Physics and Computation

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There is a deep connection between Physics and Computation. Indeed, any computation can be represented as a physical process. In 1981 Richard Feynman raised some provocative questions in connection to the simulation of physical phenomena using a special device called a "Quantum Computer". Such a device was intended to mimic physical processes exactly the same as Nature. Remarks coming from such an influential figure generated widespread interest in these ideas, and today after 31 years there are still open questions. What kind of physical phenomena can be mimicked?, How?, and What are its limitations? What would happen if Nature only uses computable numbers? I will address these questions and at the end discuss recent attempts to realize "Discrete Quantum Computation" which uses only computable numbers (finite fields), in line with Alan Turing's legacy.