Presentation

A genetic algorithm for finding the k shortest paths in a network

Duc Nguyen

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Outline

Introduction

Problem definition and goals

Problem description

Given a network $G(V, E)$ where $V = \{1, 2, ...n\}$ denotes the set of nodes and $E = \{e_1, e_2, ..., e_m\}$ denotes the set of edges connecting nodes. Let $n_0 \subseteq V$ be source node, $M = \{n_0, u_1, ..., u_m\} \subseteq V$ be the set of destination nodes and $Band(e)$ be the bandwidth of edge e.

Given a path $P(V_p, E_p)$ in the network G and

$$Band(P) = \min\{Band(e) : e \in P(V_p, E_p)\}$$

Let B be a required value of the bandwidth, P is the shortest path if $Band(P) \geq B$

Find all the shortest paths from source node to each destination node.

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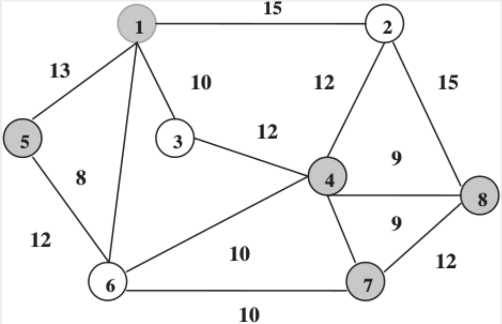
Example



The shortest paths P with the restricted bandwidth $B = 10$

1 2 8 7 6 4 gives $Band(P) = 10$

1 5 6 7 8 2 4 gives $Band(P) = 10$

Introduction

Problem definition and goals

Where we find the problem

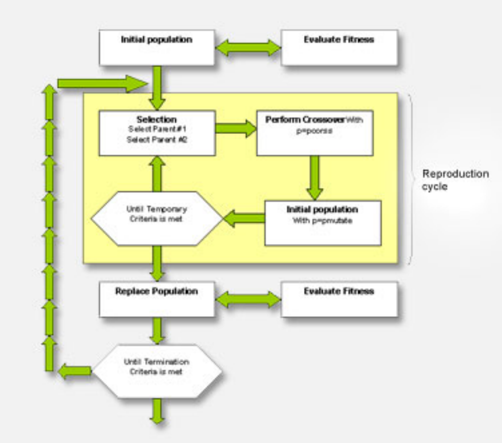
- In a multiparty multimedia teleconference, it requires to maintain the route to send video and voice at each conference site to the other sites.
- In distant education systems, the voice and video of the instructor are sent to all students.
- In video-on-demand system, batching a number of customer requests from the same video object and using one I/O stream to serve multiple customers..

Outline

Concepts

Genetic algorithm

A heuristic search based on the process of natural selection for improving the solution's quality by exploiting historical information.



Genetic algorithm components

- Encoding method: representing every solution domain into a sequence of data called chromosome.
- Initial population method: generating initial population.
- Objective function: verifying and weighting how a chromosome is closed to expected solution.
- Genetic operators: generating new chromosomes from historical information (basic operators: crossover and mutation operations).
- Terminator: determining to terminate reproduction cycle.

Outline

Design and Example

Design

Given a network $G(V, E)$ and $|V| = N$

- Encoding method: an array of integers with length N to represent the respectively visited nodes of a path in G.
- Initial population method: randomly generating the set of candidate solutions in a form of above encoding method.
- Objective function: testing a chromosome with 1-connectivity condition and the bandwidth constraint.
- Genetic operators: Crossover operation(random cut-point) and mutation operation(replacing bit-by-bit basis).
- Terminator: terminating the algorithm if the number of reproduction cycles is reached.

Design and Example

Figure 1 A chromosome form (where n_i, n_j, n_k, ..., n_m are the nodes between the source node n_0 and destination node d).

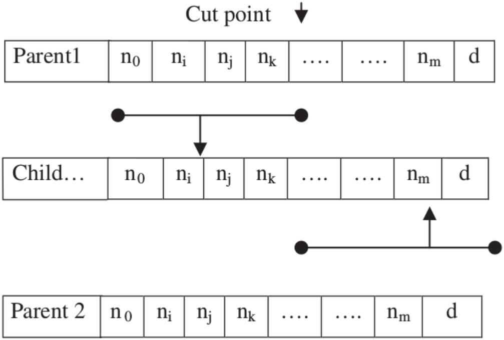


Figure 2 Crossover operation.

Design and Example

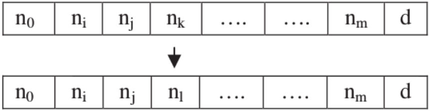
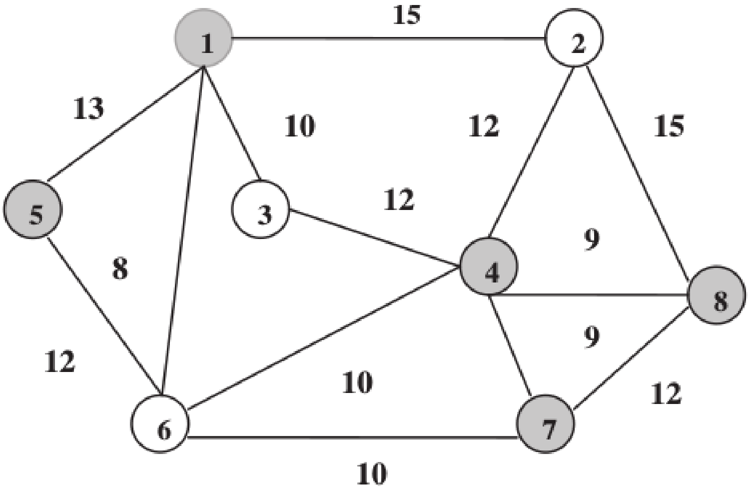


Figure 3 Mutation operation.

Design and Example



Design and Example

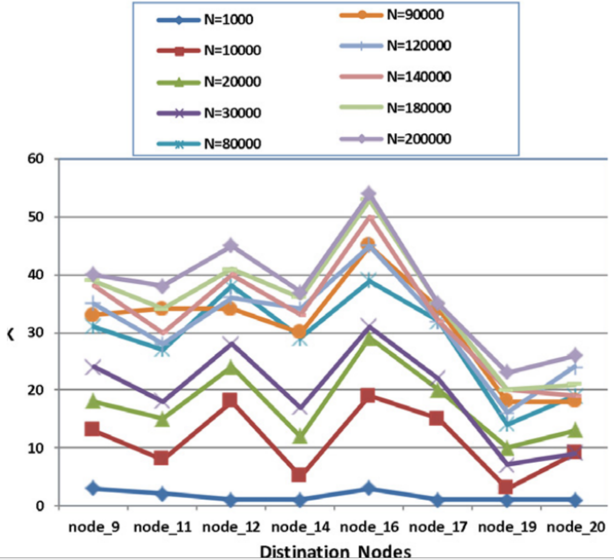
Algorithm: Genetic algorithm for finding the k shortest paths

Input: pop_size, maxgen, P_m, P_c, n_0, the destination nodes U, B.
Output:

1. Generate the initial population as in Section 3.2.
2. gen $\leftarrow$ 1.
3. **While** (gen $< =$ maxgen) **do**
4. $P \leftarrow 1$
5. **While** ($p < =$ pop_size) **do**
6. Obtain chromosomes of the new population, select two chromosomes from the parent population according to P_c. Apply crossover, and then mutate the new child according to P_m parameter.
7. Compute the bandwidth of the new child ($Band(P)$) according to Eq. (1).
8. If $B(P) \geqslant B$ thenSave this child as a candidate solution.
9. $P \leftarrow p + 1$.
10. End if
11. End
12. Print all obtained solutions.
13. End

Outline

Experiments



Questions ?

Duc Nguyen