

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*. ♠ ♣ ♥ ♦

2. Syllabus, etc.

For this week:

- (i) Learn the rules of Texas Hold'em.
(see <http://www.fulltiltpoker.net> for example)
- (ii) Read addiction handout, addiction.pdf, on the course website,
<http://www.stat.ucla.edu/~frederic/100A/sum21> .
- (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/sum21> .

I do not give hw hints by email. Conceptual questions only.

Only one question is off limits, and it is “What did we do in class?”

If you have taken Stat 100A or 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?

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♠ .

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.

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

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

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

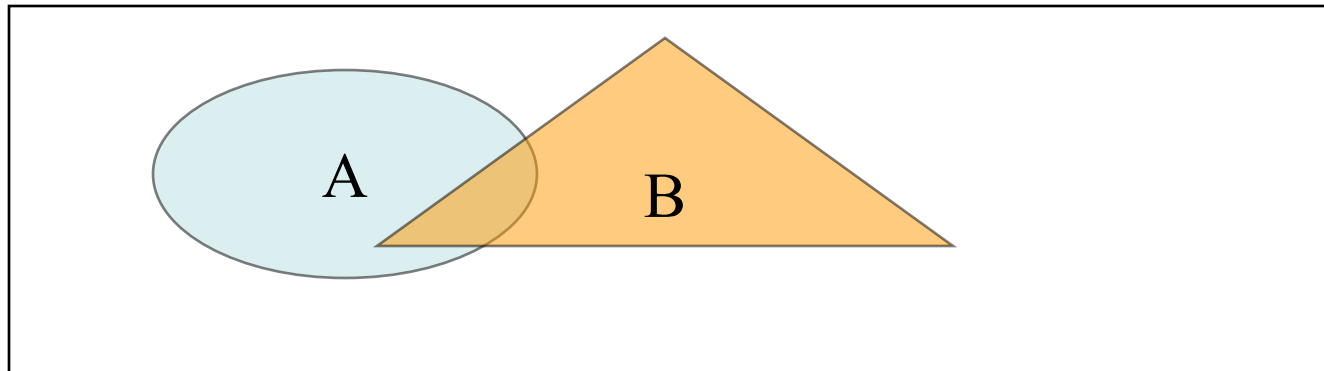
$P(A^c)$ means $P(\text{not } A)$.

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

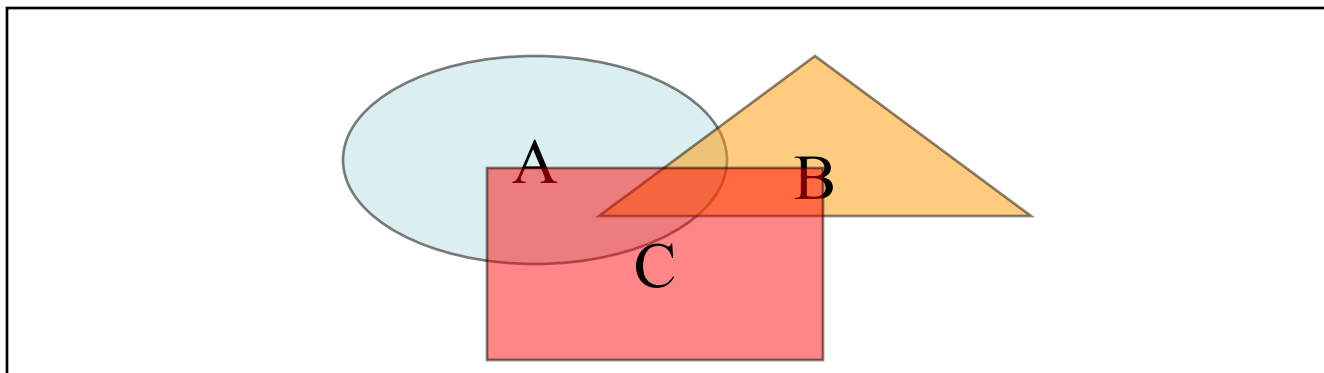
- 1) $P(A) \geq 0$.
- 2) $P(A) + P(A^c) = 1$.
- 3) If A_1, A_2, A_3, \dots are mutually exclusive, then
 $P(A_1 \text{ or } A_2 \text{ or } A_3 \text{ or } \dots) = P(A_1) + P(A_2) + P(A_3) + \dots$

(#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, \dots, A_n are equally likely & mutually exclusive,
and if $P(A_1 \text{ or } A_2 \text{ or } \dots \text{ or } A_n) = 1,$
then $P(A_k) = 1/n.$

[So, you can *count*: $P(A_1 \text{ or } A_2 \text{ or } \dots \text{ or } A_k) = k/n.$]

Ex. You have 76, and the board is KQ54. $P(\text{straight})?$

[52-2-4=46.] $P(\text{straight}) = P(8 \text{ on river OR } 3 \text{ on river})$
 $= P(8 \text{ on river}) + P(3 \text{ on river}) = 4/46 + 4/46.$

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 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: $(A\spadesuit, K\heartsuit) \neq (K\heartsuit, A\spadesuit)$.]

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

8. Permutations and Combinations.

e.g. you get 1 card, opp. gets 1 card.

of distinct possibilities?

52×51 . [ordered: (A♣, K♥) \neq (K♥, A♣) .]

Each such outcome, where order matters, is called a *permutation*.

Number of permutations of the deck? $52 \times 51 \times \dots \times 1 = 52!$

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

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♣) .]

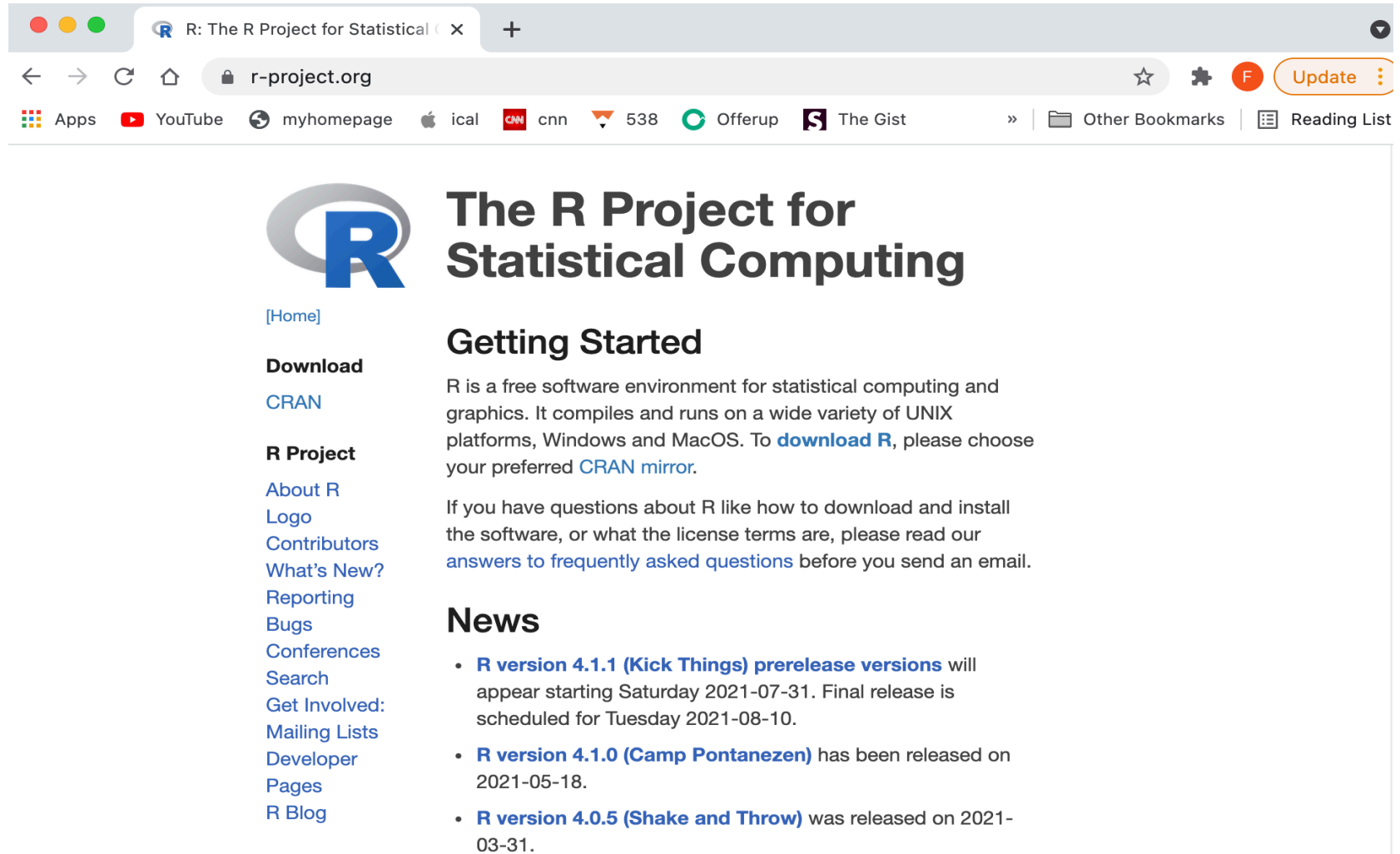
So, the number of *distinct* hands where *order doesn't matter* is

52 x 51 / 2.

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

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

9. **R.** To download and install *R*, go directly to cran.case.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 USA, and click on cran.case.edu. From there, click on “download R for ...”, and then get the latest version.



The screenshot shows a web browser window with the address bar displaying r-project.org. The page features the R logo, a navigation menu on the left, and main content sections for 'Getting Started' and 'News'.

The R Project for Statistical Computing

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Getting Started

R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To **download R**, please choose your preferred [CRAN mirror](#).

If you have questions about R like how to download and install the software, or what the license terms are, please read our [answers to frequently asked questions](#) before you send an email.

News

- **R version 4.1.1 (Kick Things) prerelease versions** will appear starting Saturday 2021-07-31. Final release is scheduled for Tuesday 2021-08-10.
- **R version 4.1.0 (Camp Pontanezen)** has been released on 2021-05-18.
- **R version 4.0.5 (Shake and Throw)** was released on 2021-03-31.

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CRAN Mirrors

The Comprehensive R Archive Network is available at the following URLs, please choose a location close to you. Some statistics on the status of the mirrors can be found here: [main page](#), [windows release](#), [windows old release](#).

If you want to host a new mirror at your institution, please have a look at the [CRAN Mirror HOWTO](#).

0-Cloud

<https://cloud.r-project.org/>

Automatic redirection to servers worldwide, currently sponsored by Rstudio

Algeria

<https://cran.usthb.dz/>

University of Science and Technology Houari Boumediene

Argentina

<http://mirror.fcaglp.unlp.edu.ar/CRAN/>

Universidad Nacional de La Plata

Australia

<https://cran.csiro.au/>

CSIRO

<https://mirror.aarnet.edu.au/pub/CRAN/>

AARNET

<https://cran.ms.unimelb.edu.au/>

School of Mathematics and Statistics, University of Melbourne

<https://cran.curtin.edu.au/>

Curtin University

Austria

<https://cran.wu.ac.at/>

Wirtschaftsuniversität Wien

Belgium

<https://www.freeststatistics.org/cran/>

Patrick Wessa

<https://ftp.belnet.be/mirror/CRAN/>

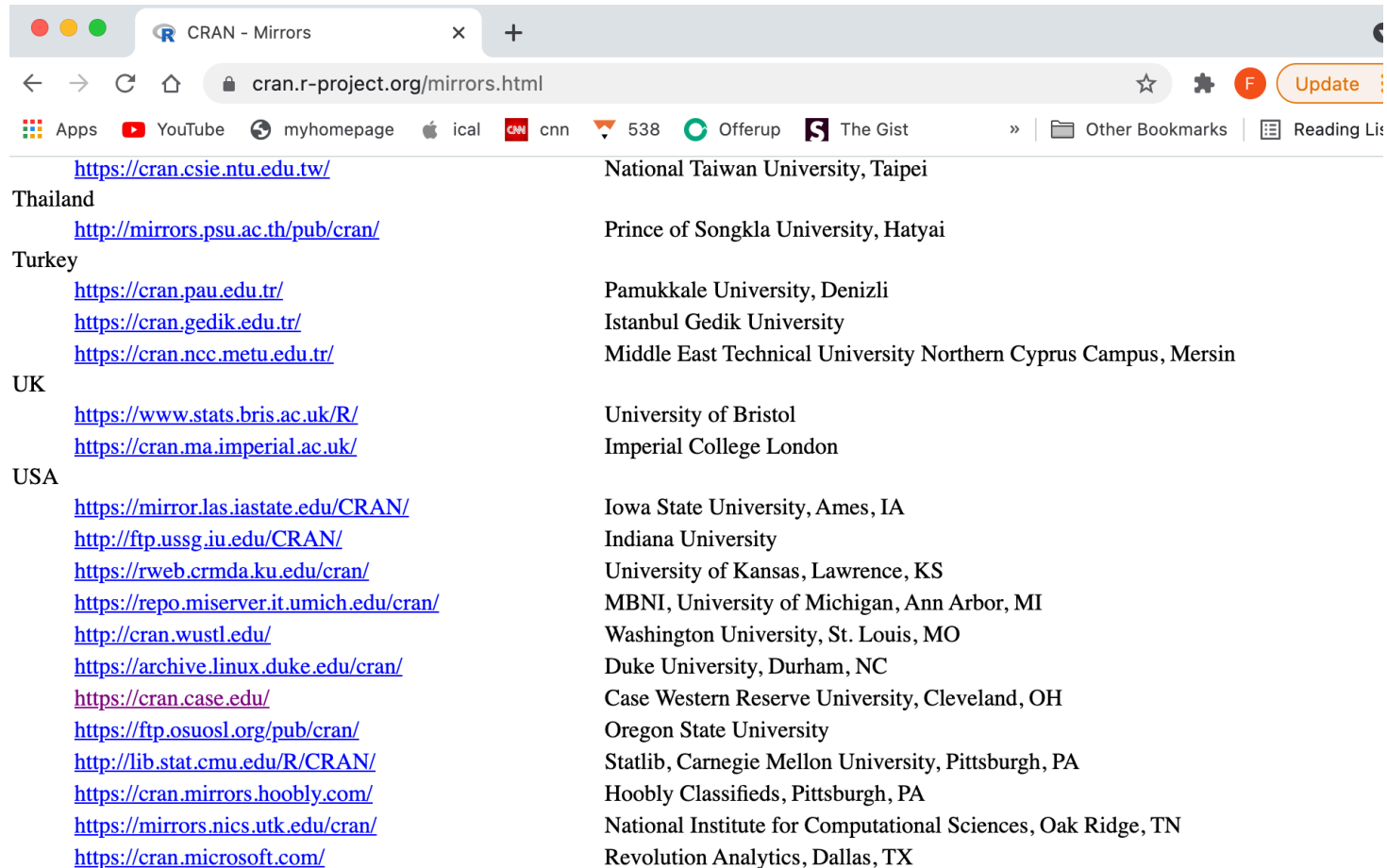
Belnet, the Belgian research and education network

Brazil

<https://nbcgib.uesc.br/mirrors/cran/>

Computational Biology Center at Universidade Estadual de Santa Cruz

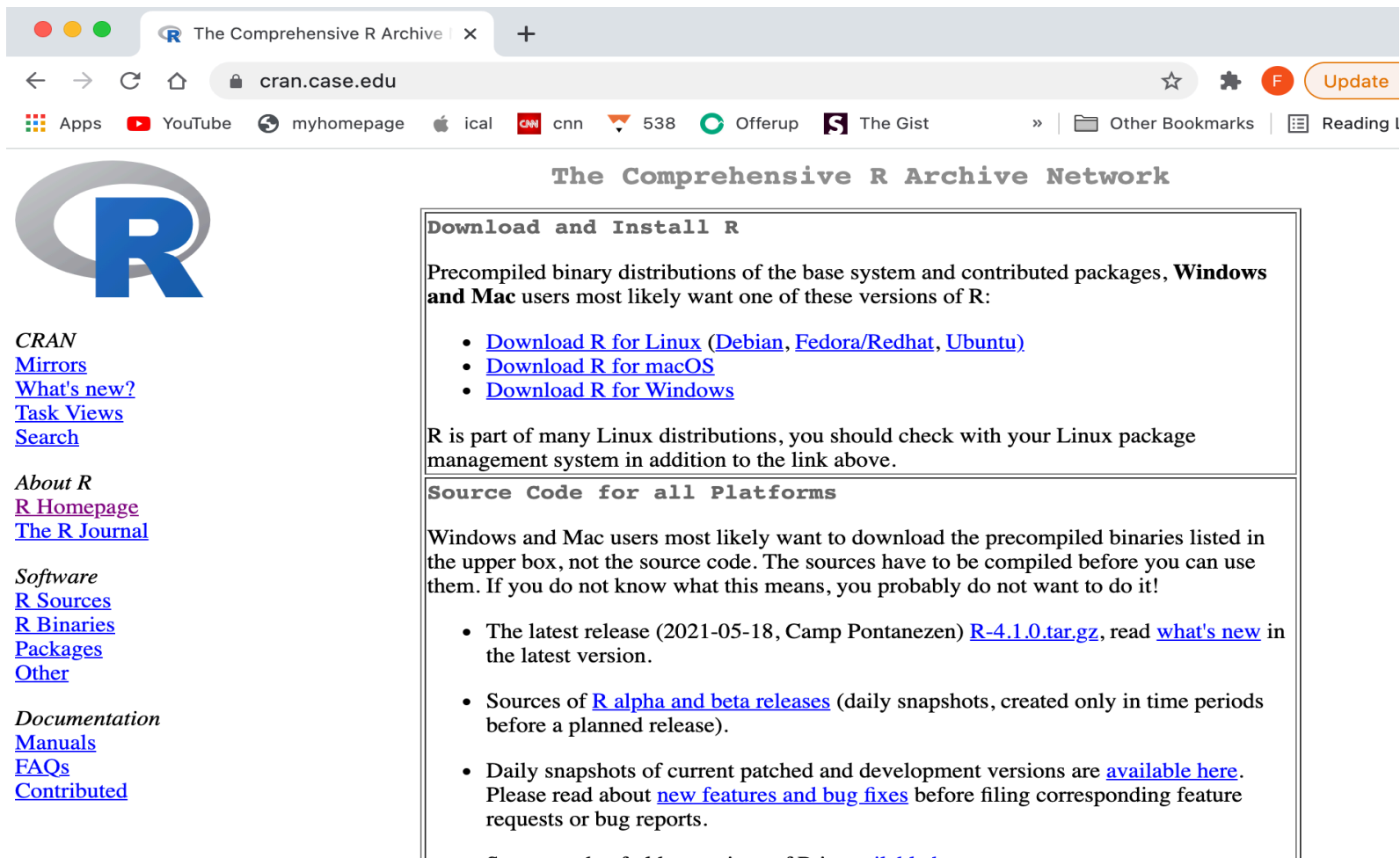
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The screenshot shows a web browser window with the address bar displaying cran.r-project.org/mirrors.html. The page content lists various CRAN mirrors organized by country. The countries listed are Thailand, Turkey, UK, and USA. Each country has a list of mirrors with their respective URLs and names.

Country	Mirror URL	Mirror Name
Thailand	https://cran.csie.ntu.edu.tw/	National Taiwan University, Taipei
	http://mirrors.psu.ac.th/pub/cran/	Prince of Songkla University, Hatyai
Turkey	https://cran.pau.edu.tr/	Pamukkale University, Denizli
	https://cran.gedik.edu.tr/	Istanbul Gedik University
	https://cran.ncc.metu.edu.tr/	Middle East Technical University Northern Cyprus Campus, Mersin
UK	https://www.stats.bris.ac.uk/R/	University of Bristol
	https://cran.ma.imperial.ac.uk/	Imperial College London
USA	https://mirror.las.iastate.edu/CRAN/	Iowa State University, Ames, IA
	http://ftp.ussg.iu.edu/CRAN/	Indiana University
	https://rweb.crmdata.ku.edu/cran/	University of Kansas, Lawrence, KS
	https://repo.miserver.it.umich.edu/cran/	MBNI, University of Michigan, Ann Arbor, MI
	http://cran.wustl.edu/	Washington University, St. Louis, MO
	https://archive.linux.duke.edu/cran/	Duke University, Durham, NC
	https://cran.case.edu/	Case Western Reserve University, Cleveland, OH
	https://ftp.osuosl.org/pub/cran/	Oregon State University
	http://lib.stat.cmu.edu/R/CRAN/	Statlib, Carnegie Mellon University, Pittsburgh, PA
	https://cran.mirrors.hoobly.com/	Hoobly Classifieds, Pittsburgh, PA
	https://mirrors.nics.utk.edu/cran/	National Institute for Computational Sciences, Oak Ridge, TN
	https://cran.microsoft.com/	Revolution Analytics, Dallas, TX

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The screenshot shows a web browser window with the address bar set to cran.case.edu. The page title is "The Comprehensive R Archive Network". On the left side, there is a navigation menu with links: [CRAN](#), [Mirrors](#), [What's new?](#), [Task Views](#), [Search](#), [About R](#), [R Homepage](#), [The R Journal](#), [Software](#), [R Sources](#), [R Binaries](#), [Packages](#), [Other](#), [Documentation](#), [Manuals](#), [FAQs](#), and [Contributed](#). The main content area is titled "Download and Install R" and contains the text: "Precompiled binary distributions of the base system and contributed packages, **Windows and Mac** users most likely want one of these versions of R:". Below this text are three bullet points with links: [Download R for Linux \(Debian, Fedora/Redhat, Ubuntu\)](#), [Download R for macOS](#), and [Download R for Windows](#). Further down, it says "R is part of many Linux distributions, you should check with your Linux package management system in addition to the link above." Below this is a section titled "Source Code for all Platforms" with the text: "Windows and Mac users most likely want to download the precompiled binaries listed in the upper box, not the source code. The sources have to be compiled before you can use them. If you do not know what this means, you probably do not want to do it!". This section contains three bullet points: "The latest release (2021-05-18, Camp Pontanezen) [R-4.1.0.tar.gz](#), read [what's new](#) in the latest version.", "Sources of [R alpha and beta releases](#) (daily snapshots, created only in time periods before a planned release).", and "Daily snapshots of current patched and development versions are [available here](#). Please read about [new features and bug fixes](#) before filing corresponding feature requests or bug reports."

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

$P(X = A\spadesuit)$? $P(X = 2\clubsuit)$?

We will discuss this next time.