

## Binary Basics

The binary number system is the most fundamental incarnation of computer science, and strings of zeros and ones comprise the foundation of all the software and all the data in digital computers. From the beginning, computers were designed to work directly on binary rather than decimal numbers at their lowest levels, because the binary concept has advantageous properties. British mathematician Charles Boole outlined a logic system in which the basic AND, OR, and NOT operations could form simple statements with a binary property and could be combined and stacked into the most sophisticated of logical constructs; this became the basis of computer hardware and software. In hardware, AND, OR, and NOT operations can be easily deployed as "gates," and combining enough gates generates a computer. Claude Shannon took binary a step further with his demonstration that electrical switching circuits could automatically execute Boolean logic; in essence, Shannon proved that zeroes and ones could represent all information. The science of spintronics could harbor an even more staggering breakthrough, according to University of California, Santa Barbara physics professor David Awschalom. "In contrast to zeroes and ones, with spintronics, we might go to a system with an arbitrarily large number of states," he explains. "The electron is either off or it's present with the spin pointing in one of many different directions. Each direction is a 'bit,' so that you would increase the density of information by many orders of magnitude."

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