

Assignment 1

This assignment will introduce you to cyclic operations in transit. Work individually and submit your work as an Excel file. Do not submit a paper copy! Short answers are expected.

Tasks and Questions

1. In the class site **under the Readings section** you will find Furth's *Urban Transit*, which provides an overview of many of the topics we will be covering in-depth this semester. For this assignment you are asked to read sections 61.1–61.3, but you are welcome to read the rest if you want.
2. Along with this problem statement you will find an Excel file (**see the Supporting Files**). It contains end-to-end running times for the two directions of a bus service, for several days of operation, for times of the day between 7:00 and 18:00. Only data from workdays is included, i.e. data from weekends and holidays is excluded. There are three worksheets. The first two have running times by direction, and the third has combined running times that you will use only for step 9. All worksheets have the time of day that an observed trip started (in decimal hours from midnight) in the first column and the observed trip duration (in minutes) in the second column. Download this file and verify its contents.
3. Calculate the mean, median, minimum, maximum, and 95th percentile running times using all observations of each direction. (You should have two of each statistic, one per direction.)
4. The cycle time c of a simple route is calculated as

$$c = t_1 + r_1 + t_2 + r_2 \quad (1)$$

where t_1 and t_2 are the scheduled running times of directions 1 and 2, respectively, and r_1 and r_2 are the recovery times of each direction, respectively. The sum of the running time and the recovery time for each direction is referred to as the *half-cycle time* for that direction. Calculate the running time, recovery time, and half-cycle time for each direction, as well as the cycle time for this scheduled transit service, using the statistics you calculated on step 3.

5. Recall that the relationship between cycle time c , headway h , and number of vehicles n is

$$c = nh \quad \text{or} \quad n = \left\lceil \frac{c}{h} \right\rceil \quad (2)$$

Using the cycle time from step 4, calculate the number of vehicle required to provide service with a headway of 10 minutes.

6. Sort the data of each of the directions by time of day and generate a scatter plot of running times as a function of time of day for each direction. What do you observe? Are all the running times a product of the same operating environment? Why or why not? If you observe differences, what might be causing them?

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7. Divide the day into time periods (AM peak, mid-day, and PM peak) by visual inspection of your scatter plots. When does each period begin and end?
8. Repeat steps 3–5, now analyzing each time period independently. Provide all running time statistics, the cycle time, and the number of vehicles required to operate with 10-minute headways for each time period. How is the number of vehicles required for service different from what you determined in step 5? How much recovery time would be provided during each time period if the number of vehicles determined in step 5 were used? How much recovery time would be provided with the number of vehicles determined by time period?
9. Suppose that the operator of this transit service tried to operate at 7-minute headways with 10 vehicles during the PM peak time period. What is the probability that a cycle can be completed before a vehicle is scheduled to begin the next cycle in the PM peak time period? Is this a reliable scheduled service? How would passenger waiting times be affected? Assume that passengers use schedules to time their arrival to stops. For this step only, assume that the transit service operates like a shuttle service with a single terminal, and use combined running time observations, which are provided in the third worksheet.
10. Repeat step 9, this time assuming the line has a terminal at each end, and vehicle's layover at both terminals to recover the schedule. Use direction-specific running time observations.
11. Now suppose that the operator of this transit service is operating at 10-minute headways with the number of vehicles you determined in step 8 for each time period. Mr. Rider complains that a lot of time is wasted at terminals when buses are laying over, and argues that service could be made more frequent by scheduling with the average running times. What would you respond to Mr. Rider?

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