MIAMI, Florida Traffic and Evacuation

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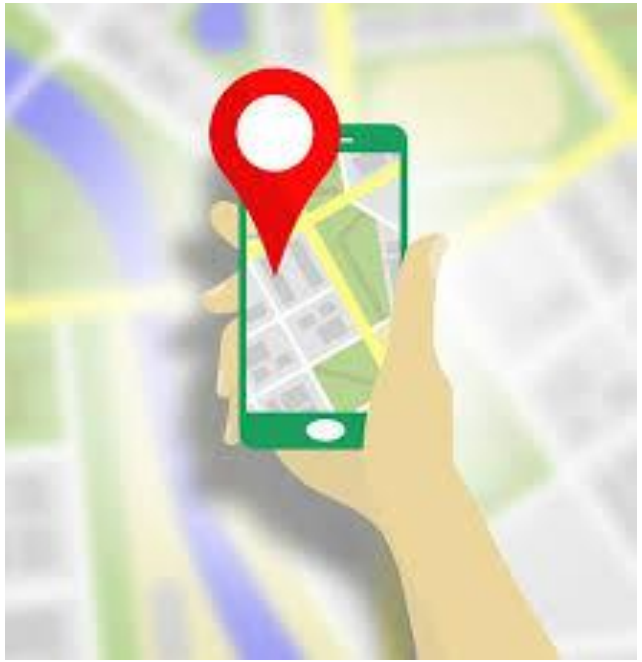
Optimizing Evacuation Routes using Real-Time Traffic Information

Agenda

- Define the problem
- Obtain the data
- Explore the data
- Model the data
- Evaluate the model
- Respond to the problem



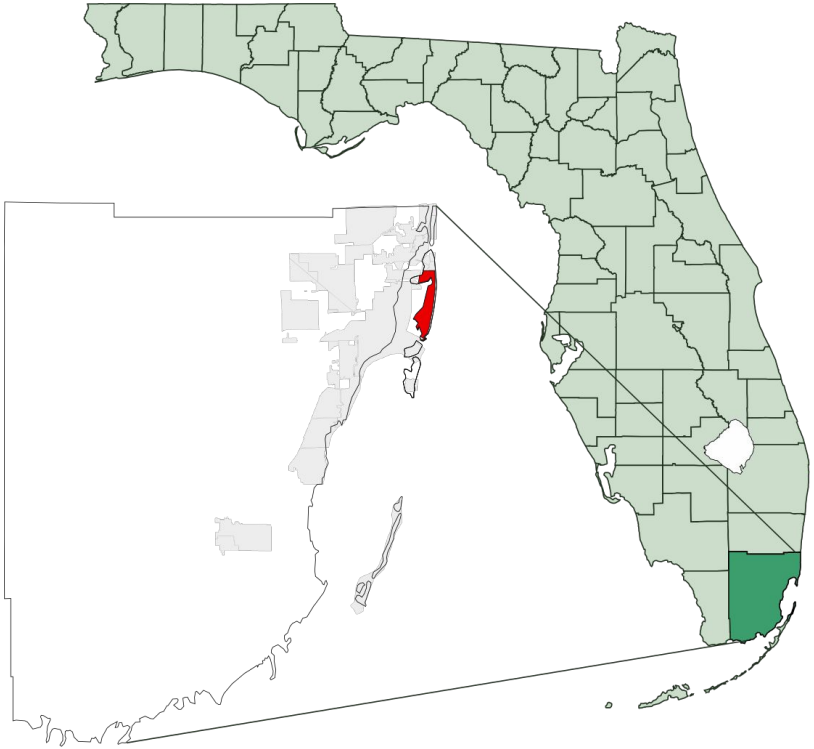
Define the Problem

- Get to safety as fast as possible.
- Many current GIS and navigation systems do not rely on real-time data.
- Real time road closures or damaged roads, power outages and other blocked routes may affect traffic lights, travel time, travel safety and more.

Define the Problem

Leverage social media, news feeds and other datasets to search for any of these conditions and identify if and where they exist in a specific location (street, neighborhood, city etc.)

Where to base our model?



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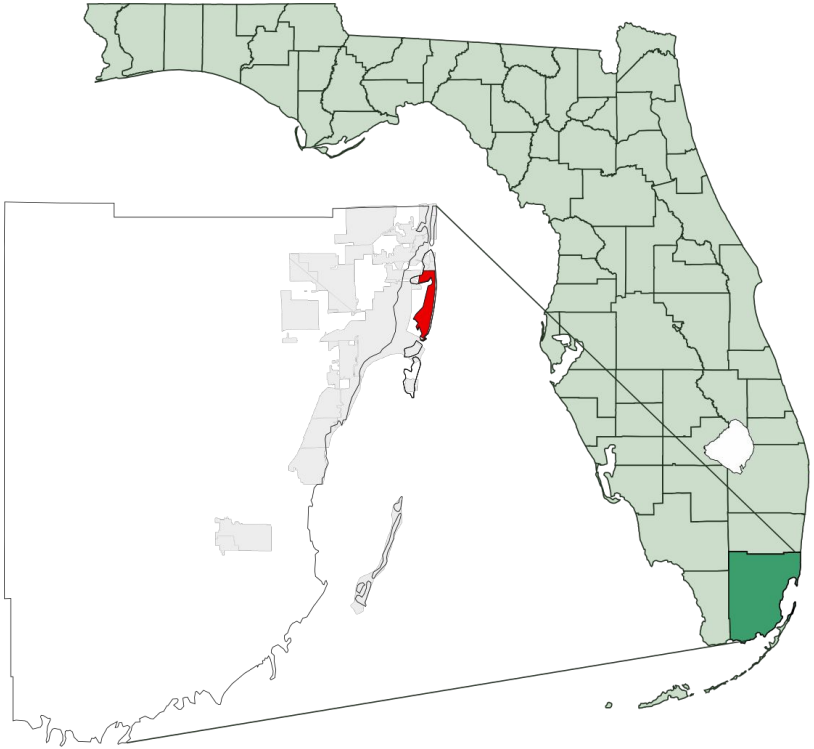
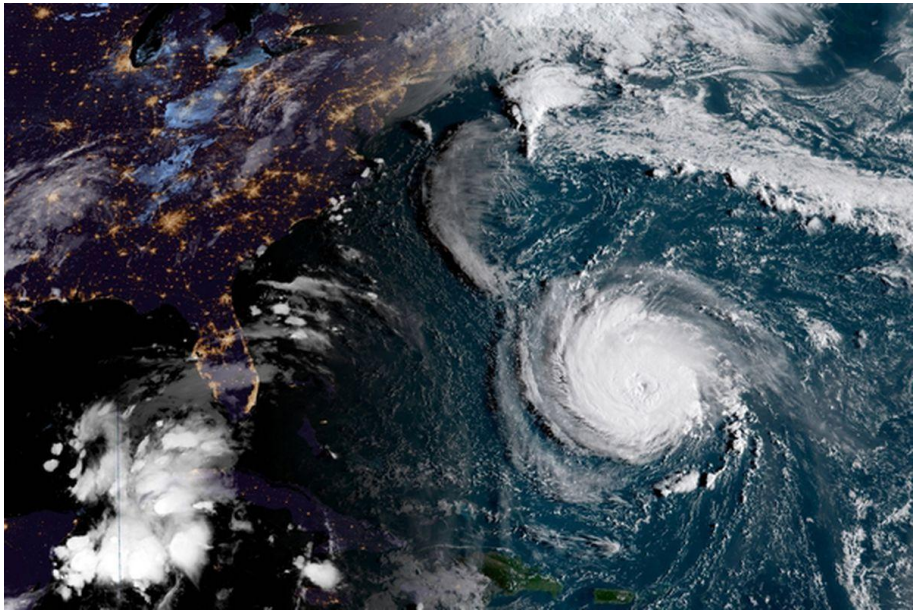




“ *Problem : Use tweets to classify if a road in the Miami area is closed in real-time* ”

Our solution

Gather all Maimi tweets

Collect posts from news/traffic over 1 week.

Process and Model

Test and fine-tune classifier on one road, apply to the rest.

Find new route

Use optimization to produce fastest path upon closure of a road.

Data Gathering: scrape twitter, FL511

https://twitter.com/fl511_southeast?lang=en

- Used GetOldTweets3 module written by Mottl
- Most accurate and all encompassing source of traffic
- Used highway status to create target variable

Time-sensitive Scraping

- Pulled all tweets posted in or around Miami from July 24 to July 30, 2019

- Gathered maximum tweets available: 80,000 tweets every day, for eight days.

- Pulled tweets from Miami local news sites over the past year.

- Found better results from all tweets than from news site's tweets.

Modeling

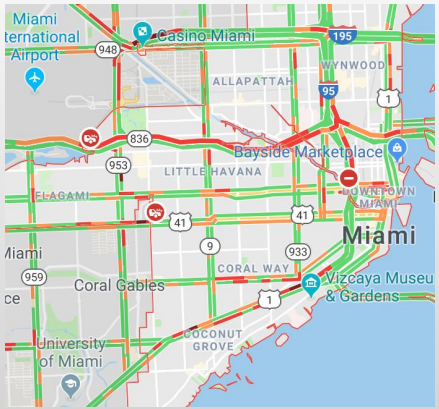
- Focused on 6 major roadways, looking at each direction independently
- Looked at 2 corpuses: all tweets in an hour and news sites only in an hour
- Hyperparameters for every road model tuned based on I-95 North performance; test accuracy average performance
- Support Vector Classification had the best accuracy

Model Goal

INPUT

time	tweets
2019-07-28 11:00:00+00:00	That look good I need one https://www.facebook...
2019-07-28 12:00:00+00:00	OH. Now I understand. And no.Divers agree loca...
2019-07-28 13:00:00+00:00	I just spit out my coffee. This is real.Awww s...
2019-07-28 14:00:00+00:00	This week, Henry joins Kevin on Management Con...
2019-07-28 15:00:00+00:00	Same principle. COM over the back leg. Watch h...

OUTPUT



time	I-95 North	I-95 South	95 Express North	95 Express South	I-195 East	I-195 West
30-07-2019, 07 PM	1	0	0	0	0	0
30-07-2019, 08 PM	1	0	0	0	0	0
30-07-2019, 09 PM	1	1	1	0	0	0
30-07-2019, 10 PM	1	1	1	0	0	0
30-07-2019, 11 PM	1	1	1	0	0	0

Model Performances

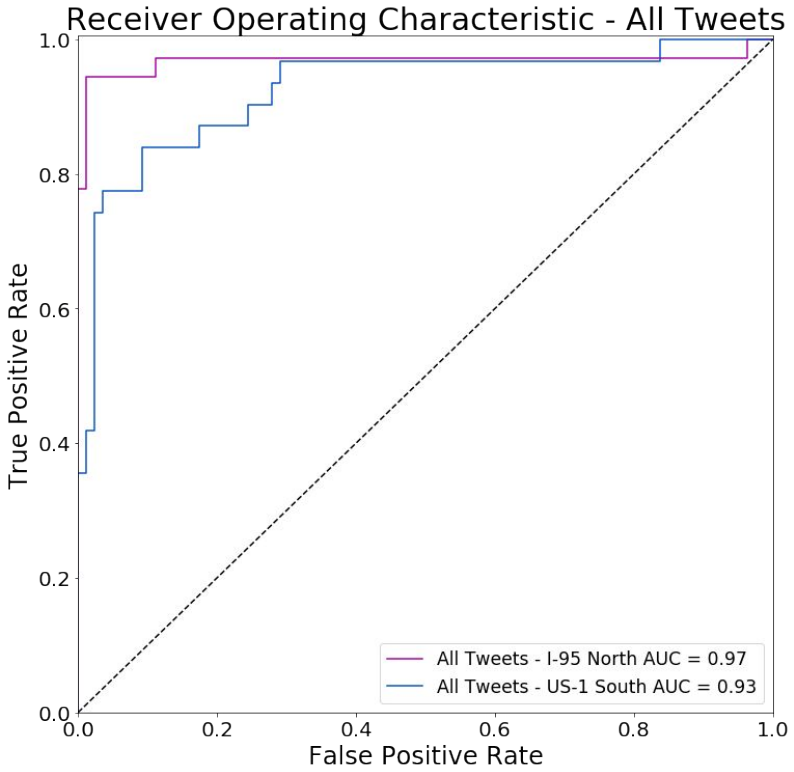
All Tweets: ngram_range=(2,5)

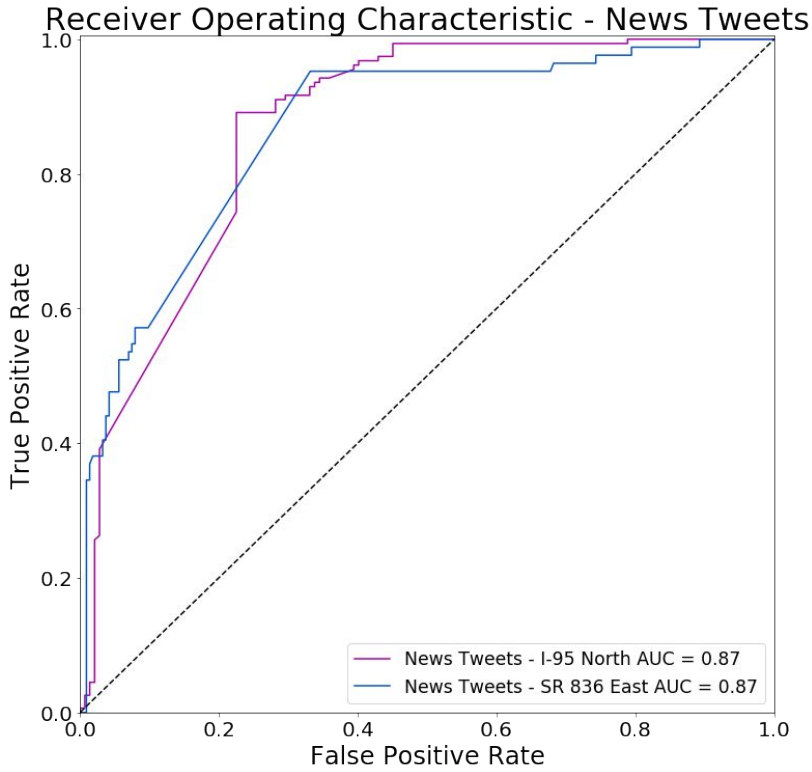
	Avg	Best	Worst
Road	-	I-95 North	US-1 South
Baseline Accuracy	0.73	0.69	0.73
Train Accuracy Improvement	0.23	0.31	0.20
Test Accuracy Improvement	0.07	0.21	-0.03

News Tweets: ngram_range=(4,8)

	Avg	Best	Worst
Road	-	I-95 North	SR 836 East
Baseline Accuracy	0.73	0.52	0.73
Train Accuracy Improvement	0.15	0.31	0.14
Test Accuracy Improvement	-0.01	0.13	-0.10

ROC Curves

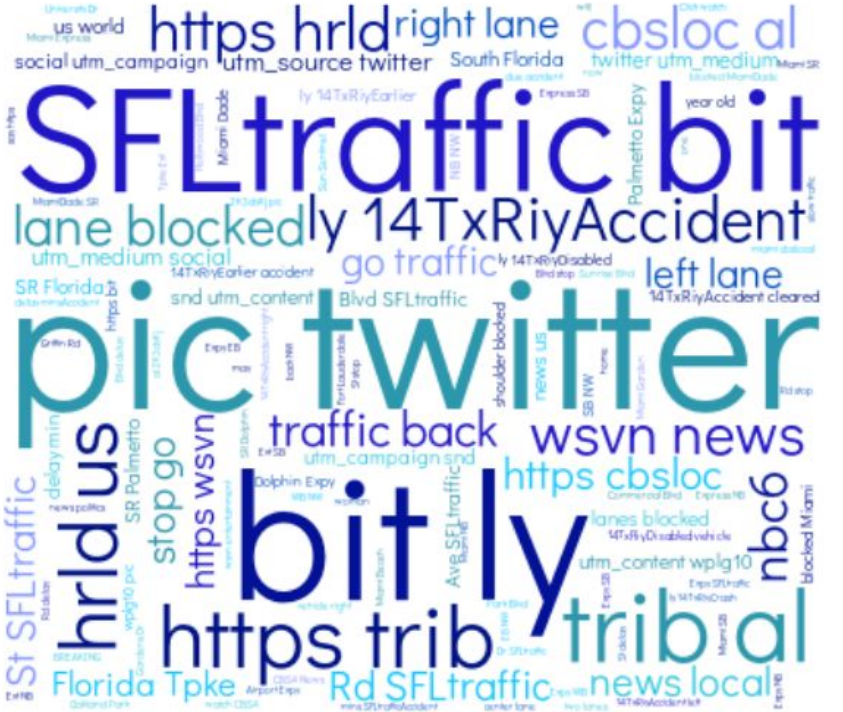

Receiver Operating Characteristic - All Tweets
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
All Tweets - I-95 North AUC = 0.97
All Tweets - US-1 South AUC = 0.93


Receiver Operating Characteristic - News Tweets
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
News Tweets - I-95 North AUC = 0.87
News Tweets - SR 836 East AUC = 0.87

Word Use Frequency

All Tweets

News Site Tweets



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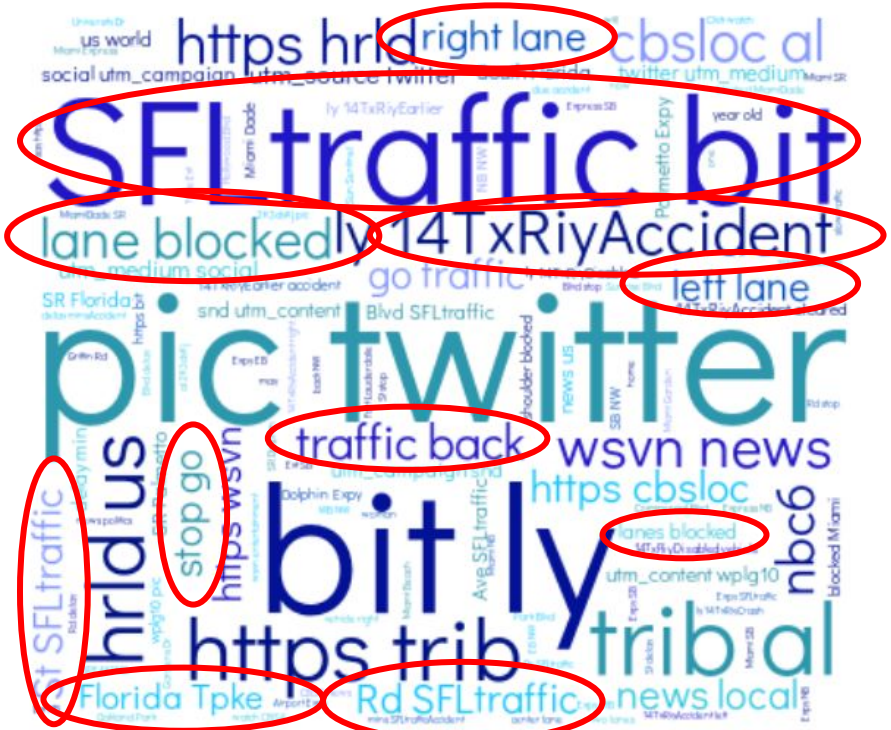
All Tweets

News Site Tweets



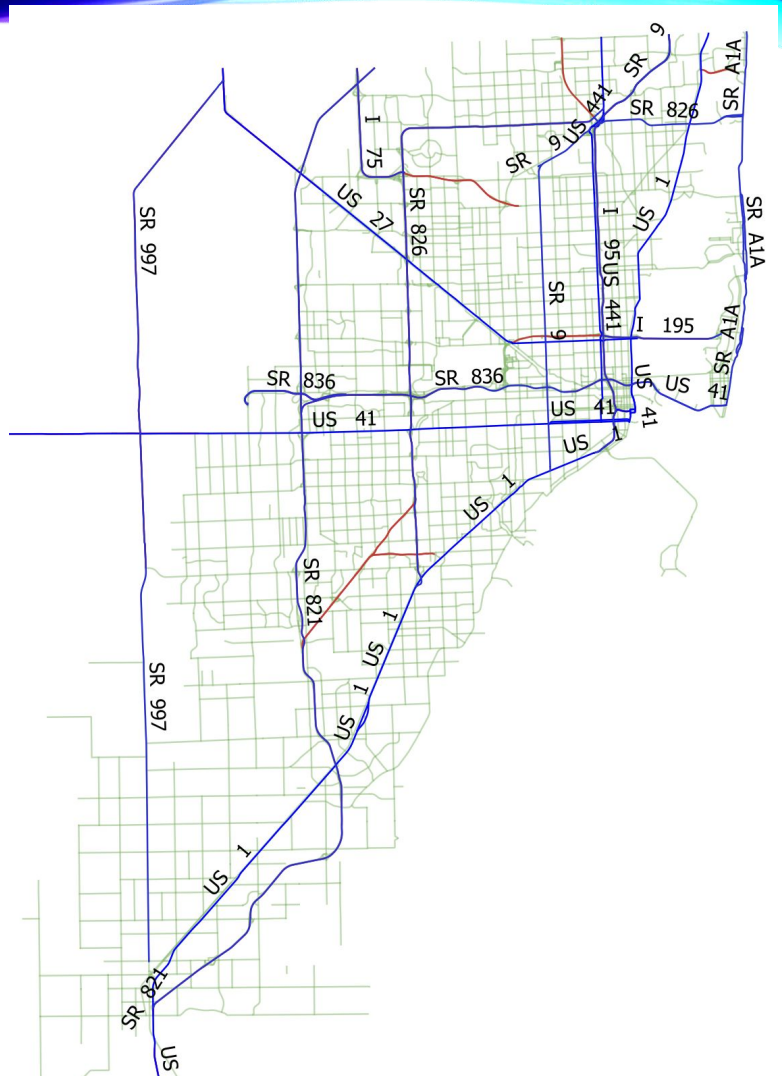
Optimization

We can now predict when a road is closed in real-time

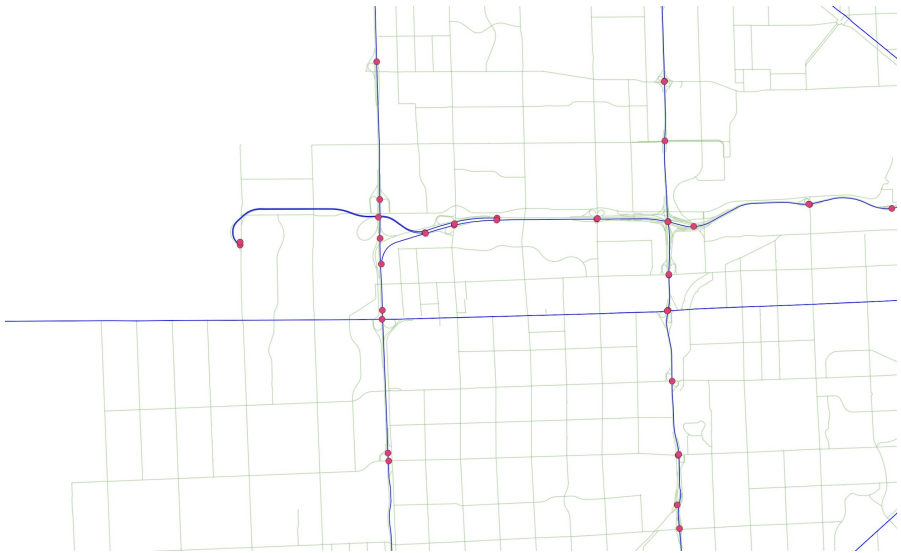
Let's form an evacuation plan

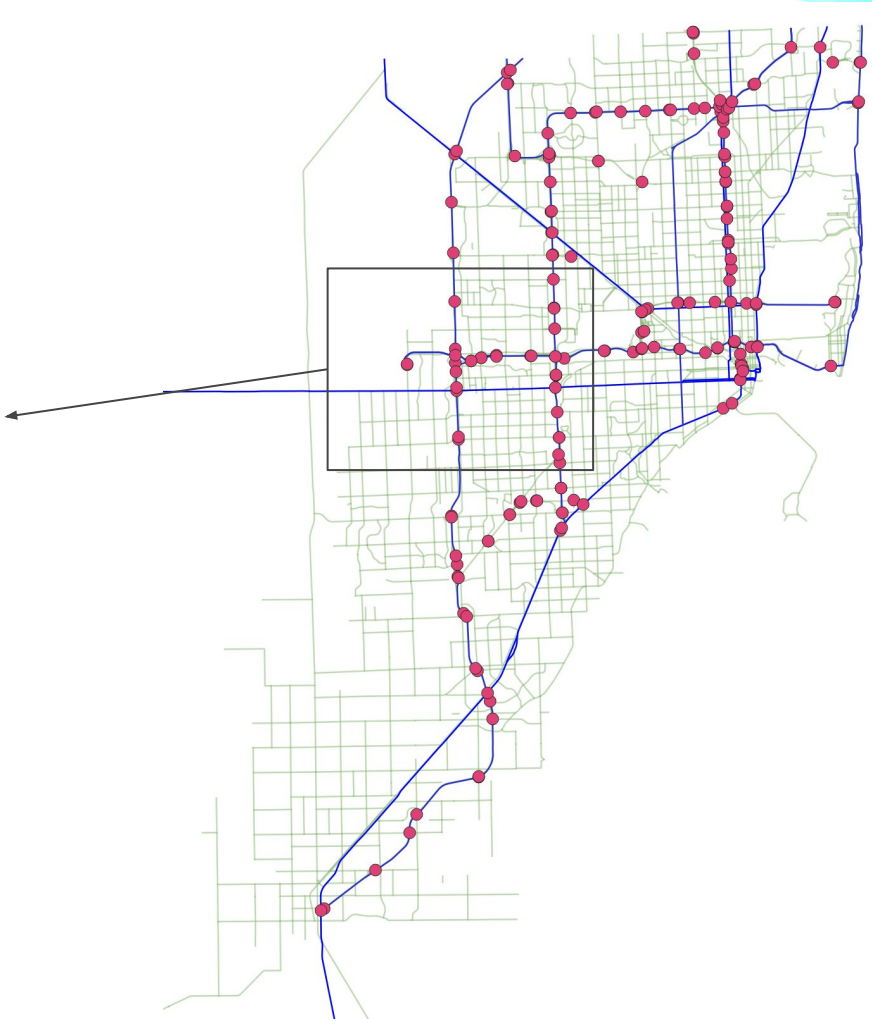
Choose highways as they have more lanes and higher speed limits

Also consider map coverage and direction of evacuation



Optimization





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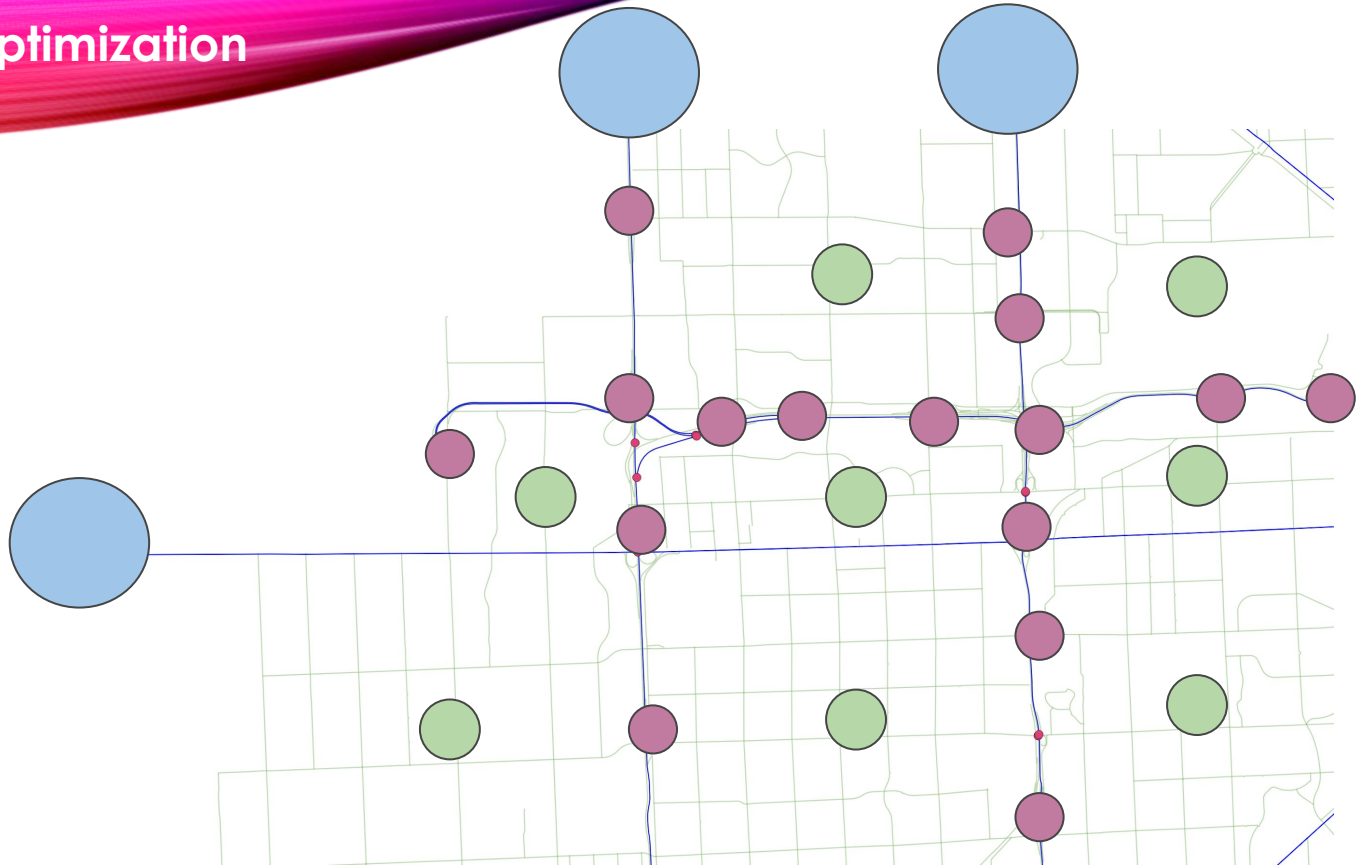
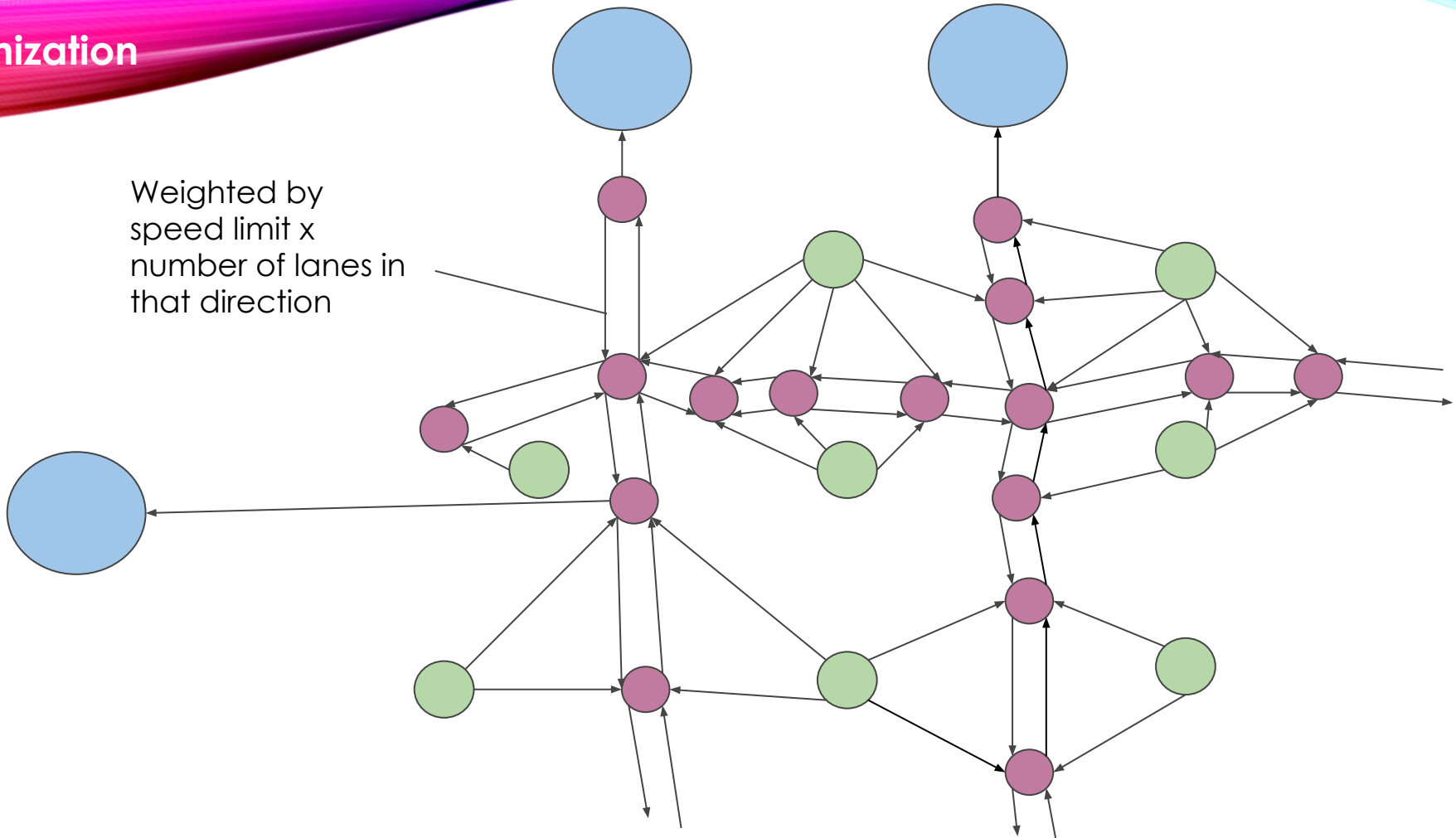


Interchanges

Safety

Optimization

Weighted by speed limit x number of lanes in that direction



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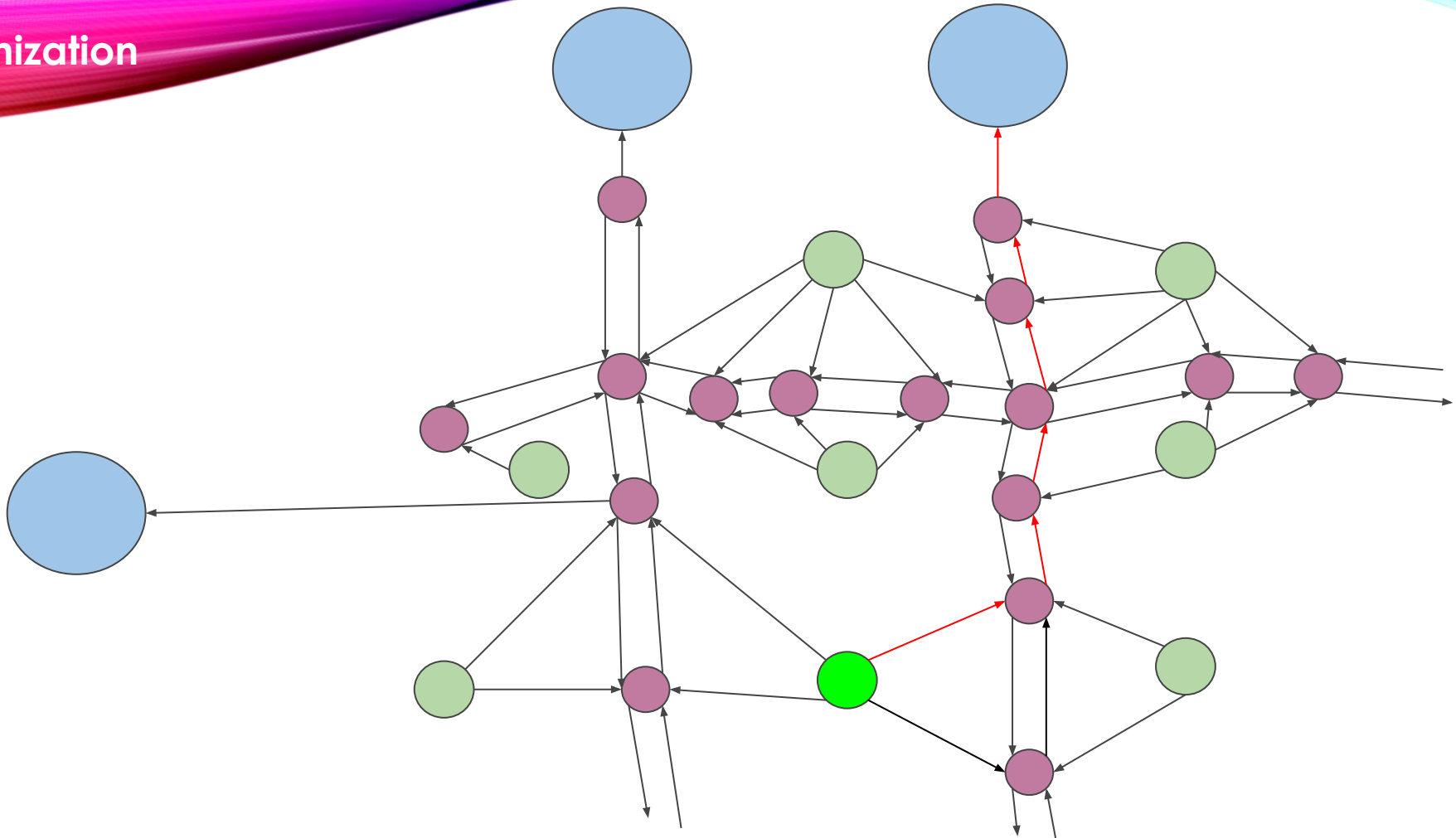

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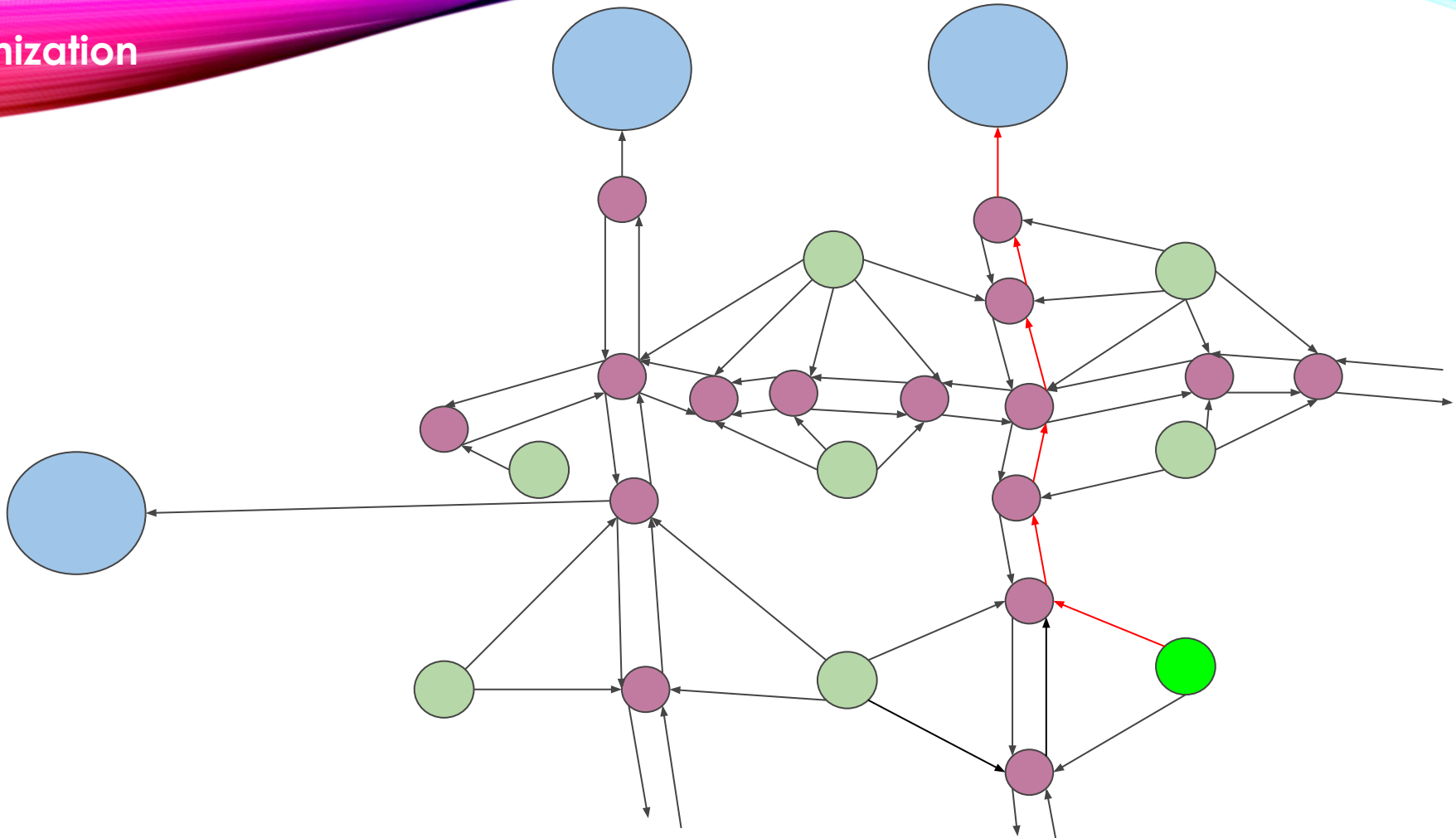

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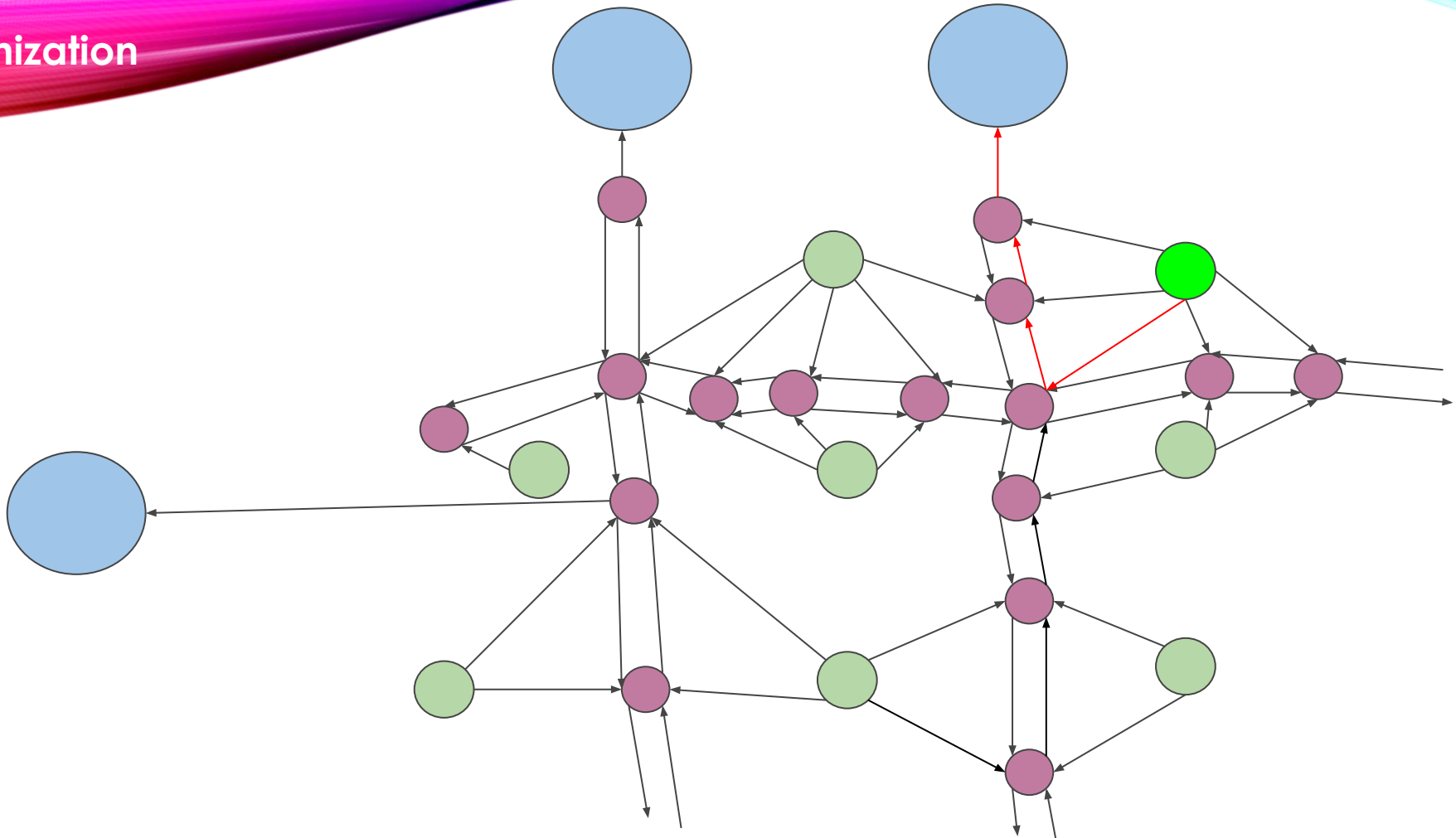

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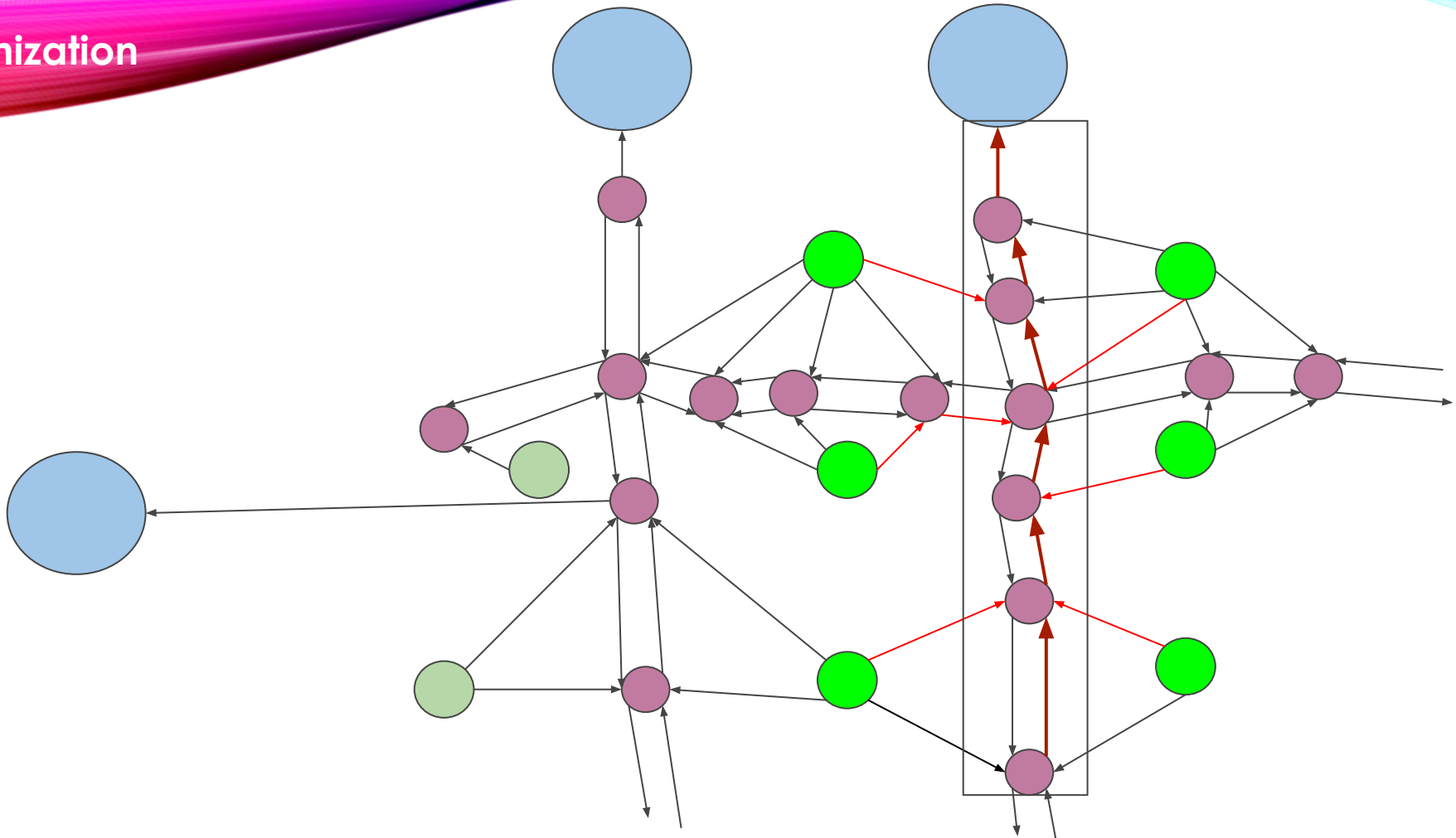


Maximum Flow Problem

https://en.wikipedia.org/wiki/Maximum_flow_problem

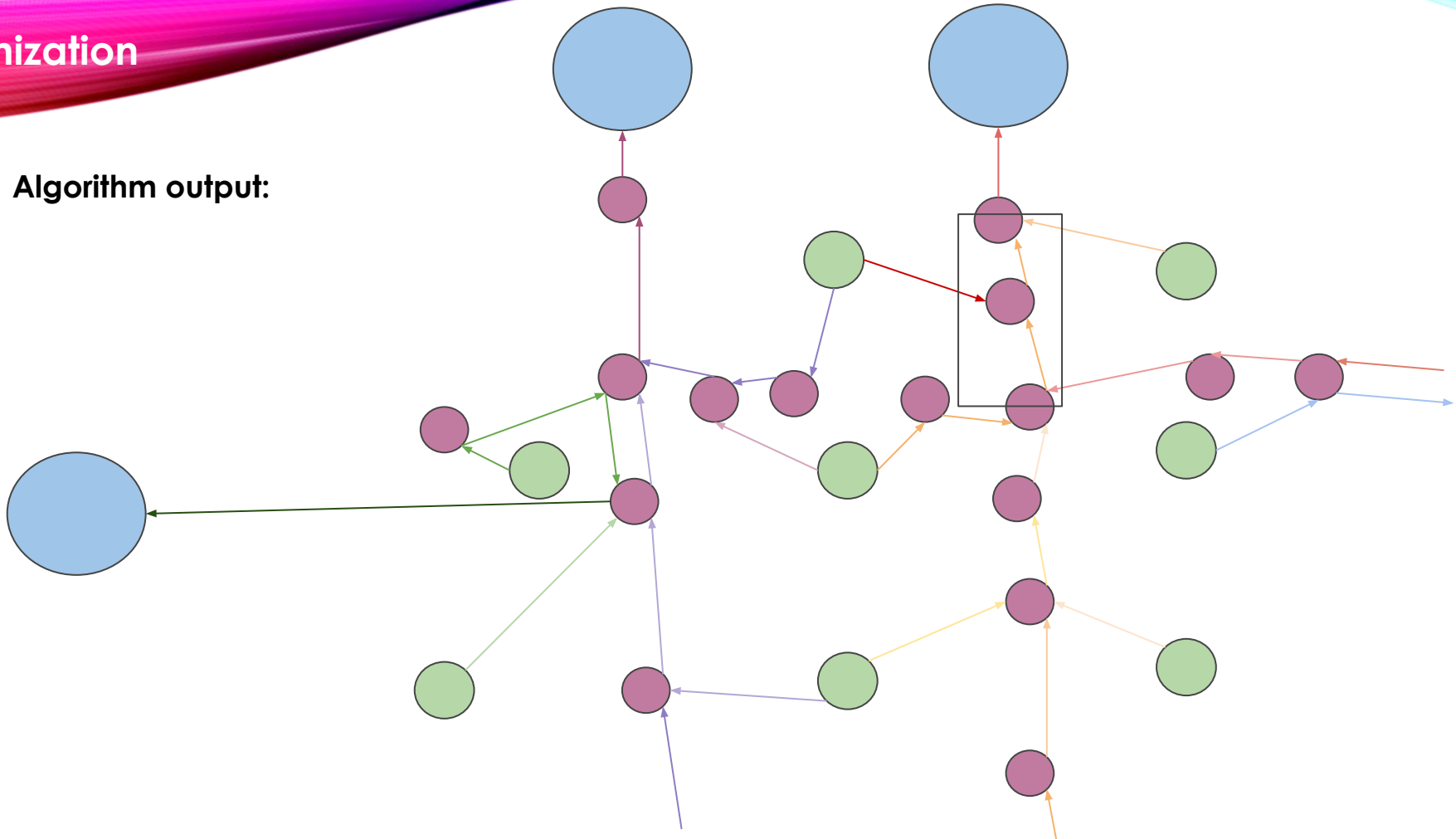
Linear Program - Can be solved with Simplex Method

Ford-Fulkerson Algorithm: Allows solves maximum flow optimally (Proof of optimality - Max Flow Min Cut Theorem: https://en.wikipedia.org/wiki/Max-flow_min-cut_theorem)

Very computationally efficient - Worst case is O(nlog^3n) time, but in practice much faster, https://cs.idc.ac.il/~smozes/msms-planar-flow.pdf

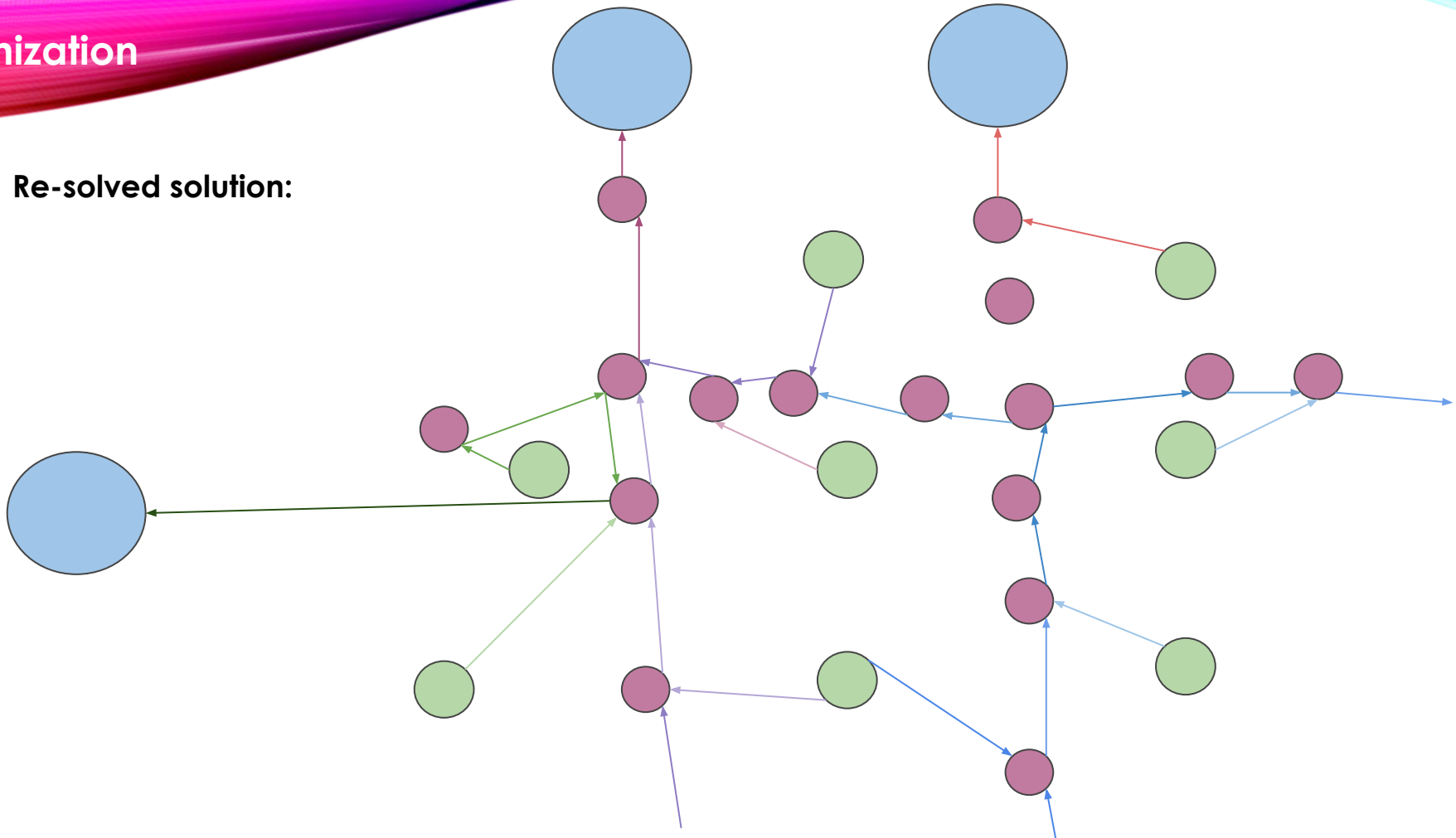
Optimization

Algorithm output:



Optimization

Re-solved solution:




Thank You