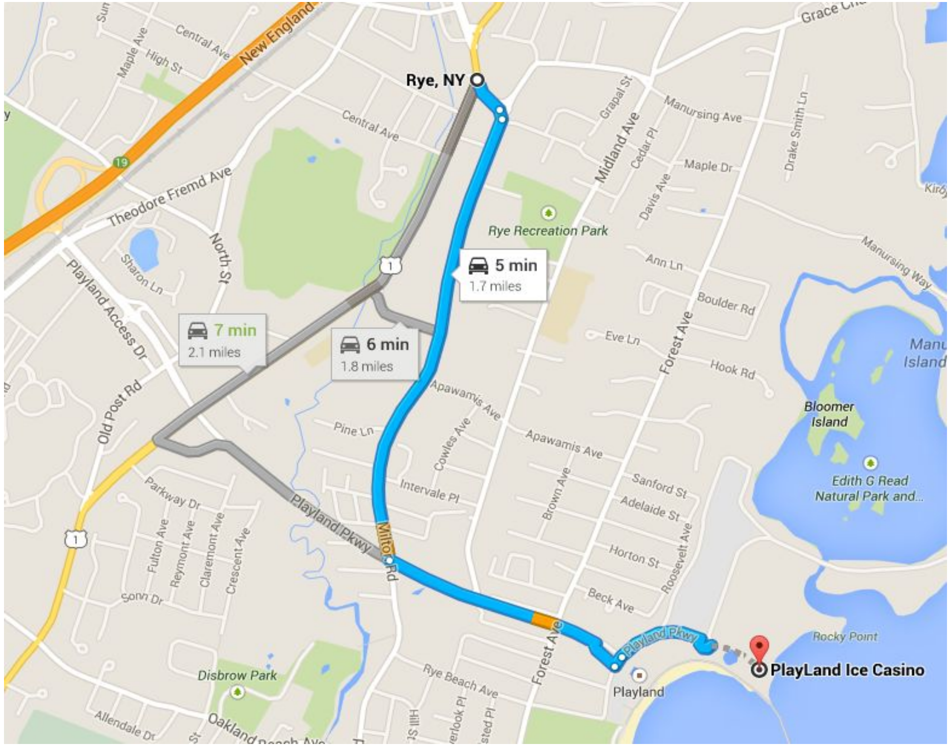
What is the fastest way to travel from Rye town to Playland?

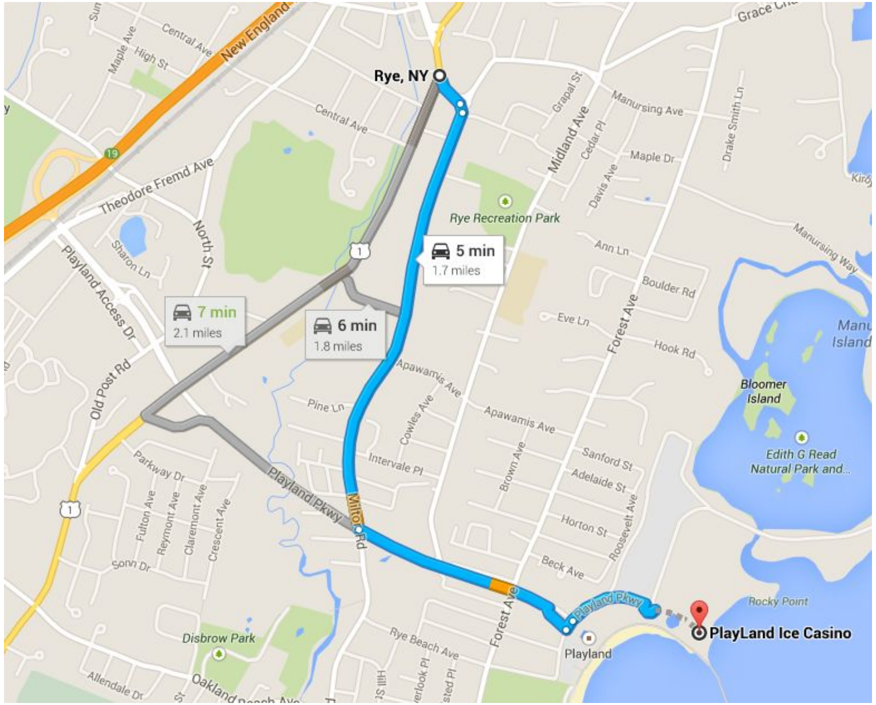
Mihir Bala

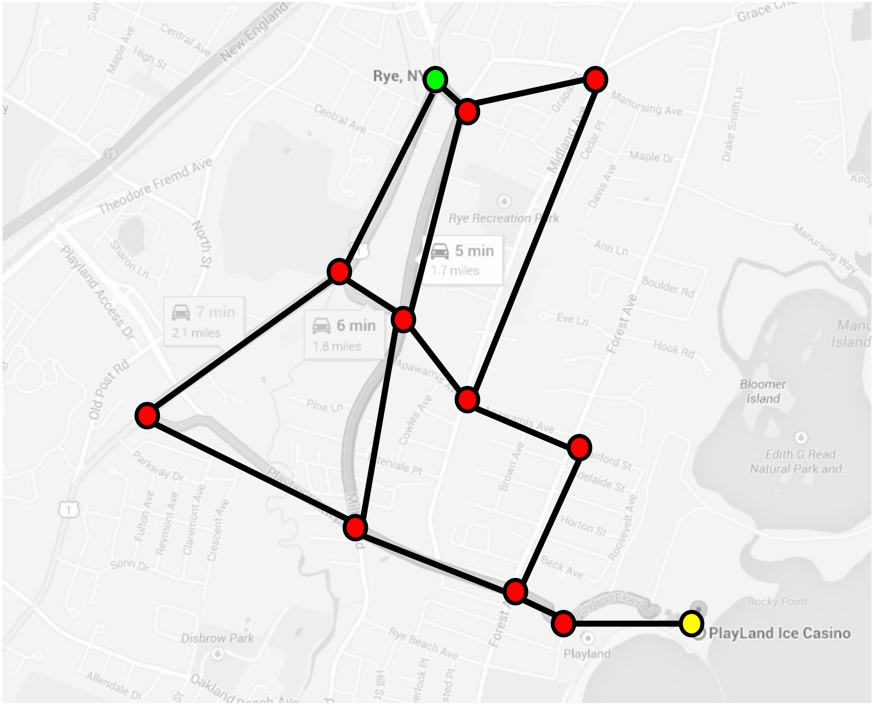
Ask Google Maps...



But how did Google compute this route?

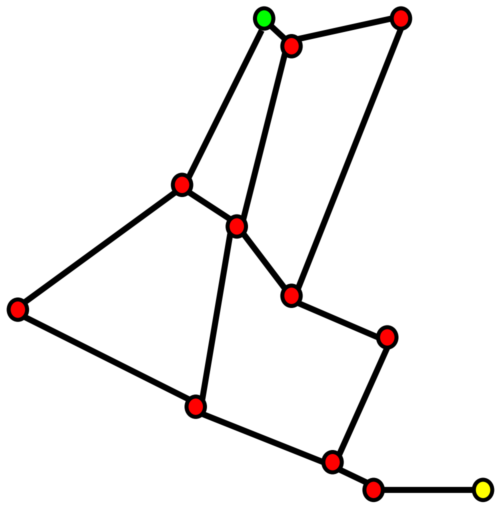
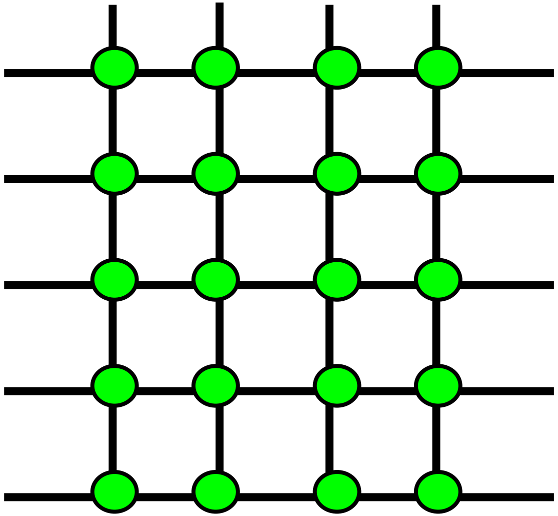
Step 1: Model the map as a “graph”



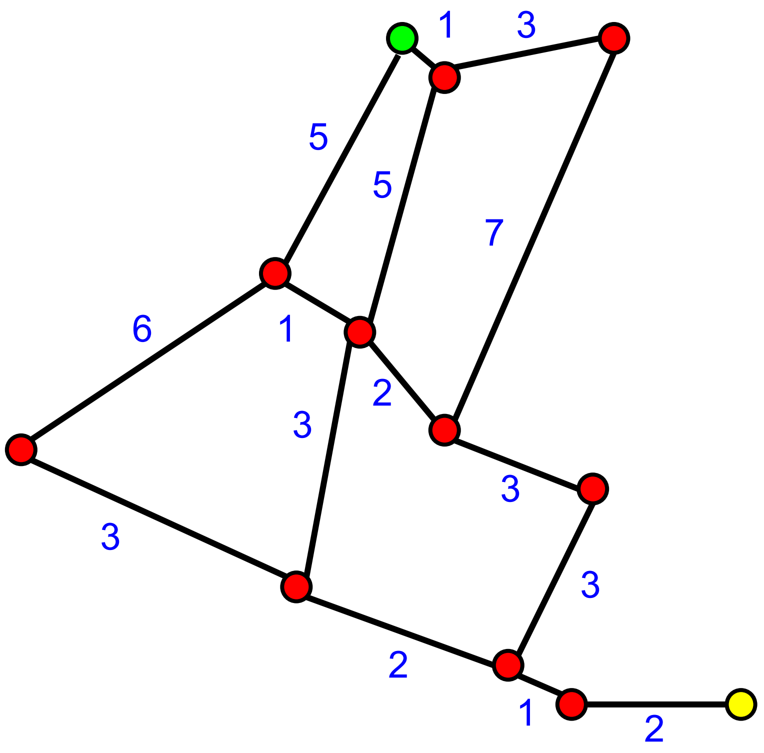


What is a graph?

- Computer science data structure
- A collection of edges and nodes

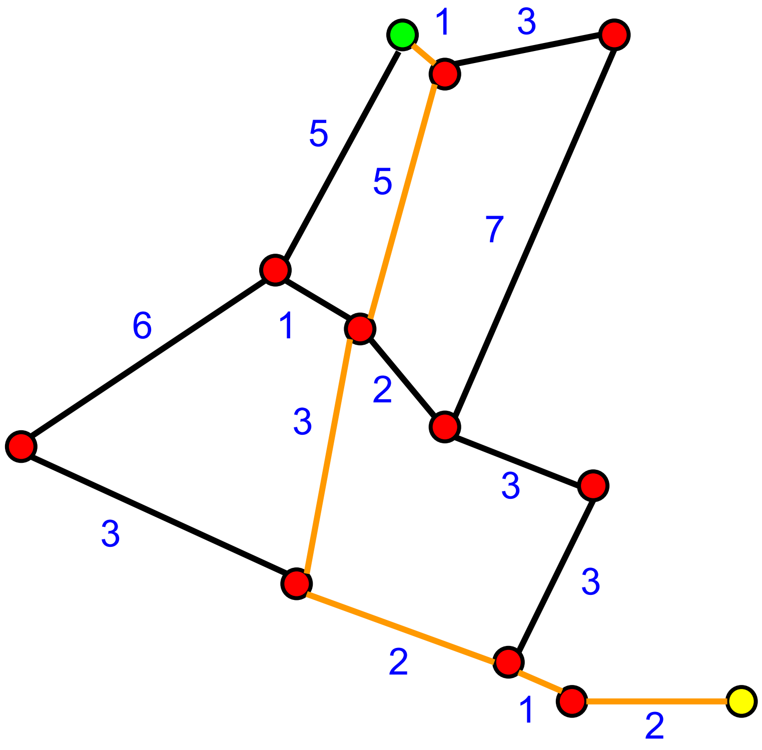

Step 2: Add “cost” to the edges



Cost is determined by:

- Distance
- Road type
- Traffic congestion

Step 3: Compute the “best” route



Djikstra’s algorithm:

- Finds the lowest cost route between two nodes in a graph

What is the fastest way to fly from Rye town to Playland?

Civilian UAVs (drones)

- Monitoring deforestation
- Preventing animal poaching
- Delivering medicine to remote areas
- Topographic mapping

Challenges

- No pre-defined paths (roads)
- Different obstacles
  - Terrain (mountains)
  - Weather (wind)
- Earth’s curvature
- Budget

Pentagon’s budget:

$500,000,000,000

- Satellite navigation
- Expensive on-board computers

My budget:

$5

- GPS waypoints
- Cheap Cloud computing

How civilian drones are routed today

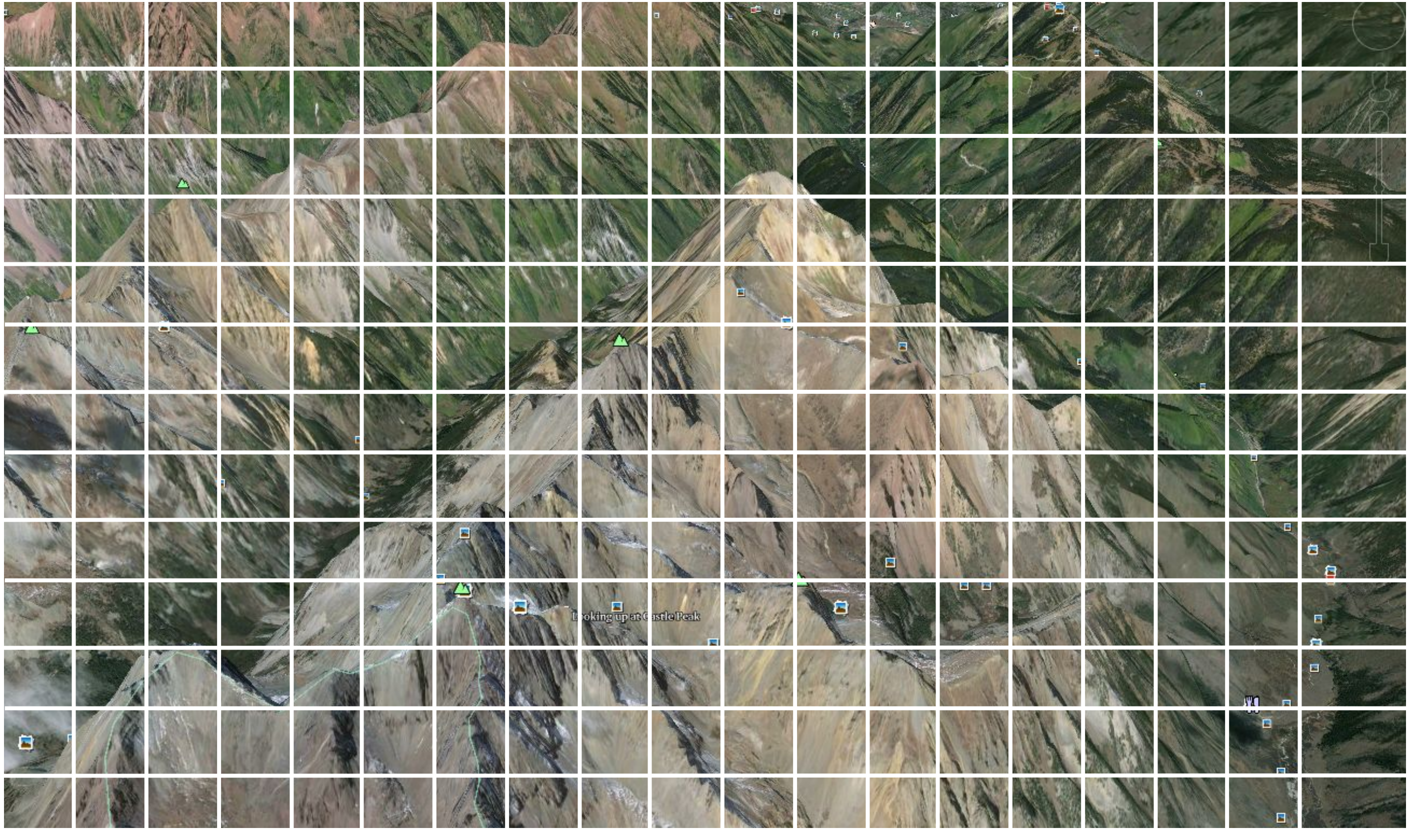
- Manual plotting of 3D route
- Converted to sequence of GPS waypoints
- GPS waypoints uploaded into drone

This is like the world before Google Maps!

Can we build a Google Maps-like service for routing drones?

Cheap, automated, and works anywhere in the world!

Step 1: Overlay a grid on the terrain



Step 2: Use elevation data for cost

Step 3: Use Djikstra's algorithm

Issues

- Grid size makes cost computation prohibitive
  - Example: a 100 km^2 grid will have 1,000,000 nodes!
- Insight: most of the grid is unused
  - Compute cost on the fly
- Need A* variation of Djikstra's algorithm
  - Dynamically discovers terrain
  - Used to route the Mars Rover
  - Animation showing how A* works

My solution

- Novel extensions to A* routing algorithm:
  - Faster computation of elevation
  - Dynamic conditions (weather data)
- Usability for drone routing
- Accessibility through the Cloud

Demo

http://neon-griffin-788.appspot.com

Citations

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Thank you!