Tiebreaking Strategies for A* Search

: How to Explore the Final Frontier

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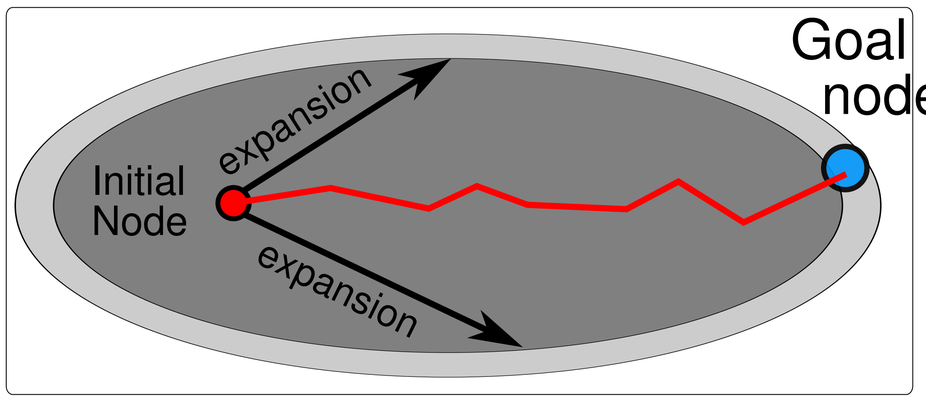
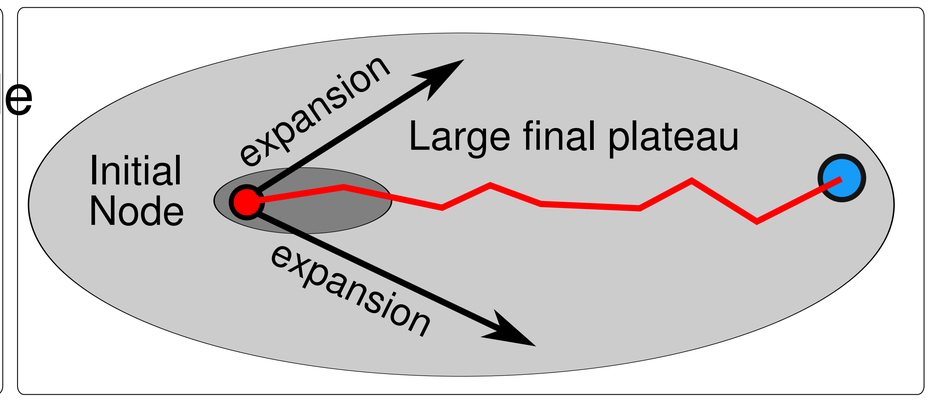
1. Search Space wrto f value: **Tiebreaking Quite Important**

f > f* (entire search space, A* never expands outside ellipse)
f = f* (some nodes are expanded by A*)
f < f* (all nodes are expanded by A*)

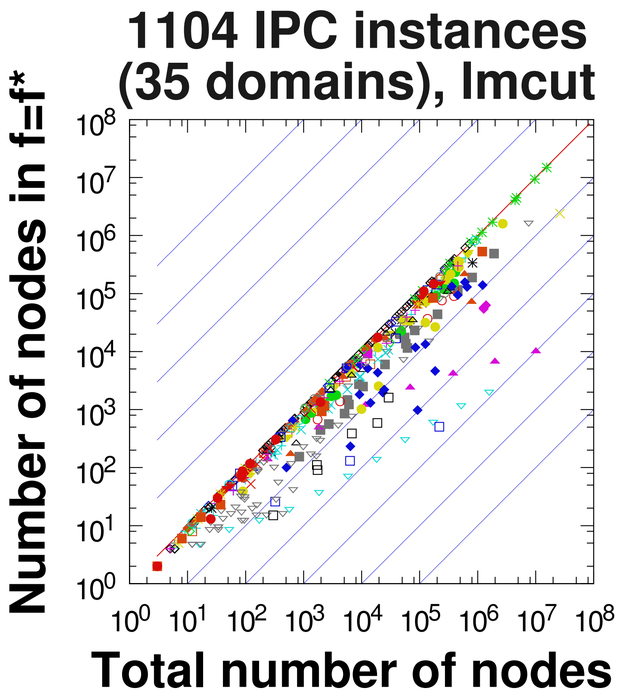
Optimal solution



Grid Pathfinding etc.
Small f=f* plateau
→ Tiebreaking unimportant

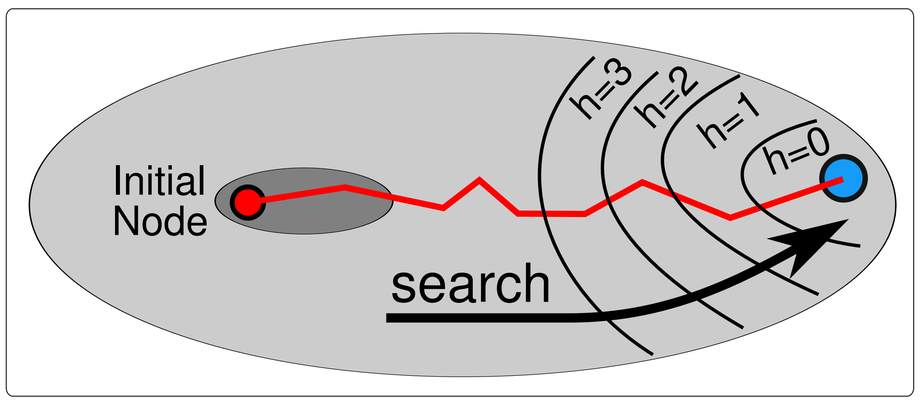


Planning Problems:
Almsot ALL nodes in f=f* plateau
→ Tiebreaking quite important



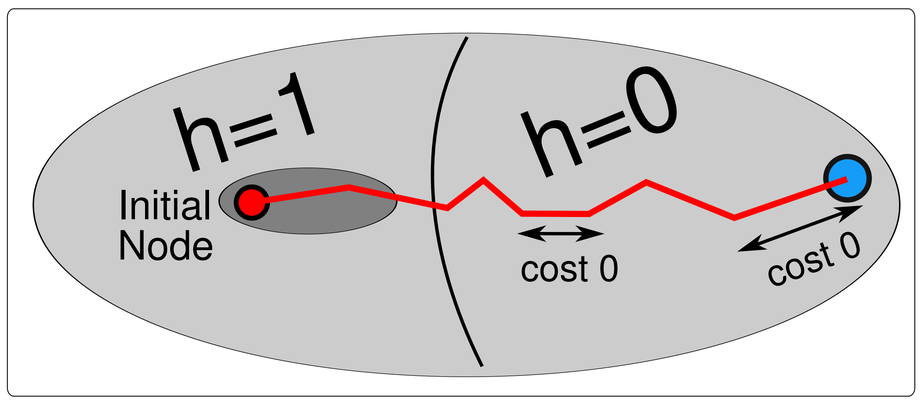
2. h tiebreaking (std. method) can fail with 0-cost edges

Domains with Positive Action Costs only

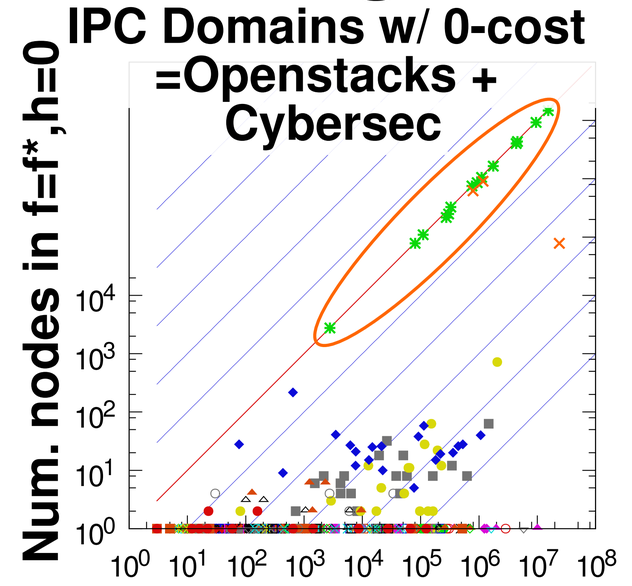


h-based tiebreaking
gives heuristic guidance

Domains with 0-cost Actions

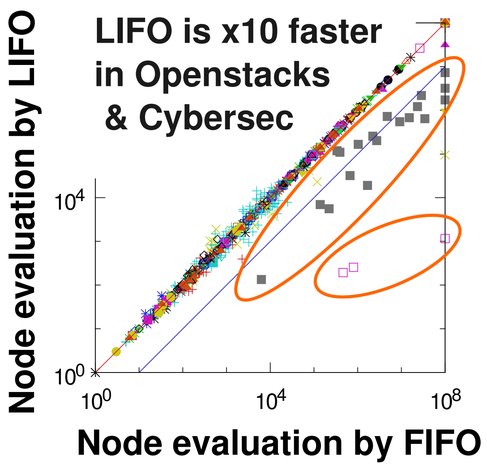


Almost ALL nodes in h=0
h-tiebreaking does not work



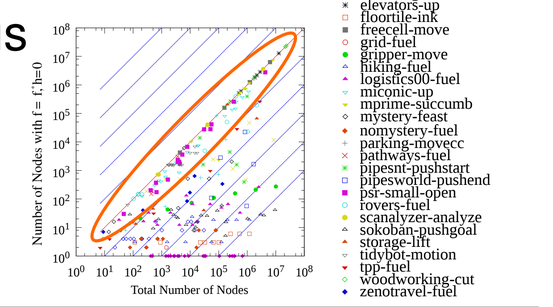
3. h-tiebreaking is underspecified: LIFO/FIFO makes difference with Zero-cost actions

- Many nodes with same f value **and h value**
- A* must select exactly one node
- Many solvers use either LIFO/FIFO
- Many papers do not mention this detail
- Huge performance difference by LIFO/FIFO in domains with zero-cost actions



4. Unit-cost IPC (num. step) → Zerocost (resource usage)

- More realistic resource optimization domains
  - Resource-consuming actions: positive cost
  - 0-cost otherwise
  - e.g. Driverlog: minimize fuel
    (drive-truck: cost>0, other actions: cost=0)
- 620 new instances (28 domains)
- Larger h=0 plateaus overall



5. Improve upon LIFO: RandomDepth

- Divide Final Plateau (f=f*,h=0) into layers
- LIFO = Depth-first = select largest depth
- FIFO = Breadth-first = select smallest depth
- Bias → pathological behavior ∴ Diversify it
- Selecting the depth at random: RandomDepth

	Domain Set	[h, FIFO] (FD Default)	[h, LIFO]	[h, RD, RO] (Proposed)
LMcut	IPC Instances (1104)	558	565	**572.8 (↑ 14.8)**
	Zerocost Instances(680)	256	279	**294.2 (↑ 38.2)**
	Sum(1724)	814	844	**867.0 (↑ 53.0)**
M&S	IPC Instances (1104)	479	**488**	484.0 (↑ 5.0)
	Zerocost Instances(680)	276	290	**310.2 (↑ 34.2)**
	Sum(1724)	755	778	**794.2 (↑ 39.2)**