Outline for the day:

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

For next class:

(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/sum14.

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

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

If you are the first to find an error in the book not on the error website, email me and if
you’re right you’ll get +1 pt on the final exam for a rel. major error (or ¼ for a
very minor error), but you get -¼ if you’re wrong, for either type of error.

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

**Chip Counts:**

<table>
<thead>
<tr>
<th>Player</th>
<th>Chips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamie Gold</td>
<td>$60,000,000</td>
</tr>
<tr>
<td>Paul Wasicka</td>
<td>$18,000,000</td>
</tr>
<tr>
<td>Michael Binger</td>
<td>$11,000,000</td>
</tr>
</tbody>
</table>

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

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

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?

88 (3: 8♠ 8♦, 8♠ 8♥, 8♦ 8♥)
77 (3)
44 (3)

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

4n Xn (3 x 32)
9♠ 4n (3)
9♠ Yn (24). Total: 132 out of 903 = 14.62%.

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 or B) means P(A or B or both)

*Mutually exclusive*: P(A and B) = 0.


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 \( \leftrightarrow \) 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 tiebreaker, the nuts, the unbreakable nuts.

7. **Ly vs. Negreanu, p66.**

8. **Basic Principle of Counting.**

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♥) ≠ (K♥, A♣) .]

In general, with $j$ experiments, each with $a_i$ possibilities, the # of distinct outcomes where order matters is $a_1 \times a_2 \times \ldots \times a_j$. 

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

Each such outcome, where order matters, is called a permutation.
Number of permutations of the deck? 52 \times 51 \times \ldots \times 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

\[ \text{since now } (A\spadesuit , K\heartsuit) = (K\heartsuit , A\spadesuit) . \]

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

\[ 52 \times 51 / 2. \]

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

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

\text{Ex.} \text{ You have 2 } \spadesuit \text{s, and there are exactly 2 } \spadesuit \text{s on the flop. Given this info, what is } P(\text{at least one more } \spadesuit \text{ on turn or river})? \\
\text{Answer:} \quad 52-5 = 47 \text{ cards left (9 } \spadesuit \text{s, 38 others).} \\
\text{So } n = \text{choose}(47,2) = 1081 \text{ combinations for next 2 cards.} \\
\text{Each equally likely (and obviously mutually exclusive).} \\
\text{Two-} \spadesuit \text{ combos: } \text{choose}(9,2) = 36. \text{ One-} \spadesuit \text{ combos: } 9 \times 38 = 342. \\
\text{Total } = 378. \text{ So answer is } 378/1081 = 35.0\%. \\
\hline
\text{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,

$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$.

(p6 of book)
Ex. 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 #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 $378/1081 = 35.0\%$.

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**Answer #2:** Use the addition rule.

$$P(\geq 1 \text{ more ♣}) = P(♣ \text{ on turn OR river})$$

$$= P(♣ \text{ on turn}) + P(♣ \text{ on river}) - P(\text{both})$$

$$= \frac{9}{47} + \frac{9}{47} - \frac{\text{choose}(9,2)}{\text{choose}(47,2)}$$

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

Wrong Answer:
P(A or K on 1st card) + P(A or K on 2nd card) + …
= \( \frac{6}{50} \times 5 = 60.0\% \).
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? \( \text{choose}(6,3) \times \text{choose}(44,2) = 18,920 \) …
… 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(no A and no K) = \( \frac{\text{choose}(44,5)}{\text{choose}(50,5)} \)
= \( \frac{1086008}{2118760} = 51.3\% \), 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.
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11. Deal til first ace appears. Let \( X = \) the next card after the ace. 
\[ P(X = \text{A}\spadesuit)? \quad P(X = \text{2}\spadesuit)? \]