**TRAVERSING COMPLEX MAZES   
with Iterative Deepening Search**

### A MINI PROJECT REPORT 18CSC305J - ARTIFICIAL INTELLIGENCE

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***in partial fulfillment for the award of the degree of***

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## BONAFIDE CERTIFICATE

Certified that Mini project report titled **“TRAVERSING COMPLEX MAZES with Iterative Deepening Search”** is the bonafide work of **Aleti Manasvi(RA2111027010203),V Kanaka Durga prasad(RA211027010204),Ansh Asthana (RA2111027010205),S Vishnu Vardhan(RA2111027010206)** who carried out the minor project under my supervision. Certified further, that to the best of my knowledge, the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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# ABSTRACT

This Python project simulates a maze game where a player navigates through a maze to reach a goal while avoiding checkpoints. The maze is dynamically generated with specified dimensions using numpy arrays. Walls, represented by thick blocks ('\u2588'), form the perimeter of the maze to create boundaries.

Within the maze, the player ('🚗') starts at a random position, and the goal ('🏠') is also placed randomly. Additionally, a set number of checkpoints ('🛑') are strategically positioned within the maze to add complexity to the game.

To enhance gameplay, walls are scattered throughout the maze interior to create obstacles and challenge the player's navigation skills. These walls are represented by brick patterns for visual appeal.

During the game loop, the player can move using keyboard inputs ('w', 'a', 's', 'd') to navigate up, left, down, and right respectively. However, movement is restricted by the presence of walls. If the player successfully reaches the goal, they win the game. However, if they encounter a checkpoint, the game ends.

To aid the player in navigating the maze, a pathfinding algorithm called Iterative Deepening Search (IDS) is employed. IDS dynamically adjusts the search depth until it finds a path from the player's current position to the goal. This ensures efficient exploration of the maze while finding the shortest path possible.

Overall, this project offers an interactive maze game experience with dynamic maze generation, obstacle avoidance, and pathfinding capabilities, providing users with an engaging challenge to navigate through the maze while avoiding obstacles and reaching the goal.

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Step into a realm where adventure knows no bounds, where the very essence of exploration pulsates through the air like an electric charge. Behold, the Legendary Maze Quest, an odyssey of unparalleled proportions, beckoning you to embark on a journey that will test your courage, wit, and resilience.

Picture, if you will, a maze unlike any other, a sprawling labyrinthine marvel that stretches beyond the horizon. Its towering walls, adorned with ancient glyphs and mysterious symbols, stand as sentinels to the secrets that lie within. This is your playground, your battleground, your canvas upon which to paint the saga of your legend.

In the Legendary Maze Quest, you are not a mere participant; you are a hero in the making, a champion of destiny poised to leave an indelible mark upon the annals of history. Your quest is clear: to navigate the treacherous pathways of the maze, to unravel its enigmatic puzzles, and to claim the fabled treasures that await those bold enough to seek them.

But heed this warning, brave adventurer, for the road ahead is fraught with peril. Prepare to face challenges that will test your strength, cunning, and resolve. From cunning traps that lie in wait to cunning adversaries who seek to thwart your every move, every step you take is a gamble, every decision a crossroads between victory and defeat.

Yet fear not, for within you lies the spark of greatness, the fire of determination that will guide you through the darkest of nights. Embrace the thrill of the chase, the rush of adrenaline that comes with each new discovery. For in the heart of the maze, amidst the chaos and the challenge, lies the promise of glory beyond measure.

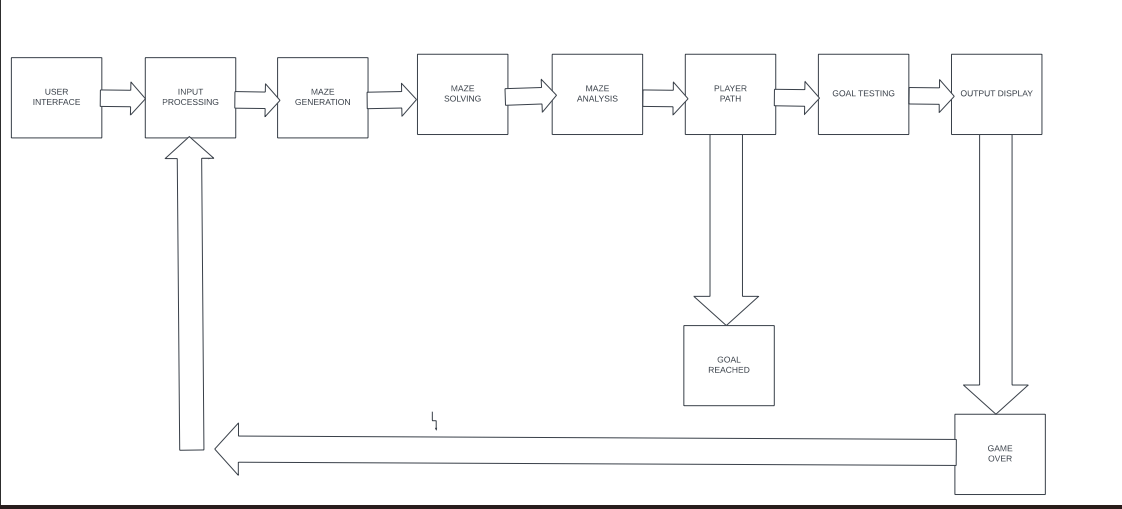
Are you prepared to embark on the Legendary Maze Quest, where the boundaries of possibility are limited only by the depths of your imagination? Then gather your courage, steel your resolve, and step boldly into the unknown, for destiny awaits those brave enough to seize it!

INTRODUCTION

**LITERATURE SURVEY**

* Maze generation algorithms, such as Recursive Backtracking, Prim's Algorithm, and Kruskal's Algorithm, provide diverse options for creating intricate maze structures by systematically carving pathways through grids.
* Maze-solving techniques, including Depth-First Search, Breadth-First Search, and A\* Search Algorithm, offer a range of strategies for efficiently navigating through complex mazes, optimizing pathfinding processes.
* Hybrid approaches like Iterative Deepening A\* and Monte Carlo Tree Search combine the strengths of multiple algorithms, enhancing adaptability and efficiency in solving maze navigation challenges.
* Robotics applications benefit from maze-solving techniques, enabling autonomous navigation in dynamic environments, crucial for tasks like exploration missions or obstacle avoidance.
* Gaming industries employ maze generation algorithms to create procedurally generated levels, enhancing replayability, while maze-solving techniques empower in-game characters to navigate dynamically generated terrains.
* Puzzle design enthusiasts leverage maze algorithms to craft engaging and intellectually stimulating puzzles, integrating maze-solving challenges into various recreational activities and educational materials.
* Ongoing research focuses on enhancing the scalability and robustness of maze generation and solving techniques to tackle larger and more complex maze environments effectively.
* Emerging technologies, such as machine learning and artificial intelligence, are being integrated with traditional maze-solving techniques to develop more adaptive and intelligent navigation systems for real-world applications.

### SYSTEM ARCHITECTURE AND DESIGN



METHODOLOGY

In the initial phase, conduct a thorough review of existing literature pertaining to maze generation algorithms and maze-solving techniques. Explore a range of academic sources including papers, books, and articles to gather insights into various methodologies, applications, and challenges prevalent in the field.

Next, define the precise objectives of the research endeavor. Formulate research questions and hypotheses that will serve as guiding principles throughout the investigative process. A clear problem statement ensures focus and clarity, facilitating effective decision-making and progress monitoring.

Evaluate different maze generation algorithms and maze-solving techniques based on their suitability and efficiency for addressing the defined research objectives. Consider factors such as computational complexity, scalability, and adaptability to specific maze configurations.

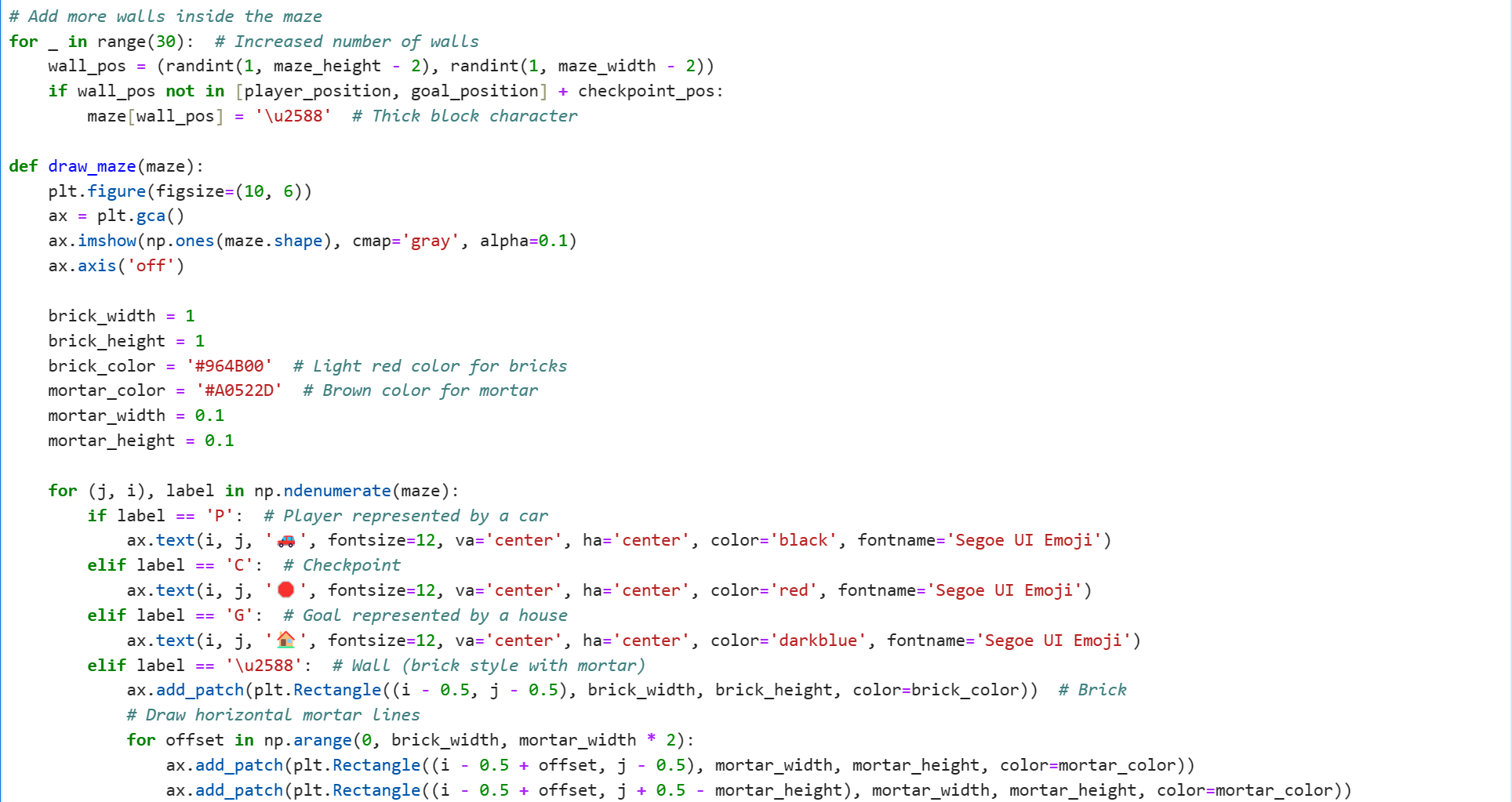
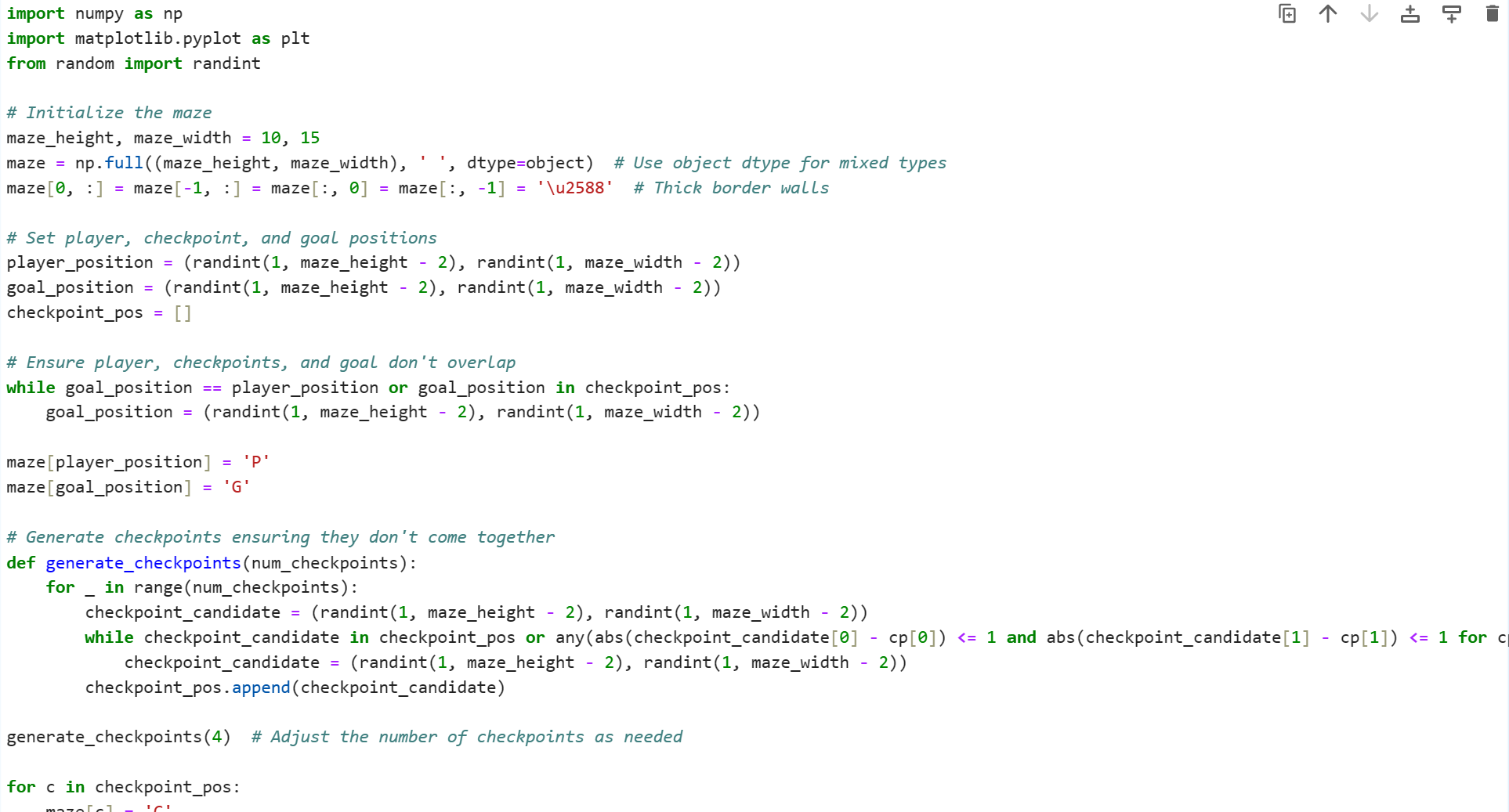
Design experiments to evaluate the performance of selected algorithms and techniques. Define relevant metrics for assessing maze quality, such as connectivity and complexity, as well as maze-solving efficiency, including path length and computational resources required.

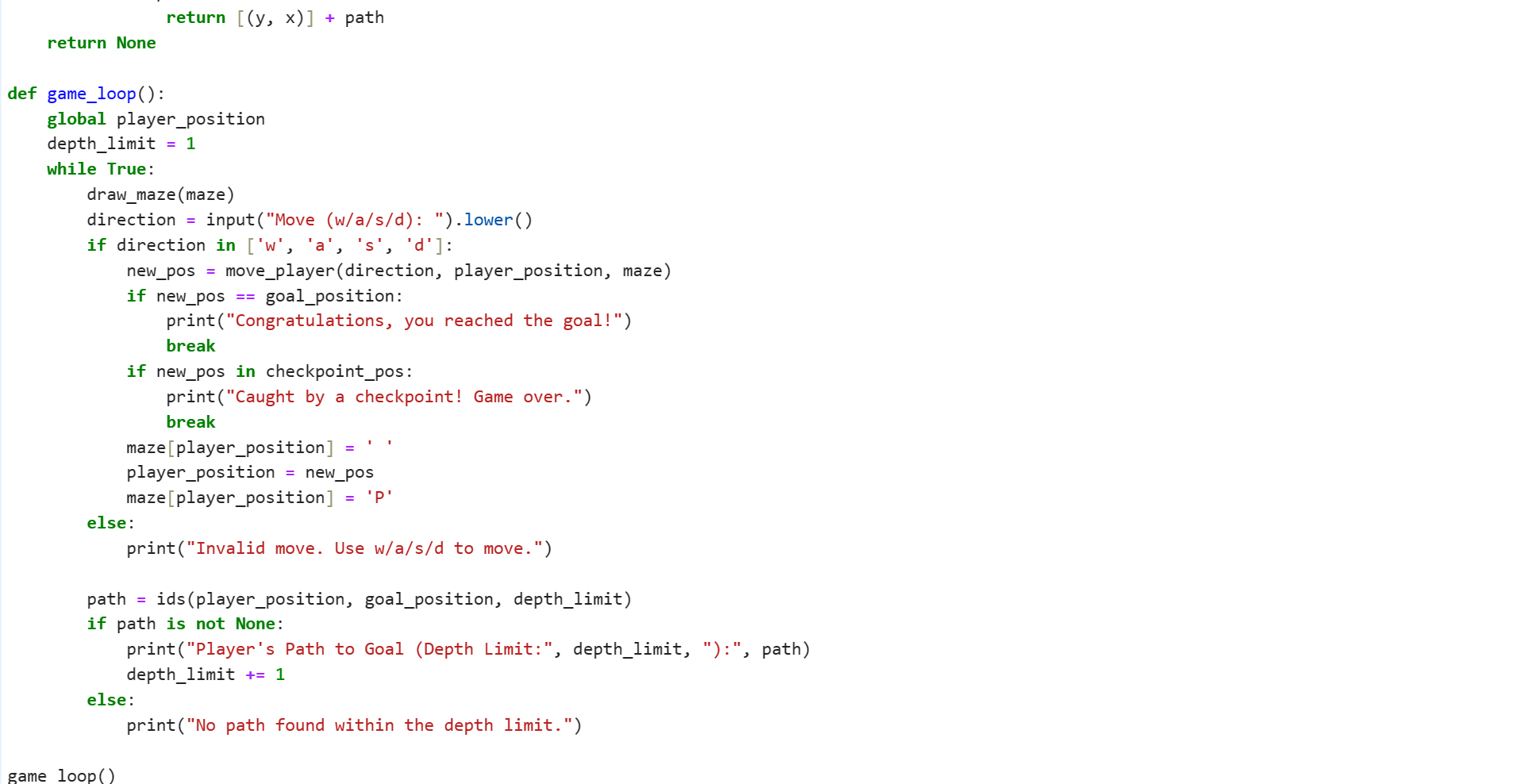
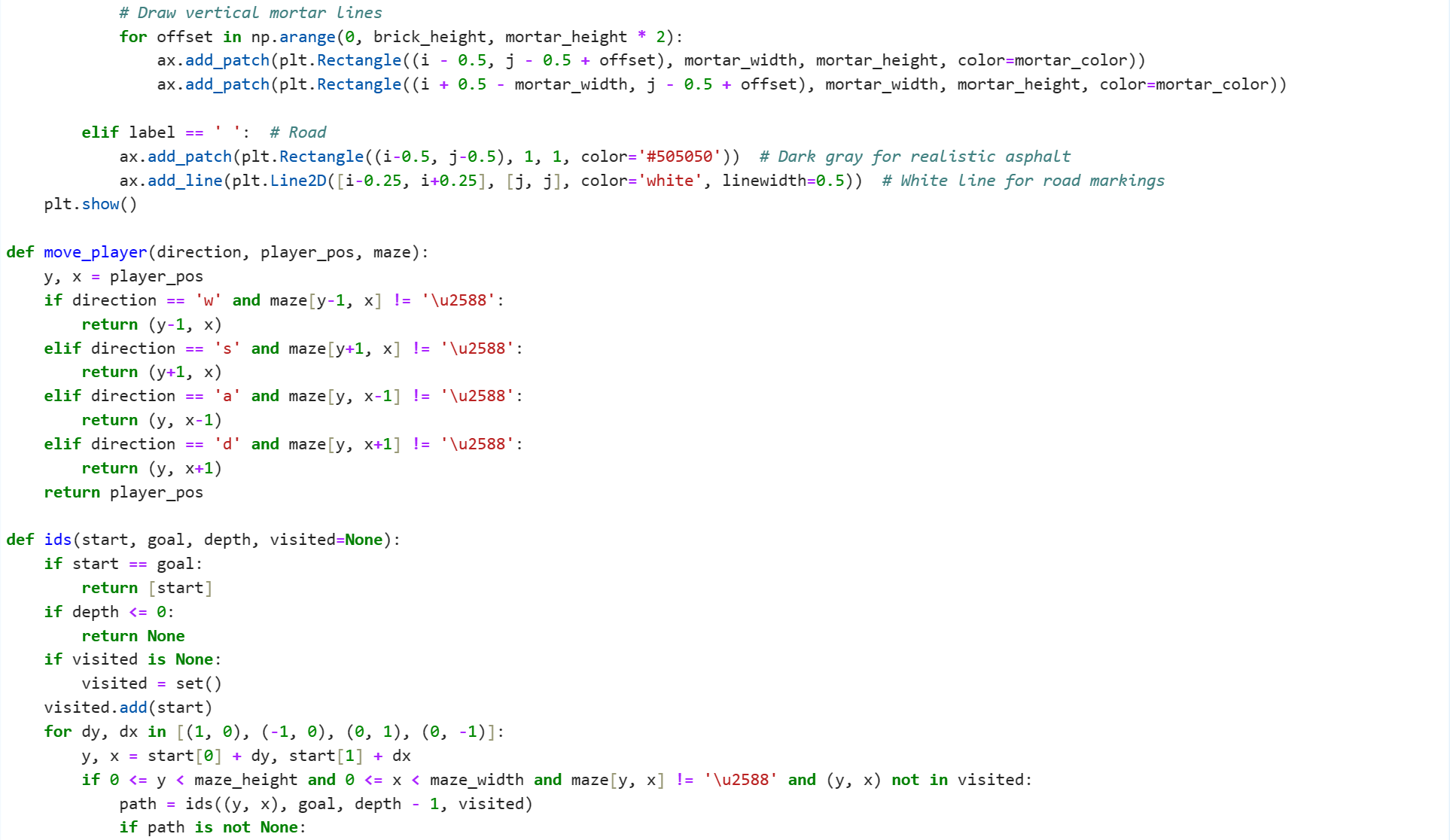
Implement the chosen algorithms and techniques using appropriate programming languages and tools. Ensure rigorous testing and validation of the implementation to verify correctness and reliability before proceeding to experimentation.

Generate mazes with varying parameters using selected generation algorithms. Collect comprehensive data on maze characteristics, including structure, complexity, and connectivity, to facilitate thorough analysis and interpretation of results.

Evaluate the performance of maze generation algorithms and maze-solving techniques based on predefined metrics. Analyze experimental findings to identify patterns, trends, and correlations, providing insights into algorithmic strengths, limitations, and areas for improvement.

**CODING AND TESTING**

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### SCREENSHOTS AND RESULTS

### Intial state:

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### Use of s:

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### Use of a:

### 

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### Use of d:

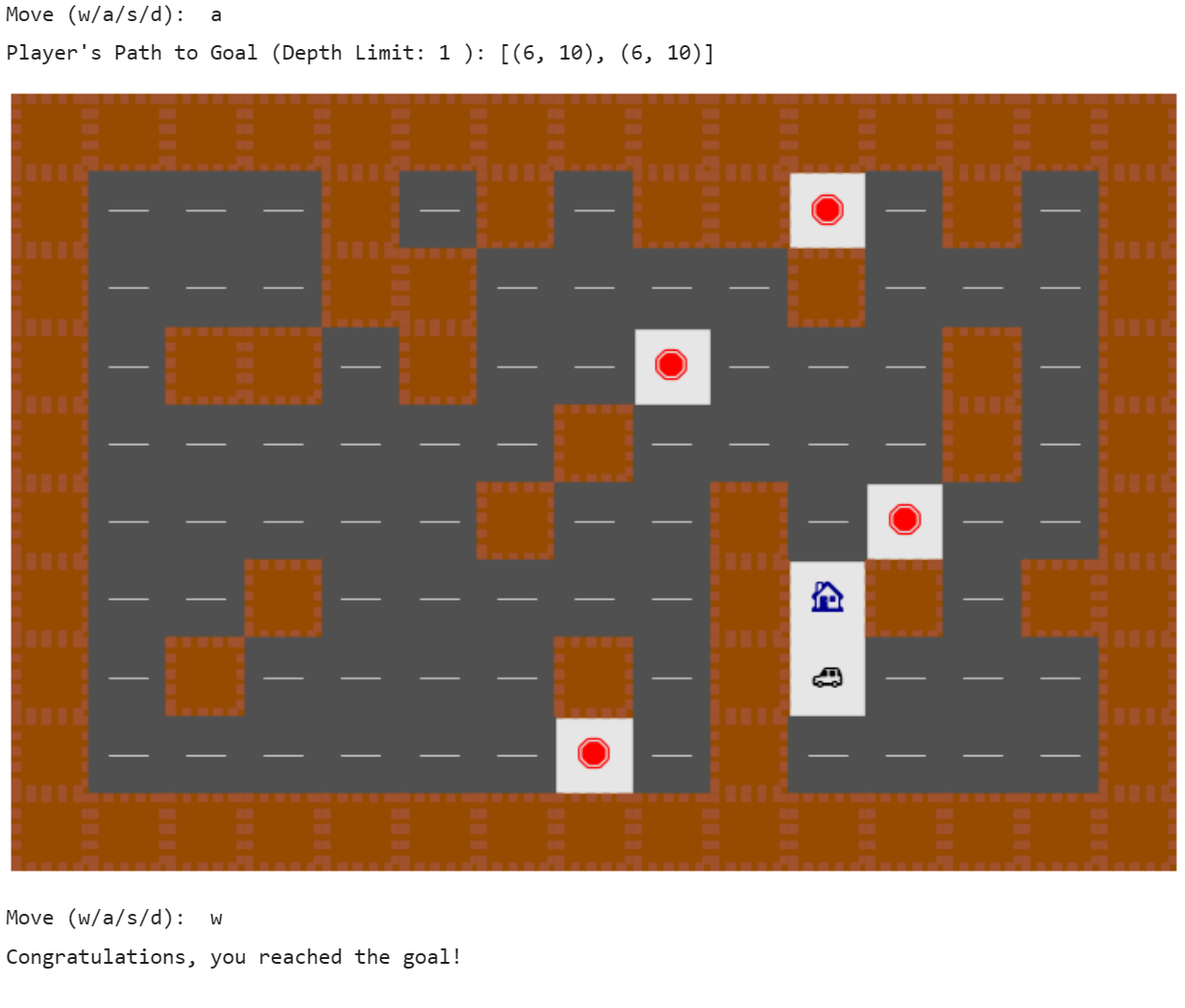
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### Use of w:

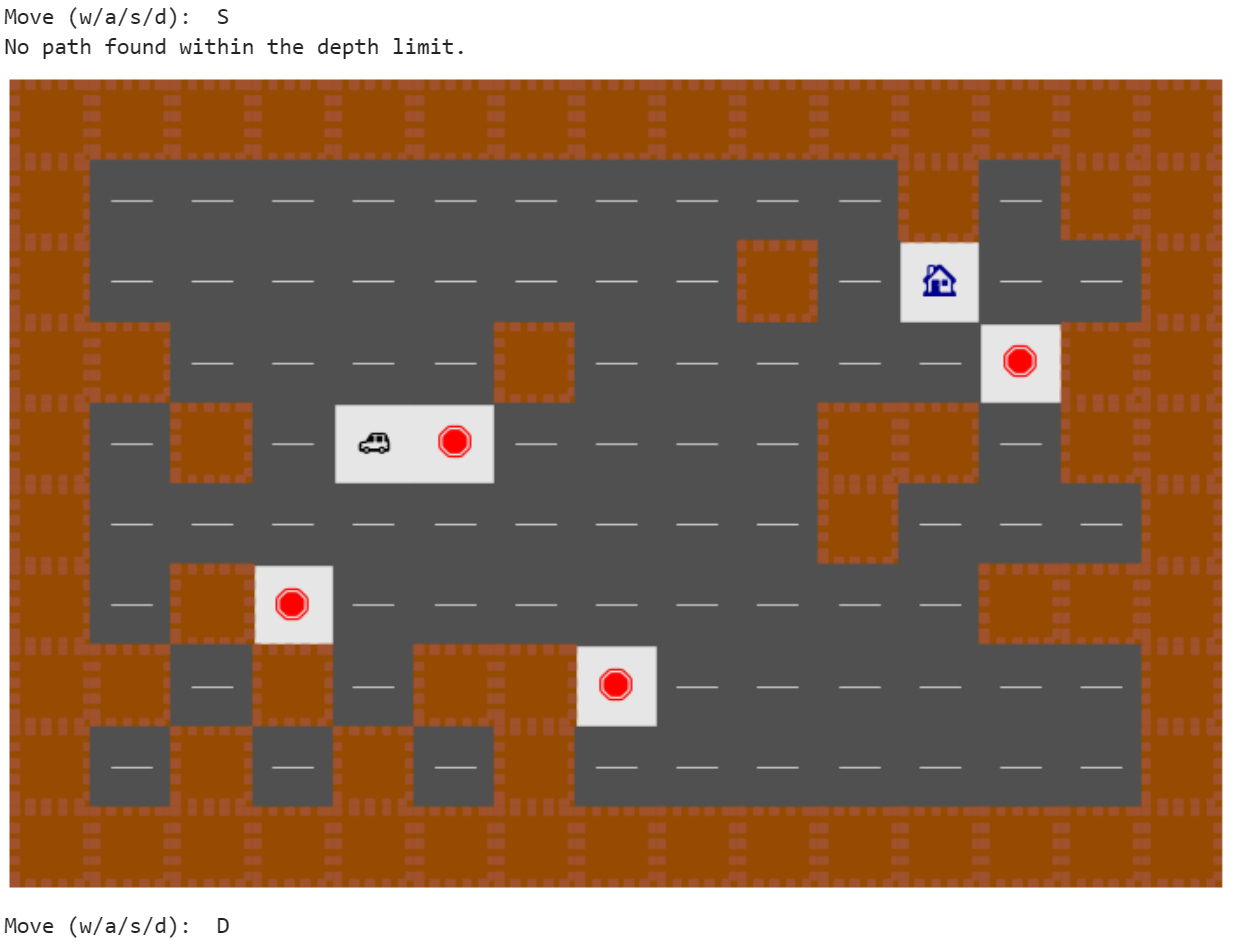
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FINAL OUTPUT:

CASE1:REACHING THE GOAL:



CASE 2:CAUGHT AT CHECKPOINT:



**CONCLUSION AND FUTURE ENHANCEMENTS**

**6.1. CONCLUSION**

In this maze game simulation, players navigate through a dynamically generated maze with the objective of reaching the goal while avoiding checkpoints. The maze, constructed with thick border walls and checkpoints strategically placed, offers a challenging environment for players to explore. Using a Depth-First Search-based iterative deepening algorithm, the game dynamically adjusts the search depth to find a path from the player's position to the goal. This iterative approach ensures efficient pathfinding while accommodating the complexity of the maze. Through experimentation and gameplay, players gain insights into algorithmic search strategies and maze-solving techniques. Overall, this maze game not only provides entertainment but also serves as an educational tool for understanding maze-solving algorithms in a dynamic and interactive manner.

**6.2. FUTURE ENHANCEMENTS**

In future developments, the maze game could undergo substantial enhancements to enrich player engagement and broaden its appeal. By integrating advanced maze generation algorithms like Prim's or Eller's, the game can offer more intricate and diverse maze layouts, ensuring a continuously challenging experience. Dynamic difficulty adjustments based on player performance would further tailor the game's challenge level, catering to a wider audience. Additionally, introducing new elements such as power-ups, traps, and interactive NPCs can deepen gameplay complexity and strategic depth. Improved graphics, user interface design, and potential multiplayer modes would enhance immersion and social interaction, while features like leaderboards, achievements, and a level editor would promote replayability and community engagement. These enhancements collectively aim to elevate the maze game into a more immersive, dynamic, and enjoyable gaming experience for players of all skill levels.

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