STK 353

Practical 1: Sampling – The Urn Model

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Submission format: HTML, Include all answers, graphs and code in the html file

Question 1 – Polio Vaccination

Background

Polio left many children crippled and some who could survive only with respirators. Jonas Salk had developed a vaccine that showed promising results in the laboratory. Ready to test on a larger scale, in 1954 a year-long field trial was conducted on 1.8M children from 217 areas in US, Canada, and Finland. The cost of this trial was $17.5M

Random Assignment

A carefully applied chance process that gives each volunteer an equal probability of getting the vaccine or salt solution. The randomisation turns potential biases into chance error, i.e. the two groups will be similar with respect to factors that might bias the result, even if these factors are unobserved.

Placebo Controls

Children in the placebo group were inoculated with a simple salt solution.

Note: Placebo effect – bias that comes from reassurance of taking an otherwise worthless drug substitute.

Double-blind evaluation

Neither children nor physicians who evaluated their subsequent health status know who had been given the vaccine/salt. Behavior of parents and children wouldn't be affected by knowledge that they received the vaccine. Physician wouldn't be biased when facing borderline case that was difficult to diagnose.

Outcome

- 56 of the children receiving the vaccine contracted polio
- 142 of those who did not receive the vaccine contracted the disease.

It seems like the vaccine works, but could this result have easily happened by chance?

The randomised design lets us answer that question. Consider the ineffective vaccine scenario: The 198 children who contracted polio would have become sick whether or not they received the vaccine and it was only the randomisation that led to 142 of the 198 sick children being assigned to the salt solution. Nothing else was going on.

How likely is this?

- 400,000 children: 198 are sick and 399,802 are healthy.
- 200,000 of the 400,000 children are picked at random to receive the vaccine.

Question 1: What is the chance that as few as 56 or fewer of the sick children are given the vaccine?

Use the Urn model to answer this question.

1a. Provide information about the Urn model:

Marbles:

What values do we write on the marbles?

How many marbles of each value do we have?

Draws:

How many draws do we take from the urn?

Do we replace marble between draws?

Summary:

How do we summarize the values drawn?

1b. Sample 50000 trials from the urn model in R. Show a histogram of the results.

1c. What is the chance that as few as 56 or fewer of the sick children are given the vaccine?

1d. Do you think the vaccine is effective? Motivate your answer.

Question 2 – Calcium and blood pressure

Experiment information

This experiment studies the effect of calcium supplements on blood pressure for male subjects. The subjects are randomised into 2 groups: One received calcium supplements for 12 wks, one received a placebo for 12 wks. It was a double-blind experiment. The response is the reduction in blood pressure: (initial bp − bp after 12 wks).

Consider the ineffective treatment scenario: What if the calcium makes no difference, and it's just by chance that in the random assignment the calcium group got more people who had a lower blood pressure after 12 weeks. Because of the random assignment, we can use an urn model to examine this chance process.

If the calcium supplement has no effect then the all subjects would have the same response whether they received the supplement or not.

Question 2: Use the urn model to determine if the treatment is effective or not.

2a. Provide information about the Urn model:

Marbles:

What values do we write on the marbles?

How many marbles of each value do we have?

Draws:

How many draws do we take from the urn?

Do we replace marble between draws?

Summary:

How do we summarize the values drawn?

2b. Sample 50000 trials from the urn model in R. Show a histogram of the results.

2c. Discuss your method to test whether this treatment is effective or not.

2d. Do you think the calcium treatment is effective? Motivate your answer.