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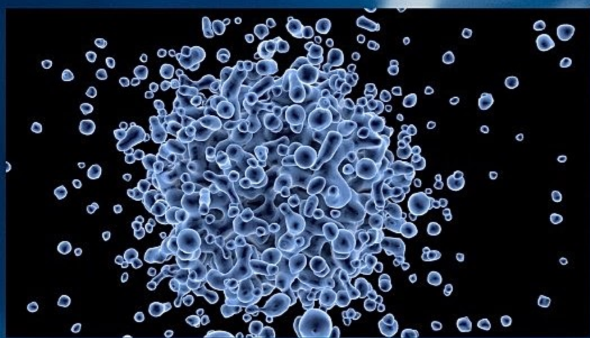

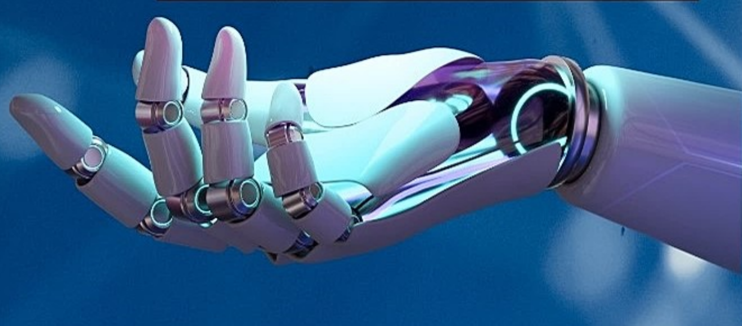

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Research Article

Analyzing Game Strategies of the Don't Get Angry Board Game Using Computer Simulations

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Abstract **–** In the research described in this paper, we used computer simulations to analyze and compare different types of game strategies in the popular board game Don't Get Angry. Following a brief introduction, we summarized a few previous research papers examining similar board games' game strategies. Next, after a review of the Don't Get Angry game's official rules, we outlined four strategies that can be applied to increase the likelihood of winning. We simulated 50,000 games in which all four players made their moves randomly and 50,000 games where each used a different strategy. We tracked how frequently each player finished first, second, third, or last during the simulations. Furthermore, we recorded how many rounds were needed to complete the game for each player, how many times the players' pawns were kicked out and returned to their houses by other players, and the number of players' remaining steps during every gameplay. From the analysis of the recorded data, we could conclude that significant differences exist in the chances of winning the game for the examined strategies when all players use different strategies. The results improve the specific domain knowledge for the Don't Get Angry board game. It may help create more vigorous computer opponents and encourage further study to create a tool for evaluating students' strategic thinking while playing.

Keywords – Don't Get Angry, Ludo, Board Game, Game Strategy, Computer Simulations

I. Introduction

Gamification and various computer and mobile educational games have been popular recently. Carefully chosen or designed games can motivate students and improve their memories, language learning, mathematical thinking, strategic thinking, and many other skills [1]–[13]. Classical board games are not exempt from this paradigm; they can also be effectively used in education [9]–[13] or as occupational therapy for decreasing hyperactivity, impulsivity, and inattention in children with attention deficit and hyperactivity disorder [14]. Winning in many classical board games usually depends on the randomness (dice roll) and the players' strategic thinking skills. One of the classical board games for 2–4 players, famous in many countries, is Don't Get Angry. The game originates from Germany, developed by Josep Friedrich Schmidt in the winter months of the turn of 1907/1908. Schmidt was inspired by the Indian game Pachisi and the English game Ludo. The game has been serially produced since 1914 and has sold more than 60 million times [15][16]. The Ludo, Pachisi, and Don't Get Angry board games are very similar; the players can use similar strategies to get more chances of winning the games.

In the following sections, first, we briefly overview several research papers that deal with the game strategies of Ludo and similar board games. Next, we summarize the official rules of the Don’t Get Angry board game and outline some basic strategies that might increase the chance of winning. These game strategies could be helpful in the implementation of similar board games with computer opponents. Usually, developing mathematical models makes comparing different game strategies more difficult. However, using computer simulations may make comparing strategies easier and more effective. Thus, we used computer simulations to analyze, compare, and examine our four game strategies.

II. Literature Survey

We have not found research papers that specifically deal with the Don’t Get Angry board game's game strategy. However, we can find several prior research papers dealing with other variants of this board game, especially with Ludo. Because the rules of the Ludo, Don’t Get Angry, Parchisi and other variants of the board game are very similar, players' strategies are similar too.

Previous studies [17]–[19] have shown us various kinds of strategies for these board games: (1) random strategy, where the player randomly chooses his piece to move, (2) aggressive strategy, when the player knocks out the opponents’ pieces whenever possible, (3) defensive strategy, when the player tries to defend his pieces against the attack from opponents, (4) fast-playing strategy, when the player always selects the piece that is closer to the finish, (5) mixed strategy, when the player combines the previous strategies according to the current state of the gameplay or his intuition.

Sarankirthik et al. [17] developed a modified version of the Ludo board game, where two dice were used instead of one, and the game was enriched with quiz questions. After examining aggressive, defensive, and fast-playing strategies, they concluded that the defensive strategy outperformed the other two regarding win percentage.

In their research, Alvi and Ahmed [18] calculated the state-space complexity of the Ludo game and compared it with the state complexity of other classical board games. Popular board games have state complexity values of 10^{50} for Chess, 10^{28} for Othello, 10^{20} for Backgammon, and 10^{18} for Checkers. In contrast, Ludo has a state complexity of 10^{22}, indicating that it cannot be solved with the available computational resources [18]. Alvi and Ahmed also examined aggressive, defensive, and fast-playing strategies for the board game Ludo, concluding that the defensive strategy performed better. Additionally, they defined a mixed strategy that outperformed the others.

Davoudian and Nagabhushan [19] focused on the Indian Cowry board game in their research. They defined and compared five strategies: random, fast, balanced (hybrid), aggressive, and defensive game strategy. They started by contrasting each strategy with the random strategy used by three players. The best results were obtained by the defensive strategy (83% wins) and the aggressive strategy (76% wins). When they compared all the strategies against one another, the defensive strategy won 38% of the games, and the aggressive strategy won 33%.

III. Game Rules and Strategies

The Don’t Get Angry game is played on a game board (see Fig. 1) with pawns and dice. In the beginning, every player has four pawns in the house (four color positions in squares in the corner of the game board). The game's goal is to get all pawns from the house to the finish (four color positions in the form of lines), while every pawn must go around on all game fields before reaching the finish. The number of fields to pass is determined by rolling a dice. If a six is rolled, the player can repeat the roll and move forward by the rolling sum. When the player gets to a field occupied by the opponent's pawn, he must kick it out and send the opponent’s pawn back to its house [15].

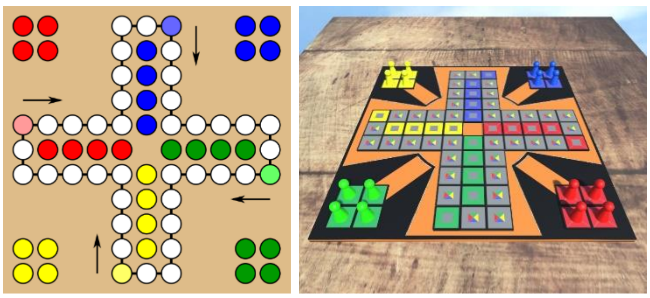

Fig. 1 Game boards of the Don’t Get Angry Game [15][20]

The game's official rules had stayed the same since 1914, when it was published. However, many home variations of the rules were developed by players over the years [15][16]. The official rules are the following. When six is rolled, the player must place one of the pawns from the house to the starting field (marked with the brighter color of the player). Then, the player must roll the dice again and advance the given number of fields with the pawn. The starting field must be cleared as soon as possible. However, if the player has no pawn in the house, he advances the given number of fields with the pawn of his choice. If the player is in front of his finish line and needs to throw a single number to win, and the player rolls the number six, he can throw one more time. He wins when he rolls the needed number and places the last pawn into the finish line. If, while the player moves around the playing fields, a pawn gets onto the field occupied by an opponent's pawn, the opponent's pawn must return to the house. The player cannot kick out his own pawn, and the move is unplayable if his own pawn occupies the target field. If the player has more pawns in circulation, he can decide which one to draw. A dice roll in one round by one player cannot be divided between more pawns. If a player has no pawn on the playing field (which applies to every player at the beginning of the game), he rolls three times in the given round until he puts his pawn into play and then follows the game's rules [15].

In the following subsections, we defined four strategies that might increase the chance of winning this board game. These strategies were used in computer simulations of gameplays for later analysis.

A. *First strategy: Random selection of movements (random strategy)*

In this strategy, when the player needs to choose a movement, he randomly selects one of the possible pawns to draw. Even though this is probably the worst strategy a player might follow in this board game, we defined it for a simple reason: we wanted to compare this random selection of the movements with our other strategies and see how the other strategies can increase the chance of winning.

B. *Second strategy: Moving mainly with the same pawn at once (fast-playing strategy)*

The thought of this strategy is the following. If a player tries to go around the playing field with the same pawn at once, his moving pawn will probably get a few times kicked out because his pawn will spend less time on the playing field. However, during this time, the player's other pawns waiting near the starting field might be kicked out many times, but it's not as much loss as they would be kicked out in the middle of the playing field or before the finish line. When the player cannot move with the pawn near the finish, he will move with a pawn inside the finish line (if possible) or with his other randomly selected pawn.

C. *Third strategy: Increasing the distance from the opponents' pawns (defensive strategy)*

In this strategy, first, the player calculates the distances between his pawns and the opponents' pawns behind them that endanger them. Next, he estimates the distances between the fields where his pawns might get with the rolled steps and the opponents' pawns behind them that threaten them. The player chooses the pawn where the difference of the distances is the largest, i.e., where he can increase the distance from the opponents' pawns behind him the most. If the player cannot move with any pawn in the playing field, he tries to proceed with a pawn inside the finish line.

D. *Fourth strategy: Kicking off the opponents' pawns always, when possible, otherwise moving mainly with the same pawn at once (aggressive & fast-playing strategy)*

After comparing the previous two game strategies with computer simulations, we examined whether the second strategy (fast-playing strategy) described in subsection III.B is better than the third strategy (defensive strategy) described in subsection III.C. Because the second strategy (fast-playing strategy) was better, we decided to try to improve our second strategy. In this fourth strategy, the player checks if his pawns can kick out opponents' pawns. If there is such a movement, he kicks out the opponent's pawn (if there are more possibilities, he randomly chooses one of them). When there is no opportunity to send any of the opponents' pawns to their house, the player follows our second game strategy described in subsection III.B and always chooses the pawn closest to the finish line.

IV. Computer Simulations of Gameplays

Computer simulations are commonly utilized in research and education as a substitute for real-life experimentation when conducting experiments is impractical due to safety concerns, the need for many experiments, costly or time-consuming experiments, or when mathematical modeling of a designed system is not feasible [21]–[26]. In the research described in this paper, we simulated 50,000 - 50,000 gameplays of the Don't Get Angry board game to analyze different game strategies. First, we simulated 50,000 gameplays where all four players used the same and the simplest strategy, our first strategy described in subsection III.A (random strategy). Next, we executed a computer simulation of 50,000 gameplays, where each player used a different game strategy; this article described the four strategies in subsections III.A–III.D. All the simulations were run in MATLAB, version R2023a Update 4.

V. Simulations Results

During the computer simulations, we recorded how often the players finished in the first, second, third, or last places. Moreover, we recorded how many rounds were needed to complete the game for each player and how many times the players were kicked out and returned to their houses by other players. We also recorded the number of players' remaining steps during every gameplay. Next, we evaluated the recorded data and analyzed the game strategies. Our findings are summarized in the following subsections.

A. *All players used the same strategy: Random selection of movements*

In the first computer simulation of 50,000 gameplays, all players used the game strategy described in subsection III.A (random strategy). When all four players use the same strategy, the chance of winning the game is equal for all players. The simulation results supported this; the first, second, third, and fourth place was evenly distributed among players. The computer simulation results showed that every player's chance of finishing in every position was between 24.62% and 25.53%, i.e., around 25%.

The minimum number of rounds needed to finish the game was 33, and the maximum number to complete the game was 285. The mean number of rounds was around 116.8, while the standard deviation was around 28.5 (see Table 1).

Table 1. Descriptive statistics on the number of rounds needed to finish the game (N = 50,000)

	Player 1	Player 2	Player 3	Player 4
Minimum:	33	33	37	38
Maximum:	280	280	263	285
Mean:	116.64	116.98	116.89	116.76
Std. Dev.:	28.646	28.541	28.434	28.572

Fig. 2 shows the mean number of total remaining steps on the game field (including the finish line) needed to finish the game during the gameplay. The figure shows only one plot instead of four plots (one plot for every player) since the players' plots are completely overlayed.

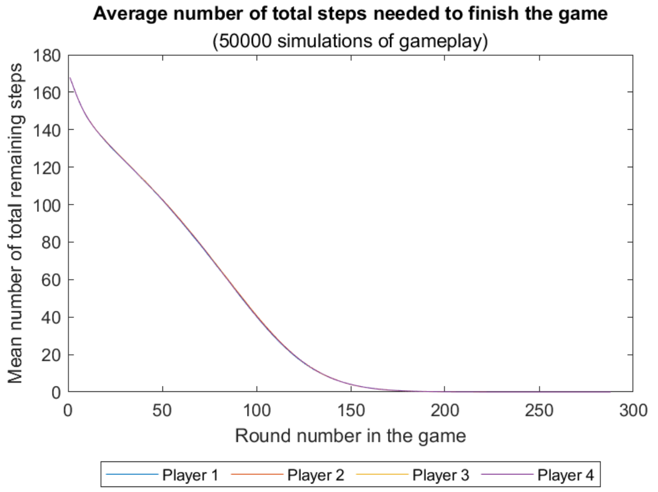

Fig. 2 Average number of total steps needed to finish the game

Because the game contains 40 fields (4*40 steps for all four pawns) and the finish line consists of 4 fields (4+3+2+1 steps for all four pawns), the total number of steps needed at the beginning of the game is 4*40+4+3+2+1=170. We can see in Fig. 2 that this number decreases during the gameplay. However, the decrease is not linear because the players kick each other's pawns out in some parts of the gameplay more frequently than in others. E.g., the players cannot kick each other's pawns out at the beginning of the game or when there are only a few pawns on the gameboard far from each other.

Table 2 shows how often players' pawns were returned to their houses during the gameplay. As we can examine, there were cases where none of the player's pawns were kicked out by the opponents during the whole gameplay (minimum: 0). The maximum number of returns during one gameplay was 43. The mean number of returns is around 10.7, while the standard deviation is about 4.9.

Table 2. Descriptive statistics on the number of returns to houses (N = 50,000)

	Player 1	Player 2	Player 3	Player 4
Minimum:	0	0	0	0
Maximum:	40	43	41	40
Mean:	10.73	10.78	10.75	10.74
Std. Dev.:	4.918	4.910	4.850	4.893

Fig. 3 shows the mean number of players' returns to houses during the gameplay. We can see on the figure that players' pawns were kicked out mainly around the 25th round of the gameplay.

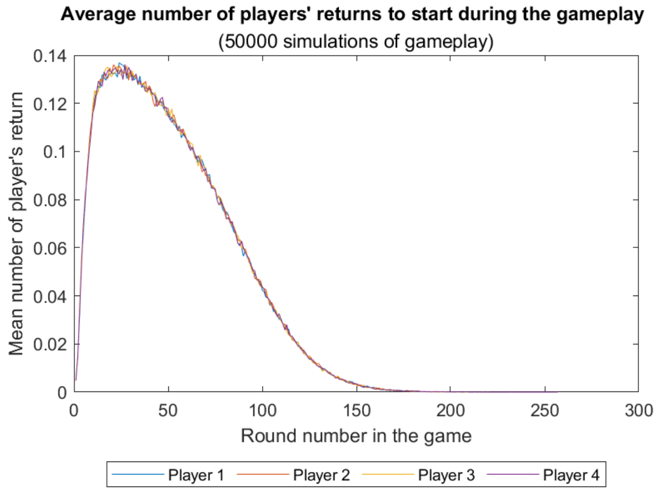

Fig. 3 Average number of players' returns to houses during the gameplay

B. *Each player used a different game strategy*

After computer simulations, where all four players used the same game strategy, we simulated 50,000 games in which each player used a different strategy. These strategies were described in subsections of section III. The computer simulation results showed that the chance of finishing in the first, second, fourth, or last place was significantly different for every player's strategy (see Fig. 4). As we can see from the bar chart, our fourth strategy (aggressive & fast-playing strategy used by Player 4) is the best of all our strategies. If Player 4 plays against players using our first, second, and third strategy, Player 4 has a 38.2% chance of winning the game and only a 12.8% chance of finishing in last place. We can also observe that if Player 1, using our first strategy, plays against players using our second, third, and fourth strategy instead of players using the same strategy (discussed in the previous subsection), the possibility of Player 1 winning the game drastically decreases from 25% to 9.7%, and the chance of finishing in last place excessively increases from 25% to 45.4%.

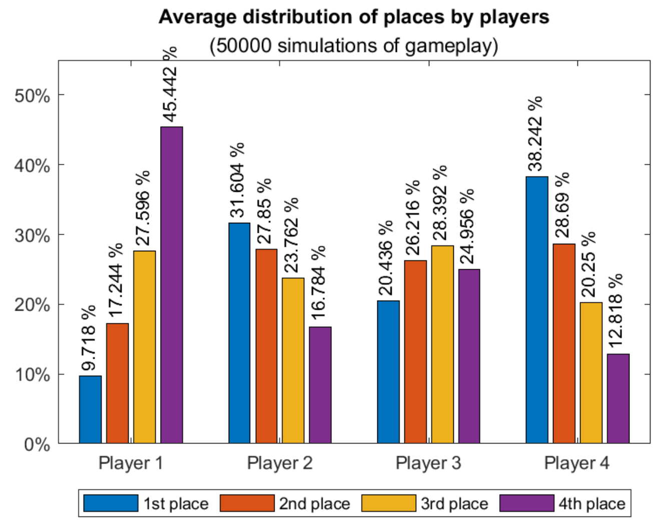

Fig. 4 Average distribution of 1st (winner), 2nd, 3rd, and 4th place in the game by players

Table 3 shows descriptive statistics on the number of rounds needed to finish the game for each player.

Table 3. Descriptive statistics on the number of rounds needed to finish the game (N = 50,000)

	Player 1 (First strategy)	Player 2 (Second strategy)	Player 3 (Third strategy)	Player 4 (Fourth strategy)
Minimum:	34	30	35	34
Maximum:	228	207	228	208
Mean:	112.99	98.45	104.22	95.48
Std. Dev.:	23.613	24.010	23.793	23.913

By observing Table 3, we can see that the minimum number of rounds is 30, and the maximum is 228. For our best strategy (Player 4), the mean number of rounds to finish the game is 95.48, and the standard deviation is 23.913. Comparing the results of Player 1 with the results in Table 1, we can observe that the mean number of rounds needed to finish the game decreased when Player 1 had opponents with better strategies from 116.64 to 112.99, and the standard deviation decreased to 23.613.

Fig. 5 illustrates the mean number of total steps needed to finish the game during the gameplay. We can observe from the figure that there are considerably different plots for different strategies. We got the "flattest" plot for Player 4 (our best strategy) and the "humped" plot for Player 1 (our worst strategy). If we compare the plot for Player 1 in this figure with the plot in Fig. 2, we can observe that even the plot for the same strategy (our first strategy) is different. The reason for the more "humped" plot in Fig. 2 could be that Player 1 got more times kicked out by his opponents during the first part of the gameplay in the latter computer simulations, where the opponents used different, better strategies.

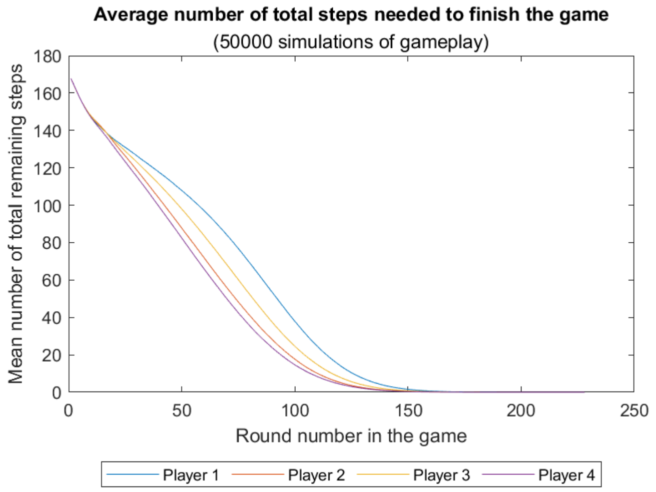

Fig. 5 Average number of total steps needed to finish the game

Table 4 shows how often players' pawns were returned to their houses by kicking them out by opponents. As we can examine, there were cases where none of the player's pawns were kicked out by the opponents during the whole gameplay (minimum: 0). The maximum number of returns during one gameplay was between 31–37. The mean number of returns for Player 4 (our best strategy) is 7.88, and the standard deviation is 3.804. For Player 1 (our worst strategy), the mean number of returns is 10.52, and the standard deviation is 4.370.

Table 4. Descriptive statistics on the number of returns to houses (N = 50,000)

	Player 1 (First strategy)	Player 2 (Second strategy)	Player 3 (Third strategy)	Player 4 (Fourth strategy)
Minimum:	0	0	0	0
Maximum:	33	31	37	36
Mean:	10.52	8.48	9.06	7.88
Std. Dev.:	4.370	3.910	4.071	3.804

Fig. 6 illustrates when players' pawns were mainly returned to their houses during the gameplay. The four plots in the figure show that all four players' pawns were mainly kicked out by other players in the first part of the gameplay, between the 10th and 50th rounds. We can also see that, except at the very beginning of the gameplay, the pawns of Player 1 (our worst strategy) were returned to start the most times, while the pawns of Player 4 (our best strategy) were kicked out less frequently.

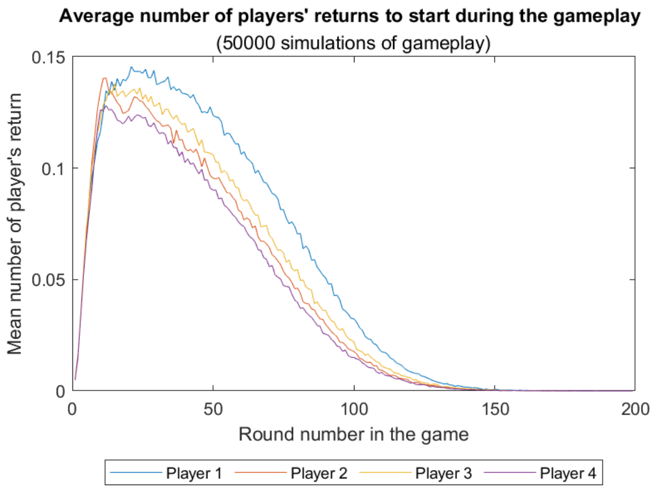

Fig. 6 Average number of players' returns to houses during the gameplay

VI. Discussion

After comparing the results of the simulations with the results described in similar research papers [17]–[19], we can notice an interesting point. In board games like Ludo and Cowry, the defensive strategy outperformed the fast-playing strategy. But in the board game Don't Get Angry, the fast-playing strategy outperformed the defensive strategy. We believe that a different rule in the Don't Get Angry game may impact the outcome despite the possibility of minor variations in how the defensive strategies are implemented in the games. When a player rolls a six on the dice in a Ludo board game, he has two options: move forward with any of his pawns or insert a pawn from the house. However, in the official rules of the game Don't Get Angry, each time a player rolls a six and has any pawn in his house, he must add a pawn to the game field. This might result in the fact that all players have many pawns in the game field, so the player cannot effectively defend himself from the opponents because there is no space to escape. Here, the fast-playing approach is more effective than the defensive strategy.

VII. Conclusions and Future Work

In this paper, after a short literature review, we used computer simulations to analyze various strategies of a classical board game. Based on the recorded data analysis, it can be concluded that the examined strategies have varying chances of winning. However, we do not need to forget that even our best strategy is only an average or worse if other players use the same or better strategy or they have more luck. Even though our strategies analyzed in this paper might increase the chance of winning in some situations, there is no winning strategy in this board game; the players must observe every step of the actual gameplay, rely on their luck and intuitions, and combine the already known strategies.

The results of using computer simulations could be valuable in creating efficient computer opponents for this and similar board games. Furthermore, the results could also be used in developing software to analyze students' strategic abilities during gameplay.

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