# Advanced Analytics with R

## Simulation

# Simulation Framework

***Step 1. Modelling***

Define a function to model one iteration of the simulation.

***Step 2. Processing***

Run the simulation model for certain number of iterations.

***Step 3. Summarizing***

Summarize the simulation results.

***Step 4. Decision making***

Make your decision based on the simulation result.

# Game of luck

- Each customer pays $10 to participate in the game.
- The number of participants per game is limited to 30.
- All participants are gathered in a room. One by one, they write down their birthdays.
- The customers who share the same birthday with someone else in the room will receive a prize.
- If you are the organizer of the game, what is the maximum price of the prize that you would like to buy in order to earn a profit in long run? (Suppose you want to organize this game for many times)

# Birthday Problem, Version 1

- There are 30 people in a room.
- What is the probability that at least two of them have the same birthday?
- Ignore the possibility of a leap year.

# Step 1. Model one iteration

# Effect of “Rank” – Example of 5

| | | | | | |
|---|---|---|---|---|---|
| **No repeated birthdays** | 312 | 45 | 56 | 300 | 213 |
| ***Rank:*** | 5 | 1 | 2 | 4 | 3 |
| **With repeated birthdays** | 312 | 45 | 300 | 300 | 213 |
| ***Rank:*** | 5 | 1 | 3 | 3 | 2 |

# Step 2. Processing

- Option 1. Run the Step 1 function for many iterations and then calculate the result.

- Option 2. Use While loop to achieve a desirable outcome.

# Step 3. Summarizing

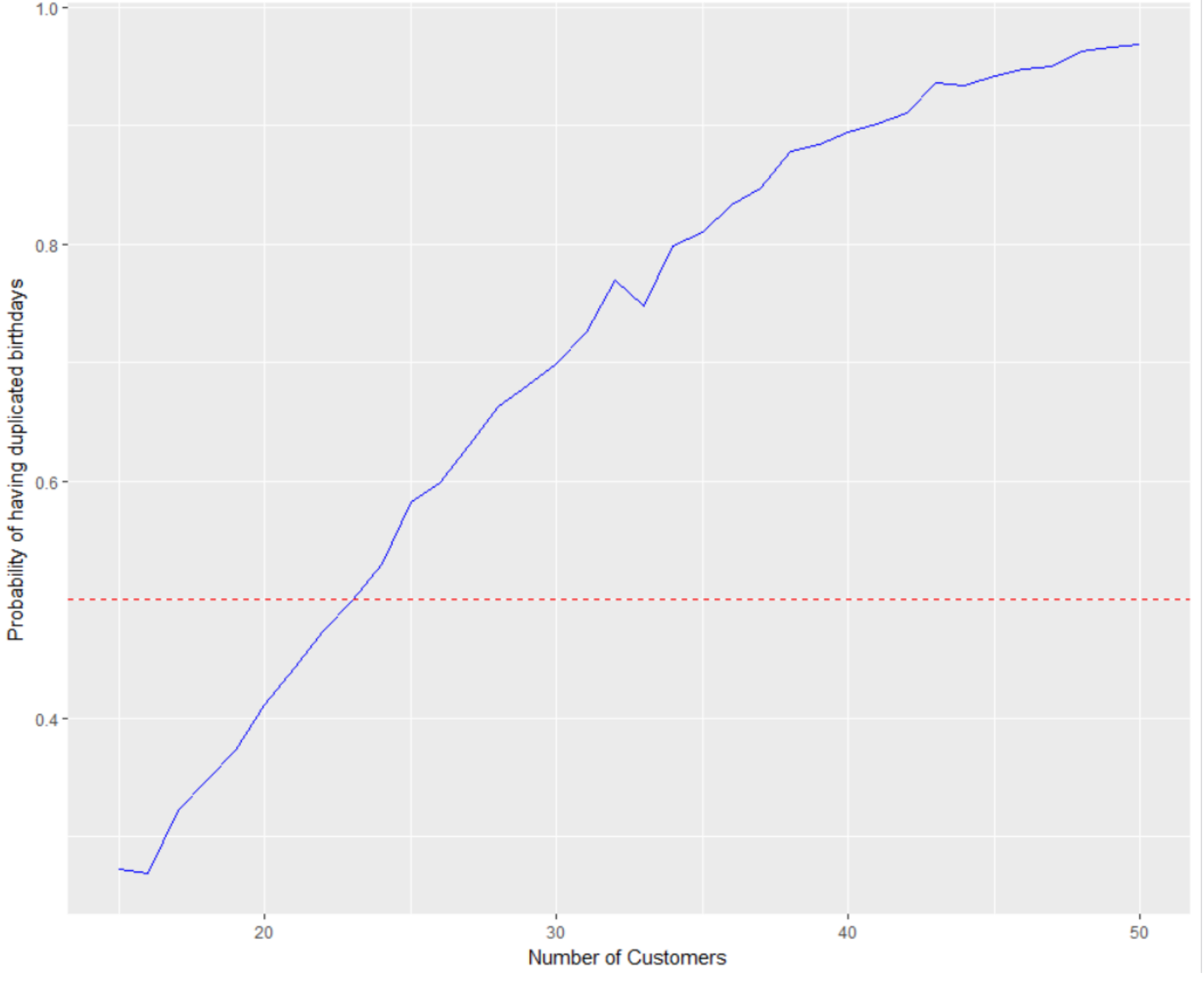
- Get the total number of iterations that contains repeated birthdays and divide it by the total number of iterations. This is the simulated probability.

# Step 4. Decision Making

$$300 - 0.706 \times x \times 2 > 0$$

# Birthday Problem, Version 2

- What is the minimum number of people needed to make the probability of at least two of them having the same birthday to be at least 50%?
- How does the probability change when the number of customers changes?

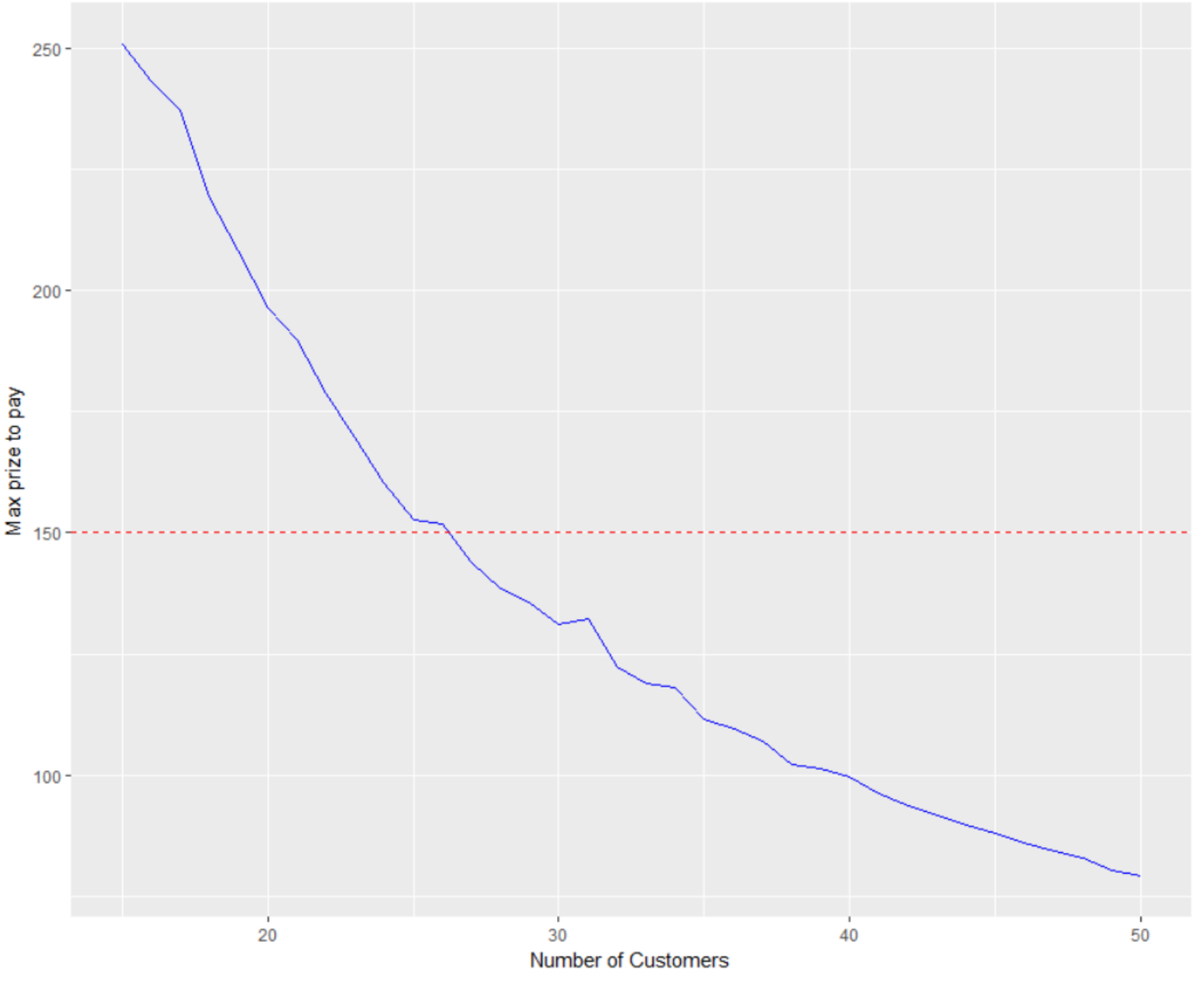

1.0
0.8
0.6
0.4
Probability of having duplicated birthdays
20
30
40
50
Number of Customers

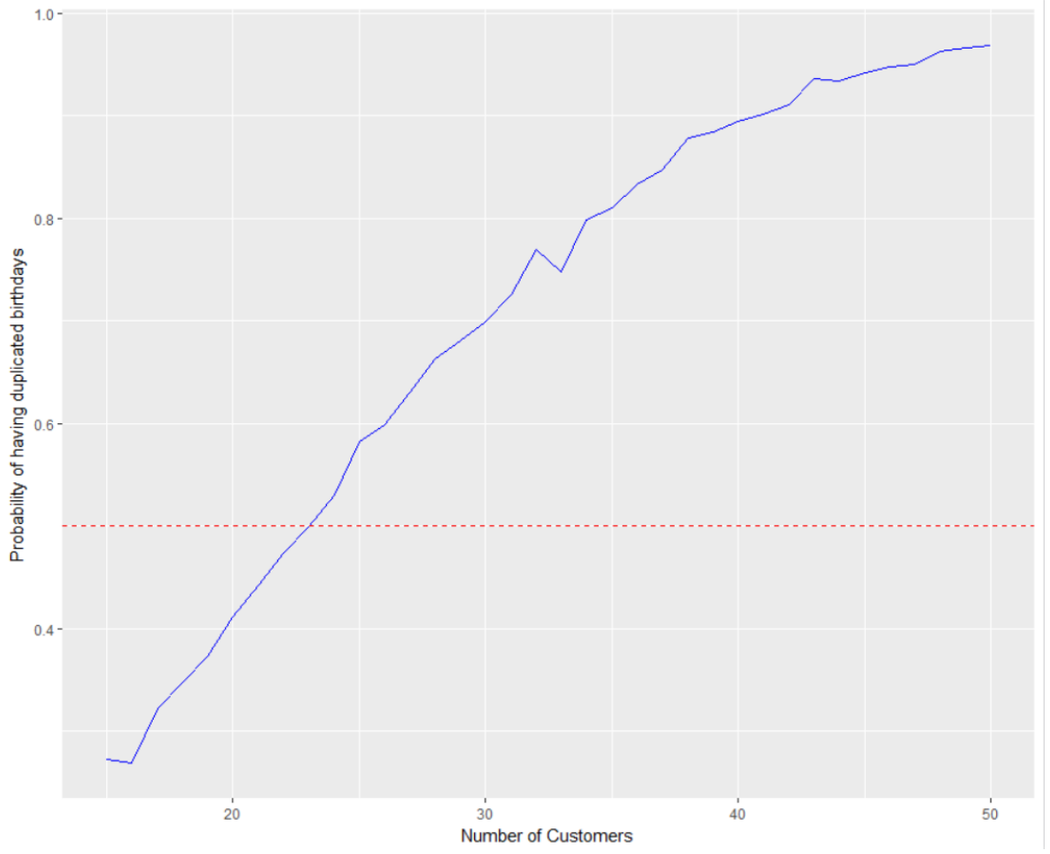
# Birthday Problem, Version 3

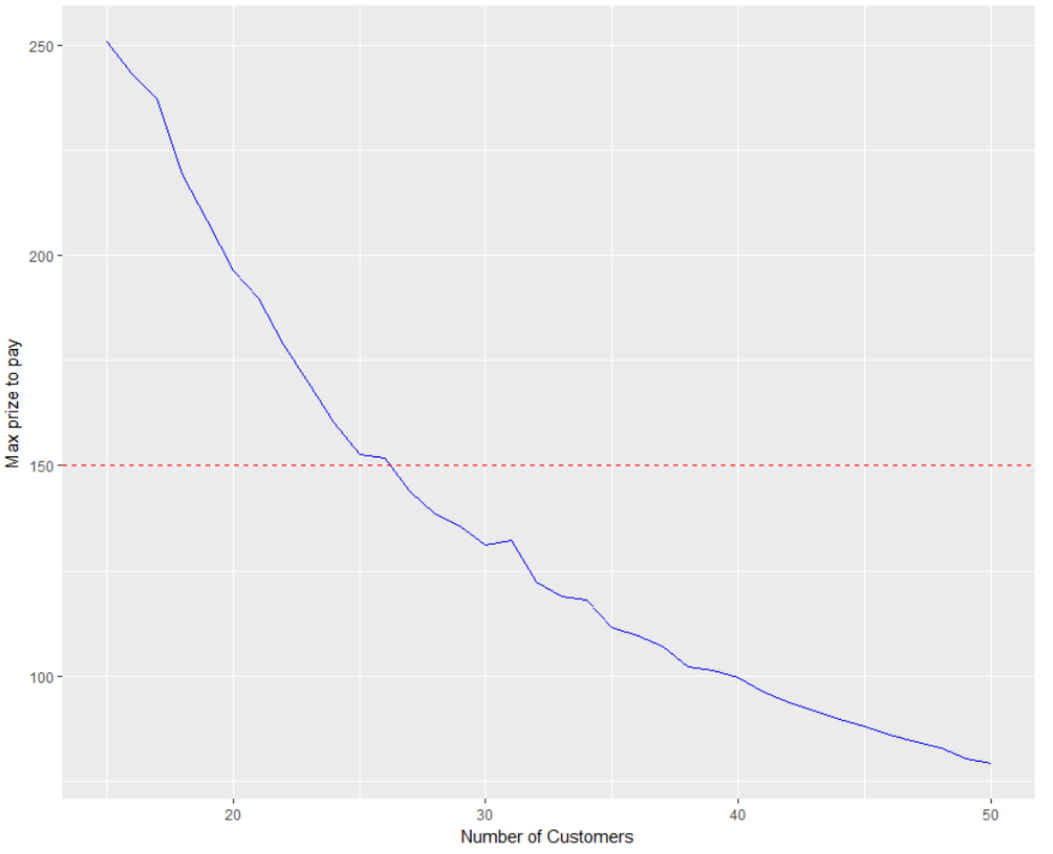
- What is the maximum price that you would like to pay for each prize, if you want to make profit from this game? (Assuming 30 customers per game)

# Birthday Problem, Version 4

- The prize must be attractive for participants. According to a survey, if a customer pay $10 to participate, then he/she would expect a prize of at least $150 dollars. Based on this finding, what is the ideal number of customers per game?


250
200
150
100
Max prize to pay
20
30
40
50
Number of Customers


1.0
0.8
0.6
0.4
Probability of having duplicated birthdays
20
30
40
50
Number of Customers


250
200
150
100
Max prize to pay
20
30
40
50
Number of Customers

# Birthday Problem, Version 5

- If we don’t ignore the possibility of leap year, how will it affect the decision?