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Artificial Intelligence

Tabu Search

Introduction

- Tabu – socially or culturally proscribed: forbidden to be used, mentioned, or approached because of social or cultural rather than legal prohibitions.
(http://encarta.msn.com/dictionary_1861698691/taboo.html)
- Glover, F. 1986. Future Paths for Integer Programming and Links to Artificial Intelligence. *Computers and Operations Research*. Vol. 13, pp. 533-549.

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Overview of Tabu Search

- Tabu search is based on introducing **flexible memory** structures in conjunction with ~~strategic restrictions~~ and **aspiration levels** as a means for exploiting search spaces [1].
- Meta-heuristic that guides a local heuristic search procedure to explore the solution space beyond local optimum by use of a **Tabu list**.

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Overview of Tabu Search

- Used to solve combinatorial (finite solution set) optimization problems
- A dynamic neighborhood search method
- Use of a flexible memory to restrict the next solution choice to some subset of neighborhood of current solution

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Tabu Search Strategy

- 3 main strategies:
 - **Forbidding strategy**: control what enters the tabu list
 - **Freeing strategy**: control what exits the tabu list and when
 - **Short-term strategy**: manage interplay between the forbidding strategy and freeing strategy to select trial solutions

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Parameters of Tabu Search

- Local search procedure
- Neighborhood structure
- Aspiration conditions
- Form of tabu moves
- Addition of a tabu move
- Maximum size of tabu list
- Stopping rule

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Basic Ingredients of Tabu Search

- A chief way to exploit memory in tabu search is to classify a subset of the moves in a neighborhood as forbidden (or **tabu**).
- A **neighborhood** is constructed to identify adjacent solutions that can be reached from current solution.
- The classification depends on the history of the search, and particularly on the recency or frequency that certain move or solution components, called **attributes**, have participated in generating past solutions.
- A **tabu list** records forbidden moves, which are referred to as **tabu moves**.
- Tabu restrictions are subject to an important exception. When a tabu move has a sufficiently attractive evaluation where it would result in a solution better than any visited so far, then its tabu classification may be overridden. A condition that allows such an override to occur is called an **aspiration criterion**.

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Basic Tabu Search Algorithm

- Step 1: Choose an initial solution i in S . Set $i^* = i$ and $k=0$.
- Step 2: Set $k=k+1$ and generate a subset V of solution in $N(i,k)$ such that either one of the Tabu conditions is violated or at least one of the aspiration conditions holds.
- Step 3: Choose a best j in V and set $i = j$.
- Step 4: If $f(j) < f(i^*)$ then set $i^* = i$.
- Step 5: Update Tabu and aspiration conditions.
- Step 6: If a stopping condition is met then stop. Else go to Step 2.

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Tabu Search Stopping Conditions

Some immediate stopping conditions could be the following:

1. $N(i, K+1) = 0$. (no feasible solution in the neighborhood of solution i)
2. K is larger than the maximum number of iterations allowed.
3. The number of iterations since the last improvement of i^* is larger than a specified number.
4. Evidence can be given that an optimum solution has been obtained.

Stopping criterion can, for example, use a fixed number of iterations, a fixed amount of CPU time, or a fixed number of consecutive iterations without an improvement in the best objective function value. Also stop at any iteration where there are no feasible moves into the local neighborhood of the current trial solution.

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References

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