Artificial Intelligence

8 PUZZLE GAME

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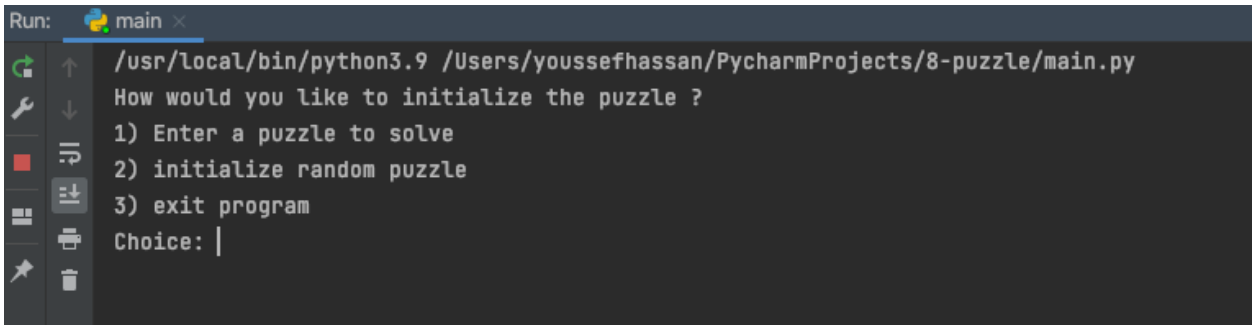
- **Data structures used:**

1. We used set to make a copy of points in frontier list to search faster as it occurs in order of (1) which is faster than searching in a list.
2. BFS: Queue
3. DFS: Stack
4. A*: Heap

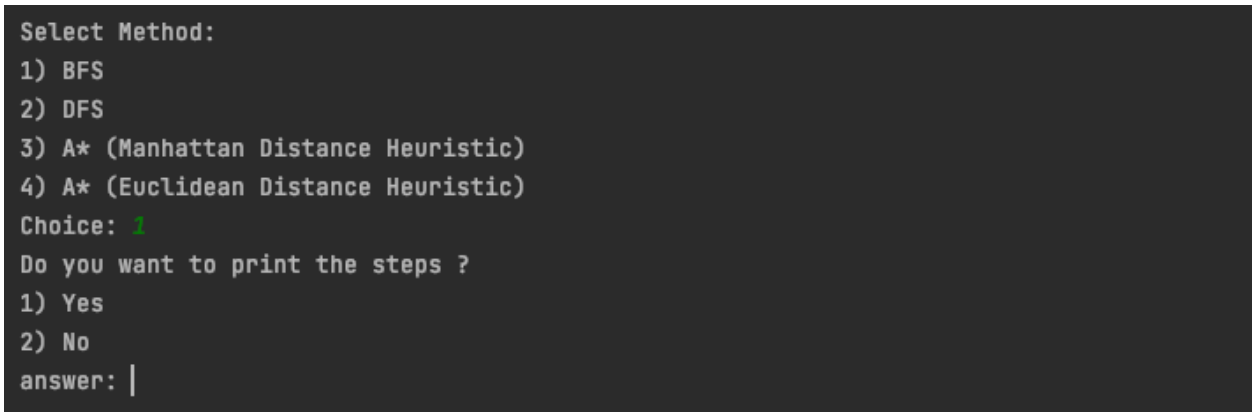
- **Heuristics**
  Manhattan heuristic is more admissible as it's closer to the output.

- **On start:**

1. Programmer ask the user to enter a puzzle to solve or to start with random puzzle.



2. Then you choose which algorithm to solve the puzzle and if you want to print the path.



- **Test Cases:**
  BFS
  - Starting Board State:

```
-------------
| 6      | 1      |        |
-------------
| 5      | 3      | 8      |
-------------
| 4      | 7      | 2      |
```

Cost of Path = 20
Number of Nodes Expanded = 51903
Depth of Search = 20
BFS Running time = 0.47003 sec

  - Path:

```
Step Number: 1
-------------
| 6      | 1      |        |
-------------
| 5      | 3      | 8      |
-------------
| 4      | 7      | 2      |
-------------
Step Number: 2
-------------
| 6      |        | 1      |
-------------
| 5      | 3      | 8      |
-------------
| 4      | 7      | 2      |
-------------
Step Number: 3
-------------
| 6      | 3      | 1      |
-------------
| 5      |        | 8      |
-------------
| 4      | 7      | 2      |
-------------
```

Step Number: 4

6	3	1
	5	8
4	7	2

Step Number: 5

6	3	1
4	5	8
	7	2

Step Number: 6

6	3	1
4	5	8
7		2

Step Number: 7

6	3	1
4		8
7	5	2

Step Number: 8

6	3	1
4	8	
7	5	2

Step Number: 9

6	3	1
4	8	2
7	5	

Step Number: 10

6	3	1
4	8	2
7		5

Step Number: 11

6	3	1
4		2
7	8	5

Step Number: 12

6	3	1
	4	2
7	8	5

Step Number: 13

	3	1
6	4	2
7	8	5

Step Number: 14

3		1
6	4	2
7	8	5

Step Number: 15

3	1	
6	4	2
7	8	5

Step Number: 16

3	1	2
6	4	
7	8	5

Step Number: 17

3	1	2
6	4	5
7	8	

Step Number: 18

3	1	2
6	4	5
7		8

Step Number: 19

3	1	2
6	4	5
	7	8

Step Number: 20

3	1	2
	4	5
6	7	8

Step Number: 21

	1	2
3	4	5
6	7	8

DFS:
Starting Board State:

```
---------------------
| 6   |     | 3   |
---------------------
| 1   | 8   | 4   |
---------------------
| 2   | 5   | 7   |
---------------------
```

Cost of Path = 8145
Number of Nodes Expanded = 174874
Depth of Search = 66124
DFS Running time = 0.960892915725708 sec

A* Manhattan heuristics:

Cost of Path = 20
Number of Nodes Expanded = 489
Depth of Search = 20
A* Running time = 0.0255317 sec

Path:

Step Number: 1

4	1	2
5	3	7
8	6	

Step Number: 2

4	1	2
5	3	
8	6	7

Step Number: 3

4	1	
5	3	2
8	6	7

Step Number: 4

4		1
5	3	2
8	6	7

Step Number: 5

4	3	1
5		2
8	6	7

Step Number: 6

4	3	1
	5	2
8	6	7

Step Number: 7

4	3	1
8	5	2
	6	7

Step Number: 8

4	3	1
8	5	2
6		7

Step Number: 9

4	3	1
8		2
6	5	7

Step Number: 10

4	3	1
	8	2
6	5	7

Step Number: 11

	3	1
4	8	2
6	5	7

Step Number: 12

3		1
4	8	2
6	5	7

Step Number: 13

3	1	
4	8	2
6	5	7

Step Number: 14

3	1	2
4	8	
6	5	7

Step Number: 15

3	1	2
4		8
6	5	7

Step Number: 16

3	1	2
4	5	8
6		7

Step Number: 17

3	1	2
4	5	8
6	7	

Step Number: 18

3	1	2
4	5	
6	7	8

Step Number: 19

3	1	2
4		5
6	7	8

Step Number: 20

3	1	2
	4	5
6	7	8

Step Number: 21

	1	2
3	4	5
6	7	8

A* Euclidean heuristic:
Cost of Path = 22
Number of Nodes Expanded = 1010
Depth of Search = 22
A* Running time = 0.09825992584228516 sec
Starting Board State:

```
-------------
| 5   | 1   | 7   |
--------------------
| 3   | 4   | 8   |
--------------------
|     | 2   | 6   |
```

Path:
Step Number: 1

```
-------------
| 5     | 1     | 7     |
-------------
| 3     | 4     | 8     |
-------------
|       | 2     | 6     |
-------------
```

Step Number: 2

```
-------------
| 5     | 1     | 7     |
-------------
|       | 4     | 8     |
-------------
| 3     | 2     | 6     |
-------------
```

Step Number: 3

```
-------------
| 5     | 1     | 7     |
-------------
| 4     |       | 8     |
-------------
| 3     | 2     | 6     |
-------------
```

Step Number: 4

5		7
4	1	8
3	2	6

Step Number: 5

	5	7
4	1	8
3	2	6

Step Number: 6

4	5	7
	1	8
3	2	6

Step Number: 7

4	5	7
1		8
3	2	6

Step Number: 8

4	5	7
1	2	8
3		6

Step Number: 9

4	5	7
1	2	8
3	6	

Step Number: 10

4	5	7
1	2	
3	6	8

Step Number: 11

4	5	
1	2	7
3	6	8

Step Number: 12

4		5
1	2	7
3	6	8

Step Number: 13

4	2	5
1		7
3	6	8

Step Number: 14

4	2	5
1	7	
3	6	8

Step Number: 15

4	2	
1	7	5
3	6	8

Step Number: 16

4		2
1	7	5
3	6	8

Step Number: 17

	4	2
1	7	5
3	6	8

Step Number: 18

1	4	2
	7	5
3	6	8

Step Number: 19

1	4	2
3	7	5
	6	8

Step Number: 20

1	4	2
3	7	5
6		8

Step Number: 21

```
-------------
| 1       | 4       | 2       |
-------------
| 3       |         | 5       |
-------------
| 6       | 7       | 8       |
-------------
```

Step Number: 22

```
-------------
| 1       |         | 2       |
-------------
| 3       | 4       | 5       |
-------------
| 6       | 7       | 8       |
-------------
```

Step Number: 23

```
-------------
|         | 1       | 2       |
-------------
| 3       | 4       | 5       |
-------------
| 6       | 7       | 8       |
-------------
```