TEST CASE 1

Solving for:

start_board: [5, 1, 3, 4, 2, 10, 6, 8, 13, 9, 7, 12, 0, 14, 11, 15]

goal_board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

BFS took too long, so I exited

Solved with a_star_h1 method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 47

h1(n): -1

h2(n): 0

f1(n): 46

f2(n): 47

ID: 140578797971384

Parent ID: 140578797971104

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 0, 15]

g(n): 37

h1(n): 9

h2(n): 10

f1(n): 46

f2(n): 47

ID: 140578797971104

Parent ID: 140578797970824

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 12, 13, 14, 11, 15]

g(n): 27

h1(n): 19

h2(n): 20

f1(n): 46

f2(n): 47

ID: 140578797970824

Parent ID: 140578797970544

State Description:

Board: [1, 2, 3, 4, 5, 6, 0, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 26

h1(n): 20

h2(n): 21

f1(n): 46

f2(n): 47

ID: 140578797970544

Parent ID: 140578797969928

State Description:

Board: [1, 2, 3, 4, 5, 0, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 25

h1(n): 21

h2(n): 22

f1(n): 46

f2(n): 47

ID: 140578797969928

Parent ID: 140578795351904

State Description:

Board: [1, 0, 3, 4, 5, 2, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 24

h1(n): 22

h2(n): 23

f1(n): 46

f2(n): 47

ID: 140578795351904

Parent ID: 140578795351120

State Description:

Board: [0, 1, 3, 4, 5, 2, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 23

h1(n): 23

h2(n): 24

f1(n): 46

f2(n): 47

ID: 140578795351120

Parent ID: 140578795349664

State Description:

Board: [5, 1, 3, 4, 0, 2, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 22

h1(n): 24

h2(n): 25

f1(n): 46

f2(n): 47

ID: 140578795349664

Parent ID: 140578795349160

State Description:

Board: [5, 1, 3, 4, 2, 0, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 21

h1(n): 24

h2(n): 26

f1(n): 45

f2(n): 47

ID: 140578795349160

Parent ID: 140578795349048

State Description:

Board: [5, 1, 3, 4, 2, 10, 6, 8, 9, 0, 7, 12, 13, 14, 11, 15]

g(n): 11

h1(n): 34

h2(n): 36

f1(n): 45

f2(n): 47

ID: 140578795349048

Parent ID: 140578586796160

State Description:

Board: [5, 1, 3, 4, 2, 10, 6, 8, 0, 9, 7, 12, 13, 14, 11, 15]

g(n): 10

h1(n): 35

h2(n): 37

f1(n): 45

f2(n): 47

ID: 140578586796160

Parent ID: 140578586796384

State Description:

Board: [5, 1, 3, 4, 2, 10, 6, 8, 13, 9, 7, 12, 0, 14, 11, 15]

g(n): 0

h1(n): 45

h2(n): 47

f1(n): 45

f2(n): 47

ID: 140578586796384

Parent ID: None

Number of moves: 11

Nodes added to open list: 69

Nodes added to closed list: 22

Solved with a_star_h2 method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 47

h1(n): -1

h2(n): 0

f1(n): 46

f2(n): 47

ID: 140578797971048

Parent ID: 140578586796776

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 0, 15]

g(n): 37

h1(n): 9

h2(n): 10

f1(n): 46

f2(n): 47

ID: 140578586796776

Parent ID: 140578795351736

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 12, 13, 14, 11, 15]

g(n): 27

h1(n): 19

h2(n): 20

f1(n): 46

f2(n): 47

ID: 140578795351736

Parent ID: 140578795351456

State Description:

Board: [1, 2, 3, 4, 5, 6, 0, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 26

h1(n): 20

h2(n): 21

f1(n): 46

f2(n): 47

ID: 140578795351456

Parent ID: 140578795350840

State Description:

Board: [1, 2, 3, 4, 5, 0, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 25

h1(n): 21

h2(n): 22

f1(n): 46

f2(n): 47

ID: 140578795350840

Parent ID: 140578795351400

State Description:

Board: [1, 0, 3, 4, 5, 2, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 24

h1(n): 22

h2(n): 23

f1(n): 46

f2(n): 47

ID: 140578795351400

Parent ID: 140578795349944

State Description:

Board: [0, 1, 3, 4, 5, 2, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 23

h1(n): 23

h2(n): 24

f1(n): 46

f2(n): 47

ID: 140578795349944

Parent ID: 140578795349272

State Description:

Board: [5, 1, 3, 4, 0, 2, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 22

h1(n): 24

h2(n): 25

f1(n): 46

f2(n): 47

ID: 140578795349272

Parent ID: 140578795349664

State Description:

Board: [5, 1, 3, 4, 2, 0, 6, 8, 9, 10, 7, 12, 13, 14, 11, 15]

g(n): 21

h1(n): 24

h2(n): 26

f1(n): 45

f2(n): 47

ID: 140578795349664

Parent ID: 140578795349552

State Description:

Board: [5, 1, 3, 4, 2, 10, 6, 8, 9, 0, 7, 12, 13, 14, 11, 15]

g(n): 11

h1(n): 34

h2(n): 36

f1(n): 45

f2(n): 47

ID: 140578795349552

Parent ID: 140578795350168

State Description:

Board: [5, 1, 3, 4, 2, 10, 6, 8, 0, 9, 7, 12, 13, 14, 11, 15]

g(n): 10

h1(n): 35

h2(n): 37

f1(n): 45

f2(n): 47

ID: 140578795350168

Parent ID: 140578795349160

State Description:

Board: [5, 1, 3, 4, 2, 10, 6, 8, 13, 9, 7, 12, 0, 14, 11, 15]

g(n): 0

h1(n): 45

h2(n): 47

f1(n): 45

f2(n): 47

ID: 140578795349160

Parent ID: None

Number of moves: 11

Nodes added to open list: 49

Nodes added to closed list: 15

TEST CASE 2

Solving for:

start_board: [1, 0, 3, 4, 5, 2, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

goal_board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

Solved with bfs method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 52

h1(n): -1

h2(n): 0

f1(n): 51

f2(n): 52

ID: 140578654353840

Parent ID: 140578654862528

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 0, 13, 14, 15, 12]

g(n): 42

h1(n): 9

h2(n): 10

f1(n): 51

f2(n): 52

ID: 140578654862528

Parent ID: 140578656332544

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 11, 13, 14, 15, 12]

g(n): 32

h1(n): 19

h2(n): 20

f1(n): 51

f2(n): 52

ID: 140578656332544

Parent ID: 140578656179368

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 11, 13, 14, 0, 12]

g(n): 22

h1(n): 29

h2(n): 30

f1(n): 51

f2(n): 52

ID: 140578656179368

Parent ID: 140578656098288

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 11, 13, 0, 14, 12]

g(n): 12

h1(n): 39

h2(n): 40

f1(n): 51

f2(n): 52

ID: 140578656098288

Parent ID: 140578656097392

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 15, 11, 13, 10, 14, 12]

g(n): 2

h1(n): 49

h2(n): 50

f1(n): 51

f2(n): 52

ID: 140578656097392

Parent ID: 140578656097056

State Description:

Board: [1, 2, 3, 4, 5, 0, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

g(n): 1

h1(n): 50

h2(n): 51

f1(n): 51

f2(n): 52

ID: 140578656097056

Parent ID: 140578656395160

State Description:

Board: [1, 0, 3, 4, 5, 2, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

g(n): 0

h1(n): 51

h2(n): 52

f1(n): 51

f2(n): 52

ID: 140578656395160

Parent ID: None

Number of moves: 7

Nodes added to open list: 13425

Nodes added to closed list: 4150

Solved with a_star_h1 method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 52

h1(n): -1

h2(n): 0

f1(n): 51

f2(n): 52

ID: 140578656098512

Parent ID: 140578656098288

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 0, 13, 14, 15, 12]

g(n): 42

h1(n): 9

h2(n): 10

f1(n): 51

f2(n): 52

ID: 140578656098288

Parent ID: 140578656097672

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 11, 13, 14, 15, 12]

g(n): 32

h1(n): 19

h2(n): 20

f1(n): 51

f2(n): 52

ID: 140578656097672

Parent ID: 140578656097952

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 11, 13, 14, 0, 12]

g(n): 22

h1(n): 29

h2(n): 30

f1(n): 51

f2(n): 52

ID: 140578656097952

Parent ID: 140578656097784

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 11, 13, 0, 14, 12]

g(n): 12

h1(n): 39

h2(n): 40

f1(n): 51

f2(n): 52

ID: 140578656097784

Parent ID: 140578656097448

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 15, 11, 13, 10, 14, 12]

g(n): 2

h1(n): 49

h2(n): 50

f1(n): 51

f2(n): 52

ID: 140578656097448

Parent ID: 140578656097280

State Description:

Board: [1, 2, 3, 4, 5, 0, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

g(n): 1

h1(n): 50

h2(n): 51

f1(n): 51

f2(n): 52

ID: 140578656097280

Parent ID: 140578656395160

State Description:

Board: [1, 0, 3, 4, 5, 2, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

g(n): 0

h1(n): 51

h2(n): 52

f1(n): 51

f2(n): 52

ID: 140578656395160

Parent ID: None

Number of moves: 7

Nodes added to open list: 24

Nodes added to closed list: 7

Solved with a_star_h2 method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 52

h1(n): -1

h2(n): 0

f1(n): 51

f2(n): 52

ID: 140578656098344

Parent ID: 140578656098232

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 0, 13, 14, 15, 12]

g(n): 42

h1(n): 9

h2(n): 10

f1(n): 51

f2(n): 52

ID: 140578656098232

Parent ID: 140578656097112

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 11, 13, 14, 15, 12]

g(n): 32

h1(n): 19

h2(n): 20

f1(n): 51

f2(n): 52

ID: 140578656097112

Parent ID: 140578656097056

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 11, 13, 14, 0, 12]

g(n): 22

h1(n): 29

h2(n): 30

f1(n): 51

f2(n): 52

ID: 140578656097056

Parent ID: 140578656097168

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 11, 13, 0, 14, 12]

g(n): 12

h1(n): 39

h2(n): 40

f1(n): 51

f2(n): 52

ID: 140578656097168

Parent ID: 140578656097952

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 15, 11, 13, 10, 14, 12]

g(n): 2

h1(n): 49

h2(n): 50

f1(n): 51

f2(n): 52

ID: 140578656097952

Parent ID: 140578656098512

State Description:

Board: [1, 2, 3, 4, 5, 0, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

g(n): 1

h1(n): 50

h2(n): 51

f1(n): 51

f2(n): 52

ID: 140578656098512

Parent ID: 140578656395160

State Description:

Board: [1, 0, 3, 4, 5, 2, 7, 8, 9, 6, 15, 11, 13, 10, 14, 12]

g(n): 0

h1(n): 51

h2(n): 52

f1(n): 51

f2(n): 52

ID: 140578656395160

Parent ID: None

Number of moves: 7

Nodes added to open list: 24

Nodes added to closed list: 7

TEST CASE 3

Solving for:

start_board: [2, 0, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

goal_board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

Solved with bfs method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 34

h1(n): -1

h2(n): 0

f1(n): 33

f2(n): 34

ID: 140578653481168

Parent ID: 140578655286832

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 0, 15]

g(n): 24

h1(n): 9

h2(n): 10

f1(n): 33

f2(n): 34

ID: 140578655286832

Parent ID: 140578641506088

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 12, 13, 14, 11, 15]

g(n): 14

h1(n): 19

h2(n): 20

f1(n): 33

f2(n): 34

ID: 140578641506088

Parent ID: 140578656173976

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 10, 12, 13, 14, 11, 15]

g(n): 4

h1(n): 29

h2(n): 30

f1(n): 33

f2(n): 34

ID: 140578656173976

Parent ID: 140578656099352

State Description:

Board: [1, 2, 3, 4, 5, 0, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 3

h1(n): 30

h2(n): 31

f1(n): 33

f2(n): 34

ID: 140578656099352

Parent ID: 140578656097784

State Description:

Board: [1, 2, 3, 4, 0, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 2

h1(n): 31

h2(n): 32

f1(n): 33

f2(n): 34

ID: 140578656097784

Parent ID: 140578656098512

State Description:

Board: [0, 2, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 1

h1(n): 32

h2(n): 33

f1(n): 33

f2(n): 34

ID: 140578656098512

Parent ID: 140578656395160

State Description:

Board: [2, 0, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 0

h1(n): 33

h2(n): 34

f1(n): 33

f2(n): 34

ID: 140578656395160

Parent ID: None

Number of moves: 7

Nodes added to open list: 13069

Nodes added to closed list: 4040

Solved with a_star_h1 method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 34

h1(n): -1

h2(n): 0

f1(n): 33

f2(n): 34

ID: 140578656098400

Parent ID: 140578656098008

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 0, 15]

g(n): 24

h1(n): 9

h2(n): 10

f1(n): 33

f2(n): 34

ID: 140578656098008

Parent ID: 140578656097840

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 12, 13, 14, 11, 15]

g(n): 14

h1(n): 19

h2(n): 20

f1(n): 33

f2(n): 34

ID: 140578656097840

Parent ID: 140578656098232

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 10, 12, 13, 14, 11, 15]

g(n): 4

h1(n): 29

h2(n): 30

f1(n): 33

f2(n): 34

ID: 140578656098232

Parent ID: 140578656097504

State Description:

Board: [1, 2, 3, 4, 5, 0, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 3

h1(n): 30

h2(n): 31

f1(n): 33

f2(n): 34

ID: 140578656097504

Parent ID: 140578656097168

State Description:

Board: [1, 2, 3, 4, 0, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 2

h1(n): 31

h2(n): 32

f1(n): 33

f2(n): 34

ID: 140578656097168

Parent ID: 140578656097056

State Description:

Board: [0, 2, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 1

h1(n): 32

h2(n): 33

f1(n): 33

f2(n): 34

ID: 140578656097056

Parent ID: 140578656395160

State Description:

Board: [2, 0, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 0

h1(n): 33

h2(n): 34

f1(n): 33

f2(n): 34

ID: 140578656395160

Parent ID: None

Number of moves: 7

Nodes added to open list: 23

Nodes added to closed list: 7

Solved with a_star_h2 method!

Path (end->start):

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 0]

g(n): 34

h1(n): -1

h2(n): 0

f1(n): 33

f2(n): 34

ID: 140578656097896

Parent ID: 140578656097952

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 0, 15]

g(n): 24

h1(n): 9

h2(n): 10

f1(n): 33

f2(n): 34

ID: 140578656097952

Parent ID: 140578656097672

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 12, 13, 14, 11, 15]

g(n): 14

h1(n): 19

h2(n): 20

f1(n): 33

f2(n): 34

ID: 140578656097672

Parent ID: 140578656097280

State Description:

Board: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 10, 12, 13, 14, 11, 15]

g(n): 4

h1(n): 29

h2(n): 30

f1(n): 33

f2(n): 34

ID: 140578656097280

Parent ID: 140578656098512

State Description:

Board: [1, 2, 3, 4, 5, 0, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 3

h1(n): 30

h2(n): 31

f1(n): 33

f2(n): 34

ID: 140578656098512

Parent ID: 140578656097504

State Description:

Board: [1, 2, 3, 4, 0, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 2

h1(n): 31

h2(n): 32

f1(n): 33

f2(n): 34

ID: 140578656097504

Parent ID: 140578656097056

State Description:

Board: [0, 2, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 1

h1(n): 32

h2(n): 33

f1(n): 33

f2(n): 34

ID: 140578656097056

Parent ID: 140578656395160

State Description:

Board: [2, 0, 3, 4, 1, 5, 7, 8, 9, 6, 10, 12, 13, 14, 11, 15]

g(n): 0

h1(n): 33

h2(n): 34

f1(n): 33

f2(n): 34

ID: 140578656395160

Parent ID: None

Number of moves: 7

Nodes added to open list: 23

Nodes added to closed list: 7