**Overview: The Limits of Classical Computers and the Potential of Quantum Computing**

**Classical Computers:**

* Consist of simple components (data representation, processing, control) organized in hierarchical structures
* Compute by manipulating bits (discrete units of information with values 0 or 1)
* Combinations of bits represent more complex information
* Compute by combining logic gates (e.g., AND Gates) to perform basic operations (e.g., addition)
* As components shrink, quantum effects (e.g., quantum tunneling) become significant

**Quantum Computers:**

* Utilize qubits (quantum bits) that can exist in a superposition of states, representing both 0 and 1 simultaneously
* Exploit superposition and entanglement (instantaneous connections between qubits)
* Quantum gates manipulate qubits in superpositions and rotate probabilities
* Final measurements collapse superpositions, producing a specific sequence of 0s and 1s
* Provide exponential speed-ups compared to classical computers in certain areas (e.g., database searching)

**Applications of Quantum Computers:**

* **Database Searching:** Faster searching algorithms
* **Cryptography:** Breaking current encryption systems
* **Simulations:** Accurate simulations of quantum systems, including molecules