IS597PR

Monte Carlo Simulation - Beijing Mahjong

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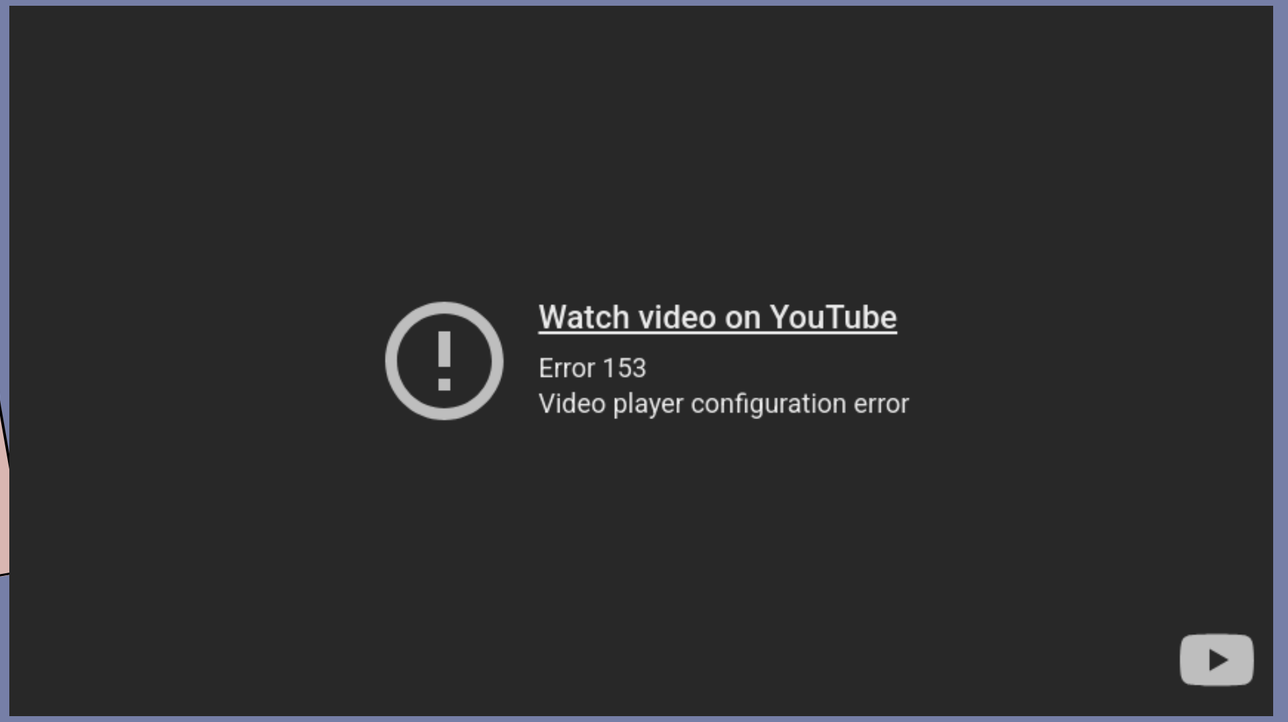
How to Play Mahjong?

A simple guide from YouTube:



In Our Case

A standard winning hand must consist of **four melds (sets)** and **one pair (eyes)**:

- **Pongs – three identical tiles (e.g., three 5 of wans/characters)**
- **Chis – three consecutive tiles of the same suit (e.g., 3–4–5 of tongs/dots)**
- **Gongs – four identical tiles (a special type of Pung that yields a bonus fan)**
- **The pair (eyes) is any two identical tiles (e.g., two Red Dragons/Honours)**

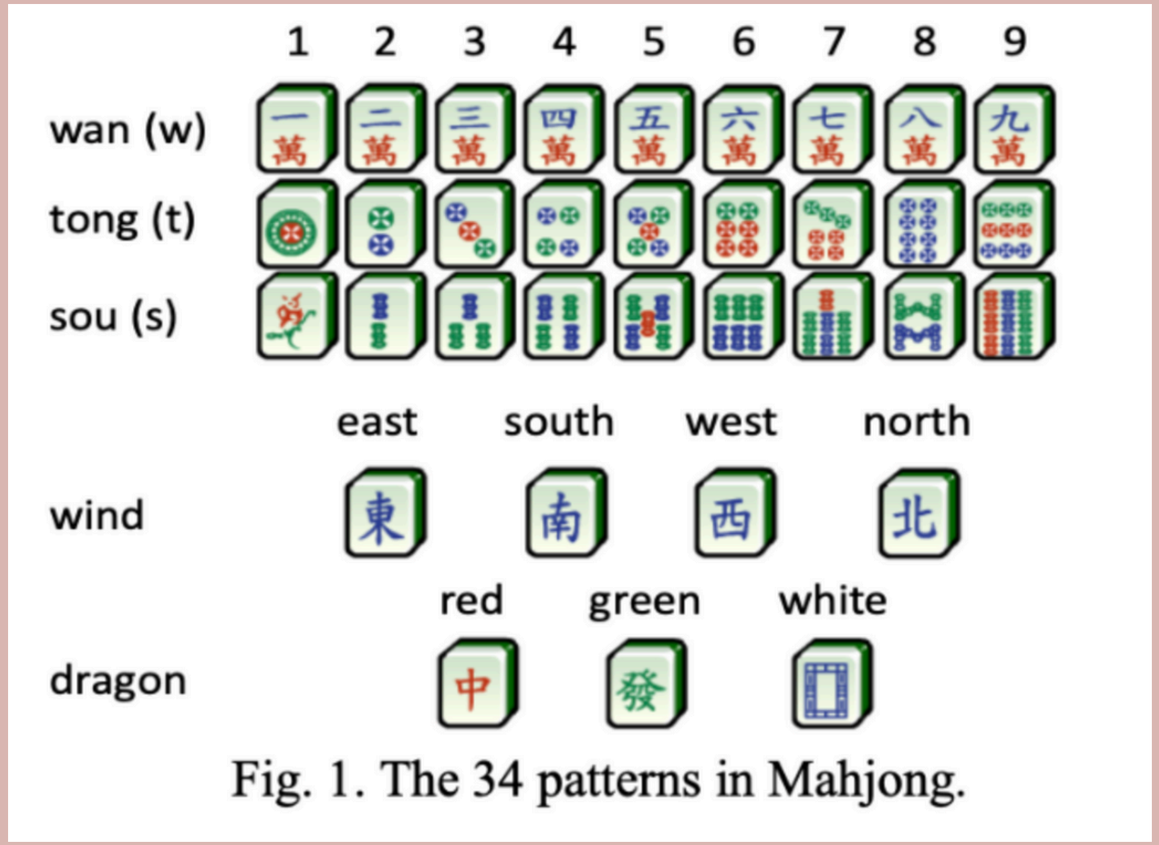


Fig. 1. The 34 patterns in Mahjong.

Compare to the regular Mahjong, Beijing style mahjong doesn't have bonus tiles, so there are only 136 tiles instead of 144

Methodology

Our project uses a **Monte Carlo** simulation to model and compare long-term outcomes of player strategies under Beijing-style Mahjong rules. We ran the simulation 1000 times. (50 trials, each trial includes 20 rounds)

Introduce Fan - Multiplier

Like other games, Mahjong also allows for doubling (FAN) of points, depending on the category or type of the player's hand combination.

Category	Example	Fan Value
Basic Hand	**Self-draw, Concealed hand, All simples**	**1 fan**
Common wins	**All pongs, Mixed triple chow**	**2 fan**
Advanced hands	**Pure flush, Little dragons**	**4–6 fan**
Add-on bonuses	**Gong +1 fan; "Gong open" win +1 fan**	**Variable (1–2 fan)**

Special Features

Strategy Feature

We define three player strategies as decision policies on when to declare a win:

Defensive strategy (DEF):

Rarely claims chi/pong/gong to avoid exposing melds (only when risk is below respective thresholds)

Aggressive strategy (AGG):

Willing to claim pong/gong for fan bonuses; can claim chi early if wall has sufficient tiles (wall_remaining > chi_wall_threshold)

Neutral strategy (NeutralPolicy):

Used as baseline opponents in Experiment 1 (2v2 configuration) to provide a balanced comparison environment. Balanced between DEF and AGG strategies, preventing winning on small fans at low risk

RISK_CALCULATION: MAX_DENOMINATOR: 100 (RISK = DISCARDS / MAX(DENOMINATOR, WALL + DISCARDS))

Phase 1

- The Wall is Built: The full set of 136 Mahjong tiles is shuffled and stacked face-down to form the Tile Wall.
- Tiles are dealt: Each of the four players receives their starting hand of tiles from the Wall.
- Three players start with 13 tiles.
- The Dealer (Random) starts with 14 tiles.

Phase 2

Draw a tile:

- Action: The current player draws one new tile from the top of the Tile Wall.
- Checking the Wall: The system continuously monitors the availability of tiles.
- Game End (Draw): If the Wall is completely empty when a player attempts to draw, the round ends immediately in a draw.
- Result: The new tile is added to the player's hand, bringing their total tiles to 14, ready for the discard phase.

Phase 3

After drawing a tile, the player immediately checks if they can declare HU (Win).

- The Check: The player's hand is analyzed instantly using the newly drawn tile to see if a legal, winning combination of four melds and one pair has been formed.
- Fan Calculation: If a win is possible, the system calculates the Fan (scoring multipliers) the winning hand achieves.
- Strategic Decision: The player then decides whether or not to declare the win (this is a strategic choice in some variants, especially if the Fan is low).
- Outcome: If the player declares the win, the round ends, and scoring begins. If they choose not to or cannot win, the game proceeds to the discarding phase.

Phase 4

This is the final step of the current player's turn, where they reduce their hand size and present a new tile for opponents to claim:

- The Decision: The player must choose one tile to discard from their current 14-tile hand. This is a critical strategic decision, as they must balance forming their own hand with avoiding giving opponents a winning or useful tile.
- The Discard Pile: The tile is placed face-up into the central Discard Pile.
- Transition: Once the tile is discarded, the game immediately returns to Phase 3 (Claiming Discarded Tiles), where the other three players check if they can use that tile for HU, Gong, Pong, or Chi.

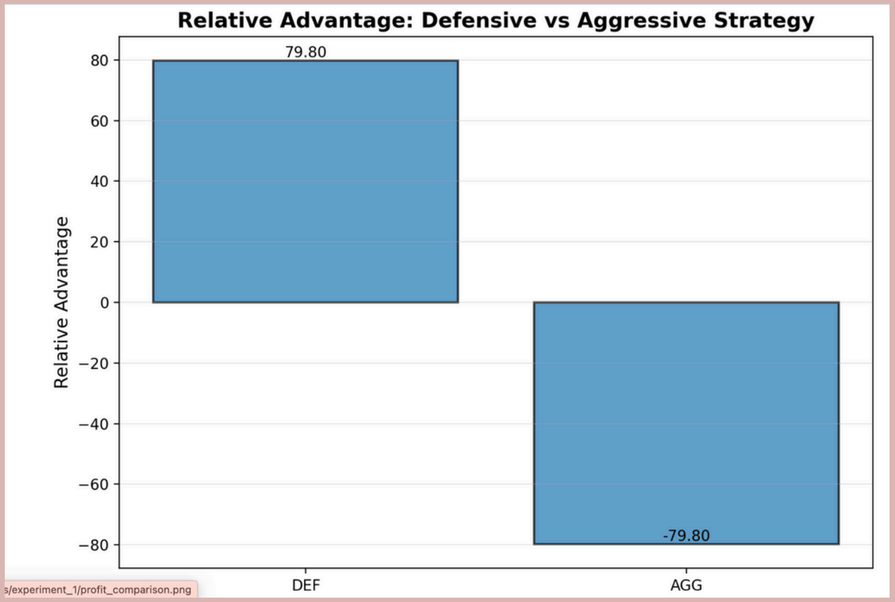
Priorities:

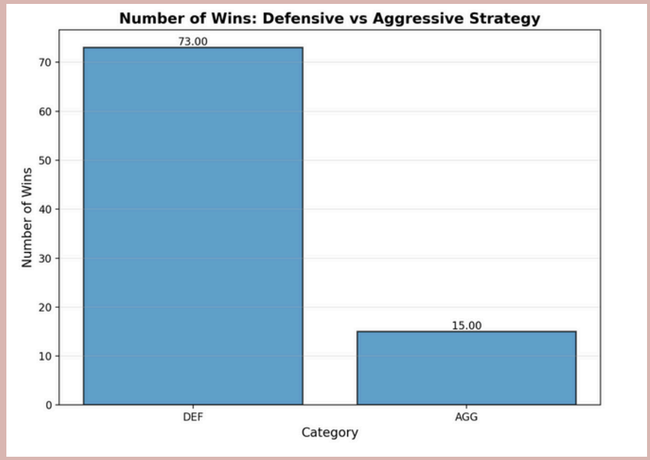
- **HU (Win)**: This is the highest priority and immediately ends the round.
- **Gong (Four of a Kind**): Allows a player to complete four identical tiles, followed by drawing a replacement tile.
- **Pong (Triplet)**: Allows a player to complete three identical tiles. The claiming player immediately takes the next turn.
- **Chi (Sequence)**: This is the lowest priority and can only be done by the player immediately following the discarder. The claiming player immediately takes the next turn.

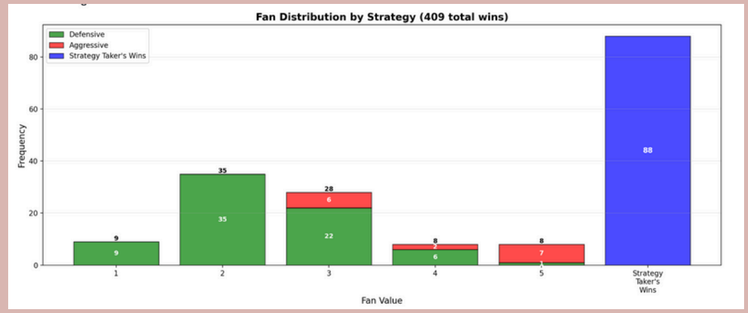
Hypothesis #1

Defensive players, who prioritize winning whenever possible, will achieve higher expected long-term profit than aggressive players, who only win on hands meeting or exceeding a specified fan threshold.

Result:



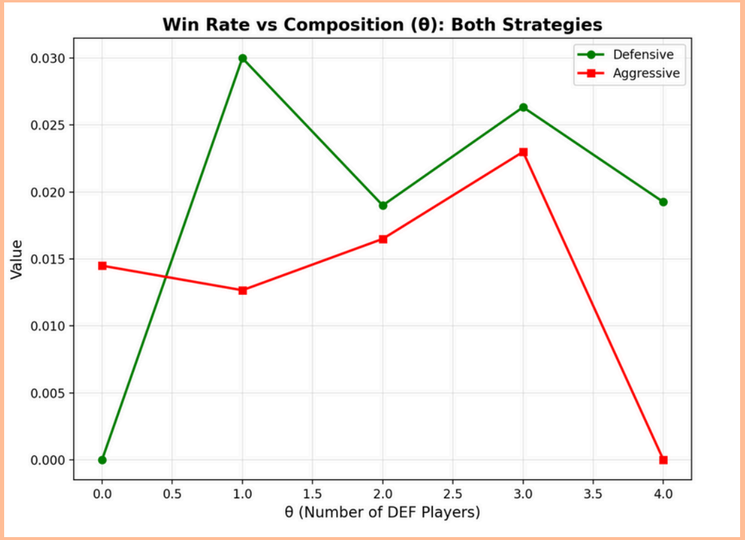


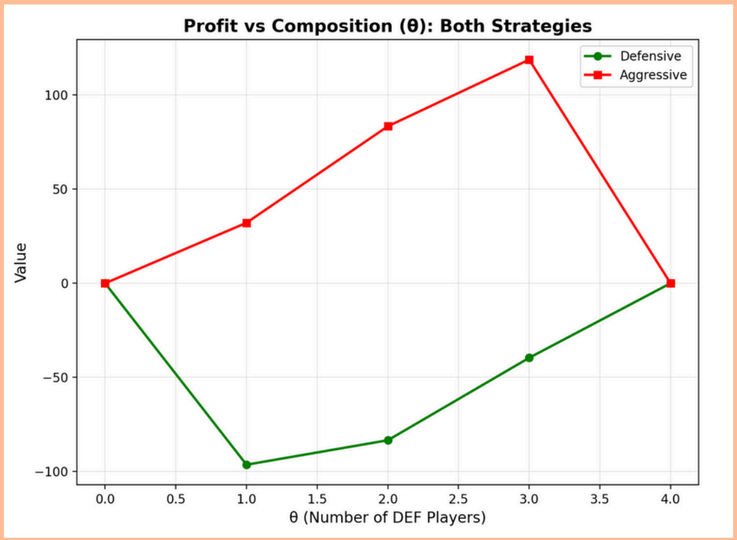


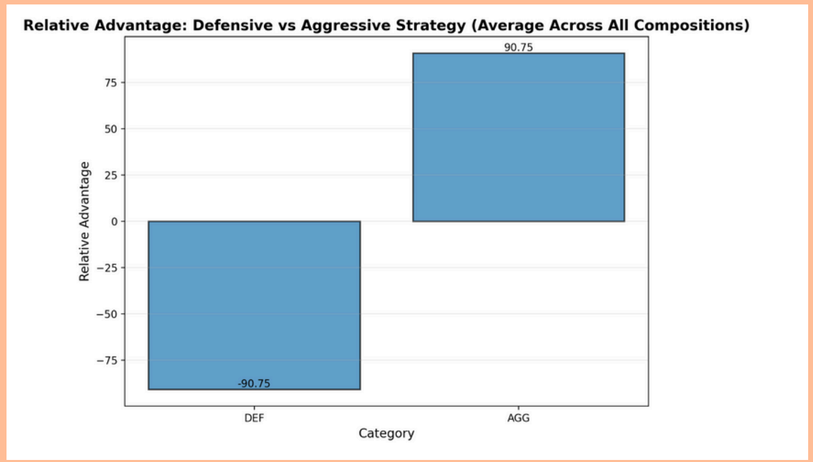
Hypothesis #2

The relative performance of aggressive and defensive strategies depends on the composition of opponents at the table.
As the proportion of defensive players increases, the expected profit of aggressive players rises, while that of defensive players declines.

Result:







Conclusion

Win & Earn

Defensive players have a higher win rate, and earn more profits. (experiment1)

Even though aggressive players achieve higher fan values, their much lower win frequency prevents those large hands from earning.

Table compositions

Aggressive players gain an advantage in profit when surrounded by other aggressive players

Defensive players are consistently outperformed by aggressive players in total profit. Regardless of whether there are one, two, or three defensive players at the table, aggressive players always earn higher profits.

Thank you!

Presented by: Teacher Avery

REFERENCES

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Analyzing who is telling the story (first-person, third-person omniscient, etc.) can influence how readers perceive events and characters in a narrative. Understanding the narrative voice helps students grasp why certain information is revealed or withheld by the author.

South China Morning Post. (2018, August 12). Learn how to play mahjong in 2.5 minutes [Video]. YouTube.
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