McNemar Test

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- Purpose/Type of data
- Null Hypothesis/ Alternative Hypothesis
- Real Data

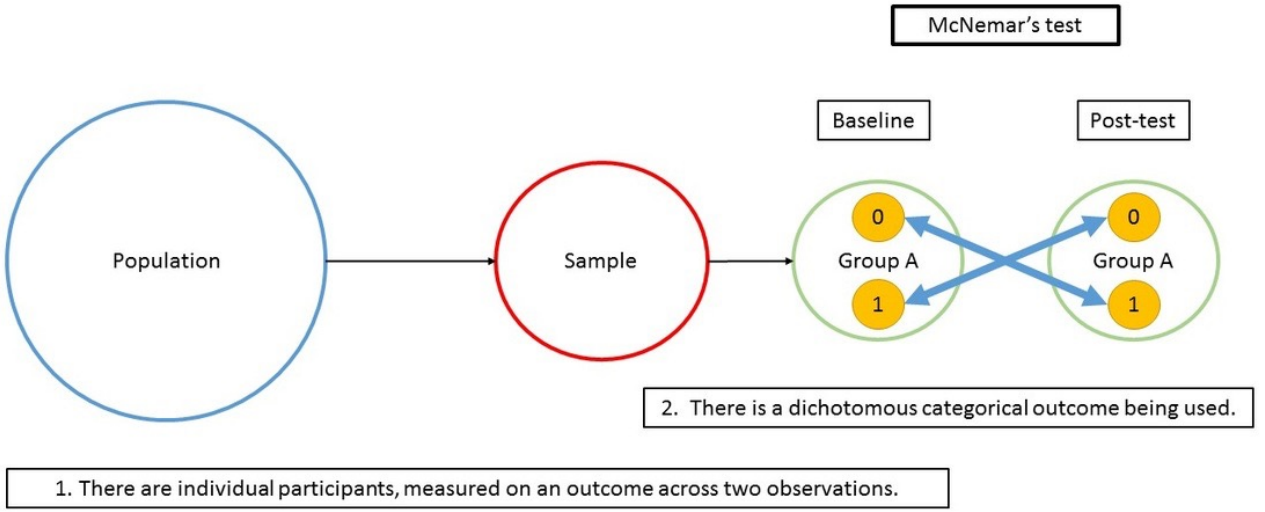
ASSUMPTION

- Paired data
- Categorical data
- 2x2 contingency table
- Dependent samples
- Test whether a population remains the same before and after testing

INTRODUCTION

Purposes

- The McNemar test is utilized to find statistical significance of a change in proportion for the paired nominal (categorical) data.



Requirements

- **Data type:** Binary or Categorical Data
- **Pair data:** Each subject or case is classified into two categories, and their data is collected twice. This results in a 2x2 contingency table.
- **Sample size:** the expected effect size, significance level, and power of the test.

H0/H1

Hypothesis

- H0 - Null Hypothesis: there is no significant difference between the control is exposed.

$$H_0 : B = C$$

- H1 - Alternative Hypothesis: There is a significant difference between the control is exposed.

$$H_1 : B \neq C$$

Test Statistic

$$\chi^2 = \frac{(b-c)^2}{b+c}$$

- If the null hypothesis is true, the McNemar Chi-square statistic = 0.

- McNemar 検定

試験後 / 試験前	成功	失敗	和
成功	A (P_{11})	B (P_{12})	A+B ($P_{1.}$)
失敗	C (P_{21})	D (P_{22})	C+D ($P_{2.}$)
和	A+C ($P_{.1}$)	B+D ($P_{.2}$)	n (1)

Decision Rule

- The sampling distribution of the McNemar statistic is a Chi-square distribution.
- Since the McNemar test is always done on data in a 2 X 2 table, the degrees of freedom for this statistic = 1
- For a test with $\alpha = 0.05$, the critical value for the McNemar statistic = 3.84.
  - The null hypothesis is not rejected if the McNemar statistic < 3.84.
  - The null hypothesis is rejected if the McNemar statistic > 3.84.

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REAL DATA

Data Introduction

- Air Quality Monitoring Data(PM2.5)
- 77 monitoring station in Taiwan
- Records per hour

Monitoring Station	Date	Quality Index	00:00	01:00	……
三義	2/1	PM2.5	15	18	……
三重	2/2	PM10	10	12	……
……	…	…	…	…	……

Goal

- To test whether is air quality worse after Moon Festival

REAL DATA

Process

1. Decided which air quality pollutant to use. ($PM_{2.5}$)
2. Defined the threshold of the air quality. (15)
3. Transfered the table into a 2x2 contigency table.
4. Conducted McNemar Test.

Consequeces

		After Moon Festival	
		Polluted	Not Polluted
Before Moon Festival	Polluted	2	0
	Not Polluted	44	31

REAL DATA

Results

		After Moon Festival	
		Polluted	Not Polluted
Before Moon Festival	Polluted	2	0
	Not Polluted	44	31

- P-value = 9.022e-11

→ The air quality detected after Moon Festival is worse than its before.

Codes in R

```
mcnemar.test(dataframe)
```