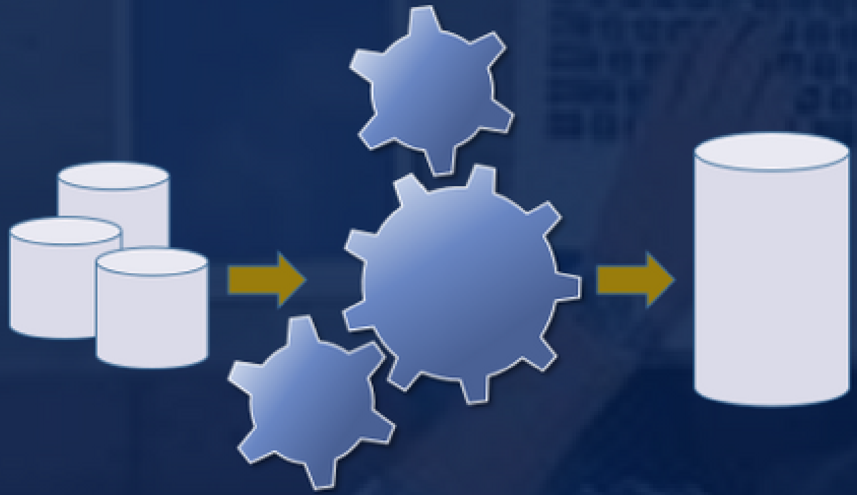
Rsquared Academy



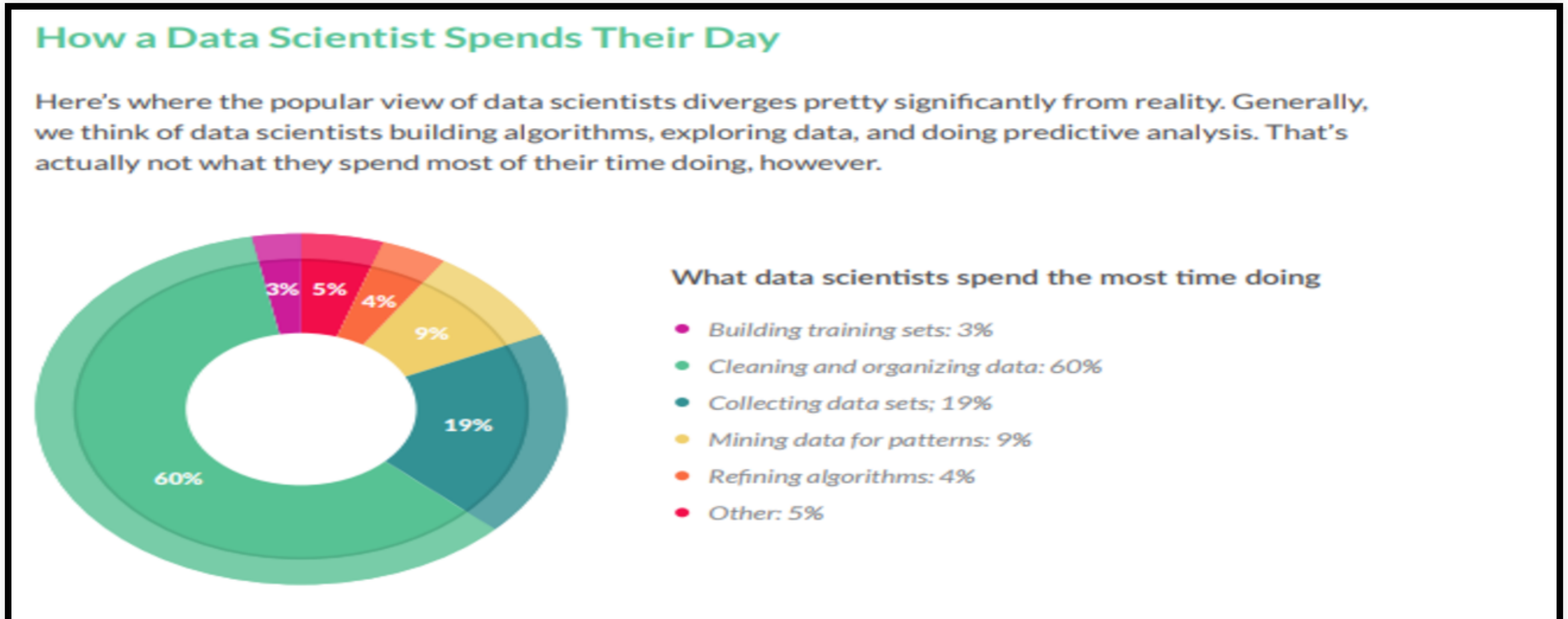
Data Wrangling with dplyr

Agenda

- filter data
- select variables/columns
- arrange data
- generate new variables
- create grouped summaries

Introduction

According to a survey by CrowdFlower, data scientists spend most of their time cleaning and manipulating data rather than mining or modeling them for insights. As such, it becomes important to have tools that make data manipulation faster and easier. In today's post, we introduce you to dplyr, a grammar of data manipulation.



How a Data Scientist Spends Their Day

Here's where the popular view of data scientists diverges pretty significantly from reality. Generally, we think of data scientists building algorithms, exploring data, and doing predictive analysis. That's actually not what they spend most of their time doing, however.

3%
5%
4%
9%
19%
60%
What data scientists spend the most time doing
● Building training sets: 3%
● Cleaning and organizing data: 60%
● Collecting data sets; 19%
● Mining data for patterns: 9%
● Refining algorithms: 4%
● Other: 5%

Libraries

```r
library(dplyr)
library(readr)
```

dplyr Verbs

dplyr provides a set of verbs that help us solve the most common data manipulation challenges while working with tabular data (dataframes, tibbles):

- `select`: returns subset of columns
- `filter`: returns a subset of rows
- `arrange`: re-order or arrange rows according to single/multiple variables
- `mutate`: create new columns from existing columns
- `summarise`: reduce data to a single summary

Case Study

We will explore dummy data that resembles web logs of an ecommerce company. You can download the data from here or import it directly using `read_csv()` from the readr package. We will use dplyr to answer a few questions we have about the above data:

- what is the average order value by device types?
- what is the average number of pages visited by purchasers and non-purchasers?
- what is the average time on site for purchasers vs non-purchasers?
- what is the average number of pages visited by purchasers and non-purchasers using mobile?

Data

```
ecom <- read_csv('data/web.csv')
```

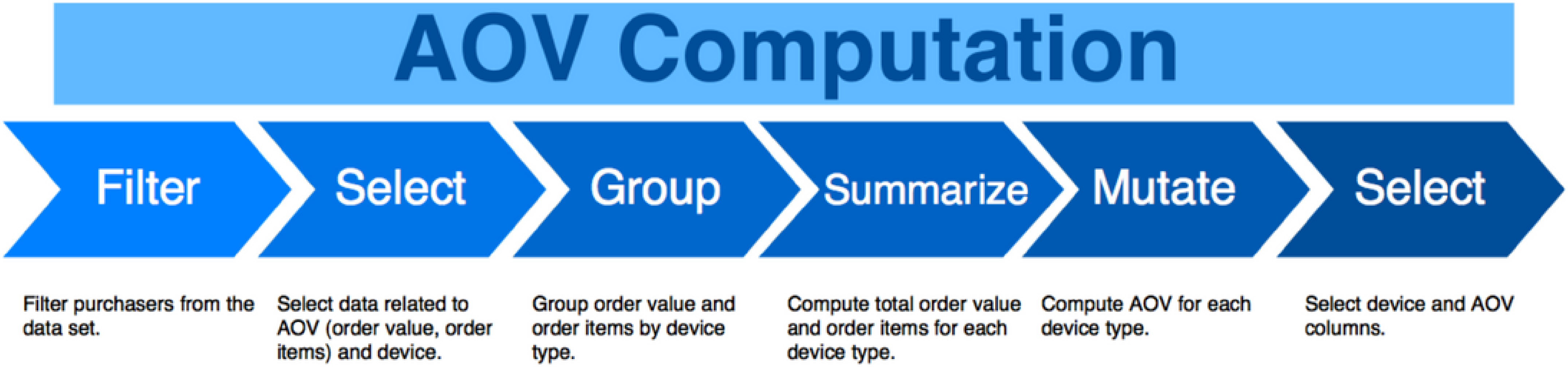
```
## # A tibble: 1,000 x 11
##       id referrer device bouncers n_visit n_pages duration country
##    <int> <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>
##  1     1 google   laptop true          10    1.00      693 Czech Repu
##  2     2 yahoo    tablet true           9    1.00      459 Yemen
##  3     3 direct   laptop true           0    1.00      996 Brazil
##  4     4 bing     tablet false          3   18.0       468 China
##  5     5 yahoo    mobile true           9    1.00      955 Poland
##  6     6 yahoo    laptop false          5    5.00      135 South Afri
##  7     7 yahoo    mobile true          10    1.00       75.0 Bangladesh
##  8     8 direct   mobile true          10    1.00      908 Indonesia
##  9     9 bing     mobile false          3   19.0       209 Netherland
## 10    10 google   mobile true           6    1.00      208 Czech Repu
## # ... with 990 more rows, and 3 more variables: purchase <chr>,
## #   order_items <dbl>, order_value <dbl>
```

Data Dictionary

Below is the description of the data set:

- id: row id
- referrer: referrer website/search engine
- os: operating system
- browser: browser
- device: device used to visit the website
- n_pages: number of pages visited
- duration: time spent on the website (in seconds)
- repeat: frequency of visits
- country: country of origin
- purchase: whether visitor purchased
- order_value: order value of visitor (in dollars)

AOV Computation



AOV Computation

Filter – Filter purchasers from the data set.

Select – Select data related to AOV (order value, order items) and device.

Group – Group order value and order items by device type.

Summarize – Compute total order value and order items for each device type.

Mutate – Compute AOV for each device type.

Select – Select device and AOV columns.

AOV by Devices

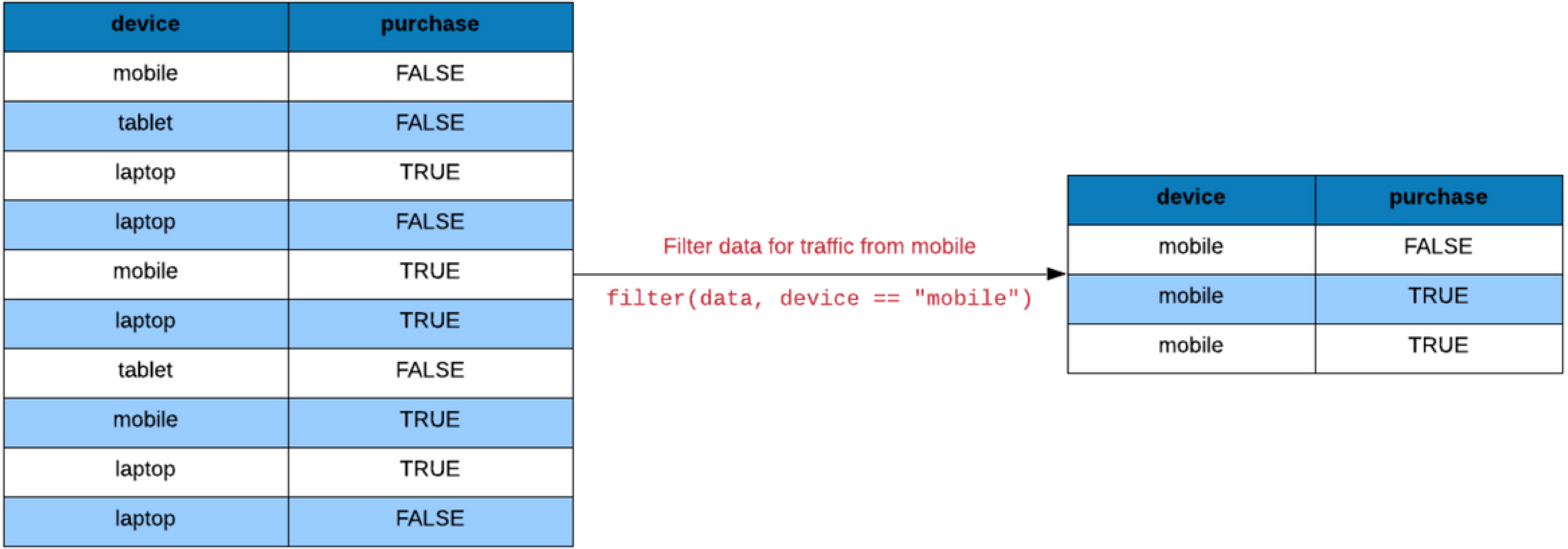
```r
ecom %>%
  filter(purchase == 'true') %>%
  select(device, order_value, order_items) %>%
  group_by(device) %>%
  summarise_all(funs(sum)) %>%
  mutate(
    aov = order_value / order_items
  ) %>%
  select(device, aov)
```

```
## # A tibble: 3 x 2
##   device   aov
##   <chr>  <dbl>
## 1 laptop   353
## 2 mobile   280
## 3 tablet   261
```

Step 1: Filter Purchasers

In order to compute the AOV, we must first separate the purchasers from non-purchasers. We will do this by filtering the data related to purchasers using the `filter()` function. It allows us to filter rows that meet a specific criteria/condition. The first argument is the name of the data frame and the rest of the arguments are expressions for filtering the data. Let us look at a few examples:

Filter



device	purchase
mobile	FALSE
tablet	FALSE
laptop	TRUE
laptop	FALSE
mobile	TRUE
laptop	TRUE
tablet	FALSE
mobile	TRUE
laptop	TRUE
laptop	FALSE

Filter data for traffic from mobile

```
filter(data, device == "mobile")
```

device	purchase
mobile	FALSE
mobile	TRUE
mobile	TRUE

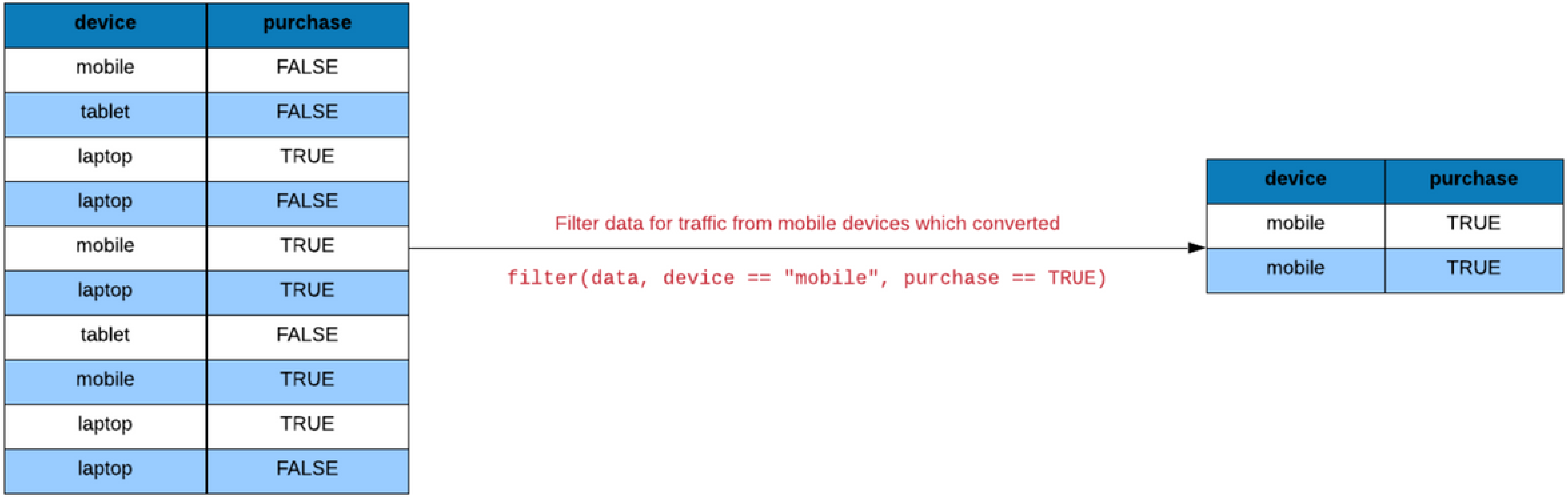
Filter all visits from mobile

```r
filter(ecom, device == "mobile")
```

```
## # A tibble: 344 x 11
##       id referrer device bouncers n_visit n_pages duration country
##    <int> <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>
##  1     5 yahoo    mobile true           9    1.00    955   Poland
##  2     7 yahoo    mobile true          10    1.00     75.0 Bangladesh
##  3     8 direct   mobile true          10    1.00    908   Indonesia
##  4     9 bing     mobile false          3   19.0     209   Netherlanc
##  5    10 google   mobile true           6    1.00    208   Czech Repu

##  6    13 direct   mobile false          9   14.0     406   Ireland
##  7    15 yahoo    mobile false          7    1.00     19.0 France
##  8    22 google   mobile true           5    1.00    147   Brazil
##  9    23 bing     mobile false          0    7.00    196   Russia
## 10    29 google   mobile true          10    1.00    338   Russia
## # ... with 334 more rows, and 3 more variables: purchase <chr>,
## #   order_items <dbl>, order_value <dbl>
```

Filter



device	purchase
mobile	FALSE
tablet	FALSE
laptop	TRUE
laptop	FALSE
mobile	TRUE
laptop	TRUE
tablet	FALSE
mobile	TRUE
laptop	TRUE
laptop	FALSE

Filter data for traffic from mobile devices which converted

```
filter(data, device == "mobile", purchase == TRUE)
```

device	purchase
mobile	TRUE
mobile	TRUE

Visits from mobile that converted

```
filter(ecom, device == "mobile", purchase == "true")
```

```
## # A tibble: 36 x 11
##       id referrer device bouncers n_visit n_pages duration country
##    <int> <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>
##  1    13 direct   mobile false          9    14.0      406 Ireland
##  2    41 bing     mobile false          4    20.0      440 Czech Repu
##  3    98 bing     mobile false          3    18.0      288 Portugal
##  4   112 social   mobile false         10    11.0      242 Argentina
##  5   125 yahoo    mobile false          6    14.0      322 China
##  6   134 google   mobile false          1    18.0      252 Indonesia
##  7   143 social   mobile false          7    16.0      352 Sweden
##  8   156 direct   mobile false          4    18.0      324 China
##  9   219 social   mobile false          1    20.0      520 United Sta
## 10   227 yahoo    mobile false          0    13.0      351 United Sta
## # ... with 26 more rows, and 3 more variables: purchase <chr>,
## #   order_items <dbl>, order_value <dbl>
```

Visits from mobile & visited > 5 pages

```r
filter(ecom, device == "mobile", n_pages > 5)
```

```
## # A tibble: 139 x 11
##       id referrer device bouncers n_visit n_pages duration country
##    <int> <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>
##  1     9 bing     mobile false          3   19.0       209 Netherlanc
##  2    13 direct   mobile false          9   14.0       406 Ireland
##  3    23 bing     mobile false          0    7.00      196 Russia
##  4    30 yahoo    mobile false          8    9.00      225 Colombia
##  5    41 bing     mobile false          4   20.0       440 Czech Repu
##  6    42 direct   mobile false          1   13.0       234 Indonesia
##  7    89 direct   mobile false          4    8.00      144 Ecuador
##  8    92 google   mobile false          5    8.00      192 Indonesia
##  9    98 bing     mobile false          3   18.0       288 Portugal
## 10   112 social   mobile false         10   11.0       242 Argentina
## # ... with 129 more rows, and 3 more variables: purchase <chr>,
## #   order_items <dbl>, order_value <dbl>
```

Case Study: Visits that converted

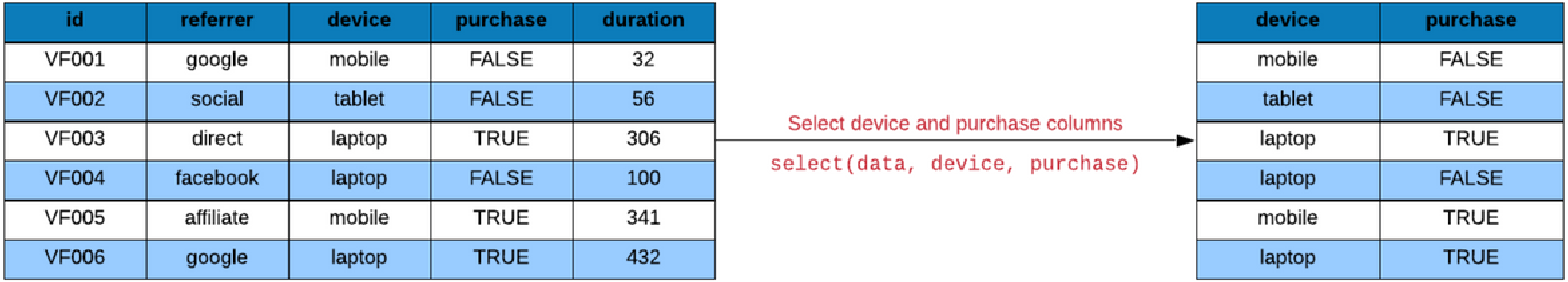
```r
filter(ecom, purchase == "true")
```

```
## # A tibble: 103 x 11
##       id referrer device bouncers n_visit n_pages duration country
##    <int> <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>
##  1     4 bing     tablet false          3    18.0      468 China
##  2    13 direct   mobile false          9    14.0      406 Ireland
##  3    17 bing     tablet false          5    16.0      368 Peru
##  4    19 social   tablet false          7    10.0      290 Colombia
##  5    27 direct   tablet false          2    19.0      342 Japan
##  6    34 social   tablet false          9    20.0      420 Indonesia
##  7    41 bing     mobile false          4    20.0      440 Czech Repu
##  8    94 yahoo    tablet false          2    16.0      480 China
##  9    98 bing     mobile false          3    18.0      288 Portugal
## 10   101 yahoo    tablet false          2    14.0      364 Poland
## # ... with 93 more rows, and 3 more variables: purchase <chr>,
## #   order_items <dbl>, order_value <dbl>
```

Step 2: Select relevant columns

After filtering the data, we need to select relevent variables to compute the AOV. Remember, we do not need all the columns in the data to compute a required metric (in our case, AOV). The `select()` function allows us to select a subset of columns. The first argument is the name of the data frame and the subsequent arguments specify the columns by name or position. Let us look at a few examples:

Select



id	referrer	device	purchase	duration
VF001	google	mobile	FALSE	32
VF002	social	tablet	FALSE	56
VF003	direct	laptop	TRUE	306
VF004	facebook	laptop	FALSE	100
VF005	affiliate	mobile	TRUE	341
VF006	google	laptop	TRUE	432

Select device and purchase columns

```
select(data, device, purchase)
```

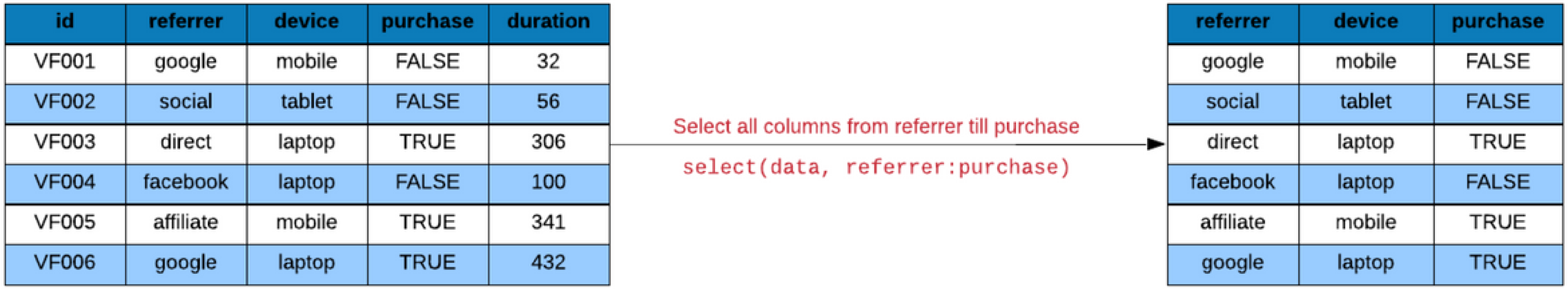
device	purchase
mobile	FALSE
tablet	FALSE
laptop	TRUE
laptop	FALSE
mobile	TRUE
laptop	TRUE

Select device and purchase columns

```r
select(ecom, device, purchase)
```

```
## # A tibble: 1,000 x 2
##    device purchase
##    <chr>  <chr>
##  1 laptop false
##  2 tablet false
##  3 laptop false
##  4 tablet true
##  5 mobile false
##  6 laptop false
##  7 mobile false
##  8 mobile false
##  9 mobile false
## 10 mobile false
## # ... with 990 more rows
```

Select



id	referrer	device	purchase	duration
VF001	google	mobile	FALSE	32
VF002	social	tablet	FALSE	56
VF003	direct	laptop	TRUE	306
VF004	facebook	laptop	FALSE	100
VF005	affiliate	mobile	TRUE	341
VF006	google	laptop	TRUE	432

Select all columns from referrer till purchase

```
select(data, referrer:purchase)
```

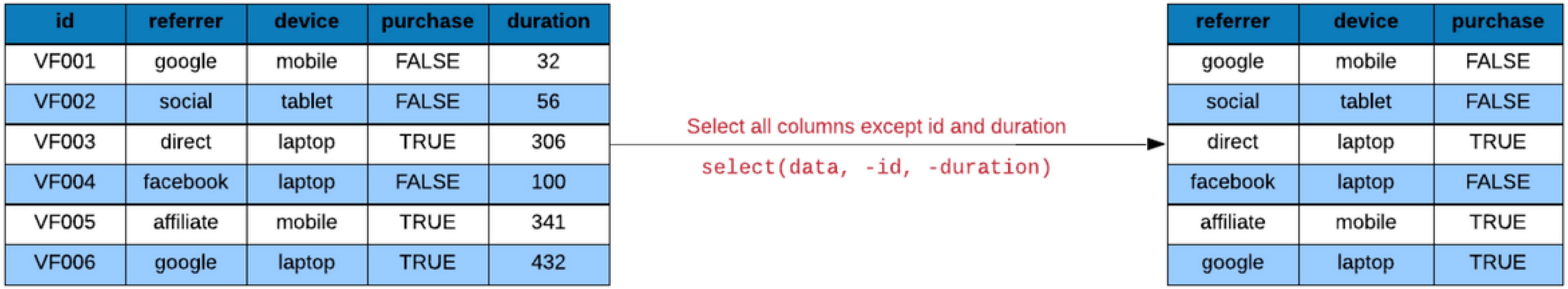
referrer	device	purchase
google	mobile	FALSE
social	tablet	FALSE
direct	laptop	TRUE
facebook	laptop	FALSE
affiliate	mobile	TRUE
google	laptop	TRUE

Select all columns from device to purchase

```r
select(ecom, device:purchase)
```

```
## # A tibble: 1,000 x 7
##    device bouncers n_visit n_pages duration country        purchase
##    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>          <chr>
##  1 laptop true          10    1.00    693   Czech Republic false
##  2 tablet true           9    1.00    459   Yemen          false
##  3 laptop true           0    1.00    996   Brazil         false
##  4 tablet false          3   18.0     468   China          true
##  5 mobile true           9    1.00    955   Poland         false
##  6 laptop false          5    5.00    135   South Africa   false
##  7 mobile true          10    1.00     75.0 Bangladesh     false
##  8 mobile true          10    1.00    908   Indonesia      false
##  9 mobile false          3   19.0     209   Netherlands    false
## 10 mobile true           6    1.00    208   Czech Republic false
## # ... with 990 more rows
```

Select



id	referrer	device	purchase	duration
VF001	google	mobile	FALSE	32
VF002	social	tablet	FALSE	56
VF003	direct	laptop	TRUE	306
VF004	facebook	laptop	FALSE	100
VF005	affiliate	mobile	TRUE	341
VF006	google	laptop	TRUE	432

Select all columns except id and duration

```
select(data, -id, -duration)
```

referrer	device	purchase
google	mobile	FALSE
social	tablet	FALSE
direct	laptop	TRUE
facebook	laptop	FALSE
affiliate	mobile	TRUE
google	laptop	TRUE

Select all columns excluding id and country

```
select(ecom, -id, -country)
```

```
## # A tibble: 1,000 x 9
##    referrer device bouncers n_visit n_pages duration purchase order_i
##    <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>          <
##  1 google   laptop true          10    1.00    693    false
##  2 yahoo    tablet true           9    1.00    459    false
##  3 direct   laptop true           0    1.00    996    false
##  4 bing     tablet false          3   18.0     468    true
##  5 yahoo    mobile true           9    1.00    955    false

##  6 yahoo    laptop false          5    5.00    135    false
##  7 yahoo    mobile true          10    1.00     75.0 false
##  8 direct   mobile true          10    1.00    908    false
##  9 bing     mobile false          3   19.0     209    false
## 10 google   mobile true           6    1.00    208    false
## # ... with 990 more rows, and 1 more variable: order_value <dbl>
```

Case Study: Select

For our case study, we need to select the columns order value and order items to calculate the AOV. We also need to select the device column as we are computing the AOV for different devices.

```
select(ecom, device, order_value, order_items)
```

```
## # A tibble: 1,000 x 3
##    device order_value order_items
##    <chr>        <dbl>       <dbl>
##  1 laptop           0        0
##  2 tablet           0        0
##  3 laptop           0        0
##  4 tablet         434        6.00
##  5 mobile           0        0
##  6 laptop           0        0
##  7 mobile           0        0
##  8 mobile           0        0
##  9 mobile           0        0
## 10 mobile           0        0
## # ... with 990 more rows
```

Case Study: Select

But we want the above data only for purchasers. We will combine `filter()` and `select()` functions to extract data related to purchasers.

```
ecom1 <- filter(ecom, purchase == "true")
ecom2 <- select(ecom1, device, order_value, order_items)
ecom2
```

```
## # A tibble: 103 x 3
##    device order_value order_items
##    <chr>        <dbl>       <dbl>
##  1 tablet         434        6.00
##  2 mobile         651        3.00
##  3 tablet        1049        6.00
##  4 tablet        1304        9.00
##  5 tablet         622        5.00
##  6 tablet        1613        7.00
##  7 mobile         184        3.00
##  8 tablet         286        9.00
##  9 mobile         764        6.00
## 10 tablet        1667        6.00
## # ... with 93 more rows
```

Step 3: Group data by devices

Since we want to compute the AOV for each device, we need to compute the total order value and total order items for each device. To achieve this, we will group the selected variables by device type. Using the `group_by()` function, we will group our case study data by device types. The first argument is the name of the data frame and the second argument is the name of the column based on which the data will be split. Let us look at a few examples:

Group data by referrer type

```r
group_by(ecom, referrer)
```

```
## # A tibble: 1,000 x 11
## # Groups:   referrer [5]
##       id referrer device bouncers n_visit n_pages duration country
##    <int> <chr>    <chr>  <chr>      <int>   <dbl>    <dbl> <chr>
##  1     1 google   laptop true           10    1.00    693   Czech Repu
##  2     2 yahoo    tablet true            9    1.00    459   Yemen
##  3     3 direct   laptop true            0    1.00    996   Brazil
##  4     4 bing     tablet false           3   18.0     468   China
##  5     5 yahoo    mobile true            9    1.00    955   Poland
##  6     6 yahoo    laptop false           5    5.00    135   South Afri
##  7     7 yahoo    mobile true           10    1.00     75.0 Bangladesh
##  8     8 direct   mobile true           10    1.00    908   Indonesia
##  9     9 bing     mobile false           3   19.0     209   Netherland
## 10    10 google   mobile true            6    1.00    208   Czech Repu
## # ... with 990 more rows, and 3 more variables: purchase <chr>,
## #   order_items <dbl>, order_value <dbl>
```

Case Study: Group

In the second line in the previous output, you can observe `Groups: referrer [5]`. The data is split into 5 groups as the referrer variable has 5 distinct values. For our case study, we need to group the data by device type.

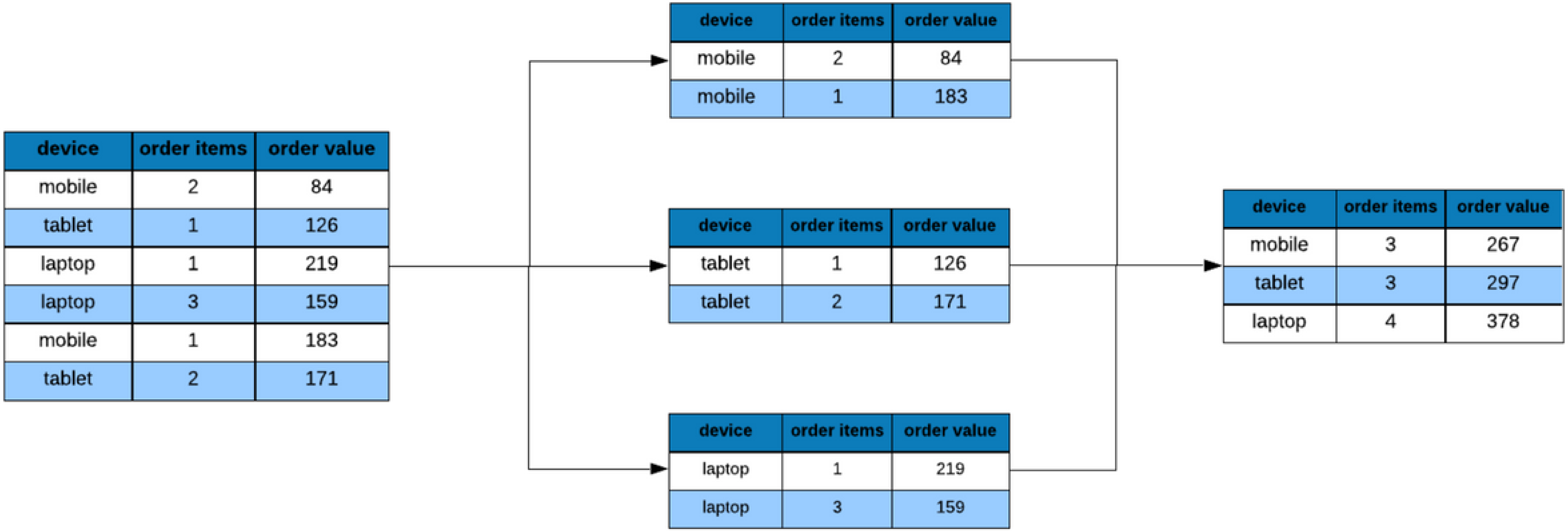
```
ecom3 <- group_by(ecom2, device)
ecom3
```

```
## # A tibble: 103 x 3
## # Groups:   device [3]
##    device order_value order_items
##    <chr>        <dbl>       <dbl>
##  1 tablet         434        6.00
##  2 mobile         651        3.00
##  3 tablet        1049        6.00
##  4 tablet        1304        9.00
##  5 tablet         622        5.00
##  6 tablet        1613        7.00
##  7 mobile         184        3.00
##  8 tablet         286        9.00
##  9 mobile         764        6.00
## 10 tablet        1667        6.00
## # ... with 93 more rows
```

Step 4: Total order value and order items

The next step is to compute the total order value and total order items for each device. We will use them to then compute the average order value. Now we need to reduce the order value and order items data to a single summary. We can achieve this using the `summarise()` function. The first argument is the name of a data frame and the subsequent arguments are functions that can generate a summary. For example, we can use `min`, `max`, `sum`, `mean` etc.

Summarize



device	order items	order value
mobile	2	84
tablet	1	126
laptop	1	219
laptop	3	159
mobile	1	183
tablet	2	171

device	order items	order value
mobile	2	84
mobile	1	183

device	order items	order value
tablet	1	126
tablet	2	171

device	order items	order value
laptop	1	219
laptop	3	159

device	order items	order value
mobile	3	267
tablet	3	297
laptop	4	378

Summarise

For our case study, we need the totals of order value and order items. What function can we use to obtain them? The `sum()` function will generate the sum of the values and hence we will use it inside the `summarise()` function. Remember, we need to provide a name to the summary being generated.

```
ecom4 <- summarise(ecom3, total_value = sum(order_value),
          total_items = sum(order_items))
ecom4
```

```
## # A tibble: 3 x 3
##   device total_value total_items
##   <chr>        <dbl>       <dbl>
## 1 laptop       56531         160
## 2 mobile       51504         184
## 3 tablet       51321         197
```

Summarise

There you go, we have the total order value and total order items for each device type. Another way to achieve the above result is to use the `summarise_all()` function. How does that work? It generates the specified summary for all the columns in the data set except for the column based on which the data has been grouped. So we need to ensure that the data frame does not have any irrelevant columns.

Case Study: Summarise

In our case study, we have split the data based on the device type and we have 2 other columns which are order value and order items. If we use `summarise_all()` function, it will generate the summary for the two columns based on the function specified. To specify the functions, we need to use another argument `funs` and it can take any number of valid functions.

```
ecom4 <- summarise_all(ecom3, funs(sum))
ecom4
```

```
## # A tibble: 3 x 3
##   device order_value order_items
##   <chr>        <dbl>       <dbl>
## 1 laptop       56531         160
## 2 mobile       51504         184
## 3 tablet       51321         197
```

Mutate

device	order items	order value
mobile	3	267
tablet	3	297
laptop	4	378

device	order items	order value	aov
mobile	3	267	267 / 3
tablet	3	297	297 / 3
laptop	4	378	378 / 4

device	order items	order value	aov
mobile	3	267	89
tablet	3	297	99
laptop	4	378	94.5

Step 5: Compute AOV

Now that we have the total order value and total order items for each device category, we can compute the AOV. We will create a new column to store the result. To create a new column, we will use the `mutate()` function. The first argument is the name of the data frame and the subsequent arguments are expressions for creating new columns based out of existing columns.

```
ecom5 <- mutate(ecom4, aov = order_value / order_items)
ecom5
```

```
## # A tibble: 3 x 4
##   device order_value order_items   aov
##   <chr>        <dbl>       <dbl> <dbl>
## 1 laptop       56531         160   353
## 2 mobile       51504         184   280
## 3 tablet       51321         197   261
```

Step 6: Select relevant columns

The last step is to select the relevant columns. We require the device type and the corresponding aov and hence we can get rid of other columns. Use the `select()` function to extract the relevant columns.

```
ecom6 <- select(ecom5, device, aov)
ecom6
```

```
## # A tibble: 3 x 2
##   device    aov
##   <chr>   <dbl>
## 1 laptop    353
## 2 mobile    280
## 3 tablet    261
```

Average Order Value

AOV by Devices

Let us combine all the code from the above steps:

```
ecom1 <- filter(ecom, purchase == "true")
ecom2 <- select(ecom1, device, order_value, order_items)
ecom3 <- group_by(ecom2, device)
ecom4 <- summarise_all(ecom3, funs(sum))
ecom5 <- mutate(ecom4, aov = order_value / order_items)
ecom6 <- select(ecom5, device, aov)
ecom6
```

```
## # A tibble: 3 x 2
##   device    aov
##   <chr>   <dbl>
## 1 laptop    353
## 2 mobile    280
## 3 tablet    261
```

AOV by Devices

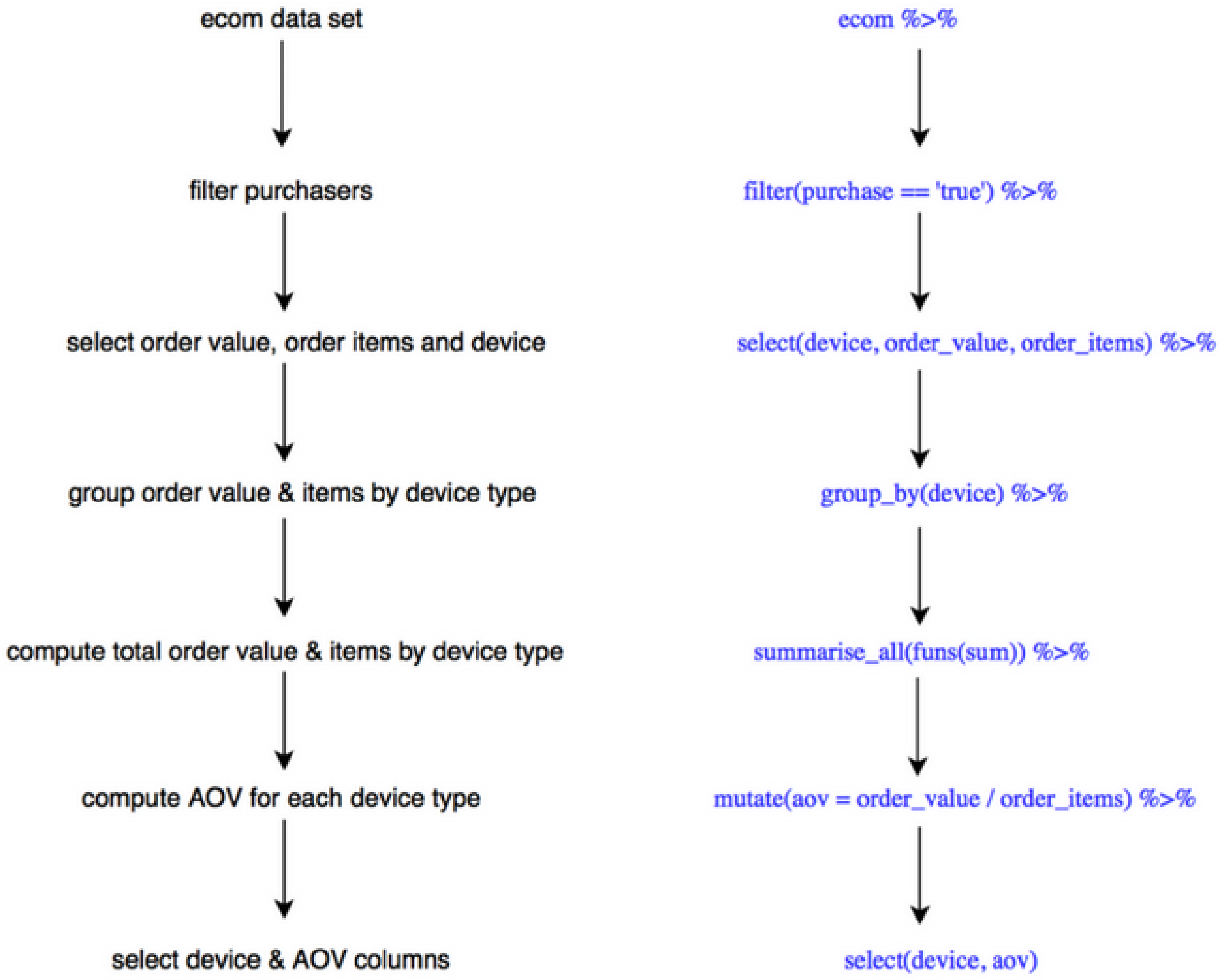
If you observe, at each step we create a new variable(data frame) and then use it as an input in the next step i.e. the output from one function becomes the input for another function. Can we achieve the final outcome i.e. `ecom6` without creating the intermediate data frames (ecom1 - ecom5)? Yes, we can. We will use the `%>%` operator to chain the above steps so that we can avoid creating the intermediate data frames. Let us see how to do that.

AOV by Devices

```
ecom %>%
  filter(purchase == 'true') %>%
  select(device, order_value, order_items) %>%
  group_by(device) %>%
  summarise_all(funs(sum)) %>%
  mutate(
    aov = order_value / order_items
  ) %>%
  select(device, aov)
```

```
## # A tibble: 3 x 2
##   device   aov
##   <chr>  <dbl>
## 1 laptop   353
## 2 mobile   280
## 3 tablet   261
```

AOV by Devices



ecom data set

filter purchasers

select order value, order items and device

group order value & items by device type

compute total order value & items by device type

compute AOV for each device type

select device & AOV columns

```
ecom %>%
filter(purchase == 'true') %>%
select(device, order_value, order_items) %>%
group_by(device) %>%
summarise_all(funs(sum)) %>%
mutate(aov = order_value / order_items) %>%
select(device, aov)
```

Practice Questions

- what is the average number of pages visited by purchasers and non-purchasers?
- what is the average time on site for purchasers vs non-purchasers?
- what is the average number of pages visited by purchasers and non-purchasers using mobile?

Thank You

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