GENERAL

probability practice problems with solutions

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Introduction

Probability is the mathematical language that helps us quantify uncertainty. Whether you're a student preparing for a statistics exam, a data scientist tackling real world datasets, or simply an inquisitive learner, mastering probability concepts is essential. However, understanding theory alone often falls short of true proficiency. The key to solidifying intuition and building confidence lies in **solving practice problems**. By working through carefully crafted scenarios, you not only reinforce definitions but also learn how to apply them in diverse contexts.

This article offers a comprehensive collection of **probability practice problems with solutions**. We'll walk you through fundamental concepts, explore common problem types, and then dive into a curated set of examples that span from basic counting to advanced conditional probability. Each problem comes with a detailed, step by step solution so you can follow the reasoning and identify where mistakes might occur.

Whether you're studying for a test, preparing for a coding interview, or simply sharpening your analytical skills, these exercises will provide a structured pathway to mastery. Let's begin the journey from theory to practice and unlock the full potential of probability.

Why Practice Problems Matter

In probability, concepts such as independence, conditional probability, and expectation are abstract until you see them applied. Practice problems help in several ways:

- Reinforcement of Theory – Repeated exposure to formulas and definitions solidifies memory.
- Skill Development – Translating a real world situation into a mathematical model is a skill that improves with repetition.
- Error Identification – Working through solutions reveals common pitfalls, such as misapplying the multiplication rule.
- Confidence Building – Seeing yourself solve a variety of problems boosts self assurance for exams or interviews.

In short, practice problems are the bridge between learning and mastery. They transform passive knowledge into active competence.

Key Concepts in Probability

Before diving into problems, let's quickly review the building blocks that will appear repeatedly:

1. Sample Space (S) – The set of all possible outcomes of a random experiment.
2. Event (A, B, …) – A subset of the sample space.
3. Probability (P) – A number between 0 and 1 assigned to each event, representing its likelihood.
4. Complementary Events – If A is an event, its complement is $\overline{A} = S \setminus A$.
5. Independent Events – Two events A and B are independent if $P(A \cap B) = P(A)P(B)$.
6. Conditional Probability – The probability of A given B: $P(A|B) = \frac{P(A \cap B)}{P(B)}$.
7. Bayes' Theorem – A way to reverse conditional probabilities: $P(B|A) = \frac{P(A|B)P(B)}{P(A)}$.

8. Counting Principles – Permutations, combinations, and the rule of product/sum for counting outcomes.
9. Discrete vs. Continuous Random Variables – Discrete variables take countable values; continuous variables are uncountable and require probability density functions.
10. Expected Value (E[X]) – The average outcome of a random variable.

With these concepts in mind, we can tackle a wide range of probability questions.

Types of Probability Problems

Probability practice problems come in many flavors. Understanding the categories helps you choose the right approach.

1. Counting Problems

These problems require counting the number of favorable outcomes using combinations, permutations, or inclusion exclusion.

2. Conditional Probability

Questions that ask for the probability of an event given that another event has occurred.

3. Bayes' Theorem

Scenarios where you need to reverse the direction of conditioning, often involving medical tests or quality control.

4. Discrete Random Variables

Problems involving probability mass functions, expected value, variance, or generating functions.

5. Continuous Random Variables

These involve probability density functions, cumulative distribution functions, and integrals.

6. Independence and Dependence

Questions that test whether events are independent or dependent and the implications for probability calculations.

7. Compound Experiments

Multi stage experiments where each stage may involve different random variables.

8. Real World Applications

Scenarios drawn from business, medicine, engineering, or everyday life.

Sample Practice Problems with Solutions

Below are ten carefully chosen problems that cover a spectrum of difficulty and topics. Each problem is followed by a comprehensive solution that explains the reasoning step by step.

A fair six sided die is rolled twice. What is the probability of getting a sum of 7?

Solution:

There are \\(6 \\times 6 = 36\\) equally likely outcomes. The pairs that sum to 7 are:

- (1,6)
- (2,5)
- (3,4)

- (4,3)
- (5,2)
- (6,1)

That's 6 favorable outcomes. Therefore, \\(P(\\text{sum}=7) = \\frac{6}{36} = \\frac{1}{6}\\).

Problem 2: Drawing Cards Without Replacement

From a standard deck of 52 cards, draw two cards sequentially without replacement. What is the probability that both are spades?

Solution:

The probability the first card is a spade is \\(\\frac{13}{52} = \\frac{1}{4}\\). After removing one spade, 12 spades remain in a deck of 51 cards, so the second draw has probability \\(\\frac{12}{51}\\). The joint probability is:

Problem 3: Conditional Probability – Birthday Paradox

Two people are selected at random from a group of 23. What is the probability that they share the same birthday?

Solution:

It is easier to compute the complement: the probability that they have different birthdays. The first person can have any birthday (365/365). The second person must avoid that birthday: \\(364/365\\). Thus:

The probability of a shared birthday is:

Note: This calculation assumes a 365 day year and no leap years.

Problem 4: Bayes' Theorem – Medical Test Accuracy

A disease affects 1% of a population. A diagnostic test has a 95% true positive rate (sensitivity) and a 90% true negative rate (specificity). If a person tests positive, what is the probability that they actually have the disease?

Solution:

Let D be the event "has disease" and T be "tests positive."

- Prior: \\(P(D) = 0.01\\), \\(P(\\overline{D}) = 0.99\\).
- Sensitivity: \\(P(T|D) = 0.95\\).
- Specificity: \\(P(\\overline{T}|\\overline{D}) = 0.90\\) !' \\(P(T|\\overline{D}) = 0.10\\).

Compute the marginal probability of a positive test:

Now apply Bayes' theorem:

Even with a highly accurate test, the low prevalence inflates the false positive rate.

Problem 5: Discrete Random Variable – Dice Sum Distribution

Let X be the sum of two fair six sided dice. Find the probability mass function \\(P(X = k)\\) for k = 2,3,…,12.

Solution:

We list the number of ways each sum can occur:

k	Favorable Outcomes
2	1
3	2
4	3
5	4
6	5
7	6
8	5
9	4
10	3
11	2
12	1

Since there are 36 total outcomes, the pmf is:

For example, \\(P(X=7) = \\frac{6}{36} = \\frac{1}{6}\\).

Problem 6: Continuous Random Variable – Uniform Distribution

A random variable X is uniformly distributed on the interval [0, 5]. Compute the probability that X is greater than 3.

Solution:

For a uniform distribution, the pdf is \\(f_X(x) = \\frac{1}{b-a}\\) for \\(a \\le x \\le b\\). Here, \\(a=0\\), \\(b=5\\), so \\(f_X(x)=\\frac

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