Indicator variable (I) → 1

↳ If statement

$I_{x_i = \text{"B"}}$ → whether $x_i =$ "B" (true) → 1

(false) → 0

$I(x_i = \text{"B"}$ or $x_i = \text{"C"})$

①

$$\underset{\downarrow}{Y_i} = \underset{\searrow}{\hat{\beta}_0} + \underbrace{I(x_i = \text{"B"})}_{\to 0} \hat{\beta}_1 + \underbrace{I(x_i = \text{"C"})}_{} \hat{\beta}_2 + \varepsilon_i$$

exam_score (fitted)

intercept

if $x_i =$ "B" → $Y_i = \beta_0 + \beta_1$ (avg exam_score for class "B")

- $x_i =$ "C" → $Y_i = \beta_0 + \beta_2$ (—〃———————— "C")

$x_i =$ "A" → $Y_i = \beta_0$ (—〃———————— "A")

②

$$Y_i = \underline{\beta_0} + I(x_i = \text{"B"})\beta_1 + I(x_i = \text{"C"})\beta_2 + \beta_3 \overset{\text{study\_hours}}{Z_i} + \varepsilon_1$$

β_0: avg for class "A" when $Z_i = 0$

β_1: diff of avg between class "B" and "A" when $Z_i = 0$

β_3: change of average exam score for one unit increase in study_hours

④

$$Y_i = \beta_0 + \overbrace{I(x_i = \text{"B"})}^{1}\beta_1 + \beta_2 \underline{Z_i} + \beta_3 Z_i \times \underbrace{I(x_i = \text{"B"})}_{0}$$

$x_i \in \{\text{'A'}, \text{'B'}\}$

if $x_i =$ "B" → $Y_i = \beta_0 + \beta_1 + \beta_2 Z_i + \beta_3 Z_i$

$= \beta_0 + \beta_1 + (\beta_2 + \beta_3) Z_i$

if $x_i =$ "A" → $Y_i = \underline{\beta_0} + \beta_2 \underline{Z_i}$

diff of expected change in response variable for class B compared to class A

$$Y_i = \underbrace{\beta_0}_{\text{intercept}} + \beta_1 Z_{1i} + \underbrace{\beta_2 Z_{2i}}_{3} + \underbrace{\beta_{12} Z_{1i} \times Z_{2i}}_{3} + \varepsilon_i$$

average change of Y_i for a one-unit increase of Z_{1i} when Z_{2i} is fixed $= \beta_1 + \beta_{12} Z_{2i}$

3 types: N/A, <0.5, ≥0.5

$$Y_i = \underbrace{\beta_0}_{\text{baseline}} + \underbrace{I_{\geq 0.5}}\beta_1 + I_{<N.A}\beta_2$$

year, prog (3 categorical var)

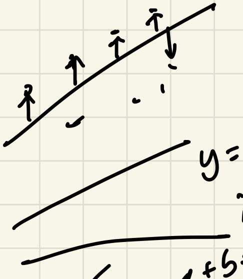
$$Y_i = \beta_0 + \boxed{\beta_1}\boxed{year} + \underbrace{I_{\leq 0.5}}\boxed{\beta_2} + \underbrace{I_{<N.A}}\beta_3$$

$$\beta_4 \boxed{year} \times \underbrace{\quad}_{0} + \beta_5\, year \times \underbrace{\quad}_{0}$$

$\boxed{a + bx}$

$\downarrow$

$b_0 + b_1 x \rightarrow$



$y = \underbrace{\boxed{a}}_{\text{intercept}} + \underbrace{\boxed{b}}_{\text{slope}}x$

x y

$y = a + bx$

$I(x_i = \beta)$

$I(x_i : C)$

$Y = \beta_0 + \boxed{\beta_1} \rightarrow$

$Y = \boxed{\beta_0} + ~~I(x_i : \beta)~~ \boxed{\beta_1}$
$+ \boxed{I(x_i = C)}\beta_2$

response (exam score)

$Y_i = \beta_0 +$

$\beta_0 \rightarrow$ avg exam score when $x_i = A$

$\beta_1 \rightarrow$ diff of avg score between class A and B

$\beta_2 \rightarrow$

$Y = \underbrace{\beta_0 + \beta_2}$ avg exam score when $x_i = C$

$Y = \beta_0 + \beta_1 (I_{x_1 = 'b'}) + \beta_2 (I_{x_i = 'c'})$

if $x_i = 'a' \Rightarrow Y = \boxed{\beta_0} \Rightarrow$ avg. of score when $x_i = 'a'$

if $x_i = 'b' \Rightarrow Y = \beta_0 + \boxed{\beta_1} \Rightarrow$  $x_i = 'b'$

$\beta_1 = (\beta_0 + \beta_1) - \beta_0$

$x_i = 'c' \Rightarrow Y = \beta_0 + \boxed{\beta_2} \Rightarrow$

$Y = \boxed{\beta_0} + \boxed{\beta_1}(I_{x_1 = 'b'}) + \underline{\beta_2}(I_{x_i = 'c'}) + \beta_3 Z_i \to$ study hour

$\beta_0 \downarrow$ intercept

$x_i : b \quad Y = \underline{\beta_0 + \boxed{\beta_1}} + \boxed{\beta_3} Z_i \quad \downarrow 0$

$x_i : C \quad Y = \underline{\beta_0 + \beta_2} + \boxed{\beta_3} Z_i$

$x_i : a \quad Y = \underline{\beta_0} + \beta_2 Z_i$

$\boxed{2}x + 3$

$\downarrow$ slope

$Y = \beta_0 + \beta_1 (I x_i = 'b') + \beta_2 (I x_i = 'c') + \underline{\beta_3 \boxed{Z_i}}$

$+ \beta_4 (I x_i = 'b') \times Z_i + \beta_5 (I x_i = 'c') \times Z_i$

if '$x_i = a$', $Y = \boxed{\beta_0} + \boxed{\beta_3} Z_i$

slope: avg change for a one unit increase i

if '$x_i = B$' $= Y = \beta_0 + \beta_1 + \beta_3 Z_i + \beta_4 Z_i$

$= \underbrace{\beta_0 + \beta_1} + (\underbrace{\beta_3 + \beta_a}) Z_i$

if '$x_i = c$' $= Y = \underbrace{\beta_0 + \beta_2} + (\beta_3 + \beta_5) Z_i$

$$Y = \beta_0 + \beta_1 z_1 + \beta_2 z_2 + \boxed{\beta_3 z_1 z_2}$$

z_2 as fixed

$$Y = (\underbrace{\beta_0 + \beta_2 z_2}_{}) + \beta_1 z_1 + \beta_3 z_1 z_2$$

$$z_1 (\underbrace{\beta_1 + \beta_3 z_2}_{})$$

$\boxed{z_1 \text{ as fixed}}$

$$(\underbrace{\beta_0 + \beta_1 z_1}_{}) + \underbrace{z_2 \beta_2 + z_2 \beta_3 z_1}_{}$$

$$z_2 (\beta_2 + \beta_3 z_1)$$

$$\underbrace{\boxed{Y}}_{\text{continuous}} = \underbrace{\boxed{\beta_0}}_{\text{intercept}} + \underbrace{\boxed{\beta_1}}_{\text{slope}} \boxed{x_i} \rightarrow \text{continuous variable}$$

if $x_i = 0$, $Y_i = \beta_0$

if x_i change by one unit, Y_i will also change by β_1

$I_{(x_i='B')}$

$1_{(x_i='B')}$ } indicator var (0 or 1)

You have 3 classes (A, B, C)

$I(x_i='A')$ $\qquad$ $I(x_i='B')$

$$Y_i = \beta_0 + \boxed{\beta_1} I(x_i='A') + \beta_2 I(x_i='B')$$

if $x_i='C'$, $Y_i = \beta_0$

$x_i:'A'$, $Y_i = \beta_0 + \boxed{\beta_1}$

$x_i='B'$, $Y_i = \beta_0 + \boxed{\beta_2}$

$$Y_i = \beta_0 + \beta_1 \underline{I(x_i : A)} + \beta_2 \underline{I(x_i : 'B')} + \beta_3 Z_i$$

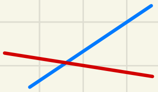
if $x_i = 'C'$. $Y_i = \boxed{\beta_0} + \underline{\beta_3} Z_i$

if $x_i = 'A'$, $Y_i = \boxed{\beta_0 + \beta_1} + \underline{\beta_3} Z_i$

$x_i : 'B'$, $Y_i = \boxed{\beta_0 + \beta_2} + \underline{\beta_3} Z_i$

$$Y_i = \beta_0 + \beta_1 \underbrace{I(X_i = A)}_{0} + \beta_2 \underbrace{I(X_i = `B')}_{0} + \boxed{\beta_3 Z_i}$$

$$+ \beta_4 \underbrace{I(X_i = A)}_{0} Z_i + \beta_5 \underbrace{I(X_i = `B')}_{0} Z_i$$



if $X_i = `C'$, $Y_i = \underline{\beta_0} + \underline{\beta_3} Z_i$

$X_i = `A'$, $Y_i = \beta_0 + \beta_1 + \beta_3 Z_i + \beta_4 Z_i$

$$= \underbrace{(\beta_0 + \beta_1)}_{\text{intercept "A"}} + \underbrace{(\beta_3 + \underline{\beta_4})}_{\text{slope "A"}} Z_i$$

$X_i = `B'$, $Y_i = \beta_0 + \beta_2 + \beta_3 Z_i + \beta_5 Z_i$

$$= (\beta_0 + \beta_2) + (\underline{\beta_3} + \underline{\beta_5}) Z_i$$