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Adaptive Snake Game with AI Control

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Abstract: *By fusing AI-controlled and manual gameplay, Advanced Snake, a sophisticated browser-based game, was developed to enhance the classic Snake experience. In classic snake games, a growing snake must be steered across a limited grid without colliding with itself or the walls. This project preserves the basic fundamentals of the original game while adding some innovative components to make it more engaging and educational.*

Players can choose between two major modes of play: player-controlled mode, where they move the snake using keyboard inputs (arrow keys or WASD), and AI-controlled mode, which employs the A pathfinding algorithm to automatically determine the optimal way to acquire food while avoiding obstacles. This AI setup allows users to observe the operation of pathfinding and collision avoidance algorithms in a dynamic, real-time environment. In order to demonstrate fundamental concepts of artificial intelligence decision-making, the AI continuously recalculates the snake's path as the game board and its position change.*

In order to enhance the user experience, the project includes variable pace settings that let players change the game's tempo to fit their ability level. Different visual skins (Classic, Neon, and Retro) can be applied to alter the appearance of the game grid and snake. To further aid AI or players in visualizing the game environment, a toggleable grid overlay can be activated.

Using a real-time difficulty scaling algorithm, the adaptive component of the game adjusts the playing environment based on the performance of the AI or player. The snake's speed can be increased, new obstacles can be added, the allowed space can be reduced, or the scoring method can be changed. In addition to guaranteeing that the game stays difficult, this method offers a great platform for testing the resilience and learning potential of various AI techniques.

According to the experimental findings, heuristic algorithms do well in environments that are static or semi-predictable but suffer as complexity rises. Strong path optimization is shown by A search, however it is not flexible enough to adjust to dynamic elements like shifting barriers or changing game speed. However, when trained in a suitably diversified context, agents based on reinforcement learning exhibit encouraging outcomes. In addition to learning intricate tactics like looping safely, avoiding traps, and optimizing reward collecting, agents trained with deep Q-networks (DQN) exhibit the capacity to generalize across levels. Large amounts of processing power and meticulous adjustment of hyperparameters like learning rate, reward structure, and exploration-exploitation balance are necessary for training such agents.*

Keywords*:* AI in games, A* pathfinding, JavaScript, Snake games, browser-based games, interactive user interfaces, and game development

I. INTRODUCTION

Snake has been a mainstay of arcade gaming for many years due to its simple yet immensely fascinating fundamentals. A snake that moves constantly inside a tiny rectangular area is controlled by the player. That's the game's core concept. As you devour the food items that appear at random locations on the game board, the snake grows longer. The task becomes more difficult as the snake becomes larger since the player has to avoid running into the walls of the game

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board and the snake's own longer body. Despite its simple rules, the game is entertaining and intellectually engaging, effectively testing players' reflexes, strategic planning, and spatial awareness.

Over time, other variations and adaptations of the Snake game have appeared on devices such as mobile phones, console games, and web browsers. Despite a few minor visual or gameplay enhancements, the majority of these versions remain stick to the core principles and don't use complex computational or technological concepts.

By including a number of innovative features while preserving the game's simple, engaging gameplay, the Advanced Snake project seeks to modernize the beloved Snake game. The inclusion of AI-controlled games is a notable enhancement. This AI mode makes use of the A (A-star) pathfinding algorithm*, a widely used method in computer science and artificial intelligence, to discover the shortest path between points in a space while accounting for barriers. The Snake game's AI-controlled snake dynamically determines the optimal route to the nearest food item as the gaming environment changes due to the snake's growth or the appearance of new barriers.

To further demonstrate the value of algorithmic decision-making in real-time situations, the AI ensures collision avoidance by predicting potential collisions with walls and self-intersections. Observing the AI activity can teach users and learners about fundamental AI concepts such as adaptive decision-making, pathfinding, and problem-solving in dynamic and limited systems.

The project incorporates AI along with several other components to enhance user engagement and customisation. The variable speed control is one of the features that allows players to change the game's tempo to fit their skill level. To obtain a sense of the game's mechanics, beginners can start out at slower rates. More seasoned players can challenge themselves to play at quicker speeds, which makes the game more exciting and difficult. Additionally, users can customize the game board and snake's appearance by selecting from a range of visual skins, including Classic, Neon, and Retro. The aesthetic appeal of the game is enhanced by these skins, which also provide players a sense of personalization and immersion that fits their preferences.

Additionally, because the optional grid overlay clearly separates the playing area into cells, it serves as a visual aid that is particularly useful for understanding movement patterns and strategy. This lets human players better plan their movements and aids the AI, which employs the grid structure for pathfinding computations.

As a browser-based application, the Advanced Snake project is technically implemented with HTML5, CSS, and JavaScript. The responsive canvas element, which is a component of HTML5, renders all game elements, such as the grid, food, and snake, and forms the structural foundation of the program. By controlling color schemes, applying different skins, and designing visually appealing layouts, CSS makes the game look professional and well-made. The fundamental game functionality is handled by JavaScript, including AI pathfinding techniques, level progression, score calculation, snake movement, collision detection, and user input processing. Using the A* pathfinding concepts, the JavaScript-implemented AI module continuously evaluates the game circumstances and makes decisions to ensure the snake moves safely and successfully toward the objective food.

The gaming interface is fun and easy to use, with controls and buttons for stopping the game, starting a new one, altering speed, flipping the grid, and switching between player-controlled and AI-controlled modes. In player mode, the snake's movement can be easily and quickly controlled with keyboard shortcuts like the arrow keys or WASD. These design choices not only allow players to experiment with different gaming configurations, but they also ensure an impeccable user experience.

An additional crucial element of the idea is data durability through local storage. This browser feature enables players to continue improving during sessions by allowing the game to save user-specific data, such as high scores, current score, and preferred settings. This allows the game to provide a continuous and personalized experience without requiring server-side data storage or an internet connection thanks to localStorage.

The Advanced Snake project has a great deal of educational potential. Through the integration of AI into a simple and popular game, the project creates a useful platform for experimentation and learning. As users see the AI make decisions in real time, they can understand how pathfinding algorithms work in dynamic scenarios and explore the consequences of different speed and strategy combinations. The project also demonstrates the potential of web technologies like HTML5, CSS, and JavaScript to create interactive, visually appealing, and computationally intelligent content.

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II. LITERATURE SURVEY

Chen (2025) et al. [1] compared the K-Nearest Neighbors, Decision Tree, and Linear Regression models in a study called "Car Price Prediction Using Machine Learning." Although this study focuses on predictive modeling in cars, it emphasizes the importance of algorithm selection and decision-making processes, which are closely linked to applying AI logic in games. To determine the accuracy and efficiency of the model was the main objective in order to provide a comparison study that can direct real-time decision systems, similar to pathfinding in AI-controlled games.

Harris (2023) et al. [2] developed a Snake game for the browser that uses AI pathfinding to demonstrate grid-based movement and obstacle avoidance. The aim was to create an independent snake that could efficiently travel toward food without encountering barriers. The main objective was to show how pathfinding algorithms are used in real-time gameplay while offering details on practical AI applications for online games.

Parsons (2022) et al. [3] delved deeper into autopilot techniques for Snake in order to demonstrate autonomous navigation. In this work, we show how AI can adapt movement strategies dynamically to game-state changes, focusing on decision-making and route optimization.

Johar (2021) et al. [4] created a Snake AI with reinforcement learning to demonstrate how to make adaptive choices in response to environmental input. The study looked into how AI might eventually learn the best routes to maximize rewards and reduce collisions.

Zhou (2021) et al. [5] investigated utilizing reinforcement learning to teach an AI to play Snake using reward-based pathfinding algorithms. Both studies show how reinforcement learning can enable intelligent, self-governing games that improve performance dynamically with experience.

Schoberg (2019) et al. [6] Schoberg's work focused on integrating AI into the classic Snake game and investigated how algorithmic strategies could enhance gameplay. The study concentrated on strategies for efficient food collection and collision avoidance, two essential aspects of Snake AI. By applying heuristic-based methods and rule-driven logic, the AI could foresee potential collisions with walls or its own tail and dynamically change its travel direction. Additionally, optimization approaches that allowed the AI to prioritize food items while minimizing risky activities were the focus of the research. By demonstrating the potential for intelligent, adaptive games using relatively simple algorithms.

Kharrufa (2021) et al. [7]intended to enhance Snake's AI performance by utilizing pathfinding techniques intended for grid navigation. The study, which concentrated on dynamic obstacle avoidance, including the snake's tail and environmental constraints, revealed strategies for selecting the optimal paths in a constrained space. Unlike heuristic-based approaches that rely on predetermined rules, pathfinding algorithms like A* or Dijkstra's method allowed the AI to evaluate multiple potential paths and assign scores according on variables like risk, distance, and the likelihood of food collection. The importance of computational foresight and algorithmic efficiency was illustrated in this work by showing that careful route optimization significantly improved overall performance and survival time." By carefully weighing the trade-off between danger (collision likelihood) and reward (food acquisition), Kharrufa's AI demonstrated a more strategic, intelligent gameplay style to better understand algorithmic decision-making in dynamic, constrained environments.

Mase (2021) et al. [8]demonstrated AI-controlled Snake gaming in an effort to demonstrate how pathfinding algorithms respond in real-time to shifting game states. Demonstrating how AI works in a real-world environment with dynamic obstacles and snake growth was the main objective. As the game state changed, the study found that algorithms like A* could efficiently recalculate trajectories, avoiding collisions and optimizing paths for gathering food. Users and developers may now see how AI decision-making varies based on the context thanks to the visualization technique. Through this study, the use of pathfinding logic in dynamic systems is better understood. Through this study, the use of pathfinding logic in dynamic systems is better understood.Another application of AI is the integration of visualization techniques into educational resources. Adaptability and real-time responsiveness were emphasized in the study as critical metrics for evaluating AI effectiveness. Overall, it ties the theoretical concepts of artificial intelligence to practical implementation in interactive online games.

Patel (2020) et al. [9] highlighted the importance of interactive user interfaces and canvas rendering in their examination of browser-based game creation using HTML5, CSS, and JavaScript. Giving programmers tips on how to create responsive and aesthetically pleasing web games was the aim of the study. According to Patel's research,

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HTML5 canvas enables dynamic display of game elements, while CSS enhances appearance and interactivity. Highlighting best practices for performance optimization, layout design, and game logic management were among the objectives. Synchronization between user input and game rendering was one of the other topics discussed in the article. The methodical approach to web-based game design provided by this study is useful for developing interactive games such as Snake. It serves as the technical foundation for incorporating browser-based AI systems.

Li (2019) et al. [10] analyzed AI methods by comparing the pathfinding strategies of BFS, DFS, and A* in simple grid-based games. The objective was to evaluate the effectiveness and efficiency of each algorithm in handling dynamic game scenarios. The study found that A*'s heuristic-based approach yielded the greatest pathfinding outcome by striking a balance between speed and accuracy. Although BFS and DFS could navigate in simple situations, Li demonstrated that they performed worse in larger or more dynamic grids. Main objective was to inform developers about algorithm choices for adaptive decision-making real-time games. The study also showed how these algorithms could be applied to educate students how to solve computational problems in game settings. This paper provides an essential blueprint for implementing AI-controlled Snake games.

Singh (2022) et al. [11] focused on autonomous mobility through pathfinding and collision avoidance in arcade games using adaptive AI. It was intended to develop AI that could adapt its behavior dynamically to game situations in order to improve task efficiency and survival. As to the study, adaptive AI has the potential to react to changing barriers and modify its trajectory in real time. In order to create intelligent agents in video games, Singh emphasized the importance of combining pathfinding algorithms with decision-making logic. The study promotes the theory that AI could learn from its environment and forecast future events, which is pertinent to Snake AI. Accuracy, quickness, and flexibility were among the performance metrics that were highlighted. The outcomes support integrating AI into interactive educational materials. In general, the study links independent gamingtheory and practice.

Kumar (2021) et al. [12] examined modifying web games' user interfaces (UI), including themes, interactive panels, and speed control. Enhancing player engagement and providing greater customisation for the game experience were the goals of the study. User-friendly interfaces improve user satisfaction and allow players to adjust game settings according to their skill level and preferences, as demonstrated by Kumar. The study focused on design strategies for web-based gaming panels, interactive buttons, and dynamic information updates. One goal was to incorporate technology, such as event management and real-time rendering, with a straightforward layout. Demonstrating how UI elements affect usability and gaming perception was the main contribution.In browser-based games like Snake, control accessibility and visual feedback are crucial, therefore this study is particularly relevant. It mixes UI design with interactive game dynamics to provide the greatest possible user experience.

Table 1 Shows Comparative Review Of Fruit Sorting Machine Based On Weight.

Author(s) & Year	**Objective**	**Method/ Algorithm Used**	**Focus Area**	**Key Contribution**	**Relevance to Snake Game AI**
Chen et al. (2025)	Compare ML models for car price prediction	KNN, Decision Tree, Linear Regression	Predictive Modeling (Cars)	Highlights importance of model selection & efficiency	Reinforces the value of algorithm choice in real-time AI systems like pathfinding in Snake
Harris et al. (2023)	Demonstrate AI pathfinding in browser-based Snake game	Grid-based movement, Obstacle Avoidance	Browser Game AI Implementation	Showed how pathfinding works in real-time environments	Provides practical application of pathfinding logic in online Snake gameplay
Parsons et al. (2022)	Develop dynamic autopilot for	Autonomous Navigation	Adaptive Movement Strategies	Demonstrated AI adapting movement to	Critical for route optimization and real-time strategy

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	Snake			game-state changes	adjustment in Snake
Johar (2021)	Show reinforcement learning's role in Snake AI	Reinforcement Learning	Adaptive AI in Games	AI adapts to environment, learns optimal paths for reward collection	Demonstrates how Snake AI can self-improve through learning from experience
Zhou (2021)	Use RL for reward-based learning in Snake	Reinforcement Learning	Reward-based Pathfinding	Enabled intelligent gameplay through dynamic learning	Reinforces potential of RL in creating self-governing Snake agents
Schoberg (2019)	Integrate AI into classic Snake for efficient play	Heuristic-based, Rule-driven Logic	Gameplay Strategy	Collision avoidance, food prioritization, foresight strategies	Introduces simple but effective AI strategies
Kharrufa (2021)	Enhance AI via grid-based pathfinding and risk management	A*, Dijkstra's Algorithm	Pathfinding in Constrained Space	Showed score-based path evaluation and strategic risk-reward trade-offs	Relevant for designing strategic AI in Snake that handles tail and walls intelligently
Mase (2021)	Demonstrate AI adaptability to dynamic game states in real time	A* Algorithm, Visualization Techniques	Real-Time AI & Visualization	Showed how AI recalculates paths and responds visually to dynamic conditions	Supports real-time adaptive Snake AI and educational visualization
Patel (2020)	Build interactive browser-based games using web technologies	HTML5, CSS, JavaScript Canvas	UI & Game Engine	Explained canvas rendering, user interaction, and game logic synchronization	Offers technical base for integrating AI in browser-based Snake games
Li (2019)	Compare BFS, DFS, and A* in dynamic game scenarios	BFS, DFS, A*	Pathfinding Performance	A* shown as most balanced for speed & accuracy in dynamic conditions	Provides algorithmic insight for selecting best pathfinding technique for Snake
Singh (2022)	Use adaptive AI for obstacle handling and route optimization in arcade games	Adaptive Pathfinding & Decision Logic	Autonomous Navigation	Emphasized AI's ability to predict & adapt dynamically	Strongly supports dynamic AI behaviors in Snake, especially under changing game conditions
Kumar (2021)	Improve UI	UI/UX Design,	User	Highlighted	Ensures Snake game is

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	design for browser-based games	Dynamic Rendering	Experience in Games	impact of responsive design, interactive controls, and customization	playable and accessible, enabling better visualization of AI behavior

III. PROPOSED MODELLING

Figure 1 Shows That Block Diagram Of Flowchart Of Stock Price Prediction System

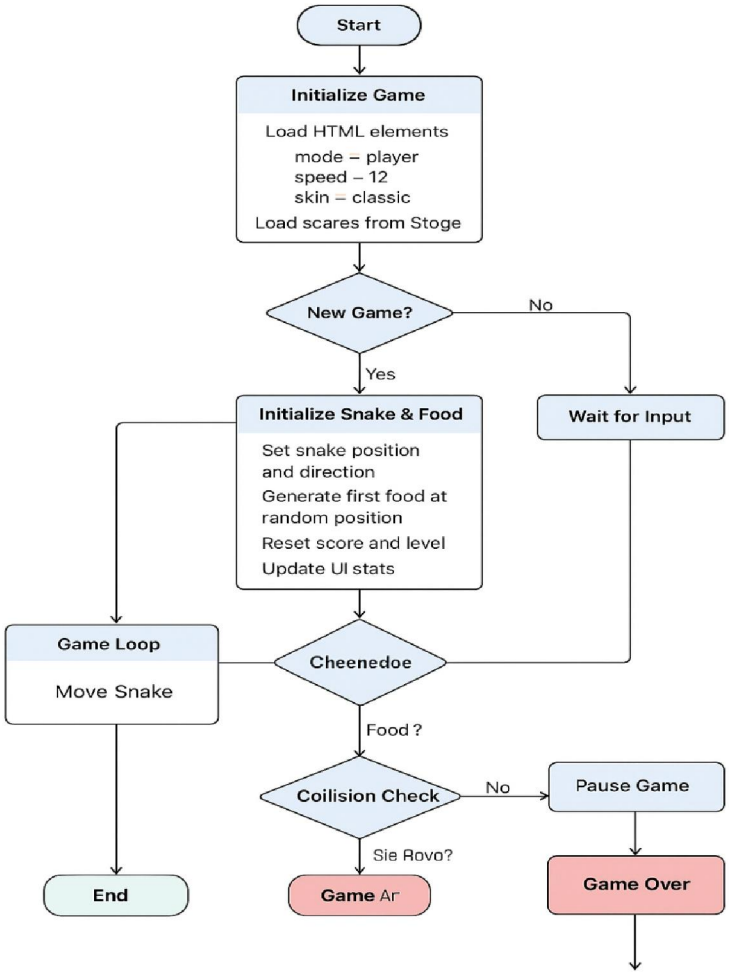

Figure 1 Block Diagram Of Flowchart Of Stock Price Prediction System

The flowchart for the Advanced Snake Game with AI Pathfinding shows the game's logical structure and progression from setup to the end of playtime. An enhanced version of the classic Snake game that enables autonomous gaming is created by integrating artificial intelligence through the use of A* pathfinding. Among the ways the flowchart depicts the interactions between various game elements are initialization, player or AI control, continuous repetition of game activities, collision detection, and game termination.

The first node in the flowchart is called Start, and it indicates when the game starts in a web browser. Upon starting the game, the player loads the HTML, CSS, and JavaScript files. These files include the index.html structure, style.css's visual styling, and the core functionality of app.js and ai.js. The availability of all necessary components is ensured at

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this step before the user interacts with the interface. The flow then proceeds to the Initialize Game step, when the resources are loaded and the game environment is first constructed. Throughout Initialize Game, the system performs several crucial functions.

First, JavaScript code is identified and connected to the required HTML elements, such as the canvas for rendering visuals, the control buttons for starting and ending the game, and the display regions for the level, score, and mode. This is also where the default parameters for the mode (Player), speed (12), and skin (Classic) are set. Additionally, the system retrieves the saved high score from the browser's local storage so that players can monitor their highest scores. At the end of initialization, when the game is ready, the system asks the user if they want to begin a new game.

Throughout Initialize Game, the system performs several crucial functions. Initially, the JavaScript code is identified and connected to the required HTML elements, such as the canvas for graphic rendering, the control buttons for starting and ending the game, and the display sections for the score, level, and mode. Additionally, default parameters for the skin (Classic), speed (12), and mode (Player) are specified at this stage. Additionally, the system takes the saved high score from the browser's local storage so that players can monitor their highest scores. When the game is ready and initialization is complete, the system asks the user if they want to begin a new game.

The Initialize Snake & Food phase resets all dynamic game elements upon game launch. Usually located in the center of the canvas, the snake is oriented and positioned based on its initial values. In order to prevent the initial food from overlapping into the snake's body, it is generated at random on the grid. The score and level counts are simultaneously reset, and the interface is changed to reflect the new values. The initialization phase ensures a stable performance and a clear state at the start of each gaming session. The Game Loop, the most important part of the game, is reached after this setup.

The main element of the Snake game is the Game Loop, which keeps running until a stopping condition is met, such as pausing or ending the game. This loop controls the snake in real time, including its movement, interactions with food, and collisions with objects. For every loop cycle, the system selects the snake's movement based on the active mode.

The choice for Check Mode indicates whether the player is controlling the snake or whether the AI mode is active. In "Player," the application waits for keyboard inputs, often the WASD or arrow keys, to adjust the snake's direction. If the mode is set to "AI," on the other hand, the system employs the A* pathfinding method, which is implemented in ai.js. The fastest and safest route to the food is determined by this algorithm by analyzing the game grid and treating obstacles like walls or the snake's own body as barriers. The snake can then play independently since the AI decides the course of its next step.

The Move Snake method adjusts the grid position of the snake after the direction has been determined. Each body segment moves to the position of the one preceding it as the head progresses one step in the current direction. If it has recently eaten, the snake expands because its tail stays still. Collision and Event Checking, the following area of the flowchart, is where the system evaluates various interactions. The first step is to do a food collision check. A new food item is made at a different random location, the snake grows longer, and if the snake's head position coincides with the food's location, the score increases. Furthermore, the snake becomes faster and more difficult as the level increases based on the score.

Self-collision or walls are the subject of the second important check. A collision event is detected by the game when the snake's head touches its own body or reaches the edge of the canvas. When the Game Over state is entered, the loop is instantly broken. In the absence of a collision, the loop continues as usual. The Render Canvas procedure is executed by the system following the checks, updating the visual representation of the game. Once the canvas has been cleared, new elements are drawn, including the food's location, the snake's current position, and any toggled active grids. The skin type of the snake (Classic, Neon, or Retro) dictates its color and pattern.

When the player has to pause for a while or throughout extended sessions, the pause feature is quite useful. The option to pause the game at any point while playing is represented by the Pause / Resume choice in the flowchart. Players can take a break without losing their progress when the pause command is used since it causes the game loop to momentarily stop, freezing all actions and movements. The game resumes from the same point in time when the player returns, giving the gamer more control and convenience.

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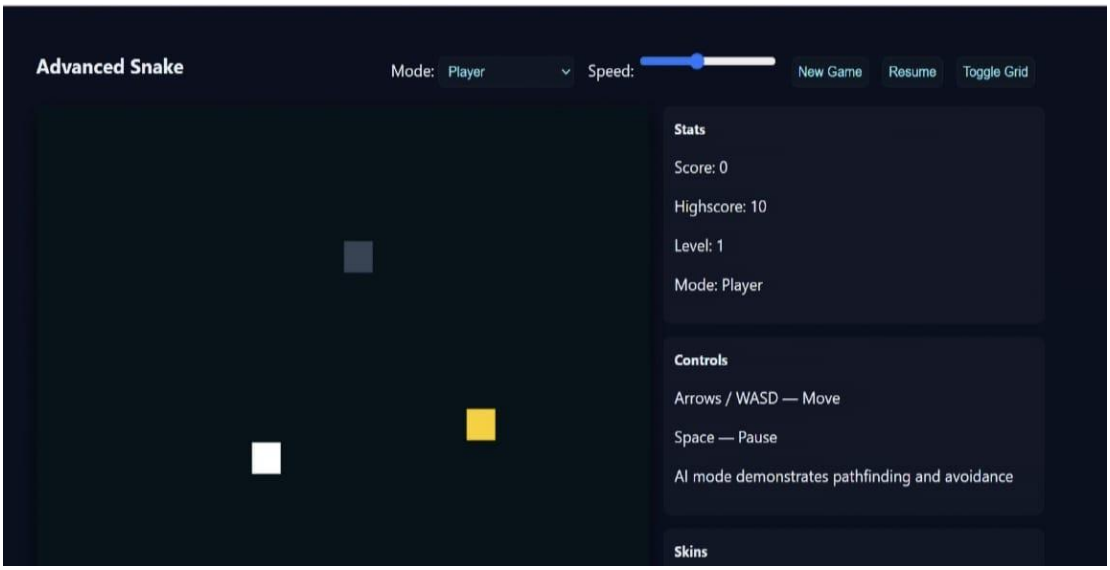
When a collision is detected, the system goes into the "Game Over" state. When the game loop is over, the player is greeted with the message "Game Over." The system calculates whether the current score is higher than the previously saved high score. If it does, the new value is stored locally and replaces the old record. During sessions, this permanent ranking system encourages users to improve their performance. After the game over event, there are two alternatives available to the player: either quit the game or pick "New Game," which restarts the flow to the beginning.

The final node in the flowchart is the End state. The current game session is either over or almost over. Even when the session is over, local storage ensures that achievements, including top scores, are saved for use in further games. Long after the game window has ended, this design gives the player a sense of accomplishment and continuity. The flowchart illustrates the Advanced Snake Game's logical structure and the balance between AI-driven automation, user participation, and system operations. It starts with initialization, progresses through real-time gaming controlled by the user or artificial intelligence, controls dynamic events like collisions and scoring, and concludes with termination.

The smooth transition between options and actions ensures consistent behavior and fluent gameplay. This project effectively combines the ideas of web-based interactive design and artificial intelligence by utilizing local data persistence, many skins and modes, and pathfinding intelligence. Thus, in addition to providing a technical synopsis of the Advanced Snake Game's logic, the flowchart provides a visual depiction of how each phase contributes to the overall functionality of the game.

IV. RESULT AND DISCUSSION



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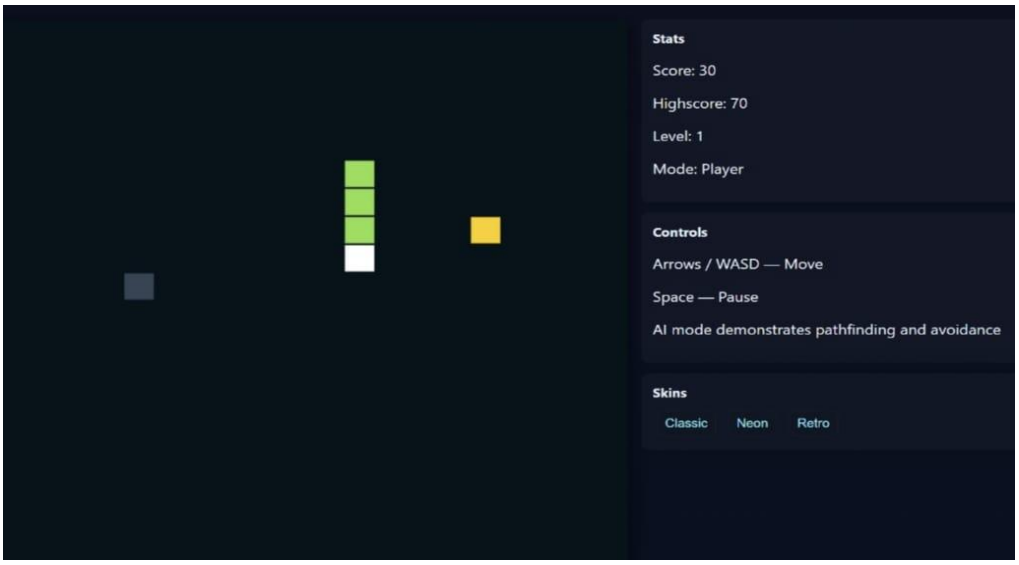

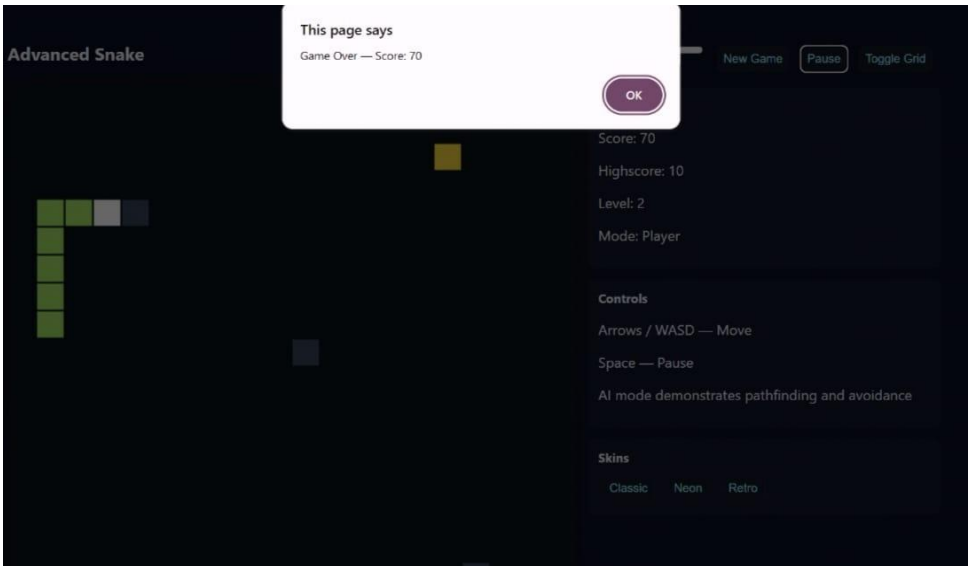

A responsive and engaging version of the traditional Snake game with contemporary improvements is demonstrated by the Advanced Snake system's gameplay outcomes. Three crucial phases of gameplay are shown in the screenshots: the beginning, middle, and end of the game. The game has an intuitive UI that shows important gaming metrics including Score, Highscore, Level, and Mode. A mode switch between player and AI is also included, along with user controls and skin customization possibilities.

A final score of 70 is shown in the game over prompt in the first image, indicating that the player (in Mode: Player) successfully traversed the environment to get a pretty high score before to termination, most likely as a result of a collision. The side panel shows the top score as 10, which is interesting. This mismatch could be the result of a glitch in the score persistence logic or the game not updating the high score in real-time. This outcome indicates that data synchronization between the game state and UI elements needs to be improved.

With a score of 30, level 1, and active movement in the direction of a food item (yellow block), the second graphic depicts a mid-game scenario. Effective use of real-time rendering and object tracking is confirmed by the snake's visual representation (white head, green body) and the obstacles' spatial layout (gray blocks). According to standard level

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progression mechanics, the snake's length increases and the available space gets more constrained, giving the impression that the game gets harder and harder. The grid-based design makes it easier to achieve the predictable movement that both manual and AI-controlled modes require.

The third picture shows the game in its starting stage, with the same player mode enabled and a score of 0. An adjustable gaming experience is suggested by the speed slider at the top. By enabling users to dynamically adjust the level of difficulty, this feature helps the system achieve its flexibility aim. The ability to switch between "Player" and possibly "AI" modes (as suggested by the AI control description) further illustrates the dual-mode capabilities, which allows for the testing of AI pathfinding and avoidance logic.

The game's control instructions (WASD or arrow keys for movement, space to pause) are clear from the standpoint of the user interface and gameplay, and the skins (Classic, Neon, Retro) are thoughtfully designed to improve visual attractiveness. The system offers intelligent navigation when AI is enabled, as indicated by the "AI mode demonstrates pathfinding and avoidance" function, which is not explicitly seen in the pictures. Obstacles, food items, and dynamic speed control provide the foundation for testing alternative AI algorithms, such as A*, Dijkstra's, or reinforcement learning techniques, under varied limitations.

Regarding system responsiveness, the game seems to manage updates and movement in real-time with negligible latency, which is essential for preserving fluid gameplay. Visual feedback, like the game-over popup, improves the user experience by displaying the final score and explicitly signaling the end of a session.

In conclusion, the game skillfully combines modular AI demonstration capabilities with an engaging player world. In addition to adjusting speed and observing how various algorithms might perform in pathfinding and obstacle avoidance, the user can alternate between manual control and AI mode. Although there are some minor glitches, such as the top score not updating properly, which point to areas that need technical work, the game provides a solid foundation for testing AI tactics in grid-based settings. This technology facilitates academic study on AI-controlled agent behavior and adaptive game design as well as leisure gaming.

V. CONCLUSION

An excellent example of combining modern artificial intelligence methods with classic arcade games is the Advanced Snake Game project. The system's combination of Player Mode and AI Mode illustrates the value of the A* (A-star) pathfinding algorithm in real-time decision-making while also providing users with an engaging interactive experience. The AI-controlled snake successfully determines the optimal pathways, avoids obstacles, and gets to the goal food by itself, demonstrating intellectual behavior similar to that of human gamers.

The project additionally emphasizes the use of web technologies such as HTML5, CSS, and JavaScript, which enable it to be responsive, lightweight, and accessible through a browser without requiring additional installs. With its many skins, adjustable speed controls, and user-friendly interface, the entire user experience is enhanced. The game also introduces features like dynamic canvas rendering, pause/resume capabilities, and local storage for high scores, which combine technical innovation with simplicity in a harmonious way.

In conclusion, this project effectively achieves its objectives of combining web development, artificial intelligence training, and entertainment. It demonstrates how innovative algorithms and programming approaches could revive the allure of classic games. The Advanced Snake Game is therefore a practical example of how to incorporate AI pathfinding, web-based game design, and user interaction into a single, cohesive system. Upcoming enhancements like more complex AI learning models, multiplayer capabilities, or adjustable difficulty could further expand the possibilities of this imaginative project.

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2. Harris, S. (2023) developed a browser-based Snake game with AI pathfinding, demonstrating grid-based movement and obstacle avoidance.
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