

Wrangling data with dplyr

2/20/23

dplyr : go wrangling



The main verbs of **dplyr**

select()

filter()

mutate()

arrange()

summarize()

group_by()



The main verbs of **dplyr**

select() = *Subset columns (variables)*

filter()

mutate()

arrange()

summarize()

group_by()

select()

```
1 select(<DATA>, <VARIABLES>)
```

select()

```
1 diamonds
```

```
# A tibble: 53,940 × 10
```

	carat	cut	color	clarity	depth	table	price	x	y
	<dbl>	<ord>	<ord>	<ord>	<dbl>	<dbl>	<int>	<dbl>	<dbl>
1	0.23	Ideal	E	SI2	61.5	55	326	3.95	3.98
2	0.21	Premium	E	SI1	59.8	61	326	3.89	3.84
3	0.23	Good	E	VS1	56.9	65	327	4.05	4.07
4	0.29	Premium	I	VS2	62.4	58	334	4.2	4.23
5	0.31	Good	J	SI2	63.3	58	335	4.34	4.35
6	0.24	Very G...	J	VVS2	62.8	57	336	3.94	3.96
7	0.24	Very G...	I	VVS1	62.3	57	336	3.95	3.98
8	0.26	Very G...	H	SI1	61.9	55	337	4.07	4.11
9	0.22	Fair	E	VS2	65.1	61	337	3.87	3.78
10	0.23	Very G...	H	VS1	59.4	61	338	4	4.05
"	"	"	"	"	"	"	"	"	"



new data alert!



diamonds

	carat	cut	color	clarity	depth	table	price	x	y	z
1	0.23	Ideal	E	SI2	61.5	55.0	326	3.95	3.98	2.43
2	0.21	Premium	E	SI1	59.8	61.0	326	3.89	3.84	2.31
3	0.23	Good	E	VS1	56.9	65.0	327	4.05	4.07	2.31
4	0.29	Premium	I	VS2	62.4	58.0	334	4.20	4.23	2.63
5	0.31	Good	J	SI2	63.3	58.0	335	4.34	4.35	2.75
6	0.24	Very Good	J	VVS2	62.8	57.0	336	3.94	3.96	2.48
7	0.24	Very Good	I	VVS1	62.3	57.0	336	3.95	3.98	2.47
8	0.26	Very Good	H	SI1	61.9	55.0	337	4.07	4.11	2.53
9	0.22	Fair	E	VS2	65.1	61.0	337	3.87	3.78	2.49
10	0.23	Very Good	H	VS1	59.4	61.0	338	4.00	4.05	2.39
11	0.30	Good	J	SI1	64.0	55.0	339	4.25	4.28	2.73
12	0.23	Ideal	J	VS1	62.8	56.0	340	3.93	3.90	2.46
13	0.22	Premium	F	SI1	60.4	61.0	342	3.88	3.84	2.33
14	0.31	Ideal	J	SI2	62.2	54.0	344	4.35	4.37	2.71
15	0.20	Premium	E	SI2	60.2	62.0	345	3.79	3.75	2.27
16	0.32	Premium	E	I1	60.9	58.0	345	4.38	4.42	2.68
17	0.30	Ideal	I	SI2	62.0	54.0	348	4.31	4.34	2.68
18	0.30	Good	J	SI1	63.4	54.0	351	4.23	4.29	2.70

Where does it come from?

The ggplot2 R package

How can I use it?

```
library(ggplot2)  
View(diamonds)
```



it's invisible!

select()

```
1 select(diamonds, carat, cut, color, clarity)
```

select()

```
1 select(diamonds, carat, cut, color, clarity)
```

```
# A tibble: 53,940 × 4
```

	carat	cut	color	clarity
	<dbl>	<ord>	<ord>	<ord>
1	0.23	Ideal	E	SI2
2	0.21	Premium	E	SI1
3	0.23	Good	E	VS1
4	0.29	Premium	I	VS2
5	0.31	Good	J	SI2
6	0.24	Very Good	J	VVS2
7	0.24	Very Good	I	VVS1
8	0.26	Very Good	H	SI1
9	0.22	Fair	E	VS2
10	0.23	Very Good	H	VS1
"	"	"	"	"

select()

```
1 select(diamonds, carat, cut, color, clarity)
2 select(diamonds, carat:clarity)
3 select(diamonds, 1:4)
4 select(diamonds, starts_with("c"))
5 ?select_helpers
```

gapminder

```
1 library(gapminder)
2 gapminder
```

```
# A tibble: 1,704 × 6
```

	country	continent	year	lifeExp	pop	gdpPercap
	<fct>	<fct>	<int>	<dbl>	<int>	<dbl>
1	Afghanistan	Asia	1952	28.8	8425333	779.
2	Afghanistan	Asia	1957	30.3	9240934	821.
3	Afghanistan	Asia	1962	32.0	10267083	853.
4	Afghanistan	Asia	1967	34.0	11537966	836.
5	Afghanistan	Asia	1972	36.1	13079460	740.
6	Afghanistan	Asia	1977	38.4	14880372	786.
7	Afghanistan	Asia	1982	39.9	12881816	978.
8	Afghanistan	Asia	1987	40.8	13867957	852.
9	Afghanistan	Asia	1992	41.7	16317921	649.
10	Afghanistan	Asia	1997	41.8	22227415	635.

```
" # A tibble: 1,704 × 6
```



new data alert!



gapminder

	country	continent	year	lifeExp	pop	gdpPercap
1	Afghanistan	Asia	1952	28.801	8425333	779.4453
2	Afghanistan	Asia	1957	30.332	9240934	820.8530
3	Afghanistan	Asia	1962	31.997	10267083	853.1007
4	Afghanistan	Asia	1967	34.020	11537966	836.1971
5	Afghanistan	Asia	1972	36.088	13079460	739.9811
6	Afghanistan	Asia	1977	38.438	14880372	786.1134
7	Afghanistan	Asia	1982	39.854	12881816	978.0114
8	Afghanistan	Asia	1987	40.822	13867957	852.3959
9	Afghanistan	Asia	1992	41.674	16317921	649.3414
10	Afghanistan	Asia	1997	41.763	22227415	635.3414
11	Afghanistan	Asia	2002	42.129	25268405	726.7341
12	Afghanistan	Asia	2007	43.828	31889923	974.5803
13	Albania	Europe	1952	55.230	1282697	1601.0561
14	Albania	Europe	1957	59.280	1476505	1942.2842
15	Albania	Europe	1962	64.820	1728137	2312.8890

Where does it come from?

The gapminder R
package

How can I use it?

```
library(gapminder)  
View(gapminder)
```



it's invisible!

Your Turn 1

Alter the code to select just the **pop column:**

```
1 select(gapminder, year, lifeExp)
```

Your Turn 1

```
1 select(gapminder, pop)
```

```
# A tibble: 1,704 × 1
```

```
  pop
```

```
  <int>
```

```
1  8425333
```

```
2  9240934
```

```
3 10267083
```

```
4 11537966
```

```
5 13079460
```

```
6 14880372
```

```
7 12881816
```

```
8 13867957
```

```
9 16317921
```

```
10 22227415
```

```
"# A tibble: 1,704 × 1"
```

Make a prediction

Which of these is NOT a way to select the **country** and **continent** columns together?

```
1 select(gapminder, -c(year, lifeExp, pop, gdpPercap))
2
3 select(gapminder, country:continent)
4
5 select(gapminder, starts_with("c"))
6
7 select(gapminder, ends_with("t"))
```


Make a prediction

Which of these is NOT a way to select the **country** and **continent** columns together?

```
1 select(gapminder, ends_with("t"))
```

```
# A tibble: 1,704 × 1
```

```
  continent
```

```
  <fct>
```

```
1 Asia
```

```
2 Asia
```

```
3 Asia
```

```
4 Asia
```

```
5 Asia
```

```
6 Asia
```

```
7 Asia
```

```
8 Asia
```

```
9 Asia
```

```
10 Asia
```

```
"continent" 1 604
```

The main verbs of **dplyr**

select()

filter() = *Subset rows by value*

mutate()

arrange()

summarize()

group_by()

filter()

```
1 filter(<DATA>, <PREDICATES>)
```

Predicates: TRUE or FALSE statements

Comparisons: >, >=, <, <=, != (not equal), and == (equal).

Operators: & is “and”, | is “or”, and ! is “not”

%in%

```
1 "a" %in% c("a", "b", "c")
```

```
[1] TRUE
```

filter()

```
1 filter(diamonds, cut == "Ideal", carat > 3)
```

```
# A tibble: 4 × 10
```

	carat	cut	color	clarity	depth	table	price	x	y
	<dbl>	<ord>	<ord>	<ord>	<dbl>	<dbl>	<int>	<dbl>	<dbl>
1	3.22	Ideal	I	I1	62.6	55	12545	9.49	9.42
2	3.5	Ideal	H	I1	62.8	57	12587	9.65	9.59
3	3.01	Ideal	J	SI2	61.7	58	16037	9.25	9.2
4	3.01	Ideal	J	I1	65.4	60	16538	8.99	8.93

```
# ... with 1 more variable: z <dbl>
```

Your turn 2

Show:

All of the rows where **pop** is greater than or equal to 100000

All of the rows for El Salvador

All of the rows that have a missing value for **year** (no need to edit this code)

```
1 filter(gapminder, pop >= 100000)
2 filter(gapminder, country == "El Salvador")
3 filter(gapminder, is.na(year))
```

filter()

```
1 filter(diamonds, cut == "Ideal" | cut == "Very Good", carat > 3)
```

```
# A tibble: 6 × 10
```

	carat	cut	color	clarity	depth	table	price	x	y
	<dbl>	<ord>	<ord>	<ord>	<dbl>	<dbl>	<int>	<dbl>	<dbl>
1	3.22	Ideal	I	I1	62.6	55	12545	9.49	9.42
2	3.5	Ideal	H	I1	62.8	57	12587	9.65	9.59
3	3.04	Very Go...	I	SI2	63.2	59	15354	9.14	9.07
4	4	Very Go...	I	I1	63.3	58	15984	10.0	9.94
5	3.01	Ideal	J	SI2	61.7	58	16037	9.25	9.2
6	3.01	Ideal	J	I1	65.4	60	16538	8.99	8.93

```
# ... with 1 more variable: z <dbl>
```

Your turn 3

Use Boolean operators to alter the code below to return only the rows that contain:

El Salvador

Countries that had populations over 100000 in 1960 or earlier

```
1 filter(gapminder, country == "El Salvador" | country == "Oman")
2 filter(_____, _____)
```

Your turn 3

Use Boolean operators to alter the code below to return only the rows that contain:

El Salvador

Countries that had populations over 100000 in 1960 or earlier

```
1 filter(gapminder, country == "El Salvador")  
2 filter(gapminder, pop > 100000, year <= 1960)
```


The main verbs of **dplyr**

select()

filter()

mutate() = *Change or add a variable*

arrange()

summarize()

group_by()

mutate()

```
1 mutate(<DATA>, <NAME> = <FUNCTION>)
```

mutate()

```
1 mutate(  
2   diamonds,  
3   log_price = log(price),  
4   log_pricesq = log_price^2  
5 )
```

mutate()

```
# A tibble: 53,940 × 12
  carat cut      color clarity depth table price      x      y
  <dbl> <ord>    <ord> <ord>    <dbl> <dbl> <int> <dbl> <dbl>
1  0.23 Ideal    E      SI2      61.5    55    326  3.95  3.98
2  0.21 Premium E      SI1      59.8    61    326  3.89  3.84
3  0.23 Good     E      VS1      56.9    65    327  4.05  4.07
4  0.29 Premium I      VS2      62.4    58    334  4.2   4.23
5  0.31 Good     J      SI2      63.3    58    335  4.34  4.35
6  0.24 Very G... J      VVS2      62.8    57    336  3.94  3.96
7  0.24 Very G... I      VVS1      62.3    57    336  3.95  3.98
8  0.26 Very G... H      SI1      61.9    55    337  4.07  4.11
9  0.22 Fair     E      VS2      65.1    61    337  3.87  3.78
10 0.23 Very G... H      VS1      59.4    61    338  4     4.05
# with 53,930 more rows and 2 more variables: <dbl>, <dbl>
```

The main verbs of **dplyr**

select()

filter()

mutate()

arrange() = *Sort the data set*

summarize()

group_by()

arrange()

```
1 arrange(<DATA>, <SORTING VARIABLE>)
```

arrange()

```
1 arrange(diamonds, price)
```

```
# A tibble: 53,940 × 10
```

	carat	cut	color	clarity	depth	table	price	x	y
	<dbl>	<ord>	<ord>	<ord>	<dbl>	<dbl>	<int>	<dbl>	<dbl>
1	0.23	Ideal	E	SI2	61.5	55	326	3.95	3.98
2	0.21	Premium	E	SI1	59.8	61	326	3.89	3.84
3	0.23	Good	E	VS1	56.9	65	327	4.05	4.07
4	0.29	Premium	I	VS2	62.4	58	334	4.2	4.23
5	0.31	Good	J	SI2	63.3	58	335	4.34	4.35
6	0.24	Very G...	J	VVS2	62.8	57	336	3.94	3.96
7	0.24	Very G...	I	VVS1	62.3	57	336	3.95	3.98
8	0.26	Very G...	H	SI1	61.9	55	337	4.07	4.11
9	0.22	Fair	E	VS2	65.1	61	337	3.87	3.78
10	0.23	Very G...	H	VS1	59.4	61	338	4	4.05
"	1.11	52-530			1.1	1.1	1.1	1.1	1.1

arrange()

```
1 arrange(diamonds, cut, price)
```

```
# A tibble: 53,940 × 10
  carat cut    color clarity depth table price      x      y
  <dbl> <ord> <ord> <ord>    <dbl> <dbl> <int> <dbl> <dbl>
1  0.22 Fair    E      VS2     65.1    61    337  3.87  3.78
2  0.25 Fair    E      VS1     55.2    64    361  4.21  4.23
3  0.23 Fair    G      VVS2    61.4    66    369  3.87  3.91
4  0.27 Fair    E      VS1     66.4    58    371  3.99  4.02
5  0.3   Fair    J      VS2     64.8    58    416  4.24  4.16
6  0.3   Fair    F      SI1     63.1    58    496  4.3   4.22
7  0.34 Fair    J      SI1     64.5    57    497  4.38  4.36
8  0.37 Fair    F      SI1     65.3    56    527  4.53  4.47
9  0.3   Fair    D      SI2     64.6    54    536  4.29  4.25
10 0.25 Fair    D      VS1     61.2    55    563  4.09  4.11
"      "      "      "      "      "      "      "      "      "
```


desc()

```
1 arrange(diamonds, cut, desc(price))
```

```
# A tibble: 53,940 × 10
  carat cut    color clarity depth table price      x      y
  <dbl> <ord> <ord> <ord>    <dbl> <dbl> <int> <dbl> <dbl>
1   2.01 Fair    G      SI1     70.6   64  18574  7.43  6.64
2   2.02 Fair    H      VS2     64.5   57  18565  8     7.95
3   4.5  Fair    J      I1      65.8   58  18531 10.2  10.2
4    2   Fair    G      VS2     67.6   58  18515  7.65  7.61
5   2.51 Fair    H      SI2     64.7   57  18308  8.44  8.5
6   3.01 Fair    I      SI2     65.8   56  18242  8.99  8.94
7   3.01 Fair    I      SI2     65.8   56  18242  8.99  8.94
8   2.32 Fair    H      SI1     62     62  18026  8.47  8.31
9   5.01 Fair    J      I1     65.5   59  18018 10.7  10.5
10  1.93 Fair    F      VS1     58.9   62  17995  8.17  7.97
"      "      "      "      "      "      "      "      "      "
```

Your turn 4

Arrange gapminder by **year**. Add **lifeExp** as a second (tie breaking) variable to arrange on.

Which country had the lowest life expectancy in 1952?

Your turn 4

```
1 arrange(gapminder, year, lifeExp)
```

```
# A tibble: 1,704 × 6
```

	country	continent	year	lifeExp	pop	gdpPercap
	<fct>	<fct>	<int>	<dbl>	<int>	<dbl>
1	Afghanistan	Asia	1952	28.8	8425333	779.
2	Gambia	Africa	1952	30	284320	485.
3	Angola	Africa	1952	30.0	4232095	3521.
4	Sierra Leone	Africa	1952	30.3	2143249	880.
5	Mozambique	Africa	1952	31.3	6446316	469.
6	Burkina Faso	Africa	1952	32.0	4469979	543.
7	Guinea-Bissau	Africa	1952	32.5	580653	300.
8	Yemen, Rep.	Asia	1952	32.5	4963829	782.
9	Somalia	Africa	1952	33.0	2526994	1136.
10	Guinea	Africa	1952	33.6	2664249	510.

```
" " " " " " " " " " " "
```

Your turn 5

Use `desc()` to find the country with the highest `gdpPerCap`.

Your turn 5

```
1 arrange(gapminder, desc(gdpPercap))
```

```
# A tibble: 1,704 × 6
```

	country	continent	year	lifeExp	pop	gdpPercap
	<fct>	<fct>	<int>	<dbl>	<int>	<dbl>
1	Kuwait	Asia	1957	58.0	212846	113523.
2	Kuwait	Asia	1972	67.7	841934	109348.
3	Kuwait	Asia	1952	55.6	160000	108382.
4	Kuwait	Asia	1962	60.5	358266	95458.
5	Kuwait	Asia	1967	64.6	575003	80895.
6	Kuwait	Asia	1977	69.3	1140357	59265.
7	Norway	Europe	2007	80.2	4627926	49357.
8	Kuwait	Asia	2007	77.6	2505559	47307.
9	Singapore	Asia	2007	80.0	4553009	47143.
10	Norway	Europe	2002	79.0	4535591	44684.

Detour: The Pipe | >

Detour: The Pipe

```
1 diamonds <- arrange(diamonds, price)
2 diamonds <- filter(diamonds, price > 300)
3 diamonds <- mutate(diamonds, log_price = log(price))
4
5 diamonds
```

Detour: The Pipe

```
1 diamonds <- diamonds |>
2   arrange(price) |>
3   filter(price > 300) |>
4   mutate(log_price = log(price))
5
6 diamonds
```

Passes the result of one function to another function

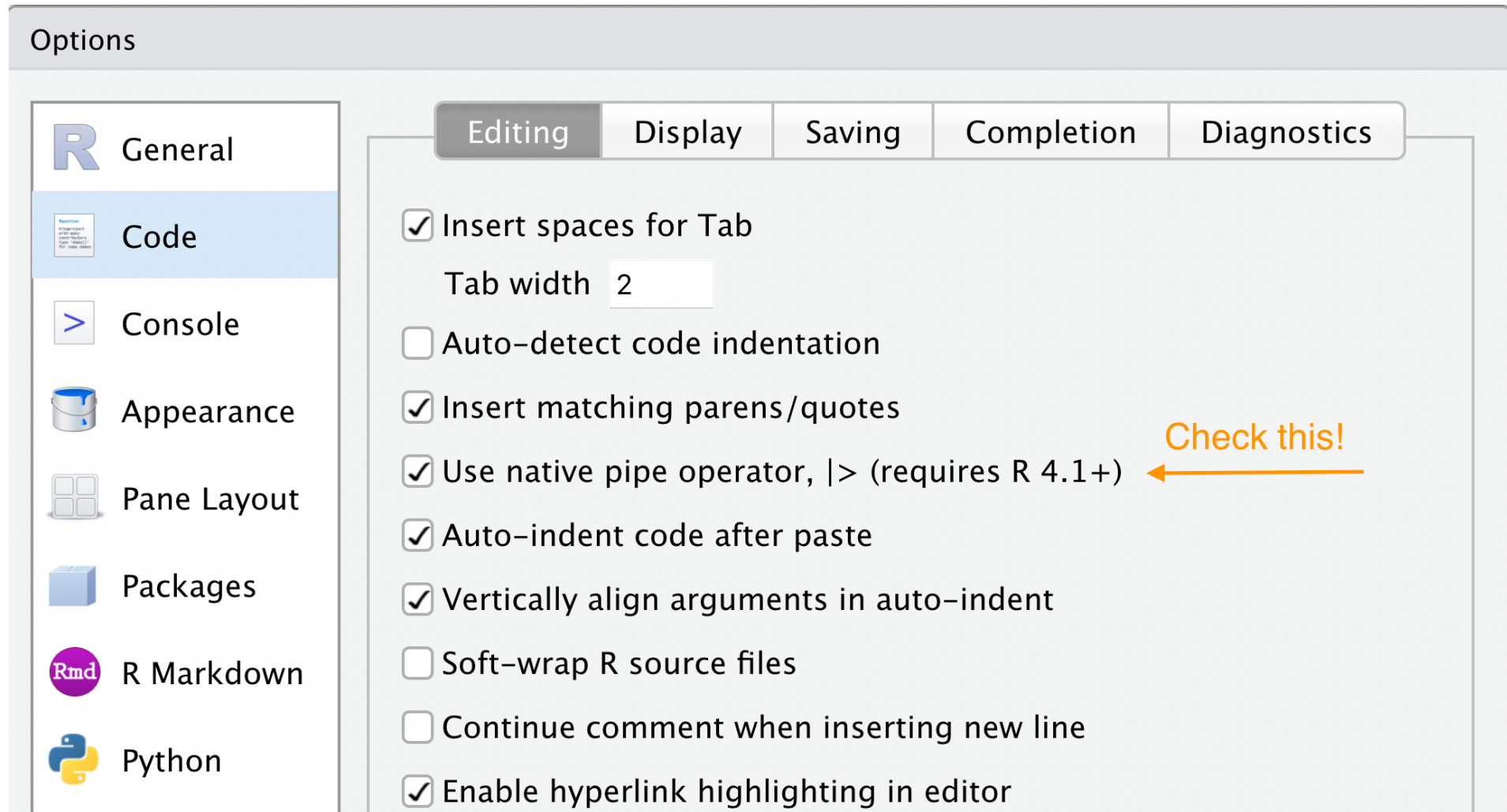
Keyboard shortcuts

Insert < - with alt/opt + -

Insert | > with ctrl/cmd +
shift + m

Keyboard shortcuts

Tools > Global Options > Code



The magrittr pipe

In the wild, you'll see `%>%` a lot. This is the old pipe prior to when R had a built-in one. Either pipe is fine, but we'll use the so-called native pipe `|>`

See [R for Data Science](#) for more info

Your turn 6

Use `|>` to write a sequence of functions that:

Filter only countries that are in the continent of Oceania.

Select the `country`, `year` and `lifeExp` columns

Arrange the results so that the highest life expectancy is at the top.

Your turn 6

```
1 gapminder |>
2   filter(continent == "Oceania") |>
3   select(country, year, lifeExp) |>
4   arrange(desc(lifeExp))
```

```
# A tibble: 24 × 3
  country      year lifeExp
  <fct>      <int>   <dbl>
1 Australia    2007    81.2
2 Australia    2002    80.4
3 New Zealand  2007    80.2
4 New Zealand  2002    79.1
5 Australia    1997    78.8
6 Australia    1992    77.6
7 New Zealand  1997    77.6
8 New Zealand  1992    76.3
9 Australia    1987    76.3
10 Australia   1982    74.7
" ... "
```

Challenge!

1. Import the diabetes data from the importing data. A copy of the CSV file is available in this folder.
2. Add the variable **bmi** to the data set using height and weight using the formula: $(\text{weight} / \text{height}^2) * 703$
3. Select just **id**, **glyhb**, and the new variable you created.
4. Filter rows that have BMI > 35. How many rows and columns are in your new data set?

```

1 diabetes <- read_csv("diabetes.csv")
2 diabetes |>
3   mutate(bmi = (weight / height^2) * 703) |>
4   select(id, glyhb, bmi) |>
5   filter(bmi > 35)

```

```

# A tibble: 61 × 3
   id glyhb  bmi
  <dbl> <dbl> <dbl>
1  1001  4.44  37.4
2  1002  4.64  48.4
3  1022  5.78  35.8
4  1029  4.97  40.8
5  1253  4.67  36.0
6  1254 12.7   42.5
7  1280  5.10  38.3
8  1501  4.41  40.0
9  2753  5.57  35.3
10 2757  6.33  35.3

```

The main verbs of **dplyr**

select()

filter()

mutate()

arrange()

summarize() = *Summarize the data*

group_by() = *Group the data*

summarize()

```
1 summarize(<DATA>, <NAME> = <FUNCTION>)
```

summarize()

```
1 summarize(diamonds, n = n(), mean_price = mean(price))
```

```
# A tibble: 1 × 2
```

	n	mean_price
	<int>	<dbl>
1	53940	3933.

Your turn 7

Use `summarise()` to compute these statistics about the gapminder data set:

1. The first (`min()`) year in the data
2. The last (`max()`) year in the data
3. The total number of observations (`n()`) and the total number of unique countries in the data (`n_distinct()`)

Your turn 7

```
1 gapminder |>
2   summarize(
3     first = min(year),
4     last = max(year),
5     n = n(),
6     n_countries = n_distinct(country)
7   )
```

```
# A tibble: 1 × 4
  first last      n n_countries
  <int> <int> <int>      <int>
1  1952  2007  1704      142
```

group_by()

```
1 group_by(<DATA>, <VARIABLE>)
```

group_by()

```
1 diamonds |>  
2   group_by(cut)
```

```
# A tibble: 53,940 × 10
```

```
# Groups:   cut [5]
```

	carat	cut	color	clarity	depth	table	price	x	y
	<dbl>	<ord>	<ord>	<ord>	<dbl>	<dbl>	<int>	<dbl>	<dbl>
1	0.23	Ideal	E	SI2	61.5	55	326	3.95	3.98
2	0.21	Premium	E	SI1	59.8	61	326	3.89	3.84
3	0.23	Good	E	VS1	56.9	65	327	4.05	4.07
4	0.29	Premium	I	VS2	62.4	58	334	4.2	4.23
5	0.31	Good	J	SI2	63.3	58	335	4.34	4.35
6	0.24	Very G...	J	VVS2	62.8	57	336	3.94	3.96
7	0.24	Very G...	I	VVS1	62.3	57	336	3.95	3.98
8	0.26	Very G...	H	SI1	61.9	55	337	4.07	4.11
9	0.22	Fair	E	VS2	65.1	61	337	3.87	3.78
10	0.23	Very G...	E	VVS1	59.4	61	338	4.05	4.05

group_by()

```
1 diamonds |>  
2   group_by(cut) |>  
3   summarize(n = n(), mean_price = mean(price))
```

```
# A tibble: 5 × 3  
  cut          n mean_price  
  <ord>      <int>      <dbl>  
1 Fair       1610      4359.  
2 Good       4906      3929.  
3 Very Good 12082      3982.  
4 Premium   13791      4584.  
5 Ideal     21551      3458.
```

Your turn 8

Extract the rows where `continent == "Europe"`. Then use `group_by()` to group by country. Finally, use `summarize()` to compute:

1. The total number of observations for each country in Europe
2. The lowest observed life expectancy for each country

Your turn 8

```
1 gapminder |>
2   filter(continent == "Europe") |>
3   group_by(country) |>
4   summarize(n = n(), min_le = min(lifeExp))
```

A tibble: 30 × 3

	country	n	min_le
	<fct>	<int>	<dbl>
1	Albania	12	55.2
2	Austria	12	66.8
3	Belgium	12	68
4	Bosnia and Herzegovina	12	53.8
5	Bulgaria	12	59.6
6	Croatia	12	61.2
7	Czech Republic	12	66.9
8	Denmark	12	70.8
9	Finland	12	66.6
10	France	12	67.4
"	"	"	"

Your turn 9

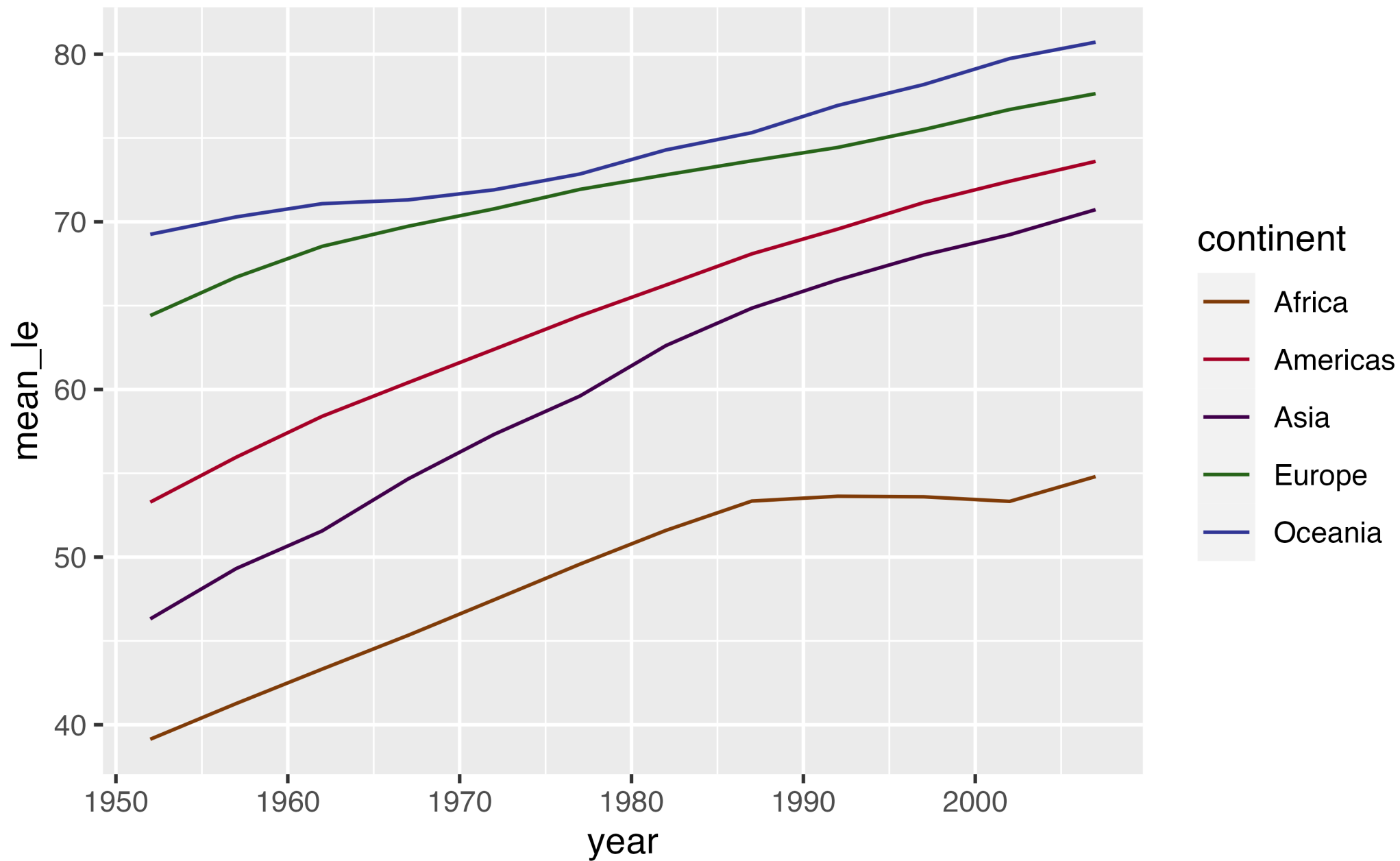
Use grouping to calculate the mean life expectancy for each continent and year. Call the mean life expectancy variable **mean_le**. Plot the life expectancy over time (no need to change the plot code).

```
1 gapminder |>
2   _____ |>
3   _____ |>
4   ggplot(aes(x = year, y = mean_le, col = continent)) +
5   geom_line() +
6   scale_color_manual(values = continent_colors)
```

Your turn 9

Use grouping to calculate the mean life expectancy for each continent and year. Call the mean life expectancy variable **mean_le**. Plot the life expectancy over time (no need to change the plot code).

```
1 gapminder |>
2   group_by(continent, year) |>
3   summarize(mean_le = mean(lifeExp)) |>
4   ggplot(aes(x = year, y = mean_le, col = continent)) +
5   geom_line() +
6   scale_color_manual(values = continent_colors)
```



Joining data

Use `left_join()`, `right_join()`, `full_join()`, or `inner_join()` to join datasets

Use `semi_join()` or `anti_join()` to filter datasets against each other

Resources

R for Data Science: A comprehensive but friendly introduction to the tidyverse. Free online.

Posit Primers: Free interactive courses in the Tidyverse

10 dplyr tips: a Twitter thread on other useful aspects of dplyr

