Causal Inference

Chapter 2. The completely randomized assignment.

– Studies of this type: laboratory experiments, clinical trials with no complications.

– Examples of types of randomization: complete, Bernoulli, pairwise.

1 Fisher's mode of inference on focusing on the null hypothesis.

(1) Idea.

R. A. Fisher was the first modern scientist to propose physical randomization. (quote by Neyman).

For inference, he suggested to try establish evidence against the "null" effect hypothesis by first assuming it is true.[1]

(2) His procedure can be summarized as follows.

(a) Physically do the randomization.

(b) Calculate a statistic $S^{obs} = S(Y^{obs}, Z)$, a function of the observed data.

(c) Assuming null of no causal effect, fill in missing potential outcomes.

(d) Assuming null, generate many hypothetical replications of the randomization, and in each of which calculate the statistic, $S^{obs,rep}$.

(e) Compare S^{obs} with the values $S^{obs,rep}$.

(3) Approximations

(4) Limitations

[1]The method of proof by contradiction is mostly known due to the Pythagoreans ("$\epsilon\iota\varsigma \quad \alpha\tau o\pi o\nu \quad \alpha\pi\alpha\gamma\omega\gamma\eta$") in discovering irrational numbers, and later became a major methodological tool ("reductio ad absurdum").

2 Neyman's mode of inference.

(1) Motivation: Range of non-null plausible values of causal effect.

(2) Neyman's mode of inference is summarized as follows.

   (a) Set an estimand, a causal effect of scientific interest.

   (b) Find a consistent estimator of the estimand.

   (c) Find approximate variance of estimator.

   (d) Find approximate distribution of estimator,
   get confidence intervals.

(3) How does this apply if we are interested in the causal effect of larger population ? (Neyman, 1923)

(4) Neyman's approach as model of inference:
operating characteristics.

(5) Covariates and their role in the randomized assignment.