Autonomous Vehicles: Is It Necessary to Develop?

Qiu Kunyuan
Ren Shize
Zeng Shizhi
Du Fangyu

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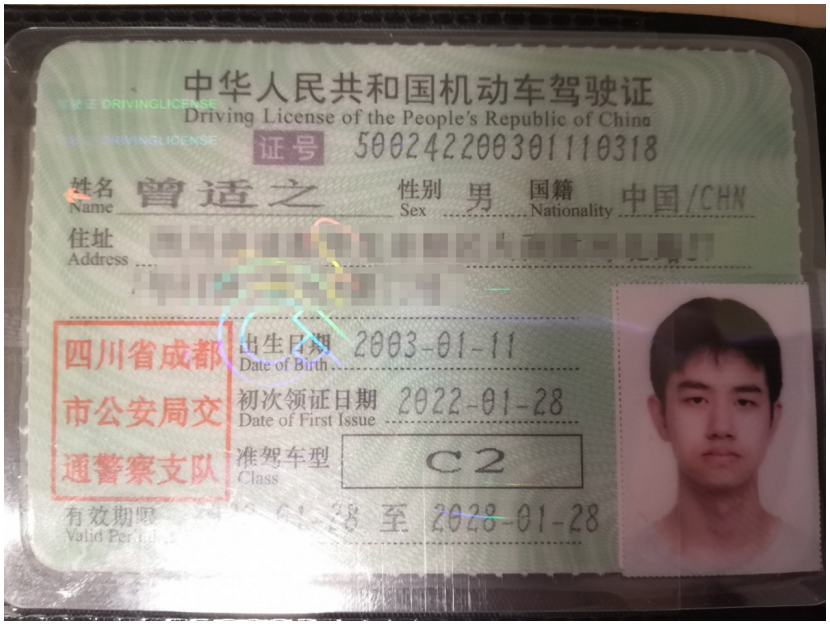
TOC

Tired Driver...

Earlier this year, I was qualified with the driver's license...



I was excited about holding the steering wheel with my own hand at the first, but the reality seems not to be that ideal.
Since then, my father always asked me to drive as long as my family went out. During this Spring Festival, I drove my family to the Xiling Snow Mountain for a trip. It was a 3.5-hour ride and made me very tired.

...Thinks for Automation

Autonomous driving is a hotspot recently and some companies are acquiring good achievements.
This technology may liberate me from the exhaustion.

Is It Necessary to Take the Risk?

Autonomous driving is

- in rapid evolution
- the most expeditious way to bring cutting-edge research to the industry
- the most anticipated utilization of new computer science
- ...

However, this old but young technology faces challenges from

- cost
- safety and robustness
- technical feasibility
- ethics
- ...

Is It Necessary to Take the Risk?

Automatic driving has many benefits to the society and can make many technologies into use.
Though it still faces many problems, the overcoming of such challenges is in a good anticipation.
In conclusion, it's necessary to develop automatic driving to improve people's lives regardless of facing what problems.

Human Errors Causes Traffic Jam

Humanity is a vulnerable species, and they are likely to make errors. For example, they easily estimate the distance to a traffic lamp shorter than reality.

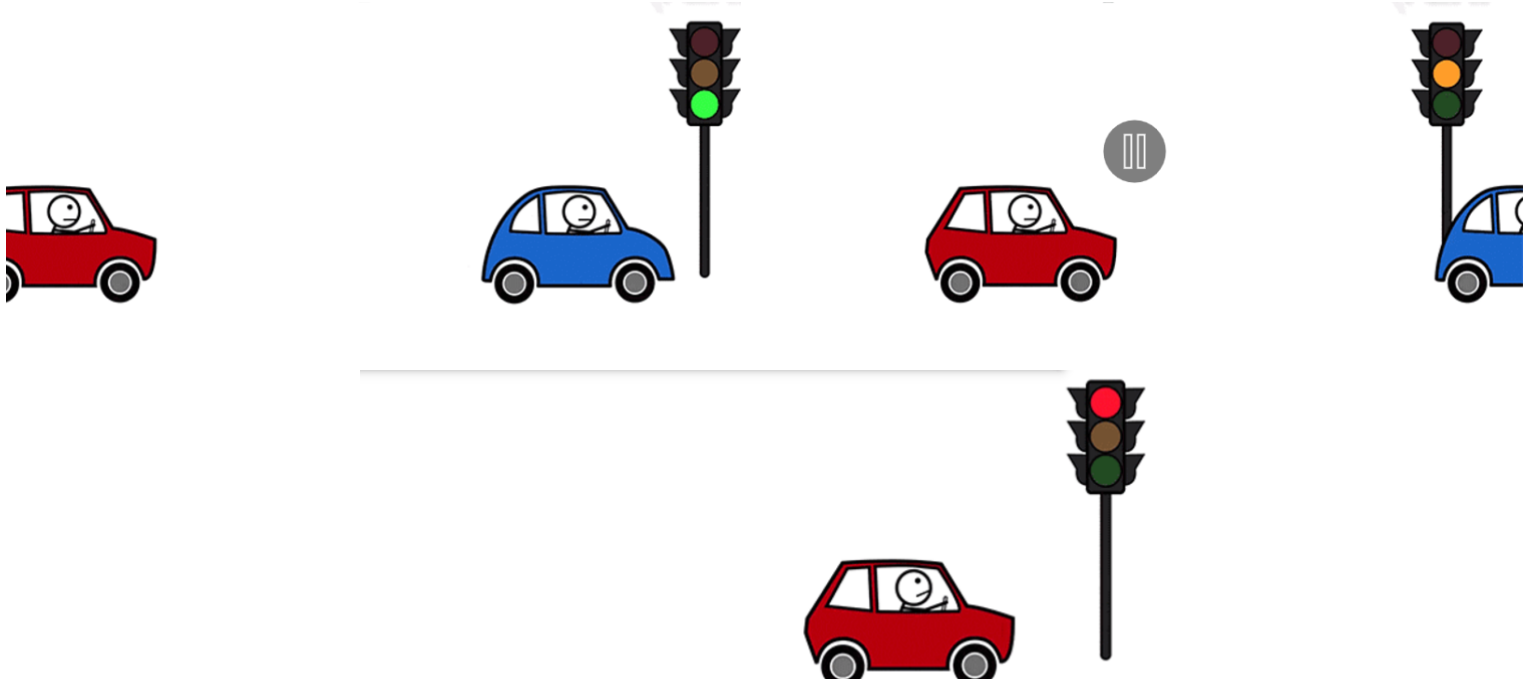
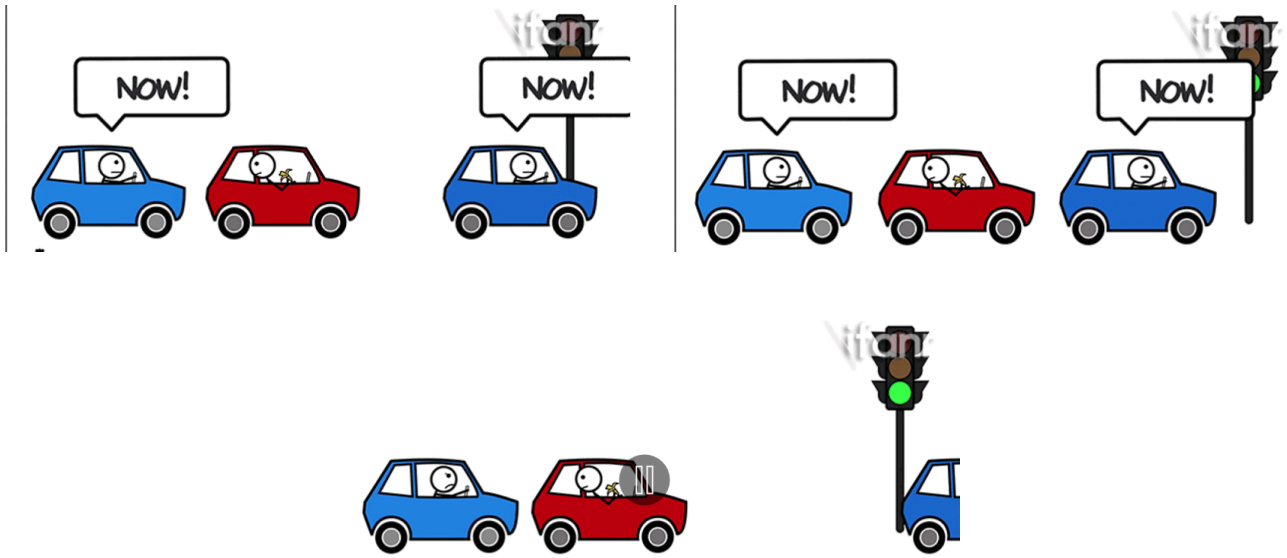


Figure: Underestimate the distance

Human Errors Causes Traffic Jam

Another example is a distracted driver leads to a traffic jam in front of a crossroad.



Automated Vehicles Minimize Human Errors

The autonomous driven vehicles are never distracted, their on-board sensors including LiDAR and mmWave radar and computer vision sensors and GNSS receivers never produce erroneous readings comparing with human case (1).
Therefore, such ambiguity and delay of humanity can be mostly averted by the utilization of robotically automated vehicles.

Automated Vehicles Minimize Human Errors

Five years ago, the well-known firm McKinsey released a report claiming that full adoption of autonomous driving could reduce traffic accidents by 90 percent and reduce damages and medical costs by $190 billion a year.
Research from MIT's Center for the Future of Transportation shows that based on current technology, driverless cars can be expected to have a reaction time of 0.01 to 0.001 seconds, 50 to 500 times better than a human driver

Ghost Traffic Jam

When the traffic flow on a section of road reaches a certain **critical density**, the stochastic volatility of local traffic results in the so-called **Ghost Jam**.

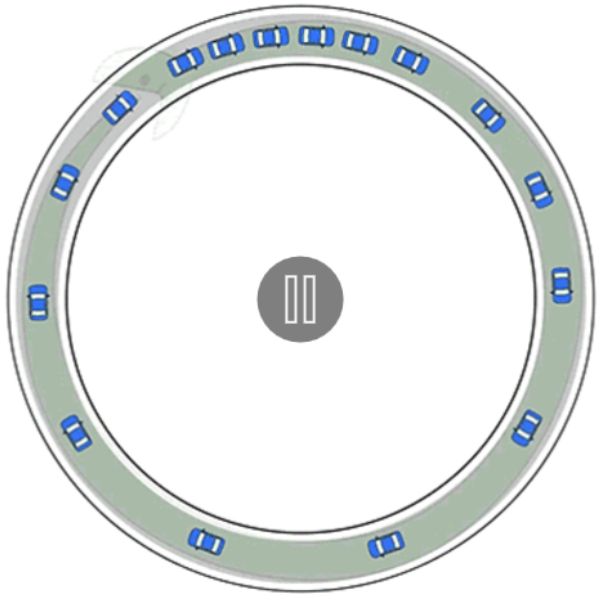


Figure: Ghost Jam in Illustration

Such random fluctuation creates a *bulge* on the local traffic density, and in the nonlinear time invariant system of the road traffic such *bulges* are amplified.

Ghost Traffic Jam: Cellular Autonomon Theory

The Nagel–Schreckenberg model[1] explains the **Ghost Traffic Jam**(2) theoretically.

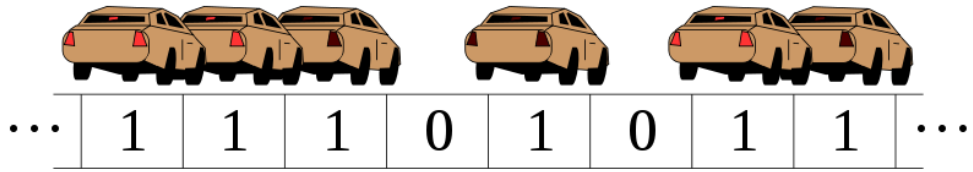


Figure: N-S Cell Autonomon

The 2D plane plot(4) indicates the emergence of the ghost jam.

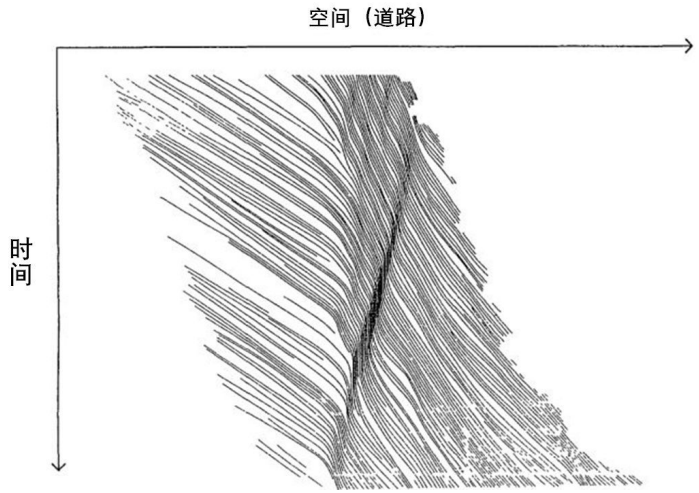


Figure: 2D Time-Density Plot

Automated Vehicles Reduces Ghost Traffic Jam

Analysis on such *ghost traffic jam* by Benjamin Seibold[2][3] indicates that the *ghost jam* phenomenon are induced by the inferior optimal responding strategy of average human driver. The nonexistence of long range sensing approaches and global optimization algorithms make human driver focuses on and only their local status. However, the automated vehicles with high speed data link to a global governing system adjusts their behaviour according to the global efficiency in real time. Numerical analysis[2] and field experiment[3] shows that 2% of self-driving cars reduces traffic jitters by 50% in average cases.

5G and Further Communication System

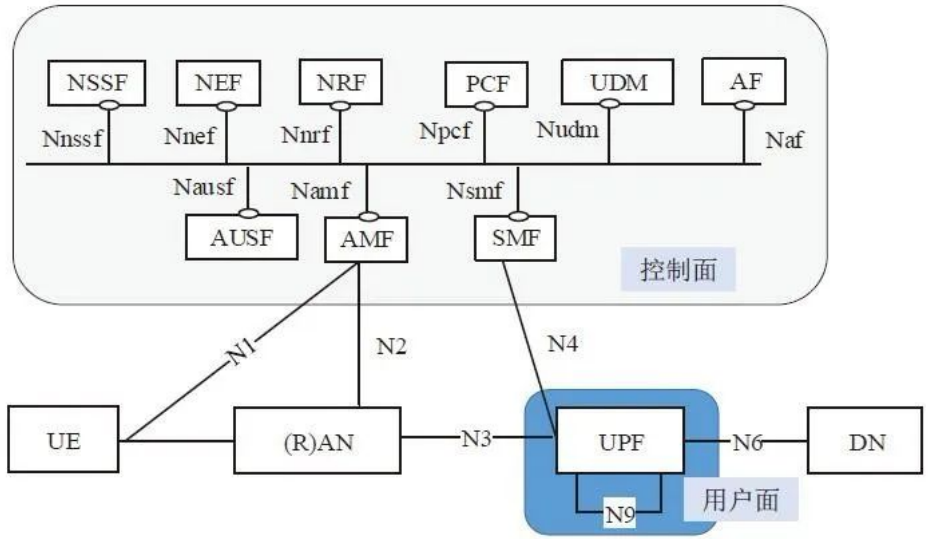


图1　5G SA网络架构

High Speed Large Bandwidth Infrastructure

Solid State LiDAR

Sensor Fusion and Pathfinding

Overview

- cost
- safety and robustness
- technical feasibility
- ethics
- ...

Overview

前一阵有在朋友圈有一段很流行的话如下：

When you’re fundraising, it’s AI （当你在融资的时候，这是AI业务）

When you’re hiring, it’s ML （当你招人的时候，你说需要机器学习的工程师）

When you’re implementing, it’s linear regression （当你具体实现一个功能的时候，变成了线性回归）

When you’re debugging, it’s printf() （而最终调试的时候，你一直在printf）

对于挤破头想要读AI博士的同学，我希望各位想想清楚，等你们的毕业时候，市场上的蛋糕会真的还和现在一样大么。到那个时候，到底需要的是廉价的调参工人，还是精通数学的底层理论研究者，都不是现在能回答的问题。

而热潮总会褪去，跟风也总会停止。如同几年前人人都在讨论大数据一样，如同现在人人都想加区块链业务一样，浪潮褪去之后，留在沙滩上继续往前走的永远是少数人。

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看到大家都用print调试我就放心了

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Industrial Robustness

From the perspective of vehicle model, automatic driving vehicles, or the vehicles installed with some artificial intelligence systems that can partly control the vehicle itself instead of the drivers for a short time, almost all these vehicles are powered by electricity.
And for the **batteries**, most of the time, they can work wonderfully. However, they are so flammable that for some time, they could burn or explode and then cause severe injuries even death.

Industrial Robustness of AI and Other

On April 21, 2019, a spontaneous combustion accident occurred on a TESLA electronic car in Shanghai without any sign or warning. About 2 weeks later, another spontaneous combustion accident occurred on a TESLA in San Francisco.
In August 2022, an unexpected accident(5) happened on a famous star Jimmy Lin (林志颖) in Chinese Taiwan because of his TESLA and caused irreversible damage to him.

Industrial Robustness

Figure: TESLA Accident Involving Lin Zhiying

Cybersecurity Concerns

Since the vehicles installed with some artificial intelligence systems that can partly control the vehicle itself instead of the drivers for a short time, there exists possibility of hacking.
For a skilled hacker, hacking into an all-electric vehicle could even allow the vehicle to drive passengers to a designated location.

Ethic Concerns

Just like the second presenter said, everyone believes that automatic driving can let the incidence rate of traffic accidents has a **90 percent reduction**.
But just like our computers and our mobile phones, they could inevitably crash when using. Under this condition, the automatic vehicle may cause unexpected road accident.
On March 18, 2018, an Uber automatic driving hit a pedestrian crossing the street.

That automated car was making error again and again, at last, the tragedy occurred, and the pedestrian died finally.

Ethic and Legitimation Concerns

So, for the **last 10 percent of the traffic accident**, who is the main responsible person for this accident? If that car was controlled by a real person, that question should be easily answered.
The beneficial entanglement biases to the vehicle producers and large companies since they take control of massive **capitals** comparing with average people.

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