```
Total time: 0.050s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: expand at line 51

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
    51                                           @cpu
    52                                           def expand(board):
    53      1540        0.4ms            .      0.8%        for i in range(len(board.data)):                                # to find the loca
    54      3867        1.0ms            .      2.0%            for j in range(len(board.data[i])):
    55      3097        0.9ms            .      1.7%                if board.data[i][j] == '*':
    56       385        0.1ms            .      0.2%                    location = [i,j];
    57       385        0.1ms            .      0.2%                    break
    58
    59       385        0.1ms            .      0.2%        actions = []
    60      1427        5.4ms            .     10.8%        for move in possible_actions(constants.board, location):        # to find all poss
    61      1042       41.9ms            .     84.0%            actions.append([result(location, move, board.data) , move]) # prepare all poss
    62
    63       385        0.1ms            .      0.2%        return actions                                                  # After expanding


Total time: 0.003s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: possible_actions at line 67

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
    67                                           @cpu
    68                                           def possible_actions(board, location):                                  # to find all poss
    69       385        0.1ms            .      4.7%        actions = ["RIGHT","LEFT","UP","DOWN"]
    70       385        0.1ms            .      3.0%        actionstopeform = []
    71
    72      1925        0.5ms            .     18.0%        for x in actions:
    73                                                           # for moving right
    74      1540        0.4ms            .     13.9%            if x == "RIGHT":
    75       385        0.2ms            .      5.8%                if location[1]+1 < len(board):
    76       252        0.1ms            .      3.5%                    actionstopeform.append([x,location[0],location[1]+1])
    77                                                           # for moving left
    78      1155        0.3ms            .     10.6%            elif x == "LEFT":
    79       385        0.1ms            .      4.5%                if location[1]-1 >= 0:
    80       269        0.1ms            .      4.1%                    actionstopeform.append([x,location[0],location[1]-1])
    81                                                           # for moving up
    82       770        0.2ms            .      6.7%            elif x == "UP":
    83       385        0.1ms            .      4.8%                if location[0]-1 >= 0:
    84       268        0.1ms            .      4.3%                    actionstopeform.append([x,location[0]-1,location[1]])
    85                                                           # for moving down
    86       385        0.1ms            .      4.0%            elif x == "DOWN":
    87       385        0.1ms            .      4.8%                if location[0]+1 < len(board):
    88       253        0.1ms            .      4.2%                    actionstopeform.append([x,location[0]+1,location[1]])
    89
    90       385        0.1ms            .      3.2%        return actionstopeform


Total time: 0.040s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: result at line 94

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
    94                                           @cpu
    95                                           def result(location,action,board):
    96      1042       32.4ms            .     81.7%        newBoard = copy.deepcopy(board)                             # copy of a board so t
    97      1042        2.4ms            .      6.1%        temp = copy.deepcopy(newBoard[action[1]][action[2]])
    98      1042        2.4ms            .      5.9%        newBoard[action[1]][action[2]] = copy.deepcopy('*')
    99      1042        2.3ms            .      5.8%        newBoard[location[0]][location[1]]  = copy.deepcopy(temp)
   100      1042        0.2ms            .      0.5%        return newBoard                                             # return new board aft


Total time: 0.000s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: misplaced at line 104

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   104                                           @cpu
   105                                           def misplaced(puzzle):
   106                                               num_misplaced = 0
   107                                               for i in range(len(puzzle.data)):
   108                                                   for j in range(len(puzzle.data)):
   109                                                       if puzzle.data[i][j] != constants.goalBoard[i][j] and puzzle.data[i][j] !=
   110                                                           num_misplaced += 1
   111                                               return num_misplaced


Total time: 0.015s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: manhattan at line 114

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   114                                           @cpu
   115                                           def manhattan(state):
   116       626        0.2ms            .      1.3%        state = state.data
   117       626        0.2ms            .      1.2%        goal_state = constants.goalBoard
   118       626        0.2ms            .      1.1%        distance = 0
   119
   120                                                       # Create a dictionary that maps each value to its position in the goal state
   121       626        0.1ms            .      1.0%        goal_dict = {}
```

```
   122      2504        0.7ms            .      4.9%        for i in range(len(goal_state)):
   123      7512        2.1ms            .     14.0%            for j in range(len(goal_state[0])):
   124      5634        1.6ms            .     11.0%                if goal_state[i][j] != '*':
   125      5008        1.6ms            .     10.8%                    goal_dict[goal_state[i][j]] = (i, j)
   126
   127                                                         # Calculate Manhattan distance
   128      2504        0.7ms            .      4.5%        for i in range(len(state)):
   129      7512        2.1ms            .     14.0%            for j in range(len(state[0])):
   130      5634        2.2ms            .     15.1%                if state[i][j] != '*' and state[i][j] != goal_state[i][j]:
   131      3278        0.9ms            .      5.7%                    value = state[i][j]
   132      3278        0.9ms            .      6.3%                    row, col = goal_dict[value]
   133      3278        1.2ms            .      8.2%                    distance += abs(row - i) + abs(col - j)
   134
   135       626        0.2ms            .      1.1%        return distance


Total time: 0.000s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: linear_conflict at line 137

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   137                                                 @cpu
   138                                                 def linear_conflict(board, goal):
   139                                                     n = len(board)
   140                                                     linear_conflicts = 0
   141
   142                                                     # Find the linear conflicts in rows
   143                                                     for i in range(n):
   144                                                         row = board[i]
   145                                                         goal_row = goal[i]
   146                                                         for j in range(n):
   147                                                             if row[j] != '*' and row[j] in goal_row:
   148                                                                 for k in range(j+1, n):
   149                                                                     if row[k] != '*' and row[k] in goal_row and goal_row.index(row[j])
   150                                                                         linear_conflicts += 2
   151
   152                                                     # Find the linear conflicts in columns
   153                                                     for j in range(n):
   154                                                         column = [board[i][j] for i in range(n)]
   155                                                         goal_column = [goal[i][j] for i in range(n)]
   156                                                         for i in range(n):
   157                                                             if column[i] != '*' and column[i] in goal_column:
   158                                                                 for k in range(i+1, n):
   159                                                                     if column[k] != '*' and column[k] in goal_column and goal_column.i
   160                                                                         linear_conflicts += 2
   161
   162                                                     return linear_conflicts


Total time: 0.000s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: f at line 165

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   165                                                 @cpu
   166                                                 # Heuristic Function to calculate hueristic value f(x) = h(x) + g(x)
   167                                                 def f(board):
   168                                                         manhattan_distance = manhattan(board)
   169                                                         manhattan_distance += linear_conflict(board.data, constants.goalBoard) # Add l
   170                                                         return manhattan_distance + board.depth


Total time: 0.000s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: zero_function at line 174

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   174                                                 @cpu
   175                                                 def zero_function(board):
   176                                                     return 0


Total time: 0.095s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: a_star at line 179

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   179                                                 @memory_profiler.profile
   180                                                 @cpu
   181                                                 def a_star(initialProblem, f):
   182         1            .            .         .        initialNode = Node(data = initialProblem)              # node←NODE(STATE=problem.
   183         1            .            .         .        frontier = PriorityQueue()
   184         1        0.1ms        0.1ms      0.1%        frontier.append((f(initialNode), initialNode))         # frontier←a priority queu
   185
   186         1            .            .         .        reached = {str(initialProblem): initialNode}           # reached←a lookup table,
   187
   188       386        0.2ms            .      0.2%        while not frontier.empty():                            # while not IS-EMPTY(front
   189       386        0.2ms            .      0.2%            node = frontier.get()                              # node←POP(frontier)
   190
   191       386        0.2ms            .      0.2%            if constants.goalBoard == node[1].data:            # if problem.IS-GOAL(node.
   192                                                             #print('Max queue size:', frontier.getSize())   # only for debug
   193         1            .            .         .            return node[1]                                     # then return node
   194
   195      1427       53.1ms            .     55.9%            for child in expand(node[1]):                      # for each child in EXPANI
```

```
   196                                                   # s←child.STATE
   197      1042        1.2ms            .      1.3%      s =  Node( data = child[0], depth = node[1].depth + 1, move = child[1], pr
   198
   199                                                   # if s is not in reached or child.PATH-COST < reached[s].PATH-COST then
   200      1042        1.9ms            .      2.0%      if str(s.data) not in reached or s.depth < reached[str(s.data)].depth:
   201       625        0.8ms            .      0.8%          reached[str(s.data)] = s                    # reached[s]←child
   202       625       37.2ms        0.1ms     39.1%          frontier.append((f(s) ,s))                  # add child to frontier
   203
   204                                           return constants.failure                                  # return failure


Total time: 0.000s
File: /Users/rishabhjain/Documents/Masters/SEM 2/Aritificial Intelligence/Program/assignment_1/a_star.py
Function: printStatistics at line 207

Line #      Hits         Time      Per Hit    % Time    Line Contents
==============================================================
   207                                           @cpu
   208                                           def printStatistics(solution):
   209         1            .            .      0.4%      pathCost = 0
   210         1            .            .      0.4%      stateSequence = []
   211         1            .            .         .      actionSequence = []
   212
   213        29            .            .      4.3%      while solution.prev != None:
   214        28            .            .      4.3%          stateSequence.insert(0, solution.data)
   215        28            .            .      4.3%          actionSequence.insert(0, solution.move)
   216        28            .            .      3.8%          solution = solution.prev
   217        28            .            .      3.0%          pathCost += 1
   218
   219         1            .            .      3.0%      print('Action sequence:')
   220         1            .            .     17.9%      print(*actionSequence, sep='\n')
   221
   222         1            .            .      1.3%      print('\nState sequence:')
   223         1        0.1ms        0.1ms     55.1%      print(*stateSequence, sep='\n')
   224
   225         1            .            .      2.1%      print('\nPath cost:', pathCost)
```