Transport modeling

ICP- Problem Set

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Probability and Sampling

1. A police officer observed that one out of 5 drivers violating is apprehended. We compute the probability that a driver who violates speed limit ten times per week is apprehended exactly once, not at all. Find also variance and standard deviation [0.268, 0.108] if we wish to determine number of apprehension use E(x) = np = 2 and variance = 1.265.
2. The average arrival rate of vehicles at a signalized intersection is 720 vph. We want to find the probability of having 0, 1,2,3,4, 5 or more vehicles arriving over 10 second interval. [0.135, 0.271, 0.271, 0.18, 0.090, 0.053]
3. A technician needs to fix 3 road signs immediately. The past experience show that when he walks into the warehouse 60% of the signs are ready for use, 40 % need changes before use. The warehouse has 5 road signs in stock. Let us determine the probability such that the third sign ready for immediate use is found on the last check (i.e. Fifth sign). This is simply carried out by k = 3, n=5, x = n-k =2 and p = 0.6 [0.207]
4. Vehicles at a stop sign require 7 seconds headway through the main street to cross the stream. For the flow rate of 1000 vph, the probability that a given headway will be greater than 7 seconds is given by $p(t \geq T)$ = [0.143]
5. The life expectancy of traffic lights is normally distributed with a mean of 1500 hours and SD = 75 hours. What will be the probability that a bulb will last between 1500 - 1650 hours. In solving this we compute Z1 and Z2 by employing eqn 1 and look for the values in the standard Z tables. So $p(1500<x<1650)$ = 47.71%. we further seek to find the percent of bulbs lasting between 1485 -1500 hours. Note that for Z = negative value, use $\Phi(-Z) = 1 - \Phi(Z)$. [7.93%]
6. It is found that the percentage of left turn vehicles from eastbound approach is 20% and average hourly volume of eastbound is 2000 vph. The cycle length for this intersection is 90 seconds. Estimate the probability that no more than 4 left turn vehicles will come in a cycle.[0.02]

7. The cycle length of a signalized intersection is 90 seconds. Based on the field study we have learned that the arrival rate of vehicles is 400 vph. Estimate the probability that no more than 10 vehicles will arrive at this intersection within a cycle.[0.583]
8. If the probability that a vehicle approaching an intersection will turn left is = 0.25 and the probability that it will turn right is 0.15. Find the probability that the vehicle will turn right given that it does not turn left. [0.2]
9. Given that observed mean headway is 3.5 seconds and standard distribution is 2.6 seconds, then compute the probability that the headway lies between 0 and 0.5. Assume that the minimum expected headway is 0.5 seconds.
10. If the mean and standard deviation of certain observed set of headways is 2.25 and 0.875 respectively, then compute the probability that the headway lies in an interval of 1.5 to 2.0 seconds.
11. Consider the following example. We want to be 95% confident that our error lies within tolerance ± 1 for some speed samples with SD = 7.2. for 95% confidence we obtain from the table, the Z value = 1.96, simply $n \geq Z^2S^2 / e^2$ we get n = 200 samples.
12. Consider a certain area the population of which may be classified in groups according to: automobile ownership and household. Let assume that m observations are required by cell in order to guarantee a 95% confidence level in the estimation of trip rates.

Car ownership	Household size	% of population
With car	Four or less	9
	More than four	16
Without car	Four or less	25
	More than four	50

13. Assume that for the purposes of a transport study the population of a certain area has been classified according to two income categories, and that there are only two modes of transport available (car and bus) for the journey to work. Let assume that the population distribution is given by:

	Low income	High income	Total
Bus user	0.45	0.15	0.60
Car user	0.20	0.20	0.40
Total	0.65	0.35	1.00

14. Assume the following information is available: Average income of population (I): 33 600 $/year Average car ownership (CO): 0.44 cars/household Assume also that small

on-mode surveys yield the following. If the total population was 180 000 inhabitants find how many use respective mode.

Mode	I ($ / year)	CO (cars/household)
Car	78 000	1.15
Bus	14 400	0.05
Metro	38 400	0.85

15. Worked out example from reference 1 [K] example 8.1, 8.3, 8.4, 8.5 through 8.11, (8.12 to 8.17 optional) all.
16. An observer has determined that the time headways between successive vehicles on a section of highway are exponentially distributed and that 65% of the headways between vehicles are 9 seconds or greater. If the observer decides to count traffic in 30-second time intervals, estimate the probability of the observer counting exactly four vehicles in an interval.
17. At a specified point on a highway, vehicles are known to arrive according to a Poisson process. Vehicles are counted in 20-second intervals, and vehicle counts are taken in 120 of these time intervals. It is noted that no cars arrive in 18 of these 120 intervals. Approximate the number of these 120 intervals in which exactly three cars arrive.
18. For the data collected in Problem 17, estimate the percentage of time headways that will be 10 seconds or greater and those that will be less than 6 seconds.
19. A vehicle pulls out onto a single-lane highway that has a flow rate of 300 vph (Poisson distributed). The driver of the vehicle does not look for oncoming traffic. Road conditions and vehicle speeds on the highway are such that it takes 1.7 seconds for an oncoming vehicle to stop once the brakes are applied. Assuming a standard driver reaction time of 2.5 seconds, what is the probability that the vehicle pulling out will get in an accident with oncoming traffic?

20. Consider the conditions in Problem 20. How short would the driver reaction times of oncoming vehicles have to be for the probability of an accident to equal 0.20?