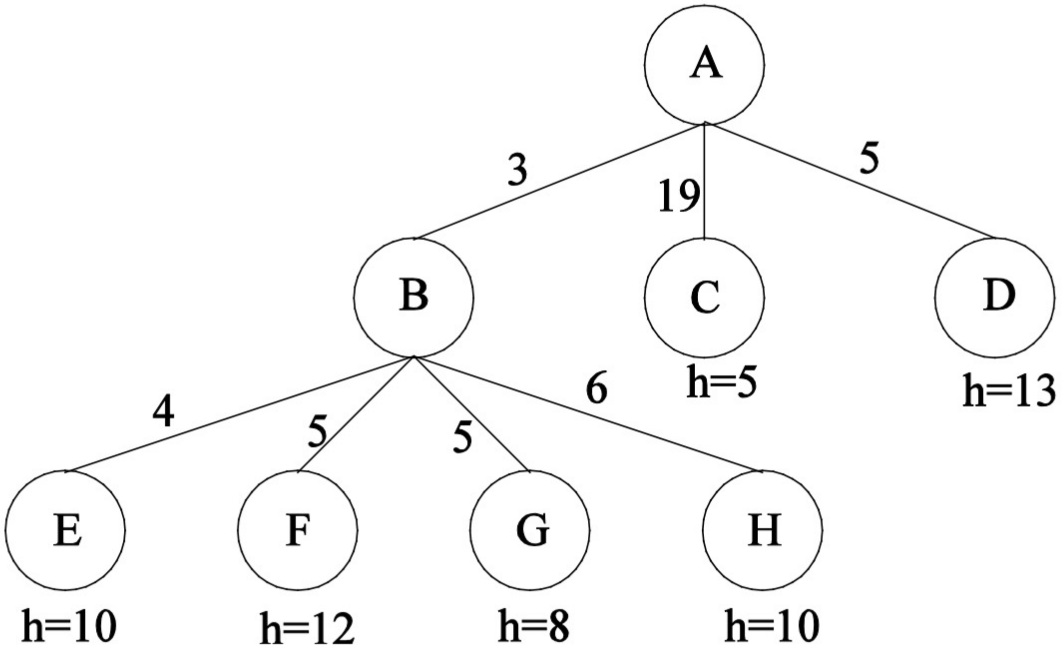
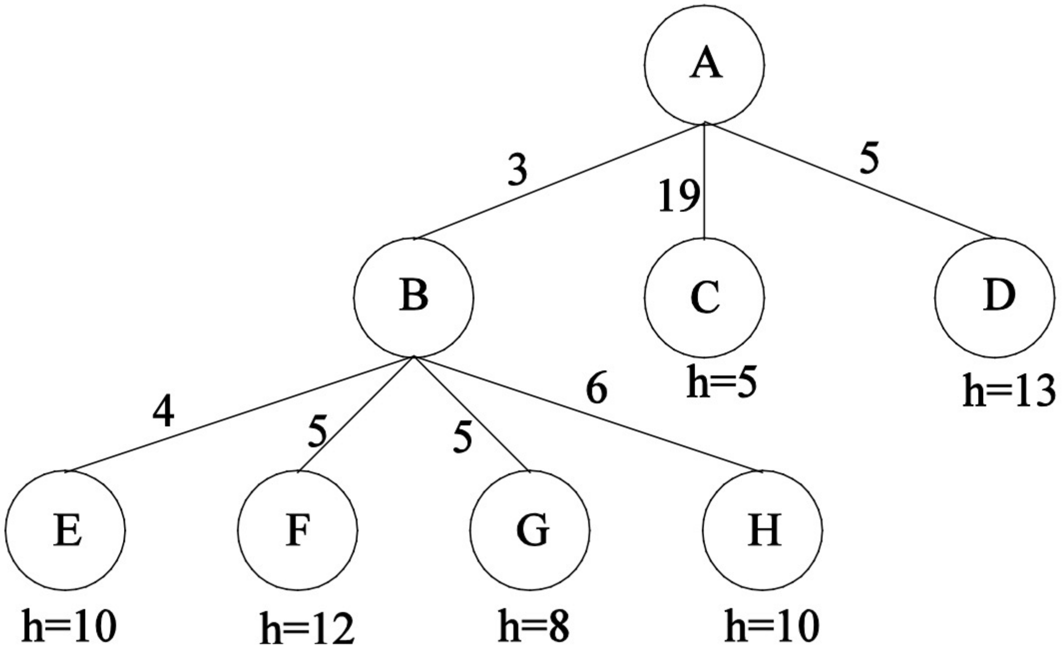
Midterm Practice

Exercises



Consider the following search tree produced after expanding nodes A and B, where each arc is labeled with the cost of the corresponding operator, and the leaves are labeled with the value of a heuristic function, h. For uninformed searches, assume children are expanded left to right. In case of ties, expand in alphabetical order.

Exercises



Which leaf node will be expanded next by each of the following search methods?

- Depth-First search
  - E
- Greedy Best-First search
  - C (smallest h)
- Uniform-cost search
  - D (smallest g value)
- A* search
  - G (smallest g+h value)

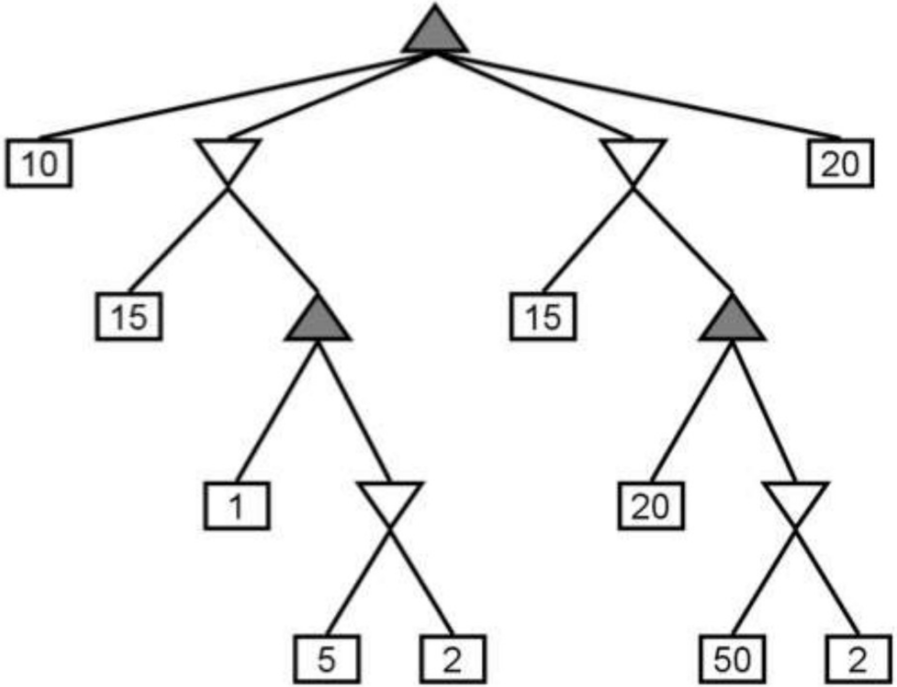
Exercises

- If g(s) and h(s) are two admissible A* heuristics, then is f(s) = ½ g(s) + ½ h(s) admissible?
  - TRUE: Let h*(s) be the true distance from s. We know that g(s) <= h*(s) and h(s) <= h*(s), thus f(s) <= ½ h*(s) + ½ h*(s). We can simplify to f(s) <= h*(s).
- For a search problem, the path returned by uniform cost search may change if we add a positive constant C to every step cost
  - TRUE: Consider the following costs: S to A: 4 A to G: 5 S to G: 10 Now, Consider that there are two paths from the start state (S) to the goal (G), S → A → G (total cost = 9) and S → G (total cost = 10). The optimal path is through A. Now, if we add 2 to each of the costs, the optimal path is directly from S to G with the cost of 12. Since uniform cost search finds the optimal path, its path will change.

Exercises

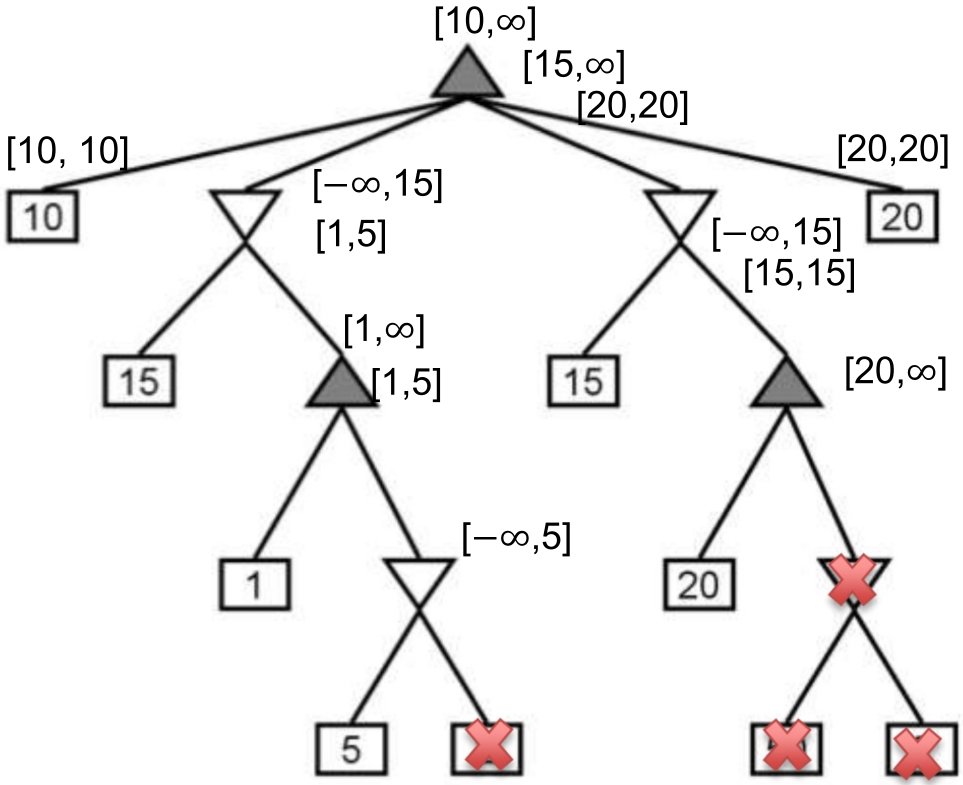
- The first-order expression $(\exists x\ x{=}x) \Rightarrow (\forall y\ \exists z\ y{=}z)$ is a valid sentence.
  - TRUE: The premise is true for any model in which there is an object. Since there is an object in the model, then for every y we can find a z (namely, the object referred to by y) that is the same as y.
- Smoothing is needed in a Naive Bayes classifier to compute the maximum likelihood estimates of P (feature | class).
  - FALSE: Smoothing converts maximum likelihood estimates into smoothed estimates.

Exercises



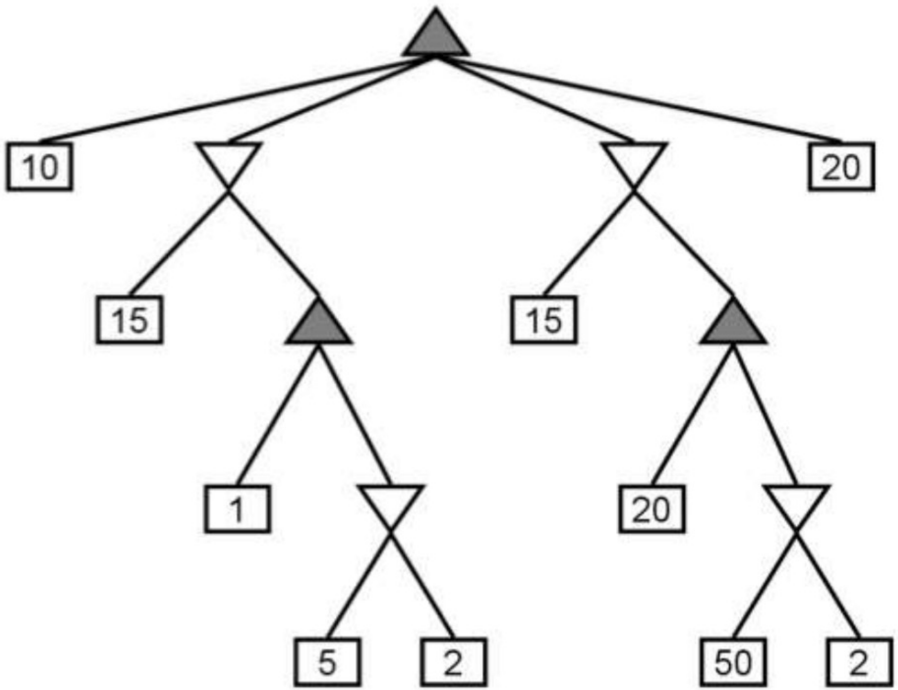
- Minimax value for root?
  - 20

Exercises



- Draw an X through any nodes which will not be visited by alpha-beta pruning, assuming children are visited in left-to-right order.

Exercises



- Is there another ordering for the children of the root for which more pruning would result? If so, state the order.
  - Yes, if we had most left child is 20

Exercises

Suppose you are given the following axioms:

a. `0 ≤ 3.`

b. `7 ≤ 9.`

c. `∀ x   x ≤ x.`

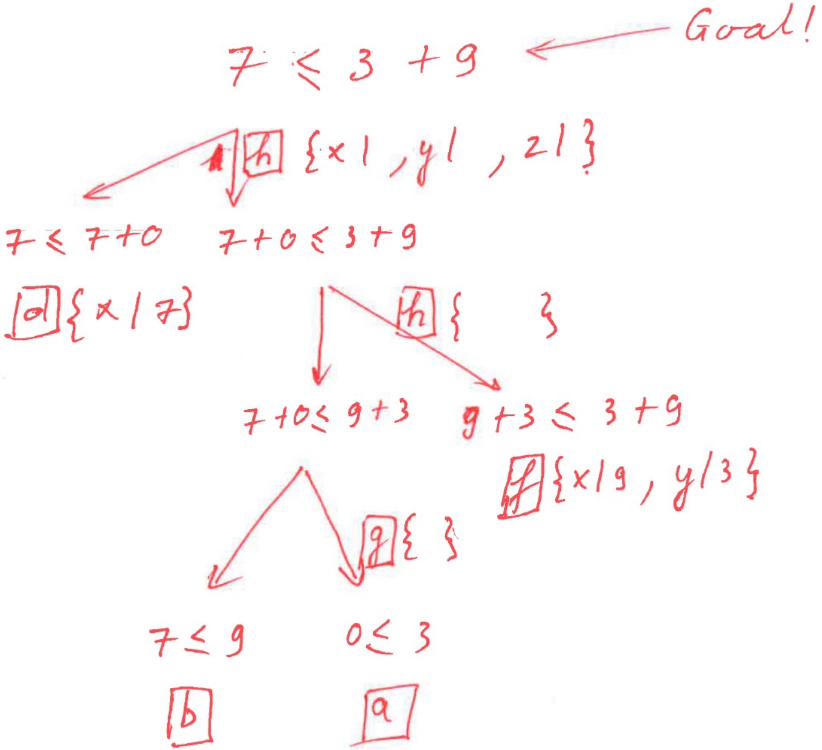
d. `∀ x   x ≤ x + 0.`

e. `∀ x   x + 0 ≤ x.`

f. `∀ x, y      x + y ≤ y + x.`

g. `∀ w, x, y, z      w ≤ y ∧ x ≤ z ⇒ w + x ≤ y + z.`

h. `∀ x, y, z   x ≤ y ∧ y ≤ z ⇒ x ≤ z`



Give a backward-chaining proof of the sentence 7 ≤ 3 + 9

Exercise

- You’ve been hired to build a quality control system to decide whether car engines coming off an assembly line are bad or ok. However, this decision must be based on three noisy boolean observations: the engine may be wobbly (motion sensor), rumbly (sound sensor), or hot (heat sensor). Each sensor gives a Boolean observation: true or false.
  You formalize the problem using the following variables and domains:
  Cause: B ∈ {bad, ok}
  Evidence: W, R, H ∈ {true, false}
  You reason that a naive Bayes classifier is appropriate (conditional independence), and build one which predicts P(B|W, R, H).

Exercise

(a) Under the naive Bayes assumption, write an expression for P(b|w, r, h) in terms of only probabilities of the forms P(b), P(w|b), P(r|b), and P(h|b).

- $P(b|w,r,h) = \frac{P(w,r,b|b) * P(b)}{P(w,r,h)}$
- $P(w,r,h|b) = P(w|b) * P(r|b) * P(h|b)$
- $P(w,r,h) = \sum_{b'} P(w,r,h,b') = \sum_{b} P(w,r,h|b') * P(b')$

- $P(b|w,r,h) = \frac{P(w|b) * P(r|b) * P(h|b) * P(b)}{\sum_{b'} P((w|b')) * P(r|b') * P(h|b') P(b')}$

Exercise

(b) The company has records for several engines which recently came off the assembly line. Estimate P(B=OK), P(B=bad), P(W|B), P(R|B), P(H|B), ...

B	W	R	H
ok	*false*	*false*	*true*
ok	*false*	*true*	*false*
ok	*false*	*true*	*false*
ok	*true*	*false*	*false*
ok	*false*	*false*	*false*
bad	*true*	*false*	*false*
bad	*true*	*true*	*false*
bad	*false*	*true*	*true*

Exercise

(c) Given this data, out of the 2 rows of the tables provided, which are the correct maximum likelihood parameters for the naive Bayes model of this domain.

$\hat{P}(B)$

bad	3/8
ok	5/8

$\hat{P}(W \mid B)$

true	*bad*	2/8
false	*bad*	1/8
true	*ok*	1/8
false	*ok*	4/8

$\hat{P}(R \mid B)$

true	*bad*	2/8
false	*bad*	1/8
true	*ok*	2/8
false	*ok*	3/8

$\hat{P}(H \mid B)$

true	*bad*	1/8
false	*bad*	2/8
true	*ok*	1/8
false	*ok*	4/8

$\hat{P}(B)$

bad	3/8
ok	5/8

$\hat{P}(W \mid B)$

true	*bad*	2/3
false	*bad*	1/3
true	*ok*	1/5
false	*ok*	4/5

$\hat{P}(R \mid B)$

true	*bad*	2/3
false	*bad*	1/3
true	*ok*	2/5
false	*ok*	3/5

$\hat{P}(H \mid B)$

true	*bad*	1/3
false	*bad*	2/3
true	*ok*	1/5
false	*ok*	4/5