Volkswagen: Navigating Tough Automotive Tasks with Quantum Computing

CASE STORY

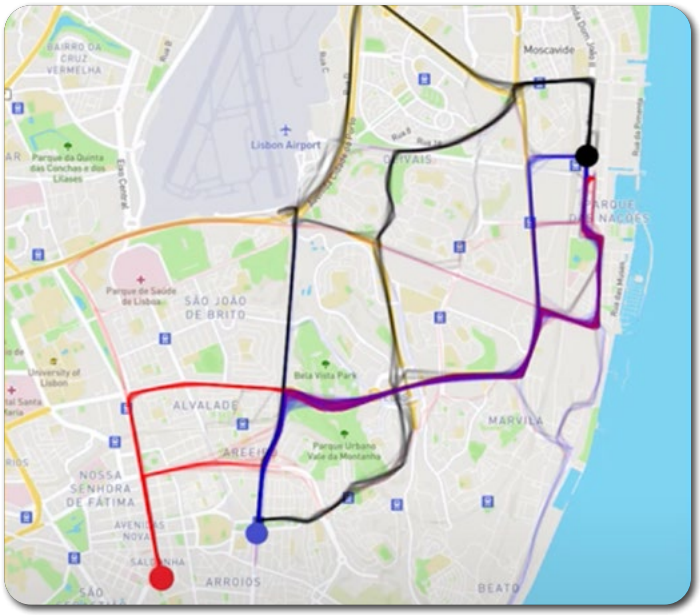
Volkswagen has been a leader in exploring how to leverage quantum computers for complex tasks across a broad spectrum of manufacturing, logistics, and mobility use cases. We will review two of them in this case story.

Drivers routinely rely on the comforting voice of a GPS navigation system to guide them to their destination—but many of us also have had the experience of ending up in interminable traffic jams. Volkswagen demonstrated an efficient solution to this challenge using D-Wave quantum computers, steadily guiding drivers along routes that are optimized in real-time in response to traffic conditions. Buoyed by this success, this automaker is now leveraging this cutting-edge technology to tackle other logistical challenges.

The company selected an intensive test-case for traffic: managing a fleet of buses carrying attendees of the 2019 Web Summit conference in Lisbon, Portugal. This scenario posed a number of significant challenges. The Altice Arena, where the event was held, is at the edge of the city—more than a dozen kilometers from downtown, with ample opportunities for traffic along the way. As an added challenge, the streets of Lisbon are notoriously steep and twisty, with some neighborhoods that would be especially difficult to traverse or even completely inaccessible for buses.

Volkswagen's solution was to develop an Android-based app that regularly communicates with a cloud-based 'quantum web service' (QWS) platform. This was in turn directly coupled to a D-Wave quantum computer, which supplied bus drivers running the app with the best route to their destination given current traffic conditions. In the run-up to the conference, Volkswagen researchers identified three bus lines with a total of 23 stops that would provide the best coverage in terms of relaying attendees between Altice Arena, their accommodations, and other key destinations in the city.

A series of test-runs in Lisbon and Wolfsburg, Germany helped the team to optimize how often the app contacts the QWS, as well as strategies for devising routes that are balanced in terms of avoiding traffic congestion while still traversing the city as speedily as possible. The Volkswagen team also identified numerous areas in Lisbon where steep hills or mazes of narrow one-way streets would hinder travel, and marked these as 'exclusion zones' for route-planning purposes.



Over the four days of the conference, the nine buses in Volkswagen's 'Quantum Shuttle' fleet completed 162 QWS-guided trips. Planning these routes entailed solving a total of 1,275 optimization tasks, and the researchers noted that none of the three bus lines consistently followed the same path—highlighting the importance of QWS guidance in adapting to current road conditions. And thanks to this real-time guidance, the buses were able to achieve fairly consistent travel times regardless of the time of day.

A Colorful Situation

The Volkswagen team was inspired by the outcome of this real-world test of quantum technology. "We consider this to be the first real commercial application that depended on live access to a quantum processor," said Volkswagen quantum computing researcher Sheir Yarkoni in a presentation at D-Wave's Qubits Conference 2020. "We then started looking at what other possible use-cases we could match between this service that we've built and applications that would help the business units at Volkswagen."

One application identified by the Volkswagen team relates to the process of painting car bodies as they travel down the assembly line. Every car initially receives a base coating of black or white 'filler color' before the final color is applied, and an ideal production workflow should minimize the number of times that workers need to switch between filler colors. At first glance, this seems like a simple process to manage, but these factories are producing numerous different car models in varying quantities, collectively comprising a complex mixture of black and white paint jobs. This results in a lot of effort switching between colors.

By applying the same D-Wave quantum computing system used in the Lisbon study, Yarkoni and colleagues were able to come up with a much more efficient solution for that production run. "In a test run, we managed to reduce the color switches in the entire sequence significantly," he said.

This did not require any change to the order in which vehicles were being processed; instead, the quantum team optimized the painting workflow based on the queue of car designs.

For example, if a small subset of minivans was slated to be painted black rather than white, the algorithm would specifically assign those paint jobs to minivans falling within stretches of the production run where other vehicles are already being painted black.

The efficiency gains potential from these early collaborations have left the Volkswagen team bullish about D-Wave's technology and its potential impact on the automotive industry.

> ***"At Volkswagen, we are focusing on building up a deep understanding of meaningful applications of quantum computing in a corporate context. The D-Wave system gives us the opportunity to address optimization tasks with a large number of variables at an impressive speed."***
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