Homework #4: Pattern Databases

Due Monday by 11:59pm **Points** 100 **Submitting** a file upload
Available after Apr 16 at 11:59pm

HW #4

23, 2018 at 11:59pm

For this assignment, undergr[illegible]n teams with up to one other student, while graduate students must work individua[illegible] the assignment with other students in thinking about how to solve these problems, but all programming and other portions of the assignment must be entirely your own work. You may not show your code to other students. If you are working with another student, you need to designate this by forming a group in Canvas.

Task:

In this assignment you will implement two pattern databases for the 3x5 sliding-tile puzzle.

Pattern Databases:

You should build pattern databases containing the following tiles:

a) 0 1 2 3 4 5 (3,603,600 entries)

b) 0 9 10 11 12 13 14 (32,432,400 entries)

Undergraduates can hard-code these patterns into the PDB code and ranking function. Graduate students should write code that takes any pattern as input for building the pdb.

Your PDB should store its values as an array/vector of 8-bit values. To build the PDB, do a breadth-first search from the goal state. Compute the (abstract) rank of a state to store its depth in the PDB. If you generate a state in the BFS which is already in the PDB you should discard the state to avoid generating states multiple times.

Ranking/Unranking:

Use a lexicographical ranking and unranking function (as described in class). To compute the abstract rank you must:

1) Compute the dual of the pattern

2) Compute the mixed-radix value of the pattern

3) Compute the rank of the mixed-radix pattern

Note that a naive implementation of step 1 takes O(n^2) time, while a smarter implementation (which computes the location of each tile first) will only take O(n) time.

Testing:

Test your code on the 20 test instances from homework three. Cor
expanded using:

- Only Manhattan distance
- The max of Manhattan distance and the PDBs

What to turn in:

Your submission should inclu or the assignmen
your program that tests on al te students should
provides the experimental re xplains the patter

Verifying Correctness:

If you print the distribution of depths in your PDBs, you should get

```
PDB complete; 3603600 of 3603600 entries written
PDB Distribution
0 : 1
1 : 2
2 : 4
3 : 9
4 : 20
5 : 32
6 : 53
7 : 78
8 : 140
9 : 215
10 : 383
11 : 572
12 : 994
13 : 1487
14 : 2551
15 : 3662
16 : 6083
17 : 8412
18 : 13285
19 : 17198
20 : 25715
21 : 31361
22 : 44669
23 : 51069
24 : 69998
25 : 76509
26 : 102351
27 : 108545
28 : 142635
29 : 146533
30 : 187956
31 : 184448
```

```
32 : 225205
33 : 207344
34 : 240235
35 : 208040
36 : 231516
37 : 190931
38 : 204510
39 : 159615
40 : 162910
41 : 120053
42 : 116888
43 : 80612
44 : 74123
45 : 47370
46 : 40866
47 : 23813
48 : 19044
49 : 9876
50 : 7331
51 : 3174
52 : 2077
53 : 658
54 : 369
55 : 62
56 : 8
PDB complete; 32432400 of 32432400 entries written
PDB Distribution
0 : 1
1 : 2
2 : 3
3 : 3
4 : 4
5 : 8
6 : 17
7 : 27
8 : 54
9 : 98
10 : 184
11 : 294
12 : 540
13 : 863
14 : 1582
15 : 2471
16 : 4440
17 : 6836
18 : 11915
19 : 17564
20 : 29623
21 : 41898
22 : 68189
23 : 91631
24 : 142003
25 : 179843
26 : 266385
27 : 319689
28 : 455866
```

```
29 : 520655
30 : 720291
31 : 789805
32 : 1062662
33 : 1117571
34 : 1453505
35 : 1457091
36 : 1820909
37 : 1730218
38 : 2067704
39 : 1863445
40 : 2138225
41 : 1833591
42 : 2021831
43 : 1644785
44 : 1735078
45 : 1331858
46 : 1337673
47 : 963259
48 : 915737
49 : 614432
50 : 551891
51 : 343792
52 : 291498
53 : 167802
54 : 133293
55 : 68521
56 : 49397
57 : 21711
58 : 13909
59 : 4827
60 : 2605
61 : 508
62 : 252
63 : 22
64 : 14
```


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HW3 Rubric (2)

Criteria	Ratings	
Ranking Function	2 F	20.0 pts Full Credit (gr
Pattern Databases	5 F	40.0 pts Full Credit (gr
Tests	2 Full Credit (Undergrad)	20.0 pts Full Credit (gr
Write-up	20.0 pts Full Credit	0.0 p No M