

# SHORTEST PATH SEARCH ON THE DATABASE



and more ...

**“The various religions are like different roads converging on the same point.**

**What difference does it make if we follow different routes, provided we arrive at the same destination?”**

Mahatma Gandhi

A handwritten signature in black ink, reading "MK Gandhi". The signature is written in a cursive, flowing style with a large, prominent "G" and a small dot at the end.



WHAT IS *pgRouting*?

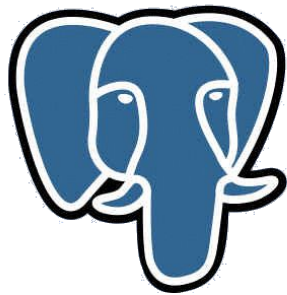
# a LIBRARY



*Georepublic*

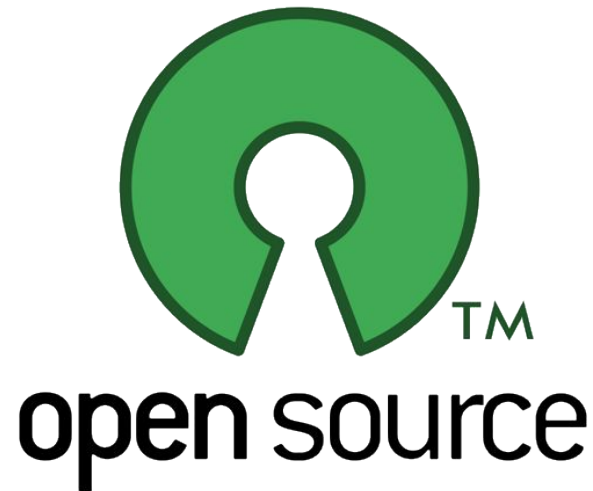
# AN EXTENSION

PostgreSQL



*Georepublic*

# An OPEN SOURCE PROJECT



*Georepublic*

# A COMMUNITY PROJECT



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# NOT



I am not a front end!

But, I can be used to  
create one.



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# ALL ABOUT THAT GRAPH



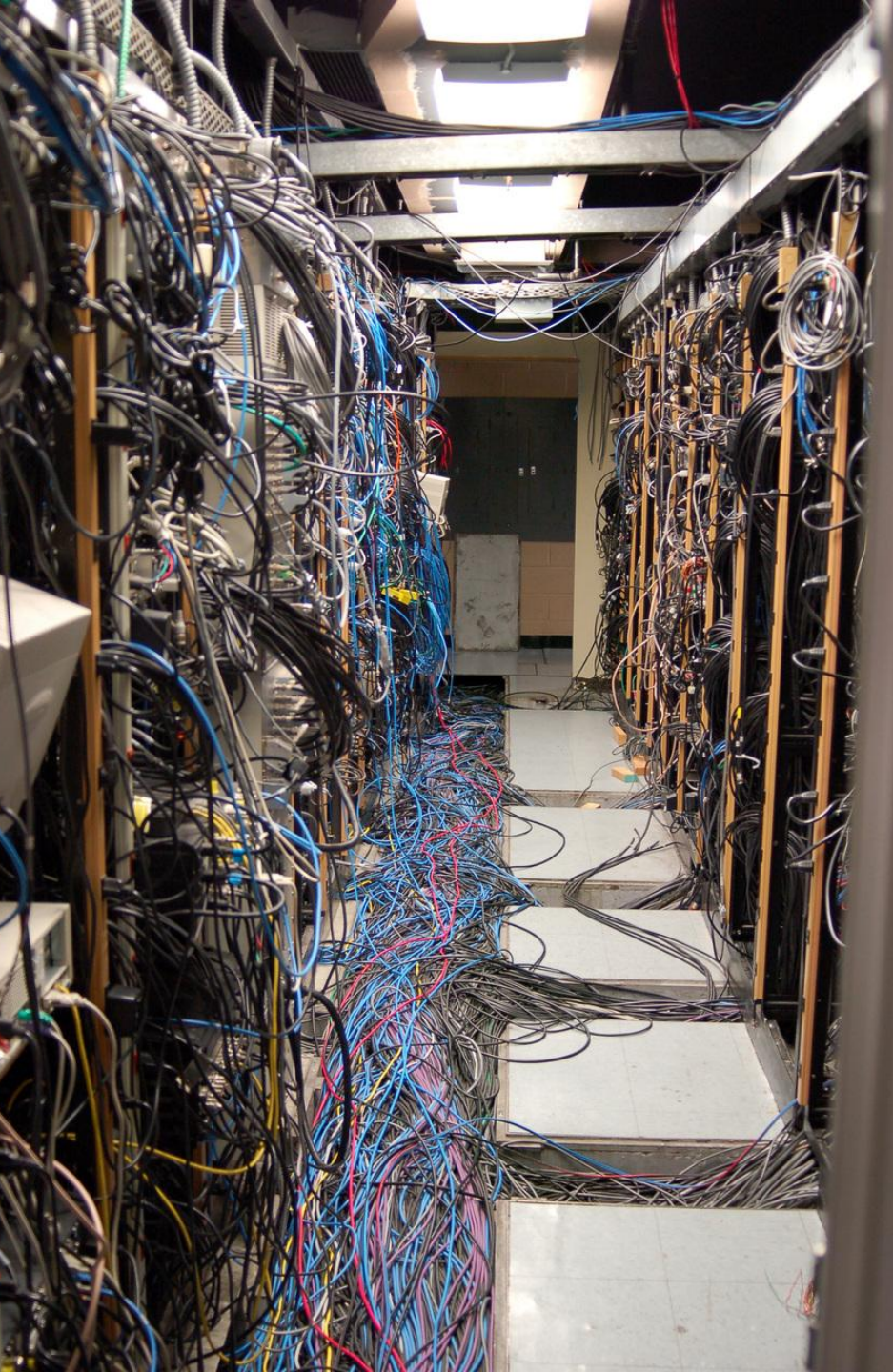
# RIVERS

# RELATIONSHIPS



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# COMMUNICATIONS

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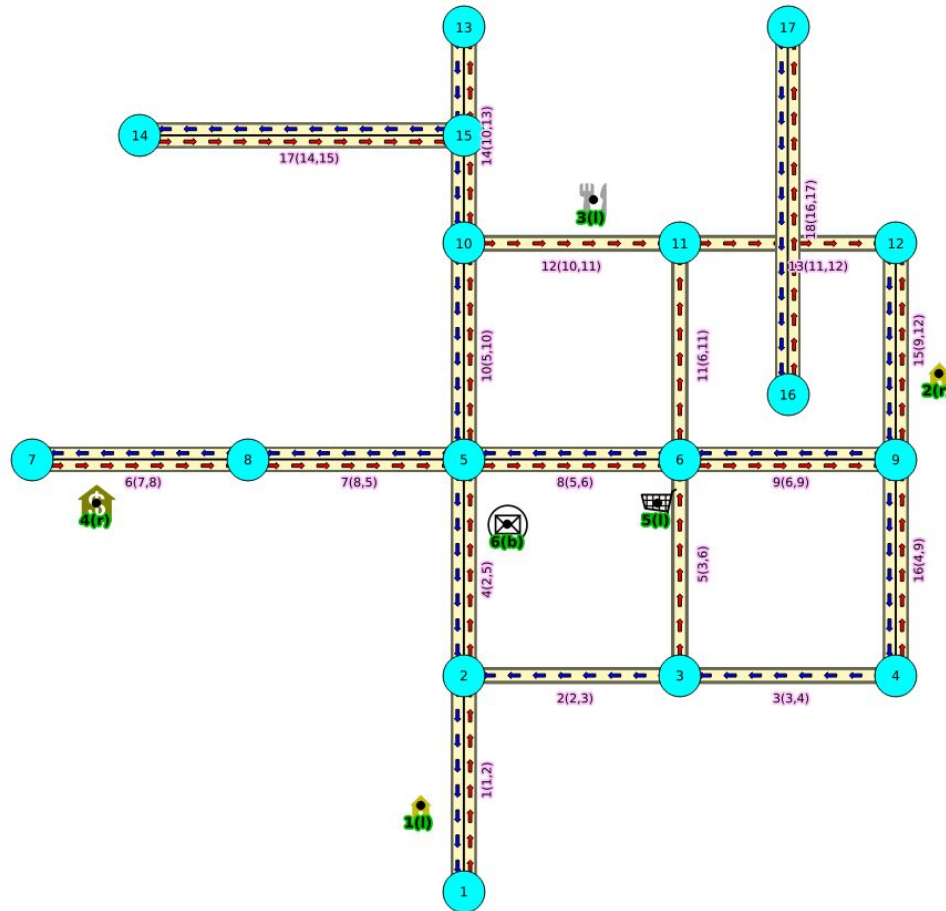
# ROADS



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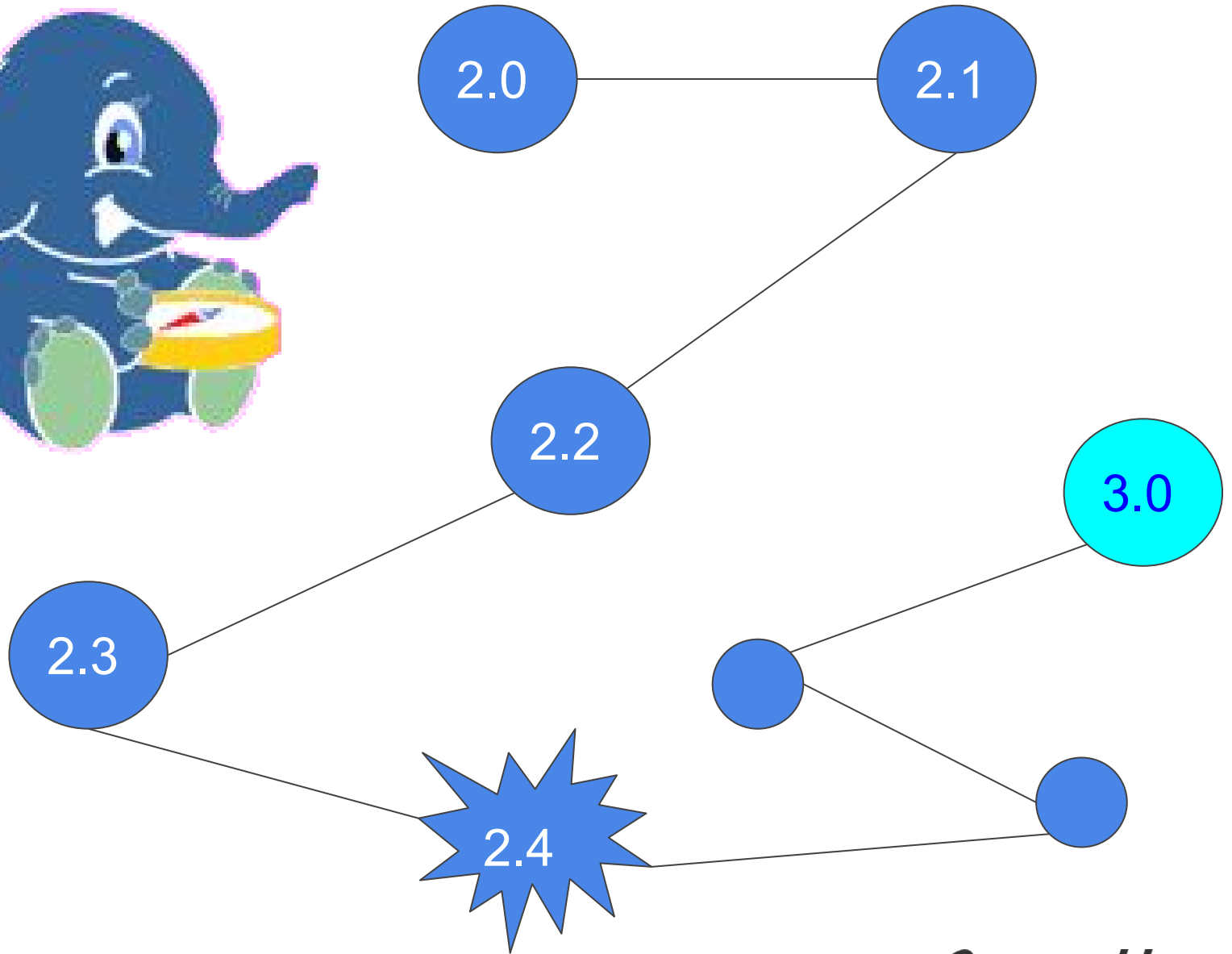
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# THE REPRESENTED ROADS





# EVOLUTION





2.0

2013

- *pgr\_dijkstra*
- *pgr\_drivingDistance*
- *pgr\_ksp*
- *pgr\_apspJohnson*
- *pgr\_apspWarshall*
- *pgr\_kDijkstra*
- *pgr\_astar*
- *pgr\_bdAstar*
- *pgr\_bdDijkstra*
- *pgr\_tsp*
- *pgr\_trsp*
- *pgr\_alphaShape*
- *pgr\_pointsAsPolygon*



2.1

SEP-2015

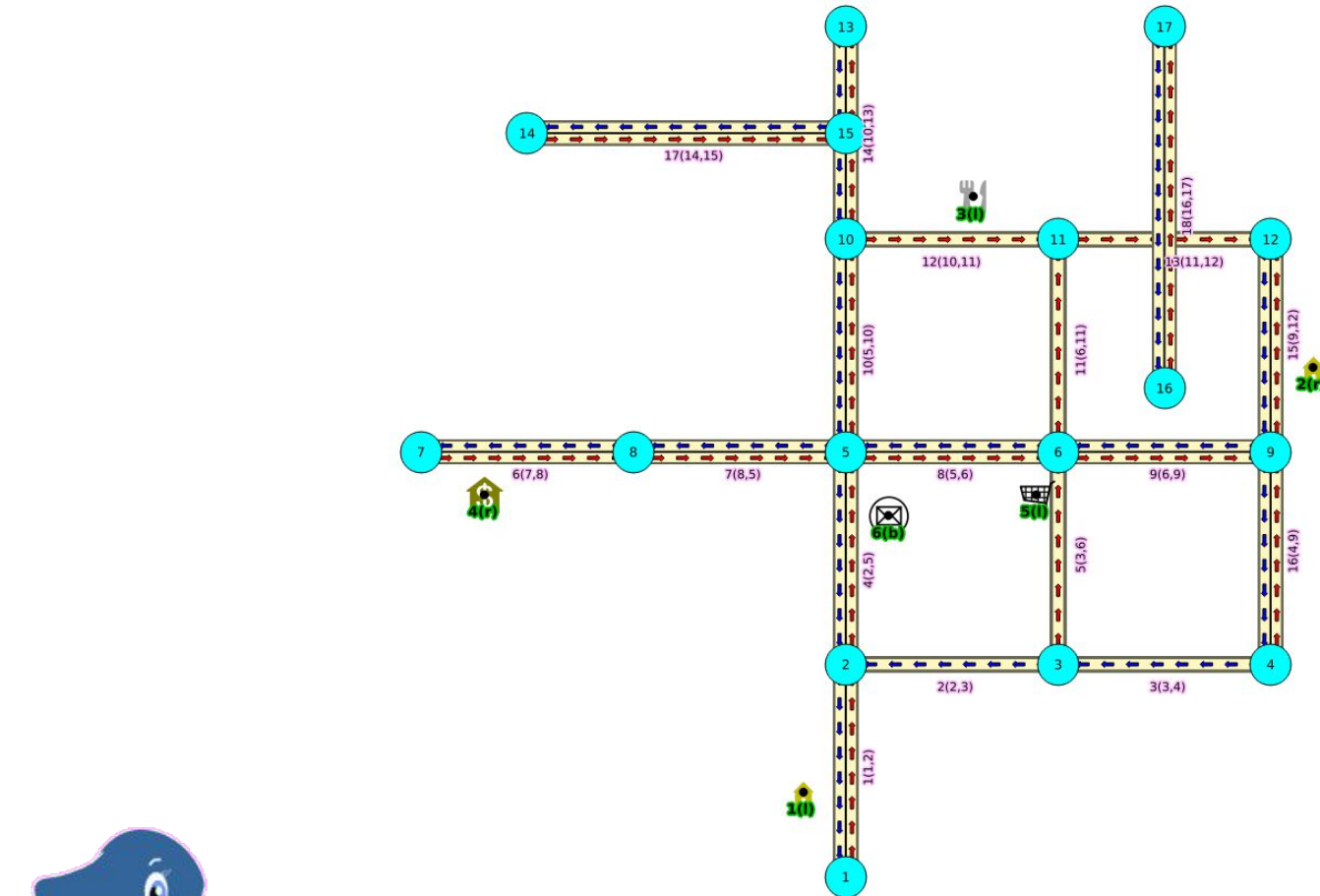
- *pgr\_dijkstra*
- *pgr\_drivingDistance*
- *pgr\_ksp*
- *pgr\_apspJohnson*
- *pgr\_apspWarshall*
- *pgr\_kDijkstra*
- *pgr\_astar*
- *pgr\_bdAstar*
- *pgr\_bdDijkstra*
- *pgr\_tsp*
- *pgr\_trsp*
- *pgr\_alphaShape*
- *pgr\_pointsAsPolygon*
- *pgr\_dijkstra*
  - *One to Many*
  - *Many to One*
  - *Many to Many*
- *pgr\_trspViaVertices*
- *pgr\_trspViaEdges*
- *pgr\_labelGraph*
- *pgr\_oneDepot*
- *pgr\_gsoc\_vrppdtw*

GSoc Students 2013 - 2014  
Thank you Razequl & Manikata!



Georepublic

GO FROM vertex 2 TO vertex 3



# THE QUERY

```
SELECT * FROM pgr_dijkstra('
    SELECT id,
        source,
        target,
        cost,
        reverse_cost,
    FROM edge_table',
    2, 3);
```



# THE RESULT

seq	path_seq	node	edge	cost	agg_cost
1	1	2	4	1	0
2	2	5	8	1	1
3	3	6	9	1	2
4	4	9	16	1	3
5	5	4	3	1	4
6	6	3	-1	0	5

(6 rows)



- *pgr\_dijkstra(group)*
- *pgr\_drivingDistance*
- *pgr\_ksp*
- *pgr\_astarJohnson*
- *pgr\_astarWarshall*
- *pgr\_astarCost (group)*
- *pgr\_astar*
- *pgr\_bdAstar*
- *pgr\_bdDijkstra*
- *pgr\_tsp*
- *pgr\_trsp(group)*
- *pgr\_alphaShape*
- *pgr\_pointsAsPolygon*
- *pgr\_labelGraph*
- *pgr\_oneDepot*
- *pgr\_gsoc\_vrppdtw*
- *pgr\_withPoints(group)*
- *pgr\_withPointsCost(group)*
- *pgr\_withPointsDD*
- *pgr\_withPointsKSP*
- *pgr\_dijkstraVia*



- *pgr\_dijkstra*
- *pgr\_drivingDistance*
- *pgr\_ksp*
- *pgr\_Johnson*
- *pgr\_floydWarshall*
- *pgr\_dijkstraCost*
- ~~*pgr\_tsp*~~
- ~~*pgr\_euclideanTSP*~~
- *pgr\_astar*
- *pgr\_bdAstar*
- *pgr\_bdDijkstra*
- *pgr\_trsp*
- *pgr\_alphaShape*
- *pgr\_pointsAsPolygon*
- *pgr\_labelGraph*
- *pgr\_oneDepot*
- *pgr\_gsoc\_vrppdtw*
- *pgr\_withPoints(group)*
- *pgr\_withPointsCost(group)*
- *pgr\_withPointsDD*
- *pgr\_withPointsKSP*
- *pgr\_dijkstraVia*
- *pgr\_dijkstraCostMatrix*
- *pgr\_withPointsCostMatrix*



## 2.3

# GSoC Students

- *pgr\_maxFlowPushRelabel(group)*
- *pgr\_maxFlowEdmondsKarp(group)*
- *pgr\_maxFlowBoykovKolmogorov(group)*
- *pgr\_maximumCardinalityMatching*
- *pgr\_edgeDisjointPaths*
- *pgr\_contractGraph*







2015 GSoC Student  
Thank you Rohith!

# CONTRACTION

# CONTRACTION

- Graph Contraction, when working on big graphs:
  - road graphs,
  - electric networks
- Speeds up some graph algorithms.
- The current implementation:
  - Flexible Framework
    - “Easy” to add a new operation.
  - Dead end contraction
  - Linear contraction



# THE CONTRACTION SKELETON

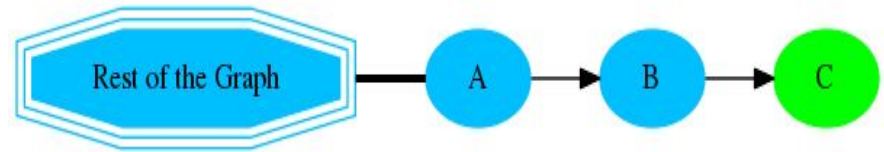
- An initial set up that may involve analyzing the graph given as input and setting the non contractible nodes or edges.
- A cycle that will go and perform a contraction operation until/while possible, and then move to the next contraction operation.
- Adding a new operation then becomes an “easy” task:
  - Add new contraction operation class.
  - Add some interaction between contractions.
- Currently, there are two implemented operation for contracting a graph
  - Dead End contraction
  - Linear contraction



# DEAD END

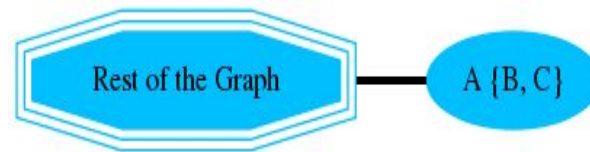
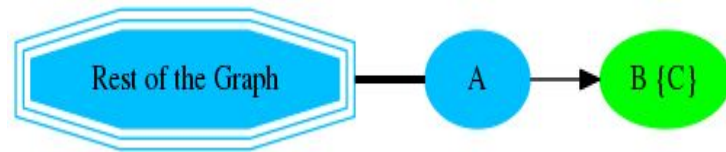
## Undirected Graph

- The number of adjacent vertices is one.



## Directed Graph

- Case 1
  - No outgoing edges
  - At least one incoming edge.
- Case 2
  - One incoming edge
  - One outgoing edge
  - Same identifier on the edges.

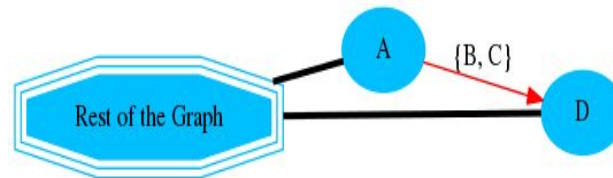
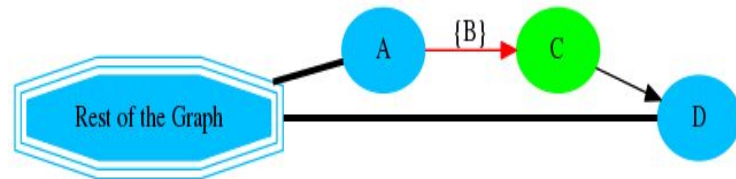
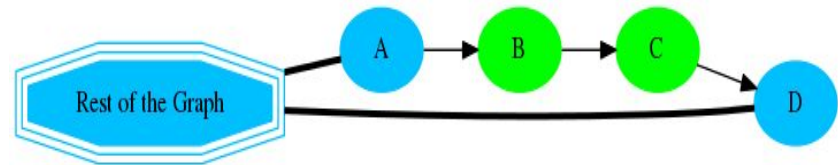


# LINEAR

## Linear Node

- Two adjacent vertices.
- At least one incoming edge and one outgoing edge.

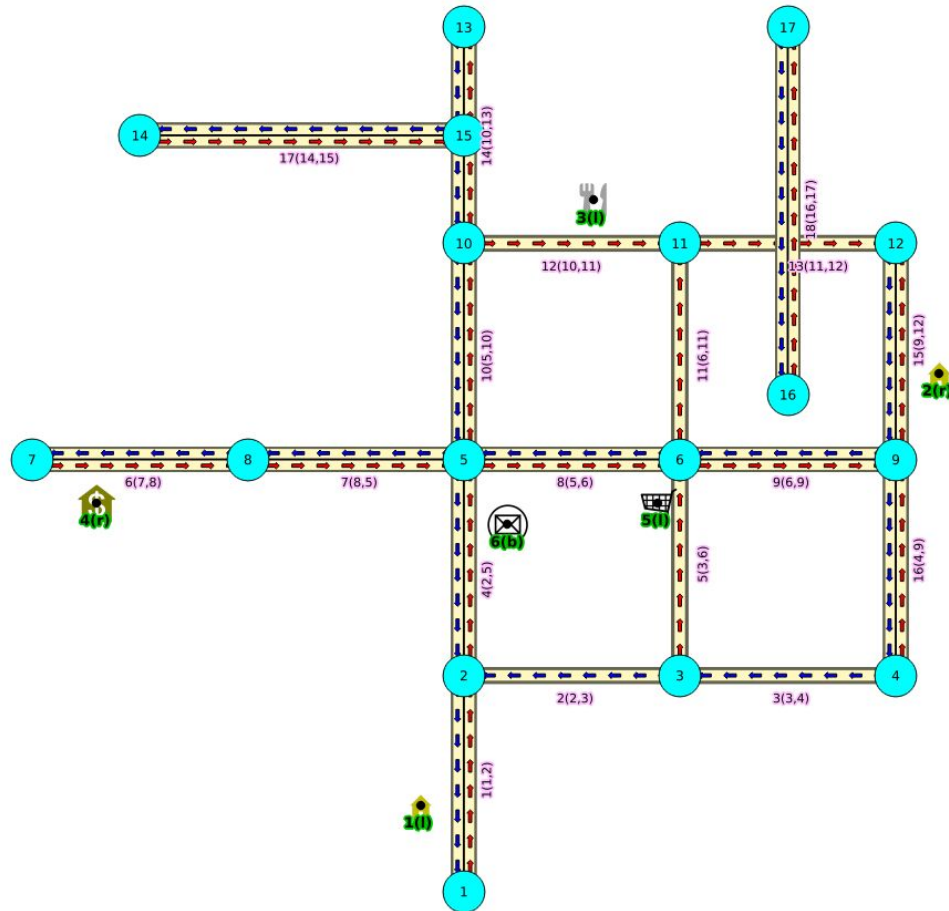
## Linear Contraction



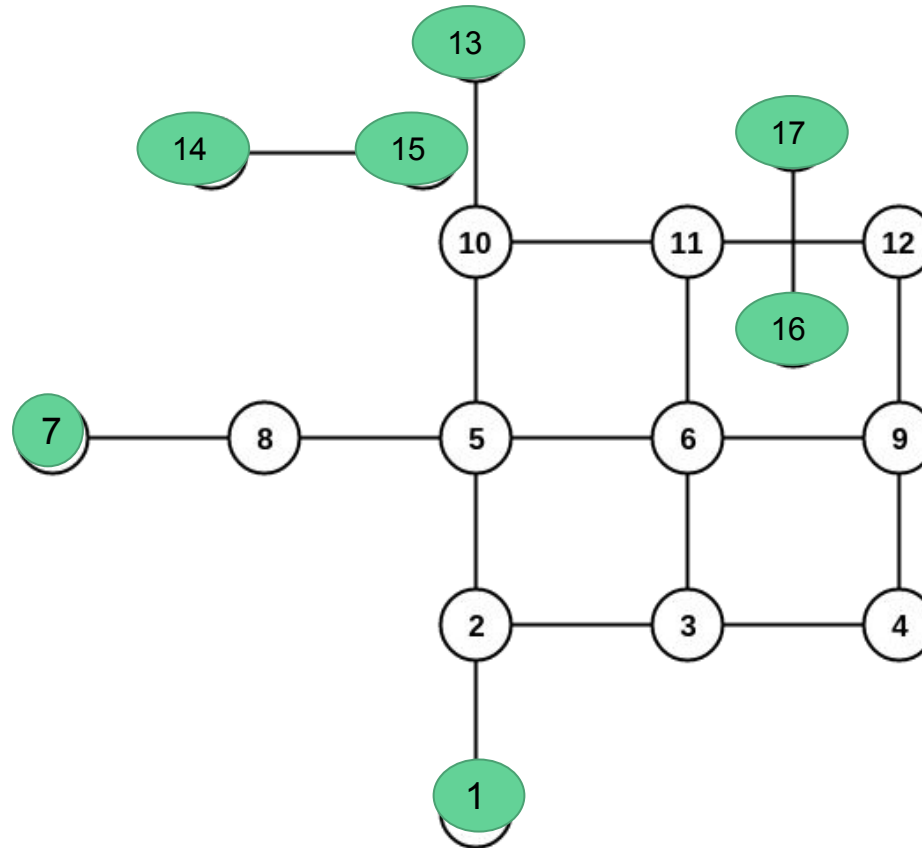


EXAMPLE

## THE REPRESENTED ROADS

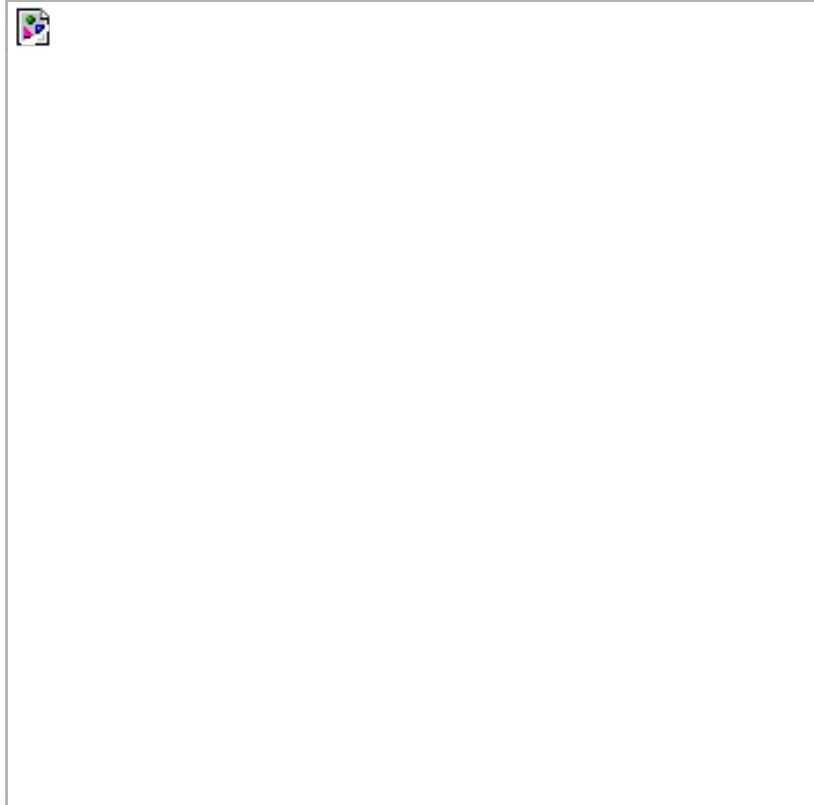


# DEAD END

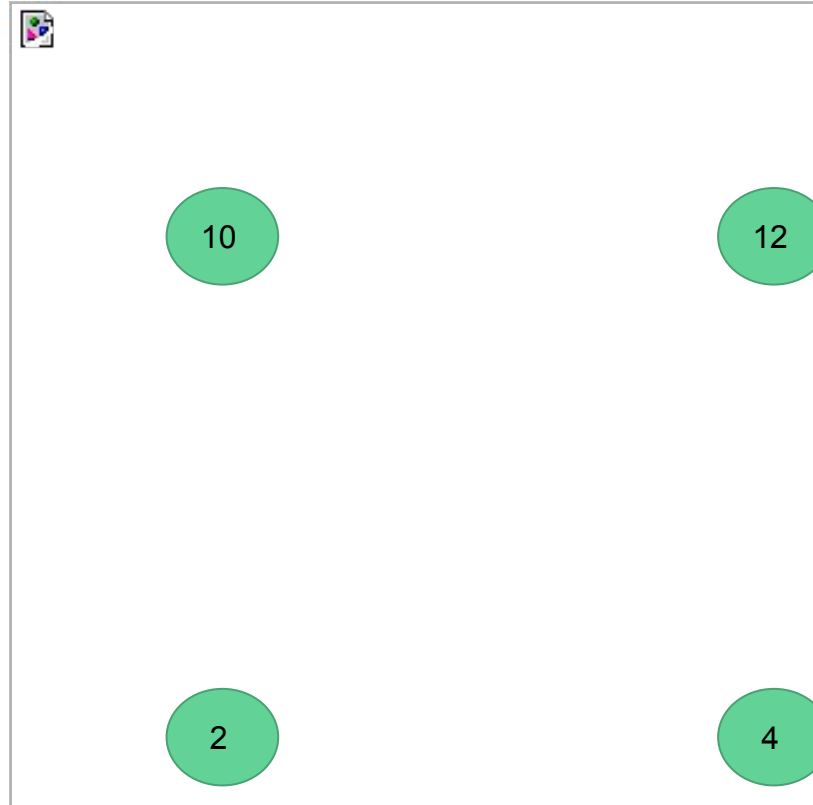




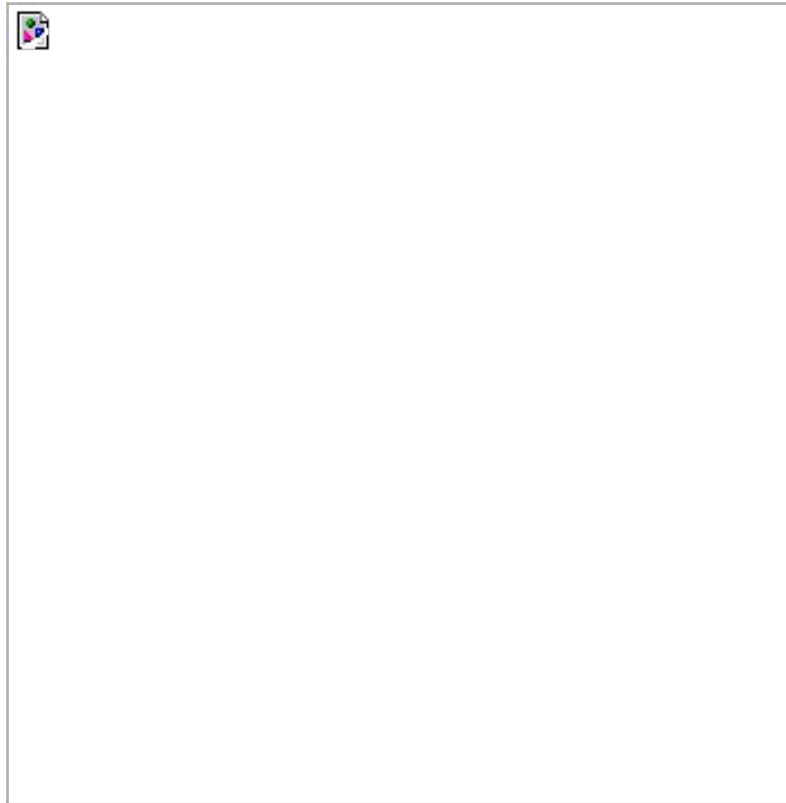
# AFTER CONTRACTION



# LINEAR



# AFTER CONTRACTION



# THE QUERY

```
SELECT *  
FROM pgr_contractGraph(  
    'SELECT id,  
        source,  
        target,  
        cost,  
        reverse_cost  
FROM edge_table',  
    ARRAY[1, 2]);
```



# THE RESULTS

seq	type	id	contracted_vertices	source	target	cost
1	v	2	{1}	-1	-1	-1
2	v	5	{7,8}	-1	-1	-1
3	v	15	{14}	-1	-1	-1
4	v	17	{16}	-1	-1	-1
5	e	-1	{4}	9	3	2
6	e	-2	{10,13}	5	11	2
7	e	-3	{12}	11	9	2

(7 rows)





2016 GSoC Student  
Thank you Andrea!

FLOW

# Maximum FLOW

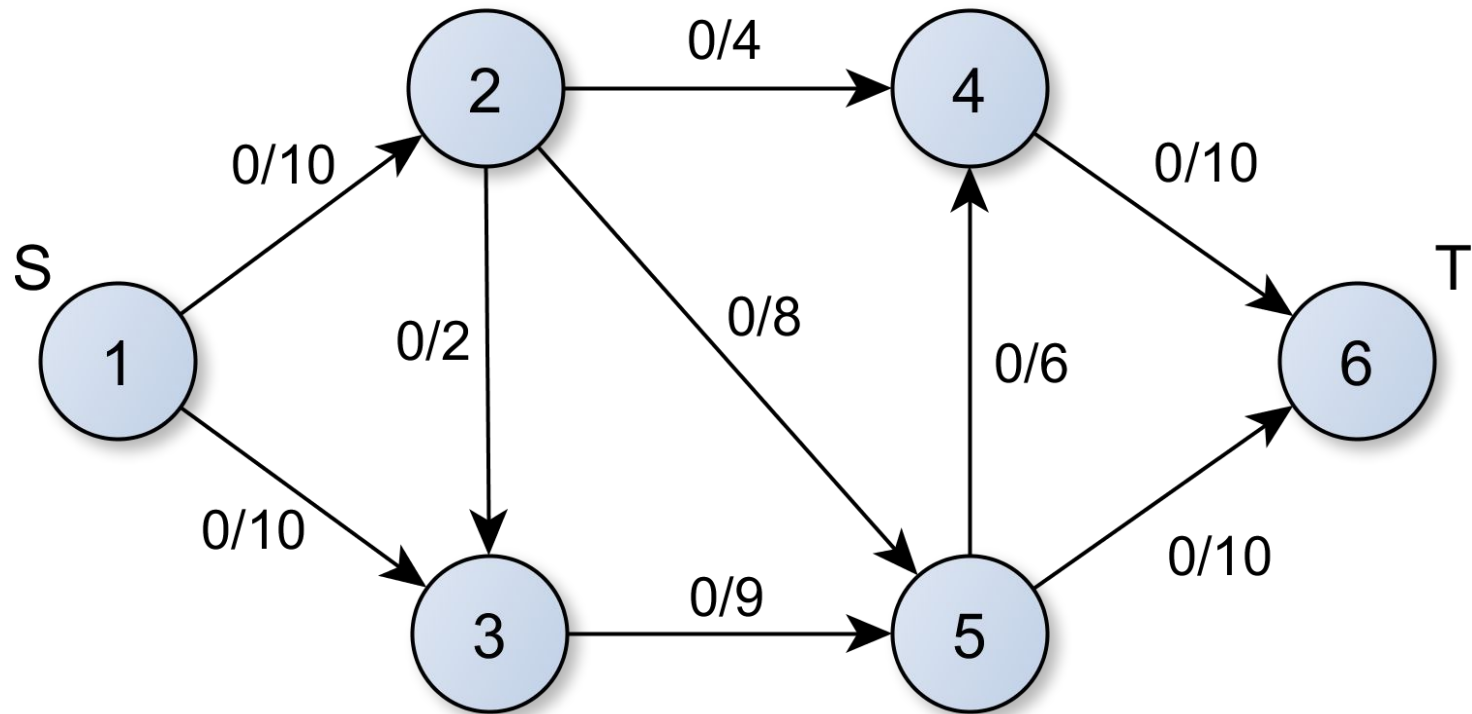
Maximum flow algorithms route the maximum amount of one commodity from one source  $S$  to one sink  $T$ .

This functionality was added to the library, in addition to some example applications:

- Edge disjoint paths
- Multiple source/sink flow
- Maximum cardinality matching



# Maximum FLOW

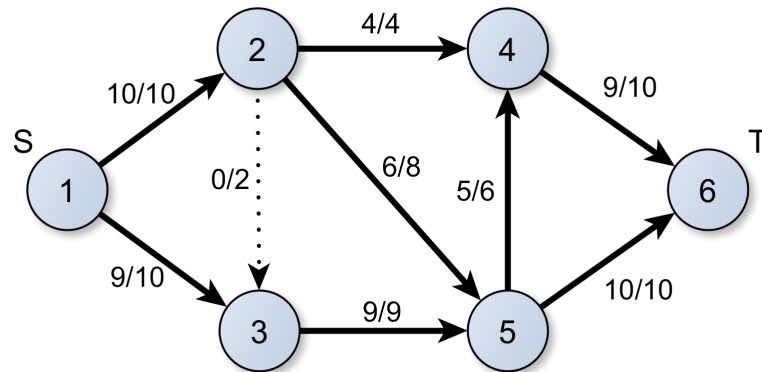




# Maximum FLOW

```
CREATE TABLE flow_example (  
    id SERIAL,  
    source INTEGER,  
    target INTEGER,  
    capacity INTEGER  
);
```

```
INSERT INTO flow_example (source, target, capacity) VALUES  
(1, 2, 10),  
(1, 3, 10);  
(2, 3, 2),  
(2, 4, 4);  
(2, 5, 8);  
(3, 5, 9);  
(4, 6, 10);  
(5, 4, 6);  
(5, 6, 10);
```



# THE QUERY

```
SELECT * FROM pgr_maxFlowEdmondsKarp (  
    'SELECT id,  
        source,  
        target,  
        capacity  
    FROM flow_example',  
    1, 6  
);
```

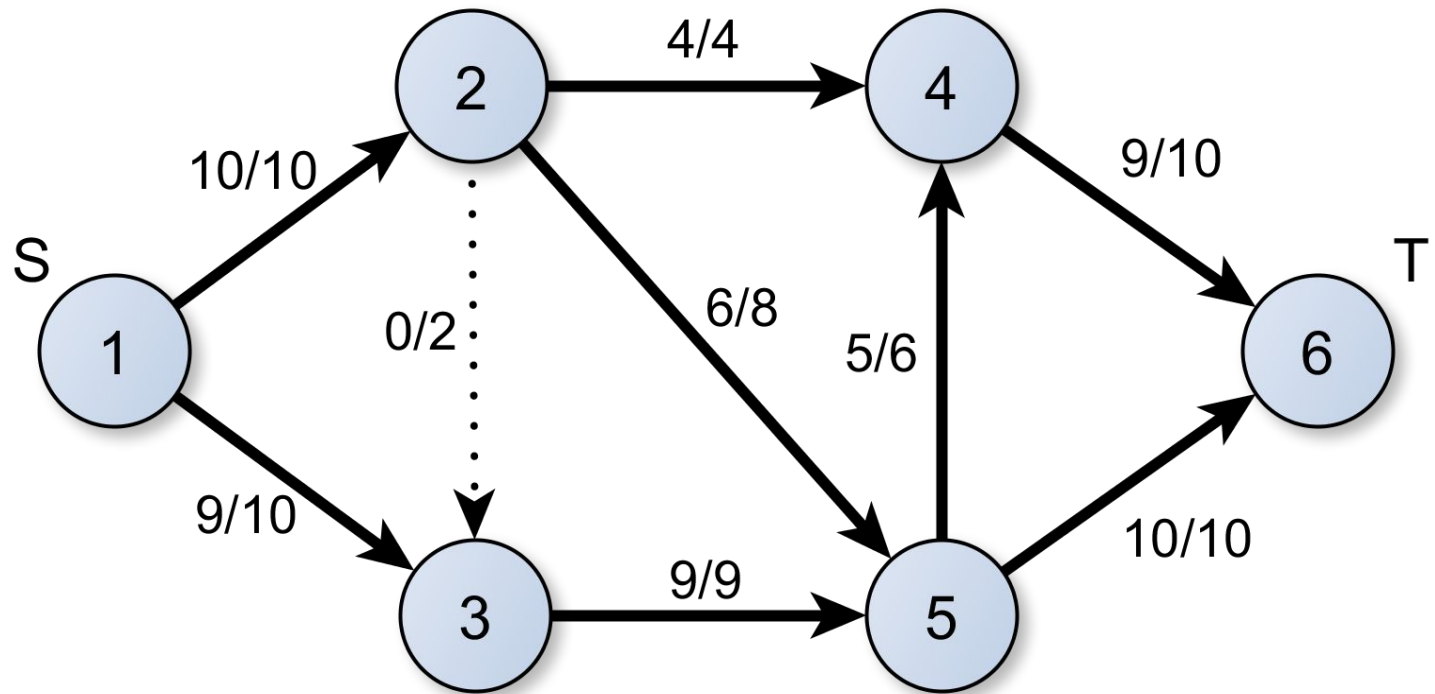


# THE RESULTS

seq	edge_id	source	target	flow	residual_capacity
1	1	1	2	10	0
2	2	1	3	9	1
3	4	2	4	4	0
4	5	2	5	6	2
5	6	3	5	9	0
6	7	4	6	9	1
7	8	5	4	5	1
8	9	5	6	10	0

(8 rows)







2015 GSoC Student  
Thank you Sarthak!

*osm2pgrouting*

2.4

MAR-2017

## PLAN

- *pgr\_astar*
  - *One to Many*
  - *Many to One*
  - *Many to Many*



Fork me on GitHub

**github**  
SOCIAL CODING

<https://github.com/pgRouting>



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Thank you!



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# More Information

Website: [pgrouting.org](http://pgrouting.org)  
Documentation: [docs.pgrouting.org](http://docs.pgrouting.org)  
Workshop: [workshop.pgrouting.org](http://workshop.pgrouting.org)  
Support: [pgrouting.org/support.html](http://pgrouting.org/support.html)

**... or talk to me during FOSS4G 2017 ASIA:**

→ Vicky [vicky@georepublic.de](mailto:vicky@georepublic.de)



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