CT1100: Computer Systems

Topic 5: Data Transformation
dplyr part 1

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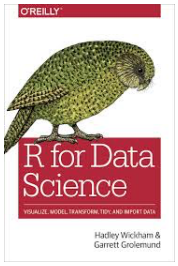
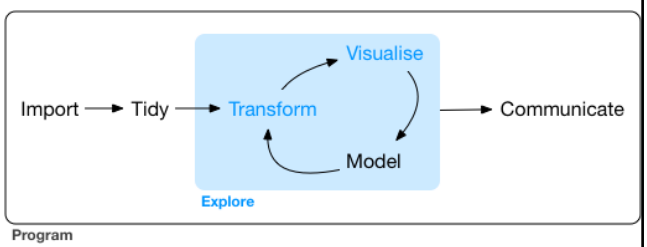
Overview

- Visualisation is an important tool for insight generation, but it's rare that you get the data in exactly the right form you need (Wickham and Grolemund 2017)
  - Create new variables
  - Create summaries
  - Order data
- **dplyr** package is designed for data transformation





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Recap - Data Frames/Tibbles

- The most common way of storing data in R
- A two-dimensional structure, with rows (observations) and columns (variables)

```
> observations
# A tibble: 219,000 x 12
   station  year month   day  hour date                rain  temp  rhum
   <chr>   <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl>
 1 ATHENRY  2017     1     1     0 2017-01-01 00:00:00   0     5.2    89
 2 ATHENRY  2017     1     1     1 2017-01-01 01:00:00   0     4.7    89
 3 ATHENRY  2017     1     1     2 2017-01-01 02:00:00   0     4.2    90
 4 ATHENRY  2017     1     1     3 2017-01-01 03:00:00   0.1   3.5    87
 5 ATHENRY  2017     1     1     4 2017-01-01 04:00:00   0.1   3.2    89
 6 ATHENRY  2017     1     1     5 2017-01-01 05:00:00   0     2.1    91
 7 ATHENRY  2017     1     1     6 2017-01-01 06:00:00   0     2      89
 8 ATHENRY  2017     1     1     7 2017-01-01 07:00:00   0     1.7    89
 9 ATHENRY  2017     1     1     8 2017-01-01 08:00:00   0     1      91
10 ATHENRY  2017     1     1     9 2017-01-01 09:00:00   0     1.1    91
# … with 218,990 more rows, and 3 more variables: msl <dbl>, wdsp <dbl>,
#   wddir <dbl>
```


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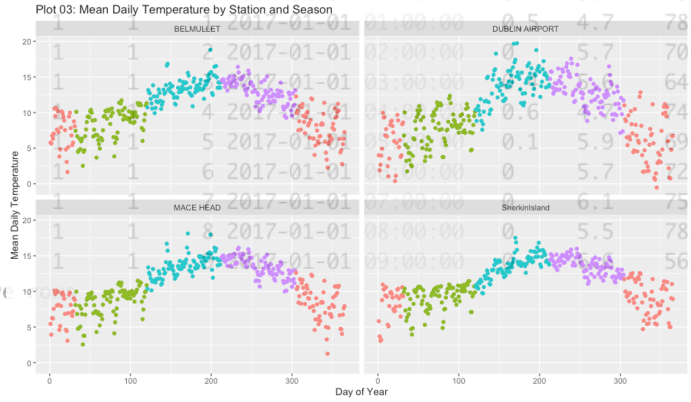
```
> my_obs
# A tibble: 35,040 x 12
   station    year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>     <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 BELMULLET  2017     1     1     0 2017-01-01 00:00:00   0     5.2    79 1023     13   340
 2 BELMULLET  2017     1     1     1 2017-01-01 01:00:00   0.5   4.7    78 1024.    15   350
 3 BELMULLET  2017     1     1     2 2017-01-01 02:00:00   0     5.7    70 1024.    16   360
 4 BELMULLET  2017     1     1     3 2017-01-01 03:00:00   0     5.1    64 1024.    19   360
 5 BELMULLET  2017     1     1     4 2017-01-01 04:00:00   0.6   4.6    74 1025.    20    10
 6 BELMULLET  2017     1     1     5 2017-01-01 05:00:00   0.1   5.9    69 1025.    20    10
 7 BELMULLET  2017     1     1     6 2017-01-01 06:00:00   0     5.7    72 1026.    20    10
 8 BELMULLET  2017     1     1     7 2017-01-01 07:00:00   0     6.1    75 1027.    21   360
 9 BELMULLET  2017     1     1     8 2017-01-01 08:00:00   0     5.5    78 1028.    24    10
10 BELMULLET  2017     1     1     9 2017-01-01 09:00:00   0     3.6    56 1028.    22    10
# … with 35,030 more
```



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dplyr Basics: 5 key functions

Function	Purpose
filter()	Pick observations by their values
arrange()	Reorder the rows
select()	Pick variables by their names
mutate()	*Create new variables with functions of existing variables*
summarise()	*Collapse many values down to a single summary*

- "A grammar of data manipulation" https://dplyr.tidyverse.org
- All verbs (functions) work similarly
  - The first argument is a data frame/tibble
  - The subsequent arguments decide what to do with the data frame/tibble
  - The result (data frame/tibble) supports chaining of steps – NOTE the "pipe operator" which we will cover later.

1. filter()

- First argument the name of the data frame
- Subsequent arguments are expressions that filter the data frame
- Subsequent arguments can be viewed as a succession of "and" statements
- Number of columns does not change
- Number of rows reduced (filtered)

```
> bel <- filter(observations,station=="BELMULLET")
> bel
# A tibble: 8,760 x 12
   station  year month   day  hour date                rain
   <chr>    <dbl> <dbl> <int> <int> <dttm>              <dbl>
 1 BELMUL… 2017     1     1     0 2017-01-01 00:00:00   0
 2 BELMUL… 2017     1     1     1 2017-01-01 01:00:00   0.5
 3 BELMUL… 2017     1     1     2 2017-01-01 02:00:00   0
 4 BELMUL… 2017     1     1     3 2017-01-01 03:00:00   0.4
 5 BELMUL… 2017     1     1     4 2017-01-01 04:00:00   0.6
 6 BELMUL… 2017     1     1     5 2017-01-01 05:00:00   0.1
 7 BELMUL… 2017     1     1     6 2017-01-01 06:00:00   0
 8 BELMUL… 2017     1     1     7 2017-01-01 07:00:00   0
 9 BELMUL… 2017     1     1     8 2017-01-01 08:00:00   0
10 BELMUL… 2017     1     1     9 2017-01-01 09:00:00   0
# … with 8,750 more rows, and 5 more variables: temp <dbl>,
#   rhum <dbl>, msl <dbl>, wdsp <dbl>, wddir <dbl>
```

Relational operators in R

Operators	Description
<	less than
<=	less than or equal to
>	greater than
>=	greater than or equal to
==	exactly equal to
!=	not equal to
!x	not x
x | y	x OR y
x & y	x AND y

```
> bel <- filter(observations,station=="BELMULLET")
> bel
# A tibble: 8,760 x 12
   station  year month   day  hour date                rain
   <chr>    <dbl> <dbl> <int> <int> <dttm>              <dbl>
 1 BELMUL… 2017     1     1     0 2017-01-01 00:00:00   0
 2 BELMUL… 2017     1     1     1 2017-01-01 01:00:00   0.5
 3 BELMUL… 2017     1     1     2 2017-01-01 02:00:00   0
 4 BELMUL… 2017     1     1     3 2017-01-01 03:00:00   0.4
 5 BELMUL… 2017     1     1     4 2017-01-01 04:00:00   0.6
 6 BELMUL… 2017     1     1     5 2017-01-01 05:00:00   0.1
 7 BELMUL… 2017     1     1     6 2017-01-01 06:00:00   0
 8 BELMUL… 2017     1     1     7 2017-01-01 07:00:00   0
 9 BELMUL… 2017     1     1     8 2017-01-01 08:00:00   0
10 BELMUL… 2017     1     1     9 2017-01-01 09:00:00   0
# … with 8,750 more rows, and 5 more variables: temp <dbl>,
#   rhum <dbl>, msl <dbl>, wdsp <dbl>, wddir <dbl>
```


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Show rows for “MACE HEAD” in January

```
> mhj <- filter(observations,station=="MACE HEAD",month==1)
>
> mhj
# A tibble: 744 x 12
   station    year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>     <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 MACE HEAD 2017     1     1     0 2017-01-01 00:00:00   0.5   5.6    88 1023.    17   340
 2 MACE HEAD 2017     1     1     1 2017-01-01 01:00:00   0     5.4    84 1023.    17   340
 3 MACE HEAD 2017     1     1     2 2017-01-01 02:00:00   0.1   4.7    87 1023.    14   340
 4 MACE HEAD 2017     1     1     3 2017-01-01 03:00:00   0     4.7    81 1023.    15   350
 5 MACE HEAD 2017     1     1     4 2017-01-01 04:00:00   0     4.5    80 1024.    12   350
 6 MACE HEAD 2017     1     1     5 2017-01-01 05:00:00   0     5      71 1024     13    20
 7 MACE HEAD 2017     1     1     6 2017-01-01 06:00:00   0     5.1    66 1024.    13    30
 8 MACE HEAD 2017     1     1     7 2017-01-01 07:00:00   0     4.8    76 1026.    19    10
 9 MACE HEAD 2017     1     1     8 2017-01-01 08:00:00   0.1   4.8    78 1026.    16   360
10 MACE HEAD 2017     1     1     9 2017-01-01 09:00:00   0.1   4.4    82 1027.    15    10
# … with 734 more rows
```


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Useful approaches for filtering more than one value

- %in% operator in R

```
> filter(observations,station %in% c("ATHENRY","MACE HEAD"),month==1,day==1,hour==12)
# A tibble: 2 x 12
  station    year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
  <chr>     <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 ATHENRY    2017     1     1    12 2017-01-01 12:00:00     0   5.1    75 1027.    11   360
2 MACE HEAD  2017     1     1    12 2017-01-01 12:00:00     0   6.7    67 1028.    16    20
>
> filter(observations,station == "ATHENRY" | station == "MACE HEAD",month==1,day==1,hour==12)
# A tibble: 2 x 12
  station    year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
  <chr>     <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 ATHENRY    2017     1     1    12 2017-01-01 12:00:00     0   5.1    75 1027.    11   360
2 MACE HEAD  2017     1     1    12 2017-01-01 12:00:00     0   6.7    67 1028.    16    20
```


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Challenge 5.1

- Show the weather for “ROCHES POINT” on October 16th at 12 midday

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2. arrange()

- Changes the order of rows.
- Used for sorting values
- Takes a tibble and a set of column names to order by

```
> arrange(observations,temp)
# A tibble: 219,000 x 12
   station     year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>      <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 CASEMENT    2017    12    11     4 2017-12-11 04:00:00     0  -6.2    91  989.     5   250
 2 GURTEEN     2017    12    11     3 2017-12-11 03:00:00     0  -6      94  989.     2   240
 3 GURTEEN     2017    12    11     4 2017-12-11 04:00:00     0  -6      95  990.     1   240
 4 GURTEEN     2017    12    11     1 2017-12-11 01:00:00     0  -5.9    92  988.     3   230
 5 GURTEEN     2017    12    11     5 2017-12-11 05:00:00     0  -5.8    95  990.     1   260
 6 GURTEEN     2017    12    11     0 2017-12-11 00:00:00     0  -5.7    94  988      2   280
 7 CASEMENT    2017    12    11     2 2017-12-11 02:00:00     0  -5.6    92  988.     4   230
 8 GURTEEN     2017    12    11     2 2017-12-11 02:00:00     0  -5.6    94  989.     3   230
 9 MOORE PARK  2017     1     3     9 2017-01-03 09:00:00     0  -5.6    91 1033.     1   330
10 CASEMENT    2017    12    11     3 2017-12-11 03:00:00     0  -5.4    92  988.     4   250
# … with 218,990 more rows
```


Mean Sea Level Pressure

```
> arrange(observations,msl)
# A tibble: 219,000 x 12
   station              year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>               <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 VALENTIA OBSERVATORY 2017    10    16    11 2017-10-16 11:00:00   9.8  14.6    95  962.    24   100
 2 BELMULLET            2017     2     2    20 2017-02-02 20:00:00   2.5   9.4    94  964.    25   140
 3 BELMULLET            2017     2     2    19 2017-02-02 19:00:00   0     9.3    89  964.    15   140
 4 BELMULLET            2017     2     2    18 2017-02-02 18:00:00   0.1   9.4    87  965.    17   140
 5 MACE HEAD            2017     2     2    15 2017-02-02 15:00:00   0.2  10.1    86  965.    23   120
 6 BELMULLET            2017     2     2    17 2017-02-02 17:00:00   0.3   9.6    88  965     18   140
 7 MACE HEAD            2017     2     2    16 2017-02-02 16:00:00   0.4   9.7    90  965.    19   140
 8 MACE HEAD            2017     2     2    17 2017-02-02 17:00:00   0.2   9.5    90  965.    17   140
 9 BELMULLET            2017     2     2    16 2017-02-02 16:00:00   0    10.6    79  965.    18   140
10 MACE HEAD            2017     2     2    14 2017-02-02 14:00:00   0    10.8    82  966.    22   120
# … with 218,990 more rows
```

Humidity

```
> arrange(observations,rhum)
# A tibble: 219,000 x 12
   station        year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>         <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 SherkinIsland  2017    11    23     5 2017-11-23 05:00:00     0   8.6    20  991.    29   260
 2 SherkinIsland  2017    11    28    13 2017-11-28 13:00:00     0   7.9    20 1019.    11   320
 3 SherkinIsland  2017    11    28    14 2017-11-28 14:00:00     0   8.1    20 1018.    11   330
 4 SherkinIsland  2017    11    18    23 2017-11-18 23:00:00     0  11.9    21 1024.    11   260
 5 SherkinIsland  2017    11    19     5 2017-11-19 05:00:00     0  11.5    21 1024.     8   260
 6 SherkinIsland  2017    11    19     7 2017-11-19 07:00:00     0  10.4    21 1024.     4   220
 7 SherkinIsland  2017    11    21     8 2017-11-21 08:00:00   1.4  12.8    21 1006.    20   200
 8 SherkinIsland  2017    11    22     1 2017-11-22 01:00:00   2.5  12.8    21  995.    19   210
 9 SherkinIsland  2017    11    23    18 2017-11-23 18:00:00     0   8.2    21 1005.     6    10
10 SherkinIsland  2017    11    24    15 2017-11-24 15:00:00     0   6.1    21 1015.     8   320
# … with 218,990 more rows
```


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More than one value

```
> arrange(observations,month,temp)
# A tibble: 219,000 x 12
   station     year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>      <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 MOORE PARK  2017     1     3     9 2017-01-03 09:00:00     0  -5.6    91 1033.     1   330
 2 MOORE PARK  2017     1     3     8 2017-01-03 08:00:00     0  -5.4    91 1033.     1   160
 3 MARKREE     2017     1    23     4 2017-01-23 04:00:00     0  -5.1    96 1024.    NA    NA
 4 MOORE PARK  2017     1     3     7 2017-01-03 07:00:00     0  -5.1    92 1033.     1   250
 5 MARKREE     2017     1    23     5 2017-01-23 05:00:00     0  -5      98 1024.    NA    NA
 6 MARKREE     2017     1    23     2 2017-01-23 02:00:00     0  -4.8    97 1025.    NA    NA
 7 MARKREE     2017     1    23     3 2017-01-23 03:00:00     0  -4.8    98 1025.    NA    NA
 8 MOORE PARK  2017     1     3     6 2017-01-03 06:00:00     0  -4.8    92 1033.     1   270
 9 MT DILLON   2017     1    21     8 2017-01-21 08:00:00     0  -4.6    96 1027.     2   350
10 MARKREE     2017     1    23     1 2017-01-23 01:00:00     0  -4.4    96 1026.    NA    NA
# … with 218,990 more rows
```


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In descending order - desc()

```
> arrange(observations,desc(temp))
# A tibble: 219,000 x 12
   station       year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>        <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 PHOENIX PARK  2017     6    21    13 2017-06-21 13:00:00   0.1  28.3    51 1010     NA    NA
 2 PHOENIX PARK  2017     6    21    12 2017-06-21 12:00:00   0    27.5    54 1011.    NA    NA
 3 PHOENIX PARK  2017     6    21    14 2017-06-21 14:00:00   0    27.5    49 1010.    NA    NA
 4 PHOENIX PARK  2017     6    21    16 2017-06-21 16:00:00   0    26.8    61 1009.    NA    NA
 5 CASEMENT      2017     6    21    12 2017-06-21 12:00:00   0    26.6    54 1011.    11   150
 6 MOORE PARK    2017     6    19    16 2017-06-19 16:00:00   0    26.6    50 1018.     3   200
 7 DUNSANY       2017     6    21    12 2017-06-21 12:00:00   0    26.5    55 1010.     8   150
 8 PHOENIX PARK  2017     6    21    11 2017-06-21 11:00:00   0    26.5    56 1011.    NA    NA
 9 PHOENIX PARK  2017     6    17    16 2017-06-17 16:00:00   0    26.4    42 1024.    NA    NA
10 PHOENIX PARK  2017     6    21    15 2017-06-21 15:00:00   0    26.4    61 1009.    NA    NA
# … with 218,990 more rows
```


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Mean Sea Level Pressure

```
> arrange(observations,desc(msl))
# A tibble: 219,000 x 12
   station              year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>               <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 VALENTIA OBSERVATORY  2017    12    22    19 2017-12-22 19:00:00   0     9.7    97 1039.    NA    NA
 2 VALENTIA OBSERVATORY  2017    12    22    18 2017-12-22 18:00:00   0     9.9    98 1039     NA    NA
 3 VALENTIA OBSERVATORY  2017    12    22    11 2017-12-22 11:00:00   0    10.3    97 1039.    NA    NA
 4 VALENTIA OBSERVATORY  2017    12    22    20 2017-12-22 20:00:00   0.2   9.5    98 1039.    NA    NA
 5 VALENTIA OBSERVATORY  2017    12    22    21 2017-12-22 21:00:00   0.2   9.5    97 1039.    NA    NA
 6 CORK AIRPORT          2017    12    22    21 2017-12-22 21:00:00   0     8.9   100 1039.     4   260
 7 CORK AIRPORT          2017    12    22    20 2017-12-22 20:00:00   0     9.4    99 1039.     3   290
 8 SherkinIsland         2017    12    22    19 2017-12-22 19:00:00   0     9      95 1039.     6   250
 9 SherkinIsland         2017    12    22    20 2017-12-22 20:00:00   0.1   9      96 1039.     3   280
10 VALENTIA OBSERVATORY  2017    12    22    12 2017-12-22 12:00:00   0    10.4    98 1039.    NA    NA
# … with 218,990 more rows
```


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Windspeed

```
> arrange(observations,desc(wdsp))
# A tibble: 219,000 x 12
   station        year month   day  hour date                rain  temp  rhum   msl  wdsp wddir
   <chr>         <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 ROCHES POINT   2017    10    16    12 2017-10-16 12:00:00   1.3  12      96  983.    59   180
 2 ROCHES POINT   2017    10    16    11 2017-10-16 11:00:00   0.2  11.7    88  983.    55   160
 3 SherkinIsland  2017    10    16    11 2017-10-16 11:00:00   0    13.4    92  975.    52   170
 4 MACE HEAD      2017     2    23     2 2017-02-23 02:00:00   0     7.6    86  985.    50   250
 5 ROCHES POINT   2017    10    16    13 2017-10-16 13:00:00   1    12.9    98  986.    50   190
 6 MACE HEAD      2017     2    23     3 2017-02-23 03:00:00   0     7      84  987     48   270
 7 MALIN HEAD     2017    12    31     7 2017-12-31 07:00:00   0.1   7      84  974.    48   250
 8 SherkinIsland  2017    10    16    10 2017-10-16 10:00:00   0.7  11.4    97  974.    47   150
 9 MACE HEAD      2017     2    23     4 2017-02-23 04:00:00   0     7.2    86  990.    46   290
10 MACE HEAD      2017    12    31     2 2017-12-31 02:00:00   0     8.2    78  979.    46   240
# … with 218,990 more rows
```


Challenge 5.2

- Arrange the observations by month and by highest temperature

3. select()

- It is not uncommon to get datasets with hundreds, or even thousands, of variables
- A challenge is to narrow down on the variables of you're interested in
- select() allows you to rapidly zoom in on a useful subset using operations based on the variable names
- Number of rows does not change

```
> new_obs <- select(observations,station,year,month,day,hour,temp)
> new_obs
# A tibble: 219,000 x 6
   station  year month   day  hour  temp
   <chr>   <dbl> <dbl> <int> <int> <dbl>
 1 ATHENRY  2017     1     1     0   5.2
 2 ATHENRY  2017     1     1     1   4.7
 3 ATHENRY  2017     1     1     2   4.2
 4 ATHENRY  2017     1     1     3   3.5
 5 ATHENRY  2017     1     1     4   3.2
 6 ATHENRY  2017     1     1     5   2.1
 7 ATHENRY  2017     1     1     6   2
 8 ATHENRY  2017     1     1     7   1.7
 9 ATHENRY  2017     1     1     8   1
10 ATHENRY  2017     1     1     9   1.1
# … with 218,990 more rows
```


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Useful options with select()

```
> select(observations,station:rain)
# A tibble: 219,000 x 7
   station  year month   day  hour date                rain
   <chr>   <dbl> <dbl> <int> <int> <dttm>              <dbl>
 1 ATHENRY  2017     1     1     0 2017-01-01 00:00:00   0
 2 ATHENRY  2017     1     1     1 2017-01-01 01:00:00   0
 3 ATHENRY  2017     1     1     2 2017-01-01 02:00:00   0
 4 ATHENRY  2017     1     1     3 2017-01-01 03:00:00   0.1
 5 ATHENRY  2017     1     1     4 2017-01-01 04:00:00   0.1
 6 ATHENRY  2017     1     1     5 2017-01-01 05:00:00   0
 7 ATHENRY  2017     1     1     6 2017-01-01 06:00:00   0
 8 ATHENRY  2017     1     1     7 2017-01-01 07:00:00   0
 9 ATHENRY  2017     1     1     8 2017-01-01 08:00:00   0
10 ATHENRY  2017     1     1     9 2017-01-01 09:00:00   0
# … with 218,990 more rows
```

```
> select(observations,-(station:rain))
# A tibble: 219,000 x 5
    temp  rhum   msl  wdsp wddir
   <dbl> <dbl> <dbl> <dbl> <dbl>
 1   5.2    89 1022.     8   320
 2   4.7    89 1022      9   320
 3   4.2    90 1022.     8   320
 4   3.5    87 1022.     9   330
 5   3.2    89 1023.     8   330
 6   2.1    91 1023.     8   330
 7   2      89 1024.     7   330
 8   1.7    89 1024.     7   340
 9   1      91 1025      7   330
10   1.1    91 1026.     8   330
# … with 218,990 more rows
```


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Special functions with select()

Special functions

As well as using existing functions like `:` and `c`, there are a number of special functions that only work inside `select`

- `starts_with(x, ignore.case = TRUE)`: names starts with `x`
- `ends_with(x, ignore.case = TRUE)`: names ends in `x`
- `contains(x, ignore.case = TRUE)`: selects all variables whose name contains `x`
- `matches(x, ignore.case = TRUE)`: selects all variables whose name matches the regular expression `x`
- `num_range("x", 1:5, width = 2)`: selects all variables (numerically) from x01 to x05.
- `one_of("x", "y", "z")`: selects variables provided in a character vector.
- `everything()`: selects all variables.

Examples

```
> select(observations,starts_with("w"))
# A tibble: 219,000 x 2
    wdsp wddir
   <dbl> <dbl>
 1     8   320
 2     9   320
 3     8   320
 4     9   330
 5     8   330
 6     8   330
 7     7   330
 8     7   340
 9     7   330
10     8   330
# … with 218,990 more rows
```

```
> select(observations,ends_with("p"))
# A tibble: 219,000 x 2
    temp  wdsp
   <dbl> <dbl>
 1   5.2     8
 2   4.7     9
 3   4.2     8
 4   3.5     9
 5   3.2     8
 6   2.1     8
 7   2       7
 8   1.7     7
 9   1       7
10   1.1     8
# … with 218,990 more rows
```

everything()

```
> select(observations,ends_with("p"),everything())
# A tibble: 219,000 x 12
    temp  wdsp station  year month   day  hour date                rain  rhum   msl wddir
   <dbl> <dbl> <chr>   <dbl> <dbl> <int> <int> <dttm>              <dbl> <dbl> <dbl> <dbl>
 1   5.2     8 ATHENRY  2017     1     1     0 2017-01-01 00:00:00   0      89 1022.   320
 2   4.7     9 ATHENRY  2017     1     1     1 2017-01-01 01:00:00   0      89 1022    320
 3   4.2     8 ATHENRY  2017     1     1     2 2017-01-01 02:00:00   0      90 1022.   320
 4   3.5     9 ATHENRY  2017     1     1     3 2017-01-01 03:00:00   0.1    87 1022.   330
 5   3.2     8 ATHENRY  2017     1     1     4 2017-01-01 04:00:00   0.1    89 1023.   330
 6   2.1     8 ATHENRY  2017     1     1     5 2017-01-01 05:00:00   0      91 1023.   330
 7   2       7 ATHENRY  2017     1     1     6 2017-01-01 06:00:00   0      89 1024.   330
 8   1.7     7 ATHENRY  2017     1     1     7 2017-01-01 07:00:00   0      89 1024.   340
 9   1       7 ATHENRY  2017     1     1     8 2017-01-01 08:00:00   0      91 1025    330
10   1.1     8 ATHENRY  2017     1     1     9 2017-01-01 09:00:00   0      91 1026.   330
# … with 218,990 more rows
```


Summary: 3 of the 5 verbs

Function	Purpose
filter()	Pick observations by their values
arrange()	Reorder the rows
select()	Pick variables by their names
mutate()	*Create new variables with functions of existing variables*
summarise()	*Collapse many values down to a single summary*

- ”A grammar of data manipulation” https://dplyr.tidyverse.org
- All verbs (functions) work similarly
  - The first argument is a data frame/tibble
  - The subsequent arguments decide what to do with the data frame/tibble
  - The result (data frame/tibble) supports chaining of steps – NOTE the “pipe operator” which we will cover later.

Challenge 5.3

- Create tibble one that has the columns month, hour, day, date, station and msl
- Filter the tibble to a second tibble for October 16th, and for "VALENTIA OBSERVATORY" and "DUBLIN AIRPORT"
- Display the hourly values on a time series (x axis is date) using ggplot2 with the aesthetic set to station