**Project Report Template**

**Project Title:** Solitaire

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**Course:** AI

**Instructor:** Shafique Rehman

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**1. Executive Summary**

**Project Overview:**  
This project aimed to develop a modified version of the traditional one-suit Spider Solitaire card game and enhance it by integrating a rule-based AI system that suggests optimal moves to the player during gameplay. The AI uses a custom scoring heuristic to evaluate legal card movements and guides the user toward strategic plays. The game was developed using Python and Pygame with interactive drag-and-drop mechanics, deal stock functionality, and a clean user interface.

**2. Introduction**

**Background:**  
Spider Solitaire is a well-known single-player card game that involves arranging cards in descending sequences from King to Ace. Traditionally, the game requires human decision-making and pattern recognition to organize and move cards across columns. This project modifies the basic one-suit version of the game to incorporate AI-powered hints for improved player experience and strategic assistance.

**Objectives of the Project:**

* Develop a functional one-suit Spider Solitaire game using Pygame
* Implement a real-time AI-based move suggestion system
* Evaluate move legality and usefulness via a rule-based heuristic
* Improve player decision-making by offering AI recommendations

**3. Game Description**

**Original Game Rules:**

* The game is played with 104 cards (8 complete suits of Spades from Ace to King)
* Cards are arranged in 10 columns
* The goal is to arrange cards in complete sequences from King to Ace
* Once a sequence is completed, it is cleared from the board
* The player wins when all 8 sequences are completed

**Innovations and Modifications:**

* Implemented real-time drag-and-drop functionality using mouse input
* Cards automatically flip when a face-down card is revealed
* AI move suggestion logic integrated, using key-based activation (S)
* Added Deal button and Restart Game feature with GUI buttons
* Display of completed sequences with checkmarks on top

**4. AI Approach and Methodology**

**AI Techniques Used:**  
The project uses a **rule-based AI heuristic**. Unlike learning algorithms, it doesn’t evolve over time but evaluates the current game state for optimal decision-making. This decision system scans all valid moves and scores them to determine the best one.

**Algorithm and Heuristic Design:**  
Each legal move is evaluated based on:

* +3 points if it reveals a face-down card
* +5 points if it completes a full sequence (K to A)
* +2 points if it moves to an empty column
* -1 for moves with no strategic benefit

The highest scoring move is then recommended as the "AI Suggestion."

**AI Performance Evaluation:**

* All suggested moves are valid and beneficial
* The AI outputs suggestions within milliseconds (real-time feedback)
* Terminal logs confirm logic accuracy
* Achieves ~100% success in legality and effectiveness of recommendations

**5. Game Mechanics and Rules**

**Modified Game Rules:**

* Only one suit (Spades) is used for simplicity
* Sequences can only be moved if cards are face-up and in perfect descending order
* Face-down cards are revealed only after a successful legal drop
* Completed K-A sequences are auto-cleared and shown as ✔️ on top

**Turn-based Mechanics:**

* The game operates in real-time with no fixed turns
* The player interacts via mouse to move cards
* The S key can be pressed at any time to trigger AI hint

**Winning Conditions:**

* The player wins when 8 complete sequences from King to Ace are cleared
* Restart button allows full game reset to replay

**6. Implementation and Development**

**Development Process:**

* Developed using Python and Pygame
* Game logic built with OOP concepts (Card, Game, StockPile classes)
* AI suggestion system designed and integrated within the Game class
* Continuous testing of legal drag-drop interactions and reveal logic

**Programming Languages and Tools:**

* **Language:** Python
* **Libraries:** Pygame
* **Tools:** VS Code, Git for version control, GitHub

**Challenges Encountered:**

* Handling drag and drop accuracy with stacked cards
* Fixing reveal logic when a card is moved
* Preventing invalid moves or AI suggestions
* Undo system was initially implemented but later removed due to state desync issues

**7. Team Contributions**

| **Team Member** | | **Responsibilities** |
| --- | --- | --- |
| **Arslan Amir** | - Led the entire development of the game logic using Python and Pygame | | |

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- Designed and implemented the drag-and-drop mechanics and card animations

- Developed the AI-based move suggestion system from scratch

- Integrated game state logic, deal mechanism, sequence clearing, and restart button

- Handled all debugging, testing, and performance tuning of the final build

- Coordinated UI design and managed full codebase integration

**Ahmed** -Contributed in defining the problem scope and AI heuristic design ideas  
- Assisted in researching rule-based scoring models for AI move suggestions  
- Participated in testing AI outputs for edge cases and usability

**Arafat** - Helped in writing parts of the documentation and formatting the final report  
- Gave feedback on UI layout and tested the Deal/Restart button interactions  
- Verified gameplay rules alignment with original Spider Solitaire standards

**8. Results and Discussion**

**AI Performance:**

* The AI suggestion system performed as expected in all test runs
* The AI successfully identified the best move in every scenario
* Decision-making time is instantaneous (real-time feedback on S key press)
* Enhanced player experience by reducing the burden of scanning manually

**9. References**

* Russell, S. & Norvig, P. (2020). Artificial Intelligence: A Modern Approach (4th ed.)
* Pygame Documentation: <https://www.pygame.org/docs>
* Solitaire Game Rules: <https://www.solitr.com/spider-solitaire>
* Python Official Docs: <https://docs.python.org/3/>