Local Search

Local search methods work on complete state formulations. They keep only a small number of nodes in memory.

Local search is useful for solving optimization problems:

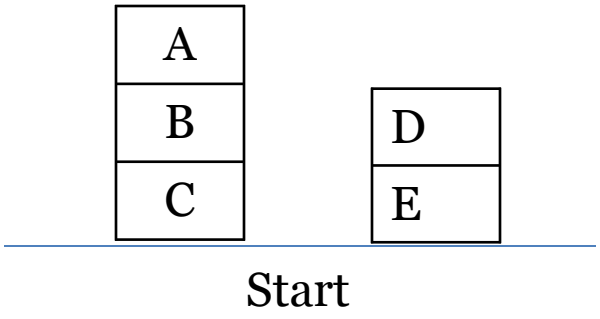
- **Often it is easy to find a solution**
- **But hard to find the best solution**

Algorithm goal: find optimal configuration (e.g., TSP),

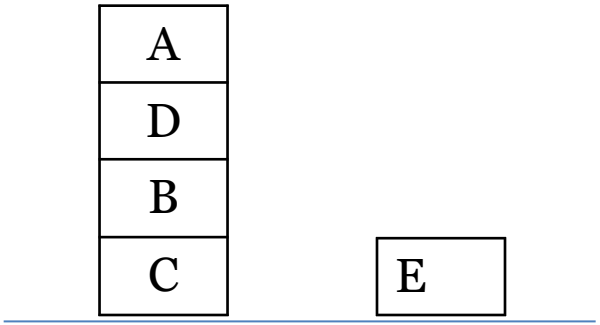
- Hill climbing
- Gradient descent
- Simulated annealing

- For some problems the state description contains all of the information relevant for a solution. Path to the solution is unimportant.
- Examples:
  - map coloring
  - 8-queens
  - cryptarithmetic

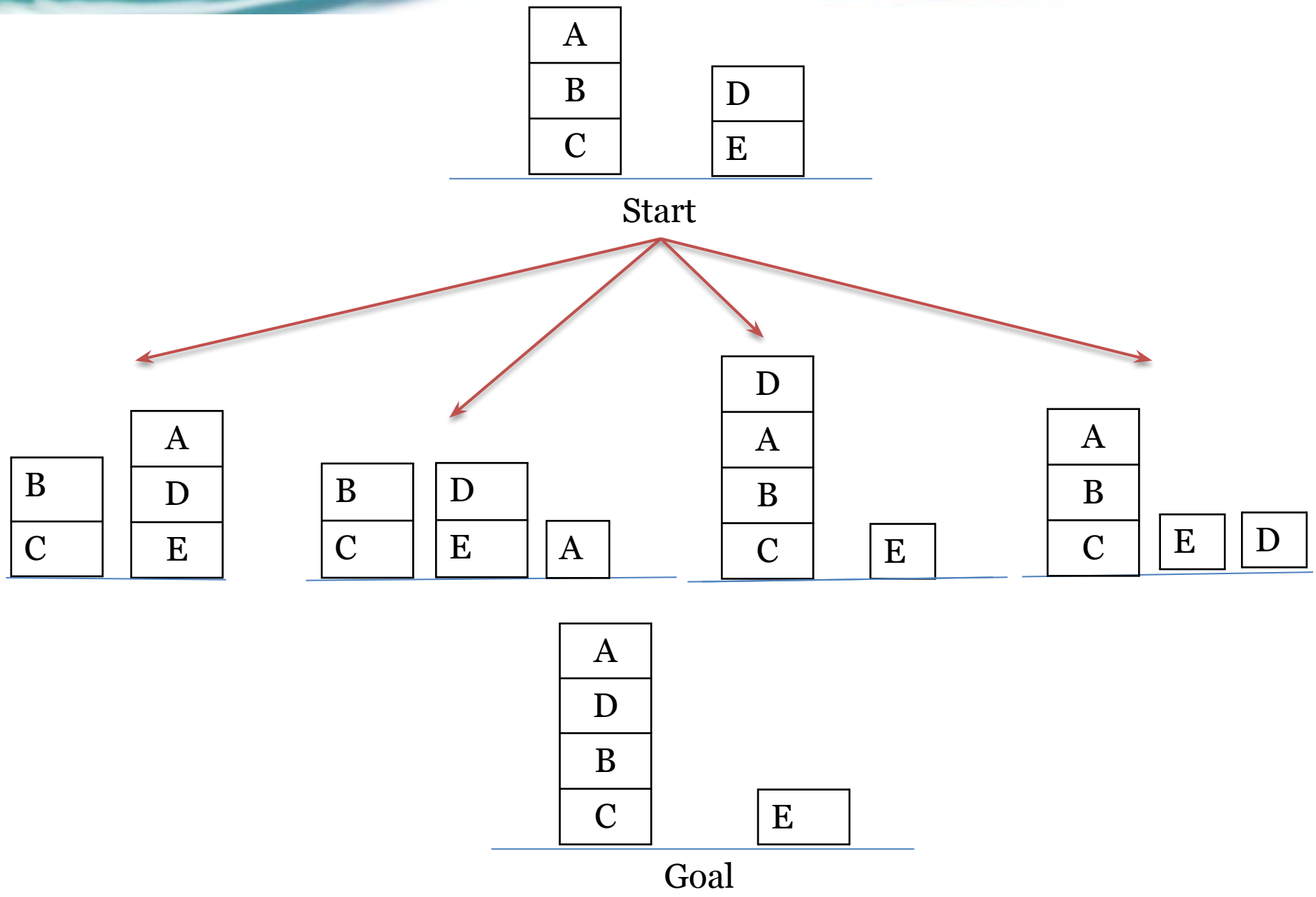
Block Worlds Domain



Start



Goal


A
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Start
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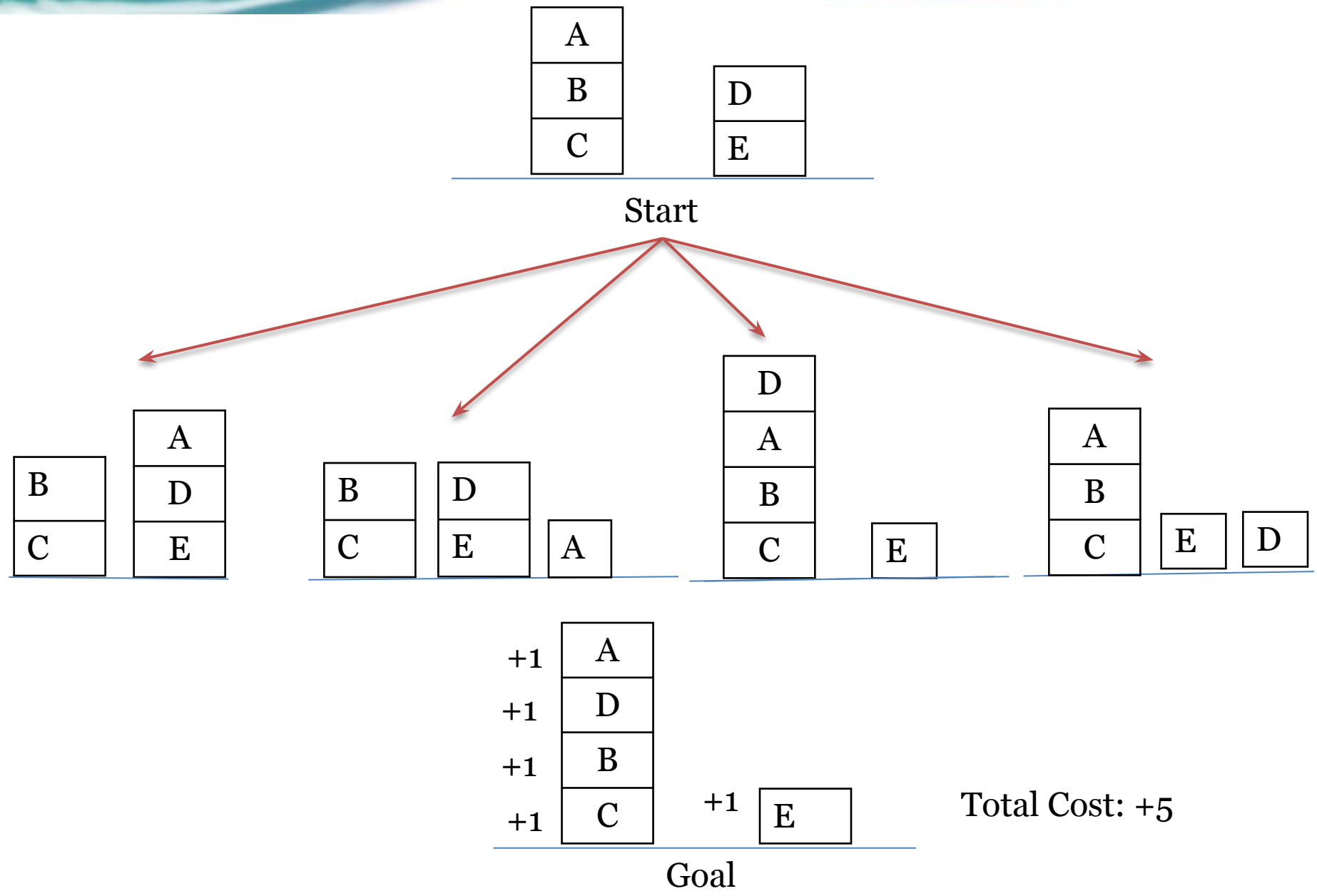
A
B
C
E
D
A
D
B
C
E
Goal

Rule: Heuristic Function

h1(n)= add 1 if the block is on the correct location
subtract 1 if the block is on the incorrect location


A
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Start
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D
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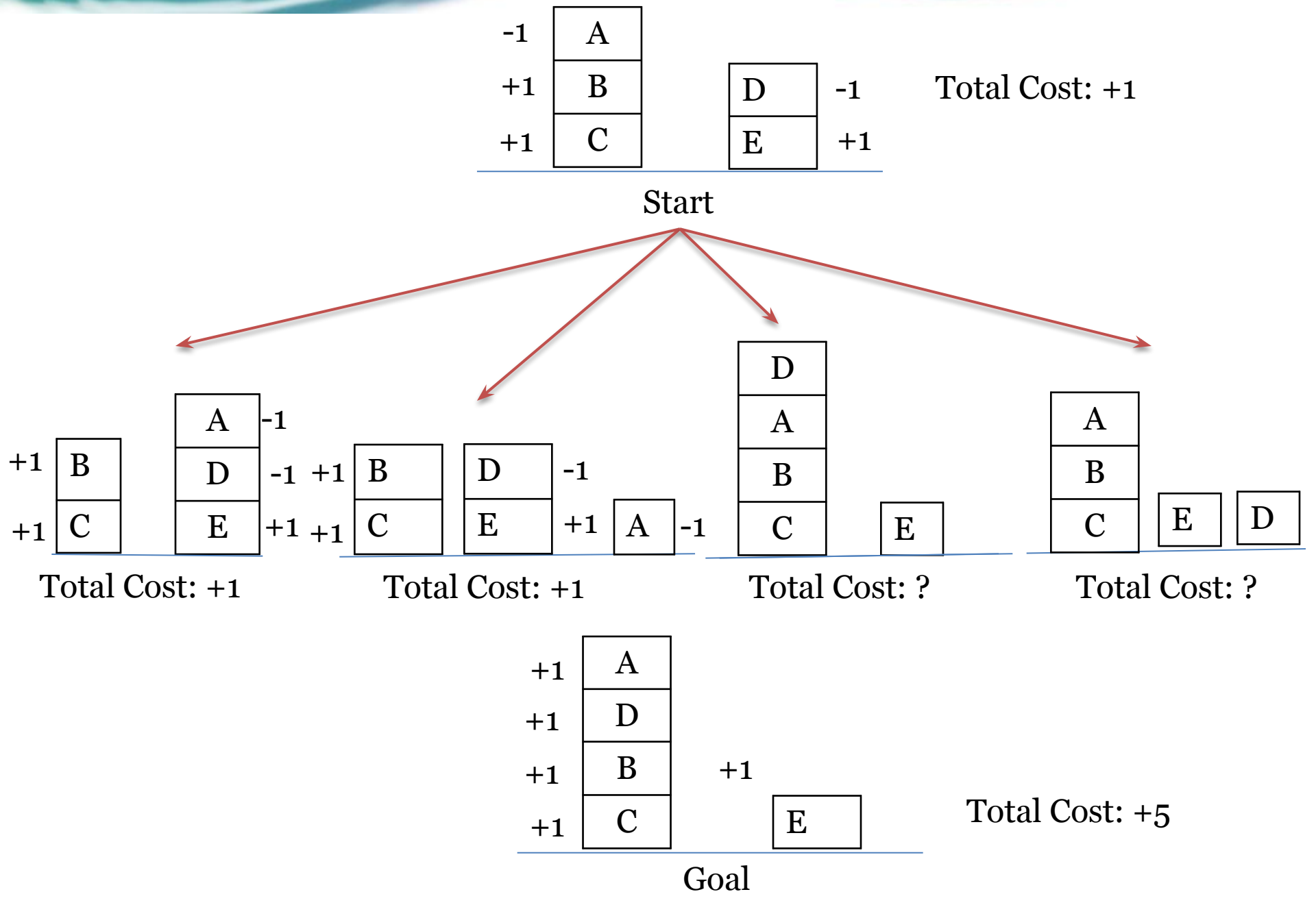
A
D
A
B
C
E
A
B
C
E
D
+1
+1
+1
+1
A
D
B
C
+1
E
Goal
Total Cost: +5


-1
A
+1
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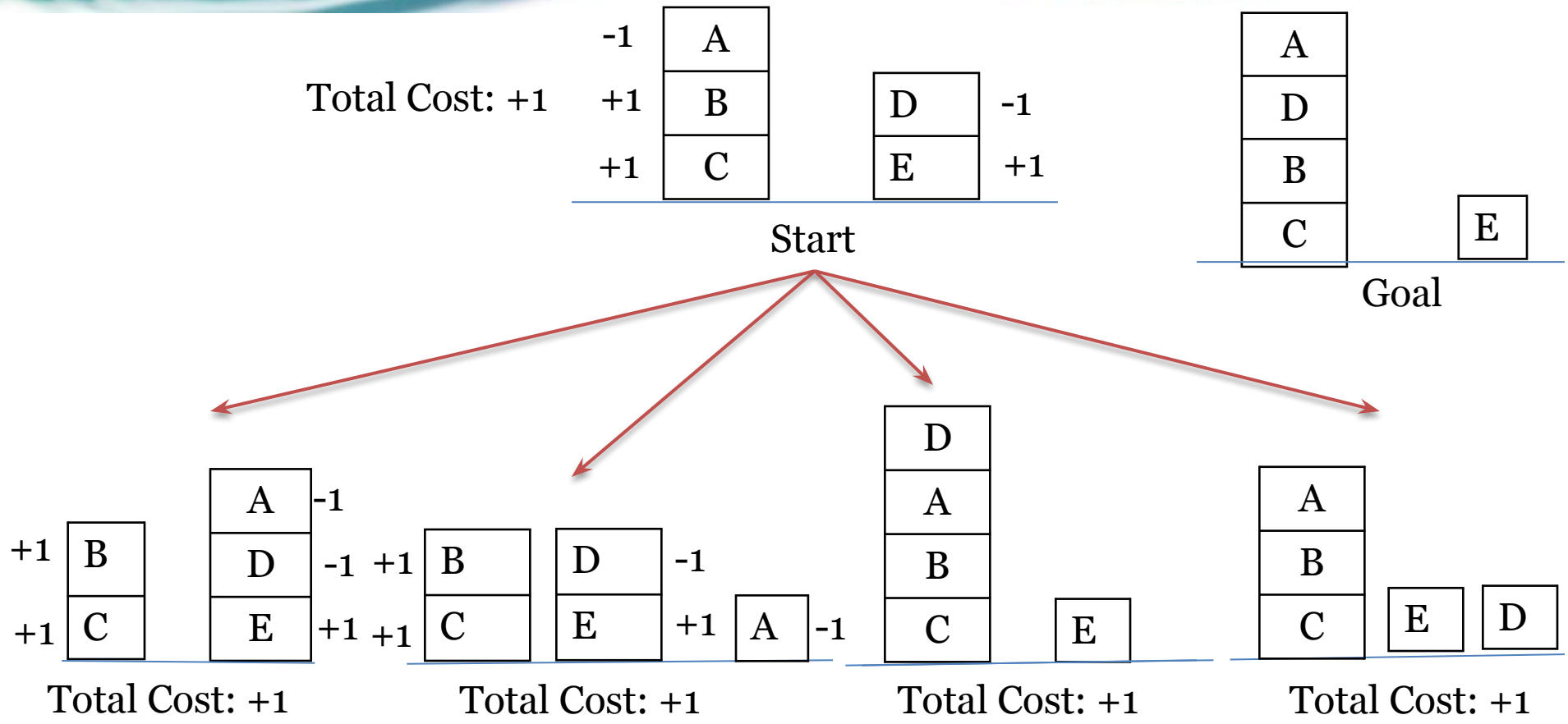
+1
C
D
-1
E
+1
Total Cost: +1
Start
+1
B
+1
C
A
-1
D
-1
E
+1
Total Cost: +1
+1
B
+1
C
D
-1
E
+1
A
-1
Total Cost: +1
D
A
B
C
E
Total Cost: ?
A
B
C
E
D
Total Cost: ?
+1
A
+1
D
+1
B
+1
C
+1
E
Total Cost: +5
Goal


Total Cost: +1
-1
+1
+1
A
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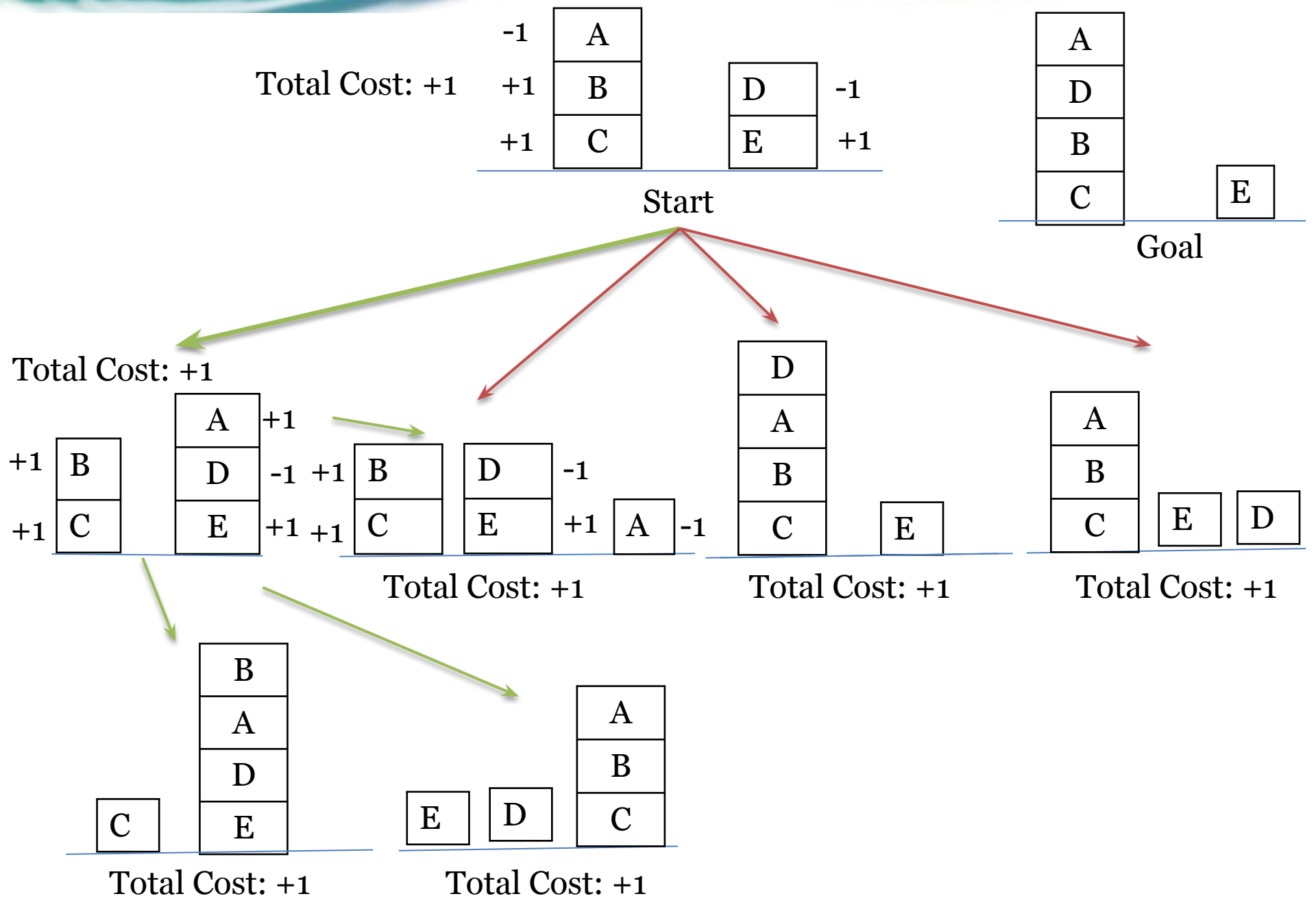
-1
+1
Start
A
D
B
C
E
Goal
+1
+1
B
C
A
D
E
-1
-1
+1
+1
Total Cost: +1
B
C
D
E
A
-1
-1
+1
+1
Total Cost: +1
D
A
B
C
E
Total Cost: +1
A
B
C
E
D
Total Cost: +1


Total Cost: +1
-1
+1
+1
A
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-1
+1
Start
A
D
B
C
E
Goal
Total Cost: +1
+1
+1
B
C
A
D
E
+1
-1
+1
+1
Total Cost: +1
+1
B
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-1
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A
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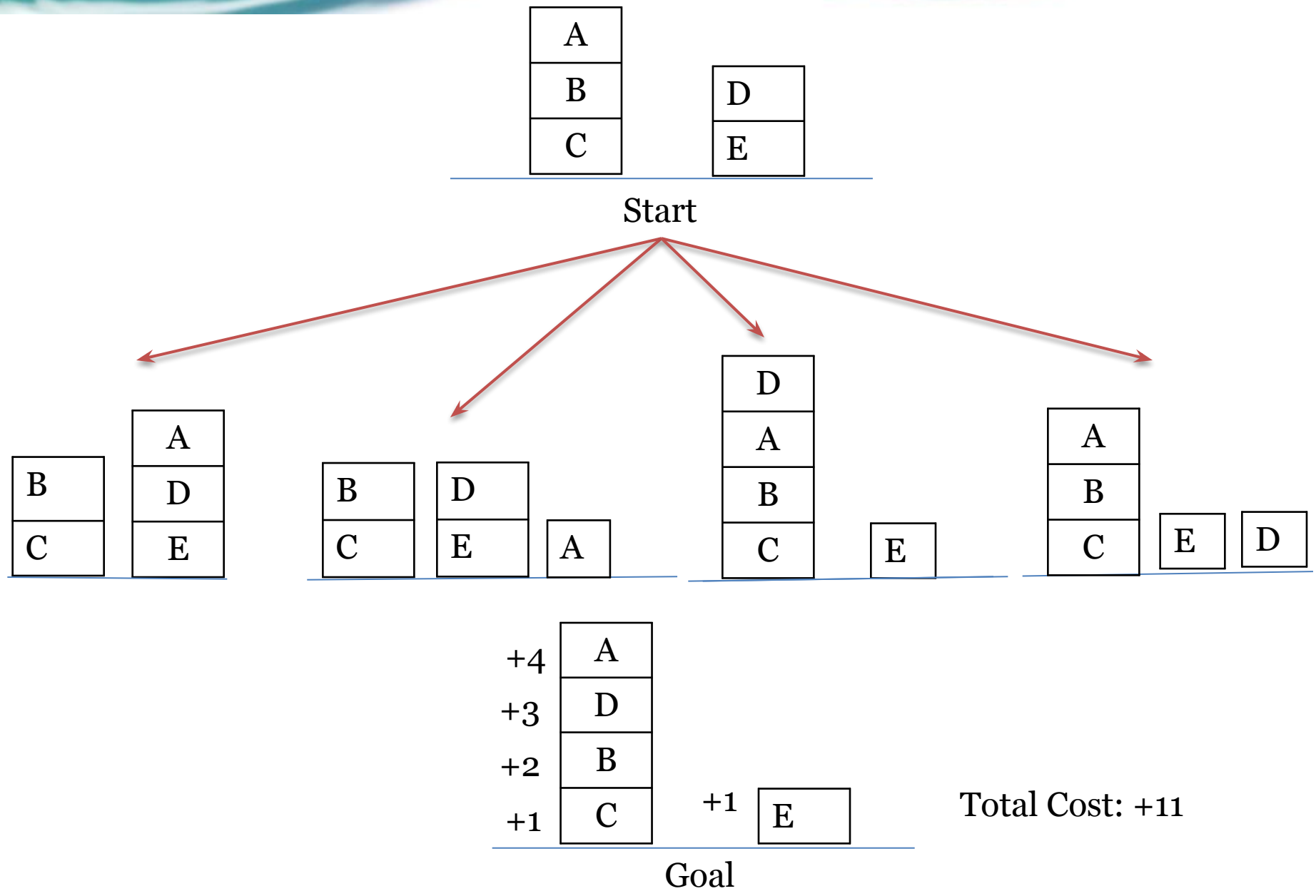
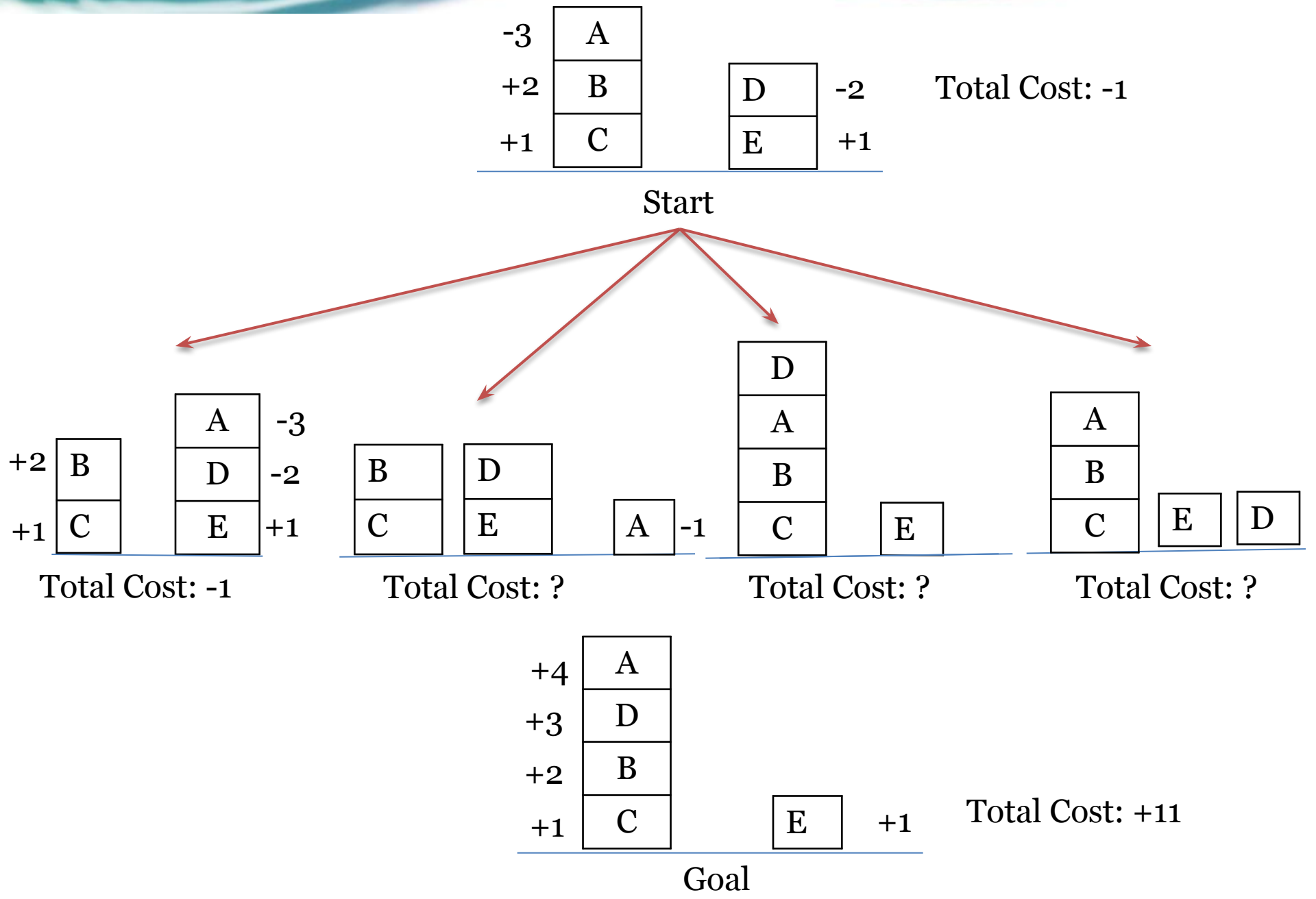
Total Cost: +1
D
A
B
C
E
Total Cost: +1
A
B
C
E
D
Total Cost: +1
C
B
A
D
E
Total Cost: +1
E
D
A
B
C
Total Cost: +1

Rule

h2(n)= add 1 for every block in the correct structure that the block in sitting on
subtract 1 for every block in the incorrect structure


A
B
C
D
E
Start
B
C
A
D
E
B
C
D
E
A
D
A
B
C
E
A
B
C
E
D
+4
+3
+2
+1
A
D
B
C
+1
E
Goal
Total Cost: +11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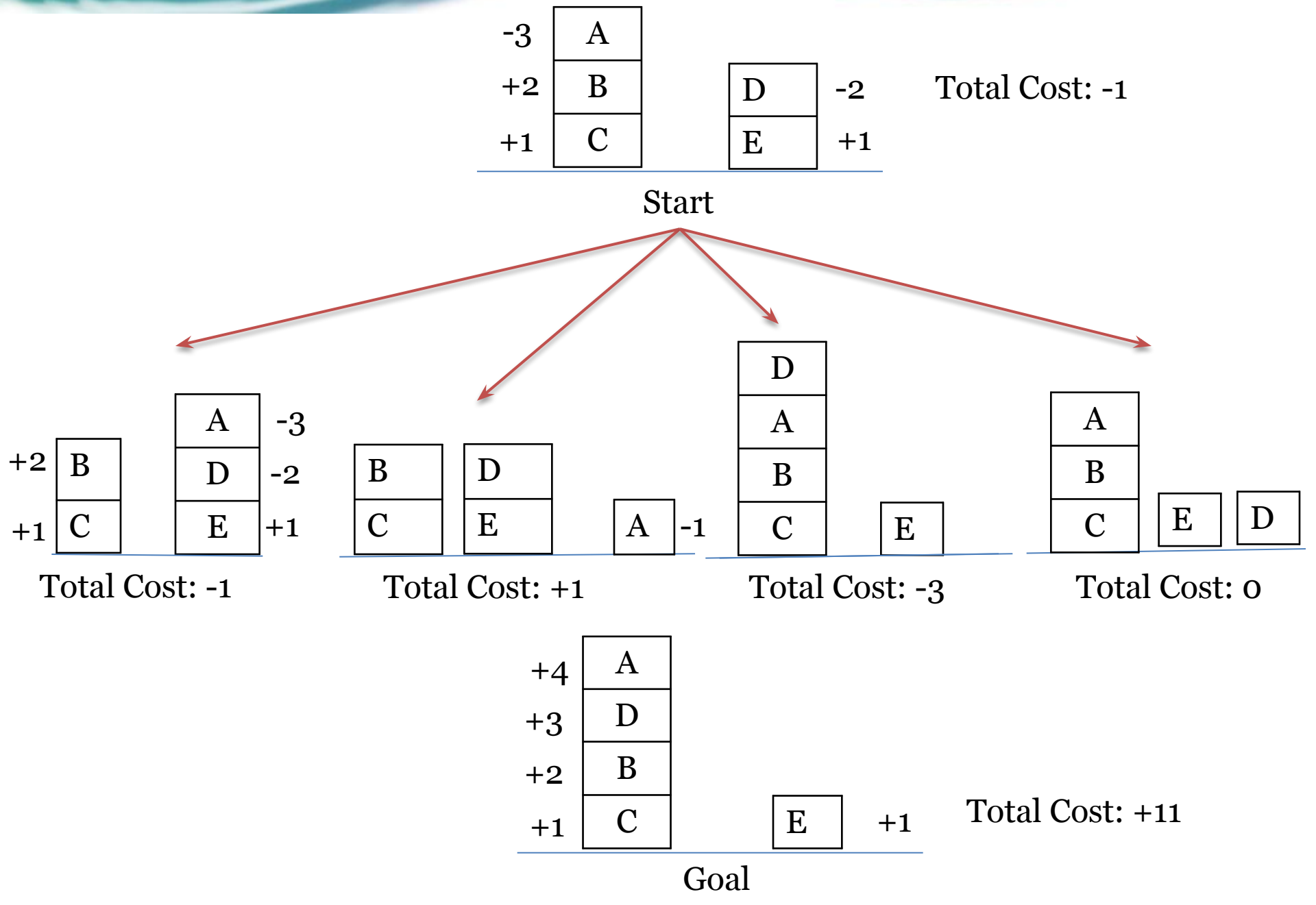
A
+2
B
+1
C
D
-2
E
+1
Total Cost: -1
Start
+2
B
+1
C
A
-3
D
-2
E
+1
Total Cost: -1
B
C
D
E
A
-1
Total Cost: ?
D
A
B
C
E
Total Cost: ?
A
B
C
E
D
Total Cost: ?
+4
A
+3
D
+2
B
+1
C
E
+1
Total Cost: +11
Goal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-2
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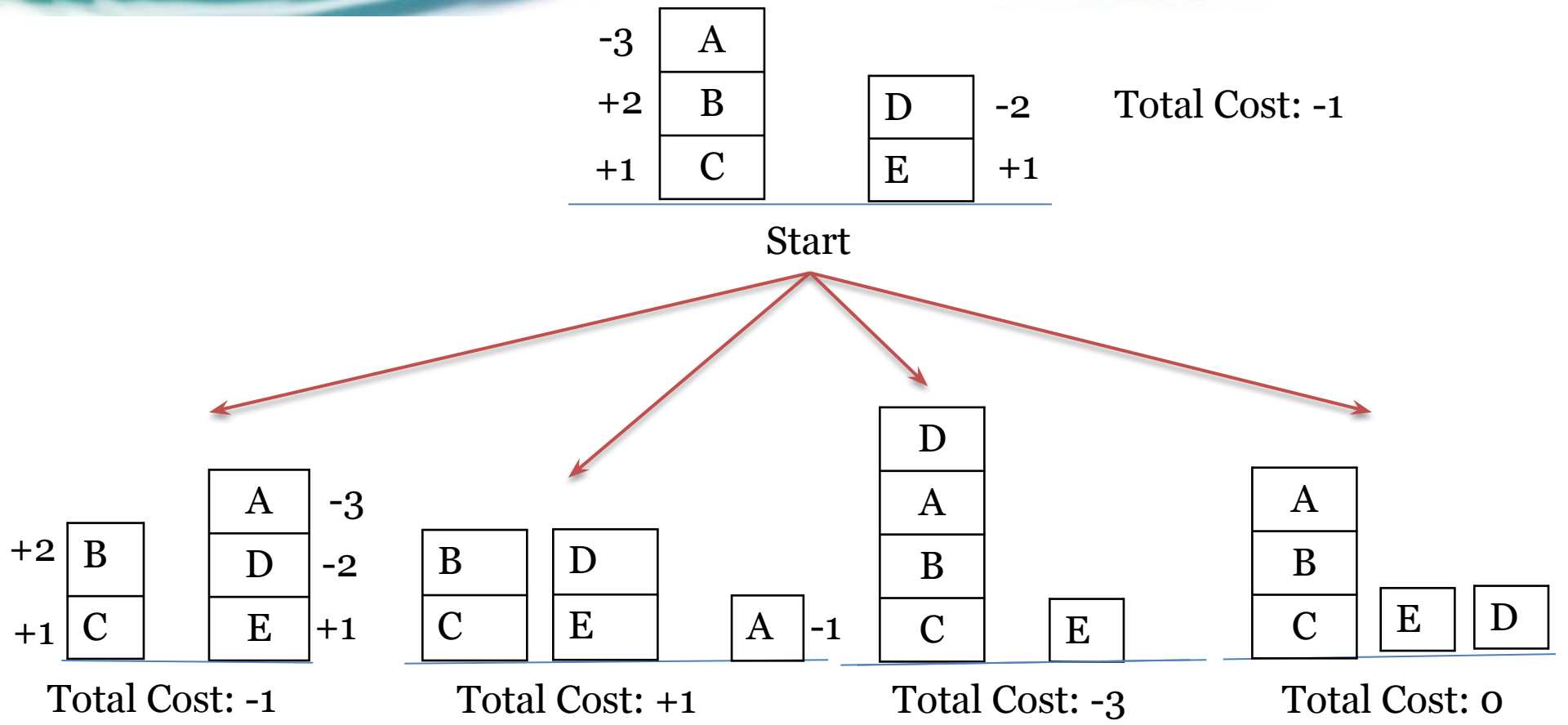
+1
Total Cost: -1
Start
+2
B
+1
C
A
-3
D
-2
E
+1
Total Cost: -1
B
C
D
E
A
-1
Total Cost: +1
D
A
B
C
E
Total Cost: -3
A
B
C
E
D
Total Cost: 0
+4
A
+3
D
+2
B
+1
C
E
+1
Total Cost: +11
Goal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Total Cost: -1
Start
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-3
D
-2
E
+1
Total Cost: -1
B
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Total Cost: +1
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Total Cost: -3
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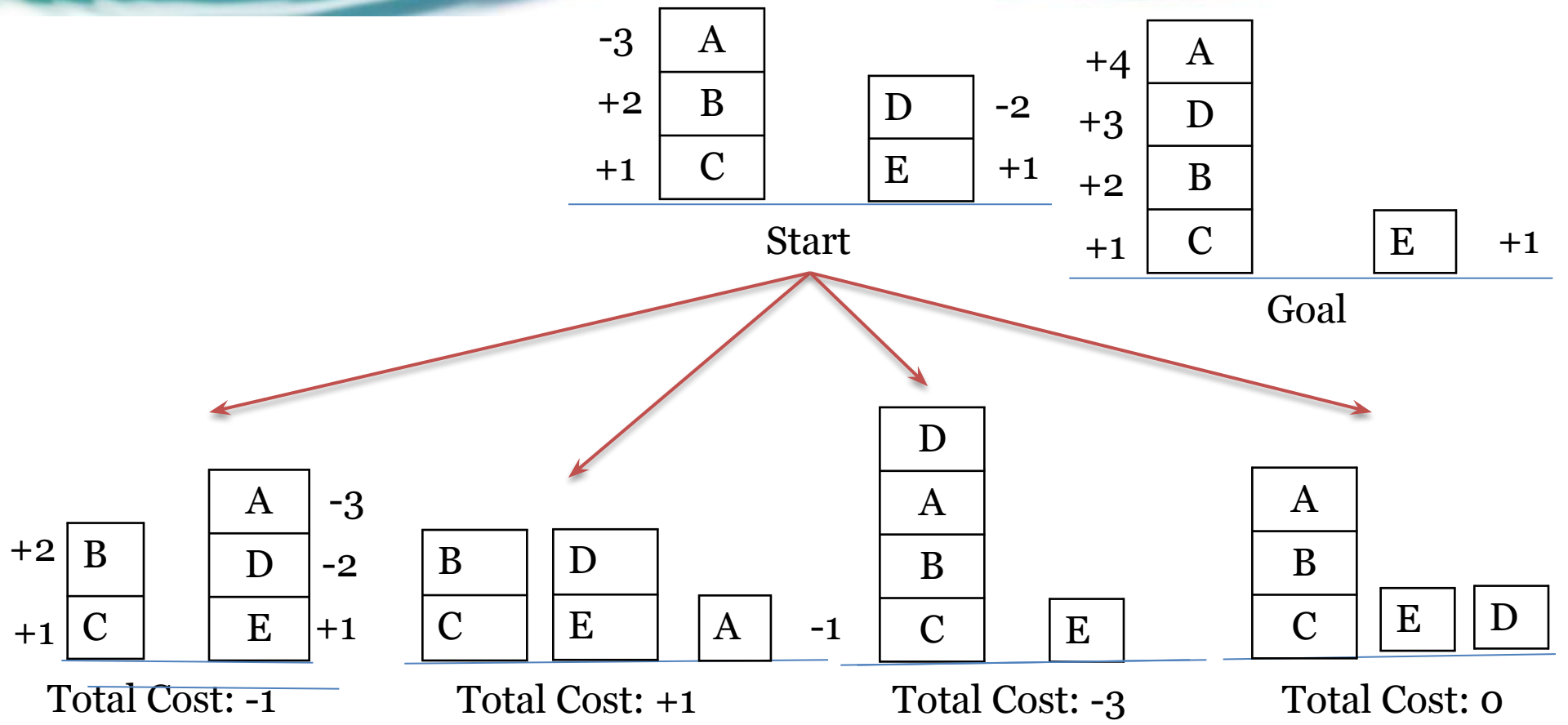
D
Total Cost: 0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+1
Goal
+2
B
+1
C
A
-3
D
-2
E
+1
Total Cost: -1
B
D
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A
-1
Total Cost: +1
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Total Cost: -3
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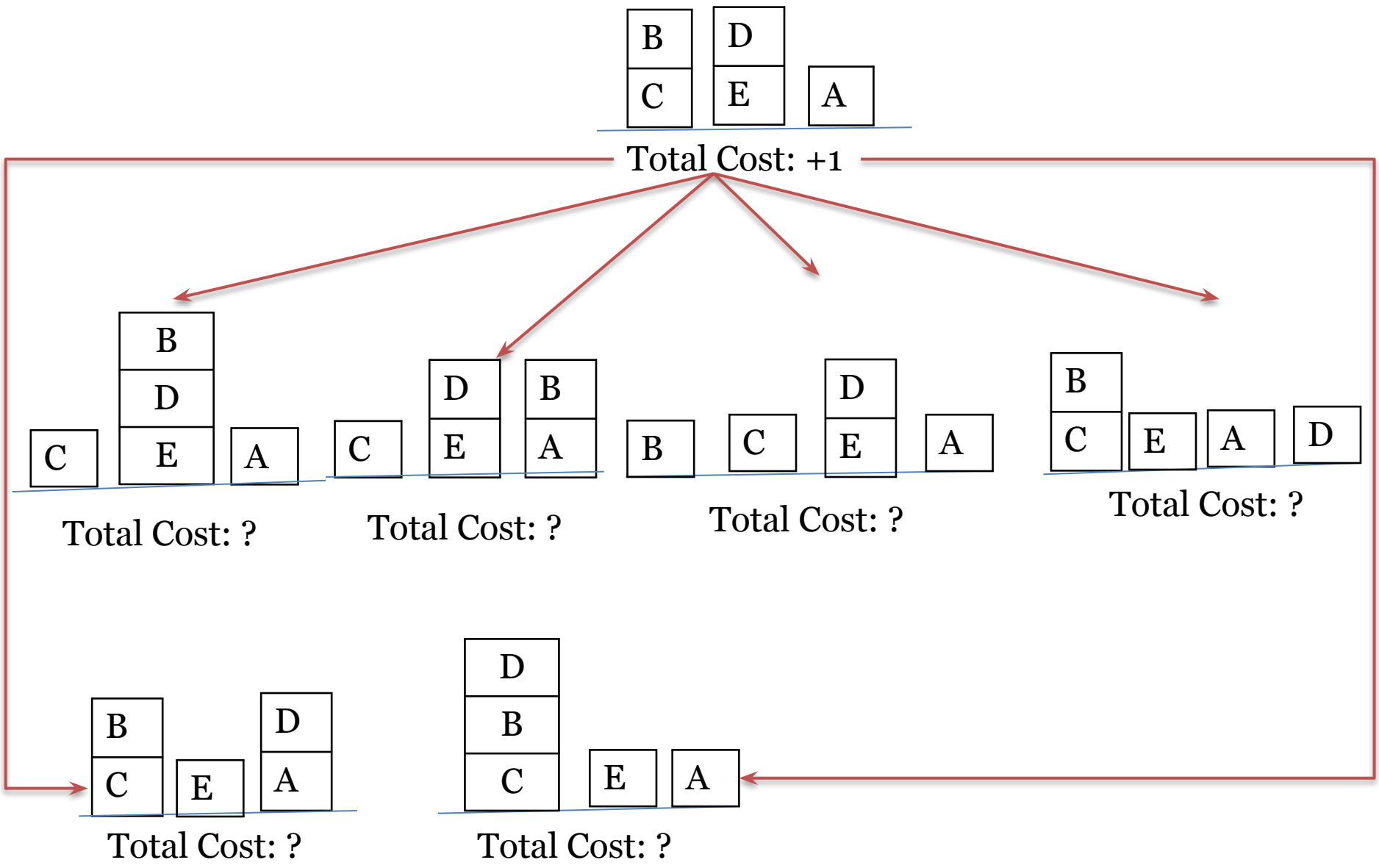
Total Cost: 0


B
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Total Cost: +1
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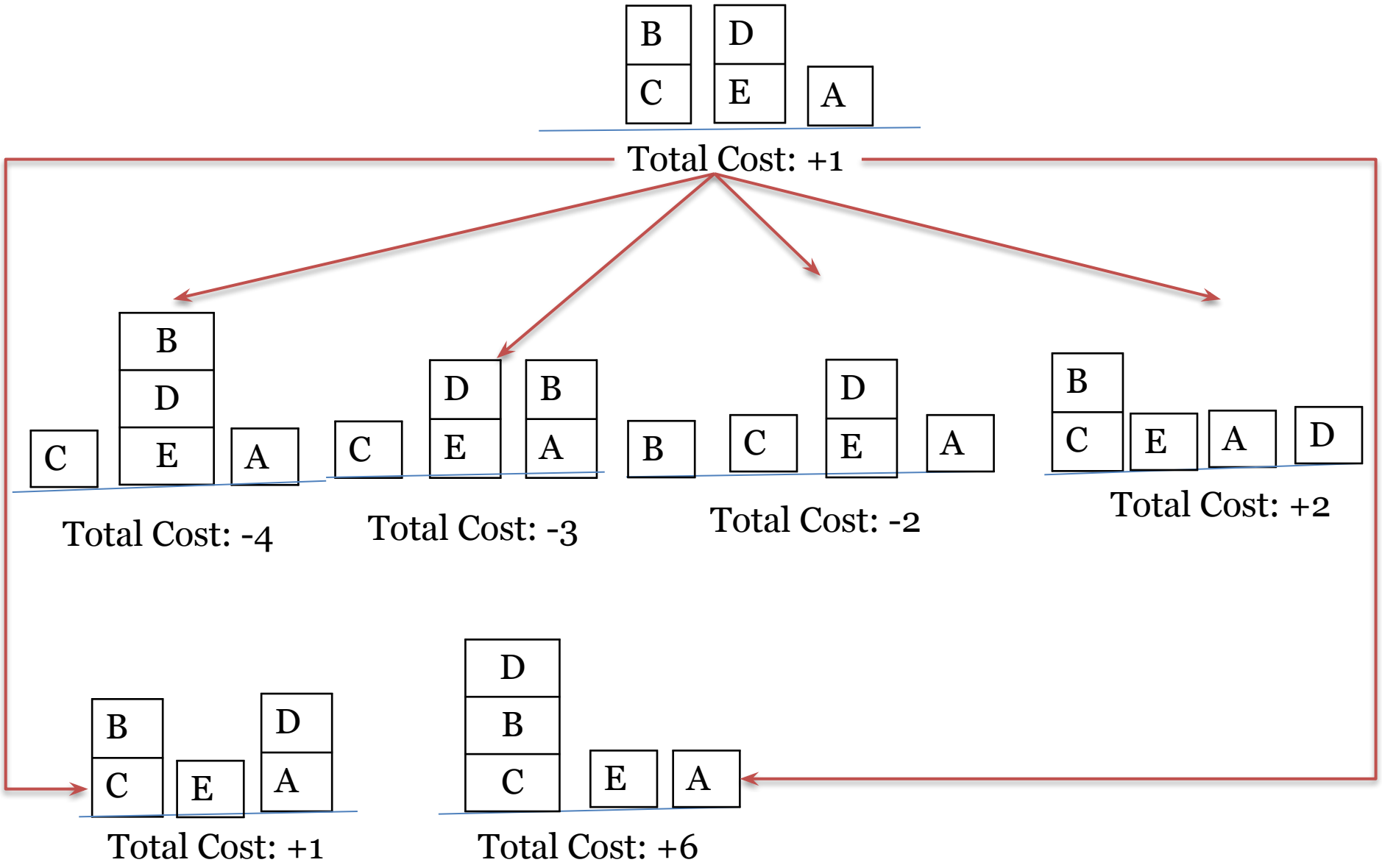
A
Total Cost: ?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Total Cost: +1
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Total Cost: -4
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D
B
C
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A
Total Cost: -2
B
C
E
A
D
Total Cost: +2
B
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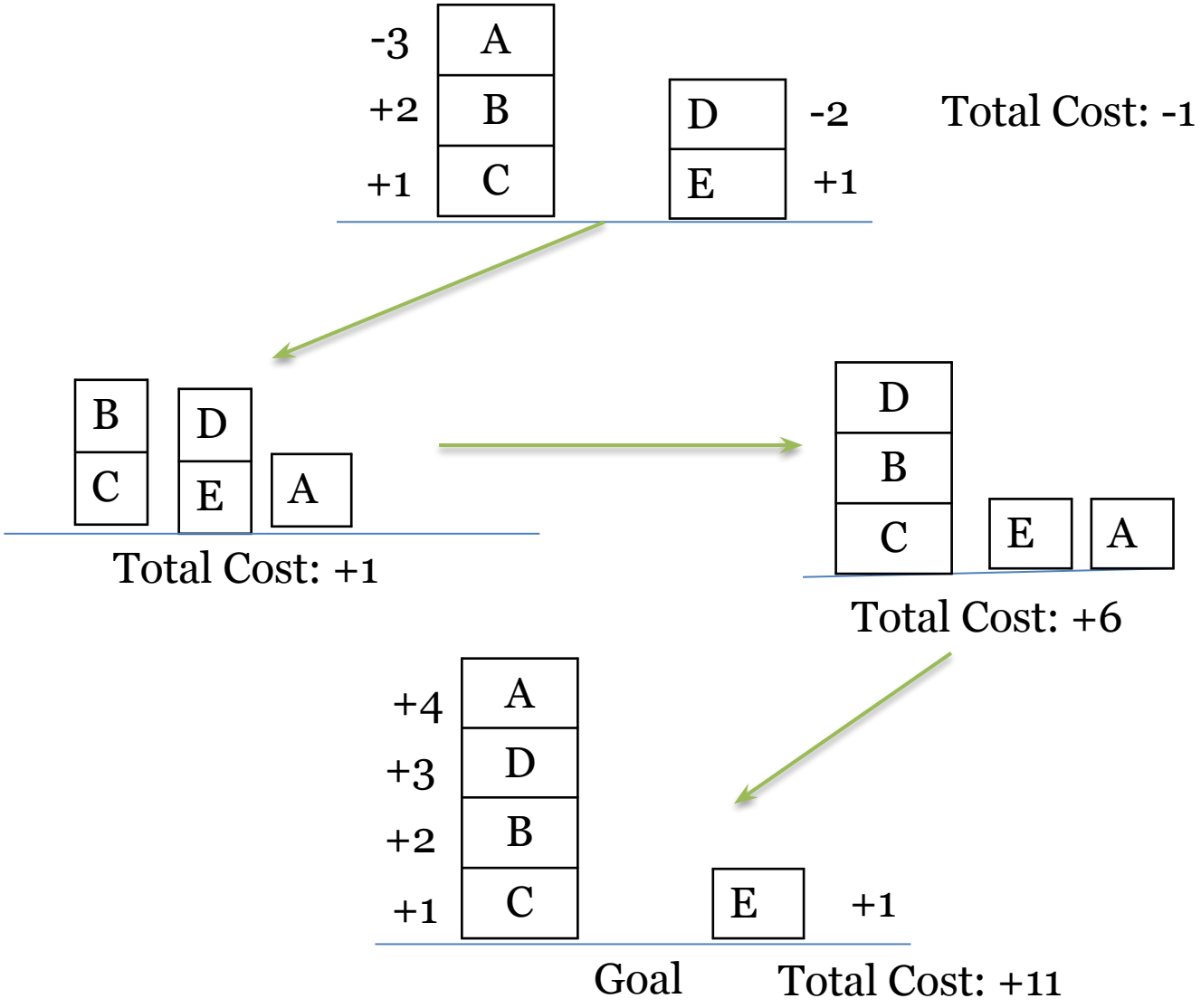
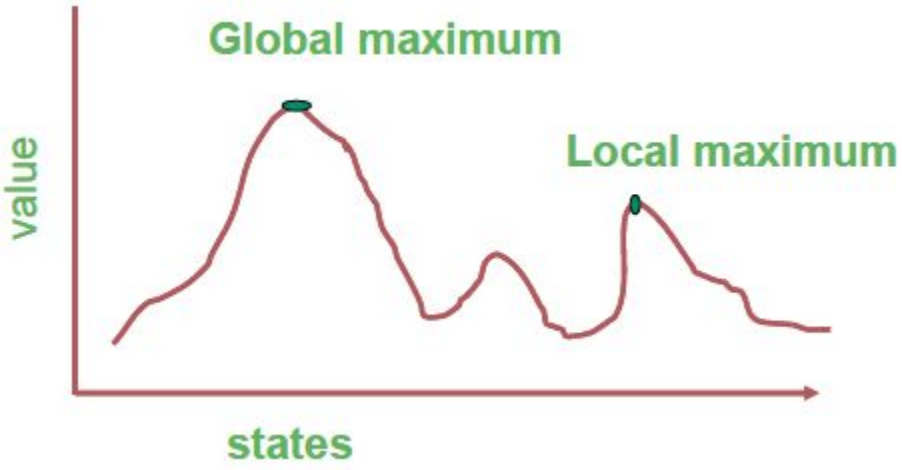
D
A
Total Cost: +1
D
B
C
E
A
Total Cost: +6

Final Solution



Local Maxima



Hill Climbing (Cont…)

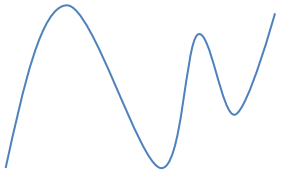
Local maxima
Once the top of a hill is reached the algorithm will halt since every possible step leads down.

Plateaux
If the landscape is flat, meaning many states have the same goodness, algorithm degenerates to a random walk.

Ridges
If the landscape contains ridges, local improvements may follow a zigzag path up the ridge, slowing down the search.

Surface

Surface
h1: Local Maxima



Surface
h2: Global Maxima