Lecture 2: Pot Odds

Basic Pot Odds

Why do we need to learn about pot odds?

In the last lecture, the "Fundamental Theroem of Poker" was introduced and explained. We determined that, according to the fundamental theorem of poker when we are playing poker, in general "we should be betting in a way which offers our opponents incorrect odds to call when we are winning in a hand, and we should fold whenever we are losing in a hand and our opponent offers us incorrect odds to call". Since according to this definition, pot odds are central to understanding and applying the fundamental theorem of poker, we will therefore need a good understanding of pot odds in order to learn to play profitable poker.

What are odds of winning a hand?

All odds are expressed as ratios, for example, 2:1 or 4:1. Odds are often used to calculate your chances of improving in a hand. For example, if you are drawing to the nut flush draw after the flop, your odds of hitting a flush on the next card are 4.1:1. This ratio expresses how many times we will miss our hand for every time we will hit it. So, when we hear that our chances of hitting are 4.1:1, we can think of it like this: For every 1 time we will hit our hand on the next card, we will miss our hand 4.1 times. Conversely, if it is our opponent that is drawing to a flush, we will know that for every 1 time our opponent outdraws us on the next card, we will hold 4.1 times.

Here are some common odds for hitting a hand on the next card:

Drawing to:

- Open ended straight – 4.8:1
- Flush Draw – 4.1:1
- Gutshot straight draw – 10.5:1
- 2 Overcards – 6.7:1
- A set – 22:1
- One pair, drawing to two pair or trips – 8.2:1

We can also calculate odds by the number of outs we have. To do this you take the number of cards left in the deck, then minus the number of outs you have. Divide the answer by the number of outs you have to get your odds. The number of cards remaining in the deck is always the number of *unseen* cards. So you don't count the cards that have been dealt to opponents as you don't know what these cards are. So for example, if you are drawing to a diamond flush draw on the turn, you take: 52 cards in the deck minus the 2 in your hand, minus the 4 on the board = 46. The number of outs you are drawing to will be 13 diamonds minus the 2 in your hand, minus the two on the board = 9. So we take 46 – 9 = 37. Then divide 37 by 9 = 4.1. So your odds of hitting are 4.1:1

In real life, these odds are complicated by a huge variety of factors, such as the fact that sometimes when you hit your hand your opponent will have hit a better hand, or will have a redraw. Or, board texture for drawing to overcards, dominated top pair hands, etc. The list is huge. For now just continue to think about it as if we were playing poker with the hands face up, as we were when thinking about the fundamental theorem.

What are pot odds?

Pot odds are odds concerning bets and the amount of money in the pot. To calculate our pot odds, we take the total amount in the pot (including our opponent's bet) as the first number, and the amount we have to call as the second number, then reduce it down. For example, if there is $100 in the pot and our opponent bets the pot at us, the pot now contains $200 and we have to call $100. So the pot odds we are being given are 200:100, which reduces to 2:1. Our pot odds in this case are therefore 2:1. These odds are also known as *expressed odds*. We can also think of this ratio as telling us how much we win for how much we lose. When we lose, we lose $100. When we win, we win $200.

How can we use these odds?

We need to compare our odds of winning to the odds the pot is giving us in order to see whether we are making good calls and good bets. In order to make a break even or profitable call, we need our odds of winning to be equal to or greater than the odds the pot is giving us.

Lets take the example from above where our opponent bets $100 into a $100 pot. Our pot odds are 2:1. Lets assume that we also have 2:1 odds of winning the hand. Now we know that when we win, we win $200, and when we lose, we lose $100. We also know that we will win 1 time for every 2 times we lose. So, doing the maths:

- We win 1 time x $200 = + $200
- We lose 2 times x $100 = - $200

In total over 3 hands we make a profit of $0 on the hand. In order to get our *expectation*, or *expected value* of the hand, we divide the total by the number of times we have played, in this case 3. In this case, our expected value from the hand is still $0. It is a break even call. Expected value gives you an average profit or loss that you make for each hand.

Now lets change our odds of winning to 4:1. Doing the maths on this:

- We win 1 time x $200 = + $200
- We lose 4 times x $100 = - $400

So our call is now unprofitable. We will expect a total loss of - $200 for the hand over 5 hands, and an expected value of -$40 on the hand.

Now we can fully understand the role pot odds play in the fundamental theorem of poker. If we call when we are getting incorrect odds to do so, or offer our opponent the correct odds to draw, we are making mistakes and therefore our opponent will gain. If we fold when we are getting incorrect odds to draw, and get our opponent to call with incorrect odds, we will gain.

Implied Odds

What are implied odds?

To make things more complex, expressed pot odds are not the full story. Expressed odds assume that there is no more betting to come, and therefore that the amount you will win is the amount that is currently in the pot. Of course, in real life, often you will be able to win another bet or two from your opponent when you do hit your hand. Implied odds, then, are odds that take into account future betting. Implied odds are often the real odds you need to calculate when thinking about your hand. Instead of taking the ratio of the pot to the call you have to make, you should instead take the ratio of what the total pot will be to the call you have to make.

Lets take the example from above where you are 4:1 to win the hand, and are being given pot odds of 2:1. Now lets say that, when we hit our hand, we will be able to bet the pot again, and get a call. Our pot sized bet on the river will therefore be: $200 in the pot, plus our $100 call = $300. The total pot we will win is therefore $500 (the $200 currently in the pot, plus the $300 we will win on the river). So our implied odds are 500:100, or 5:1. Now we can see that our unprofitable call has turned into a profitable one. Doing the maths:

- We win 1 time x $500 = $500
- We lose 4 times x $100 = - $400

Our expectation on the hand has changed from - $200 to + $100 over 5 hands, and our total expected value has changed from -$40 to +$20. So if we know our opponent will call a bet on the river, we can now profitably make the call on the turn. Instead of just assuming we should fold all the time when given incorrect expressed pot odds to call, we should take our interpretation of the fundamental theorem to mean that we should fold when we are not getting the correct implied pot odds to make the call. We should also remember our opponents implied pot odds when we are looking to giving them the incorrect odds to call. Often it will turn out that giving our opponent incorrect odds to draw will not be possible, as it would mean betting very large amounts to win small pots. The simplest way of reducing our opponents implied odds is to be capable of folding more often when they have hit a hand that beats us. That way, we can simply offer our opponent incorrect expressed pot odds to draw to their hand, and know that they are making a mistake by believing they have the implied odds to call and outdraw us.

Why shouldn't we try to give our opponent incorrect implied odds to call?

Well, lets look at a situation where our opponent is drawing to a flush draw on the turn. Again, the pot will be $100. Now lets say both us and our opponent have $1000 stacks.

Since I know that my opponent can win a pot sized bet on the river if he hits his hand, why shouldn't I just bet, say, $500? In this case, my opponent will be offered incorrect implied odds in the hand. His implied odds work out to be 2.2:1, so he will not be able to make a profit on the hand by calling this bet with a draw.

Well, if our hands are face up, that bet would be fine (probably not optimal, but profitable). Since we know our opponent is drawing to a flush, we can now offer him incorrect implied odds to make this call. However, in real life, we can't see our opponent's cards. Now we are faced with a situation in which *some of the time* we will be betting against an opponent with a flush draw, but *some of the time* we will be betting against an opponent with a made hand. And *some of the time* his made hands will be better than our hand. The danger is that when we bet $500 into a $100 pot, my opponent will fold all his weaker hands and all his draws, and call only when he has us beat. The first obvious problem with this is that it runs contrary to the fundamental theorem of poker; we are allowing our opponent to make the correct play and fold when we have him beat. The second problem is connected to this; we will win $100 some of the time, when he folds, but when he calls we will lose $500, or worse, our whole stack on later streets. Even if we NEVER put in any more money when called, our opponent only needs to

have a better hand than us more than 1 time in 5 for us to be making a loss on the hand.

Reverse Implied Odds

What are reverse implied odds?

Reverse implied odds are basically the opposite of implied odds. They deal with future rounds of betting or situations where we stand to win a small pot when we win, but lose a big pot when we lose. The above example is an example of a reverse implied odds problem. A simpler example of a reverse implied odds problem is the flipside of the example we considered when thinking about implied odds. When we discovered that our implied odds gave us a profitable call, we also know that in this situation our opponent has *bad reverse implied odds*. When we miss our our flush, we don't put in any more money, so our opponent wins a small pot when he wins. But when we hit, our opponent puts in more money, so loses a big pot.

What kind of situations do reverse implied odds apply to?

Reverse implied odds apply to any situation where we stand to win a small pot when we win, but lose a big pot when we lose. The most common hands with bad reverse implied odds are hands that are easily dominated.

Hands like KJ, and weak Ax hands generally have bad reverse implied odds. In general, when we hit top pair on the flop, our opponent will fold all his worse hands (all non-top pair hands), and we will win a small pot. But when he continues and wants to put a lot of money in the pot, he will often have a better top-pair hand that dominates our hand.

Weak draws and made hands are also often dominated. On a T98 board you might want to put in a lot of money with my 76. But you'll lose a lot of money when your opponent already has a higher straight, or hits a J or Q for a higher straight, and wont win much money from his weak pair hands. The same goes for hitting a small flush.

Odds and Problems

How do odds relate to the concept of "Equity"?

Last lecture we also introduced the concept of equity to help define what it means to be "winning in a hand". In this lecture, we've used "odds of winning" for the same purpose. "Equity" and "odds of winning" are equivalent mathematical ideas. The reason we've used odds of winning in this lecture is that when you are actually playing at a table it's much easier to simply compare odds of winning to your pot odds than it is to work out from your equity what pot odds you should call. However, when you are putting in work away from the table, "equity" turns out to be a much more useful concept.

Why is equity more useful than odds?

Odds turn out to have a variety of problems with their application to the fundamental theorem of poker. Odds are best used with situations in which all the variables are known. If we know what our opponent's hand is, we can work out exactly what our odds of winning are. But poker is a game of incomplete information; we can't ever know this for sure. Sometimes what we think are outs will in fact give our opponent a better hand. And odds just aren't really versatile enough to be able to carry out calculations for what is true "some of the time". A similar problem is with implied odds. If we can know for sure whether our opponent will call our bet on the river, we can know what our implied odds are. But in real poker situations, our opponent will call some of the time and fold some of the time. Some of the time his hand will be too weak to call a bet on the river, or he may have been bluffing on the turn and now has to fold. These situations make it very difficult to use odds to give anything but a rough approximation of what our true odds are. (n.b. equity being a simple percentage makes it far easier to calculate for these types of situations. Since odds of winning and equity are equivalent mathematical concepts, you can also work this out in terms of odds. It's just more difficult for most people.)

Calculating expectation from equity

Earlier, we showed you how to calculate your expectation, or expected value from a hand using pot odds. The same calculations can be easily made using your equity instead. Here's how to do it:

You take the amount you win when you win the pot, divide it by 100, then multiply it by your equity in the hand. Then you take the amount you lose when you lose the pot, divide it by 100, then multiply it by your opponents equity (or for multiway pots, 100 – your equity). The sum of these will be your expected value from the hand. So, for an example in which we have to call $100 into a $200 pot, where our equity is 33.33%:

- ($200 / 100) * 33.33 = + $66.66
- ($100 / 100) * 66 = - $66.66

Here our play has an expected value of $0. Our call is again break-even. So you should be able to see how odds of winning relate to equity: odds of winning of 2:1 is the same as having 33% equity in a hand.

Converting odds to equity

To convert your odds to equity, all you need to do is to divide 100 by the sum of both sides of the odds ratio, then

multiply by the second half of the ratio. So for the example of your being 2:1 to outdraw someone:

- 100 / (2 + 1) = 33.33

So your equity is 33.33%.