PRIME MINISTER'S SCIENCE PRIZES
AOTEAROA NEW ZEALAND

2020 Prime Minister's Future Scientist Prize

Project on whether quantum computing can improve breast cancer diagnosis wins Prime Minister's Future Scientist prize

James Zingel, a former student of Bethlehem College in Tauranga, has been selected as the 2020 Prime Minister's Future Science Prize Winner.

James' research project used a breast cancer dataset run through both a classic computer and a quantum computer in an effort to see which is superior in analysing the data and determining the type of breast cancer present.

With increasing computing power, there is the opportunity to use these new, more powerful quantum computers to find additional patterns in data. One of these areas is in the medical field, for the early diagnoses of cancer and other diseases, since early attention can greatly improve survival rates. Correct early identification could assist doctors in making correct judgements and in turn save many lives.

"In medicine, it's really important there's an early diagnosis that's correct and it's quite hard for doctors to do this. So, if the computer can correctly identify what the disease is, you have a much better chance of surviving it. It's particularly important in breast cancer. There's an open source dataset that I can use, so I decided to try these new techniques," James said.

Quantum computers operate fundamentally differently from classic computers, using qubits that can take on an infinite number of states as opposed to computer bits that can be either on or off. Qubits in quantum computers allow for more complexity in analysis and can approach problems from a different point of view to classic computers.

"The main difference between quantum computing and classical computing is in classical computing you have bits which are either '1' or '0', they are electronic circuits that are either on or off, as that's how electricity works. But in quantum computing it can be two-thirds on or maybe one-third on and that allows for a whole other avenue of complexity."

This complexity means that quantum computers can potentially be faster at computing certain problems. This is known as a 'quantum speedup', and James aimed to find out if it was possible to find a quantum speedup when classifying cancer types.

James taught himself linear algebra and the ingenious methods used to calculate algorithms. He used a type of machine learning algorithm called a Support Vector Machine. This is a robust machine learning algorithm, which as recently as March 2019 had been proven to work successfully on both classic and quantum computers.

"In my findings I concluded that, at the moment, the classical method is better than the quantum one, but I suspect as our quantum computing grows and we get more qubits in our

quantum computers, I think the quantum algorithm will much outperform the classical one in the very near future."

James has spent hundreds of hours delving into this project and has learnt so much in terms of quantum physics and machine learning. Being able to go from a general understanding of quantum physics theory, to describing it in maths, and finally coding it in a language that generates coherent results has been a fantastic progression that he has loved completing. He now has the tools that he can go on to apply to new datasets, which he can then derive valuable information from.

"I love sharing my project with people. I love teaching them a bit more about quantum physics, especially as they think I'm an expert in it, but I'm really not, but it really is my passion and I love how people always get excited by it and excited by the future and that's the exact same reaction that I have, so it's been a wonderful project to do."

Bethlehem College Principal Larne Edmeades holds great hopes for what James will be able to achieve in the future.

"James' project was obviously a very significant part of his senior schooling here at Bethlehem, but to be fair, the majority of the momentum came from James himself. And I'm sure, given his whole-hearted approach, that he will do tremendously well with like-minded and talented people at university level."

James has just started his first year at the University of Auckland undertaking a Bachelor of Science, double-majoring in physics and math. He receives a prize of $50,000 to go towards the cost of his education.

"Ideally I want to get in involved in quantum physics. I'd love to become a quantum physicist and discover some new things about quantum physics or quantum computing, but we will see what happens at university."