



Local Search Topology
Implications for planner performance

Mark Roberts
Adele Howe
Colorado State University
Fort Collins, Colorado

Hoffmann's Topological Analyses: The Taxonomy

M I N I M A	med < c	M1	BW4oop		Schedule	Mystery Mprime Mic-ADL Freecell Assembly
		M0	Hanoi BW-3op Fridge Breifcase	Grid		
N O M I N I M A	med < c	MX	Logistics Ferry Gripper	Tireworld Mic-SIM Mic-STR Movie TSP		
			DC	DH	DR	DU
			Undirected	Harmless	Recognized	Unrecognized

September 22, 2007

Local Search Topology

3

Hoffmann's Topological Analyses: Results

- Empirical results show FF performance followed the taxonomy very well
- Theoretical results prove the taxonomy class for each domain under h_+ and h_{ff}

September 22, 2007

Local Search Topology

4

Hoffmann's Topological Analyses: Limitations

- Computing h_+ is *NP*-hard
 - Problem instances had to be small
- Applied to a single planner: FF

The findings are convincing for FF
Do they transfer to other planners?

September 22, 2007

Local Search Topology

5

Questions

- Does the taxonomy distinguish performance for HSh+ planners?
- What about non-HSh+ planners?

September 22, 2007

Local Search Topology

6

Approach

- Collect
 - publicly available planners
 - benchmark problems in the 20 domains
 - performance of the planners on problems
- Analyze taxonomy effect on performance of HS planners using h+
- Analyze taxonomy effect on performance of non-HS planners

September 22, 2007

Local Search Topology

7

Setup: Variables

- Predictors (Independent)
 - 910 Problems (290 “challenging” problems)
 - 28 Planners (10 HSh+, 18 non-HSh+)
 - Taxonomy Category
- Responses (Dependent)
 - Runtime : [0,1800] seconds
 - Success : { yes, no }

September 22, 2007

Local Search Topology

8

Setup: Success Ratio

- Construct a contingency table
- Perform a G-test (exact version of χ^2)

G=0.58, p=0.75			G=55.81, p<<0.001		
	S	F		S	F
MX	249	39	DC	177	29
M0	10	2	DH	159	38
M1	516	94	DR	150	0
			DU	289	68

FF 2.3, all problems

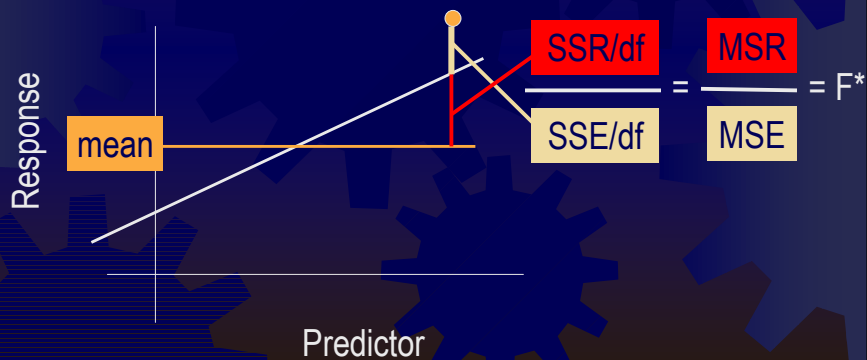
September 22, 2007

Local Search Topology

9

Setup: Runtime

- Split by planner, taxonomy, and time
- Construct ANOVA: TTC, TTS, TTF



September 22, 2007

Local Search Topology

10

Setup: Runtime

- Significant ANOVA justifies pair-wise analysis
- TukeyHSD determines differences

	DC	DH	DR	DU
DC	--	CS	CS	
DH	cf	--	CS	
DR	c	C	--	
DU				--

c=complete
s=success
f=failure

presence of
letter shows
a similarity

September 22, 2007

Local Search Topology

11

Taxonomy versus HSh+

- All G-tests and ANOVAs significant
- Pair-wise comparison
 - TTF predictable regardless of taxonomy
 - Challenging problems: TTS does not depend on dead-end type
 - Extremes of taxonomy distinguish performance (except point two above)

Provisionally state that the taxonomy does distinguish performance for HSh+

September 22, 2007

Local Search Topology

12

Taxonomy versus non-HSh+

- ✦ Taxonomy lacks effect for success ratio
- ✦ TTS does not depend on taxonomy
- ✦ Taxonomy effect for TTF on both categories

Provisionally state that the taxonomy does **not** distinguish performance for non-HSh+

September 22, 2007

Local Search Topology

13

Limitations

- ✦ Planner
 - Switching search methods
 - Optimal versus satisficing
 - Grouped versus individual planners
- ✦ Problem
 - Inter-domain difficulty
 - Low cell counts

September 22, 2007

Local Search Topology

14

Summary

- Applied statistical hypothesis testing to determine effect of a model in explaining performance
 - Taxonomy explains HSh+
 - Taxonomy fails to explain non-HSh+
- Further work to deal with limitations

September 22, 2007

Local Search Topology

15

Future Work

- Extend to newer problems
 - Problem generators
- Probe inter-domain difficulty
- Better control across planner families
- Link to results on domain complexity

September 22, 2007

Local Search Topology

16

et al.

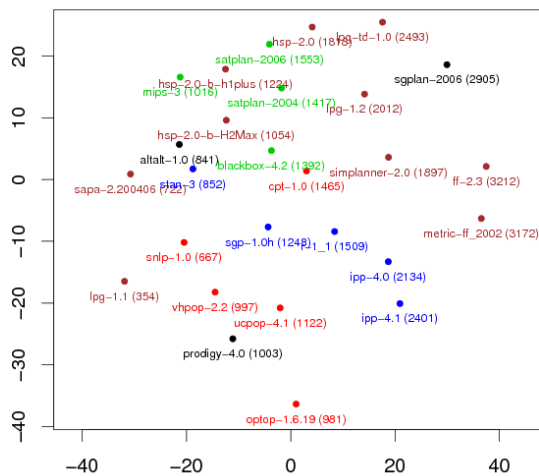
- Funding from CSU, NSF, AFOSR
- MEPS group: Landon Flom, Christie Williams, Crystal Redman
- CSU Student Group: Mark Rogers, Andrew Sutton, Artem Sokolov, Keith Bush, Laura Barbulescu, and others
- ICAPS 2005/6 attendees: Too many names
- The International Planning Competition, public planners and problems

September 22, 2007

Local Search Topology

17

Planner Success Sammon Map for all data



September 22, 2007

Local Search Topology

18