Lecture 0: Introduction, Set Theory, and Boolean Algebra

Sta 230 / Mth 230

Colin Rundel

January 10, 2014

General Info

Classroom: Old Chem 116
Time: Wednesdays, Fridays
10:05 - 11:20 am

Professor: Colin Rundel
Office: Old Chemistry 223C
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Teaching Assistants: Hunter Nisonoff - *hmn5@duke.edu*
Spencer Woody - *spencer.woody@duke.edu*

Course Website: *http://stat.duke.edu/~cr173/Sta230_Sp14*

Materials

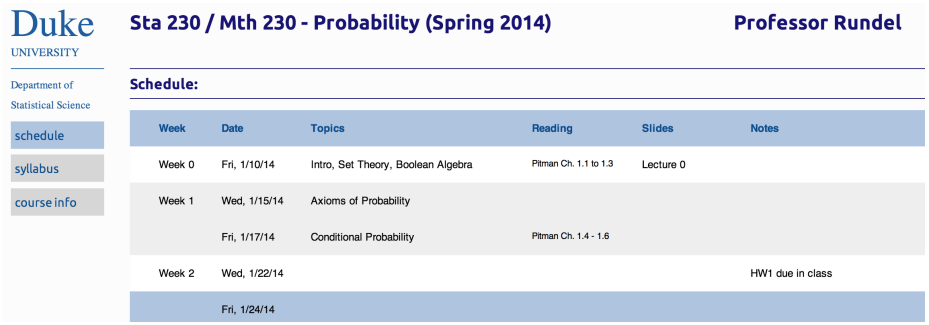
Textbook: Probability, Pitman
Springer, 1^{st} Edition 7^{th} Printing, 1993
ISBN: 978-0-387-97974-8

Calculator: 4 function

Webpage

http://stat.duke.edu/courses/Spring12/sta104.1

- All announcements and assignments will be posted on the website.
- Lecture slides will be posted before lecture.



Duke UNIVERSITY

Department of Statistical Science

schedule
syllabus
course info

Sta 230 / Mth 230 - Probability (Spring 2014) **Professor Rundel**

Schedule:

Week	Date	Topics	Reading	Slides	Notes
Week 0	Fri, 1/10/14	Intro, Set Theory, Boolean Algebra	Pitman Ch. 1.1 to 1.3	Lecture 0	
Week 1	Wed, 1/15/14	Axioms of Probability			
	Fri, 1/17/14	Conditional Probability	Pitman Ch. 1.4 - 1.6		
Week 2	Wed, 1/22/14				HW1 due in class
	Fri, 1/24/14				

Office Hours

Professor: Tuesdays 3:00 pm - 5:00 pm
or by appointment.

TAs: Sunday - Thursday 4pm - 9pm starting next week at the SECC (Old Chemistry 211A)

- You are highly encouraged to stop by with any questions or comments about the class.
- Note that most homework assignments will be due on Wednesday. I recommend that you attempt all homework problems over the weekend so that you can come to office hours with questions.

Grading

Homework	30%
Midterm 1	20%
Midterm 2	20%
Final	30%

Homework

- Questions from the book and external sources.
- Due at the beginning of class on the due date.
- Graded out of 100
- Late work policy:
  - Late but during class: -10 points
  - After class on due date: -20 points
  - Next day: no credit
- Show all your work to receive full credit.
- Encouraged to work with others, but you must turn in your own work.
- Lowest homework score will be dropped.
- An excused absence does not excuse homework, make alternative arrangements ahead of time.

Exams

- Midterm 1: *Wednesday, February 21st*
- Midterm 2: *Wednesday, March 28th*
- Final: *Wednesday, April 30th, 2:00 - 5:00 pm* (Cumulative)
- No make-up exams will be given.
- "cheat sheet" - one sheet ($8\frac{1}{2}$" $\times$ 11") of notes prepared by you (no photocopies) to the exam. You may use both sides of the sheet.
- You *cannot pass* the class if you do not take the final.

Email

- I will regularly send announcements by email, so make sure to check your email daily.
- While email is the quickest way to reach me outside of class, note that it is much more efficient to answer most statistical questions in person.

Policies

- There will not be make-ups for any of the homework or exams.
- All regrade requests on homework assignments and exams should be submitted to me within one week of receiving your graded work. There will be no grade changes after the final exam.
- Academic Integrity & Duke Community Standard
- Excused absences

What is a set?

Georg Cantor

A set is a gathering together into a whole of definite, distinct objects of our perception or of our thought - which are called elements of the set.

A set is a grouping of *distinct* objects. We will denote sets using capital letters (A,B) and the elements of the set using *curly braces* ($\{\}$).

To define a set we either *enumerate* all elements or use *set-builder notation*:

The set of card suits

$$\{\clubsuit, \diamondsuit, \heartsuit, \spadesuit\}$$

The set of all prime numbers

$$\{x | x \text{ is prime}\}$$

Set notation and operations

$x \in A$	x is an element of A	
$A \cup B$, $A + B$	is the union of A and B	$\{x \mid x \in A \text{ or } B\}$
$A \cap B$, AB	is the intersection of A and B	$\{x \mid x \in A \text{ and } B\}$
$A \subseteq B$	means A is a subset of B	$x \in A \Rightarrow x \in B$
$A \subset B$	means A is a proper subset of B	$A \subseteq B$ and $A \neq B$
$A \backslash B$	is the difference of A and B	$\{x \in A \mid x \notin B\}$
$\emptyset, \{\}$	is the empty set	
$A', \overline{A}, A^c$	is the complement of A	$A' = \{x \mid x \notin A\}$
$\lvert A \rvert$	is the cardinality of A	

Set operation properties

Commutativity	$A \cup B = B \cup A$ $A \cap B = B \cap A$
Associativity	$(A \cup B) \cup C = A \cup (B \cup C)$ $(A \cap B) \cap C = A \cap (B \cap C)$
Distribution	$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$
Idempotence	$A \cup A = A$ $A \cap A = A$
Absorption	$A \cup (A \cap B) = A$ $A \cap (A \cup B) = A$
—	$A \cup A' = U$ $A \cap A' = \emptyset$

De Morgan's Laws

Useful rules that allow us to relate conjunction (union / or) and disjuction (intersection / and) using only negation.

$$(A \cup B)' = A' \cap B'$$

$$(A \cap B)' = A' \cup B'$$

Some examples

Show the following relations are true:

1. A+BC=(A+B)(A+C)
2. (A+C)A+AC+C=A+C
3. B+A(B+C)+BC=B+AC

A little Logic / Boolean Algebra

Logic statements are statements that must be either *true* or *false*. In general we indicate logic statements using lower case letters (e.g. p,q).

There is a natural correspondence between set theory and logic operators:

Set Theory	Logic
$A \cup B$	p or q
$A \cap B$	p and q
$A = B$	$p \leftrightarrow q$
$A \subseteq B$	$p \rightarrow q$
$(A \cup B)' = A' \cap B'$	$(p$ or $q)' \leftrightarrow p'$ and q'
$(A \cap B)' = A' \cup B'$	$(p$ and $q)' \leftrightarrow p'$ or q'

More Correspondence

Additionally, we can construct logic statements from sets by asking if an element belongs to a set, e.g.

$$A \cup B \longrightarrow x \in (A \cup B) \leftrightarrow x \in A \text{ or } x \in B$$

Example - let A be the set of possible weather for today,

$$\{sun, clouds, rain, snow\}.$$

More on why we care about all of this next time.

Adequacy of Logical operators

(Proof Sketch)