Intro to anonymization (I)

DATA PRIVACY AND ANONYMIZATION IN R

Claire McKay Bowen

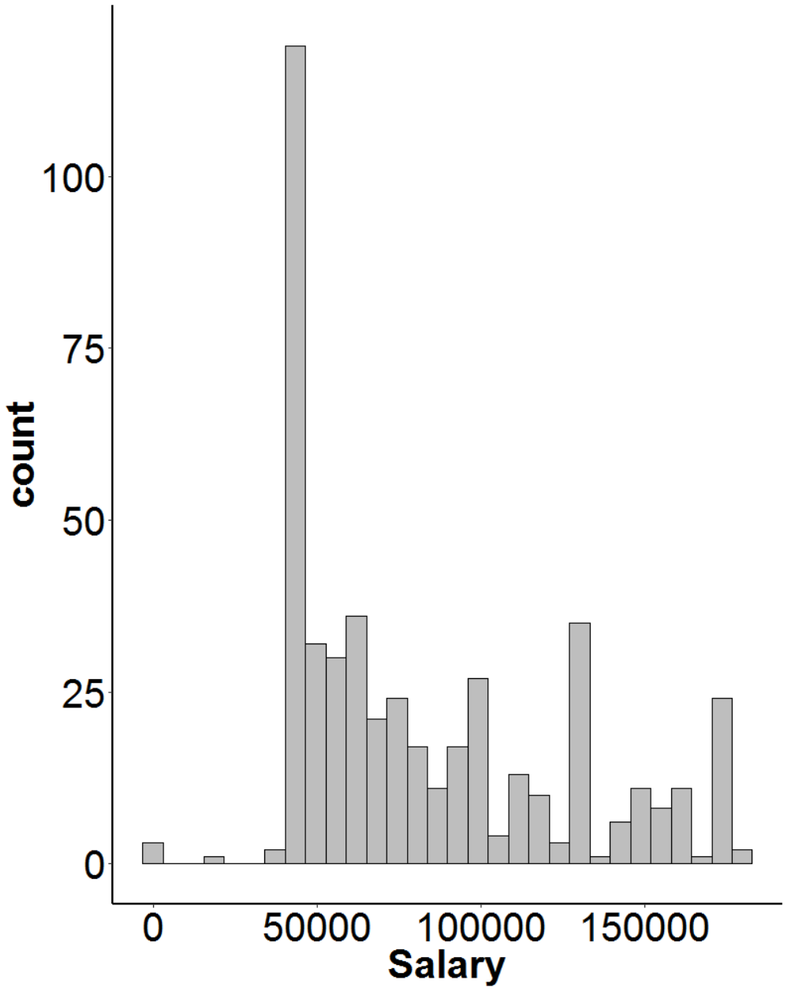
Postdoctoral Researcher, Los Alamos National Laboratory

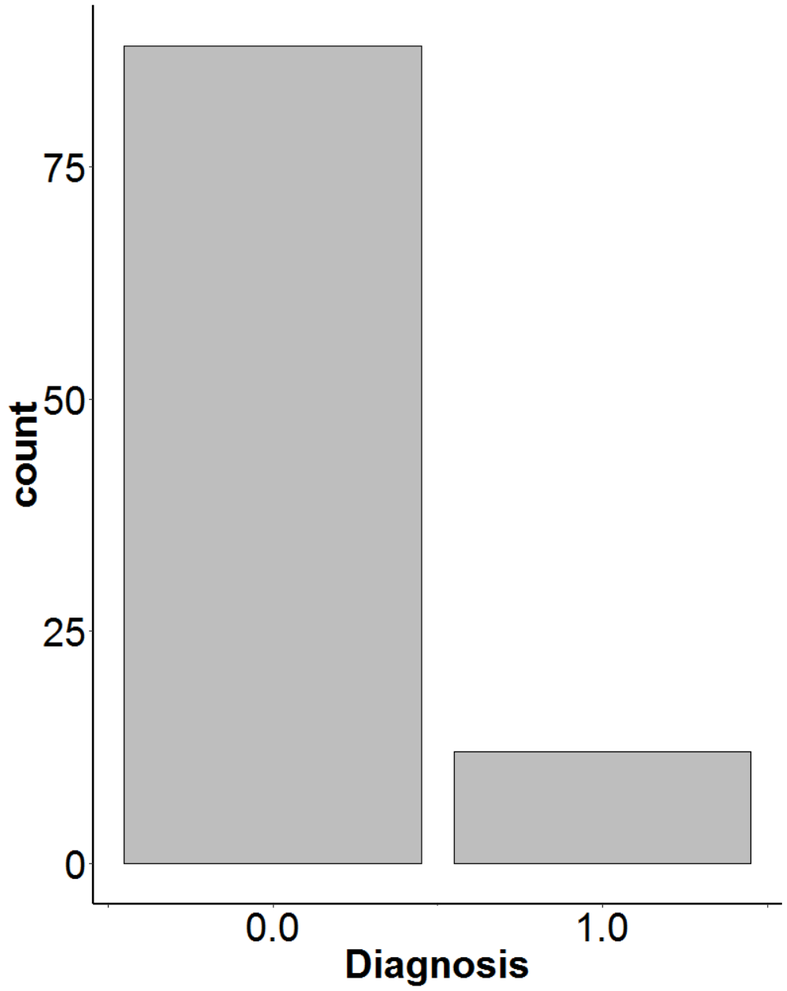

MEDICAL
MEDICAL
MEDICAL
MEDICAL
MEDICAL
Health Care
Doctor
Hospital
Pharmacist
Nurse
Dentist
First Aid
Surgeon
Emergency

Course outline

- **Chapter 1:** removing identifiers and generating synthetic data
- **Chapter 2:** differential privacy and Laplace mechanism
- **Chapter 3:** differentially private properties
- **Chapter 4:** differentially private data synthesis

White House salary and fertility data sets





The White House salary data

```
library(dplyr)
whitehouse
```

```
# A tibble: 469 x 5
                  Name   Status Salary     Basis
                 <chr>    <chr>  <dbl>     <chr>
 1      Abrams, Adam W. Employee  66300 Per Annum
 2        Adams, Ian H. Employee  45000 Per Annum
 3      Agnew, David P. Employee  93840 Per Annum
 4        Albino, James Employee  91800 Per Annum
 5 Aldy, Jr., Joseph E. Employee 130500 Per Annum
 6     Alley, Hilary J. Employee  42000 Per Annum
 7 Amorsingh, Lucius L. Employee  56092 Per Annum
 8  Anderson, Amanda D. Employee  60000 Per Annum
# ... with 461 more rows, and 1 more variables: Title <chr>
```

Removing identifiers and rounding

Removing Identifiers

```
whitehouse %>%
    mutate(Name = 1:469)
```

Rounding

```
whitehouse %>%
    mutate(Salary = round(Salary, digits = -3))
```

Let's practice!

DATA PRIVACY AND ANONYMIZATION IN R

Intro to anonymization (II)

DATA PRIVACY AND ANONYMIZATION IN R

Claire McKay Bowen

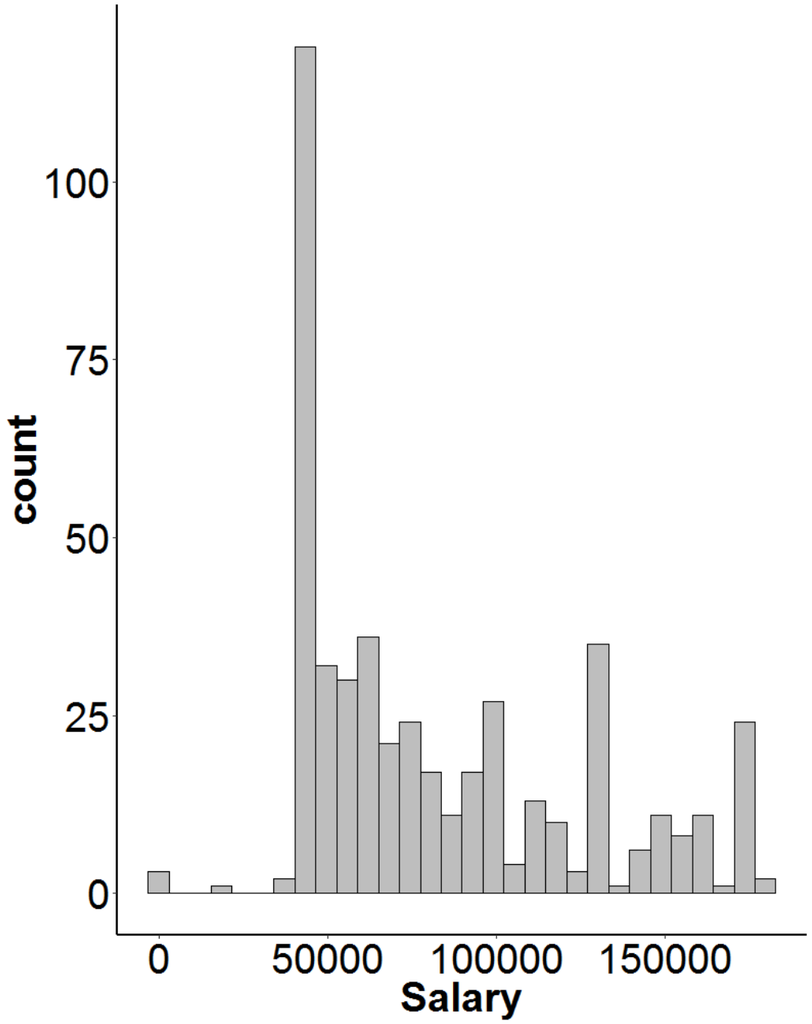
Postdoctoral Researcher, Los Alamos National Laboratory

The White House salary data

```
whitehouse
```

```
# A tibble: 469 x 5
                   Name   Status Salary     Basis
                  <chr>    <chr>  <dbl>     <chr>
 1      Abrams, Adam W. Employee  66300 Per Annum
 2        Adams, Ian H. Employee  45000 Per Annum
 3      Agnew, David P. Employee  93840 Per Annum
 4        Albino, James Employee  91800 Per Annum
 5 Aldy, Jr., Joseph E. Employee 130500 Per Annum
 6     Alley, Hilary J. Employee  42000 Per Annum
 7 Amorsingh, Lucius L. Employee  56092 Per Annum
 8  Anderson, Amanda D. Employee  60000 Per Annum
# ... with 461 more rows, and 1 more variables: Title <chr>
```

Histogram of salaries



Generalization

```
whitehouse.gen <- whitehouse %>%
    mutate(Salary = ifelse(Salary < 100000, 0, 1))
whitehouse.gen
```

```
# A tibble: 469 x 5
                  Name   Status Salary     Basis
                 <chr>    <chr>  <dbl>     <chr>
 1      Abrams, Adam W. Employee      0 Per Annum
 2        Adams, Ian H. Employee      0 Per Annum
 3      Agnew, David P. Employee      0 Per Annum
 4        Albino, James Employee      0 Per Annum
 5 Aldy, Jr., Joseph E. Employee      1 Per Annum
 6     Alley, Hilary J. Employee      0 Per Annum
 7 Amorsingh, Lucius L. Employee      0 Per Annum
 8  Anderson, Amanda D. Employee      0 Per Annum
# ... with 461 more rows, and 1 more variables: Title <chr>
```

Top coding

```
whitehouse.top <- whitehouse %>%
    mutate(Salary = ifelse(Salary >= 165000, 165000, Salary))
whitehouse.top %>%
    filter(Salary >= 165000)
```

```
# A tibble: 27 x 5
                  Name   Status Salary     Basis
                 <chr>    <chr>  <dbl>     <chr>
 1    Axelrod, David M. Employee 165000 Per Annum
 2    Barnes, Melody C. Employee 165000 Per Annum
 3     Bauer, Robert F. Employee 165000 Per Annum
 4     Brennan, John O. Employee 165000 Per Annum
 5  Brown, Elizabeth M. Employee 165000 Per Annum
 6    Browner, Carol M. Employee 165000 Per Annum
 7    Cutter, Stephanie Employee 165000 Per Annum
# ... with 20 more rows, and 1 more variables: Title <chr>
```

Quick intro to ...

- `count()`
- `summarize_at()`

count()

```
whitehouse %>%
    count(Status)
```

```
# A tibble: 3 x 2
  Status                     n
  <chr>                  <int>
1 Detailee                  31
2 Employee                 437
3 Employee (part-time)       1
```

```
whitehouse %>%
    count(Status, Title, sort = TRUE)
```

```
# A tibble: 279 x 3
   Status   Title                                                  n
   <chr>    <chr>                                              <int>
 1 Employee STAFF ASSISTANT                                       23
 2 Employee RECORDS MANAGEMENT ANALYST                            15
 3 Employee ANALYST                                               10
 4 Employee SPECIAL ASSISTANT TO THE PRESIDENT AND ASSO…          10
 5 Employee SPECIAL ASSISTANT TO THE PRESIDENT FOR LEGI…          10
 6 Employee ASSOCIATE DIRECTOR                                     9
 7 Employee SENIOR ANALYST                                         8
 8 Employee ASSISTANT DIRECTOR                                     7
 9 Employee SPECIAL ASSISTANT                                      7
10 Employee ASSISTANT SHIFT LEADER                                 6
# ... with 269 more rows
```

summarize_at()

```
whitehouse %>%
    summarize_at(vars(Salary), sum)
```

```
# A tibble: 1 x 1
    Salary
     <dbl>
1 38796307
```

summarize_at()

```
whitehouse %>%
  summarize_at(vars(Salary), funs(mean, sd))
```

```
# A tibble: 1 x 2
      mean        sd
     <dbl>     <dbl>
1 82721.34 41589.43
```

Let's practice!

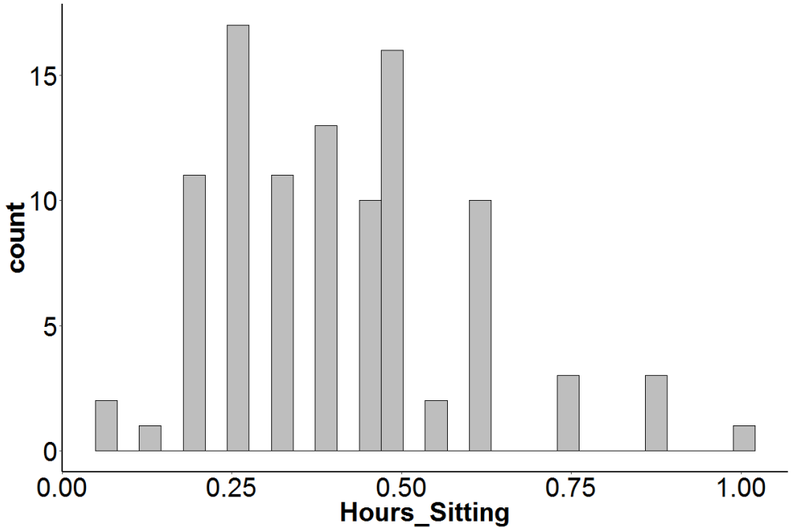
DATA PRIVACY AND ANONYMIZATION IN R

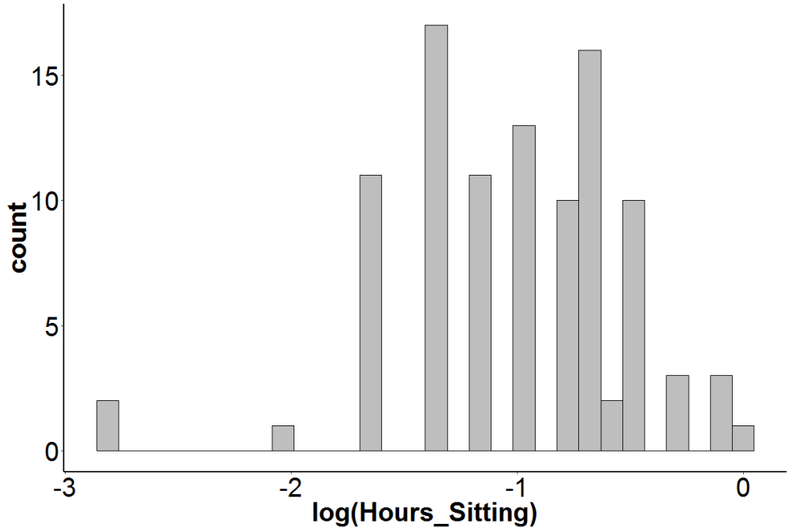
Data synthesis

DATA PRIVACY AND ANONYMIZATION IN R

Claire McKay Bowen
Postdoctoral Researcher, Los Alamos National Laboratory

Probability distributions





Male fertility data

```
library(dplyr)
fertility
```

```
# A tibble: 100 x 10
   Season   Age Child_Disease Accident_Trauma Surgical_Intervention
    <dbl> <dbl>         <int>            <int>                 <int>
 1  -0.33  0.69             0                1                     1
 2  -0.33  0.94             1                0                     1
 3  -0.33  0.50             1                0                     0
 4  -0.33  0.75             0                1                     1
 5  -0.33  0.67             1                1                     0
 6  -0.33  0.67             1                0                     1
 7  -0.33  0.67             0                0                     0
 8  -0.33  1.00             1                1                     1
# ... with 92 more rows, and 5 more variables: High_Fevers <int>,
#   Alcohol_Freq <dbl>, Smoking <int>, Hours_Sitting <dbl>, Diagnosis <int>
```

Generating synthetic data part 1

Sampling from a Binomial Distribution

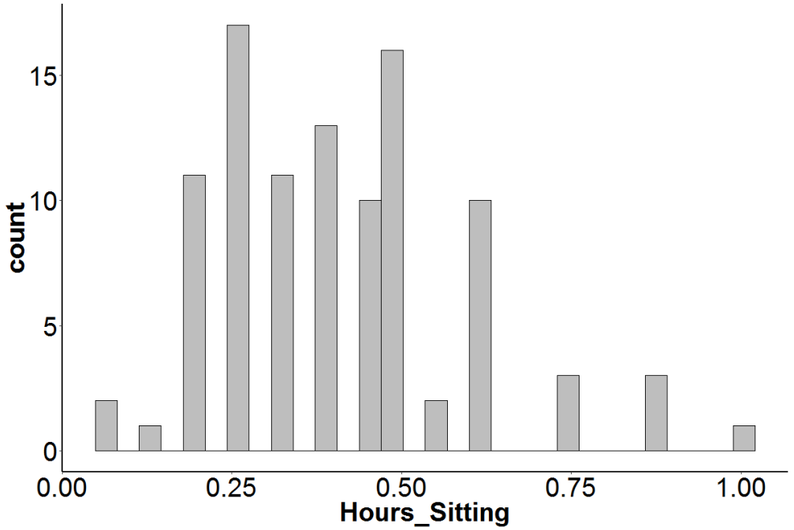
```
fertility %>% summarize_at(vars(Child_Disease), mean)
```

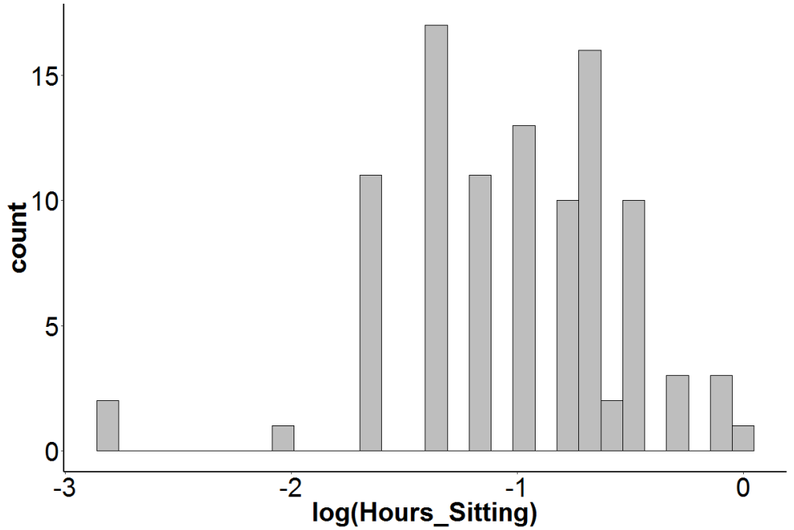
```
# A tibble: 1 x 1
  Child_Disease
          <dbl>
1          0.87
```

```
set.seed(42)
child.disease <- rbinom(100, 1, 0.87)
sum(child.disease)
```

```
83
```

Examining the data





Generating synthetic data part 2

Sampling from a Normal Distribution

```
fert <- fertility %>%
    mutate(Hours_Sitting = log(Hours_Sitting))
fert %>%
    summarize_at(vars(Hours_Sitting), funs(mean, sd))
```

```
# A tibble: 1 x 2
    mean        sd
   <dbl>     <dbl>
1 -1.012244 0.5047788
```

```
set.seed(42)
hours.sit <- rnorm(100, -1.01, 0.50)
hours.sit <- exp(hours.sit)
```

How to handle improper values

Hard Bounding

```
hours.sit[hours.sit < 0] <- 0
hours.sit[hours.sit > 1] <- 1
range(hours.sit)
```

```
0.0815495 1.0000000
```

Let's practice!

DATA PRIVACY AND ANONYMIZATION IN R