Math 1710 Class 1

Dr. Allen Back

Aug. 28, 2009
Outline

1 Topics

If You've Studied Stats . . .

Formal Probability

Letters

Independent Events

Spinner

Gen. Addition Rule
1. Topics

2. If You’ve Studied Stats ...
Outline

1. Topics

2. If You’ve Studied Stats . . .

3. Formal Probability
Outline

1. Topics
2. If You’ve Studied Stats . . .
3. Formal Probability
4. Letter Sample Space
Outline

1. Topics

2. If You’ve Studied Stats . . .

3. Formal Probability

4. Letter Sample Space

5. Independent Events
Outline

1. Topics
2. If You’ve Studied Stats …
3. Formal Probability
4. Letter Sample Space
5. Independent Events
6. Spinner
Outline

1. Topics
2. If You’ve Studied Stats . . .
3. Formal Probability
4. Letter Sample Space
5. Independent Events
6. Spinner
7. Gen. Addition Rule
Math 1710 Topics

Probability (5 wks)

- Basic Ideas
- Random Variables
- Law of Large Numbers
- Normal and Binomial Distributions
- Central Limit Theorem
- Sampling Distributions
Math 1710 Topics

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- Basic Ideas
- Random Variables
- Law of Large Numbers
- Normal and Binomial Distributions
- Central Limit Theorem
- Sampling Distributions

Data (3 wks)
- Descriptive Statistics (1 Var)
  (Graphical and Quantitative)
- Correlation and Regression (2 Var)
- Sampling and Experimentation
Math 1710 Topics

Data (3 wks)
- Descriptive Statistics (1 Var)
  (Graphical and Quantitative)
- Correlation and Regression (2 Var)
- Sampling and Experimentation

Basic Inference (4 wks)
- Confidence Intervals
- Hypothesis Testing
- (Z,t, proportions, means, two-sample)
Math 1710 Topics

Basic Inference (4 wks)
- Confidence Intervals
- Hypothesis Testing
- \((Z,t,\text{ proportions, means, two-sample})\)

More Refined (2 wks)
- Chi Square
- Inference for Regression
Some different emphases.
Some different emphases.

But generally comparable.
AP Stats vs. 1710

Some different emphases.
But generally comparable.
So retaking not recommended.
Some different emphases.

But generally comparable.

So retaking not recommended.
Though many people do.
Some different emphases.
But generally comparable.
So retaking not recommended.
Though many people do.
If you do, pls be sure to work/attend regularly.
AP Stats vs. 1710

Some different emphases.
But generally comparable.
So retaking not recommended.
Though many people do.
If you do, pls be sure to work/attend regularly.
Our exams quite different.
Some different emphases. 
**But generally comparable.**
So retaking not recommended. 
Though many people do.
If you do, pls be sure to work/attend regularly.
Our exams quite different. 
(And not that close to textbook.)
Some different emphases.

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Our exams quite different.

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Lecture a good guide to exam priorities.
Some different emphases.

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Our exams quite different.

(And not that close to textbook.)

Lecture a good guide to exam priorities.

(Some explanations will go beyond what you will be responsible for.)
Random Phenomenon - Individually not predictable. But *if repeated*, long term relative frequency is.
Fancy Words

Random Phenomenon
Outcome
Fancy Words

Random Phenomenon -
e.g. rolling a die
Random Phenomenon -
e.g. rolling a die
Outcome
e.g. a 3.
Fancy Words

Random Phenomenon -
e.g. rolling a die
Outcome
e.g. a 3.
Sample Space $S$ - Set of all possible outcomes.
e.g. $S = \{1, 2, 3, 4, 5, 6\}$. 
Random Phenomenon -
e.g. rolling a die
Outcome
e.g. a 3.
Sample Space $S$ - Set of all possible outcomes.
e.g. $S = \{1, 2, 3, 4, 5, 6\}$.
Event $E$ - a subset of the sample space – a set of outcomes.
e.g. $E = \{2, 4, 6\}$
“Rolling an even number.”
Random Phenomenon - Individually not predictable. But if repeated, long term relative frequency is. Random Phenomenon - e.g. tossing two coins
Random Phenomenon - e.g. tossing two coins
Outcome e.g. HT.
Fancy Words

Random Phenomenon -
e.g. tossing two coins
Outcome
e.g. HT.
Sample Space $S$ - Set of all possible outcomes.
e.g. $S = \{HH, HT, TH, TT\}$. 
Random Phenomenon -
e.g. tossing two coins
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Sample Space $S$ - Set of all possible outcomes.
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Event $E$ - a subset of the sample space – a set of outcomes.
e.g. $E = \{HT, TH\}$
“Rolling a total of 1 head.”
We won’t usually be this formal!

(1) \( 0 \leq P(\text{Outcome}) \leq 1 \).

(2) \( \sum P(\text{All Outcomes in } S) = 1 \).

(3) \( \sum P(\text{Outcomes in an Event}) = P(\text{Event}) \).
We won’t usually be this formal!

(1) $0 \leq P(\text{Outcome}) \leq 1$.

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We won’t usually be this formal!

1. \(0 \leq P(\text{Outcome}) \leq 1.\)
2. \(\sum P(\text{All Outcomes in } S) = 1.\)
3. \(\sum P(\text{Outcomes in an Event}) = P(\text{Event}).\)
(1) $0 \leq P(E) \leq 1$ for any event $E$.
(2) $P(\emptyset) = 0$, $P(S) = 1$.
(3) $P(A \cup B) = P(A) + P(B)$ if $A$ and $B$ are disjoint.
(4) $P(A^c) = 1 - P(A)$
Probability Properties

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A Probability Assignment

English language frequencies:
- E 13.0%
- H 3.5%
- W 1.6
- T 9.3%
- L 3.5%
- V 1.3%
- N 7.8%
- C 3.0%
- B 0.9%
- R 7.7%
- F 2.8%
- X 0.5%
- O 7.4%
- P 2.7%
- K 0.3%
- I 7.4%
- U 2.7%
- Q 0.3%
- A 7.3%
- M 2.5%
- J 0.2%
- S 6.3%
- Y 1.9%
- Z 0.1%
- D 4.4%
- G 1.6%
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Sample Space $S$: $S=\{A,B,C,...Z\}$.
A Probability Assignment

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Sample Space $S$: $S=\{A, B, C, \ldots, Z\}$.

An Outcome: e.g. an M.
A Probability Assignment

English language frequencies:

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Sample Space $S$: $S=\{A,B,C,\ldots,Z\}$.

An Outcome: e.g. an M.

An Event $E$: e.g. being a vowel. Formally: $E=\{A,E,I,O,U\}$

$P(E) = 13.0 + 7.4 + 7.4 + 7.3 + 2.7% = 37.8%.$
Prob of Event frm Prob Outcomes

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$E_2$: a letter in ‘HELLO’.
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$E_2$: a letter in ‘HELLO’.

$E_2 = \{H, E, L, O\}$. 
Sample Space $S$: $S=\{A,B,C,...Z\}$.

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$E_2$: a letter in ‘HELLO’.

$E_2 = \{H, E, L, O\}$.

$P(E_2) = 3.5 + 13 + 3.5 + 7.4\% = 37.8\%$. 
Addition Rule

\[ E_2 = \{H, E, L, O\}. \]
\[ P(E_2) = 3.5 + 13 + 3.5 + 7.4\% = 37.8\%. \]
\[ E_3 = \{B, A, D\}. \]
\[ P(E_3) = 0.9 + 7.3 + 4.4\% = 12.6\%. \]

\( E_2 \) and \( E_3 \) are disjoint events.
Addition Rule

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\[ E_2 \text{ and } E_3 \text{ are disjoint events.} \]
\[ P(E_2 \cup E_3) = P(E_2) + P(E_3) = 37.8 + 12.6\% \]
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$E_2 \cup E_3$ means “a letter in HELLO or BAD.”
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\[ E_2 \cup E_3 \text{ means "a letter in HELLO or BAD."} \]
\[ E_2 \cup E_3 = \{H, E, L, O, B, A, D\}. \]
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\[ E_2 \cup E_3 \text{ means “a letter in HELLO or BAD.”} \]
\[ E_2 \cup E_3 = \{H, E, L, O, B, A, D \}. \]

Union (\( \cup \)) corresponds to “or’.”
Equally Likely Outcomes

Sometimes all $n$ outcomes in a sample space are equally likely.
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e.g. fair die, fair coins, ...
Equally Likely Outcomes

Sometimes all $n$ outcomes in a sample space are equally likely. e.g. fair die, fair coins, ... If so, each has probability $\frac{1}{n}$. 
Sometimes all $n$ outcomes in a sample space are equally likely. e.g. fair die, fair coins, ... If so, each has probability $\frac{1}{n}$. So the sample space $S = \{HH, HT, TH, TT\}$ for tossing 2 coins shows us

<table>
<thead>
<tr>
<th>Num Heads</th>
<th>Prob.</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>$\frac{1}{4}$</td>
</tr>
<tr>
<td>1</td>
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</tr>
<tr>
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Independence Informally

Independence of A and B means knowing A happened doesn’t affect the chance of B happening.
Independence Informally

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**Product Rule** for independent events: $P(A \cap B) = P(A)P(B)$. 
Independence Informally

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**Product Rule** for independent events: \( P(A \cap B) = P(A)P(B) \).
Independence Informally

Independence of A and B means knowing A happened doesn’t affect the chance of B happening. **Product Rule** for independent events: \( P(A \cap B) = P(A)P(B) \). Intersection (\( \cap \)) corresponds to “and’.”
## Spinner Prob Asst

<table>
<thead>
<tr>
<th>Discount</th>
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</tr>
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<tbody>
<tr>
<td>10%</td>
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</tr>
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<tr>
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<td>2/12=.17</td>
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<td>1/12=.08</td>
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Customers Spin a Wheel

12 equal size areas.
Wheel gives customer discount in %.
Topics
If You’ve Studied Stats . . .

Formal Probability
Letters
Independent Events

Spinner
Gen. Addition Rule

Spinner Prob Asst

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(1) Prob of at least a 40% discount?

10% + 20% + 40% = .5 + .25 + .17 = .92
Spinner Prob Asst

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(1) Prob of at least a 40% discount?

.17 + .08 = .25
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(1) Prob of at least a 40% discount?
.17 + .08 = .25

(2) Prob two customers in a row get 10% discount?
.5 .5 = .25
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(1) Prob of at least a 40% discount?
.17 + .08 = .25

(2) Prob two customers in a row get 10% discount?

\[
\begin{align*}
\text{.5} & \quad \text{.5}
\end{align*}
\]
Topics
If You’ve Studied Stats

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(1) Prob of at least a 40% discount?

.17 + .08 = .25

(2) Prob two customers in a row get 10% discount?

.5 \times .5 = .25
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(3) Prob 3 consecutive customers get 20%?
(3) Prob 3 consecutive customers get 20%?

\[0.25 \times 0.25 \times 0.25 = 0.015625\]
(3) Prob 3 consecutive customers get 20%?

\[ .25 \times .25 \times .25 = .25^3. \]
Spinner Prob Asst

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(3) Prob 3 consecutive customers get 20%?

\[ .25 \times .25 \times .25 = .25^3. \]

(4) Prob none of first four get over 20%?
If You’ve Studied Stats . . .

Formal Probability
Letters
Independent Events
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Gen. Addition Rule

Discount   Probability
10%        6/12 = .5
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100%       1/12 = .08

(3) Prob 3 consecutive customers get 20%?  

\[ .25 \times .25 \times .25 = .25^3 \]

(4) Prob none of first four get over 20%?  
\[ P(\text{all 20\% or less}) = \left(\frac{3}{4}\right)^4 \]
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(5) Prob that first 100% is fifth customer?
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(5) Prob that first 100% is fifth customer?

11/12 11/12 11/12 11/12 1/12
(5) Prob that first 100% is fifth customer?

\[
\left( \frac{11}{12} \right)^4 \left( \frac{1}{12} \right)
\]
Spinner Prob Asst

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(6) Chance that at least one of the first six shoppers gets less than a 100% discount?
(6) Chance that at least one of the first six shoppers gets less than a 100% discount?

Hard b/c could be 1 or 2 or . . .

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<tbody>
<tr>
<td>10%</td>
<td>6/12 = .5</td>
</tr>
<tr>
<td>20%</td>
<td>3/12 = .25</td>
</tr>
<tr>
<td>40%</td>
<td>2/12 = .17</td>
</tr>
<tr>
<td>100%</td>
<td>1/12 = .08</td>
</tr>
</tbody>
</table>
(6) Chance that at least one of the first six shoppers gets less than a 100% discount?

Hard b/c could be 1 or 2 or . . .

P(0 get less than 100%) = P(all 100%) = \left( \frac{11}{12} \right)^6
(6) Chance that at least one of the first six shoppers gets less than a 100% discount?

Hard b/c could be 1 or 2 or . . .

\[
P(0 \text{ get less than 100%}) = P(\text{all 100%}) = \left(\frac{11}{12}\right)^6.
\]

So complement rule says answer to (6) is \(1 - \left(\frac{11}{12}\right)^6\).
If You've Studied Stats . . .

Formal Probability

Letters

Independent Events

Spinner

Gen. Addition Rule

Venn Diagram Picture

\[ A = \{1, 2\} \quad B = \{2, 3\} \]

\[ A \cap B = \{2\} \quad A \cup B = \{1, 2, 3\} \]

\[ P(A \cup B) = P(A) + P(B) - P(A \cap B) \]

\[ 1, 2, 3 \quad 1, 2 \quad 2, 3 \quad 2 \]
Playing Sports

Suppose

- 30% play soccer
- 20% basketball
- 12% both.

Probability of playing at least one?
Playing Sports

Suppose

- 30% play soccer
- 20% basketball
- 12% both.

Probability of playing at least one?

**Soln:** \(0.30 + 0.20 - 0.12 = 0.38.\)
Suppose

- 30% play soccer
- 20% basketball
- 12% both.

Probability of playing at least one?

**Soln:** \(0.30 + 0.20 - 0.12 = 0.38\).

or