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**pypowerup**

***Release 0.1.0***

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# CHAPTER 1

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## Authors

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Sophia Man Yang, Nianbo Dong, Rebecca Maynard



## CHAPTER 2

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### PyPowerUp

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PyPowerUp is the Python implementation for the research article “PowerUp!: A Tool for Calculating Minimum Detectable Effect Sizes and Minimum Required Sample Sizes for Experimental and Quasi-experimental Design Studies (Dong & Maynard, 2013)”. It is a power analysis tool for 21 experimental and quasi-experimental designs.

Given study design, PyPowerUp computes minimum detectable effect sizes `effect_size`, power `power`, and minimum required samples sizes `sample_size`.

To install PyPowerUp, run this command in your terminal:

```
$ pip install pypowerup
```

To use the functions:

```
from pypowerup import effect_size, power, sample_size
```



# CHAPTER 3

## Individual Random Assignment Designs

### 3.1 Simple Individual Random Assignment (IRA)

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	1	individual	1	NA

```
[1]: from pypowerup import effect_size, power, sample_size

[2]: # effect size, i.e., minimum detectable effect sizes (MDES):
    effect_size(design='ira', n=787, power=0.8, alpha=0.05, two_tailed=True, p=0.5, r21=0,
    ↪ g=0)
[2]: 0.19997988869985736

[3]: # sample size, i.e., minimum required samples sizes (MRSS):
    sample_size(design='ira', es=0.2, power=0.8, alpha=0.05, two_tailed=True, p=0.5, ↪
    ↪ r21=0, g=0)
[3]: 787.0

[4]: # power
    power(design='ira', es=0.2, n=787, alpha=0.05, two_tailed=True, p=0.5, r21=0, g=0)
[4]: 0.8000799952735076
```

#### Parameters for IRA

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```

### Output validation with statsmodels

Here we used statsmodels with the same parameters to validate our model results. Note nobs1 in statsmodels is the sample size for treatment group, which is half of the total sample size output from our model. Thus, we define nobs1=787/2=393.5 in the models below.

```
[5]: from statsmodels.stats.power import TTestIndPower
```

```
[6]: # effect size
analysis = TTestIndPower()
analysis.solve_power(power=0.8, nobs1=393.5, ratio=1, alpha=0.05, alternative='two-sided')
```

```
[6]: 0.19997768751017836
```

```
[7]: # sample size (statsmodels output treatment sample size only, which is the half of
# our computed total sample size)
```

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(continued from previous page)

```
analysis.solve_power(0.2, power=0.8, nobs1=None, ratio=1, alpha=0.05, alternative='two-sided')
```

[7]: 393.4056989990335

```
[8]: # power
analysis.solve_power(0.2, nobs1=393.5, ratio=1.0, alpha=0.05, alternative='two-sided')
```

[8]: 0.8000942129794306

With the same parameters, we get the same results as the `statsmodels`. However, `statsmodels` does not do power analysis for more complicated designs, which we will cover next.

### 3.2 Blocked (Stratified) Individual Random Assignment (BIRA)

### **3.2.1 BIRA2 1c**

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	constant

```
[1]: from pypowerup import effect_size, power, sample_size
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design = "bira2_1c", n=80, J=14, power=0.8, alpha=0.05, two_tailed=True, ↴p=0.5, r21=0, q=0)
```

```
[2] : 0.1675746241777643
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units.
sample_size(design = "bira2_1c", n=80, es=0.168, power=0.8, alpha=0.05, two_
tailed=True, p=0.5, r21=0, q=0)
```

[3]: 14, 0

```
[4]: # power
power(design = "bira2_lc", n=80, J=14, es=0.168, alpha=0.05, two_tailed=True, p=0.5, r=0.2, r21=0, sigma=0)
```

```
[4]: 0.801986386400488
```

## Parameters for BJRA2\_1c:

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<code>head</code>	<code>notranslate</code>	<code>notranslate</code>	<code>notranslate</code>

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</tbody> </table>

```

### 3.2.2 BIR A2\_1f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	fixed

```

[5]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design = "bira2_1f", n=10, J=200, power=0.8, alpha=0.05, two_tailed=True,
            p=0.5, r21=0, g=0)

```

```

[5]: 0.1253671054395026

```

```

[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units.
sample_size(design = "bira2_1f", n=10, es=0.125, power=0.8, alpha=0.05, two_
            tailed=True, p=0.5, r21=0, g=0)

```

[6]: 201.0

[7]: # power  
`power(design = "bira2_1f", n=10, J=200, es=0.125, alpha=0.05, two_tailed=True, p=0.5, ↵r21=0, g=0)`

[7]: 0.7976961337604935

### Parameters for BIRA2\_1f

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```

### 3.2.3 BIRA2\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	random

```
[8]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "bira2_1r", n=80, J=480, rho2=0.35, omega2=0.1, power=0.8,
            alpha=0.05,
            two_tailed=True, p=0.5, r21=0, r2t2=0, g=0)

[8]: 0.033290496240165834
```

  

```
[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "bira2_1r", es=0.033290496240165834, n=80, rho2=0.35, omega2=0.1,
            power=0.8, alpha=0.05,
            two_tailed=True, p=0.5, r21=0, r2t2=0, g=0)

[9]: 480.0
```

  

```
[10]: # power
power(design = "bira2_1r", es=0.033290496240165834, n=80, J=480, rho2=0.35, omega2=0.
      1, alpha=0.05,
      two_tailed=True, p=0.5, r21=0, r2t2=0, g=0)

[10]: 0.800001211704756
```

#### Parameters for BIRA2\_1r

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```

### 3.2.4 BIR3\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	individual	1	random

```
[11]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "bir3_1r", n=80, J=10, K=100, rho3=0.2, rho2=0.15, omega3=0.1, ↴
omega2=0.1,
            power=0.8, alpha=0.05, two_tailed=True, p=0.5, r21=0, r2t2=0, r2t3=0, g=0)
```

```
[11]: 0.04451381756409839
```

```
[12]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "bira3_1r", es=0.04451381756409839, n=80, J=10, rho3=0.2, rho2=0.
           ↪15, omega3=0.1, omega2=0.1,
           power=0.8, alpha=0.05, two_tailed=True, p=0.5, r21=0, r2t2=0, r2t3=0, g=0)
[12]: 100.0

[13]: # power
power(design = "bira3_1r", es=0.04451381756409839, n=80, J=10, K=100, rho3=0.2, ↪
       ↪rho2=0.15, omega3=0.1, omega2=0.1,
       alpha=0.05, two_tailed=True, p=0.5, r21=0, r2t2=0, r2t3=0, g=0)
[13]: 0.8000026614774113
```

### Parameters for BIRA3\_1r

Parameter	Description
design	"bira3_1r"
es	Effect size (e.g., 0.5)
n	Sample size (e.g., 80)
J	Number of groups (e.g., 10)
rho3	Correlation between group 3 and others (e.g., 0.2)
rho2	Correlation between group 2 and others (e.g., 0.15)
omega3	Omega squared for group 3 (e.g., 0.1)
omega2	Omega squared for group 2 (e.g., 0.1)
power	Power (e.g., 0.8)
alpha	Type I error rate (e.g., 0.05)
two_tailed	Two-tailed test (True)
p	Probability of a Type I error (e.g., 0.5)
r21	Correlation between group 1 and others (0)
r2t2	Correlation between group 2 and others (0)
r2t3	Correlation between group 3 and others (0)
g	Gamma value (0)
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section	"design"
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```

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### 3.2.5 BIR4\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	individual	1	random

```
[14]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "bir4_1r", n=10, J=4, K=4, L=20, rho4=0.05, rho3=0.15, rho2=0.
        .15,
                    omega4=0.5, omega3=0.5, omega2=0.5, r21=0.5, r2t2=0.5, r2t3=0.5, r2t4=0.5,
                    g=1,
                    power=0.8, alpha=0.05, two_tailed=True
        )
[14]: 0.1191537036343213
```

```
[15]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design = "bira4_1r", es=0.1191537036343213, n=10, J=4, K=4, rho4=0.05,
            ↪rho3=0.15, rho2=0.15,
            omega4=0.5, omega3=0.5, omega2=0.5, r21=0.5, r2t2=0.5, r2t3=0.5, r2t4=0.5,
            ↪ g=1,
            power=0.8, alpha=0.05, two_tailed=True)

[15]: 20.0
```

  

```
[16]: # power
power(design = "bira4_1r", es=0.1191537036343213, n=10, J=4, K=4, L=20, rho4=0.05,
       ↪rho3=0.15, rho2=0.15,
       omega4=0.5, omega3=0.5, omega2=0.5, r21=0.5, r2t2=0.5, r2t3=0.5, r2t4=0.5,
       ↪ g=1,
       alpha=0.05, two_tailed=True)

[16]: 0.8000404338335202
```

### Parameters for BIRA4\_1r

Parameter	Description
design	"bira4_1r"
es	Effect size (e.g., 0.1191537036343213)
n	Sample size (e.g., 10)
J	Number of strata (e.g., 4)
K	Number of treatments per stratum (e.g., 4)
rho4	Correlation coefficient between strata 4 and treatment 4 (e.g., 0.05)
rho3	Correlation coefficient between strata 3 and treatment 4 (e.g., 0.15)
rho2	Correlation coefficient between strata 2 and treatment 4 (e.g., 0.15)
omega4	Within-stratum variance for stratum 4 (e.g., 0.5)
omega3	Within-stratum variance for stratum 3 (e.g., 0.5)
omega2	Within-stratum variance for stratum 2 (e.g., 0.5)
r21	Correlation coefficient between strata 2 and treatment 1 (e.g., 0.5)
r2t2	Correlation coefficient between strata 2 and treatment 2 (e.g., 0.5)
r2t3	Correlation coefficient between strata 2 and treatment 3 (e.g., 0.5)
r2t4	Correlation coefficient between strata 2 and treatment 4 (e.g., 0.5)
g	Number of groups (e.g., 1)
power	Desired power (e.g., 0.8)
alpha	Significance level (e.g., 0.05)
two_tailed	Whether the test is two-tailed (True)



</tbody> </table>

# CHAPTER 4

## Cluster Random Assignment Designs

### 4.1 Simple Cluster Random Assignment (CRA)

#### 4.1.1 CRA2\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	2	cluster	2	random

```
[1]: from pypowerup import effect_size, sample_size, power

[2]: # effect size, i.e., minimum detectable effect sizes (MDES):
    effect_size(design='cra2_2r', rho2=0.15, r21=0.40, r22=0.53, g=1, n=100, J=40,
                alpha=0.05, power=0.8, p=0.5)
[2]: 0.2502054873913746

[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units.
    sample_size(design='cra2_2r', es=0.2502054873913746, rho2=0.15, r21=0.40, r22=0.53,
                g=1, n=100, alpha=0.05, power=0.8, p=0.5)
[3]: 40.0

[4]: # power
    power(design='cra2_2r', es=0.2502054873913746, rho2=0.15, r21=0.40,
           r22=0.53, g=1, n=100, J=40, alpha=0.05, p=0.5)
[4]: 0.8000094900703394
```

#### Parameters for CRA2\_2r

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```

## 4.1.2 CRA3\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	3	cluster	3	random

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design='cra3_3r', rho3=0.38, rho2=0.10, r21=0.37, r22=0.53,
            r23=0.87, g=1, n=20, J=2, K=66, alpha=0.05, power=0.8, p=0.5)
```

```
[5]: 0.19949475029929953
```

```
[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units.
sample_size(design='cra3_3r', es=0.19949475029929953, rho3=0.38,
            rho2=0.10, r21=0.37, r22=0.53, r23=0.87, g=1, n=20, J=2,
            alpha=0.05, power=0.8, p=0.5)
```

```
[6]: 66.0
```

```
[7]: # power
power(design='cra3_3r', es=0.19949475029929953, rho3=0.38, rho2=0.10, r21=0.37,
       r22=0.53, r23=0.87, g=1, n=20, J=2, K=66, alpha=0.05, p=0.5)
```

```
[7]: 0.8000043161361032
```

### Parameters for CRA3\_3r

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#### 4.1.3 CRA4\_4r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	4	cluster	4	random

```
[8]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design='cra4_4r', rho4=0.05, rho3=0.05, rho2=0.10, r21=0.50, r22=0.50,
            r23=0.50, r24=0.50, g=1, n=10, J=2, K=3, L=20,
            alpha=0.05, power=0.8, p=0.5)
```

```
[8]: 0.29231230598875796
```

```
[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units.
sample_size(design='cra4_4r', es=0.29231230598875796, rho4=0.05, rho3=0.05, rho2=0.10,
           ↪ r21=0.50, r22=0.50,
           ↪ r23=0.50, r24=0.50, g=1, n=10, J=2, K=3, alpha=0.05, power=0.8, p=0.5)

[9]: 20.0
```

  

```
[10]: # power
power(design='cra4_4r', es=0.29231230598875796, rho4=0.05, rho3=0.05, rho2=0.10,
       ↪ r21=0.50, r22=0.50,
       ↪ r23=0.50, r24=0.50, g=1, n=10, J=2, K=3, L=20, alpha=0.05, p=0.5)

[10]: 0.800046080238779
```

### Parameters for CRA4\_4r

Parameter	Description
design	'cra4_4r'
es	0.29231230598875796
rho4	0.05
rho3	0.05
rho2	0.10
r21	0.50
r22	0.50
r23	0.50
r24	0.50
g	1
n	10
J	2
K	3
alpha	0.05
power	0.8
p	0.5
L	20

```

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## 4.2 Blocked (Stratified) Cluster Randomized Assignment (BCRA)

### 4.2.1 BCRA3\_2f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	fixed

```
[1]: from pypowerup import effect_size, sample_size, power
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra3_2f', rho2=0.10, r21=0.50, r22=0.50, g=1, n=20, J=44, K=5)

[2]: 0.10219354337360606

[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design='bcra3_2f', es=0.10219354337360606, rho2=0.10, r21=0.50, r22=0.50, ↵g=1, n=20, J=44)

[3]: 5.0

[4]: # power
power(design='bcra3_2f', es=0.10219354337360606, rho2=0.10, r21=0.50, r22=0.50, g=1, ↵n=20, J=44, K=5)

[4]: 0.8000016066584502

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```

## 4.2.2 BCRA3\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	random

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra3_2r', rho3=0.38, rho2=0.10, omega3=0.50, r21=0.37,
            r22=0.53, r2t3=0, g=0, n=20, J=2, K=64)

[5]: 0.20020041517111645
```

```
[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design='bcra3_2r', es=0.20020041517111645, rho3=0.38, rho2=0.10, omega3=0.
             ←50, r21=0.37,
             r22=0.53, r2t3=0, g=0, n=20, J=2)

[6]: 64.0
```

```
[7]: # power
power(design='bcra3_2r', es=0.20020041517111645, rho3=0.38, rho2=0.10, omega3=0.50,
      r21=0.37,
      r22=0.53, r2t3=0, g=0, n=20, J=2, K=64)

[7]: 0.8000043161361032
```

```
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```

### 4.2.3 BCRA4\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	cluster	2	random

```
[8]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra4_2r', rho4=0.05, rho3=0.15, rho2=0.15, omega4=0.5, omega3=0.
           ↪5, r21=0.5, r22=0.5,
           r2t3=0.5, r2t4=0.5, g=0, n=10, J=4, K=4, L=20)
```

[8]: 0.14584081061169768

```
[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design='bcra4_2r', es=0.14584081061169768, rho4=0.05, rho3=0.15, rho2=0.
             ↵15, omega4=0.5, omega3=0.5, r21=0.5, r22=0.5,
             r2t3=0.5, r2t4=0.5, g=0, n=10, J=4, K=4)
```

[9]: 20.0

```
[10]: # power
```

```
power(design='bcra4_2r', es=0.14584081061169768, rho4=0.05, rho3=0.15, rho2=0.15, ρ4=0.05, ρ3=0.15, ρ2=0.15, ρ1=0.15, omega4=0.5, omega3=0.5, r21=0.5, r22=0.5, r2t3=0.5, r2t4=0.5, g=0, n=10, J=4, K=4, L=20)
```

[10]: 0.8000357933435768

Parameters	<code>effect_size</code>	<code>sample_size</code>	<code>power</code>
<code>docutils literal notranslate</code>	<code>&lt;/span&gt;&lt;/code&gt;</code>	<code>&lt;/span&gt;&lt;/code&gt;</code>	<code>&lt;/span&gt;&lt;/code&gt;</code>



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#### 4.2.4 BCRA4\_3f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	cluster	3	fixed

```

[11]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra4_3f', rho3=0.15, rho2=0.15, r21=0.5, r22=0.5,
            r23=0.5, g=2, n=10, J=4, K=4, L=15)

[11]: 0.2399780453218905

[12]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design='bcra4_3f', es=0.2399780453218905, rho3=0.15, rho2=0.15, r21=0.5, r22=0.5,
            r23=0.5, g=2, n=10, J=4, K=4)

[12]: 15.0

[13]: # power
power(design='bcra4_3f', es=0.2399780453218905, rho3=0.15, rho2=0.15, r21=0.5, r22=0.
      ↪5,
      r23=0.5, g=2, n=10, J=4, K=4, L=15)

[13]: 0.8000158353898167
```

```

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```

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</tbody> </table>
```

#### 4.2.5 BCRA4\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	cluster	3	random

```
[14]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra4_3r', rho4=0.05, rho3=0.15, rho2=0.15, omega4=0.5,
            r21=0.5, r22=0.5, r23=0.5, r2t4=0.5, g=3, n=10, J=4, K=20, L=20)
```

```
[14]: 0.12100407246925271
```

```
[15]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design='bcra4_3r', es=0.12100407246925271, rho4=0.05, rho3=0.15, rho2=0.
            ↪15, omega4=0.5,
            r21=0.5, r22=0.5, r23=0.5, r2t4=0.5, g=3, n=10, J=4, K=20)
```

```
[15]: 20.0
```

```
[16]: # power
power(design='bcra4_3r', es=0.12100407246925271, rho4=0.05, rho3=0.15, rho2=0.15,
       ↪omega4=0.5,
       r21=0.5, r22=0.5, r23=0.5, r2t4=0.5, g=3, n=10, J=4, K=20, L=20)
```

```
[16]: 0.800053034680572
```

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# CHAPTER 5

## Quasi-experimental Designs

### 5.1 Regression Discontinuity (RD)

#### 5.1.1 RD2\_1f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	fixed

```
[1]: from pypowerup import effect_size, sample_size, power
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rd2_1f", n=55, J=20, r21=0.5, g=1, design_effect=2.75)
```

```
[2]: 0.19828457764454652
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rd2_1f", es=0.19828457764454652, n=55, r21=0.5, g=1, design_
            ↴effect=2.75)
```

```
[3]: 20.0
```

```
[4]: # power
power(design = "rd2_1f", es=0.19828457764454652, n=55, r21=0.5, J=20, g=1, design_
            ↴effect=2.75)
```

```
[4]: 0.8000010686602212
```

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## 5.1.2 RD2\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	random

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rd2_1r", n=50, J=40, r21=0.5, g=1, r2t2=0.1, omega2=0.2, rho2=0.15, design_effect=2.75)

[5]: 0.15782962225367275

[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rd2_1r", es=0.15782962225367275, n=50, r21=0.5, g=1, r2t2=0.1, omega2=0.2, rho2=0.15, design_effect=2.75)

[6]: 40.0

[7]: # power
power(design = "rd2_1r", es=0.15782962225367275, n=50, J=40, r21=0.5, g=1, r2t2=0.1, omega2=0.2, rho2=0.15, design_effect=2.75)

[7]: 0.8000090684884187

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```

### 5.1.3 RDC\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	2	cluster	2	random

```
[8]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rdc_2r", rho2=0.15, r21=0.5, r22=0.5, g=1, n=55, J=179, design_
    ↴effect=2.75)
```

```
[8]: 0.20086870136611698
```

```
[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rdc_2r", es=0.20086870136611698, rho2=0.15, r21=0.5,
            r22=0.5, g=1, n=55, design_effect=2.75)
```

```
[9]: 179.0
```

```
[10]: # power
power(design = "rdc_2r", es=0.20086870136611698, rho2=0.15, r21=0.5,
       r22=0.5, g=1, n=55, J=179, design_effect=2.75)
```

```
[10]: 0.8000017574724924
```

```
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thead><tbody> <tr class="row-even"><td><td><td><td></td></tr></tbody></table>
```



## 5.1.4 RDC\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	3	cluster	3	random

```
[11]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rdc_3r", rho3=0.15, rho2=0.15, r21=0.5, r22=0.5,
            r23=0.5, g=1, n=18, J=3, K=230, design_effect=2.75)

[11]: 0.20079075638849297

[12]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5,
            r22=0.5, r23=0.5, g=1, n=18, J=3, design_effect=2.75)

[12]: 230.0

[13]: # power
power(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5, r22=0.
      5,
      r23=0.5, g=1, n=18, J=3, K=230, design_effect=2.75)

[13]: 0.8000015459112233
```

Parameter	Description	Value
rho3	Minimum detectable effect size (MDES)	0.15
rho2	Minimum detectable effect size (MDES)	0.15
r21	Treatment Level 1	0.5
r22	Treatment Level 2	0.5
r23	Treatment Level 3	0.5
g	Number of groups	1
n	Sample size per group	18
J	Number of clusters	3
K	Number of individuals per cluster	230
design_effect	Design effect	2.75

```

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```

## 5.1.5 RD2\_3f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	fixed

```
[14]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rd3_2f", rho2=0.15, r21=0.5, r22=0.5, g=0, n=18, J=3, K=71,
            ↴design_effect=2.75)
```

```
[14]: 0.20131125779908843

[15]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "rd3_2f", es=0.20131125779908843, rho2=0.15, r21=0.5, r22=0.5,
            ↪g=0,
            n=18, J=3, design_effect=2.75)

[15]: 71.0

[16]: # power
power(design = "rd3_2f", es=0.20131125779908843, rho2=0.15, r21=0.5, r22=0.5, g=0,
       n=18, J=3, K=71, design_effect=2.75)

[16]: 0.8000020062425997

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```

## 5.1.6 RD2\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	random

```
[17]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rdc_3r", rho3=0.15, rho2=0.15, r21=0.5, r22=0.5, r23=0.5,
            g=1, n=18, J=3, K=230, design_effect=2.75)

[17]: 0.20079075638849297
```

```
[18]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5,
            ↴r22=0.5, r23=0.5,
            g=1, n=18, J=3, design_effect=2.75)

[18]: 230.0
```

```
[19]: # power
power(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5, r22=0.
      ↴5, r23=0.5,
      g=1, n=18, J=3, K=230, design_effect=2.75)

[19]: 0.8000015459112233
```

```
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```

## 5.2 Interrupted Time-Series (ITS)

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	constant at level 3 random at level 2

```
[1]: from pypowerup import effect_size, sample_size, power
```

### No comparison units

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "its_nocompare", rho2=0.03, T=5, n=75, K=10, r22=0, tf=2, g=0)
```

```
[2]: 0.3658177052373508
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "its_nocompare", es=0.3658177052373508, rho2=0.03, T=5, n=75, ↴
r22=0, tf=2, g=0)
```

```
[3]: 10.0
```

```
[4]: # power
power(design = "its_nocompare", es=0.3658177052373508, rho2=0.03, T=5, n=75, K=10, ↴
r22=0, tf=2, g=0)
```

```
[4]: 0.8000060699483386
```

```

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width="16</colgroup> <thead valign="bottom"> <tr class="row-odd"><th class="head">Parameters</th>
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```

### **With comparison units**

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "its_wcompare", rho2=0.03, T=5, n=75, K=10, r22=0, tf=2, g=0, q=2)

[5]: 0.44803335835368546
```

```
[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "its_wcompare", es=0.44803335835368546, rho2=0.03, T=5, n=75, ↴
    ↪r22=0, tf=2, g=0, q=2)

[6]: 10.0
```

```
[7]: # power
power(design = "its_wcompare", es=0.44803335835368546, rho2=0.03, T=5, n=75, K=10, ↴
    ↪r22=0, tf=2, g=0, q=2)

[7]: 0.8000060699483386
```

```
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# CHAPTER 6

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## Credit and disclaimer

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This document is heavily built on <https://www.causalevaluation.org/uploads/7/3/3/6/73366257/powerup.xlsx>. All the design and variable explanations are from this sheet.



# CHAPTER 7

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## References

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Dong, N. & Maynard, R. A. (2013). PowerUp!: A tool for calculating minimum detectable effect sizes and minimum required sample sizes for experimental and quasi- experimental design studies, Journal of Research on Educational Effectiveness, 6(1), 24-67. doi: 10.1080/19345747.2012.673143. <https://www.causalevaluation.org/uploads/7/3/3/6/73366257/powerup.xlsm>

Bulus, M., Dong, N., Kelcey, B., & Spybrook, J. (2019). PowerUpR: Power Analysis Tools for Multilevel Randomized Experiments. R package version 1.0.4. <https://CRAN.R-project.org/package=PowerUpR>