Autonomous control of autonomous vehicles

Dialog with a slightly technology-affine grandma with student of informatics:

Vehicles without drivers? Do you mean that they drive alone? Are you crazy?

Of course, they will drive alone. Safer and better than us human drivers.

Do you really think cars alone will drive better than we humans do?

It is hard to accept, but yes. Once cars will be more like airplanes today. Human will only be there for the feeling of safety of some passengers.

But how they could be better and safer than human beings?

Computers are becoming ever more powerful and ever cheaper. Computers are becoming more like a human brain. This brain can learn essentially anything the same way as babies. They can analyze what is happening on the road and decide whether to accelerate, turn or brake.

Moreover, with many autonomous vehicles in the streets, there will be no difference between a taxi, car-sharing and vehicle renting. Autonomous vehicles will even deliver your groceries, drugs and post.

Hold on. And who will tell the cars, what to do?

You will tell them, where you want to go. Computers will coordinate autonomous vehicles.

Yet, another computer?

Yes. Because we humans have only limited capacity, we can perhaps coordinate some dozens of vehicles, some experienced guys maybe a hundred, but beyond that it is tremendously difficult and demanding. As a typical man, I cannot think about two things at once.

But how can you make sure that this computer will be better?

Well, it will learn again the same way babies do. Eventually it will reach a stage where it will be able to coordinate these big fleets.

My dear, I doubt it! We were also supposed to have a nuclear fusion by now.

I know grandma. There are many challenges. Nonetheless, it will be exciting. We will see!

Autonomous control of autonomous fleets

Autonomous control of thousands and millions of autonomous vehicles (for various on-demand mobility services ranging from car-sharing to same day parcel delivery) in an urban environment is very challenging for human dispatchers. Experience of many delivery and on-demand mobility companies show that each dispatcher is able to manage couple of dozens of vehicles and in some straightforward cases up to one hundred vehicles. This is empirically the maximum one human brain is able to handle. As the scale increases humans are not able to process variables fast enough.

However, how many such dispatchers are needed for a fleet of a million vehicles in a megacity such as Munich? Most importantly, how would they split their tasks? The coordination and control of the vehicles including re-allocating them to places where the customer expects them, organizing cleaning, re-charging and servicing has a temporal and spatial aspect. Should the dispatchers divide their responsibilities according to a spatial aspect, so that each of them is responsible for couple of square kilometers? Certainly it is possible, but they would miss the time aspect and, moreover, still require a central entity with a big picture for the re-allocation of the vehicles. Furthermore, it is very hard to imagine the division of the dispatchers' responsibilities in the time domain. In general, if the division is made, it is on the costs of system efficiency and performance. Hence, there is a need to develop another way of controlling and managing these large fleets of autonomous vehicles than having an army of human dispatchers. Here is the vision.

The vision – Artificial dispatcher baby

Humans are incredibly smart when it comes to learning challenges of vehicle dispatching and in creatively solving complex operational challenges. We are able to consider many factors and develop a fingertip feeling and sometimes decide by the belly feeling. That works perfectly on very small scale. Here is the core of the idea.

Imagine the artificial dispatcher as a baby. Babies observe the parents and people around them and absorb whatever they can, like a sponge. Similarly in the first phase the artificial dispatcher baby observes human dispatchers and creates the basic description of what is happening and starts developing connections. The dispatcher baby learns the causalities and decisions that lead to good and bad fleet performance. It develops its own hypotheses and starts to test them by using machine learning techniques. If the hypotheses are right, it saves them, if they are wrong, it learn from it and modify the hypotheses.

As this artificial dispatcher baby grows and reaches the level of human understanding of fleet management, it tries to take over small part of the decision making. Similarly, as parents grant more responsibility to their children, if they seem to understand the concept, the artificial dispatcher child is given more responsibility in the areas, where the developed knowledge is the same or better than human dispatcher parents.

Finally, with even more learning and experience the artificial dispatcher turns into a teenager and an adult and over-performs the human dispatchers in most aspects. Humans are only there to assist with very peculiar cases. Here are the three main attributes of the proposed idea.

Scalable Thanks to the machine learning approach, the proposed idea is easily scalable and adaptable to local conditions than traditional constraint programing optimization approaches.

Efficient Because of much higher cognitive performance, it is not necessary to divide the whole spatial-temporal challenge into smaller isolated parts, but solve it on the system level instead. Already this is more efficient. Furthermore, many logistic and delivery companies operate currently very small fleets and struggle at times with either too little or too many orders. Virtual aggregation of the orders and fleets may further improve the efficiency.

Sustainable By being able to control large fleets, the demand can be better matched with supply, the cleaning, refueling and recharging facilities can be better utilized and as a result the whole fleet can be better utilized. That means that for serving the same demand fewer vehicles are needed.