

Evolutionary Computation

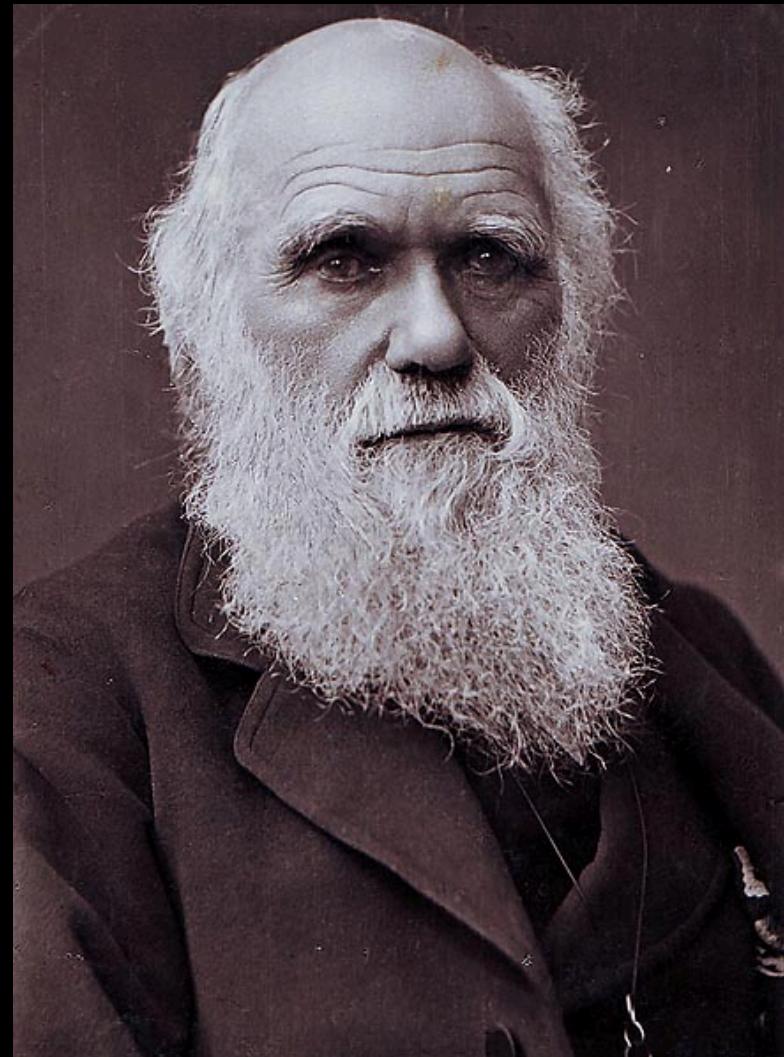
Stephanie Forrest

External Professor, Santa Fe Institute
Computer Science Professor, Arizona State University



Basic Principles of Evolution

- Random variation
- Selection
- Inheritance

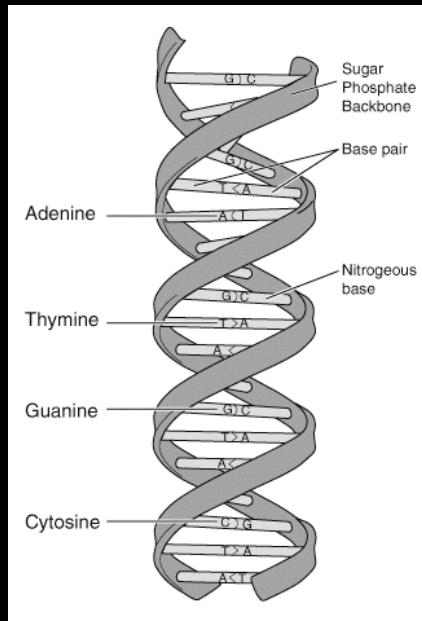


What are the genetic representations?

- Discrete units (genes)
- Genotype vs. phenotype
- Information stored in a linear array



Mendel (1865)



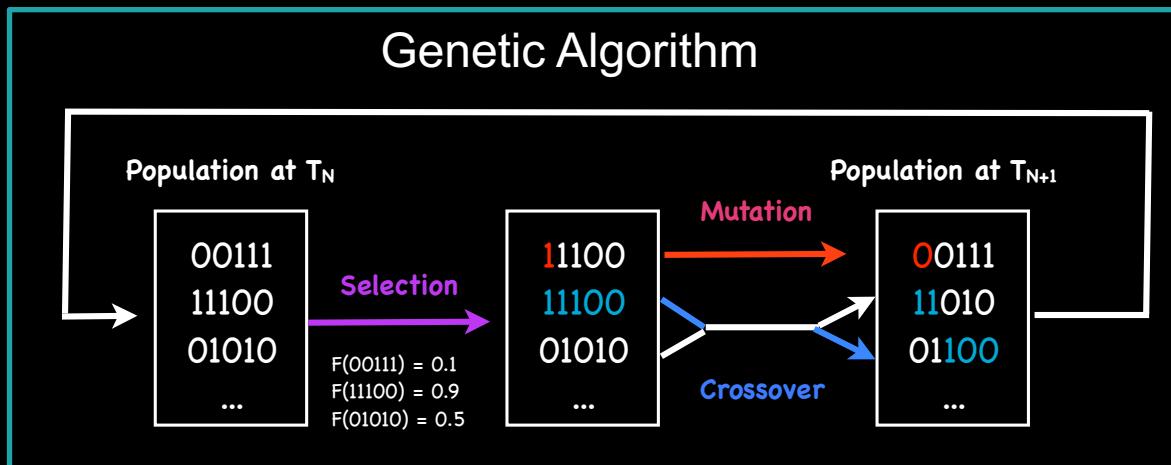
Crick & Watson (1953)

Darwinian evolution in a computer

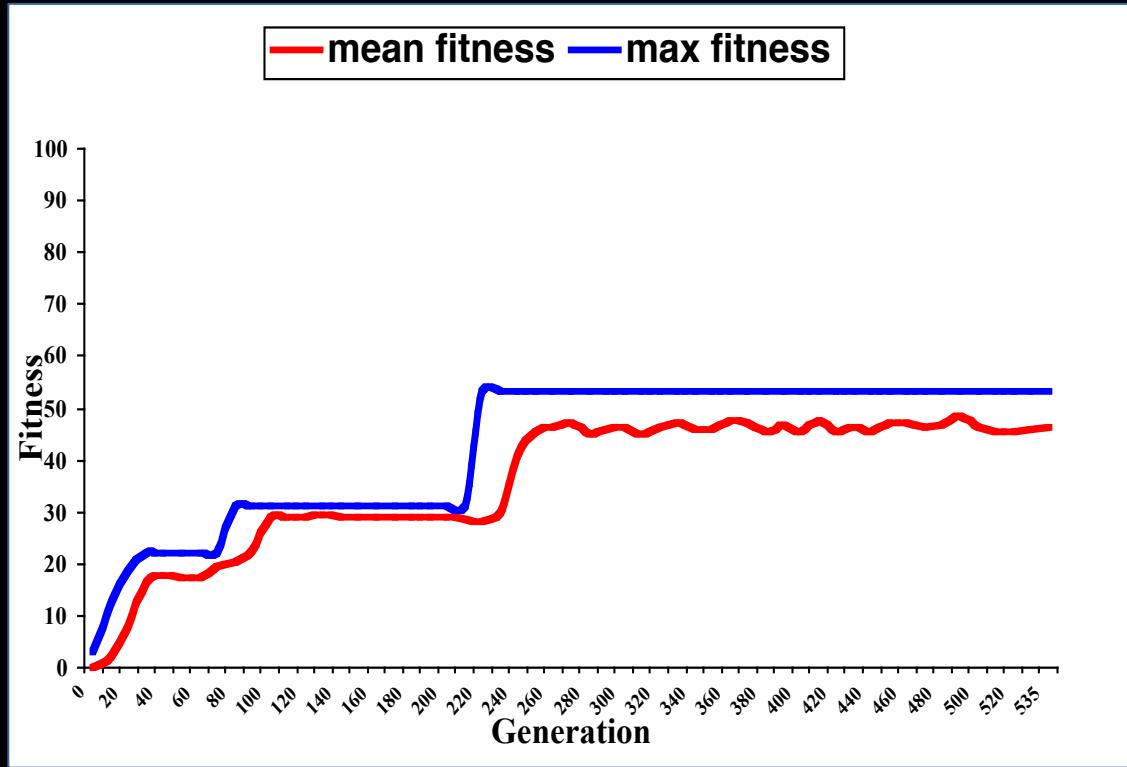
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Holland (1962)

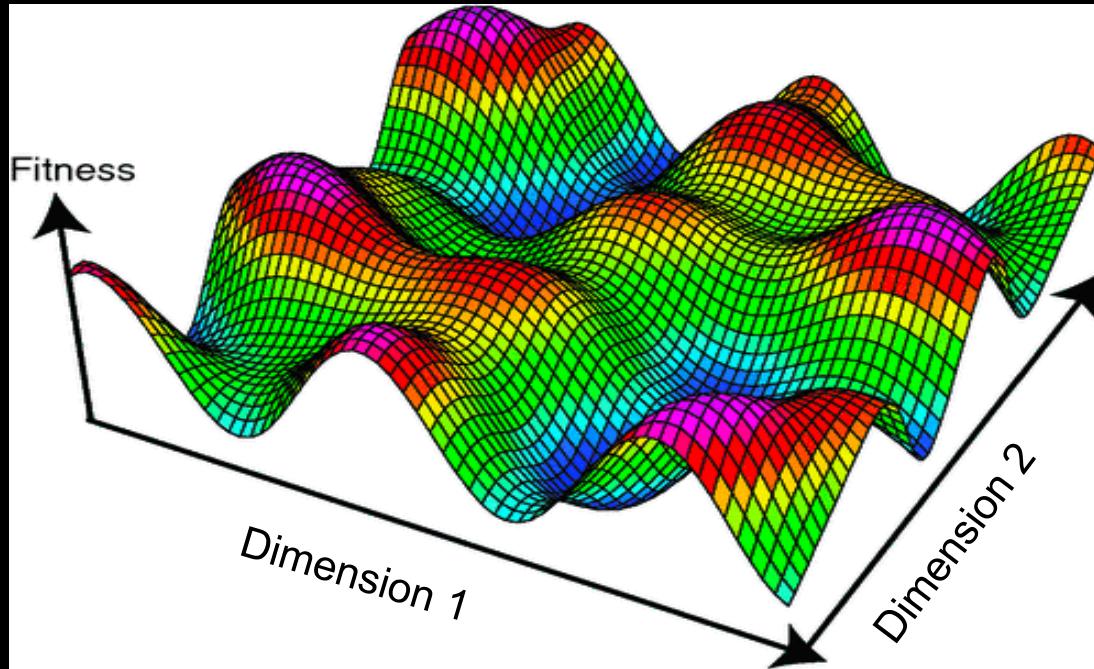


Example Performance Curve



Applications

- Engineering
 - Multi-parameter function optimization



Charles R. Marshall (2014)

Function Optimization

$$F(x, y) = yx^2 - x^4$$

$$\begin{array}{r} 0\ 0\ 1 \\ \backslash\backslash \\ 1 \end{array} \quad \begin{array}{r} 1\ 0\ 1 \\ \backslash\backslash \\ 5 \end{array} \quad \text{Base 2}$$

Base 10

$$F(001111) = F(1,5) = 5 \cdot 1^2 - 1^4 = 4$$

Origins

- Genetic Algorithms (Holland, 1962)
- Evolutionstrategie (Rechenberg, 1965)
- Evolutionary Programming (Fogel et al., 1966)
- Genetic Programming (Koza, 1992)
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Further Reading

- An Introduction to Genetic Algorithms
Melanie Mitchell, MIT Press 1996

Introduction to Evolutionary Computing
A.E. Eiben and J.E. Smith, Springer 2015

Adaptation in Natural and Artificial Systems: An Introductory Analysis
with Applications to Biology, Control and Artificial Intelligence
J. H. Holland, MIT Press 1992

S. Forrest. Genetic algorithms: principles of natural selection applied
to computation. *Science*, 261:872–878, Aug. 1993.

References

- Hardesty, L. Automatic Bug Repair. *MIT News*. 2015.
- Ma S, Kemmeren P, Gresham D, Statnikov A (2014) *De-Novo Learning of Genome-Scale Regulatory Networks in *S. cerevisiae**. PLoS ONE 9(9): e106479. <https://doi.org/10.1371/journal.pone.0106479>
- Marshall Charles R. (2014) The evolution of morphogenetic fitness landscapes: conceptualising the interplay between the developmental and ecological drivers of morphological innovation. *Australian Journal of Zoology* 62, 3-17.