Correlation Complexity of Classical Planning Domains

Jendrik Seipp Florian Pommerening Gabriele Röger Malte Helmert
University of Basel

Motivation

How complex must a heuristic be to guide
a forward search directly to the goal?

- What does "guide directly to the goal" mean?
  $\rightarrow$ descending and dead-end avoiding
- How can we measure the complexity of a heuristic?
  $\rightarrow$ dimension of potential heuristics

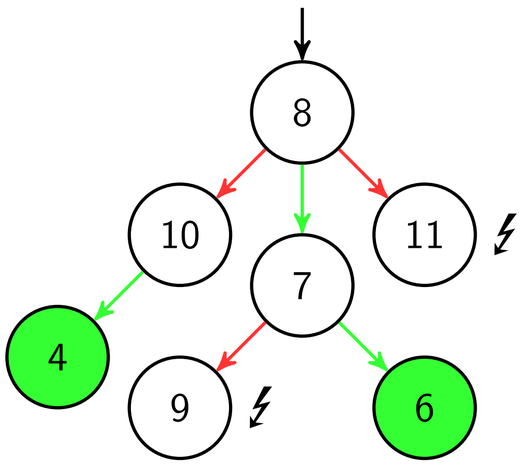
Related Concepts

- (macro-)persistent Hamming width (Chen and Giménez, 2007; 2009)
- serialized iterated width (Lipovetzky and Geffner, 2012; 2014)

comparisons to correlation complexity in the paper

Heuristic Properties

- alive state: reachable + solvable + non-goal
- descending: all alive states have an improving successor
- dead-end avoiding: all improving successors of alive states are solvable



Potential Heuristics

$$\varphi(s) = \sum_{F \in \mathcal{F}} w(F)[s \models F]$$

- features $\mathcal{F}$: conjunctions of facts
- weight function w: assigns numeric value to each feature
- heuristic value φ: sum of a state's feature weights
- dimension: size of largest feature

Correlation Complexity

- correlation complexity of a planning **task**:
  minimum dimension of a descending, dead-end avoiding potential heuristic for the task
- correlation complexity of a planning **domain**:
  maximal correlation complexity of all tasks in the domain

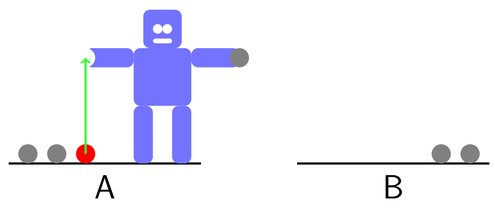
Domains with Correlation Complexity 2

- Blocksworld-no-arm
- Gripper
- Spanner
- VisitAll

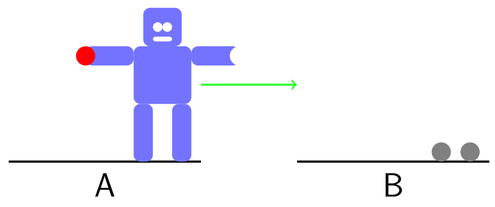
Gripper has Correlation Complexity 2

Weight Function

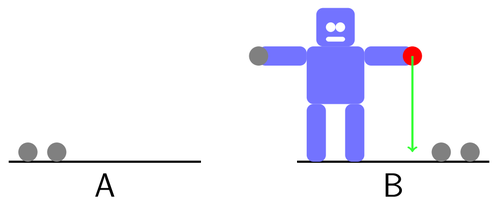
$$w(\text{r-in-B}) = 1$$
$$w(\text{b-in-A}) = 8$$
$$w(\text{b-in-G}) = 4$$
$$w(\text{r-in-B} \wedge \text{b-in-G}) = -2$$



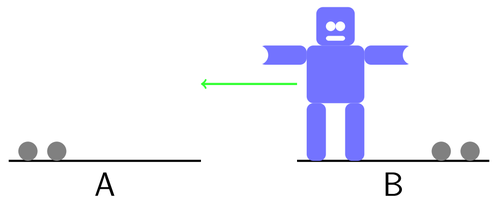
adds: b-in-G
removes: b-in-A
difference: $+4 - 8 = -4$



adds: r-in-B, r-in-B $\wedge$ b-in-G
removes: —
difference: $+1 + (-2) = -1$



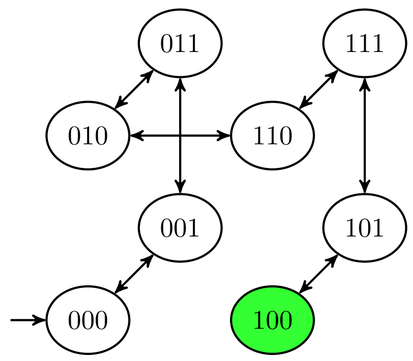
adds: —
removes: b-in-G, r-in-B $\wedge$ b-in-G
difference: $-4 - (-2) = -2$



adds: —
removes: r-in-B
difference: -1

Example Task with Correlation Complexity 3

- 3-bit Gray code:



Conclusion and Future Work

- All studied benchmark domains have correlation complexity 2.
- Find good features and weights automatically.