Section 1

MANE 3332.03

Subsection 1

Lecture 3, January 30

Agenda

- Course Questions
- Start Chapter 2 lecture

Handouts

- Lecture 3 Slides
- Lecture 3 Marked Slides

Chapter 2

Our goal is to understand, quantify, and model the type of variations we encounter. When we incorporate the variation into our thinking and analyses, we can make the informed judgments from our results that are not invalidated by the variation.

Fundamental Definitions

Random experiment

is an experiment that can result in different outcomes, even though it is repeated in the same manner

Sample Space

is the set of all possible outcomes of a random experiment

Event

is a subset of the sample space of a random experiment

Examples of Random Experiments, Sample Space, Events

- Consider the bead bowl
- Consider the Texas Lottery's Pick Three game (I am not encouraging gambling)

TxLottery.org

Latest Estimated Jackpots:
Mega Millions: **$42 Million** for 01/20/04
Lotto Texas: **$55 Million** for 01/21/04
Texas Two Step: **$ 400,000** for 01/20/04

Where the $ Goes

Got a Question? | Jobs | Legal Notices | About Us | Contact Us | Sitemap

Results & More
Mega Millions
Lotto Texas
Texas Two Step
Cash Five
Pick 3
Scratch Offs
From the Executive Director
Claim Centers
License & Retailer Forms

How to Play Pick 3

Play *Pick 3* **Twice A Day!** *Pick 3* is a twice daily game offering a 50-cent play, twelve drawings a week (six Day and six Night drawings) and a **top prize of $500** (on a $1 play.)

It's easy to play. Just pick three numbers from "0" to "9", choose how you want to play them, the number of drawings you want to play and the time of day you want to play. *Pick 3* drawings are held twice daily at 12:27 p.m. and 10:12 p.m. Central Time. *Pick 3*, 2 Times A Day, 2 Times The Fun!

How to Play *

First, pick three numbers from "0" to "9" or mark the QP (Quick Pick) box and your numbers will be randomly selected for you.

Second, select how you want to play your three numbers (Exact Order, Any Order, Exact/Any Order, Combo).

If You Play	For	And Numbers Drawn Are	You Win
Exact Order Odds 1:1,000 — 516	$.50 $1.00	516	$250 $500
Any Order 2 like numbers Odds 1:333 — 665	$.50 $1.00	665 566 656	$80 $160
Any Order 3 different numbers Odds 1:167 — 516	$.50 $1.00	615 651 516 561 165 156	$40 $80
Exact/ Any Order 2 like numbers Odds 1:333 — 797	$.50 Exact Order $.50 Any Order $1.00	797 Exact Order 797 977 779 Any order	$250+$80=$330 Pays both exact order & any order when 797 is drawn $80
Exact/ Any Order 3 different numbers Odds — 654	$.50 Exact Order $.50 Any Order $1.00	654 Exact Order 645 654 465 456 564 546 Any order	$250+$40=$290 Pays both exact order & any order when 654 is drawn

Join Player Connect

PLAY RESPONSIBLY
Problem Gambling Information

Tree Diagrams

- Tree diagrams are a useful tool for understanding sample spaces and events. Apply to Pick Three game.

Probability

- The probability of an event is the likelihood that it occurs
- Probability is expressed as a number between 0 and 1
- Probability of an event can be found by dividing the number of outcomes of the desired events divided by the total number of outcomes in the sample space (if all events are equally likely)

Counting Techniques

- Consider ordered versus unordered subsets
- Ordered subsets (Permutations)

$$P_r^n = \frac{n!}{(n-r)!}$$

- Unordered subsets (Combinations)

$$C_r^n = \frac{n!}{r!\,(n-r)!}$$

- Good idea to do a calculator check

Axioms (Rules) of Probability

Probability is a number that is assigned to each member of a collection of events from a random experiment that satisfies the following properties:

If S is the sample space and E is any event in a random experiment,

1. $P(S) = 1$
2. $0 \leq P(E) \leq 1$
3. For two events E_1 and E_2 with $E_1 \cap E_2 = \emptyset$

$$P\left(E_1 \cup E_2\right) = P\left(E_1\right) + P\left(E_2\right)$$

- Consider problem 2-70

Practice Problems - Single Event

A Word of Warning

- It usually looks very easy when I work a problem
- I have been using statistics for almost 40 years
- This is something you MUST practice
- Rework class room examples and textbook examples

Probability of Multiple Events

Intersection:

$P(A \cap B)$ *is "the probability of A and B occurring*

Union:

$P(A \cup B)$ *is "the probability of A or B (or both)"*

Complement:

$P(A')$ *is "the probability of not A"*

- Venn diagrams are a very useful tool for understanding multiple events and calculating probabilities

Addition Rules

- Used to calculate the union of two events

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

- If two events are mutually exclusive ($A \cap B = \emptyset$)

$$P(A \cup B) = P(A) + P(B)$$

- Consider problems 2-82 and 2-85

Addition Rule for 3 or More Events

- For three events

$$\begin{aligned} P(A \cup B \cup C) = \quad & P(A) + P(B) + P(C) \\ & -P(A \cap B) - P(A \cap C) - P(B \cap C) \\ & +P(A \cap B \cap C) \end{aligned}$$

- For a set of events to mutually exclusive all pairs of variables must satisfy $E_1 \cap E_2 = \emptyset$
- For a collection of mutually exclusive events,

$$P(E_1 \cup E_2 \cup \ldots \cup E_k) = P(E_1) + P(E_2) + \cdots + P(E_k)$$

Conditional Probability

- Hayter (2002) states that "For experiments with two or more events of interest, attention is often directed not only at the probabilities of individual events but also at the probability of an event occurring **conditional** on the knowledge that another event has occurred."
- The **conditional probability** of an event B given an event A, denoted $P(B|A)$ is

$$P(B|A) = \frac{P(A \cap B)}{P(A)}$$

for $P(A) > 0$

- Consider problems 2-99

Multiplication Rules

- This rule provides another method for calculating $P(A \cap B)$

$$P(A \cap B) = P(A|B)P(B) = P(B|A)P(A)$$

- This leads to the total probability rule

$$\begin{aligned} P(B) = & \quad P(B \cap A) + P(B \cap A') \\ = & \quad P(B|A)P(A) + P(B|A')P(A') \end{aligned}$$

- Consider problems from 3rd edition (next slide) and 2-129

Example Problem 2-76

2-76. Samples of laboratory glass are in small, light packaging or heavy, large packaging. Suppose that 2 and 1% of the sample shipped in small and large packages, respectively, break during transit. If 60% of the samples are shipped in large packages and 40% are shipped in small packages, what proportion of samples break during shipment?

Figure 3: problem 2-76

Independent Events

- Two events are independent if any one of the following is true:
  1. $P(A|B) = P(A)$
  2. $P(B|A) = P(B)$
  3. $P(A \cap B) = P(A)P(B)$
- Consider problem 2-146

Reliability Analysis

- Reliability is the application of statistics and probability to determine the probability that a system will be working properly
- Components can be arranged in series. All components must work for the system to work.

$$P(\text{system works}) = P(A \text{ works})P(B \text{ works})$$

- Components can be arranged in parallel. As long as one component works, the system works.

$$P(\text{system works}) = 1 - (1 - P(A \text{ works})) \times 1 - P(B \text{ works}))$$

- Consider problem 2-157