15.S50 - Poker Theory and Analytics

Basic Strategy

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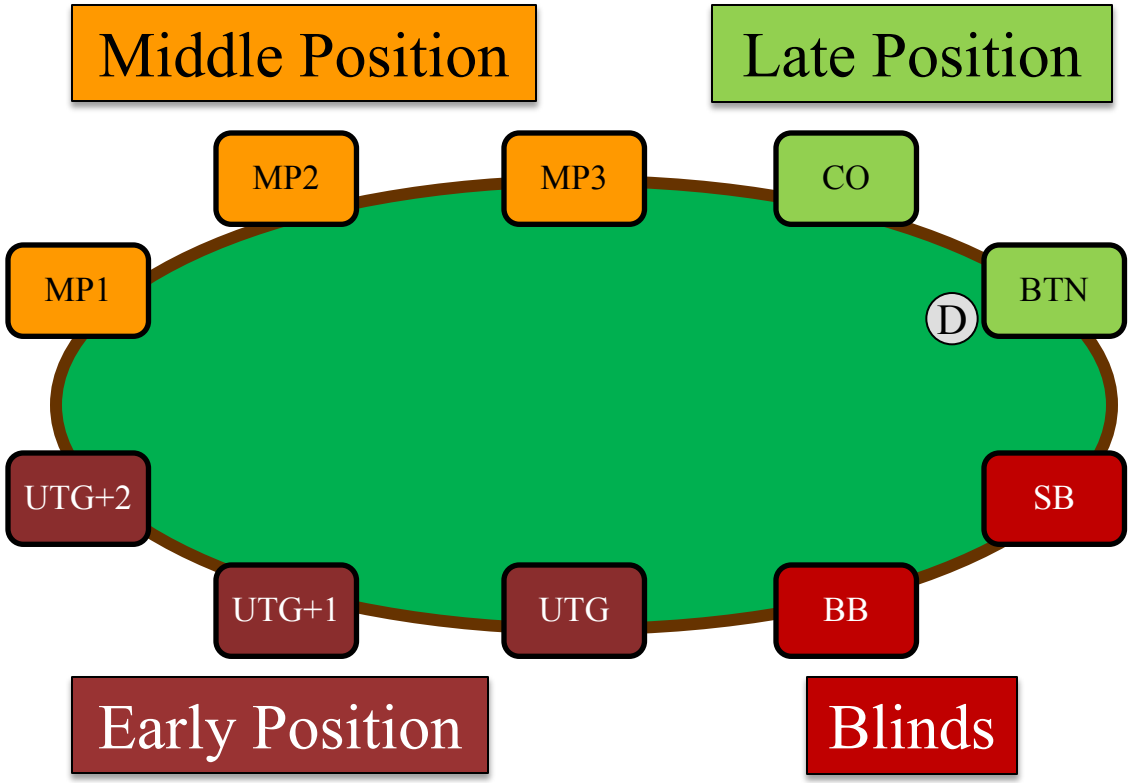
MITpokerClass

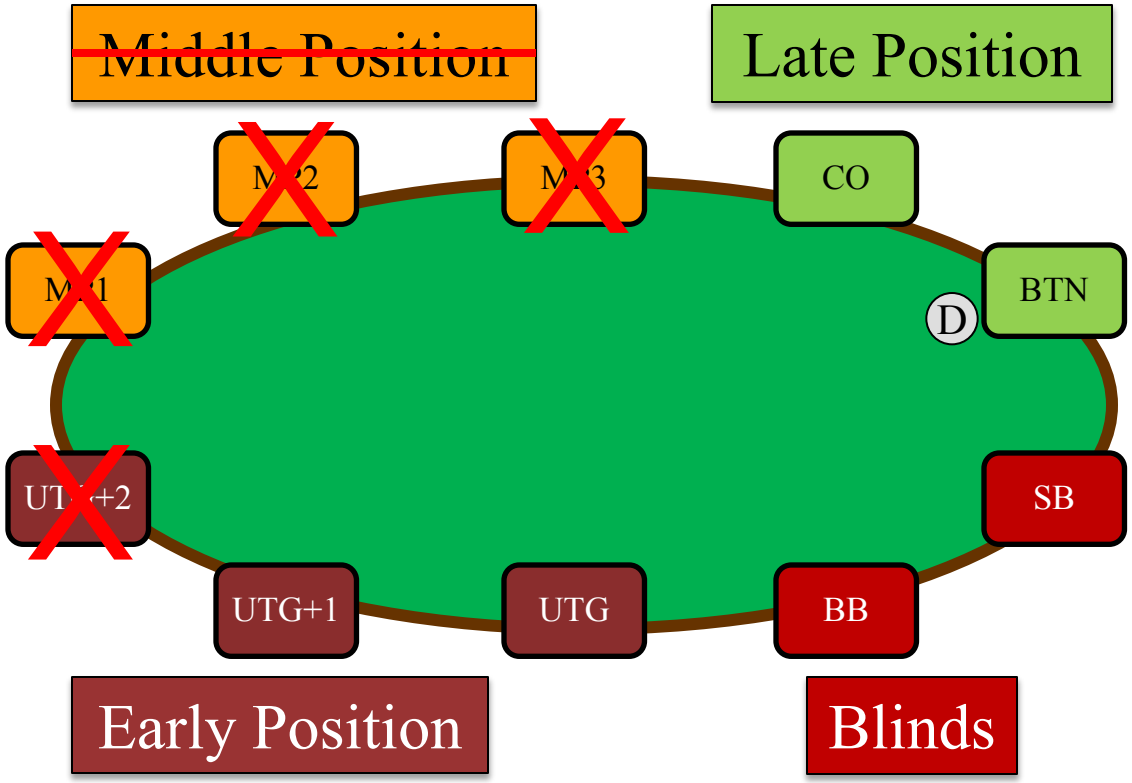
Basic Strategy

- Terminology – Position
- Pot Odds
- Implied Odds
- Fold Equity and Semi-Bluffing

Position Terminology



Position Terminology (6-handed)



Position Basics

- In general, later position is preferred since you get more information before acting
- Playable hands are wider for later positions
- Blinds get a discount to see flops, but are in the worst position for every round thereafter
- Early position offers more opportunity for aggression, and is preferred in some low-M situations
  - e.g. in the “Game of Chicken” situation, first actor gets to “throw the steering wheel out the window”

Basic Strategy

- Terminology – Position
- Pot Odds
- Implied Odds
- Fold Equity

Why do odds come into play?

- Common situation is weak made hand vs drawing hand
  - i.e. pair or two pair on flop vs straight or flush draw
  - Or pocket pair vs anything else pre flop
- Drawer has to balance chance of hitting draw vs how much each addition card costs
- Made hand wants to
  - Bet enough for the drawer to not have a +EV call
  - Bet an amount that bad players might mistake as good odds

Pot Odds


Post Ante
LEAVE TABLE
VIEW LOBBY
gfro47666
$2110
John_VH925
$490
xandilino
$950
$80
MateyDmitriy
$910
BonhamNReno
$930
GOOSE BAY Z
$930
Dobby2
$1150
Chat
Notes
Stats
Info
Last Action
Desmond_MIT posts the ante


LEAVE TABLE
VIEW LOBBY
gfro47666
$2110
Desmond_MIT
$370
xandilino
$950
$370
$380
All In
MateyDmitriy
$910
GOOSE BAY Z
$910
Chat
Notes
Stats
Info
BonhamNRend
$930
Dobby2
$1110
Last Action
John_VH925 is All-in

Pot Odds

John_VH925 (UTG+1): $500 **Blinds 20/40 + 10**
Hero (MP1): $500

Pre Flop: ($140) Hero is MP1 with A♥ T♥
1 fold, John_VH925 raises to $120, Hero calls $120, *5 folds*

Flop: ($380) 8♥ 3♥ K♣ (2 players)
John_VH925 bets $370 all in, Hero…

Should the hero call?

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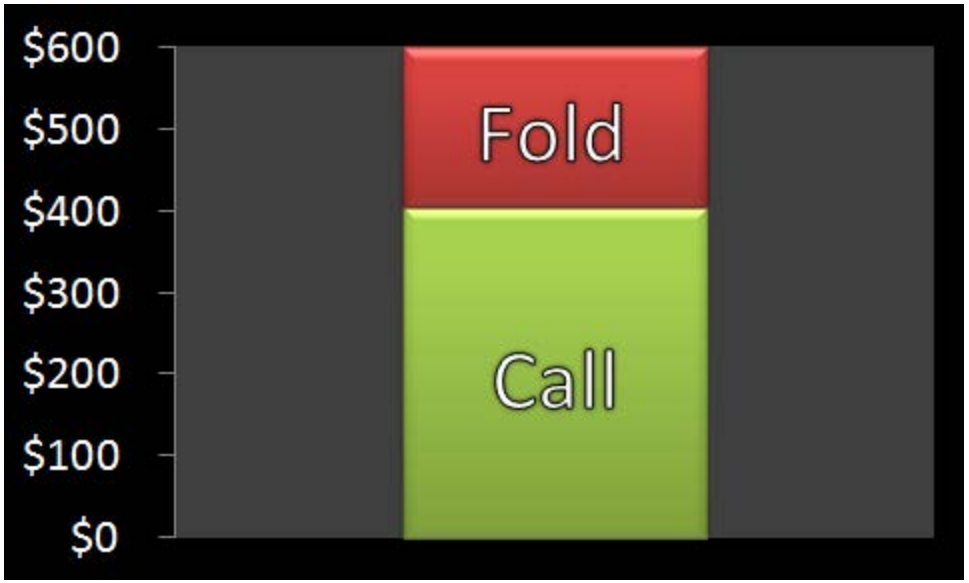
Pot Odds

- **What is the maximum bet the hero should call?**

Bet Size



Concept – Expected Value (EV)

- Expected Value is the probability-weighted average of possible results
- EV = Win% * WinAmt - Lose% * LoseAmt
- For example,
  - If Win% = 25% and you are facing a $60 bet into a pot of $100
  - EV = 25% * (100+60) - 75% * 30 = 17.5
- In general, decision rules will be made based on Expected Value
- In Scenario A,
  - our Hero is facing a bet into a pot of $380
  - EV = W% * (380 + *x*) - L% * *x*
  - Calling threshold is at EV = 0

Concept – Pot Odds

- Pot Odds are the relationship of the call amount to the size of the pot
- In general, a call will be +EV if Win% > CallAmt/(PotAfterCall)
- For example in our scenario,
  - If the bet were $100 into pot of $380
  - Pot Odds would be $100/$580, where $580 = (Pot + Bet + Call)
  - Hero's call contributes ~17% of the pot
  - He can profitably call if Win% > 17% of the time
- Win% is based on "Outs" (cards that result in a win)
- Outs are 9 hearts to hit flush
- Win% = 1 – (40/49 * 39/48) ≈ 34%. This gives us the odds to call
- EV = 34% * $480 - $100 * 66% = $97.2

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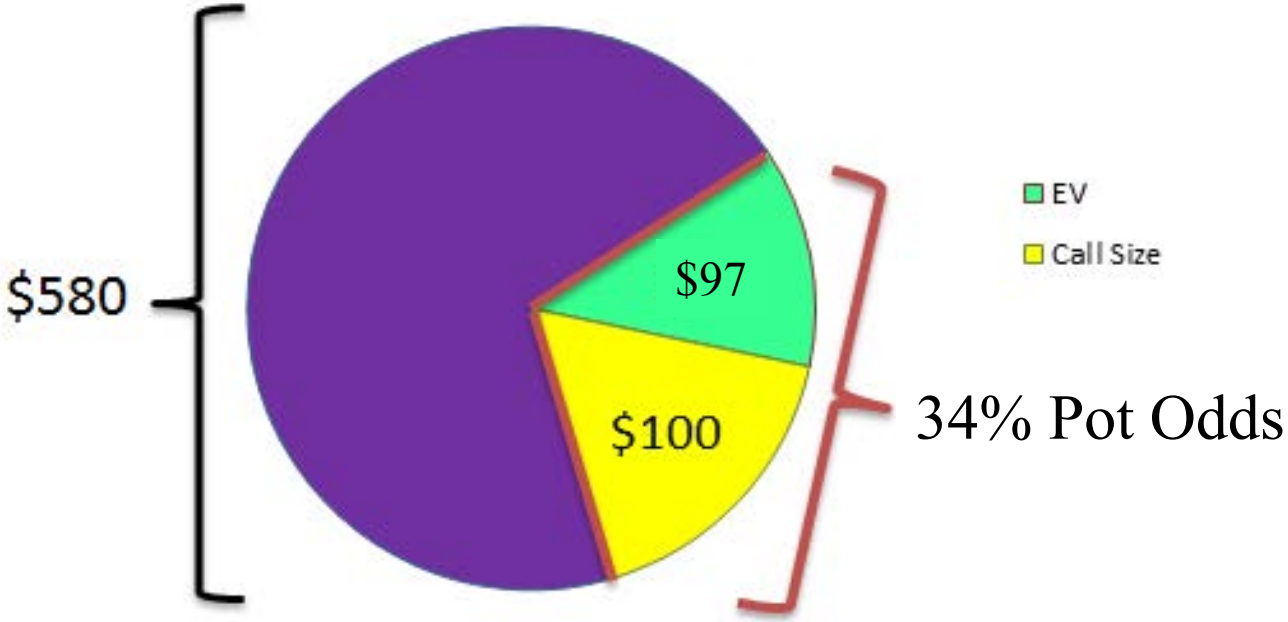
Concept – Pot Odds



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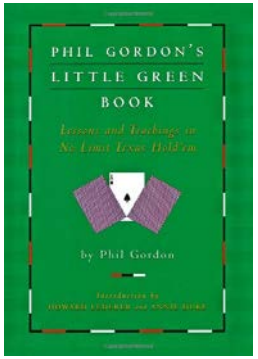
Pot Odds – Gordon's Rule of 2 or 4

- Phil Gordon
  - Fourth Place in 2001 WSOP ME
  - One WPT title
  - Win Two North American Bridge Championships
  - Head Referee World Series of Rock Paper Scissors
  - Author of *Phil Gordon's Little Green Book*



Buy at Amazon Gordon, Phil. *Phil Gordon's Little Green Book: Lessons and Teachings in No Limit Texas Hold'em*. Simon Spotlight, 2005.

Pot Odds – Gordon's Rule of 2 or 4

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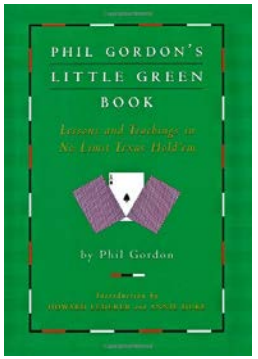
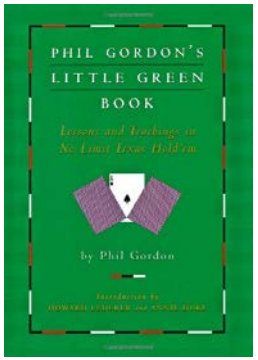
  - Author of *Phil Gordon's Little Green Book*



- Each Out is worth about 2% equity per card
- If you get to see both turn and river, use 4% per card
- For example, if have a low pair on the flop and are drawing to three-of-a-kind, you have 2 outs or about 4% to make your hand on each card.
- Other common examples include:
  - Flush Draw (9 outs) gives you odds of 9/47 ≈ 18% = 9*2%
  - Inside Straight Draw (4 outs) gives you odds of 4/47 ≈ 8% = 4*2%

Pot Odds – Gordon's Rule of 2 or 4

- Phil Gordon
  - Author of *Phil Gordon's Little Green Book*



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- Other common examples include:
  - Flush Draw (9 outs) gives you odds of 9/47 ≈ 18%
  - Inside Straight Draw (4 outs) gives you odds of 4/47 ≈ 8%

Concept – Pot Odds

- Breakeven is when EV = 0

- Bet is *x* into a pot of $380
- Chance of hitting flush is 9 Outs * 4% (since we get both cards)
- Win% ≈ 36%
- Exact Win% = 1 – (40/49 * 39/48) ≈ 34%.

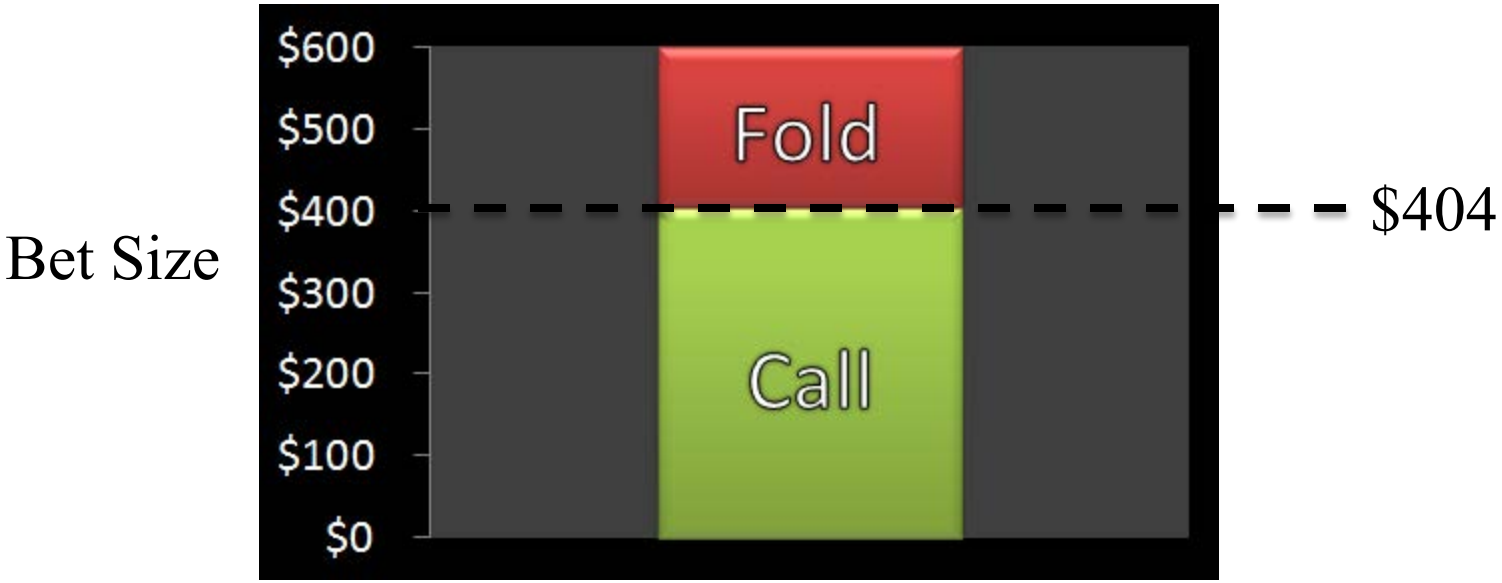
- EV = 34% * ($380+*x*) - 66% * *x* = 0 at *x* = $404

- **So the maximum bet we should call is $404**

- Check with 404 / (404*2 + 380) ≈ 0.34

Solution Set

- Our Hero should call any bet **up to $404** and fold to anything larger



Practical Solution

John_VH925 (UTG+1): $500 **Blinds 20/40 + 10**
Hero (MP1): $500

Pre Flop: ($140) Hero is MP1 with A♥ T♥
1 fold, John_VH925 raises to $120, Hero calls $120, *5 folds*

Flop: ($380) 8♥ 3♥ K♣ (2 players)
John_VH925 bets $370 all in, Hero…

Should the hero call?

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Practical Solution

- In real time: Our Hero knows he will hit the flush about 36% of the time, so he can profitably call up to 36% of the new pot. In the case of a $370 bet, the Hero will decide to call since the new pot will be 380 + 370 + 370 = 1120 and his contribution is 370/1120 (33%), which is less than his chance of winning (36%)

More Examples

Villain (MP): $250 Blinds 20/40 + 10
Hero (BTN): $1000

Pre Flop: ($140) Hero is BTN with 6♦ 7♦
Villain raises to $90, Hero calls $90

Flop: ($320) 8♠ 5♥ K♣ (2 players)
Villain bets $150 all in, Hero…

More Examples

1. What are we drawing to?
   - Straight (open-ended)
2. What are our outs?
   - Any 9, any 4 (8 cards total)
3. Chance of hitting draw?
   - 8 * 4% = 32%
4. Correct play?
   - Call, since call is 150 of 620 or 24%
5. EV of decision?
   - 32% * 470 - 68% * 150 = 48.4

More Examples

Villain (MP): $3000 **Blinds 100/200**
Hero (BTN): $3000

Pre Flop: ($300) Hero is BTN with 5♦ 5♥
Villain raises to $400, 2 calls, Hero calls $400

Flop: ($1900) 5♣ A♣ 6♣ (2 players)
Villain bets $200, 2 folds, Hero…

More Examples

1. What are we drawing to?
   - Full House or 4-of-a-kind
2. What are our outs?
   - 3x A or 6, 1x 5 (7 cards total)
3. Chance of hitting draw?
   - 7 * 2% = 14%
4. Correct play?
   - Call, since call is 200 of 2300 or 9%
5. EV of decision?
   - 14% * 2100 - 86% * 200 = 122

More Examples

Villain (BB): $200 **Blinds 100/200**
Hero (SB): $1000

Pre Flop: ($300) Hero is SB with 5♣ 7♥
Hero…

More Examples

1. What are we drawing to?
   - Anything
2. Chance of hitting draw?
   - 57o vs ATC ≈ 40% [32o vs ATC ≈ 32%]
3. Correct play?
   - Call, since call is 100 of 400 or 25%
4. EV of decision?
   - 40% * 300 - 60% * 100 = 60

Basic Strategy

- Terminology – Position
- Pot Odds
- Implied Odds
- Fold Equity

Implied Odds – Hand Rules

- We are trying to find the amount of chips we need to win **after hitting our draw** to make the bet we are facing a good call
- We do this by figuring out what the pot would have to be after our call to make our *x*% chance of winning equal to the *x*% of the pot for the call
- For example, if we have a flush draw (18% to hit), and we are facing a bet of $180 into a pot of $300, then our call represents $180/$660 = 27% of the pot (i.e. too expensive to call)
- This would be a good call if we contributed 18% of the pot, or $180/$1000. So we need to find $1000 – $660 = $340 in dead money
- The additional **$340** after the draw makes our **$180** bet worth **18%** of a **$1000** pot

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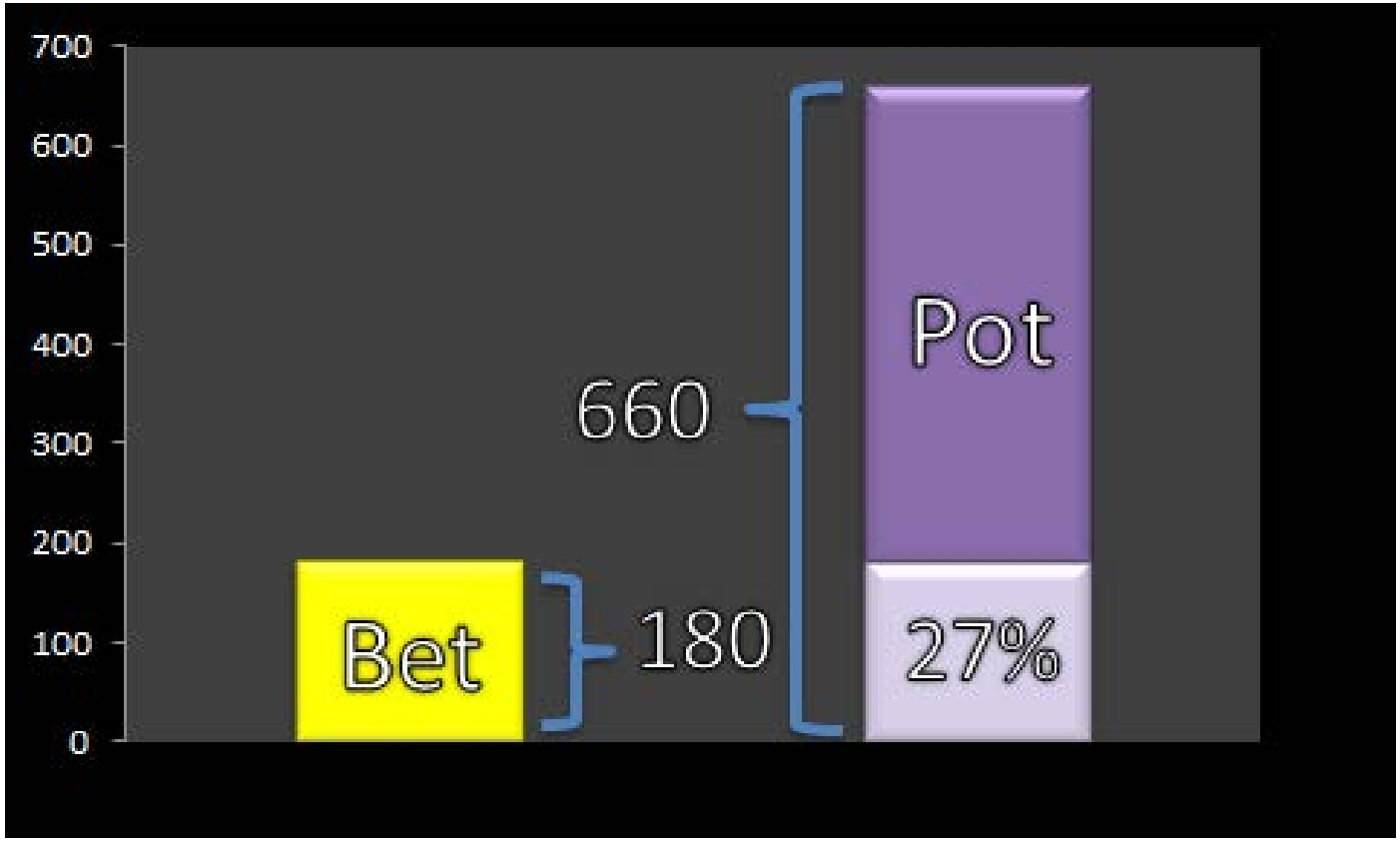
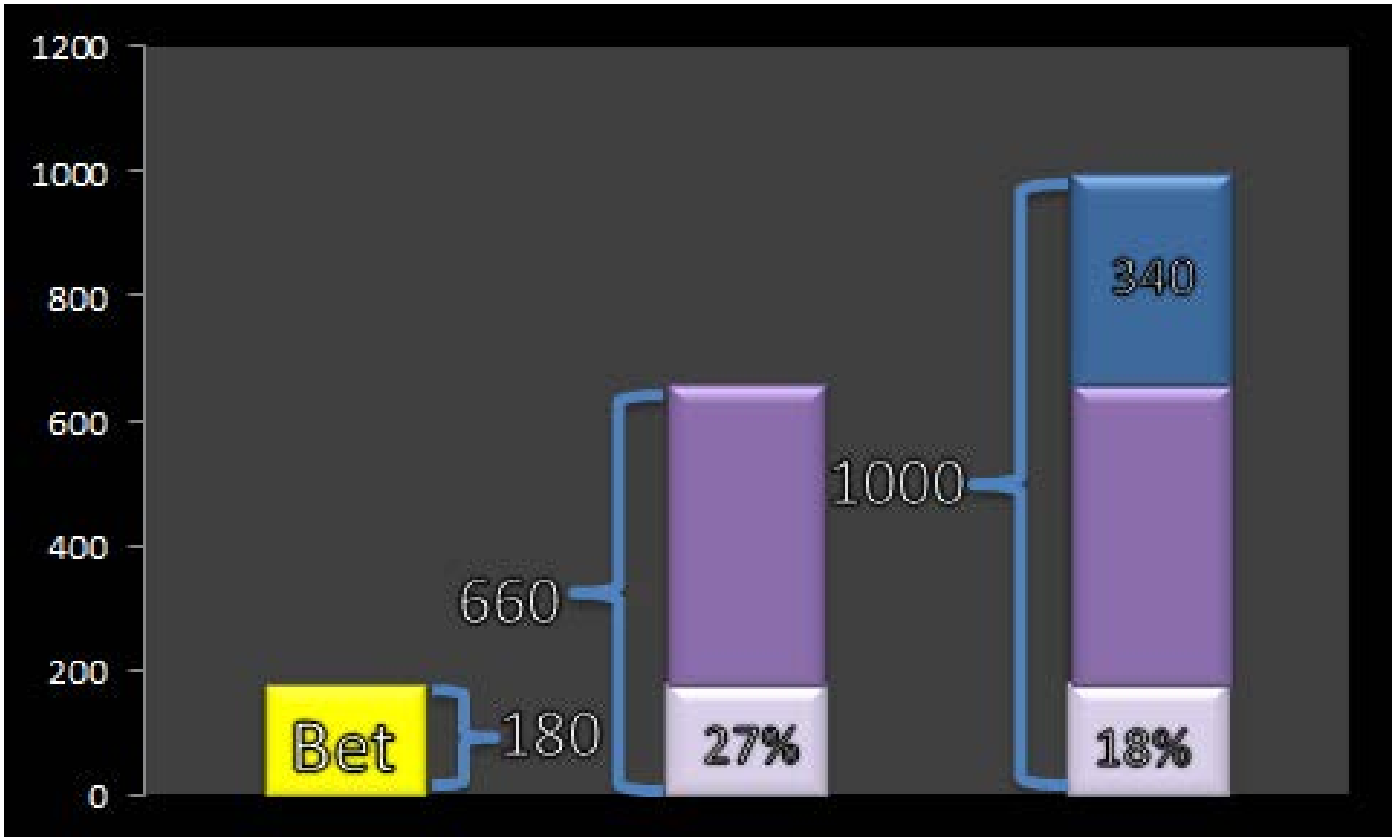
We need 18% for this to be a good call



We make our call 18% by adding $340 of dead money



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Implied Odds Examples

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Implied Odds Examples

Villain (MP): $3000 **Blinds 25/50**
Hero (BTN): $3000

Pre Flop: ($75) Hero is BTN with K♦ T♥
Villain raises to $150, *2 folds*, Hero calls $150, *2 folds*

Flop: ($375) T♣ A♥ 6♦ (2 players)
Villain bets $100, Hero…

Implied Odds Examples

1. What are we drawing to?
   - Two pair or 3-of-a-kind
2. What are our outs?
   - 3x K, 2x T (5 cards total)
3. Chance of hitting draw?
   - 5 * 2% = 10%
4. Pot odds?
   - $100 of $575, or about 17%, too expensive
5. Additional bets after draw to breakeven?
   - $100/10% = $1000 – $575 = $425 more

Implied Odds Examples

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Implied Odds Examples

Villain (MP): $3000 **Blinds 25/50**
Hero (BTN): $3000

Pre Flop: ($75) Hero is BTN with K♣ Q♣
Villain raises to $100, 2 folds, Hero calls $100, 2 folds

Flop: ($275) T♣ J♣ 3♥ (2 players)
Villain bets $600, Hero…

Implied Odds Examples

1. What are we drawing to?
   - Straight or Flush
2. What are our outs?
   - Any A, any 9, 7 other ♣ (15 cards total)
3. Chance of hitting draw?
   - 15 * 2% = 30%
4. Pot odds?
   - $600 of $1475, or about 41%, too expensive
5. Additional bets after draw to breakeven?
   - $600/30% = $2000 – $1475 = $525 more

Drawing Formulas

- EV (Marginal Value of Any Decision)
  - x = Win%*WinAmt – Lose%*LoseAmt
- Rule of 2 or 4 (Chance of Hitting Draw)
  - x = 2% * #Outs * #FreeCards
- Pot Odds (Decision Rule to Call Bet)
  - Win% > CallAmt/(Pot + BetAmt + CallAmt)
- Implied Odds (Additional Chips After Draw Hits Needed to Call)
  - x = (BetAmt / Win%) - (Pot + BetAmt + CallAmt)

Drawing Formulas (Example)

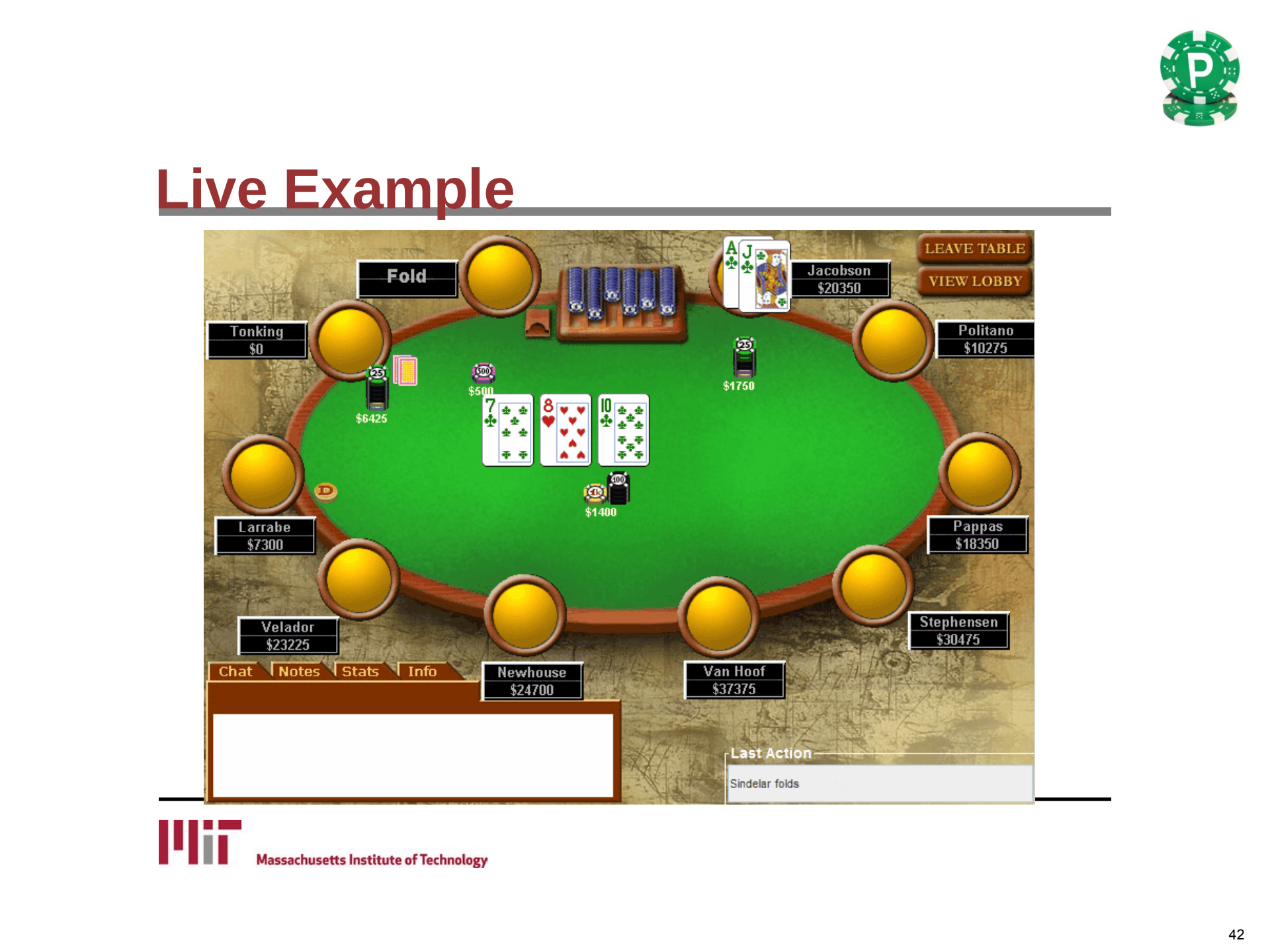
- EV (Marginal Value of Decision)
  - Calling a $150 bet into a $320 pot to have a 32% chance of winning
  - **$48.4** = 32%*($320+$150) - 68%*$150
- Rule of 2 or 4 (Chance of Hitting Draw)
  - You have 9 Outs to a Flush and get to see Turn (not River)
  - **18%** = 2% * 9 * 1
- Pot Odds (Decision Rule to Call Bet)
  - You are facing a $370 all-in bet for a $380 pot with a flush draw
  - 36% > $370/($380 + $370 + $370) = **TRUE**
- Implied Odds (Additional Chips After Draw Hits Needed to Call)
  - $100 bet into pot of $375 with 2-pair/3-o-a-k draw on Turn
  - **$425** = ($100 / 10%) - ($375 + $100 + $100)

Live Example

Live Example

- YouTube video:

  ManiaOFpoker. “World Series Of Poker 2014 Main Event Episode 14 HD 720p.” November 11, 2015. *YouTube*. Accessed May 1, 2014. https://youtube/Q1HkLjq-GGQ?t=23m24s



Live Example

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Live Example

Hero (UTG): 22,450k 150k/300k Blinds + 50k
Tonking (SB): 6,775k

Pre Flop: (950k) Hero is UTG with A♣ J♣
Hero calls 300k, *7 folds*, Tonking calls 150k, Sindelar checks

Flop: (1,400k) 7♣ 8♥ T♣ (3 players)
Tonking checks, Sindelar bets 500k, Hero raises to 1,750k, Tonking raises 4,525k to 6,275k all in, Sindelar folds

Hero…

Live Example

- **What are we drawing to?**
  - Flush, maybe straight
- **What are our outs?**
  - 2,3,4,5,6,8,9,Q,K of ♣ (9 cards) and maybe 9 of ♠ ♦ ♥ (3 cards)*50%
  - Count this as 10.5 outs
- **Chance of hitting draw?**
  - 10.5 * 4% = 42%
- **Correct play?**
  - Pot will be 1400k + 500k + 2*6,275k = 14,450k. Call amount is 4,525k or ≈ 31%. So call.
- **EV of Decision?**
  - EV = 42% * 9925k – 58% * 4,525k = 1544k

Drawing – Be careful about

- **Drawing to a hand that might not win at showdown**
  - i.e. a Q-high or lower flush
  - Or the low end of a straight
  - Or a flush/straight on a paired board

- **Assuming you will get to see turn and river for one bet**
  - This very rarely happens unless the aggressor is all-in
  - A lot of players will bet on flop with a draw to get this

- **Overestimating how easy it is to extract additional chips**
  - Flush draws hitting on turn/river are very easy to spot
  - Straight draws are less easy, hitting sets is difficult to see

- **Betting too little and letting other players make +EV calls**
  - Most flop, turn bets should be around half to 2/3rds of the pot

Basic Strategy

- Terminology – Position
- Pot Odds
- Implied Odds
- Fold Equity and Semi-Bluffing

Fold Equity


LEAVE TABLE
VIEW LOBBY
tigerlynn
$1468
cldimpulse
$3463
bsadi84
$865
Desmond_MIT
$840
xXmillzy25Xx
$2773
$350
Check
Chat
Notes
Stats
Info
Last Action
Turkito694 checks

Fold Equity

Turkito694 (UTG): $2098.00 Blinds $5/$10
Hero (CO): $990.00

Pre Flop: ($15.00) Hero is CO with 6♠ 7♠

River: ($350.00) A♦ 5♥ 8♦ Q♠ 2♦ (2 players)
Turkito694 checks
Hero bets $150…

How often does this bluff have to work to be profitable?

Concept – Fold Equity

- Fold Equity is the value a player gains from the likelihood that the other player will fold to his bet, assuming a call will result in a loss

- Fold Equity = Current Pot * Fold% - Bet * (1-Fold%)
  - If SD-Win% = 0

- Fold Equity = Current Pot * Fold% + (1-Fold%) * EV-if-Called
  - If SD-Win% > 0
- SD Value = (1-Fold%) * EV-if-Called

- **Bluffing** is a bet that is +EV because Fold Equity > 0
- **Semi-bluffing** is a bet that is +EV with negative Fold Equity offset by sufficiently high Showdown-Win%

Fold Equity

River: ($350.00) A♦ 5♥ 8♦ Q♠ 2♦ (2 players)
Turkito694 checks
Hero bets $150…

How often does this bluff have to work to be profitable?

Bet is 150 into pot of 350. Showdown-Win% = 0.

EV = 350 * Fold% - 150 * (1 - Fold%)

EV > 0 when Fold% > 150/(350+150) = 30%

Check with EV = 30% * 350 – 70% * 150 = 0

This seems +EV, given that Hero is representing a flush

Fold Equity

Turkito694 (UTG): $2098.00 Blinds $5/$10
Hero (CO): $990.00

Pre Flop: ($15.00) Hero is CO with 6♠ 7♠

River: ($350.00) A♦ 5♥ 8♦ Q♠ 2♦ (2 players)
Turkito694 checks
Hero bets $150…

How often does this bluff have to work to be profitable?

Semi-Bluffing – Impact of Win%

- Using our example:
  - BetAmt = 150
  - Pot = 350
  - $Fold\% = \frac{-2*BetAmt*Win\%+BetAmt-Pot*Win\%}{-2*BetAmt*Win\%+BetAmt-Pot*Win\%+Pot}$
  - Fold% = (13W% - 3) / (13W% - 10)

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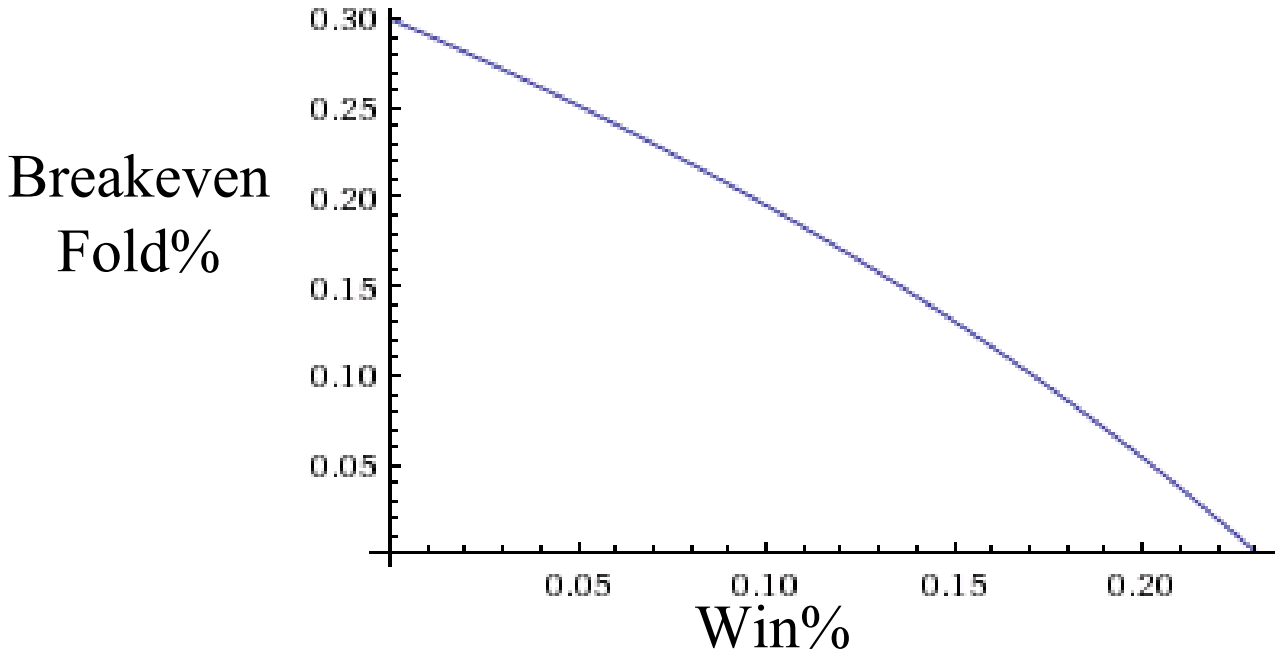
Semi-Bluffing – Impact of Win%

BetAmt = 150 Pot = 350

Fold% = (13Win% - 3) / (13Win% - 10)



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Semi-Bluffing – Impact of Win%

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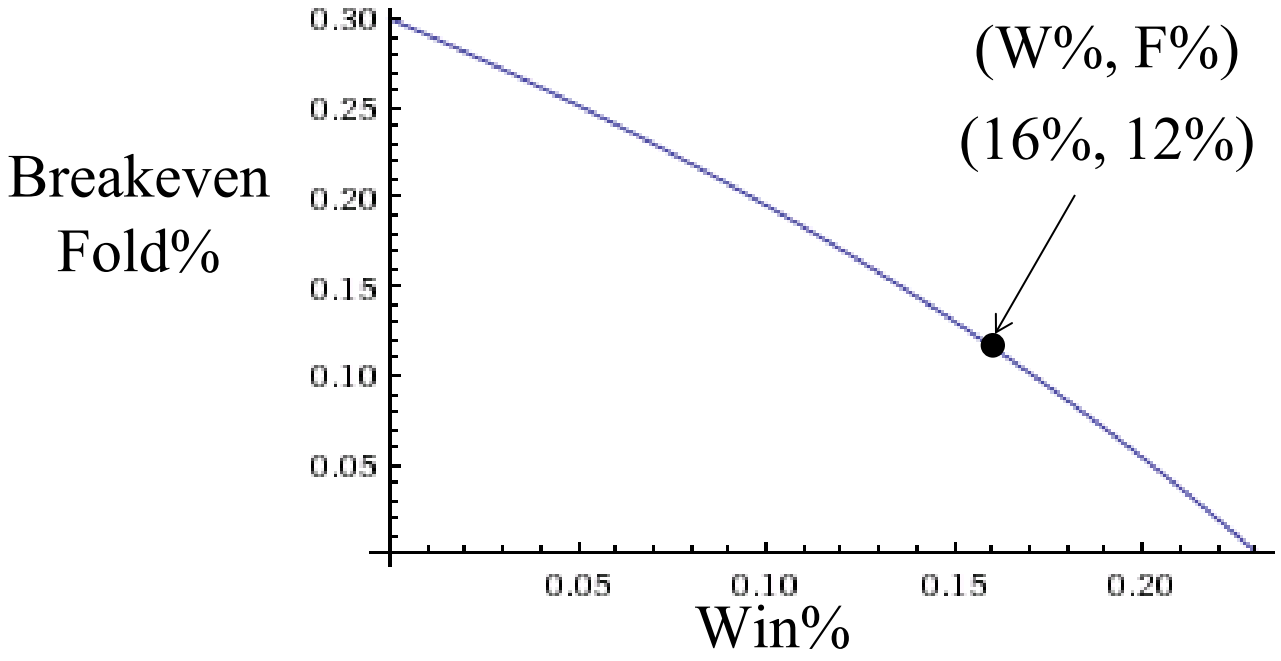

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Semi-Bluffing – Impact of Win%

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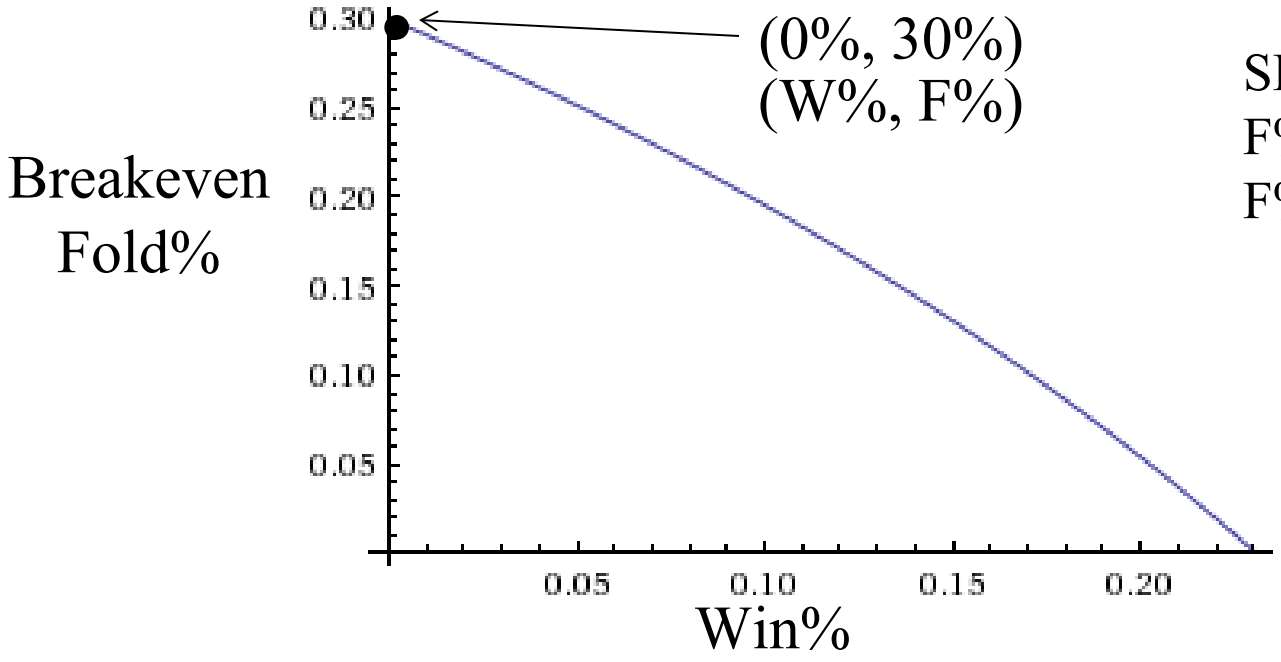
Fold% = (13Win% - 3) / (13Win% - 10)



SD-Value = 0

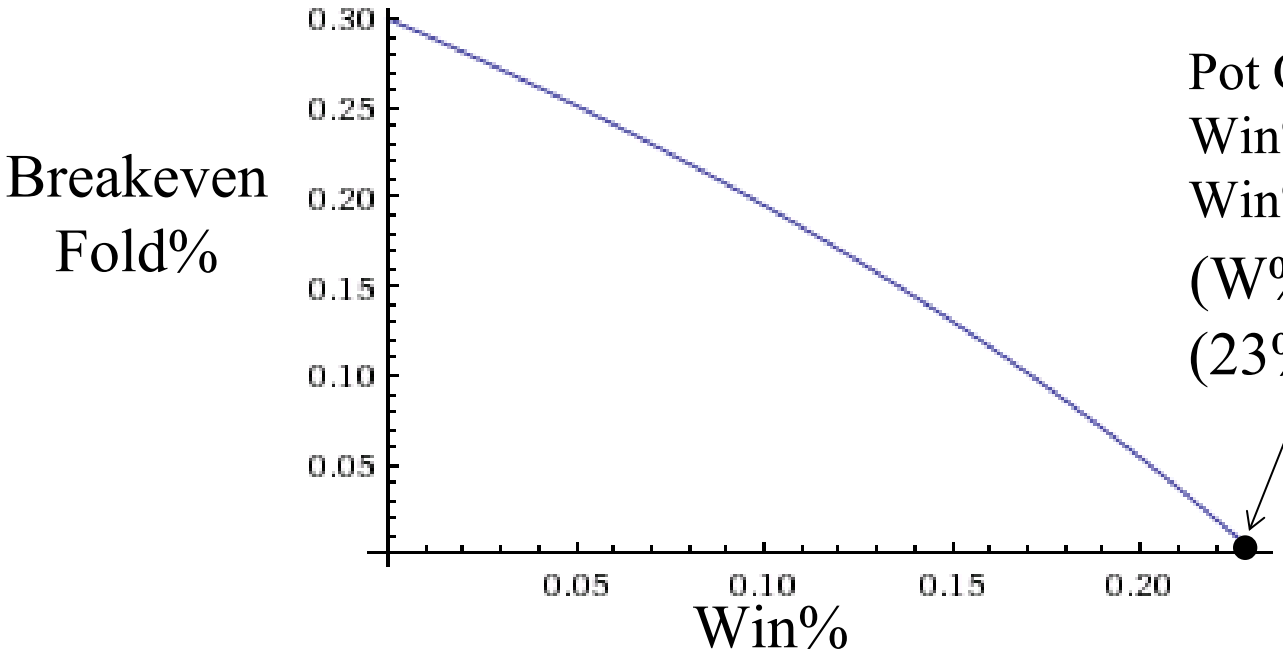
F% = 150/(150+350)

F% = 0.30

Semi-Bluffing – Impact of Win%

BetAmt = 150 Pot = 350

Fold% = (13Win% - 3) / (13Win% - 10)



Pot Odds Breakeven

Win% = 150/(350+150+150)

Win% ≈ 0.23

(W%, F%)

(23%, 0%)

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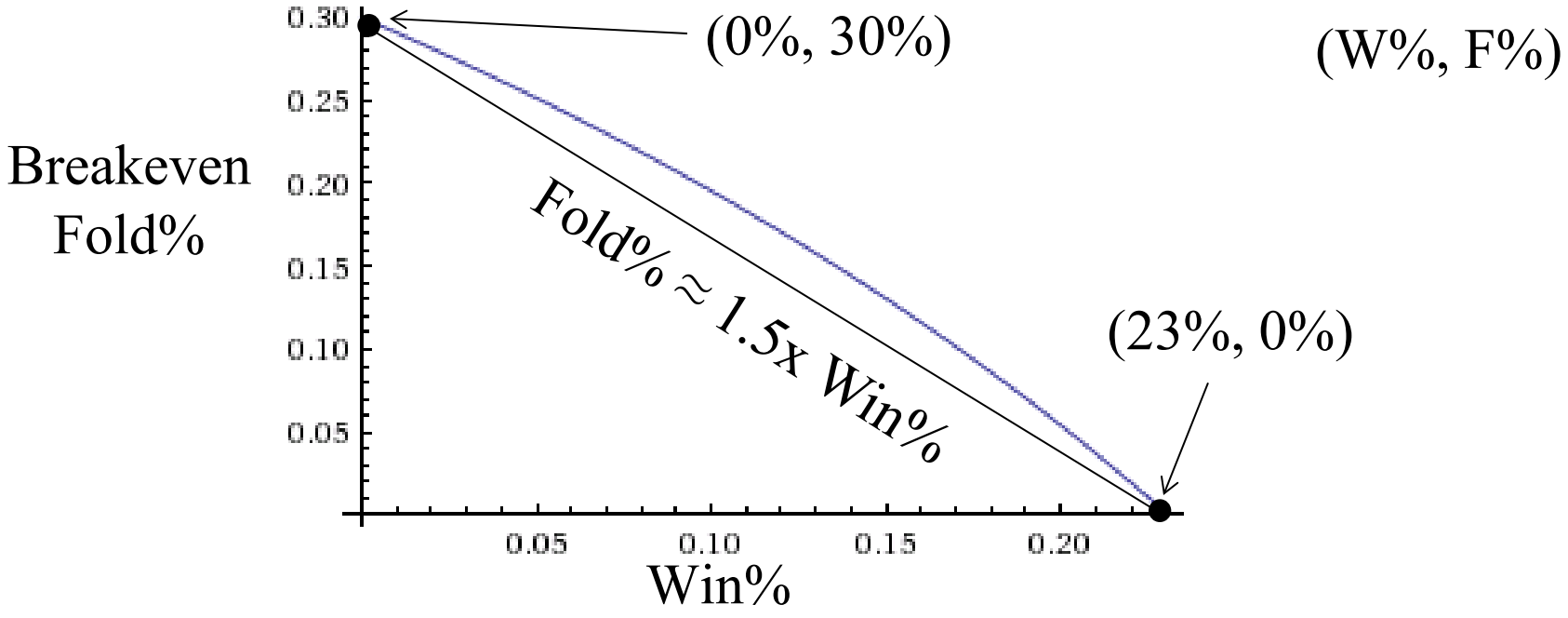
Semi-Bluffing – Impact of Win%

BetAmt = 150 Pot = 350

Fold% = (13Win% - 3) / (13Win% - 10)



Sensitivity to Bet Size – Impact of Win%

- A pot sized bet would mean a 1% increase in Win% leads to a 1.5% decrease in breakeven Fold%

$$\lim_{Bet \to \infty} \frac{\partial F\%}{\partial W\%} = 2$$

- A higher bet increases the sensitivity, but it is bound by the interval (1,2)

$$\lim_{Bet \to Pot} \frac{\partial F\%}{\partial W\%} = 1.5$$

$$\lim_{Bet \to 0} \frac{\partial F\%}{\partial W\%} = 1$$

Fold Equity – Real Time

- When SDValue = 0
  - F% needed = bet / (pot + bet)
  - Pot sized bet needs to win 50% of time
  - Scales approximately linearly down to zero
    - i.e. a half pot size bet needs to win about 25% of the time
    - actual fold rate needed is .5 / 1.5 = 33%
- When SDValue > 0
  - This is difficult to develop quick rules
  - In general, your value is much higher if you have a real draw
  - A good assumption is your SD-Win% decreases the Fold% 1.5x to 1
  - Preflop is basically always semi-bluffing

Live Example

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Fold Equity Examples

Villain (MP): $3000 **Blinds 25/50**
Hero (BTN): $3000

Pre Flop: ($75) Hero is BTN with T♦ 5♠
Villain raises to $150, *2 folds*, Hero calls $150, *2 folds*

River: ($375) 4♣ 8♥ 9♦ 6♥ 6♦ (2 players)
Villain checks, Hero bets $250…

Fold Equity Examples

1. Bluff or semi-bluff?
   - Bluff
2. What is our Showdown Win%?
   - 0
3. What is our breakeven Fold%?
   - $250 / $625 = 40%
4. Is this a good bet if Villain calls 25% of the time?
   - Yes, 75% > 40%
5. What is our Fold Equity if Villain calls 25%?
   - $375 * 75% - $250 * 25% = 218.75

Live Example

Massachusetts Institute of Technology

Fold Equity Examples

Villain (MP): $800 **Blinds 25/50**
Hero (BTN): $1500

Pre Flop: ($75) Hero is BTN with 9♥ T♥
Villain raises to $150, *2 folds*, Hero calls $150, *2 folds*

Turn: ($775) 4♣ 8♠ 7♦ 2♥ (2 players)
Villain checks, Hero bets $450 …

Fold Equity Examples

1. Bluff or semi-bluff?
   - Semi-bluff, SD Win% = 16%
2. What is our Showdown Value if Villain calls 80%?
   - 80% * [16% * $1225 - 84% * $450] = -$145.6
3. What is our breakeven Fold%?
   - $450 / $1225 = 37% - 16%*1.5 = 13%
4. Is this a good bet if Villain calls 80% of the time?
   - Yes, 20% > 13%
5. What is our Fold Equity if Villain calls 80%?
   - $775*.20 + .80*(16%*$1225 - 84%*$450) = 9.4

Live Example

Live Example

- YouTube video:

  ManiaOFpoker. “World Series Of Poker 2014 Main Event Episode 14 HD 720p.” November 11, 2013. *YouTube*. Accessed May 1, 2015. https://youtu.be/Q1HkLjq-GGQ?t=30m5s

Live Example

Live Example

Jacobson (MP2): 22,000k 150k/300k Blind + 50k
Hero (CO): 18,000k

Pre Flop: (950k) Hero is CO with A♣ Q♥
4 folds, Jacobson raises to 650k, 1 fold, Hero raises to 1,425k, *3 folds*, A♥ exposed, Jacobson calls 775k

Flop: (3,800k) K♦ J♥ 3♣ (2 players)
Jacobson checks, Hero bets 1,800k

Is this a good bet?

Live Example

Pre Flop: (950k) Hero is CO with A♣ Q♥

Flop: (3,800k) K♦ J♥ 3♣ (2 players)
Jacobson checks, Hero bets 1,800k

Is this a good bet?

If SD-Win% = 0, the bet is +EV at F%>1800/(3800+1800) = 33%

If only the inside straight draw is good, Win% = 8%, making the breakeven Fold% closer to 21%

Live Example

Pre Flop: (950k) Hero is CO with A♣ Q♥

Flop: (3,800k) K♦ J♥ 3♣ (2 players)
Jacobson checks, Hero bets 1,800k

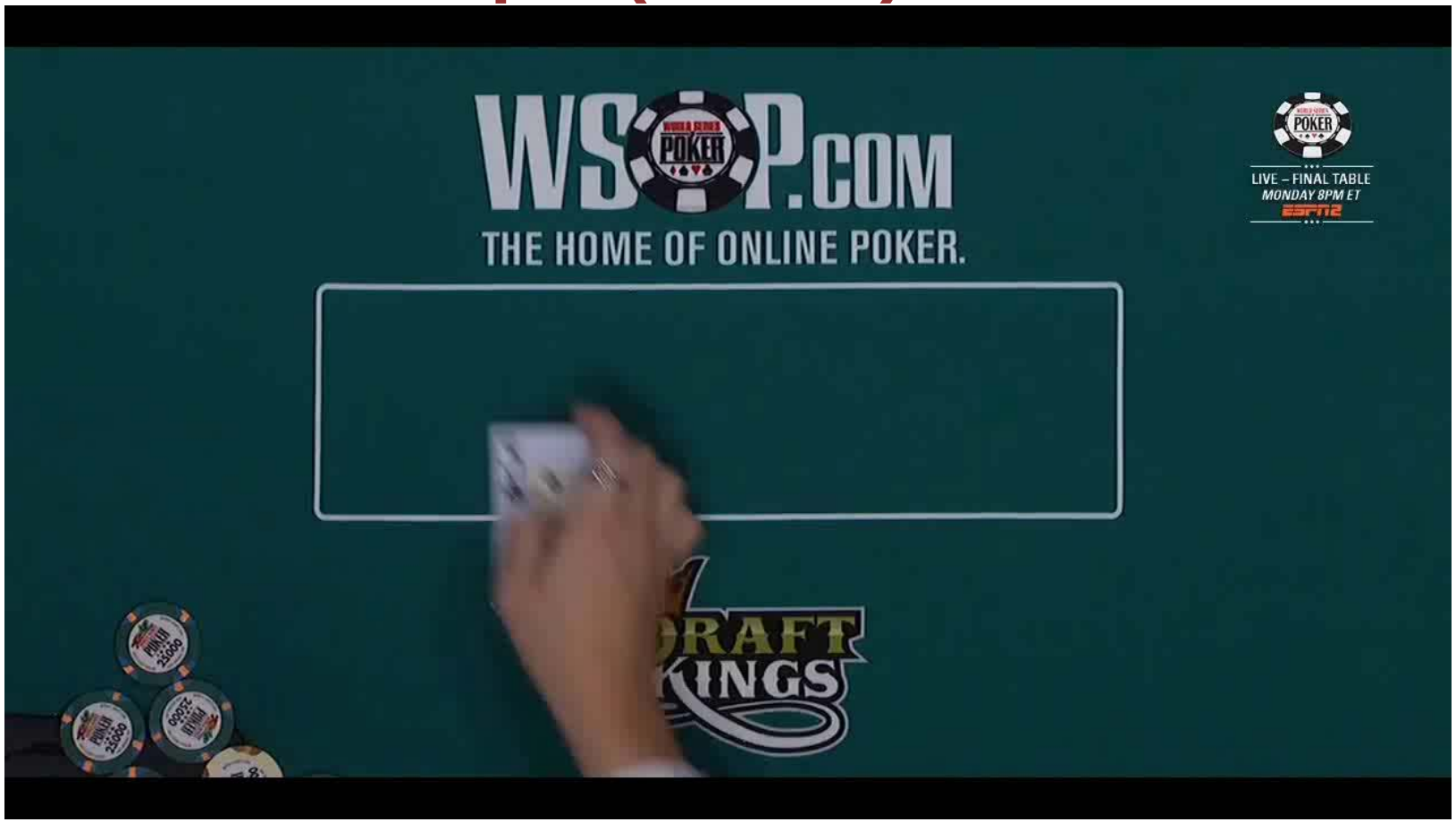
Is this a good bet?

If we assume any T wins (4 card) and any A wins sometimes (2 cards * .5) then chance to make draw is about 5 * 2 = 10%

Full solution is
EV = 3800 * F% - [90% * 1800 * (1-F%)] + [10% * (1-F%) * 5600] = 0 at F% = 21.8%

This is profitable if the Villain folds more than 22% of the time.

Live Example (Result)



Bluffing Formulas

- Fold% (Minimum Fold Rate if SDWin% = 0)
  - *x* = BetAmt / (Pot + BetAmt)
- Fold Equity (EV of Bluff, assuming SDWin% = 0)
  - *x* = Fold% * Pot - (1-Fold%) * BetAmt
- Showdown-Value (EV Contribution of Being Called)
  - *x* = (1-Fold%) * (Win%*WinAmt - Lose%*LoseAmt)
- Fold Equity (EV of Semi-Bluff, if SDWin% > 0)
  - *x* = Fold% * Pot + (1-Fold%) * (Win%*WinAmt - Lose%*LoseAmt)
- Semi-Bluff Fold% (Quick Rule for Breakeven Semi-Bluff Fold%)
  - *x* = BetAmt / (Pot + BetAmt) - 1.5x Win%

Bluffing Formulas (Example)

- Fold% (Minimum Fold Rate if SDWin% = 0)
  - Making a $150 bluff into a $350 pot
  - **30%** = $150 / ($350 + $150)
- Fold Equity (EV of Bluff, assuming SDWin% = 0)
  - Making a $250 bluff into a pot of $625 against a 25% call rate
  - **$218.75** = 75% * $625 - (1-75%) * $250
- Showdown-Value (EV Contribution of Being Called)
  - Making a $450 bluff into a pot of $775 with a 16% WinRate against an 80% call rate
  - **-$145.6** = (1-20%) * (16%*$1225 - 84%*$450)
- Fold Equity (EV of Semi-Bluff, if SDWin% > 0)
  - **$9.4** = 20% * $1225 + (1-20%) * (16%*1225 - 84%*450)
- Semi-Bluff Fold% (Quick Rule for Breakeven Semi-Bluff Fold%)
  - **13%** = $450 / ($775 + $450) - 1.5*16%

Bluffing – Be careful about

- **Betting too little on a bluff**
  - If you had a real hand, you wouldn't bet 1/3rd of the pot
    - Or at least you shouldn't, but we'll get to that
  - Bet enough to make a draw -EV
- **Betting too much on a bluff**
  - Pot overbets are basically never a good idea (unless you are pot committed on a normal sized bet)
  - If you are short-stacked, don't bluff an amount that would require you to call a raise (i.e. you would have the odds to call a raise)
- **Being afraid of being caught bluffing or showing down bad cards**
  - This is really common, especially live
- **Semi-bluffing when a free card is offered**
- **Bluffing calling stations**

15.S50 Poker Theory and Analytics

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