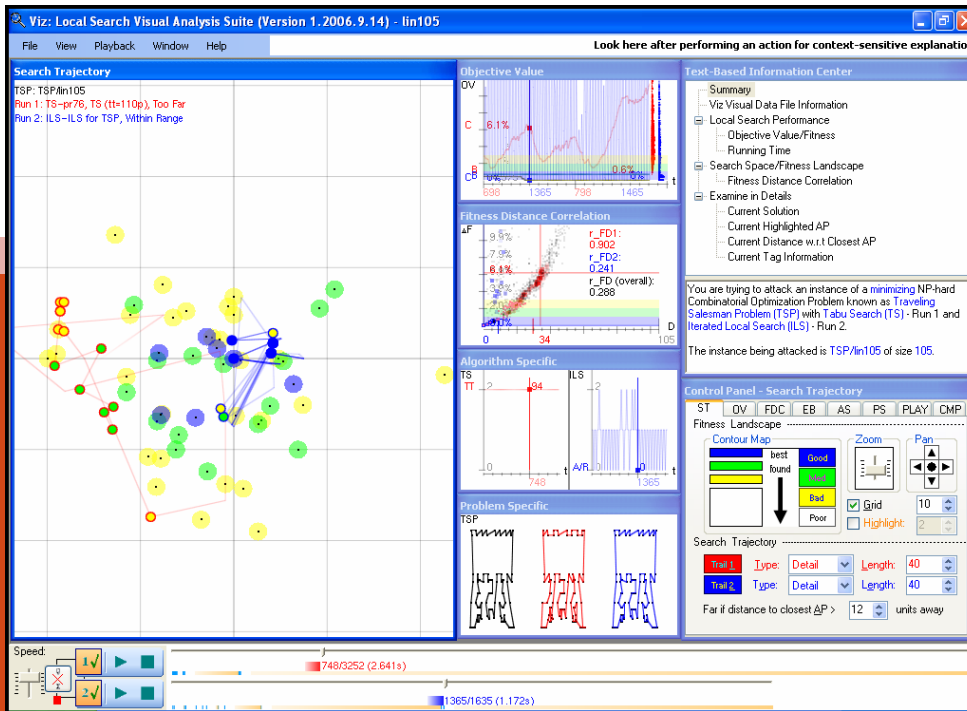


Visualizing Local Search Algorithms



School of Computing



School of Information Systems

Steven Halim, Roland Yap
School of Computing
National University of Singapore
{stevenha,ryap}@comp.nus.edu.sg

Lau Hoong Chuin
School of Information Systems
Singapore Management University
hclau@smu.edu.sg

Understand local search through visualization and animation

A way for debugging and tuning local search

The behavior of local search algorithms for solving Combinatorial Optimization Problems (COP) is not well understood. Given that local search is heuristic-based and often stochastic, it is difficult to analyze and runtime experimentation is needed to understand the algorithm behavior.

We present an off-line program visualization tool for analyzing Local Search behavior, called Viz. Viz combines the strengths of both human and computer to answer various local search behavior. Viz can draw *local search trajectories* in both *algorithm* and *problem independent* fashion and is intended to provide a visual tool for the algorithm designers to experiment with the results of local search. Viz also provides the usual algorithm and problem specific visualizations and loads of other important local search analysis tools.

All of these important analysis information can be yours just by logging simple information from your local search runs using Viz log file format!!

For more details and to download Viz, please visit:
<http://www.comp.nus.edu.sg/~stevenha/viz>

Viz Main Features:

- Allows for more intuitive exploration of local search behavior
- Multi-Source Visualizations
- Animated Search Playback
- Multiple Detail Levels
- Animation & Visualization aids
- Visual Comparison
- Customize-able GUI

Using Viz is Easy:

- Implement a local search for attacking a COP
- Record simple information from local search runs, e.g. current combinatorial solution, objective value, etc
- Pass those RunLogs into Viz Data Conversion Wizard
- Playback the local search run in Viz and analyze it

Questions about Local Search Behavior:

- Does it behave like as what we intended?
- How good is the local search in intensification?
- How good is the local search in diversification?
- Is there any sign of cycling behavior?
- How does the local search algorithm make progress?
- Where in the search space does the search spend most of its time?
- How far is the starting/initial/greedy solution w.r.t the global optima/best known solution?
- Does the search quickly find the global optima/best known solution region or does it wander around in other regions?
- How wide is the local search coverage?
- What is the effect of modifying a certain search parameter/component/strategy w.r.t the search behavior?
- How do two different algorithms compare?

The advantages for understanding local search behavior:

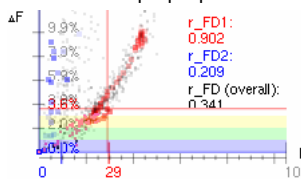
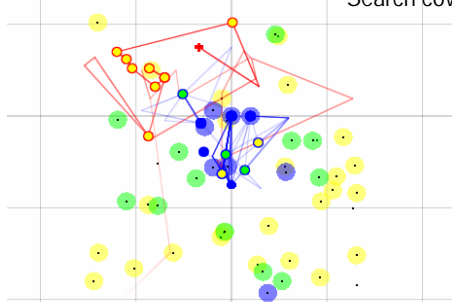
- It gives intuition for addressing the LS Tuning Problem
- We can spot and debug incorrect LS behavior

Viz is geared towards enhancing higher level human reasoning by integrating the search trajectories, objective values, with algorithm and problem specific visuals

TSP: TSP/lin105
Run 1: TS=lin105, TS (tt=110p), Within Range
Run 2: ILS=ILS for TSP, Within Range

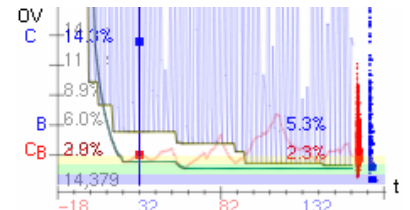
Search Trajectory Visualization

Observable: Solution Cycling, Intensification, Diversification, Search coverage, Fitness Landscape properties, etc.



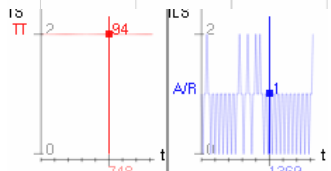
Fitness Distance Correlation Visualization

Observable: characteristic of Fitness Landscape, etc.



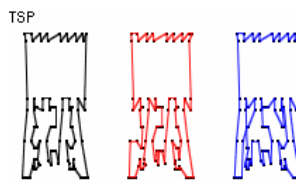
Objective Value Visualization

Observable: Solution quality fluctuations, Improvement over Time, etc.



Algorithm Specific Visualization

Observable: the current tabu tenure in Tabu Search, acceptance/rejection rate in Iterated Local Search, etc.

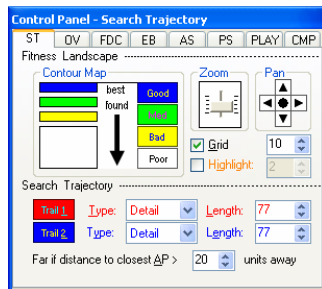


Problem Specific Visualization

Observable: TSP: crossings in the tours, distribution of vertices, QAP: the quality of the facility-location assignments, etc.

Control Panel

Adjusts the way Viz displays the visualizations. This includes choosing the color scheme, highlighting or filtering certain items, adjusting the level of details, etc.



Text-Based Information Center

- Summary
- Viz Visual Data File Information
- Local Search Performance
 - Objective Value/Fitness
 - Running Time
- Search Space/Fitness Landscape
 - Fitness Distance Correlation
- Examine in Details
 - Current Solution
 - Current Highlighted AP
 - Current Distance w.r.t Closest AP
 - Current Tag Information

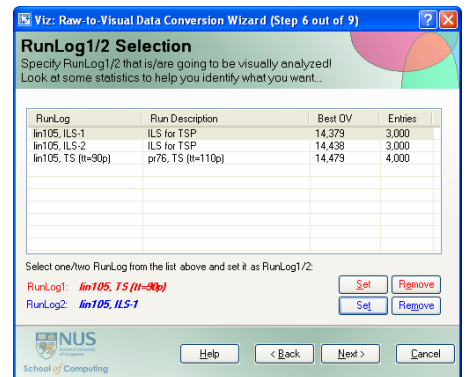
FDC of this fitness landscape is 0.341 (straight/forward). Diameter of fitness landscape is 105.
FDC of solutions found by Run 1 is 0.902 (straight/forward). Average distance is 29.60. Approx 1/4 diameter.
FDC of solutions found by Run 2 is 0.209 (straight/forward). Average distance is 9.48. Approx 1/11 diameter.

Viz GUI

The integrated local search visual analysis suite. This tool playback the local search for analysis.

Text-Based Information Center

The integrated statistical analysis tools are displayed as text.



Viz Raw-to-Visual Data Conversion Wizard
This wizard will do all the dirty work in calculating the necessary information to transform the raw RunLog files into visualize-able format...

