Programming, Problem Solving, and Algorithms

CPSC203, 2019 W1

Announcements

Project 3 released soon. Due 11:59p, Nov 29.

“Problem of the Day” continues!

Today:

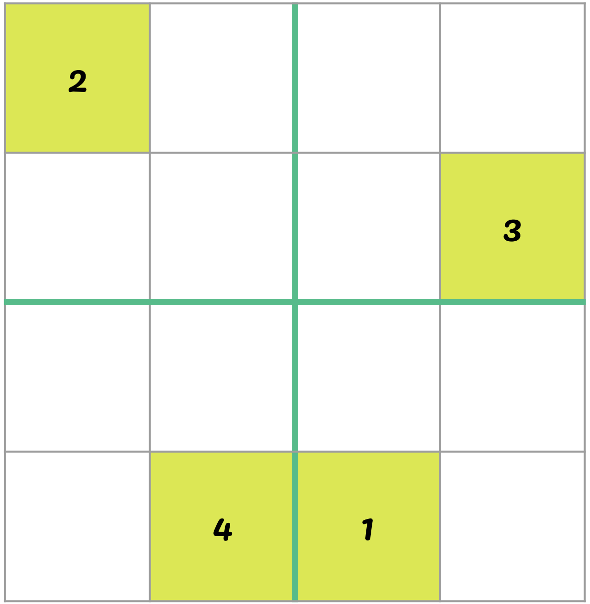
Sudoku Implementation - one last thought

Maps!

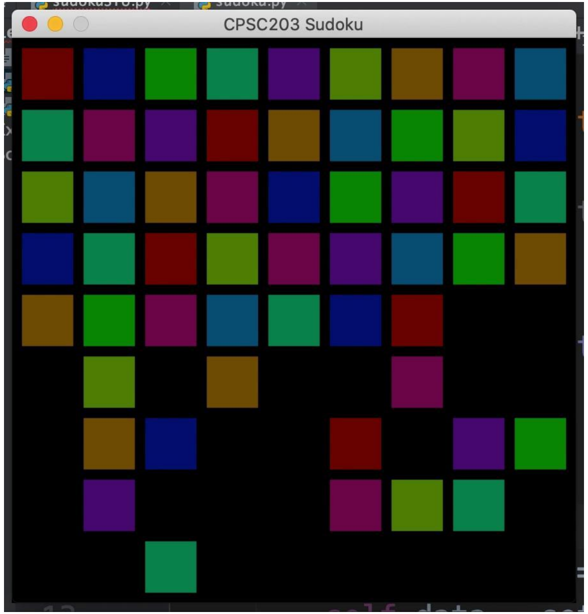
Shortest Path

Sudoku, one last thought…

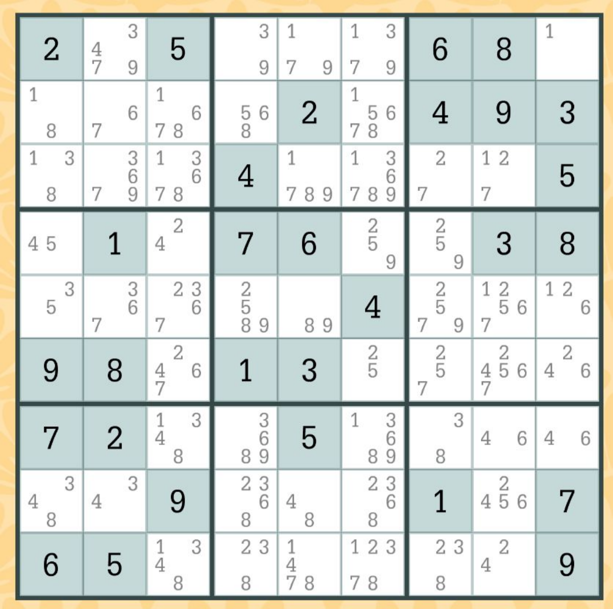
Recall our algorithm for searching… could we be smarter?



2			
			3
	4	1	

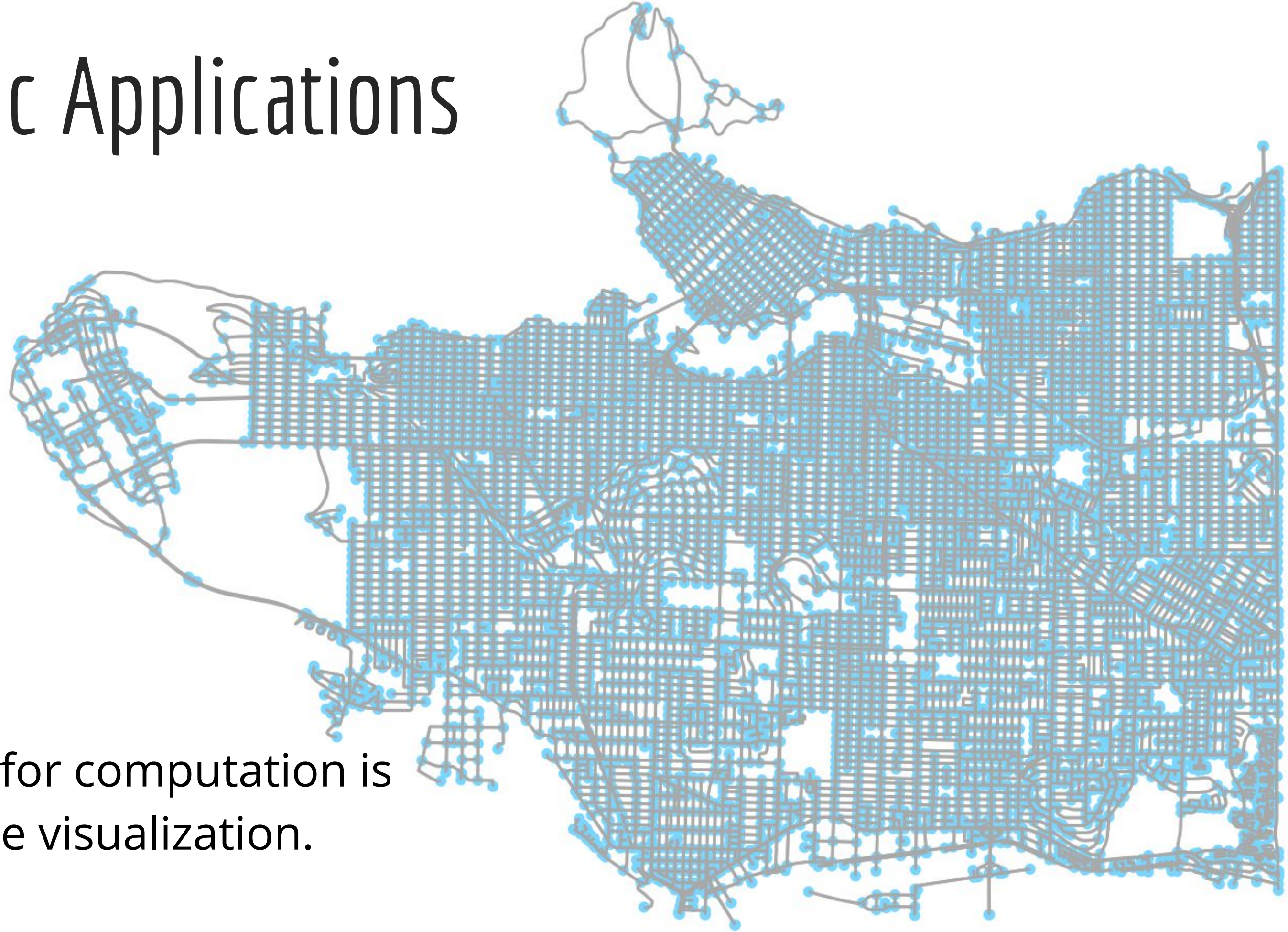


CPSC203 Sudoku



2	3 4 7 9	5	3 9	1 7 9	1 3 7 9	6	8	1
1 8	6 7	1 6 7 8	5 6 8	2	1 5 6 7 8	4	9	3
1 3 8	3 6 7 9	1 3 6 7 8	4	1 7 8 9	1 3 6 7 8 9	2 7	1 2 7	5
4 5	1	2 4	7	6	2 5 9	2 5 9	3	8
3 5	3 6 7	2 3 6 7	2 5 8 9	8 9	4	2 5 7 9	1 2 5 6 7	1 2 6
9	8	2 4 6 7	1	3	2 5	2 5 7	2 4 5 6 7	2 4 6
7	2	1 3 4 8	3 6 8 9	5	1 3 6 8 9	3 8	4 6	4 6
3 4 8	3 4	9	2 3 6 8	4 8	2 3 6 8	1	2 4 5 6	7
6	5	1 3 4 8	2 3 8	1 4 7 8	1 2 3 7 8	2 3 8	2 4	9

Geographic Applications



The data we use for computation is separate from the visualization.

Data:

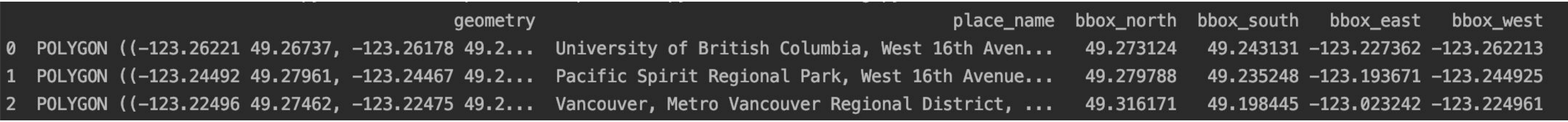
Open Street Maps

An open-source alternative to Google Maps' *data*.

https://www.openstreetmap.org/directions?engine=fossgis_osrm_car&route=49.2643%2C-123.1772%3B49.2584%2C-123.2466#map=14/49.2593/-123.2119

OSM provides an Application Programmer's Interface (API) that allows our program to request data, which is returned in a reasonable format.

Example: `ox.gdf_from_places(place_names,gdf_name='UBCVan')`



```
                                          geometry                                          place_name  bbox_north  bbox_south   bbox_east   bbox_west
0  POLYGON ((-123.26221 49.26737, -123.26178 49.2...  University of British Columbia, West 16th Aven...   49.273124   49.243131 -123.227362 -123.262213
1  POLYGON ((-123.24492 49.27961, -123.24467 49.2...  Pacific Spirit Regional Park, West 16th Avenue...   49.279788   49.235248 -123.193671 -123.244925
2  POLYGON ((-123.22496 49.27462, -123.22475 49.2...  Vancouver, Metro Vancouver Regional District, ...   49.316171   49.198445 -123.023242 -123.224961
```

Map applications

Three parts:

1. Assembling the data - OSM, local data stores, statsCan, etc. This is mostly the art of assembling geodataframes.

2. Computing on the data - osmnx simplifies graph algorithms and computation, but also supports other spatial computation.

3. Visualizing the data - matplotlib for static maps, folium for interactive maps.

Introductory Demo

What surprises you in the code?

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What surprises you in the maps?

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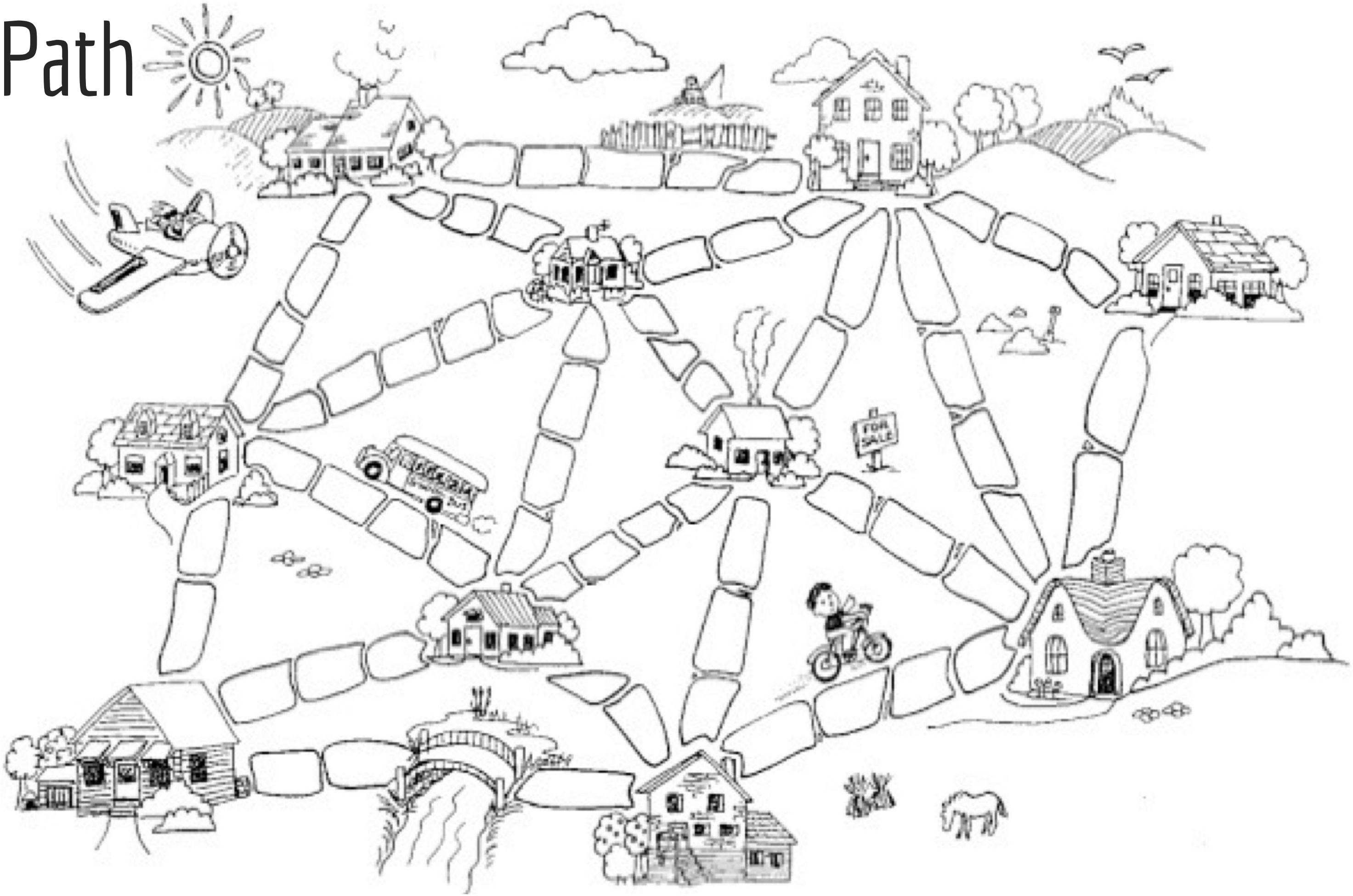
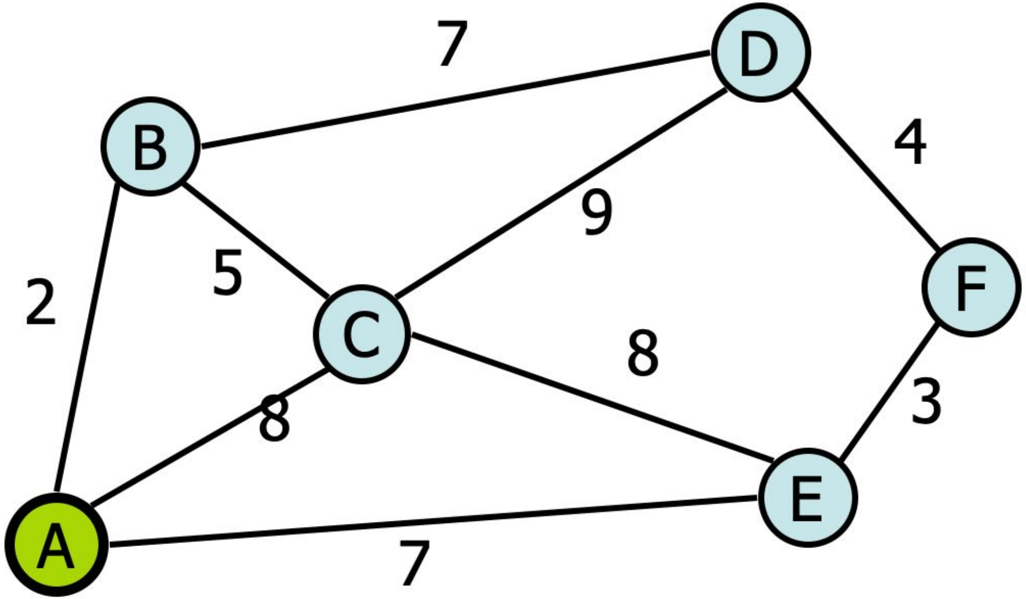
Shortest Path

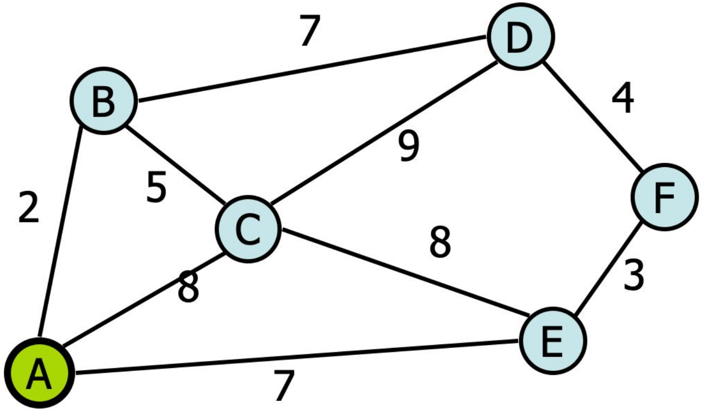


Dijkstra’s Algorithm

Single Source Shortest Path: Given a graph G and a start vertex s, returns the shortest path from s to every other vertex in G.



Dijkstra’s Algorithm



Initialize structure:

1. For all v, d[v] = “infinity”, p[v] = null
2. Initialize source: d[s] = 0
3. Initialize priority (min) queue
4. Initialize set of labeled vertices to ∅.

Repeat these steps n times:

```
•   Find & remove minimum d[] unlabelled
    vertex: v

•   Label vertex v

•   For all unlabelled neighbors w of v,
        If cost(v,w) < d[w]
            d[w] = cost(v,w)
            p[w] = v
```

Dijkstra’s Algorithm

How is this algorithm similar to BFS/DFS?

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How is this algorithm different than BFS/DFS?

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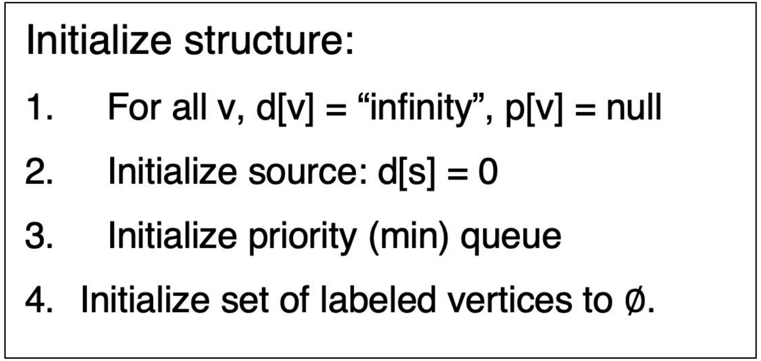

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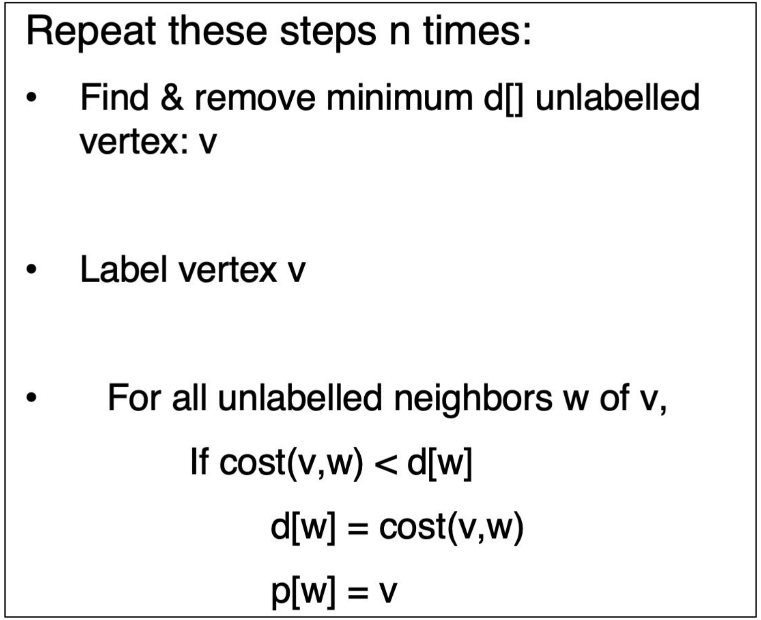

```
Repeat these steps n times:
•   Find & remove minimum d[] unlabelled
    vertex: v

•   Label vertex v

•     For all unlabelled neighbors w of v,
          If cost(v,w) < d[w]
              d[w] = cost(v,w)
              p[w] = v
```

POTD #34 Tue

https://github.students.cs.ubc.ca/cpsc203-2019w-t1/potd34

Describe any snags you run into:

1. Line ___: ______________________________
2. Line ___: ______________________________
3. Line ___: ______________________________
4. Line ___: ______________________________
5. Line ___: ______________________________

ToDo for next class...

POTD: Continue every weekday! Submit to repo.

Reading: TLACS Ch 10 & 12 (lists and dictionaries)

References:

https://www.youtube.com/watch?v=wsSEKm-rU6U

https://github.com/gboeing/osmnx-examples/tree/master/notebooks

https://gist.github.com/psychemedia/b49c49da365666ba9199d2e27d002d07