

The Bicycle Thief

CIS 110, Fall 2015



Where to Buy a Bike

Someone has been selling used bikes on Tuesday afternoons all year out of a basement closet in SEAS.

- Who's been selling them?
- Where do they come from?
- How do they get there?

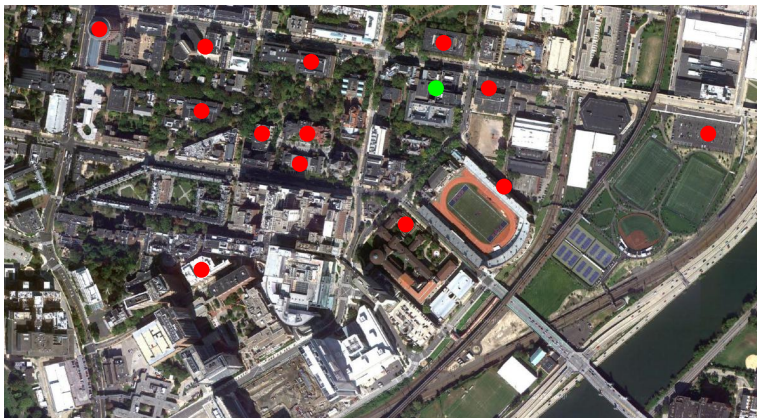


Courtesy Google Maps

The Bicycle Thief

One bike disappears from each of these spots every weekday morning!

- No time to go to each building separately
- Dangerous to go back to a building twice in one morning
- What is the shortest route to “collect” one bike from each building?

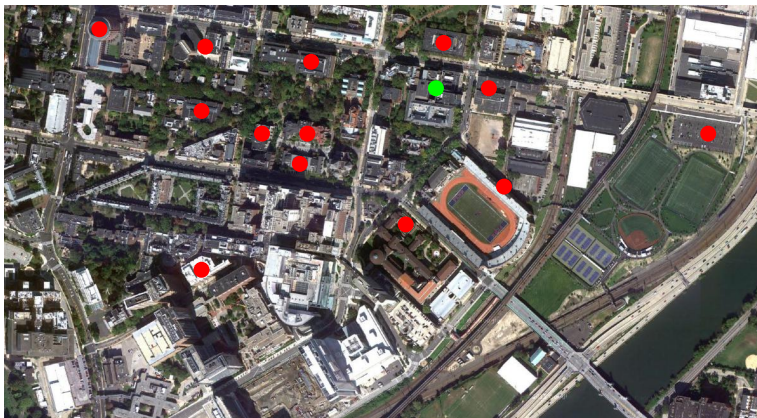


Courtesy Google Maps

Traveling Salesman Problem (TSP)

Find shortest tour of n cities: visit each exactly once, and return to start?

- Best known algorithms pretty much test every tour to find shortest
- If a better algorithm exists, you can do a zillion other interesting things fast too (e.g. rob a bank)

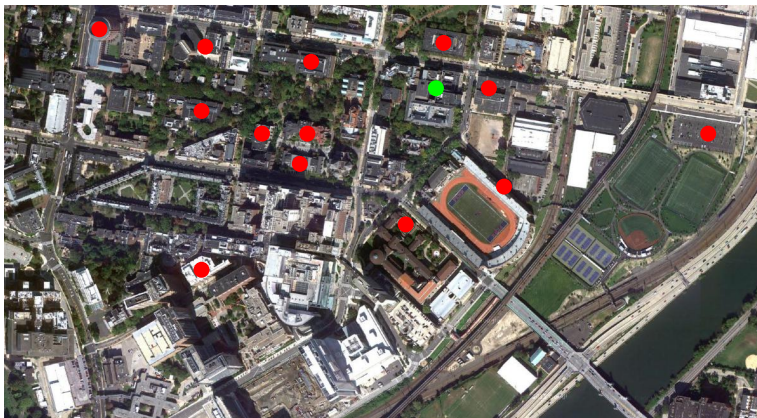


Courtesy Google Maps

Traveling Salesman Problem (TSP)

Find shortest tour of n cities: visit each exactly once, and return to start?

- Formally: TSP is an \mathcal{NP} -complete problem*
- Fast algorithm would mean $\mathcal{P} = \mathcal{NP}$ *
- Most famous open question in computer science



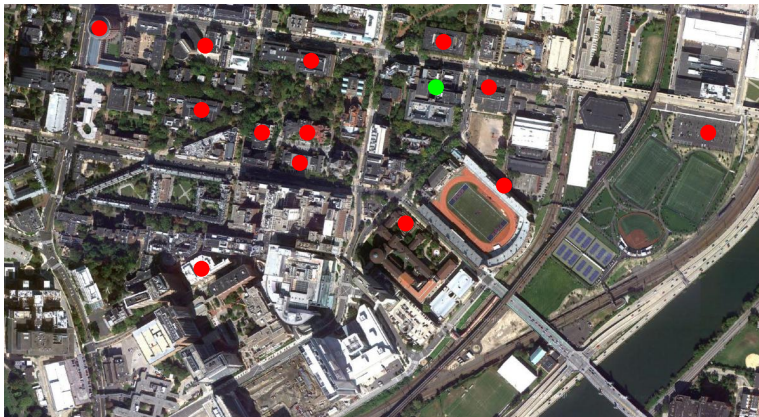
*Don't worry about what this means.

Courtesy Google Maps

Traveling Salesman Problem (TSP)

Trying everything is hard: instead use a *heuristic* (guess)

- Nearest Insertion: Add point to tour after closest point in tour
- Smallest Increase: Add point where it causes shortest detour

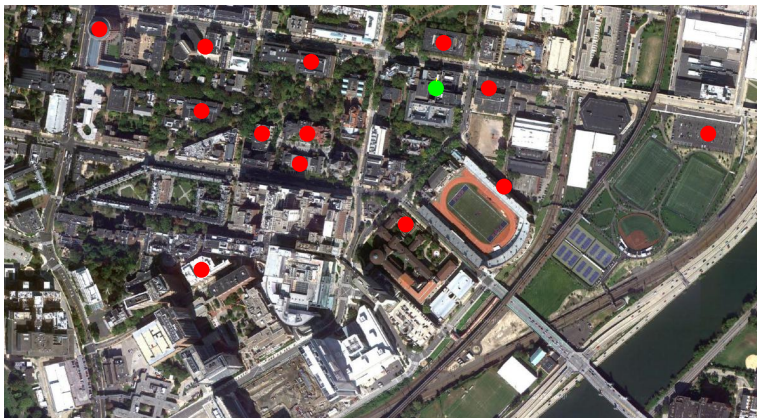


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- SEAS (distance: 0)

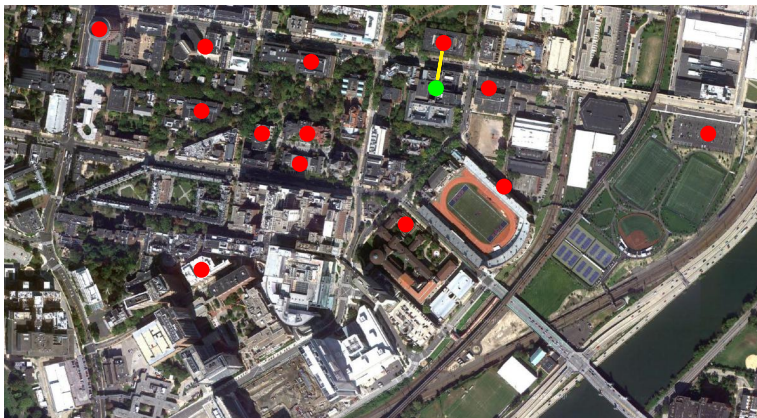


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Hill > SEAS (1.22)

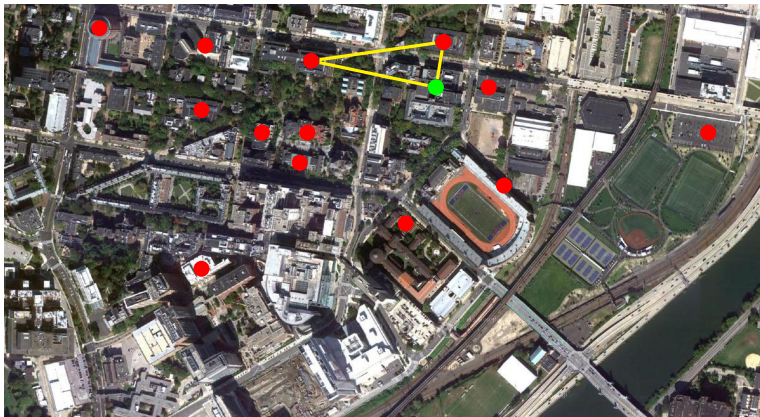


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Van Pelt > SEAS (4.06)

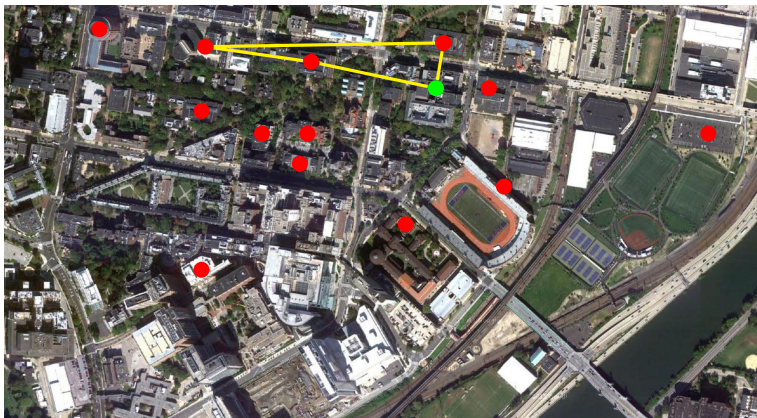


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Annenberg > Van Pelt (6.86)

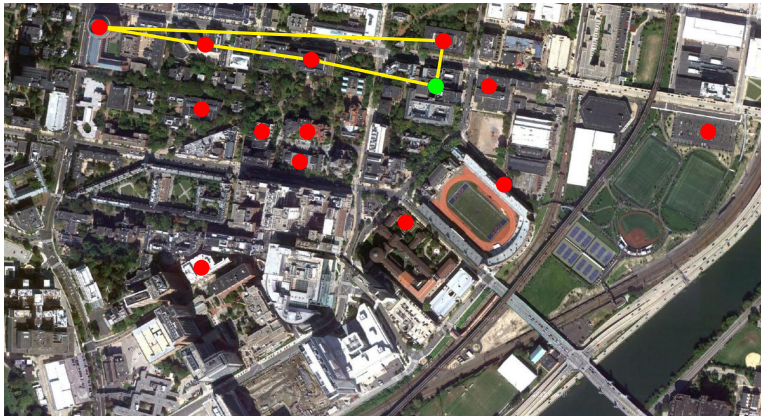


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Huntsman > Annenberg (9.68)

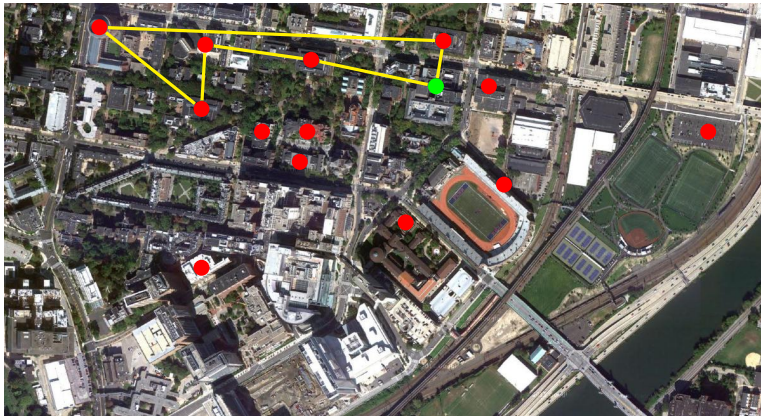


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Steinberg-Dietrich > Annenberg (10.84)

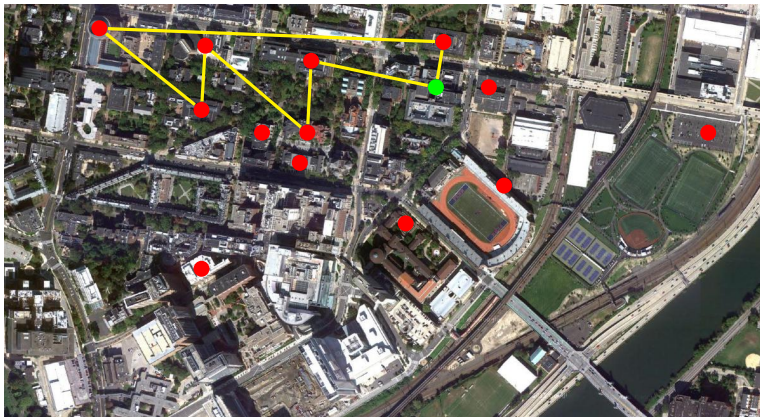


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- College > Van Pelt (12.15)

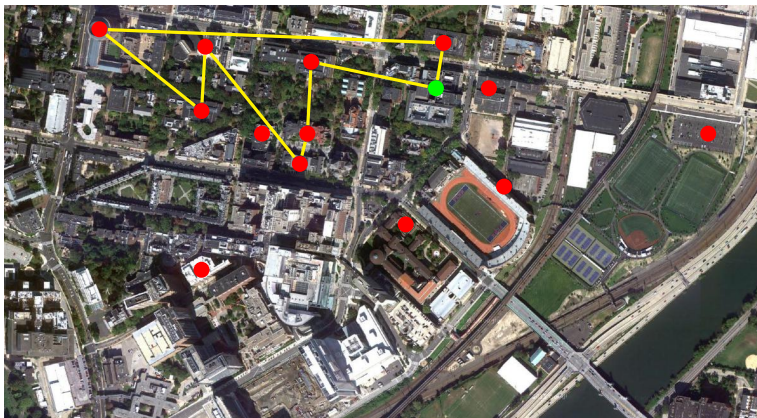


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Houston > College (12.78)

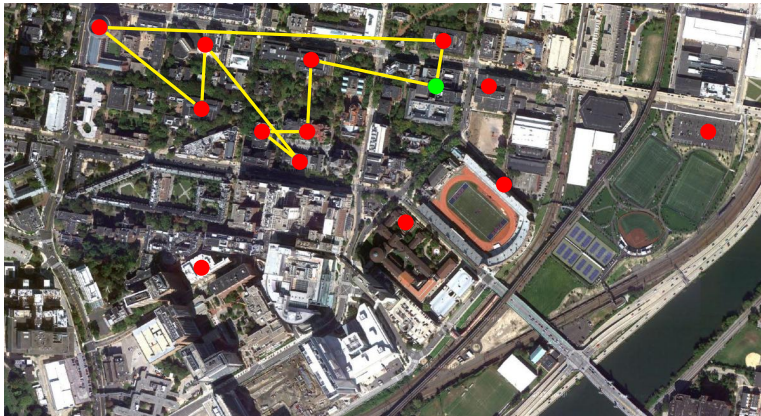


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Claudia-Cohen > College (13.61)

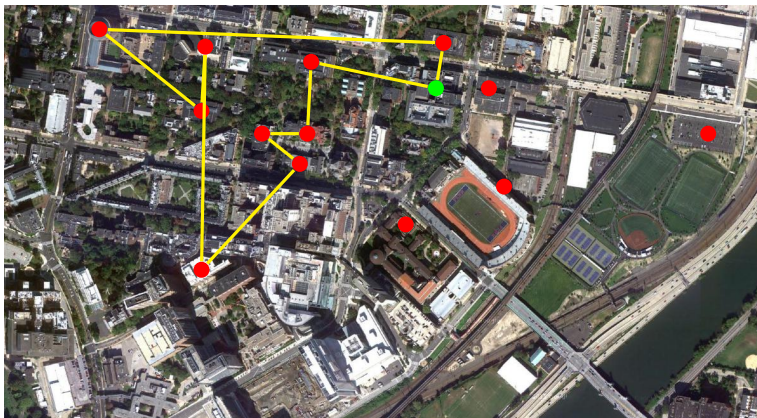


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Fagin > Houston (16.48)

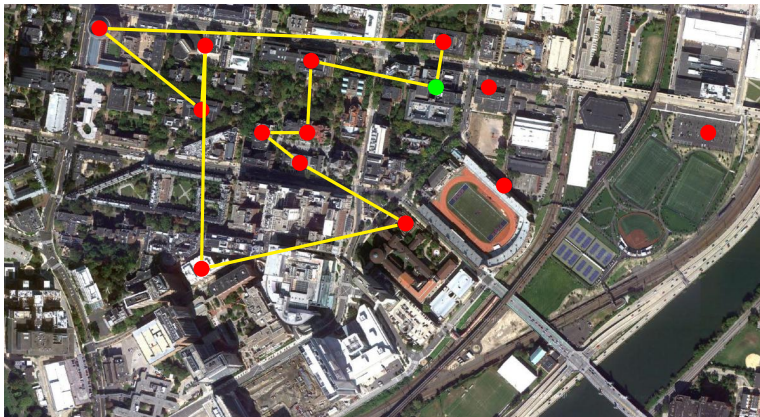


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Penn Museum > Houston (18.95)

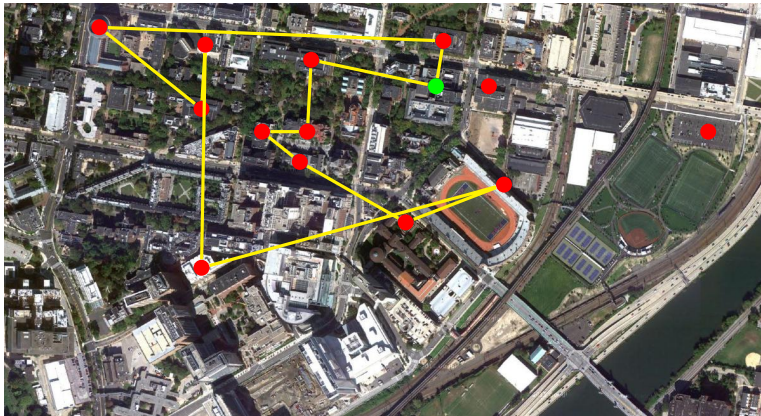


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Education Commons/Stadium > Fagin (21.72)

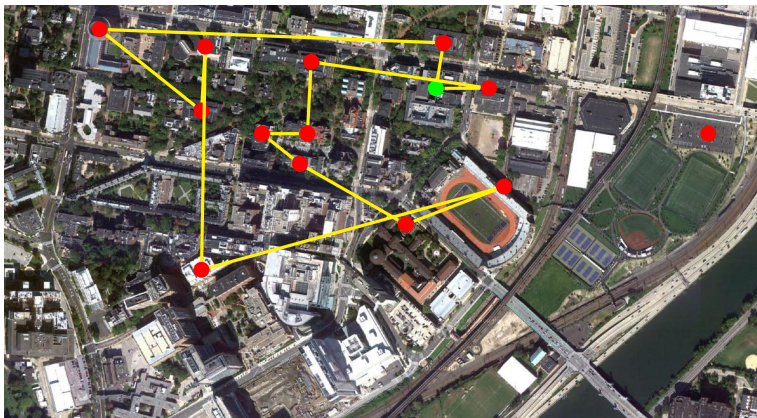


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- $DRL > SEAS$ (23.11)

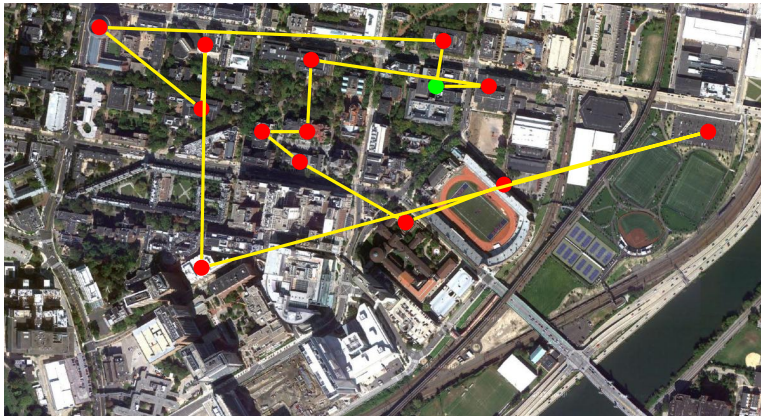


Courtesy Google Maps

Traveling Salesman Problem (Nearest Insertion)

Add each point after point it is closest to in tour

- Penn Park > Education Commons/Stadium (28.69)

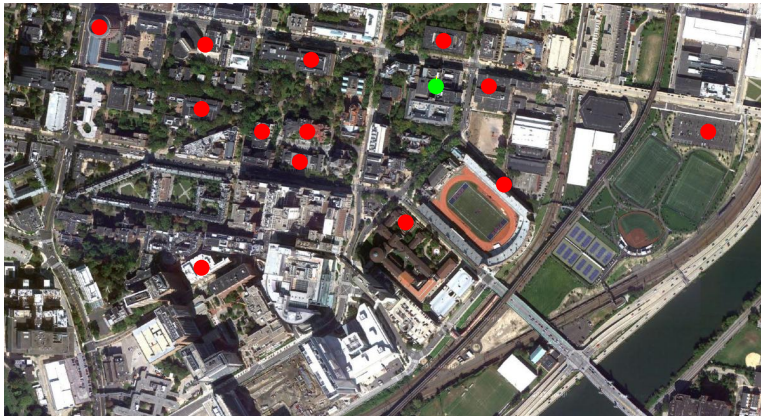


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- SEAS (distance: 0)

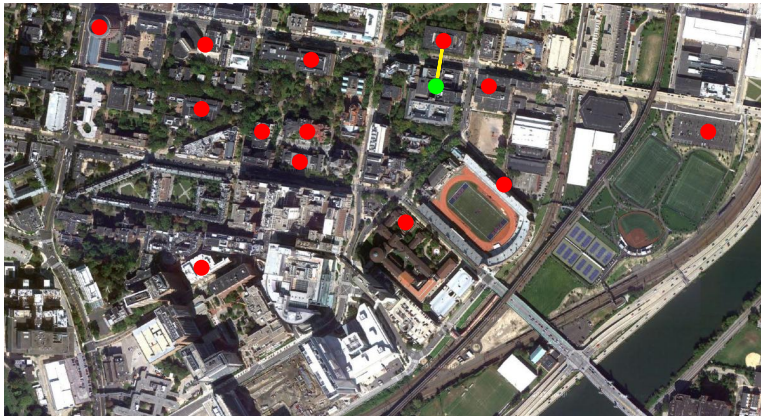


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Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Hill > SEAS (1.22)

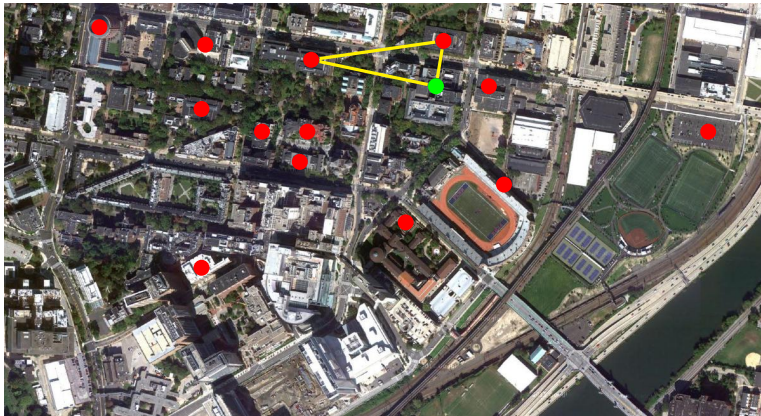


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Van Pelt > SEAS (4.06)

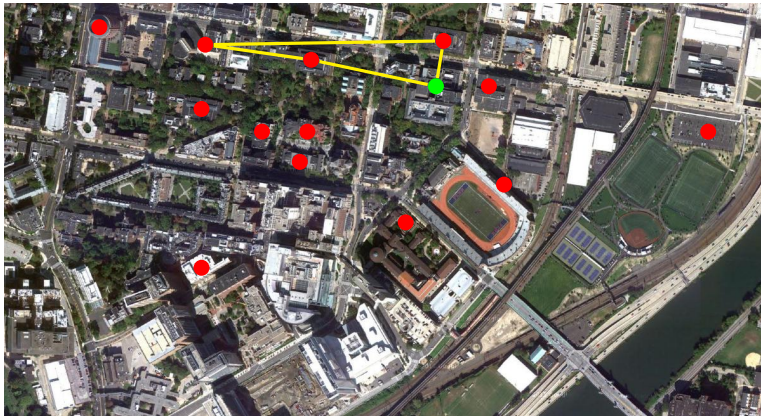


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Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Annenberg > Van Pelt (6.86)

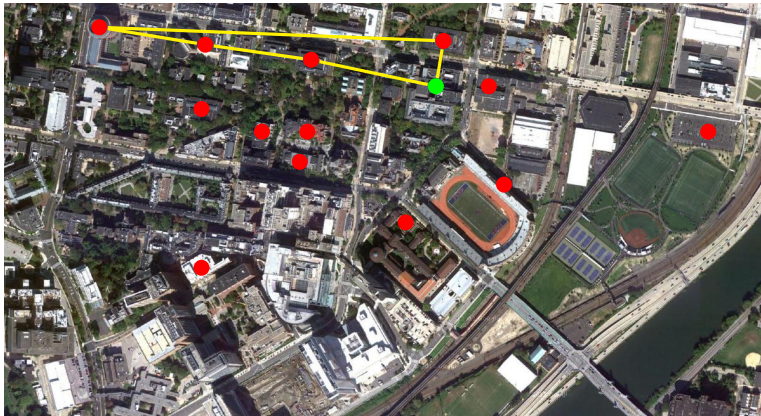


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Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Huntsman > Annenberg (9.68)

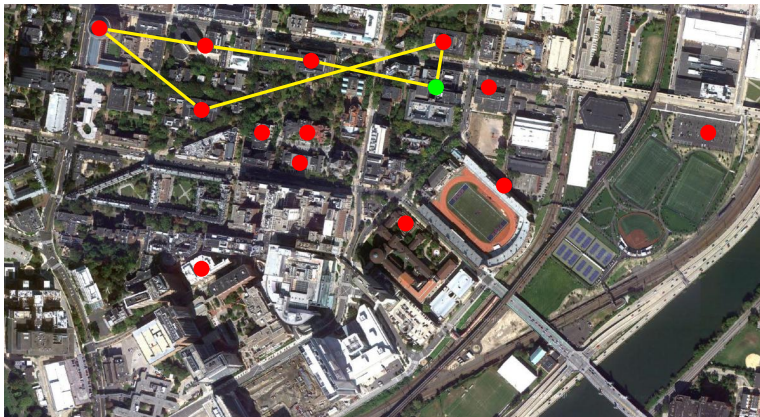


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Steinberg-Dietrich $>$ Huntsman (10.18)

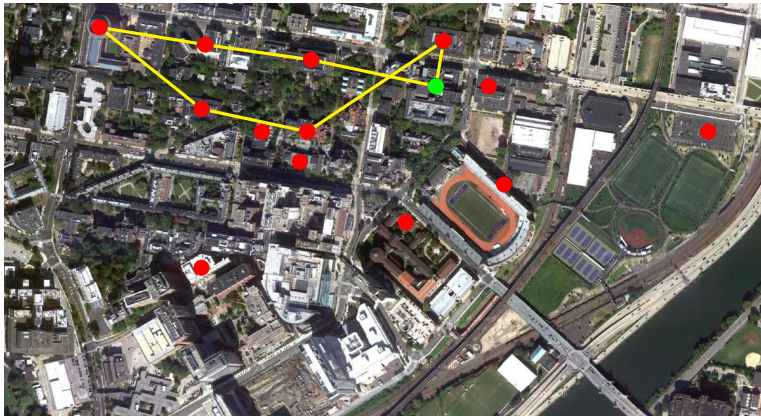


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- College > Steinberg-Dietrich (10.45)

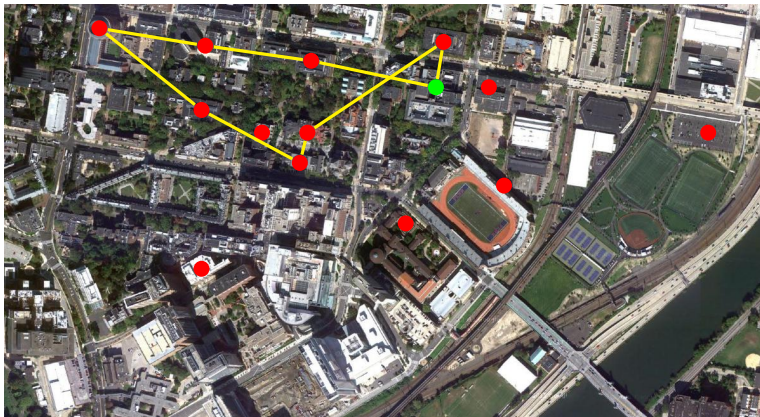


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Houston > Steinberg-Dietrich (10.91)

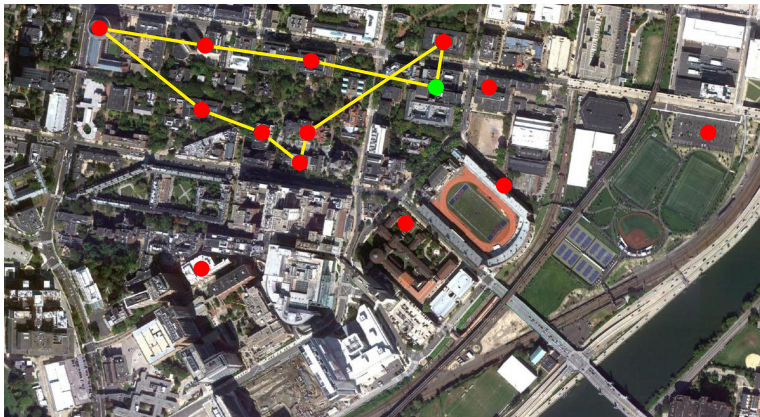


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Claudia-Cohen $>$ Steinberg-Dietrich (10.93)

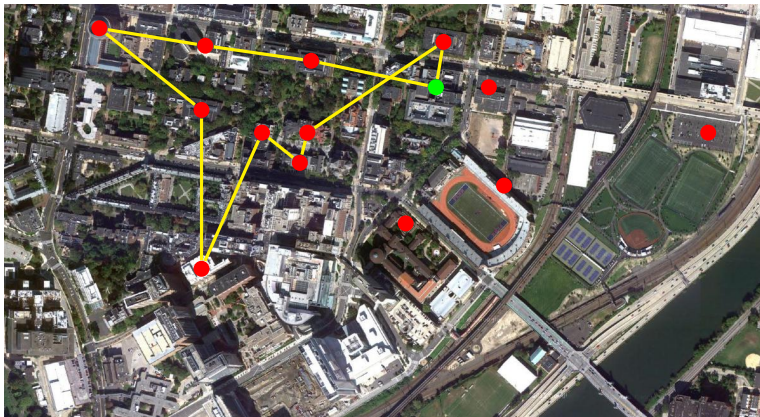


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Fagin > Steinberg-Dietrich (13.13)

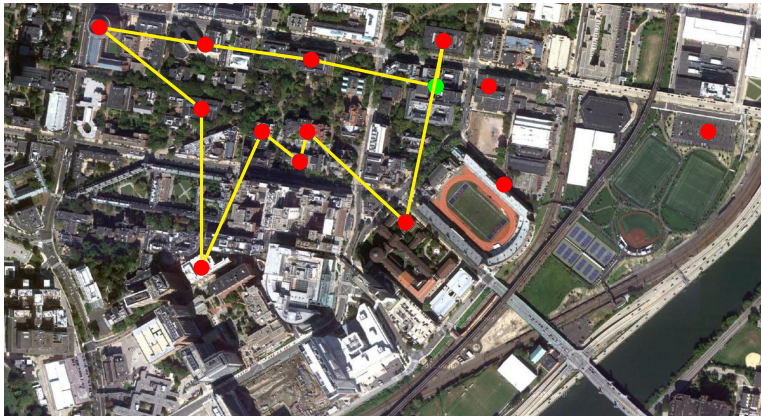


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Penn Museum > College (16.20)

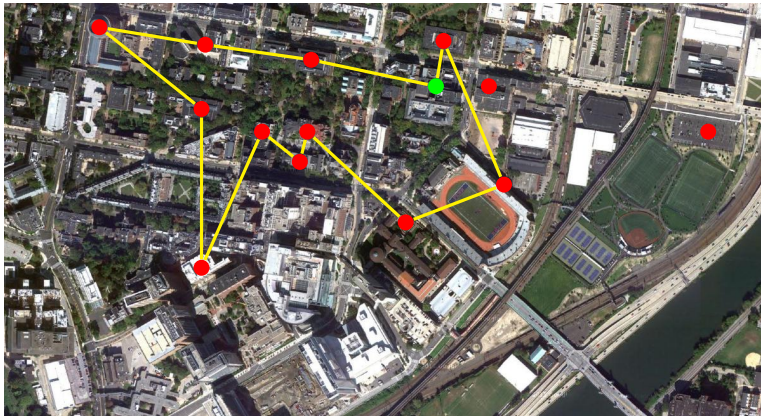


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Education Commons/Stadium > Penn Museum (17.20)

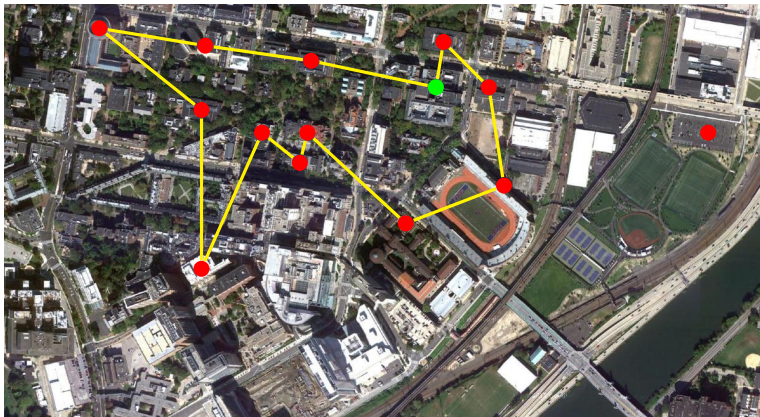


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- DRL > Penn Museum (17.31)

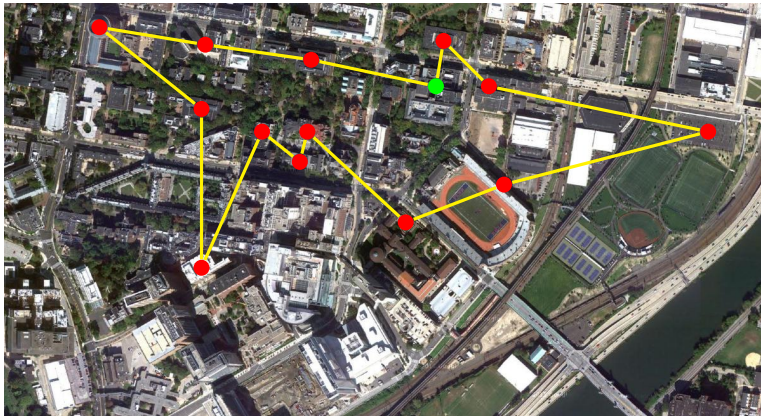


Courtesy Google Maps

Traveling Salesman Problem (Smallest Increase)

Add each point where it causes smallest increase in tour length

- Penn Park > Education Commons/Stadium (21.74)



Courtesy Google Maps