Stat 100a, Introduction to Probability. Rick Paik Schoenberg

Outline for the day:

1. Addiction.
2. Syllabus, etc.
3. Wasicka/Gold/Binger example.
4. Meaning of probability.
5. Axioms of probability.
6. Hw1 terms.
7. Basic principle of counting.
8. Permutations and combinations.
9. R.
10. 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/poker for example)

(ii) Read addiction handout, addiction1.pdf, on the course website,
http://www.stat.ucla.edu/~frederic/100a/sum16 .

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

(iv) Read ch. 1-3 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/sum16 .

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

If you have taken Stat 35 before, please see me after class.

Wasicka/Gold/Binger Example

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.

Day 7, Hand 229. Gold: 4s 3c. Binger: Ah 10h. Wasicka: 8s 7s.

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

Gold: 4♠ 3♣. Binger: A♥ 10♥. Wasicka: 8♠ 7♠.
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%.**

4. Meaning of Probability.

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.

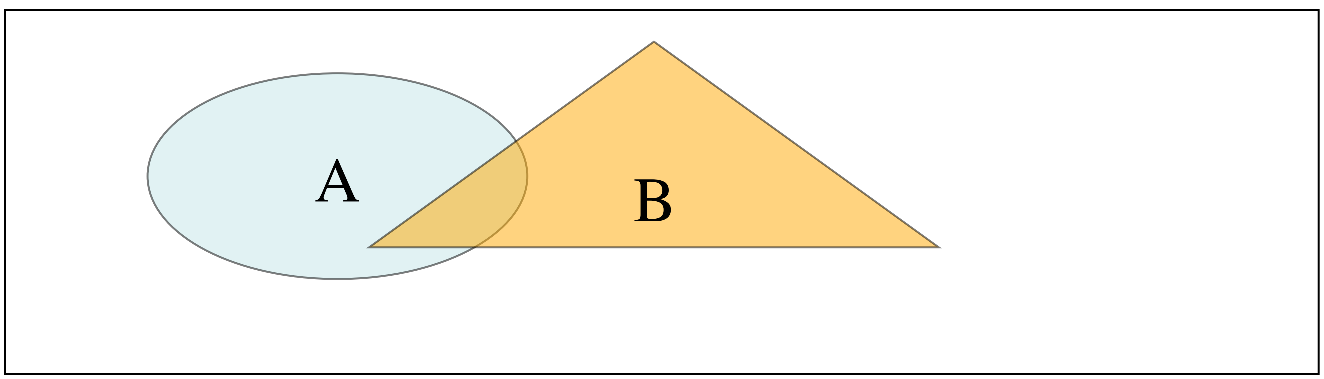
P(A *or* B) means P(A or B or both)
Mutually exclusive: P(A and B) = 0.
Independent: P(A given B) [written "P(A|B)"] = P(A).
$P(A^c)$ means P(not A).

5. Axioms (initial assumptions/rules) of probability:

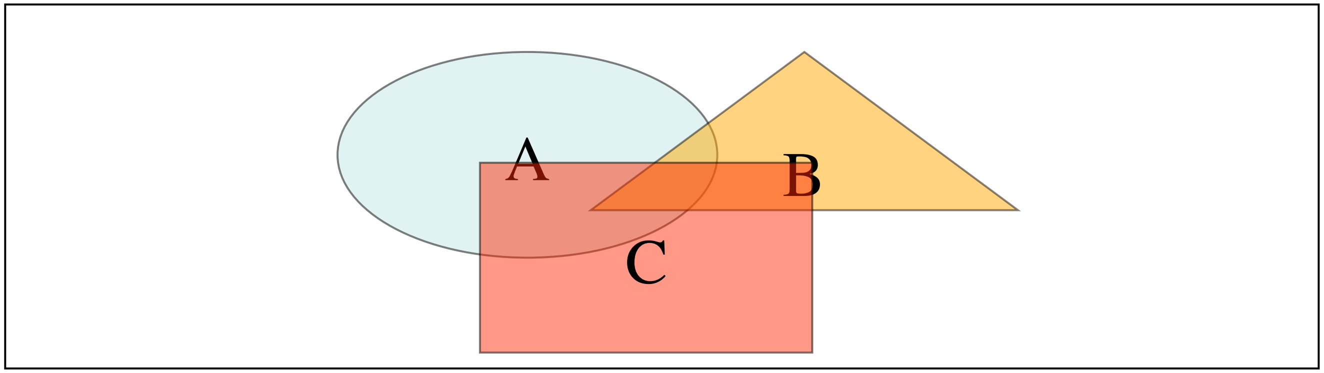
1) $P(A) \geq 0$.
2) $P(A) + P(A^c) = 1$.
3) If $A_1, A_2, A_3, \ldots$ are mutually exclusive, then
   $P(A_1 \text{ or } A_2 \text{ or } A_3 \text{ or } \ldots) = P(A_1) + P(A_2) + P(A_3) + \ldots$

(#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.

Assume you never fold. I say this so one can't object "But I would never play 7♦ 5♦."

flop a straight flush. For example, you have 7♦ 5♦ and the flop is 4♦ 8♦ 6♦.

flopping 2 pairs. For example, you have 7♦ 7♥ and the flop is 3♥ 3♠ J♥.

Or, you have 7♦ 3♥ and the flop is 7♥ 3♠ J♥.

pocket pair. When your two cards form a pair by themselves, like 7♦ 7♥.

face cards. K, Q, or J.

the nuts. Given the board, the best possible hand you could currently have in terms of the ranking order of poker hands, not in terms of probability of winning or improving in the future. For example, if the board is 7♥ 3♠ J♥ 8♦, then if you have 10♦ 9♦, then you have the nuts. If you have 10♥ 9♥, it would be slightly better in terms of probability of winning, but either way you have the nuts.

the unbreakable nuts. When you are guaranteed to win no matter what your opponent might have and no matter what board cards might come. In the above example where you have 10♥ 9♥ and the board is 7♥ 3♠ J♥ 8♦, you do not have the unbreakable nuts because you could lose for instance if the river is 9♠ and your opponent has Q♠ 10♦. However, if the board is 8♥ 7♥ 6♥ and you have 10♥ 9♥, then you have the unbreakable nuts.

in terms of. 3.2b is not easy. Assuming A and B are independent, you have to express the odds against (AB) using only the $O_{A'}$ and $O_{B'}$. You can't use any other variables. In part a you expressed it in terms of P(A) and P(B), so just figure out how to convert P(A) into an expression of $O_{A'}$.

7. Basic Principle of Counting.

If there are a_1 distinct possible outcomes on trial #1, and for each of them, there are a_2 distinct possible outcomes on trial #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?
52×51. [ordered: (A♣ , K♥) ≠ (K♥ , A♣) .]

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

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!

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

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♣) .]

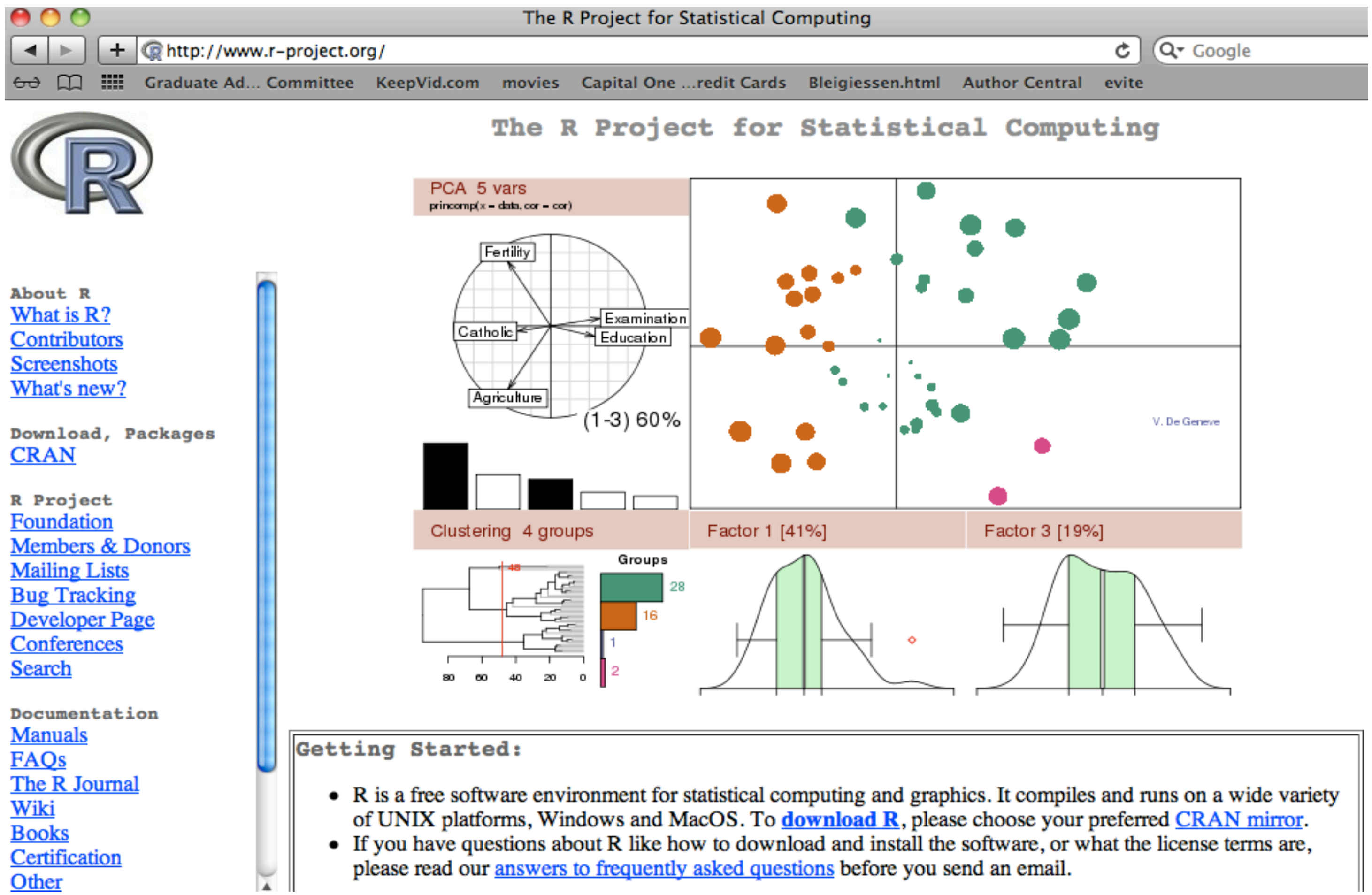
So, the number of *distinct* hands where *order doesn't matter* is

52 x 51 / 2.

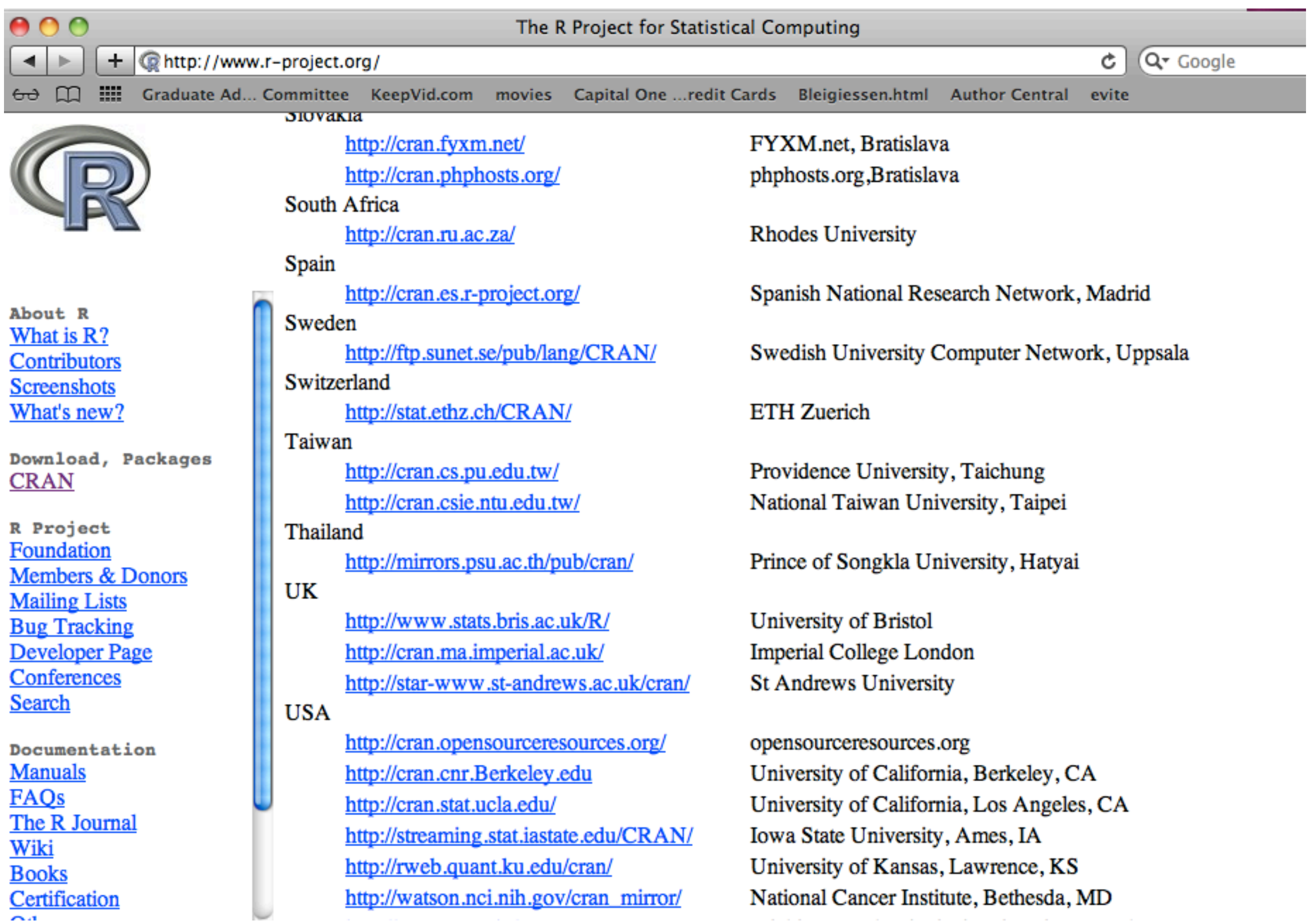
In general, with n distinct objects, the # of ways to choose k *different* ones, *where order doesn't matter*, is

"n choose k" = choose(n,k) $= \dfrac{n!}{k!\,(n-k)!}$.

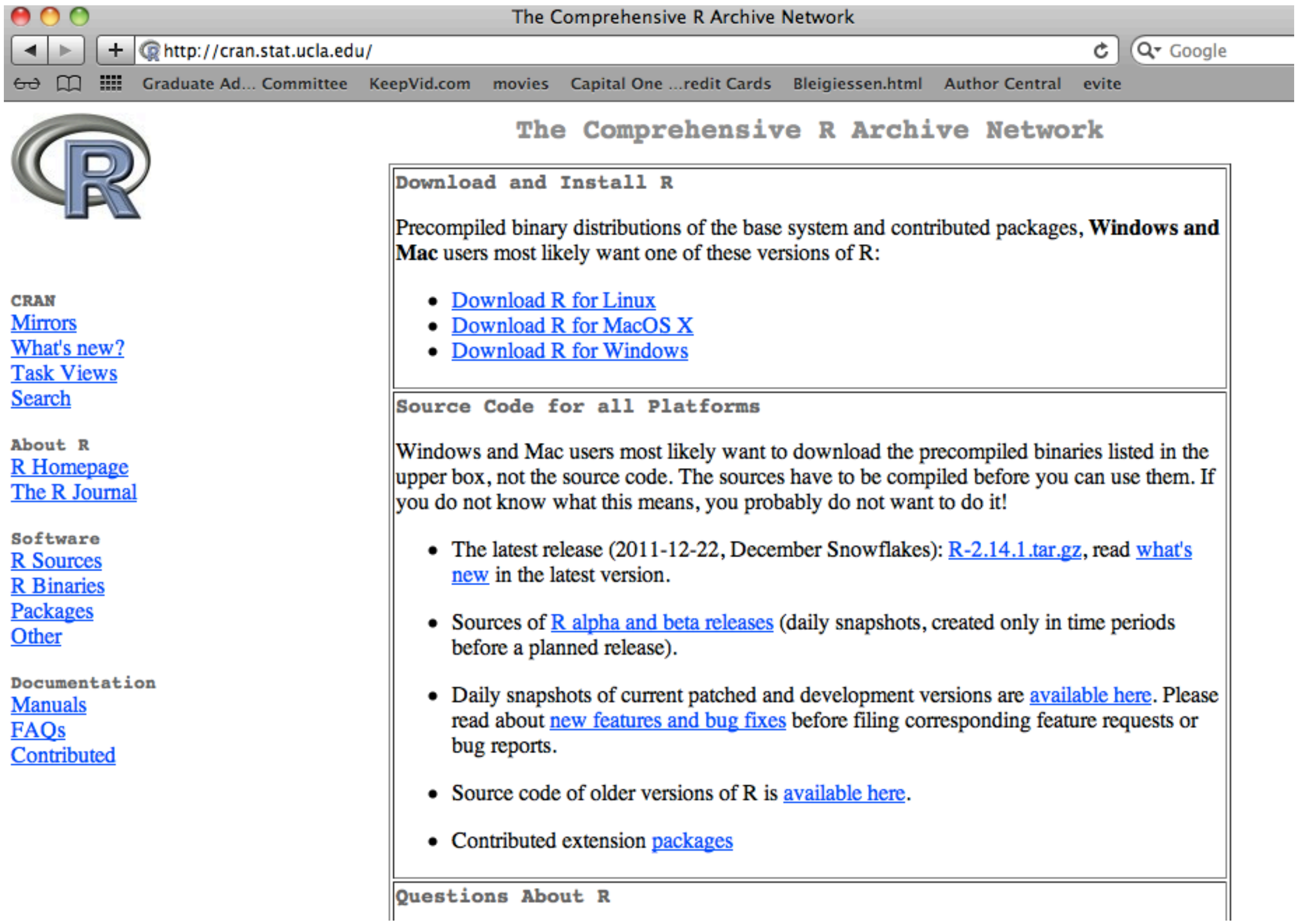
9. R. To download and install *R*, go directly to cran.stat.ucla.edu, or as it says in the book at the bottom of p157, you can start at www.r-project.org, in which case you click on "download *R*", scroll down to UCLA, and click on cran.stat.ucla.edu. From there, click on "download R for …", and then get the latest version.



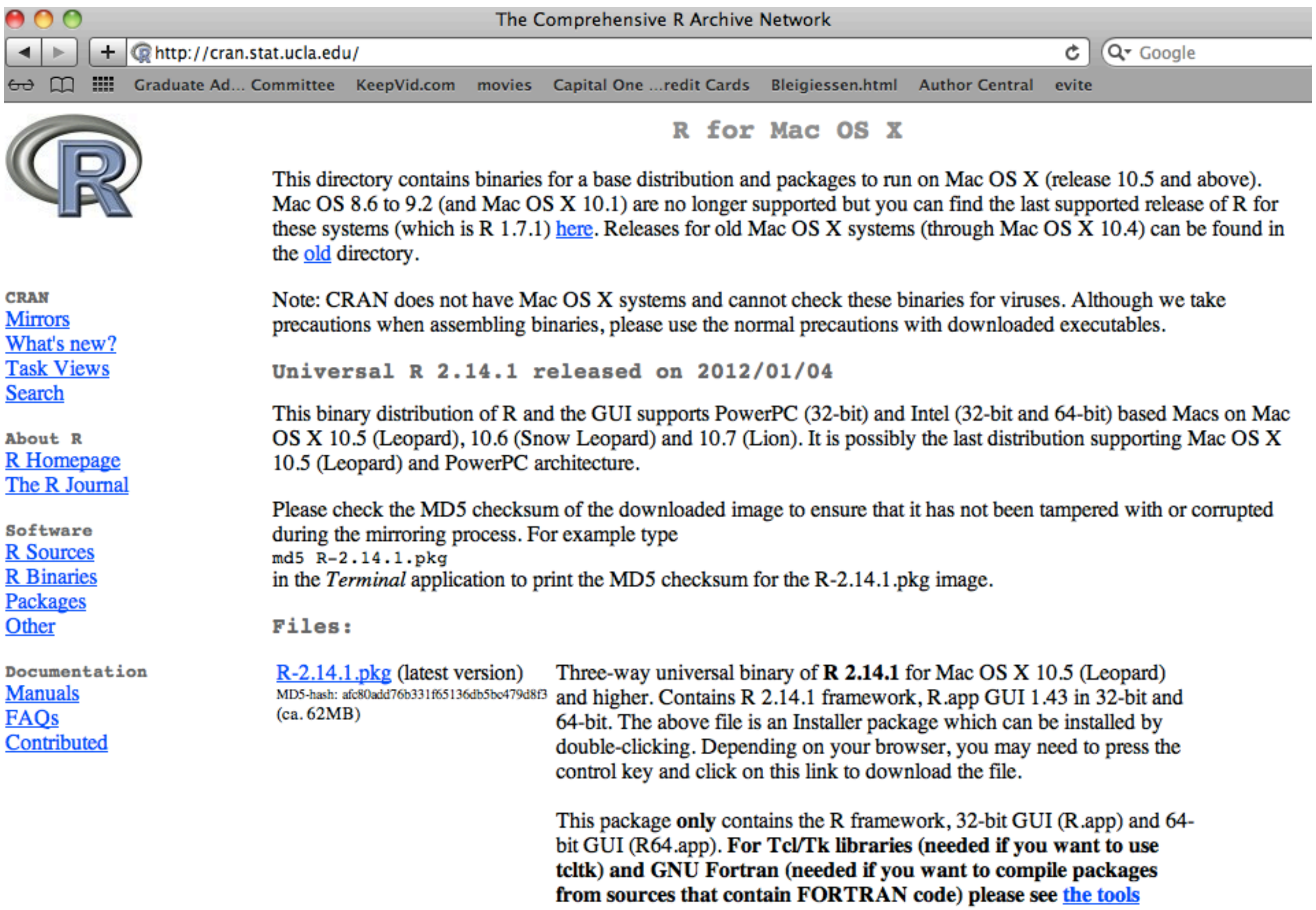
To download and install *R*, go directly to cran.stat.ucla.edu, or as it says in the book at the bottom of p157, you can start at www.r-project.org, in which case you click on "download *R*", scroll down to UCLA, and click on cran.stat.ucla.edu.
From there, click on "download R for …", and then get the latest version.



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.



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

P(X = A♠)? P(X = 2♣)?