

Advanced GIS Final Project Report



Analyzing Parking Facilities in UT Dallas using Network Analysis

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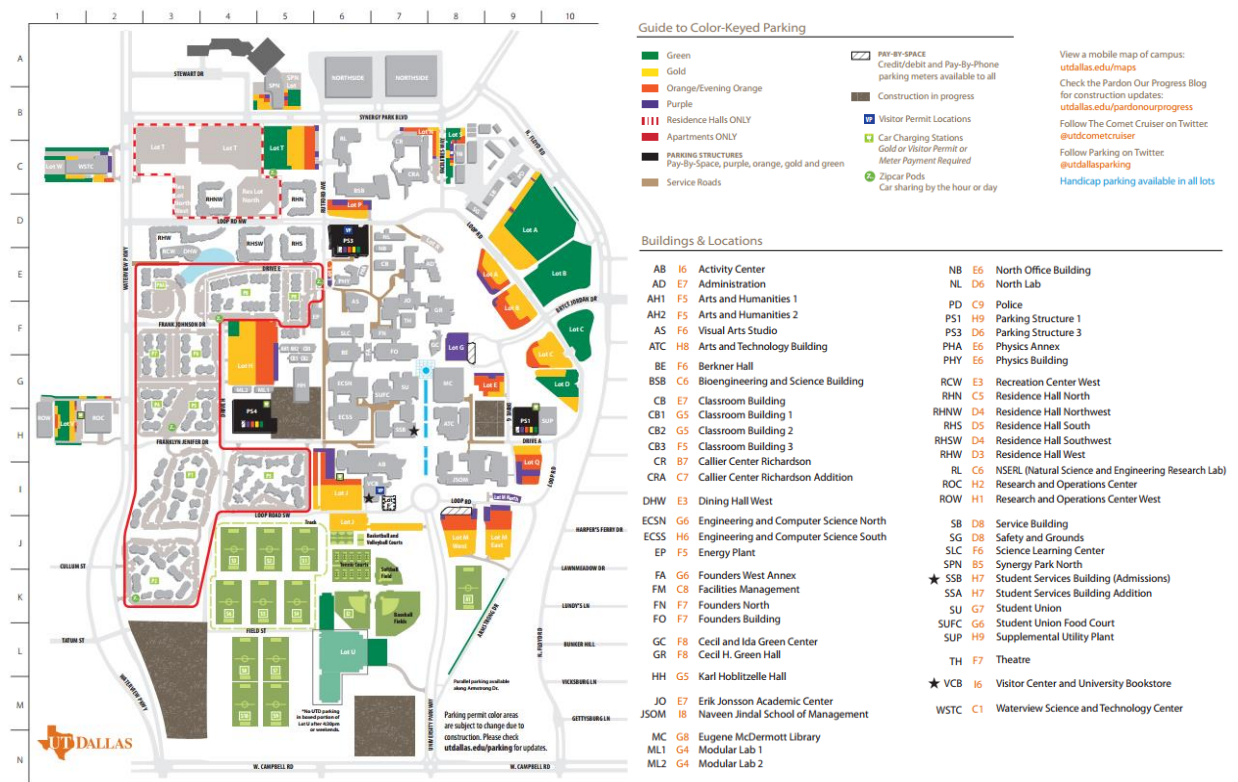
1. Inspiration:

As a Parking Enforcement officer on campus, many of the visitors to UTD campus ask me where they can park their vehicles. Guiding each and every visitor to their routes will be a hectic task for any PEO. Hence in this project, I have come up with an idea to solve this problem using Network Analysis in GIS where the visitors parking can be hassle free.

2. Objective:

Not all the visitors who come to UT Dallas campus can find a free parking space or obtain a visitor permit for parking. Even if they find a free parking space, it is only for a limited 10 minute time period.

So, in order to resolve this problem, I intend to propose a new routing system such that the visitors who come to UT Dallas campus will be redirected to the nearest pay by space stations (PBS) for parking their vehicles on campus. All the Pay by space stations are not of equal capacity. The pay by space stations in the parking structures have relatively more number of spaces than the lots. Hence, in case one of the pay by space station gets filled up then the visitors will be directed to the next nearest pay by space station. In addition, I would like to calculate the estimated drive time from the origin point to the pay by space station and also create a service area which are accessible from these pay by space parking spots by taking walking time into consideration.



UTD Parking Map and Annotations

3. Literature Review:

GIS and Network Analysis - Manfred M. Fischer

Network Analysis using GIS Techniques, A case of Chandigarh city, India – Praveen Kumar, Dinesh Kumar

Network Analysis in GIS: Review, Assessment, and Projections - Kevin M. Curtin

4. Data Sources:

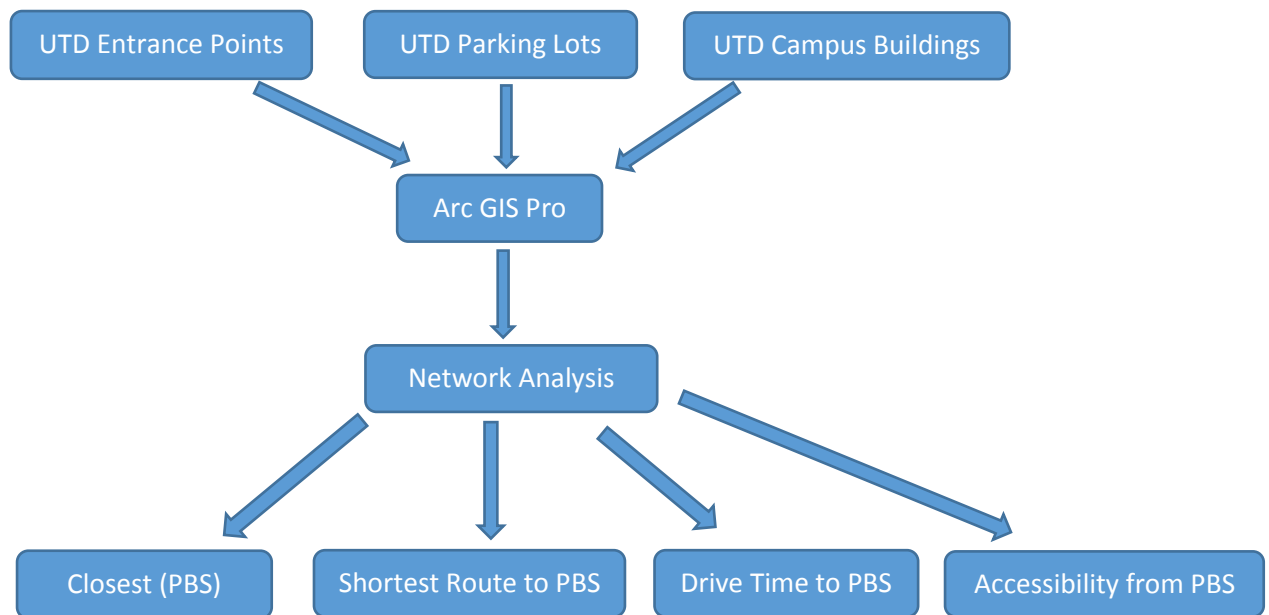
1. All the parking lots, parking structures and major entrance points to the university were manually mapped in ArcGIS pro with Open Street Map as the Base Maps.

2. For the mapping purpose, the parking map was obtained from the Parking and Transportation department. All the lots and pay by space meters were mapped taking this as reference. The attribute data was then built by collating information from the Parking department.

3. The UTD campus buildings blue print was obtained from the research team of Dr. May Yuan.

5. Analysis and Methodology:

The analysis was carried out in ArcGIS Pro. A flow chart of the analysis is shown in the figure



The methodology that was used can be broken down into the following

5.1 Closest Facility (PBS) Analysis:

In this kind of network analysis, the Pay by Space stations were imported as Facilities and the major UTD entrance points were imported as Incidents. The mode was given as Driving Time in minutes and the direction as towards the facilities. The number of facilities to find were given as 6 because there are approximately 6 major Pay by space parking stations in the campus. The current system time was given as the Arrive/depart time in the parameters so that it will perform real-time analysis. Also the output geometry was desired to be along the network. There were no barrier points given because very few road intersection points make the incoming vehicles to be stopped. Hence the barrier points were ignored. Once all the parameters were successfully imported, then we run the closest facility analysis which will show the closest pay by space meters available for the visitors to park their vehicles which are clearly depicted in the results section of this document.

5.2 Shortest Route Analysis from one PBS to other:

This shortest routing analysis will be majorly helpful when one do not find any space available to park in one of the pay by space stations. Then the visitor will be redirected from the existing pay by space station to the next nearest pay by space station for parking their vehicles. All the pay by space stations are not of equal capacity so it is not easy to directly get a space in the PBS especially during the major events in the Campus. For example most of the parking structures in campus have more than 100 metered spaces available for parking which are significantly higher than that of spaces available in the parking lots like LOT M west, LOT F, LOT G etc.

Here the pay by space parking stations were imported as stops, the Mode was given as driving time in minutes and the sequence to find was given as *"the best"* as we want the optimized route. Similar to the closest facility analysis, here also the current time was given as the input for Arrive/Depart Time and the output geometry was along the network. Once all the parameters were successfully set, we run the shortest routing analysis which will be giving the best routing path from one PBS to other. If we would like to see the direction if travel from one stop to other and the exact turn points we can click on the directions which will generate a report for these. The shortest routing path is depicted in the results section.

5.3 OD cost Matrix Analysis from Entrance point to PBS

What if we would like to measure the drive time from each entrance point to the Pay by space station? In such cases, the OD cost Matrix Analysis will be of greater use to us. Here we import the major UTD entrance points as the Origin Points and the Pay by space stations as the Destination points. The driving time in minutes was given as the mode and also the cut off was given a 5 min. It will be showing the connecting path from the origin to the destination which can be driven under the cut off time. Here the number of destinations were set as six and also the Data and Time were set to Current System Time. The output Geometry was set to the Straight Lines as we would like to see the connecting path between the origin and destination points. Once all the parameters were successfully set, we run the OD cost Matrix analysis which will be giving the straight line segments connecting the entry point to the pay by space parking station. When clicked on it we can see the approximate time of travel and also the distance.

The OD cost Matrix Analysis which was performed here is similar to the closest Facility analysis where time is the major factor that is under consideration. But when it comes to computation speed and quicker achievable output OD cost Matrix analysis outperforms the closest facility analysis. OD cost Matrix is generally intended to solve large problems where computation speed matters a lot. But it will not be providing the exact routing information. On the other hand, the closest facility solver will be giving more accurate driving directions along the road network and even the true shape of the routes to the facilities.

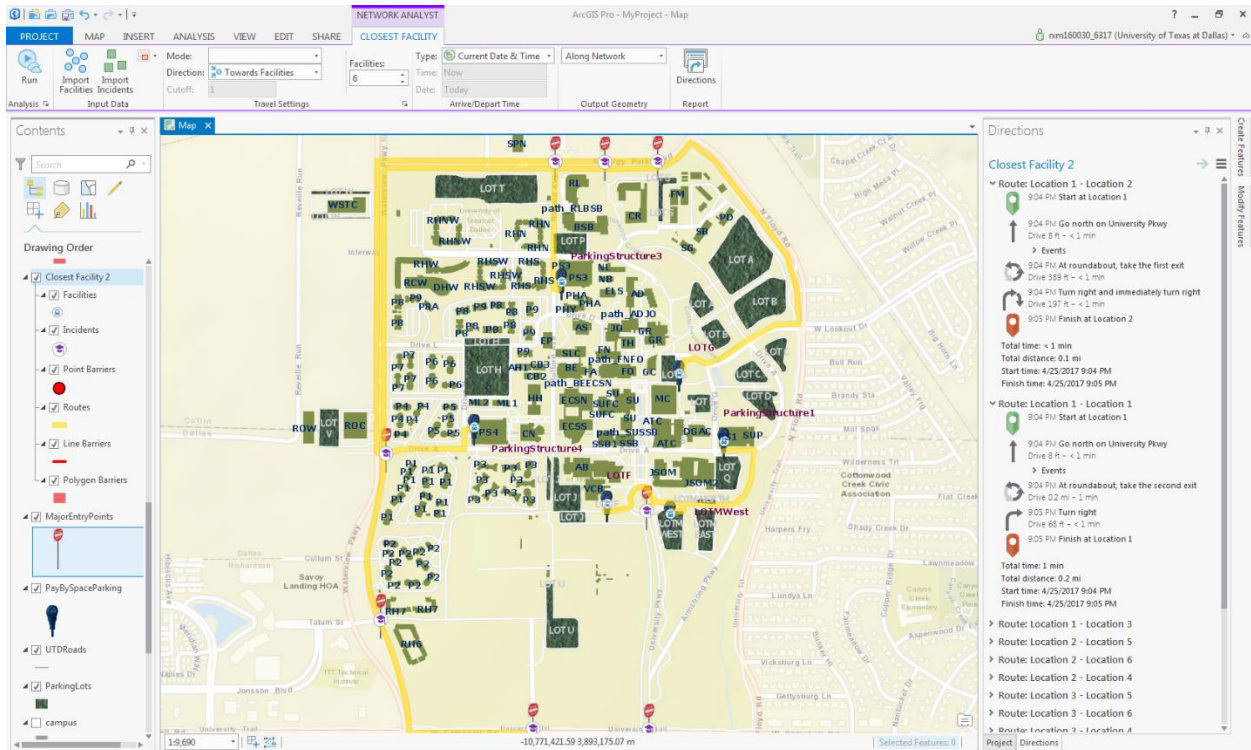
5.4 Finding Accessibility from PBS by creating Service Areas

What do the visitors do after parking his vehicle in the Pay by space station. They will be heading to their desired building, department, library or theatre depending upon their visiting needs. What all buildings or departments will be accessible to the visitor based on his walking time? To address all these questions, here we create a service area depending on the walking time that will be taken by the visitor.

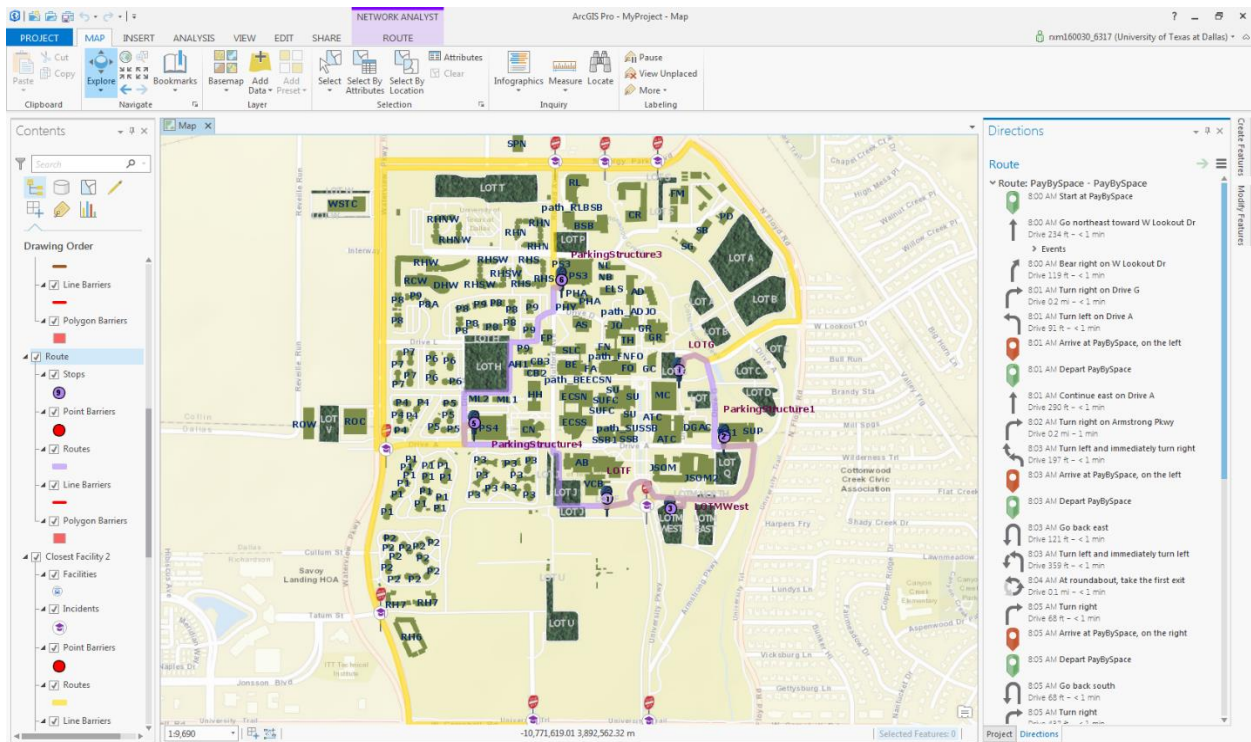
Here we import the PBS Areas as the input facilities and choose the mode as Walking Time in minutes and also the direction as Away from the facilities since we are checking for the accessibility of the buildings from the PBS stations. The cut off values specified were 5,10,15,20. The Type is chosen as Current Date/Time as we are performing real time analysis. The output polygon detail level is chosen as Standard Precision because the processing time and polygon quality are relatively improved for this

option. On the counterpart, the quality slightly deteriorates as we move towards the borders of the polygon features.

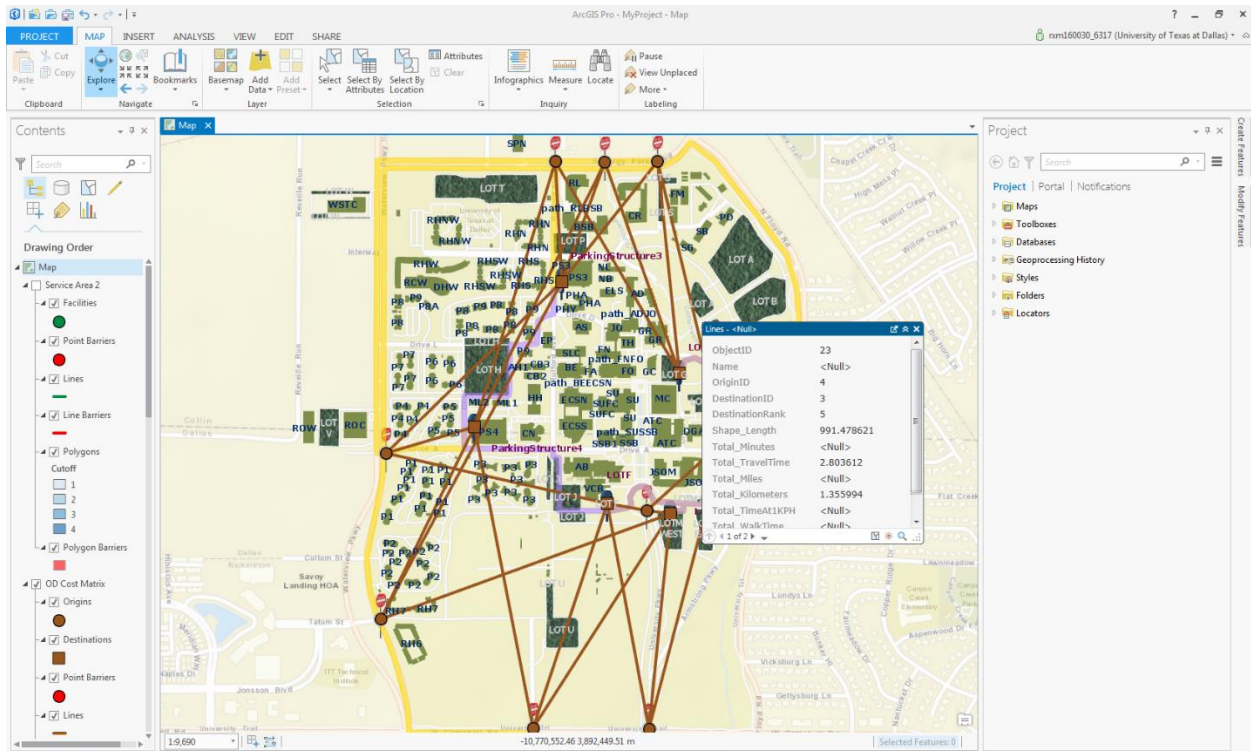
6. Results:



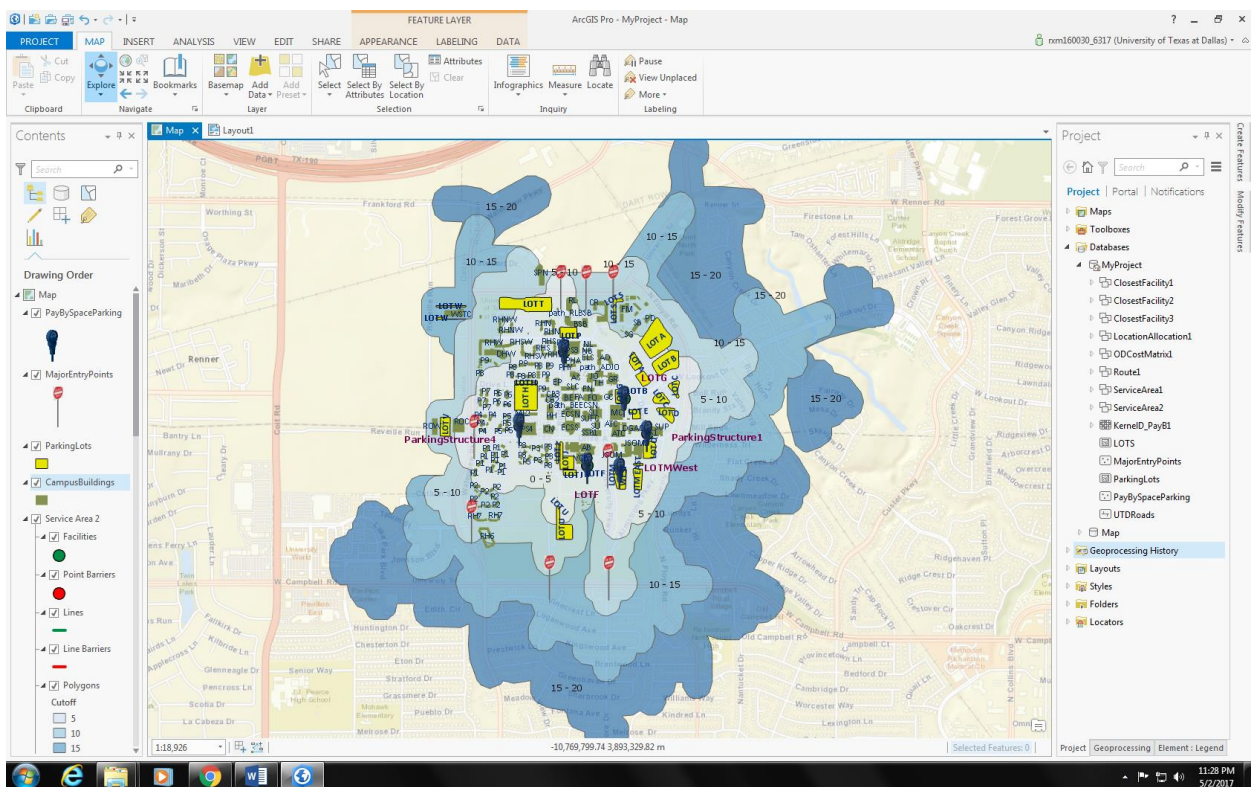
Closest PayBySpace Facility Analysis



Shortest Route for PayBySpace Parking Facility



OD- Cost Matrix Analysis



Service Area showing Accessibility from PBS to Buildings on campus

7. Discussions and Conclusions:

From the results obtained by doing each of these analysis we can understand that:

By diverting the visitors to the nearest pay by space station using this closest facility approach in Network Analysis, the probability of getting cited by the parking enforcement officers for parking without a UTD permit will be very less. This also makes visitors parking much simpler and reduces the manual work documentation process for the visitor center department who issue the temporary visitor parking pass.

From the shortest routing analysis we can observe that it is better for most of the visitors to get to the nearest parking structure (PS1, PS3 or PS4) than the parking lots for parking their vehicles. This is because of an increase capacity for parking.

From the OD cost matrix analysis we measured the approximate drive time in minutes from all the major entrance points of the campus to the pay by space parking stations.

Finally, the service area creation provides the visitor about the accessibility information to various buildings, departments, schools, food courts in the campus that he can reach within the specified range of time intervals.

8. References:

Parking Map – Parking and Transportation, Retrieved April 20, 2017 from

https://www.utdallas.edu/services/download/Parking_Map.pdf

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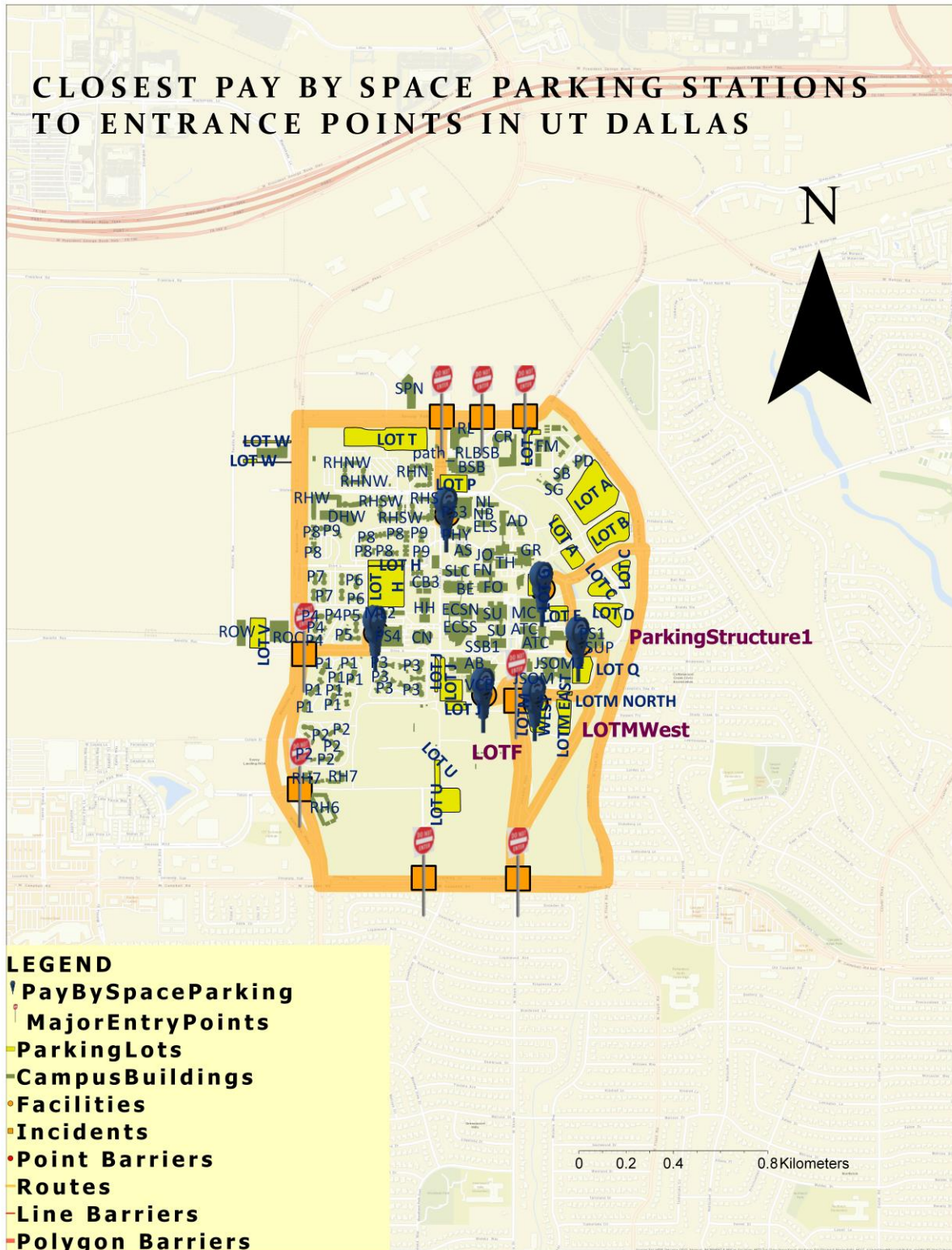
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<http://help.arcgis.com/en/arcgisdesktop/10.0/pdf/network-analyst-tutorial.pdf>

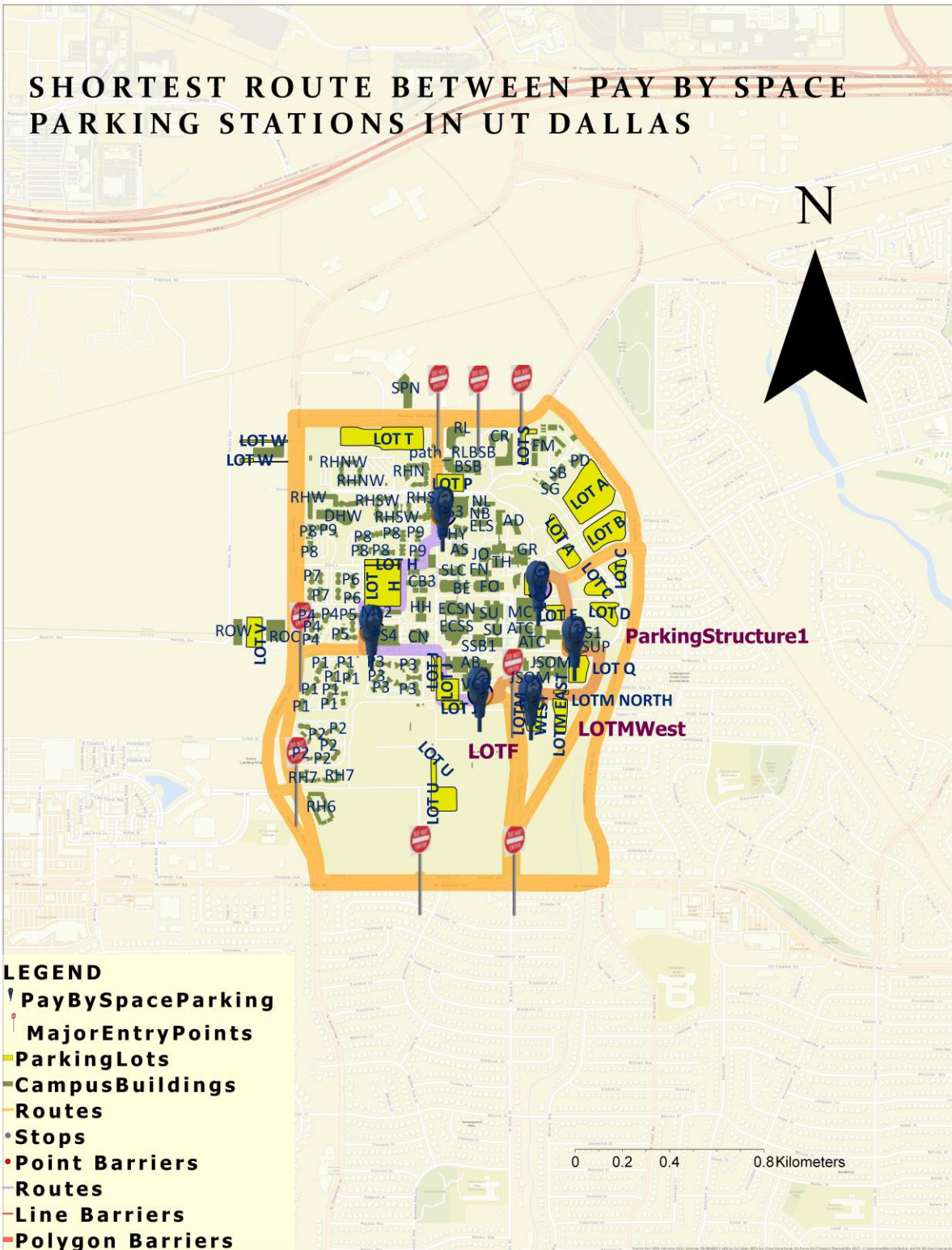
9. Acknowledgements:

I would like to thank Professor Dr. Qiu Fang for his support, advice and encouragement for this project. I also would like to thank the TA Fan Shi, who helped me out during the critical lab assignments. Finally, I would like to thank the Parking and Transportation Department for giving an opportunity to work for them which resulted in generating the idea for this project there by solving real world geospatial routing problem.

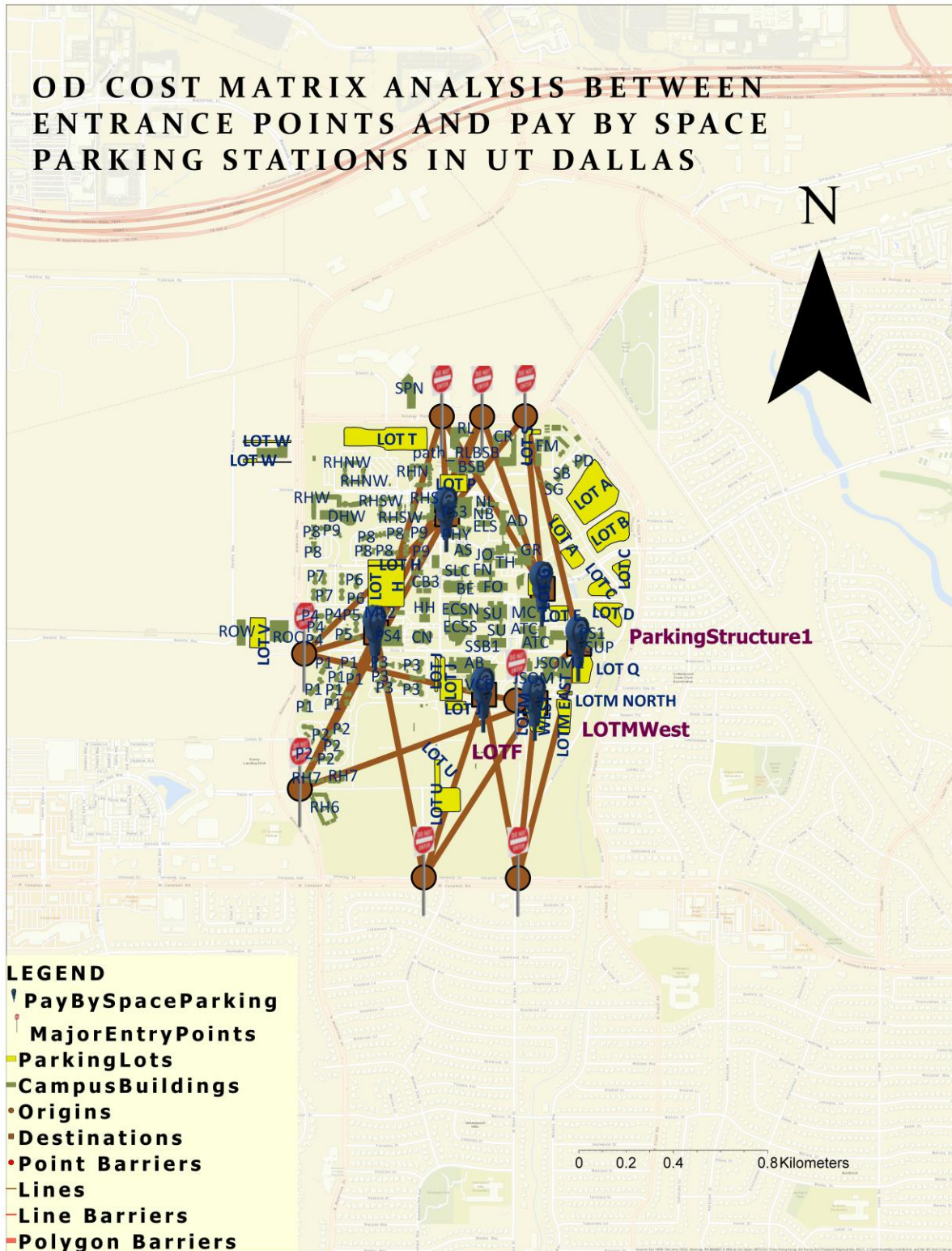
10. Appendix – Map Layouts



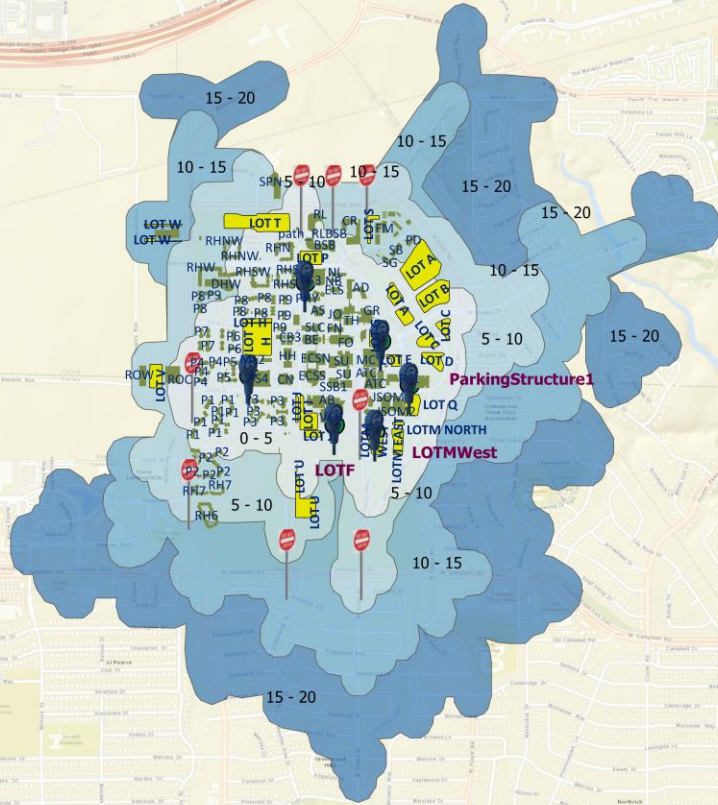
SHORTEST ROUTE BETWEEN PAY BY SPACE PARKING STATIONS IN UT DALLAS



OD COST MATRIX ANALYSIS BETWEEN ENTRANCE POINTS AND PAY BY SPACE PARKING STATIONS IN UT DALLAS



ACCESSIBILITY FROM PAY BY SPACE PARKING STATIONS TO THE BUILDING IN UT DALLAS



LEGEND

- PayBySpaceParkingPolygons
- MajorEntryPoints
- ParkingLots
- CampusBuildings
- Facilities
- Point Barriers
- Lines
- Line Barriers
- Cutoff
- 5 Cutoff Range: 0 - 5
- 10 Cutoff Range: 5 - 10
- 15 Cutoff Range: 10 - 15
- 20 Cutoff Range: 15 - 20
- Polygon Barriers

0 0.325 0.65 1.3 Kilometers