The Net Cast Wide: Mastering the Sudoku Swordfish Strategy

Research Report

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1 Introduction: The Power of Three

In the hierarchy of Sudoku solving techniques, the **Swordfish** represents the natural evolution of the X-Wing. While the X-Wing locks a candidate into a 2×2 relationship (two rows and two columns), the Swordfish expands this logic to a 3×3 grid. It is a "Size 3 Fish" pattern that is often the key to breaking expert-level puzzles.

Like its predecessor, the Swordfish ignores the standard 3×3 boxes and focuses entirely on the geometry of rows and columns. It detects a state where the possible locations for a digit are so entangled across three parallel lines that they force eliminations in the orthogonal direction.

2 The Theoretical Framework

2.1 The Logic of Triple Constraints

A Swordfish occurs when a specific candidate digit (let's call it k) is restricted to no more than three cells in three specific lines (the "Base Sets"). Critically, these cells must align such that they occupy only three lines in the perpendicular direction (the "Cover Sets").

The Theorem:
If digit k appears in three Rows (R_A, R_B, R_C) and within those rows, it is restricted to three Columns (C_1, C_2, C_3):
Then digit k **must** appear exactly once in each of the three intersections $(R_A \cap \{C_{1,2,3}\})$, $(R_B \cap \{C_{1,2,3}\})$, and $(R_C \cap \{C_{1,2,3}\})$.

Because the three rows *must* place their instances of digit k into these three columns, the columns are effectively "full" regarding digit k for the specific purpose of satisfying these rows.

Result: We can eliminate digit k from *all other rows* that pass through columns C_1, C_2, and C_3.

2.2 Variations: 2-2-2 vs 3-3-3

A Swordfish does not need to form a perfect 3×3 grid of 9 candidates. As long as the relationship is 3 Rows $\rightarrow$ 3 Columns, it holds.

- **The Perfect Swordfish:** Candidates exist at all 9 intersection points.
- **The 2-2-2 Swordfish:** Each row only has 2 candidates, but they are staggered so they cover 3 columns.
- **Sashimi Swordfish:** A variant where the pattern is incomplete (requires advanced chaining logic).

3 Visual Analysis: Horizontal Swordfish

In this scenario, we identify three rows where a candidate appears restricted to the same three columns.

Scenario: Candidate **5**.
Base Sets: Row 2, Row 5, Row 8.
Cover Sets: Column 2, Column 5, Column 8.

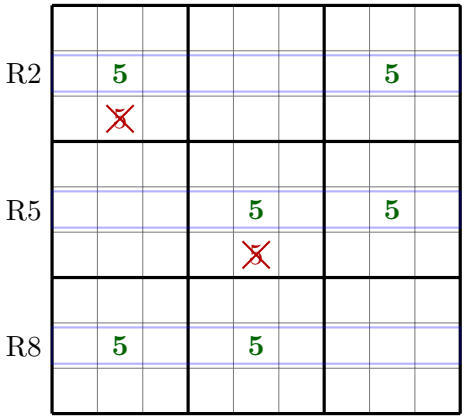

Figure 1: Horizontal Swordfish (2-2-2 Formation). Rows 2, 5, 8 (Base) claim Cols 2, 5, 8. Eliminations occur in the columns outside the base rows.

The Logic Trace:

1. **Row Analysis:**

- Row 2 must put a 5 in C2 or C8.
- Row 5 must put a 5 in C5 or C8.
- Row 8 must put a 5 in C2 or C5.

2. **The Closed Loop:** Although no row has all three positions, collectively rows 2, 5, and 8 claim columns 2, 5, and 8 completely.
3. **Conclusion:** The three 5s required for Rows 2, 5, and 8 *must* reside in columns 2, 5, and 8.
4. **Elimination:** No other row (like Row 3 or Row 6) can place a 5 in Columns 2, 5, or 8. The candidates marked with red X are removed.

4 Step-by-Step Detection Guide

Spotting a Swordfish is difficult because you cannot simply scan for a shape. You must scan for a relationship.

1. **Highlighter Mode:** Use a digital tool or mental filter to highlight ONLY the candidate digit you are analyzing (e.g., 5s).
2. **Count Candidates:** Look for rows (or columns) that have only 2 or 3 highlighted cells.
3. **The "Three-Line" Match:**
   - Find a row with 2-3 candidates. Note the columns.
   - Find a second row with 2-3 candidates in the *same* columns.
   - Find a third row with 2-3 candidates in the *same* columns.
4. **Execute:** If the pattern holds, look up and down those columns and delete any candidates that are not part of your three base rows.

5 Conclusion

The Swordfish is a powerful, if rare, tool in the solver's arsenal. It represents the "Size 3" entry in the Fish family (X-Wing is Size 2, Jellyfish is Size 4). Mastering this technique requires moving beyond local pattern recognition (like finding a pair in a box) to global pattern recognition, understanding how constraints on one side of the board can force truth values on the other.