

## Randomized Trials (随机实验)

Causal Effect (因果效应):  $Y_{1i} - Y_{0i}$

If we want to find the causal effect of a treatment, naturally we need to compare the outcome of the treatment group and the control group.

First we can construct a dummy variable  $D_i$  to indicate whether the  $i$ -th component is in the treatment group or the control group:

$$D_i = \begin{cases} 1, & \text{if the } i\text{-th component is in the treatment group} \\ 0, & \text{if the } i\text{-th component is in the control group} \end{cases}$$

$$\text{Difffence in group means} = Avg_n[Y_{1i} | D_i = 1] - Avg_n[Y_{0i} | D_i = 0]$$

But this equation is not what we are looking for. (Why?) We use  $\kappa$  to denote the effect of the treatment, then we have:

$$Y_{1i} = Y_{0i} + \kappa$$

$$\begin{aligned} \text{Difffence in group means} &= Avg_n[Y_{1i} | D_i = 1] - Avg_n[Y_{0i} | D_i = 0] \\ &= \kappa + Avg_n[Y_{0i} | D_i = 1] - Avg_n[Y_{0i} | D_i = 0] \\ &= \kappa + \{Avg_n[Y_{0i} | D_i = 1] - Avg_n[Y_{0i} | D_i = 0]\} \end{aligned}$$

According to this, the difference between the two groups can be written as:

Difffence in group means = Average causal effect + Section bias (选择偏误)