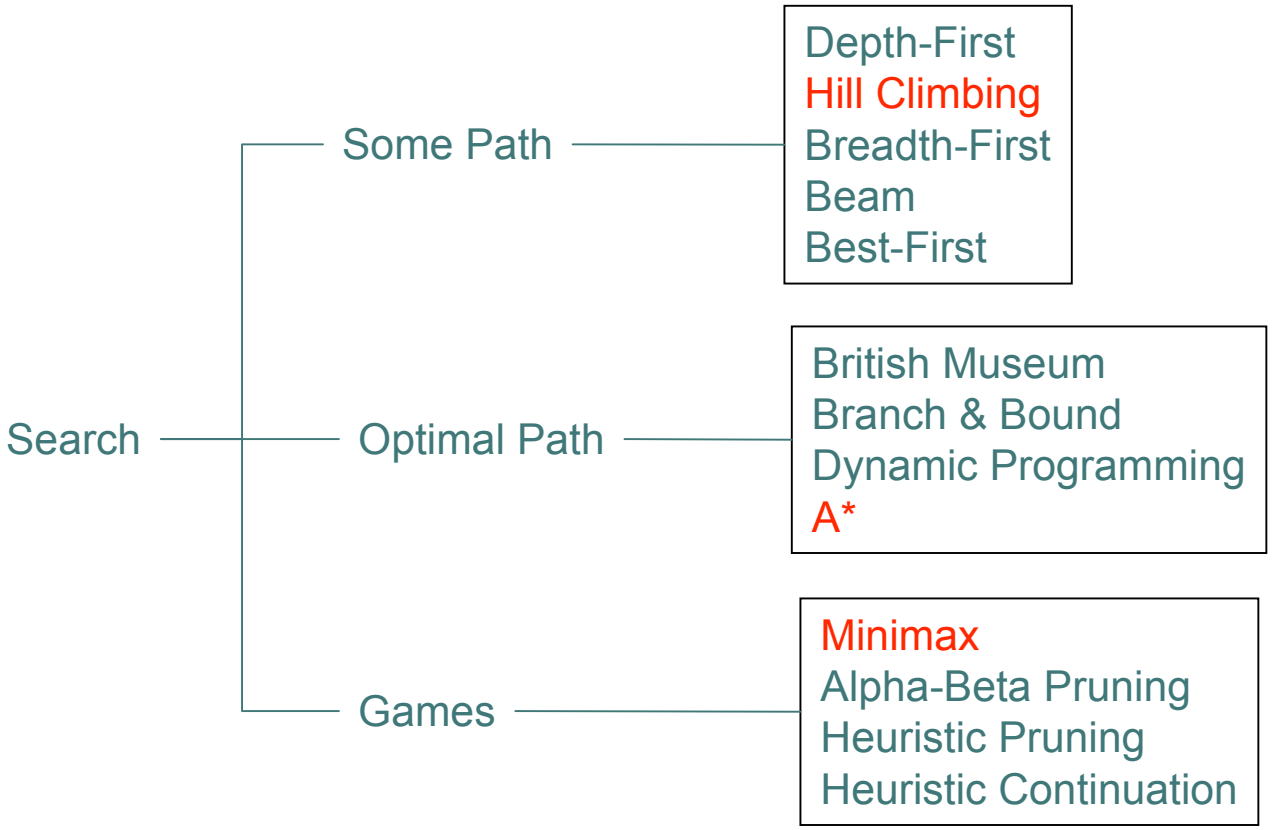
Searching & Planning

- Searching is about <u>exploring alternatives</u>.
  - Uninformed search
    - Does not use heuristics to speed up the search
    - Potentially wastes a lot of time looking at completely unviable solutions
    - “brute force” search
  - Informed search
    - Does use a heuristic to speed up the search (e.g. manhattan distance in A*)
    - Only explores viable solutions

➢ Most AI search procedures are informed search procedures; the search spaces are usually too big to consider brute force search.

Searching & Planning



Source: Artificial Intelligence, P. Winston, Addison-Wesley, 1984

A*: Another Perspective

- Form a queue of partial paths. Let the initial queue consist of the zero-length, zero-step path from the starting position to nowhere.
- Until the queue is empty or the goal is reached, determine if the first path in the queue reaches the goal.
  - If the first path reaches the goal, do nothing.
  - If the first path does not reach the goal:
    - Remove the first path from the queue.
    - Form new paths from the removed path by extending one step.
  - Add the new paths to the queue.
  - Sort the queue by the *sum of cost accumulated so far* and a *lower-bound (manhattan distance bound) of the cost remaining*, with least cost paths in front.
  - *If two or more paths reach a common node, delete all those paths except for one that reaches the common nodes with the minimum cost.*
- If the goal node has been reached, announce success; otherwise announce failure.

Hill-Climb Search

- Enter the starting position on queue
- Until the queue is empty or the goal has been reached, determine if the first element is the goal.
  - If the first element is the goal, do nothing
  - If the first element is not the goal node, remove the first element from the queue, *sort the first element's children, if any, by the estimated remaining distance*, and add the sorted set of children to the front of the queue (least cost in front).
- If the goal has been reached, announce success, otherwise announce failure.

Adversarial Search

- All the search procedures considered so far assume that the goal is static.
- However, this is not a realistic assumption in games.
  - In games the opponent reacts to the player's moves in such a way as to maximize his/hers own gain.
  - We need search procedures that take this into account.
- In adversarial search we want to take the possible reactions of the opponent into account:
  - Assume that opponent is rational, that is, the opponent wants to maximize their own gain.
  - This means when searching for alternatives we want to select alternatives that maximize our own gain but minimize that of the opponent → minimax search

Minimax

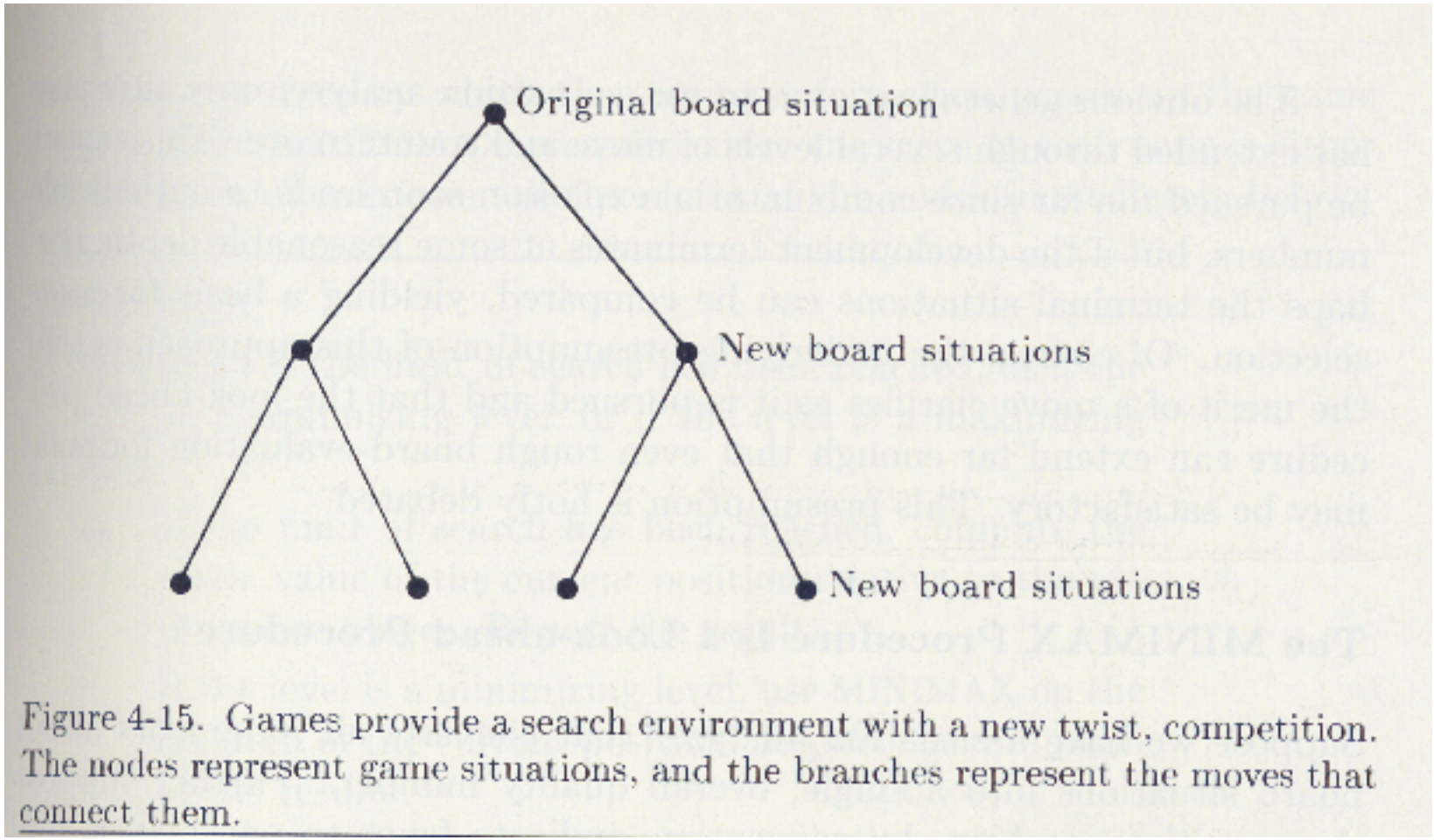
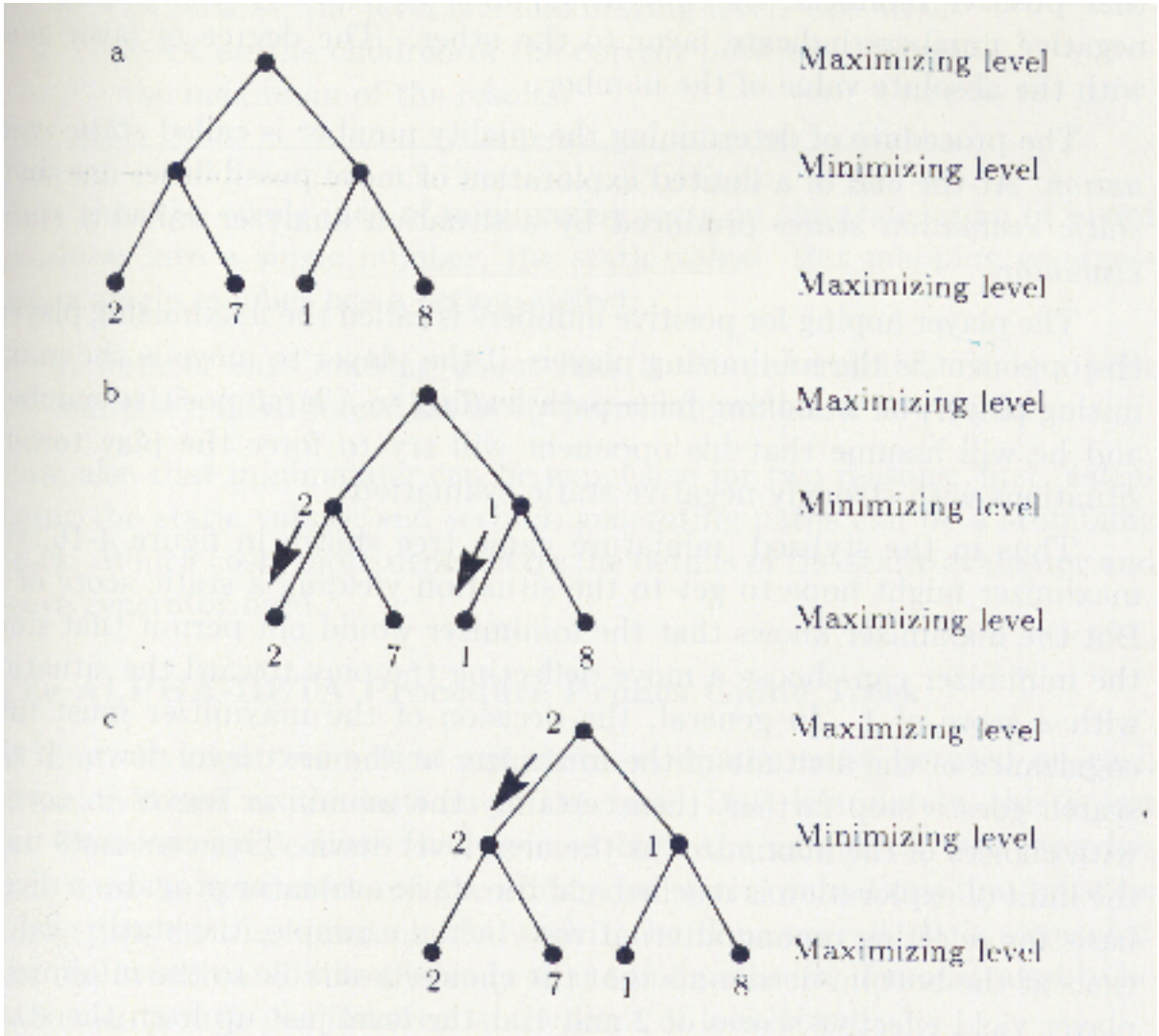


Figure 4-15. Games provide a search environment with a new twist, competition. The nodes represent game situations, and the branches represent the moves that connect them.

Minimax


a
Maximizing level
Minimizing level
Maximizing level
2
7
1
8
b
Maximizing level
Minimizing level
Maximizing level
2
1
2
7
1
8
c
Maximizing level
Minimizing level
Maximizing level
2
2
1
2
7
1
8