WTECH DATA SCIENCE AND ARTIFICAL INTELLIGENCE
CLASS WORK
GROUP 1

1. Construct a sample space for the experiment that consists of rolling a single die. Find the events that correspond to the phrases "an even number is rolled" and "a number greater than two is rolled."

SOLUTION

$$\text{Sample Space } = \{1,2,3,4,5,6\}$$
$$Even\ number\ (e) = \{2,4,6\}$$
$$Number\ (n) > 2 = \{3,4,5,6\}$$
$$E\ (\text{“}an\ even\ number\ is\ rolled\text{”}\ and\ \text{“}a\ number\ greater\ than\ two\ is\ rolled.\text{”})$$
$$= P(e) and\ P(n)$$
$$P(e) \cap P(n)$$
$$\{2,4,6\} \cap \{3,4,5,6\}$$

2. Construct a sample space that describes all three-child families according to the genders of the children with respect to birth order.

SOLUTION

$$\text{Total Sample Space } = \mathrm{K^n} = 2^3 \Rightarrow 8$$
$$\mathrm{K} = 2, \mathrm{n} = 3$$
$$Sample\ Space$$
$$= [\{B,B,B\},\{B,B,G\},\{B,G,B\},\{B,G,G\},\{G,B,B\},\{G,B,G\},\{G,G,B\},\{G,G,G\}]$$

3. A coin is called "balanced" or "fair" if each side is equally likely to land up. Assign a probability to each outcome in the sample space for the experiment that consists of tossing a single fair coin.

SOLUTION
Sample Space= {H,T}
Probability (H) = ½
Probabilty (T) = ½

4. A die is called "balanced" or "fair" if each side is equally likely to land on top. Assign a probability to each outcome in the sample space for the experiment that consists of tossing a single fair die. Find the possibilities of the events E: "an even number is rolled" and T "a number greater than two is rolled."

Answer
Sample Space = {1,2,3,4,5,6}
Pr (1) = 1/6

Pr (2)= 1/6
Pr (3)= 1/6
Pr (4)= 1/6
Pr (5)= 1/6
Pr (6)= 1/6

Pr (E) = 1/6 + 1/6 +1/6 = 3/6 =1/2
Pr (T) = 1/6 + 1/6 + 1/6 +1/6 = 4/6 = 2/3

5. Two fair coins are tossed. Find the probability that the coins match, i.e., land heads or land tails.

   Answer
   Sample Space = ({H, T}, {T, H}, {H, H}, {T, T}
   Pr (HH) = ¼
   Pr (TT) = ¼
   Pr (Mc) = ¼ +1/4 = 2/4 = 1/2

6. The student body breakdown in a local high school according to race and ethnicity is 51% white, 27% black, 11% Hispanic, 6% Asian, and 5% for all others. A student is randomly selected from this high school. (To select "randomly" means that every student has the same chance of being selected.) Find the probabilities of the following events:
   1. B: the student is black,
   2. M: the student is a minority (that is, not white),
   3. N: the student is not black

SOLUTION

Total Sample = 100
Probability (B) = 27/100 = 0.27
Probability (M) = 27 + 11 + 6+ 5= 49/100= 0.49
Probability (N) = 51 + 11+ 6 + 5 = 73/100= 0.73

7. The student body in the high school considered in the last example may be broken down into ten categories as follows: 25% white male, 26% white female, 12% black male, 15% black female, 6% Hispanic male,5% Hispanic female, 3% Asian male, 3% Asian female, 1% male of other minorities combined, and 4% female of other minorities combined. A student is randomly selected from this high school. Find the probabilities of the following events:

a.B: the student is black

b.MF: the student is a non-white female

c.FN: the student is female and is not black

SOLUTION

Total Sample = 0.25 + 0.26 + 0.12 + 0.15 + 0.06 + 0.05 + 0.03 + 0.03 + 0.01 + 0.04 = 1

Probability (B) = 0.12 + 0.15 = 0.27

Probability (MF) = 0.25 + 0.12 + 0.15 + 0.06 + 0.05 + 0.03 + 0.03 + 0.01 + 0.04 = 0.74

Probability (FN) = 0.26 + 0.05 + 0.03 +0.04 = 0.38

8. The sample space that describes all three-child families according to the genders of the children with respect to birth order is S={bbb,bbg,bgb,bgg,gbb,gbg,ggb,ggg}. For each of the following events in the experiment of selecting a three-child family at random, state the complement of the event in the simplest possible terms, then find the outcomes that comprise the event and its complement.

a. At least one child is a girl.
b. At most one child is a girl.
c. All of the children are girls.
d. Exactly two of the children are girls.
e. The firstborn is a girl.

SOLUTION

S= {bbb, bbg,bgb,bgg,gbb,gbg,ggb,ggg}

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a. At least one child is a girl.

$A = \{bbg, bgb, bgg, gbb, gbg, ggb, ggg\}$ $\quad$ $\boldsymbol{A' = \{bbb\}}$

a. B = {bbb, bgb, gbb, bbg} B' = {bgg, gbg, ggb, ggg}
b. C = {ggg} C' = { bbb,bbg,bgb,bgg,gbb,gbg,ggb}
c. D = {bgg, gbg, ggb} D' = {bbb, bbg, bgb, gbb, ggg}
d. E = {gbb, gbg, ggb, ggg} E' = {bbb, bbg, bgb, bgg}

9. Many diagnostic tests for detecting diseases do not test for the disease directly but for a chemical or biological product of the disease, hence are not perfectly reliable. The *sensitivity* of a test is the probability that the test will be positive when administered to a person who has the disease. The higher the sensitivity, the greater the detection rate and the lower the false negative rate.

Suppose the sensitivity of a diagnostic procedure to test whether a person has a particular disease is 92%. A person who actually has the disease is tested for it using this procedure by two independent laboratories.

1. What is the probability that both test results will be positive?
2. What is the probability that at least one of the two test results will be positive?

SOLUTION

Positive = 0.92

Negative = 0.08

No of events = 2

P (A) = 0.92

P (B) = 0.92

a. $P(A \cap B) = P(A) \cdot P(B)$

   = 0.92* 0.92

   = 0.8464

b. P (A or B) = P (A) + P (B) – P (A and B)

   = 0.92 + 0.92 – 0.8464

   = 1.84 – 0.8464

   = 0.9936

10. A box contains 10 white and 10 black marbles. Construct a sample space for the experiment of randomly drawing out, with replacement, two marbles in succession and noting the color each time. (To draw "with replacement" means that the first marble is put back before the second marble is drawn.) list the outcomes that comprise each of the following events.

1. At least one marble of each color is drawn.
2. No white marble is drawn.

Answer

S = {ww, bw, wb, bb}

E1 = {ww, bw, wb, bb}

E2 = { bb}

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State the null and alternative hypotheses for each of the following situations.

1. The average time workers spent commuting to work in Verona five years ago was 38.2 minutes. The Verona Chamber of Commerce asserts that the average is less now.
2. The mean salary for all men in a certain profession is $58,291. A special interest group thinks that the mean salary for women in the same profession is different.
3. The accepted figure for the caffeine content of an 8-ounce cup of coffee is 133 mg. A dietitian believes that the average coffee served in local restaurants is higher.
4. The average yield per acre for all types of corn in a recent year was 161.9 bushels. An economist believes that the average yield per acre is different this year.
5. An industry association asserts that the average age of all self-described fly fishermen is 42.8 years. A sociologist suspects that it is higher.

	Null Hypothesis	**Alternative Hypothesis**
1. 1 The average time workers spent commuting to work in Verona five years ago was 38.2 minutes. The Verona Chamber of Commerce asserts that the average is less now.	Average commuting time to work in Verona = 38.2 minutes H_0= 38.2	Average commuting time to work in Verona < 38.2 minutes H_a <38.2

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2 . The mean salary for all men in a certain profession is $58,291. A special interest group thinks that the mean salary for women in the same profession is different	The mean salary for all men in a certain profession is $58,291 H_0= $58,291	the mean salary for women in the same profession ≠ $58,291 $H_a \neq$ 58,291
3 The accepted figure for the caffeine content of an 8-ounce cup of coffee is 133 mg. A dietitian believes that the average coffee served in local restaurants is higher.	The accepted figure for the caffeine content of an 8-ounce cup of coffee is = 133 mg H_0= 133mg	Average coffee served > 133 mg H_a > 133mg
4. The average yield per acre for all types of corn in a recent year was 161.9 bushels. An economist believes that the average yield per acre is different this year.	average yield per acre = 161.9 bushels H_0= 161.9 bushel	average yield per acre ≠161.9 bushels H_a ≠161.9 bushel
5 An industry association asserts that the average age of all self-described fly fishermen is 42.8 years. A sociologist suspects that it is higher.	average age of all self-described fly fishermen = 42.8 years H_0=42.8 yrs	Average age of all self-described fly fishermen > 42.8 years. H_a > 42.8yrs

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