Variable Neighborhood Search

曾奕博

CONTENTS

PART 1

Introduction

Variable Neighborhood Search

Variable Neighborhood Search(VNS)： A recent metaheuristic for solving combinatorial and global optimization problems whose basic idea is systematic change of neighborhood within a local search.

- Traveling Salesman Problem
- Vehicle Routing Problem
- Location and Clustering Problems
- Graphs and Networks
- Scheduling

Variable Neighborhood Search

Variable Neighborhood Search(VNS) is based on three simple facts:

- A local minimum w.r.t. one neighborhood structure is not necessary so with another.
- A global minimum is a local minimum w.r.t. all possible neighborhood structures.
- For many problems local minima w.r.t. one or several are relatively close to each other.

PART 2

Details of VNS

Details of VNS

VNS includes:

- variable neighborhood descent （VND）
- shaking procedure

- Neighborhood: A neighborhood is the set of all the solutions that can be obtained by performing an operation on the current solution
- Neighborhood Action: It is a function that produces a set of neighbor solutions for the current solution s.

$$S = 1001 \longrightarrow N(s)=\{0001,1101,1011,1000\}$$

VND

Initialization. Select the set of neighborhood structures $\mathcal{N}_k$, for $k = 1, \ldots, k_{max}$, that will be used in the search; find an initial solution x; choose a stopping condition;

Repeat the following sequence until the stopping condition is met:

(1) Set $k \leftarrow 1$;

(2) Repeat the following steps until $k = k_{\max}$:

(a) Shaking. Generate a point x' at random from the kth neighborhood of x ($x' \in \mathcal{N}_k(x)$);

(b) Move or not. If this point is better than the incumbent, move there ($x \leftarrow x'$), and continue the search with $\mathcal{N}_1$ ($k \leftarrow 1$); otherwise, set $k \leftarrow k + 1$;

Step of VND

VND

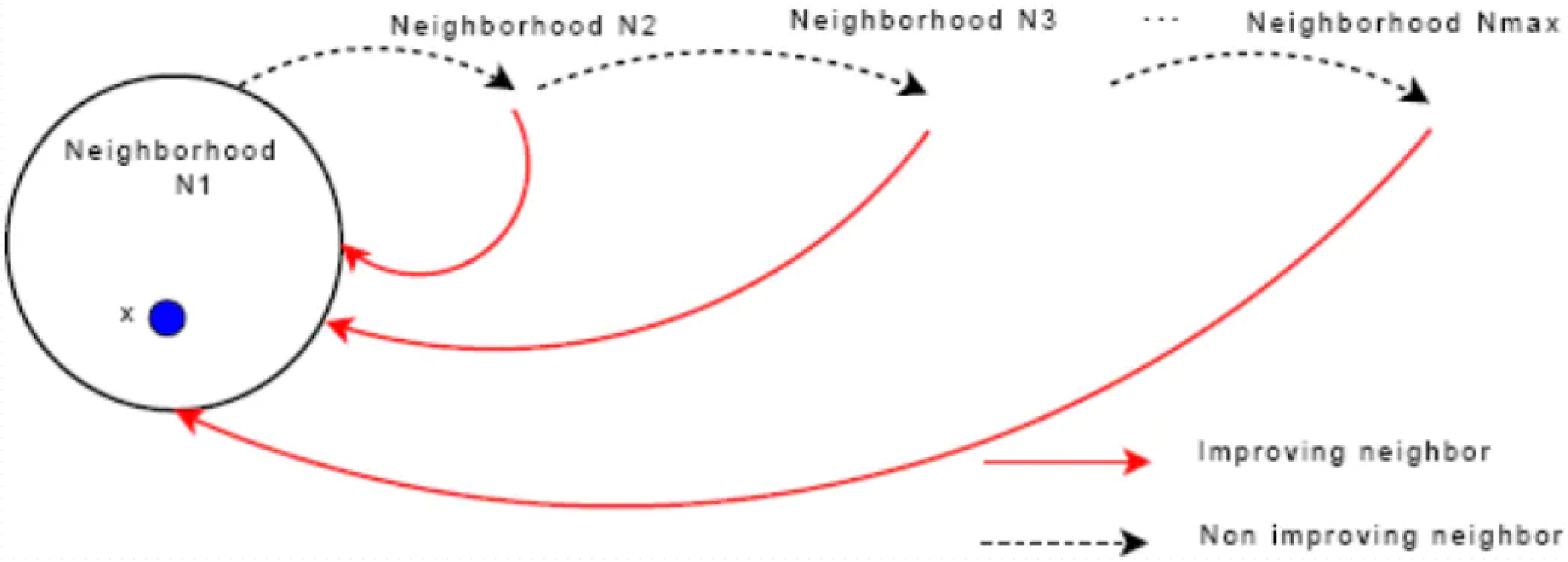

Figure of VND

Shaking procedure

Shaking procedure: disturbance operator

It is used to produce different neighborhood solutions

Variable Neighborhood Search（VNS)

Initialization. Select the set of neighborhood structures $\mathcal{N}_k$, for $k = 1, \ldots, k_{max}$, that will be used in the search; find an initial solution x; choose a stopping condition;

Repeat the following sequence until the stopping condition is met:

(1) Set $k \leftarrow 1$;

(2) Repeat the following steps until $k = k_{\max}$:

(a) Shaking. Generate a point x' at random from the kth neighborhood of x ($x' \in \mathcal{N}_k(x)$);

(b) Local search. Apply some local search method with x' as initial solution; denote with x'' the so obtained local optimum;

(c) Move or not. If this local optimum is better than the incumbent, move there ($x \leftarrow x''$), and continue the search with $\mathcal{N}_1$ ($k \leftarrow 1$); otherwise, set $k \leftarrow k + 1$;

Step of VNS

Stopping Condition

- Maximum CPU time
- Maximum number of iterations
- Maximum number of iterations between two improvements

Extension of VNS

- Reduced VNS：A simplification of VNS, it gets rid of local search, in order to reduce running time.
- Skewed VNS: Once the best solution in a large region has been found it is necessary to go quite far to obtain an improved one.

PART

3

Advantages and disadvantages

Advantages and disadvantages

Advantages:

- Simple. The principle are simple and can be applied widely
- Accurate. The accuracy of the solution is guaranteed
- Time-saving. Short computing time.

Disadvantages:

- It takes a lot of experience to design neighborhood and initial solution.