Joins

Grinnell College

February 10, 2026

Warm-up

You've got two lists:

- A list of people who RSVP'd to your party
- A list of people who showed up

Who do you email:

1. To say thank you for coming
2. To ask, "Hey, where were you?"
3. To ask, "Who are you and why were you at my house?"

Missing Slide

Define tables and database

Overview

- Keys
- Joins

Keys

Most generally, a **key** is an identifier or set of identifiers for observations in a table

- **Primary Key** is a key associated with a table of interest that *uniquely identifies* each observation
- **Foreign Key** is a variable or set of variables that correspond to a primary key in a different table

Key Considerations

- Single or compound keys
- Checking for uniqueness
- Anticipate conflicts from future entries in primary keys
- Use appropriate identifiers

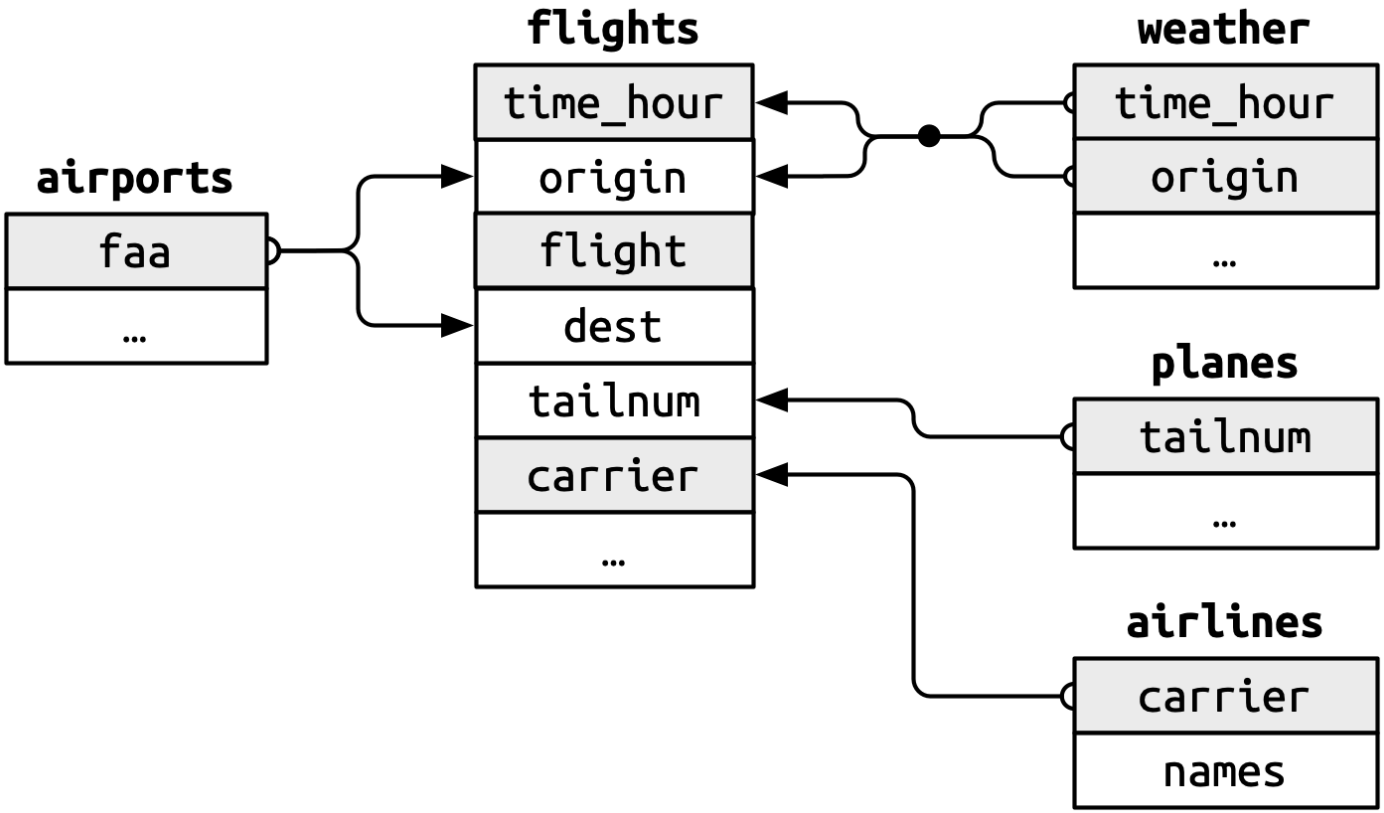
Primary Keys

```
> head(airlines)

  carrier name
  <chr>   <chr>
1 9E      Endeavor Air Inc.
2 AA      American Airlines Inc.
3 AS      Alaska Airlines Inc.
4 B6      JetBlue Airways
5 DL      Delta Air Lines Inc.
6 EV      ExpressJet Airlines Inc.
```

Primary Keys

```
> head(airports[, c(1, 2, 3, 4)])

  faa   name                                lat   lon
  <chr> <chr>                             <dbl> <dbl>
1 04G   Lansdowne Airport                  41.1 -80.6
2 06A   Moton Field Municipal Airport      32.5 -85.7
3 06C   Schaumburg Regional                42.0 -88.1
4 06N   Randall Airport                    41.4 -74.4
5 09J   Jekyll Island Airport              31.1 -81.4
6 0A9   Elizabethton Municipal Airport     36.4 -82.2
```

Key Relations



Gray boxes represent primary keys

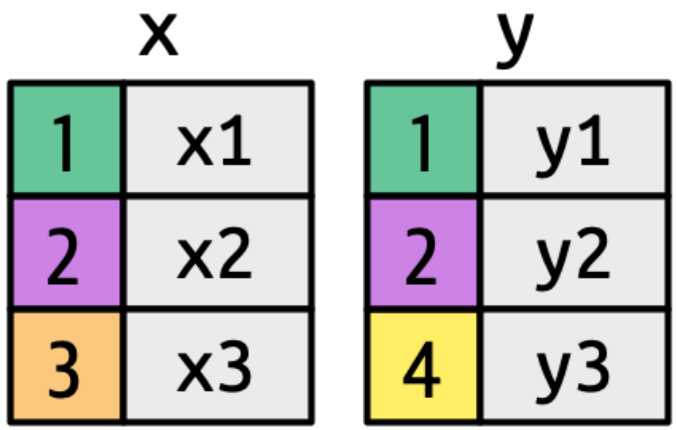
A Note on Notation

In virtually all of our examples, we'll assume we are working with two datasets or tables, X and Y

X will always be our primary table (with the primary key) and will serve as the first argument in any functions of the form $f(X, Y)$

This is especially important as most joins are *not* commutative

Visualizing Joins



Types of Joins

1. Mutating Joins
   - Defined by combination of different datasets
   - Typically used to add variables or metadata
   - Left, right, inner, full
2. Filtering Joins
   - Characterized by filtering of datasets
   - New variables are not added to existing
   - Semi, anti

Mutating Joins

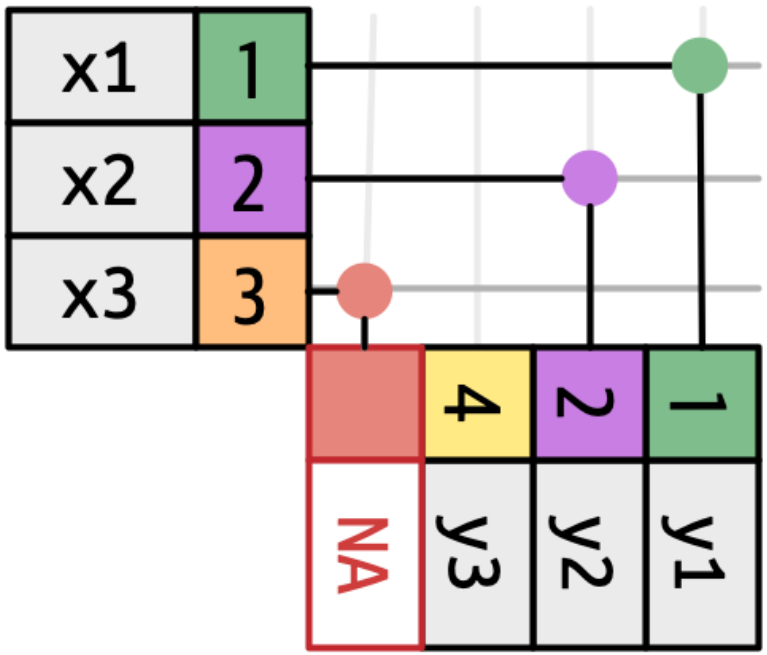
Left (and Right) Joins

The primary purpose of a left join is to preserve a primary table X while adding metadata from Y

- Retains all rows of X
- Adds corresponding variables from Y
- Adds `NA` to rows of Y when missing
- Example: bringing in plane specific data to the table of all flights

Left Joins

```
left_join(x, y)
```



key	val_x	val_y
1	x1	y1
2	x2	y2
3	x3	NA

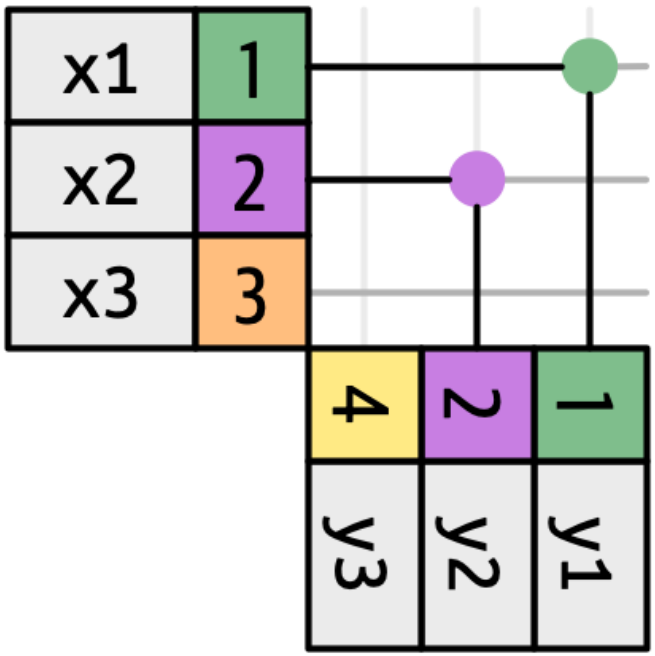
Inner Joins

Inner joins are primary used for finding complete records

- Retains only rows in X that have a match in Y
- This join is commutative
- Example: A table of all enrolled Grinnell students inner joined with all STEM courses offered Spring 2026 will return a list of all students enrolled in a science class (with class information)

Inner Joins

```
inner_join(x, y)
```



key	val_x	val_y
1	x1	y1
2	x2	y2

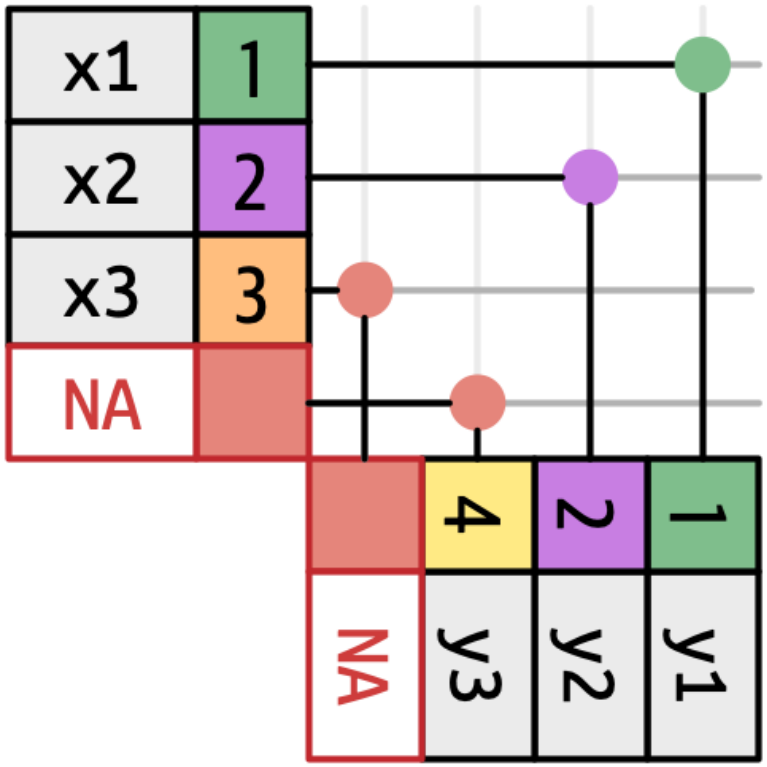
Outer/Full Joins

Outer joins are primarily used as a diagnostic tool

- Retains all rows from X and Y
- Adds `NA` in either when missing
- Quickly shows which tables have missing entries
- Example: Merging a list of all MAP students with all MAP directors will show if there are any students listed as having a MAP without and advisor or if any advisors are paid for a MAP but have no students

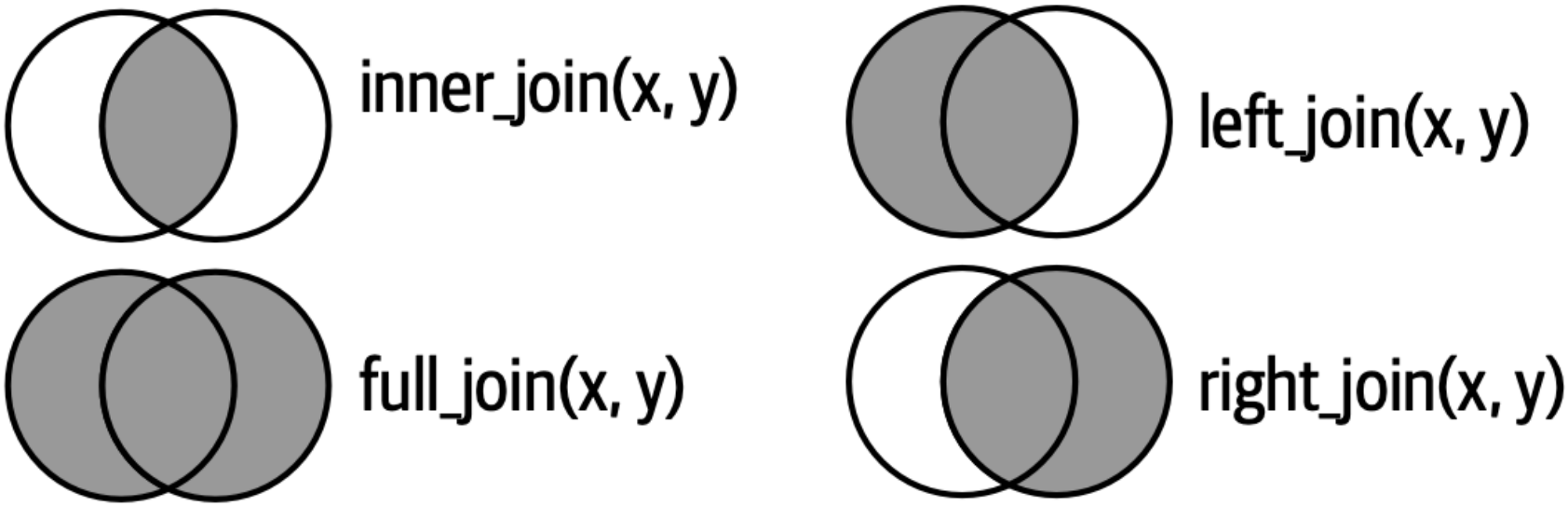
Full Joins

```
full_join(x, y)
```



key	val_x	val_y
1	x1	y1
2	x2	y2
3	x3	NA
4	NA	y3

Mutating Joins



Filtering Joins

Filtering Joins

In all cases, filtering joins are characterized by both removing rows from X and adding no new data from Y

Essentially we ask ourselves, am I filtering on a logical condition (for some purpose) or am I using this join as a diagnostic tool?

Both semi_join(x,y) and anti_join(x,y) are basically `dplyr::filter()` where the filtering criteria comes from a separate table

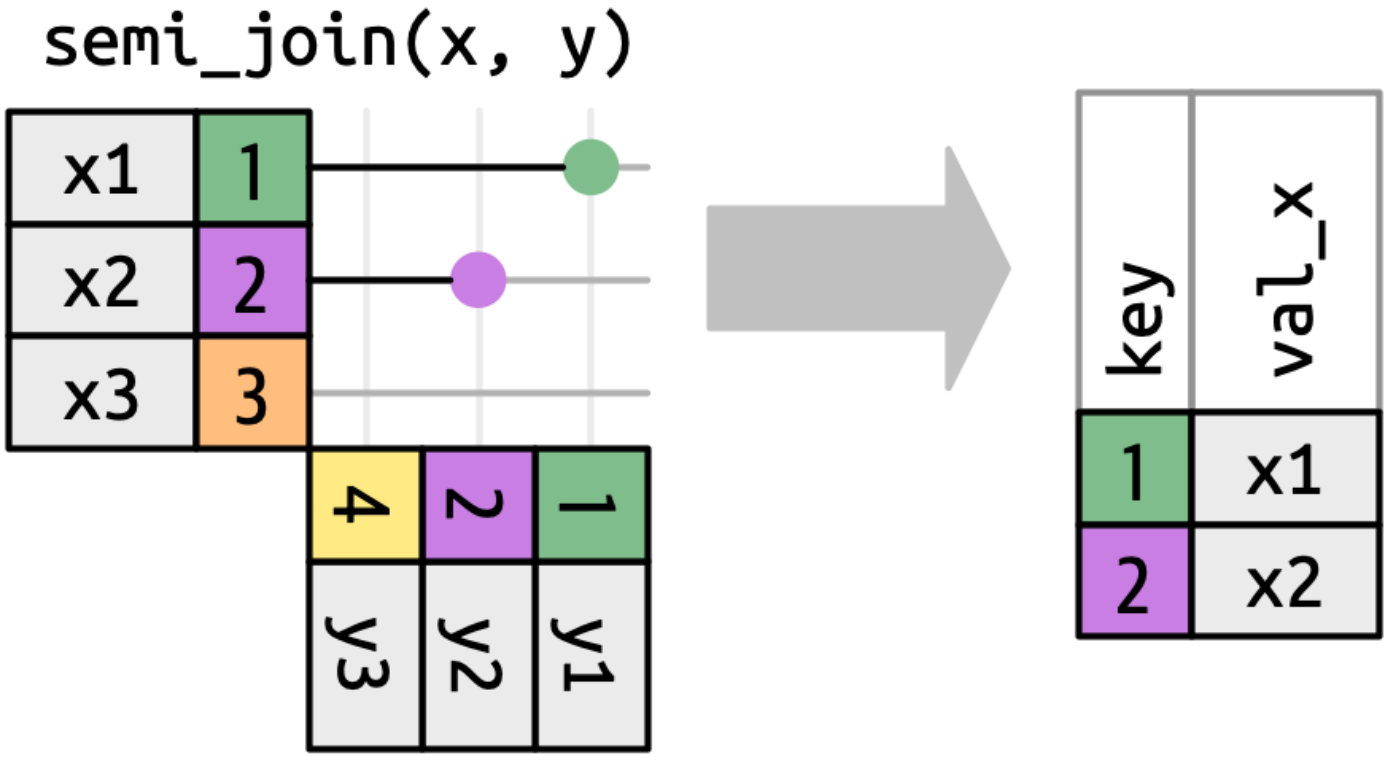
Semi Joins

Semi joins are used for keeping observations from one table that appear in another

Basically `semi_join(X, Y)` is equivalent to `dplyr::filter(X, key %in% Y$key)`

Example: From my list of customers, which ones have an order placed in the last 2 months?

Mutating Joins



Anti Joins

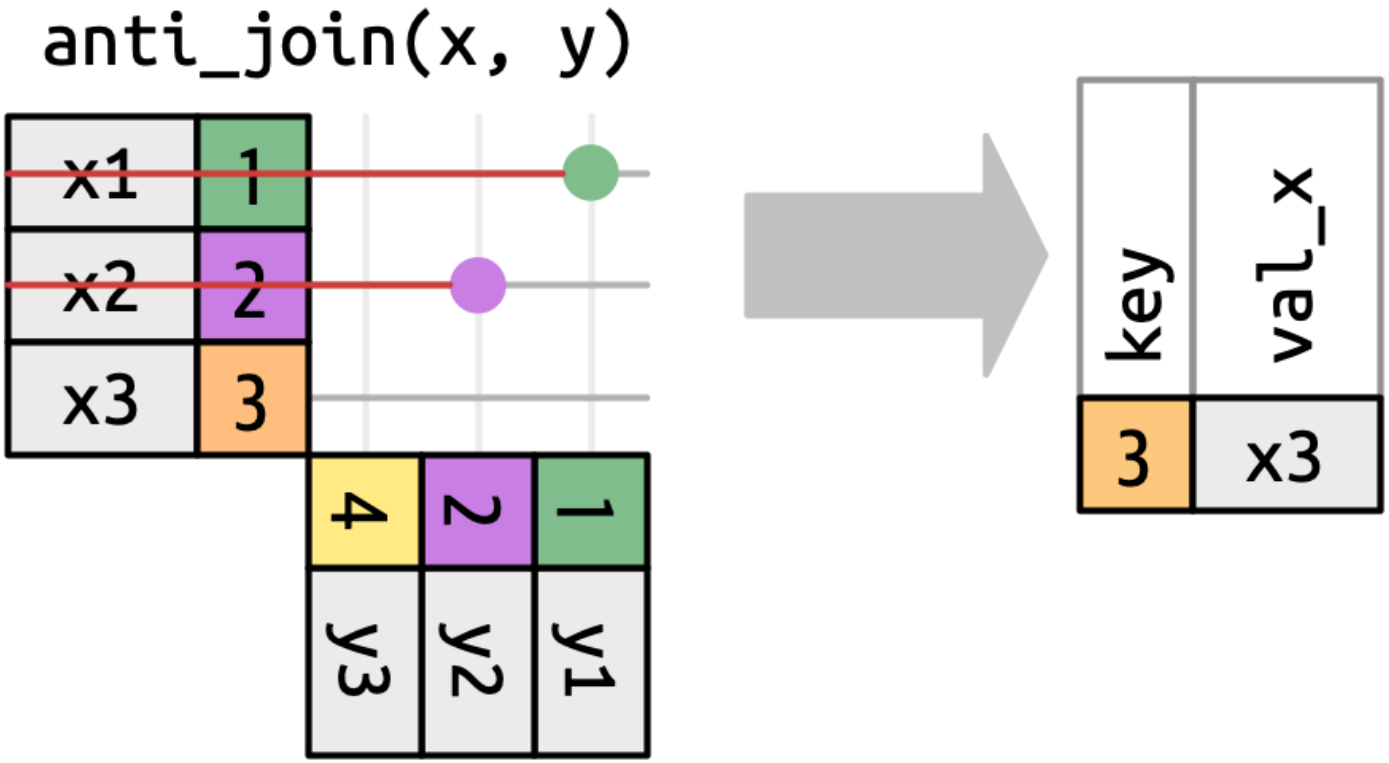
Almost exclusively a diagnostic tool for data quality

`anti_join(X, Y)` is equivalent to
`dplyr::filter(X, !(key %in% Y$key))`

Example: anti joining a list of Grinnell students with Spring 2026 enrollment will return a list of any students not enrolled in classes this semester

This is an example of *implicit* missing values; no `NA`s are returned

Mutating Joins



How do Joins Work?

- Equijoins vs nonequisjoins
- `by = "stuff"` vs `by = join_by(stuff)`
- `by = c("a" == "b")` vs `join_by(x == y)`
- Tidy selection
- Key name confusion
- What to retain