creating database entries

1. Go to the database directory.
2. Type sqlite3 Edison2.db, this will connect you to Edison database.
3. You can rename database file to any other name if needed.
4. Type .schema to get info about current tables and indexes in the database.
5. type .schema <table name> to get information about specific table
6. Now we will create two tables for the new network: sample_node and sample_edge.
7. The number and data type of the new tables' attributes should be consistent with data columns in the two newly generated files sample2.info and sample2.uel2.
8. After creating the two tables. type .schema sample_node to make sure table is created successfully. Do the same step again .schema sample_edge.
9. Now to add the metadata for the network, we use table network. To get familiar with existing networks type select * from network. Available networks to Edison have the attribute “available” set to true.

10. Before changing/ adding data in network table, dump existing data to a save place as backup. To do these steps:

```
sqlite> .mode csv
sqlite> .output network_backup_4_7_2016.csv
sqlite> select * from network;
sqlite> .output stdout
```

11. Using sql insert command enter the new network data, don't include id as it is automatically generated in the dbms.
12. all networks should have available attribute set to false at beginning until they pass all testing.

Importing data into database

1. Go to scripts directory. Edit loaddata.qsub file, put the name of the table first, in this case sample. Followed by name of node and edge attributes files sample2.uel and sample2.info. This will load the data from each file to the corresponding table. Data includes node/edge ids and attributes.
2. To verify data is loaded correctly:
    - a. login back to database
    - b. verify number of nodes correct "select count(*) from sample_node" and compare with network number of nodes.
    - c. verify number of edges correct "select count(*) from sample_edge" and compare with network number of edges.
    - d. verify if isolated nodes exist "select count(*) from sample_node where id not in (select start from sample_edge) and id not in (select end from sample_edge)" if count == 0 then no isolated nodes exist.
    - e. verify if network is undirected or has no duplicate edges "select count(*)/2 as duplicates from sample_edge a, sample_edge b where a.start = b.end and a.end = b.start" if duplicates == 0 then no duplicate edges exist.
    - f. verify if self loops exists "select count(*) from sample_edge a where start == end " if count == 0 that means no self loops.
    - g. verify if node ids are not negative "select count(*) from temp_node where id < 0 " and "select count(*) from temp_edge where start < 0 or end < 0" count should be 0 in both cases.
    - h. verify if nodes ids are numeric select count(*) from sample_edge where typeof(start) = "integer" and typeof(end) = "integer" and select(*) from sample_node where typeof(id) = "integer"

5 Verification Testing