1-1 Meeting

Master in Computer Science

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Short Term Goals

- Read papers on optimization with genetic algorithms
  - If it is already and how being used for maintenance
- Read papers on Artificial Life
- Thinking about problems that can be used in research

Optimization and Evolutionary Algorithms

- An optimization problem, in a basic form, consists of solving the task of maximizing or minimizing a real function by choosing values from a pool of possible solution elements (vectors) according to procedural instructions provided for the algorithm;
- Evolutionary approaches usually follow a specific strategy with different variations to select candidate elements from population set and apply crossover and/or mutations to modify the elements while trying to improve the quality of modified elements;
- These algorithms can be applied to several problemas of optimization and be performed in any programming language;
- Three of principals algorithm are:
  - Genetic Algorithm;
  - Differential Evolution Algorithm;
  - Particle Swarm Optimization Algorithm.

Genetic algorithm

- Based on natural selection and genetics;
- Each individual represents a solution in search space for given problem;
- Each individual is one vector (chromosome) of components (genes);
- The individuals with better fitness scores are selected who mate and produce better offspring by combining chromosomes of parents;
- Operators:
  - Selection Operator: Preference to the individual with good fitness scores;
  - Crossover Operator: Individual selected by selection operator has their genes exchanged in crossover sites chosen randomly, creating new individual;
  - Mutation Operator: It is insert randomly genes in offspring, thus ensuring diversity in the population.
- Algorithm:
  - Initialize populations;
  - Determine fitness of population;
  - Select parents;
  - Crossover and generate new population;
  - Perform mutation on new population;
  - calculate fitness for new population.

DE (Differential Evolution) algorithm

- It is a population-based algorithm originated in natural slection mechanism;
- Use a very effective mutation process based on the difference of randomly selected vector pairs. In contrast to the GA that runs on the basis of previously defined, probability distribution function;
- It does not need informations about the derivatives;
- Algorithm:

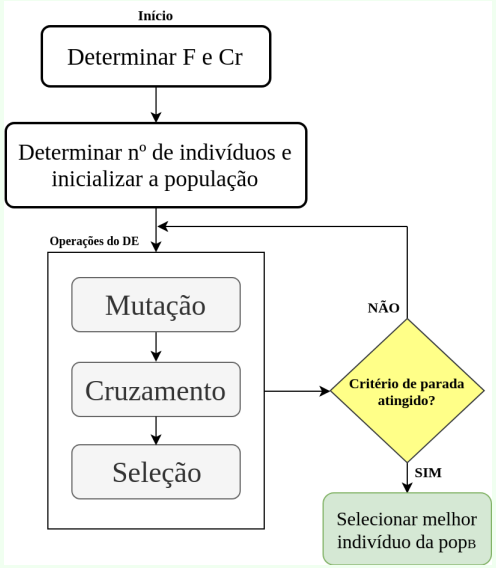

Figura 1: DE

PSO (Particle Swarm Optimization) algorithm

- Based on groups of birds and schools of fish;
- Each particle has associated a position, velocity and fitness value;
- Each particle has associated a best historical position and fitness value;
- Some particle has associated a best position and fitness value in all group;
- Algorithm:
  - Initialize population with positions, velocities and fitness values;
  - Compute new velocity of ith particle with $vell_i = w * vell_i + c1 * (bPosl_i - posl_i) + c2 * (bPosG - posl_i)$;
  - Compute new position of ith particle with $posl_i = posl_i + vell_i$;
  - Update the best historical position and fitness of each particle;
  - Update the best position and fitness value of the group.

References

- https://medium.com/@shubham.k.dokania/evolutionary-algorithms-i-differential-evolution-4d60b8f4e79b
- https://www.slideshare.net/ABilalzcan/differential-evolution-algorithm-dea
- https://www.geeksforgeeks.org/genetic-algorithms/
- https://www.geeksforgeeks.org/particle-swarm-optimization-pso-an-overview/

Implementation of GA, DE and PSO algorithm in Python

- Google colabs:
  - GA: `https://colab.research.google.com/drive/10Fof6_zMYrctmX-43B9Lz3NfgamhUfSU`
  - DE: `https://colab.research.google.com/drive/1XVwqUWYNF8tR7OFkhyYHsKOtV-v4S_6x`
  - PSO: `https://colab.research.google.com/drive/1en8OkvNXi2FlZzgjw5jsM1NaKOEw7PJw`

Resume paper: Genetic Algorithm Optimization Applied to Electromagnetics: A Review

- RESUME: `https://github.com/mascarenhasav/master/blob/main/research/resume_paper_MascarenhasAV_202220691.pdf`
- REFERENCE: D. S. Weile and E. Michielssen, ”Genetic algorithm optimization applied to electromagnetics: a review,” in IEEE Transactions on Antennas and Propagation, vol. 45, no. 3, pp. 343-353, March 1997, doi: 10.1109/8.558650

Studies on the schemata theory

- Paper: Genetic Algorithm Based on Schemata Theory
- REFERENCE: `https://www.intechopen.com/chapters/15615`

Start using DEAP library

- I had some problems to implement, and ended up not being able to solve the problems

Implementation of GA with DEAP lib to solve problems

- Google colab: `https://colab.research.google.com/drive/1TPHMEdOCdCV4wrp6yC-8Ie2ws0dVlBfC#scrollTo=HsBEQKhZW0u7`
- Basead on the paper: DEAP: A Python Framework for Evolutionary Algorithms
- REFERENCE: `https://www.researchgate.net/publication/235707002_DEAP_A_Python_framework_for_Evolutionary_Algorithms`