Discrete Random Variables – Quiz

Probability & Statistics

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Question 1

What is a random variable?

A. A variable that changes randomly over time
B. A rule that assigns a number to each outcome of a random experiment
C. The probability of an event
D. A sample from a population

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D. A sample from a population

Answer: B

A random variable is a function that assigns a numerical value to each outcome in the sample space, allowing us to analyze random experiments quantitatively.

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Question 2

Which of the following is a discrete random variable?

A. Stock price
B. Temperature in Celsius
C. Number of trades in an hour
D. Time until next order

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C. Number of trades in an hour
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Answer: C
Discrete random variables take countable values. The number of trades is countable (0, 1, 2, ...), while stock price, temperature, and time are continuous.

Question 3

The Probability Mass Function (PMF) must satisfy:

A. All probabilities are negative
B. Probabilities can exceed 1
C. All probabilities are non-negative and sum to 1
D. The sum of probabilities equals the mean

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B. Probabilities can exceed 1

C. All probabilities are non-negative and sum to 1

D. The sum of probabilities equals the mean

Answer: C

A valid PMF requires p(x) ¿= 0 for all x, and the sum over all possible values must equal 1.

Question 4

For a fair die, what is $P(X = 4)$?

A. $1/4$
B. $1/6$
C. $4/6$
D. $1/36$

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Answer: B
For a fair die, each outcome has equal probability: $P(X = x) = 1/6$ for x in $\{1, 2, 3, 4, 5, 6\}$.

Question 5

The CDF F(x) represents:

A. P(X = x)
B. P(X ¡= x)
C. P(X ¿ x)
D. P(X ¿= x)

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Answer: B
The Cumulative Distribution Function F(x) = P(X ¡= x) gives the probability that X is at most x.

Question 6

For a Bernoulli(p) distribution, what is E[X]?

A. p(1-p)
B. $1/p$
C. p
D. np

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C. p
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Answer: C
For Bernoulli(p), $E[X] = 0 \times (1\text{-}p) + 1 \times p = p$. The expected value equals the probability of success.

Question 7

The variance of a Bernoulli(p) random variable is:

A. p
B. p^2
C. p(1-p)
D. 1-p

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Answer: C
Var(X) = E[X^2] - (E[X])^2 = p - p^2 = p(1-p) for a Bernoulli distribution.

Question 8

If X ~ Binomial(n, p), what does X count?

A. Time until first success
B. Number of successes in n independent trials
C. Number of events in a fixed interval
D. Number of failures before r successes

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Answer: B
The binomial distribution counts the number of successes in n independent Bernoulli trials, each with probability p.

Question 9

For X ˜ Binomial(10, 0.3), what is E[X]?

A. 0.3
B. 3
C. 7
D. 2.1

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C. 7
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Answer: B
For Binomial(n, p), $E[X] = np = 10 \times 0.3 = 3$.

Question 10

The Poisson distribution is appropriate for modeling:

A. Number of heads in 10 coin flips
B. Waiting time until first success
C. Number of rare events in a fixed interval
D. Continuous measurements

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A. Number of heads in 10 coin flips
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Answer: C
The Poisson distribution models the count of events occurring in a fixed interval of time or space, when events are rare and independent.

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Question 11

For X ~ Poisson(lambda), what is Var(X)?

A. lambda^2
B. lambda
C. 1/lambda
D. sqrt(lambda)

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Answer: B
A unique property of the Poisson distribution is that both mean and variance equal lambda.

Question 12

If defaults occur at a rate of 5 per year (Poisson), what is the expected number of defaults?

A. $1/5 = 0.2$
B. 5
C. 25
D. sqrt(5)

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B. 5

C. 25

D. sqrt(5)

Answer: B

For Poisson(lambda), E[X] = lambda = 5 defaults per year.

Question 13

The geometric distribution models:

A. Number of successes in n trials
B. Number of trials until the first success
C. Number of events in a fixed interval
D. Sum of normal random variables

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Question 13

The geometric distribution models:

A. Number of successes in n trials
B. Number of trials until the first success
C. Number of events in a fixed interval
D. Sum of normal random variables

Answer: B
The geometric distribution counts how many trials are needed until the first success occurs.

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Question 14

For X ˜ Geometric(p=0.2), what is E[X]?

A. 0.2
B. 0.8
C. 5
D. 20

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A. 0.2

B. 0.8

C. 5

D. 20

Answer: C

For Geometric(p), $E[X] = 1/p = 1/0.2 = 5$. On average, we expect 5 trials until the first success.

Question 15

What property does the geometric distribution have?

A. Symmetry
B. Memoryless property
C. Constant variance
D. Mean equals mode

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Answer: B
The geometric distribution is memoryless: past failures don't affect future probability of success. Each trial is independent.

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Question 16

The binomial coefficient C(n,k) in the binomial PMF represents:

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B. The number of ways to arrange k successes in n trials
C. The expected value
D. The variance

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Answer: B
$C(n,k) = n!/(k!(n-k)!)$ counts the number of ways to choose which k of the n trials are successes.

Question 17

If X ~ Binomial(n, p), then Var(X) equals:

A. np
B. npˆ2
C. np(1-p)
D. n(1-p)

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C. np(1-p)
D. n(1-p)

Answer: C
For Binomial(n, p), Var(X) = np(1-p). Variance is maximized when p = 0.5.

Question 18

What is the relationship between Bernoulli and Binomial distributions?

A. They are unrelated
B. Binomial is the sum of n independent Bernoulli random variables
C. Bernoulli is the limit of Binomial as n approaches infinity
D. Bernoulli has more parameters than Binomial

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D. Bernoulli has more parameters than Binomial

Answer: B
If X1, X2, ..., Xn are independent Bernoulli(p), then their sum X1 + X2 + ... + Xn follows Binomial(n, p).

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Question 19

As lambda increases in a Poisson distribution, the distribution:

A. Becomes more left-skewed
B. Becomes narrower
C. Becomes more symmetric and bell-shaped
D. Variance decreases

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C. Becomes more symmetric and bell-shaped
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Answer: C
As lambda increases, the Poisson distribution spreads out and becomes more symmetric, approaching a normal distribution shape.

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Question 20

The hypergeometric distribution differs from binomial because:

A. It has more parameters
B. It models sampling without replacement
C. It only applies to continuous variables
D. It has infinite possible values

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C. It only applies to continuous variables
D. It has infinite possible values

Answer: B
Hypergeometric models sampling without replacement from a finite population, while binomial assumes independent trials (equivalent to sampling with replacement or from an infinite population).

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