**7.4 Addition and Multiplication Rules of Probability – Overview**

**Addition Rules**

**Addition Rule for Probability**:Consider two events A and B. The probability of A or B occurring is

**Diagram

Description automatically generated**

*P(A or B) = P(A) + P(B) – P(A and B)*

Shape, circle

Description automatically generated**Mutually Exclusive Events:** Two events are considered to be mutually exclusive if they have no outcomes in common.

**Addition Rule for Mutually Exclusive Events**:

*P(A or B) = P(A) + P(B)*

**Example 1:** Suppose we collected data from MATH 125 students about their major and attendance record. Then we randomly selecting a single student. Assume no double majors.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Statistics** | **Art** | **Chemistry** | ***Total*** |
| **Perfect** | 100 | 40 | 80 | 220 |
| **Good** | 20 | 50 | 70 | 140 |
| **Poor** | 30 | 15 | 30 | 75 |
| ***Total*** | 150 | 105 | 180 | 435 |

1. Find the probability the student is a Statistics major.
2. Find the probability the student has Good attendance.
3. Find the probability the student is a Statistics major and has Good attendance.
4. Find the probability the student is a Statistics major or has Good attendance.
5. Find the probability the student is a Chemistry major or has Poor attendance.
6. Find the probability the student is an Art major or a Chemistry major.

**Conditional Probability**

The conditional probability of Event B, given that Event A has already occurred is written as: P(B | A)

* Event A is the “additional information” that we know, so we can restrict what we are looking at if we have a table. Then we are interested in Event B.

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| --- | --- | --- | --- | --- |
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**Example 2**:

1. Given the student has Perfect attendance, find the probability they are a Chemistry major.
2. Find the probability the student has Perfect attendance given they are a Chemistry major.
3. Given the student is an Art major, find the probability they have Poor attendance.

**Example 3**: A swim team consists of 6 boys and 4 girls. A relay team of 4 swimmers is chosen at random from the team members. What is the probability that 2 boys are selected for the relay team given that the first two selections were girls?

**Multiplication Rules**

**Independent Events**: The result of one event does not influence the probability of the other.

**Dependent Events**: The result of one event does influence the probability of the other.

**Multiplication Rule for Independent Events:** Consider two independent events A and B.

The probability of A and B occurring is:

*P(A and B) = P(A) x P(B)*

**Example 2**: Three cards are drawn with replacement from a standard deck of 52 cards.

Find the probability that the first card will be a diamond, the second card will be a red card, and the third card will be a queen.

**Multiplication Rule for Dependent Events:** Consider two dependent events A and B.

The probability of A and B occurring is:

*P(A and B) = P(A) x P(B | A)*

*“Both events occurred” = “A occurred, then B occurred later”*

**Example 3**: If you are dealt two cards from a standard 52 card deck without replacement. Find the probability of getting a 10 of hearts and then a red card.

**Bayes Theorem:** Useful for converting from one conditional probability to another (Example 10 in Learn)

, when P(B) > 0.