The Computer and the Brain:
Perspectives on
Human and
Artificial Intelligence

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THE COMPUTER AND THE BRAIN: PERSPECTIVES ON HUMAN AND ARTIFICIAL INTELLIGENCE

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989

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INTRODUCTION

While the field of cognitive science is generally understood to have devoloped in the late 1950s, the questions posed by researchers in this new field respond to the issues raised by Descartes and seventeenth-century rationalist philosophers and echo the epistemological deliberations introduced by Plato in the Socratic dialogues. The historicity of cognitive science, both its framework and assumptions, is a fascinating feature of this developing discipline.

John von Neumann was one of the first to address the highly controversial issue of appropriate models to use in discussing cognitive science. The issue that von Neumann raised most pointedly, one that is still hotly debated, is the language of the brain. In his Silliman Lectures, von Neumann questions the validity of using the computer as an interpretive model for human thought, asserting that the language of the brain is not mathematical. Later in the same lecture series, however, he attributes a statistical pattern to the brain. This paradoxical stance of von Neumann's is representative of the rapidly shifting nature of cognitive science. It is also representative of the study of the nature of language; creating exciting scenarios which lead men to attempt to understand the greatest of all paradoxes, the brain.

The Computer and the Brain: Perspectives on Human and Artificial Intelligence is a collection of interdisciplinary analyses addressing the issue of the language of the brain. The contributors include computer scientists, neuroscientists, psychologists, linguists, and historians. The resulting collection suggests the state of knowledge more than a generation after John von Neumann entitled his tantalizing and provocative lectures, The Computer and the Brain.

ACKNOWLEDGMENTS

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The commemoration of John von Neumann began on February 8, 1987, at his birthplace in Budapest, Hungary, thirty years after his death. Dr. Ferenc Nagy, who organized the Hungarian commemoration, kindly assisted in preparing the exhibit for the Arizona symposium. We also gratefully acknowledge Dénes Nagy, professor at the Eötvös Lorand University in Budapest, who conceived of linking the Hungarian and Arizona symposia and who, while a visiting professor at Arizona State University, organized a series of workshops on human and artificial intelligence related to the symposium.

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"John von Neumann: Formative Years" is adapted from Nicholas Vonneuman's John von Neumann As Seen By His Brother and is reprinted here with the kind permission of Nicholas Vonneuman. "The von Neumann - Ortvay Connection" is taken from The Computer, the Brain, and the Missing Link (In Memoriam John von Neumann), a summary of the Hungarian book Neumann János és a "magyar titok" (John von Neumann and the "Hungarian secret"), OMIKK, 1987, and is reprinted here with the permission of the editors, Dénes Nagy, Ferenc Nagy, and Péter Horváth and of the publisher, the National Technical Information Centre and Library, Budapest.

William Aspray's "John von Neumann's Contributions to Computing and Computer Science" contains material adapted from the author's essay, "The Mathematical Reception of the Modern Computer: John von Neumann and the Institute for Advanced Study Computer," in Studies in the History of Mathematics, edited by Esther R. Phillips, and is reprinted here with the permission of The Mathematical Association of America. MIT Press has also granted permission to Ray Jackendoff to reprint material from Consciousness and the Computational Mind in his essay on "Languages of the Computational Mind." John Haugeland likewise acknowledges permission from MIT Press to reprint portions of Artificial

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LIST OF ILLUSTRATIONS

- p.4 Charles de Bouelles, "Libellus de nichilo," Liber de intellectu et al. (Paris, 1510) fol. 63.
- p.6 Gregor Reisch, Margarita philosophica (Freiburg, 1503) fol. 16v.
- p.8 Hartmann Schedel, Liber chronicarum (Nuremberg, 1493) fol. 5v.
- p.11 Yin and yang.
- p.14 Macrobius, In somnium Scipionis (Brescia, 1485) fol. b4v.
- p.15 The numbers 1 to 4 as representations of a dot, line, plane surface, and volume.
- p.48 Graph of the logarithm of the number of elementary operations per second by the largest existing digital computers plotted as a function of time (years).
- p.57 A potential surface represented as a slice through a hillside.
- p.61 Attractors for the logistic (Equation 1).
- p.91 Flow of information through the hippocampal formation.
- p.92 Numbers of transmitting fibers, receiving cells and contact probabilities for parts of the hippocampus.
- p.98 Implications of postnatal maturation of hippocampus.
- p.116 Necker cube.
- p.126 History of neural modeling.
- p.128 History of Artificial Neural Systems.
- p.131 Growth in the number of components on a die.
- p.132 Increase in chip area.
- p.133 Space occupied by 1 million bits.
- p.134 Cost per bit.
- p.135 Probe yield as a function of chip area.
- p.137 Design cost.
- p.138 Increase in interconnect density.
- p.140 Comparison of CMOS and neurons.
- p.141 Comparison of neural and semiconductor systems.
- p.144 Analog neural network.
- p.146 Relaxation from an initial input of ---- to stored T.
- p.147 Tij element (after Mead et al. 1986).
- p.148 Block diagram of one cell of interconnectivity chip.
- p.160 a) Drawing of a biological neuron; b) Electronic analog.
- p.162 The feature extraction process. a) Shows an image of a handwritten character. b), c), and d) show examples of feature templates, and the resultant feature maps for the image shown in a). In the templates, black is excitation and gray is inhibition. b) and c) check for line endstops; d) checks for horizontal lines.
- p.164 Optical micrograph of a 46 x 96 neuron CMOS chip.

List of Illustrations

xvi

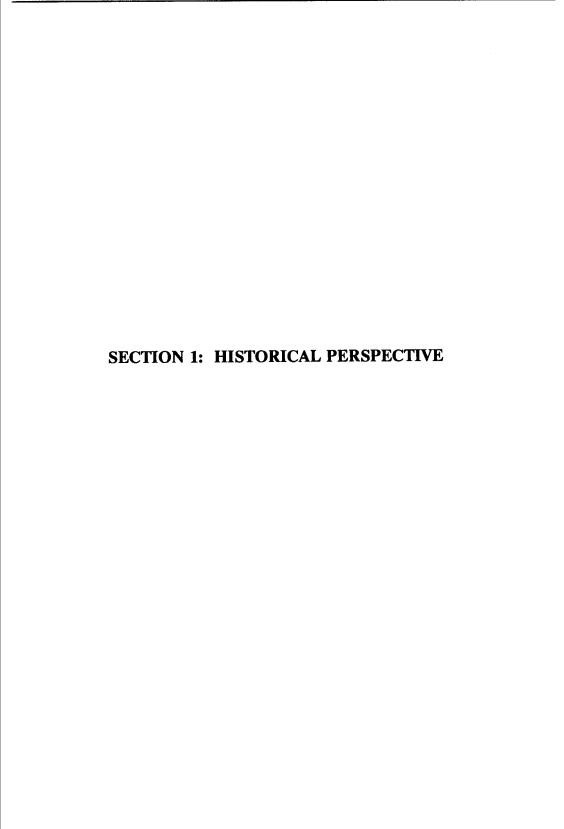
p.166	Functional schematic of the chip.
p.174	Forms of linguistic information.
p.178	Forms of visual information (after Marr 1982).
p.181	Forms of musical information (after Lerdahl and Jackendoff 1983).
p.183	Possible connections among central levels of representation.
p.230	Letter from Maurice H. Greenhill to Warren McCulloch.
p.231	Letter from John von Neumann to Warren McCulloch.

CONTENTS

Introduction	v
Acknowledgments	ix
List of Editors and Contributors	xi
List of Illustrations	xv
Section 1: Historical Perspective	
Binary Systems, Ratios, and Esthetic Judgments in the Renaissance S. K. Heninger, Jr.	3
Artificial Intelligence and the Western Mind John Haugeland	17
The Brain and the Computer Robert P. Multhauf	31
Section 2: Synapses or Chips	
"The Computer and the Brain" Revisited Terrence J. Sejnowski	45
Behavior as a Trajectory through a Field of Attractors Peter R. Killeen	53
Computation in the Brain: The Organization of the Hippocampal Formation in Space and Time Lynn Nadel	83
Brain-Style Computation: Mental Processes Emerge from Interactions among Neuron-Like Elements David E. Rumelhart	111

viii Contents

Section 3: Cognitive Science and Technology	
VLSI Implementations of Neural Systems L. A. Akers, D. K. Ferry, and R. O. Grondin	125
Electronic Neural Network Chips L. D. Jackel, R. E. Howard, H. P. Graf, W. E. Hubbard, J. S. Denker, and D. Henderson	159
Section 4: Language and Computer Science	
Languages of the Computational Mind Ray Jackendoff	171
On Primary and Secondary Language Helmut Schnelle	191
Linguistics, Learnability, and Computation Wendy Wilkins	197
Section 5: John von Neumann's Contribution to Cognitive Science	
John von Neumann Jean R. Brink and C. Roland Haden	211
John von Neumann: Formative Years Nicholas Vonneuman	217
The von Neumann - Ortvay Connection Dénes Nagy, Péter Horváth, and Ferenc Nagy	227
John von Neumann's Contributions to Computing and Computer Science William Aspray	241
Interviews with Edward Teller and Eugene P. Wigner Jean R. Brink and C. Roland Haden, eds.	253



BINARY SYSTEMS, RATIOS, AND ESTHETIC JUDGMENTS IN THE RENAISSANCE

S. K. HENINGER, Jr. UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL

As you may recall, John von Neumann introduced *The Computer and the Brain* with a modest disclaimer. "Since I am neither a neurologist nor a psychiatrist," he wrote, "but a mathematician, the work that follows requires some explanation and justification." Well, I have to go von Neumann one better. I am certainly not a neurologist or a psychiatrist--and I cannot even claim to be a mathematician. But I am fascinated by what the new sciences can do, and I am enormously pleased to have the opportunity of participating in a conference paying homage to von Neumann and his colleagues.

When Jean Brink asked me to come to the conference, she told me that she would like a paper about modes of perception in the Renaissance and concepts of memory and theories of intelligence and things like that. The challenge, of course, is how to make any of that relevant to what is going on today. As I thought about all this material, though, a teasing comparison came to dominate my thinking. In many fundamental ways, a computer is like a poem, such as Dante's Divine Comedy. To begin with, both are man-made constructs, and both use signs, languages of an artificial sort. Moreover, a poem encodes information as though it were a memory bank, while it must allow a reader to retrieve this information. So I began to play with the notion that Renaissance works of art in all media--in painting and music as well as poetry--bore comparison to computers.

Furthermore, it occurred to me that those working in artificial intelligence face a problem similar to the one faced by those in the Renaissance who saw their works of art as representation in small of the great universe, a microsystem encompassing the infinite variety in nature. In Renaissance terms, a system of artificial intelligence is a microcosm representing the limitless potential of the macrocosm. Anyone devising a program of artificial intelligence is necessarily limited to a finite system; and yet, this system should be responsive to as many contingencies as possible. Although the system is finite, ideally it should submit to manipulation in an infinite number of ways. So I decided it might be worthwhile to explore with you this purpose of art: the relating of the man-made and therefore finite to the natural and therefore all-encompassing.

Now, since I profess to be a cultural historian, let me get historical. My instructions were to talk about the Renaissance. But it is extremely difficult to set dates for that event glibly called the Renaissance, so I am going rather arbitrarily to talk about what the scene looked like in the year 1500--by which time the

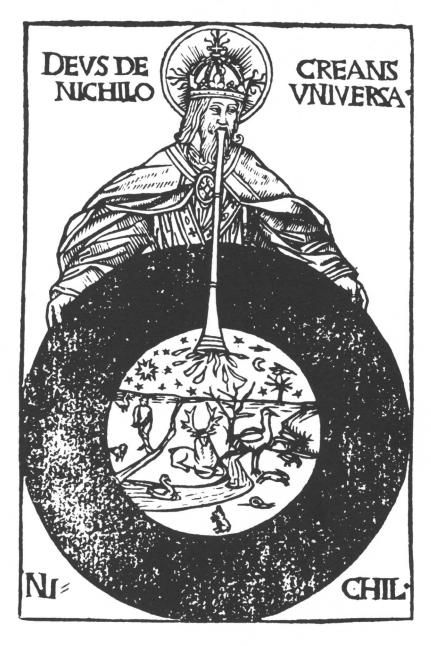


Figure 1. Charles de Bouelles, "Libellus de nichilo," Liber de intellectu et al. (Paris, 1510) fol. 63.