

Genetic Algorithms

1. A genetic algorithm (GA) for optimization is most likely to succeed given

- A. a small population of fit and similar individuals.
- B. a large population of fit and similar individuals.
- C. a small diverse population of fit individuals.
- D. a large diverse population of fit individuals.

2. The Fitness Function in Genetic Algorithms is

- A. method to measure how fit a candidate solution is in solving the problem.
- B. the objective function for the optimization problem being solved.
- C. a substitute to approximate the survival abilities of individuals in nature.
- D. a least squares approximation for a polynomial.

3. The basic idea behind Genetic Algorithms is to work with a population

- A. of problem solvers that interact with each other through signs.
- B. of candidate solutions to try and create better candidates by mixing genes.
- C. of candidate solutions in which each candidate is heuristically refined.
- D. of problem solvers each of which does an independent heuristic search.

4. Genetic Algorithms are

- A. a class of algorithms that try and build solutions by introducing evolution and selection of the best in a population of candidate solutions
- B. Methods, based on the theory of natural selection and evolutionary biology, for solving optimization problems.
- C. methods for genetically modifying ants to do ant colony optimization
- D. a heuristic search method used in artificial intelligence and computing.

5. The Fitness Function in Genetic Algorithms is

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7. An optimization problem is stated as follows:

maximize $f(x, y) = x^2/2 + 125/y^2$ where $x, y \in \mathbb{R}^+$

The above optimization problem comes under the category of

- A. Unconstrained optimization problem.**
- B. Linear optimization problem.
- C. Integer value optimization problem.
- D. Real value optimization problem.

8. Which of the following(s) is/are the pre-requisite(s) when Genetic Algorithms are applied to solve problems?

- (i) Encoding of solutions.**
- (ii) Well-understood search space.
- (iii) Method of evaluating the suitability of the solutions.**
- (iv) Contain only one optimal solution.

- A. i and ii only.
- B. ii and iii only.
- C. i and iii only.**
- D. iii and iv only. Wrong

9. Roulette wheel selection scheme is preferable when

- A. Fitness values are uniformly distributed**
- B. Fitness values are non-uniformly distributed.
- C. Needs low selection pressure
- D. Needs high population diversity

10. Which GA operation is computationally most expensive?

- A. Initial population creation
- B. Selection of sub population for mating
- C. Reproduction to produce next generation
- D. Convergence testing

11. Which of the following is not true for Genetic algorithms?

- A. It is a probabilistic search algorithm
- B. It is guaranteed to give global optimum solutions
- C. If an optimization problem has more than one solution, then it will return all the solutions
- D. It is an iterative process suitable for parallel programming

12. The basic idea behind Ant Colony Optimization algorithms is to work with a population

- A. of problem solvers that interact with each other through signs
- B. of candidate solutions to try and create better candidates by mixing genes.
- C. of candidate solutions in which each candidate is heuristically refined.
- D. of problem solvers each of which does an independent heuristic search.

13. Genetic algorithms are example of

A: heuristic

B: Evolutionary algorithm

C: ACO

D: PSO

14. Parameters that affect GA

A: initial population

B: selection process

C: fitness function

D: all of these

15. The basic idea behind Ant Colony Optimization algorithms is to work with a population

A :of problem solvers that interact with each other through signs

B :of candidate solutions to try and create better candidates by mixing genes.

C :of candidate solutions in which each candidate is heuristically refined.

D :of problem solvers each of which does an independent heuristic search.

16. EV is dominantly used for solving .

A: optimization problems

B: NP problem

C: simple problems

D: none of these

17. **EV is considered as?**

A: adaptive

B: complex

C: both a and b

D: none of these

18. **Fitness function should be**

A: maximum

B: minimum

C: intermediate

D: none of these

19. **Applying recombination and mutation leads to a set of new candidates, called as ?**

A: sub parents

B: parents

C: offsprings

D: grand child

20. **Which of these emphasize of development of behavioral models?**

A: Evolutionary programming

B: Genetic programming

C: Genetic algorithm

D: All the mentioned

21. Produces two new offspring from two parent string by copying selected bits from each parent is called

- (A) Mutation
- (B) Inheritance
- (C) Crossover**
- (D) None of these

22. Genetic operators includes

- (A) Crossover
- (B) Mutation
- (C) Both A & B**
- (D) None of these

23. GA techniques are inspired by _____ biology.

- (A) Evolutionary**
- (B) Cytology
- (C) Anatomy
- (D) Ecology

True& false

wer

1. Optimization is the process of finding the conditions that give the minimum or maximum value of a function, where the function represents the effort required or the desired benefit. **T**
2. A search space is the set or domain through which an algorithm search. **T**
3. The idea of selection phase is to select the worst individuals and let them pass their genes to the next generation. **false** the best
4. Parent Selection is the process of selecting parents which mate and recombine to create off-springs for the current generation **false next** next
5. Random selection In this strategy we randomly select parents from the existing population. **T**
6. Coevolution is the process of reciprocal evolutionary change that occurs between pairs of species or among groups of species as they interact with one another. **T**
7. Optimization and robustness are weakly related in terms of a common objective, which is to achieve some improvement **false** strongly
8. Robustness is the ability of a computer system to cope with errors during execution and cope with erroneous input **true**
9. Size optimization where the aim is to find the optimal dimensions of the structural components. **true**

10. Shape optimization where the shape of the structure is parameterized and these parameters are optimized. **true**
11. Topology optimization where the optimal spatial distribution of structural material or structural components is determined. **true**
12. Homogenous population - a population whose every element is **diffrent** regarding the variables required for the research **false similar**
13. Chromosomes thread-like structures located inside the nucleus of organism. **True**
14. Self-learning algorithms for a Static **directed** search suggest the restructuring of the probabilistic characteristics of the search **false random**
15. Simulations, similarly as dreams for humans, can play a fitness-enhancing role for cognitive robots **T**
16. Optimization the process of finding the conditions that give the minimum or maximum value of a function, where the function represents the effort required or the desired benefit. **True**
17. Robustness is the ability of a computer system to cope with errors during execution and cope with erroneous input. **True**
18. Alleles is different possible settings for a trait. **true**
19. Locus is the position of each gene is located at a particular. **true**
20. Genome is The complete collection of genetic material. **true**

- 21. Genotype is The particular set of genes contained in a genome. true ✓
- 22. Diploid is the chromosomes are arrayed in pairs. True ✓
- 23. Fitness landscapes or adaptive landscapes are the set of all possible genotypes, their degree of similarity, and their related fitness values. True ✓
- 24. Mutation is a genetic operator used to maintain genetic diversity from one generation of a population of chromosomes to the next. true ✓

➤ the idea of selection phase.



The idea of selection phase is to select the fittest individuals and let them pass their genes to the next generation.

Two pairs of individuals (parents) are selected based on their fitness scores.

Individuals with high fitness have more chance to be selected for reproduction

➤ A fitness function.

A fitness function is a particular type of objective function that is used to summarize, as a single figure of merit, how close a given design solution is to achieving the set aims. Fitness functions are used in genetic programming and genetic algorithms to guide simulations towards optimal design solutions.

➤ Crossover.

✓ Two parents produce two offspring : ✓

The chromosomes of the two parents are copied to the next generation ✓

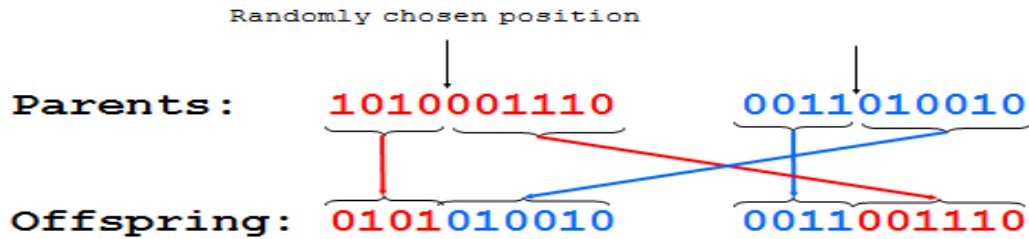
The two parents are randomly recombined (crossed-over) to form new offspring.

Types of crossover

- One-point crossover

ONE-POINT CROSSOVER

- Randomly one position in the chromosomes is chosen ✓
- Child 1 is head of chromosome of parent 1 with tail of chromosome of parent 2 ✓
- Child 2 is head of 2 with tail of 1 ✓



-Two-point crossover

Parents: 1010001110 0011010010

Offspring: 1010010010 0011001110

-Uniform crossover

- A random mask is generated
- The mask determines which bits are copied from one parent and which from the other parent
- Bit density in mask determines how much material is taken from the other parent (takeover parameter)

- **Mask:** 0110011000 (Randomly generated)
- **Parents:** 1010001110 0011010010
- **Offspring:** 0011001010 1010010110

➤ Evolutionary Algorithm

Algorithm 1.1 Pseudo-code of an Evolutionary Algorithm

1. $P \leftarrow \text{GenerateInitialPopulation}();$
 2. $\text{Evaluate}(P);$
 3. **while** $\text{!StopCondition}()$ **do**
 4. $P' \leftarrow \text{SelectParents}(P);$
 5. $P' \leftarrow \text{ApplyVariationOperators}(P');$
 6. $\text{Evaluate}(P');$
 7. $P \leftarrow \text{SelectNewPopulation}(P, P');$
 8. **end while**
 9. **Result:** The best solution found
-

➤ the basic genetic algorithm.

Algorithm 1 Basic GENETIC ALGORITHM

- 1: initialize population
 - 2: **repeat**
 - 3: **repeat**
 - 4: crossover
 - 5: mutation
 - 6: phenotype mapping
 - 7: fitness computation
 - 8: **until** population complete
 - 9: selection of parental population
 - 10: **until** termination condition
-

➤ Mutation

After a crossover is performed, mutation takes place. Mutation is a genetic operator used to maintain genetic diversity from one generation of a population of chromosomes to the next.

Operators Types:

- One simple way is, Flip Bit.
- The others are Boundary, Non-Uniform, Uniform, and Gaussian.

The operators are selected based on the way chromosomes are encoded

SEARCH SPACES AND FITNESS LANDSCAPES

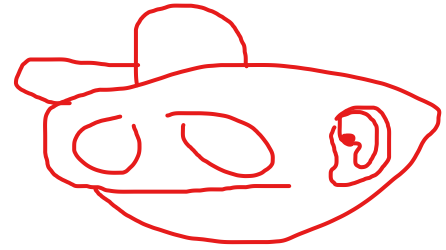
– A search space is the set or domain through which an algorithm searches. In computer science, the space may be a well-defined and finite data structure.

→ Fitness landscapes or adaptive landscapes are the set of all possible genotypes, their degree of similarity, and their related fitness values.

➤ TERMINATION

The algorithm terminates if the population has converged (does not produce offspring which are significantly different from the previous generation). Then it is said that the genetic algorithm has provided a set of solutions to our problem

➤ RANDOM SELECTION



In this strategy we randomly select parents from the existing population. There is no selection pressure towards fitter individuals and therefore this strategy is usually avoided.

➤ ELITISM

The first best chromosome or the few best chromosomes are copied to the new population. The rest is done in a traditional way. Such individuals can be lost if they are not selected to reproduce or if crossover or mutation destroys them. extensively improves the GA's performance

➤ Eco path

is a powerful software system which uses simulation and computational methods to model marine ecosystems. It is widely used by marine and fisheries scientists as a tool for modelling and visualizing the complex relationships that exist in real world marine ecosystems

➤ EVOLUTIONARY GAME THEORY

✓ Evolutionary game theory originated as an application of the mathematical theory of games to biological contexts, arising from the realization that

frequency dependent fitness introduces a strategic aspect to evolution. Recently, however, evolutionary game theory has become of increased interest to economists, sociologists, and anthropologists--and social scientists in general--as well as philosophers.



➤ How learning can guide evolution “self-adaptation”

Self-Adaptation in evolution strategies usually aims at steering the mutation process. The mutation process depends on several parameters, most notably, on the mutation strength. In a sense, this parameter controls the spread of the population due to random mutation. The mutation strength has to be varied during the optimization process

➤ Artificial life

Artificial life (often abbreviated A Life or A-Life) is a field of study where in researchers examine systems related to natural life, its processes, and its evolution, through the use of simulations with computer models, robotics, and biochemistry

❖ Note

➤ Study well all our sheets for Exercises

