N PUZZLE
SOLVER

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PROJECT IDEA

The N-puzzle (also called Game of Fifteen, Mystic Square and many others) is a sliding puzzle that consists of a n × n board with n^2 tiles (every tile has one number from 1 to n^2-1) and one empty space.

The objective is to place the numbers on tiles to match final configuration using the empty space.

5	10	14	7
8	3	6	1
15		12	9
2	11	4	13

The solver can slide four adjacent tiles (left, right, down and up) into the empty space. The Figure shows the target when n=4.

Furthermore, each state will be represented as 2D array (array[n][n]), and the transition between states will be through moving the empty square, which will have the value of 0.

The n-puzzle is a classical problem for modelling algorithms involving heuristics.

The goal of the project is to build an intelligent solver that can solve n-puzzle problem using informed search methods (best-first-search algorithm).

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The outputs of the project:

1) Total number of steps to reach solution (path cost).

2) Total number of processed nodes until the strategy finds solution.

3) Maximum number of nodes that have been stored concurrently.

4) Simulation of the solution process showing the transitions from the initial state to the goal state.

MAIN FUNCTIONALITIES

1) Choose the size of the game board

   The application allows you to choose between different board sizes:

   - 8

   - 15

   - 25

2) Choose the heuristic function

   The application uses different heuristic functions and compare between them.

   The heuristic functions provided by the application; h(N) is equal to:

   - Number of misplaced tiles

   - Sum of Euclidian distances of tiles from their goal positions.

   - Sum of Manhattan distances of tiles from their goal positions.

   - 2 * the number of direct tile reversals.

3) Different actions for each tile (if it legal)

   - Up

   - Down

   - Left

   - Right

4) Change the initial state each time (random)

   - Shuffles the puzzle.

LITERATURE REVIEW

1) Pedagogical Possibilities for the N-Puzzle Problem

This paper is written about a project funded by the National Science Foundation with a goal of unifying the Artificial Intelligence (AI) course around the theme of machine learning. The project uses machine learning as a theme to unify core AI topics in the context of the N-puzzle game. Analyzing the N-puzzle as part of a larger project to unify core AI topics using machine learning. Search is a fundamental concept to the Computer Science data structures and algorithms courses as well as to the artificial intelligence course. In AI the concept of search is usually introduced by using the idea of state space representation of games. The N-puzzle game is among the classical games that have been used extensively in this area.

2) Evaluating Search Algorithms for Solving n-Puzzle

Artificial game playing has gathered significant attention in past few decades. n-puzzle is a classical problem in computer science in evaluating search heuristics. Recently, AlphaGo beat the world champion Lee Sedol in Go. Find a shortest path to an n-Puzzle is an NP-Hard problem. Puzzle and games have gathered huge interest of humans from ancient times. People have been trying to teach computers to play (or pretend to play) these games. At the core of these intelligent computers are efficient algorithms which guide them to make moves and choose one optimum path out of several.

3) Experimental Comparison of Uninformed and Heuristic AI Algorithms for N Puzzle Solution

This paper compares the performance of popular AI algorithms in approaching the solution of a N-Puzzle of size 8, on a 3x3 matrix board. The paper also depicts the extent each algorithm goes through while processing the solution and hence helps to clarify the specific cases in which one may be preferred over another. Analyzing algorithms for solving a n-puzzle is an attempt to look at the better of the algorithms for this case. To solve the problem, one moves a set of square tiles arranged randomly in a square board to arrive at a pre-determined order.

4) Games, computers, and artificial intelligence

computer-games research has been rejuvenated since the mid-80s with the publication of innovative search algorithms. The first game to have a non-human World Champion was checkers (8 × 8 draughts) ... Inventor Richard Korf introduced the IDA* algorithm, using the 15-puzzle to illustrate his ideas (search-space size is O (1013). 16 years later, Korf and his colleagues have improved our sliding-tile puzzle solving capabilities by an incredible factor of 1012! solving the 15-puzzle became a routine computational exercise, one that was repeated in many AI courses. Database Heuristics" uses new heuristics to push the sliding-tile frontier forward. Solving instances of the 24-puzzle (search-space size is O (1025)) is now going to become routine.

5) Artificial Intelligence and Game Development Hemn mela Karim Barznji

In this article narrative review, I am compared and summarized the all relation and Chronological processing between AI and game development. The main function of Artificial Intelligence (AI) in games production is winning importance and often affects the success or failure of a game. Artificial intelligence (AI) is about making computers able to perform the thinking tasks that humans and animals are capable of. Expert systems emerged as a knowledge-based approach to solving AI problems in the 1980s. Currently, AI has been applied widely and is one of the important components in game development. The use of Artificial Intelligence (AI) has a long history in the video games industry. Since 2003, the Rochester Institute of Technology (RIT) has had a course on AI for Games. This course covers a variety of traditional AI techniques as well as how they are applied into games.
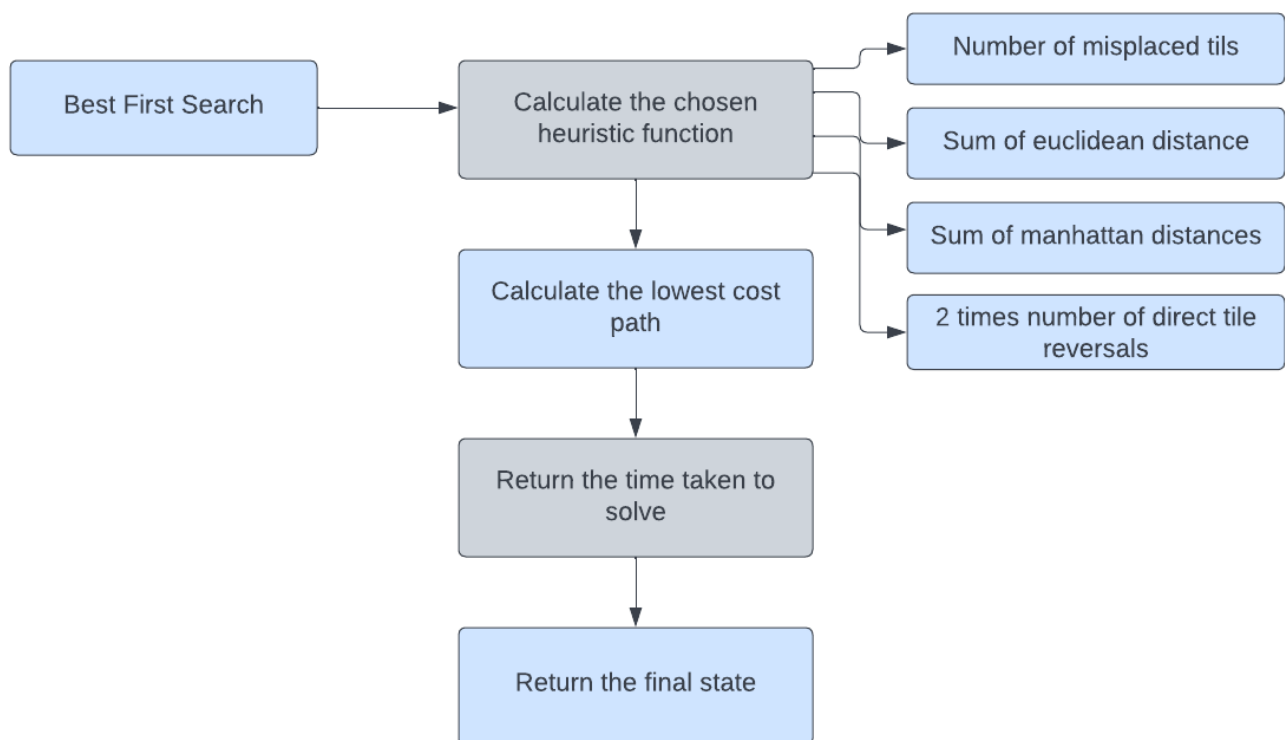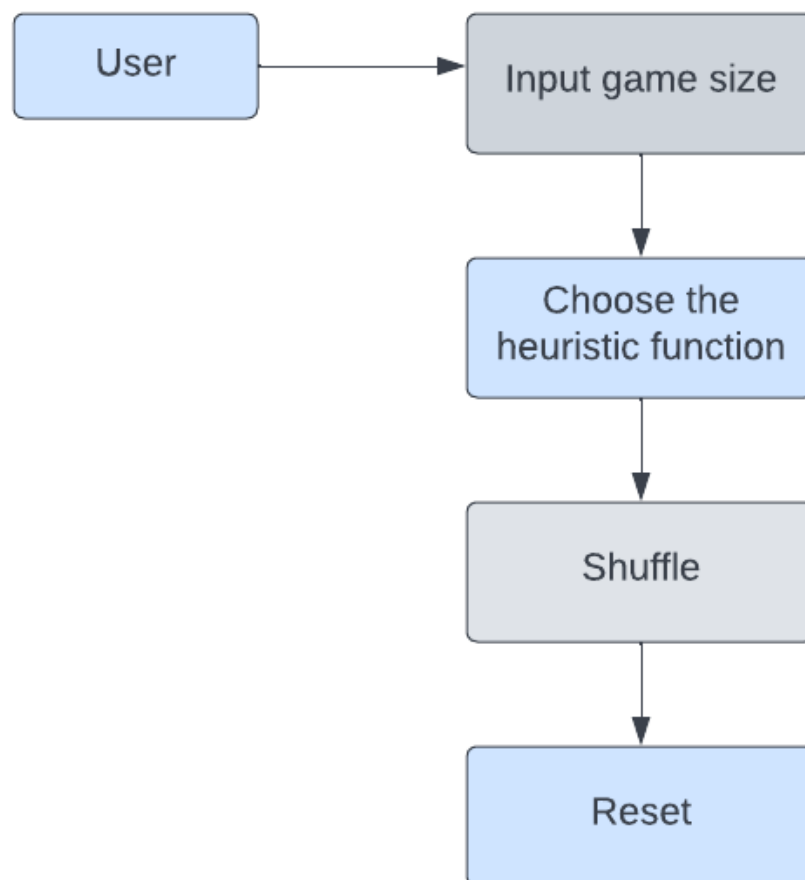
DETATILS OF ALGORITHM

Figure 1: Algorithm block diagram
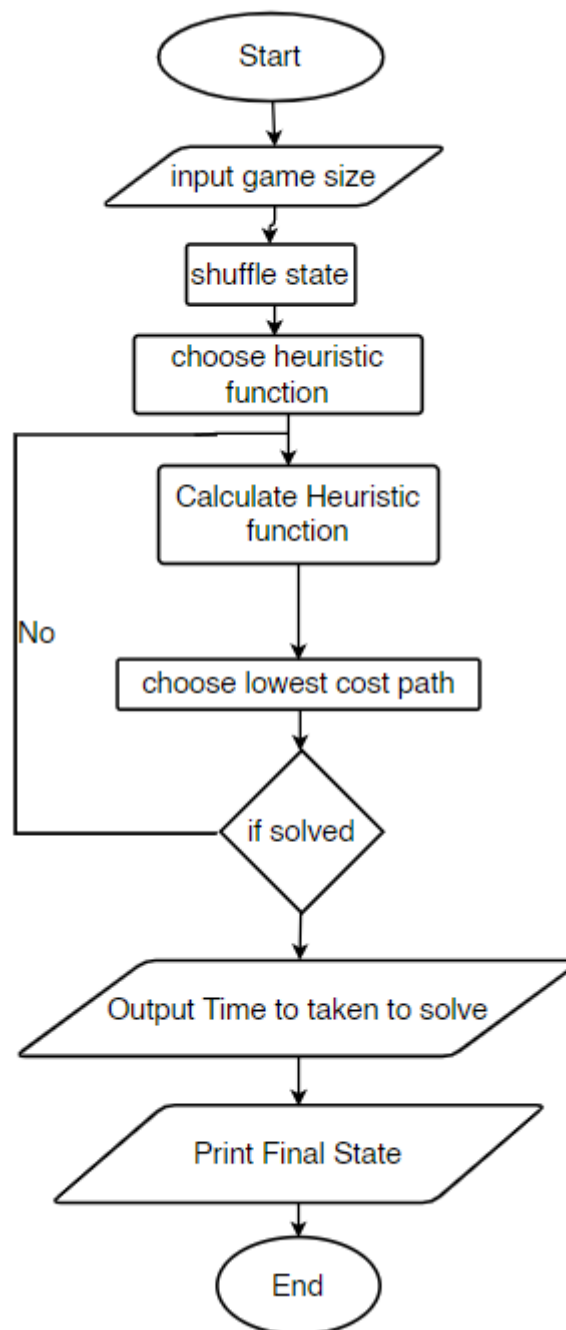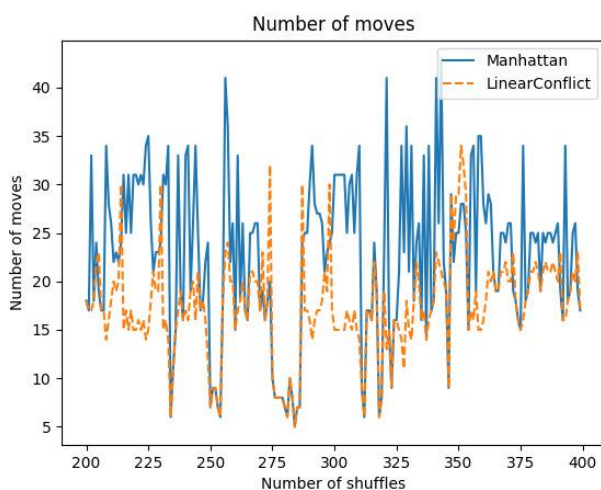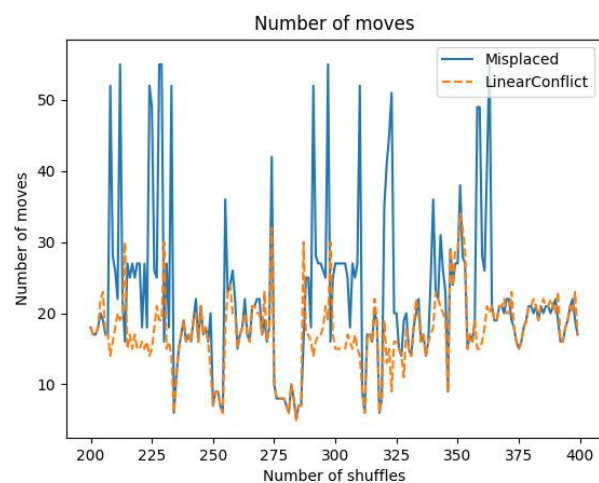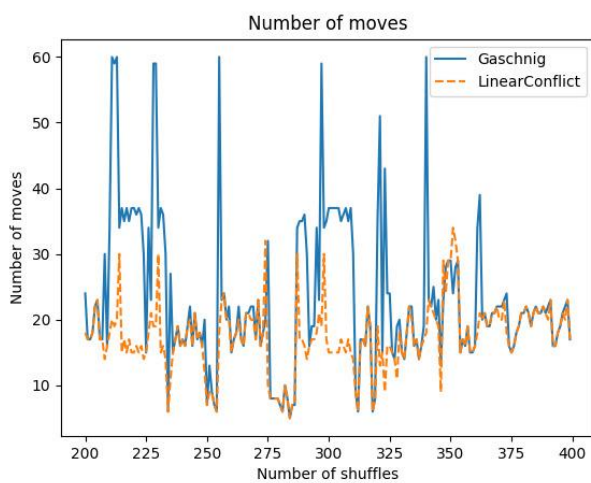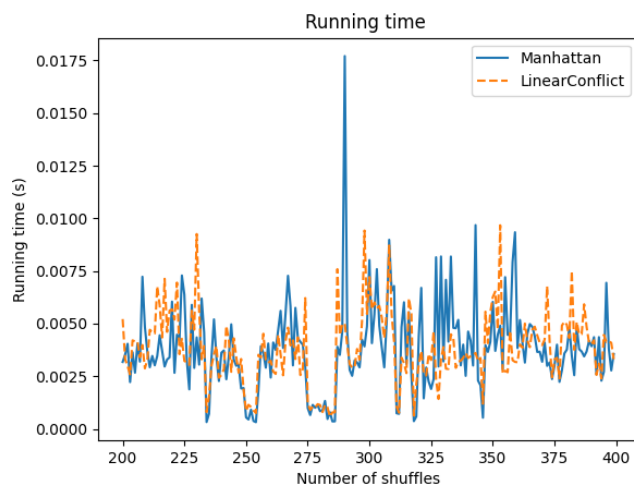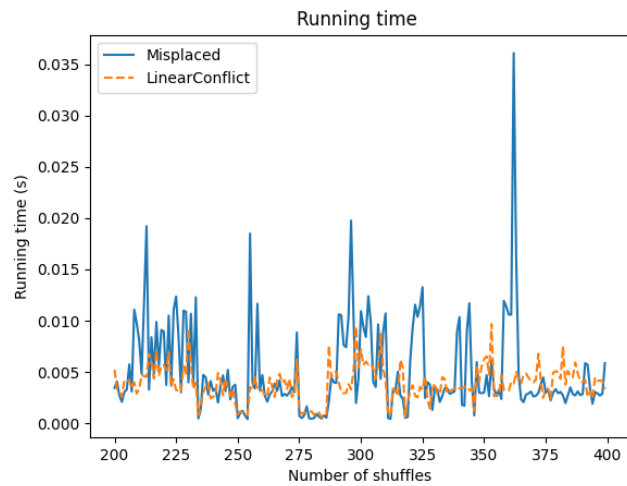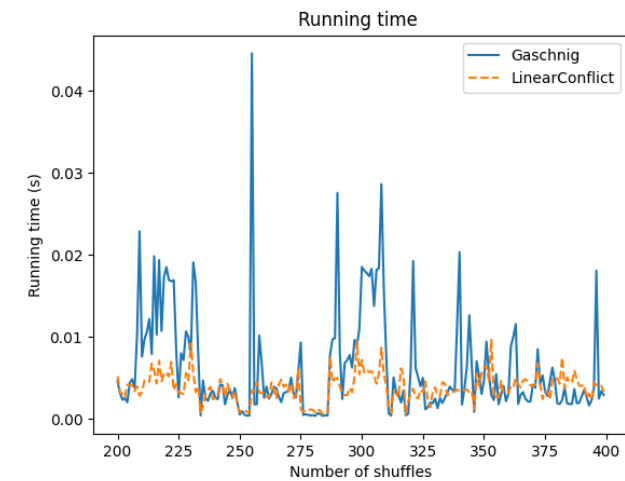
Figure 2: System block diagram

Figure 3: Algorithm flowchart

RESULTS OF EXPERIMENT

1) Number of moves

2) Running time

3) Running time (Cost)

Running time (Cost) — Manhattan / LinearConflict

Running time (Cost) — Misplaced / LinearConflict

Running time (Cost) — Gaschnig / LinearConflict
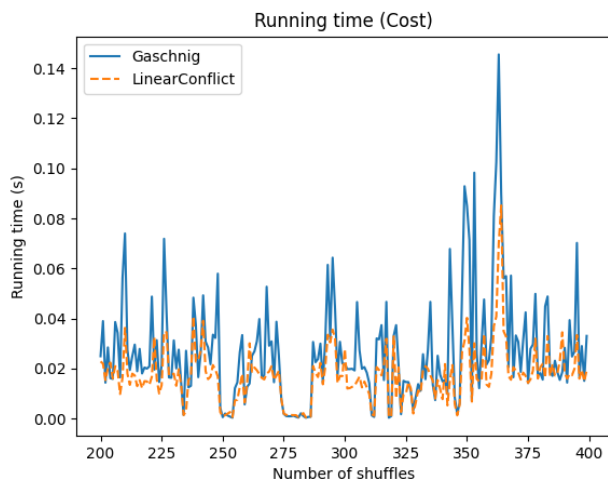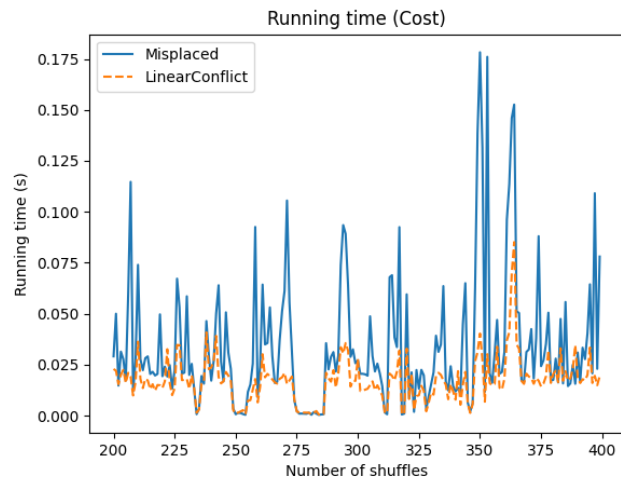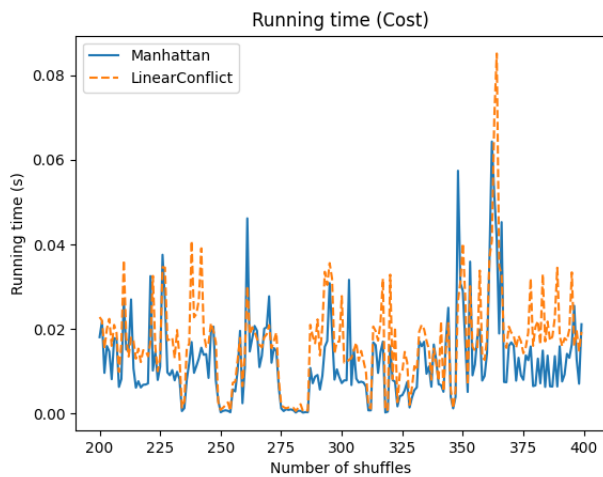
DEVELOPMENT PLATFORM

- **IDE: PyCharm**

  PyCharm is an integrated development environment used for programming in Python. It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems, and supports web development with Django. PyCharm is developed by the Czech company JetBrains.

- **Libraries:**

  1. PyGame

  Pygame is a cross-platform set of Python modules designed for writing video games. It includes computer graphics and sound libraries designed to be used with the Python programming language.

  2. Matplotlib

  Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK.

- **Programing Language: Python**

  Python is a high-level, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation. Python is dynamically-typed and garbage-collected. It supports multiple programming paradigms, including structured, object-oriented and functional programming.

CITATION

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