Solving TSP: Tabu Search and code examples

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Outline of Topics

Code example: Generating solutions for TSP

- Download the source code from Canvas
- `load('cities.mat')`
- Open the matrix ‘cities’, which is a 2 $\times$ 48 cities TSP problem
    - 48 USA state capital cities
    - The minimal tour has length 10628.
    - Check this page
- Open the optimal solution ‘att48_s.txt’ file and copy
- `optimalsolution =[` paste the solution `]`
- `inputcities = cities(:,optimalsolution)`
- `distance(inputcities)`
- Read help file about how to generate random permutation: `help randperm`

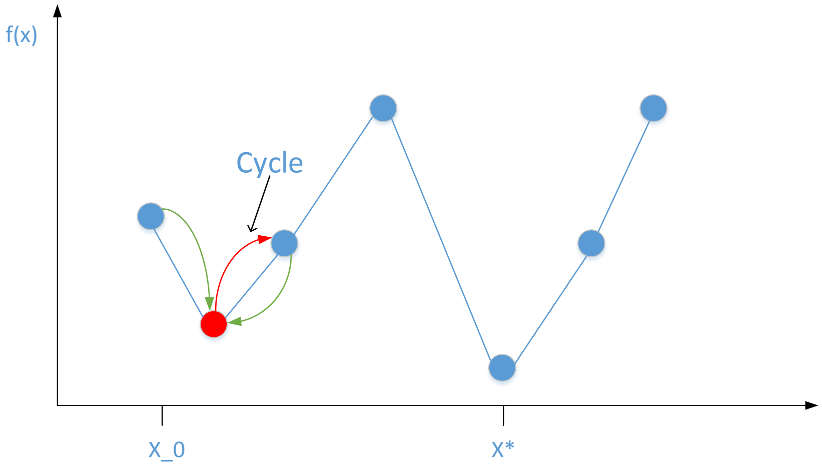
Tip: How to implement Simulated Annealing

- The best starting point is a local search algorithm, e.g., hill climbing
- Open simple_hill_climbing_two_opt.m' file
- Complete the code to get a hill climbing algorithm for TSP
- Implement the random non-improving step (Lecture 4, pages 17-18)

Question

- We have learned Simulated Annealing which can escape from local optima by accepting worse solutions with some probability.
- **Question**: is there any other strategies to find better local optima?

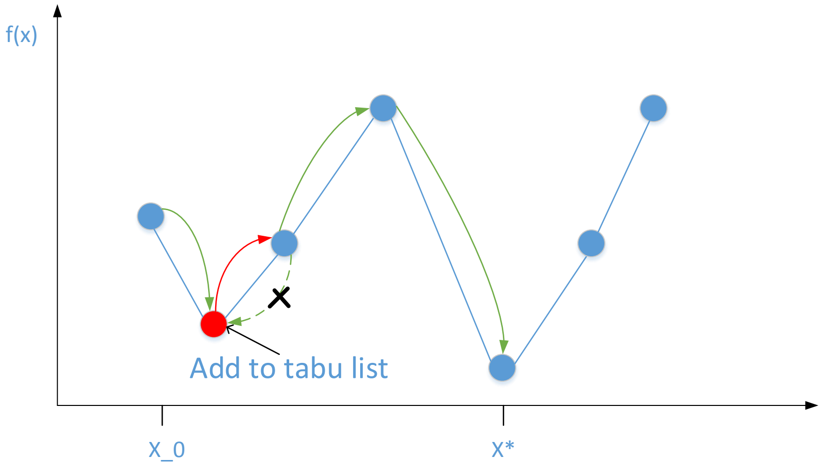
Search trajectory: cycles



Tabu search

- Invented by Professor Fred W. Glover in 1986 and formalized in 1989
- Many applications since publications
- ‘Tabu’ means “things that cannot be touched because they are sacred”
- Main idea: use memory to guide local search process away from local optima
  - Maintains a memory structure called tabu list that memorises previously visited solutions
  - Forbids the local search algorithm immediately return to previously visited solutions

Search trajectory: Tabu search



More about Tabu list

- Tabu list consists of:
  - banned solutions; or
  - a set of rules to ban solutions
- Use tabu list to exclude some neighborhood solutions for local search
- Essentially construct a neighborhood $N^*(x)$ solutions to be explored
- The simplest Tabu list:
  - Recently visited solutions
  - The duration of memory (in search steps) called Tabu tenure
  - Rule out any search attempts that would lead back to those previously visited solutions
- Extension: maintain a tabu list to avoid unfavourable neighbourhood solutions

Problem: How to construct a Tabu list for TSP

- We aim to solve TSP using tabu search
- The key component: Tabu list
- Assuming the we use the 2-OPT algorithm for local search
- Question: How to design a tabu list?

Tabu search algorithm pseudocode

Tabu search algorithm

```
while (terminationflag != true)
        Determine set $N^*(x)$ of non-tabu neighbours of $x$
        $x_{new} = LocalSearch(N^*(x))$
        Update tabu list based on $x_{new}$
        $x = x_{new}$
Output $x^i$
```

Take home message

- Main idea: escape or **avoid** local optima
- Tabu search tutorial: here