2023Fall Probability & Statistics for EECS 2023/12/08

Final Project Option 3

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This is the Final Project Option 3 entitled “Reverse Engineering the Mechanism of WeChat Red Envelope”. This project can be done by a team with no more than three students. Your team is required to use Python for the programming part. Your team needs to submit all things in Jupyter Notebook format, including Python codes, simulation results, analysis, discussions, tables, figures, *etc.* Always keep the **academic integrity** in mind and remember to give credit to any source that inspires you.

- **Goal:** In this project, let’s subjectively feel and objectively **reverse-engineer** the random allocation mechanism of WeChat Red Envelope, short as WRE mechanism. It is an open exploration based on the sampled data from actual WeChat application. There is no “standard/correct” answer and it is all about **logically** combine observation, modeling, reproduce and justification to clearly draw a **reasonable** conclusion.
- **Hints:** There are recommended steps as follows but you may improvise as long as your contents remain logically clear. Have fun with probabilistic and statistical analysis!

1. **Observation.** You should collect sufficient & representative data using the WeChat application to have a direct observation of how the money in Red Envelope is distributed. Remember to clearly mention your experiment settings. For example,
   - How many scales have you tried while conducting the experiment? 5 RMB in the a group of 3 users or 50 RMB in a group of 10 users.
   - How many trials have you repeated to get the results?
2. **Modeling.** Find a proper method to plot/demonstrate your data such that you can have intuition/insights from it. Accordingly, you should propose your model based on the observed data and make clearly the implicit assumptions in your model. This model should mathematically characterize observational behavior of the WRE mechanism. For a concrete example of modeling,
   - Consider observing a sequences of 10000 trials of coin flips with the same coin, among which there are 4990 heads and 5010 tails.
   - Assuming that each coin flip is independent across trials, I approximately model the coin flip as a Bernoulli distribution with probability 0.5 (you may not expect to have exactly 5000 heads and 5000 tails in practical sampling scenarios).

3. **Reproduce.** Based on your modeling, you should reproduce the WRE mechanism via implementation. The reproduced "MyWRE" should reflect your understanding of the WRE mechanism in the model. Note that you do not need to reproduce the "WeChat" but just the Red Envelope with a random allocation mechanism.

4. **Justification.** Run "MyWRE" and the actual WeChat in parallel for some trials. Compare their behaviors, observe the results, and see if you have the expected results to justify your modeling. Often times, there are unexpected outcomes that your should explain and analyze to revise your current model, which means you should go back to step 1 to have more data and accordingly proceed the following steps again.

- **From Analysis to Decision-Making Policy:** After several rounds of revision (i.e., loops of steps 1 to 4), you should be happy about your current model which can better mirror the behavior of WeChat than the initial model. Now, you should think further about further decision-making question based on your previous analysis:

  When should you start to snatch/grab Red Envelopes? At the very beginning of their appearance or waiting for a right moment. The decision-making policy should depend on the number of people in the Wechat group, and the number of people who have already obtained the red envelopes.

- **Further Explorations:**

  (a) Does the WRE mechanism behave the same inside and outside China?

  (b) Does the WRE mechanism behave the same for a work day and a holiday? Maybe you want to have some tests on the coming Christmas.

  (c) QQ also has a builtin Red Envelope function. Are they exactly the same?

  (d) Can you propose a "user-specific" WRE mechanism such that it is optimized for groups with known backgrounds, e.g., a group of children, a company working group with the boss and employees, and a family group with close or distant relatives? For example, in a group of young children, you may want their received money to be similar in case some unlucky one would get upset upon the new year.

  (e) Can you propose an "fairness-ware" WRE mechanism such that it is optimized for successive Red Envelopes? Consider a group of five users, each of them sends a Red Envelope in their group to celebrate the new year. However, upon the revealing of the third Red Envelope, there is one unlucky user who has got significantly less money than others. How can you dynamically just the WRE mechanism to compensate unlucky users in a group for fairness?