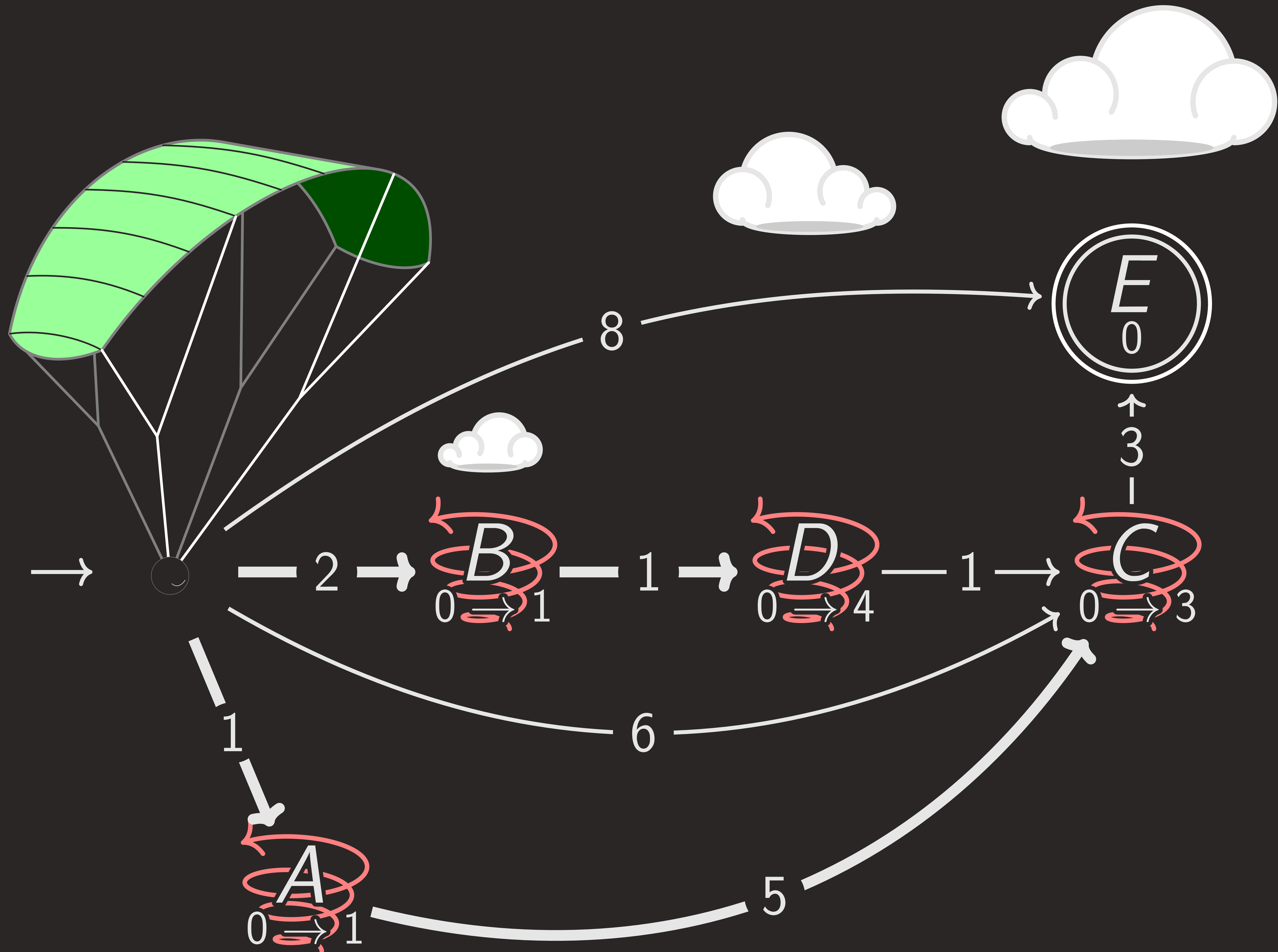
Dynamic Heuristics and Optimal Search



A Formalism for Optimal Search with Dynamic Heuristics

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Dynamic Heuristic

$$h\colon \text{States} \times \text{Information} \to \mathbb{R}_{\geq 0} \cup \{\infty\}$$

- h is **DYN-✱** if h is ✱ for every (reachable) information
- h is **DYN-monotonic** if $h(s, I) \leq h(s,$ update$(I))$ and $h(s, I) \leq h(s,$ refine$(I))$

Optimal Solution

DYN-A* with a **DYN-admissible** h returns optimal solutions.

No Reopening

DYN-A* with re-eval check and a **DYN-monotonic**, **DYN-consistent** h does not reopen states.

DYN-A*

initialize
while open is not empty **do**
  refine
  re-eval check
  goal check
  for all successors **do**
    update
    insert into open

Proof Approach

Follow **classic proofs** while referring to **time stamps** in the pseudo code that mark **changing information**.

Conditions for **soundness** and **completeness** in terms of generalized DYN-A*.

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Applications

- Lazy A* (Zhang and Bacchus 2012; Tolpin et al. 2013)
- LTL_f trajectory constraints (Simon and Röger 2015)
- Online abstraction refinement (Eifler and Fickert 2018)
- Interleaved search (Franco and Torralba 2019)
- Landmark progression (e.g., Büchner et al. 2023)

Applying Results

- define dynamic heuristic
- properties hold initially
- properties are preserved

Future

- integrate g-values
- cover deferred evaluation
- study optimal efficiency