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978-0-521-12293-1 - The Quest for Artificial Intelligence: A History of Ideas and Achievements
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THE QUEST FOR ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) is a field within computer science that is attempting to build enhanced intelligence into computer systems. This book traces the history of the subject, from the early dreams of eighteenth-century (and earlier) pioneers to the more successful work of today's AI engineers. AI is becoming more and more a part of everyone's life. The technology is already embedded in face-recognizing cameras, speech-recognition software, Internet search engines, and health-care robots, among other applications. The book's many diagrams and easy-to-understand descriptions of AI programs will help the casual reader gain an understanding of how these and other AI systems actually work. Its thorough (but unobtrusive) end-of-chapter notes containing citations to important source materials will be of great use to AI scholars and researchers. This book promises to be the definitive history of a field that has captivated the imaginations of scientists, philosophers, and writers for centuries.

Nils J. Nilsson, Kumagai Professor of Engineering (Emeritus) in the Department of Computer Science at Stanford University, received his doctorate in electrical engineering from Stanford in 1958. He then spent twenty-three years at the Artificial Intelligence Center of SRI International working on statistical and neural-network approaches to pattern recognition, co-inventing the A* heuristic search algorithm and the STRIPS automatic planning system, directing work on the integrated mobile robot Shakey, and collaborating in the development of the PROSPECTOR expert system. Professor Nilsson returned to Stanford in 1985 and served as Chairman of the Department of Computer Science, taught courses in artificial intelligence and machine learning, and conducted research on flexible robots. He has served on the editorial boards of *Artificial Intelligence* and the *Journal of Artificial Intelligence Research*. He was also an area editor for the *Journal of the Association for Computing Machinery*. He is a past president and Fellow of the Association for the Advancement of Artificial Intelligence and a Fellow of the American Association for the Advancement of Science. Professor Nilsson has also published five textbooks on artificial intelligence.

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The Quest for Artificial Intelligence

A History of Ideas and Achievements

Nils J. Nilsson
Stanford University

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For Grace McConnell Abbott,

my wife and best friend

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Preface

Artificial intelligence (AI) may lack an agreed-upon definition, but someone writing about its history must have some kind of definition in mind. For me, artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment. According to that definition, lots of things – humans, animals, and some machines – are intelligent. Machines, such as "smart cameras," and many animals are at the primitive end of the extended continuum along which entities with various degrees of intelligence are arrayed. At the other end are humans, who are able to reason, achieve goals, understand and generate language, perceive and respond to sensory inputs, prove mathematical theorems, play challenging games, synthesize and summarize information, create art and music, and even write histories. Because "functioning appropriately and with foresight" requires so many different capabilities, depending on the environment, we actually have several continua of intelligences with no particularly sharp discontinuities in any of them. For these reasons, I take a rather generous view of what constitutes AI. That means that my history of the subject will, at times, include some control engineering, some electrical engineering, some statistics, some linguistics, some logic, and some computer science.

There have been other histories of AI, but time marches on, as has AI, so a new history needs to be written. I have participated in the quest for artificial intelligence for fifty years – all of my professional life and nearly all of the life of the field. I thought it would be a good idea for an "insider" to try to tell the story of this quest from its beginnings up to the present time.

I have three kinds of readers in mind. One is the intelligent lay reader interested in scientific topics who might be curious about what AI is all about. Another group, perhaps overlapping the first, consists of those in technical or professional fields who, for one reason or another, need to know about AI and would benefit from a complete picture of the field – where it has been, where it is now, and where it might be going. To both of these groups, I promise no complicated mathematics or computer jargon, lots of diagrams, and my best efforts to provide clear explanations of how AI programs and techniques work. (I also include several photographs of AI people. The selection of these is somewhat random and doesn't necessarily indicate prominence in the field.)

A third group consists of AI researchers, students, and teachers who would benefit from knowing more about the things AI has tried, what has and hasn't worked, and good sources for historical and other information. Knowing the history of a field is

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important for those engaged in it. For one thing, many ideas that were explored and then abandoned might now be viable because of improved technological capabilities. For that group, I include extensive end-of-chapter notes citing source material. The general reader will miss nothing by ignoring these notes. The main text itself mentions Web sites where interesting films, demonstrations, and background can be found. (If links to these sites become broken, readers may still be able to access them using the "Wayback Machine" at http://www.archive.org.)

The book follows a roughly chronological approach, with some backing and filling. My story may have left out some actors and events, but I hope it is reasonably representative of AI's main ideas, controversies, successes, and limitations. I focus more on the ideas and their realizations than on the personalities involved. I believe that to appreciate AI's history, one has to understand, at least in lay terms, something about how AI programs actually work.

If AI is about endowing machines with intelligence, what counts as a machine? To many people, a machine is a rather stolid thing. The word evokes images of gears grinding, steam hissing, and steel parts clanking. Nowadays, however, the computer has greatly expanded our notion of what a machine can be. A functioning computer system contains both hardware and software, and we frequently think of the software itself as a "machine." For example, we refer to "chess-playing machines" and "machines that learn," when we actually mean the programs that are doing those things. The distinction between hardware and software has become somewhat blurred because most modern computers have some of their programs built right into their hardware circuitry.

Whatever abilities and knowledge I bring to the writing of this book stem from the support of many people, institutions, and funding agencies. First, my parents, Walter Alfred Nilsson (1907–1991) and Pauline Glerum Nilsson (1910–1998), launched me into life. They provided the right mixture of disdain for mediocrity and excuses (Walter), kind care (Pauline), and praise and encouragement (both). Stanford University is literally and figuratively my *alma mater* (Latin for "nourishing mother"). First as a student and later as a faculty member (now emeritus), I have continued to learn and to benefit from colleagues throughout the university and especially from students. SRI International (once called the Stanford Research Institute) provided a home with colleagues who helped me to learn about and to "do" AI. I make special acknowledgment to the late Charles A. Rosen, who persuaded me in 1961 to join his Learning Machines Group there. The Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), the Air Force Office of Scientific Research (AFOSR), the U.S. Geological Survey (USGS), the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA) all supported various research efforts I was part of during the last fifty years. I owe thanks to all.

To the many people who have helped me with the actual research and writing for this book, including anonymous and not-so-anonymous reviewers, please accept my sincere appreciation together with my apologies for not naming all of you personally in this preface. There are too many of you to list, and I am afraid I might forget to mention someone who might have made some brief but important suggestions. Anyway, you know who you are. You are many of the people whom I mention in

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the book itself. However, I do want to mention Heather Bergman of Cambridge University Press; Mykel Kochenderfer, a former student; and Wolfgang Bibel of the Darmstadt University of Technology. They all read carefully early versions of the entire manuscript and made many helpful suggestions. (Mykel also provided invaluable advice about the LaTeX typesetting program.)

I also want to thank the people who invented, developed, and now manage the Internet, the World Wide Web, and the search engines that helped me in writing this book. Using Stanford's various site licenses, I could locate and access journal articles, archives, and other material without leaving my desk. (I did have to visit libraries to find books. Publishers, please allow copyrighted books, especially those whose sales have now diminished, to be scanned and made available online. Join the twenty-first century!)

Finally, and most importantly, I thank my wife, Grace, who cheerfully and patiently urged me on.

In 1982, the late Allen Newell, one of the founders of AI, wrote, "Ultimately, we will get real histories of Artificial Intelligence . . . , written with as much objectivity as the historians of science can muster. That time is certainly not yet."

Perhaps it is now.

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