

On a 4×4 Othello Board, the Move That Flips the Most Is a Best Move in Only a Little Over Half of the Positions

— of the **22191** positions with two or more moves, the move flipping the most discs is one of the best moves in **12030**, a share of **0.542112** — the separator is whether one asks about the discs flipped by one move or the disc difference left at the end — [Paper 886]

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Abstract

In Othello, a move that flips many discs looks like a good move. This paper counts, on a 4×4 board that can be solved, how often the move flipping the most coincides with a best move, over every position. No new theorem or law is claimed. First, 4×4 Othello can be solved: **58533** positions were examined, and with best play on both sides Black, moving first, loses by -8 (Section 2). Second, and this is the core. The move flipping the most is best only a little over half the time: of the **22191** positions with two or more moves, it is one of the best moves in **12030**, a share of **0.542112** (Section 3). Third, the solving side beats the flipping side: with Black solving and White flipping the most, Black, who loses by -8 under best play, wins by $+2$ (Section 3). Fourth, the flipping side loses even more to the solving side: with Black flipping the most and White solving, Black loses by -9 ; with both flipping the most, by -6 (Section 3). Fifth, the solution matches play: playing both sides by the solution gave -8 , matching the solved value (Section 2). Sixth, the separator is whether one asks about the discs flipped by one move or the disc difference left at the end: flipped discs can be flipped back, so flipping many in one move does not promise the final difference (Section 4). **Keywords:** Othello, game solving, minimax, greedy move, disc difference.

Scope of this paper (scope note): No new theorem or law is claimed: that small-board games can be solved to the end, best-play search (minimax), and that moves taking the immediate gain are not always best, are all known. No larger boards are claimed: 6×6 and 8×8 results are not treated; only 4×4 was counted. Strong programs are not entered: speeding up search and designing evaluations are not treated. One scoring is fixed: results are counted only as the final disc difference, without adding empty squares to the winner; among moves flipping equally many, the lowest-numbered square is chosen. Relation to earlier papers: Paper 846 showed that whether you can win is settled by painting backwards, while how many moves it takes is not in that label. This paper stands beside it. Here too the value is found by solving from the end, and we count how it disagrees with the immediate number of flips. Paper 633 showed that paying largest coins first uses the fewest coins in yen but one too many at 48 pence in old British coins. This paper stands beside it too. There, one example showed the immediate maximum missing the overall best. Here we count that this happens in 0.457888 of positions. What is added is solving the 4×4 board, measuring the share 0.542112 where the most-flipping move is best, playing solving and flipping against each other four ways, and placing the separator on one move's count versus the final difference.

1. Notation and the Question

Setting: on a 4×4 board, two black and two white discs are placed on the four centre squares, and Black moves first. Enclosed discs are flipped; a player with no move passes; the game ends when neither can move. The result is Black's final disc count minus White's.

$$v(\text{position}) = \max_{\text{move}} (-v(\text{next position})), \quad \text{greedy move} = \arg \max_{\text{move}} (\text{discs flipped by the move})$$

The solution computed the final difference from the side to move, remembering positions already seen, from the end. The greedy move flips the most discs, choosing the lowest-numbered square on ties.

Question: how often is the move that flips the most a best move?

2. Solving

Computation 2.1: the game was solved from the initial position.

Observation 2.2

4×4 Othello can be solved, and the first player loses. 58533 positions were examined, and with best play Black loses by -8 : playing both sides by the solution also gave -8 .

3. Flipping the Most and Best Moves

Computation 3.1: in every position with two or more moves, whether the most-flipping move is among the best moves was counted, and the strategies were played against each other four ways.

Black	White	difference for Black
solve	solve	−8
solve	flip most	+2
flip most	solve	−9
flip most	flip most	−6

Observation 3.2

this is the core. The move flipping the most is best only a little over half the time. Of the 22191 positions with two or more moves, it is among the best moves in 12030, a share of 0.542112: in the remaining 0.457888 of positions, choosing it worsens the final difference.

Observation 3.3

the disagreement shows in who wins. Black, who loses by −8 under best play, wins by +2 by solving against a White that flips the most: conversely, Black flipping the most loses by −9 to a solving White, one disc worse than best play.

4. The Separator

Observation 4.1

the separator is whether one asks about the discs flipped by one move or the disc difference left at the end. Flipping many in one move increases one’s discs on the spot: but flipped discs can be flipped back on the next move. How many one move flips does not promise the difference left at the end.

Observation 4.2

placed beside Papers 846 and 633.846 showed that whether you can win is settled by painting backwards. Here too the value was found by solving from the end. 633 showed paying largest coins first uses one too many at 48 pence in old British coins, one example of the immediate maximum missing the overall best. Here we counted that this happens in 0.457888 of positions.

Observation 4.3

what is not said. Results for 6×6 or 8×8 , how to build strong programs, and scoring conventions that count empty squares are not treated. What is shown is that on a 4×4 board the most-flipping move coincides with a best move in a share of 0.542112.

5. Census and Closing

1. solving 4×4 (Section 1): **final disc difference**.
2. **58533 positions** (Observation 2.2): **remembered while searching**.
3. best play gives -8 (Observation 2.2): **the first player loses**.
4. **22191 positions with two or more moves** (Observation 3.2): **room to choose**.
5. most-flipping move best in **0.542112** (Observation 3.2): **the core**.
6. missing in 0.457888 (Observation 3.2): **nearly half**.
7. solving **Black wins by +2** (Computation 3.1): **against a flipping White**.
8. **flipping Black loses by -9** (Computation 3.1): **one disc worse than best**.
9. **solution and play agree** (Observation 2.2): **independent**.
10. **one move's count, or final difference** (Observation 4.1): **the separator; Papers 846, 633**.

Closing: On a 4×4 Othello board, the move that flips the most is a best move in only a little over half of the positions. Solving examines 58533 positions; best play has Black losing by -8 ; and in positions with two or more moves the most-flipping move is best in a share of 0.542112, because flipped discs can be flipped back, so one move's count does not promise the final difference. Black, who loses under best play, wins by $+2$ by solving against a White flipping the most, and loses by -9 flipping the most against a solving White: the disagreement shows in who wins. Placed among the earlier papers: beside Paper 846's "settled by painting backwards" and Paper 633's "one

example of the immediate maximum missing”, we placed how many positions that miss occurs in. To be honest: only the 4×4 board was counted, and the same share is not claimed for larger boards.

References

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