

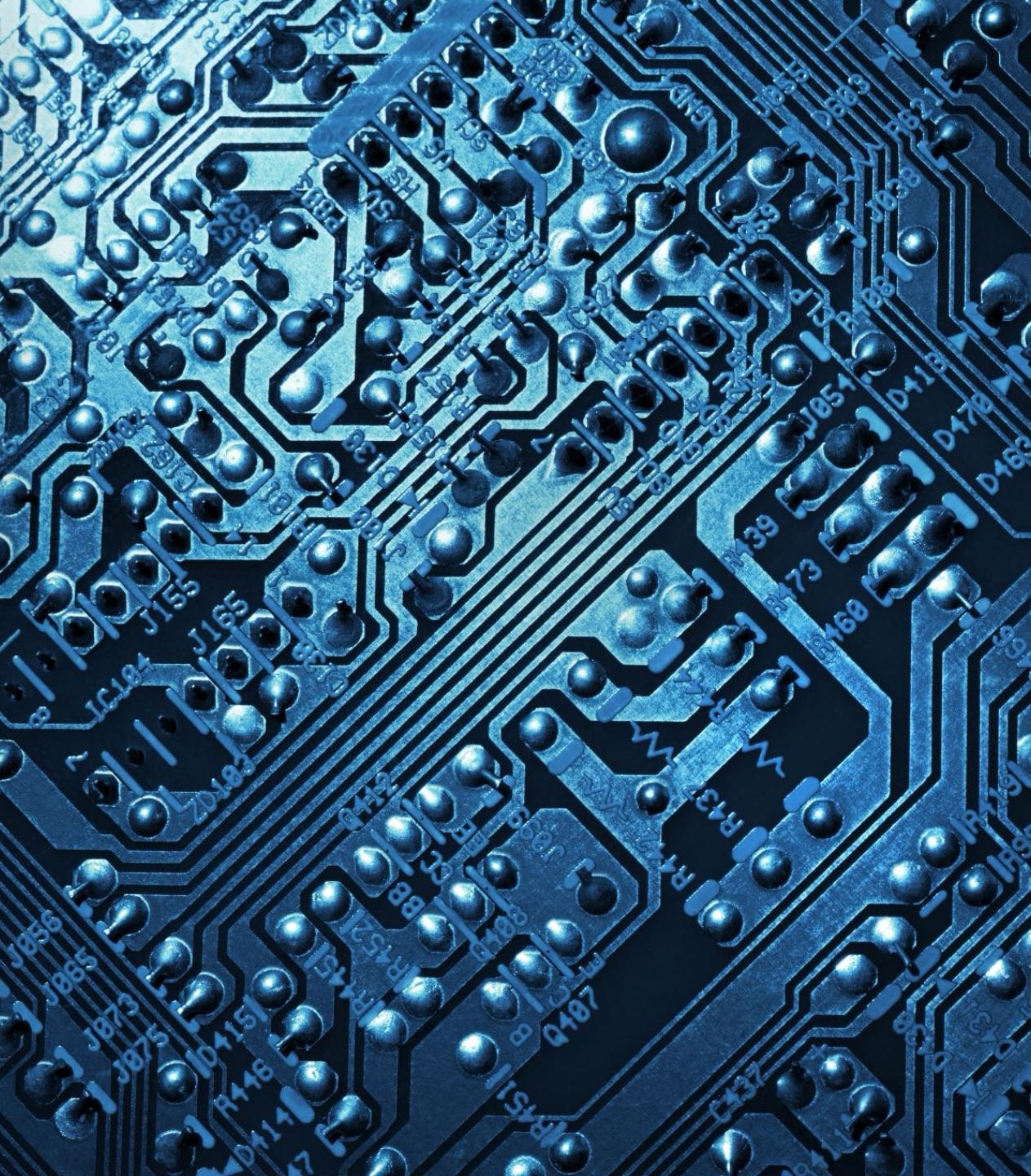
Quantum Computing Overview

An Introduction to Quantum
Computing

Mohammed Fatehi

Quantum Computing Basics

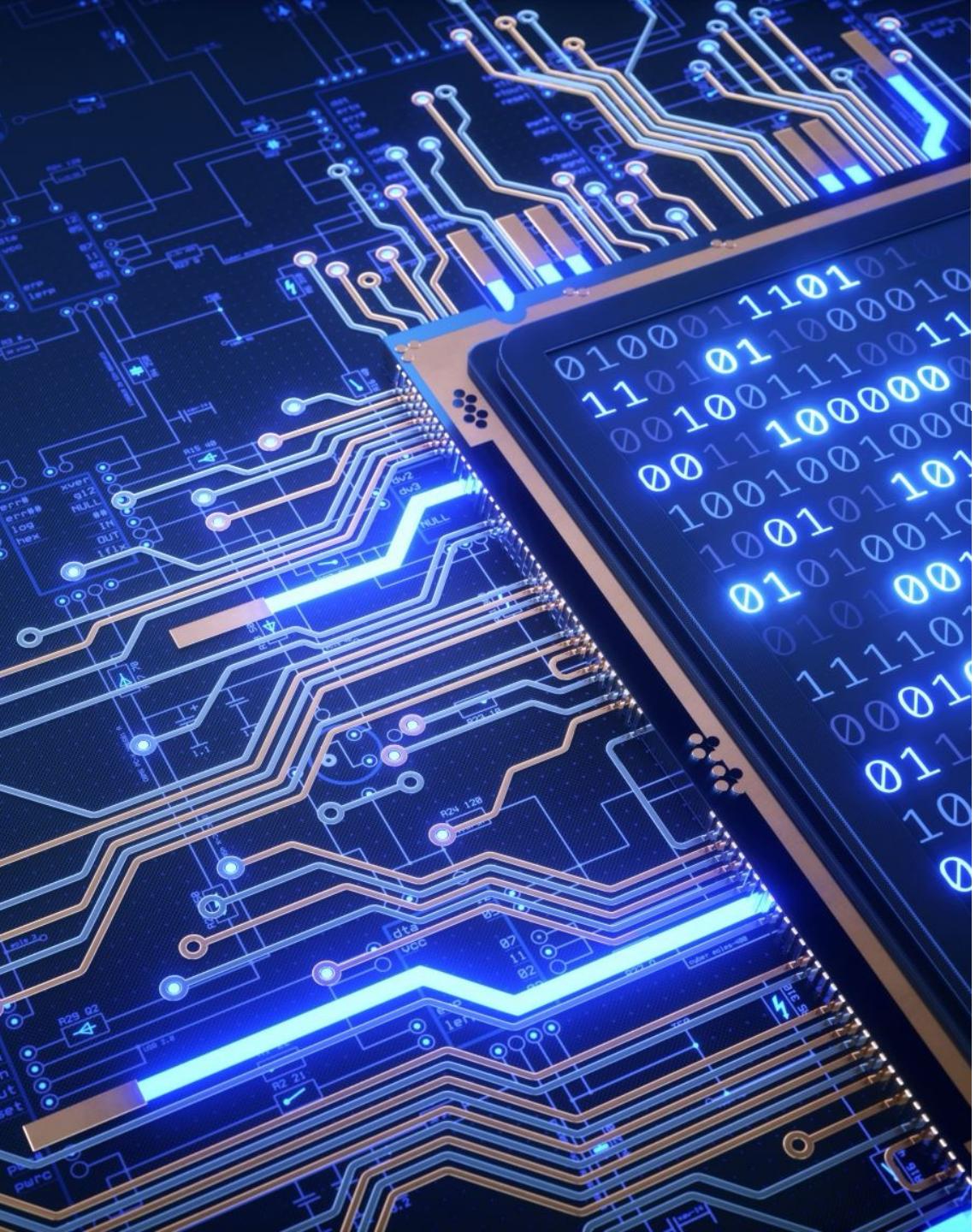
- A quantum computer is a computer that takes advantage of quantum mechanical phenomena. On small scales, physical matter exhibits properties of both particles and waves, and quantum computing leverages this behavior, specifically quantum superposition and entanglement, using specialized hardware.



Classical vs Quantum Computing

- Classical physics cannot explain the operation of a quantum computer. A scalable quantum computer could perform some calculations exponentially faster than any current classical computer. However, the current state of the technology is largely experimental and impractical.





Qubits and Superposition

- The basic unit of information in quantum computing is the qubit, similar to the bit in traditional digital electronics. Unlike a classical bit, a qubit can exist in a superposition of its two 'basis' states.



Quantum Algorithms

- Quantum algorithms involve creating procedures that allow a quantum computer to perform calculations efficiently and quickly. Examples include Shor's algorithm for factoring and Grover's algorithm for unstructured search.

Quantum Decoherence and Error Correction

- Physically engineering high-quality qubits has proven challenging. If a physical qubit is not sufficiently isolated from its environment, it suffers from quantum decoherence, introducing noise into calculations. Error correction is essential to maintaining coherence.





Quantum Cryptography

- Quantum computing has significant potential applications in cryptography and cybersecurity. Quantum key distribution (QKD) enables secure exchange of cryptographic keys, ensuring confidentiality and integrity of communication.

Quantum Supremacy

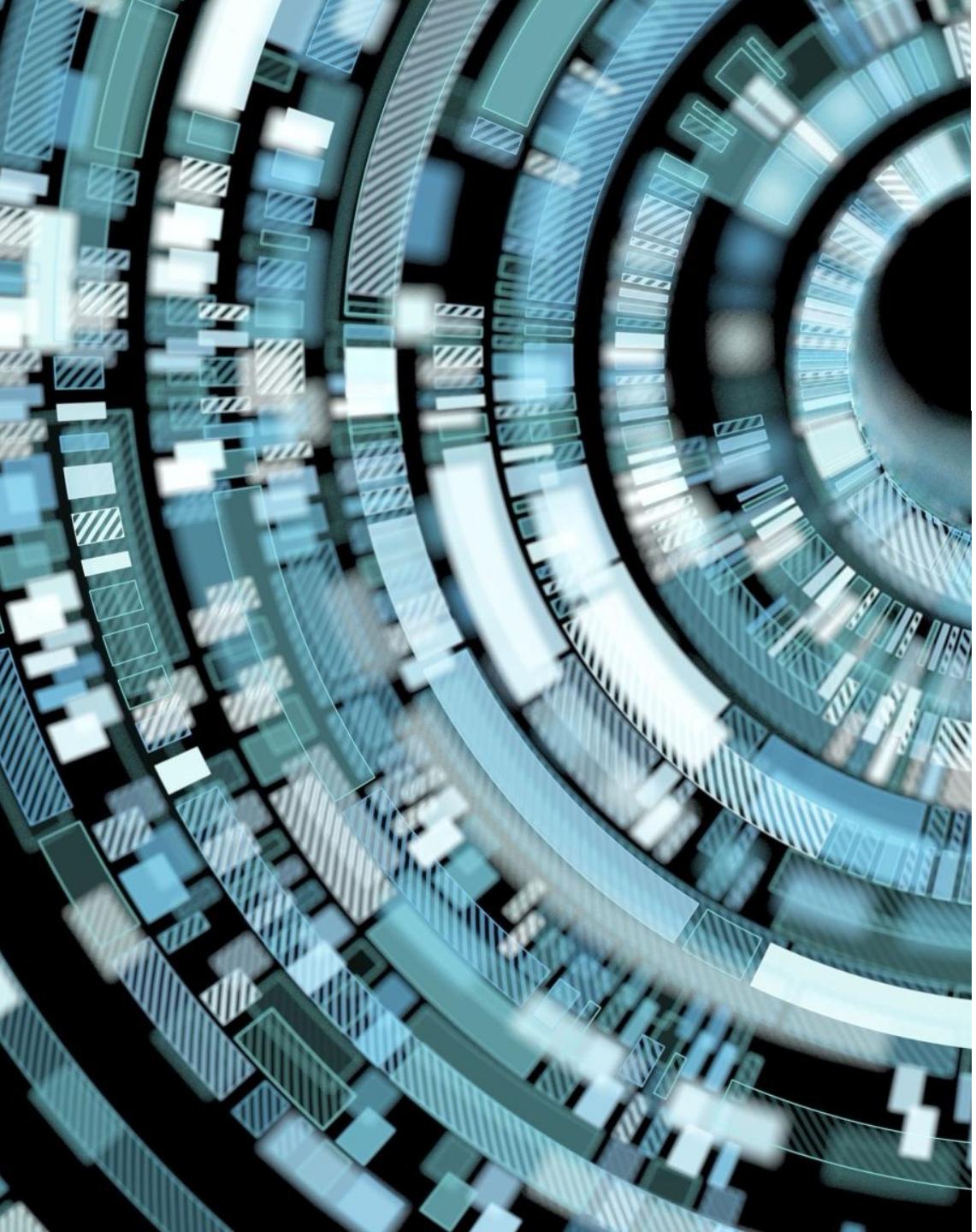
- Quantum supremacy describes the point at which a quantum computer can perform a computation that is beyond the capabilities of classical computers. Google and NASA have claimed to achieve this with their Sycamore quantum computer.





Challenges and Future Prospects

- Building a large-scale quantum computer faces numerous challenges, including decoherence, error rates, and scalability. Despite these challenges, ongoing research and investment aim to overcome these obstacles.



Conclusion

- Quantum computing is a rapidly evolving field with the potential to revolutionize computing. While many challenges remain, the future of quantum computing holds great promise for various applications.