History of Computation

The history of computation is longer than the history of computing hardware and modern computing technology. Digital computing is intimately tied to the representation of numbers. Bu long before abstractions like the number arose, there were mathematical concepts to serve the purpose of civilisation. These concepts are implicit in concrete practices.

The concept of numbers became concrete and familiar enough for counting to arise. Advances in the numeral system and mathematical notation eventually led to the discovery of mathematical operations such as addition, subtraction, multiplication, division, square root, and so forth. Eventually the operations were formalized, and concepts about the operation became understood well enough to be stated formally and even proven.

By the High Middle Ages, the positional Hindu-Arabic numeral system had reached Europe, which allowed for systematic computation of numbers. During this period, the representation of a calculation on paper actually allowed calculation of mathematical expressions, and the tabulation of mathematical functions such as square root and the common logarithm and the trigonometric functions. By the time of Issac Newton’s research, paper was an important computing resource, and even in our present time, researchers would cover random scraps of paper with calcultation, to satisfy their curosity about an equation. Even into the period of programmable calculators, Richard Feynman would unhesistantly compute any steps which overflowed the memory of the calculators, by handm just to learn the answer.

The earliest known tool for use in computation was the abacus, and it was thought to have been invented in c. 2700-2300 BC. Its original style of usage was by lines drawn in sand with pebbles. In c. 1050-771 BC the south-pointing chariot was invented in ancient China. It was the first known geared mechanism to use a differential gear, which was later used in analog computers. In the 5th Century BC in ancient India, the grammarian Panini formulated the grammar of Sanskrit in 3959 rules known as the Ashtadhyayi which was highly systematized and technical. In 3rd Century BC, Archimedes used the mechanical principle of balance to calculate mathematical problems, such as the number of grains of sand in the universe. The Antikythera mechanism is belived to be the earliest known mechanical analog computer. It was designed to calculate astronomical positions. It was discovered in 1901 in the Ankitythera wreck off the Greed island of Antikythera.

Mechanical analog computer devices appeared again a thousand years later in the medieval Islamic world and were developed by Muslim astronomers, such as the mechanical geared astrolabe, and the torquetum. According to Simon Singh, Muslim mathematicians also made important advances in cryptography, such as the development of cryptanalysis and frequency analysis. Programmable machines were also invented by Muslim engineers, such as automatic flute player and Al-Jazari’s humanoid robots and castle clock, which is considered to be the first programmable analog computer.

During the Middle Ages, several European philosophers made attempts to produce analog computer devices. Influenced by the Arabs and Scholasticism, Majorcan philosopher Ramon Llull devoted a great part of his life to defining and designing several logical machines that, by combining simple and undeniable philosophical truths, could produce all possible knowledge. These machines were never actually built, as they were more of a thought experiment to produce new knowledge in systematic ways; although they could make simple logical operations, they still need human being for the interpretation of results. Moreover they lacked a versatile architechture, each machine serving only very concrete purposes. In spite of this, Llull’s work had a strong influence on Gottfried Leibniz, who developed his ideas further, and built several calculating tools using them,

Indeed, when John Napier discovered logarithms for computations purposes in the early 17th century, there followed a period of considerable progress by inventors and scientists in making calculating tools. The apex of this early era of formal computing can be seen in the difference engine and its successor the analytical engine, both by Charles Babbage. The analytical engine combined concepts from his work and that of others to create a device that if constructed as desinged would have possessed many properties of a modern electronic computer. This was a fundamental shift in thought. Babbage’s device could be reprogrammed to solve new problems by the entry of new data, and act upon previous calculations within the same series of instructions. Ada Lovelace took this concept one step further, by creating a program for the analytical engine to calculate Bernoulli numbers, a complex calculation requiring a recursive algorithm.

This is considered to be the first example of a true computer program, a series of instructions that act upon data not known in full until the program is run.

Several examples of analog computations survived into recent times. A planimeter is a device which does integrals, using distance as the analog quantity. Until the 1980s, HVAC systems used air both as the analog quantity and the controlling element. Unlike modern digital computers, analog computers are not very flexible, and need to be reconfigured manually to switch them from working on one problem to another. Analog computers had an advantage over early digital computers in that they could be used to solve complex problems using behavioral analogues while the earliest attempts at digital computers were quite limited.

Since computers are rare in this era, the solutions were often hard-coded into paper forms such as nomograms, which could then produce analog solutions to these problems, such as the distribution of pressures and temperatures in a heating system.

None of the early computational devices were really computers in the modern sense, and it took considerable advancement in mathematics and theory before the first modern computers could be designed.

The first recorded idea of using digital electronics for computing was the 1931 paper "The Use of Thyratrons for High Speed Automatic Counting of Physical Phenomena" by C. E. Wynn-Williams. During the World War II, ballistics computing was done by women, who were hired as “computers”. The ENIAC (Electronic Numerical Integrator And Computer) was the first electronic general-purpose computer, announced to the public in 1946. It was Turing-complete digital, and capable of being reprogrammed to solve a full range of computing problems.

The microprocessor was introduced with the Intel 4004. It was then developed as a single-chip microprocessor from 1969 to 1970, led by Intel’s Marcian Hoff and Federico Faggin and Busicom’s Masatoshi Shima. The microprocessor led to the development of microcomputers, and the microcomputer revolution.

Future of Computation

Moore's Law, more of an observation turned prediction that has more or less held up, is described as:

> *The number of transistors on a chip roughly doubles every two years, as their cost goes down*

In 1956, Gordon Moore sketched out his prediction of the pace of silicon technology. Decades later, Moore's Law remains true, driven largely by Intel's unparalled silicon expertise. Since transistors are the work horses of a computer, doubling the transistors generally means doubling the computer processing power. And it's not just CPUs that are improving at an exponential rate. Every couple of years, storage devices like memory and hard drives are bigger and faster, displays are better, and cameras capture better images.

Today's computers operate using semiconductors, metals and electricity. Future computers might use atoms, DNA or light. Moore's Law predicts doubling, but when the computers go from quartz to quantum, the factor will be off the scale.

What would the world be like, if computers are the size of molecules a reality? These are the types of computers that could be everywhere, but never seen. Nano sized bio-computers that could target specific areas inside our body. Giant networks of computers, in our clothing, our house, our car. Entrenched in almost every aspect of our lives and yet we may never give them a single thought.

Ubiquitous computing is a concept where computing is made to appear anytime and everywhere. It can occur using any device, in any location, and in any format including laptop computers, tablets and terminals in everyday objects such as a refrigerator or a pair of glasses.

References

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- Future of computations:
  http://www.futureforall.org/computers/computers.htm
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