Novelty vs. Potential Heuristics: A Comparison of Hardness Measures for Satisficing Planning

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Motivation

- Correlation complexity (Seipp et. al 2016) and novelty width (Lipovetzky and Geffner, 2012; 2014) are different approaches to quantify the hardness of planning tasks
- These measures are not closely related
- Provide a measure that is closely related to both

Potential Heuristics

A **potential heuristic** is a heuristic that is computed with a weighted count of the partial assignments that agree with the given state.

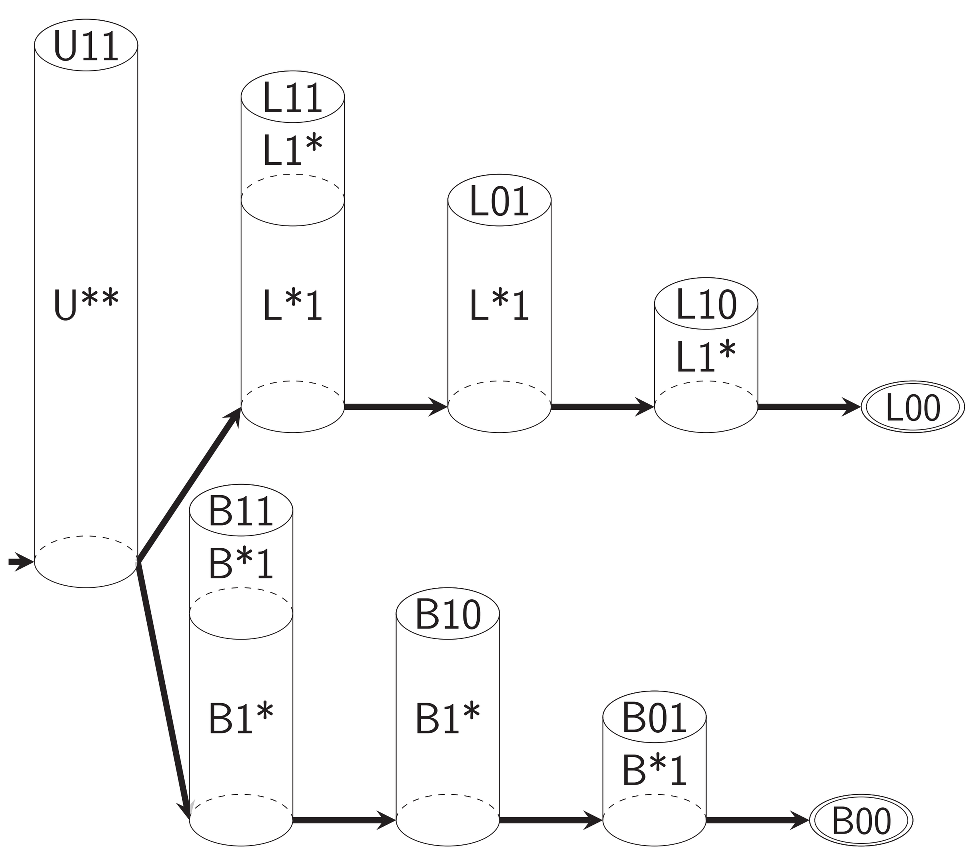
$$h^{pot}(s) = \sum_{p \in \mathcal{P}} (w(p) \cdot [p \subseteq s])$$

The **dimension** of h^{pot} is $max_{p\in\mathcal{P}, w(p)\neq 0}|p|$.

Correlation Complexity vs. River Measure

Correlation complexity:

- alive = reachable + solvable
- What dimension is required to construct a potential heuristic where all descending paths from **all alive states** lead to a goal?



Initial state I = U11

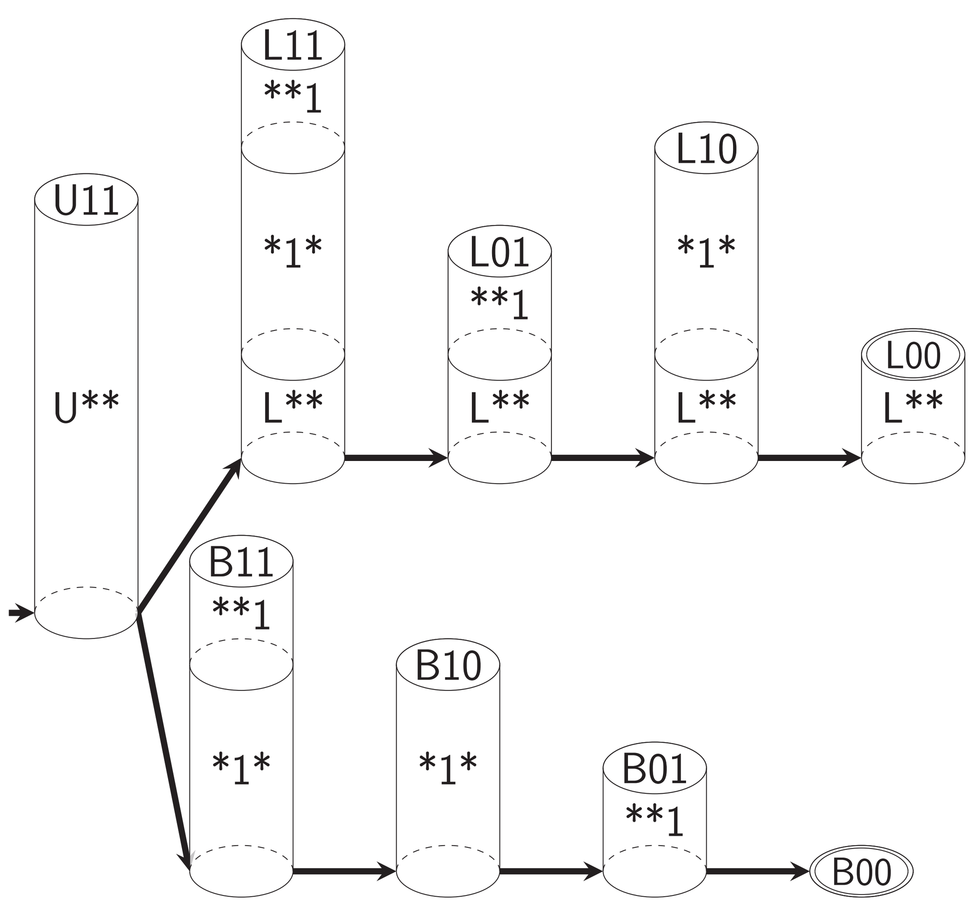
Goal γ = *00

p	$w(p)$
U^{**}	5
$L1^{*}$	1
$L^{*}1$	2
$B1^{*}$	2
$B^{*}1$	1

dimension = 2

River Measure:

- What dimension is required to construct a potential heuristic where all descending paths from **the initial state** lead to a goal?



p	$w(p)$
U^{**}	4
L^{**}	1
$^{*}1^{*}$	2
$^{**}1$	1

dimension = 1

Novelty Width

- Novelty width is the smallest k that guarantees to find a plan with novelty width search:

if $\gamma \subseteq I$:
  return *extractPlan*(I)
open := [I]
closed := $\{p \mid p \subseteq I, |p| = k\}$
while *open* $\neq \emptyset$:
  s := pop first element of *open*
  foreach $s' \in$ *successors*(s):
    if $\gamma \subseteq s'$:
      return *extractPlan*(s')
    if $\exists q \subseteq s'$ with $|q| = k, q \notin$ *closed*:
      insert each $p \subseteq s'$ with $|p| = k$ in *closed*
      append s' to *open*
return fail, k is not sufficiently large

Comparison

Novelty width is not comparable to correlation complexity.

- NW(Π') < CC(Π') for some Π'
- NW(Π'') > CC(Π'') for some Π''

River measure is comparable to both.

- RM(Π) $\leq$ NW(Π) + 1
- RM(Π) $\leq$ CC(Π)

River measure is a bridge to compare novelty width and correlation complexity.

Novelty Width vs. River Measure

- Construct h^{pot} to prove RM(Π) $\leq$ NW(Π) + 1
- States of plan found with novelty width search: $\pi_0, \pi_1, \ldots, \pi_L$
- Pick weights such that π_i is the only improving successor of π_{i-1}