AMEENA AL SUMAITI

Associate Professor of Electrical Engineering and Computer Science at Khalifa University in Abu Dhabi

Patrick Nicolet, CEO of Linebreak Ltd., former Group Chief Technology Officer of Capgemini

Moving on to more the applied part, where do you see the opportunities, Ameena?

Ameena Al Sumaiti, Associate Professor of Electrical Engineering and Computer Science at Khalifa University in Abu Dhabi

Imagine the roads where Artificial Intelligence will take over the role of all human drivers with data driven electric car and no more accidents. This sounds like science fiction but Artificial Intelligence will play a vital role in the development of autonomous vehicles. Through machine learning techniques, Artificial Intelligence would be able to make these cars move through traffic, make decisions and perceive their surroundings. Artificial intelligence will analyze the traffic all the time, allowing for dynamic traffic management, which will reduce traffic congestion and improve the overall traffic flow. Artificial Intelligence will predict traffic conditions, use of public services and the demand for ridesharing services. The data driven insights will be very valuable in optimizing routes, scheduling services and at the same time, allocating charging resources. Artificial Intelligence will support logistics, optimize the roads, predict the demand and manage the inventory, which is crucial for efficient transportation of goods. Artificial Intelligence will also support charging infrastructure operators and this will contribute to its management in terms of energy costs as well as maintenance, which finally, will contribute to its economic sustainability.

Artificial Intelligence will also support electric utilities in the form of facilitating integration of electric vehicles into the power networks, which will reduce the strain on them and balance the load, which is very important during peak power loads especially. Artificial Intelligence will also improve the end-user experience by providing information about the available charging infrastructure, waiting times and how to navigate to the nearest charging infrastructure. Artificial Intelligence will revolutionize the transport sector by looking at the optimal planning of the sector and transport will be made easier by leveraging data and algorithms for safe, sustainable and efficient transport.

In the Smart Operations Research Lab at Khalifa University, we have covered multiple projects focusing on how AI will revolutionize the transport sector and we have looked at its planning from two points of view. One of them is the long-term planning of the transport sector and the other one is the short-term operational planning. When we talk about long-term planning, we are looking at two things: the location and sizing of charging infrastructure and predicting their energy demand. We looked at predicting energy demand for the charging infrastructure and the weather impact. Weather conditions like temperature, humidity and wind speed will impact the energy demand of these charging infrastructures. In hot weather, electric batteries will degrade very quickly, which make more charging necessary. In winter, the battery will need to be heated before charging, which will increase the demand on the power

network. Artificial Intelligence is actually going to also help in identifying the energy demand of electric vehicles and at the same time, schedule their charging sessions.

The second project we looked at is around optimizing the location and sizing of the charging infrastructure. We considered the average initial range of EVs, projection of population growth, EVs adoption, distance parameters, charging demand, and capacity constraints, with the target of finding the best locations and sizes for the charging infrastructure.

Then we moved to short-term planning of autonomous transportation, where we also considered multiple projects. Autonomous cars are actually sensor driving cars and when they operate on the streets which can be shared by also cars with human drivers such as emergency vehicles including police cars. We need to make sure that both types of cars operate well on the roads in such a way that human-driven vehicles and emergency vehicles, reach their destination quicker whenever they are needed. We developed an emergency vehicle with a lane change model that used the power of AI to plan how these human-driven emergency vehicles would reach their destinations fast using the benefits of autonomous vehicles, given that they are going to give priority access to these emergency vehicles to reach their destinations.

In another project, we looked at the other side and considered an autonomous emergency vehicle, because if there is a fire or we need an ambulance, every second counts. We need to make sure that these emergency vehicles can cope with the other cars on the street, so we have used the power of AI to plan these autonomous emergency vehicles so that they can reach their destinations by finding the optimal path as well as controlling the traffic and navigating through it without causing problems for other road users. What makes it challenging for autonomous vehicles is adverse weather conditions because, for example, if it is raining the roads will be wet and in that case we need to make sure that there are no accidents. We needed the power of AI to take the weather impact into account in our planning problem and we made sure that no accidents will take place when we program our autonomous vehicles. And this has really been achieved in the Smart Operations Lab.

I am going to focus on one research showcase where we actually considered Dubai. Dubai is divided into fourteen districts and we wanted to elucidate how powerful AI is in planning the charging infrastructure. To do this, we considered two types of charging, first the electric charging infrastructure and second, dynamic wireless charging, which raised the question of why we should consider the latter. The idea is that if we want the streets be fully autonomous, we also want charging to be autonomous, which is why dynamic wireless charging is really important. We considered two case studies, in the first of which we looked at optimally allocating and sizing dynamic wireless charging infrastructure and the charging stations' infrastructure as well, without using the power of AI and only focusing on the optimization. Then we developed a novel AI model, which is a hybridized model taking benefits from multiple AI algorithms, and we tackled the same problem again. We found that we were able to minimize the government infrastructure cost by 2.12% compared to the former case.

This is my overview of the research we have done at Khalifa University in the Smart Operations research lab.

Patrick Nicolet

Thank you for these insights, Ameena, showing both the potential of Artificial Intelligence to give insights but also to automate and this is quite comprehensive. It shows that we can tackle complex problems, usually infrastructures. Yesterday, we had a session on food and the immense amount of waste that could be addressed by applying the same approach. One caveat just for the discussion is that it works well in machine-to-machine interactions where

you can really apply it, but unfortunately when you put human beings into this equation it introduces some random elements that make it more difficult to apply AI, as is the case with autonomous vehicles in particular. There is clearly huge potential.