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PROBABILISTIC BEHAVIOR AND ENTROPY VARIATION IN TRAFFIC FLOW

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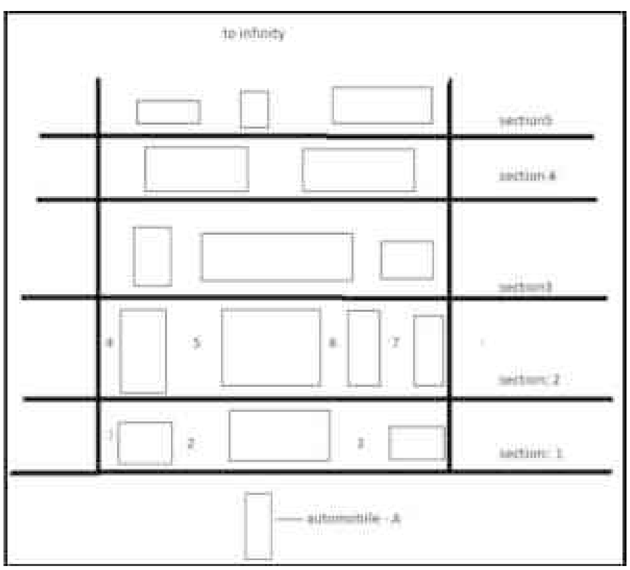
Abstract : Entropy based approach for anomaly detection in the traffic flow is quite a famous approach. We observe that the variation of entropy values with respect to time and its relation to probability . The application of concept of fluid mechanics in traffic is well known research domain. But though there might be many striking similarities but there is much dissimilarity too. Hence there occur many questions that cannot be answered by these well known concepts. So we take a statistical path and search for an eloquent way to think of a solution.

Keywords: Probabilistic Behavior, Entropy Variation, Traffic flow

I. INTRODUCTION

Probabilistic behavior of automobiles on road Imagine automobile-A moving through a street where it encounters many other automobiles of different sizes. Now at section 1 it has 3 options at section 2.

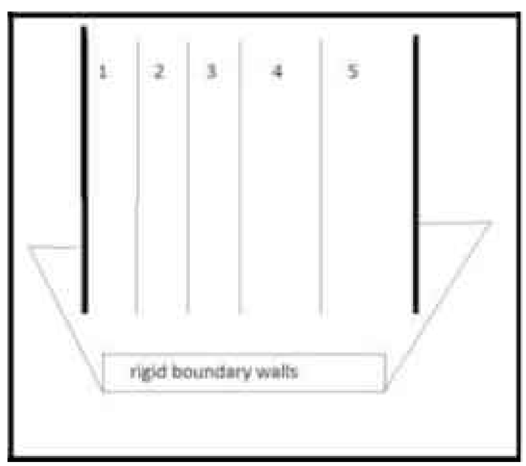


It has 4 options and so on. So, if one says what is the probability of car taking route 1 = (1/3). Again the probability of automobile –A taking route 6 after going through route 1 is =(1/3)(1/4)=(1/12). Hence, if are generalizes,

$$N = \frac{1}{n_1} + \frac{1}{n_1}\frac{1}{n_2} + \frac{1}{n_1}\frac{1}{n_2}\frac{1}{n_3} + \frac{1}{n_1}\frac{1}{n_2}\frac{1}{n_3}\frac{1}{n_4} \ldots\ldots\ldots\ldots$$

Where,
n1 = number of choices for the driver has at section 1.
n2 = number of choices for the driver has at section 2.
n3 = number of choices for the driver has at section 3.
so on.

5 lane hypothesis:



Case 1:

Free flow

In free flow these lanes become non-existent. So there are only 3 options at each section

Left

Right

Straight

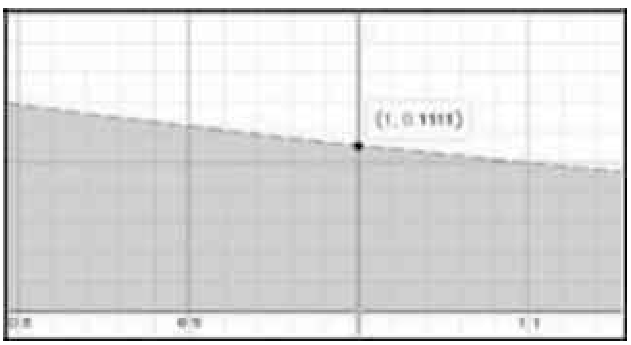
Assuming due to rigid boundary walls on left and right side of 1 & 5 lanes respectively. By common sense we can say an automobile will take lane 3 to achieve maximum speed.

Hence,

N(free flow)= (1/3)[1+(1/3)+(1/3)(1/3).....]

Extending this to a continuous function in order to plot a graph of a continuous function

f(x)=(1/3)[(1/3)^x]



This graph shows the plot of 0<y<f (x) & x=1.The behavior of the function is strictly decreasing between the interval of 0 to +∞.

Case 2:

Synchronized flow of traffic

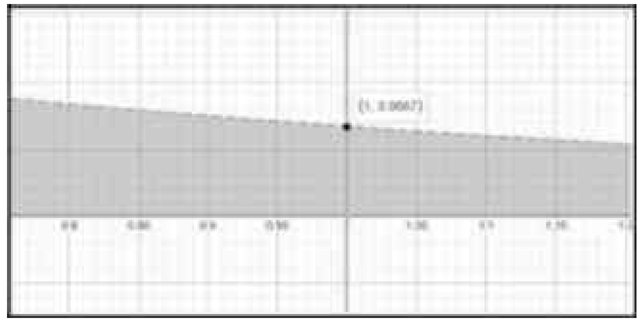
In synchronized flow a person tends to achieve maximum speed ,

maximize option and minimizing time. So preferably the person will

take lane 2, 3&4 and 1&5 is to be avoided due to rigid boundary walls.

N(synchronized

flow)=(1/5)[1+(1/3)+(1/3)(1/3)+…] Extending it to continuous function; g(x)=(1/5)[(1/3)^x]



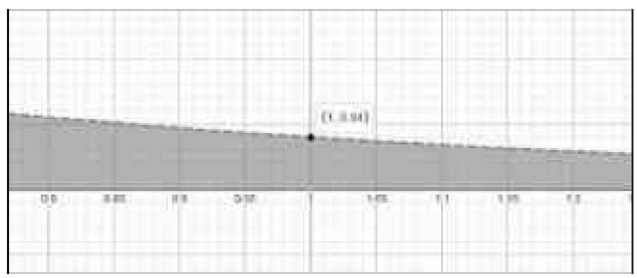
This graph shows the plot of 0<y<g(x) & x=1.The behavior of the function is strictly decreasing between the interval of 0 to +∞.

Case 3:

In Jams

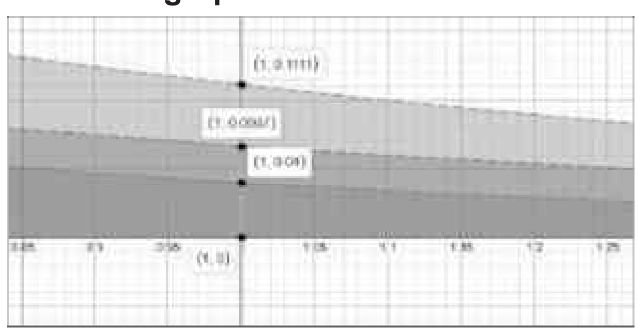
In jams maximum speed isn't an option minimizing time is of utmost importance. So all 5 lanes become accessible.

h(x) = (1/5)[(1/5)^x]



This graph shows the plot of 0<y<h(x) & x=1.The behavior of the function is strictly decreasing between the interval of 0 to +∞.

Resultant graph:



This graph shows the plot of 0<y<h(x) [in green];0<y<g(x)[blue];0<y<f(x)[red]& x=1[Orange].The behavior of the function is strictly decreasing between the interval of 0 to +∞.

2. PROBABILITY AND ENTROPY RELATION & ENTROPY VARIATION

Entropy is known as the is the degree of disorder prevailing in a system of molecule. Now let one think that her molecules are the automobile present in the street.

It is known total probability of occurrence of a favorable event is N; hence probability of not occurring of a favorable event is 1-N = N'.
N' can also be interpreted as the degree of disorder. Now it is known from the definition,

That on extending the discrete function to continuous function, N' for free flow

$$N' \text{ (free flow)} = 1 - \int_0^{+\infty} f(x)$$

For **Synchronized flow**: $N' \text{ (synchronized flow)} = 1 - \int_0^{+\infty} g(x)$

For **Jams**: $N' \text{ (Jams)} = 1 - \int_0^{+\infty} h(x)$

And here one concludes:

Entropy (S) is a function of N' and if N' increases, S increases.

So, for a system to be existent the S ≥0.

The 5 lane concept can exist in real life because the area under the graph on x axis keeps on decreasing. Hence N' will keep on increasing and S will increase.

3. CONCLUSION

Authors can conclude that in traffic jams have an origin from synchronized flow of traffic. The foundation of entropy variation and probability distribution are fundamentally related. On taking a closer look on the mathematical aspect of entropy and probability astounding similarities are found. The rigid boundary walls have significant impact on flow of traffic. Free flow dynamics is completely different from synchronized flow dynamics and jams.

Entropy of free flow < entropy of synchronized flow < entropy of jams.

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