8-Puzzle

Java 22.0.1

Visão Geral

Este projeto aborda a aplicação do algoritmo de busca em largura (**Breadth-first Search**) sobre o jogo **8-Puzzle**. Foi desenvolvido com Java 22, no Linux Ubuntu 22.04.

Instalação

Clone o repositório e compile o código utilizando o comando **javac**, de acordo com o exemplo:

```
git clone https://github.com/joaovitorbatistella/EightPuzzle.git
cd EightPuzzle/EightPuzzle
javac -d . src/com/mycompany/*.java
```

Execução

Para executar, utilize o comando **java** e o caminho onde se encontra a função **Main**

```
java com.mycompany.EightPuzzle
```

Ao executar, será necessário informar o puzzle de entrada e o puzzle na qual representará o estado final ou desejado.

As entradas devem conter valores inteiros separados por um espaço em branco, exemplo:

```
1 2 4 3 0 5 7 6 8
```

```
0 1 2 3 4 5 6 7 8
```

A saída do programa contém o número de nodos criados até a solução do puzzle, o tempo de execução do resolvedor (**Breadth-first Search**), o número de passos necessários para solucionar o puzzle e qual o caminho para a solução.

Exemplo:

```
Running...
Goal found!
Tracing path...

Number of states needed to solve (expanded nodes): 9618
Time to solve (ms): 95.715531
Solution steps: 15

Path:

1 2 4
3 0 5
7 6 8

1 2 4
3 6 5
7 0 8

1 2 4
3 6 5
7 8 0

1 2 4
3 6 0
7 8 5

1 2 0
3 6 4
7 8 5

1 0 2
3 6 4
7 8 5

0 1 2
3 6 4
7 8 5

3 1 2
0 6 4
7 8 5

3 1 2
```

```
6 0 4
7 8 5

3 1 2
6 4 0
7 8 5

3 1 2
6 4 5
7 8 0

3 1 2
6 4 5
7 0 8

3 1 2
6 4 5
0 7 8

3 1 2
0 4 5
6 7 8

0 1 2
3 4 5
6 7 8
```

Testes

Os testes executados foram comparados à performance do resolvedor **Sliding Generator And Solver**, aqui abreviado para *SGAS*.

Teste #1

Gerado no SGAS com shuffle = 1.

Entradas:

```
1 2 3 4 5 0 7 8 6
```

```
1 2 3 4 5 6 7 8 0
```

Saída:

```
Number of states needed to solve (expanded nodes): 3
Time to solve (ms): 0.22812
Solution steps: 1

Path:

1 2 3
4 5 0
7 8 6

1 2 3
4 5 6
7 8 0
```

Saída no SGAS:

```
<SolutionTime>0</SolutionTime>
<NoOfStoredNodes>3</NoOfStoredNodes>
<NoOfNodeExpansion>2</NoOfNodeExpansion>
<SolutionStep>1</SolutionStep>

<Node0>1,2,3,4,5,0,7,8,6</Node0>
<Node1>1,2,3,4,5,6,7,8,0</Node1>
```

Teste #2

Gerado no SGAS com shuffle = 3.

Entradas:

```
1 2 3 0 4 6 7 5 8
```

```
1 2 3 4 5 6 7 8 0
```

Saída:

```
Number of states needed to solve (expanded nodes): 20
Time to solve (ms): 0.359827
Solution steps: 3

Path:

1 2 3
0 4 6
7 5 8

1 2 3
4 0 6
7 5 8

1 2 3
4 5 6
7 0 8

1 2 3
4 5 6
7 8 0
```

Saída no SGAS:

```
<SolutionTime>0</SolutionTime>
<NoOfStoredNodes>12</NoOfStoredNodes>
<NoOfNodeExpansion>13</NoOfNodeExpansion>
<SolutionStep>3</SolutionStep>

<Node0>1,2,3,0,4,6,7,5,8</Node0>
<Node1>1,2,3,4,0,6,7,5,8</Node1>
<Node2>1,2,3,4,5,6,7,0,8</Node2>
<Node3>1,2,3,4,5,6,7,8,0</Node3>
```

Teste #3

Gerado no SGAS com shuffle = 9.

Entradas:

```
1 2 3 0 5 7 4 8 6
```

```
1 2 3 4 5 6 7 8 0
```

Saída:

```
Number of states needed to solve (expanded nodes): 534
Time to solve (ms): 1.909455
Solution steps: 9

Path:

1 2 3
0 5 7
4 8 6

1 2 3
5 0 7
4 8 6

1 2 3
5 7 0
4 8 6

1 2 3
5 7 6
4 8 0

1 2 3
5 7 6
4 0 8

1 2 3
5 0 6
4 7 8

1 2 3
0 5 6
4 7 8

1 2 3
4 5 6
0 7 8

1 2 3
4 5 6
7 0 8

1 2 3
```

```
4 5 6
7 8 0
```

Saída no SGAS:

```
<SolutionTime>8</SolutionTime>
<NoOfStoredNodes>236</NoOfStoredNodes>
<NoOfNodeExpansion>388</NoOfNodeExpansion>
<SolutionStep>9</SolutionStep>

<Node0>1,2,3,0,5,7,4,8,6</Node0>
<Node1>1,2,3,5,0,7,4,8,6</Node1>
<Node2>1,2,3,5,7,0,4,8,6</Node2>
<Node3>1,2,3,5,7,6,4,8,0</Node3>
<Node4>1,2,3,5,7,6,4,0,8</Node4>
<Node5>1,2,3,5,0,6,4,7,8</Node5>
<Node6>1,2,3,0,5,6,4,7,8</Node6>
<Node7>1,2,3,4,5,6,0,7,8</Node7>
<Node8>1,2,3,4,5,6,7,0,8</Node8>
<Node9>1,2,3,4,5,6,7,8,0</Node9>
```

Teste #4

Gerado no SGAS com shuffle = 27.

Entradas:

```
8 4 2 0 3 5 7 6 1
```

```
1 2 3 4 5 6 7 8 0
```

Saída:

```
Number of states needed to solve (expanded nodes): 150484
Time to solve (ms): 33964.743003
Solution steps: 21

Path:

8 4 2
0 3 5
7 6 1

8 4 2
7 3 5
0 6 1

8 4 2
7 3 5
6 0 1

8 4 2
7 3 5
6 1 0

8 4 2
7 3 0
6 1 5

8 4 2
7 0 3
6 1 5

8 4 2
7 1 3
6 0 5

8 4 2
7 1 3
0 6 5

8 4 2
0 1 3
7 6 5

8 4 2
```

1 0 3
7 6 5

8 0 2
1 4 3
7 6 5

0 8 2
1 4 3
7 6 5

1 8 2
0 4 3
7 6 5

1 8 2
4 0 3
7 6 5

1 0 2
4 8 3
7 6 5

1 2 0
4 8 3
7 6 5

1 2 3
4 8 0
7 6 5

1 2 3
4 8 5
7 6 0

1 2 3
4 8 5
7 0 6

1 2 3
4 0 5
7 8 6

1 2 3

```
4 5 0
7 8 6

1 2 3
4 5 6
7 8 0
```

Saída no SGAS:

```
<SolutionTime>1333</SolutionTime>
<NoOfStoredNodes>21724</NoOfStoredNodes>
<NoOfNodeExpansion>57393</NoOfNodeExpansion>
<SolutionStep>21</SolutionStep>

<Node0>8,4,2,0,3,5,7,6,1</Node0>
<Node1>8,4,2,7,3,5,0,6,1</Node1>
<Node2>8,4,2,7,3,5,6,0,1</Node2>
<Node3>8,4,2,7,3,5,6,1,0</Node3>
<Node4>8,4,2,7,3,0,6,1,5</Node4>
<Node5>8,4,2,7,0,3,6,1,5</Node5>
<Node6>8,4,2,7,1,3,6,0,5</Node6>
<Node7>8,4,2,7,1,3,0,6,5</Node7>
<Node8>8,4,2,0,1,3,7,6,5</Node8>
<Node9>8,4,2,1,0,3,7,6,5</Node9>
<Node10>8,0,2,1,4,3,7,6,5</Node10>
<Node11>0,8,2,1,4,3,7,6,5</Node11>
<Node12>1,8,2,0,4,3,7,6,5</Node12>
<Node13>1,8,2,4,0,3,7,6,5</Node13>
<Node14>1,0,2,4,8,3,7,6,5</Node14>
<Node15>1,2,0,4,8,3,7,6,5</Node15>
<Node16>1,2,3,4,8,0,7,6,5</Node16>
<Node17>1,2,3,4,8,5,7,6,0</Node17>
<Node18>1,2,3,4,8,5,7,0,6</Node18>
<Node19>1,2,3,4,0,5,7,8,6</Node19>
<Node20>1,2,3,4,5,0,7,8,6</Node20>
<Node21>1,2,3,4,5,6,7,8,0</Node21>
```