Introduction to Neural Networks

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Module 6.3: Genetic Algorithms

This Sub-Module …

- Briefly describes some of the history behind the development of genetic algorithms (GAs).

- Describes the basic ideas behind genetic algorithms.

- Implementation generally involves a few types of 'operators' inspired by biological systems

Genetic Algorithms

- Another metaphor for random search.
- Based on biological evolution.
- Analogies to biological mechanisms of sexual selection.
  - Chromosomes/Genes/DNA: solution schema
  - Combining DNA: crossover operation
  - Mutation: mutation operator
  - Natural Selection: fitness function

GA -- History

- Invented by Holland (1960s).
- Schema theorem developed in 1975.
- Many implementations, possibilities, and applications.
- One of the most useful global optimization technique.

Crossover Operator

5 3 3 | 7 6 0 2 1 1 6   7 8 6 | 3 1 1 9 4 6 3

5 3 3 | 3 1 1 9 4 6 3

7 8 6 | 7 6 0 2 1 1 6
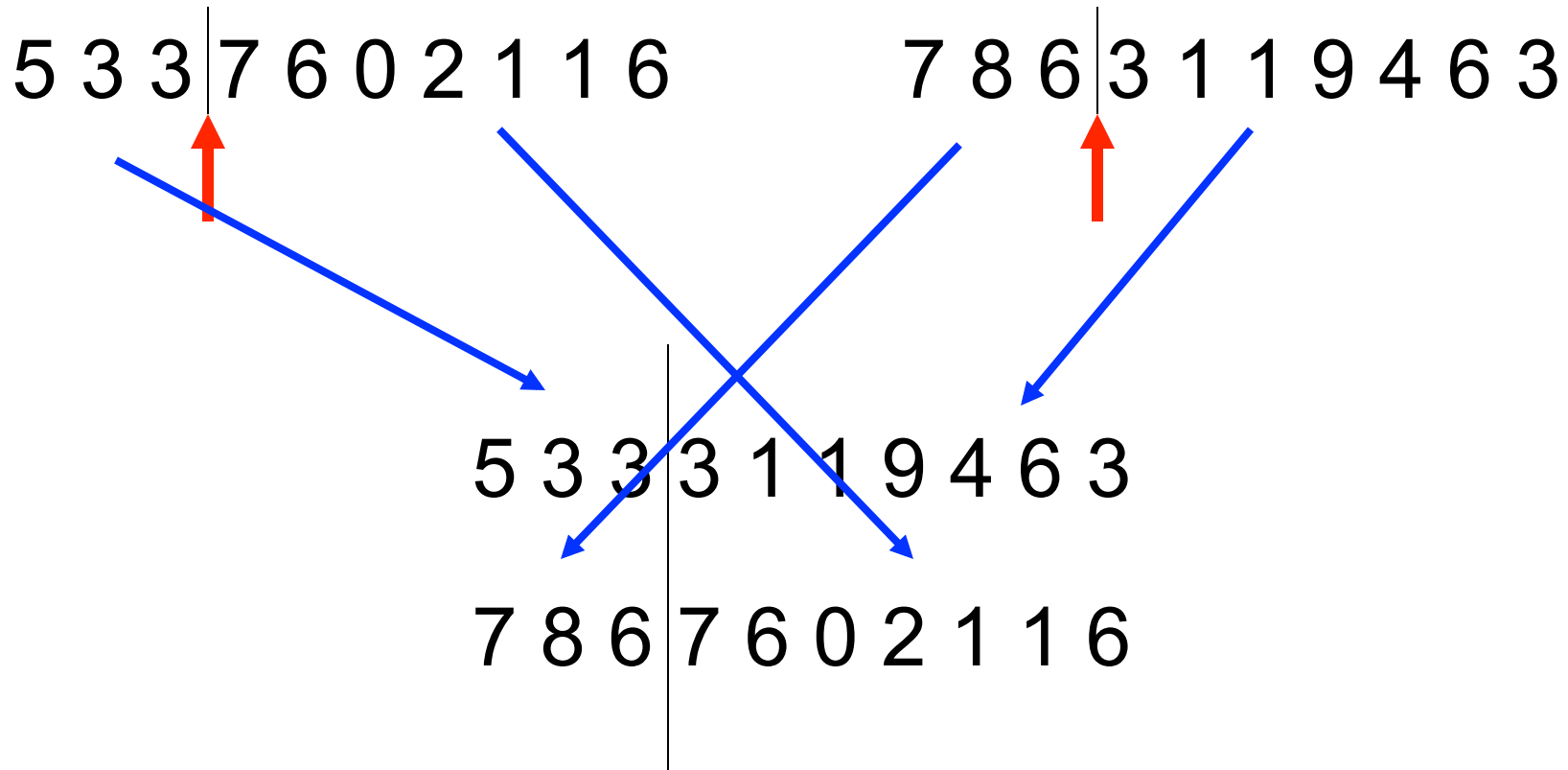
Two new "children" (solutions).

Mutation Operator

5 3 3 3 1 1 9 4 6 3

5 3 3 3 1 1 5 4 6 3

Natural Selection via Fitness Operators

- Once new children are created, a *fitness operator* is applied to all population members.

- Those members that rank high enough in fitness value, are kept for another generation of crossover and mutation operations.

- Those members that do not rank sufficiently high are "deleted".

Implementation Issues

- Crossover operators
  - Many different operators possible
  - *E.g.,*   3 5 1 1 6 7 9 9 0 5 5 3 2

- Mutation operators
  - Different probability values
  - Different functional dependencies
- Fitness operators
  - Different scaling functions

Conclusion

- We've looked at two meta-heuristics inspired by nature.
  - Simulated Annealing: Thermodynamics and Statistical Mechanics
  - Genetic Algorithms: Evolution and Natural Selection
- More metaphors exist
- Many many research papers about on these topics.
- They can be applied to neural networks.