# On Improving Plan Quality via Local Enhancements

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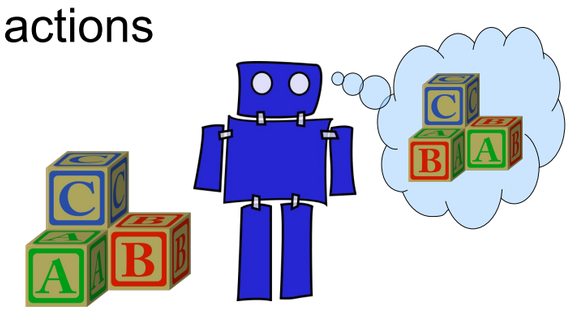
## 1. Background and Objectives

### What is Planning?

- Finding plans – sequences of actions
- Input
  - A set of actions with preconditions and effects
  - Descriptions of the initial state and the goal state
- Output
  - Plan = a valid sequence of actions that transform the world from the initial state to the goal state



### Planning Algorithms

- There are already many successful planners
  - **Optimal planners** (find shortest possible plans) are **slow** and cannot handle large problems
  - **Suboptimal planners** (produce longer plans) are a lot **faster** and can find plans for harder problems
- We need to choose between quality and performance

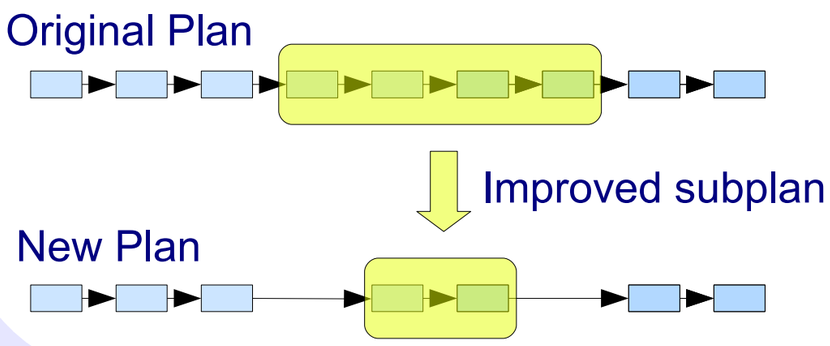
### Our Goal

- **Combine** the planning approaches to have both **performance** and plans of **good quality**

## 2. The Proposed Method

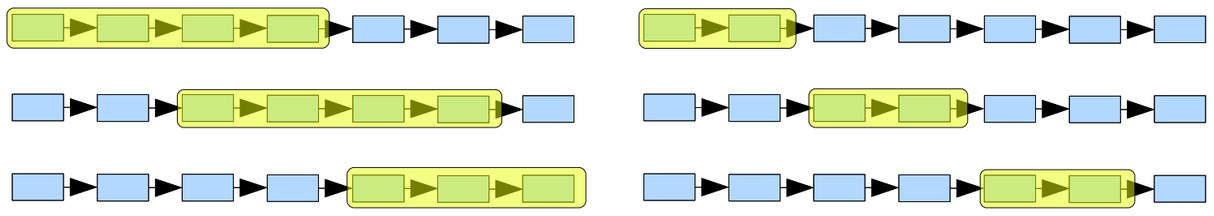
### Our Approach – The Basic Idea

A) Find a sub-optimal plan ***P***
B) Select a sub-plan (sub-sequence) of ***P***
C) Replace it with an improved subplan (thus improving ***P*** itself)
D) Keep repeating B) and C) until the entire plan is optimal or time is out




### How do we do that?

A) A fast sub-optimal planner finds the initial plan ***P*** (we used LPG, but any fast planner is suitable)
B) The sub-plans are selected by systematically shifting a window of increasing size through ***P***
C) The subplan optimization is formulated as a planning problem and solved by an optimal planner (we used the SAT-based SASE approach)

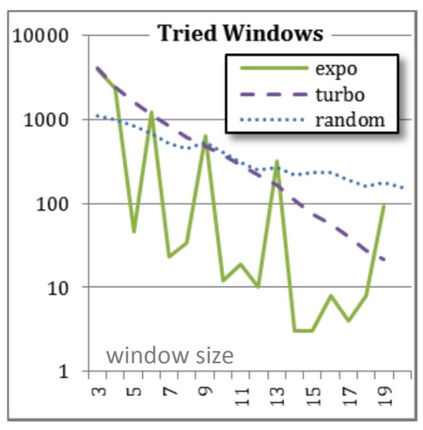


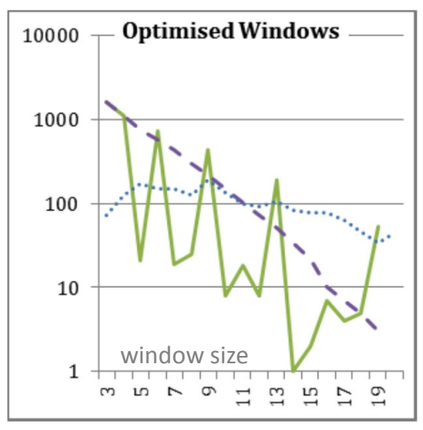
Window shifting methods: Halfstep (left) and Fullstep (right)

## 3. Results and Conclusions

### Experiments

- Cumulative results of eight classical STRIPS domains from the International Planning Competitions
- Compared the new method with the fast planner LPG and the optimal planner SASE




The comparison of three window enlargement strategies: turbo = increase by one; expo = increase by a factor of 1.5; random = random size between 2 and 20

| Method | Makespan score | ΔLPG | ΔSASE |
|---|---|---|---|
| LPG | 71.27 | 0.00 | -75.38 |
| SASE | 146.65 | 75.38 | 0.00 |
| Expo-fullstep | 170.41 | 99.14 | 23.76 |
| Turbo-halfstep | 179.53 | 108.25 | 32.87 |

The makespan score of a planner indicates the number and quality of the produced plans. Higher value = better performance

### Does it work? – Conclusion

- We can **solve as many problems as the fastest planning algorithm**
- According to our experiments the **plans** are allways **significantly improved**, moreover an optimal (or almost optimal) plan is often produced
- It is a successful anytime algorithm capable of finding optimal plans

SoCS 2012: The Fifth Annual Symposium on Combinatorial Search