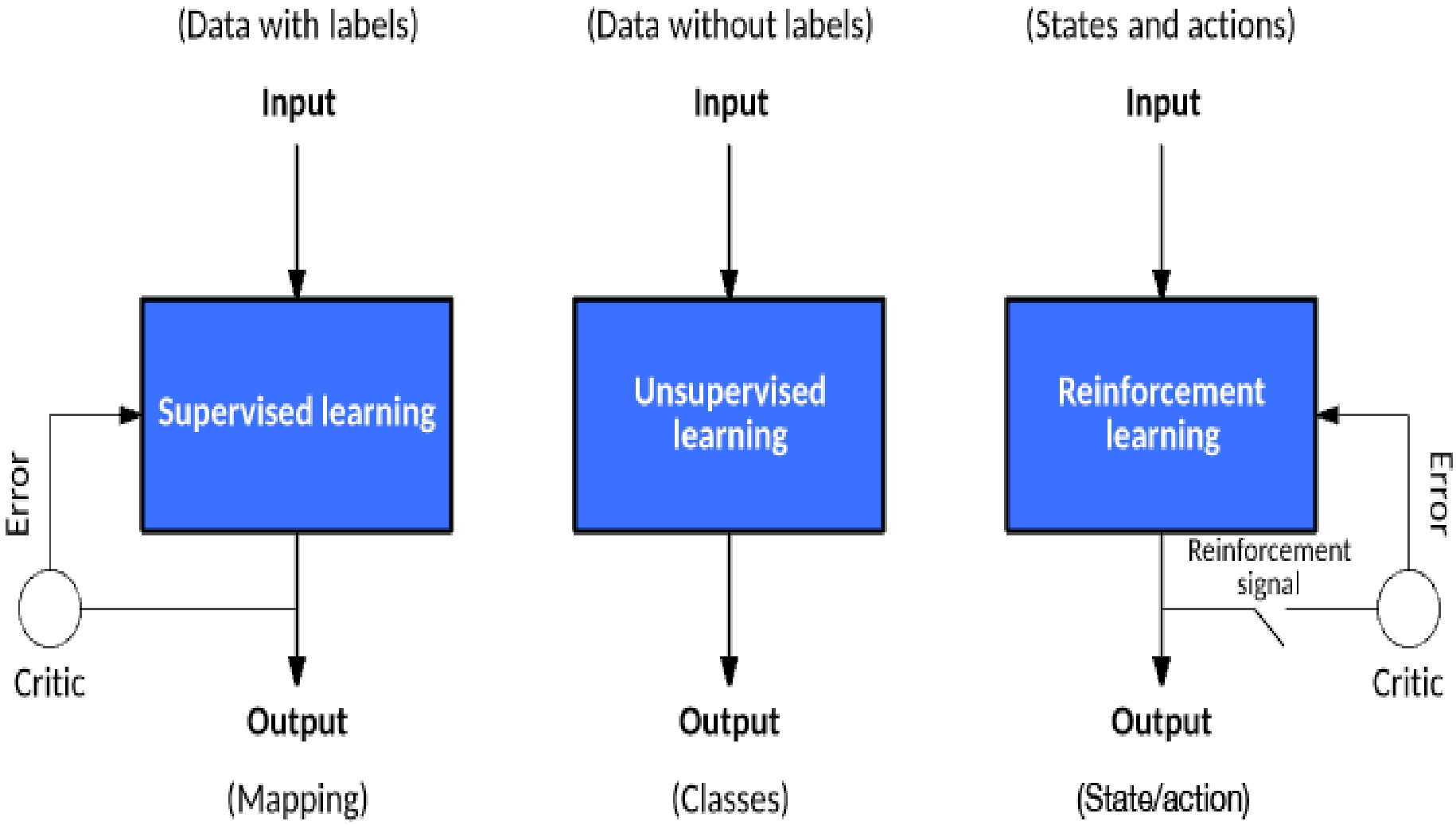
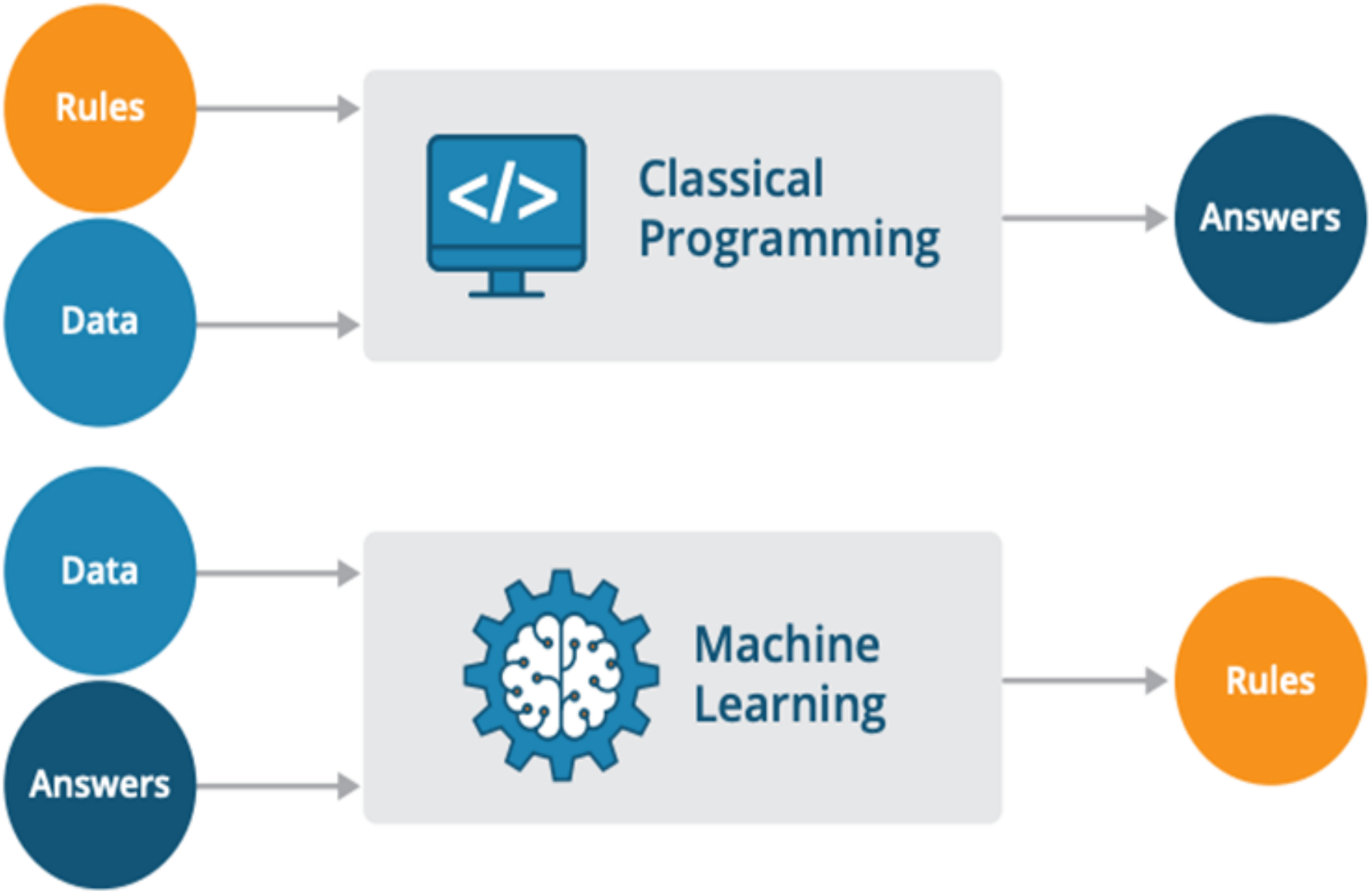
Linear Regression

Expected change in Y per unit X


(Data with labels)
Input
Supervised learning
Error
Critic
Output
(Mapping)
(Data without labels)
Input
Unsupervised learning
Output
(Classes)
(States and actions)
Input
Reinforcement learning
Reinforcement signal
Error
Critic
Output
(State/action)


Rules
Data
Classical Programming
Answers
Data
Answers
Machine Learning
Rules

Traditional Machine Learning

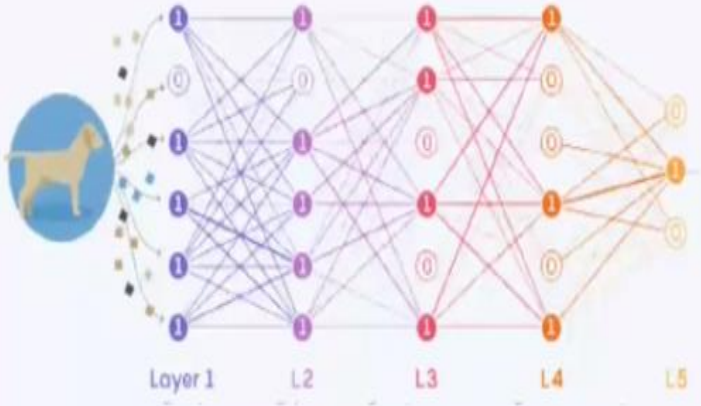
Feature Engineering

Classification

OUTPUT: "DOG"

DEEP LEARNING
ARTIFICIAL **N**EURAL **N**ETWORK (**ANN**)

INPUT: Image

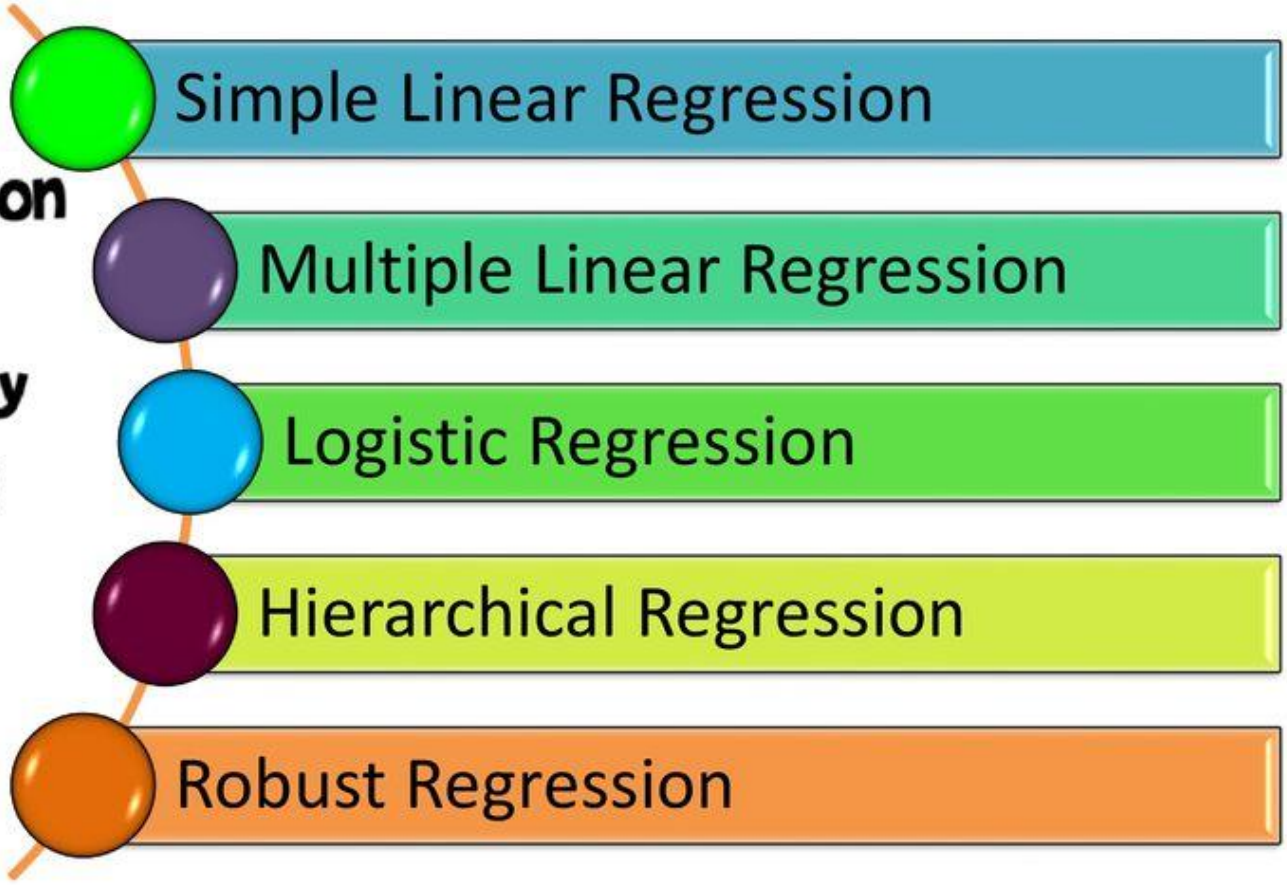


OUTPUT: "DOG"

Feature Learning and **Classification**

Regression Analysis

Making a prediction is when we use clues in the story to make a guess about what will happen next.



Introduction

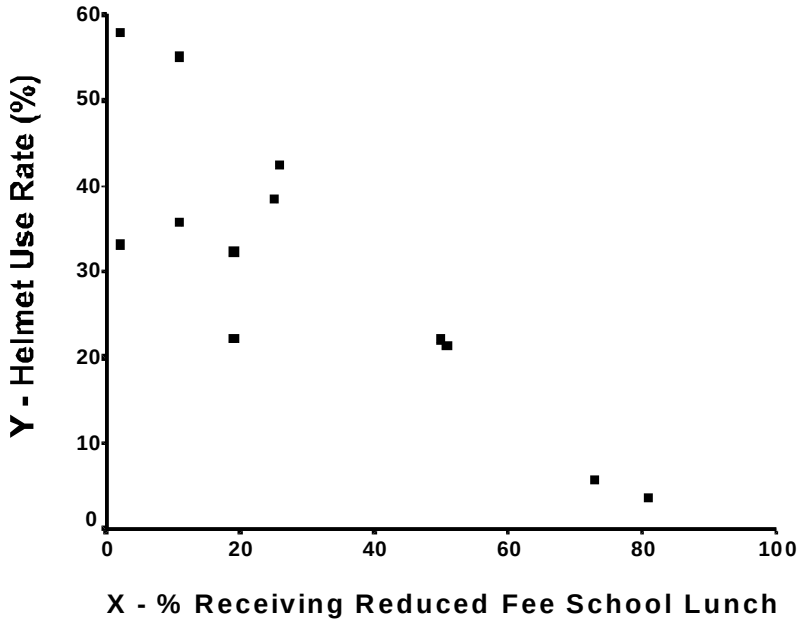
- X = independent (explanatory) variable
- Y = dependent (response) variable
- Use instead of correlation

  when distribution of X is fixed by researcher (i.e., set number at each level of X)

  studying functional dependency between X and Y

Illustrative data (bicycle.sav)

- Same as prior chapter
- X = percent receiving reduce or free meal (RFM)
- Y = percent using helmets (HELM)
- n = 12 (outlier removed to study linear relation)



Regression Model (Equation)

$\hat{y} = a + bX$ "y hat"

where

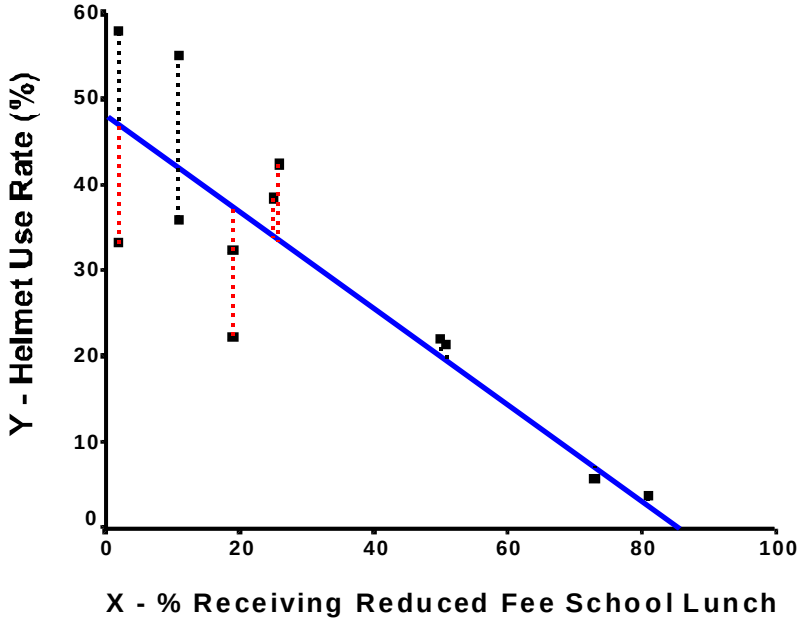
$\hat{y}$ represents predicted average of Y at a given X

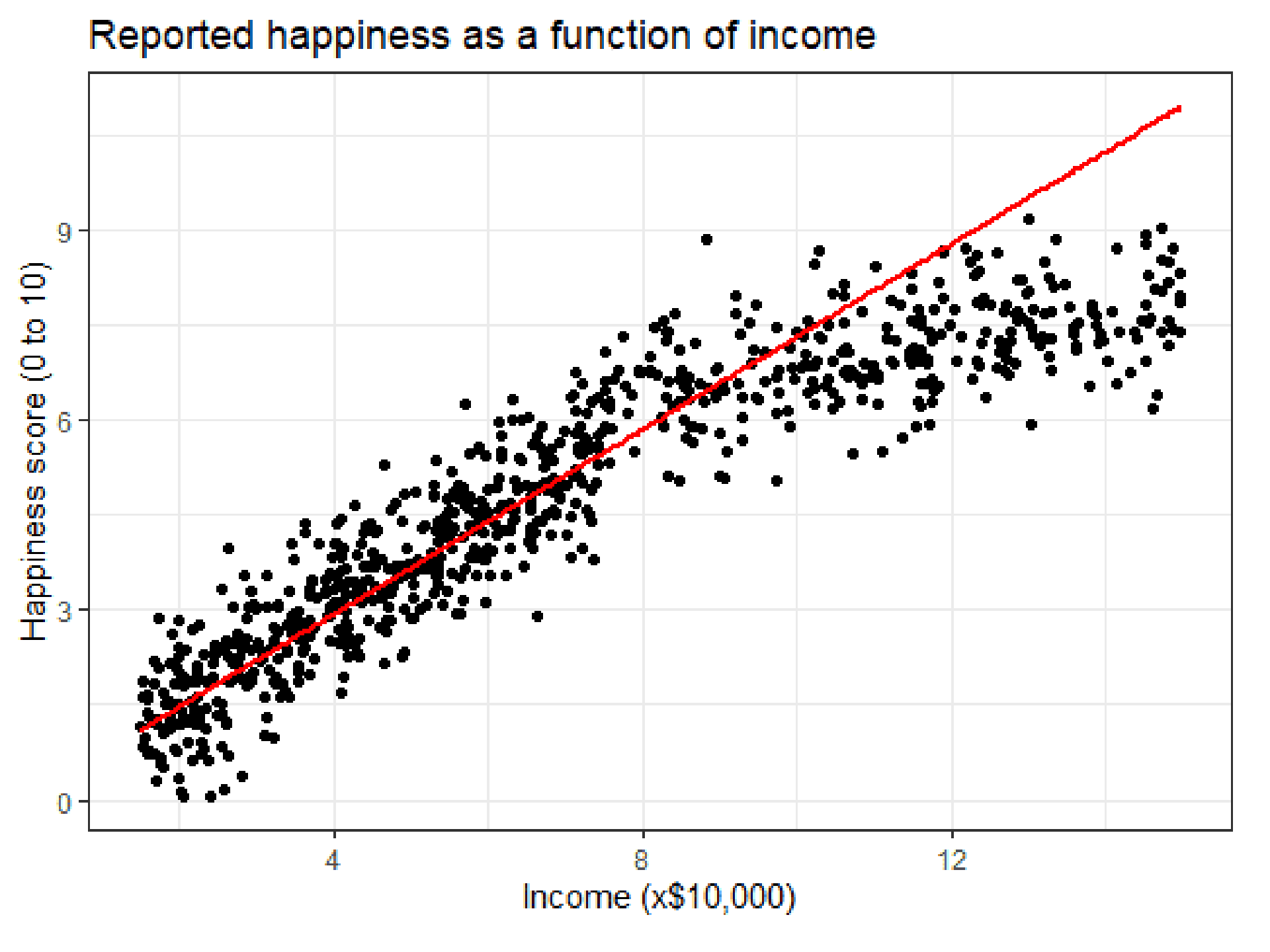
a represents the line's intercept

b represents the line's slope

How formulas determine best line
(p. 15.2)

- Distance of points from line = *residuals* (dotted)
- Minimizes sum of square residuals
- *Least squares regression line*




Reported happiness as a function of income
Happiness score (0 to 10)
0
3
6
9
4
8
12
Income (x$10,000)

Formulas for Least Squares Coefficients

with Illustrative Data

$$b = \frac{SS_{XY}}{SS_{XX}} = \frac{-4231.1333}{7855.67} = -0.539$$

$$a = \bar{y} - b\bar{x} = 30.8833 - (-0.539)(30.8333) = 47.49$$

SPSS output:

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	47.490	4.242		11.194	.000
	X (% children receiving school lunch)	-.539	.106	-.849	-5.087	.000

a. Dependent Variable: Y (% bicycle riders wearing helmets)

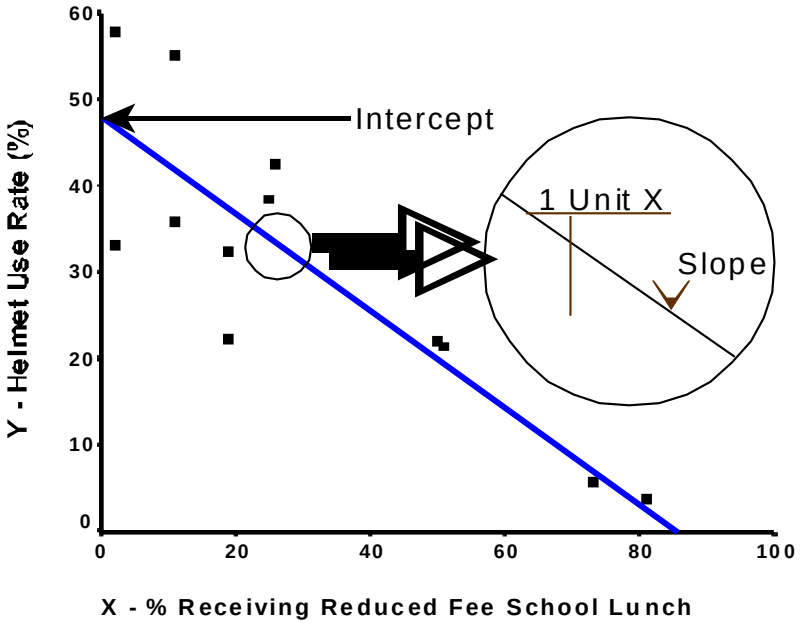
Alternative formula for slope

$$b = \frac{s_Y r}{s_X}$$

Interpretation of Slope (*b*)

(p. 15.3)

- *b* = expected change in *Y* per unit *X*
- Keep track of units!
  - *Y* = helmet users per 100
  - *X* = % receiving free lunch
- e.g., *b* of –0.54 predicts d*ecrease* of 0.54 units of *Y* for each unit *X*



Ma`lumki chiziqli funksiya tuzish uchun a va b koeefitsentlar aniqlanishi kerak, bir chiziqli regression usul uchun ularni toppish formulalari quyida keltirilgan:

$$b = r\,\frac{S_y}{S_x} \qquad (2)$$

$$a = \hat{y} - b\hat{x} \qquad (3)$$

bu yerda:

r – chiziqli funksiya uchun korellyatsiya koeffitsenti;

S_y - chiquvchi qiymatlar uchun o`rtacha kvadratik chetlanish;

S_x - kiruvchi qiymatlar uchun o`rtacha kvadratik chetlanish;

$\hat{y}$ – y qiymatlarning o`rta arifmetigi;

$\hat{x}$ - x qiymatlarning o`rta arifmetigi.

Chiziqli funksiya uchun Korrelyatsion koeffitsent formulasi:

$$r = \frac{\sum(x-\hat{x})(y-\hat{y})}{\sqrt{\sum(x-\hat{x})^2 * \sum(y-\hat{y})^2}} \qquad (2.2)$$

Chiziqli Dataset qiymatlari uchun o`rtacha kvadrat chetlanish:

$$S_y = \sqrt{\frac{\sum(y-\hat{y})^2}{n-1}} \qquad (2.3)$$

$$S_x = \sqrt{\frac{\sum(x-\hat{x})^2}{n-1}} \qquad (2.4)$$

Barcha koeffitsentlar topilgandan so`ng natija chiziqli funksiya tenglamasi hisoblanadi. Bashorat qilinishi kerak bo`lgan holat uchun argument qiymati (x data) kiritiladi va natija quyidagi funksiya yordamida hisoblanib chiqariladi:

$$F(x) = a + b\,x$$