Week 3: Basic regression

4. How useful is a linear model

Stat 140 - 04

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Slides posted at *http://sshanshans.github.io/stat140*

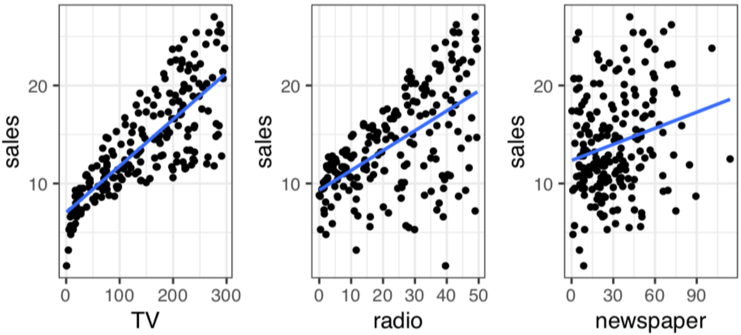
We have a data set of 200 markets, and we are interested in the relationship between sales and advertising budget. We look at the following variables.

- **sales** is a measure of sales volume in thousands of units
- **TV** is TV advertising budget
- **radio** is radio advertising budget
- **newspaper** is newspaper advertising budget

Poll question

Which of these models would you prefer to use for predicting sales?

a. TV
b. radio
c. newspaper

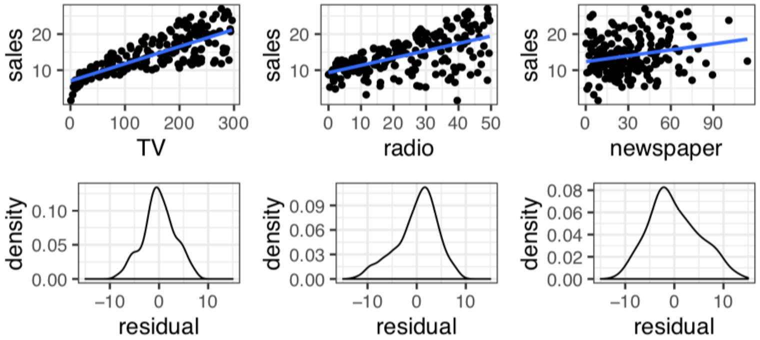


Being as specific and concrete as possible, write down a rule for selecting your preferred model

1. based only on **visual characteristics** of the plot.
2. based only on **a quantitative summary** of the data. You can describe how you would calculate your numeric summary of the data in a general sense; if you'd like you can write down a formula.

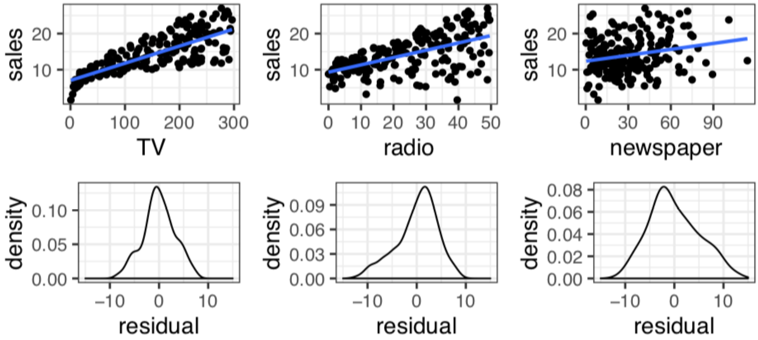
Residuals:

- $e_i = y_i - \hat{y}_i$ (vertical distance between point and line)
- Smaller residuals mean the predictions were better.
- The key is to measure the spread of residuals.

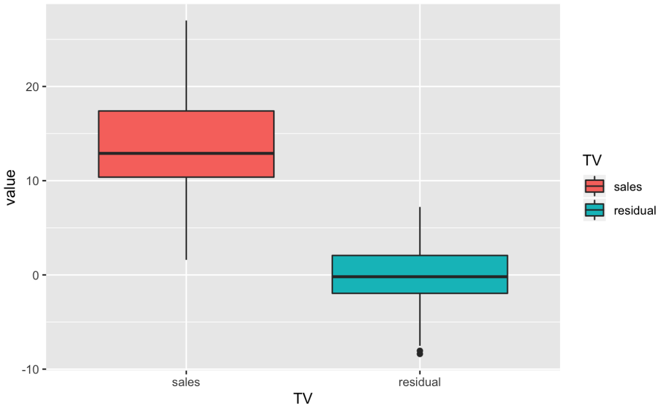


Measure spread of residuals with the standard deviation. We call this the **residual standard error**, s_{RES}.

- TV: 3.26
- radio: 4.28
- newspaper: 5.09



The variability in the residuals describes how much variation remains after using the model



Let's compute the reduction in variation.

$$\frac{s^2_{\textsf{sales}} - s^2_{\textsf{RES}}}{s^2_{\textsf{sales}}} = 0.61$$

This number describes the amount of variation in the y-variable that is explained by the least squares line.

An value of 61% indicates that 61% of the variation in sales can be accounted for by the TV advertisement budget.

Variation accounted by the model

- TV: 0.61
- radio: 0.33
- newspaper: 0.05

meaning,

- 61% of the variation in sales can be accounted for by the TV advertisement budget;
- 33% of the variation in sales can be accounted for by the radio advertisement budget;
- 5% of the variation in sales can be accounted for by the newspaper advertisement budget.

Statisticians found the variation accounted by the model can be computed by R^2, the **square of correlation**.

Square of the correlation coefficient R: between 0 and 1, closer to 1 is better.

R^2 describes the amount of variation in the y-variable that is explained by the least squares line.

linear_fit ← lm(Mortality ∼ Calcium, data = mortality_water)
summary(linear_fit)

```
##
## Call:
## lm(formula = Mortality ~ Calcium, data = mortality_water)
##
## Residuals:
##     Min      1Q  Median     3Q    Max
## -348.61 -114.52   -7.09 111.52 336.45
##
                          b0 intercept
## Coefficients:
                                                              Useful later
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 1676.3556    29.2981  57.217  < 2e-16 ***
## Calcium       -3.2261     0.4847  -6.656 1.03e-08 ***
## ---
                        b1 slope
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
                                                R squared
## Residual standard error: 143 on 59 degrees of freedom
## Multiple R-squared:  0.4288, Adjusted R-squared:  0.4191
## F-statistic:  44.3 on 1 and 59 DF,  p-value: 1.033e-08
```