Artificial Intelligence for the Card Game Durak

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Introduction:

Durak is a two-player card game that starts by dealing cards to each player until they have a hand of six cards. The final card of the deck is then placed face up to determine the trump suit for the game. The gameplay consists of a series of bouts where the attacker begins by placing a card, and the defender may attempt to beat it by playing a card of their own. After that, the attacker can continue the attack or end it, and the defender can continue to defend or pick up the cards. The winner of each bout becomes the attacker for the next bout. The aim of the game is to get rid of all one's cards. The goal of this work was to develop various AI players for the game and compare their performance.

Framework and Selected Technology:

The game is implemented in C# for .NET 6. It includes a command-line interface with options for running experiments between AI players.

Artificial Intelligence Agents

"The project features five distinct agents:

- **Random**: makes random moves without considering the game state.

- Rule-based agents:
  - **Greedy**: makes moves by selecting the lowest value cards.
  - **Smart**: uses strategies that take into consideration the opponent's hand.

- **Minimax**: a game-theoretic algorithm that evaluates the best move based on the minimax principle. It uses two heuristics to evaluate the state:
  -Basic, which is a traditional approach using the game state.
  -Playout, which generates a copy of the game state and plays out the remainder of the game.

- **MCTS (Monte Carlo Tree Search)**: an algorithm that uses simulated playouts of a game to estimate the value of each possible move.

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Github:

Results:

Open-world:

In this environment, players have complete knowedge of the game state and can see all the cards. The MCTS agent was the strongest, followed by the minimax and smart agents.

	random	greedy	smart	minimax	MCTS
random		8.5% ∓ 2.9%	5.7% ∓ 2.4%	2.9% ∓ 1.7%	0.5% ∓ 0.5%
greedy	91.5% ∓ 2.8%		47.8% ∓ 2.1%	38.5% ∓ 5%	2.7% ∓ 1.1%
smart	94.3% ∓ 2.3%	52.2% ∓ 2.1%		2.9% ∓ 1.7%	5% ∓ 2.2%
minimax	97.1% ∓ 1.7%	61.4% ∓ 5%	60.1% ∓ 5.1%		20.6% ∓ 4.2%
MCTS	99.45% ∓ 0.5%	97.2% ∓ 1.6%	95% ∓ 2%	79.4% ∓ 4.2%	

Win rates between agents in the open world (98% confidence intervals)

Closed-world:

Unlike open-world, players do not have complete information about the game state and can only see certain elements such as their own cards and the trump card. The MCTS agent was the strongest, followed by the smart and minimax agents.

	random	greedy	smart	minimax	MCTS
random		8.4% ∓ 2.8%	6.2% ∓ 2.4%	6.9% ∓ 4.3%	1.5% ∓ 1.1%
greedy	91.5% ∓ 2.8%		50.6% ∓ 1.2%	47.4% ∓ 1.7%	19% ∓ 4.1%
smart	93.7% ∓ 2.4%	49.3% ∓ 1.2%		53.8% ∓ 3.7%	26.9% ∓ 4.7%
minimax	93.1% ∓ 2.6%	52.5% ∓ 1.7%	46.2% ∓ 3.7%		16.7% ∓ 3.8%
MCTS	98.4% ∓ 1.1%	80.9% ∓ 4.1%	73.1% ∓ 4.7%	82.8% ∓ 4.4%	

Win rates between agents in the open world (98% confidence intervals)

Conclusion:

This study developed an AI framework for the card game Durak and tested various agents such as Minimax, Rule-Based, and MCTS. The MCTS agent consistently outperformed the others in both perfect and imperfect information versions of the game.