Genetic Algorithms

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Introduction

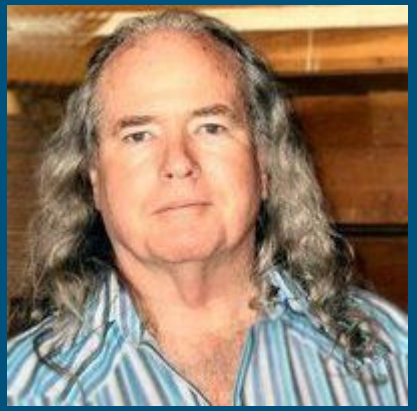
- Overview of Genetic Algorithms
- History of Genetic algorithms
- In Depth look at 3 algorithms
- Applications of Algorithms
- Conclusion and Future of Genetic algorithms

Overview

- Genetic Algorithms are algorithms that are based on processes in nature such as evolution, natural selection.
- The basic idea genetic algorithms is best shown in the evolutionary algorithm
  - Stochastic variation operators: crossing over and mutation
  - Mimics natural selection, over generations the optimal solution will emerge
- There are many different kinds of genetic algorithms because of the No Free Lunch Theorem
  - If an algorithm if very well suited to performing a specific task, it must be not well suited to performing other tasks.

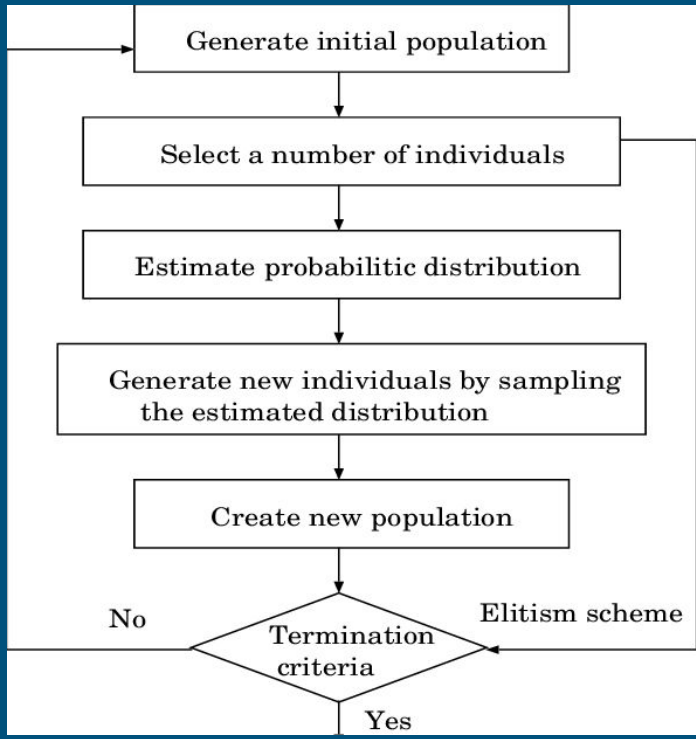
History

- Genetic Algorithms - Proposed by Holland in 1975
- Memetic Algorithms - Proposed by Moscato in 1989
- Estimation of Distribution Algorithms - Proposed by Mulhenbein and Paaß in 1996
- Particle Swarm Optimization - Proposed by Kennedy and Eberhart in 1995



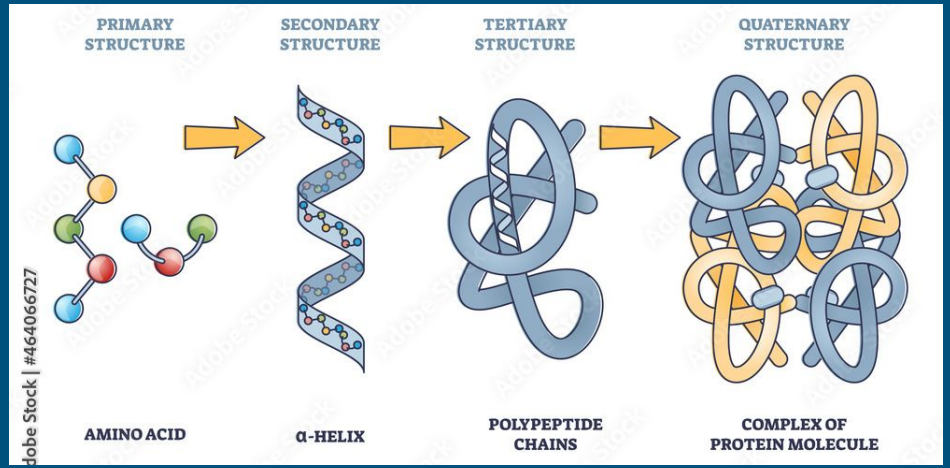
Estimation of Distribution Algorithms

- Variation on the standard Genetic Algorithm
- Lacks the Stochastic Operators of crossing over and mutation
- New population is created by sampling from the traits of the most fit solutions.



Application: Protein Structure Estimation

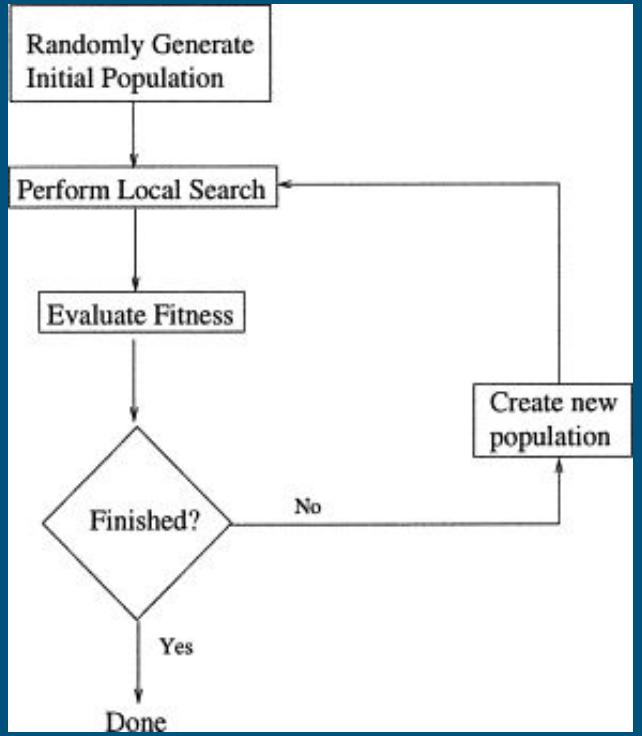
- There is an EDA built into the Rosetta software suite called EdaRose.
- Is able to predict what the structure of a protein might be given its sequence.
- The ability to predict these structures could help us better understand when and proteins become dysfunction which is associated with cancer.



Rosetta Commons

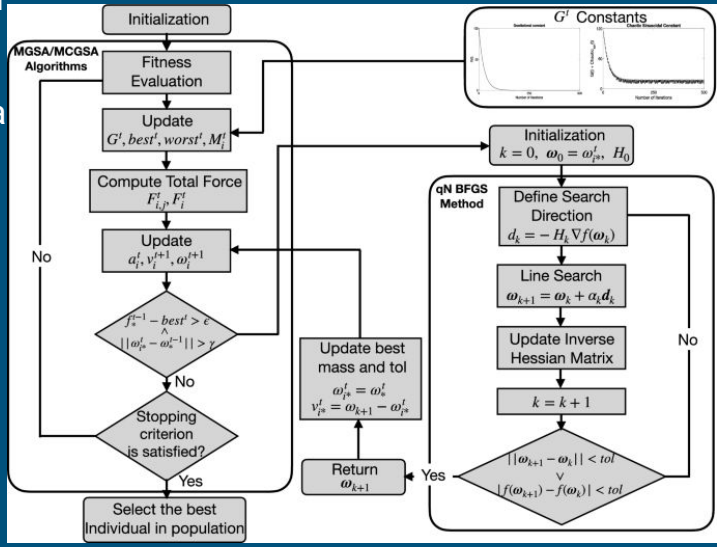
Memetic Algorithms

- Based on the Philosophical concept of Memes and the Anthropological concept of cultural evolution
- Solutions are broke down into memes which perform a local search on sub-objectives
- The most optimal memes are combined to create solutions.
    - Must be careful how these parts interact



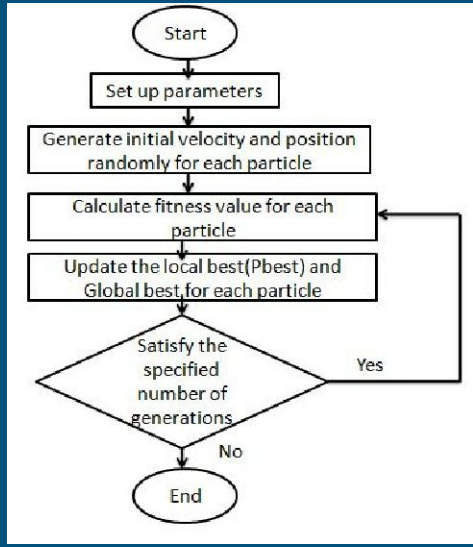
Application: Neural Network Training

- Back propagation is one of the most popular Neural network training methods
  - Drawbacks: Slow Convergence, getting stuck in local optima
- Memetic Chaotic Gravitational Search Algorithm
  - Off-shoot of the memetic algorithm
  - Worse solutions are drawn toward more optimal solutions(Gravity)
  - Randomization operator to prevent being stuck in local optima(Chaotic)
  - Performed on the parts of the solutions, evaluated against sub-objectives(Memes)
- Out Performed BackPropagation in XOR, classification, function adjustment.



Particle Swarm Algorithms

- Based on the movements of swarms of insects or flocks of birds.
- Each solution will accelerate in the direction of their personal best and the global best
- Increases the exploration of solutions that are similar to the most optimal solutions to potentially find even better ones.
- Velocities are constrained over time to reduce exploration and promote exploitation.



Application: Electromagnetic Engineering

- Many optimization algorithms used within electrical engineering have issues becoming trapped in local optima
- Mutated Quantum-Behaved Particle Search Optimization
  - Instead of velocity, particle positions are found using a probabilistic function based on quantum mechanics, prevents being trapped in local optima.
  - Mutation allows for even more exploration.
- Tested against other algorithms to find the most optimal circuit construction
  - Found the most optimized solution.
  - Ran most efficiently.

The Future and Conclusion

- The Performance of many genetic algorithms struggle with scalability.
- There will continue to be a need to develop more and more Genetic algorithms as time goes on due to the No Free Lunch Theorem,
- There are so many processes within the natural world

Sources

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