Evolutionary computation has a long history. Unfortunately, this history is virtually unknown to many practitioners in the field. This is a shame, not simply for the handicap that it imposes on the scientific advancement of the field, but also because the history of evolutionary computation is a truly fascinating tale of multiple independent beginnings, ingenious inventions, disappointments, and marvelous successes, often achieved in the face of limited, if not antiquated, computing equipment. It is a story that deserves to be told, heard, and repeated to others.

The word *story* appears in “history,” and rightly so. History is not a mere cataloguing of events or a listing of independent facts and places and writings; and that is particularly so with science. The history of any science cannot be adequately represented by a simple index, perhaps organized chronologically or alphabetically—the most rudimentary of possible orderings. Such listings amount to nothing more than the inventory of a stamp collection and make no real contribution to a greater understanding of the science that underlies each effort.

Although the *Science Citation Index* does not suffice as a historical document, this and other listings of prior art do provide a record—a fossil record—of the endeavor of science. Like the fossil record of natural evolution, they also contain many missing links. An incomplete accounting, unfortunately, is unavoidable: Publications of limited distribution, particularly conference proceedings, often have short lifespans and then vanish with little trace. Eventually, their authors too vanish, and unfortunately the memories of their contribution to the advancement of knowledge die with them. This situation is just now beginning to occur in the field of evolutionary computation; it makes the timeliness of an accurate accounting of the history of this field even more important. Many pioneers in evolutionary computation can still provide firsthand information regarding their facts, data, processes, and the culture in which they worked. Two decades from now, circumstances will be very different and we will need to rely on a record such as that provided by the current volume.

Natural evolution is a historical process: “Anything that changes in time, by definition, has a history” (Mayr, 1982, p. 1). And the essence of evolution is change. Evolution is a dynamic, two-step process of random variation and selection (Mayr, 1988, pp. 97–98) that engenders constant change to individuals within a population in response to environmental dynamics and demands. Individuals who are poorly adapted to their current environment are culled from the population. The adaptations that allow specific individuals to survive are heritable, coded in a complex genetic milieu that is passed on to successive progeny. Thus, adaptations are a historical sequence of consecutive events, each one leading to the next. The converse, however, is also true: History itself is an evolutionary process, not just in the sense that it changes over time but also in the more strict sense that it undergoes mutation and selection.

The situation is not unlike the child’s game of *telephone*. Several children are needed to play. An initial message, perhaps provided by a teacher, is sent from one child to another, whispered in the ear, then passed along again in sequence. Each child can only hear what the last child whispers. The message is subject to mutation at each step, occasionally by accident, sometimes with devious intent. At last, the final student divulges the message that he or she heard, as it was understood. This “mutant” message is then compared to the actual message, revealed by the teacher. In effect, the teacher applies a form of selection to restore the original message. And so it is with history: “Written histories, like science itself, are constantly in need of revision. Erroneous interpretations of an earlier author eventually become myths, accepted without question and carried forward from generation to generation” (Mayr, 1982, p. 1).

The aim of this volume, then, is to perform the function of selection on what has mostly been a process of mutation. Such error correction is surely needed for the conventional accounting of the history of evolutionary computation is more of a fable or science fiction than a factual record. Readers only casually acquainted with the field may be surprised to learn, for
example, that the idea to use recombination in population-based evolutionary simulations did not arise in a single major innovation (cf. Mitchell, 1996, p. 3; Levy, 1992, p. 169) but in fact was commonly, if not routinely, applied in multiple independent lines of investigation in the 1950s and 1960s. It may also be of interest that the prospects of using computers to study "life-as-it-could-be" (i.e., artificial life) rather than "life-as-we-know-it" were plainly clear to population geneticists and evolutionary biologists in the same time frame (cf. Waldrop, 1992, p. 200). Many supposedly recent inventions (e.g., the use of more than two parents to generate offspring, the evolution of neural networks, the coevolution of individuals in a population) actually occurred more than 30 years ago. By unearthing these scientific fossils here, I hope both to revive interest in many of these long-forgotten works simply for the fact that they exist and to reawaken investigation into avenues of scientific inquiry that have been hibernating far too long.

All historical accounting is necessarily subjective. While compiling this record, I have made several judgments as to which papers merit reprinting. Ultimately, the papers selected met one or more of the following criteria: (1) They offered a first or very early attempt at a specific approach, (2) they had a significant impact on the future development of the field, (3) they could have had a significant impact had they received due attention, (4) they represented a key turning point in the field, or (5) I found them to be personally interesting. With only two exceptions, no papers more recent than five years from the publication of this volume were chosen; I felt that later papers had not been allowed the time to "fossilize" yet. Assuredly, several such candidate papers will enter in future editions of this work.

There were two other criteria: I had to be able to both find and read the paper. No doubt, despite the assistance of colleagues, significant research in simulated evolution from the former Soviet Union and other countries remains to be discovered.

With the exception of the information in the first chapter, the fossil record presented here begins in the 1950s and progresses forward through time, concluding with more contemporary research. This chronology reveals the multiple independent efforts in evolutionary computation in light of the state-of-the-art at the time those contributions were offered. In some cases of very closely related work, multiple papers from different periods have been reprinted in a single section; yet there are strong connections among several papers separated by many chapters and, thus, possibly decades of time. The index provided at the back of the volume should aid the reader in finding common threads among these various instances, while the original material that introduces each section places the reprinted works in the context of prior art and subsequent evolution.

I have had the good fortune to know many of the pioneers in evolutionary computation. Several related personal anecdotes and helped review the editorial introductions to their own contributions, as well as offered comments on the overall content. In addition, many colleagues reviewed portions of this work, while a few generous friends scrutinized it in its entirety. In particular, thanks are owed to Russell Anderson, Jim Antonisse, Wirt Atmar, Robert Axelrod, Thomas Bäck, Peter Bienert, William Bovassett, George Box, George Burgin, Michael Conrad, Frank Cornett, Michael Cramer, Jason Daida, Lawrence Davis, Don Dearholt, Bill Dress, George Dyson, Tom English, Larry Ersay, Lawrence Fogel, Anne Fraser, Alex Fraser, Richard Friedberg, George Friedman, Roman Galar, Joseph Goguen, David Goldberg, John Greferstotte, John Holland, Howard Kaufman, John Koza, Michael Lyle, Bob Marks, Zbigniew Michalewicz, Javier Montez, Heinz Mühlenbein, James North, Martin Nowak, Al Owens, Howard Pattee, Fred Petry, Martin Pincus, Bill Porte, Tom Ray, Ingo Rechenberg, Michel Rogson, Ron Root, Hans-Paul Schwefel, Michele Sebag, Rob Smith, Steve Smith, Robert Toombs, and Lotfi Zadeh. I'm especially grateful to Joe Felsenstein for providing an exhaustive listing of efforts to use computer simulation in genetic systems from the 1950s to the 1970s; to Antanas Zilinskas for providing several references to Russian literature along with English translations; to my brother, Gary, not only for his careful review of the text, but for spending many hours assisting me in digging up old papers in the library; to Jacquelyn Moore for helping me locate several pioneers in evolutionary computation; and to Pete Angeline, who not only helped improve the exposition but framed its concept with me over a period of two years. I also appreciate the assistance of John Griffin, Marilyn Giannakouros, Denise Phillip, Mark Morrell, and Karen Hawkins at IEEE Press.

Hans Bremermann, a recipient of the Lifetime Achievement Award from the Evolutionary Programming Society, died in early 1996, but I was fortunate that he was able to review the relevant material in his section before his death. I regret not being able to show him the finished product. I also regret not being able to learn firsthand about the efforts of several other pioneers, including Nils Barricelli, Woody Bledsoe, Bradford Dunham, Gordon Pask, and Jack Walsh. I hope they would be pleased.

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References


