

Artificial Intelligence

LECTURE 4

Searching

- Searching - using a computer algorithm to find an item with specified properties among a collection of items.

Variants of depth-first search

- Backtracking search.
- Minimax search.

Backtracking Algorithms

- A solution space - the space of all candidate solutions of a given problem.
- A backtracking algorithm incrementally builds candidates to the solutions, and abandons each partial candidate c as soon as it determines that c cannot possibly be completed to a valid solution.
- The partial candidates are the nodes of a tree structure, the potential search tree.

Backtracking Algorithms

- The backtracking algorithm traverses the search tree from the root down, in depth-first order.
- At each node c , the algorithm checks whether c can be completed to a valid solution. If it cannot, the whole sub-tree rooted at c is skipped. Otherwise, the algorithm:
 - (1) checks whether c is a valid solution and
 - (2) recursively enumerates all sub-trees of c .

Minimax

- The minimax algorithm uses the fact that the two players are working towards opposite goals.
- The algorithm's opponent will be trying to minimize whatever value the algorithm is trying to maximize.

Heuristics

- Heuristics - experience-based techniques for problem solving.
- Heuristics are methods that in many cases can greatly simplify or shorten the way to the goal.

Genetic Algorithms

- Genetic algorithms are biologically inspired algorithms.
- Genetic algorithms emulates the biological evolutionary process in intelligent search.

Genetic Algorithms

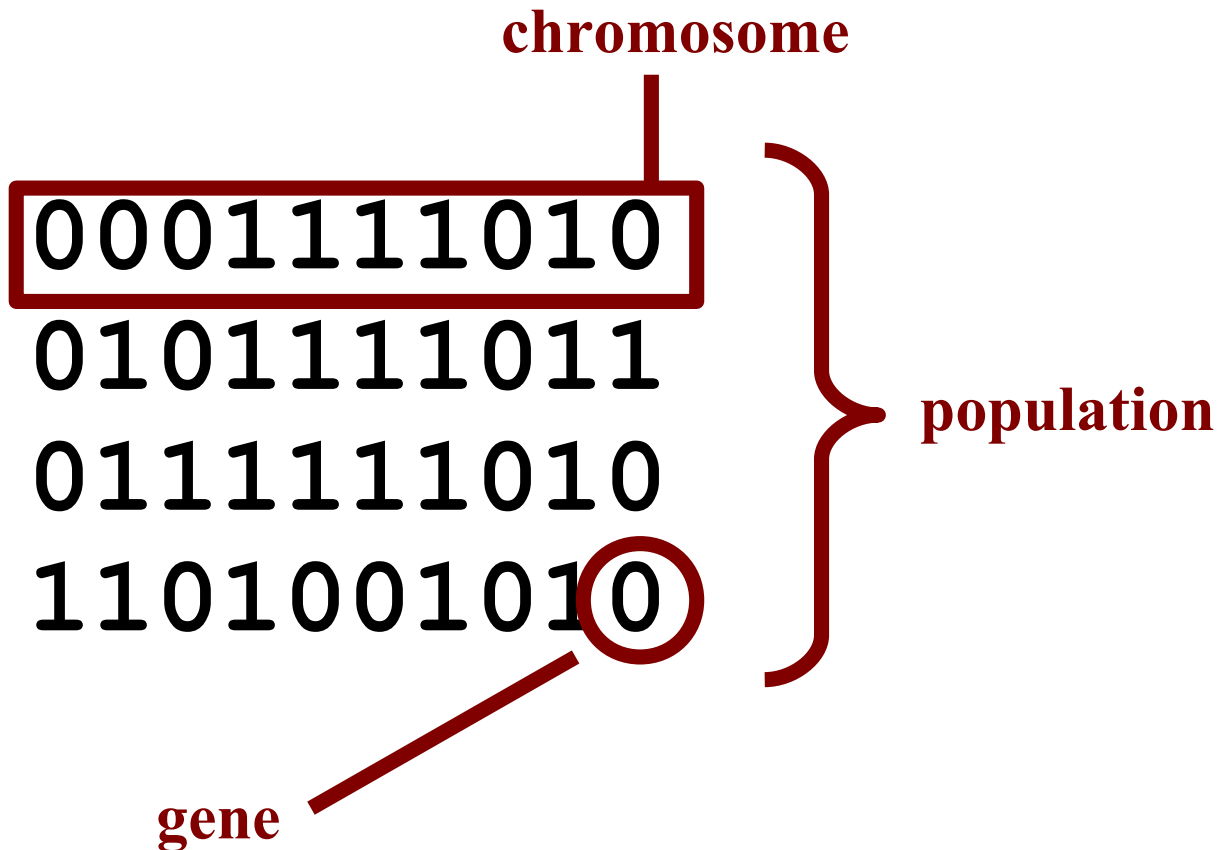
- The basic elements of a genetic algorithm are:
 - selection of solutions based on their goodness,
 - reproduction for crossover of genes,
 - mutation for random change of genes.
- Through these processes, genetic algorithms find better and better solutions to a problem just as species evolve to better adapt to their environments.

Genetic Algorithms

Chromosomes - binary bit strings.

Population - a set of chromosomes.

Gene - a single element of the chromosome.



The Cycle of Genetic Algorithms

- A genetic algorithm operates through a simple cycle of stages:
 - Creation of a population of strings.
 - Evaluation of each string (using a given fitness function).
 - Selection of best strings.
 - Genetic manipulation to create new population of strings.
- Each cycle of a genetic algorithm produces a new generation of possible solutions for a given problem.

The Cycle of Genetic Algorithms

- Possible solutions are encoded into bit strings, called chromosomes.
- Population = a set of possible solutions

Genetic Manipulation

Crossover

Parent 1:

011|10001

Offspring 1:

011|01110

Parent 2:

110|01110

Offspring 2:

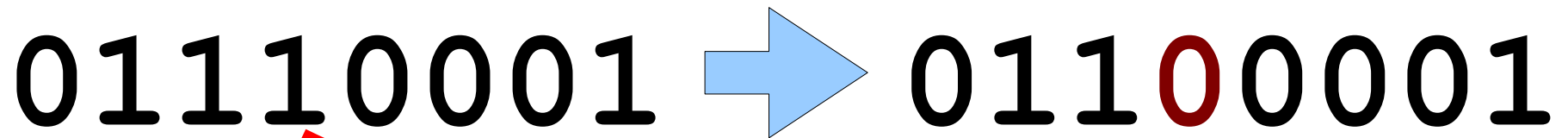
110|10001

↑
Crossover point

Genetic Manipulation

Mutation

01110001 → 01100001



A point mutation

Traveling Salesman Problem (TSP)

- Traveling Salesman Problem (TSP) is a well-known hard optimization problem.
- TSP:
 - Given an undirected weighted graph.
 - Find a shortest path (tour) in which every vertex is visited exactly once, except that the initial and terminal vertices are the same.

A genetic algorithm approach to the TSP

- Each solution is a permutation of the cities.
- The objective is to minimize the total distance of each tour.
- The fitness function:
 - The lesser the total distance, the more the fitness function value.

The significance of genetic algorithms

- The genetic algorithm is a guided random search method.
- We use randomness, which depends on chance, but we also incorporate some guidance to search solutions effectively.
- The genetic algorithms can be used for optimization problems and machine learning.

The significance of genetic algorithms

- The genetic algorithms search from a population of points, rather than a single point in the space.
- The genetic algorithms use the objective (fitness) function itself, not derivatives or other auxiliary quantities.