

Walk Score with Shortest Distance

```
In [18]: from IPython.display import Image
import urllib3
urllib3.disable_warnings()
%load_ext cypher
```

The cypher extension is already loaded. To reload it, use:
 %reload_ext cypher

Find Routes Using Shortest Distance To Single Amenity

Get baseline algorithm working with shortest distance using Muriettas as single amenity point. This should return a single route between muriettas and the Bankers Court location.

```
In [32]: %%cypher http://neo4j:password@localhost:7474/db/data
match (d:Building {Code: 'Test 1'})
with d, point({ longitude: d.lon, latitude: d.lat }) as p1

// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600 and p2.name="Murrieta's Bar & Grill"
with p2,d,p1
match p=shortestPath((d)-[:ROUTE*..100]-(p2))
return p

limit 10
```

1 rows affected.

Out[32]:

```
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Find Routes to All Amenities in 1600 m boundary

Extend algorithm to find all amenities within 1600 m boundary and return these as routes to the Bankers Court test building.

This will return all paths between Bankers Court and Amenity nodes within a 1600 m boundary.

```
In [15]: %%cypher http://neo4j:password@localhost:7474/db/data
// find all shortest paths to building from amenities in 1600m boundary
match (b:Building {Code:'Test 1'})
with b, point({longitude: b.lon, latitude: b.lat }) as p1

with b,p1

// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600

with b,p1,collect(p2) as pointsOfInterest
unwind (pointsOfInterest) as point
match p=shortestPath((b)-[:ROUTE*..100]-(point))
return p limit 10
```

10 rows affected.

Out[15]:

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[{'Long': -114.0674729, 'lon': -114.0674729, 'City': 'Calgary', 'FinishDate': '2010-05-17', 'Code': 'Test 1', 'lat': 51.0450665, 'Lat': 51.0450665, 'Name': 'Bankers Court'}, {'distance': 55.00820997686417, 'count': 1}, {'uid': '2826511', 'lon': -114.0680498, 'location': {'type': 'Point', 'coordinates': [-114.0680498, 51.0447309], 'crs': {'srid': 4326, 'name': 'wgs-84', 'type': 'link', 'properties': {'href': 'http://spatialreference.org/ref/epsg/4326/ogcwkt', 'type': 'ogcwkt'}}}, 'user': 'MelioraCogito', 'version': 41, 'node_osm_id': 27418619, 'lat': 51.0447309, 'timestamp': '2015-05-16T09:43:29', 'changeset': '31196817}, {'distance': 414.71753927442523, 'toRel': 61290, 'count': 3, 'length': 6, 'fromRel': 98691}, {'uid': '2826511', 'lon': -114.0739679, 'location': {'type': 'Point', 'coordinates': [-114.0739679, 51.0449164], 'crs': {'srid': 4326, 'name': 'wgs-84', 'type': 'link', 'properties': {'href': 'http://spatialreference.org/ref/epsg/4326/ogcwkt', 'type': 'ogcwkt'}}}, 'user': 'MelioraCogito', 'version': 54, 'node_osm_id': 31062775, 'lat': 51.0449164, 'timestamp': '2015-05-16T09:43:29', 'changeset': '31196817}, {'distance': 7.6559777522704495, 'toRel': 98660, 'count': 1, 'length': 1, 'fromRel': 98658}, {'uid': '1616926', 'lon': -114.073973, 'location': {'type': 'Point', 'coordinates': [-114.073973, 51.0448477], 'crs': {'srid': 4326, 'name': 'wgs-84', 'type': 'link', 'properties': {'href': 'http://spatialreference.org/ref/epsg/4326/ogcwkt', 'type': 'ogcwkt'}}}, 'user': 'huaraz', 'version': 1, 'node_osm_id': 4535202997, 'lat': 51.0448477, 'timestamp': '2016-12-03T05:01:31', 'changeset': '44129655}, {'distance': 137.93853250145185, 'toRel': 24000, 'count': 3, 'length': 6, 'fromRel': 88494}, {'uid': '31437', 'lon': -114.0740403, 'location': {'type': 'Point', 'coordinates': [-114.0740403, 51.0436257], 'crs': {'srid': 4326, 'name': 'wgs-84', 'type': 'link', 'properties': {'href': 'http://spatialreference.org/ref/epsg/4326/ogcwkt', 'type': 'ogcwkt'}}}, 'user': 'Zippanova', 'version': 36, 'node_osm_id': 31062772, 'lat': 51.0436257, 'timestamp': '2013-12-29T03:58:07', 'changeset': '19690562}, {'distance': 171.27717472855576, 'toRel': 109620, 'count': 1, 'length': 1, 'fromRel': 109618}, {'uid': '31437', 'lon': -114.076485, 'location': {'type': 'Point', 'coordinates': [-114.076485, 51.0436949], 'crs': {'srid': 4326, 'name': 'wgs-84', 'type': 'link', 'properties': {'href': 'http://spatialreference.org/ref/epsg/4326/ogcwkt', 'type': 'ogcwkt'}}}, 'user': 'Zippanova', 'version': 23, 'node_osm_id': 31027872, 'lat': 51.0436949, 'timestamp': '2013-12-29T03:58:07', 'changeset': '19690562}, {'distance': 32.643818691321975}, {'RawScore': 1, 'lon': -114.0760291, 'WalkScoreBaseRank': 1, 'version': 2, 'changeset': '31196817', 'uid': '2826511', 'Long': -114.0760291, 'location': {'type': 'Point', 'coordinates': [-114.0760291, 51.0437568], 'crs': {'srid': 4326, 'name': 'wgs-84', 'type': 'link', 'properties': {'href': 'http://spatialreference.org/ref/epsg/4326/ogcwkt', 'type': 'ogcwkt'}}}, 'user': 'MelioraCogito', 'Lat': 51.0437568, 'node_osm_id': 740336260, 'lat': 51.0437568, 'timestamp': '2015-05-16T09:43:29'}]

```

Calculate Distance Along Path

Now we will calculate the distance along the paths but for a limited number of amenities to validate the calculation for distance. We'll use Vendome Cafe as its the first result returned.

```
In [34]: %%cypher http://neo4j:password@localhost:7474/db/data
// calculate total distance for a limited number of amenity points to
the building
match (b:Building {Code:'Test 1'})
with b,point({ longitude: b.lon, latitude: b.lat }) as p1

with b,p1

// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600
with b,p1,p2 limit 10
with b,p1,collect(p2) as pointsOfInterest
unwind (pointsOfInterest) as point
match p=shortestPath((b)-[rels:ROUTE*..100]-(point))

RETURN point.name, REDUCE(s = 0, r IN rels | s + r.distance) AS total
order by total desc

limit 10
```

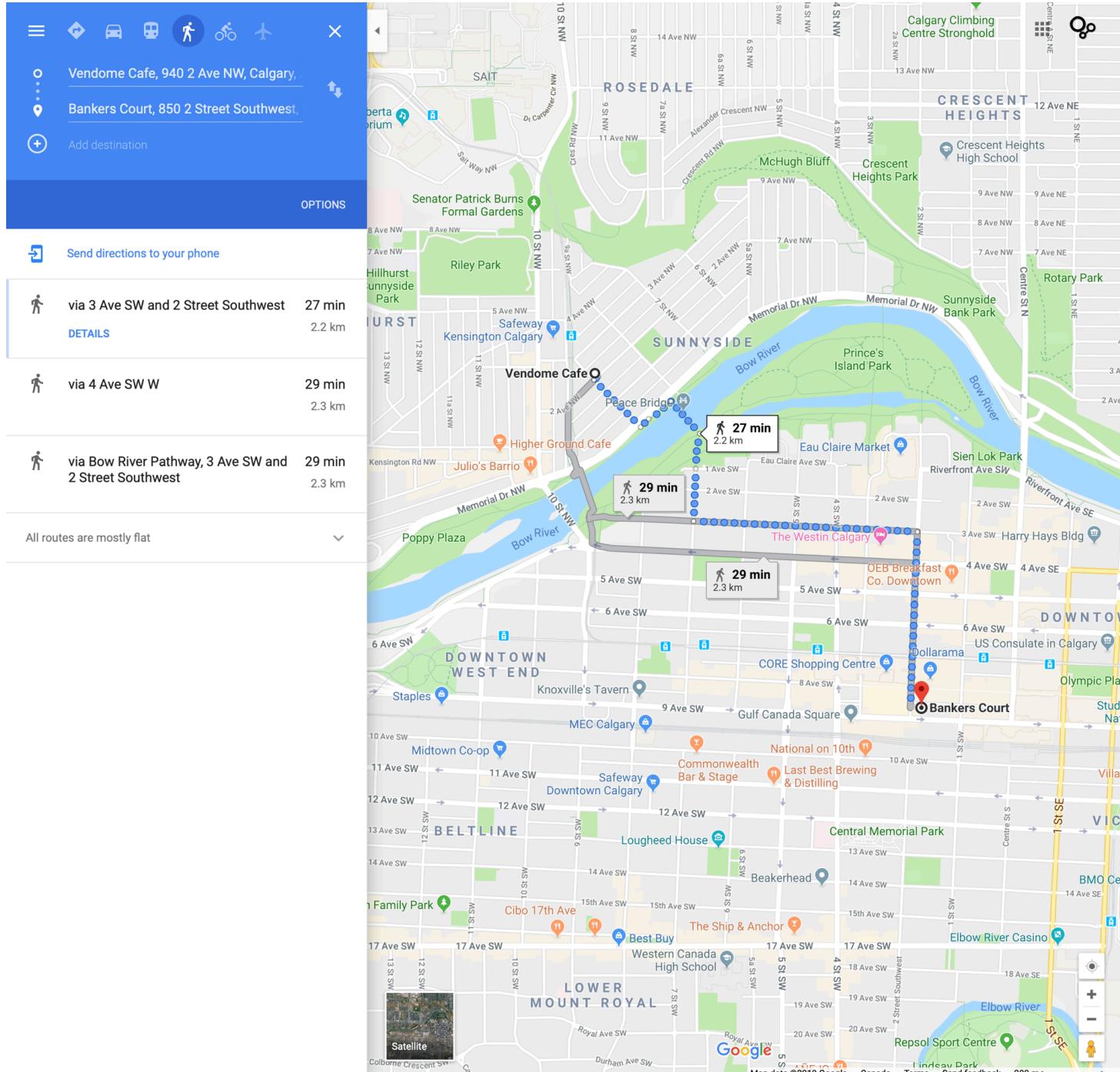
10 rows affected.

Out[34]:

	point.name	total
	Vendome Cafe	2937.7084035941016
	Banzai	2858.6763221967567
	Rendezvous Cafe	1950.1083497788013
	Starbucks	1560.438957431028
	Impark Lot 132	877.7183640595596
	None	819.2412529248895
	Jack Singer Concert Hall	766.9592606778581
CPA Lot 25 City Centre Parkade (public)	10 Ave entrance	760.9628375384975
	None	700.4998747869727
	Starbucks	372.36903969313715

Validate the approach against a known point from the list using google maps

If we use the first item, Vendome Cafe and place this in Google Maps to Bankers Court, we get a distance of 2.2 km which is within a reasonable tolerance to our computed value of 2.9km.



```
In [35]: %%cypher http://neo4j:password@localhost:7474/db/data
// calculate total distance for each amenity point to the building
match (b:Building {Code:'Test 1'})
with b,point({ longitude: b.lon, latitude: b.lat }) as p1

with b,p1
// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600

with b,p1,collect(p2) as pointsOfInterest
unwind (pointsOfInterest) as point
match p=shortestPath((b)-[rels:ROUTE*..100]-(point))

RETURN point.name, REDUCE(s = 0, r IN rels | s + r.distance) AS total
order by total desc

limit 10
```

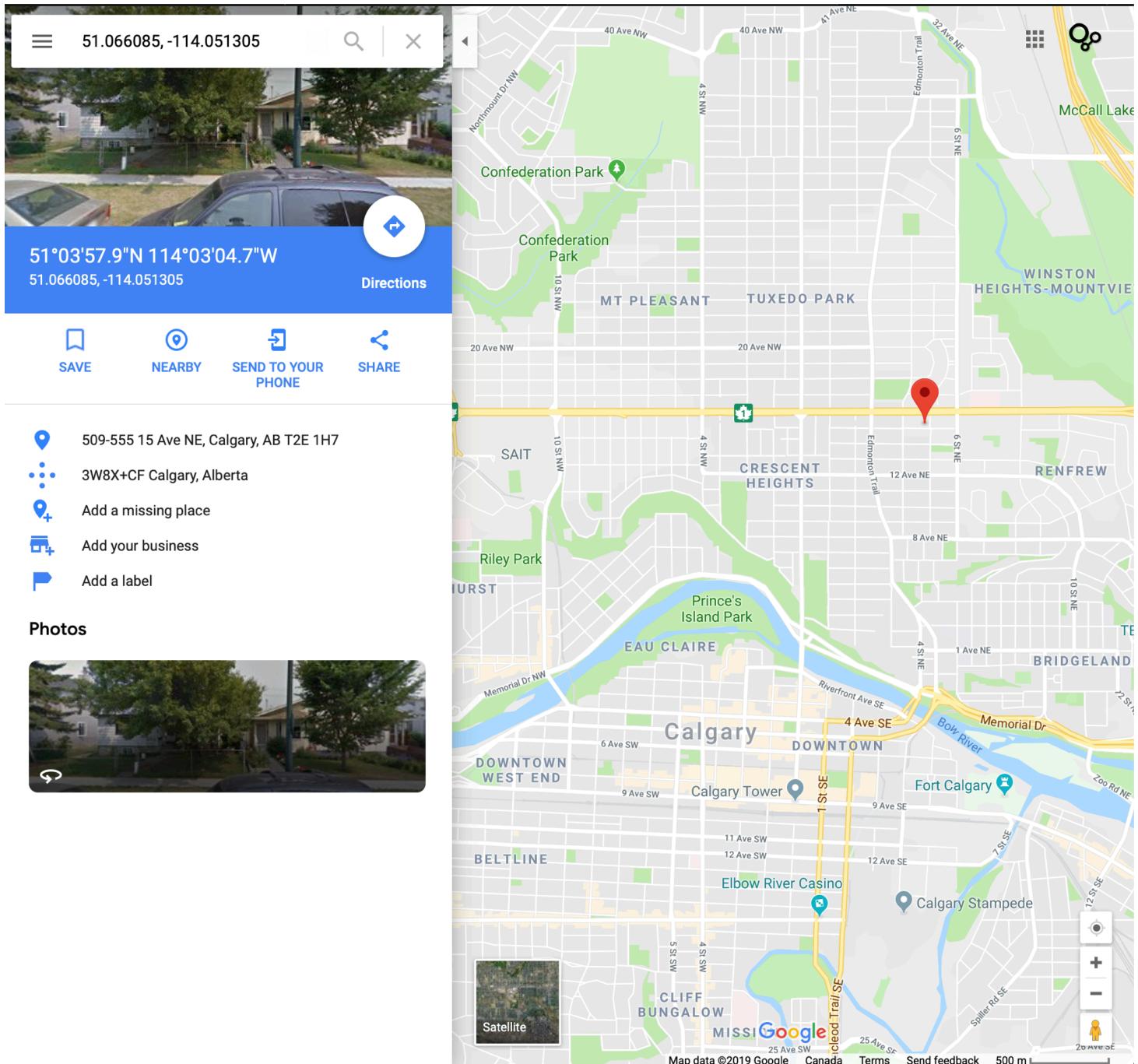
10 rows affected.

Out[35]:

	point.name	total
	Villa Firenze	6187.86216214336
	St Vladimir's Ukrainian Orthodox Church	6069.296566030687
	Barvinkov Ukrainian Dance Society	6023.574709702453
	Il Sogno	5774.892117777112
	BMO	5757.156657069253
	Alberta Ballet	5754.449894135083
	Rocky's Sausage Haus	5726.856338562247
	Lukes Drug Mart	5715.474621773315
	Women's Centre of Calgary	5702.794932984235
	Discount Car and Truck Rentals	4956.18250822555

Compute the Walk Score for a Location Outside Downtown:

We know most locations downtown will have high walkscores. Lets take a location outside the downtown.



The hypothesis is that the standard walkscore algorithm tends to rank higher than one that uses actual routes, as it only factors in linear distance from the main point and the amenities.

First we will use the standard 'as the crow flies' straight distance function to compute distance from My Old House to the Amenities:

```
In [30]: %%cypher http://neo4j:password@localhost:7474/db/data
// calculate total distance for a limited number of amenity points to
the building
match (b:Building {Code:'My Old House'})
with b,point({ longitude: b.lon, latitude: b.lat }) as p1

with b,p1

// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600 and p2.name <> 'None'
with b,p1,collect(p2) as pointsOfInterest

unwind (pointsOfInterest) as point

with point, distance(p1,point.location) as total

RETURN point.name, total order by total desc

limit 10
```

10 rows affected.

Out[30]:

	point.name	total
	Barvinkov Ukrainian Dance Society	1571.2247434757687
	Petro Canada;Executive Suites By Roseman	1571.1665262831978
	BMO	1570.3085899158352
	The Cat n' Fiddle Pub	1565.7946820982079
	Il Sogno	1563.570715296738
	St Vladimir's Ukrainian Orthodox Church	1549.384755179807
	Rocky's Sausage Haus	1534.9437487985604
	Women's Centre of Calgary	1512.1052460721114
	Lukes Drug Mart	1443.288025232632
	Villa Firenze	1412.0639045931562

```
In [23]: %%cypher http://neo4j:password@localhost:7474/db/data
// calculate total distance for a limited number of amenity points to
the building
match (b:Building {Code:'My Old House'})
with b,point({ longitude: b.lon, latitude: b.lat }) as p1

with b,p1

// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600
with b,p1,p2
with b,p1,collect(p2) as pointsOfInterest
unwind (pointsOfInterest) as point
match p=shortestPath((b)-[rels:ROUTE*..100]-(point))

RETURN point.name, REDUCE(s = 0, r IN rels | s + r.distance) AS total
order by total desc

limit 10
```

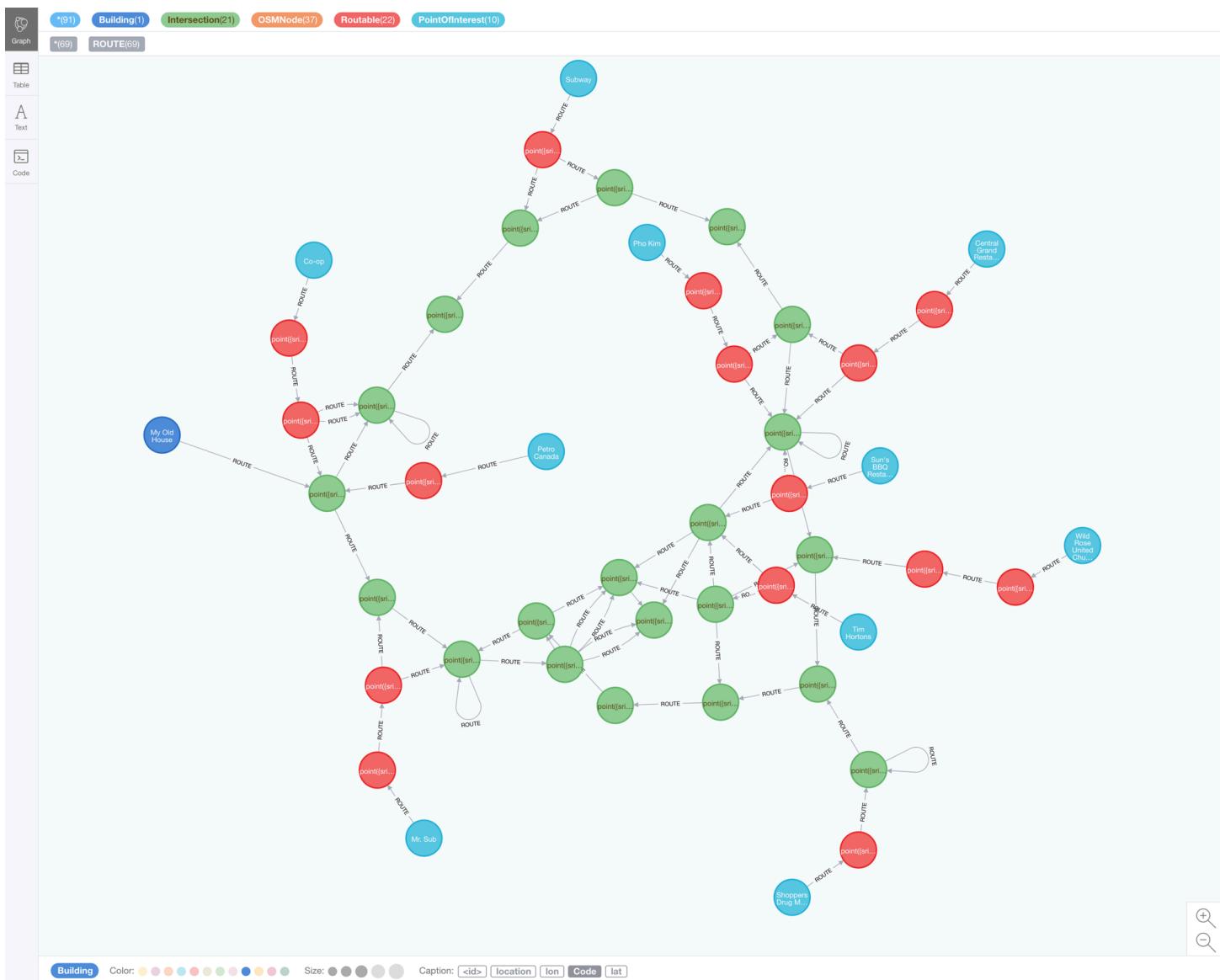
10 rows affected.

Out[23]:

	point.name	total
	The Cat n' Fiddle Pub	5763.616639510899
	Villa Firenze	3477.548961951674
	None	3474.5504852457693
	BMO	3231.798459247258
	St Vladimir's Ukrainian Orthodox Church	3080.434585682856
	Rocky's Sausage Haus	3069.7873128778974
	Il Sogno	3064.4432887152857
	Women's Centre of Calgary	3045.7259072998845
	Lukes Drug Mart	3037.1300538565742
	Barvinkov Ukrainian Dance Society	3034.7127293546223

From this analysis, we can see that the distances computed by the Shortest Distance algorithm are considerably higher than the linear distance used by Walk Score. This validates the hypothesis that the traditional Walk Score algorithm is likely overestimating the resulting Walk Score for equivalent Amenity to Building locations.

A visualization of these paths follows:



```
In [27]: %%cypher http://neo4j:password@localhost:7474/db/data
```

```
// -----
// Neo4j Spatial Experiments, December 2018
// Written by Menome Technologies Inc. http://www.menome.com
//
// Cypher Version of the Walk Score Calculation
// -----
```

```

// 6 compute walk score Walk Score® = Raw Score x 6.67 - (ID - ABL)
// Can use any lat/long or pre-configured Buildings Test 1, Test 2, Test 3, My Old House
match (d:Building {Code:'My Old House'})
with d,point({ longitude: d.lon, latitude: d.lat }) as p1
// get all intersections in the area around Calgary
match (i:Intersection) where distance(p1,i.location) <= 10000
with p1,d,count(i)/3.1502 as ID

// determine ID Penalty
with p1,d,ID,
CASE
    WHEN ID <= 60 then 0.05
    WHEN ID > 60 and ID <=90 then .04
    WHEN ID > 90 and ID <=120 then .03
    WHEN ID > 150 and ID <= 200 then .01
    ELSE 0.0
END as IDPenalty

// compute ABL Penalty
match (i:Intersection) where distance(p1,i.location) <= 10000
with d,p1,IDPenalty,i, collect(i) as intersections
unwind intersections as i1
match (i1)-[r:ROUTE]->(i2:Intersection)
with d,p1,IDPenalty,avg(r.distance) as ABL

with ABL,p1,d,IDPenalty,
CASE
    WHEN ABL <= 120 then 0.0
    WHEN ABL > 120 and ABL <=150 then .01
    WHEN ABL > 150 and ABL <=165 then .02
    WHEN ABL > 165 and ABL <= 180 then .03
    WHEN ABL > 180 and ABL <= 195 then .04
    ELSE .05
END as ABLPenalty

// compute walk score
with p1,d,IDPenalty,ABLPenalty

// find all points of interest in boundary
match (p:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p.location)
<= 1600 and p.name <>'None'

// compute walk score using weighted boundaries
with p1,d,IDPenalty,ABLPenalty,collect(p) as points
unwind points as point
with p1,d,IDPenalty,ABLPenalty,point,
CASE
    when distance(p1,point.location) <= 400 then point.RawScore

```

```

    when distance(p1,point.location) > 400 and distance(p1,point.location) <= 800 then point.RawScore * 0.75
    when distance(p1,point.location) > 800 and distance(p1,point.location) <= 1200 then point.RawScore * 0.40
    when distance(p1,point.location) > 1200 and distance(p1,point.location) <= 1600 then point.RawScore * 0.125
    else 0
END as rawScore

with p1,d, IDPenalty, ABLPenalty, sum(rawScore) as totalRawScore

with IDPenalty, ABLPenalty, totalRawScore,
// Check rawscore total - 15 is max
CASE
    when totalRawScore > 15.0 then 15.0 * 6.67
    else totalRawScore * 6.67
END as score

return (score - (IDPenalty * score + ABLPenalty * score)) as WalkScore
, IDPenalty, ABLPenalty

```

1 rows affected.

Out[27]: `WalkScore IDPenalty ABLPenalty`

WalkScore	IDPenalty	ABLPenalty
95.0475	0.0	0.05

Use Actual Shortest Distance to Compute Walk Score

Now that we can compute paths from the building to the amenities, we can use this to compute actual block distance.

```

In [29]: %%cypher http://neo4j:password@localhost:7474/db/data
// -----
// Neo4j Spatial Experiments, December 2018
// Written by Menome Technologies Inc. http://www.menome.com
//
// Cypher Version of the Walk Score Calculation
// ----

// 6 compute walk score Walk Score® = Raw Score x 6.67 - (ID - ABL)
// Can use any lat/long or pre-configured Buildings Test 1, Test 2, Test 3
match (d:Building {Code:'My Old House'})
with d, point({ longitude: d.lon, latitude: d.lat }) as p1
// get all intersections in the area around Calgary
match (i:Intersection) where distance(p1,i.location) <= 10000
with p1,d,count(i)/3.1502 as ID

```

```

// determine ID Penalty
with p1,d,ID,
CASE
    WHEN ID <= 60 then 0.05
    WHEN ID > 60 and ID <=90 then .04
    WHEN ID > 90 and ID <=120 then .03
    WHEN ID > 150 and ID <= 200 then .01
    ELSE 0.0
END as IDPenalty

// compute ABL Penalty
match (i:Intersection) where distance(p1,i.location) <= 10000
with d,p1,IDPenalty,i, collect(i) as intersections
unwind intersections as i1
match (i1)-[r:ROUTE]->(i2:Intersection)
with d,p1,IDPenalty,avg(r.distance) as ABL

with ABL,p1,d,IDPenalty,
CASE
    WHEN ABL <= 120 then 0.0
    WHEN ABL > 120 and ABL <=150 then .01
    WHEN ABL > 150 and ABL <=165 then .02
    WHEN ABL > 165 and ABL <= 180 then .03
    WHEN ABL > 180 and ABL <= 195 then .04
    ELSE .05
END as ABLPenalty

// compute walk score
with p1,d,IDPenalty,ABLPenalty

// find all points of interest in boundary
match (p2:PointOfInterest)-[]-(t:OSMTags) where distance(p1,p2.location) <= 1600

with p1,d,IDPenalty,ABLPenalty,collect(p2) as points
unwind (points) as point

// find path to shortest distance
match p=shortestPath((d)-[rels:ROUTE*..100]-(point))

with point,p1,d,IDPenalty,ABLPenalty, REDUCE(s = 0, r IN rels | s + r.distance) AS distanceTo

// compute walk score using weighted boundaries
with point,p1,d,IDPenalty,ABLPenalty,
CASE
    when distanceTo <= 400 then point.RawScore
    when distanceTo > 400 and distanceTo <= 800 then point.RawScore *

```

```

0.75
    when distanceTo > 800 and distanceTo <= 1200 then point.RawScore *
0.40
    when distanceTo > 1200 and distanceTo <= 1600 then point.RawScore *
* 0.125
    else 0
END as rawScore

with p1,d, IDPenalty, ABLPenalty, sum(rawScore) as totalRawScore

with IDPenalty, ABLPenalty, totalRawScore,
// Check rawscore total - 15 is max
CASE
    when totalRawScore > 15.0 then 15.0 * 6.67
    else totalRawScore * 6.67
END as score

return (score - (IDPenalty * score + ABLPenalty * score)) as WalkScore
, IDPenalty, ABLPenalty

```

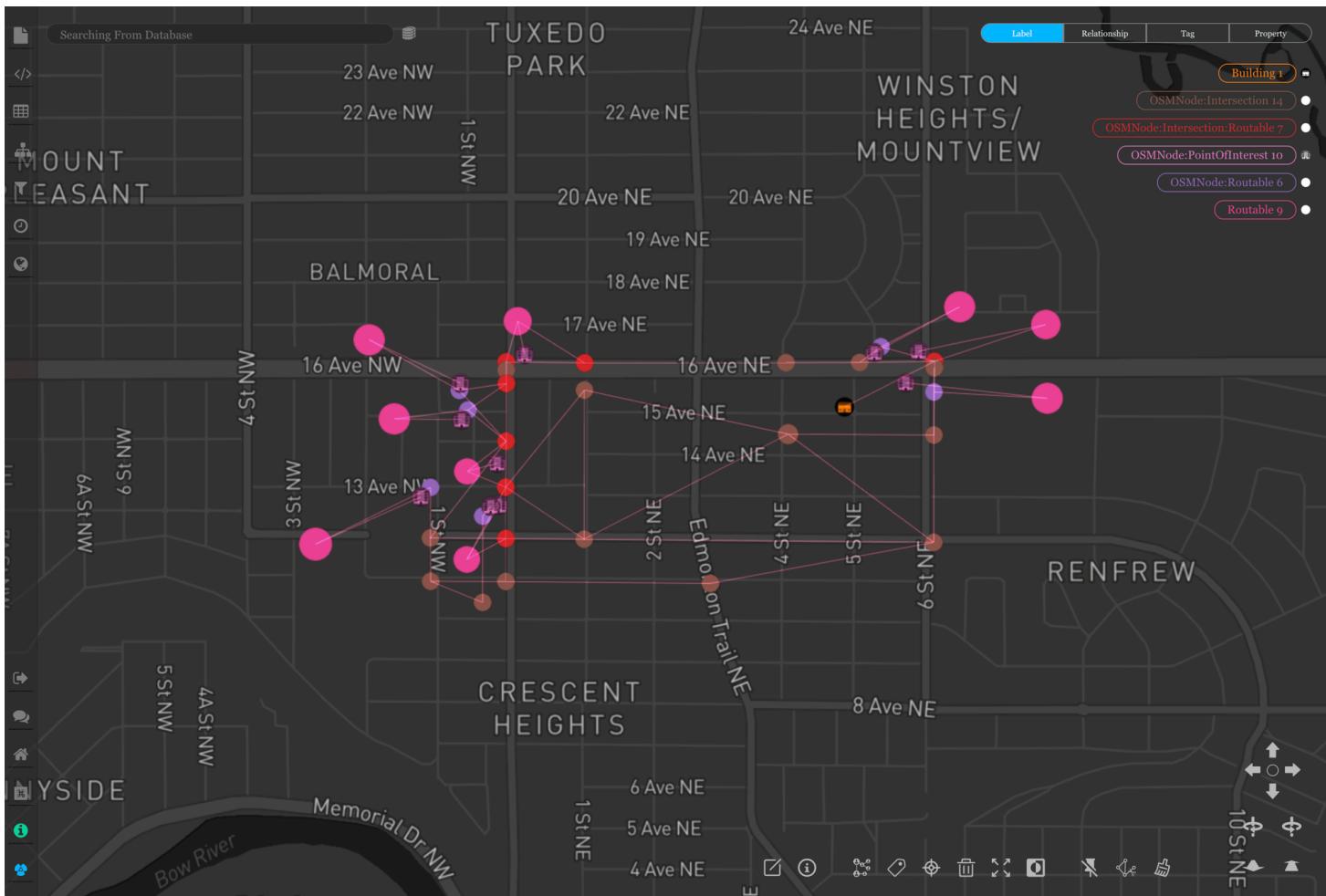
1 rows affected.

Out[29]: **WalkScore** **IDPenalty** **ABLPenalty**

49.42469999999994	0.0	0.05
-------------------	-----	------

As expected, we see the Walk Score comes out considerably lower. However, it may be that in Calgary, the open street map data is sparse outside the downtown which will cause the results to be skewed down.

By using GraphXR, we can plot the OSM data on the map and see that this is indeed the case:



It should also be possible to use Dykstra or A* to further increase the accuracy of the algorithm.

Additional improvements would include adding in Yelp ratings for ranks to weight the amenities according to actual user feedback.

```
In [28]: %%cypher http://neo4j:password@localhost:7474/db/data
// ensure link to intersection from house
match(b:Building {Code:'My Old House'})
match (o:OSMNode {node_osm_id:2311845184})
merge (b)-[:ROUTE {distance=300}]->(o)

File "<ipython-input-28-6b704f1f8db7>", line 1
    match(b:Building {Code:'My Old House'})
    ^
SyntaxError: invalid syntax
```

```
In [ ]:
```