Orf 467
Transportation Systems Analysis and Planning

Fall 2017/18

Homework 5: Ride-Sharing Potential in MyCounties

The objective of this homework is for you to assess the ride-sharing opportunities for your hometown county and to establish the computational framework for you to do the same for your state or the state(s) that will be assigned to you. You are to produce something for your county (and then State(s)) that looks like the Helsinki report: http://orfe.princeton.edu/~alaink/SmartDrivingCars/PDFs/shared-mobility-simulations-helsinki.pdf. (ie, describes the nature of the trips originating in your county/state on a typical day, assesses the ride-sharing potential for various levels-of-service and conclude by providing some insights about the role of ride-sharing at some future time in that county/state.)

The trips that form the basis of your investigations are the individual trip records for a typical day generated by Kyle Marocchini'18 which can be found in:
http://orf467.princeton.edu/NationWideTrips'17Kyle/

- Each row of each file represents one PersonTrip for this typical day.
  - Files are sorted by oX, oY, oTime. Thus ALL trips originating from a pixel appear contiguously in a file. Each pixel has been assigned to a unique county even for those pixels contain areas in more than one county because one or more county boundaries runs through them. This sorting makes it trivial to find trips that originate at about the same time and place as long "about the same place" is defined as "within the same pixel".
- The files names contain the FIPS County Code . There is at least one file for each county.
- The file layout is:
  - 1st 2 cols are pointers that can be used to identify the trip maker and find her/his demographic data,
  - Trip type pointer,
  - next 8 cols describe the Origin of the trip (type (H, W, S, Other), Name, County, Longitude, Latitude, Pixel coords {oX, oY} that the {Lon, Lat} map to according to Link.
  - next 8 cols describe the Origin of the trip
  - Final col is the Great Circle Distance for the trip. Let's consistently multiply if by 1.2 so get a slightly better representation of the distance a traveler would likely need to travel to make the trip and the distance that a vehicle would need to travel to serve that trip directly. (I realize that this is somewhat cumbersome. If it proves too cumbersome we'll drop it later.)

Trip Length Distribution for your county:

- Prepare for each county the following table
  - you write a script that reads each file, grabs the distance vector, sorts it by oX, oY, GCD then walks down the file and writes in a table...

Item	1st Pixel	2nd Pixel	…	Nth Pixel
xPixel	●	●	●	●
yPixel	●	●	●	●
# trips < 0.25 miles (GDC)	●	●	●	●
0.25 ≤ # trips < 2 miles	●	●	●	●
2 ≤ # trips < 100 miles	●	●	●	●
100 ≤ # trips < 500 miles	●	●	●	●
500 ≤ # trips < 750 miles	●	●	●	●
750 ≤ # trips <	●	●	●	●
Total # PersonTrips in pixel	●	●	●	●
	●	●	●	●

The Summary Table will allow you to create a trip length distribution stack chart like I produced for all of the Kyle'17 county files.
http://orf467.princeton.edu/TripLengthDistributionKyle'17NationWideTrips.pdf

Even better is that you should be able to display geographically distributed pie chart where the percentages of the trips are slices, the size of each pie is the total # personTrips in a picel and each pie is centered on the pixel coord. It would be great if you can overlay this on a Google map.

Time-of-Day Distribution for your county:

- You can make a similar table by time of day of the origination for each pixel. I recommend that you group by hour (do an integer divide of the oTime by 3600 and you'll have 28 rows in the table: label, xPixel, yPixel, 24 hours, Total.
- You can further summarize that table by Time-of-Day groups: Overning (0+->6am), Morning peak (6+->9), Morning Lull (9+ -> noon), Early Afternoon (Noon+ -> 4) Evening Rush (4+ -> 7), Evening (7+ -> Midnight).
  - You can then sort the Cols in descending values of Total #, add a row with cum trip total and then look at just the min # pixels that represent say 80% of the originating trips in the county. Display those in geographic pie charts.

Assess the ride-share potential for various levels of service at each pixel in your county:

- Ride-sharing is the grouping of individuals that want to originate at about the same place at about the same time going in about the same direction. It is all about the 'about'
  - Initially we will consider that:
    - about the same place is: 'same oPixel
    - about the same time is:
      - no ride sharing if GDC < 0.25 mile (essentially intra-pixel and you're walking!
      - within 5 minutes if GDC < 2 miles
      - within 7 minutes if 2+ < GCD < 10 miles
      - within 10 minutes if 10+ < GDC < 100 miles
      - **within 15 minutes if 100+ < GDC < 750 miles (and we're taking you to the closest Amtrak station**

- **within** 30 minutes if 750+ < GDC (and we're taking you to the closest major airport)
    - About the same place…
        - +/- one pixel value of the first destination assigned to a 'to be departing' aTaxi if GDC < 2miles
        - +/- 2 pixel values of the first destination if 2+ < GCD < 10 miles.
        - +/- n pixel values of the first destination if 10+ < GDC < 100 miles, where n is probably 3 to start, but we'll need to think about it.
        - if 100+ < GDC < 750 miles then it depends how far the nearest Amtrak station is and the value of its pixel coord.
        - If 750+ < GDC then it depends how far the nearest airport is and the value of its pixel coord.
- Perform this analysis by establish a Tensor of aTaxi departures (Queue of loading-yet-to depart aTaxis x summary data + assigned personTrips to each in queue (make it 1,000 x 50 x 7) long and hopefully you won't ever have more than 1,000 pending departures. For each departure you save with into a 50x7 array:
    - Row 1: oXpixel, oYPixel, ToA (Time of Arrival of 1st passenger, its oTime), which starts a countdown clock to the aTaxi departure time (entry 1,4), dXpixel of 1st passenger, dYpixel of 1st passenger, GCD of 1st passenger.
    - Row n : oXpixel, oYPixel, oTime of nth assigned passenger, repeat of aTaxi departure time from Row 1, dXpixel of 1st passenger, dYpixel of n^{st} passenger, GCD of n^{st} passenger
- This Tensor is updated by walking down the PersonTrip File.
    - Once the oPixel value changes, then all waiting vehicles are departed and a new aTaxiDepartureTensor is initialized.
    - After a Trip is assigned to either a waiting-to-depart aTaxi or at the 1st passenger on a new aTaxi:
        - Read the next trip. Depart all aTaxis whose departure time < oTime of new Trip maker.
            - Write to a permanent file the departed vehicles and move up in the departure queue the undeparted aTaxis.
            - Assign as the n+1st passenger the first possible of the aTaxis in the queue, else, assign to a new aTaxi added to the end of the queue.
            - Read the next trip.

Analysis of the departed aTaxis

- Generate the distribution of
    - aTaxi occupancy @ time of departure (total, by oPixel,, by ToD)
    - for each departed aTaxi generate the preferred sequence of drop-offs and calculate the aTaxiVehicleDistance (VehicleMilesTraveled, VMT) = the pixel -> pixel cartesian distance traveled by the aTaxi multiply by 1.2
    - Sum the O->D Cartesian distance (PersonMilesTraveled, PMT)for each traveler in teach aTaxi
    - Compute the Average Vehicle Occupancy (AVO) for each departed aTaxi.
    - Compute the AVO for each pixel: the ratio of Sum{PMT} all aTaxis departing a Pixel during the entire day/ Sum{VMT} all aTaxis departing a Pixel during the entire day
    - Compute AVO for each county.
    - Compute AVO for each time-of-day group.