part 4

Bibliography

A SELECTED DESCRIPTOR-INDEXED BIBLIOGRAPHY TO THE LITERATURE ON ARTIFICIAL INTELLIGENCE

by Marvin Minsky

This listing is intended as an introduction to the literature on Artificial Intelligence—*i.e.*, to the literature dealing with the problem of making machines behave intelligently. We have divided this area into categories and cross-indexed the references accordingly. Large bibliographies without some classification facility are next to useless. This particular field is still young, but there are already many instances in which workers have wasted much time in rediscovering (for better or for worse) schemes already reported. In the last year or two this problem has become worse, and in such a situation just about any information is better than none.

This bibliography is intended to serve just that purpose—to present some information about this literature. The selection was confined mainly to publications directly concerned with construction of artificial problem-solving systems. Many peripheral areas are omitted completely or represented only by a few citations. The classification system is not particularly accurate. The descriptive categories that we have selected do not always permit very sharp distinctions and not always useful ones. There are surely many errors in the assignments of papers to the categories, both for those I have not read, and for those which I did not fully understand. I have seen, or discussed with the authors, about half of the papers. Of about half the remainder, I felt qualified to guess about the contents on other grounds. On most of the remainder I guessed anyway and may have missed entirely.

The meanings of the descriptors—the names of the categories—are not given here in any detail, because the present state of the art will not bear standardization. The terms do assume understanding of the main

points discussed in my paper (1961*a*), which is readily available. Obviously, there is much ambiguity in the assignments, *e.g.,* between *learning* and *inductive inference.* In most cases I did *not* assign papers to all competing categories, so that the searcher may have to look in several reasonable listings to find full coverage. Not all of the original papers were retrieved for bibliographic checking. This bibliography should therefore not be used as a base for other compilations without checking all the references carefully. Our purpose was to make available a guide, and not to do all the work necessary for inclusiveness or accuracy. Many erroneous citations, propagated from one bibliography to another over the years, are corrected here, but others have surely been introduced; I have noticed this already in pirated editions of this compilation.

The selection was made on two bases. Papers *directly* concerned with design, construction, and use of problem-solving machinery were admitted more or less indiscriminately; papers in relevant mathematical, psychological and physiological domains were selected more critically to represent entry points to those literatures. A number of clearly relevant areas were omitted almost entirely, and a few remarks on this selection follow. No attempt was made to be comprehensive; in most cases we give only a recent sample for each author. There is very little on the foreign literature; except for England, the foreign literature has been weak until very recently, probably because this field simply does not develop without the testing of models by digital computation. I might remark, at this point, that I do not regard the literature in this field as a substantial source of buried treasures of good ideas; the major problems have not yet been generally recognized and challenged. But there are certainly a great many bad ideas about, and it will pay the worker to be able to recognize them quickly. My own preferences are outlined clearly enough in Minsky, 1961*a*.

Automata Theory, Switching Theory, Recursive Function Theory, Logic

We have included only a few, fairly basic papers. What is needed is a theory of computation and a theory of hierarchies within the computable functions. Neither is available today in satisfactory form. We have included quite a few papers concerned with the problem of proving theorems by machine; these are all concerned with heuristic problems, although the authors may not always choose so to look at things. We have also included several references to the question of reliable computation with unreliable elements (stemming from Von Neumann, 1956); while this question is not directly connected with the artificial intelligence problem, it will surely be important in the realization of these ideas. Similarly with theory of probabilistic machines; here the literature is still rather thin. We neglect the very large literature on minimization of automata and switching circuits, although there are many useful heuristic methods therein.

Language, Mechanical Translation

A number of references to natural and formal languages are included; this area is highly relevant and much more could be adjoined. No references at all are included for Mechanical Translation, even though we feel that this work is important; Oettinger's compilation[1] with 645 entries will serve the purpose.

Information Theory, Coding Theory, Statistical Decision Theory

Only a few references are given. Although coding and decision problems are fundamental to us, we cannot yet say what is relevant.

Neurophysiology and Physiological Psychology

These will someday show how the brain works, and already quite a bit is known about the *Psychology of Problem-solving;* we have tried to include a good many citations of outstanding work in these areas. We have not included much on learning in lower animals; it is our conviction that if one's goal is to build machines to solve difficult problems, it will not help for one to become preoccupied with the mechanics of systems which do not solve very difficult problems. We have omitted the entire area of *Adaptive Servomechanisms* as being similar in nature, but our omission of *Operations Research* is due only to unfamiliarity; we are sure that this is a valuable source of heuristic analysis and technique; likewise for *Information Retrieval.* One area which certainly deserves a larger representation is that of theories of *Inductive Inference;* the philosophical literature contains a great deal on this subject.

The present collection is a revision of the document listed below as Minsky, 1961*c*. The original collection was based on my own files, the collection of Alice M. Pierce,[2] a listing by Allen Newell,[3] and listings of Russell Kirsch,[4] Simmons and Simmons,[5] and the afore-mentioned collec-

[1] A. G. Oettinger, Bibliography of Mathematical Linguistics and Automatic Translation, Cambridge, Mass., Computation Laboratory, Department of Linguistics, Division of Engineering and Applied Physics, Harvard University, September, 1959. 645 entries, many Soviet.

[2] A. M. Pierce, A Concise Bibliography of the Literature on Artificial Intelligence, Bedford, Mass.: Communication Sciences Laboratory, Electronic Research Directorate AFCRC-TN-59-773, ARDC, USAF, September, 1959.

[3] Allen Newell, Bibliography GI-506, March, 1958. Unpublished.

[4] R. A. Kirsch, Bibliography for NBS Graduate Course 204–204, Washington, D.C.: Data Processing Systems Division, National Bureau of Standards, September, 1959–April, 1960. Effective computational processes with finite and infinite machines.

[5] P. L. Simmons and R. F. Simmons, The Simulation of Cognitive Processes: An Annotated Bibliography, Santa Monica, Calif., System Development Corp., *IRE Transactions on Electronic Computers,* September, 1962, **EC-10:** 462–483. 498 references with informative annotations and subject index. Many Soviet references.

tion of Oettinger.[6] I expect to publish one more revision; the relevant literature now numbers perhaps 2000 papers. A bibliography of that size, without descriptors, would be completely useless, and even our type of index is approaching its limit of practical application. The "citation-index" method appears to be useless here. The only hope is that as the most profitable lines of thought emerge more clearly, we will be able to become more selective.

[6] *Op. cit.*

DESCRIPTOR INDEX

A descriptor is represented by a capital letter and a subscript. The letters indicate main divisions, and the subscripts represent a further breakdown. Following each descriptor, we list those citations in the Bibliography which are associated with that particular descriptor.

A: Mathematical Theory of Computers and Automata

Berkeley 1949

A_1 Finite-state Machines; Mathematical Theory

Ashby 1952*a*, 1956*a*, 1959; Babcock 1960*b*; Burks and Wang 1957; Burks 1959; Culbertson 1952, 1956; Hohn, Seshu, and Aufenkamp 1957; Holland 1959; Keller 1961; Kleene 1956; McCulloch and Pitts 1943; McNaughton 1961; Minsky 1959*b*; Moore 1956*a*; Mullin 1959; Murray 1955; Von Neumann 1951, 1956; Rabin and Scott 1959; Shannon 1954; Unger 1958

A_2 Logical Network Theory

Babcock 1960*b*; Burks 1959; Copi, Elgot, and Wright 1958; George 1956; Gill 1960; Holland 1958; Kleene 1956; McCulloch and Pitts 1943; McNaughton 1961; Minsky 1954*a*, 1956*a*, 1959*b*; Mullin 1959; Shannon 1949*b*; Tarjan 1958; Von Foerster 1959

A_3 Switching Theory

Calderwood and Porter 1958; McNaughton 1961; Moore and Shannon 1956*b*; Mullin 1959; Shannon 1949*b*

A_4 Infinite Memory (Turing) Machines

Burks and Wang 1957; Chomsky 1959*b*; Davis 1958; Kleene 1952; De Leeuw, Moore, Shannon, and Shapiro 1956; Lofgren 1958; McNaughton 1961; Minsky 1961*d*; Von Neumann 1951; Rabin and Scott 1959; Rogers 1959; Shannon 1956; Solomonoff 1960; Turing 1936; Wang 1957

A_5 Infinite Structure (Growing) Machines

Burks and Wang 1957; Burks 1959, 1960; Holland 1959, 1960, 1962; McNaughton 1961; Von Neumann 1951

A_6 Probabilistic Machine Theory

Ashby 1951; Blum and McCulloch 1960*a*; Cowan 1960*a*, 1960*b*; Culbertson 1952, 1956; Good 1959; Householder and Landahl 1945; Landahl, Mc-

Culloch, and Pitts 1943; De Leeuw, Moore, Shannon, and Shapiro 1956; Mackay 1949; McCulloch 1957*b*, 1959*a*, 1960; McNaughton 1961; Minsky 1954*a*, 1962; Moore and Shannon 1956*b*; Von Neumann 1951; Solomonoff 1960; Verbeek 1960*a*, 1960*b*; Wang 1957

A_7 Computability and Recursive Function Theory

Church 1936; Davis 1958; Davis and Putnam 1959; Godel 1931; Holland 1959; Kleene 1935, 1952; De Leeuw, Moore, Shannon, and Shapiro 1956; McCarthy 1956, 1960; McNaughton 1961; Minsky 1961*d*; Post 1943; Rabin and Scott 1959; Rogers 1959, 1960; Turing 1936

A_8 Theory of Computation

Bledsoe 1961*b*; Burks 1960; Carr 1958; McCarthy 1960, 1961; McNaughton 1961

B: Computer Structures

Berkeley 1949

B_1 Conventional Digital Computers

Andree 1958; Babbage (see appendixes in Bowden 1953); Oettinger 1952; Prywes and Gray 1962; Shannon 1954; Shoulders 1960; Ware 1960

B_2 Parallel Computers

Babcock 1960*b*, 1961; Blum and McCulloch 1960*a*; Burks 1959, 1960; Chow 1957; Cowan 1960*b*; Holland 1960, 1962; McCulloch 1951*b*; Nash 1954; Newell 1960*b*; Selfridge 1959; Shoulders 1960; Unger 1958, 1959; Uttley 1956*a*, 1959*b*; Verbeek 1960*a*, 1960*b*; Von Foerster 1959

B_3 Reliability through Redundancy of Components

Allanson 1956*b*; Blum and McCulloch 1960*a*; Blum 1960*b*; Cowan 1960*a*, 1960*b*; Elias 1958; Kochen 1959; Landahl, McCulloch, and Pitts 1943; Lofgren 1958, 1962; McCulloch 1957*b*, 1959*a*, 1960; Moore and Shannon 1956*b*; Von Neumann 1951, 1956, 1958; Verbeek 1960*a*, 1960*b*

B_4 Random "Neural Nets"

Allanson 1956*a*; Ashby 1950*a*; Babcock 1960*b*; Barus 1959; Cadwallader-Cohen *et al.* 1961; Clark and Farley 1955; Farley and Clark 1954; Good 1959; Hawkins 1961; Hebb 1949; Keller 1961; Milner 1957, 1960, 1961*a*; Minsky 1954*a*, 1959*a*; Minsky and Selfridge 1960; Pask 1959, 1960*b*; Rapoport 1948; Rochester, Holland, Haibt, and Duda 1956; Rosenblatt 1958*a*, 1958*b*, 1959*b*, 1960*a*; Uttley 1954, 1955, 1959*b*; Von Foerster 1959

B_5 Allegedly Brainlike Computers

Angyan 1959; Babcock 1960*a*; Balescu 1956; Coupling 1950; Crichton and Holland 1959; Harmon 1959; Harmon, Levinson, and Van Bergeijk 1962*a*;

Hebb 1949; Keller 1961; Milner 1957; Minsky 1954*a*, 1956*b*; Rashevsky 1940, 1960; Rosenblatt 1958*a*, 1958*b*, 1959*b*, 1960*a*, 1962; Russell 1957; Uttley 1954, 1959*b*

B_6 Neural Nets, Not Necessarily Random in Structure

Allanson 1956*b*; Babcock 1960*a*, 1960*b*, 1961; Barus 1959; Van Bergeijk and Harmon 1960; Bledsoe and Browning 1959; Bledsoe 1961*a*; Blum 1960*b*; Burks 1959, 1960; Copi, Elgot, and Wright 1958; Cowan 1960*a*, 1960*b*; Culbertson 1950, 1952, 1956; Farley and Clark 1954, 1960*b*; George 1956; Good 1958; Greene 1959*a*; Harmon 1959; Harmon, Levinson and Van Bergeijk 1962*a*; Harmon 1962*b*; Hawkins 1961; Holland 1958, 1959; Householder and Landahl 1945; Kamentsky 1959; Kleene 1956; Kudielka and Lucas 1961; Landahl, McCulloch, and Pitts 1943; Landahl 1962; Levinson and Harmon 1962; Mackay 1956*b*; Malin 1961; McCulloch and Pitts 1943; McCulloch 1945, 1957*b*, 1959*a*, 1960; Milner 1957, 1960, 1961*a*; Minsky 1954*a*, 1956*a*, 1956*b*, 1959*b*, 1962; Mullin 1959; Von Neumann 1956; Rapoport 1948; Rapoport and Shimbel 1949; Rashevsky 1940, 1960; Rochester, Holland, Haibt, and Duda 1956; Selfridge 1948; Sholl and Uttley 1953; Swallow and Weston 1959; Tarjan 1958; Uttley 1954, 1956*a*, 1959*b*; Von Foerster 1959; Von Foerster and Zopf 1961; Walter 1954; Wiener and Rosenbleuth 1946; Willis 1959

C: Search Problems[7]

Ashby 1945, 1948, 1956*a*, 1958*b*; Bledsoe 1961*c*, 1961*d*; Bremermann 1958; Coupling 1950; Holland 1962; Martens 1959; Minsky 1954*b*, 1961*a*; Newell 1960*b*; Polanyi 1957; Russell 1957; Von Foerster and Zopf 1961

C_1 Enumerative Algorithms, Decision Procedures

Ashby 1952*a*; Bellman 1957; Chomsky 1959*b*; Davis 1958; Dunham, Fridshal, and Sward 1959; Highleyman 1961*b*; McCarthy 1956; Minsky 1962; Newell, Shaw, and Simon 1958*b*, 1958*c*; Pervin 1959; Prawitz, Prawitz, and Vogera 1960; Pringle 1951; Quine 1955; Wang 1960*a*

C_2 Imperfect Searches Involving Failure, as Opposed to Decision Procedures

Davis and Putnam 1959, 1960; Gilmore 1959, 1960; Newell and Simon 1956*a;* Newell, Shaw, and Simon 1957*a*, 1958*b*, 1958*c*; Wang 1960*a*

C_3 Discussion of Efficiency Problems for Large Searches

Arnold 1959; Ashby 1952*a*, 1956*b*; Bledsoe 1961*c*; Davis and Putnam 1959, 1960; Friedberg 1958; Friedberg, Dunham, and North 1959; Howland, Minsky, and Selfridge 1959; Mackay 1961*b*; McCarthy 1956; Minsky and Selfridge 1960; Newell, Shaw, and Simon 1957*a*; Papert 1961; Prywes and Gray 1962; Samuel 1959*a*; Willis 1960

[7] These categories are particularly hard to separate.

C_4 Heuristics for Reducing Search Magnitude

Arnold 1959; Ashby 1952*a*, 1956*b*; Bellman 1957; Mackay 1956*b*; Tonge 1960

C_5 Partition of Problems into Subproblems

Arnold 1959; Ashby 1952*a*, 1956*b*; Bellman 1957; Bledsoe 1961*c*; Darlington 1958; Friedberg, Dunham, and North 1959; Holland 1962; Spiegelthal 1960; Tonge 1960; Wang 1960*a*; Willis 1960

C_6 Sequential Improvement Schemes

Andrew 1958, 1959*a*; Ashby 1956*b*, 1959; Barus 1959; Bellman 1957; Darlington 1958; Gabor, Wilby, and Woodcock 1961; Holland 1962; Mackay 1959*a*; Minsky 1954*b*; Minsky and Selfridge 1960; Prywes and Gray 1962; Selfridge 1956; Tonge 1960

C_7 Problems of Local Peaks, and the Mesa Phenomenon

Campaigne 1959; Darlington 1958; Friedberg 1958; Friedberg, Dunham, and North 1959; Howland, Minsky, and Selfridge 1959; Minsky 1954*b*; Minsky and Selfridge 1960

C_8 Hill-climbing; Multiple Simultaneous Optimization

Andrew 1958, 1959*a*; Arnold 1959; Eykhoff 1960; Friedberg 1958; Friedberg, Dunham, and North 1959; Gabor, Wilby, and Woodcock 1961; Highleyman 1961*b*; Howland, Minsky, and Selfridge 1959; Kailath 1961; Kilburn, Grimsdale, and Summer 1959; Loveland 1958; Minsky 1954*b*; Minsky and Selfridge 1960; Selfridge 1956, 1959; Widrow 1959

C_9 Discussion of Randomness and Creativity

Cadwallader-Cohen *et al.*, 1961; Campbell 1956, 1960; Cohen 1962; Coupling 1950; Kilburn, Grimsdale, and Summer 1959; Mackay 1949; Minsky 1956*b*

D: Pattern Recognition and Perception

Van Bergeijk and Harmon 1960; Deutsch 1955; Householder and Landahl 1945; Miller and Chomsky 1957*a*; Pierce 1961; Rashevsky 1945*b*; Shepard and Chang 1961*a*; Sholl and Uttley 1953; Singer 1961; Taylor 1959*a*; Uhr and Vossler 1961*a*; Uhr 1961*b*; Wiener 1949*b*

D_1 General Discussion, Reviews

Attneave 1954; Babcock 1960*b*, 1961; Barlow 1959; Clark and Farley 1955; Culbertson 1948; Dineen 1955; Estavan 1959; Farley, Frishkopf, Clark, and

Gilmore 1957; Farley 1960*a*; Gold 1959; Green 1957; Greene 1959*a*; Hebb 1958; Kalin 1960; Kirsch, Cahn, Ray, and Urban 1957; Koffka 1935; Kohler 1929; Mackay 1956*b*; Marill and Green 1960; Marill 1961*b*; Minot 1959; Minsky 1959*a*, 1961*a*; Pitts 1955; Rashevsky 1940, 1960; Selfridge 1955, 1956; Selfridge and Neisser 1960; Sperry 1952; Stevens 1957, 1961*a*; Sutherland 1959; Unger 1959; Uttley 1954, 1956*b*; Von Foerster 1959; Wulfeck and Taylor 1957

D_2, D_3 Discussion of Matching Criteria

Attneave 1954; Clark and Farley 1955; Denes and Mathews 1960; Duncker 1945; Estes 1960; Farley 1960*a*; Frankel 1959; Fry and Denes 1959; Glantz 1960; Highleyman 1961*a*, 1962; Hughes and Halle 1959; Jakowatz, Shuey, and White 1960; Mattson 1959; McLachlan 1958; Papert 1961; Selfridge 1955, 1956; Selfridge and Neisser 1960; Sprick and Ganzhorn 1959; Steinbuch 1958*a*; Stevens 1957; Taylor 1959; Wada *et al.* 1959

D_4 Property-list or Character-vector Schemes

Babcock 1961; Bledsoe and Browning 1959; Bledsoe 1961*a*; Dimond 1957; Dineen 1955; Doyle 1960; Duncker 1945; Feigenbaum and Simon 1961*b*; Frishkopf and Harmon 1961; Lewis 1962; McLachlan 1958; Minot 1959; Minsky 1956*b*; Papert 1961; Samuel 1959*a*; Selfridge 1955, 1956; Slagle 1961; Steinbuch 1958*a*; Stevens 1961*a*

D_5 Schemes Involving Articulation, Recursion, Attention; Division into Parts

Attneave 1954; Balescu 1956; Banerji 1960; Barnett 1958; Bomba 1959; Canaday 1962; Eden and Halle 1961; Frishkopf and Harmon 1961; Grimsdale, Sumner, Tunis, and Kilburn 1959*a*; Haller 1959; Harris 1951; Hebb 1949, 1958; Hughes and Halle 1959; Ladefoged 1959; Mackay 1950; Miller 1962; Minsky 1959*a*, 1961*b*; Mooers 1951*a*; Sherman 1959; Stevens 1961*a*; Uhr 1959*a*; Unger 1959

D_6 Human Visual Perception

Adrian 1946; Allport 1955; Attneave 1954, 1955; Broadbent 1958; Campbell 1958; Farley 1960*a*; Freiberger and Murphy 1961; Gibson 1929, 1950; Green 1959; Hake and Hyman 1953; Harmon, Levinson, and Van Bergeijk 1962*a*; Hayek 1952; Hebb 1949; Householder 1943; Julesz 1960*a*, 1960*b*, 1962*a*; Koffka 1935; Kohler 1929, 1951; Lawrence and Coles 1954; Lawrence and La Berge 1956; Mackay 1960*b*, 1961*c*; Marshall and Talbot 1942; Miller 1956*b*; Neisser 1959*a*, 1959*b*, 1960; Pitts and McCulloch 1947; Roberts 1962; Scott and Williams 1959; Selfridge and Neisser 1960; Stevens 1951; Sutherland 1959; Uhr 1960

D_7 Nonvisual Perception, Especially Speech Recognition Machines

Bauman and Licklider 1954; Byrnes, Gold, and Kemball 1958; David 1955, 1958*a*; David, Matthews, and McDonald 1958*b*; David 1961; Davis, Bid-

dulph, and Balashek 1953; Denes and Mathews 1960; Fatehchand 1960; Forgie and Forgie 1959; Fry and Denes 1953, 1959; Harmon 1959; Harmon, Levinson, and Van Bergeijk 1962*a*; Hughes and Halle 1959; Ladefoged 1959; Marill 1961*b*; Miller 1958; Petrick 1961*a*; Pierce and David 1958; Shultz 1957; Steinbuch 1958*b*; Stevens 1951; Wiener 1950*b*

D_8 Picture Transformations, Especially Local Homogeneous (Kernel)

Attneave 1954; Babcock 1960*b*; Bomba 1959; Buell 1961; David 1961; Dineen 1955; Elias *et al.* 1952; Kalin 1960; Kirsch, Cahn, Ray, and Urban 1957; Landahl 1962; Minot 1959; Selfridge 1955, 1956; Sherman 1959; Stevens 1961*a*, 1961*b*; Unger 1958, 1959

D_9 Pattern Recognition as a Statistical Decision Problem

Chow 1957; Doyle 1960; Estes 1960; Farley 1960*a*; Frankel 1959; Hawkins 1961; Highleyman 1961*b*; Marill and Green 1960; Minsky and Selfridge 1960; Papert 1961; Rosenblatt 1958*a*, 1958*b*, 1959*a*, 1959*b*, 1960*a*, 1962; Sebestyen 1960, 1961; Stevens 1961*a*; Uhr 1961*b*; Unger 1958; Uttley 1954, 1956*a*, 1956*b*, 1956*c*, 1959*a*, 1959*b*; Wiener 1949*a*

D_{10} Character-reading Machines, Printed Text or Handwritten

Bailey and Norrie 1957; Baran and Estrin 1960; Barus 1959; Bledsoe and Browning 1959; Bledsoe 1961*a*; Bomba 1959; Broido 1958; Chow 1957; Dimond 1957; Doyle 1960; Eden 1962; Eldredge 1957; Flores 1958; Frankel 1959; Freiberger and Murphy 1961; Frishkopf and Harmon 1961; Glauberman 1959; Greanias, Hoppel, Cloomok, and Osborn 1957*a*; Greanias and Hill 1957*b*; Grimsdale, Sumner, Tunis, and Kilburn 1959*a*; Haller 1959; Heasly 1959; Highleyman and Kamentsky 1959*a*, 1959*b*, 1960; Highleyman 1961*a*, 1962; Kamentsky 1959; Kazmierczak 1959; Leimer 1962; Marill and Green 1960; Mattson 1959; Minot 1959; Pahl and Johnson 1959; Roberts 1960; Rosenblatt 1958*a*; Selfridge and Neisser 1960; Sherman 1959; Sprick and Ganzhorn 1959; Steinbuch 1958*a*; Stevens 1957, 1961*a*; Taylor 1959; Uhr 1959*a*; Unger 1959; Wada *et al.* 1959

D_{11} Discovery of Useful Properties for Distinguishing Patterns

Babcock 1960*b*, 1961; Banerji 1960; Bruner, Goodnow, and Austin 1956; Buell 1961; David 1961; Denes and Mathews 1960; Deutsch 1955; Freiberger and Murphy 1961; Gill 1959; Glantz 1960; Golomb 1960; Heasly 1959; Hubel and Wiesel 1959, 1962; Hughes and Halle 1959; Julesz 1962*a*; Kazmierczak 1959; Kirsch, Cahn, Ray, and Urban 1957; Lettvin, Maturana, McCulloch, and Pitts 1959; Mackay 1956*b*; Marill 1961*b*; Mattson 1959; McLachlan 1958; Minot 1959; Minsky 1956*b*, 1959*a*; Minsky and Selfridge 1960; Newell, Shaw, and Simon 1960*a*; Papert 1961; Sebestyen 1960, 1961; Selfridge 1955, 1956, 1959; Solomonoff 1957; Sprick and Ganzhorn 1959; Stevens 1961*b*; Uhr 1959*a*, 1960; Uhr and Vossler 1961*c*; Von Foerster and Zopf 1961; Watson 1959

D_{12} Transformation-invariant Properties Not Requiring Prenormalization

Babcock 1960*b*, 1961; Bomba 1959; Buell 1961; Deutsch 1955; Doyle 1960; Harmon 1960*a*, 1960*b*; Hu 1962; Hubel and Wiesel 1959, 1962; Kalin 1960; Lettvin, Maturana, McCulloch, and Pitts, 1959; McCulloch 1951*b*; Minot 1960; Pitts and McCulloch 1947; Roberts 1960; Rosenblatt 1960*a*; Selfridge and Neisser 1960; Stevens 1961*a*, 1961*b*; Wiener 1948

D_{13} Discrimination by Use of Weighted Sums of Relatively Simple Properties

Bledsoe and Browning 1959; Bledsoe 1961*a*; Braverman 1959; Chow 1957; Denes and Mathews 1960; Doyle 1960; Gamba 1961; Hawkins 1961; Joseph 1960; Keller 1961; Marill and Green 1960; Mattson 1959; Minsky and Selfridge 1960; Murray 1959, 1961; Roberts 1960; Rosenblatt 1958*a*, 1958*b*, 1959*a*, 1959*b*, 1960*a*, 1962; Selfridge 1959; Taylor 1959; Turing 1953; Uttley 1954, 1956*c*, 1959*b*; Wada *et al.* 1959; Willis 1959

D_{14} Systems Using Hierarchies of Recognition Devices

Canaday 1962; Denes and Mathews 1960; Hubel and Wiesel 1959, 1962; Ladefoged 1959; Lettvin, Maturana, McCulloch, and Pitts 1959; Miller, Galanter, and Pribram 1960; Miller 1962; Minsky 1962; Neisser 1959*a*, 1959*b*, 1960; Rosenblatt 1962; Russell 1957; Selfridge 1959; Selfridge and Neisser 1960; Tinbergen 1951; Uttley 1954, 1956*b*, 1956*c*, 1959*b*

E: Learning Systems

General discussion: Andrew 1959*a*, 1959*b*; Ashby 1948, 1956*a*; Bledsoe 1961*d*; Carr 1958; Chomsky and Miller 1957*b*; Culbertson 1950; Deutsch 1956; Eldredge 1957; Estavan 1959; Feigenbaum and Simon 1961*b*; Feigenbaum 1961*c*; George 1959*b*; Greene 1959*b*; Gyr 1960; Holland 1962; Hull 1943, 1952; Kochen and Levy 1956; Mackay 1961*b*; Minsky 1961*a*; Newell and Simon 1962; Pask 1959, 1960*b*, 1961; Richards 1951, 1952; Rosenblatt 1962; Russell 1957; Shimbel 1950; Singer 1961; Sluckin 1954; Stevens 1951; Turing 1950; Von Foerster and Zopf 1961; Weir 1958; Wyckoff 1954

E_1 Animal Learning Behavior

Deese 1952; Hebb 1958, 1961; Hilgard 1956; Hull 1935; Landahl 1962; Minsky 1956*b*; Skinner 1961; Sutherland 1959; Thorpe 1956; Tinbergen 1951; Watson 1959; Zemanek, Kretz, and Angyan 1960

E_2 Human Learning Behavior

Allport 1955; Bush and Estes 1959; Chomsky 1959*a*; Deese 1952; Feigenbaum and Simon 1961*b*; Gibson 1940; Green 1959; Hebb 1958, 1961; Hilgard 1956; Kochen 1958*a*; Miller, Galanter, and Pribram 1960; Newell

and Simon 1962; Pask and Von Foerster 1960*c*; Shepard and Chang 1961*a*; Simon 1961*b*; Skinner 1953, 1957, 1961

E_3 Reinforcement (Reward, Extinction)

Barus 1959; Bush and Mosteller 1955; Bush and Estes 1959; Campaigne 1959; Chomsky 1959*a*; Clark and Farley 1955; Coupling 1950; Estes 1950; Farley and Clark 1954; Friedberg 1958; Friedberg, Dunham, and North 1959; George 1957; Good 1958; Gorn 1959; Keller 1961; Kilburn, Grimsdale, and Summer 1959; Kirsch 1954; Landahl 1962; Loveland 1958; Mattson 1959; Milner 1957, 1960; Minsky 1954*a*, 1956*b*; Minsky and Selfridge 1960; Oettinger 1952; Papert 1961; Roberts 1960; Rosenblatt 1958*a*, 1958*b*, 1959*a*; Samuel 1959*a*; Selfridge 1959; Skinner 1957, 1961; Wiener 1948; Willis 1959

E_4 Correlation Computations

Arnold 1959; Eykhoff 1960; Friedberg 1958; Friedberg, Dunham, and North 1959; Jakowatz, Shuey, and White 1960; Kac 1962; Kailath 1961; Kilburn, Grimsdale, and Summer 1959; Mattson 1959; McLachlan 1958; Minsky and Selfridge 1960; Newell 1955; Rosenblatt 1959*a*; Samuel 1959*a*; Steinbuch 1961; Watson 1959

E_5 Association, Nonreinforcement Learning Ideas

Barus 1959; Feigenbaum 1959, 1961*a*; Feigenbaum and Simon 1961*b*; Furst 1949; Hayek 1952; Hebb 1949, 1958; Lashley 1951; Milner 1957, 1960; Prywes and Gray 1962; Stevens 1959; Uttley 1956*a*, 1956*b*, 1956*c*, 1959*a*, 1959*b*

E_6 Confirmation of Internally Generated Hypotheses

Banerji 1960; Bledsoe and Browning 1959; Bledsoe 1961*a*; Chomsky 1959*a*; Feldman 1959, 1961*a*; Feldman, Tonge, and Kanter 1961*b*; Koffka 1935; Kohler 1929; Mackay 1961*b*; Minsky 1961*b*; Newell 1955; Newell, Shaw, and Simon 1960*a*; Papert 1961; Solomonoff 1957, 1959*a*

E_7 "Adaptation," Adjustment of Internal Parameters

Angyan 1959; Ashby 1947*a*, 1952*a*, 1959; Bellman and Kalaba 1958; Cadwallader-Cohen *et al.* 1961; Campbell 1956; Coupling 1950; Darlington 1958; Eykhoff 1960; Kac 1962; Pask and Von Foerster 1960*c*; Stevens 1961*a*; Uhr and Vossler 1961*a*

E_8 "Conditioning"

Angyan 1959; Braines, Napalkov, and Shreider 1959*a*; Householder and Landahl 1945; Landahl 1962; Von Neumann 1956; Pitts 1943; Rashevsky 1940, 1960; Walter 1950, 1951; Zemanek, Kretz, and Angyan 1960

E_9 Statistical Learning Theories

Ashby 1945; Atkinson 1954; Bemer 1959; Bush and Mosteller 1955; Bush and Estes 1959; Estes 1950; Farley 1960*a*; Foulkes 1959; Galanter and

1960; Minsky 1961*a*; Newell 1960*b*; Newell and Simon 1961*b*, 1961*c*, 1961*d*, 1962; Pask and Von Foerster 1960*c*; Pask 1961; Polanyi 1957; Simon 1961*a*; Stevens 1951; Tonge 1960

G_1 Administration Problem for Heuristic Programming

Bellman and Brock 1960*b*; Gelernter 1959*a*; Minsky 1956*b*, 1956*c*, 1959*a*, 1962; Newell, Shaw, and Simon 1957*a*, 1959*a*, 1960*a*; Reitman 1959, 1961; Slagle 1961

G_2 Search-tree Termination with Static Evaluation Function (Game Playing)

Bellman 1957; Bernstein *et al.* 1958*a*; Bernstein and Roberts 1958*b*; Freimer 1960; Kister, Stein, Ulam, Walden, and Wells 1957; Newell 1955; Newell, Shaw, and Simon 1958*b*; Samuel 1959*a*; Shannon 1950*a*, 1950*b*; Stein and Ulam 1957; Turing 1953; Wiener 1948

G_3 Explicit Use of Goals and Subgoals

Bellman 1957; Berstein *et al.* 1958*a*; Bernstein and Roberts 1958*b*; Churchman and Ackoff 1950*a*; De Groot 1946; Gelernter 1959*a*; McCarthy 1959; McCulloch 1955*c*; Miller, Galanter, and Pribram 1960; Minsky 1954*a*, 1956*b*; Newell 1955; Newell, Shaw, and Simon 1958*a*, 1958*b*, 1958*c*; Newell and Simon 1961*b*, 1961*c*, 1961*d*; Selfridge 1956; Shannon 1950*a*, 1950*b*; Simon 1961*b*; Spiegelthal 1960

G_4 Human Problem-solving (Psychological Literature)

Boring 1955; Bruner, Goodnow, and Austin 1956; Campbell 1958; Chomsky 1959*a*; Clarkson and Simon 1960; De Groot 1946; Duncan 1959; Feldman 1959, 1961*a*; Feldman, Tonge, and Kanter 1961*b*; Galanter and Miller 1960; Ghiselin 1952; Hadamard 1945; Hebb 1958; Heidbreder 1924; Hovland 1952; Humphrey 1951; John and Miller 1957; Johnson 1955; Katona 1940; Kochen and Levy 1956; Koffka 1935; Kohler 1929; Licklider 1960; Linsky 1952; Luchins 1942; Miller 1956*b*; Miller and Chomsky 1957*a*; Moore and Anderson 1954*a*, 1954*b*; Newell, Shaw, and Simon 1957*a*, 1958*a*, 1958*b*, 1958*c*, 1959*a*, 1960*a*; Newell and Simon 1961*b*, 1961*c*, 1961*d*, 1962; Piaget 1926, 1950, 1954; Poincare 1954; Polya 1954, 1954*a*; Rappaport 1951; Robinson 1957; Simon and Newell 1956*a*; Simon 1957, 1961*a*, 1961*b*; Vinacke 1962; Wertheimer 1945

G_5 The Effect of Different Training Sequences

Birch 1945; Boring 1955; Friedberg 1958; Friedberg, Dunham, and North 1959; Galanter 1959; Katona 1940; Kochen 1958*a*; Luchins 1942; Minsky 1959*a*; Newell, Shaw, and Simon 1958*a*, 1958*b*, 1958*c*; Piaget 1926; Polya 1954, 1954*a*; Russell 1956; Simon 1956*b*; Skinner 1953, 1961; Solomonoff 1957

G_6 Reasoning and Discovery, Human

Birch 1945; Boring 1955; Bruner, Goodnow, and Austin 1956; Campbell 1960; Deutsch 1954, 1956; Ghiselin 1952; Hebb 1949, 1958; Hovland 1952; Luchins 1942; Miller, Galanter, and Pribram 1960; Newell, Shaw, and Simon 1958*a*, 1958*c*, 1959*a*, 1960*a*; Newell and Simon 1961*b*, 1961*c*, 1961*d*; Polanyi 1957; Rashevsky 1945*b*, 1946; Robinson 1957

G_7 Theorem Proving by Machine

Copi and Beard 1959; Davis and Putnam 1959, 1960; Dunham, Fridshal, and Sward 1959; Gelernter and Rochester 1958; Gelernter 1959*a*, 1959*b*; Gelernter, Hansen, and Loveland 1960*a*; Gilmore 1959, 1960; Kleene 1952; McCarthy 1961; Minsky 1956*b*, 1956*c*, 1959*a*, 1962; Newell and Simon 1956*a*; Newell, Shaw, and Simon 1957*a*, 1959*a*, 1960*a*; Newell and Simon 1961*b*, 1961*c*, 1961*d*; Poincare 1954; Polya 1954*a*; Prawitz, Prawitz, and Vogera 1960; Quine 1955; Robinson 1957; Slagle 1961; Wang 1960*a*, 1960*b*, 1961

G_8 Use of Deductive Logic in Problem-solving

Church 1956; Copi and Beard 1959; Dunham, Fridshal, and Sward 1959; Gardner 1952, 1958; Gilmore 1959, 1960; Malin 1961; McCallum and Smith 1951; McCarthy 1959; Minsky 1961*b*; Moore and Anderson 1954*a*; Newell and Simon 1956*a*; Newell, Shaw, and Simon 1957*a*, 1959*a*, 1960*a*; Peirce 1887; Rashevsky 1945*b*, 1946

G_9 Program-writing or Sequential-action Problems

Amarel 1960; Campaigne 1959; Friedberg 1958; Friedberg, Dunham, and North 1959; Kilburn, Grimsdale, and Summer 1959; McCarthy 1959; Newell, Shaw, and Simon 1960*a*; Simon 1961*c*

G_{10} Character-Method Selection Machines

Gelernter and Rochester 1958; Gelernter 1959*b*; Gelernter, Hansen, and Loveland 1960*a*; Minsky 1956*b*, 1959*a*; Newell, Shaw, and Simon 1959*a*, 1960*a*; Slagle 1961

H: Languages

Ashby 1956*a*; Feigenbaum 1961*c*; Stevens 1951

H_1 Natural Languages

Bar-Hillel 1960, 1962; Bloomfield 1933; Ceccato 1956; Chomsky 1953, 1955, 1956, 1957*a*; Chomsky and Miller 1957*b*, 1958; Chomsky 1959*a*; Gold 1959; Green 1961*a*; Harris 1951, 1960; Lindsay 1960, 1961, 1962*a*, 1962*b*; Mandelbrot 1953; McCulloch 1952; Miller 1951; Newell and Simon 1962; Ogden 1933; Pendergraft 1961; Pierce and David 1958; Sapir 1939;

Shannon and Weaver 1949*a*; Skinner 1957, 1961, 1961; Wiener 1950*b*; Williams 1956; Yngve 1956, 1961

H_2 Formal Languages

Carr 1958; Chomsky 1953, 1955, 1956, 1957*a*; Chomsky and Miller 1957*b*, 1958; Chomsky 1959*b*, 1959*c*; Copi, Elgot, and Wright 1958; Davis 1958; Gibson 1929; Green 1961*a*; Harris 1951; Kleene 1952, 1956; Levien 1962; Miller 1951; Newell and Simon 1956*a*; Newell and Shaw 1957*b*; Newell, Shaw, and Simon 1959*a*, 1960*a*; Ogden 1933; Post 1943; Prywes and Gray 1962; Rosenbloom 1950; Solomonoff 1958, 1959*a*, 1959*b*; Wang 1960*a*; Williams 1956; Yngve 1961

H_3 Programming Language Systems

Andree 1958; Backus 1959; Bemer 1959; Carr 1958; David 1961; Ernst 1962; Gorn 1957; Green 1961*a*; Holland 1960; Mathews 1961; McCarthy 1960; Newell and Shaw 1957*b*; Newell, Shaw, and Simon 1958*a*, 1959*a*, 1960*a*; Newell 1960*b*; Newell and Tonge 1960*c*; Orchard-Hays 1961; Petrick 1961*b*; Reitman 1961; Rochester 1953; Rochester, Goldberg, and Edwards 1959; Shaw, Newell, Simon, and Ellis 1958; Unger 1958, 1959

H_4 Symbol-manipulation Programming Systems

Carr 1958; Craik 1952; Eden and Halle 1961; Fredkin 1960; Gelernter and Rochester 1958; Gelernter 1959*a*; Gelernter, Hansen, and Gerberich 1960*b*; Green 1959, 1961*a*, 1961*b*; Hiller and Isaacson 1959*a*; Kahrimanian 1953; McCarthy 1959, 1960; Miller, Minker, Reed, and Shindle 1960; Newell and Simon 1956*a*; Newell and Shaw 1957*b*; Newell, Shaw, and Simon 1958*a*, 1958*b*, 1958*c*, 1959*a*, 1960*a*; Newell and Tonge 1960*c*; Newell 1961*e*; Orchard-Hays 1961; Petrick 1961*b*; Rochester, Goldberg, and Edwards 1959; Shaw, Newell, Simon, and Ellis 1958; Slagle 1961; Strachey 1952; Tonge 1960; Williams 1956; Yngve 1956

H_5 Role of Language in Thinking and Communication

Bar-Hillel and Carnap 1953*a*, 1953*b*; Bar-Hillel 1955*a*, 1955*b*; Bloomfield 1933; Broadbent 1958; Campbell 1958; Cherry 1952, 1957; Chomsky 1959*a*; Hoviland 1952; Koffka 1935; Kohler 1929; Lashley 1951; Lenneberg 1956; Linsky 1952; Mackay 1954*a*, 1956*c*, 1961a; *Miller* 1951; Miller and Selfridge 1956*a*; Minsky 1961*b*; Mooers 1956*a*, 1956*b*, 1959; Mowrer 1954; Newell 1955; Osgood, Suci, and Tannenbaum 1957; Pask 1960*b*; Pierce 1961; Rothstein 1954; Ryle 1949; Sapir 1939; Selfridge 1956; Skinner 1957

H_6 Language and Coding for Models

Burks 1960; Chomsky and Miller 1957*b*; Craik 1952; Lindsay 1960, 1961, 1962*a*, 1962*b*; Mackay 1949, 1961*a*; Mandelbrot 1953; Mooers 1956*a*, 1956*b*; Von Neumann 1958; Newell 1955; Newell, Shaw, and Simon 1960*a*; Newman 1959

H_7 Information Theory and Coding Theory

Alluisi 1957; Attneave 1954, 1955; Bar-Hillel and Carnap 1953*a*, 1953*b*; Bar-Hillel 1955*a*, 1955*b*; Barlow 1959; Brillouin 1951; Cherry 1952, 1957; Cohen 1962; Cowan 1960*a*, 1960*b*; Elias 1958; Frankel 1959; Heasly 1959; Jackson 1950; Jacobson 1959; Mackay 1950, 1953, 1956*c*, 1959*a*, 1961*a*, 1961*b*; Mandelbrot 1953; Miller 1956*a*, 1956*b*, 1956*c*; Pierce 1961; Rapoport 1956; Rothstein 1954; Scott and Williams 1959; Shannon and Weaver 1949*a*; Shannon 1949*b*; Sluckin 1958; Wiener 1948; Wozencraft and Horstein 1960

I: Inductive Inference Machines

Ashby 1956*a*; Gyr 1960; Russell 1957

I_1 Conditional Probability

Andrew 1959*a*, 1959*b*, 1961; Barlow 1959; Brooks, Hopkins, Neumann, and Wright 1957; Cohen 1962; Foulkes 1959; Fry and Denes 1959; Good 1961*a*; Hagelbarger 1955; Hake and Hyman 1953; Hiller and Isaacson 1959*a*; Jakowatz, Shuey, and White 1960; Kemeny 1955*b*; Kudielka and Lucas 1961; Luce and Raiffa 1957; Mackay 1956*b*, 1959*a*; Minsky 1956*b*, 1962; Polya 1954, 1954*a*; Popper 1960; Selfridge 1955, 1956; Shannon 1955; Sluckin 1958; Solomonoff 1960; Uttley 1956*a*, 1956*b*, 1956*c*, 1959*a*, 1959*b*; Watanabe 1960; White 1959; Wiener 1949*a*; Zemanek, Kretz, and Angyan 1960

I_2 Grammatical Induction; Abstracting the Form of a Set of Formal Expressions

Brooks, Hopkins, Neumann, and Wright 1957; Chomsky 1959*a*; Miller and Chomsky 1957*a*; Minsky 1956*b*, 1959*a*, 1961*a*, 1962; Newell and Simon 1956*a*; Newman 1959; Selfridge 1955, 1956; Solomonoff 1958, 1959*a*, 1959*b*, 1960; Uhr and Vossler 1961*c*

I_3 Abbreviative Encoding

Andrew 1961; Martens 1959; Pierce 1961; Rosenblatt 1960*a*; Selfridge 1956; Shannon and Weaver 1949*a*; Solomonoff 1958, 1959*a*

I_4 Hypothesis Formation and Confirmation

Amarel 1960; Bruner, Goodnow, and Austin 1956; Chomsky and Miller 1957*b*; Good 1958; Hovland and Hunt 1960, 1961; Hunt 1960*a*; Hunt and Hovland 1960*b*; Kochen 1958*a*; Mackay 1956*a*, 1956*b*, 1961*b*; Miller and Chomsky 1957*a*; Neisser 1960; Newell, Shaw, and Simon 1960*a*; Popper 1960; Solomonoff 1958, 1959*a*; Uhr and Vossler 1961*c*; Watanabe 1960; Weir 1958

I_5 Theories of Inductive Inference

Good 1961*a*; Hayek 1952; Luce and Raiffa 1957; Minsky 1962; Polya 1954, 1954*a*; Popper 1960; Ryle 1949; Solomonoff 1960; Somenzi 1956; Watanabe 1960

I_6 Simplicity and Induction

Burge 1958; Good 1961*a*; Goodman 1951, 1958; Kemeny 1953, 1955*c*; McCarthy 1956; McCulloch 1951*b*; Minsky 1959*a*, 1962; Popper 1960; Shannon 1949*b*; Solomonoff 1957, 1959*a*, 1960

J: Heuristics

Darlington 1958; Feigenbaum 1961*c*; Friedberg 1958; Gyr 1960; Malin 1961

J_1 Discussion of Heuristics for Machine Solution of Problems

Ashby 1956*b*; Berstein *et al.* 1958*a*; Bernstein and Roberts 1958*b*; Bouricius and Keller 1959; Friedberg, Dunham, and North 1959; Gelernter 1959*b*; Gelernter, Hansen, and Loveland 1960*a*; Gilmore 1959, 1960; Holland 1959; Kister, Stein, Ulam, Walden, and Wells 1957; Miller, Galanter, and Pribram 1960; Minsky 1956*b*, 1956*c*, 1961*a*, 1961*b*, 1962; Newell 1955; Newell and Simon 1956*a*; Newell, Shaw, and Simon 1957*a*, 1958*a*, 1958*b*, 1958*c*, 1959*a*, 1960*a*; Newell 1960*b*; Reitman 1959, 1961; Selfridge 1956; Simon 1961*a*; Slagle 1961; Solomonoff 1957; Stein and Ulam 1957; Tonge 1960; Turing 1953; Wang 1960*a*; Wozencraft and Horstein 1960; Martens 1959

J_2 Discussion of Human Problem-solving Heuristics

Ashby 1956*b*; Bernstein *et al.* 1958*a*; Bouricius and Keller 1959; Campbell 1960; Chomsky 1959*a*; De Groot 1946; Duncan 1959; Good 1958; Greene 1959*c*; Hadamard 1945; Humphrey 1951; Johnson 1955; Kochen 1958*a*; McCarthy 1956; McCulloch 1955*c*; Miller, Galanter, and Pribram 1960; Newell 1955; Newell and Simon 1956*a*; Newell, Shaw, and Simon 1957*a*, 1958*a*, 1958*b*, 1958*c*, 1959*a*, 1960*a*; Newell 1960*b*; Newell and Simon 1961*b*, 1961*c*, 1961*d*, 1962; Poincare 1954; Polanyi 1957; Polya 1954, 1954*a*; Reitman 1959, 1961; Simon 1961*a*, 1961*b*; Slagle 1961; Tonge 1960; Vinacke 1962; Wang 1960*a*

K: Theories of Brain Function

Eccles 1953; Householder 1943; Pask 1961; Uhr and Vossler 1961*a*; Wiener 1948; Young 1956

K_1 Connection or Path Reinforcement, Synaptic Facilitation

Andrew 1959*a*; Babcock 1960*a*; Barus 1959; Farley and Clark 1954; Good 1962; Hebb 1949, 1958; Landahl 1962; Minsky 1954*a*; Rosenblatt 1958*a*, 1958*b*, 1962; Willis 1959

K_2 Cell-Assembly Theories

Barus 1959; Clark and Farley 1955; Good 1962; Hebb 1949, 1958; Milner 1957, 1960, 1961*a*, 1961*b*; Minsky 1954*a*; Minsky and Selfridge 1960; Rochester, Holland, Haibt, and Duda 1956; Selfridge 1959

K_3 Other Neurophysiological Models

Angyan 1959; Ashby 1946; Babcock 1960*a*; Barlow 1959; Coburn 1951, 1952; Culbertson 1948; Goldstein 1960; Harmon 1959; Harmon, Levinson, and Van Bergeijk 1962*a*; Hartline 1938; Hebb 1949; Hubel and Wiesel 1959, 1962; Kalin 1960; Kohler 1951; Kubie 1930, 1941; Landahl 1962; Lashley 1942, 1951; Lettvin, Maturana, McCulloch, and Pitts 1959; Marshall and Talbot 1942; McCulloch 1960; Milner 1957, 1960, 1961*a*, 1961*b*; Minsky 1954*a*; Penfield and Rasmussen 1950; Pfeiffer 1955; Pierce and David 1958; Pitts and McCulloch 1947; Precker 1954; Pribram 1959; Rashevsky 1940, 1945*a*, 1946, 1960; Reitman 1959; Rosenblatt 1962; Shimbel 1950; Sholl and Uttley 1953; Sholl 1956; Sperry 1951; Sutherland 1959; Taylor 1956; Uttley 1954, 1955, 1959*b*; Von Foerster 1949; Wall and Melzak 1962; Walter 1953; Wechsler 1960; Young 1956; Zemanek, Kretz, and Angyan 1960

K_4 Comparing Machines and Brains

Ashby 1947*a*; Bremermann 1958; Broadbent 1954; Crozier 1951; Good 1959, 1962; Mackay 1949, 1951, 1952, 1954*b*, 1960*b*, 1962; McCulloch 1949*a*; McCulloch and Pfeiffer 1949*b*; McCulloch 1951*b*, 1955*a*, 1957*a*; Miller, Galanter, and Pribram 1960; Milligan 1959; Von Neumann 1951, 1958; Newell and Simon 1961*b*, 1961*c*, 1961*d*; Pfeiffer 1955; Pitts 1955; Quastler 1957; Sperry 1952; Spilsbury 1952; Taube 1961; Walter 1950, 1951

L: Epistemological Questions

Boring 1946; Craik 1952; Culbertson 1950; Deutsch 1951; Good 1961*b*; Kattsoff 1954; Kemeny 1955*a*; Mackay 1951, 1952, 1954*b*; McCulloch 1945; McCulloch and Pfeiffer 1949*b*; McCulloch 1951*b*, 1955*a*, 1957*a*; Minsky 1961*a*; Newell and Simon 1961*b*, 1961*c*, 1961*d*; Pask 1960*b*; Pask and Von Foerster 1960*c*; Pask 1961; Pitts 1955; Popper 1960; Rosenblueth, Wiener, and Bigelow 1943; Rosenblueth and Wiener 1950; Ryle 1949; Scriben 1953; Turing 1950; Wiener 1948; Wisdom 1952; Young 1956

L_1 What Can a Machine Know?

Booth 1960; Hayek 1952; McCulloch and Pitts 1943; McCulloch 1954; Pask 1959; Skinner 1961; Taube 1961; Turing 1936

L_2 Can Machines Think? Nature of Intelligence

Armer 1961; Ashby 1961*a*; Balescu 1956; Coupling 1950; Good 1959; Kelly and Selfridge 1962; Laing 1962; Lionnais 1957; Mackay 1949, 1962; Mc-

Culloch 1954, 1955*c*; Minsky 1959*a*; Moiseyev 1960; Newell, Shaw, and Simon 1957*a*; Reitman 1962; Rogers 1960; Rosenbloom 1950; Ross 1933; Samuel 1960*b*; Simon 1961*b*; Somenzi 1956; Taube 1960; Troll 1954; Turing 1950; Wang 1957, 1960*a*; Wechsler 1958, 1960; Wilkes 1953, 1956; Williams 1960; Wright 1959

L_3 Free Will in Man and Machines

Boring 1957; Mackay 1960*a*, 1962; McCulloch 1954; Russell 1940; Samuel 1960*b*; Skinner 1961; Turing 1950

L_4 The Mind-Brain Problem

Adrian 1946; Brain 1959; Eccles 1953; Feigl 1959; Gerard 1946; Good 1962; Hayek 1952; Laslett 1950; Mackay 1960*a*, 1962; Mays 1952; Meszar 1953; Ryle 1949; Skinner 1961; Sperry 1952; Thomson and Sluckin 1954*b*; Turing 1950

M: Memory and Information Retrieval

Ashby and Riguet 1961*b*; Fredkin 1960; Newell, Shaw, and Simon 1958*c*; Rosenblatt 1958*b*; Stevens 1951; Wechsler 1960; Young 1956

M_1 Retrieval of Relevant Information

Attneave 1954; Bar-Hillel 1962; Brillouin 1951; Bush 1945; Feigenbaum 1959, 1961*a*; Feigenbaum and Simon 1961*b*; Furst 1949; Green 1961*a*; Kehl, Horty, Bacon, and Mitchell 1961; Luhn 1958, 1959; Miller, Galanter, and Pribram 1960; Minsky 1961*b*; Mooers 1956*a*, 1956*b*, 1959; Newell, Shaw, and Simon 1957*a*; Paycha 1959; Prywes and Gray 1962; Ray and Kirsch 1957; Samuel 1959*a*, 1959*b*; Simmons 1940; Solomonoff 1959*b*; Stevens 1959; Willis 1959

M_2 Reasoning about Stored Information

Green 1961*a*; Lindsay 1961, 1962*a*, 1962*b*; Luhn 1957; McCallum and Smith 1951; McCarthy 1959; Minsky 1961*b*; Mooers 1951*b*, 1956*b*, 1959; Newell, Shaw, and Simon 1958*a*, 1958*b*; Paycha 1959; Stevens 1959; Watanabe 1960

M_3 Human Memory, Psychological Literature

Attneave 1954, 1955; Broadbent 1954; Campbell 1958; Duncan 1959; Ernst 1962; Estes 1960; Feigenbaum and Simon 1961*b*, 1962; Furst 1949; Gibson 1929; Good 1958; Hebb 1958; Kitona 1940; Kochen 1958*a*; Kubie 1930, 1941; Lawrence and Coles 1954; Lawrence and La Berge 1956; McCulloch 1954; Miller 1956*a*, 1956*b*, 1957*b*; Miller, Galanter, and Pribram 1960; Spilsbury 1952; Von Foerster 1949

N: Servomechanisms and Stability Mechanisms, Cybernetics

Ashby 1948, 1956*a*; Belenesku 1958; Berkeley 1949; Braines, Napalkov, and Svechinskii 1959*b*; Bremermann 1958; Couffignal 1959; Feigenbaum 1961*c*; Gabor 1954; Kemeny 1955*a*; Kolman 1960; De Latil 1953; Lyapunov 1960; Mays 1956; Moiseyev 1960; Newman 1958; Pask 1958; Pask and Von Foerster 1960*c*; Pask 1961; Rapoport and Shimbel 1949; Rashevsky 1940, 1960; Rothstein 1954; Russell 1957; Shaginyan 1959; Sluckin 1954; Sobolev, Kitor, and Lyapunov 1958; Sutherland, Mugglin, and Sutherland 1958; Tsien 1954; Weber 1949; Wiener 1958; Wisdom 1951

N_1 Adaptive Control Systems

Andrew 1961; Ashby 1958*b*; Bellman and Kalaba 1958, 1959*a*, 1960*a*; Braines, Napalkov, and Shreider 1959*a*; Eykhoff 1960; Freimer 1959; George 1959*a*; Jakowatz, Shuey, and White 1960; De Latil 1956; Pitts and McCulloch 1947; Reich and Ernst 1960; Russell 1957; Widrow 1959; Wiener 1948

N_2 Teleological Mechanisms

Andrew 1959*a*; Ashby 1952*a*, 1959; Churchman and Ackoff 1950*a*; Deutsch 1951; Elsasser 1958; Klaus 1961; Mackay 1960*b*; Rosenblueth, Wiener, and Bigelow 1943; Rosenblueth and Wiener 1950; Schutzenberger 1954; Wiener 1948

N_3 Automation, Machines, and Society

Ackoff 1955; Beer 1956*b*; Diebold 1952; George 1959*a*; Hugh-Jones 1956; De Latil 1956; Mehl 1959; Merriman, Wass, and Gill 1959; Shubik 1960*b*; Wiener 1948, 1950*a*, 1960

N_4 Cybernetics and Psychiatry, Society, etc.

Ashby 1954; Berg 1960; Kochen and Levy 1956; Kubie 1930, 1941; Lettvin and Pitts 1943; McCulloch 1953; Sutro 1959; Thomson and Sluckin 1954*a*; Weinberg 1951; Wiener 1948

N_5 "Self-organizing" Systems

Ashby 1947*b*, 1952*a*; Babcock 1960*b*; Braines and Napalkov 1960; Pask 1959; Pask and Von Foerster 1960*a*; Pask 1960*b*, 1962; Von Foerster 1949, 1959, 1960

N_6 Homeostasis and Stability

Ashby 1946, 1947*a*, 1950*a*, 1952*a*, 1953, 1956*b*, 1958*b*, 1959, 1962; Cadwallader-Cohen *et al.* 1961; Elsasser 1958; George 1957; De Latil 1956; Pask and Von Foerster 1960*a*; Verbeek 1960*a*; Von Foerster 1949; Wall and Melzak 1962; Weber 1949; Wiener 1948

N_7 Social Organizations

Ackoff 1959; Asch 1952; Beer 1956*b*, 1957, 1961; Blau 1955; Cohen and Cyert 1961; Cyert, Feigenbaum, and March 1959; Davis 1958; Gullahorn and Gullahorn 1962; Homans 1961; Rome and Rome 1959

P: Some Special Categories

Kudielka and Lucas 1961

P_1 Theory of Games (after Von Neumann, 1947)

Ackoff 1959; Blackwell and Girshick 1954; Galanter and Gerstenhaber 1956; George 1957; Luce and Raiffa 1957; Von Neumann and Morgenstern 1947; Pask and Von Foerster 1960*a*, 1960*c*; Shubik 1960*a*, 1960*b*; White 1959

P_2 Statistical Decision Theory

Ackoff 1959, 1962; Adey 1959; Blackwell and Girshick 1954; Galanter and Gerstenhaber 1956; Gold 1959; Highleyman 1961*b*; Kochen 1958*a*; Luce and Raiffa 1957; Marill and Green 1960; Shubik 1960*a*, 1960*b*; Simon 1956*b*; Wald 1950

P_3 Man-Machine Interaction

Bemer 1959; Bush 1945; Craik 1947; Estavan 1959; Galanter 1959; Licklider 1960; Pask and Von Foerster 1960*c*; Taube 1959; Yntema and Torgerson 1961

P_4 Self-reproducing Machines

Burks 1959, 1960; Holland 1962; Jacobson 1958; Kemeny 1955*a*; Lofgren 1958, 1961, 1962; Moore 1956*c*; Von Neumann 1951, 1958; Penrose 1959*a*, 1959*b*

P_5 Game Playing

Ashby 1952*b*; Bernstein *et al.* 1958*a*; Bernstein and Roberts 1958*b*; Byard 1950; De Groot 1946; Good 1959; Hagelbarger 1955; Haldane 1952; Jackson 1960; Kirsch 1954; Kister, Stein, Ulam, Walden, and Wells 1957; Koppel 1952; Luce and Raiffa 1957; Martens 1959; McCulloch 1955*c*; Michie 1961; Newell 1955; Newell, Shaw, and Simon 1958*b*, 1959*c*; Pask and Von Foerster 1960*a*; Pervin 1959; Prinz 1952; Richards 1951, 1952; Samuel 1959*a*, 1960*a*; Selfridge 1956; Shannon 1950*a*, 1950*b*, 1955; Stein and Ulam 1957; Strachey 1952; Turing 1953; White 1959; Wiener 1948

P_6 Music Writing

Brooks, Hopkins, Neumann, and Wright 1957; David 1961; Hiller and Isaacson 1959*a*; Hiller 1959*b*; Kassler 1961; Mathews 1961; Reitman 1961

P_7 Maze Learning

Coupling 1950; Minsky 1954*b*; Moore 1959; Pfeiffer 1952; Shannon 1952; Wallace 1952

P_8 Industrial Applications

Beer 1956*a*, 1956*b*; Blau 1955; Clarkson and Meltzer 1960; Clarkson 1962; Cohen 1960; Cyert, Feigenbaum, and March 1959; Helgeson and Kwo 1956; Jackson 1956; Mitchell 1957; Shubik 1960*a*, 1960*b*

Further Categories

An attempt was made to classify the papers by broader types. This was done hastily and is particularly subject to error. These categories are designated by two-digit numbers.

1. Program status:
   11. No machine experiment involved.
   12. Program for general-purpose computer.
   13. Experiment involving special-purpose hardware.
   14. Uses special programming system.
   15. For practical application.
   16. Psychological experiment.
2. Technical domain:
   21. Mathematical.
   22. Psychological.
   23. (Neuro) Physiological.
   24. Philosophical.
3. Paper type:
   31. Review article.
   32. With extensive bibliography.
   33. Proposed experiment.
   34. Report of experiment.
   35. Tutorial.
   36. General discussion.

BIBLIOGRAPHY

The citations are given in the conventional form except for the inclusion of additional information (e.g., volume *and* number) where it might be useful. Following the citations is the list of descriptors, sometimes in order of importance, but not always. Following the descriptors are occasionally found lists of citations, indicating other papers reporting closely related work. The references to the future are particularly useful, and we regret not including more of this ancestral structure.

When several citations occur in the same published volume, the volume is cited only as one or two bracketed letters, *e.g.*, "in [AD]." The listing of such volumes, useful in itself, is found at the end of the Bibliography. That collection would serve well as a beginning for a library on artificial intelligence.

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