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CSCI 164 Artificial Intelligence

04/30/2022

8 Puzzle 15 Puzzle Search Algorithms

A\* search algorithm

PROBLEM: 0

Sequence: ['root', 'd', 'd', 'l', 'u', 'u', 'r', 'd', 'l', 'l', 'd', 'r', 'r', 'u', 'u', 'l', 'd', 'r', 'd']

Testing results: ['160273485', '163270485', '163275480', '163275408', '163205478', '103265478', '130265478', '135260478', '135206478', '135026478', '135426078', '135426708', '135426780', '135420786', '130425786', '103425786', '123405786', '123450786', '123456780']

Number of expanded nodes: 427

Time to find solution: 0.0372 seconds

PROBLEM: 1

Sequence: ['root', 'r', 'd', 'l', 'u', 'r', 'u', 'l', 'l', 'd', 'r', 'd', 'l', 'u', 'r', 'u', 'l', 'd', 'r', 'r', 'u', 'l', 'd', 'd', 'r']

Testing results: ['462301587', '462310587', '462317580', '462317508', '462307518', '462370518', '460372518', '406372518', '046372518', '346072518', '346702518', '346712508', '346712058', '346012758', '346102758', '306142758', '036142758', '136042758', '136402758', '136420758', '130426758', '103426758', '123406758', '123456708', '123456780']

Number of expanded nodes: 2843

Time to find solution: 0.5734 seconds

PROBLEM: 2

Sequence: ['root', 'l', 'u', 'l', 'u', 'r', 'd', 'l', 'd', 'r', 'u', 'r', 'u', 'l', 'd', 'l', 'u', 'r', 'd', 'r', 'u', 'l', 'd', 'l', 'u', 'r', 'd', 'r', 'd']

Testing results: ['821574360', '821574306', '821504376', '821054376', '021854376', '201854376', '251804376', '251084376', '251384076', '251384706', '251304786', '251340786', '250341786', '205341786', '245301786', '245031786', '045231786', '405231786', '435201786', '435210786', '430215786', '403215786', '413205786', '413025786', '013425786', '103425786', '123405786', '123450786', '123456780']

Number of expanded nodes: 8557

Time to find solution: 3.8141 seconds

PROBLEM: 3

Sequence: ['root', 'd', 'l', 'l', 'u', 'r', 'd', 'l', 'd', 'r', 'u', 'l', 'u', 'r', 'd', 'r', 'd', 'l', 'u', 'r', 'u', 'l', 'd', 'd', 'r']

Testing results: ['840156372', '846150372', '846105372', '846015372', '046815372', '406815372', '416805372', '416085372', '416385072', '416385702', '416305782', '416035782', '016435782', '106435782', '136405782', '136450782', '136452780', '136452708', '136402758', '136420758', '130426758', '103426758', '123406758', '123456708', '123456780']

Number of expanded nodes: 1239

Time to find solution: 0.1533 seconds

PROBLEM: 4

Sequence: ['root', 'd', 'l', 'd', 'l', 'u', 'r', 'd', 'r', 'u', 'u', 'l', 'd', 'd', 'r', 'u', 'l', 'l', 'u', 'r', 'd', 'l', 'd', 'r', 'r']

Testing results: ['530478126', '538470126', '538407126', '538427106', '538427016', '538027416', '538207416', '538217406', '538217460', '538210467', '530218467', '503218467', '513208467', '513268407', '513268470', '513260478', '513206478', '513026478', '013526478', '103526478', '123506478', '123056478', '123456078', '123456708', '123456780']

Number of expanded nodes: 2588

Time to find solution: 0.4828 seconds

PROBLEM: 5

Sequence: ['root', 'd', 'r', 'r', 'u', 'l', 'l', 'd', 'r', 'd', 'l', 'u', 'r', 'd', 'r', 'u', 'u', 'l', 'd', 'l', 'd', 'r', 'r']

Testing results: ['068314257', '368014257', '368104257', '368140257', '360148257', '306148257', '036148257', '136048257', '136408257', '136458207', '136458027', '136058427', '136508427', '136528407', '136528470', '136520478', '130526478', '103526478', '123506478', '123056478', '123456078', '123456708', '123456780']

Number of expanded nodes: 358

Time to find solution: 0.0284 seconds

PROBLEM: 6

Sequence: ['root', 'r', 'd', 'l', 'u', 'u', 'l', 'd', 'd', 'r', 'u', 'u', 'l', 'd', 'r', 'd', 'r']

Testing results: ['453207186', '453270186', '453276180', '453276108', '453206178', '403256178', '043256178', '243056178', '243156078', '243156708', '243106758', '203146758', '023146758', '123046758', '123406758', '123456708', '123456780']

Number of expanded nodes: 173

Time to find solution: 0.0117 seconds

PROBLEM: 7

Sequence: ['root', 'l', 'u', 'r', 'd', 'r', 'u', 'l', 'l', 'd', 'd', 'r', 'u', 'l', 'd', 'r', 'r', 'u', 'l', 'd', 'r']

Testing results: ['128307645', '128037645', '028137645', '208137645', '238107645', '238170645', '230178645', '203178645', '023178645', '123078645', '123678045', '123678405', '123608475', '123068475', '123468075', '123468705', '123468750', '123460758', '123406758', '123456708', '123456780']

Number of expanded nodes: 325

Time to find solution: 0.0251 seconds

PROBLEM: 8

Sequence: ['root', 'r', 'd', 'd', 'l', 'u', 'r', 'u', 'l', 'd', 'r', 'd', 'l', 'u', 'r', 'r', 'd', 'l', 'l', 'u', 'r', 'r', 'u', 'l', 'd', 'r', 'd']

Testing results: ['035684712', '305684712', '385604712', '385614702', '385614072', '385014672', '385104672', '305184672', '035184672', '135084672', '135804672', '135874602', '135874062', '135074862', '135704862', '135740862', '135742860', '135742806', '135742086', '135042786', '135402786', '135420786', '130425786', '103425786', '123405786', '123450786', '123456780']

Number of expanded nodes: 3665

Time to find solution: 0.8849 seconds

PROBLEM: 9

Sequence: ['root', 'r', 'u', 'r', 'u', 'l', 'l', 'd', 'd', 'r', 'u', 'r', 'u', 'l', 'l', 'd', 'd', 'r', 'r', 'u', 'u', 'l', 'l', 'd', 'r', 'd', 'r']

Testing results: ['684317025', '684317205', '684307215', '684370215', '680374215', '608374215', '068374215', '368074215', '368274015', '368274105', '368204175', '368240175', '360248175', '306248175', '036248175', '236048175', '236148075', '236148705', '236148750', '236140758', '230146758', '203146758', '023146758', '123046758', '123406758', '123456708', '123456780']

Number of expanded nodes: 1375

Time to find solution: 0.1891 seconds

PROBLEM: 10

Sequence: ['root', 'd', 'r', 'r', 'd', 'l', 'u', 'r', 'u', 'l', 'l', 'd', 'r', 'd', 'l', 'u', 'r', 'r', 'd', 'l', 'u', 'u', 'r', 'd', 'd']

Testing results: ['028514637', '528014637', '528104637', '528140637', '528147630', '528147603', '528107643', '528170643', '520178643', '502178643', '052178643', '152078643', '152708643', '152748603', '152748063', '152048763', '152408763', '152480763', '152483760', '152483706', '152403786', '102453786', '120453786', '123450786', '123456780']

Number of expanded nodes: 1034

Time to find solution: 0.1159 seconds

PROBLEM: 11

Sequence: ['root', 'l', 'u', 'u', 'l', 'd', 'r', 'r', 'u', 'l', 'd', 'd', 'r', 'u', 'u', 'l', 'l', 'd', 'd', 'r', 'u', 'l', 'd', 'r', 'r']

Testing results: ['618273540', '618273504', '618203574', '608213574', '068213574', '268013574', '268103574', '268130574', '260138574', '206138574', '236108574', '236178504', '236178540', '236170548', '230176548', '203176548', '023176548', '123076548', '123576048', '123576408', '123506478', '123056478', '123456078', '123456708', '123456780']

Number of expanded nodes: 1659

Time to find solution: 0.2381 seconds

PROBLEM: 12

Sequence: ['root', 'r', 'r', 'd', 'l', 'l', 'd', 'r', 'r', 'u', 'l', 'l', 'u', 'r', 'r', 'd', 'l', 'd', 'l', 'u', 'r', 'u', 'l', 'd', 'd', 'r', 'r']

Testing results: ['042385671', '402385671', '420385671', '425380671', '425308671', '425038671', '425638071', '425638701', '425638710', '425630718', '425603718', '425063718', '025463718', '205463718', '250463718', '253460718', '253406718', '253416708', '253416078', '253016478', '253106478', '203156478', '023156478', '123056478', '123456078', '123456708', '123456780']

Number of expanded nodes: 3981

Time to find solution: 1.0106 seconds

PROBLEM: 13

Sequence: ['root', 'd', 'l', 'l', 'u', 'r', 'd', 'd', 'l', 'u', 'r', 'r', 'u', 'l', 'l', 'd', 'd', 'r', 'u', 'r', 'd']

Testing results: ['420385716', '425380716', '425308716', '425038716', '025438716', '205438716', '235408716', '235418706', '235418076', '235018476', '235108476', '235180476', '230185476', '203185476', '023185476', '123085476', '123485076', '123485706', '123405786', '123450786', '123456780']

Number of expanded nodes: 553

Time to find solution: 0.0500 seconds

PROBLEM: 14

Sequence: ['root', 'd', 'r', 'd', 'l', 'u', 'r', 'u', 'r', 'd', 'd', 'l', 'u', 'u', 'l', 'd', 'r', 'u', 'r', 'd', 'l', 'd', 'r']

Testing results: ['054672813', '654072813', '654702813', '654712803', '654712083', '654012783', '654102783', '604152783', '640152783', '642150783', '642153780', '642153708', '642103758', '602143758', '062143758', '162043758', '162403758', '102463758', '120463758', '123460758', '123406758', '123456708', '123456780']

Number of expanded nodes: 530

Time to find solution: 0.0486 seconds

PROBLEM: 15

Sequence: ['root', 'l', 'u', 'l', 'd', 'r', 'u', 'u', 'l', 'd', 'r', 'u', 'r', 'd', 'l', 'u', 'l', 'd', 'r', 'u', 'r', 'd', 'l', 'd', 'r']

Testing results: ['314572680', '314572608', '314502678', '314052678', '314652078', '314652708', '314602758', '304612758', '034612758', '634012758', '634102758', '604132758', '640132758', '642130758', '642103758', '602143758', '062143758', '162043758', '162403758', '102463758', '120463758', '123460758', '123406758', '123456708', '123456780']

Number of expanded nodes: 1648

Time to find solution: 0.2413 seconds

PROBLEM: 16

Sequence: ['root', 'r', 'r', 'u', 'u', 'l', 'd', 'l', 'u', 'r', 'd', 'r', 'd', 'l', 'u', 'l', 'd', 'r', 'r', 'u', 'l', 'd', 'r']

Testing results: ['637218045', '637218405', '637218450', '637210458', '630217458', '603217458', '613207458', '613027458', '013627458', '103627458', '123607458', '123670458', '123678450', '123678405', '123608475', '123068475', '123468075', '123468705', '123468750', '123460758', '123406758', '123456708', '123456780']

Number of expanded nodes: 514

Time to find solution: 0.0466 seconds

PROBLEM: 17

Sequence: ['root', 'l', 'd', 'r', 'u', 'l', 'd', 'l', 'd', 'r', 'u', 'l', 'u', 'r', 'r', 'd', 'd', 'l', 'u', 'r', 'd']

Testing results: ['430621875', '403621875', '423601875', '423610875', '420613875', '402613875', '412603875', '412063875', '412863075', '412863705', '412803765', '412083765', '012483765', '102483765', '120483765', '123480765', '123485760', '123485706', '123405786', '123450786', '123456780']

Number of expanded nodes: 586

Time to find solution: 0.0540 seconds

PROBLEM: 18

Sequence: ['root', 'u', 'r', 'd', 'r', 'u', 'u', 'l', 'd', 'd', 'r', 'u', 'l', 'd', 'l', 'u', 'r', 'd', 'r', 'u', 'u', 'l', 'd', 'r', 'd']

Testing results: ['158274036', '158074236', '158704236', '158734206', '158734260', '158730264', '150738264', '105738264', '135708264', '135768204', '135768240', '135760248', '135706248', '135746208', '135746028', '135046728', '135406728', '135426708', '135426780', '135420786', '130425786', '103425786', '123405786', '123450786', '123456780']

Number of expanded nodes: 1748

Time to find solution: 0.2612 seconds

PROBLEM: 19

Sequence: ['root', 'd', 'l', 'd', 'r', 'u', 'u', 'l', 'd', 'd', 'r', 'u', 'l', 'd', 'r']

Testing results: ['130458726', '138450726', '138405726', '138425706', '138425760', '138420765', '130428765', '103428765', '123408765', '123468705', '123468750', '123460758', '123406758', '123456708', '123456780']

Number of expanded nodes: 110

Time to find solution: 0.0070 seconds

PROBLEM: 20

Sequence: ['root', 'l', 'u', 'u', 'r', 'r', 'd', 'd', 'l', 'd', 'r']

Testing results: ['16235A749C08DEBF', '16235A7490C8DEBF', '162350749AC8DEBF', '102356749AC8DEBF', '120356749AC8DEBF', '123056749AC8DEBF', '123456709AC8DEBF', '123456789AC0DEBF', '123456789A0CDEBF', '123456789ABCDE0F', '123456789ABCDEF0']

Number of expanded nodes: 13

Time to find solution: 0.0010 seconds

PROBLEM: 21

Sequence: ['root', 'd', 'r', 'u', 'l', 'd', 'd', 'r', 'r', 'r', 'd']

Testing results: ['0634217859ABDEFC', '2634017859ABDEFC', '2634107859ABDEFC', '2034167859ABDEFC', '0234167859ABDEFC', '1234067859ABDEFC', '1234567809ABDEFC', '1234567890ABDEFC', '123456789A0BDEFC', '123456789AB0DEFC', '123456789ABCDEF0']

Number of expanded nodes: 16

Time to find solution: 0.0013 seconds

PROBLEM: 22

Sequence: ['root', 'r', 'r', 'd', 'r', 'd', 'l', 'l', 'd', 'r', 'r']

Testing results: ['012456379BC8DAEF', '102456379BC8DAEF', '120456379BC8DAEF', '123456079BC8DAEF', '123456709BC8DAEF', '123456789BC0DAEF', '123456789B0CDAEF', '1234567890BCDAEF', '123456789ABCD0EF', '123456789ABCDE0F', '123456789ABCDEF0']

Number of expanded nodes: 11

Time to find solution: 0.0009 seconds

PROBLEM: 23

Sequence: ['root', 'r', 'u', 'l', 'u', 'r', 'r', 'd', 'd', 'r', 'd']

Testing results: ['51246A38097BDEFC', '51246A38907BDEFC', '512460389A7BDEFC', '512406389A7BDEFC', '012456389A7BDEFC', '102456389A7BDEFC', '120456389A7BDEFC', '123456089A7BDEFC', '123456789A0BDEFC', '123456789AB0DEFC', '123456789ABCDEF0']

Number of expanded nodes: 11

Time to find solution: 0.0011 seconds

PROBLEM: 24

Sequence: ['root', 'u', 'l', 'd', 'l', 'l', 'u', 'r', 'r', 'd', 'r']

Testing results: ['12345678D9CFEBA0', '12345678D9C0EBAF', '12345678D90CEBAF', '12345678D9ACEB0F', '12345678D9ACE0BF', '12345678D9AC0EBF', '1234567809ACDEBF', '1234567890ACDEBF', '123456789A0CDEBF', '123456789ABCDE0F', '123456789ABCDEF0']

Number of expanded nodes: 12

Time to find solution: 0.0009 seconds

PROBLEM: 25

Expanded node limit reached

Number of expanded nodes: 100000

Time to find solution: 1071.4452 seconds

PROBLEM: 26

Expanded node limit reached

Number of expanded nodes: 100000

Time to find solution: 1050.6870 seconds

PROBLEM: 27

Expanded node limit reached

Number of expanded nodes: 100000

Time to find solution: 1121.3167 seconds

PROBLEM: 28

Expanded node limit reached

Number of expanded nodes: 100000

Time to find solution: 1118.1361 seconds

PROBLEM: 29

Expanded node limit reached

Number of expanded nodes: 100000

Time to find solution: 1076.1535 seconds

Need to execute algorithm to get solutions and finish last algorithm.

https://github.com/Barcalegion/CSCI164TileProject