The Contributions of John Henry Holland

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Model building is the art of selecting those aspects of a process that are relevant to the question being asked. As with any art, this selection is guided by taste, elegance, and metaphor; it is a matter of induction, rather than deduction. High science depends on this art.

- John H. Holland

John Henry Holland (1929 - 2015) was a longtime professor of computer science, engineering, and psychology at the university of Michigan. Holland was also one of the first to get a PhD in what later became computer science in 1959.

Complex Systems and Genetic Algorithms

John Henry Holland was fundamental in the development of Michigan's center for the study of complex/nonlinear systems, and what will eventually be known as genetic algorithms. In the mid-1960's, John developed the programming technique known as the genetic algorithm, which was able to "evolve" in ways that resemble natural selection.

Genetic Code
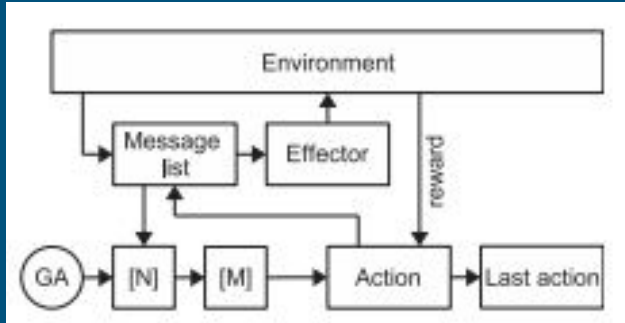
Holland worked on creating a genetic "code" that would represent the structure of any computer program, which eventually became his *classifier* system.

Classifier System

- Consists of a set of rules, each performing particular actions every time its conditions are satisfied by some piece of information
- Represented with strings of bits, the number '1' if the characteristic is present, '0' if not present, and '*' for undetermined.
- The system starts with randomized strings of 1's and 0's, and rates them based on the quality of their result.
- High-quality strings 'mate' while low-quality strings perish, and then the process is repeated.

Implicit Parallelism

Within Holland's genetic algorithms, a single string belongs to *all* of the regions in which its bits appear.

- Example: The string 11011001 is a member of many regions including 11******, 1******1, **0**00*, and so on.

Because of this, it allows the system to test multiple regions while manipulating relatively few strings. This characteristic is called *implicit parallelism*, which gives genetic algorithms and this classifier system an advantage over other problem-solving processes.

Modern day uses of Genetic Algorithms

- Financial mathematics
- Bug detection
- Image processing
- File allocation
- Neural Networks
- Mechanical Engineering
- Medical Science (RNA structure prediction, protein prediction, etc.)
- Many more…

Emergence

Holland's work on genetic algorithms supports other research within the field of artificial intelligence emphasizing how lower-order activities are the building blocks for higher-level phenomenon. Holland argued that the complex physical systems are not the product of abstract rules but the consequences of diverse agents and their interactions in the world.

Sources

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