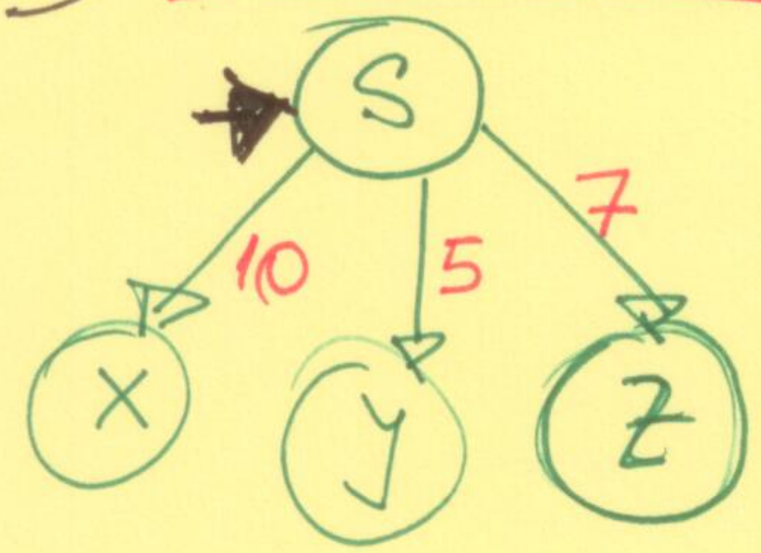
Uninformed Search

1) Second example of Uniform-Cost search



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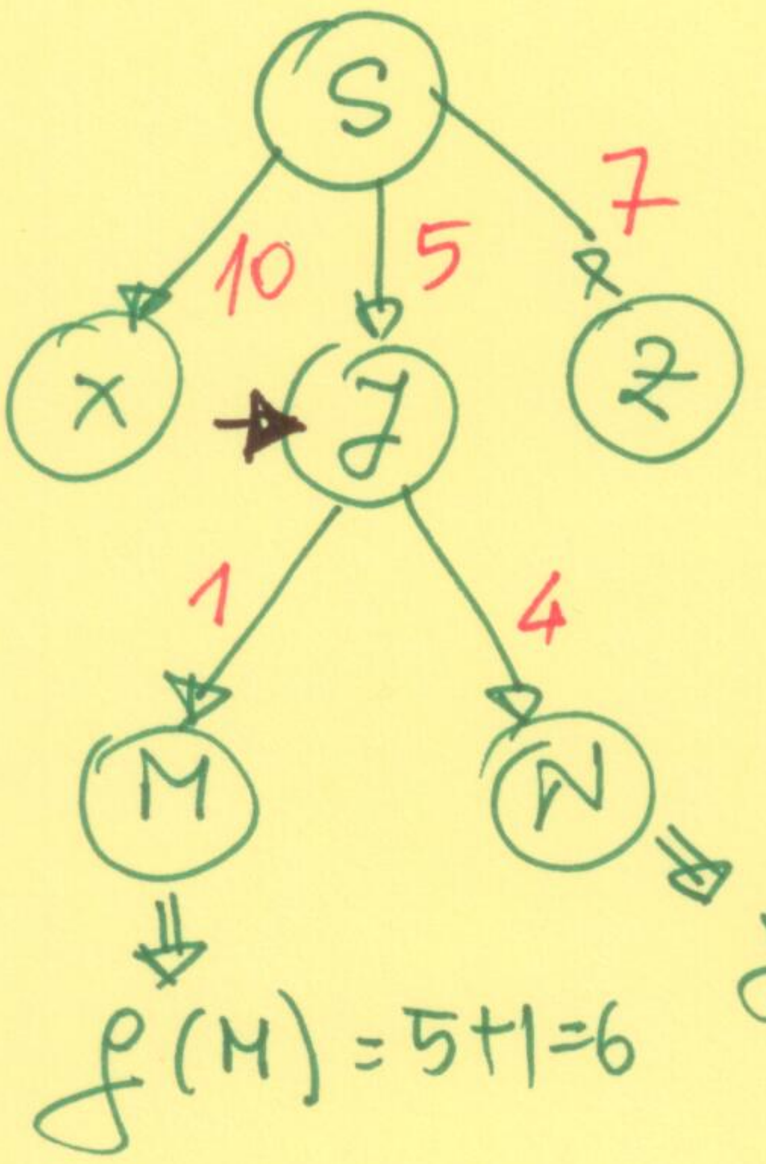
Step 1

Current node = S

Explored = {S}

Frontiers = {Y, Z, X}
5 7 10

Next node? Y



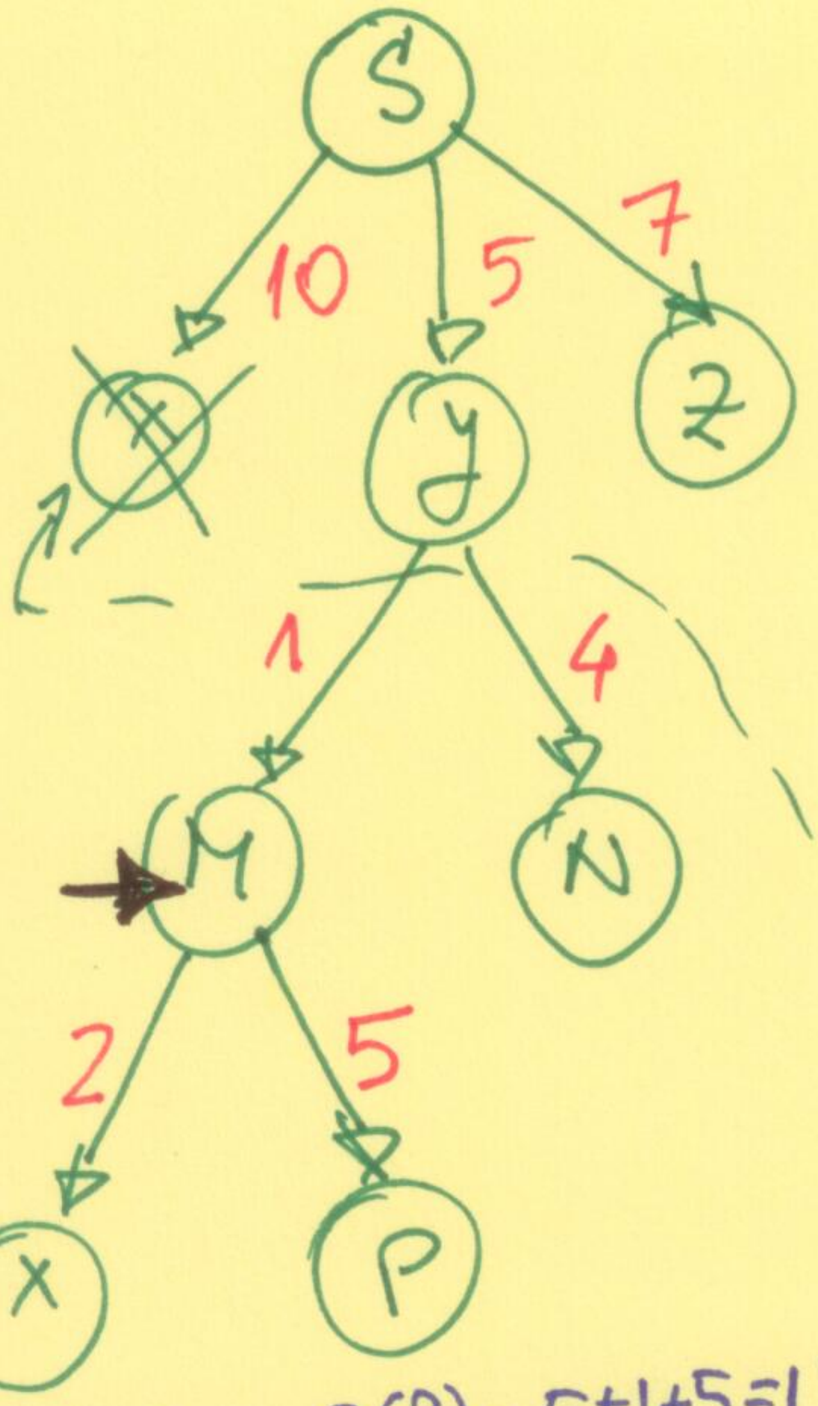
Step 2

Current node = Y

Explored = {S, Y}

Frontiers = {M, Z, N, X}
6 7 9 10

Next node? M



$f(x) = 5+1+2 = 8$

$f(P) = 5+1+5 = 11$

Step 3

Current Node? M

Explored = {S, Y, M}

Frontier = {Z, X, N, P}
7 8 9 11

(*) X was in the frontier before, but $g(x)$ was 10 and now $g(x) = 8$

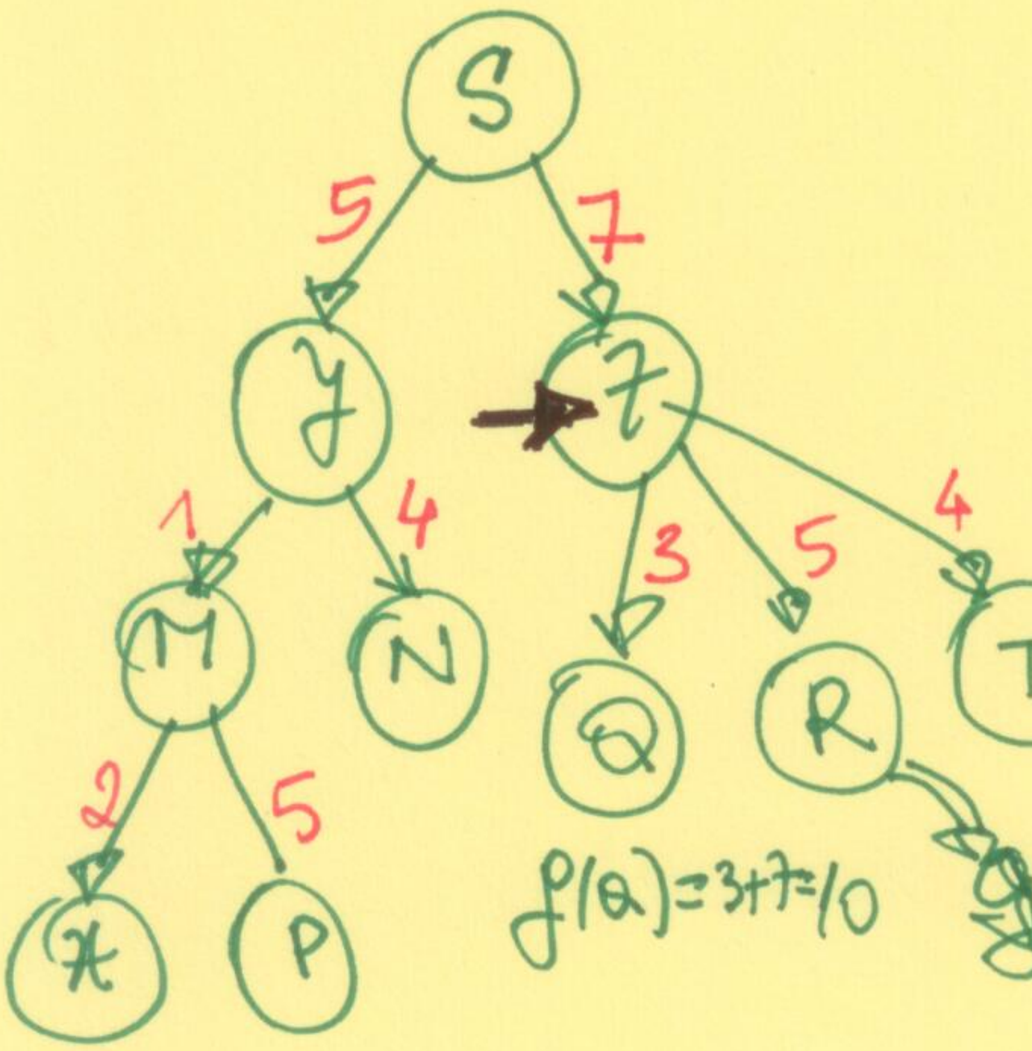
Next node? Z

step 4

Current Node = Z

Explored = {S, Y, M, Z}

Frontier = {X, N, Q, P, T, R}
8 9 10 11 11 12



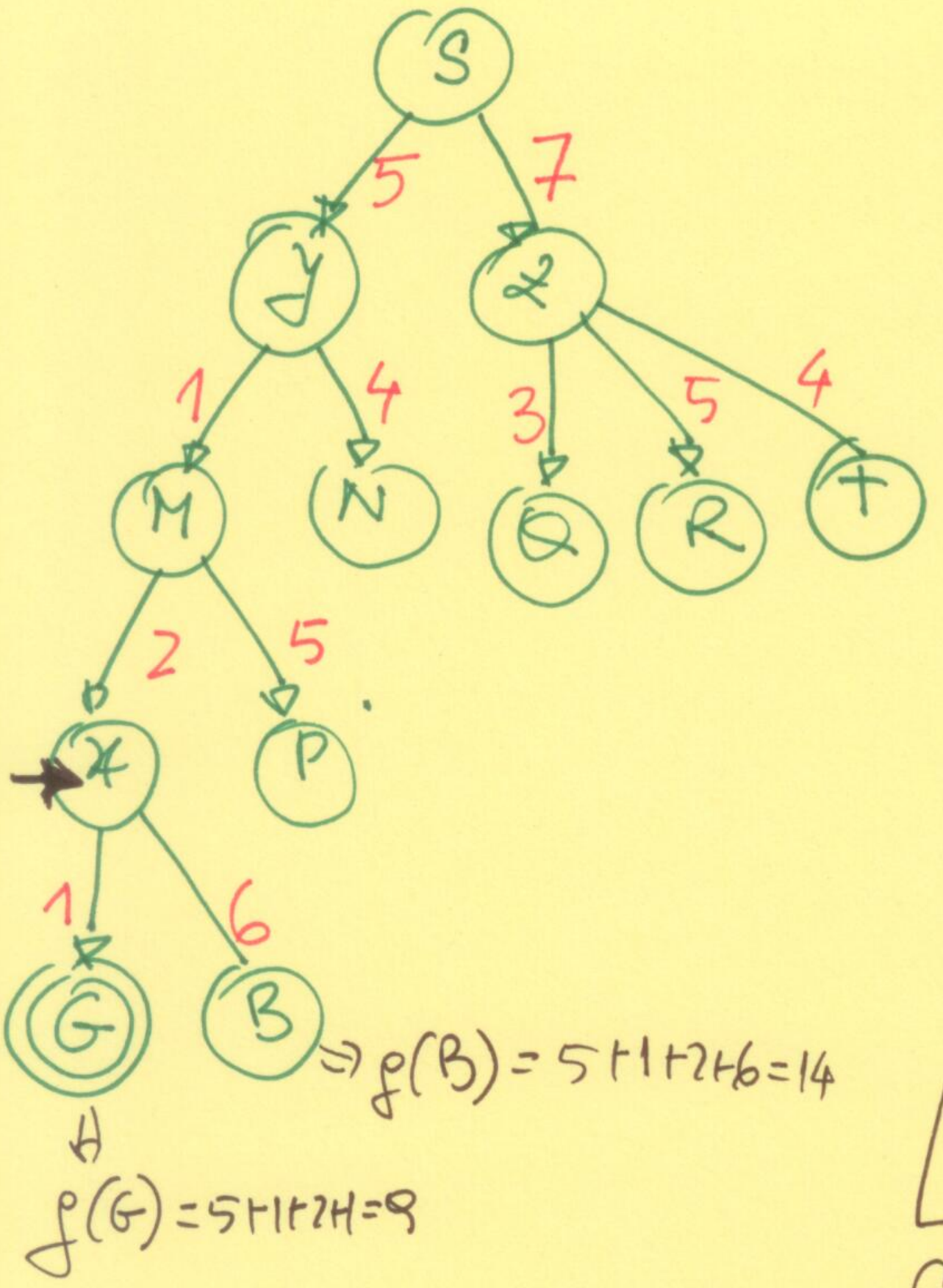
$f(T) = 7+4 = 11$

$f(Q) = 3+7 = 10$

$f(R) = 7+5 = 12$

Next node?

X



$g(B) = 5+1+2+6 = 14$

$g(G) = 5+1+2+H = 9$

Step 5

Current node = X

Explored = {S, X, M, Z, x}

Frontier = {G, N, Q, P, T, R, B}
9 9 10 11 11 12 14

Next node? G.

Step 6

Current node = G

Explored = {S, Y, M, Z, x, G}

G is the goal state!

What is the solution?

Father(G) = x

Father(x) = M

Father(M) = Y

Father(Y) = S

Solution: S → Y → M → x → G

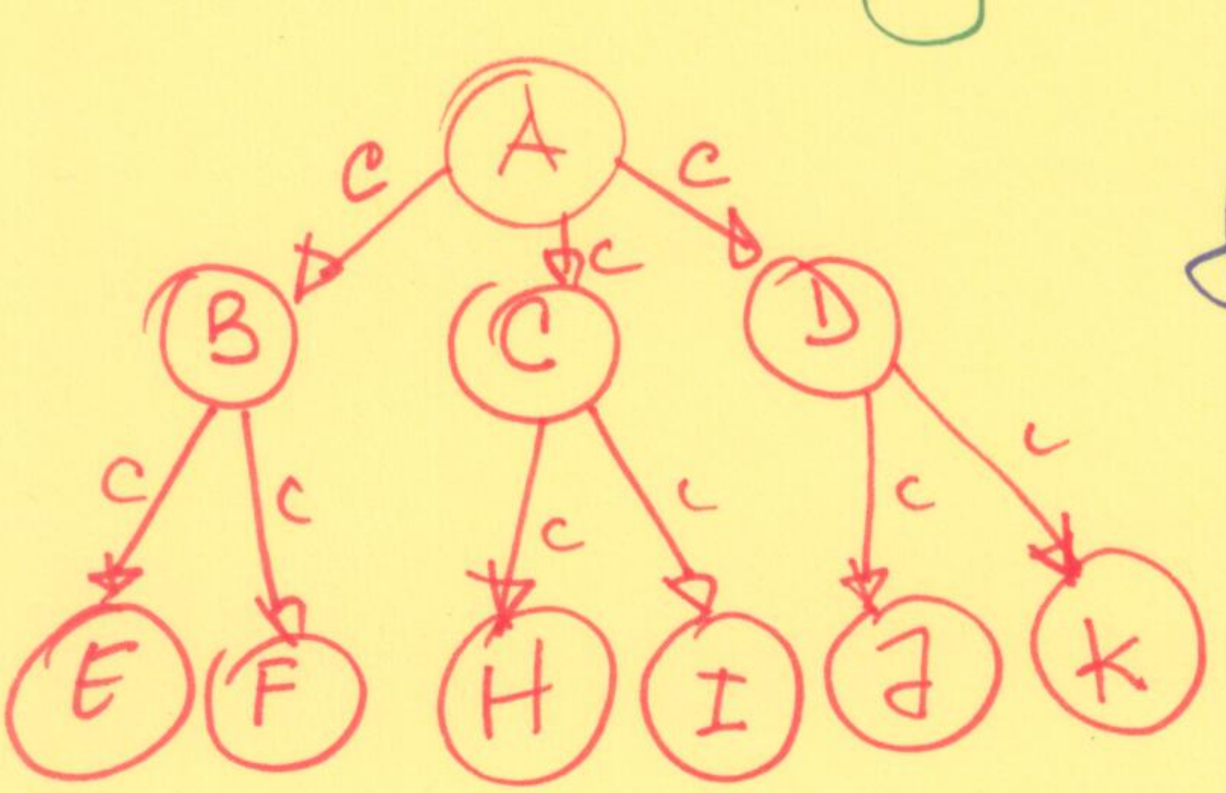
Path Cost = 9

Search Problem from the Textbook

3.21 Prove each of the following statements:

a) Breadth-first search is a special case of uniform-cost search.

Answer. Because Uniform-cost search is informed by the cost of transitions from a node "n_1" to a node "n_2" when taking an action "a", if all costs $c(n_i, a, n_j)$ are equal $= c \Rightarrow g(n) \propto \text{depth}(n)$



$\Downarrow$

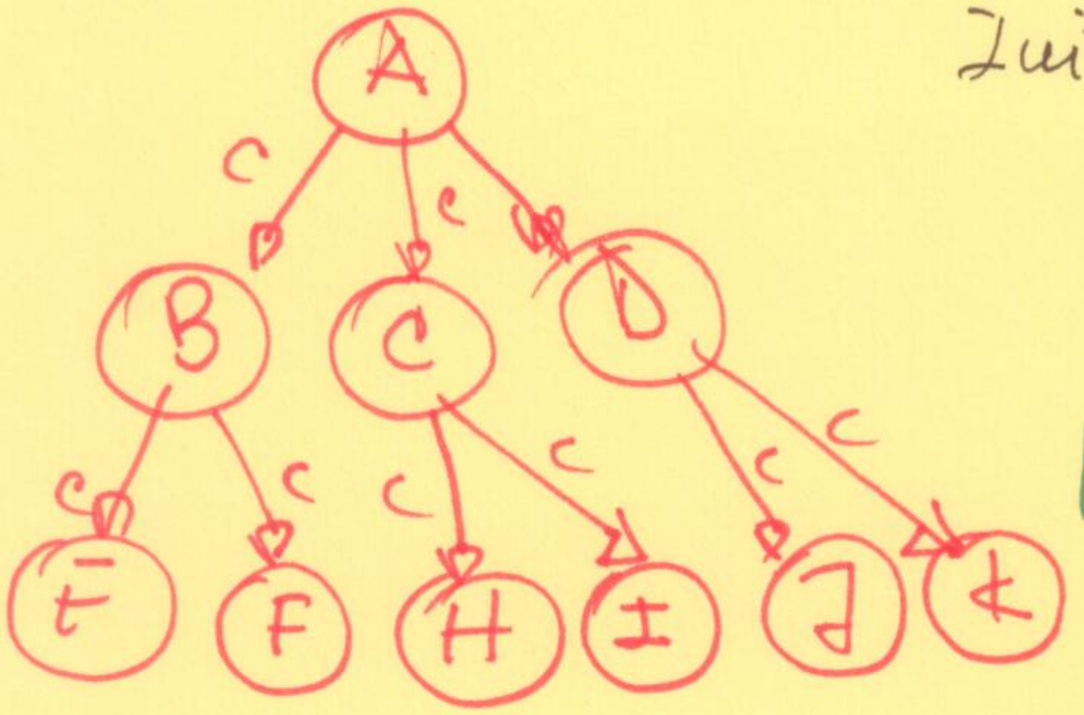
$g(\text{node}) = c * \text{depth}(\text{node})$

$\propto$ depth node.

$\Downarrow$

Uniform-cost becomes Breadth-first search.

Proof



Initial node = A Goal = K

Uniform-cost search

Step 1
Current node = A
Explored = {A}
Frontier = {B, C, D} (c, c, c)
Next node = B

Step 2 Current node = B
Explored = {A, B}
Frontier = {C, D, E, F} (c, c, 2c, 2c)
Next node = C

Step 3 Current node = C
Explored = {A, B, C}
Frontier = {D, E, F, H, I} (c, 2c, 2c, 2c, 2c)
Next node = D

Step 4 Current node = D
Explored = {A, B, C, D}
Frontier = {E, F, H, I, J, K} (2c, 2c, 2c, 2c, 2c, z)
Next node = E

Step 5 Current node = E
Explored = {A, B, C, D, E}
Frontier = {F, H, I, J, K} (2c, 2c, 2c, x, 2c)
Next node = F

Breadth-first search

Step 1
Current node = A
Explored = {A}
Frontier = {B, C, D}
Next node = B

Step 2 current node = B
Explored = {A, B}
Frontier = {C, D, E, F}
Next node = C

Step 3 Current node = C
Explored = {A, B, C}
Frontier = {D, E, F, H, I}
Next node = D

Step 4 Current node = D
Explored = {A, B, C, D}
Frontier = {E, F, H, I, J, K}
Next node = E

Step 5 Current node = E
Explored = {A, B, C, D, E}
Frontier = {F, H, I, J, K}
Next node = F

Uniform-cost search (continued)

Step 6 | Current node = F

Explored = {A, B, C, D, E, F}

Frontier = { H (2c), I (2c), J (2c), K (2c) }

Next node = H

Step 7 | Current node = H

Explored = {A, B, C, D, E, F, H}

Frontier = { I (2c), J (2c), K (2c) }

Next node = I

Step 8 | Current node = I

Explored = {A, B, C, D, E, F, H, I}

Frontier = { J (2c), K (2c) }

Next node = J

Step 9 | Current node = J

Explored = {A, B, C, D, E, F, H, I, J}

Frontier = { K (2c) }

Next node = K

Step 10 | Current node = K

Explored = {A, B, C, D, E, F, H, I, J, K}

K is the GOAL!

The solution is:

A → D → K

Step 6 | Current node = F

Explored = {A, B, C, D, E, F}

Frontier = {H, I, J, K}

Next node = H

Step 7 | Current node = H

Explored = {A, B, C, D, E, F, H}

Frontier = {I, J, K}

Next node = I

Step 8 | Current node = I

Explored = {A, B, C, D, E, F, H, I}

Frontier = {J, K}

Next node = J

Step 9 | Current node = J

Explored = {A, B, C, D, E, F, H, I, J}

Frontier = {K}

Next node = K

Step 10 | Current node = K

Explored = {A, B, C, D, E, F, H, I, J, K}

K is the GOAL!

The solution is

A → D → K

SELF-TEST

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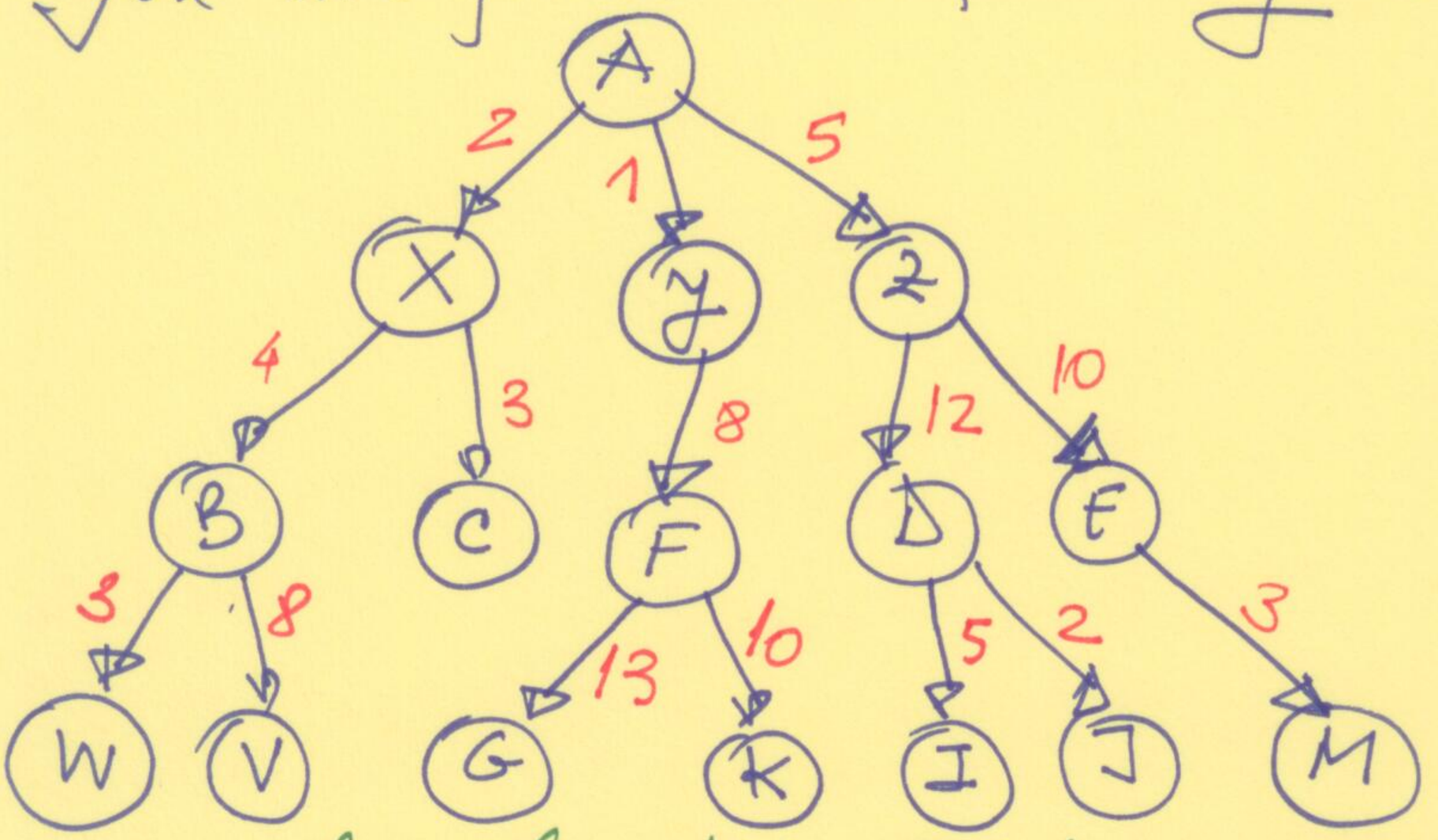
You are given the following search tree



Initial node = A Goal nodes = {G, J}

[A] Perform the first five steps of search and indicate:
(a) the Explored list (1 pts)
(b) the Frontier (1 pts)
(c) the next node. (1 pts)

when using:
1) Breadth-first search
2) Uniform-cost search
3) Depth-first search
4) Iterative-deepening search

Total 60

[B] Show the structure of node D

Total 40

D.state = explored list in node D 4 pts
D.parent 1 pt.
D.action = next node when in D 3 pts
D.path-cost. 2 pt

SELF-TEST 2

Given the following state of the 8-puzzle:

$$\begin{matrix} \bullet & 1 & 8 \\ 4 & 3 & 2 \\ 5 & 7 & 6 \end{matrix}$$

as the startup initial state

If the cost of sliding the empty square is equal to the sum of its neighboring square in the successor state, use uniform-cost search to perform the first 4 steps towards the goal state

$$G = \begin{matrix} 1 & 2 & 3 \\ 8 & \circ & 4 \\ 7 & 6 & 5 \end{matrix}$$

Example of computing the cost:

Successor $\begin{bmatrix} \bullet & 1 & 8 \\ 4 & 3 & 2 \\ 5 & 7 & 6 \end{bmatrix} = \begin{bmatrix} 4 & 1 & 8 \\ \bullet & 3 & 2 \\ 5 & 7 & 6 \end{bmatrix}$

S A

$C(I, A) = 4 + 3 + 5$

$= 12$