

# Linear Regression

Practice Worksheet · 20 Questions · Multiple Choice

## QUICK MEMORY POINTS

SLOPE = RATE	Y-INT = START	PLUG & CHUG	CONTEXT CHECK
For every 1 unit in x, y changes by slope on average	Predicted y when x = 0 (May not be realistic!)	Replace x with given value, solve for y-hat	Always ask: does this make sense in the real world?

## QUESTIONS

### Question 1

A regression equation is  $\hat{y} = -0.12x + 9.5$ , where  $x$  = weeks of training and  $y$  = mile time (minutes). What does the slope  $-0.12$  mean?

$$\hat{y} = -0.12x + 9.5$$

- A) For every additional week of training, mile time decreases by 0.12 minutes on average.
- B) For every additional minute of mile time, training decreases by 0.12 weeks.
- C) A person with 0 weeks of training runs a mile in 0.12 minutes.
- D) Mile time increases by 12 minutes for every 100 weeks of training.

### Question 2

Using  $\hat{y} = -0.12x + 9.5$ , what is the y-intercept and is it meaningful in context?

$$\hat{y} = -0.12x + 9.5$$

- A) y-intercept = 9.5; a person with 0 weeks of training has a predicted mile time of 9.5 minutes. Meaningful.
- B) y-intercept =  $-0.12$ ; it means training reduces time.
- C) y-intercept = 9.5; mile time is always 9.5 regardless of training.
- D) y-intercept = 0; the line passes through the origin.

### Question 3

Predict the mile time after 20 weeks of training using  $\hat{y} = -0.12x + 9.5$ .

$$\hat{y} = -0.12x + 9.5, \quad x = 20$$

- A)  $\hat{y} = 9.5 - 0.12(20) = 9.5 - 2.4 = 7.1$  minutes
- B)  $\hat{y} = -0.12(9.5) + 20 = 18.86$  minutes

C)  $\hat{y} = 9.5 + 0.12(20) = 11.9$  minutes

D)  $\hat{y} = -0.12 + 9.5 \times 20 = 189.88$  minutes

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#### Question 4

$\hat{y} = 0.43x + 52.1$ , where  $x$  = practice free throws/week and  $y$  = free throw % in games. Interpret the slope.

$$\hat{y} = 0.43x + 52.1$$

- A) For each additional free throw practiced per week, game FT% increases by 0.43 percentage points on average.
- B) A player who practices 0 free throws has a 0.43% success rate.
- C) For every 1% increase in game FT rate, practice increases by 0.43 throws per week.
- D) Free throw % increases by 43% for every 100 practice throws.

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#### Question 5

For  $\hat{y} = 0.43x + 52.1$  (free throws), is the y-intercept of 52.1 meaningful?

$$\hat{y} = 0.43x + 52.1$$

- A) Yes - a player who practices 0 free throws per week is predicted to make about 52.1% in games.
- B) No - a free throw % cannot be 52.1 since that is above 50%.
- C) No -  $x = 0$  is impossible; you must practice at least once.
- D) Yes - it means the average player makes 52.1% regardless of practice.

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#### Question 6

A player wants 75% free throw rate. Using  $\hat{y} = 0.43x + 52.1$ , how many practice throws per week does the model suggest?

$$\text{Solve: } 75 = 0.43x + 52.1$$

- A) Solve  $75 = 0.43x + 52.1 \rightarrow x = 22.9 / 0.43 =$  approximately 53.3 throws per week
- B) Solve  $75 = 0.43x + 52.1 \rightarrow x =$  approximately 32.4 throws per week
- C) Plug  $x = 75 \rightarrow \hat{y} = 84.4\%$
- D) Solve  $75 = 0.43x + 52.1 \rightarrow x =$  approximately 100 throws per week

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#### Question 7

$\hat{y} = 3.2x + 42.5$ , where  $x$  = years of experience and  $y$  = annual salary (thousands of \$). Interpret BOTH the slope and y-intercept.

$$\hat{y} = 3.2x + 42.5 \text{ (y is in thousands of dollars)}$$

- A) Slope: Each extra year of experience --> salary increases \$3,200 on avg. Y-int: 0 years exp. earns ~\$42,500.
- B) Slope: Starting salary is \$3,200. Y-int: Each year adds \$42,500.
- C) Slope: Salary increases by \$3.20 per year. Y-int: Baseline salary is \$42.
- D) Slope: For every \$3,200 more in salary, experience increases by 1 year.

### Question 8

Using  $\hat{y} = 3.2x + 42.5$  (salary model), predict the salary of someone with 15 years of experience.

$$\hat{y} = 3.2x + 42.5, x = 15$$

- A)  $\hat{y} = 3.2(15) + 42.5 = 48 + 42.5 = 90.5$  (thousands) = \$90,500
- B)  $\hat{y} = 3.2(15) + 42.5 = 90.5$  --> \$90 (not in thousands)
- C)  $\hat{y} = 3.2 + 42.5(15) = \$640.70$  thousand
- D)  $\hat{y} = 3.2(15) - 42.5 = \$5,500$

### Question 9

Would you trust the salary model  $\hat{y} = 3.2x + 42.5$  for someone with 50 years of experience? Why?

$$\hat{y} = 3.2x + 42.5 \text{ (original data likely collected for 0-30 yrs)}$$

- A) No - 50 years is likely outside the data range (extrapolation), making the prediction unreliable.
- B) Yes - the model is linear so it works for any value of  $x$ .
- C) Yes - if the R-squared is high, all predictions are equally trustworthy.
- D) No - the slope becomes negative after many years of experience.

### Question 10

$\hat{y} = 12.3x - 498$ , where  $x$  = temperature (degrees F) and  $y$  = pool visitors. The y-intercept is -498. Why does this NOT make sense?

$$\hat{y} = 12.3x - 498$$

- A) When temperature = 0 degrees F, the model predicts -498 visitors -- impossible (cannot have negative people).
- B) The slope 12.3 is too large to be realistic.
- C) Pool visitors should increase when temperature is 0 degrees F.
- D) A y-intercept less than zero always means the model is wrong.

### Question 11

Predict the number of pool visitors when temperature is 88 degrees F using  $\hat{y} = 12.3x - 498$ .

$$\hat{y} = 12.3x - 498, x = 88$$

- A)  $\hat{y} = 12.3(88) - 498 = 1082.4 - 498 = 584.4 =$  approximately 584 visitors
- B)  $\hat{y} = 12.3(88) - 498 = 1082.4 + 498 = 1580$  visitors
- C)  $\hat{y} = 12.3 - 498(88) = -43,812$  visitors
- D)  $\hat{y} = 88 / 12.3 - 498 =$  approximately -490.8 visitors

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### Question 12

$\hat{y} = 1.5x + 120$  ( $x$  = pages read,  $y$  = reading speed in wpm). Student A: 'For every additional page, speed increases by 1.5 wpm on average.' Student B: 'If you read 1.5 more pages, speed goes up by 1 wpm.' Who is correct?

$$\hat{y} = 1.5x + 120$$

- A) Student A - slope means  $y$  changes by 1.5 for every 1-unit increase in  $x$ .
- B) Student B - the slope is a ratio so both statements are equivalent.
- C) Both are correct - they describe the same relationship differently.
- D) Neither - the slope only applies when  $x = 0$ .

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### Question 13

Which statement correctly interprets the slope of  $\hat{y} = -2.4x + 180$  where  $x$  = hours of TV/week and  $y$  = GPA x 10?

$$\hat{y} = -2.4x + 180$$

- A) For each additional hour of TV per week, GPA (x10) decreases by 2.4 points on average.
- B) For each 2.4 hours of TV, GPA (x10) decreases by 1 point.
- C) The GPA (x10) starts at -2.4 and increases by 180.
- D) TV watching has no effect because the slope is negative.

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### Question 14

$\hat{y} = 4.5x + 200$  predicts monthly sales ( $y$ ) based on ad spending in hundreds of dollars ( $x$ ). What does the  $y$ -intercept 200 represent?

$$\hat{y} = 4.5x + 200$$

- A) When ad spending = \$0, predicted monthly sales = 200 units.
- B) Monthly sales increase by \$200 for every ad dollar spent.
- C) The maximum monthly sales achievable is 200 units.
- D) Sales decrease by 200 when ads are 0.

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### Question 15

A model predicts plant height (cm) from days of sunlight:  $\hat{y} = 0.8x + 3$ . After how many days of sunlight will the plant reach 19 cm?

Solve:  $19 = 0.8x + 3$

- A)  $19 = 0.8x + 3 \rightarrow 16 = 0.8x \rightarrow x = 20$  days
- B)  $19 = 0.8x + 3 \rightarrow 22 = 0.8x \rightarrow x = 27.5$  days
- C)  $x = 19 \times 0.8 + 3 = 18.2$  days
- D)  $19 - 3 = 0.8x \rightarrow x = 19$  days

### Question 16

Model A:  $\hat{y} = 5x + 10$  and Model B:  $\hat{y} = 0.5x + 10$ . For both,  $x$  increases from 4 to 5. Which model has a larger increase in  $\hat{y}$ ?

Model A: slope = 5 | Model B: slope = 0.5 | Same  $y$ -intercept

- A) Model A - slope 5 means a 5-unit increase in  $\hat{y}$  per 1-unit increase in  $x$  (vs. only 0.5 for B).
- B) Model B - the smaller slope is more stable.
- C) Both increase by the same amount because they have the same  $y$ -intercept.
- D) Cannot determine without knowing the original data.

### Question 17

$\hat{y} = -3x + 90$  predicts test score ( $y$ ) from hours of sleep missed ( $x$ ). What is the predicted score for a student who missed 0 hours of sleep?

$\hat{y} = -3x + 90, x = 0$

- A)  $\hat{y} = -3(0) + 90 = 90$  points
- B)  $\hat{y} = -3(0) + 90 = -90$  points
- C)  $\hat{y} = 0$  (no sleep missed means no score)
- D)  $\hat{y} = -3 + 90 = 87$  points

### Question 18

Which of the following is an example of EXTRAPOLATION (unreliable use of the regression model)?

Training data was collected for students who studied 1-8 hours

- A) Predicting score for a student who studied 25 hours (data only goes up to 8 hours).
- B) Predicting score for a student who studied 5 hours.
- C) Interpreting the slope of the regression equation.
- D) Calculating the  $y$ -intercept.

### Question 19

$\hat{y} = 2x + 15$  models income (thousands) from years of college. If two people differ by 3 years of college, how much does income differ on average?

$$\hat{y} = 2x + 15 \quad | \quad \Delta x = 3$$

- A)  $3 \times 2 = 6$  thousand dollars difference on average.
- B)  $2 + 15 \times 3 = 47$  thousand dollars.
- C)  $3 / 2 = 1.5$  thousand dollars difference.
- D) 15 thousand dollars - only the y-intercept matters.

### Question 20

A regression equation has a slope of 0. What does this tell you about the relationship between x and y?

$$\hat{y} = 0 * x + b \implies \hat{y} = b \text{ (horizontal line)}$$

- A) No linear relationship - the predicted value of y is the same regardless of x.
- B) x and y are perfectly correlated.
- C) As x increases, y decreases proportionally.
- D) The model is invalid and cannot be used.

### ANSWER KEY

Q1: A	Q2: A	Q3: A	Q4: A	Q5: A
Q6: A	Q7: A	Q8: A	Q9: A	Q10: A
Q11: A	Q12: A	Q13: A	Q14: A	Q15: A
Q16: A	Q17: A	Q18: A	Q19: A	Q20: A

\* All correct answers are (A). Review explanations in the web quiz for detailed reasoning.