Data-driven Mobility Homework 4

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1. MC Question: User Monte Carlo integration technique to estimate

1) To at least 3 post-decimal digits of accuracy, what is the true integral value?
a = 0, b = 1:
1.6 with absolute error < 1.8e-15

a = 0, b = 2:
2.801626 with absolute error < 0.00023

2) Using n = 100, 1000, and 10,000, estimate (via MC) the integral for the two combinations of a and b in part (a). Please keep in mind that the area of the plot is different than 1.
a = 0, b = 1:
N = 100:
1.656398
N = 1000:
1.596041
N = 10000:
1.596852

- Comment: Here I set random seed to 1 in order to get same result each time(even if not set random seed, every execution result follows the same pattern of monte carlo integration that the accuracy is increases with sampling size increasing). When set n = 10000, the value is most close to the true integral result.

a = 0, b = 2:
Selected Situation 1:
N = 100:
2.886861
N = 1000:
2.765242
N = 10000:
2.781084
Selected Situation 2:
N = 100:
2.748778
N = 1000:
2.802854

N = 10000:
2.814243

- Comment: Unlike the combination of a = 0 and b = 1, here every execution may return different accuracy result, so I didn't set random seed in this situation, generally, **in most cases,** when set n = 10000, the result is most close to the true integral result(in the situation 1 above), while sometimes, the accuracy is maximum when n = 1000(situation 2 above). This may caused by sampling bias in the interval.

2.MCMC Question: In this question, you are supposed to find a desired solution which is one that gives the highest likelihood. You are not graded on finding the whole quote but may receive bonus 5 points if you do.

1)Download a book to create a transition matrix. Please include the book you downloaded to your submission and add the transition matrix plot to your answer sheet. (10 Pts)
Here I download *Windfalls by A. G. Gardiner*.

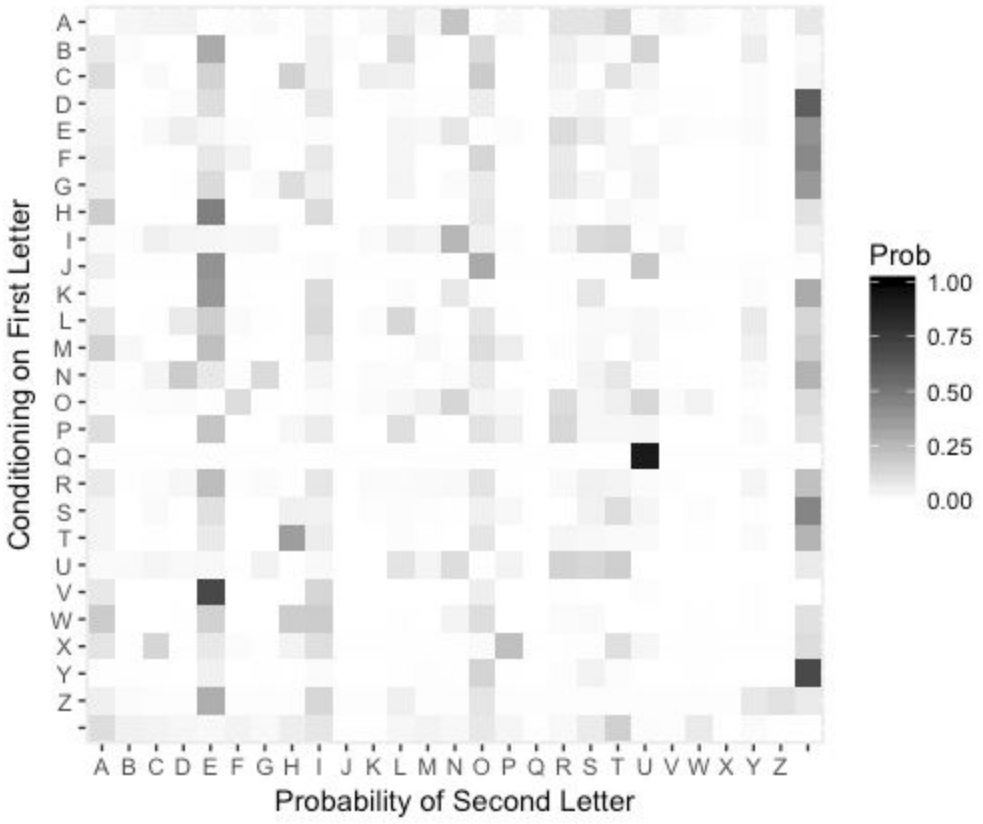

Fig1. transition matrix plot

2)Please decode the coded movie2 quote below. Please add the final decoded version of the quote to your answer sheet.
After 2000 iterations(random seed 313230), I got the decoded quote: THE WAY I SEE IT IF YOU ARE GOING TO BUILD A TIME MACHINE INTO A CAR WHY NOT DO IT WITH SOME STYLE

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2000 THE WAY I SEE IT IF YOU ARE GOING TO BUILD A TIME MACHINE INTO A CAR
WHY NOT DO IT WITH SOME STYLE
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This a Dialogue from the movie *Back to The Future*!

3)Please double the jump probability and re-run the MCMC process. Comment on the results.
After doubled the jump probability and re-run the MCMC process, I got the result below after 2000 iterations:

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2000 THE GAR I CEE IT IK ROM ALE DOIND TO UMISP A TIVE VAWHINE INTO A WAL
GHR NOT PO IT GITH COVE CTRSE
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Up to 10,000 iterations, it still not generates the whole complete sentence.

3.Conservation Law: Considering the following road section with different sensor stations, test the conservation law. You need to run the simulation code and check the results at different time steps (a time step represents 5 minutes in actual time).

1) Using sensor 401529 as the input sensor and sensor 401613 as output sensor, check the results at time step = 65 to see whether the conservation law holds or not, and insert the final chart.

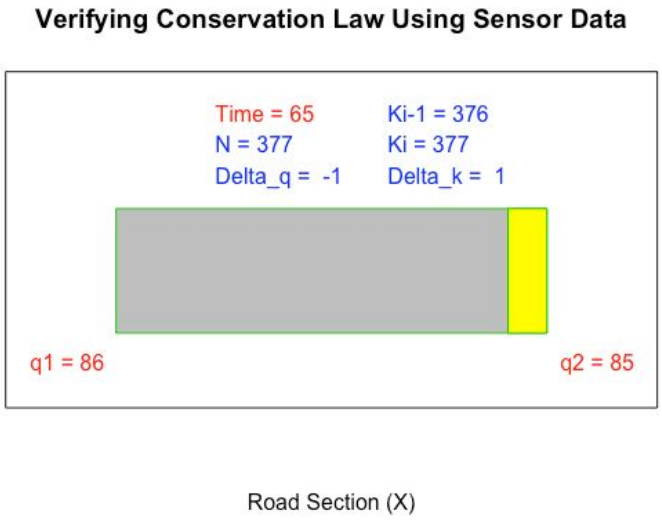

Fig2. Verifying Conservation Law Chart

In this situation, the conservation law holds.

2) Repeat above step but use sensor 401613 as input and sensor 400536 as the output, check the results at time step = 65 (Note: The section length is 0.59 miles now. You need to update the length variable dX in code).

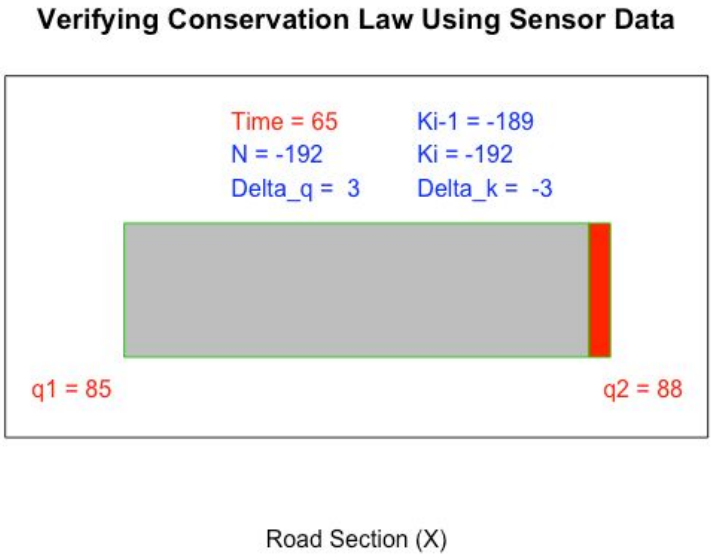

Fig3. Verifying Conservation Law Chart

As we can refer from the chart above, the conservation law doesn't holds.

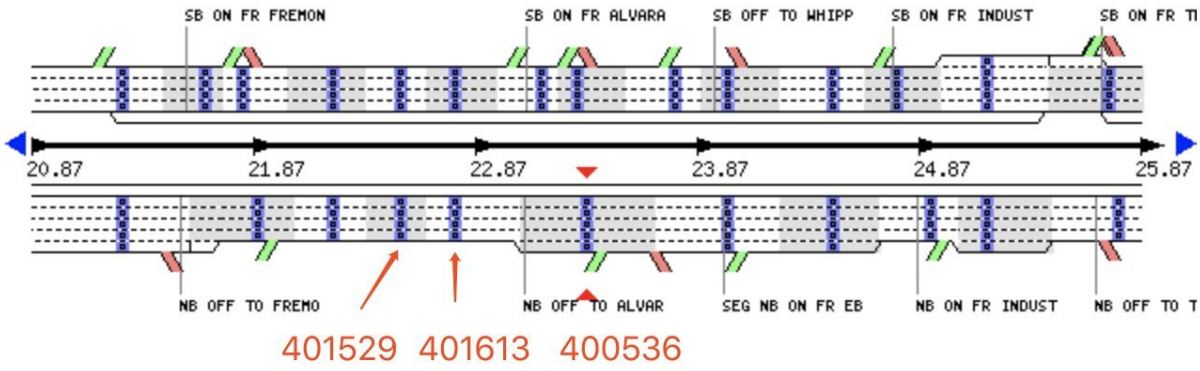

Fig4. sensors information

From PeMS I found that both sensor 401529 and sensor 401613 have 4 lanes, while sensor 400536 has 5 lanes(Fig4.), meanwhile, sensor 400536 is very close to an entrance of road.

According to the law of conservation:

$$\frac{\partial q}{\partial x} + \frac{\partial k}{\partial t} = 0$$

When x and t are constant, flow q is related to the density k. Besides, This model “it was only appropriate for use on long, crowded roadways, as the “continuous flow” approach only works with a large number of vehicles.”[1]. Hence, I think the reason why the conservation law doesn’t holds in the second road section(sensor 401613 and sensor 400536) is that the density doesn’t reach the suitable volume for the model, and according to the note: the section length is 0.59 miles, so it may also caused by the shorter distance.

[1] Traffic flow https://en.wikipedia.org/wiki/Traffic_flow