Quacking the Duckman: Building a Poker Strategy

by Brian Space

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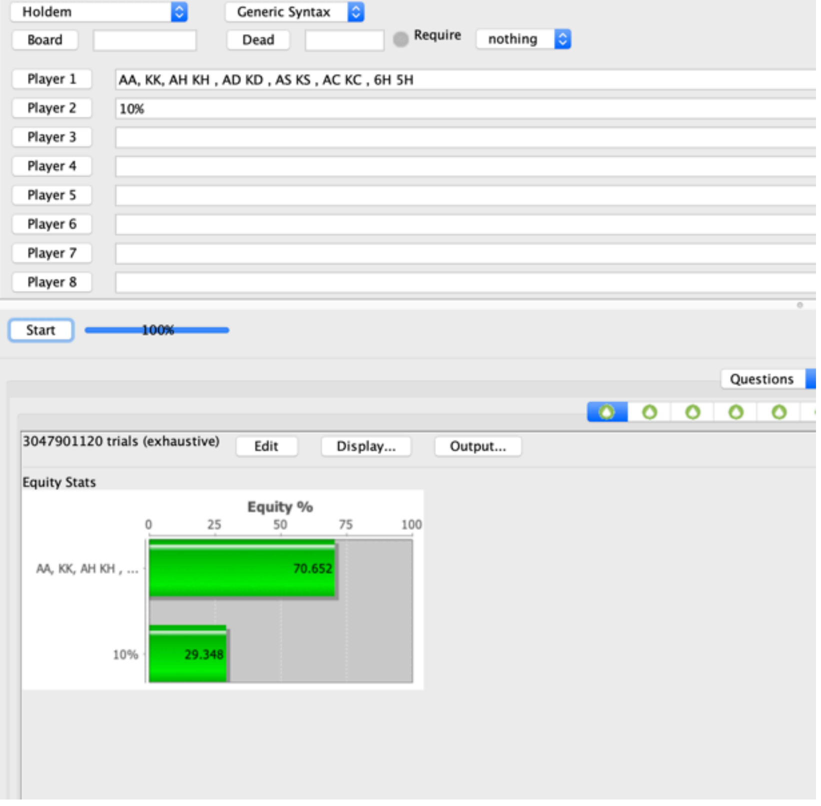
Success in academics for me means being a learning machine. Early in my poker journey, I was a new Run it Once member watching a Ben Sulsky, aka Sauce123, training video to learn the deep secrets of winning poker. It was transformative to hear brilliant cogent talk about poker – how to systematically build models of no-limit hold 'em. A few years earlier, sitting on the beach, it had finally occurred to me what it meant to play a range of holdings rather than just analyzing the particular hand I was struggling with at the time. Sulsky invoked the concept of facing another player's strategy and evaluating its value. It occurred to me that I did not know what that meant or how to do it? Colloquially "strategy" was clear; we want to win by playing our hands in some optimal way. What was I missing? I wasn't thinking optimal in the technical fashion I do now that means approximating some profit maximized constrained equilibrium, and I certainly wasn't referring to some GTO reference state.

Forward to the present day and a fellow academic and poker player, at my home academic institution no less, made the twitter pronouncement that he would henceforth be going all-in with all of his 22 and AA hands for the rest of this summer – the attack of the Duckman, Marvin Karlins, Ph.D. **@TheDuckman22**! Ducks is a colloquial name the for the dreaded holding of 22, pocket deuces. Is this a flight of fancy, fine feathered philanthropy? Can we crack his Aces or quack his ducks? Is he a lame or mighty Duckman; would he be feathering his nest?

Using the all-in range of (AA,22) is indeed a strategy that can be implemented straightforwardly at the table and is amenable to some simple estimation of its value. It also raises interesting issues to consider while evaluating concepts in live no-limit hold 'em. My first question was how practical an idea is this? It is betting large with a polarized range which has its virtues as Sulsky explained in early videos illustrating models from the Mathematics of Poker. I later wrote about such things myself in the February, 2016 issue of the Two Plus Two Magazine.

Earlier, I constructed a preflop strategy for an older friend, George, who was frustrated with poker but greatly valued the comradery of our biweekly $5/10 no-limit hold 'em games. He would lose money because he could not bring himself to fold AA and KK postflop and he was even more confounded by what he called F***ING AK. Such problems are not unknown and frequently voiced in a poker room near you. I tinkered with ProPokerTools and suggested he could go all-in every time he had the hands in the George "all-in" range I built for him (AA, KK, A♥ K♥ , A♦ K♦ , A♠ K♠ , A♣ K♣ , 6♥ 5♥) . George could continue with his usual idiosyncratic mix of limps and raises with the rest of his hands, maintaining the ability to have strong hands in most situations. I built this range so he could have a little more fun in poker yet still be close to unexploitable in his "all-in" range. He would still have plenty of hands to limp or raise in the haze of the long slog of live poker, where it is hard to figure out what anyone is doing over a small sample size. Remember, I was trying to help him lose less money while having more fun. In poker it is much better to be *"all-in" Dangerous George*, than, *"I call" Curious George*. That was the idea.

The George shoving range is not easily exploitable because it's constructed to hold its own vs. hands that, practically speaking, might call. That is, it has substantial equity vs. a reasonable calling range. Consider, it has 77% equity vs. 100% of hands, 70% equity vs. the top 10% of hands (where the weakest hands are 77 and Q♥ J♥) and 65% equity vs. the top 5% of hands (with 99 and A♥ J♥ the weakest hands) maintaining a substantial edge. An example of the equity calculation is given in the first figure below using ProPokerTools – the actual 10% range can be seen by simple clicking on the Player 2 tab revealing: (AA-77,AxKx-Ax9x,AxKy-AxJy,KxQx-KxTx,KxQy,QxJx), where the xx or xy syntax refers to suited and off-suit combinations respectively. The range is illustrated in the second figure below. Next, consider going all-in with 100+ big blinds (bb), as I envisaged George to do. This action is likely to prompt a call from only the strongest holdings, especially after his buddies had seen a few showdowns – perhaps unless they saw the 56 holding. 6♥ 5♥ is included because it does as well as one can vs. AA, the most likely calling hand, with 22.5% equity, and polarizes his range to a degree. This would also spice up George's life a little – the ♥ combination was an arbitrary choice that serves to control the frequency of 56 suited appearing in the range.



Require: nothing

Player 1: AA, KK, AH KH , AD KD , AS KS , AC KC , 6H 5H

Player 2: 10%

Player 3

Player 4

Player 5

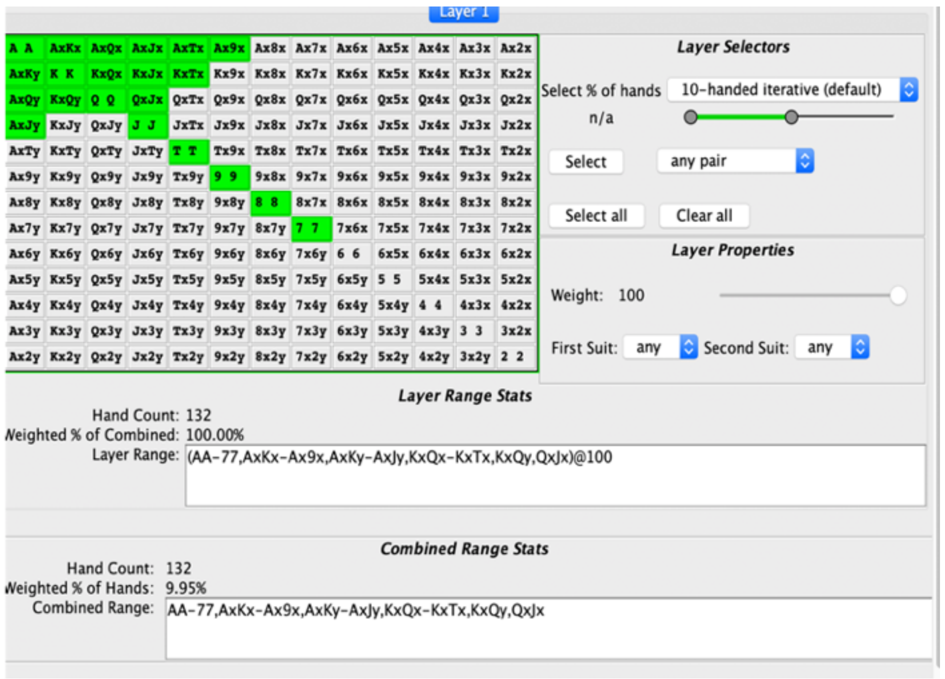
Player 6

Player 7

Player 8

3047901120 trials (exhaustive)

Equity Stats



A A	AxKx	AxQx	AxJx	AxTx	Ax9x	Ax8x	Ax7x	Ax6x	Ax5x	Ax4x	Ax3x	Ax2x
AxKy	K K	KxQx	KxJx	KxTx	Kx9x	Kx8x	Kx7x	Kx6x	Kx5x	Kx4x	Kx3x	Kx2x
AxQy	KxQy	Q Q	QxJx	QxTx	Qx9x	Qx8x	Qx7x	Qx6x	Qx5x	Qx4x	Qx3x	Qx2x
AxJy	KxJy	QxJy	J J	JxTx	Jx9x	Jx8x	Jx7x	Jx6x	Jx5x	Jx4x	Jx3x	Jx2x
AxTy	KxTy	QxTy	JxTy	T T	Tx9x	Tx8x	Tx7x	Tx6x	Tx5x	Tx4x	Tx3x	Tx2x
Ax9y	Kx9y	Qx9y	Jx9y	Tx9y	9 9	9x8x	9x7x	9x6x	9x5x	9x4x	9x3x	9x2x
Ax8y	Kx8y	Qx8y	Jx8y	Tx8y	9x8y	8 8	8x7x	8x6x	8x5x	8x4x	8x3x	8x2x
Ax7y	Kx7y	Qx7y	Jx7y	Tx7y	9x7y	8x7y	7 7	7x6x	7x5x	7x4x	7x3x	7x2x
Ax6y	Kx6y	Qx6y	Jx6y	Tx6y	9x6y	8x6y	7x6y	6 6	6x5x	6x4x	6x3x	6x2x
Ax5y	Kx5y	Qx5y	Jx5y	Tx5y	9x5y	8x5y	7x5y	6x5y	5 5	5x4x	5x3x	5x2x
Ax4y	Kx4y	Qx4y	Jx4y	Tx4y	9x4y	8x4y	7x4y	6x4y	5x4y	4 4	4x3x	4x2x
Ax3y	Kx3y	Qx3y	Jx3y	Tx3y	9x3y	8x3y	7x3y	6x3y	5x3y	4x3y	3 3	3x2x
Ax2y	Kx2y	Qx2y	Jx2y	Tx2y	9x2y	8x2y	7x2y	6x2y	5x2y	4x2y	3x2y	2 2

Layer Selectors

Select % of hands: 10-handed iterative (default)

n/a

Select: any pair

Layer Properties

Weight: 100

First Suit: any Second Suit: any

Layer Range Stats

Hand Count: 132

Weighted % of Combined: 100.00%

Layer Range: (AA-77,AxKx-Ax9x,AxKy-AxJy,KxQx-KxTx,KxQy,QxJx)@100

Combined Range Stats

Hand Count: 132

Weighted % of Hands: 9.95%

Combined Range: AA-77,AxKx-Ax9x,AxKy-AxJy,KxQx-KxTx,KxQy,QxJx

George’s all-in range has 42% equity vs. the tightest folks that might only call with AA and KK. If we add AK suited to the calling range, his equity improves to 48% equity. Further, if he is called by a not unrealistic range of (AA, KK, AK) he actually has an equity edge, with 57% of the chips in the middle expected to come his way on average. Similar things happen when the calling range is expanded to include (AA, KK, QQ) with a 55% equity edge for George. Facing a range where some equal strength holdings play a mixed strategy, of (AA, KK, A♥ K♥ , A♠ K♠ , Q♦ Q♠ , Q♥ Q♦) provides George with 50% equity.

Consider that even against (AA, KK) only, George is not doing too badly with 42% equity. Sure, if he shoves 100bb he has a negative expectation (in big blinds or bb) of about 16bb: 100bb* .42-100bb (1-.42) = -16 bb with no dead money present. To understand this, suppose George and his opponent both put in 100bb stacks making the pot 200bb. If instead of running the cards, they decide to do an equity chop, George would get back 42% of the 200bb or 84bb and would have lost 16bb in the transaction, not 8bb that might seem intuitive.

While this seems concerning, consider how often is he called? He will often scoop up some dead money when he gets the frequent folds given his very aggressive action. There are 1,326 unique starting hands in no-limit hold ‘em of which only twelve are (AA,KK) appearing only 0.9% (100*12/1326) of the time for an individual. Consider George shoving his all-in range UTG at a nine-handed table. No one has a calling hand over 90% of the time in a limped pot, neglecting some card removal and positional issues. He makes back most of the 16bb he loses when he is called by (AA,KK) as he scoops 1.5bb 91% of the time: .91*1.5bb – 0.09*16bb=-.075bb. Frequently there will be some extra dead money and George likely turns a small profit. The counter strategic adjustment of only calling AA versus George has his equity falling roughly in half, but the frequency of a range of only AA also is half compared to the (AA, KK) range and the math is quite similar.

Even if someone opens UTG, they won’t be able to call his shove very often. Imagine they tightly open to 3bb with 10% of hands, imagine they only call with (AA,KK). This will happen in 12/132 trials or 9% of the time, and George picks up the 4.5bb (that includes the blinds) the other occasions. His expectation when called is -15.6 bb (including the dead blinds). But this only happens 1/11 times giving him a winning expectation of

2.6bb under these assumptions. Thus, the George strategy is unexploitable in a vacuum (not considering how it impacts the play of his other holdings) -- there is nothing his opponents can do to stop him from pursuing this strategy profitably. A reasonable strategic adjustment is to only call AA vs. George's all-ins. Note KK alone has only 37% equity vs. the George range due to card removal effects - it means George is much more likely to hold AA.

In live poker, these worse case scenarios, only a range of (AA, KK) calling, are unlikely. Anyone finding themselves in such a game is not good at choosing games to play in. There are also substantial theoretical issues with depleting our opening and limping ranges of these strong hands. In practice, this would make almost no difference in live poker where very few players seek to actively counter exploit or follow opponents' detailed ranges. Also, let's not forget George was not previously making money with AA, KK and AK - they were all trouble hands for him playing deep stack no-limit hold 'em cash games. Considering the value of a strategy demonstrates the power of calculated aggression in the form of range construction in no-limit hold 'em. George can play algorithmically and profitably with his all-in range, albeit with some variance that itself makes him dangerous to confront. In practice, George chose to keep his strategy, going down with the ship for his whole stack with AA and seemingly reveled in the pain of cursing the bedeviling F***ING AK.

George lived believing poker is mostly luck, which is also not untrue in some senses. Nonetheless, let's analyze the Duckman's fortunes and see if the Duckman range (AA, 22) can be quacked. The Duckman strategy is a classic example of betting large with a highly polarized range, including only the largest and smallest pairs. Pairs generally have similar equity to unpaired hands that consist of over cards, have dominating performances vs. even suited connecting undercards, and are themselves similarly dominated by overpairs with roughly 80/20 equities in the later two cases.

Thus, it seems the Duckman is onto something. A near symmetry exists suggesting that any pair that calls his all-in between the 22/AA will break about even, winning ~80% when it dominates and vice versa. Similar considerations leave hands like A♠ K♠ , J♥ T♥ in bad shape, flipping with ducks and crushed by Aces. A♠ K♠ benefits some from card removal, facing AA less often as it reduces the number of combinations of AA from six to three, but is still a loser with 37% equity. Duckman's range construction, using (AA,22) shows the desirability of including the strongest "nutted" combinations in a range, they "protect" the player and make opponents proceed with caution - preflop AA is the nuts and similar considerations apply to nutted holdings on later streets where hole cards interact with board cards in more complex ways.

So how can we proceed vs. the Duckman? The simplest counter is to only play AA giving us 77.6% equity vs. the dreaded Duckman range. This is not such a big problem for the Duckman because AA occurs only rarely versus his range. Suppose he goes all-in UTG with (AA, 22). How often will another player at a nine-handed table have AA? When Duckman has AA, it only occurs for each player one time in (50*49)/2 = 1,225 times, under 0.1% of the time; they will each have 50% equity when this happens. When Duckman has 22, there are 6/1,225 combinations of AA and someone will have them about 0.5% of the time. Duckman has AA half the time and 22 the other half. Thus, Duckman won't get called more than 99% of the time.

Suppose Duckman goes all-in with 100bb UTG. Half the time he has AA and his expected value is almost 1.5bb as he almost always scoops the blinds and in the rare case when called he is against AA and splits the pot on average. The other half the time, the mighty Duckman has 22 and his expected value is roughly 1.5*(.995) - 0.78*100*(.005) + 0.22*100*(.005) = +1.2bb. This gives his UTG all-in an expectation of about 1.35bb. This is almost a worst-case scenario for our fine feathered friend as there will often be dead money in the pot as we considered for George above. Therefore, the Duckman can afford this strategy even on an academic salary and proceed swimmingly.

Now, clever folks out there might note that while KK is a slight underdog to the Duckman range, middle pairs from (55-QQ) are very slight equity favorites because they can make straights both up and down. But if we attack the Duckman range with these holdings we are open to counter-exploit by slow played superior pairs, making for complicated dynamics and messy equilibria. Practically speaking, Duckman need not worry about such considerations and can waddle forward with confidence. A last consideration is that one might consider prior action in deciding whether to call the Duckman with a middle pair, say closing the action. If there have been several prior folds, it is more likely the deck is rich in Aces than deuces, thus implicitly strengthening the Duckman's range. Poker is a game of incomplete information and all actions serve to provide an astute player with insights. In summary, I say to my colleague the Duckman, your strategy is scientist approved – get quacking. Good luck!

As an aside, I have an interest in poker theory. I believe that the nature of the optimal solutions is not yet completely understood. It seems to me from an information theoretic perspective that bet sizing should draw from distributions, providing information hiding. Solver work suggests this might be right. I also see an analogy between (statistical) mechanical energy and expected value in that the solution space of poker is a surface of constant expected value. Lastly, I have noted that the game theoretical optimal strategy is the one the requires no information of the opponents play suggesting a Shannon entropy tie in. All of this suggests to me a statistical mechanical approach to poker solutions that I have not formulated. If anyone is interested pursuing this feel free to get in touch.

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Brian Space is a scientist and professor seeking people to play Quantum Statistical Mechanics for money. He plays poker in the Tampa Bay Florida area. His poker articles are available on his web site: http://drbrian.space/poker.html