

Trabalho de Inteligência Artificial

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1 Questão 1

TREE:

```
{(3, 3, 0), 0}
|  {(3, 2, 1), 1}
|  |  {(3, 3, 0), 2}
|  |  {(3, 1, 1), 1}
|  |  |  {(3, 2, 0), 2}
|  |  |  |  {(3, 1, 1), 3}
|  |  |  |  {(3, 0, 1), 3}
|  |  |  |  |  {(3, 1, 0), 4}
|  |  |  |  |  |  {(3, 0, 1), 5}
|  |  |  |  |  |  {(1, 1, 1), 5}
|  |  |  |  |  |  |  {(2, 2, 0), 6}
|  |  |  |  |  |  |  |  {(1, 1, 1), 7}
|  |  |  |  |  |  |  |  {(0, 2, 1), 7}
|  |  |  |  |  |  |  |  |  {(0, 3, 0), 8}
|  |  |  |  |  |  |  |  |  |  {(0, 2, 1), 9}
|  |  |  |  |  |  |  |  |  |  {(0, 1, 1), 9}
|  |  |  |  |  |  |  |  |  |  |  {(0, 2, 0), 10}
|  |  |  |  |  |  |  |  |  |  |  |  {(0, 1, 1), 11}
|  |  |  |  |  |  |  |  |  |  |  |  {(0, 0, 1), 11}
|  |  |  |  |  |  |  |  |  |  |  |  {(0, 3, 0), 10}
|  |  |  |  |  |  |  |  |  |  |  |  {(1, 1, 0), 10}
|  |  |  |  |  |  |  |  |  |  |  |  |  {(2, 2, 0), 8}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 1, 0), 6}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 2, 0), 4}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(2, 2, 1), 3}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 3, 0), 2}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(2, 2, 1), 1}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 2, 0), 2}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 3, 0), 2}
```

FOUND GOAL:

{(0, 0, 1), 11} with cost 11

SOLUTION:

```
[{(3, 3, 0), (3, 1, 1), (0, 2, 1), 1),
  {(3, 1, 1), (3, 2, 0), (0, 1, 0), 1),
  {(3, 2, 0), (3, 0, 1), (0, 2, 1), 1),
  {(3, 0, 1), (3, 1, 0), (0, 1, 0), 1),
  {(3, 1, 0), (1, 1, 1), (2, 0, 1), 1),
  {(1, 1, 1), (2, 2, 0), (1, 1, 0), 1),
  {(2, 2, 0), (0, 2, 1), (2, 0, 1), 1),
  {(0, 2, 1), (0, 3, 0), (0, 1, 0), 1),
  {(0, 3, 0), (0, 1, 1), (0, 2, 1), 1),
  {(0, 1, 1), (0, 2, 0), (0, 1, 0), 1),
  {(0, 2, 0), (0, 0, 1), (0, 2, 1), 1)]
```

HISTORY:

{(3, 3, 0), 0} inserted in QUEUE

[{(3, 3, 0), 0}]

(3, 3, 0) inserted in REACHED

```

[(3, 3, 0)]
---
{(3, 3, 0), 0} removed from QUEUE
[]
---
{(3, 2, 1), 1} inserted in QUEUE
[{(3, 2, 1), 1}]
---
(3, 2, 1) inserted in REACHED
[(3, 3, 0), (3, 2, 1)]
---
{(3, 1, 1), 1} inserted in QUEUE
[{(3, 2, 1), 1}, {(3, 1, 1), 1}]
---
(3, 1, 1) inserted in REACHED
[(3, 3, 0), (3, 2, 1), (3, 1, 1)]
---
{(2, 2, 1), 1} inserted in QUEUE
[{(3, 2, 1), 1}, {(3, 1, 1), 1}, {(2, 2, 1), 1}]
---
(2, 2, 1) inserted in REACHED
[(3, 3, 0), (3, 2, 1), (3, 1, 1), (2, 2, 1)]
---
{(3, 2, 1), 1} removed from QUEUE
[{(3, 1, 1), 1}, {(2, 2, 1), 1}]
---
{(3, 1, 1), 1} removed from QUEUE
[{(2, 2, 1), 1}]
---
{(3, 2, 0), 2} inserted in QUEUE
[{(2, 2, 1), 1}, {(3, 2, 0), 2}]
---
(3, 2, 0) inserted in REACHED
[(3, 3, 0), (3, 2, 1), (3, 1, 1), (2, 2, 1), (3, 2, 0)]
---
{(2, 2, 1), 1} removed from QUEUE
[{(3, 2, 0), 2}]
---
{(3, 2, 0), 2} removed from QUEUE
[]
---
{(3, 0, 1), 3} inserted in QUEUE
[{(3, 0, 1), 3}]
---
(3, 0, 1) inserted in REACHED
[(3, 3, 0), (3, 2, 1), (3, 1, 1), (2, 2, 1), (3, 2, 0), (3, 0, 1)]
---
{(3, 0, 1), 3} removed from QUEUE
[]
---
{(3, 1, 0), 4} inserted in QUEUE
[{(3, 1, 0), 4}]
---
(3, 1, 0) inserted in REACHED
[(3, 3, 0), (3, 2, 1), (3, 1, 1), (2, 2, 1), (3, 2, 0), (3, 0, 1), (3, 1, 0)]
---
{(3, 1, 0), 4} removed from QUEUE
[]
---
{(1, 1, 1), 5} inserted in QUEUE
[{(1, 1, 1), 5}]

```

```

---
(1, 1, 1) inserted in REACHED
[(3, 3, 0),
 (3, 2, 1),
 (3, 1, 1),
 (2, 2, 1),
 (3, 2, 0),
 (3, 0, 1),
 (3, 1, 0),
 (1, 1, 1)]
---
{(1, 1, 1), 5} removed from QUEUE
[]
---
{(2, 2, 0), 6} inserted in QUEUE
[{(2, 2, 0), 6}]
---
(2, 2, 0) inserted in REACHED
[(3, 3, 0),
 (3, 2, 1),
 (3, 1, 1),
 (2, 2, 1),
 (3, 2, 0),
 (3, 0, 1),
 (3, 1, 0),
 (1, 1, 1),
 (2, 2, 0)]
---
{(2, 2, 0), 6} removed from QUEUE
[]
---
{(0, 2, 1), 7} inserted in QUEUE
[{(0, 2, 1), 7}]
---
(0, 2, 1) inserted in REACHED
[(3, 3, 0),
 (3, 2, 1),
 (3, 1, 1),
 (2, 2, 1),
 (3, 2, 0),
 (3, 0, 1),
 (3, 1, 0),
 (1, 1, 1),
 (2, 2, 0),
 (0, 2, 1)]
---
{(0, 2, 1), 7} removed from QUEUE
[]
---
{(0, 3, 0), 8} inserted in QUEUE
[{(0, 3, 0), 8}]
---
(0, 3, 0) inserted in REACHED
[(3, 3, 0),
 (3, 2, 1),
 (3, 1, 1),
 (2, 2, 1),
 (3, 2, 0),
 (3, 0, 1),
 (3, 1, 0),
 (1, 1, 1),

```

```

(2, 2, 0),
(0, 2, 1),
(0, 3, 0)]
---
{(0, 3, 0), 8} removed from QUEUE
[]
---
{(0, 1, 1), 9} inserted in QUEUE
[{(0, 1, 1), 9}]
---
(0, 1, 1) inserted in REACHED
[(3, 3, 0),
(3, 2, 1),
(3, 1, 1),
(2, 2, 1),
(3, 2, 0),
(3, 0, 1),
(3, 1, 0),
(1, 1, 1),
(2, 2, 0),
(0, 2, 1),
(0, 3, 0),
(0, 1, 1)]
---
{(0, 1, 1), 9} removed from QUEUE
[]
---
{(0, 2, 0), 10} inserted in QUEUE
[{(0, 2, 0), 10}]
---
(0, 2, 0) inserted in REACHED
[(3, 3, 0),
(3, 2, 1),
(3, 1, 1),
(2, 2, 1),
(3, 2, 0),
(3, 0, 1),
(3, 1, 0),
(1, 1, 1),
(2, 2, 0),
(0, 2, 1),
(0, 3, 0),
(0, 1, 1),
(0, 2, 0)]
---
{(1, 1, 0), 10} inserted in QUEUE
[{(0, 2, 0), 10}, {(1, 1, 0), 10}]
---
(1, 1, 0) inserted in REACHED
[(3, 3, 0),
(3, 2, 1),
(3, 1, 1),
(2, 2, 1),
(3, 2, 0),
(3, 0, 1),
(3, 1, 0),
(1, 1, 1),
(2, 2, 0),
(0, 2, 1),
(0, 3, 0),
(0, 1, 1),

```

```
(0, 2, 0),  
(1, 1, 0)]  
---  
{(0, 2, 0), 10} removed from QUEUE  
[{(1, 1, 0), 10}]  
---
```

2 Questão 2

TREE:

```
{(0, 0), 0}
|  {(3, 0), 1}
|  |  {(3, 4), 2}
|  |  |  {(0, 4), 3}
|  |  |  {(3, 0), 3}
|  |  |  {(0, 0), 2}
|  |  |  {(0, 3), 2}
|  |  |  |  {(3, 3), 3}
|  |  |  |  |  {(3, 4), 4}
|  |  |  |  |  {(0, 3), 4}
|  |  |  |  |  {(3, 0), 4}
|  |  |  |  |  {(2, 4), 4}
|  |  |  |  |  |  {(3, 4), 5}
|  |  |  |  |  |  {(0, 4), 5}
|  |  |  |  |  |  {(2, 0), 5}
|  |  |  |  |  |  |  {(3, 0), 6}
|  |  |  |  |  |  |  {(2, 4), 6}
|  |  |  |  |  |  |  {(0, 0), 6}
|  |  |  |  |  |  |  {(0, 2), 6}
|  |  |  |  |  |  |  |  {(3, 3), 5}
|  |  |  |  |  |  |  |  |  {(0, 4), 3}
|  |  |  |  |  |  |  |  |  {(0, 0), 3}
|  |  |  |  |  |  |  |  |  {(3, 0), 3}
|  |  |  |  |  |  |  |  |  |  {(0, 4), 1}
|  |  |  |  |  |  |  |  |  |  |  {(3, 4), 2}
|  |  |  |  |  |  |  |  |  |  |  {(0, 0), 2}
|  |  |  |  |  |  |  |  |  |  |  {(3, 1), 2}
|  |  |  |  |  |  |  |  |  |  |  |  {(3, 4), 3}
|  |  |  |  |  |  |  |  |  |  |  |  {(0, 1), 3}
|  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 1), 4}
|  |  |  |  |  |  |  |  |  |  |  |  |  {(0, 4), 4}
|  |  |  |  |  |  |  |  |  |  |  |  |  {(0, 0), 4}
|  |  |  |  |  |  |  |  |  |  |  |  |  {(1, 0), 4}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 0), 5}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  {(1, 4), 5}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  {(0, 0), 5}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  {(0, 1), 5}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(3, 0), 3}
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  {(0, 4), 3}
```

FOUND GOAL:

{(0, 2), 6} with cost 6

SOLUTION:

```
[((0, 0), (3, 0), 'filling 3', 1),
 ((3, 0), (0, 3), 'pouring all 3 into 4', 1),
 ((0, 3), (3, 3), 'filling 3', 1),
 ((3, 3), (2, 4), 'pouring some 3 into 4', 1),
 ((2, 4), (2, 0), 'emptying 4', 1),
 ((2, 0), (0, 2), 'pouring all 3 into 4', 1)]
```

HISTORY:

{(0, 0), 0} inserted in QUEUE

```
[{(0, 0), 0}]
```

(0, 0) inserted in REACHED

```
[(0, 0)]
```

{(0, 0), 0} removed from QUEUE

```
[]
```

```

{(3, 0), 1} inserted in QUEUE
[{(3, 0), 1}]
---
(3, 0) inserted in REACHED
[(0, 0), (3, 0)]
---
{(0, 4), 1} inserted in QUEUE
[{(3, 0), 1}, {(0, 4), 1}]
---
(0, 4) inserted in REACHED
[(0, 0), (3, 0), (0, 4)]
---
{(3, 0), 1} removed from QUEUE
[{(0, 4), 1}]
---
{(3, 4), 2} inserted in QUEUE
[{(0, 4), 1}, {(3, 4), 2}]
---
(3, 4) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4)]
---
{(0, 3), 2} inserted in QUEUE
[{(0, 4), 1}, {(3, 4), 2}, {(0, 3), 2}]
---
(0, 3) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4), (0, 3)]
---
{(0, 4), 1} removed from QUEUE
[{(3, 4), 2}, {(0, 3), 2}]
---
{(3, 1), 2} inserted in QUEUE
[{(3, 4), 2}, {(0, 3), 2}, {(3, 1), 2}]
---
(3, 1) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4), (0, 3), (3, 1)]
---
{(3, 4), 2} removed from QUEUE
[{(0, 3), 2}, {(3, 1), 2}]
---
{(0, 3), 2} removed from QUEUE
[{(3, 1), 2}]
---
{(3, 3), 3} inserted in QUEUE
[{(3, 1), 2}, {(3, 3), 3}]
---
(3, 3) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4), (0, 3), (3, 1), (3, 3)]
---
{(3, 1), 2} removed from QUEUE
[{(3, 3), 3}]
---
{(0, 1), 3} inserted in QUEUE
[{(3, 3), 3}, {(0, 1), 3}]
---
(0, 1) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4), (0, 3), (3, 1), (3, 3), (0, 1)]
---
{(3, 3), 3} removed from QUEUE
[{(0, 1), 3}]
---
{(2, 4), 4} inserted in QUEUE

```

```

[{(0, 1), 3}, {(2, 4), 4}]
---
(2, 4) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4), (0, 3), (3, 1), (3, 3), (0, 1), (2, 4)]
---
{(0, 1), 3} removed from QUEUE
[{(2, 4), 4}]
---
{(1, 0), 4} inserted in QUEUE
[{(2, 4), 4}, {(1, 0), 4}]
---
(1, 0) inserted in REACHED
[(0, 0), (3, 0), (0, 4), (3, 4), (0, 3), (3, 1), (3, 3), (0, 1), (2, 4), (1, 0)]
---
{(2, 4), 4} removed from QUEUE
[{(1, 0), 4}]
---
{(2, 0), 5} inserted in QUEUE
[{(1, 0), 4}, {(2, 0), 5}]
---
(2, 0) inserted in REACHED
[(0, 0),
 (3, 0),
 (0, 4),
 (3, 4),
 (0, 3),
 (3, 1),
 (3, 3),
 (0, 1),
 (2, 4),
 (1, 0),
 (2, 0)]
---
{(1, 0), 4} removed from QUEUE
[{(2, 0), 5}]
---
{(1, 4), 5} inserted in QUEUE
[{(2, 0), 5}, {(1, 4), 5}]
---
(1, 4) inserted in REACHED
[(0, 0),
 (3, 0),
 (0, 4),
 (3, 4),
 (0, 3),
 (3, 1),
 (3, 3),
 (0, 1),
 (2, 4),
 (1, 0),
 (2, 0),
 (1, 4)]
---
{(2, 0), 5} removed from QUEUE
[{(1, 4), 5}]
---

```


3 Questão 3

TREE:

```
{('l', 'l', 'l', 'l'), 0}
|  {('r', 'l', 'r', 'l'), 1}
|  |  {('l', 'l', 'r', 'l'), 2}
|  |  |  {('r', 'l', 'r', 'l'), 3}
|  |  |  {('r', 'r', 'r', 'l'), 3}
|  |  |  |  {('l', 'l', 'r', 'l'), 4}
|  |  |  |  {('l', 'r', 'l', 'l'), 4}
|  |  |  |  |  {('r', 'r', 'r', 'l'), 5}
|  |  |  |  |  {('r', 'r', 'l', 'r'), 5}
|  |  |  |  |  |  {('l', 'r', 'l', 'r'), 6}
|  |  |  |  |  |  |  {('r', 'r', 'l', 'r'), 7}
|  |  |  |  |  |  |  {('r', 'r', 'l', 'r'), 7}
|  |  |  |  |  |  |  {('r', 'r', 'r', 'r'), 7}
```

FOUND GOAL:

{('r', 'r', 'r', 'r'), 7} with cost 7

SOLUTION:

```
[('carry-sheep', ('l', 'l', 'l', 'l'), ('r', 'l', 'r', 'l')),
 ('go-back', ('r', 'l', 'r', 'l'), ('l', 'l', 'r', 'l')),
 ('carry-wolf', ('l', 'l', 'r', 'l'), ('r', 'r', 'r', 'l')),
 ('bring-sheep', ('r', 'r', 'r', 'l'), ('l', 'r', 'l', 'l')),
 ('carry-cabbage', ('l', 'r', 'l', 'l'), ('r', 'r', 'l', 'r')),
 ('go-back', ('r', 'r', 'l', 'r'), ('l', 'r', 'l', 'r')),
 ('carry-sheep', ('l', 'r', 'l', 'r'), ('r', 'r', 'r', 'r'))]
```

HISTORY:

```
('l', 'l', 'l', 'l') inserted in REACHED
[(('l', 'l', 'l', 'l'))]
---
('r', 'l', 'r', 'l') inserted in REACHED
[(('l', 'l', 'l', 'l'), ('r', 'l', 'r', 'l'))]
---
('l', 'l', 'r', 'l') inserted in REACHED
[(('l', 'l', 'l', 'l'), ('r', 'l', 'r', 'l'), ('l', 'l', 'r', 'l'))]
---
('r', 'r', 'r', 'l') inserted in REACHED
[(('l', 'l', 'l', 'l'),
 ('r', 'l', 'r', 'l'),
 ('l', 'l', 'r', 'l'),
 ('r', 'r', 'r', 'l'))]
---
('l', 'r', 'l', 'l') inserted in REACHED
[(('l', 'l', 'l', 'l'),
 ('r', 'l', 'r', 'l'),
 ('l', 'l', 'r', 'l'),
 ('r', 'r', 'r', 'l'),
 ('l', 'r', 'l', 'l'))]
---
('r', 'r', 'l', 'r') inserted in REACHED
[(('l', 'l', 'l', 'l'),
 ('r', 'l', 'r', 'l'),
 ('l', 'l', 'r', 'l'),
 ('r', 'r', 'r', 'l'),
 ('l', 'r', 'l', 'l'),
 ('r', 'r', 'l', 'r'))]
---
('l', 'r', 'l', 'r') inserted in REACHED
[(('l', 'l', 'l', 'l'),
 ('r', 'l', 'r', 'l'),
 ('l', 'l', 'r', 'l'),
 ('r', 'r', 'r', 'l'),
 ('l', 'r', 'l', 'r'),
 ('r', 'r', 'l', 'r'))]
```

```

('r', 'r', 'r', 'l'),
('l', 'r', 'l', 'l'),
('r', 'r', 'l', 'r'),
('l', 'r', 'l', 'r')]
---
('r', 'r', 'r', 'r') inserted in REACHED
[('l', 'l', 'l', 'l'),
 ('r', 'l', 'r', 'l'),
 ('l', 'l', 'r', 'l'),
 ('r', 'r', 'r', 'l'),
 ('l', 'r', 'l', 'l'),
 ('r', 'r', 'l', 'r'),
 ('l', 'r', 'l', 'r'),
 ('r', 'r', 'r', 'r')]
---
```

4 Questão 4

```
TREE:
{a, 0}
|  {b, 1}
|  |  {e, 2}
|  |  {f, 2}
|  {b, 1}
|  {d, 1}
|  |  {j, 2}
FOUND GOAL:
{j, 2} with cost 2
SOLUTION:
[('a', 'd', 'taking 3', 1), ('d', 'j', 'taking 9', 1)]
HISTORY:
{a, 0} inserted in QUEUE
[{a, 0}]
---
a inserted in REACHED
['a']
---
{a, 0} removed from QUEUE
[]
---
{b, 1} inserted in QUEUE
[{b, 1}]
---
b inserted in REACHED
['a', 'b']
---
{d, 1} inserted in QUEUE
[{b, 1}, {d, 1}]
---
d inserted in REACHED
['a', 'b', 'd']
---
{b, 1} removed from QUEUE
[{d, 1}]
---
{e, 2} inserted in QUEUE
[{d, 1}, {e, 2}]
---
e inserted in REACHED
['a', 'b', 'd', 'e']
---
{f, 2} inserted in QUEUE
[{d, 1}, {e, 2}, {f, 2}]
---
f inserted in REACHED
['a', 'b', 'd', 'e', 'f']
---
{d, 1} removed from QUEUE
[{e, 2}, {f, 2}]
---
-----

TREE:
{a, 0}
|  {b, 1}
|  |  {e, 2}
|  |  |  {k, 3}
```

```

|   |   |   |   {f, 4}
|   |   |   |   {l, 3}
|   |   |   |   {h, 4}
|   |   {f, 2}
|   {b, 1}
|   {d, 1}
|   |   {j, 2}
FOUND GOAL:
{j, 2} with cost 2
SOLUTION:
[('a', 'd', 'taking 3', 1), ('d', 'j', 'taking 9', 1)]
HISTORY:
a inserted in REACHED
['a']
---
b inserted in REACHED
['a', 'b']
---
e inserted in REACHED
['a', 'b', 'e']
---
k inserted in REACHED
['a', 'b', 'e', 'k']
---
f inserted in REACHED
['a', 'b', 'e', 'k', 'f']
---
l inserted in REACHED
['a', 'b', 'e', 'k', 'f', 'l']
---
h inserted in REACHED
['a', 'b', 'e', 'k', 'f', 'l', 'h']
---
d inserted in REACHED
['a', 'b', 'e', 'k', 'f', 'l', 'h', 'd']
---
j inserted in REACHED
['a', 'b', 'e', 'k', 'f', 'l', 'h', 'd', 'j']
---
```

5 Questão 5

GREEDY BEST FIRST

TREE:

```
{a, 0}
|
| {b, 1}
| | {a, 2}
| | {c, 8}
| | {e, 7}
| | {f, 2}
| | | {b, 3}
| | | {c, 9}
| | | {d, 6}
| | | {h, 6}
| {c, 9}
| {d, 4}
| | {a, 8}
| | {f, 8}
| | {g, 9}
```

FOUND GOAL:

{h, 6} with cost 6

SOLUTION:

[('b', 1), ('f', 1), ('h', 4)]

HISTORY:

{a, 0} inserted in PRIORITY QUEUE with priority 0
[(0, {a, 0})]

a inserted in REACHED with value 0
{ 'a': {a, 0} }

{a, 0} removed from PRIORITY QUEUE
[]

b inserted in REACHED with value 1
{ 'a': {a, 0}, 'b': {b, 1} }

{b, 1} inserted in PRIORITY QUEUE with priority 1
[(1, {b, 1})]

c inserted in REACHED with value 9
{ 'a': {a, 0}, 'b': {b, 1}, 'c': {c, 9} }

{c, 9} inserted in PRIORITY QUEUE with priority 9
[(1, {b, 1}), (9, {c, 9})]

d inserted in REACHED with value 4
{ 'a': {a, 0}, 'b': {b, 1}, 'c': {c, 9}, 'd': {d, 4} }

{d, 4} inserted in PRIORITY QUEUE with priority 4
[(1, {b, 1}), (4, {d, 4}), (9, {c, 9})]

{b, 1} removed from PRIORITY QUEUE
[(4, {d, 4}), (9, {c, 9})]

c updated in REACHED with value 8
{ 'a': {a, 0}, 'b': {b, 1}, 'c': {c, 8}, 'd': {d, 4} }

{c, 8} update in PRIORITY QUEUE with priority 7
[(4, {d, 4}), (7, {c, 8})]

e inserted in REACHED with value 7

```

{'a': {a, 0}, 'b': {b, 1}, 'c': {c, 8}, 'd': {d, 4}, 'e': {e, 7}}
---
{e, 7} inserted in PRIORITY QUEUE with priority 6
[(4, {d, 4}), (6, {e, 7}), (7, {c, 8})]
---
f inserted in REACHED with value 2
{'a': {a, 0}, 'b': {b, 1}, 'c': {c, 8}, 'd': {d, 4}, 'e': {e, 7}, 'f': {f, 2}}
---
{f, 2} inserted in PRIORITY QUEUE with priority 1
[(1, {f, 2}), (4, {d, 4}), (6, {e, 7}), (7, {c, 8})]
---
{f, 2} removed from PRIORITY QUEUE
[(4, {d, 4}), (6, {e, 7}), (7, {c, 8})]
---
h inserted in REACHED with value 6
{'a': {a, 0},
 'b': {b, 1},
 'c': {c, 8},
 'd': {d, 4},
 'e': {e, 7},
 'f': {f, 2},
 'h': {h, 6}}
---
{h, 6} inserted in PRIORITY QUEUE with priority 4
[(4, {d, 4}), (4, {h, 6}), (6, {e, 7}), (7, {c, 8})]
---
{d, 4} removed from PRIORITY QUEUE
[(4, {h, 6}), (6, {e, 7}), (7, {c, 8})]
---
g inserted in REACHED with value 9
{'a': {a, 0},
 'b': {b, 1},
 'c': {c, 8},
 'd': {d, 4},
 'e': {e, 7},
 'f': {f, 2},
 'g': {g, 9},
 'h': {h, 6}}
---
{g, 9} inserted in PRIORITY QUEUE with priority 5
[(4, {h, 6}), (5, {g, 9}), (6, {e, 7}), (7, {c, 8})]
---
{h, 6} removed from PRIORITY QUEUE
[(5, {g, 9}), (6, {e, 7}), (7, {c, 8})]
---
BREADTH FIRST
TREE:
{a, 0}
|   {b, 1}
|   |   {a, 2}
|   |   {c, 8}
|   |   {e, 7}
|   |   |   {b, 13}
|   |   |   {h, 16}
|   |   {f, 2}
|   {c, 9}
|   |   {a, 18}
|   |   {b, 16}
|   |   {f, 16}
|   {d, 4}
|   |   {a, 8}

```

```

|   |   {f, 8}
|   |   {g, 9}
FOUND GOAL:
{h, 16} with cost 16
SOLUTION:
[('b', 1), ('e', 6), ('h', 9)]
HISTORY:
{a, 0} inserted in QUEUE
[{a, 0}]
---
a inserted in REACHED
['a']
---
{a, 0} removed from QUEUE
[]
---
{b, 1} inserted in QUEUE
[{b, 1}]
---
b inserted in REACHED
['a', 'b']
---
{c, 9} inserted in QUEUE
[{b, 1}, {c, 9}]
---
c inserted in REACHED
['a', 'b', 'c']
---
{d, 4} inserted in QUEUE
[{b, 1}, {c, 9}, {d, 4}]
---
d inserted in REACHED
['a', 'b', 'c', 'd']
---
{b, 1} removed from QUEUE
[{c, 9}, {d, 4}]
---
{e, 7} inserted in QUEUE
[{c, 9}, {d, 4}, {e, 7}]
---
e inserted in REACHED
['a', 'b', 'c', 'd', 'e']
---
{f, 2} inserted in QUEUE
[{c, 9}, {d, 4}, {e, 7}, {f, 2}]
---
f inserted in REACHED
['a', 'b', 'c', 'd', 'e', 'f']
---
{c, 9} removed from QUEUE
[{d, 4}, {e, 7}, {f, 2}]
---
{d, 4} removed from QUEUE
[{e, 7}, {f, 2}]
---
{g, 9} inserted in QUEUE
[{e, 7}, {f, 2}, {g, 9}]
---
g inserted in REACHED
['a', 'b', 'c', 'd', 'e', 'f', 'g']
---

```

{e, 7} removed from QUEUE

[{f, 2}, {g, 9}]

DEPTH FIRST

TREE:

{a, 0}

| {b, 1}

| | {a, 2}

| | {c, 8}

| | | {a, 17}

| | | {b, 15}

| | | {f, 15}

| | | | {b, 16}

| | | | {c, 22}

| | | | {d, 19}

| | | | | {a, 23}

| | | | | {f, 23}

| | | | | {g, 24}

| | | | | {d, 29}

| | | | | {h, 25}

FOUND GOAL:

{h, 25} with cost 25

SOLUTION:

[('b', 1), ('c', 7), ('f', 7), ('d', 4), ('g', 5), ('h', 1)]

HISTORY:

a inserted in REACHED

['a']

b inserted in REACHED

['a', 'b']

c inserted in REACHED

['a', 'b', 'c']

f inserted in REACHED

['a', 'b', 'c', 'f']

d inserted in REACHED

['a', 'b', 'c', 'f', 'd']

g inserted in REACHED

['a', 'b', 'c', 'f', 'd', 'g']

h inserted in REACHED

['a', 'b', 'c', 'f', 'd', 'g', 'h']

6 Questão 6

TREE:

```
{a, 0}
|
| {b, 7}
| {c, 9}
| | {a, 18}
| | {j, 14}
| | | {c, 19}
| | | {l, 20}
| | | | {j, 26}
| | | | {k, 24}
| {d, 3}
```

FOUND GOAL:

{k, 24} with cost 24

SOLUTION:

[('c', 9), ('j', 5), ('l', 6), ('k', 4)]

HISTORY:

{a, 0} inserted in PRIORITY QUEUE with priority 0

[(0, {a, 0})]

a inserted in REACHED with value 0

{'a': {a, 0}}

{a, 0} removed from PRIORITY QUEUE

[]

b inserted in REACHED with value 7

{'a': {a, 0}, 'b': {b, 7}}

{b, 7} inserted in PRIORITY QUEUE with priority 7

[(7, {b, 7})]

c inserted in REACHED with value 9

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}}

{c, 9} inserted in PRIORITY QUEUE with priority 6

[(6, {c, 9}), (7, {b, 7})]

d inserted in REACHED with value 3

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}, 'd': {d, 3}}

{d, 3} inserted in PRIORITY QUEUE with priority 14

[(6, {c, 9}), (7, {b, 7}), (14, {d, 3})]

{c, 9} removed from PRIORITY QUEUE

[(7, {b, 7}), (14, {d, 3})]

j inserted in REACHED with value 14

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}, 'd': {d, 3}, 'j': {j, 14}}

{j, 14} inserted in PRIORITY QUEUE with priority 3

[(3, {j, 14}), (7, {b, 7}), (14, {d, 3})]

{j, 14} removed from PRIORITY QUEUE

[(7, {b, 7}), (14, {d, 3})]

l inserted in REACHED with value 20

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}, 'd': {d, 3}, 'j': {j, 14}, 'l': {l, 20}}

{l, 20} inserted in PRIORITY QUEUE with priority 4

```

[(4, {l, 20}), (7, {b, 7}), (14, {d, 3})]
---
{l, 20} removed from PRIORITY QUEUE
[(7, {b, 7}), (14, {d, 3})]
---
k inserted in REACHED with value 24
{'a': {a, 0},
 'b': {b, 7},
 'c': {c, 9},
 'd': {d, 3},
 'j': {j, 14},
 'k': {k, 24},
 'l': {l, 20}}
---
{k, 24} inserted in PRIORITY QUEUE with priority 0
[(0, {k, 24}), (7, {b, 7}), (14, {d, 3})]
---
{k, 24} removed from PRIORITY QUEUE
[(7, {b, 7}), (14, {d, 3})]
---

```

7 Questão 7

TREE:

```
{a, 0}
|
| {b, 7}
| | {a, 14}
| | {f, 8}
| | | {b, 11}
| | | {g, 10}
| | {i, 11}
| | | {b, 15}
| | | {k, 16}
| {c, 9}
| | {a, 18}
| | {j, 14}
| {d, 3}
```

FOUND GOAL:

{k, 16} with cost 16

SOLUTION:

[('b', 7), ('i', 4), ('k', 5)]

HISTORY:

{a, 0} inserted in PRIORITY QUEUE with priority 0

[(0, {a, 0})]

a inserted in REACHED with value 0

{'a': {a, 0}}

{a, 0} removed from PRIORITY QUEUE

[]

b inserted in REACHED with value 7

{'a': {a, 0}, 'b': {b, 7}}

{b, 7} inserted in PRIORITY QUEUE with priority 14

[(14, {b, 7})]

c inserted in REACHED with value 9

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}}

{c, 9} inserted in PRIORITY QUEUE with priority 15

[(14, {b, 7}), (15, {c, 9})]

d inserted in REACHED with value 3

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}, 'd': {d, 3}}

{d, 3} inserted in PRIORITY QUEUE with priority 17

[(14, {b, 7}), (15, {c, 9}), (17, {d, 3})]

{b, 7} removed from PRIORITY QUEUE

[(15, {c, 9}), (17, {d, 3})]

f inserted in REACHED with value 8

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}, 'd': {d, 3}, 'f': {f, 8}}

{f, 8} inserted in PRIORITY QUEUE with priority 15

[(15, {c, 9}), (15, {f, 8}), (17, {d, 3})]

i inserted in REACHED with value 11

{'a': {a, 0}, 'b': {b, 7}, 'c': {c, 9}, 'd': {d, 3}, 'f': {f, 8}, 'i': {i, 11}}

{i, 11} inserted in PRIORITY QUEUE with priority 16

```

[(15, {c, 9}), (15, {f, 8}), (16, {i, 11}), (17, {d, 3})]
---
{c, 9} removed from PRIORITY QUEUE
[(15, {f, 8}), (16, {i, 11}), (17, {d, 3})]
---
j inserted in REACHED with value 14
{'a': {a, 0},
 'b': {b, 7},
 'c': {c, 9},
 'd': {d, 3},
 'f': {f, 8},
 'i': {i, 11},
 'j': {j, 14}}
---
{j, 14} inserted in PRIORITY QUEUE with priority 17
[(15, {f, 8}), (16, {i, 11}), (17, {d, 3}), (17, {j, 14})]
---
{f, 8} removed from PRIORITY QUEUE
[(16, {i, 11}), (17, {d, 3}), (17, {j, 14})]
---
g inserted in REACHED with value 10
{'a': {a, 0},
 'b': {b, 7},
 'c': {c, 9},
 'd': {d, 3},
 'f': {f, 8},
 'g': {g, 10},
 'i': {i, 11},
 'j': {j, 14}}
---
{g, 10} inserted in PRIORITY QUEUE with priority 18
[(16, {i, 11}), (17, {d, 3}), (17, {j, 14}), (18, {g, 10})]
---
{i, 11} removed from PRIORITY QUEUE
[(17, {d, 3}), (17, {j, 14}), (18, {g, 10})]
---
k inserted in REACHED with value 16
{'a': {a, 0},
 'b': {b, 7},
 'c': {c, 9},
 'd': {d, 3},
 'f': {f, 8},
 'g': {g, 10},
 'i': {i, 11},
 'j': {j, 14},
 'k': {k, 16}}
---
{k, 16} inserted in PRIORITY QUEUE with priority 16
[(16, {k, 16}), (17, {d, 3}), (17, {j, 14}), (18, {g, 10})]
---
{k, 16} removed from PRIORITY QUEUE
[(17, {d, 3}), (17, {j, 14}), (18, {g, 10})]
---

```

8 Questão 8

GREEDY BEST FIRST - COST 1

TREE:

```
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}
| {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1}
| | {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}
| | | {(1, 3, 4, 8, 2, 0, 7, 6, 5), 3}
| | | {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3}
| | | | {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}
| | | | {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}
| | | | {(1, 3, 0, 8, 2, 4, 7, 6, 5), 4}
| | | {(1, 3, 4, 8, 2, 5, 7, 6, 0), 2}
| | | {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}
| | | | {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3}
| | | | | {(1, 3, 4, 8, 0, 2, 7, 6, 5), 4}
| | | | | {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}
| | | | | {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}
| | | | {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3}
| | | | | {(1, 3, 4, 8, 0, 2, 7, 6, 5), 4}
| | | | | {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}
| | | | | {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}
| | | | {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3}
| | | | | {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}
| | | | | {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}
| | | | | {(1, 3, 4, 8, 0, 2, 7, 6, 5), 4}
| | | | {(1, 3, 4, 8, 2, 0, 7, 6, 5), 3}
| | | {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}
| | | | {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2}
| | | | | {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3}
| | | | | | {(1, 3, 4, 8, 0, 5, 7, 2, 6), 4}
| | | | | | {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}
| | | | | | {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}
| | | | | {(1, 3, 4, 8, 2, 5, 7, 0, 6), 3}
| | | | | {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3}
| | | | | | {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}
| | | | | | {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}
| | | | | | {(1, 3, 4, 8, 0, 5, 7, 2, 6), 4}
| | | | | {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}
| | | | | | {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4}
| | | | | | {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4}
| | | | | | {(1, 3, 4, 8, 0, 5, 7, 2, 6), 4}
| | | | {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2}
| | | | | {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}
| | | | | | {(0, 3, 4, 1, 2, 5, 8, 7, 6), 4}
| | | | | | {(1, 3, 4, 8, 2, 5, 0, 7, 6), 4}
| | | | | | {(1, 3, 4, 2, 0, 5, 8, 7, 6), 4}
| | | | | {(1, 3, 4, 8, 2, 5, 7, 0, 6), 3}
| | | {(1, 3, 4, 8, 2, 5, 7, 6, 0), 2}
```

FOUND GOAL:

{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} with cost 4

SOLUTION:

```
[(1, 3, 4, 8, 2, 0, 7, 6, 5),
 (1, 3, 0, 8, 2, 4, 7, 6, 5),
 (1, 0, 3, 8, 2, 4, 7, 6, 5),
 (1, 2, 3, 8, 0, 4, 7, 6, 5)]
```

HISTORY:

```
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0} inserted in PRIORITY QUEUE with priority 0
[0, {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}]
```

```
(1, 3, 4, 8, 2, 5, 7, 6, 0) inserted in REACHED with value 0
```

```

{(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0} removed from PRIORITY QUEUE
[]
---
(1, 3, 4, 8, 2, 0, 7, 6, 5) inserted in REACHED with value 1
{(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 0, 7, 6, 5), 1} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1})]
---
(1, 3, 4, 8, 2, 5, 7, 0, 6) inserted in REACHED with value 1
{(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 5, 7, 0, 6), 1} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1}), (1, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
{(1, 3, 4, 8, 2, 0, 7, 6, 5), 1} removed from PRIORITY QUEUE
[(1, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
(1, 3, 0, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 2
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 0, 8, 2, 4, 7, 6, 5), 2} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}), (1, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2})]
---
(1, 3, 4, 8, 0, 2, 7, 6, 5) inserted in REACHED with value 2
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 0, 2, 7, 6, 5), 2} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}),
 (1, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}),
 (1, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
{(1, 3, 4, 8, 2, 5, 7, 0, 6), 1} removed from PRIORITY QUEUE
[(1, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}), (1, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
(1, 3, 4, 8, 0, 5, 7, 2, 6) inserted in REACHED with value 2
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 0, 5, 7, 2, 6), 2} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}),
 (1, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (1, {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2})]
---
(1, 3, 4, 8, 2, 5, 0, 7, 6) inserted in REACHED with value 2

```

```

{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 5, 0, 7, 6), 2} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}),
 (1, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (1, {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2}),
 (1, {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2})]
---
{(1, 3, 0, 8, 2, 4, 7, 6, 5), 2} removed from PRIORITY QUEUE
[(1, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
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 (1, {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2})]
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(1, 0, 3, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 3
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 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
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(1, 0, 4, 8, 3, 5, 7, 2, 6) inserted in REACHED with value 3
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{(1, 0, 4, 8, 3, 5, 7, 2, 6), 3} inserted in PRIORITY QUEUE with priority 1
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(1, 3, 4, 0, 8, 5, 7, 2, 6) inserted in REACHED with value 3

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{(1, 3, 4, 0, 8, 5, 7, 2, 6), 3} inserted in PRIORITY QUEUE with priority 1

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(1, 3, 4, 8, 5, 0, 7, 2, 6) inserted in REACHED with value 3

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(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
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{(1, 3, 4, 8, 5, 0, 7, 2, 6), 3} inserted in PRIORITY QUEUE with priority 1

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{(1, 3, 4, 8, 2, 5, 0, 7, 6), 2} removed from PRIORITY QUEUE

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(1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3})]
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{(1, 3, 4, 0, 2, 5, 8, 7, 6), 3} inserted in PRIORITY QUEUE with priority 1
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{(1, 0, 3, 8, 2, 4, 7, 6, 5), 3} removed from PRIORITY QUEUE
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(0, 1, 3, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 4
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{(1, 3, 4, 7, 8, 2, 0, 6, 5), 4} inserted in PRIORITY QUEUE with priority 1
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 (1, {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3}),
 (1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
 (1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
 (1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
 (1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4})]

---
{(1, 0, 4, 8, 3, 5, 7, 2, 6), 3} removed from PRIORITY QUEUE
[(1, {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3}),
 (1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
 (1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
 (1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
 (1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4})]

---
(0, 1, 4, 8, 3, 5, 7, 2, 6) inserted in REACHED with value 4
{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
 (0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
 (0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
 (0, 3, 4, 1, 8, 2, 7, 6, 5): {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4},
 (1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
 (1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},
 (1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
 (1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
 (1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},

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(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
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(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
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(1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
(1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}}

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{(0, 1, 4, 8, 3, 5, 7, 2, 6), 4} inserted in PRIORITY QUEUE with priority 1

```

[(1, {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3}),
(1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4})]

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(1, 4, 0, 8, 3, 5, 7, 2, 6) inserted in REACHED with value 4

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{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
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(1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
(1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
(1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},
(1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
(1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
(1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
(1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
(1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
(1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}}

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{(1, 4, 0, 8, 3, 5, 7, 2, 6), 4} inserted in PRIORITY QUEUE with priority 1

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[(1, {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3}),
(1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
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(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
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(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4})]
---
{(1, 3, 4, 0, 8, 5, 7, 2, 6), 3} removed from PRIORITY QUEUE
[(1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
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(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4})]
---
(0, 3, 4, 1, 8, 5, 7, 2, 6) inserted in REACHED with value 4
{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
(0, 3, 4, 1, 8, 2, 7, 6, 5): {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4},
(0, 3, 4, 1, 8, 5, 7, 2, 6): {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4},
(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
(1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
(1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},
(1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
(1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
(1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
(1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
(1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
(1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}}
---
{(0, 3, 4, 1, 8, 5, 7, 2, 6), 4} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
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(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),

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(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
(1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4})]
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(1, 3, 4, 7, 8, 5, 0, 2, 6) inserted in REACHED with value 4
{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
(0, 3, 4, 1, 8, 2, 7, 6, 5): {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4},
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(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
(1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
(1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},
(1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
(1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
(1, 3, 4, 7, 8, 5, 0, 2, 6): {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4},
(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
(1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
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(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
(1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}}
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{(1, 3, 4, 7, 8, 5, 0, 2, 6), 4} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3}),
(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
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(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
(1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
(1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4})]
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```
{(1, 3, 4, 8, 5, 0, 7, 2, 6), 3} removed from PRIORITY QUEUE
[(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
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(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
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(1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
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(1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4})]
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(1, 3, 0, 8, 5, 4, 7, 2, 6) inserted in REACHED with value 4
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 (0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
 (0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
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 (1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
 (1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
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 (1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
 (1, 3, 4, 7, 8, 5, 0, 2, 6): {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
 (1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
 (1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
 (1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
 (1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
 (1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
 (1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}}
---
{(1, 3, 0, 8, 5, 4, 7, 2, 6), 4} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
 (1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
 (1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
 (1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
 (1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
 (1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}),
 (1, {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4})]
---
(1, 3, 4, 8, 5, 6, 7, 2, 0) inserted in REACHED with value 4
{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
 (0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
 (0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
 (0, 3, 4, 1, 8, 2, 7, 6, 5): {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4},
 (0, 3, 4, 1, 8, 5, 7, 2, 6): {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4},
 (1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
 (1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 0, 8, 5, 4, 7, 2, 6): {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4},
 (1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},

```

```

(1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
(1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
(1, 3, 4, 7, 8, 5, 0, 2, 6): {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4},
(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
(1, 3, 4, 8, 5, 6, 7, 2, 0): {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4},
(1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
(1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
(1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
(1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}

```

{(1, 3, 4, 8, 5, 6, 7, 2, 0), 4} inserted in PRIORITY QUEUE with priority 1

```

[(1, {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3}),
(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
(1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
(1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}),
(1, {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4}),
(1, {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4})]

```

{(1, 3, 4, 0, 2, 5, 8, 7, 6), 3} removed from PRIORITY QUEUE

```

[(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
(1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
(1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}),
(1, {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4}),
(1, {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4})]

```

(0, 3, 4, 1, 2, 5, 8, 7, 6) inserted in REACHED with value 4

```

{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
(0, 3, 4, 1, 2, 5, 8, 7, 6): {(0, 3, 4, 1, 2, 5, 8, 7, 6), 4},
(0, 3, 4, 1, 8, 2, 7, 6, 5): {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4},
(0, 3, 4, 1, 8, 5, 7, 2, 6): {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4},
(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},

```

```

(1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
(1, 3, 0, 8, 5, 4, 7, 2, 6): {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4},
(1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},
(1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
(1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
(1, 3, 4, 7, 8, 5, 0, 2, 6): {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4},
(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
(1, 3, 4, 8, 5, 6, 7, 2, 0): {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4},
(1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
(1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
(1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
(1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}}

```

{(0, 3, 4, 1, 2, 5, 8, 7, 6), 4} inserted in PRIORITY QUEUE with priority 1

```

[(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
(1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
(1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
(1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
(1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
(1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
(1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
(1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}),
(1, {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4}),
(1, {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4}),
(1, {(0, 3, 4, 1, 2, 5, 8, 7, 6), 4})]

```

(1, 3, 4, 2, 0, 5, 8, 7, 6) inserted in REACHED with value 4

```

{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 2, 7, 6, 5): {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4},
(0, 1, 4, 8, 3, 5, 7, 2, 6): {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4},
(0, 3, 4, 1, 2, 5, 8, 7, 6): {(0, 3, 4, 1, 2, 5, 8, 7, 6), 4},
(0, 3, 4, 1, 8, 2, 7, 6, 5): {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4},
(0, 3, 4, 1, 8, 5, 7, 2, 6): {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4},
(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 2, 7, 6, 5): {(1, 0, 4, 8, 3, 2, 7, 6, 5), 3},
(1, 0, 4, 8, 3, 5, 7, 2, 6): {(1, 0, 4, 8, 3, 5, 7, 2, 6), 3},
(1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
(1, 3, 0, 8, 5, 4, 7, 2, 6): {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4},
(1, 3, 4, 0, 2, 5, 8, 7, 6): {(1, 3, 4, 0, 2, 5, 8, 7, 6), 3},
(1, 3, 4, 0, 8, 2, 7, 6, 5): {(1, 3, 4, 0, 8, 2, 7, 6, 5), 3},
(1, 3, 4, 0, 8, 5, 7, 2, 6): {(1, 3, 4, 0, 8, 5, 7, 2, 6), 3},
(1, 3, 4, 2, 0, 5, 8, 7, 6): {(1, 3, 4, 2, 0, 5, 8, 7, 6), 4},
(1, 3, 4, 7, 8, 2, 0, 6, 5): {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4},
(1, 3, 4, 7, 8, 5, 0, 2, 6): {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4},
(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 0, 5, 7, 2, 6): {(1, 3, 4, 8, 0, 5, 7, 2, 6), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},

```

```

(1, 3, 4, 8, 2, 5, 0, 7, 6): {(1, 3, 4, 8, 2, 5, 0, 7, 6), 2},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0},
(1, 3, 4, 8, 5, 0, 7, 2, 6): {(1, 3, 4, 8, 5, 0, 7, 2, 6), 3},
(1, 3, 4, 8, 5, 6, 7, 2, 0): {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4},
(1, 3, 4, 8, 6, 2, 0, 7, 5): {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4},
(1, 3, 4, 8, 6, 2, 7, 0, 5): {(1, 3, 4, 8, 6, 2, 7, 0, 5), 3},
(1, 3, 4, 8, 6, 2, 7, 5, 0): {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4},
(1, 4, 0, 8, 3, 2, 7, 6, 5): {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4},
(1, 4, 0, 8, 3, 5, 7, 2, 6): {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}}

---
{(1, 3, 4, 2, 0, 5, 8, 7, 6), 4} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
 (1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
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 (1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
 (1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
 (1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
 (1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}),
 (1, {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4}),
 (1, {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4}),
 (1, {(0, 3, 4, 1, 2, 5, 8, 7, 6), 4}),
 (1, {(1, 3, 4, 2, 0, 5, 8, 7, 6), 4})]

---
{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} removed from PRIORITY QUEUE
[(1, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 4, 0, 8, 3, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 0, 7, 5), 4}),
 (1, {(1, 3, 4, 8, 6, 2, 7, 5, 0), 4}),
 (1, {(0, 3, 4, 1, 8, 2, 7, 6, 5), 4}),
 (1, {(1, 3, 4, 7, 8, 2, 0, 6, 5), 4}),
 (1, {(0, 1, 4, 8, 3, 5, 7, 2, 6), 4}),
 (1, {(1, 4, 0, 8, 3, 5, 7, 2, 6), 4}),
 (1, {(0, 3, 4, 1, 8, 5, 7, 2, 6), 4}),
 (1, {(1, 3, 4, 7, 8, 5, 0, 2, 6), 4}),
 (1, {(1, 3, 0, 8, 5, 4, 7, 2, 6), 4}),
 (1, {(1, 3, 4, 8, 5, 6, 7, 2, 0), 4}),
 (1, {(0, 3, 4, 1, 2, 5, 8, 7, 6), 4}),
 (1, {(1, 3, 4, 2, 0, 5, 8, 7, 6), 4})]

---
GREEDY BEST FIRST - HEURISTIC
TREE:
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}
|   {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1}
|   |   {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}
|   |   |   {(1, 3, 4, 8, 2, 0, 7, 6, 5), 3}
|   |   |   |   {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3}
|   |   |   |   |   {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}
|   |   |   |   |   |   {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}
|   |   |   |   |   |   |   {(1, 3, 0, 8, 2, 4, 7, 6, 5), 4}
|   |   |   |   |   |   |   |   {(1, 3, 4, 8, 2, 5, 7, 6, 0), 2}
|   |   |   |   |   |   |   |   |   {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}
|   |   |   |   |   |   |   |   |   |   {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}

FOUND GOAL:
{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} with cost 4

```

SOLUTION:

```
[(1, 3, 4, 8, 2, 0, 7, 6, 5),  
 (1, 3, 0, 8, 2, 4, 7, 6, 5),  
 (1, 0, 3, 8, 2, 4, 7, 6, 5),  
 (1, 2, 3, 8, 0, 4, 7, 6, 5)]
```

HISTORY:

```
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0} inserted in PRIORITY QUEUE with priority 0  
[(0, {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0})]  
---  
(1, 3, 4, 8, 2, 5, 7, 6, 0) inserted in REACHED with value 0  
{(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}  
---  
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0} removed from PRIORITY QUEUE  
[]  
---  
(1, 3, 4, 8, 2, 0, 7, 6, 5) inserted in REACHED with value 1  
{(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},  
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}  
---  
{(1, 3, 4, 8, 2, 0, 7, 6, 5), 1} inserted in PRIORITY QUEUE with priority 3  
[(3, {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1})]  
---  
(1, 3, 4, 8, 2, 5, 7, 0, 6) inserted in REACHED with value 1  
{(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},  
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},  
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}  
---  
{(1, 3, 4, 8, 2, 5, 7, 0, 6), 1} inserted in PRIORITY QUEUE with priority 5  
[(3, {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1}), (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]  
---  
{(1, 3, 4, 8, 2, 0, 7, 6, 5), 1} removed from PRIORITY QUEUE  
[(5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]  
---  
(1, 3, 0, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 2  
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},  
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},  
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},  
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}  
---  
{(1, 3, 0, 8, 2, 4, 7, 6, 5), 2} inserted in PRIORITY QUEUE with priority 2  
[(2, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}), (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]  
---  
(1, 3, 4, 8, 0, 2, 7, 6, 5) inserted in REACHED with value 2  
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},  
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},  
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},  
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},  
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}  
---  
{(1, 3, 4, 8, 0, 2, 7, 6, 5), 2} inserted in PRIORITY QUEUE with priority 4  
[(2, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}),  
 (4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),  
 (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]  
---  
{(1, 3, 0, 8, 2, 4, 7, 6, 5), 2} removed from PRIORITY QUEUE  
[(4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}), (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]  
---  
(1, 0, 3, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 3  
{(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},  
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},  
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
```

```

(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 0, 3, 8, 2, 4, 7, 6, 5), 3} inserted in PRIORITY QUEUE with priority 1
[(1, {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3}),
 (4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
{(1, 0, 3, 8, 2, 4, 7, 6, 5), 3} removed from PRIORITY QUEUE
[(4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}), (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
(1, 2, 3, 8, 0, 4, 7, 6, 5) inserted in REACHED with value 4
{(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} inserted in PRIORITY QUEUE with priority 0
[(0, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
(0, 1, 3, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 4
{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
 (1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(0, 1, 3, 8, 2, 4, 7, 6, 5), 4} inserted in PRIORITY QUEUE with priority 2
[(0, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (2, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} removed from PRIORITY QUEUE
[(2, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}),
 (4, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (5, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
A*
TREE:
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}
|   {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1}
|   |   {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}
|   |   |   {(1, 3, 4, 8, 2, 0, 7, 6, 5), 3}
|   |   |   |   {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3}
|   |   |   |   |   {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}
|   |   |   |   |   |   {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4}
|   |   |   |   |   |   |   {(1, 3, 0, 8, 2, 4, 7, 6, 5), 4}
|   |   |   |   |   |   |   |   {(1, 3, 4, 8, 2, 5, 7, 6, 0), 2}
|   |   |   |   |   |   |   |   |   {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}
|   |   |   |   |   |   |   |   |   |   {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}
FOUND GOAL:

```



```

{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} with cost 4
SOLUTION:
[(1, 3, 4, 8, 2, 0, 7, 6, 5),
 (1, 3, 0, 8, 2, 4, 7, 6, 5),
 (1, 0, 3, 8, 2, 4, 7, 6, 5),
 (1, 2, 3, 8, 0, 4, 7, 6, 5)]
HISTORY:
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0} inserted in PRIORITY QUEUE with priority 0
[(0, {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0})]
---
(1, 3, 4, 8, 2, 5, 7, 6, 0) inserted in REACHED with value 0
{(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 5, 7, 6, 0), 0} removed from PRIORITY QUEUE
[]
---
(1, 3, 4, 8, 2, 0, 7, 6, 5) inserted in REACHED with value 1
{(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 0, 7, 6, 5), 1} inserted in PRIORITY QUEUE with priority 4
[(4, {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1})]
---
(1, 3, 4, 8, 2, 5, 7, 0, 6) inserted in REACHED with value 1
{(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 2, 5, 7, 0, 6), 1} inserted in PRIORITY QUEUE with priority 6
[(4, {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1}), (6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
{(1, 3, 4, 8, 2, 0, 7, 6, 5), 1} removed from PRIORITY QUEUE
[(6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
(1, 3, 0, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 2
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 0, 8, 2, 4, 7, 6, 5), 2} inserted in PRIORITY QUEUE with priority 4
[(4, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}), (6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1})]
---
(1, 3, 4, 8, 0, 2, 7, 6, 5) inserted in REACHED with value 2
{(1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 3, 4, 8, 0, 2, 7, 6, 5), 2} inserted in PRIORITY QUEUE with priority 6
[(4, {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2}),
 (6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}),
 (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
{(1, 3, 0, 8, 2, 4, 7, 6, 5), 2} removed from PRIORITY QUEUE
[(6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}), (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
(1, 0, 3, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 3
{(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},

```

```

(1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
(1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
(1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
(1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 0, 3, 8, 2, 4, 7, 6, 5), 3} inserted in PRIORITY QUEUE with priority 4
[(4, {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3}),
 (6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}),
 (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
{(1, 0, 3, 8, 2, 4, 7, 6, 5), 3} removed from PRIORITY QUEUE
[(6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}), (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
(1, 2, 3, 8, 0, 4, 7, 6, 5) inserted in REACHED with value 4
{(1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} inserted in PRIORITY QUEUE with priority 4
[(4, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}),
 (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2})]
---
(0, 1, 3, 8, 2, 4, 7, 6, 5) inserted in REACHED with value 4
{(0, 1, 3, 8, 2, 4, 7, 6, 5): {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4},
 (1, 0, 3, 8, 2, 4, 7, 6, 5): {(1, 0, 3, 8, 2, 4, 7, 6, 5), 3},
 (1, 2, 3, 8, 0, 4, 7, 6, 5): {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4},
 (1, 3, 0, 8, 2, 4, 7, 6, 5): {(1, 3, 0, 8, 2, 4, 7, 6, 5), 2},
 (1, 3, 4, 8, 0, 2, 7, 6, 5): {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2},
 (1, 3, 4, 8, 2, 0, 7, 6, 5): {(1, 3, 4, 8, 2, 0, 7, 6, 5), 1},
 (1, 3, 4, 8, 2, 5, 7, 0, 6): {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1},
 (1, 3, 4, 8, 2, 5, 7, 6, 0): {(1, 3, 4, 8, 2, 5, 7, 6, 0), 0}}
---
{(0, 1, 3, 8, 2, 4, 7, 6, 5), 4} inserted in PRIORITY QUEUE with priority 6
[(4, {(1, 2, 3, 8, 0, 4, 7, 6, 5), 4}),
 (6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}),
 (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (6, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4})]
---
{(1, 2, 3, 8, 0, 4, 7, 6, 5), 4} removed from PRIORITY QUEUE
[(6, {(1, 3, 4, 8, 2, 5, 7, 0, 6), 1}),
 (6, {(1, 3, 4, 8, 0, 2, 7, 6, 5), 2}),
 (6, {(0, 1, 3, 8, 2, 4, 7, 6, 5), 4})]
---

```

9 Questão 9

MINIMAX

20

```
{None} opened
| {None} opened
| | {None} opened
| | | {None} opened
| | | | {20} returns 20
| | | | {33} returns 33
| | | {20} gets value 20 by min
| | | {None} opened
| | | | {-45} returns -45
| | | | {31} returns 31
| | | {-45} gets value -45 by min
| | {20} gets value 20 by max
| | {None} opened
| | | {None} opened
| | | | {24} returns 24
| | | | {25} returns 25
| | | {24} gets value 24 by min
| | | {None} opened
| | | | {-10} returns -10
| | | | {20} returns 20
| | | {-10} gets value -10 by min
| | {24} gets value 24 by max
| {20} gets value 20 by min
| {None} opened
| | {None} opened
| | | {None} opened
| | | | {40} returns 40
| | | | {-25} returns -25
| | | {-25} gets value -25 by min
| | | {None} opened
| | | | {18} returns 18
| | | | {-42} returns -42
| | | {-42} gets value -42 by min
| | {-25} gets value -25 by max
| | {None} opened
| | | {None} opened
| | | | {24} returns 24
| | | | {-19} returns -19
| | | {-19} gets value -19 by min
| | | {None} opened
| | | | {36} returns 36
| | | | {-41} returns -41
| | | {-41} gets value -41 by min
| | {-19} gets value -19 by max
| {-25} gets value -25 by min
{20} gets value 20 by max
```

MINIMAX ALPHA-BETA LEFT

20

```
{None} opened
| {None} opened
| | {None} opened
| | | {None} opened
| | | | {20} returns 20
| | | | {33} returns 33
| | | {20} closed with value 20
| | | {None} opened
| | | | {-45} returns -45
```

```

| | | {-45} closed prematurely with -45 <= 20 (alpha)
| | {20} closed with value 20
| | {None} opened
| | | {None} opened
| | | | {24} returns 24
| | | | {25} returns 25
| | | {24} closed with value 24
| | {24} closed prematurely with 24 >= 20 (beta)
| {20} closed with value 20
| {None} opened
| | {None} opened
| | | {None} opened
| | | | {40} returns 40
| | | | {-25} returns -25
| | | {-25} closed prematurely with -25 <= 20 (alpha)
| | | {None} opened
| | | | {18} returns 18
| | | {18} closed prematurely with 18 <= 20 (alpha)
| | {18} closed with value 18
| {18} closed prematurely with 18 <= 20 (alpha)
{20} closed with value 20
MINIMAX ALPHA-BETA RIGHT
20
{None} opened
| {None} opened
| | {None} opened
| | | {None} opened
| | | | {-41} returns -41
| | | | {36} returns 36
| | | {-41} closed with value -41
| | | {None} opened
| | | | {-19} returns -19
| | | | {24} returns 24
| | | {-19} closed with value -19
| | {-19} closed with value -19
| | {None} opened
| | | {None} opened
| | | | {-42} returns -42
| | | | {18} returns 18
| | | {-42} closed with value -42
| | | {None} opened
| | | | {-25} returns -25
| | | | {40} returns 40
| | | {-25} closed with value -25
| | {-25} closed with value -25
| {-25} closed with value -25
| {None} opened
| | {None} opened
| | | {None} opened
| | | | {20} returns 20
| | | | {-10} returns -10
| | | {-10} closed with value -10
| | | {None} opened
| | | | {25} returns 25
| | | | {24} returns 24
| | | {24} closed with value 24
| | {24} closed with value 24
| | {None} opened
| | | {None} opened
| | | | {31} returns 31
| | | {-45} returns -45

```

```
| | | {-45} closed prematurely with -45 <= -25 (alpha)
| | | {None} opened
| | | | {33} returns 33
| | | | {20} returns 20
| | | {20} closed with value 20
| | {20} closed with value 20
| {20} closed with value 20
{20} closed with value 20
```

10 Questão 10

MINIMAX

```
-1
{(None, 5)} opened
|  {(None, 4)} opened
|  |  {(None, 3)} opened
|  |  |  {(None, 2)} opened
|  |  |  |  {(None, 1)} opened
|  |  |  |  |  {(-1, 0)} returns (-1, 0)
|  |  |  |  {( -1, 1)} gets value (-1, 1) by max
|  |  |  |  |  {(1, 0)} returns (1, 0)
|  |  |  {( -1, 2)} gets value (-1, 2) by min
|  |  |  {(None, 1)} opened
|  |  |  |  |  {(1, 0)} returns (1, 0)
|  |  |  {(1, 1)} gets value (1, 1) by min
|  |  |  |  {(-1, 0)} returns (-1, 0)
|  |  {(1, 3)} gets value (1, 3) by max
|  |  {(None, 2)} opened
|  |  |  {(None, 1)} opened
|  |  |  |  |  {(1, 0)} returns (1, 0)
|  |  |  {(1, 1)} gets value (1, 1) by min
|  |  |  |  {(-1, 0)} returns (-1, 0)
|  |  {(1, 2)} gets value (1, 2) by max
|  |  {(None, 1)} opened
|  |  |  {(-1, 0)} returns (-1, 0)
|  |  {(-1, 1)} gets value (-1, 1) by max
|  {(-1, 4)} gets value (-1, 4) by min
|  {(None, 3)} opened
|  |  {(None, 2)} opened
|  |  |  {(None, 1)} opened
|  |  |  |  |  {(1, 0)} returns (1, 0)
|  |  |  {(1, 1)} gets value (1, 1) by min
|  |  |  |  {(-1, 0)} returns (-1, 0)
|  |  {(1, 2)} gets value (1, 2) by max
|  |  {(None, 1)} opened
|  |  |  {(-1, 0)} returns (-1, 0)
|  |  {(-1, 1)} gets value (-1, 1) by max
|  |  |  {(1, 0)} returns (1, 0)
|  {(-1, 3)} gets value (-1, 3) by min
|  {(None, 2)} opened
|  |  {(None, 1)} opened
|  |  |  {(-1, 0)} returns (-1, 0)
|  |  {(-1, 1)} gets value (-1, 1) by max
|  |  |  {(1, 0)} returns (1, 0)
|  {(-1, 2)} gets value (-1, 2) by min
|  {(-1, 5)} gets value (-1, 5) by max
```

MINIMAX ALPHA-BETA LEFT

```
-1
{(None, 5)} opened
|  {(None, 4)} opened
|  |  {(None, 3)} opened
|  |  |  {(None, 2)} opened
|  |  |  |  {(None, 1)} opened
|  |  |  |  |  {(-1, 0)} returns -1
|  |  |  |  {(-1, 1)} closed with value -1
|  |  |  |  |  {(1, 0)} returns 1
|  |  |  {(-1, 2)} closed with value -1
|  |  |  {(None, 1)} opened
|  |  |  |  |  {(1, 0)} returns 1
|  |  |  {(1, 1)} closed with value 1
```

```

| | | {(-1, 0)} returns -1
| | {(1, 3)} closed with value 1
| | {(None, 2)} opened
| | | {(None, 1)} opened
| | | | {(1, 0)} returns 1
| | | {(1, 1)} closed with value 1
| | {(1, 2)} closed prematurely with 1 >= 1 (beta)
| | {(None, 1)} opened
| | | {(-1, 0)} returns -1
| | {(-1, 1)} closed with value -1
| {(-1, 4)} closed with value -1
| {(None, 3)} opened
| | {(None, 2)} opened
| | | {(None, 1)} opened
| | | | {(1, 0)} returns 1
| | | {(1, 1)} closed with value 1
| | | {(-1, 0)} returns -1
| | {(1, 2)} closed with value 1
| | {(None, 1)} opened
| | | {(-1, 0)} returns -1
| | {(-1, 1)} closed with value -1
| {(-1, 3)} closed prematurely with -1 <= -1 (alpha)
| {(None, 2)} opened
| | {(None, 1)} opened
| | | {(-1, 0)} returns -1
| | {(-1, 1)} closed with value -1
| {(-1, 2)} closed prematurely with -1 <= -1 (alpha)
{(-1, 5)} closed with value -1
MINIMAX ALPHA-BETA RIGHT
-1
{(None, 5)} opened
| {(None, 2)} opened
| | {(1, 0)} returns 1
| | {(None, 1)} opened
| | | {(-1, 0)} returns -1
| | {(-1, 1)} closed with value -1
| {(-1, 2)} closed with value -1
| {(None, 3)} opened
| | {(1, 0)} returns 1
| | {(None, 1)} opened
| | | {(-1, 0)} returns -1
| | {(-1, 1)} closed with value -1
| {(-1, 3)} closed prematurely with -1 <= -1 (alpha)
| {(None, 4)} opened
| | {(None, 1)} opened
| | | {(-1, 0)} returns -1
| | {(-1, 1)} closed with value -1
| {(-1, 4)} closed prematurely with -1 <= -1 (alpha)
{(-1, 5)} closed with value -1

```