1. Describe the null hypotheses to which the p-values given in Table 3.4 correspond. Explain what conclusions you can draw based on these p-values. Your explanation should be phrased in terms of `sales`, `TV`, `radio`, and `newspaper`, rather than in terms of the coefficients of the linear model.

Null hypotheses assumes that there is no relationship or effect present in the statistical inference.

① For TV : $p < 0.0001$ ⇒ we will reject the null hypothese.

⇒ there is a significant relationship between TV advertising expenditure and sales

② For ratio : $p < 0.0001$ ⇒ we will reject the null hypothese.

⇒ there is a significant relationship between ratio advertising expenditure and sales

③ For newspaper : $p = 0.8599 > 0.05$ ⇒ we will accept the null hypothese

⇒ there is no significant relationship between newspaper advertising expenditure and sales

3. Suppose we have a data set with five predictors, X_1 = GPA, X_2 = IQ, X_3 = Level (1 for College and 0 for High School), X_4 = Interaction between GPA and IQ, and X_5 = Interaction between GPA and Level. The response is starting salary after graduation (in thousands of dollars). Suppose we use least squares to fit the model, and get $\hat{\beta}_0 = 50, \hat{\beta}_1 = 20, \hat{\beta}_2 = 0.07, \hat{\beta}_3 = 35, \hat{\beta}_4 = 0.01, \hat{\beta}_5 = -10$.

(a) Which answer is correct, and why?

i. For a fixed value of IQ and GPA, high school graduates earn more, on average, than college graduates.

ii. For a fixed value of IQ and GPA, college graduates earn more, on average, than high school graduates.

iii. For a fixed value of IQ and GPA, high school graduates earn more, on average, than college graduates provided that the GPA is high enough.

iv. For a fixed value of IQ and GPA, college graduates earn more, on average, than high school graduates provided that the GPA is high enough.

(b) Predict the salary of a college graduate with IQ of 110 and a GPA of 4.0.

(c) True or false: Since the coefficient for the GPA/IQ interaction term is very small, there is very little evidence of an interaction effect. Justify your answer.

(a)

$\text{Salary} = 50 + 20\,\text{GPA} + 0.07\,\text{IQ} + 35\,\text{Level} + 0.01 \cdot \text{GPA} \cdot \text{IQ} - 10\,\text{GPA} \cdot \text{Level}$

↳ means that college graduates earn more, on average, than high-school graduates if IQ and GPA are fixed

⇒ ii is correct

(b)

$\text{Salary} = 50 + 20 \cdot 4 + 0.07 \cdot 110 + 35 \cdot 1 + 0.01 \cdot 4 \cdot 110 - 10 \cdot 4 \cdot 1 = 137.1$

⇒ total salary is $137.1 \times 1000 = 137100$ dollars

(c)

False ⇒ ($\hat{\beta}_4 = 0.01$) Although the coefficient for the GPA/IQ interaction term is small, it does not necessarily indicate the absence of an interaction effect. The magnitude of the interaction term coefficient only suggests that its impact on salary is relatively small, but it does not solely determine the presence of an interaction effect. To determine the presence of an interaction effect, statistical hypothesis testing or further analysis is required. The existence of an interaction effect should be assessed based on statistical significance testing or domain knowledge, rather than solely relying on the magnitude of the coefficient. Therefore, a small coefficient for the interaction term does not imply the absence of an interaction effect.