Practical Applications of pgRouting

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Problem:
Find all bridges, state and local, within 1 road mile of the Interstate

Solution:
pgRouting $\rightarrow$ pgr_withPoints
Outline:
1. Problem information, first thoughts, and choosing a solution
2. The perfect storm and great timing
3. Setting the data up
4. Running the procedure
5. Examining the results
6. Other uses for pgRouting
Problem

Survey was sent to our Bridge Division regarding Bridges within a road mile of the Interstate

2. How many bridges (state and local) in your state are within “reasonable access” of the Interstate?

Per the November 3, 2016 FHWA memo: "Reasonable access is defined in a September 30, 1992 NonRegulatory Supplement to 23 CFR Part 658 as at least one-road-mile from access to and from the National Network of highways, which includes the Interstate System, or further if the limits of a State’s reasonable access policy for food, fuel, repairs, and rest extend to facilities beyond one-road-mile."
Options:
1. pgRouting
2. Batch data through the Google Maps Directions API
3. Other spatial options/by hand
pgRouting

Pros:
1. Free to use
2. Easy to set up

Cons:
1. Haven’t used this solution much
Google Directions API

Pros:
1. Have API key
2. Google does routing well

Cons:
1. Rely on Google GeoCoding
2. Unable to control inputs or look at why things are happening
3. Would have to figure out batch fetches and storing the results for review
Other – Manual measurement solution

Pros:
1. Eyes on each record

Cons:
1. Too laborious
2. Could easily make a mistake or miss something
The perfect storm and great timing
FOSS4G Boston 2017

I had privilege of attending the workshops and the conference. Both were very beneficial.

pgRouting Workshops:


http://postgis.us/foss4g2017
FOSS4G Boston

By that evening back at the hotel I had a version of our LRS network routing in a web browser using GeoServer and Openlayers.

Learned basics of routing and functions and did a few relatively straightforward examples.

From this experience I felt pretty confident that I could get the answer to the bridges within 1 road mile of the interstate.
FOSS4G Boston

Luckily I purchased this book:

Found the function and code that I needed in the book!
Setting the data up:

You will need to get Postgresql running and have PostGIS and pgRouting extensions installed.

Setting the data up:

1. You need a nodes feature and a network feature
   1. Open Street Map Data
      1. Good tools to use this data exist osm2pgrouting
      2. I used our Arnold LRS
2. You could route without geometry, but it helps to visualize
3. From an ongoing project with Hexagon we have a control points feature that can be used to create the source and target information
   1. As we edit our LRS (temporally) we edit this feature
4. This control point feature can be tied together with our Dyn seg’d MLRS output in a query.
select COUNTY ,ROUTE_ID ,PASS_DIR ,SEG_NO ,MP_START ,MP_END ,
(select route_class from route_class where route_class.sri = mlrs_dyn_out.sri) as route_class,
SRI ,INV_NO ,GEOMETRYREVERSED ,COUNTY_ID ,ID₁ ,M_LENGTH ,WM_VALIDFROM ,WM_VALIDTILL ,GEOMETRY,
(SELECT gt_control_point_id
FROM gt_control_measure
WHERE lrm_control_sequence = 1
AND gt_control_measure.gt_lrm_id = id₁ )
AS SOURCE,
(SELECT gt_control_point_id
FROM gt_control_measure
WHERE lrm_control_sequence = 2
AND gt_control_measure.gt_lrm_id = id₁ )
AS TARGET
from mlrs_dyn_out;

MLRS Created from multiple procedures in Oracle
Source and Target for Network from Control Points
pgRouting produces an aggregate cost for a particular route request
   This can be as simple as the length of the segments and partial segments used
   You could really use anything as your cost i.e. carbon emissions, congestion, LOS
   Any Data tied to the LRS can be used
Other useful data items to tack on to your network include:
1. Speed Limit
2. Divided Indicator
3. One way/ Two way indicator
4. AADT
5. Capacity
If direction of route doesn’t matter, the base network with source and target is sufficient for routing

In this problem we were dealing with emergency vehicles and the assumption of direction didn’t matter was made

For practical/normal routing you would want to use a directed graph and only travel down the route in the appropriate direction

Cost and Reverse cost will dictate the directed graph routes
If you don’t have nodes with the source and target information, pgRouting provides a tool to create this based on the Geometry relationships and vertices connections.

pgRouting also has built in analysis functions to find common issues with graphs or networks

You can run these to find dead ends and connected nodes without breaks in the network
You really put your network under the microscope when you start routing on it!!
These issues aren’t found with the utilities
We are still sorting through some issues that haven’t come up until we started routing

“Other than normal maintenance I think this will be the last thing we have to fix!”

-Evan Wright 2013,14,15,n...
Loading the data: `shp2pgsql` or `-gui`

Tip: Check your geometry type and make sure it isn’t multiline when it is loaded in `postgis`.

You can convert to a regular polyline if need be.

Dijkstra will run on multiline

Anything calculating a partial cost will not work with multiline (for me this was the case)
Network and Nodes loaded, now what?
Identify the nodes that we will use to say we’ve reached the interstate.
Select nodes that are a source or target for a network link with route class of IH (Interstate) and a RAMP link

```sql
id in
(
select a.id from
(
select source as id from mdot_lrs where route_clas = 'IH'
union
select target as id from mdot_lrs where route_clas = 'IH')a
inner join
(
select source as id from mdot_lrs where route_clas = 'RAMP'
union
select target as id from mdot_lrs where route_clas = 'RAMP')b
on a.id = b.id)
```
Steps to final product:
1. Table with ID of Bridge and ID of Network Node at Interstate
2. Create function that accepts these ids and grabs the geometries from the right table and passes it to the with points function
3. SQL loop query to pass one row at a time to the function and write results to a table
4. Query table for Node ID and Bridge ID that have max cost <= 1 Mile
Final Thoughts:
1. Using a directed graph is ideal
2. Need to have 1 way attributed when doing this
3. Channels and Crossovers are VERY important to your base network
What other uses are there?
Still thinking of Bridges:
1. Detour Length Calculations for Bridges
Web Based Routing

1. Could use to find “path” for project/query extents
   1. Control input and determine what routes to use
   2. Can either create views for specific route type or modify the query in real time
3. Could look up AADT values, FC values, anything tied to LRS could be identified and quantified
Parameterized View in GeoServer

WFS Call with OpenLayers

http://localhost:8080/geoserver/ows?service=WFS&version=2.0.0&request=GetFeature&typeName=pgrouting:pg_w_pts&outputFormat=application/json&srsname=EPSG:3857&viewparams=x1:-90.1845835859194;y1:32.3025725173737;x2:-90.1740240151231;y2:32.30085486024471

```

```
Point of Interest Routing
Hotel to Clinton Library
1. Downloaded the OSM data for Little Rock area
2. Loaded it in PostGIS with osm2pgrouting
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I enjoy running and especially enjoy running in new cities so how far can I run at 7 miles an hour in 45 minutes? 22.5 minutes in one direction.

What kind of routes do I want to run on?

Using same OSM data I created catchment areas based on the class id of routes.

1. Any route
2. No Major Routes

Does direction matter when you are pedestrian
General code from pgRouting book, modified for running speed dictating cost.

Make sure units of cost match the units you specify for distance in the function call.
How accurate was our catchment area??

Tested this morning!
Observations:
On Street lighting → B
Capitol Building → A+
Sidewalks → B+
Hills → A
GIS-T 5k?
Future Plans:
1. Move data off of my Surface Laptop to a server
2. Publish newest version of LRS with routing info
3. Import OSM data as well to route on and compare
4. Apply to other problems in DOT
Thank you! Any Questions?