An Analysis of Merge Strategies for Merge-and-Shrink Heuristics

Silvan Sievers Martin Wehrle Malte Helmert

University of Basel
Switzerland

June 15, 2016

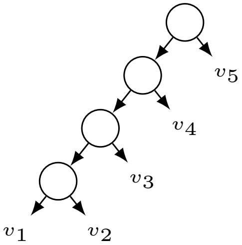
Outline

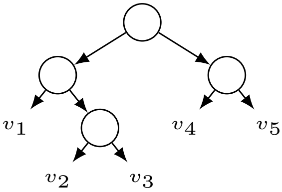
Setting

- Classical planning as heuristic search
- Merge-and-shrink: abstraction heuristic

Merge Strategy

- Binary tree over state variables



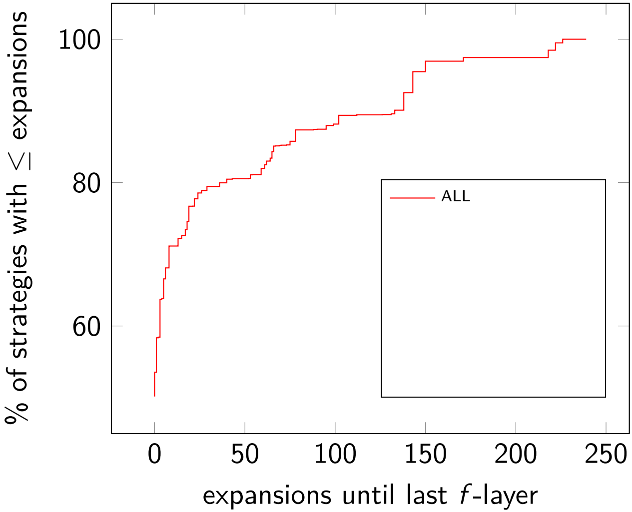


Motivation

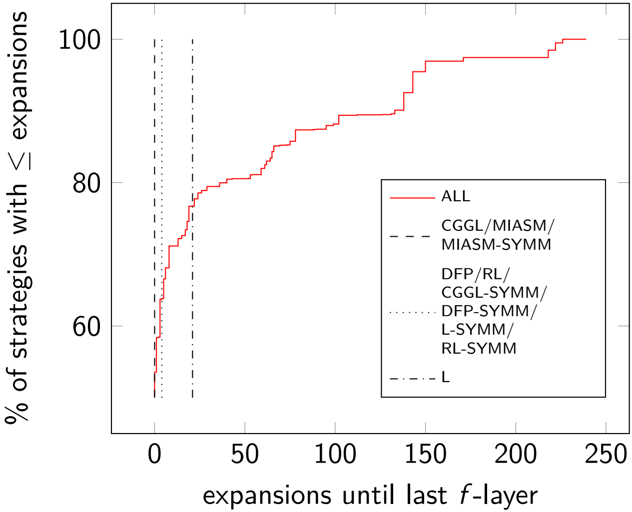
- Recent development allows (efficient) non-linear merge strategies
- Presumably (and theoretically) large potential for better merge strategies
- Only little research on merge strategies

Outline

All Merge Strategies – Zenotravel #5



All Merge Strategies – Zenotravel #5



Random Merge Strategies

- Sample of 1000 random merge strategies per task on the entire benchmark set

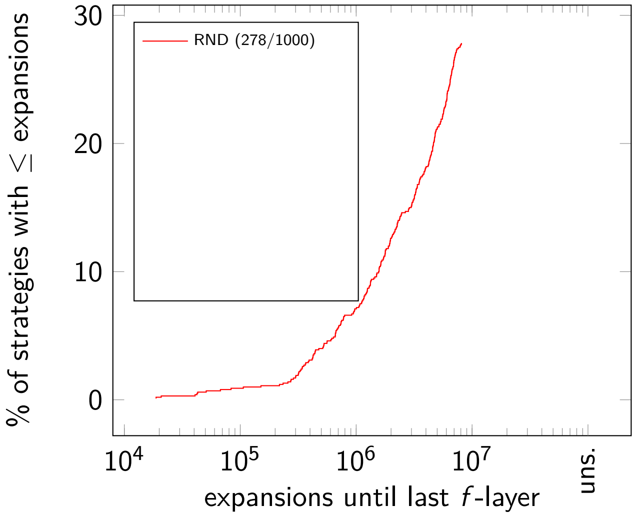
Random Merge Strategies

- Sample of 1000 random merge strategies per task on the entire benchmark set
- Expected coverage: 680.17 (baseline: 710 – 757)
- 72 tasks in 19 domains solved by strategies from the literature, but no random one

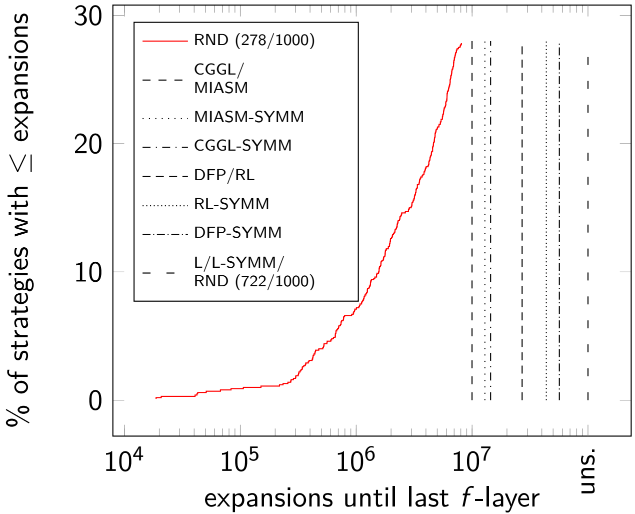
Random Merge Strategies

- Sample of 1000 random merge strategies per task on the entire benchmark set
- Expected coverage: 680.17 (baseline: 710 – 757)
- 72 tasks in 19 domains solved by strategies from the literature, but no random one
- 21 tasks in 9 domains solved by at least one random strategy, but none from the literature

Random Merge Strategies – NoMystery-2011 #9



Random Merge Strategies – NoMystery-2011 #9



DFP

- Score-based merge strategy: prefer transition systems with common labels synchronizing close to abstract goal states
- Problem: many merge candidates with equal scores

DFP

- Score-based merge strategy: prefer transition systems with common labels synchronizing close to abstract goal states
- Problem: many merge candidates with equal scores
- Use tie-breaking:
  - Prefer atomic or composite transition systems
  - Additionally: variable order (L or RL or RND)
  - Alternatively: fully randomized

DFP – Results

	Prefer atomic			Prefer composite			Ran-
	RL	**L**	**RND**	**RL**	**L**	**RND**	**dom**
Coverage	726	760	723	745	729	697	*706*
Linear (%)	10.8	10.9	10.6	81.7	*86.5*	84.3	13.2

- Performance (coverage) strongly susceptible to tie-breaking
- Strategies ranging from mostly linear to mostly non-linear

A New Strategy

- Based on the causal graph (CG)
- Compute SCCs of the CG
- Use DFP for merging within and between SCCs
- Mixture of precomputed and score-based strategies

A New Strategy (SCC-DFP) – Results

	Prefer atomic			**Prefer composite**			**Ran-**
	RL	**L**	**RND**	**RL**	**L**	**RND**	**dom**
Coverage	751 (+25)	760 *(+0)*	*732* (+9)	776 (+31)	751 (+22)	741 (+44)	736 (+30)
Linear (%)	8.2 (-2.6)	8.4 (-2.5)	8.2 (-2.4)	58.2 (-23.5)	58.7 (-27.9)	*61.6* (-23.2)	11.5 *(-1.7)*

- Complementary to MIASM

Conclusions

- Random merge strategies show the potential for devising better merge strategies
- DFP strongly susceptible to tie-breaking
- New state-of-the-art non-linear merge-strategy
- More details: paper or poster

Appendix – MIASM

- Precomputed (sampling-based) merge strategy which aims at “maximizing pruning”: partitioning of state variables based on searching the space of variable subsets

Appendix – MIASM

- Precomputed (sampling-based) merge strategy which aims at "maximizing pruning": partitioning of state variables based on searching the space of variable subsets
- Simpler score-based variant:
  - Compute all potential merges
  - Choose the one allowing the highest amount of pruning

Appendix – MIASM

- Precomputed (sampling-based) merge strategy which aims at “maximizing pruning”: partitioning of state variables based on searching the space of variable subsets
- Simpler score-based variant:
  - Compute all potential merges
  - Choose the one allowing the highest amount of pruning
  - Performance not far from original MIASM (best coverage: 747)

Appendix – Score Based MIASM

	Prefer atomic			**Prefer composite**			**Ran-**
	RL	**L**	**RND**	**RL**	**L**	**RND**	**dom**
Coverage	743	746	745	747	724	730	*726*
Linear (%)	10.4	10.5	11.9	45.2	*53.2*	51.2	11.8