Bounded Suboptimal Search

A Direct Approach Using Inadmissible Estimates

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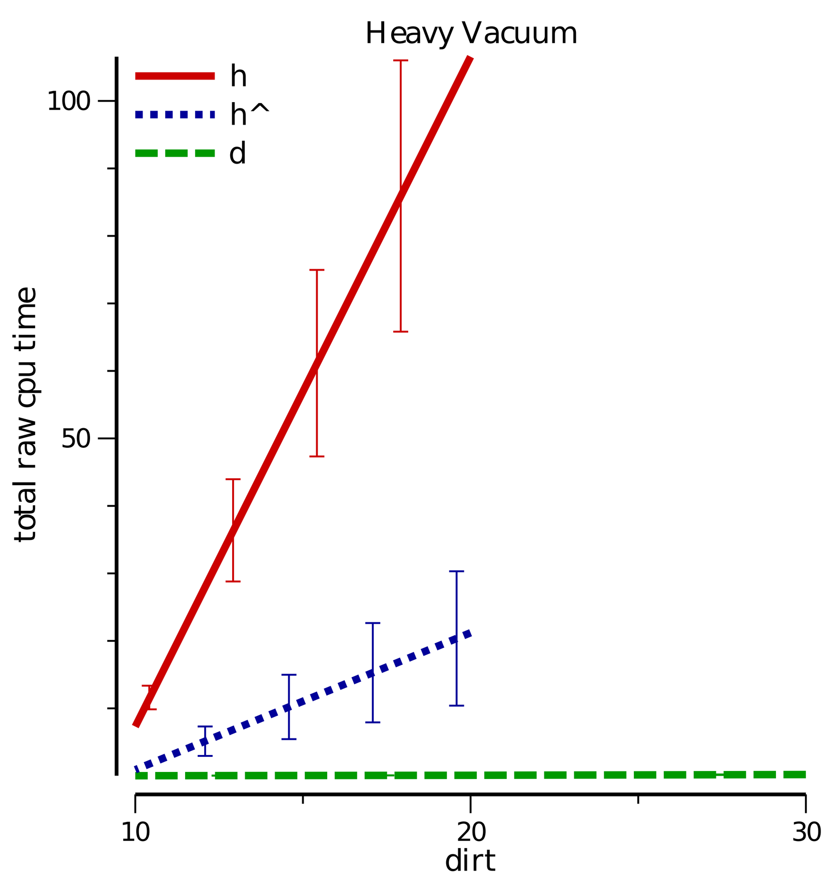
How do we get fast search without abandoning guarantees on quality?

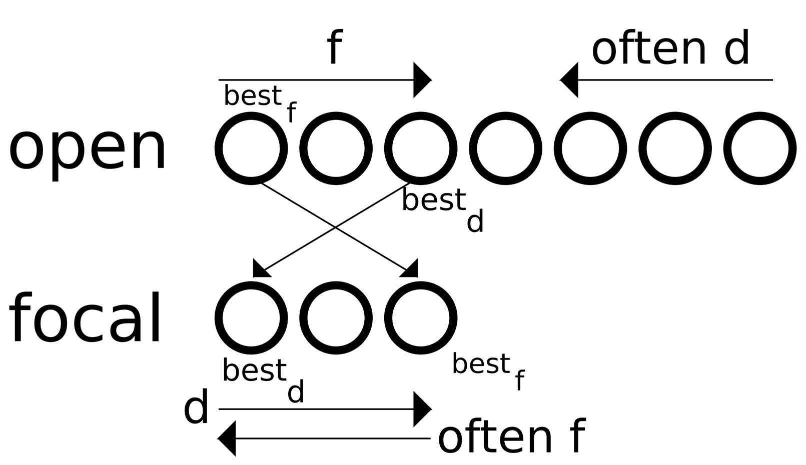
Inadmissible heuristics, including estimates of solution length, can improve the performance of search algorithms.

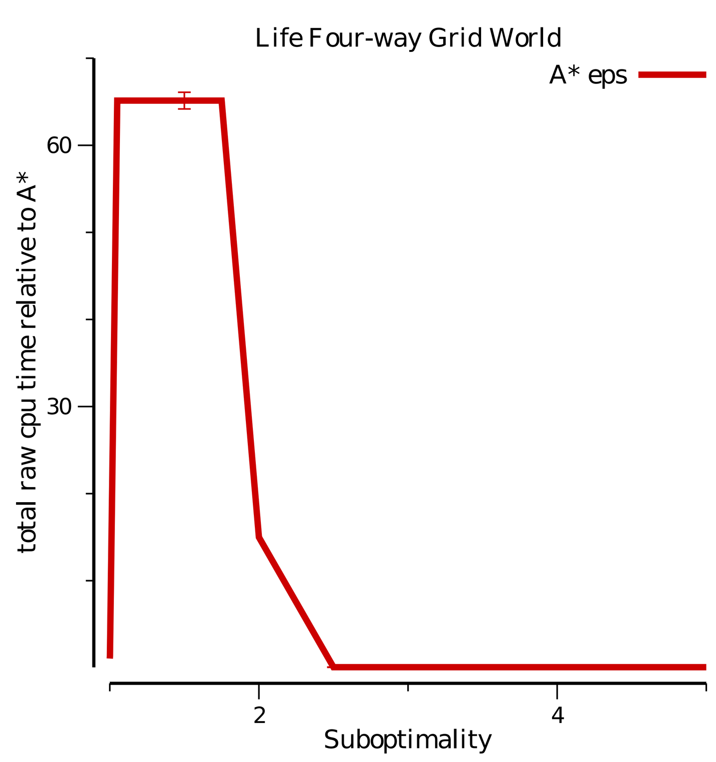


Previous Approach

A^*_ϵ (Pearl and Kim, 1982) expands the node closest to the goal that is within the suboptimality bound.

It can perform poorly.

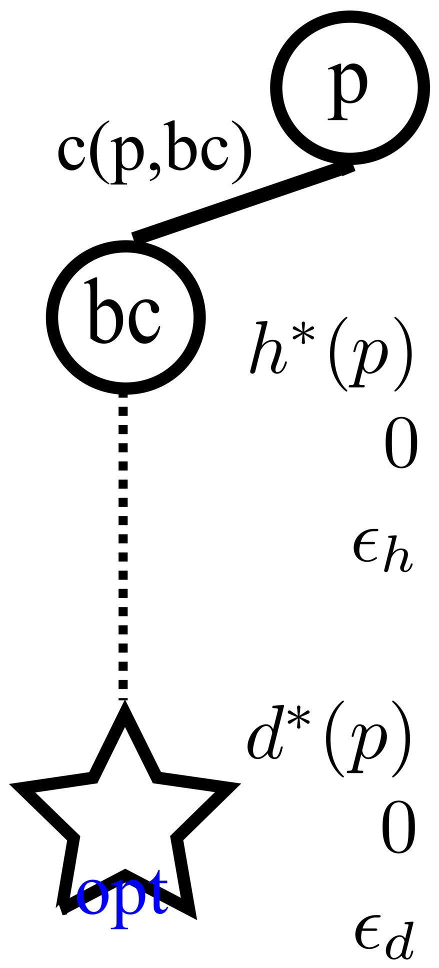




Because h underestimates, f will rise along any path. The children of nodes on focal rarely remain on focal as a result.

Improving Heuristics

Observe behavior of heuristics during search and make improved estimators.



$$h^*(p) = h^*(bc) + c(p, bc)$$
$$0 = h^*(bc) + c(p, bc) - h^*(p)$$
$$\epsilon_h = h(bc) + c(p, bc) - h(p)$$

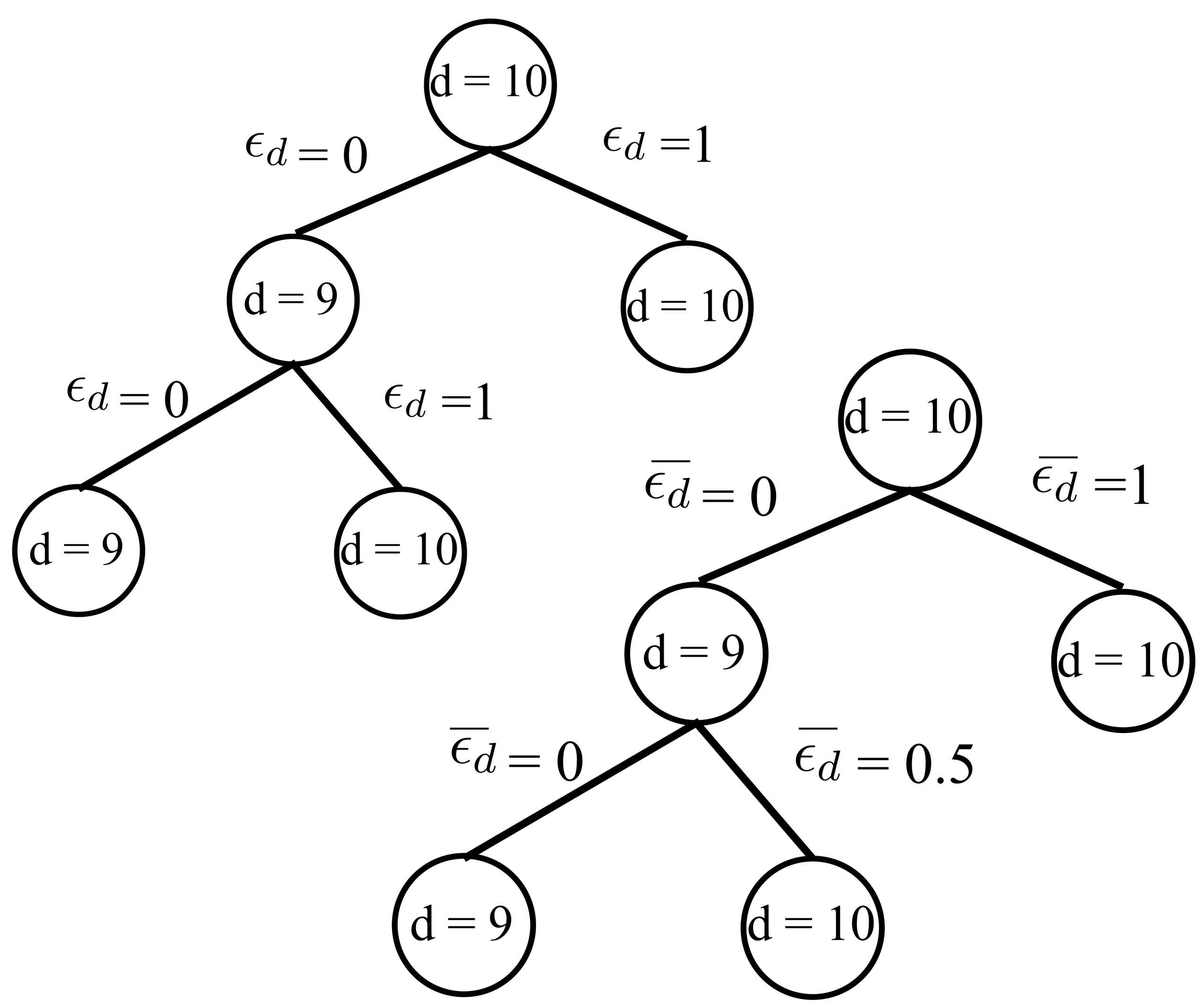
$$d^*(p) = d^*(bc) + 1$$
$$0 = d^*(bc) + 1 - d^*(p)$$
$$\epsilon_d = d(bc) + 1 - d(p)$$

$$d^*(s) = \frac{d(s)}{1-\bar{\epsilon}_d}$$

$$h^*(p) = h(p) + d^*(p) \cdot \bar{\epsilon}_h$$

Mean single step error can be estimated *during* search!

Aggregate error as search progresses.



Then, divide by the depth of the node.

Explicit Estimation Search

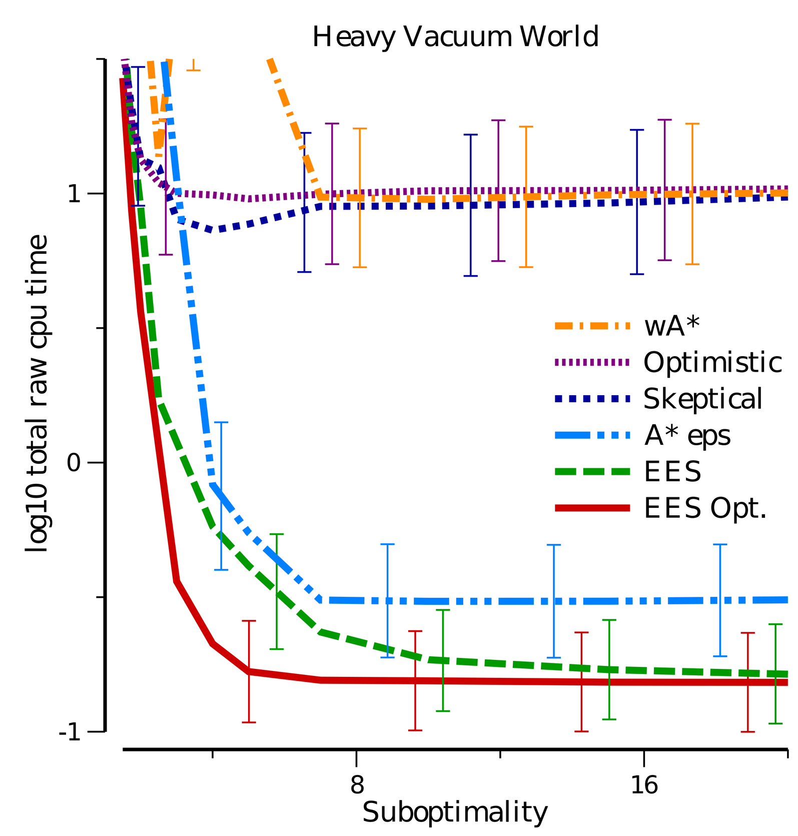
$best_{\widehat{f}}$ node with minimum $\widehat{f}$ our best estimate of optimal cost

$best_{\widehat{d}}$ node with minimum $\widehat{d}$ nearest w-admissible solution

$best_f$ node with minimum f a lower bound on optimal cost

$selectNode(best_{\widehat{d}}, best_{\widehat{f}}, best_f)$

1. **if** $\widehat{f}(best_{\widehat{d}}) \leq w \cdot f(best_f)$ **then** $best_{\widehat{d}}$
2. **else if** $\widehat{f}(best_{\widehat{f}}) \leq w \cdot f(best_f)$ **then** $best_{\widehat{f}}$
3. **else** $best_f$



Using inadmissible cost and distance estimates provides state of the art performance

and robust behavior not present in other bounded suboptmial search algorithms.