Sequential composition

DATA PRIVACY AND ANONYMIZATION IN R

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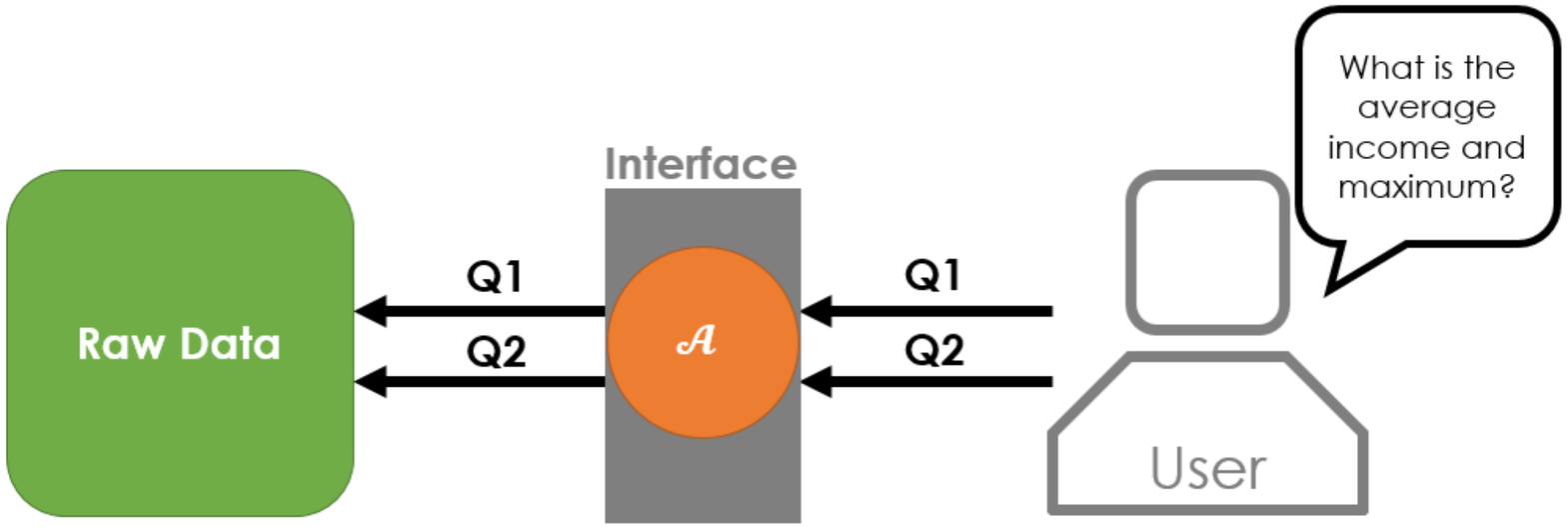
datacamp

Sequential composition



- The privacy budget must be divided by two.

Male fertility data: correction on hours sitting

```
# Mean and Variance of Hours Sitting
fertility %>%
    summarize_at(vars(Hours_Sitting), funs(mean, var))

# Apply the Laplace mechanism
set.seed(42)
rdoublex(1, 0.41, gs.mean / 0.1)
rdoublex(1, 0.19, gs.var / 0.1)
```

Male fertility data: applying Laplace mechanism

```
# Set Value of Epsilon
eps <- 0.1 / 2
# GS of Mean and Variance
gs.mean <- 0.01
gs.var <- 0.01
# Apply the Laplace mechanism
set.seed(42)
rdoublex(1, 0.41, gs.mean / eps)
```

```
0.4496674
```

```
rdoublex(1, 0.19, gs.var / eps)
```

```
0.2466982
```

For Hours Sitting in the Feritlity

Data:

- GS Mean = 0.01
- GS Variance = 0.01
- Mean = 0.41
- Variance = 0.19

Let's practice!

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Parallel composition

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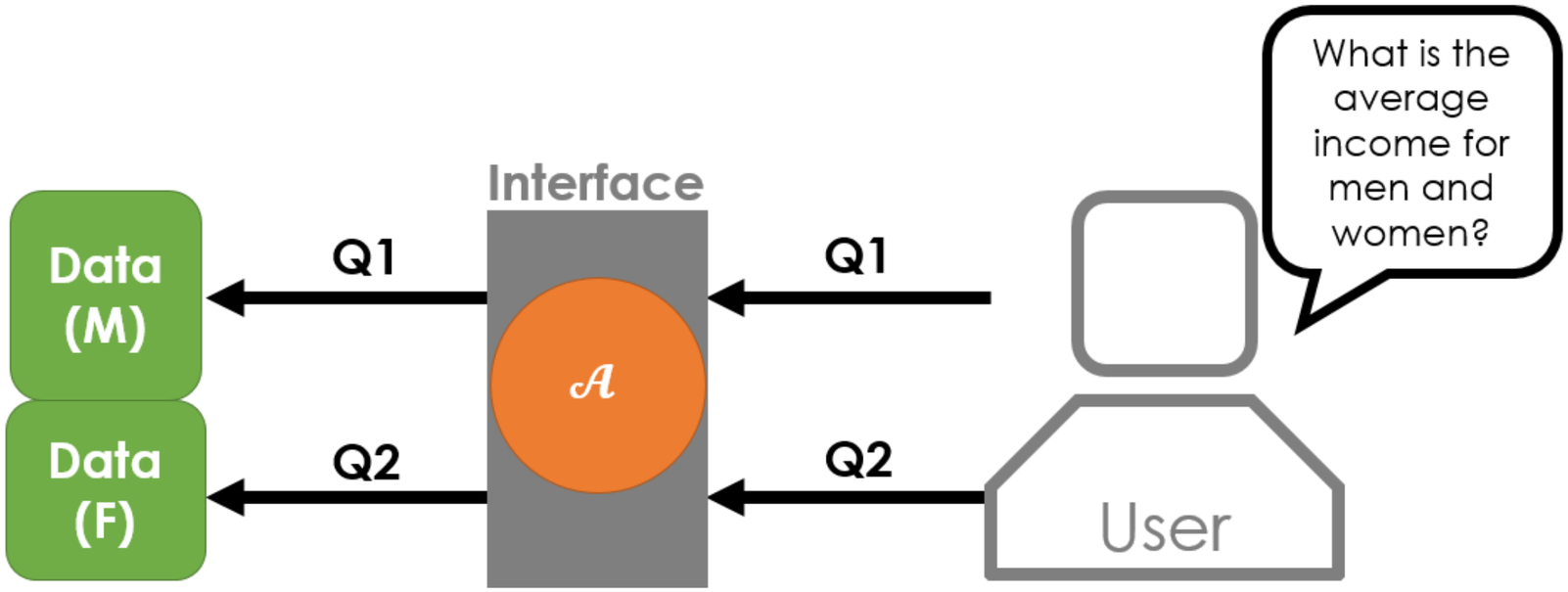
Parallel composition



- The privacy budget does not need to be divided.
- The query with the most epsilon is the budget for the data.

```
# High_Fevers and Mean of Hours_Sitting
fertility %>%
    filter(High_Fevers >= 0) %>%
    summarize_at(vars(Hours_Sitting), mean)
```

```
# A tibble: 1 x 1
  Hours_Sitting
          <dbl>
1     0.3932967
```

```
# No High_Fevers and Mean of Hours_Sitting
fertility %>%
    filter(High_Fevers == -1) %>%
    summarize_at(vars(Hours_Sitting), mean)
```

```
# A tibble: 1 x 1
  Hours_Sitting
          <dbl>
1     0.5433333
```

Male fertility data: applying Laplace mechanism

```
# Set Value of Epsilon
eps <- 0.1
# GS of mean for Hours_Sitting
gs.mean <- 1 / 100
# Apply the Laplace mechanism
set.seed(42)
rdoublex(1, 0.39, gs.mean / eps)
```

```
0.4098337
```

```
rdoublex(1, 0.54, gs.mean / eps)
```

```
0.5683491
```

Let's practice!

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Post-processing

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Male fertility data: prepping data

```
fertility %>%
    count(Smoking)
```

```
# A tibble: 3 x 2
  Smoking Count
    <int> <int>
1      -1    56
2       0    23
3       1    21
```

```
# Set Value of Epsilon
eps <- 0.1
# GS of Counts
gs.count <- 1
```

Male fertility data: apply the Laplace mechanism

```
# Apply the Laplace mechanism
set.seed(42)
smoking1 <- rdoublex(1, 56, gs.count / eps / 2) %>% round()
smoking2 <- rdoublex(1, 23, gs.count / eps / 2) %>% round()
# Post-process based on previous queries
smoking3 <- nrow(fertility) - smoking1 - smoking2
# Checking the noisy answers
smoking1
smoking2
smoking3
```

```
60
29
11
```

Let's practice!

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Impossible and inconsistent answers

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Negative counts: prepping data

```
# Set Value of Epsilon
eps <- 0.01
# GS of counts
gs.count <- 1
# Number of Participants with Abnormal Diagnosis
fertility %>%
    summarize_at(vars(Diagnosis), sum)
```

```
# A tibble: 1 x 1
  Diagnosis
      <int>
1        12
```

Negative counts: apply the Laplace mechanism

```
# Apply the Laplace mechanism and set.seed(22)
set.seed(22)
rdoublex(1, 12, gs.count / eps) %>% round()
# Apply the Laplace mechanism and set.seed(22)
set.seed(22)
rdoublex(1, 12, gs.count / eps) %>% round() %>% max(0)
```

```
-79
```

```
0
```

```
# Suppose we set a different seed
set.seed(12)
noisy_answer <- rdoublex(1, 12, gs.count / eps) %>%
   round() %>% max(0)
n <- nrow(fertility)
# ifelse example
ifelse(noisy_answer > n, n, noisy_answer)
```

```
100
```

Normalizing noise: prepping data

```
# Set Value of Epsilon
eps <- 0.01
# GS of Counts
gs.count <- 1
fertility %>%
  count(Smoking)
```

```
# A tibble: 3 x 2
  Smoking Count
    <int> <int>
1      -1    56
2       0    23
3       1    21
```

Normalizing noise: apply the Laplace mechanism

```
# Apply the Laplace mechanism and set.seed(42)
set.seed(42)
smoking1 <- rdoublex(1, 56, gs.count / eps / 2) %>%
    max(0)
smoking2 <- rdoublex(1, 23, gs.count / eps / 2) %>%
    max(0)
smoking3 <- rdoublex(1, 21, gs.count / eps / 2) %>%
    max(0)
# Checking the noisy answers
smoking <- c(smoking1, smoking2, smoking3)
smoking
```

```
65.91684 37.17455  0.00000
```

Normalizing noise: constraining results

```
# Normalize smoking
normalized <- (smoking/sum(smoking)) * (nrow(fertility))
# Round the values
round(normalized)
```

```
64 36  0
```

Let's practice!

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