Stat 19, Probability and Poker. Rick Paik Schoenberg

Outline for the day:

1. Discuss Addiction.

2. *R*.

3. Ly vs. Negreanu.

4. Counting and combinations.

5. P(A♠ after first ace).

Read harrington1.pdf for next time.

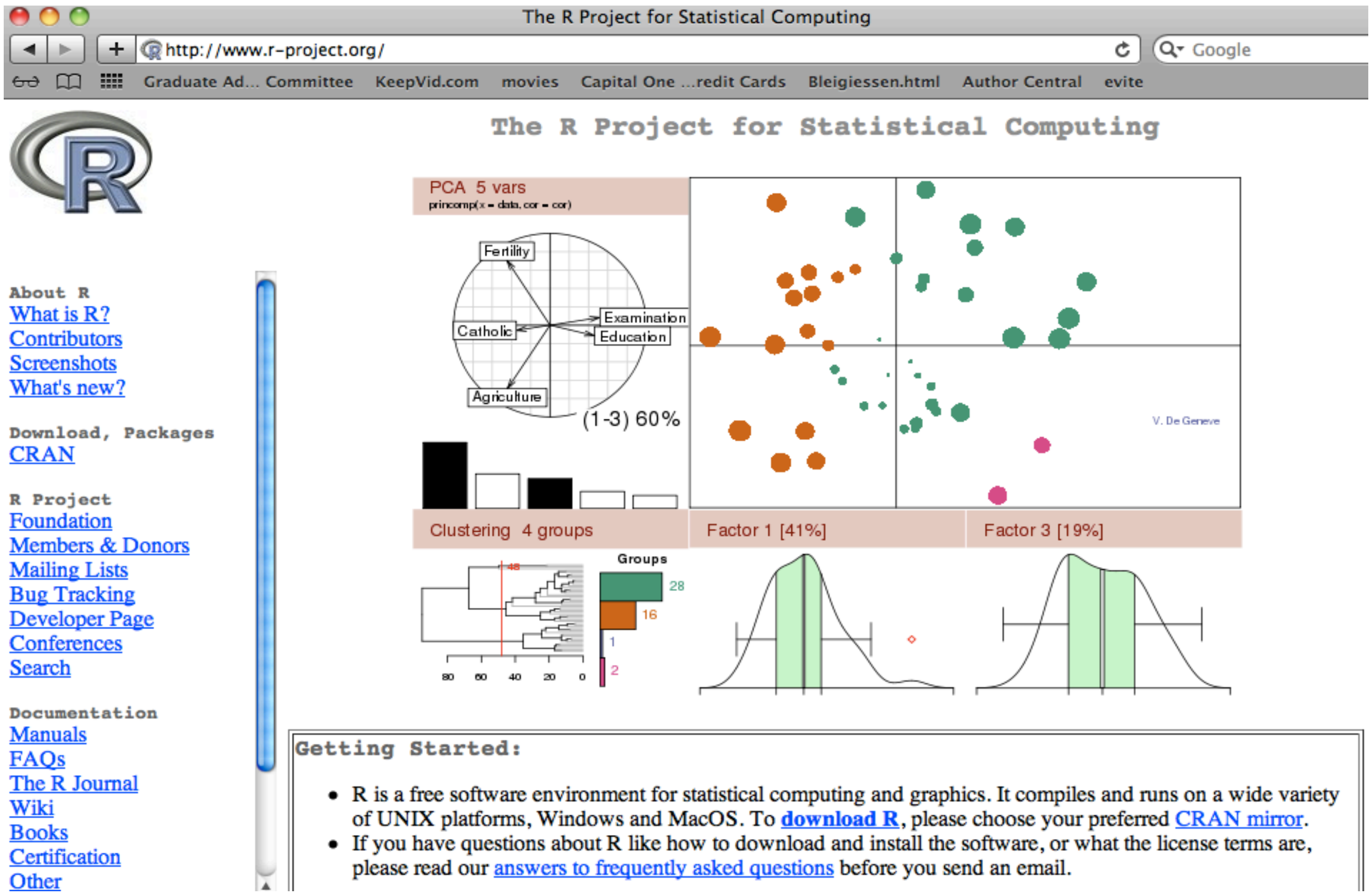
Think of 2 questions or comments for next time.

The course website is http://www.stat.ucla.edu/~frederic/19/F18 .

BADDLEY, COOPER
BARRERA, JACK
BERGMAN-TURNBULL, LIANA
BUI, ALEXIS
CHENG, LU
GONG, LAURA
HUANG, STELLA
JACKSON, SOFIE
JONES, NOAH
LEE, EDDIE
LI, VINCENT
MARTINEZ, AARIN
NGUYEN, TIFFANY
REN, DIANA
SHARMA, DHRUV
SHOURYA, SHIVESH
VALDOVINOS, FELIPE
WORDLAW, ANDREA
ZHUO, MATTHEW

R. To download and install *R*, go directly to cran.stat.ucla.edu, or 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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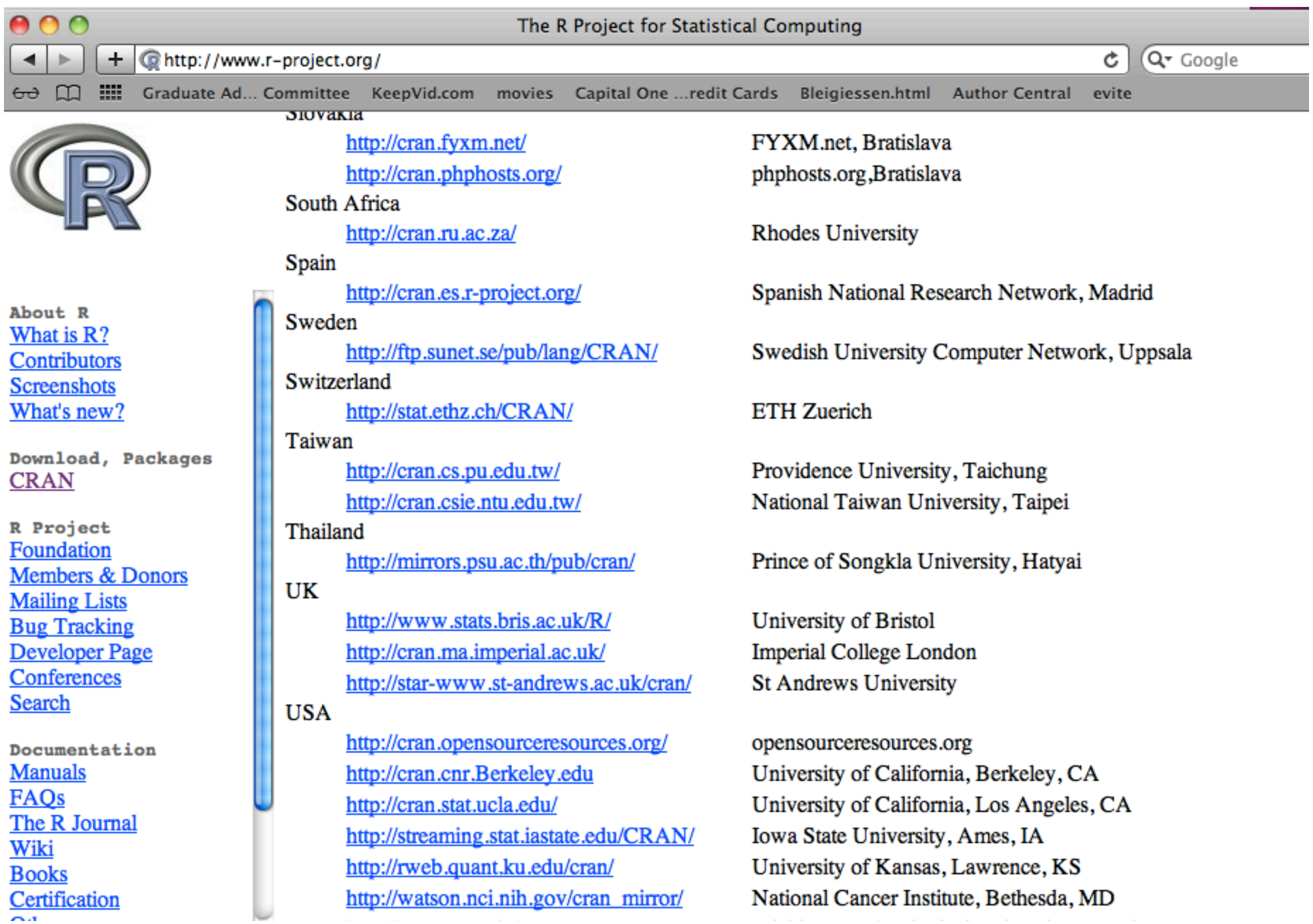

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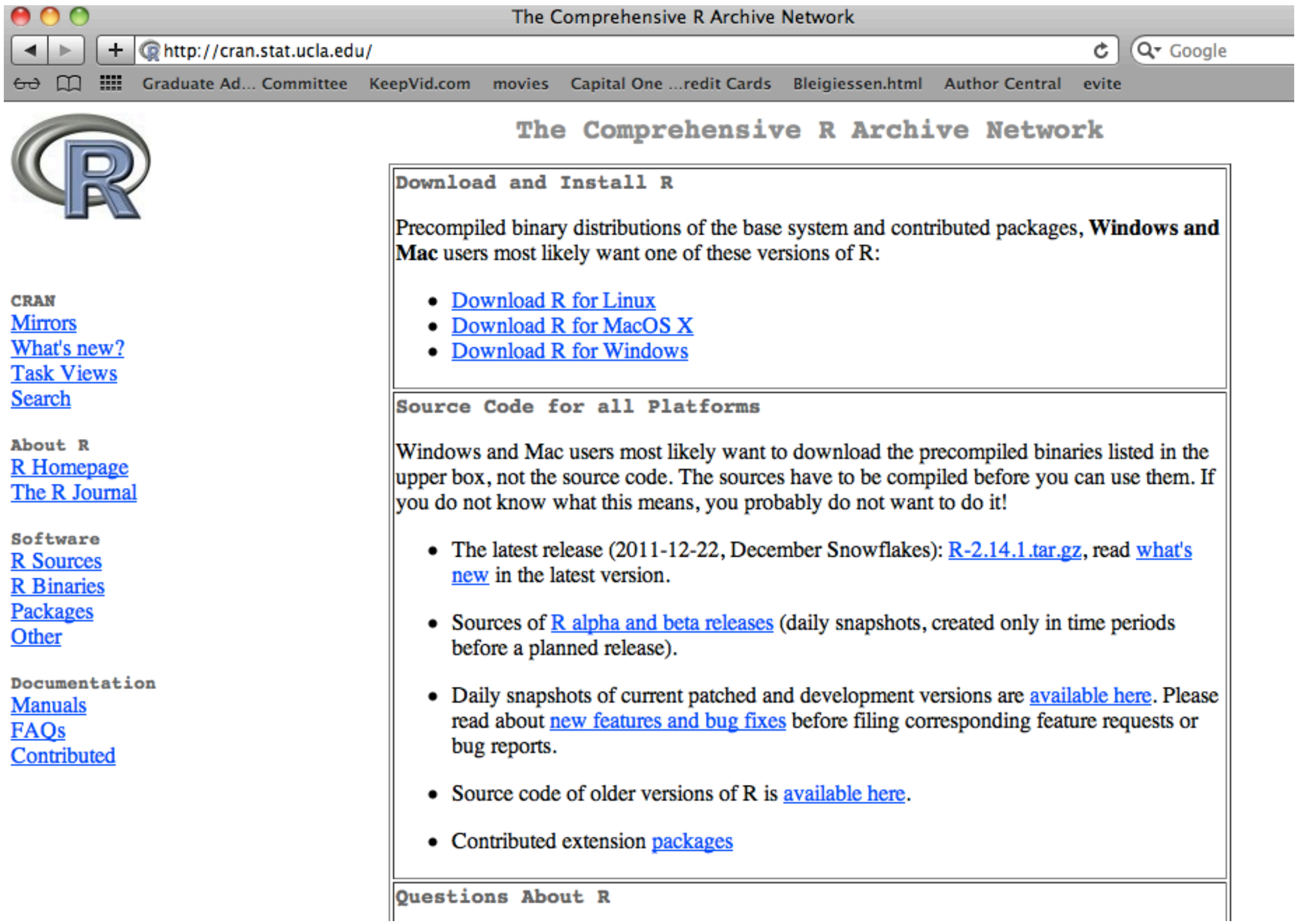

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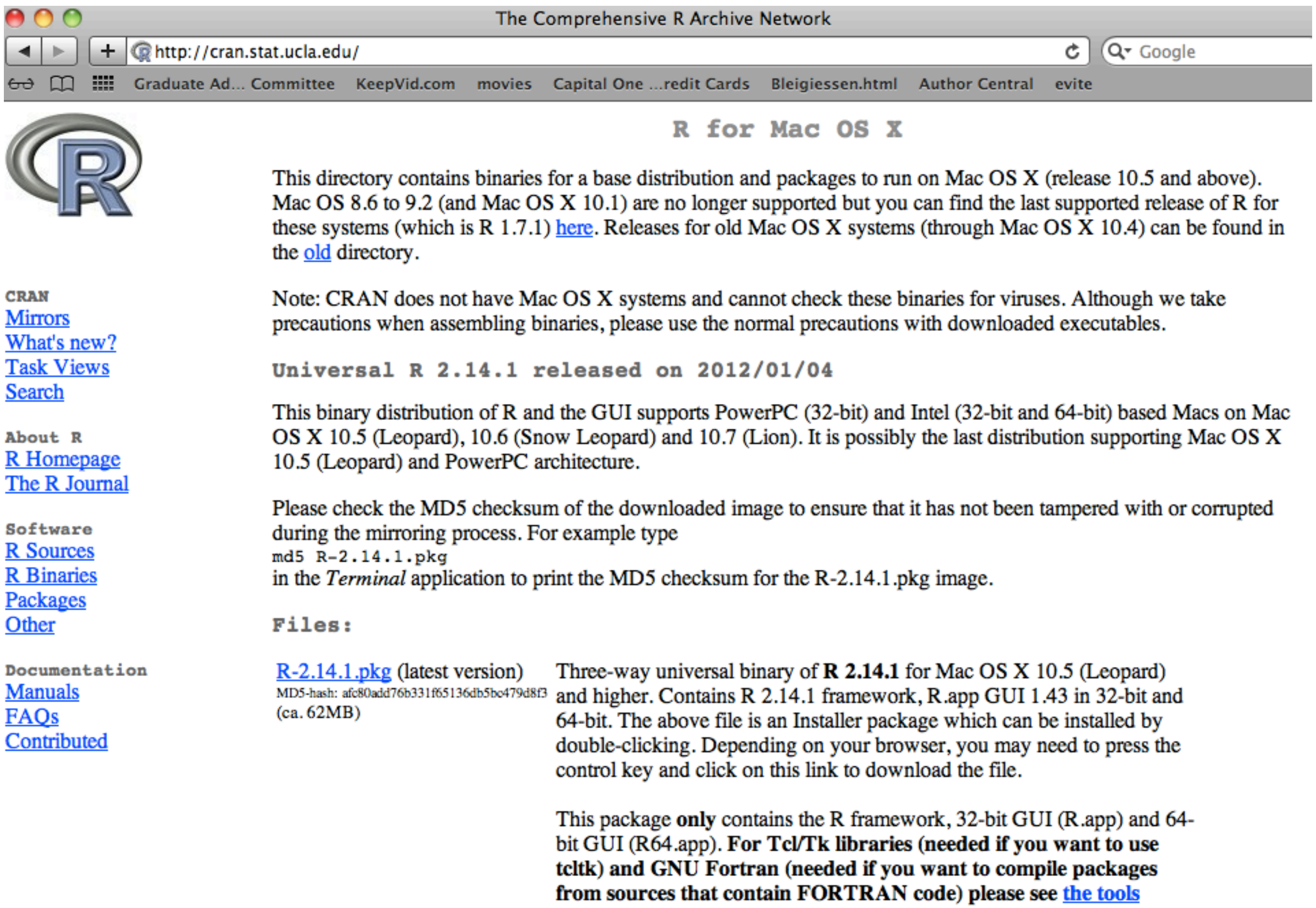


Ly vs. Negreanu.

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

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

So n = choose(47,2) = 1081 combinations for next 2 cards.

Each equally likely (and obviously mutually exclusive).

Two-♣ combos: choose(9,2) = 36. One-♣ combos: 9 x 38 = 342.
Total = 378. So answer is 378/1081 = 35.0%.

Answer #2: Use the addition rule…

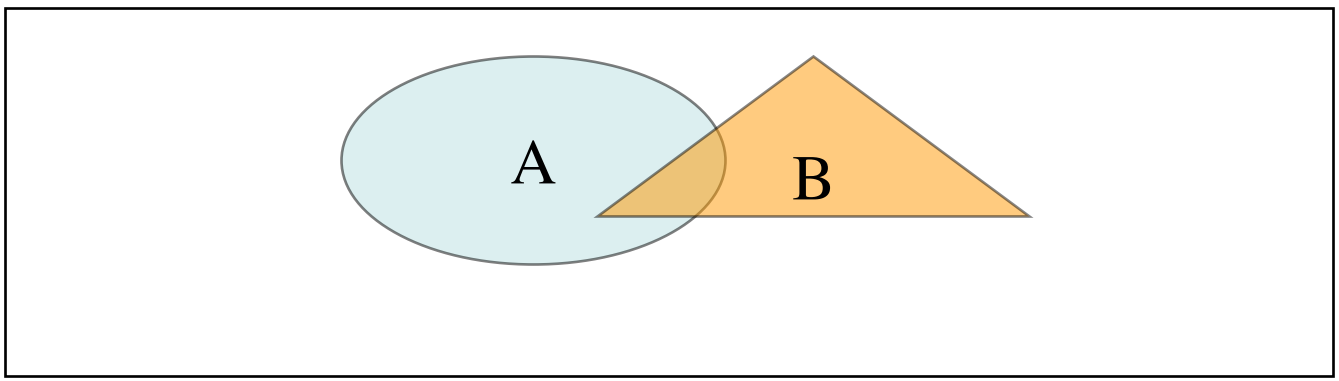
ADDITION RULE, revisited…..

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 two ♣s, and there are exactly two ♣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 (nine ♣s, 38 others).
So n = choose(47,2) = 1081 combinations for next 2 cards.
Each equally likely (and obviously mutually exclusive).
Two- ♣ combos: choose(9,2) = 36. One-♣ combos: 9 x 38 = 342.
Total = 378. So answer is 378/1081 = 35.0%.

Answer #2: Use the addition rule.

P(≥ 1 more ♣) = P(♣ on turn OR river)
= P(♣ on turn) + P(♣ on river) - P(both)
= 9/47 + 9/47 - choose(9,2)/choose(47,2)
= 19.15% + 19.15% - 3.3% = 35.0%.

Counting.

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.

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.

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

Permutations and combinations.

e.g. you get 1 card, opp. gets 1 card. # of distinct possibilities?
52 x 51. [ordered: (A♣ , K♦) $\neq$ (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!

$\sim 8.1 \times 10^{67}$

A <u>*combination*</u> 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" = $\binom{n}{k}$ = choose(n,k) = $\dfrac{n!}{k!\,(n-k)!}$.

k! = 1 x 2 x … x k. [convention: 0! = 1.]

Deal til first ace appears. Let X = the *next* card after the ace.

P(X = A♠)? P(X = 2♣)?