Does Strategy Beat the House?

A Monte Carlo Investigation of Blackjack

80 million simulated hands • 4 playing strategies • 9 betting systems

Part of AI Journey — Data & ML Engineering

github.com/arda-basarici/blackjack-sim

Executive Summary

Almost everything most people believe about beating blackjack is wrong — and a simulation of nearly 80 million hands can show exactly where, and why. This report plays four strategies and nine betting systems through millions of hands under one fixed rule set, then follows the money across 10,000 thousand-hand sessions to see what actually happens to a bankroll over time.

The engine was built from scratch with a pluggable design: any strategy — a rule of thumb, the textbook optimum, or a future neural network — implements one interface and drops into the simulator without changing the engine. That makes it a reusable research platform, and its output is validated against the known mathematics of the game.

Question	What the data says
Does playing strategy matter?	Enormously. Optimal play cuts the house edge from 46% (random) to 0.45%.
Is avoiding busts the goal?	No. The strategy that busts least loses 12x more money than the best one.
Can a betting system beat the house?	No. Martingale goes broke 40% of sessions; the expected loss is unchanged.
Does varying your bets help?	Only with information. Bet variation with no card counting equals flat betting to the dollar.
Does card counting work?	In 6 decks, barely (about breakeven). On a single deck, yes: +$314 per session.
So counting is a free win?	**No — it is the catch. That single-deck edge goes broke 20% of sessions: high reward, high ruin.**
What drives going broke?	Bet size vs bankroll, not skill. Same play: 40% ruin with Martingale, 1% flat.

How to Read This Report

The game. 6 decks (single deck where noted), dealer stands on soft 17, blackjack pays 3:2, double on any two cards. A fixed random seed makes every run reproducible.

A “session” is 1,000 hands played on a $1,000 starting bankroll at a $10 base bet — one evening at the table. We run 10,000 of them per setup.

House edge is the casino’s long-run cut per dollar bet. **Bust** means a *hand* goes over 21; **ruin** (or “going broke”) means a *bankroll* hits zero — two different things. **Win rate** is the share of hands won; **profitable** is the share of sessions that finished ahead. A strategy can win a minority of hands and still finish in profit.

1. Is the Simulator Trustworthy?

Before any finding, the engine has to earn trust. The simplest test is to check the numbers that should not depend on how the player plays. The dealer busts and deals blackjacks at rates fixed by the cards, not the player — if those drift between strategies, something is broken. They do not.

Strategy	Dealer Bust	Blackjack	Outcomes Sum	House Edge
Basic	26.8%	4.51%	100.0%	0.45%
Semi-Random	26.8%	4.55%	100.0%	5.59%
Dealer Mirror	26.8%	4.49%	100.0%	5.63%
Random	26.9%	4.51%	100.0%	45.76%

Across all four strategies the dealer busts about 27% of the time and blackjacks land near 4.5% — flat, exactly as the cards dictate, and every outcome distribution sums to 100%. The anchor is the bottom-right cell: Basic Strategy's house edge of 0.45% sits squarely on the known value for these rules. The engine reproduces real blackjack mathematics, so the differences in the rest of this report are signal, not artefacts.

2. Does Strategy Even Matter?

Start with the widest question: how much does skill change the outcome? Four strategies span the full range of play, from the mathematically optimal Basic Strategy to a player choosing at random. Each was dealt one million hands.

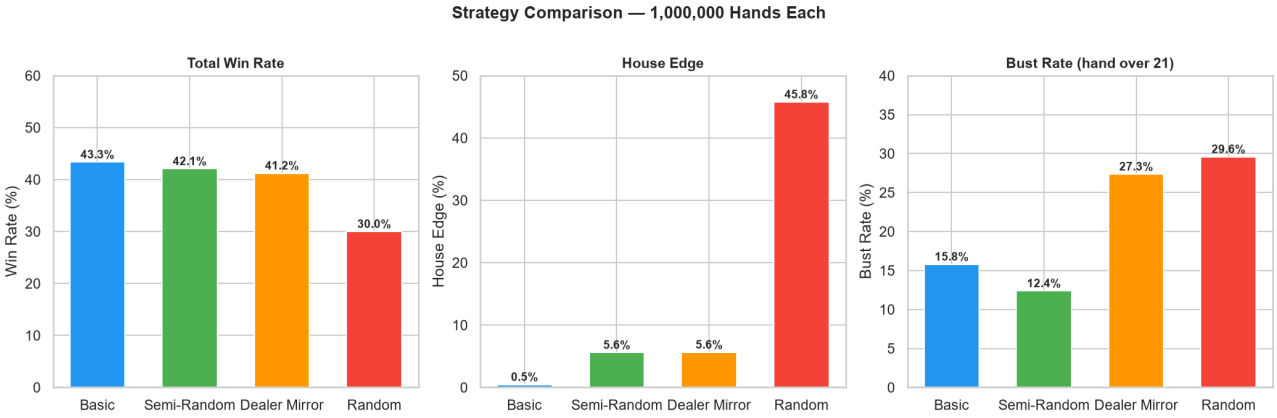

Figure 1: Win rate, house edge, and hand-bust rate across four strategies (1M hands each).

The gap is staggering. Random play hands the house a 46% edge — it bleeds money fast. Basic Strategy shrinks that to just 0.45%, about 45 percentage points better, and the simulator reproduces the known optimum exactly.

But notice the win-rate panel: the best strategy wins 43% of hands, the worst still wins 30%. A 13-point spread in hands won, yet a 45-point spread in money lost. Winning more hands is clearly not where the money is — which leads to the most surprising result in the study.

3. The Myth of “Don't Bust”

Ask a casual player for the golden rule of blackjack and most will say: don't bust. The data says that instinct is actively costing them money.

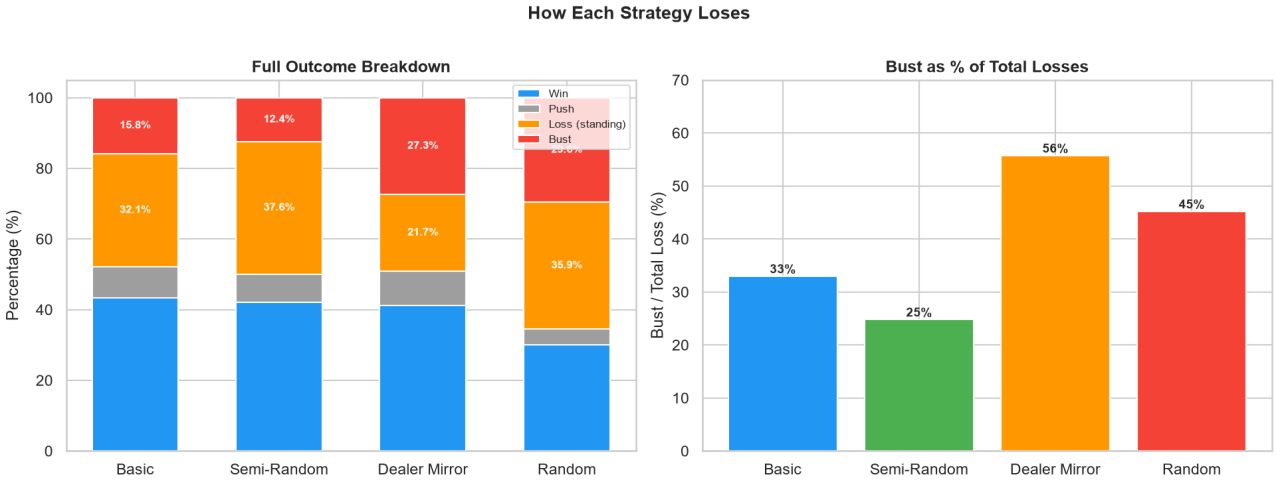

Figure 2: How each strategy loses — busting (over 21) versus losing at showdown.

Look at Semi-Random. It busts the *least* of all four (12.4%), even less than optimal play (15.8%) — yet its house edge is 12 times worse. Avoiding busts did not make it a better strategy. It made it a worse one.

The reason is subtle and important. Semi-Random dodges busts by standing on stiff hands like 14 or 15. But standing on 15 against a dealer's 10 loses almost as often as busting would — the dealer simply makes a better hand. The loss does not disappear; it moves from the “bust” column to the “beaten at showdown” column. Optimal play accepts a higher bust rate on purpose, because on those hands taking the risk loses less money than playing it safe.

> **Avoiding busts is not the goal. Losing the least money is — and sometimes that means taking the bust risk.**

4. Where the Edge Is Won

If skill is concentrated in a few decisions, which ones? The map below colours every situation — the player's hand against the dealer's visible card — by how often it wins, with Basic Strategy's correct move printed underneath.

Figure 3: Win rate and optimal action by player hand vs dealer upcard (Basic Strategy, 1M hands). Green = favourable, red = unfavourable.

Two things jump out. Most of the board is red or orange: the player acts first and can bust before the dealer even plays, so the game is structurally stacked against you — skill manages that, it does not erase it. And the colour is set by the *situation*, not the player; what skill controls is the move written in each cell.

The edge lives in two regions. Against a weak dealer card (2–6), Basic Strategy stands on stiff hands and lets the dealer bust itself; against a strong card (7+) it takes the hit, because standing is worse. And in the green cells it doubles or splits, pressing more money down exactly when it is ahead. Naive strategies never make these moves — on 16 versus a dealer 5 alone, optimal play wins up to 18 percentage points more often. (The full edge map is in Appendix A.)

5. What Actually Happens to Your Money

Knowing the right move is one thing; living with the results is another. Switching from single hands to 10,000 full sessions shows the house edge as a bankroll trajectory, not a percentage.

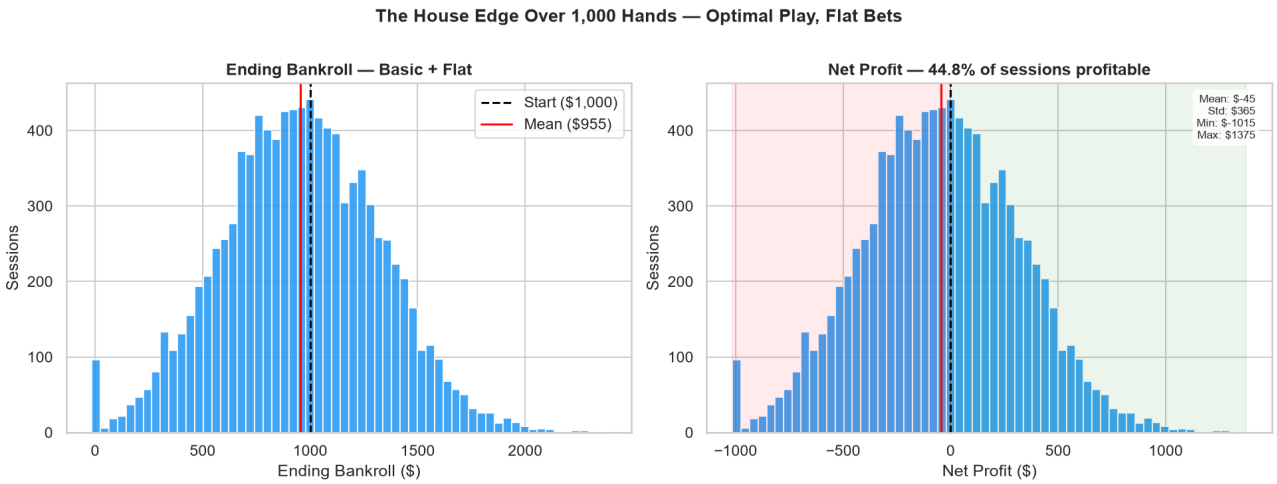

Figure 4: Ending bankroll and net profit across 10,000 sessions — optimal play, flat $10 bets, $1,000 starting bankroll.

Even with perfect play, the average session ends down about $45 — the 0.45% house edge, ground out over a thousand hands. But the average is the least interesting number here. The spread is enormous: individual sessions swing from roughly –$1015 to +$1375, and 45% of them finish in profit.

That is the whole psychology of the casino floor in one chart. Nearly half of all sessions win money — more than enough to convince a player their system works — while the long-run average sits stubbornly in the red. Short-term results are noise; only thousands of sessions reveal the true edge.

6. The Betting-System Myth

If you cannot out-play the house, can you out-bet it? Progressive systems — Martingale above all — promise exactly that: double after every loss, and one win wipes out the whole streak plus a profit. On paper it cannot fail.

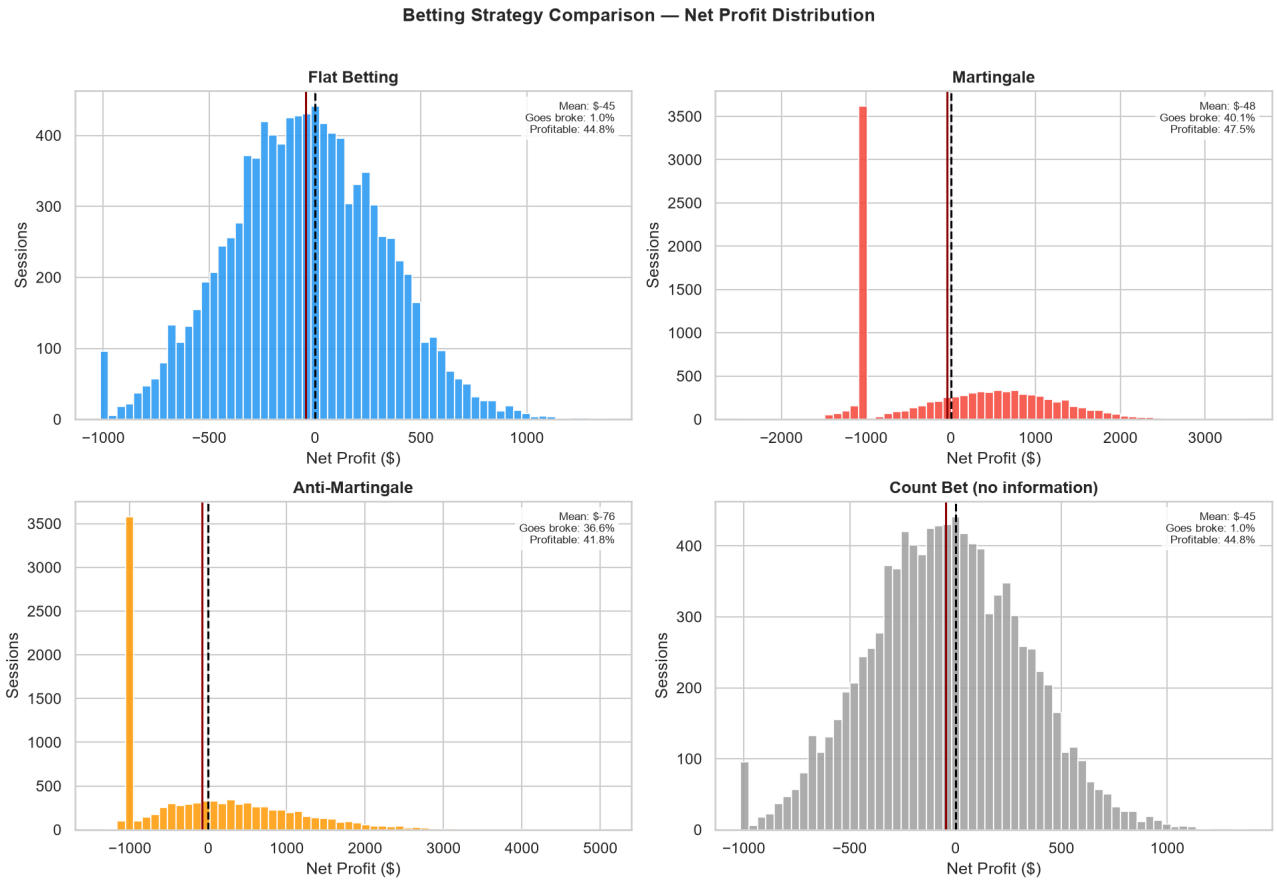

Figure 5: Net profit across four betting systems, same optimal play underneath (10,000 sessions each).

In practice Martingale goes broke 40% of the time. The distribution splits in two: a tall spike at total ruin beside a hump of small wins. Win small often, lose everything occasionally — and the average result ($-48) is no better than flat betting. The system did not change the math; it traded many small losses for a few catastrophic ones.

The cleanest proof sits in the fourth panel. “Count betting” with the counting switched *off* — bets that vary for no reason — is identical to flat betting to the dollar ($-45, 1.0% ruin). Varying your bets achieves nothing on its own. The information is the edge, never the bet pattern.

> **Betting systems do not change what you expect to lose. They only change how wildly the outcomes swing — and how often you go broke.**

7. Card Counting: Does It Actually Work?

Card counting is both over-hyped and misunderstood — Hollywood's guaranteed jackpot, the casino's cardinal sin. The truth is narrower: it is legal information, and under the right conditions it flips the edge to the player. The first chart isolates each ingredient in turn.

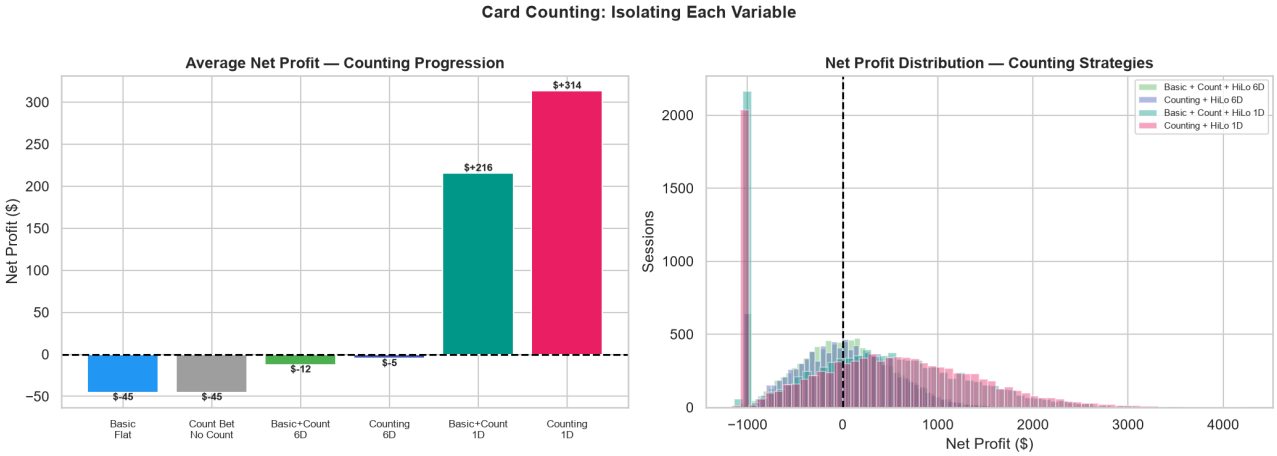

Figure 6: Average net profit per session as each piece of counting is added — bet variation, then information, then deck count.

Each step adds one thing. Bet variation alone does nothing. Add real Hi-Lo counting in a six-deck shoe and the loss shrinks toward breakeven ($-5 per session) — meaningful, but not yet a win, because in six decks the count rarely swings far enough. Switch to a single deck and everything changes: profit jumps to +$314 per session.

That +$314 is a genuine edge, not luck — the average of 10,000 sessions, with the whole distribution shifted right. It works out to roughly +1.3% on every dollar wagered, exactly the range real single-deck counters achieve, and precisely why casinos deal six to eight decks and shuffle early. (Reassuringly, the same calculation on flat betting returns –0.45% — the house edge, recovered from a different angle.)

What the Counter Actually Does Differently

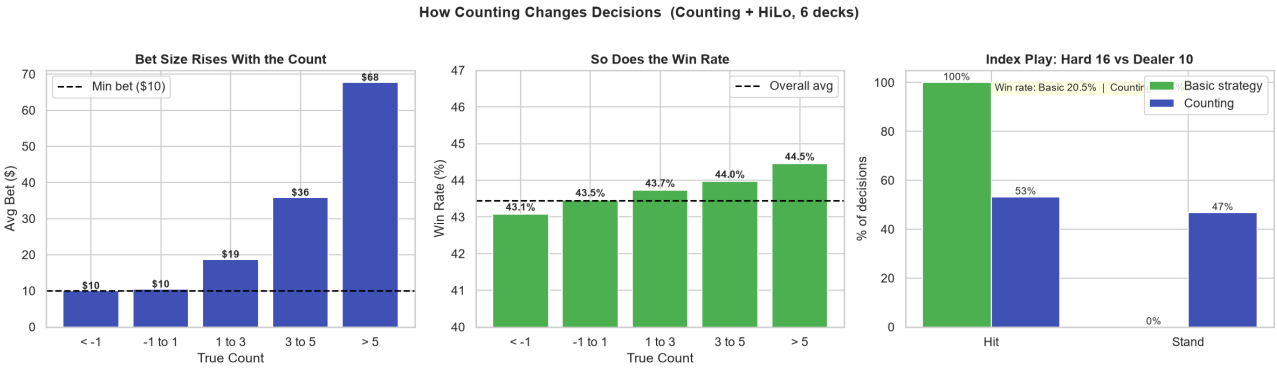

Figure 7: Three mechanisms of counting in a six-deck shoe — bets scale with the count, the win rate rises with it, and specific decisions change (hard 16 vs dealer 10).

The mechanism is concrete. As the true count climbs, the counter raises the bet from the $10 minimum up toward $68 — and that is justified, because the win rate genuinely rises with the count (a ten-rich deck means more blackjacks and more dealer busts). Counting also changes individual plays: on a hard 16 against a dealer 10, basic strategy always hits, but the counter stands almost half the time when the deck is rich — a deviation that lifts the win rate on that single hand. Small per hand, applied to the largest bets, repeated thousands of times: that is the entire edge.

8. The Catch: Profit Is Not Survival

A positive edge sounds like the end of the story. It is not — because a strategy that wins on average can still bankrupt you on the way there. This is where the single-deck result earns its asterisk.

Figure 8: How often each strategy goes broke, and the full spread of ending bankrolls for three representative strategies.

The very strategy that tops the profit chart — single-deck counting — also goes broke 20% of the time: one session in five wiped out completely. That is the opposite of safe. The aggressive bet spread that *creates* the edge is the same thing that drives the wild swings. Flat betting, by contrast, goes broke barely 1.0% of the time, but only ever bleeds slowly. More edge here is bought with more risk, not handed over for free.

And the driver of ruin is not skill — it is bet size relative to bankroll. The identical optimal play goes broke 40% of the time with Martingale and 1.0% with flat betting. Same decisions, wildly different survival. Expected value and risk of ruin are two separate dials, and a strategy has to be judged on both.

> **Profit answers “does it make money?” Risk of ruin answers “does it survive?” — and the best-paying strategy here is also one of the most dangerous.**

The Scoreboard: All Nine Configurations

Every betting setup at a glance, over 10,000 sessions each. Read it as the whole report in one table: optimal play loses slowly and safely; progressive systems trade that for ruin; counting earns a real edge on a single deck, but only by accepting real ruin risk.

Configuration	Avg Net	Ruin Rate	Hand Win %	Profitable %
Basic + Flat	$-45	1.0%	43.3%	44.8%
Basic + Martingale	$-48	40.1%	42.6%	47.5%
Basic + Anti-Martingale	$-76	36.6%	43.0%	41.8%
Basic + Count (no count)	$-45	1.0%	43.3%	44.8%
Basic + Count + HiLo 6D	$-12	6.6%	43.3%	49.1%
Basic + Count + HiLo 1D	$+216	22.1%	43.2%	58.1%
Random + Flat	$-1003	100.0%	29.4%	0.0%
Counting + HiLo 6D	$-5	6.5%	43.4%	49.6%
Counting + HiLo 1D	$+314	20.4%	43.4%	61.4%

9. What This Does — and Doesn't — Model

An analysis is defined as much by what it refuses to claim as by what it asserts. This is a faithful model of the *mathematics* of blackjack, not a how-to-win guide, and several real-world frictions are deliberately left out:

No table limits.

Real casinos cap the maximum bet, so a Martingale player cannot keep doubling. In practice that makes Martingale even more lethal than the 40% ruin shown here.

Single-deck games are rare and well defended.

The +$314 edge assumes a single deck dealt to 50% penetration and a casino that tolerates a 1-to-8 bet spread. Modern casinos use six to eight decks and watch for exactly this — both assumptions are optimistic.

Counting assumes flawless tracking.

The simulated counter never miscounts. A real human under pressure does, and every error eats into a thin edge.

Human and house factors are out of scope.

Comps, fatigue, and getting barred by the pit are real parts of advantage play and are not modelled here.

None of this changes the core findings — it sharpens them. The mathematics says counting can win on a single deck; the real world is built specifically to keep that math out of reach.

10. A Reusable Platform — and What's Next

Everything above came out of one engine, and the analysis is only a slice of what it can answer. Because every decision is recorded with full game context, new questions need new runs, not new code:

How much does a 6:5 payout cost the player?

Swap the payout rule and re-run — the single most damaging rule a casino can change.

What bet spread makes counting profitable in six decks?

Widen the spread in the betting module and measure where the line crosses zero.

How big a bankroll makes single-deck counting safe?

Map ruin rate against starting bankroll — the practical question behind the +$314 edge.

Next: Learning the Strategy From Data

The millions of recorded decisions are the training set for the sequel project: a neural network learns to play from the data alone, never told the rules. Does it rediscover Basic Strategy? Does it find the counting deviations on its own? Because strategies are pluggable, the trained model drops straight into this same framework and is judged on the very metrics in this report — a clean, directly comparable benchmark.

Appendix A — Where Basic Beats Dealer Mirror

Dealer Mirror plays by the dealer's own rules (hit to 17, never double or split). Subtracting its win rate from Basic Strategy's, then keeping only the cells where the two make different decisions, shows precisely where the edge is manufactured: the stiff hands against weak dealers, and the doubling band on 9–11.

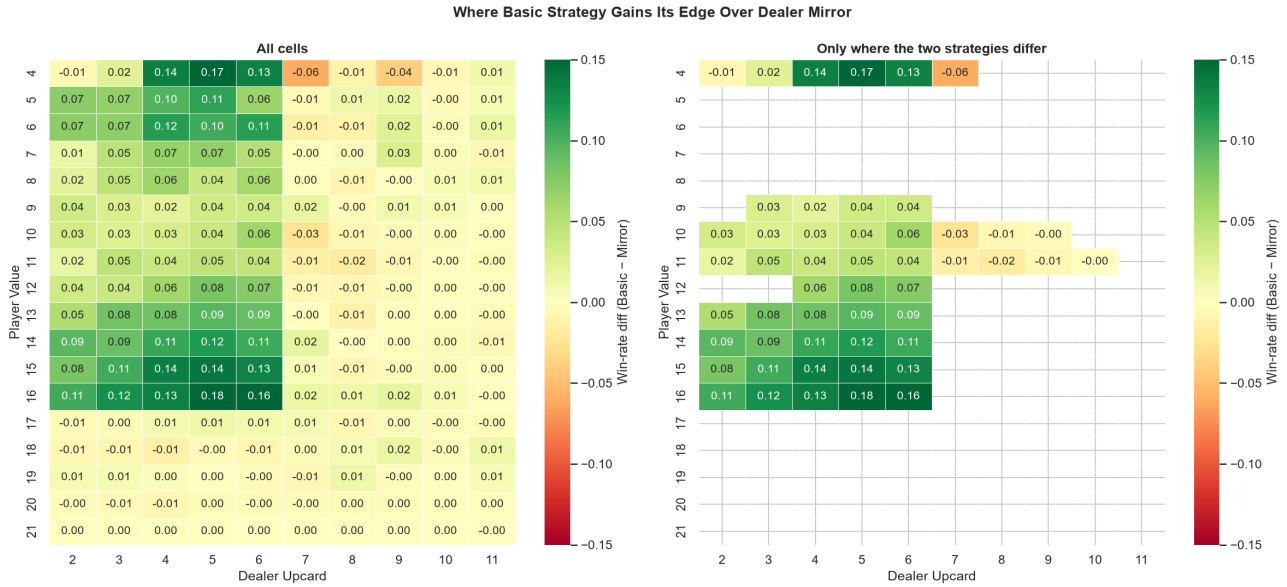

Figure A1: Win-rate difference (Basic minus Dealer Mirror). Left, all cells; right, only where the two strategies choose differently.

Appendix B — Action Maps, All Four Strategies

The same win-rate field underlies every strategy — the colour is a property of the game, not the player. What differs is the move each strategy makes. Basic Strategy shows deliberate structure (doubles, splits, disciplined stands); Dealer Mirror shows a flat cut at 17; the random strategies show no fixed action at all.

Figure B1: Win rate by game state for all four strategies, with the chosen action for the two deterministic ones (H=Hit, S=Stand, D=Double, P=Split).

Built as Part of AI Journey

A structured path from Python foundations to AI engineering. Every project real, complete, and publicly documented.

arda-basarici.github.io