How to model a traffic jam mathematically

-A solution to traffic jam-

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Traffic jam / Congestion... Definition?

Slower than 40km/h

(East Japan Highway co.)

Slower than 20km/h

(Capital Highway co.)

Slower than 10km/h in normal roads (PSC)

What do you think are the causes?

But sometimes congestions occur without any specific reasons!

We need some experiments to find solutions to social problems... is there a way?

YES!!!

By using mathematical method called

“Cellular Automata”

But before that… Let's simplify congestion

Please think:

What are the essential features of traffic jam?

How can we model traffic?

Can you guess?

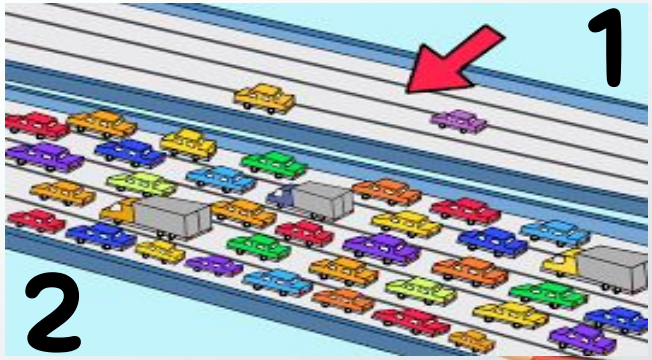
Essential features needed for analysis

1. Cars move forward if the road in the front is open (not congested)

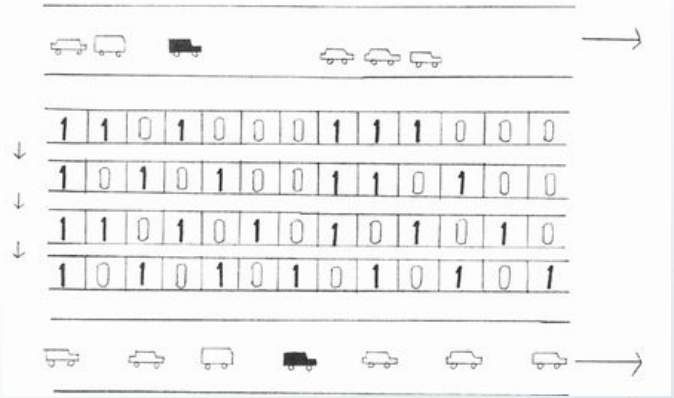
2. Cars don't move forward if there is no space in front of them (if they get stuck).

3. (Cars run on consistent speed/ no radical speeding up or slowing down)

Please keep them in mind!! We will use them from now on.



What is Cellular Automata?



Use “0 and 1” and a “rule”
to change/replace/move
“0 and 1” (rule is arbitrary!)

→Can be used to represent phenomena in the world (eg. Choosing the best places to build radio transmitting tower, simulating the best routes for airplanes)

Let's apply congestion to cellular automata

Remember the essential features?

We will set

"cell"= every 7m of highway (because approximately 1 car is 7m long"

"0"= No car is in the cell

"1"= A car is in the cell

"Rule"= If a car is in the front cell, then the following car cannot move forward.

Let's do the actual simulation!

1) When traffic is few

← front

A BLUE cell(=1) stands for a car

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	1	1	0	0	0	1	0	1	1	1	0	0	1	0	0	1	1	1	0
1	0	1	0	0	1	0	1	0	1	1	0	1	0	0	1	0	1	1	0
0	1	0	0	1	0	1	0	1	0	1	1	0	0	1	0	1	0	1	0
1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0

Let's do the actual simulation!

2) When traffic is crowded

← front

A BLUE cell(=1) stands for a car

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	1	1	1	0	0	1	1	0	1	1	1	1	0	0	1	0	1	1
1	1	0	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1	0	1
0	1	1	0	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1	1
1	0	1	1	0	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1

Let's do the actual simulation!

3) When cars do not keep distance

← front

A BLUE cell(=1) stands for a car

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	0	1	1
1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	0	1
0	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1
1	0	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1

Congestion still remains...

Let's do the actual simulation!

4) When cars keep distance

← front

A BLUE cell(=1) stands for a car

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	0	1
1	0	1	1	0	0	0	0	1	0	1	1	1	0	0	1	0	1	1	1
0	1	0	1	0	0	0	1	0	1	0	1	1	0	1	0	1	0	1	1
1	0	1	0	0	0	1	0	1	0	1	0	1	1	0	1	0	1	0	1

TRAFFIC JAM DISSOLVED!!!

Conclusion

Traffic jam can be solved by individual efforts!

If we use mathematics, we can simplify the real life problem and find solutions!


Any comment or feedback?

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