**Lump/Split is an example of a GENERAL phenomenon in data science:**

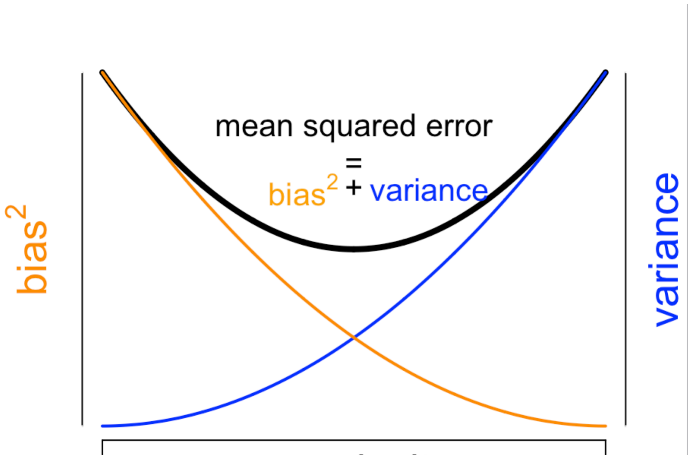
Some decision (model complexity, number of parameters, drilling down etc) triggers a tradeoff between reliability (e.g. low variance) and validity (e.g. low bias).

- As you make a model more complex and "free",
  it fits better, but eventually overfits.
  - The model gains "degrees of freedom";
    so it can fit the data more closely.
  - The data loses "degrees of freedom",
    so it can't critique the model as well.

- As you drill down into smaller subsets, leaning towards "splitting",.
  it fits better, but eventually overfits.
  - The effect size may get much bigger
    (if you chose the right split).
  - The data is sparser
    so the variance is higher.
  - We are closer to asking the right question for the individual…
    but with less accuracy as the sample size shrinks

Example: Mean Squared Error in regression; effect of model complexsity

$$MSE(\hat{\theta}) = E\left((\hat{\theta}-\theta)^2\right) = \mathrm{var}(\hat{\theta}) + bias(\hat{\theta})^2 w$$



| | | | | |
|---|---|---|---|---|
| lump | ← | | → | split |
| simple | ← | complexity | → | complex |
| few | ← | #parameters | → | many |
| few | ← | #components | → | many |
| large | ← | penalty | → | small |
| heavy | ← | prior weight | → | light |

**Bias** is high when your study is asking the wrong question; poor **Validity.**

**Variance** is high when, on repeating the study, the estimates would change greatly.; related to **Reliability.**