

First Book Using DD

Your Name

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Chapter 1

Hands-on exercise: the birthday problem!

As an illustration let's write a report using the participants in this workshop to illustrate the famous birthday problem.

What is the probability that at least two people in this room share the same birthday?

There are 21 in this room.

Is it something like $\frac{21}{365} = 0.058$?

Chapter 2

The birthday problem: the math

Actually the math says otherwise. Define $p(n)$ as the probability that at least one pair has the same birthday, then the $1 - p(n)$ is the probability that all are born in a different day. Which we can compute as:

$$1 - p(n) = 1 \times \left(1 - \frac{1}{365}\right) \times \left(1 - \frac{2}{365}\right) \times \cdots \times \left(1 - \frac{n-1}{365}\right) = \frac{365 \times 364 \times \cdots \times (365 - n + 1)}{365^n} = \frac{365!}{365^n (365 - n)!} =$$

2.1 Code for the math

(/dynamicdocs/first_dd_solution.Rmd)

Copy and paste lines below into your first_dd.Rmd

```
\begin{align}
1 - p(n) &= 1 \times \left(1 - \frac{1}{365}\right) \times \left(1 - \frac{2}{365}\right) \times \cdots \times \left(1 - \frac{n-1}{365}\right) \nonumber \\
&= \frac{365 \times 364 \times \cdots \times (365 - n + 1)}{365^n} \nonumber \\
&= \frac{365!}{365^n (365 - n)!} = \frac{n! \cdot \binom{365}{n}}{365^n} \nonumber \\
p(n = `r n.pers`) &= `r round(1 - factorial(n.pers) * \nonumber \\
&\quad \text{choose}(365, n.pers) / 365^{n.pers}, 3)` \nonumber \\
\end{align}
```


Chapter 3

Don't like math? Let's run a simple simulation!

- 1 - Simulate 10^4 rooms with $n = 21$ random birthdays, and store the results in matrix where each row represents a room.
- 2 - For each room (row) compute the number of unique birthdays.
- 3 - Compute the average number of times a room has 21 unique birthdays, across 10^4 simulations, and report the complement.

3.1 Code for the simulation

```
(/dynamicdocs/first_dd_solution.Rmd)

birthday.prob = function(n.pers_var, n.sims_var) {
  # simulate birthdays
  birthdays = matrix(round(runif(n = n.pers_var * n.sims_var, min = 1, max = 365) ),
                      nrow = n.sims_var, ncol = n.pers_var)
  # for each room (row) get unique birthdays
  unique.birthdays = apply(birthdays, 1,
                           function(x) length( unique(x) ) )
  # Indicator with 1 if all are unique birthdays
  all.different = 1 * (unique.birthdays==n.pers_var)
  # Compute average time all have different birthdays
  result = 1 - mean(all.different)
  return(result)
}

bp_sim = birthday.prob(n.pers_var = 21, n.sims_var = 10000)
```

```
print(bp_sim)
```

```
## [1] 0.4531
```

Chapter 4

Results

- Many people originally think of a prob $\sim \frac{1}{365} \times n = 0.058$
- However the true probability is of $p(n = 21) = 0.444$
- And the simulated probability is of 0.4531]