Merging Data Tables

STAT 133

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`github.com/ucb-stat133/stat133-fall-2016`

Merging Data Tables

Merging

Merging two or more tables is another frequent type of data manipulation

Motivation

```r
A <- data.frame(
  v1 = seq(2, 10, 2),
  v2 = 16:20)

A
```

```
##   v1 v2
## 1  2 16
## 2  4 17
## 3  6 18
## 4  8 19
## 5 10 20
```

```r
B <- data.frame(
  v1 = seq(0.1, 0.5, 0.1),
  v2 = seq(0.6, 1, 0.1))

B
```

```
##    v1  v2
## 1 0.1 0.6
## 2 0.2 0.7
## 3 0.3 0.8
## 4 0.4 0.9
## 5 0.5 1.0
```

Super basic merging

- R provides the functions `cbind()` and `rbind()`
- Column binding requires same number of rows
- It works on vectors, matrices, and data frames

Binding columns with `cbind()`

```
# column binding
AB <- cbind(A, B)
AB
```

```
##   v1 v2  v1  v2
## 1  2 16 0.1 0.6
## 2  4 17 0.2 0.7
## 3  6 18 0.3 0.8
## 4  8 19 0.4 0.9
## 5 10 20 0.5 1.0
```

Can you see any potential problems in this case?

Binding columns with `cbind()`

Notice that columns have repeated names:

```
AB
```

```
##   v1 v2  v1  v2
## 1  2 16 0.1 0.6
## 2  4 17 0.2 0.7
## 3  6 18 0.3 0.8
## 4  8 19 0.4 0.9
## 5 10 20 0.5 1.0
```

What happens if we do this:

```
AB$v1
```

Your Turn

What do you get in this case?

```
AB$v1
```

A) Error
B) Warning
C) Both columns `v1`
D) First column `v1`
E) Second column `v1`

Binding columns with `cbind()`

```
# column 'v1'
AB$v1

## [1]  2  4  6  8 10

# columns 'v1'
AB[ ,c('v1', 'v1')]

##   v1 v1.1
## 1  2    2
## 2  4    4
## 3  6    6
## 4  8    8
## 5 10   10
```

Binding various objects with `cbind()`

```
# more cbind
cbind(A, B, A)
```

```
##   v1 v2  v1  v2 v1 v2
## 1  2 16 0.1 0.6  2 16
## 2  4 17 0.2 0.7  4 17
## 3  6 18 0.3 0.8  6 18
## 4  8 19 0.4 0.9  8 19
## 5 10 20 0.5 1.0 10 20
```

Super basic merging

- Row binding with `rbind()`
- Row binding works on vectors, matrices, and data frames
- `rbind()` requires matrices with same number of columns
- `rbind()` on vectors requires vectors of same length
- `rbind()` on data frames
  - require columns having same names
  - require column factors having same levels

Binding rows with `rbind()`

```
# row binding
rbind(A, B)
```

```
##       v1   v2
## 1    2.0 16.0
## 2    4.0 17.0
## 3    6.0 18.0
## 4    8.0 19.0
## 5   10.0 20.0
## 6    0.1  0.6
## 7    0.2  0.7
## 8    0.3  0.8
## 9    0.4  0.9
## 10   0.5  1.0
```

Merging

- Row and column binding provide a very basic type of "merging"
- For more advanced merging operations, we usually require tables to have an **id** column

Motivation

```r
X <- data.frame(
  id = letters[1:5],
  x1 = 5:1,
  x2 = 10:6)

X
```

```
##   id x1 x2
## 1  a  5 10
## 2  b  4  9
## 3  c  3  8
## 4  d  2  7
## 5  e  1  6
```

```r
Y <- data.frame(
  id = letters[1:5],
  y1 = seq(0.1, 0.5, 0.1),
  y2 = seq(0.6, 1, 0.1))

Y
```

```
##   id  y1  y2
## 1  a 0.1 0.6
## 2  b 0.2 0.7
## 3  c 0.3 0.8
## 4  d 0.4 0.9
## 5  e 0.5 1.0
```

Merging with `merge()`

- The behavior of `merge()` depends on a combination of several arguments
- Let's see some of the frequent scenarios

Basic merge()

```
# default merge
merge(X, Y)

##   id x1 x2  y1  y2
## 1  a  5 10 0.1 0.6
## 2  b  4  9 0.2 0.7
## 3  c  3  8 0.3 0.8
## 4  d  2  7 0.4 0.9
## 5  e  1  6 0.5 1.0
```

merge() will search a common column in both data frames (i.e. column with same name)

Basic `merge()`

We can explicitly define the name of the column used for merging:

```
merge(X, Y, by = 'id')
```

```
##   id x1 x2  y1  y2
## 1  a  5 10 0.1 0.6
## 2  b  4  9 0.2 0.7
## 3  c  3  8 0.3 0.8
## 4  d  2  7 0.4 0.9
## 5  e  1  6 0.5 1.0
```

Let's make it more interesting

```
# shuffling rows in data frame Y
Y <- Y[c(3, 2, 5, 4, 1), ]
Y
```

```
##   id  y1  y2
## 3  c 0.3 0.8
## 2  b 0.2 0.7
## 5  e 0.5 1.0
## 4  d 0.4 0.9
## 1  a 0.1 0.6
```

Basic merge()

```
merge(X, Y, by = 'id')
```

```
##   id x1 x2  y1  y2
## 1  a  5 10 0.1 0.6
## 2  b  4  9 0.2 0.7
## 3  c  3  8 0.3 0.8
## 4  d  2  7 0.4 0.9
## 5  e  1  6 0.5 1.0
```

No common column names

```
X <- data.frame(
  x1 = c(10, 20),
  x2 = c(30, 40))

X
```

```
##   x1 x2
## 1 10 30
## 2 20 40
```

```
Y <- data.frame(
  y1 = c(0.1, 0.2, 0.3),
  y2 = c(0.4, 0.5, 0.6))

Y
```

```
##    y1  y2
## 1 0.1 0.4
## 2 0.2 0.5
## 3 0.3 0.6
```

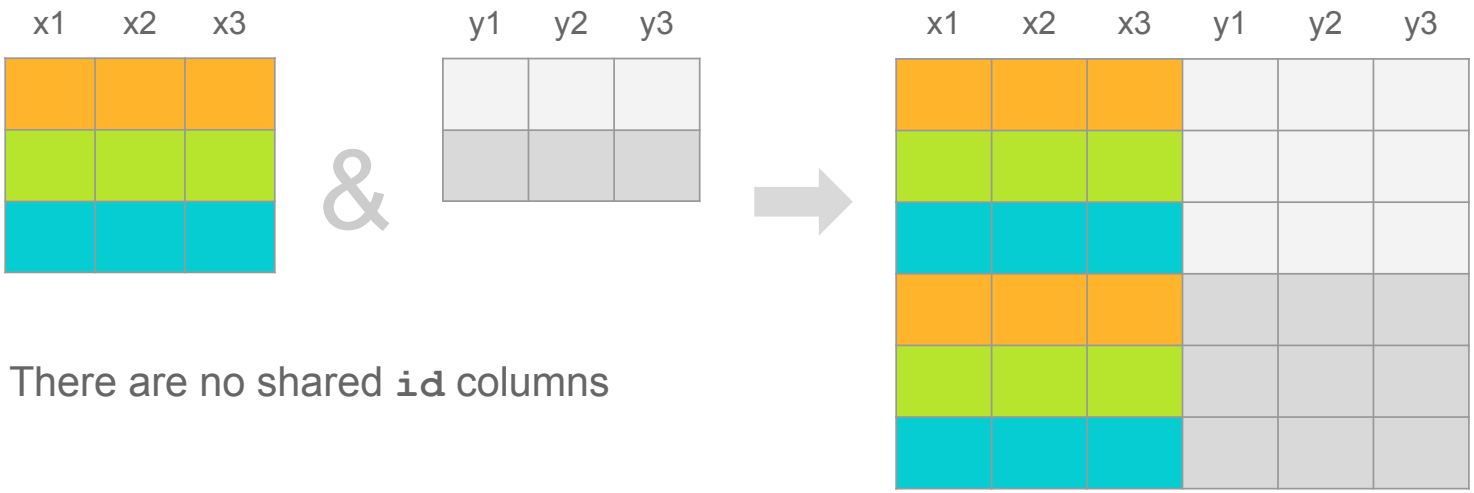
Recycled `merge()`

If there are no common column names, then recycling is applied:

```
merge(X, Y)
```

```
##   x1 x2  y1  y2
## 1 10 30 0.1 0.4
## 2 20 40 0.1 0.4
## 3 10 30 0.2 0.5
## 4 20 40 0.2 0.5
## 5 10 30 0.3 0.6
## 6 20 40 0.3 0.6
```

Merging with uncommon names



There are no shared `id` columns

Advanced Mergings

Different number of rows

```
X <- data.frame(
  id = letters[1:4],
  x1 = 4:1,
  x2 = 10:7)

X
```

```
##   id x1 x2
## 1  a  4 10
## 2  b  3  9
## 3  c  2  8
## 4  d  1  7
```

```
Y <- data.frame(
  id = c('b', 'd'),
  y1 = c(0.1, 0.2),
  y2 = c(0.6, 0.7))

Y
```

```
##   id  y1  y2
## 1  b 0.1 0.6
## 2  d 0.2 0.7
```

Default `merge()`

Merging rows that share `id`

```
merge(X, Y, by = 'id')

##   id x1 x2  y1  y2
## 1  b  3  9 0.1 0.6
## 2  d  1  7 0.2 0.7
```

Different number of rows

Values of rows not matching the `id` are filled with `NA`'s

```
merge(X, Y, by = 'id', all = TRUE)
```

```
##   id x1 x2  y1  y2
## 1  a  4 10  NA  NA
## 2  b  3  9 0.1 0.6
## 3  c  2  8  NA  NA
## 4  d  1  7 0.2 0.7
```

Advanced `merge()`

We can specify which data frame columns to include:

```
merge(X, Y, by = 'id', all.x = TRUE)
```

```
##   id x1 x2  y1  y2
## 1  a  4 10  NA  NA
## 2  b  3  9 0.1 0.6
## 3  c  2  8  NA  NA
## 4  d  1  7 0.2 0.7
```

Advanced `merge()`

We can specify which data frame columns to include:

```
merge(X, Y, by = 'id', all.y = TRUE)

##   id x1 x2  y1  y2
## 1  b  3  9 0.1 0.6
## 2  d  1  7 0.2 0.7
```

Merging Types

```
merge(x, y, by = 'id', all = FALSE)
```

id	x1	x2
a		
b		
c		
d		

&

id	y1	y2
a		
c		

→

id	x1	x2	y1	y2
a				
c				

```
merge(x, y, by = 'id', all = TRUE)
```

id	x1	x2
a		
b		
c		
d		

&

id	y1	y2
a		
c		

→

id	x1	x2	y1	y2
a				
b			NA	NA
c				
d			NA	NA

Merging Types (cont'd)

```
merge(x, y, by = 'id', all.x = TRUE)
```

id	x1	x2
a		
b		
c		
d		

&

id	y1	y2
a		
c		

→

id	x1	x2	y1	y2
a				
b			NA	NA
c				
d			NA	NA

```
merge(x, y, by = 'id', all.y = TRUE)
```

id	x1	x2
a		
b		
c		
d		

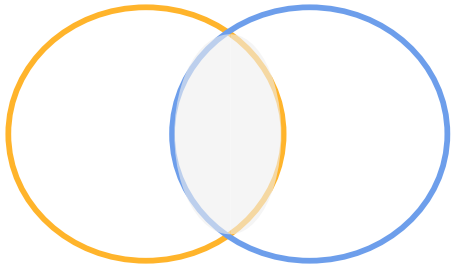
&

id	y1	y2
a		
c		

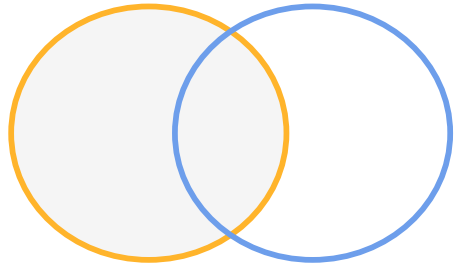
→

id	x1	x2	y1	y2
a				
c				

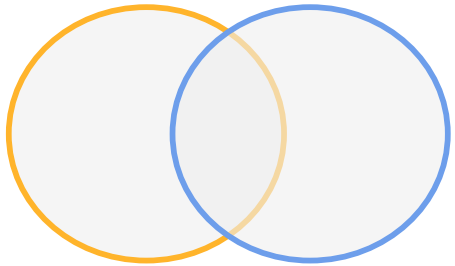
Merging Types



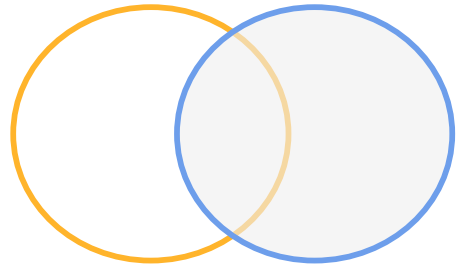
`default`



`all.x = TRUE`



`all = TRUE`



`all.y = TRUE`

More Mergings

Different id columns

```
X <- data.frame(
  idx = letters[1:4],
  x1 = 4:1,
  x2 = 10:7)

X
```

```
##   idx x1 x2
## 1   a  4 10
## 2   b  3  9
## 3   c  2  8
## 4   d  1  7
```

```
Y <- data.frame(
  idy = c('b', 'd'),
  y1 = c(0.1, 0.2),
  y2 = c(0.6, 0.7))

Y
```

```
##   idy  y1  y2
## 1   b 0.1 0.6
## 2   d 0.2 0.7
```

More `merge()` options

Sometimes the id columns have different names:

```
merge(X, Y, by.x = 'idx', by.y = 'idy')
```

```
##   idx x1 x2  y1  y2
## 1   b  3  9 0.1 0.6
## 2   d  1  7 0.2 0.7
```

More `merge()` options

```
merge(X, Y, by.x = 'idx', by.y = 'idy', all = TRUE)
```

```
##   idx x1 x2  y1  y2
## 1   a  4 10  NA  NA
## 2   b  3  9 0.1 0.6
## 3   c  2  8  NA  NA
## 4   d  1  7 0.2 0.7
```

More `merge()` options

```
merge(X, Y, by.x = 'idx', by.y = 'idy', all.x = TRUE)
```

```
##   idx x1 x2  y1  y2
## 1   a  4 10  NA  NA
## 2   b  3  9 0.1 0.6
## 3   c  2  8  NA  NA
## 4   d  1  7 0.2 0.7
```

Basic merge()

```
merge(X, Y, by.x = 'idx', by.y = 'idy', all.y = TRUE)
```

```
##   idx x1 x2  y1  y2
## 1   b  3  9 0.1 0.6
## 2   d  1  7 0.2 0.7
```

Package "dplyr"

Package "dplyr"

```r
# install "dplyr"
install.packages("dplyr")

# load "dplyr"
library(dplyr)
```

Join Functions

- `inner_join()`
- `left_join()`
- `right_join()`
- `full_join()`
- `semi_join()`
- `anti_join()`

Different number of rows

```
X <- data.frame(
  id = letters[1:4],
  x1 = 4:1,
  x2 = 10:7,
  stringsAsFactors = FALSE)

X
```

```
##   id x1 x2
## 1  a  4 10
## 2  b  3  9
## 3  c  2  8
## 4  d  1  7
```

```
Y <- data.frame(
  id = c('b', 'd'),
  y1 = c(0.1, 0.2),
  y2 = c(0.6, 0.7),
  stringsAsFactors = FALSE)

Y
```

```
##   id  y1  y2
## 1  b 0.1 0.6
## 2  d 0.2 0.7
```

Function inner_join()

inner_join() returns all rows from X where there are matching valuesin Y, and all columns from X and Y.

```
inner_join(X, Y, by = 'id')
```

```
##   id x1 x2  y1  y2
## 1  b  3  9 0.1 0.6
## 2  d  1  7 0.2 0.7
```

Function `left_join()`

`left_join()` returns all rows from `X`, and all columns from `X` and `Y`.

```
left_join(X, Y, by = 'id')
```

```
##   id x1 x2  y1  y2
## 1  a  4 10  NA  NA
## 2  b  3  9 0.1 0.6
## 3  c  2  8  NA  NA
## 4  d  1  7 0.2 0.7
```

Function right_join()

right_join() returns all rows from Y, and all columns from X and Y.

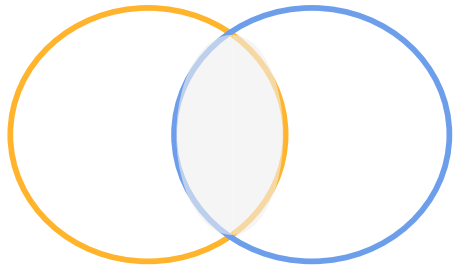
```
right_join(X, Y, by = 'id')
```

```
##   id x1 x2  y1  y2
## 1  b  3  9 0.1 0.6
## 2  d  1  7 0.2 0.7
```

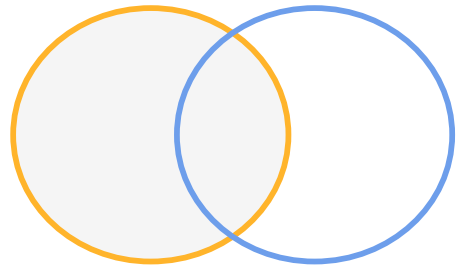
Function full_join()

```
full_join(X, Y, by = 'id')
```

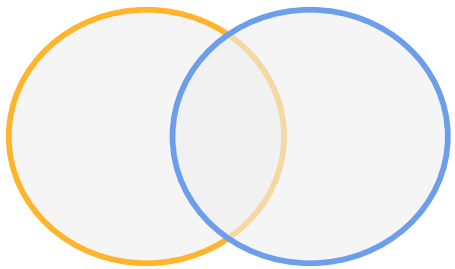
```
##   id x1 x2  y1  y2
## 1  a  4 10  NA  NA
## 2  b  3  9 0.1 0.6
## 3  c  2  8  NA  NA
## 4  d  1  7 0.2 0.7
```



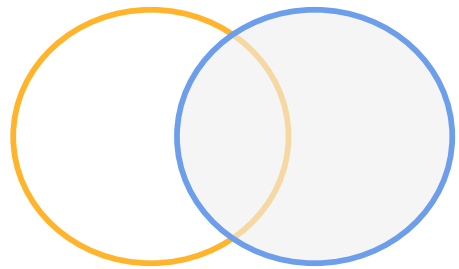
`inner_join`



`left_join`



`full_join`



`right_join`

Function semi_join()

semi_join() returns all rows from X where there are matching values in Y, keeping just columns from X.

```
semi_join(X, Y, by = 'id')
```

```
##   id x1 x2
## 1  b  3  9
## 2  d  1  7
```

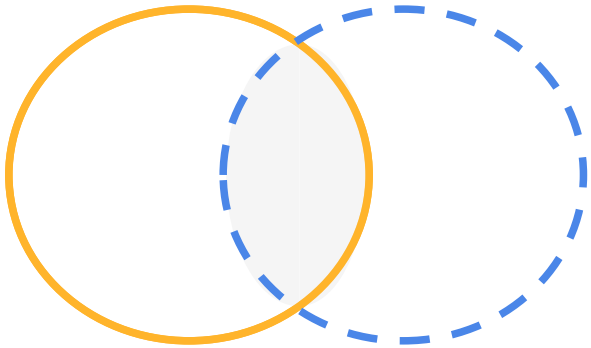
Function anti_join()

anti_join() returns all rows from X where there are not matching values in Y, keeping just columns from X.

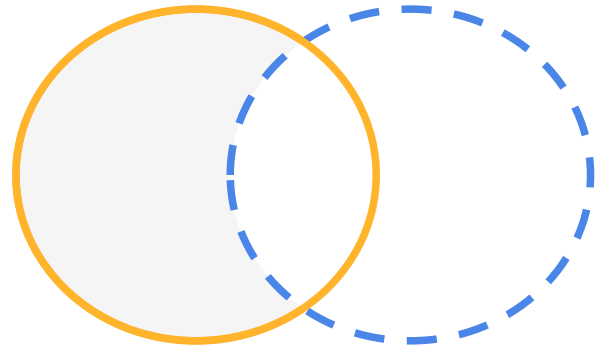
```
anti_join(X, Y, by = 'id')
```

```
##   id x1 x2
## 1  c  2  8
## 2  a  4 10
```

Semi and Anti joins



`semi_join`



`anti_join`