

Generic Search Algorithm

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Breadth-First

Procedure *Search*(G, S, goal)

Inputs: G : graph with nodes N and arcs A
 S : set of start nodes
 goal : Boolean function of nodes

Output: path from s to g s.t. $s \in S$ and $\text{goal}(g)$
or null if no solution paths are found

$\text{Frontier} \leftarrow \{(s) \mid s \in S\}$ // a set of paths

while Frontier is not empty

dequeue
remove a path $p = (s, \dots, t)$ from Frontier

if $\text{goal}(t)$ then return p

for each arc from t to n

enqueue
insert (s, \dots, t, n) into Frontier

return null

This is a queue
first-in first-out
multiple paths
pruning
don't do this
if t has already
been processed

Uninformed Example

Search Examples

Grid Example

8-Puzzle

Uninformed

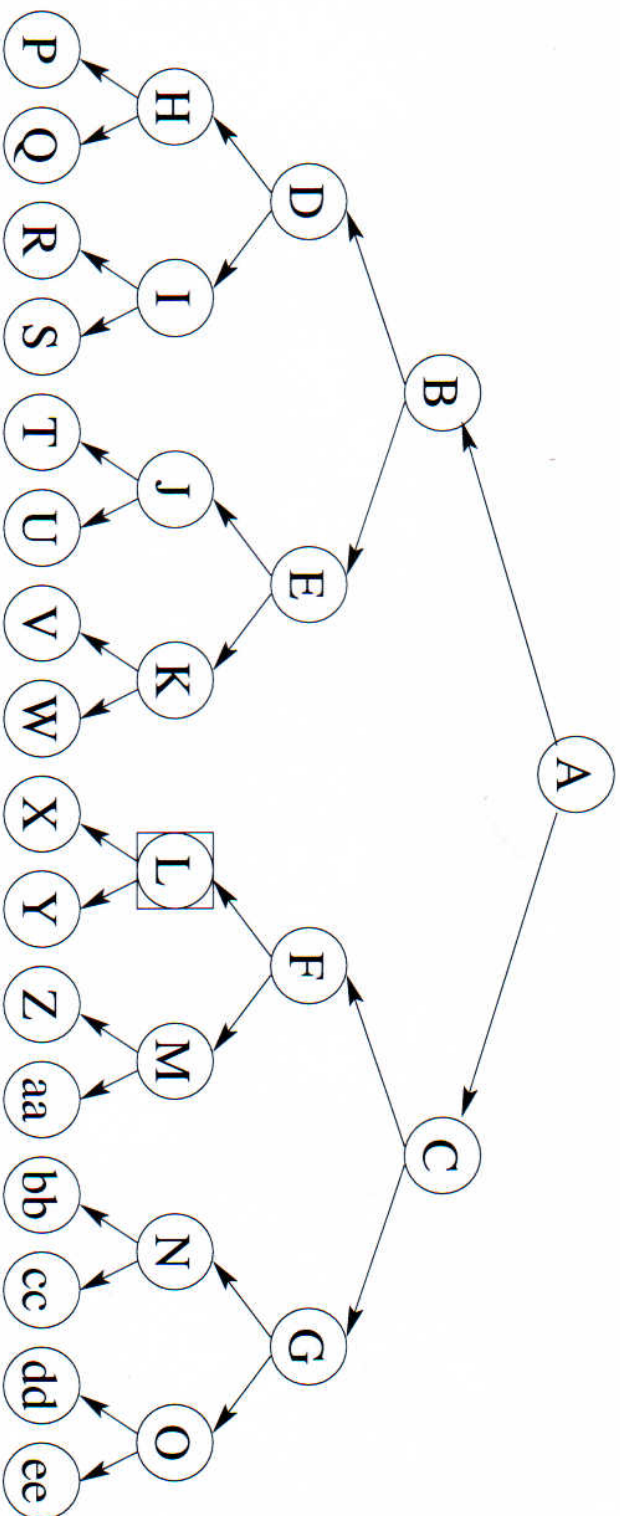
Example

Uninformed Example

2

Heuristics Example

Uniform Tree



10:

$bound = 0$ A
 $bound = 1$ A B C
 $bound = 2$ A B D E C F G
 $bound = 3$ A B D H I E J K C F L

Uninformed Example 2

Search Examples

Grid Example

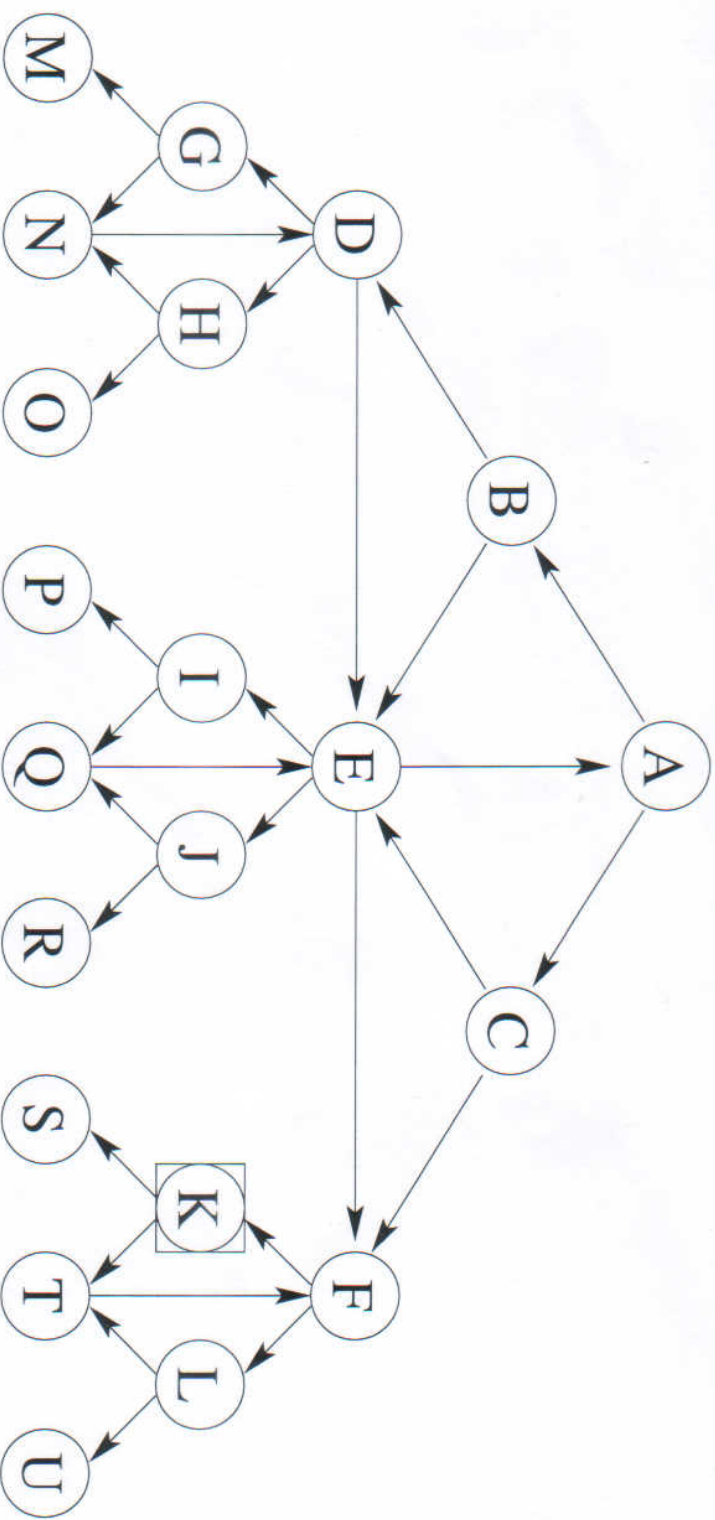
8-Puzzle

Uninformed Example

Uninformed Example 2

Heuristics Example

Uniform Tree



DFS with cycle-checking: A, B, D, G, M, N, H, N, O, E, I, P, Q, J, Q, R, F, K
 end with (A, B, D, E, F, K) path

ID: A, A⁰C, ABDECEEF, ABDGHEEIJFCEIJFCK

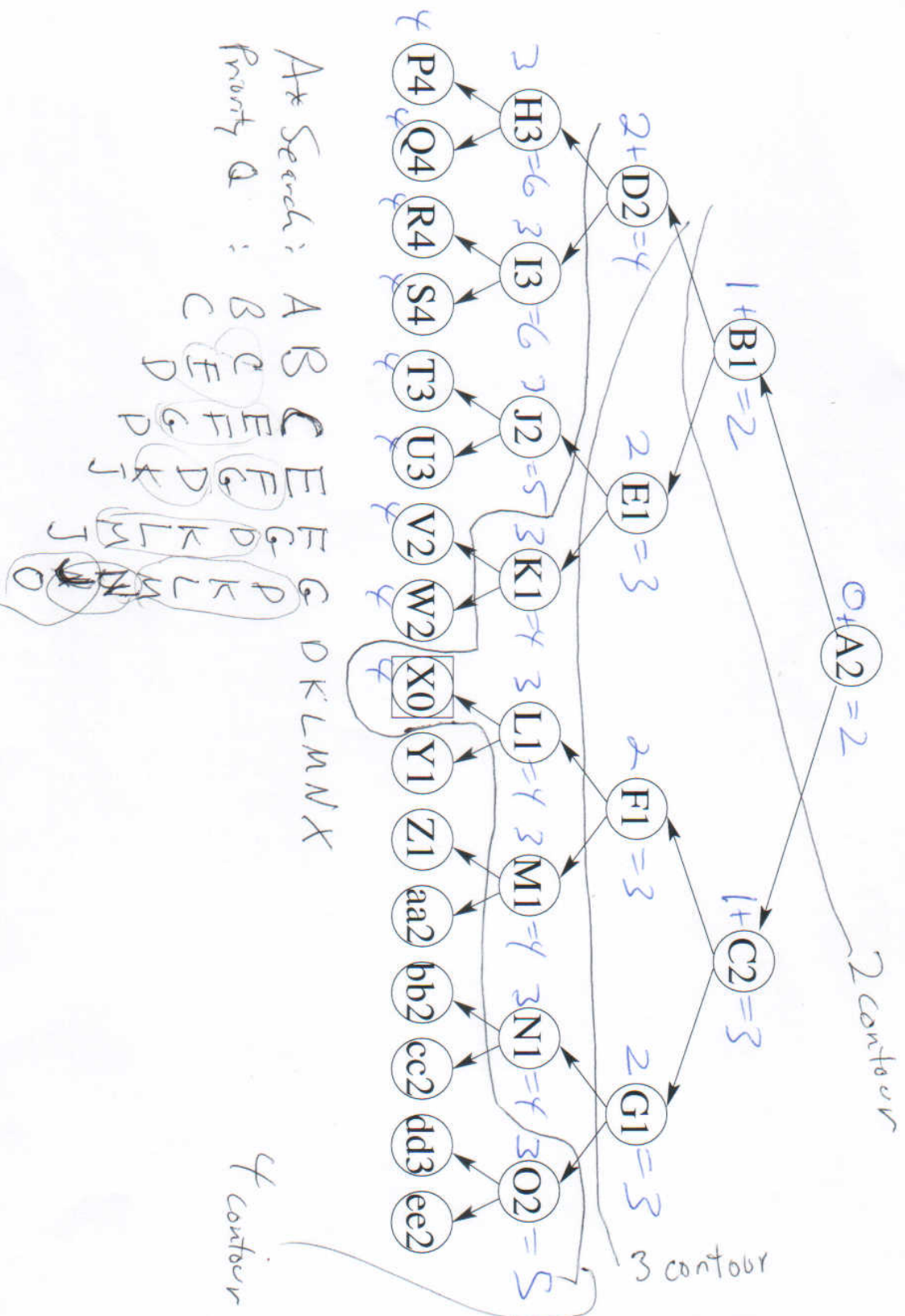
BFS: ABCDEFGHIJKL

assumes multiple-path pruning

Heuristics Example

Min cost in blue on left

- Search Examples
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- Uninformed Example 2
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- ▷ Example
- Uniform Tree



Experiment Avoiding Reverse Moves

$h_1 =$ misplaced tiles

$h_2 =$ Manhattan distance

	States Visited (Effective BF)		
d	ID	IDA*(h_1)	IDA*(h_2)
4	52 (2.35)	10 (1.35)	7 (1.17)
8	569 (2.03)	42 (1.36)	14 (1.11)
12	5357 (1.92)	315 (1.47)	45 (1.19)
16	47271 (1.87)	2410 (1.52)	226 (1.28)
20		17646 (1.55)	764 (1.29)

$$10 = x^0 + x^1 + x^2 + x^3 + x^4 \quad \text{solve for } x$$

$$x = 1.35 \text{ is closer to } 1.0$$

$$17646 = x^0 + x^1 + x^2 + \dots + x^{20} \quad \text{solve for } x$$

Consider these 8-bussys heuristic functions: