Outline for the day:

1. Addiction.
2. Syllabus, etc.
3. Wasicka/Gold/Binger example.
5. Axioms of probability.
6. Hw1 terms.
7. Basic principle of counting.
8. Permutations and combinations.
9. Ly vs. Negreanu (flush draw) example
10. R.
11. A♠ vs 2♣ after first ace.
2. Syllabus, etc.

For this week:

(i) Learn the rules of Texas Hold’em.
   (see http://www.fulltiltpoker.net/holdem.php
   and http://www.fulltiltpoker.net/handRankHigh.php)

(ii) Read addiction handout, addiction1.pdf, on the course website,
    http://www.stat.ucla.edu/~frederic/100a/W15.

(iii) Download R and try it out.
     ( http://cran.stat.ucla.edu )

(iv) Read ch. 1-2 of the textbook.

Note that the CCLE website for this course is not maintained. The course website is
http://www.stat.ucla.edu/~frederic/100a/W15.

I do not give hw hints in office hours. Conceptual questions only.

If you have taken Stat 35 before, please see me after class.
Blinds: $200,000-$400,000 with $50,000 antes.

**Chip Counts:**
- Jamie Gold: $60,000,000
- Paul Wasicka: $18,000,000
- Michael Binger: $11,000,000

**Payouts:**
- 3rd place: $4,123,310
- 2nd place: $6,102,499
- 1st place: $12,000,000


An example of the type of questions we will be addressing in this class is on the next slide. Don't worry about all the details yet.
Wasicka/Gold/Binger Example, Continued

Flop: 10♣ 6♠ 5♠. (Turn: 7♣. River: Q♠.)

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Wasicka folded?!?
--------------------------------------------------------------------------------

He had 8♠ 7♠ and the flop was 10♣ 6♠ 5♠. Worst case scenario: suppose he were up against 9♠ 4♠ and 9♥ 9♦. How could Wasicka win?

\[
\begin{align*}
88 & \quad (3: \ 8♣ 8♦, 8♣ 8♥, 8♦ 8♥) \\
77 & \quad (3) \\
44 & \quad (3)
\end{align*}
\]

[Let “X” = non-49, “Y” = A2378JQK, and “n” = non-♠.]

\[
\begin{align*}
4n \ Xn & \quad (3 \times \ 32) \\
9♣ \ 4n & \quad (3) \\
9♣ \ Yn & \quad (24). \quad \text{Total: 132 out of 903 = 14.62%}.
\end{align*}
\]

Notation: “P(A) = 60%”. A is an event.
Not “P(60%)”.

Definition of probability:

Frequentist: If repeated independently under the same conditions millions and millions of times, A would happen 60% of the times.

Bayesian: Subjective feeling about how likely something seems.

\[ P(A \text{ or } B) \text{ means } P(A \text{ or } B \text{ or both } ) \]

*Mutually exclusive:* \( P(A \text{ and } B) = 0. \)

*Independent:* \( P(A \text{ given } B) \) [written “P(A|B)”] = P(A).

\( P(A^c) \) means P(not A).
5. Axioms (initial assumptions/rules) of probability:

1) \( P(A) \geq 0 \).
2) \( P(A) + P(A^c) = 1 \).
3) If \( A_1, A_2, A_3, \ldots \) are mutually exclusive, then
   \[
   P(A_1 \text{ or } A_2 \text{ or } A_3 \text{ or } \ldots) = P(A_1) + P(A_2) + P(A_3) + \ldots
   \]
   (#3 is sometimes called the addition rule)

Probability <= Area. Measure theory, Venn diagrams

\[
P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B).\]
Fact: \( P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B) \).  
\[ P(A \text{ or } B \text{ or } C) = P(A)+P(B)+P(C)-P(AB)-P(AC)-P(BC)+P(ABC). \]

Fact: If \( A_1, A_2, \ldots, A_n \) are equally likely & mutually exclusive, and if \( P(A_1 \text{ or } A_2 \text{ or } \ldots \text{ or } A_n) = 1 \), then \( P(A_k) = 1/n \).  
[So, you can count: \( P(A_1 \text{ or } A_2 \text{ or } \ldots \text{ or } A_k) = k/n \).]

Ex. You have 76, and the board is KQ54. P(straight)? 
[52-2-4=46.]  
P(straight) = P(8 on river OR 3 on river)  
= P(8 on river) + P(3 on river) = 4/46 + 4/46.
6. Hw1 terms. 2 pair rules, the nuts, the unbreakable nuts.


If there are \( a_1 \) distinct possible outcomes on experiment \#1, and for each of them, there are \( a_2 \) distinct possible outcomes on experiment \#2, then there are \( a_1 \times a_2 \) distinct possible ordered outcomes on both.

e.g. you get 1 card, opp. gets 1 card. # of distinct possibilities? 52 \( \times \) 51. [ordered: (A♣, K♥) \( \neq \) (K♥, A♣).]

In general, with \( j \) experiments, each with \( a_i \) possibilities, the # of distinct outcomes where order matters is \( a_1 \times a_2 \times \ldots \times a_j \).
8. Permutations and Combinations.

e.g. you get 1 card, opp. gets 1 card.
# of distinct possibilities?
52 x 51. [ordered: (A♣, K♥) ≠ (K♥, A♣).]

Each such outcome, where order matters, is called a permutation.
Number of permutations of the deck? 52 x 51 x … x 1 = 52!
\[ \approx 8.1 \times 10^{67} \]
A **combination** is a collection of outcomes, where order *doesn’t* matter.

E.g. in hold’em, how many *distinct* 2-card hands are possible?

52 x 51 if order matters, but then you’d be double-counting each

[ since now (A♣, K♥) = (K♥, A♣) .]

So, the number of *distinct* hands where *order doesn’t matter* is

52 x 51 / 2.

In general, with n distinct objects, the # of ways to choose k *different* ones, *where order doesn’t matter*, is

“n choose k” = choose(n,k) = n! / k! (n-k)!

\[ k! = 1 \times 2 \times \ldots \times k. \quad [\text{convention: } 0! = 1.] \]

\[ \text{choose (n,k)} = \binom{n}{k} = \frac{n!}{k!(n-k)!}. \]

9. **Ly vs. Negreanu, p66.**

**Ex.** Suppose you have 2 ♣s, and there are exactly 2 ♣s on the flop. Given this info, what is \( P(\text{at least one more ♣ on turn or river}) \)?

**Answer:** \( 52-5 = 47 \) cards left (9 ♣s, 38 others).

So \( n = \text{choose}(47,2) = 1081 \) combinations for next 2 cards.

Each equally likely (and obviously mutually exclusive).

Two-♣ combos: \( \text{choose}(9,2) = 36 \). One-♣ combos: \( 9 \times 38 = 342 \).

Total = 378. So answer is \( 378/1081 = 35.0\% \).

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**Answer #2:** Use the addition rule…
ADDITION RULE, revisited…..

Axioms (initial assumptions/rules) of probability:

1) \( P(A) \geq 0 \).
2) \( P(A) + P(A^c) = 1 \).
3) Addition rule:
   If \( A_1, A_2, A_3, \ldots \) are mutually exclusive, then
   \[ P(A_1 \text{ or } A_2 \text{ or } A_3 \text{ or } \ldots ) = P(A_1) + P(A_2) + P(A_3) + \ldots \]

As a result, even if \( A \) and \( B \) might not be mutually exclusive,
\[ P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B). \]
Ex. You have 2 ♣s, and there are exactly 2 ♣s on the flop. Given this info, what is P(at least one more ♣ on turn or river)?

Answer #1: 52-5 = 47 cards left (9 ♣s, 38 others).

So \( n = \text{choose}(47,2) = 1081 \) combinations for next 2 cards.

Each equally likely (and obviously mutually exclusive).

Two-♣ combos: \( \text{choose}(9,2) = 36 \).

One-♣ combos: \( 9 \times 38 = 342 \).

Total = 378. So answer is \( 378/1081 = 35.0\% \).

Answer #2: Use the addition rule.

\[
P(\geq 1 \text{ more } \Diamond) = P(\Diamond \text{ on turn OR river})
\]

\[
= P(\Diamond \text{ on turn}) + P(\Diamond \text{ on river}) - P(\text{both})
\]

\[
= 9/47 + 9/47 - \text{choose}(9,2)/\text{choose}(47,2)
\]

\[
= 19.15\% + 19.15\% - 3.3\% = 35.0\%.
\]
You have AK. Given this, what is $P(\text{at least one A or K comes on board of 5 cards})$?

Wrong Answer:

$P(\text{A or K on 1st card}) + P(\text{A or K on 2nd card}) + \ldots$

$= \frac{6}{50} \times 5 = 60.0\%$.

No: these events are NOT Mutually Exclusive!!!

Right Answer:

choose(50,5) = 2,118,760 boards possible.

How many have exactly one A or K? $6 \times \text{choose}(44,4) = 814,506$

# with exactly 2 aces or kings? $\text{choose}(6,2) \times \text{choose}(44,3) = 198,660$

# with exactly 3 aces or kings? $\text{choose}(6,3) \times \text{choose}(44,2) = 18,920 \ldots$

… altogether, 1,032,752 boards have at least one A or K,

So it’s $1,032,752 / 2,118,760 = 48.7\%$.

Easier way: $P(\text{no A and no K}) = \text{choose}(44,5)/\text{choose}(50,5)$

$= 1086008 / 2118760 = 51.3\%$, so answer = $100\% - 51.3\% = 48.7\%$
10. R. To download and install R, go directly to cran.stat.ucla.edu, or as it says in the book at the bottom of p157, you can start at www.r-project.org, in which case you click on “download R”, scroll down to UCLA, and click on cran.stat.ucla.edu. From there, click on “download R for …”, and then get the latest version.
To download and install R, go directly to cran.stat.ucla.edu, or as it says in the book at the bottom of p157, you can start at www.r-project.org, in which case you click on “download R”, scroll down to UCLA, and click on cran.stat.ucla.edu. From there, click on “download R for …”, and then get the latest version.
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11. Deal til first ace appears. Let $X =$ the *next* card after the ace.
$P(X = A\spadesuit)\ ? \ P(X = 2\spadesuit)\ ?$