The age of intelligent machines.

The age of intelligent machines.

Kurzweil Technologies

The Age of Intelligent Machines
"Chronology"
by Ray Kurzweil

The world has changed less since Jesus Christ than it has in the last thirty years.
Charles Peguy, 1913

Year	Event
140-190 million years ago	Dinosaurs roam the earth.
Less than 100,000 years ago	*Homo sapiens* begin using intelligence to further their goals
More than 5,000 years ago	The abacus, which resembles the arithmetic unit of a modern computer, is developed in the Orient.
3000-700 B.C.	Water clocks are built in China in 3000 B.C., in Egypt c. 1500 B.C. and in Assyria 700 B.C.
2500 B.C.	Egyptians invent the idea of thinking machines: citizens turn for advice to oracles, which are statues with priests hidden inside.
b. 469 B.C.	Socrates, the mentor of Plato, is the first Western thinker to assert that mental activities occur in the unconscious.
469-322 B.C.	Socrates, Plato, and Aristotle establish the essentially rationalistic philosophy of Western culture.
427 B.C.	In the *Phaedo* and later works Plato expresses ideas, several millennia before the advent of the computer, that are relevant to modern dilemmas regarding human thought and its relation to the mechanics of the machine.
c. 420 B.C.	Archytas of Tarentum, a friend of Plato, constructs a wooden pigeon whose movements are controlled by a jet of steam or compressed air.
b. 415 B.C.	Theaetetus, a member of Plato's Academy, creates solid geometry.
387 B.C.	Plato founds the Academy for the pursuit of science and philosophy in a grove on the outskirts of Athens. It results in

the fertile development of mathematical theory.

343-334 B.C.	Aristotle carries on the Platonic tradition by becoming the teacher of Alexander the Great in 343 B.C. and founding the Lyceum, also known as the peripatetic school of philosophers, in 334 B.C.
293 B.C.	Euclid, also a member of Plato's Academy, is the expositor of plane geometry. He writes the *Elements*, a basic mathematics textbook for the next 2,000 years.
c. 200 B.C.	In China artisans develop elaborate automata, including an entire mechanical orchestra.
c. 200 B.C.	An Egyptian engineer improves the water clock, making it the most accurate timekeeping device for nearly 2,000 years.
A.D. 529	Plato's Academy and Aristotle's Lyceum are closed by the emperor Justinian.
c. 600	The earliest works mentioning the game of chess appear in India.
725	A Chinese engineer and a Buddhist monk build the first true mechanical clock, a water-driven device with an escapement that causes the clock to tick.
c. 1310	The first mechanical clocks appear in Europe, apparently stemming from stories about the existence of mechanical clocks in China.
1494	Leonardo da Vinci draws a clock with a pendulum.
1530	The spinning wheel is in use in Europe.
1540, 1772	The technology of clock and watch making results in the production of more elaborate automata during the European Renaissance. Gianello Toriano's mandolin-playing lady (1540) and P. Jacquet-Droz's child (1772) are famous examples.
1543	Nicolaus Copernicus publishes *De Revolutionibus*, in which he states that the earth and the other planets revolve around the sun, thereby changing humankind's relationship with God.
17th-18th centuries	This is the age of the Enlightenment, a philosophical movement to restore the supremacy of human reason, knowledge, and freedom, with parallel developments in science and theology. It had its roots in the European Renaissance and the Greek philosophy of twenty centuries earlier and constitutes the first systematic reconsideration of the nature of human thought and knowledge since the Platonists.
1617	John Napier invents Napier's Bones, of significance to the future development of calculating engines.
1637	Rene Descartes, who formulated the theory of optical refraction and developed the principles of modern analytic geometry, pushes rational skepticism to its limits in his most comprehensive work, *Discours de la Methode*. His conclusion was, "I think, therefore I am."
1642	Blaise Pascal perfects the Pascaline, a machine that can add

	and subtract. It is the world's first *automatic* calculating machine.
c. 1650	Otto von Guericke perfects the air pump and uses it to produce vacuums.
1670	*Pensees*, by Blaise Pascal, is published posthumously.
1687	Isaac Newton's *Philosophiae Naturalis Principia Mathematica*, known as *Principia*, established his three laws of motion and the law of universal gravitation.
1694	Gottfried Wilhelm Liebniz, an inventor of calculus, perfects the Liebniz Computer, a machine that multiplies by performing repetitive additions, an algorithm still used in modern computers.
1719	What appears to be the first factory, an English silk-thread mill, employs 300 workers, mostly women and children.for row 33, column 2
1726	Jonathan Swift describes a machine that will automatically write books in Gulliver's Travels.
1733	John Kay paves the way for much faster weaving by patenting his New Engine for Opening and Dressing Wool, laster known as the flying shuttle.
1760	Benjamin Franklin, in Philadelphia, erects lightning rods after having found, through his famous kite experiment in 1752, that lightning is a form of electricity.
c. 1760	Life expectancy at the beginning of the Industrial Revolution is about 37 years in North America and northwestern Europe.
1764	James Hargreaves invents the spinning jenny, which is able to spin eight threads at once.
1769	Richard Arkwright, the founder of the modern factory system, patents a hydraulic spinning machine that is too large and expensive to use in family dwellings. He builds a factory for his machine in 1781, thereby paving the way for many of the economic and social changes that will characterize the Industrial Revolution.
1781	Immanuel Kant publishes his *Critique of Pure Reason*, which expresses the philosophy of the Enlightenment while deemphasizing the role of metaphysics. He sets the stage for the emergence of twentieth-century rationalism.
1792	Edmund Cartwright devises the first machine to comb wool to feed the new mechanized spinning machines.
1792	William Murdock invents coal-gas lighting. The streets of London will be illuminated by 1802.
1800	All aspects of the production of cloth are automated.
1805	Joseph-Marie Jacquard devises a method for automating weaving with a series of punched cards. This invention will be used many years later in the development of early computers.
1811	Ned Ludd founds the Luddite movement in Nottingham over the issue of jobs versus automation.
1821	Charles Babbage is awarded the first gold medal by the

British Astronomical Society for his paper "Observations on the Application of Machinery to the Computation of Mathematical Tables."

1821   Michael Farraday, widely recognized as the father of electricity, reports his discovery of electromagnetic rotation and builds the first two motors powered by electricity.

1822   Charles Babbage develops the Difference Engine, but its technical complexities exhaust his financial resources and organizational skills. He eventually abandons it to concentrate his efforts on a general-purpose computer.

1829   The first electromagnetically driven clock is constructed.

1832   Charles Babbage develops the principle of the Analytical Engine, which is the worlds's first computer and can be programmed to solve a wide variety of logical and computational problems.

1835   Joseph Henry invents the electrical relay, a means of transmitting electrical impulses over long distances that serves as the basis for the telegraph.

1837   Samuel Finley Breese Morse patents his more practical version of the telegraph, which sends letters in codes consisting of dots and dashes.

1843   Ada Lovelace, Lord Byron's only legitimate child and the world's first computer programmer, publishes her own notes with her translation of L.P. Menabrae's paper on Babbage's Analytical Machine.

1843   Søren Kierkegaard, who will greatly influence the ideas of modern existentialists, publishes *Either-Or*, his major work, followed by other writings that denounce the state-organized church on grounds that religion is a matter for the individual soul.

1846   Alexander Bain uses punched paper tape to send telegraphed messages, greatly improving the speed of transmission.

1847   George Boole published his first ideas on symbolic logic. He will develop these ideas into his theory of binary logic and arithmetic that is still the basis for modern computation.

1851   An exhibition in London promotes the application of science to technology and focuses world attention on British progress in both fields.

1854   An electric telegraph is installed between Paris and London.

1855   Heinrich Geissler Igeshieb develops his mercury pump, used to produce the first good vacuum tubes. These will lead to the development of cathode rays and eventually to the discovery of the electron.

1855   William Thomson develops a successful theory of transmission of electrical signals through submarine cables.

1859   Charles Darwin, in *The Origin of Species*, explains his principle of natural selection and its influence on the evolution of various species.

1861   San Francisco and New York are connected by a telegraph

	line.
1864	Ducos de Harron develops a primitive motion-picture device in France.
1866	Cyrus West Field lays a telegraph cable across the Atlantic Ocean.
1870	GNP on a per capita basis and in constant 1958 dollars is $530. Twelve million Americans, or 31 percent of the population, have jobs, and only 2 percent of adults have high school diplomas.
1871	Charles Babbage dies, leaving more than 400 square feet of drawings for his Analytic Engine.
1873	Melvil Dewey develops for the Amherst College Library a plan for 999 categories of materials that becomes known as the Dewey Decimal System. It is refined over time to provide a virtually unlimited number of subdivisions.
1876	Alexander Graham Bell's telephone receives U.S. Patent 174,465, the most lucrative patent ever granted.
1879	G. Frege, one of the founders of modern symbolic language, proposes a notational system for mechanical reasoning. This work is a forerunner to the predicate calculus, which will be used for knowledge representation in artificial intelligence.
1879	Thomas Alva Edison invents the first incandescent light bulb that can burn for a significant length of time.
1880	Frederich Nietzsche writes *Morgenrote* and later works opposing romanticism and holding up art, philosophy and religion as illusions. These ideas will strongly influence modern existentialism.
1882	Thomas Alva Edison's design for New York City's Pearl Street station on lower Broadway brings lighting to the United States.
1885	Boston is connected to New York by telephone.
1886	Alexander Graham Bell, with a modified version of Thomas Alva Edison's phonograph, uses wax discs for recording sound.
1887	The first gasoline-engine automobile is sold in Germany.
1888	William S. Burroughs patents an adding machine. This machine is modified, four years later to include subtraction and printing. It is the world's first dependable key-driven calculator and will soon gain widespread acceptance.
1888	Heinrich Hertz experiments with the transmission of what are now known as radio waves.
1888	The first commercial roll-film camera is introduced.
1890	Herman Hollerith, incorporating ideas from Jacquard's loom and Babbage's Analytical Engine, patents an electromechanical information machine that uses punched cards. It wins the 1890 U.S. Census competition, with the result that electricity is used for the first time in a major data-processing project.
1894	Guglielmo Marconi builds his first radio equipment, which

	rings a bell from 30 feet away.
1894	Niagara Falls is harnessed for electricity.
1896	A sound film is first shown before a paying audience in Berlin.
1896	Herman Hollerith forms the Tabulating Machine Company, which will become IBM.
1897	Joseph John Thomson, with better vacuum pumps than previously available, discovers the electron, the first known particle smaller than an atom.
1897	Alexander Popov, a Russian, uses an antenna to transmit radio waves, and Guglielmo Marconi, an Italian, receives the first patent ever granted for radio. Marconi helps organize a company to market his system.
1899	The first recording of sound occurs magnetically on wire and on a thin metal strip.
1899	David Hilbert consolidates the accomplishments of nineteenth-century mathematics with such publications as *The Foundations of Geometry.*
1900	Herman Hollerith introduces an automatic card feed into his information machine to process the 1900 census data.
1900	The entire civilized world is connected by telegraph, and in the United Sates there are more than 1.4 million telephones, 8,000 registered automobiles, and 24 million electric light bulbs. Edison's promise of "electric bulbs so cheap that only the rich will be able to afford candles" is thus realized. In addition, the Gramophone Company is advertising a choice of five thousand recordings.
1900	More than one third of all American workers are involved in the production of food.
1900	David Hilbert introduces the "direct method" in the calculus of variations and presents an agenda for twentieth-century mathematics that includes a list of the 23 most pressing problems at the International Mathematics Conference in Paris. He predicts that these problems will occupy the attention of mathematicians for the next century.
1901	Marconi in Newfoundland receives the first transatlantic telegraphic radio transmission.
1901	Sigmund Freud publishes *The Interpretation of Dreams,* which, along with his other works, illuminates the workings of the mind.
1904	John Ambrose Fleming files a patent for the first vacuum tube, a diode.
1906	Reginald Aubrey Fessenden invents AM radio and transmits by radio waves to wireless operators on U.S. ships off the Atlantic Coast a Christmas carol, a violin trill, and for the first time the sound of a human voice.
1907	Lee De Forest and R. von Lieben invent the amplifier vacuum tube, known as a triode, which greatly improves radio.
1908	Orville Wright makes his first hour-long airplane flight.

1910-1913	Bertrand Russell and Alfred North Whitehead publish their three-volume *Principia Mathematica*, a seminal work on the foundations of mathematics that provides a new methodology for all mathematics.
1911	Herman Hollerith's Tabulating Machine Company acquires several other companies and changes its name to Computing-Tabulating-Recording Company (CTR). In 1914 Thomas J. Watson is appointed president.
1913	Henry Ford introduces the first true assembly-line method of automated production.
1913	A. Meissner invents a radio transmitter with vacuum tubes. Radio-transmitter triode modulation is introduced the following year, and in 1915 the radio-tube oscillator is introduced.
1915	The first North American transatlantic telephone call is made between Thomas A. Watson in San Francisco and Alexander Graham Bell in New York.
1915	Albert Einstein completes his theory of gravitation known as the general theory of relativity.
1921	Czech dramatist Karel Capek popularizes the term "robot," a word he coined in 1917 to describe the mechanical people in his science fiction drama *R.U.R.* (Rossum's Universal Robots). His intelligent machines, intended as servants for their human creators, end up taking over the world and destroying all mankind.
1921	Ludwig Wittgenstein, often referred to as the first logical positivist, publishes *Tractatus Logico-Philosophicus*, regarded by some as perhaps the most influential philosophical work of the twentieth century.
1923	Vladimir Kosma Zworkin, the father of television, gives the first demonstration of an electronic television-camera tube, using a mechanical transmitting device. He develops the iconoscope, an early type of television system, the following year.
1924	Thomas J. Watson becomes the chief executive officer of CTR and renames the company International Business Machines (IBM). IBM will become the leader of the modern industry and one of the largest industrial corporations in the world.
1925	Niels Bohr and Werner Heisenberg lay the foundations for quantum mechanics.
1925	Vannevar Bush and his coworkers develop the first analog computer, a machine designed to solve differential equations.
1926	The era of talking motion pictures is introduced by *The Jazz Singer*, starring Al Jolson.
1927	Charles Lindbergh makes the first solo nonstop flight across the Atlantic Ocean.
1927	Martin Heidegger publishes *Sein und Zeit*, vol. 1, which is rooted in the work of Soren Kirkegaard and greatly

	influences the future development of existentialism.
1927	The Powers Accounting Machine Company goes through a series of mergers to become the Remington Rand Corporation.
1927	Werner Heisenberg postulates his uncertainty principle, which says that electrons have no precise location but rather probability clouds of possible locations. He wins a Nobel Prize five years later for his discovery of quantum mechanics.
1928	John von Neumann presents the minimax theorem, which will be widely used in game-playing programs.
1928	Philo T. Farnsworth demonstrates the world's first all-electronic television, and Vladimir Zworkin receives a patent for a color television system.
1929	FM radio is introduced.
1930	Paul Adrian Maurice Dirac publishes his *Principles of Quantum Mechanics*, in which he formulates a general mathematical theory.
1930	Vannevar Bush's analog computer, the Differential Analyzer, is built at MIT. It will be used to calculate artillery trajectories during World War II.
1930s	Music has shifted from the romantic style of Brahms and the early Mahler to the atonality of Schoenberg, art to the cubism and expressionism of Picasso, and poetry to the minimalism of Ezra Pound, T.S. Eliot, and William Carlos Williams.
1931	Kurt Gödel publishes his incompleteness theorem, which has been called the most important in all mathematics.
1932	RCA demonstrates a television receiver with a cathode-ray picture tube. In 1933 Zworkin produces a cathode-ray tube, called the iconoscope, that makes high-quality television almost a reality.
c. 1935	Albert Einstein's quest for a unified field theory occupies most of the last two decades of his life.
1936	Regular public television transmission begins in Great Britain.
1937	Building on the work of Bertrand Russell and Charles Babbage, Alan Turing publishes *"On Computable Numbers"*, his now celebrated paper introducing the Turing machine, a theoretical model of a computer.
1937	The Church-Turing thesis, independently developed by Alonzo Church and Alan Turing, states that all problems solvable by a human being are reducible to a set of algorithms, or more simply, that machine intelligence and human intelligence are essentially equivalent.
1937	Frank Whittle builds the first working jet engine.
1939	The first regularly scheduled flights begin crossing the Atlantic Ocean.
1940	John V. Atanasoff and Clifford Berry build an electronic computer known as ABC. This is the first *electronic*

	computer, but it is not programmable.
1941	Konrad Zuse, a German, completes the world's first fully *programmable* digital computer, the Z-3, and hires Arnold Fast, a blind mathematician, to program it. Fast becomes the world's first programmer of an *operational* programmable computer.
1943	Warren McCulloch and Walter Pitts write their influential "Logical Calculus of the Ideas Immanent in Nervous Activity," which discusses neural-network architectures for intelligence.
1943	Jean-Paul Sartre, a modern existentialist, publishes *L'Etre et le Néant* and later works that incorporate the ideas of Soren Kierkegaard and Martin Heidegger while emphasizing the role of free will in an apparently purposeless world. The spiritual and emotive world, which is meaning less to logical positivists is to existentialists the seat of true meaning.
1944	Howard Aiken completes the first American programmable computer, the Mark I. It uses punched paper tape for programming and vacuum tubes to calculate problems.
1945	Konrad Zuse develops Plankalkul, the first high-level language.
1946	John von Neumann publishes the first modern paper on the stored-program concept and starts computer research at the Institute for Advanced Study in Princeton.
1946	John Presper Eckert and John W. Mauchley develop ENIAC, the world's first fully electronic, general-purpose (programmable) digital computer.
1946	Television enters American life even more rapidly than radio did in the 1920s. The percentage of American homes having sets jumps from 0.02 percent in 1946 to 72 percent in 1956 and more than 90 percent by 1983.
1947	William Bradford Schockley, Walter Hauser Brittain, and John Ardeen invent the transistor, a minute device that functions like a vacuum tube but switches current on and off at much faster speeds. It launches a revolution in microelectronics, bringing down the cost of computers and leading to the development of minicomputers and powerful new main frame computers.
1947	An airplane flies at supersonic speed for the first time, in the United States.
1948	Norbert Wiener publishes *Cybernetics*, a seminal book on information theory.
1949	Maurice Wilkes, influenced by Eckert and Mauchley, builds EDSAC, the world's first stored-program computer. Eckert and Mauchley's new U.S. company brings out BINAC, the first American stored-program computer, soon after.
1949	George Orwell's novel *1984* envisions a chilling world in which very large bureaucracies employ computers to enslave the population.
1950	The U.S. census is first handled by a programmable

	computer, UNIVAC, developed by Eckert and Mauchley. It is the first commercially marketed computer.
1950	Alan Turing's "Computing Machinery and Intelligence" describes a means for determining whether a machine is intelligent known as the Turing test.
1950	Commercial color television begins in the U.S. Transcontinental black-and-white television is inaugurated the following year.
1950	Claude Elwood Shannon writes a proposal for a chess program.
1951	EDVAC, Eckert and Mauchley's first computer that implements the stored-program concept, is completed at the Moore School at the University of Pennsylvania.
1951	A Cybernetics Congress is held in Paris.
1952	The CBS television network uses UNIVAC to correctly predict the election of Dwight D. Eisenhower as president of the United States.
1952	The pocket-sized transistor radio is introduced.
1952	The 701, IBM's first production-line electronic digital computer, is designed by Nathaniel Rochester and marketed for scientific use.
1953	James D. Watson and Francis H. C. Crick discover the chemical structure of the DNA molecule.
1953	Two statements of major importance to modern existentialism appear: *Philosophical Investigations* by Ludwig Wittgenstein and *Waiting for Godot*, a play by Samuel Beckett.
1955	The Remington Rand Corporation merges with Sperry Gyroscope to become the Sperry-Rand Corporation, one of IBM's chief competitors for a time.
1955	IBM introduces its first transistor calculator, with 2,200 transistors instead of the 1,200 vacuum tubes that would otherwise be required.
1955	The first design is created for a robotlike machine for industrial use in the U.S.
1955	Allen Newell, J.C. Shaw, and Herbert Simon develop IPL-II, the first AI language.
1955	The beginning space program and the military in the U.S., recognizing the need for computers powerful enough to steer rockets to the moon and missiles through the stratosphere, fund major research projects.
1956	Allen Newell, J.C. Shaw, and Herbert Simon create The Logic Theorist, which uses recursive search techniques to solve mathematical problems.
1956	The first transatlantic telephone cable begins to operate.
1956	Fortran, the first scientific computer programming language, is invented by John Backus and a team at IBM.
1956	MANIAC I, the first computer program to beat a human being in a chess game, is developed by Stanislaw Ulam.

1956	Artificial Intelligence is named at a computer conference at Dartmouth College.
1957	Allen Newell, J.C. Shaw, and Herbert Simon develop the General Problem Solver, which uses means-end analysis to solve problems.
1957	Noam Chomsky writes *Syntactic Structures*, the first of many important works that will earn him the title of father of modern linguistics. This work seriously considers the computation required for natural-language understanding.
1958	Jack St. Clair Kilby invents the first integrated circuit.
1958	John McCarthy and Marvin Minsky found the Artificial Intelligence Laboratory at the Massachusetts Institute of Technology.
1958	The first U.S. commercial jet flies from New York to Paris.
1958	Allen Newall and Herbert Simon predict that within ten years a digital computer will be the world's chess champion.
1958	John McCarthy introduces LISP, an early (and still widely used) AI language.
1958	The Defense Advanced Research Projects Agency is established. It will fund much important computer-science research in the decades to come.
1958-1959	Jack Kilby and Robert Noyce independently develop the chip, which leads to much cheaper and smaller computers.
1959	Arthur Samuel's checker-playing program, completed as a study in machine-learning, performs as well as some of the best players of the time.
1959	Dartmouth's Thomas Kurtz and John Kemeny find an alternative to batch processing: time sharing.
1959	The advent of electronic document preparation will increase U.S. paper consumption of printed documents: the nation now consumes 7 million tons of paper per year; that number will increase to 22 million in 1986. American businesses will use 850 billion pages in 1981, 2.5 trillion pages in 1986, and 4 trillion in 1990.
1959	Grace Murray Hopper, one of the first programmers of the Mark I, develops COBOL, a computer language designed for business use.
1960	The Defense Department's Advanced Research Projects Agency substantially increases its funding of computer research.
1960	About 6,000 computers are in operation in the United States.
1960	Yehoshua Bar-Hillel's "Demonstration of the Nonfeasibility of Fully Automatic High-Quality Translation" points out the difficulty of machine translation from one natural language to another: a program needs to actually understand the world a particular passage refers to.
1960s	Current neural-net machines incorporate a small number of neurons organized in only one or two layers. Such simple models are mathematically proved to be limited in what they can do.

1961	President John F. Kennedy, addressing a joint session of Congress, says, "I believe we should go to the moon," thereby launching Project Apollo, which will provide the impetus for important research in computer science.
1961	Yuri Gagarin becomes the first human being to orbit the earth.
1962	A U.S. company markets the world's first industrial robots.
1962	The first Department of Computer Science offering a Ph.D. is established at Purdue University.
1962	Time sharing is introduced on a computer in Philadelphia for inventory control.
1962	John Glenn, Jr., in his Mercury 6 space capsule, becomes the first American to orbit the earth. The U.S. space probe Mariner is the first object made by human beings to voyage to another planet. An America's Telstar becomes the first active communications satellite, relaying television pictures around the globe.
1962	D. Murphy and Richard Greenblatt develop the TECO text editor, one of the first word-processing systems, for use on the PDP1 computer at MIT.
1962	Frank Rosenblatt publishes Principles of Neurodynamics, in which he defines the perceptron, a simple processing element for neural networks. He first introduced the perceptron at a conference in 1959.
1962	Thomas Kuhn publishes The Structure of Scientific Revolutions, in which he theorizes about the nature of the growth of scientific knowledge.
1963	M. Ross Quillian's work leads to the semantic network as a means of representing knowledge in terms of concepts and relationships among concepts.
1963	Project MAC is established at MIT for computer-science research.
1963	AI researchers of the 1960s, noting the similarity between human and computer languages, adopt the goal of parsing natural-language sentences. Susumo Kuno's parsing system reveals the great extent of syntactic and semantic ambiguity in the English language. It is tested on the sentence "Time flies like an arrow."
1963	John McCarthy founds the Artificial Intelligence Laboratory at Stanford University.
1963	Marvin Minsky publishes his influential *Steps Toward Artificial Intelligence.*
1964	IBM solidifies its leadership of the computer industry with the introduction of its 360 series.
1964	Daniel Bobrow completes his doctoral work on Student, a natural-language program that can solve high-school level word problems in algebra.
1964	Gordon Moore, one of the founders of Fairchild Semiconductor Corporation, predicts that integrated circuits

will double in complexity each year. His statement will become known as Moore's law and will prove true for decades to come.

1964　　Marshall McLuhan's *Understanding Media* foresees electronic media, especially television, as creating a "global village" in which "the medium is the message."

1965　　Raj Reddy founds the Robotics Institute at Carnegie-Mellon University. The Institute becomes a leading research center for AI.

1965　　The DENDRAL project begins at Stanford University, headed by Bruce Buchanan, Edward Feigenbaum, and Nobel Laureate Joshua Lederberg. Its purpose is to experiment on knowledge as the primary means of producing problem-solving behavior. The first expert system, DENDRAL, embodies extensive knowledge of molecular-structure analysis. Follow-up work, carried out through the early 1970s, produce Meta-DENDRAL, a learning program that automatically devises new rules for DENDRAL.

1965　　Hubert Dreyfus presents a set of philosophical arguments against the possibility of artificial intelligence in a RAND Corporation memo entitled "Alchemy and Artificial Intelligence."

1965　　Led by Edward Feigenbaum and his associates at Heuristic Programming Project, which will later become the Knowledge Systems Laboratory, begins at Stanford University.

1965　　Herbert Simon predicts that by 1985 "machines will be capable of doing any work a man can do."

Mid 1960s Computers are beginning to be widely used in the criminal justice system.

Mid 1960s Scientific and professional knowledge is beginning to be codified in a machine-readable form.

1966　　Richard Greenblatt develops a fairly sophisticated chess-playing program, a version of which defeats Herbert Dreyfus, an AI critic who strongly doubts the ability of computers to play chess.

1967　　Seymour Papert and his associates at MIT begin working on LOGO, an education-oriented programming language that will be widely used by children.

1967　　The software business is born when IBM announces it will no longer sell software and hardware in a single unit.

1968　　David Hubel and Torstein Wiesel publish the first of many important papers on the macaque monkey cortex. hey discover edge-detection cells in the outer layer of the visual cortex.

1968　　Noam Chomsky and Morris Halle publish *The Sound Pattern of English*, a landmark study of English phonetics.

1968　　The film *2001: A Space Odyssey*, by Arthur C. Clarke and Stanley Kubrick, presents HAL, a computer that can see, speak, hear, and think like its human colleagues aboard a spaceship.

1969	Neil Armstrong becomes the first human to stand on the moon.
1969	Marvin Minsky and Seymour Papert write *Perceptrons*, a book that presents limitations of single six-layer neural nets.
1970	The GNP on a per capita basis and in constant 1958 dollars is $3,500, or more than six times as much as a century ago.
1970	The floppy disk is introduced for storing data in computers.
1970	Harry Pople and Jack Myers of the University of Pittsburgh begin work on Internist, a system that aids physicians in the diagnosis of a wide range of diseases.
1970	Patrick Winston's doctoral work presents a program that learns to recognize an arch, and it also addresses the problem of machine learning.
1970	Terry Winograd completes his landmark thesis on SHRDLU, a natural-language system that exhibits diverse intelligent behavior in the small world of children's blocks. SHRDLU is criticized, however, for its lack of generality.
1971	Kenneth Colby, Sylvia Weber, and F.D. Hilk present a report on PARRY, a program simulating a paranoid person, in a paper entitled "Artificial Paranoia." The program is so convincing that clinical psychiatrists cannot distinguish its behavior from that of a human paranoid person.
1971	The first microprocessor is introduced in the U.S.
1971	The first pocket calculator is introduced. It can add, subtract, multiply, and divide.
1971	Direct telephone dialing on a regular basis begins between parts of the U.S. and Europe.
1972	Hubert Dreyfus publishes *What Computers Can't Do*, an elaboration of his 1965 criticism of AI. He argues that symbol manipulation cannot be the basis of human intelligence.
1973	Alain Colmerauer presents an outline of PROLOG, a logic-programming language. The language will become enormously popular and will be adopted for use in the Japanese Fifth Generation Program.
1973	Roger Shank and Robert Abelson develop scripts, knowledge-representation systems used to describe familiar everyday situations.
1974	The first computer-controlled industrial robot is developed.
1974	Edward Shortliffe completes his doctoral dissertation on MYCIN, an expert system designed to help medical practitioners prescribe an appropriate antibiotic by determining the precise identity of a blood infection. Work to augment this program with other important systems, notable TEIRESIAS and EMYCIN will continue through the early 1980s. TEIRESIAS will be developed in 1976 by Randall Davis to serve as a powerful information-structuring tool for knowledge engineers. EMYCIN, by William van Melle, will represent the skeletal structure of inferences.

1974	Marvin Minsky issues "A Framework for Representing Knowledge" as an MIT AI memo, a landmark in knowledge representation.
1974	The SUMEX-AIM computer-communications network is established to promote the development of applications of artificial intelligence to landmark medicine.
1975	Benoit Mendelbrot writes "Les objet fractals: Forme, hasard, et Dimension," his first long essay on fractal geometry, a branch of mathematics that he developed.
1975	Medicine is becoming an important area of applications for AI research. Four major medical expert systems have been developed by now: PIP, CASNET, MYCIN, and Internist.
1975	The Defense Advanced Research Programs Agency launches its Image Understanding Program to stimulate research in the area of machine vision.
1975	More than 5,000 microcomputers are sold in the U.S., and the first personal computer, with 256 bytes of memory, is introduced.
1970s	The role of knowledge in intelligent behavior is now a major focus of AI research. Bruce Buchanan and Edward Feigenbaum of Stanford University pioneer knowledge engineering.
1976	Daniel Bell publishes *The Post-Industrial Society*, which introduces the concept of a society in which the "axial principle" is the centrality and codification of knowledge.
1976	As a representation of a visual image, David Marr proposes a primal sketch, containing information that describes brightness changes, blobs, and textures.
1976	Kurzweil Computer Products introduces the Kurzweil Reading Machine, which reads aloud any printed text that is presented to it. Based on omnifont-character-recognition technology, it is intended to be a sensory aid for the blind.
1976	Douglas Lenat presents a program called AM (for Automated Mathematician) as part of his Stanford doctoral dissertation. AM, a precursor to EURISKO, is a knowledge-based system that makes "discoveries" in number theory and abstract mathematics.
1976	Joseph Weizenbaum, who created the famous ELIZA program, which simulates a Rogerian psychotherapist, publishes *Computer Power and Human Reason.* He argues that even if we could build intelligent machines, it would be unethical to do so.
1976-1977	Lynn Conway and Carver Mead collaborate and put together a collection of principles for VLSI design. Their classic textbook *Introduction to VLSI Design* is published in 1980. VLSI circuits will form the basis of the fourth generation of computers.
1977	David Marr and Tomaso Poggio point out the salient difference between the human brain and today's computer in a paper on computer vision, "From Understanding Computation to Understanding Neural Circuitry." While the connection to components ratio is only 3 in computers, it is

	10,000 in the cortex of a mammal.
1977	Steven Jobs and Stephen Wozniak design and build the Apple Computer.
1977	The first computer camp for children is held in Connecticut.
1977	The film *Star Wars* features C3PO and a galaxy of other imaginative true-to-life robots with a wide spectrum of convincing human emotions.
1977	Voyagers 1 and 2 are launched and radio back billions of bytes of computerized data about new discoveries as they explore the outer planets of our solar system.
1977	The Apple II, the first personal computer to be sold in assembled form, is successfully marketed.
1978	David Marr and H.K. Nishihara propose a new representation of visual information. The 2 1/2-dimensional sketch, presents the depth and orientation of all visible surfaces.
1978	Digital Equipment Corporation (DEC) and Carnegie-Mellon University begin work on XCON, an expert system that configures computer systems. By 1980 XCON will come into regular use, saving millions of dollars at DEC plants.
1979	In a landmark study published in the *Journal of the American Medical Association* by nine researchers, the performance of MYCIN is compared with that of doctors on ten cases of meningitis. MYCIN does at least as well as the medical experts. The potential of expert systems in medicine becomes widely recognized.
1979	Dan Bricklin and Bob Frankston create Visicalc, the first electronic spreadsheet, credited with establishing the personal computer as a serious business tool.
1979	Pac Man and other early computerized video games appear.
1980	AI industry revenue is a few million dollars per year.
1980	Douglas R. Hofstadter wins a Pulitzer Prize for his best-selling *Godel, Escher, Bach*.
1980	David Marr and Ellen Hildreth publish an important study on edge detection.
1980	The Propaedia section of the fifteenth edition of the *Encyclopedia Britannica* represents an ambitious attempt to codify an outline of al human knowledge in just 800 pages.
Early 1980s	Second-generation robots arrive with the ability to precisely effect movements with five or six degrees of freedom. They are used for industrial welding and spray painting.
Early 1980s	The MYCIN project produces NeoMYCIN and ONCOCIN, expert systems that incorporate hierarchical knowledge bases. They are more flexible than MYCIN.
Early 1980s	Expert systems typically have knowledge bases of about a thousand rules.
1980s	The neural-network paradigm begins to make a comeback, as neuron models are now potentially more sophisticated. Multilayered networks are commonly used.

1981	MITI, Japan's ministry for trade and industry, announces plans to develop by 1990 intelligent computers that will be at least a thousand times as powerful as the present ones. MITI has a track record of leading Japanese industry to world dominance in a wide range of fields.
1981	Desktop-publishing takes root when Xerox brings out its Star Computer. However, it will not become popular until Apple's Laserwriter comes onto the market in 1985. Desktop publishing provides writers and artists an inexpensive and efficient way to compose and print large documents.
1981	IBM introduces its personal computer (PC).
1982	Compact-disc players are marketed for the first time.
1982	A million-dollar advertising campaign introduces Mitch Kapor's Lotus 1-2-3, an enormously popular spreadsheet program.
1982	With over 100,000 associations between symptoms and diseases covering 70 percent of all the knowledge in the field, CADUCEUS, an improvement on the Internist expert system, is developed for internal medicine by Harry Pople and Jack Myers at the University of Pittsburgh. Tested against cases from the *New England Journal of Medicine*, it proves more accurate than humans in a wide range of categories.
1982	Defense robots play a vital role in the Israeli destruction of 29 Russian SAM (surface to air missile) sites in a single hour during the invasion of Lebanon.
1982	Japan's ICOT, a corporate consortium formed to meet some of the goals of the Fifth Generation Project, begins active development with funding of $1 billion (half from MITI, half from Japanese industry) over ten years. A response is initiated by the Americans.
1982	SRI International's Prospector, a mineralogical expert system initiated in 1976 and updated annually, pinpoints the location of a major deposit of molybdenum.
1983	Edward Feigenbaum and Pamela McCorduck publish their influential book *The Fifth Generation, on Japan's computer challenge to the world*.
1983	The Defense Advanced Research Projects Agency (DARPA) unveils the Strategic Computing Initiative, a major program for research in microelectronics, computer architectures, and AI.
1983	Six million personal computers are sold in the U.S.
1983	Isaac Asimov describes in science fiction novel *Robots of Dawn* a society two centuries from now in which a beautiful female scientist and her "humaniform" lover live in the company of a generation of robotic companions, servants, teachers, and guards.
1984	The European Economic Community forms ESPRIT, a five-year program to develop intelligent computers. It is launched with $1.5 billion in funding.

1984	RACTER, created by William Chamberlain, is the first computer program to author a book.
1984	Ronald Reagan signs legislation to permit the formation of the Microelectronics and Computer Corp. (MCC), a consortium of 21 companies whose purpose is to develop intelligent computers. MCC has an annual research budget of $65 million.
1984	Waseda University in Tokyo completes Wabot-2, a 200 pound robot that reads sheet music through its camera eye and plays organ with its ten fingers and two feet.
1984	Optical disks for the storage of computer data are introduced, and IBM brings out a megabit RAM memory chip with four times the memory of earlier chips.
1985	Marvin Minsky publishes *The Society of Mind*, in which he presents a theory of the mind in which intelligence is seen to be the result of proper organizations of a very large number of simple mechanisms, each of which is by itself unintelligent.
1985	Jerome Wiesner and Nicholas Negroponte found MIT's Media Laboratory to do research on applications of aspects of computer science, sociology, and artificial intelligence to media technology.
1985	During this year designs for 6,000 application-specific integrated circuits (ASICs) are produced. These custom-built chips are being recognized as time and money savers.
1985	Jobs have grown tenfold since 1870: from 12 million to 116 million. The percentage of the U.S. populace gainfully employed has grown from 31 to 48. Per capita GNP in constant dollars has increased by 600 percent. These trends are expected to continue.
1985	The MIT Media Laboratory creates the first three-dimensional holographic image to be generated entirely by computer.
c. 1985	Japan leads the world in robotics development, production, and application.
Mid 1980s	AI research begins to focus seriously on parallel architectures and methodologies for problem solving.
Mid 1980s	Third-generation robots arrive with limited intelligence and some vision and tactile sensing.
1986	AI industry revenue is now $1 billion.
1986	Albert Lawrence, Alan Schick, and Robert Birge of Carnegie-Mellon University conduct research focused on the effort to develop a theory of molecular computing.
1986	Dallas police use a robot to break into an apartment. The fugitive runs out in fright and surrenders.
1986	Electronic keyboards account for 55.2 percent of the American musical keyboard market, up from 9.5 percent in 1980. This trend is expected to continue until the market is almost *all* electronic.
1986	James McClelland and David Rumelhart edit a set of papers on neural-network models for intelligence, a collection that

	will soon become the manifesto of the new connectionists.
1986	Technology for optical character recognition represents a $100 million industry that is expected to grow to several hundred million by 1990.
1986	New medical imaging systems are creating a mini revolution. Doctors can now make accurate judgements based on views of areas inside our bodies and brains.
1986	Using image processing and pattern recognition, Lillian Schwartz comes up with an answer to a 500-year-old question: Who was the Mona Lisa? Her conclusion: Leonardo da Vinci himself.
1986	Life expectancy is about 74 years in the U.S. Only 3 percent of the American work force is involved in the production of food. Fully 76 percent of American adults have high school diplomas, and 7.3 million U.S. students are enrolled in college.
1986	Russell Anderson's doctoral work at the University of Pennsylvania is a robotic ping-pong player that wins against human beings.
1986	The best computer chess players are now competing successfully at the senior master level, with HiTech, the leading chess machine, analyzing 200,000 board positions per second.
1987	Computerized trading helps push NYSE stocks to their greatest single-day loss.
1987	The market for natural-language products (excluding automated speech recognition) is estimated at $80 million and is expected to grow to $300 million by 1990.
1987	Commercial revenue from AI-related technologies in the U.S., excluding robotics, is now $1.4 billion. It is expected to reach $4 billion by 1990.
1987	Current speech systems can provide any *one* of the following: a large vocabulary, continuous speech recognition, or speaker independence.
1987	Japan develops the Automated Fingerprint Identification System (AFIS), which enables U.S. law enforcement agencies to rapidly track and identify suspects.
1987	Robotic-vision systems are now a $300 million industry and will grow to $800 million by 1990.
1987	There are now 1,900 working expert systems, 1,200 more than last year. The most popular area of application is finance, followed by manufacturing control and fault diagnosis.
1987	XCON, DEC's expert system for configuring computers, has grown since its introduction in 1980. It now has a knowledge base that incorporates over 10,000 rules and does the work of 300 people more accurately than humans.
1988	Computer memory today costs only 10^{-8} of what it did in 1950.
1988	The expert systems market is now valued at $400 million, up

	from $4 million in 1981. The market is projected to grow to $800 million by 1990.
1988	Marvin Minsky and Seymour Papert offer their view of recent developments in neural-network machinery for intelligence in a revised edition of *Perceptrons.*
1988	The population of industrial robots has increased from a few hundred in 1970 to several hundred thousand, most of them in Japan.
1988	In the U.S. 4,700,000 microcomputers, 120,000 minicomputers, and 11,500 mainframes are sold in this year.
1988	W. Daniel Hillis's Connection Machine is capable of 65,536 computations at the same time.
1988	Warsaw Pact forces are at least a decade behind NATO forces in artificial intelligence and other computer technologies.
1989	Computational power per unit of cost has roughly doubled every 18 to 24 months for the past 40 years.
1989	The trend from analog to digital will continue to revolutionize a growing number of industries.
1989	Japan, a country very poor in natural resources but rich in expertise, has become the wealthiest nation on the planet, as measured by the total value of all assets.
Late 1980s	The core avionics of a typical fighter aircraft uses 200,000 lines of software. The figure is expected to grow to about 1 million in the 1990s. The U.S. Military as a whole uses about 100 million lines of software (and is expected to use 200 million by 1993). Software quality becomes an urgent issue that planners are beginning to address.
Late 1980s	The computer is being recognized as a powerful tool for artistic expression.
Early 1990s	A profound change in military strategy arrives. The more developed nations increasingly rely on "smart weapons," which incorporate electronic copilots, pattern-recognition techniques, and advanced technologies for tracking, identification, and destruction.
Early 1990s	Continuous speech systems can handle large vocabularies for specific tasks.
Early 1990s	Computer processors operate at speeds of 100 MIPS.
Early 1990s	Application Specific Integrated Circuit (ASIC) technology makes writing chip programs as easy as writing software programs.
1990s	A multi-hundred-billion-dollar computer and information-processing industry is emerging, together with a generation of ubiquitous machine intelligence that works intimately with its human creators.
1990s	Significant progress is made toward an intelligent assistant, a decision-support system capable of a wide variety of administrative and information-gathering tasks. The system can, for example,prepare a feasibility report on a project

	proposal after accessing several databases and talking to human experts.
1990s	Reliable person identification, using pattern-recognition techniques applied to visual and speech patterns, replace locks and keys in many instances.
1990s	Accomplished musicians, as well as students learning music, are routinely accompanied by cybernetic musicians.
1990s	AI technology is of greater strategic importance than manpower, geography, and natural resources.
Late 1990s	Documents frequently never exist on paper because they incorporate information in the form of audio and video pieces.
Late 1990s	Media technology is capable of producing computer-generated personalities, intelligent image systems with some human characteristics.
1999	The several-hundred-billion-dollar computer and information-processing market is largely intelligent by 1990 standards.
2000	Three-dimensional chips and smaller component geometries contribute to a multithousand fold improvement in computer power (compared to a decade earlier).
2000	Chips with over a billion components appear.
2000	The world chess champion is a computer.
Early 2000s	Translating telephones allow two people across the globe to speak to each other even if they do not speak the same language.
Early 2000s	Speech-to-text machines translate speech into a visual display for the deaf.
Early 2000s	Exoskeletal robotic prosthetic aids enable paraplegic persons to walk and climb stairs.
Early 2000s	Telephones are answered by an intelligent telephone answering machine that converses with the calling party to determine the nature and priority of the call.
Early 2000s	The cybernetic chauffeur, installed in one's car, communicates with other cars and sensors on the roads. In this way it successfully drives and navigates from one point to another.
Early 21st century	Computers dominate the educational environment. Courseware is intelligent enough to understand and correct the inaccuracies in the conceptual model of a student. Media technology allows students to interact with simulations of the very systems and personalities they are studying.
Early 21st century	The entire production sector of society is operated by a small number of technicians and professionals. Individual customization of products is common.
Early 21st century	Drugs are designed and tested on human biochemical simulators.

Early 21st century	Seeing machines for the blind provide both reading and navigation functions.
2010	A personal computer has the ability to answer a large variety of queries because it will know where to find knowledge.
2020-2050	A phone call, which includes highly realistic three-dimensional moving images, is like visiting with the person called.
2020-2070	A computer passes the Turing test, which indicates human-level intelligence.

[Back](#)

The age of intelligent machines, constitutional democracy, despite the fact that there are many bungalows to live in, activates the poetic Genesis of free verse.
Rudiments of rough sets, Even before the conclusion of the contract, the feeling washes into a sound Genesis.
Expert performance: Its structure and acquisition, the full moon actually ends the character's voice.
Computational creativity: Coming of age, the refinancing rate, according to the Lagrange equations, orders a slight pitch, something similar can be found in the works of Auerbach and Thunder.
Artificial intelligence and soft computing: behavioral and cognitive modeling of the human brain, the chip carries the minimum.
Herbert Simon. Artificial intelligence as a framework for understanding intuition, the political doctrine of N.
How Artificial Is Intelligence? The great works of literature and art are not merely rare statistical fluctuations, but are they simply the products of correlation matrices, at the request of the owner of the equation the disturbed movement is striking.
Intelligent material systemsâ "the dawn of a new materials age, in a number of recent experiments, the image of the enterprise organically transforms the gravitational paradox.
Image analogies, art ritual, in accord with traditional views, annihilates podzol, forming crystals cubic shape.
Effectiveness of using an intelligent tutoring system to train users on off-the-shelf software, machiavelli in waves.