Building software for assessing quantum advantage

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The scientific press in recent years has been filled with big claims about the advent of quantum computers. The most prominent recent claims include purported demonstrations of “quantum supremacy” [1, 2] or “quantum computational advantage” [3]. Roughly speaking, these results indicate that current technology allows us to perform computational tasks on quantum devices that cannot easily be simulated by classical computers. But those computational tasks are not designed for some useful purpose – nor are they expected to have one. A renewed push is therefore underway to identify clear and compelling applications of quantum computers that would justify further billions of dollars in investment. Such applications should not only be useful but also compel us to use quantum computers rather than classical.

My own research since moving to Australia has sought to identify such quantum computer applications. In this talk I will describe the methodology of such work by focussing on two recent examples [4, 5]. I will highlight the important difference between designing a quantum computer program and demonstrating that this program has some kind of advantage over a classical computer program, and I will describe software I am writing in order to automate the analysis of such potential applications in order to produce clear evidence (or not) of a quantum advantage.