Relatório Lista1

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Implementação:

        Foi implementado 2 classes, Search que possui os algoritmos e mantém alguns atributos de interesse como listas, State, que seriam os nodos, possuindo atributos como custo, valor da heurística, e o estado que é representado como um vetor de int, além de outros valores adicionados por conveniência. State possui uma função que seria succ para gerar uma lista dos sucessores e Search possui todos algoritmos, onde idfs e idastar não compartilham a função recursiva, sendo a que retorna uma tupla a do idastar, além de um arquivo de util com a heurística e um parse.

Estratégias:

        A estratégia era implementar um estado que funcionasse de forma dinâmica e aceitasse qualquer tamanho de entrada. Inicialmente uma string, mas acabou sendo trocada para um vetor de int, o intuito era evitar o problema da representação de valores na string, o que poderia ter sido evitado mudando valores como 10 para A, mesmo assim ficou mais fácil mexer no vetor. As funções de busca então controlariam as listas e chamariam a função de sucessor e todas outras questões relacionadas com a busca como tempo. Eventualmente tivemos que fazer uma busca especializada para o problema com 15 tiles, mas o algoritmo normal também aceitaria, embora pudesse demorar ou até estourar a memória normalmente.

Desafios:

        Um deles foi para calcular a média das heurísticas e o número de nodos expandidos, pois era difícil saber onde contar eles, também alguns detalhes do pseudo-código, na hora de passar, que fazia com que o algoritmo abrisse um número diferente de nodos
.

 Os testes foram realizados em um sistema com processador ryzen 5 5600g 12 cores, 16gb ram e com o sistema operacional Ubuntu 22.04.3 LTS

8_puzzle_instances médias:

	avg_expanded_nodes	avg_solution_cost	avg_time	avg_avg_h_cost	avg_initial_h_cost
astar	895.0	22.16	0.0057218430999999995	10.027754223930009	13.88
bfs	81459.54	22.16	0.6109954079	0.0	13.88
gbfs	392.42	140.52	0.0024713955999999997	6.89304647844	13.88
idastar	2373.03	22.16	0.007692446400000002	10.432846666690002	13.88
idfs	2578290.56	22.16	6.848442800199998	0.0	13.88

8_puzzle_instances:

	astar	bfs	gbfs	idastar	idfs

5 6 2 7 1 8 3 4 0	835,22,0.005777300,9.082437276,12	70436,22,0.455174830,0,12	579,156,0.004101040,7.008771930,12	2631,22,0.008578180,9.777978339,12	809224,22,2.148778080,0,12
5 3 2 8 7 1 4 0 6	1024,23,0.006591140,10.066706021,15	98412,23,0.576042600,0,15	437,187,0.002699700,6.869509044,15	3276,23,0.010294330,10.598317176,15	1659716,23,4.415463520,0,15
1 0 7 5 2 4 3 8 6	72,17,0.000663250,9.150793651,13	11718,17,0.073638940,0,13	430,189,0.002650400,6.610747051,13	145,17,0.000477500,9.987804878,13	56332,17,0.154135730,0,13
3 6 4 2 8 0 5 7 1	953,25,0.005644950,11.678321678,17	134664,25,0.923698860,0,17	466,207,0.002893960,6.945454545,17	2720,25,0.008614460,11.781368398,17	3832745,25,10.317531870,0,17
0 6 1 7 4 2 3 8 5	91,16,0.000815640,6.725609756,10	5209,16,0.029298980,0,10	16,16,0.000086570,5.500000000,10	165,16,0.000556050,7.137809187,10	20305,16,0.053511270,0,10
0 3 8 2 1 4 7 6 5	652,22,0.003866600,9.371818182,12	59830,22,0.414840030,0,12	407,152,0.002486300,6.590846047,12	1734,22,0.005563200,9.245463882,12	572929,22,1.584868650,0,12
0 8 2 1 5 6 7 3 4	350,22,0.002176010,10.439522998,14	71614,22,0.608393130,0,14	422,168,0.002536880,6.612600536,14	1741,22,0.005628120,10.437285812,14	840836,22,2.279056490,0,14
5 0 2 6 4 8 1 7 3	612,21,0.003695880,9.811357074,11	42704,21,0.299410340,0,11	96,27,0.000645020,8.054216867,11	439,21,0.001405750,10.750000000,11	336804,21,0.913923860,0,11
3 0 8 4 1 2 6 7 5	232,17,0.001518660,7.862500000,7	10486,17,0.060601750,0,7	576,87,0.003376570,6.730019493,7	464,17,0.001493520,7.579949239,7	48030,17,0.131712030,0,7
7 2 6 3 1 5 8 0 4	177,21,0.001052790,10.827118644,13	55230,21,0.399892120,0,13	634,119,0.003867100,7.052537845,13	611,21,0.001922630,11.501489573,13	523656,21,1.418572760,0,13
2 4 7 0 3 6 8 1 5	511,23,0.003060970,9.976553341,15	86288,23,0.609794280,0,15	90,57,0.000690500,6.809815951,15	724,23,0.002317180,11.724137931,15	1183127,23,3.159671300,0,15
2 1 6 0 4 3 7 5 8	1037,23,0.006468300,10.386350492,11	87902,23,0.624138630,0,11	560,141,0.003280600,6.932391524,11	1659,23,0.005247610,10.909418982,11	1229083,23,3.302320960,0,11
1 2 8 0 3 7 5 6 4	197,19,0.001434710,8.389380531,13	24271,19,0.160408360,0,13	83,47,0.000603440,5.891156463,13	372,19,0.001220810,9.075079872,13	144153,19,0.389522580,0,13
1 4 8 2 7 6 0 3 5	697,22,0.004167770,9.280956447,14	67445,22,0.529322740,0,14	502,146,0.002989440,6.734304933,14	1420,22,0.004562110,9.659368421,14	726908,22,1.954346610,0,14
5 0 2 1 6 8 7 3 4	239,19,0.001629180,7.905707196,13	21294,19,0.143268930,0,13	66,39,0.000500450,6.134453782,13	465,19,0.001534700,8.212311558,13	119854,19,0.325856350,0,13
6 2 1 5 0 4 3 8 7	1622,22,0.010293120,9.725906926,10	67976,22,0.470452870,0,10	501,146,0.002950870,6.698768197,10	2130,22,0.006812850,9.635014006,10	746437,22,1.988249770,0,10
1 8 0 4 5 2 6 7 3	315,20,0.002303650,8.873394495,10	30932,20,0.203033390,0,10	81,44,0.000572880,6.510638298,10	794,20,0.002588580,9.229228487,10	201422,20,0.537268260,0,10
7 6 4 8 1 3 5 0 2	30,21,0.000246260,10.326923077,19	51926,21,0.360934520,0,19	46,37,0.000281630,7.869047619,19	71,21,0.000228230,12.972972973,19	463439,21,1.230015880,0,19
1 8 7 5 0 4 2 3 6	373,22,0.002140140,10.561797753,18	74010,22,0.524219310,0,18	386,160,0.002257060,6.806404658,18	456,22,0.001432600,11.548648649,18	880730,22,2.354565660,0,18
2 8 0 4 1 7 5 6 3	550,22,0.003322270,10.553030303,16	57200,22,0.421173980,0,16	429,190,0.002783250,6.808201058,16	368,22,0.001178920,10.911184211,16	529433,22,1.410569060,0,16
7 8 1 3 6 2 4 5 0	34,16,0.000331220,8.229508197,14	6175,16,0.045998990,0,14	540,132,0.003296920,6.774428274,14	27,16,0.000100490,9.636363636,14	25389,16,0.067762250,0,14
1 4 7 3 6 2 0 8 5	118,16,0.000795700,8.475490196,10	4890,16,0.027173470,0,10	453,166,0.002753890,6.643750000,10	76,16,0.000255480,8.563492063,10	18803,16,0.050177680,0,10
5 2 3 4 7 1 8 0 6	1449,25,0.008670770,10.864540182,15	128087,25,0.870836120,0,15	464,181,0.002823530,6.876073620,15	2805,25,0.008969720,11.128685173,15	3233556,25,8.646742500,0,15
5 1 3 2 6 4 7 8 0	873,22,0.006001430,10.083901774,14	59140,22,0.423869070,0,14	651,198,0.003910080,7.221929825,14	805,22,0.002600810,10.211964549,14	559966,22,1.495963990,0,14
1 0 2 5 8 6 4 7 3	808,23,0.005498970,9.784356725,13	86044,23,0.641694360,0,13	406,189,0.002578760,6.628453039,13	1666,23,0.005545760,10.285560345,13	1161412,23,3.105314230,0,13
4 7 6 0 5 2 3 8 1	1167,25,0.007459570,10.505646817,15	124428,25,0.900360320,0,15	423,187,0.002621040,6.837365591,15	2470,25,0.007929060,10.345441248,15	3012022,25,8.017030700,0,15

5 8 2 1 7 6 3 0 4	308,21,0.002169490,9.424761905,15	55828,21,0.423331850,0,15	453,203,0.002796680,6.817164179,15	1294,21,0.004139010,9.684137291,15	533665,21,1.474569220,0,15
3 0 2 6 1 4 5 7 8	41,13,0.000327210,6.080000000,7	1904,13,0.0121 24080,0,7	17,15,0.000213400,5.382352941,7	100,13,0.000528990,6.928176796,7	6472,13,0.017774540,0,7
2 0 1 7 5 3 8 6 4	533,23,0.003169080,11.037078652,13	89286,23,0.666764860,0,13	405,165,0.002404430,6.697771588,13	1609,23,0.005583930,11.262020127,13	1258485,23,3.382661850,0,13
8 1 0 5 3 7 2 4 6	346,24,0.002278700,11.500000000,16	96167,24,0.692919520,0,16	542,140,0.003329080,6.953271028,16	225,24,0.000712450,14.002777778,16	1506581,24,4.017059370,0,16
0 2 6 5 4 7 1 3 8	929,24,0.007748320,10.288535032,14	108997,24,0.794758980,0,14	135,38,0.000884470,8.691304348,14	1820,24,0.005790730,11.523000000,14	2082556,24,5.668021220,0,14
4 5 0 1 7 2 3 8 6	117,16,0.000937070,8.699507389,12	6800,16,0.042001550,0,12	67,34,0.000399250,7.914529915,12	129,16,0.000460370,9.481651376,12	28816,16,0.078384000,0,12
0 6 3 5 8 2 1 7 4	26,18,0.000192670,9.020833333,16	12237,18,0.069360470,0,16	452,194,0.002697190,6.759051186,16	37,18,0.000131850,10.245901639,16	57963,18,0.155638070,0,16
1 4 8 0 7 5 2 6 3	666,23,0.003985530,10.135992747,13	91221,23,0.745688390,0,13	432,195,0.002664930,6.809210526,13	1500,23,0.004798960,10.929971989,13	1339032,23,3.614152940,0,13
1 5 0 8 4 3 2 7 6	1734,26,0.010930630,10.785144047,14	146642,26,1.021040220,0,14	521,162,0.003279990,6.914502165,14	4075,26,0.012884910,11.365987810,14	5227219,26,14.058819870,0,14
2 3 6 8 1 0 5 4 7	1824,27,0.012099030,12.141566265,17	166169,27,1.355843940,0,17	111,79,0.000969830,7.827411168,17	5873,27,0.018461940,12.113548924,17	10582097,27,28.531232510,0,17
1 6 0 7 3 8 4 5 2	231,22,0.001378900,11.418181818,14	61999,22,0.544719690,0,14	590,98,0.003698980,6.833491912,14	487,22,0.001573670,11.715174129,14	618550,22,1.671147330,0,14
8 4 3 1 6 5 0 7 2	1807,26,0.011532060,10.707727873,14	149038,26,0.915776710,0,14	549,148,0.003416840,6.898773006,14	5296,26,0.016890970,11.096193298,14	5647709,26,15.252149800,0,14
3 8 2 7 5 1 0 6 4	655,22,0.003952760,9.455454545,12	66394,22,0.592687000,0,12	447,184,0.002826540,6.728192162,12	2349,22,0.007558360,9.770907248,12	707091,22,1.911218910,0,12
7 2 3 6 4 8 1 0 5	2298,25,0.014897610,10.224357310,13	134964,25,0.943810610,0,13	460,211,0.003212060,6.956790123,13	5296,25,0.016962700,10.857709301,13	3906491,25,10.556317570,0,13
3 1 2 4 0 8 5 7 6	76,14,0.000455960,7.451851852,8	3528,14,0.022230950,0,8	394,140,0.003776930,6.472103004,8	125,14,0.000444540,7.921658986,8	13166,14,0.036545660,0,8
8 5 3 1 2 6 4 0 7	786,25,0.004583850,11.269619270,19	141058,25,0.979598520,0,19	65,45,0.000616760,7.798319328,19	3436,25,0.010807690,11.446203094,19	4826279,25,13.288337330,0,19
2 0 8 6 1 3 4 7 5	609,21,0.003789450,9.228035538,11	51334,21,0.392573120,0,11	510,155,0.003059780,6.728982301,11	1193,21,0.003860090,9.671307807,11	445186,21,1.200742440,0,11
3 6 7 1 2 8 4 5 0	2231,26,0.014401180,10.650430571,16	147235,26,1.064540900,0,16	525,222,0.003259850,6.770652174,16	9239,26,0.029695030,10.244678786,16	5301125,26,14.300915820,0,16
0 3 6 1 2 8 4 7 5	1757,24,0.011282890,9.851374279,14	96629,24,0.863571510,0,14	533,130,0.003296520,6.888771186,14	2256,24,0.007266010,10.434656085,14	1521264,24,4.078214050,0,14
4 8 6 5 0 7 1 3 2	299,24,0.001759520,11.503006012,20	117820,24,0.849787600,0,20	416,184,0.002603810,6.963464141,20	626,24,0.002069510,13.157213930,20	2550556,24,6.914213290,0,20
7 2 0 1 8 6 3 4 5	41,18,0.000317700,9.959459459,14	12721,18,0.078495500,0,14	19,18,0.000236750,7.472222222,14	92,18,0.000398950,10.118421053,14	60744,18,0.164096830,0,14
4 0 7 1 3 2 5 8 6	543,23,0.003264660,10.689502762,15	82402,23,0.581253320,0,15	428,181,0.002505530,6.787598945,15	1145,23,0.003705690,11.042925278,15	1071876,23,2.878040880,0,15
1 4 3 0 5 8 7 6 2	438,21,0.002788170,10.062078273,11	55950,21,0.452341890,0,11	552,149,0.003399920,6.852342159,11	1201,21,0.003989430,10.725062035,11	542261,21,1.480130210,0,11
1 3 6 5 8 4 0 2 7	2864,28,0.018879330,12.255917160,16	170358,28,1.128757970,0,16	461,198,0.002905590,7.300370828,16	5557,28,0.019452000,12.401424658,16	13426501,28,35.879532620,0,16
3 1 6 4 0 8 7 5 2	221,20,0.001396040,9.784974093,12	41346,20,0.480499010,0,12	496,174,0.003017400,7.079128440,12	730,20,0.002453830,9.972016461,12	323493,20,0.856246220,0,12
8 0 5 1 4 3 7 2 6	2849,27,0.019355420,11.071413435,15	163708,27,1.156549400,0,15	88,49,0.000635600,7.538961039,15	9355,27,0.030141880,10.635500834,15	9617303,27,25.190685790,0,15

1 0 2 8 7 3 4 6 5	179,19,0.001080030,8.827922078,11	25948,19,0.334687990,0,11	601,101,0.003537970,6.789915966,11	661,19,0.002268880,8.786607143,11	160297,19,0.4297 15310,0,11
5 8 1 4 7 3 2 6 0	1075,26,0.006536430,11.579865017,16	146431,26,0.952611110,0,16	452,206,0.002853680,7.279040404,16	2195,26,0.007064730,12.091816921,16	5150682,26,13.51 8834390,0,16
6 4 1 2 0 3 7 8 5	177,18,0.001052190,8.581168831,12	16644,18,0.103383470,0,12	560,132,0.003418650,6.863911290,12	257,18,0.000928160,9.306264501,12	86884,18,0.22813 8670,0,12
6 1 7 4 8 3 5 2 0	752,24,0.004599580,10.091699605,16	113398,24,0.868470550,0,16	43,36,0.000392040,7.333333333,16	2440,24,0.007980160,10.669041769,16	2296791,24,6.159 953290,0,16
0 1 5 3 8 7 6 4 2	182,18,0.001286130,8.186495177,8	12763,18,0.076409170,0,8	480,180,0.002815810,6.946745562,8	339,18,0.001212890,8.484482759,8	60654,18,0.16473 8040,0,8
7 8 2 6 4 3 0 1 5	1355,24,0.008235440,10.085322723,12	102477,24,0.725984110,0,12	459,216,0.002861700,7.028290283,12	2316,24,0.007501250,10.876103896,12	1715624,24,4.527 848620,0,12
6 0 8 7 4 3 5 2 1	205,23,0.001573360,11.060344828,17	91593,23,0.770493380,0,17	80,55,0.000559360,7.758865248,17	272,23,0.000929650,13.210161663,17	1336827,23,3.613 670200,0,17
5 4 0 7 6 2 8 3 1	712,24,0.004259840,10.585833333,16	116022,24,0.919741690,0,16	68,46,0.000399260,6.628099174,16	3401,24,0.010893850,10.829941603,16	2536222,24,6.941 123540,0,16
5 6 1 8 7 0 2 4 3	1421,27,0.008647120,12.022785899,19	170975,27,1.330976820,0,19	525,219,0.003096040,6.796517954,19	9544,27,0.030116120,11.501880778,19	15171649,27,41.4 82851260,0,19
1 6 7 4 2 0 3 5 8	2186,25,0.013974570,9.916120219,13	132375,25,1.029090510,0,13	401,153,0.002485190,6.597475456,13	8845,25,0.028631020,9.669585129,13	3587527,25,9.884 791510,0,13
5 3 6 4 7 2 1 0 8	168,21,0.000997280,10.681818182,15	43631,21,0.327475080,0,15	632,195,0.003892350,7.222924188,15	360,21,0.001302760,10.371859296,15	344582,21,0.9311 52750,0,15
0 8 7 4 2 6 1 3 5	39,22,0.000265100,12.014705882,18	61343,22,0.492614170,0,18	416,188,0.002596900,6.955223881,18	103,22,0.000421290,13.398773006,18	599226,22,1.6279 30880,0,18
7 2 0 5 4 3 8 6 1	4038,28,0.027605090,11.154131986,14	173107,28,1.306448940,0,14	496,210,0.003014690,7.478857143,14	11359,28,0.036095310,11.551142690,14	15073854,28,40.3 45842700,0,14
5 3 0 6 7 1 8 2 4	90,20,0.001606030,9.616883117,16	37323,20,0.451298220,0,16	20,20,0.000104700,7.916666667,16	406,20,0.001370680,9.686853767,16	277227,20,0.7952 87000,0,16
5 7 2 8 3 6 4 0 1	2905,27,0.017995950,10.862562189,17	166627,27,1.052045230,0,17	659,129,0.004024300,7.118803419,17	8302,27,0.025836850,11.225801760,17	10843669,27,29.3 20440890,0,17
3 7 8 1 4 6 5 0 2	2301,27,0.014221640,11.877160817,15	165544,27,1.172782640,0,15	474,197,0.002957380,6.955847255,15	6762,27,0.021395970,11.858743390,15	10295974,27,26.8 02639120,0,15
7 4 5 8 6 3 2 0 1	698,25,0.004168870,10.871050384,19	136365,25,0.973619150,0,19	62,41,0.000472190,7.633928571,19	2421,25,0.007839190,11.361035083,19	4095213,25,10.57 0038040,0,19
0 4 1 8 2 5 3 7 6	2190,24,0.013723800,9.485266288,10	101428,24,0.681980580,0,10	423,170,0.002469160,6.562248996,10	3944,24,0.012690740,9.623691794,10	1665813,24,4.266 372930,0,10
5 1 7 2 3 6 8 4 0	936,24,0.005631120,11.838396897,16	99337,24,0.746288420,0,16	514,158,0.003189820,6.832969432,16	899,24,0.002915800,11.516891892,16	1583030,24,4.062 575990,0,16
6 3 4 8 2 1 5 7 0	238,22,0.001666450,9.926289926,16	69657,22,0.504233200,0,16	394,166,0.002449820,6.625000000,16	868,22,0.002810000,10.504485852,16	792904,22,2.0539 86070,0,16
2 0 1 5 7 6 4 8 3	3038,27,0.018786750,10.956961523,15	169153,27,1.314632180,0,15	420,181,0.002604020,6.912634409,15	14476,27,0.048046660,10.902895657,15	12496979,27,32.4 71673910,0,15
7 8 0 6 3 1 2 5 4	1632,26,0.009797080,10.818418121,18	146614,26,1.228414500,0,18	410,178,0.002555820,6.706206897,18	3141,26,0.011655890,11.723931128,18	5225955,26,13.44 9717040,0,18
6 2 4 3 7 0 5 1 8	4306,25,0.029082280,10.300276625,11	136769,25,1.062949900,0,11	386,175,0.002415160,6.514577259,11	8979,25,0.030595230,9.914988073,11	4088312,25,10.60 2118040,0,11
7 5 4 8 3 6 0 2 1	739,26,0.004392980,11.903624382,20	144168,26,1.127060060,0,20	448,176,0.002741270,6.877525253,20	1631,26,0.005250410,11.602259887,20	4873453,26,12.62 3636830,0,20
3 8 4 5 7 1 0 6 2	382,20,0.002451130,9.364353312,14	32178,20,0.272353180,0,14	389,164,0.002412160,6.535455861,14	413,20,0.001425590,9.506588580,14	214527,20,0.5534 64010,0,14
5 6 2 8 7 1 0 3 4	2084,26,0.012960960,10.702232531,16	149505,26,1.140443320,0,16	466,194,0.002898160,6.904126214,16	8936,26,0.028610790,10.443036277,16	5735592,26,15.08 4778740,0,16

3 2 4 6 5 8 0 7 1	99,16,0.000615160,7.528409091,10	6810,16,0.0561 18690,0,10	453,194,0.002804990,6.616149068,10	166,16,0.000657040,8.810344828,10	28881,16,0.07698 1450,0,10
7 5 1 6 8 4 2 0 3	2764,27,0.01712391 0,11.431719023,17	165286,27,1.31 6535180,0,17	442,193,0.002722640,6.836550837,17	7986,27,0.025369870,11.354103574,17	10128430,27,27.2 87612160,0,17
3 5 2 0 8 1 4 6 7	428,19,0.002620540,8.660714286,11	20088,19,0.145 427590,0,11	590,129,0.003601800,6.828820116,11	490,19,0.001688280,8.291414752,11	110829,19,0.2949 36500,0,11
8 0 6 7 1 3 5 2 4	715,25,0.004313330,13.085197935,21	134133,25,1.10 0047900,0,21	454,197,0.002866400,7.008695652,21	324,25,0.001107890,14.170634921,21	3745531,25,9.920 619530,0,21
2 5 8 4 1 0 6 3 7	68,15,0.000584200,7.352459016,11	3471,15,0.0234 52250,0,11	57,39,0.000454360,5.575471698,11	56,15,0.000276520,8.010869565,11	12608,15,0.03291 6010,0,11
7 0 2 1 8 6 3 4 5	34,17,0.000216300,9.274193548,13	9452,17,0.0643 93800,0,13	18,17,0.000117330,7.257142857,13	83,17,0.000361580,9.753623188,13	42323,17,0.11094 2330,0,13
2 1 5 3 8 0 6 7 4	121,15,0.000710240,7.377990431,7	4001,15,0.0253 97220,0,7	387,149,0.002308160,6.435860058,7	186,15,0.000691700,7.257861635,7	15054,15,0.03955 0820,0,7
3 8 6 4 7 0 1 5 2	993,25,0.006053830,10.744873341,17	134421,25,1.05 5082960,0,17	572,175,0.003517240,7.080357143,17	2713,25,0.008738190,11.475497874,17	3814064,25,9.906 578320,0,17
1 0 7 2 4 3 6 8 5	163,17,0.001231620,8.925531915,11	10951,17,0.082 476220,0,11	417,179,0.002601710,6.644897959,11	206,17,0.000781180,9.260623229,11	51080,17,0.13558 3420,0,11
3 6 7 5 8 0 4 1 2	2389,27,0.01587235 0,11.712006079,17	165164,27,1.37 3487220,0,17	596,175,0.003634860,7.102927290,17	5691,27,0.018109770,11.795929241,17	10083429,27,26.0 45233820,0,17
6 2 0 3 1 4 8 7 5	369,20,0.002229810,8.338118022,8	32194,20,0.459 752770,0,8	382,168,0.002450530,6.388807069,8	1408,20,0.004719310,8.118487395,8	216000,20,0.5626 78790,0,8
7 1 5 4 0 3 2 6 8	356,20,0.002192340,8.593023256,12	37083,20,0.256 524420,0,12	522,150,0.003204640,6.742734123,12	573,20,0.001970820,9.433021807,12	269408,20,0.6937 04210,0,12
8 0 7 4 6 1 5 2 3	1461,27,0.00878628 0,11.142619543,21	163614,27,1.11 0630960,0,21	580,151,0.003566830,7.113592233,21	2764,27,0.008923140,11.330114135,21	9608157,27,24.74 6378860,0,21
8 2 0 5 7 6 1 3 4	854,26,0.005506190,11.481377372,18	145000,26,1.12 0967660,0,18	458,208,0.002888350,6.909987670,18	2791,26,0.008965810,10.976107732,18	4963354,26,12.81 7018660,0,18
3 8 5 7 0 1 6 4 2	730,22,0.004640560,9.600164204,12	68791,22,0.540 515360,0,12	485,176,0.004132490,6.989449004,12	2006,22,0.006589930,9.715939448,12	761900,22,1.9581 85200,0,12
3 5 4 1 7 6 0 2 8	257,22,0.001751410,11.321759259,14	69185,22,0.555 601920,0,14	580,152,0.004851950,6.989278752,14	1238,22,0.004070480,10.963160446,14	779904,22,2.0426 50570,0,14
0 2 8 5 4 1 7 3 6	414,22,0.002588580,9.852482270,12	66051,22,0.612 514700,0,12	409,152,0.002607010,6.717241379,12	1016,22,0.003383380,10.976387249,12	713444,22,1.8879 45160,0,12
4 3 7 0 6 1 5 8 2	181,19,0.001186940,9.896440129,17	25603,19,0.196 415400,0,17	403,161,0.002480880,6.648951049,17	244,19,0.000902200,9.935802469,17	156601,19,0.4171 20350,0,17
2 1 3 4 6 5 0 7 8	336,20,0.002085740,9.108996540,8	30499,20,0.217 981200,0,8	636,186,0.003839350,7.133752244,8	722,20,0.002475270,9.396411093,8	197513,20,0.5152 09420,0,8
1 0 5 4 6 2 7 3 8	707,21,0.004381670,8.577593361,9	45472,21,0.361 885520,0,9	48,29,0.000444630,5.715909091,9	2213,21,0.007279130,8.091270894,9	365116,21,0.9449 69710,0,9
7 2 3 1 5 4 8 6 0	1467,24,0.00905749 0,11.038823049,14	106698,24,0.82 6176650,0,14	613,104,0.003641470,6.960514233,14	2265,24,0.007180450,11.277570591,14	1905883,24,4.972 171920,0,14
5 7 2 6 4 0 8 3 1	1319,25,0.00833914 0,10.782807499,13	130566,25,0.96 2969150,0,13	450,203,0.002838350,6.843750000,13	3613,25,0.011390690,10.676061008,13	3411288,25,8.812 192660,0,13

15_puzzle_instances(91 resolvidos e 9 não resolvidos):

	astar_15_puzzle
14 13 15 7 11 12 9 5 6 0 2 1 4 8 10 3	14028344,57,15.146497526,27.186899998,41

13 5 4 10 9 12 8 14 2 3 7 1 0 15 11 6	4415279,55,4.212458407,23.394823321,43
14 7 8 2 13 11 10 4 9 12 5 0 3 6 1 15	30003145,59,27.729149380,27.751703100,41
5 12 10 7 15 11 14 0 8 2 1 13 3 4 9 6	5253685,56,7.082921185,26.620789126,42
4 7 14 13 10 3 9 12 11 5 6 15 1 2 8 0	2021382,56,1.106967476,28.153197960,42
14 7 1 9 12 3 6 15 8 11 2 5 10 0 4 13	969356,52,0.510923089,27.416487786,36
2 11 15 5 13 4 6 7 12 8 10 1 9 3 14 0	7170013,52,4.369050519,23.383736205,30
12 11 15 3 8 0 4 2 6 13 9 5 14 1 10 7	2618503,50,1.898846547,24.424522613,32
3 14 9 11 5 4 8 2 13 12 6 7 10 1 15 0	313211,46,0.271005333,21.503714064,32
13 11 8 9 0 15 7 10 4 3 6 14 5 12 2 1	17805045,59,10.999859932,27.734989500,43
5 9 13 14 6 3 7 12 10 8 4 0 15 2 11 1	3525006,57,2.861210064,28.750543947,43
14 1 9 6 4 8 12 5 7 2 3 0 10 11 13 15	32334,45,0.082738111,26.236207746,35
3 6 5 2 10 0 15 14 1 4 13 12 9 8 11 7	831333,46,0.425397191,19.507478939,36
7 6 8 1 11 5 14 10 3 4 9 13 15 2 0 12	26088053,59,18.126284706,28.499027968,41
13 11 4 12 1 8 9 15 6 5 14 2 7 3 10 0	25792756,62,19.096799405,31.454643237,44
1 3 2 5 10 9 15 6 8 14 13 11 12 4 7 0	909219,42,2.299503355,18.651622057,24
15 14 0 4 11 1 6 13 7 5 8 9 3 2 10 12	-,-,-,-,-
6 0 14 12 1 15 9 10 11 4 7 2 8 3 5 13	1267588,55,4.152380246,27.259432873,43
7 11 8 3 14 0 6 15 1 4 13 9 5 12 2 10	154092,46,0.101688486,22.987149518,36
6 12 11 3 13 7 9 15 2 14 8 10 4 1 5 0	1995813,52,1.065798910,24.572979382,36
12 8 14 6 11 4 7 0 5 1 10 15 3 13 9 2	5668025,54,3.289645526,26.403395498,34
14 3 9 1 15 8 4 5 11 7 10 13 0 2 12 6	13338796,59,8.631032407,28.247415200,41
10 9 3 11 0 13 2 14 5 6 4 7 8 15 1 12	1398857,49,1.278959286,24.277053264,33
7 3 14 13 4 1 10 8 5 12 9 11 2 15 6 0	4691710,54,2.873773970,26.312233807,34
11 4 2 7 1 0 10 15 6 9 14 8 3 13 5 12	6227205,52,3.595406180,24.700271656,32
5 7 3 12 15 13 14 8 0 10 9 6 1 4 2 11	20161235,58,13.434805798,27.585266352,40
14 1 8 15 2 6 0 3 9 12 10 13 4 7 5 11	11278428,53,8.250586784,25.459157070,33
13 14 6 12 4 5 1 0 9 3 10 2 15 11 8 7	909442,52,0.848970507,27.872709694,36
9 8 0 2 15 1 4 14 3 10 7 5 11 13 6 12	3917549,54,2.285731804,26.119066251,38
12 15 2 6 1 14 4 8 5 3 7 0 10 13 9 11	215990,47,0.180093671,24.840168697,35

12 8 15 13 1 0 5 4 6 3 2 11 9 7 14 10	192534,50,0.085533491,28.164809614,38
14 10 9 4 13 6 5 8 2 12 7 0 1 3 11 15	17025056,59,11.217413925,29.273735534,43
14 3 5 15 11 6 13 9 0 10 2 12 4 1 7 8	18535767,60,12.723717676,30.110062220,42
6 11 7 8 13 2 5 4 1 10 3 9 14 0 12 15	2063117,52,2.208614419,25.982463471,36
1 6 12 14 3 2 15 8 4 5 13 9 0 7 11 10	4626661,55,2.591590644,26.974809435,39
12 6 0 4 7 3 15 1 13 9 8 11 2 14 5 10	2309697,52,1.387135228,25.791490696,36
8 1 7 12 11 0 10 5 9 15 6 13 14 2 3 4	20889986,58,14.034871953,27.636038186,40
7 15 8 2 13 6 3 12 11 0 4 10 9 5 1 14	827864,53,1.688304507,28.710055144,41
9 0 4 10 1 14 15 3 12 6 5 7 11 13 8 2	1118025,49,0.682406457,24.280758227,35
11 5 1 14 4 12 10 0 2 7 13 3 9 15 6 8	6540243,54,4.349934985,26.380556654,36
8 13 10 9 11 3 15 6 0 1 2 14 12 5 4 7	5727374,54,3.523838702,26.121908881,36
4 5 7 2 9 14 12 13 0 3 6 11 8 1 15 10	48447,42,0.159907016,23.300038513,30
11 15 14 13 1 9 10 4 3 6 2 12 7 5 8 0	7332466,64,4.056159279,33.052825986,48
12 9 0 6 8 3 5 14 2 4 11 7 10 1 15 13	2731989,50,1.672824395,24.607500763,32
3 14 9 7 12 15 0 4 1 8 5 6 11 10 2 13	539196,51,0.328794047,27.316122324,39
8 4 6 1 14 12 2 15 13 10 9 5 3 7 0 11	1430455,49,0.769865485,22.917919500,35
6 10 1 14 15 8 3 5 13 0 2 7 4 9 11 12	179689,47,0.110743018,25.475309125,35
8 11 4 6 7 3 10 9 2 12 15 13 0 1 5 14	119535,49,0.060144115,25.168520808,39
10 0 2 4 5 1 6 12 11 13 9 7 15 3 14 8	-,-,-,-,-
12 5 13 11 2 10 0 9 7 8 4 3 14 6 15 1	4399444,53,5.389449751,25.099391556,39
10 2 8 4 15 0 1 14 11 13 3 6 9 7 5 12	3031922,56,1.686261128,28.074824893,44
10 8 0 12 3 7 6 2 1 14 4 11 15 13 9 5	11641228,56,7.340103410,26.803444668,38
14 9 12 13 15 4 8 10 0 2 1 7 3 11 5 6	38607523,64,28.351341589,30.428446052,50
12 11 0 8 10 2 13 15 5 4 7 3 6 9 14 1	7221615,56,7.765572559,27.820720322,40
13 8 14 3 9 1 0 7 15 5 4 10 12 2 6 11	152123,41,0.275460112,20.696139214,29
3 15 2 5 11 6 4 7 12 9 1 0 13 14 10 8	-,-,-,-,-
5 11 6 9 4 13 12 0 8 2 15 10 1 7 3 14	484048,50,3.800729508,26.117384742,36
5 0 15 8 4 6 1 14 10 11 3 9 7 12 2 13	506538,51,0.271726784,25.545293672,37
15 14 6 7 10 1 0 11 12 8 4 9 2 5 13 3	-,-,-,-,-

11 14 13 1 2 3 12 4 15 7 9 5 10 6 8 0	-,-,-,-,-
6 13 3 2 11 9 5 10 1 7 12 14 8 4 0 15	508957,45,3.253268022,21.727099095,31
4 6 12 0 14 2 9 13 11 8 3 15 7 10 1 5	1828847,57,0.961352043,29.084569116,43
8 10 9 11 14 1 7 15 13 4 0 12 6 2 5 3	21862510,56,15.098298591,25.547554173,40
5 2 14 0 7 8 6 3 11 12 13 15 4 10 9 1	5622335,51,4.584968315,23.618298023,31
7 8 3 2 10 12 4 6 11 13 5 15 0 1 9 14	920623,47,0.549316450,22.622818579,31
11 6 14 12 3 5 1 15 8 0 10 13 9 7 4 2	-,-,-,-,-
7 1 2 4 8 3 6 11 10 15 0 5 14 12 13 9	8430894,50,8.357040985,23.921400655,28
7 3 1 13 12 10 5 2 8 0 6 11 14 15 4 9	5471060,51,3.334964449,25.117996142,31
6 0 5 15 1 14 4 9 2 13 8 10 11 12 7 3	4579005,53,2.675190400,25.342839888,37
15 1 3 12 4 0 6 5 2 8 14 9 13 10 7 11	8179227,52,4.873294957,24.664403262,30
5 7 0 11 12 1 9 10 15 6 2 3 8 4 13 14	557862,44,0.524471864,20.630121935,30
12 15 11 10 4 5 14 0 13 7 1 2 9 8 3 6	34437004,56,25.392588122,25.394338195,38
6 14 10 5 15 8 7 1 3 4 2 0 12 9 11 13	188717,49,2.925514988,23.873066342,37
14 13 4 11 15 8 6 9 0 7 3 1 2 10 12 5	1373939,56,0.738810601,28.771617648,46
14 4 0 10 6 5 1 3 9 2 13 15 12 7 8 11	3440513,48,1.961967094,22.060243222,30
15 10 8 3 0 6 9 5 1 14 13 11 7 2 12 4	7622602,57,4.316702757,27.729741041,41
0 13 2 4 12 14 6 9 15 1 10 3 11 5 8 7	2184110,54,1.377100851,27.597979875,34
3 14 13 6 4 15 8 9 5 12 10 0 2 7 1 11	619299,53,0.330551684,27.380696856,41
0 1 9 7 11 13 5 3 14 12 4 2 8 6 10 15	68633,42,0.076729003,21.781102812,28
11 0 15 8 13 12 3 5 10 1 4 6 14 9 7 2	3951356,57,2.147463188,26.913582603,43
13 0 9 12 11 6 3 5 15 8 1 10 4 14 2 7	744209,53,0.440950536,28.051742599,39
14 10 2 1 13 9 8 11 7 3 6 12 15 5 4 0	-,-,-,-,-
12 3 9 1 4 5 10 2 6 11 15 0 14 7 13 8	1900358,49,4.393936120,24.127774626,31
15 8 10 7 0 12 14 1 5 9 6 3 13 11 4 2	10972804,55,6.753401542,26.658956691,37
4 7 13 10 1 2 9 6 12 8 14 5 3 0 11 15	158355,44,0.445412593,20.888586322,32
6 0 5 10 11 12 9 2 1 7 4 3 14 8 13 15	195222,45,0.099640091,22.290462753,35
9 5 11 10 13 0 2 1 8 6 14 12 4 7 3 15	4681483,52,2.643273409,25.962040067,34
15 2 12 11 14 13 9 5 1 3 8 7 0 10 6 4	-,-,-,-,-

11 1 7 4 10 13 3 8 9 14 0 15 6 5 2 12	3559259,54,5.501645738,26.461863489,38
5 4 7 1 11 12 14 15 10 13 8 6 2 0 9 3	820923,50,0.503062764,26.079187488,36
9 7 5 2 14 15 12 10 11 3 6 1 8 13 0 4	18150875,57,11.801331091,26.873360856,41
3 2 7 9 0 15 12 4 6 11 5 14 8 13 10 1	-,-,-,-,-
13 9 14 6 12 8 1 2 3 4 0 7 5 10 11 15	438960,46,3.373360219,20.965216714,34
5 7 11 8 0 14 9 13 10 12 3 15 6 1 4 2	276325,53,0.137981605,27.766560116,45
4 3 6 13 7 15 9 0 10 5 8 11 2 12 1 14	751475,50,0.399737948,25.063399547,34
1 7 15 14 2 6 4 9 12 11 13 3 0 8 5 10	1263033,49,0.688816825,22.922221345,35
9 14 5 7 8 15 1 2 10 4 13 6 12 0 11 3	191601,44,0.112213676,21.267765068,32
0 11 3 12 5 2 1 9 8 10 14 15 7 4 13 6	9499694,54,5.761415314,25.127288869,34
7 15 4 0 10 9 2 5 12 11 13 6 1 3 14 8	5342754,57,3.241079379,28.762484231,39
11 4 0 8 6 10 5 13 12 7 14 3 1 2 9 15	4484857,54,2.713224245,25.170227912,38

Problemas com a saída (-,-,-,-,-) não foram resolvidos, que foram 9.