Thesis Defense

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Sample Size Estimation in Cluster Randomized Design: PAWS-CRD

Outline

- Introduction
- Problems
- The proposed solution
- Examples
- Accuracy

Introduction

- Cluster Randomized Design (CRD)
- Two types of sample sizes
  - Number of clusters
  - Cluster size
- Relationship with power
- Relationship with width of confidence interval (CI) of effect size (ES)

Problems

- Different combinations of sample sizes provide the same power or width of CI of ES.
  - Need the least expensive combination
- Different combinations provide the same budget
  - Need the combination with maximum power or minimum width of CI of ES

Problems

- Some programs can estimate power in CRD
  - e.g., PINT or Optimal Design.
- No program accounts for width of CI of ES
- No program provides the algorithm to find optimal combination.

The Proposed Solution

- This thesis developed the new program: PAWS-CRD
  - Power And Width of CI of ES for Sample size estimation for Cluster Randomized Design
  - Estimation based on
    - Normal approximation (Starting Value)
    - A priori Monte Carlo simulation

The Proposed Solution

- Additional features
  - Allows unequal clusters between treatment and control conditions
  - Allows for different costs

	Treatment	Control
Cluster Cost		
Individual Cost		

The Proposed Solution

- Additional features
  - Can control error variances by a covariate
  - Use ES standardized by individual-level standard deviation
  - Provide both post hoc and a priori analyses

Examples

1. What happens when a covariate is added? (Post Hoc)
2. How many classrooms are required to detect a small effect? (A priori)
3. What is the best sample size combination, given a limited budget? (A priori)

Example 1

- Effectiveness of training to administer cognitive behavioral therapy (King et al., 2002)
- 84 therapists assigned to two conditions
- 4 patients each
- DV = Beck Depression Inventory (BDI) Score
- ES with individual-level SD = 0.09
- Intraclass correlation = 0.013

Example 1

- Result = *ns*
- Post Hoc power = 0.124
- If the researchers collected BDI scores of therapists,
  - Cluster-level variable
  - Cluster-level Error Variance Explained = 10%
- Can the covariate help to achieve high power?

Example 2

- A new teaching method
- DV = Academic Achievement
- Intraclass correlation = 0.25
- Classroom size = 25
- Power = 0.8
- Meaningful ES = 0.2

Example 2

- Cost

	Treatment	Control
Cluster Cost	600	300
Individual Cost	2	2

- How many classrooms should be used?

Example 3

- Parent-teacher relationship encouragement program
- DV = Conduct Problems (BASC-II)
- Multi-site study (Level 2 = Schools)
- Intraclass correlation = 0.05
- Meaningful ES = 0.2

Example 3

- Use perceived positive school climate as a covariate
  - Intraclass correlation = 0.05
  - Amount of error variance explained in both levels = 18.49%

Example 3

- Cost

	Treatment	Control
Cluster Cost	500	50
Individual Cost	30	2

- Budget = $50,000
- Which is sample size combination providing the highest power?

Accuracy

- Using PINT
- Compare the programs' results of 300 situations

Accuracy

- Testing 300 situations based on
  1. Method to find sample size
     - Achieve power of .80
     - Achieve width of 0.2
     - Achieve width of 0.5
     - Maximum power given $500 budget
     - Maximum power given $1000 budget

Accuracy

- Testing 300 situations based on
  2. Intraclass correlation of dependent variable
     - 0.05
     - 0.25
  3. ES of treatment variable
     - 0.2
     - 0.5

Accuracy

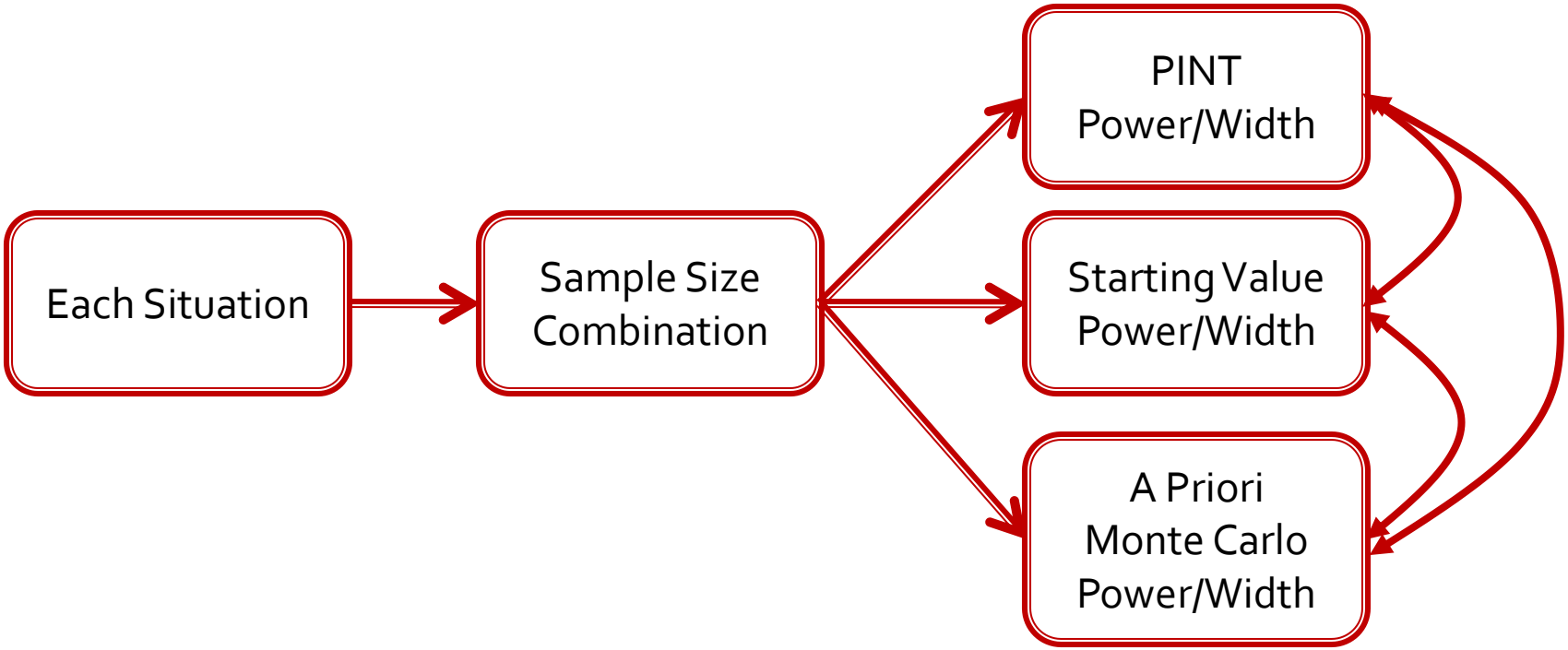
- Testing 300 situations based on
  4. Cluster costs if individual cost is $1
     - None
     - $5
     - $10

Accuracy

- Testing 300 situations based on
  5. Covariate characteristics
     - No covariate
     - Individual-level covariate
     - Covariate with intraclass correlation of 0.05
     - Covariate with intraclass correlation of 0.25
     - Cluster-level covariate

Accuracy

- 5 × 2 × 2 × 3 × 5 = 300 situations
- Testing backward



Accuracy

- The starting values replicate the PINT.
- Difference between the starting values and the a priori Monte Carlo simulation
  - Power are similar across two approaches (Difference < 0.08)

Accuracy

Type of Covariate	Difference in Power			
	M	*SD*	Min	Max
No Covariate	-0.005	0.015	-0.073	0.014
Individual-level Covariate	-0.009	0.015	-0.044	0.012
Covariate with ICC of 0.05	-0.004	0.014	-0.044	0.035
Covariate with ICC of 0.25	-0.008	0.015	-0.049	0.021
Group-level Covariate	-0.009	0.014	-0.063	0.006
Total	-0.007	0.015	-0.073	0.035

Accuracy

- The starting values replicate the PINT.
- Difference between the starting values and the a priori Monte Carlo simulation
  - Power are similar across two approaches (Difference < 0.08)
  - Width of CI of ES are similar in most cases

Accuracy

Type of Covariate	Difference in 95% CI of ES			
	M	*SD*	Min	Max
No Covariate	0.001	0.007	-0.009	0.028
Individual-level Covariate	-0.004	0.006	-0.024	0.023
Covariate with ICC of 0.05	-0.128	0.319	-2.069	0.003
Covariate with ICC of 0.25	-0.007	0.006	-0.026	0.008
Group-level Covariate	0.002	0.009	-0.027	0.044
Total	-0.027	0.150	-2.069	0.044

Accuracy

- The starting values are not accurate when
  - ICC of the covariate is 0.05
  - ICC of the dependent variable is 0.25
  - Total sample size result < 500

Conclusion

- PAWS is developed to address problems that other programs neglected.
- The starting values are accurate in most situations.

Q & A