Artificial Intelligence (CS6380)

State Space Search

IDA*: iterative deepening A*

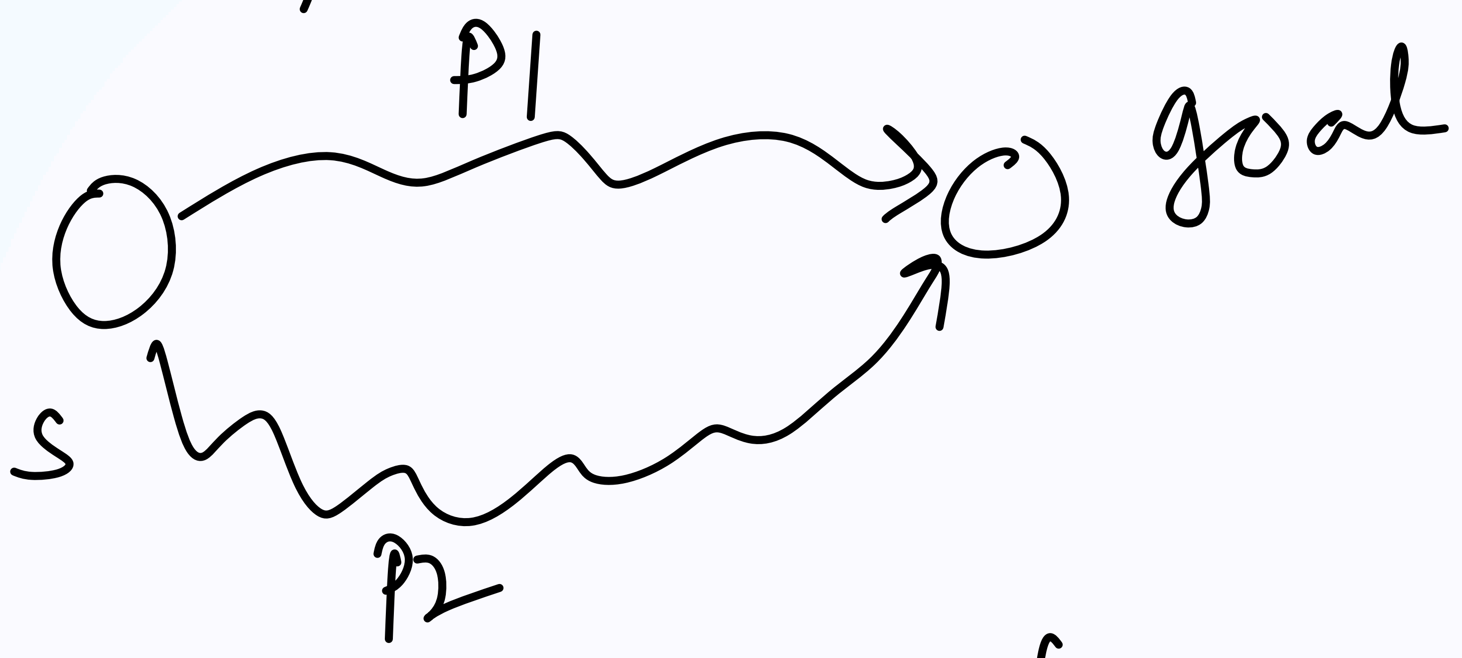
```
path               current search path (acts like a stack)
node               current node (last node in current path)
g                  the cost to reach current node
f                  estimated cost of the cheapest path (root..node..goal)
h(node)            estimated cost of the cheapest path (node..goal)
cost(node, succ)   step cost function
is_goal(node)      goal test
successors(node)   node expanding function, expand nodes ordered by g + h(node)
ida_star(root)     return either NOT_FOUND or a pair with the best path and its cost

procedure ida_star(root)
    bound := h(root)
    path := [root]
    loop
        t := search(path, 0, bound)
        if t = FOUND then return (path, bound)
        if t = ∞ then return NOT_FOUND
        bound := t
    end loop
end procedure

function search(path, g, bound)
    node := path.last
    f := g + h(node)
    if f > bound then return f
    if is_goal(node) then return FOUND
    min := ∞
    for succ in successors(node) do
        if succ not in path then
            path.push(succ)
            t := search(path, g + cost(node, succ), bound)
            if t = FOUND then return FOUND
            if t < min then min := t
            path.pop()
        end if
    end for
    return min
end function
```

pseudocode from wikipedia.

Assume that state space is finite and goal is reachable from start.

Claim: IDA* computes optimal path.

Proof sketch: When can IDA* give suboptimal path $c_1 = cost(p1)$, $c_2 = cost(p2)$.



p1 is optimal but bound is incremented s.t

$b_0 < b_1 < \ldots b_i < c_1 < c_2 < b_{i+1}$

bound jump is too high

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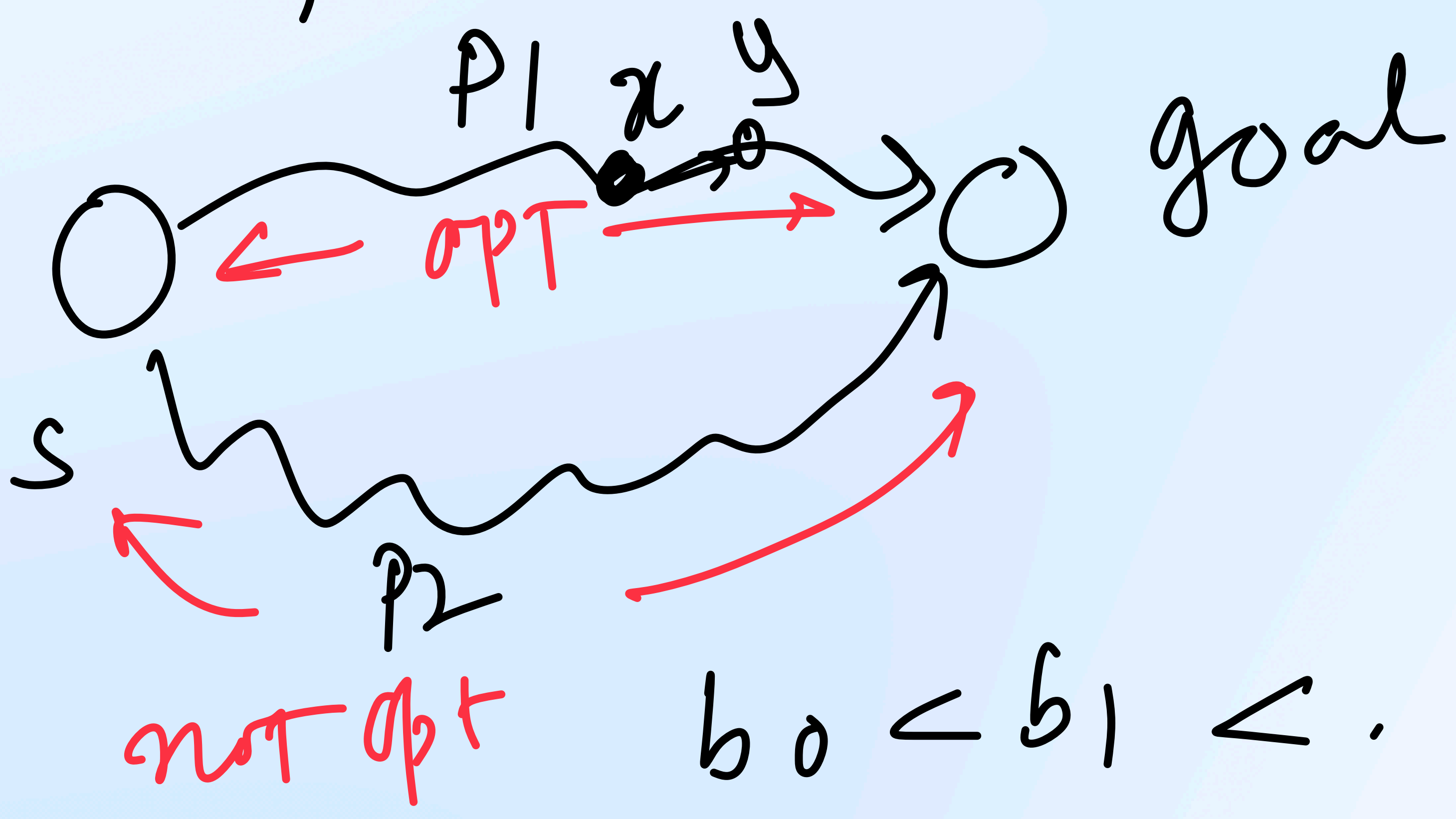

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we claim that such a jump in bounds is not possible.

- why?
- we know that when algo begins, $f(start) = b_0$ = bound.
- Assume that till the ith iteration $\exists$ some node x on p_1 s.t. $f(x) \leq b_i$
- we know that in ith iteration x was expanded

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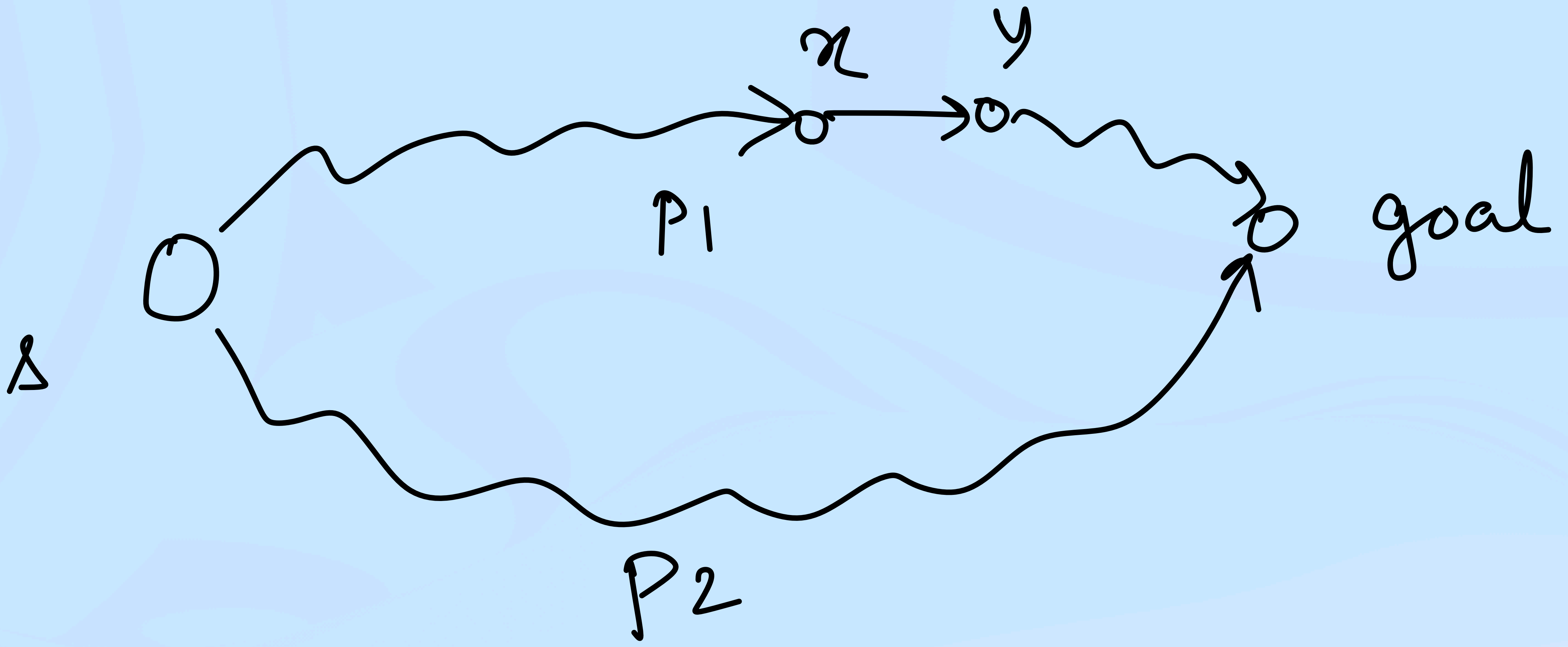

$cost(p_1) = c_1 = c^* =$ optimal cost

$cost(p_2) = c_2 > c_1$

- We know x was expanded in ith iteration (when bound $= b_i$)
- What was a candidate value bound b_{i+1}

$f(y) = g(s \rightsquigarrow x \rightarrow y) + h(y, goal)$

$= g^*(s, y) + h(y, goal)$

this is because p_1 is optimal path

$\leq g^*(s,y) + h^*(y, goal)$

$\leq c_1 = c^*$.

This implies that the value of $b_{i+1} \leq c_1$ a contradiction to the fact that $b_{i+1} > c_2$