Motivation
- Plans found quickly often lack quality.
- Anytime Planners quickly find a low-quality plan, and then improve it over time.
- Existing anytime procedures stagnate.
- For example, LAMA improves plan quality in the 2nd half of a 60 minute run by <1%, and yet this can be improved substantially (see Figure right).
- Post-processing methods (PB, DaF, PNGS, DAS, etc) improve the quality of a given input plan.
- Existing methods exhibit some good results, though tend to use excessive memory.
- For example, PNGS exhausts memory in <10 min on 86% of IPC 2008, 2011 problems.

Our Aim: Continue to improve the plan quality by post-processing.

Overview of Our Approach (BDPO)
- Apply a Large Neighborhood Search (LNS) to improve a plan, one segment at a time.
- Coherent segments are identified using a block ordering of the input plan.
- Neighborhood is determined by windowing strategies that merge blocks when required.
- Neighborhood is explored by using planners.
- Re-optimised segments are merged to form a better quality plan for the underlying problem.
- Our LNS post-processing uses restarting and online adaptation enhancements.

Block Ordering
- Deordering removes unnecessary ordering and joins together coherent steps.
- Standard deordering process only detects step-wise independence and non-interference.
- Block is a subset of steps (often non-consecutive) of the input plan.
- A block must be executed without being interleaved with any step outside the block.
- Unordered blocks can be executed in any order.
- A block can be a strict subset of another block but can not be partially overlapping.
- Block deordering identifies block-wise independence and non-interference.
- Allows further deordering and discovers coherent subplans in the form of blocks.
- A block in itself can be a suitable subplan for improvement but not always.
- Often we need to merge multiple blocks – the role of windowing strategies.

Windowing Strategies
- A window is a triple <pre, suucc, w> where w is the set of blocks to be improved, and pre and suucc are sets of blocks to be placed before and after w, respectively.
- Fixed Rule windowing
  - Uses fixed set of rules to generate candidate windows.
  - Uninformed about the plan structure and can not extract subplans over a certain length.
- Causal Followers windowing
  - Causal followers of a producer p of an atom m is a set of steps \{p, c, ..., c\} such that \langle p, m, c, ... \rangle are the causal links.
  - Causal follower blocks of a producer p of m, B_{p,m} are the unique set of blocks that contain \{p, c, ...\} excluding init and goal steps.
  - A candidate window takes one or all from \{B_{p1,m}, ..., B_{pN,m}\}.