Designing for decision-making

How to build effective data visualisations

Nicola Rennie

If you were going to make a decision based on some information...

If you were going to make a decision based on some information...

what qualities would you want that information to have?

UK To Australia Plug Adapter with 3 USB, China New Zealand Australian Plug Adaptor from UK, 4 in 1 Grounded Charger UK to Australia Travel Plug Adaptor for AUS NZ Argentina Fiji and More (Type I)

Visit the Mscien Store

4.8 ★★★★★ (115)

Amazon's Choice

100+ bought in past month

-14% £11.99

Was: £13.99

prime One-Day

FREE Returns

Exclusive Prime price

Save 5% on any 4 Terms

Get a £20 Amazon Gift Card if approved for The Amazon Barclaycard. Apply now. Representative 28.9% APR variable. Credit broker: Amazon EU S.A.R.L. Lender: Barclays. T&Cs apply.

Brand	Mscien
Plug type	Type I
UPC	850076029067
Total power outlets	4

£11.99

prime One-Day

FREE Returns

FREE delivery **Tomorrow, 15 September**. Details

Or FREE delivery **Tomorrow 07:00 - 13:00** on orders over £20 of Prime Same-day & Overnight item(s). Order within 2 hrs 29 mins. Details

Deliver to Nicola - Livingston EH53 0

In stock

Quantity: 1

Add to Basket

Buy Now

Dispatches from	Amazon
Sold by	OULUO TECH
Returns	Returnable within 30 days of receipt
Gift options	Available at checkout

UK To Australia Pl
China New Zealan
from UK, 4 in 1 Gr
Australia Travel Pl
Argentina Fiji and

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Plug type	Type I
UPC	850076029067
Total power outlets	4

The average rating is 4.8, but what's the worst review?

Is this trying to persuade or inform me?

One-Day
turns

livery **Tomorrow, 15**
ber. Details

delivery **Tomorrow**
13:00 on orders over £20
Same-day & Overnight
Order within 2 hrs 29
s. Details

Deliver to Nicola - Livingston EH53 0

In stock

Quantity: 1

Add to Basket

Buy Now

Dispatches from	Amazon
Sold by	OULUO TECH
Returns	Returnable within 30 days of receipt
Gift options	Available at checkout

Is this a reasonable price for this product?

What's the context of this price?

The average rating is 4.8, but what's the worst review?

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Click to see full view

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China New Zealan
from UK, 4 in 1 Gr
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Argentina Fiji and

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Details

Deliver to Nicola - Livingston EH53 0

In stock

Quantity: 1

Add to Basket

Buy Now

Dispatches from	Amazon
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Returns	Returnable within 30 days of receipt
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Click to see full view

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Argentina Fiji and

Visit the Mscien Store

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Was: £13.99

prime One-Day

FREE Returns

Exclusive Prime price

Save 5% on any 4 Terms

Get a £20 Amazon Gift Card if appr
Representative 28.9% APR variable.
T&Cs apply.

Brand	Mscien
Plug type	Type I
UPC	850076029067
Total power outlets	4

How long will this offer last?

Is this price accurate?

9

One-Day

turns

livery **Tomorrow, 15**
ber. Details

delivery **Tomorrow**
13:00 on orders over £20
Same-day & Overnight
Order within 2 hrs 29
mins. Details

Deliver to Nicola - Livingston EH53 0

In stock

Quantity: 1

Add to Basket

Buy Now

Dispatches from	Amazon
Sold by	OULUO TECH
Returns	Returnable within 30 days of receipt
Gift options	Available at checkout

Is this a reasonable price for this product?

What's the context of this price?

Click to see full view

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China New Zealan
from UK, 4 in 1 Gr
Australia Travel Pl
Argentina Fiji and

Visit the Mscien Store

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Amazon's Choice

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-14% £11.99

Was: £13.99

prime One-Day

FREE Returns

Exclusive Prime price

Save 5% on any 4 Terms

Get a £20 Amazon Gift Card if appr
% APR variable.

Mscien

Type I

350076029067

4

How long will this offer last?

Is this price accurate?

What other similar products exist?

How do I compare them?

One-Day

turns

livery **Tomorrow, 15**

ber. Details

delivery **Tomorrow**

13:00 on orders over £20

Same-day & Overnight

Order within 2 hrs 29

Details

Deliver to Nicola - Livingston EH53 0

In stock

Quantity: 1

Add to Basket

Buy Now

Dispatches from	Amazon
Sold by	OULUO TECH
Returns	Returnable within 30 days of receipt
Gift options	Available at checkout

Is this a reasonable price for this product?
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Mscien
Type I
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4
One-Day
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Quantity: 1
Add to Basket
Buy Now
Dispatches from Amazon
Sold by OULUO TECH
Returns Returnable within 30 days of receipt
Gift options Available at checkout
2+
VIDEO
MSCIEN
Is there extra information hidden in the images?
Can I access it?
What other similar products exist?
How do I compare them?
How long will this offer last?
Is this price accurate?

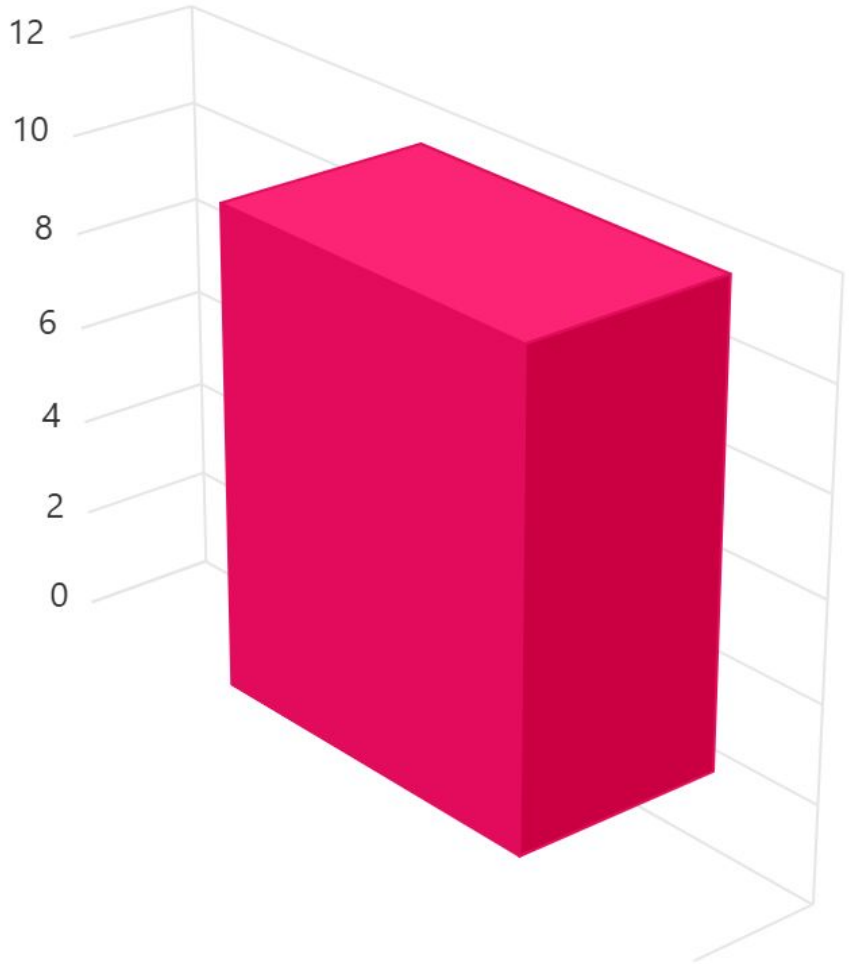
How do we design data visualisations that are:

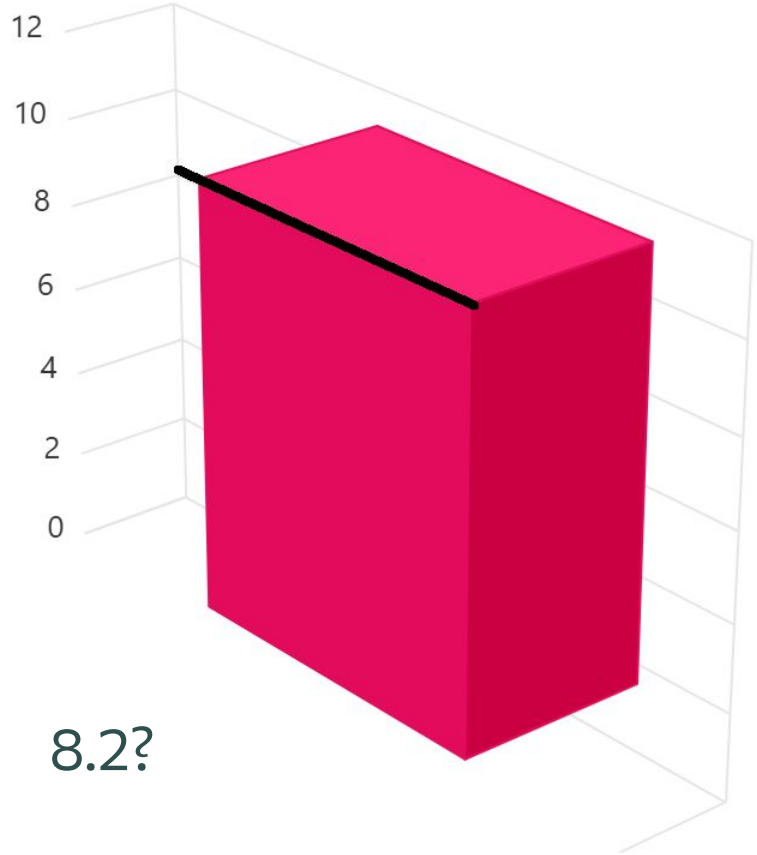
- Accurate
- Comparative
- Contextualised
- Accessible
- Informative

Design data visualisations that are

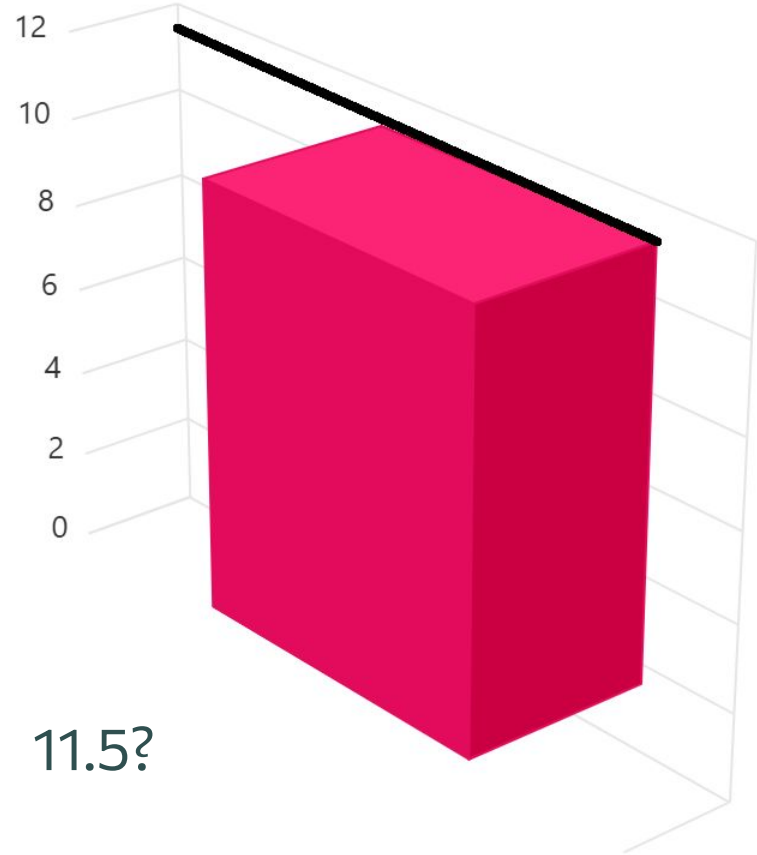
Accurate

What value does this bar represent?



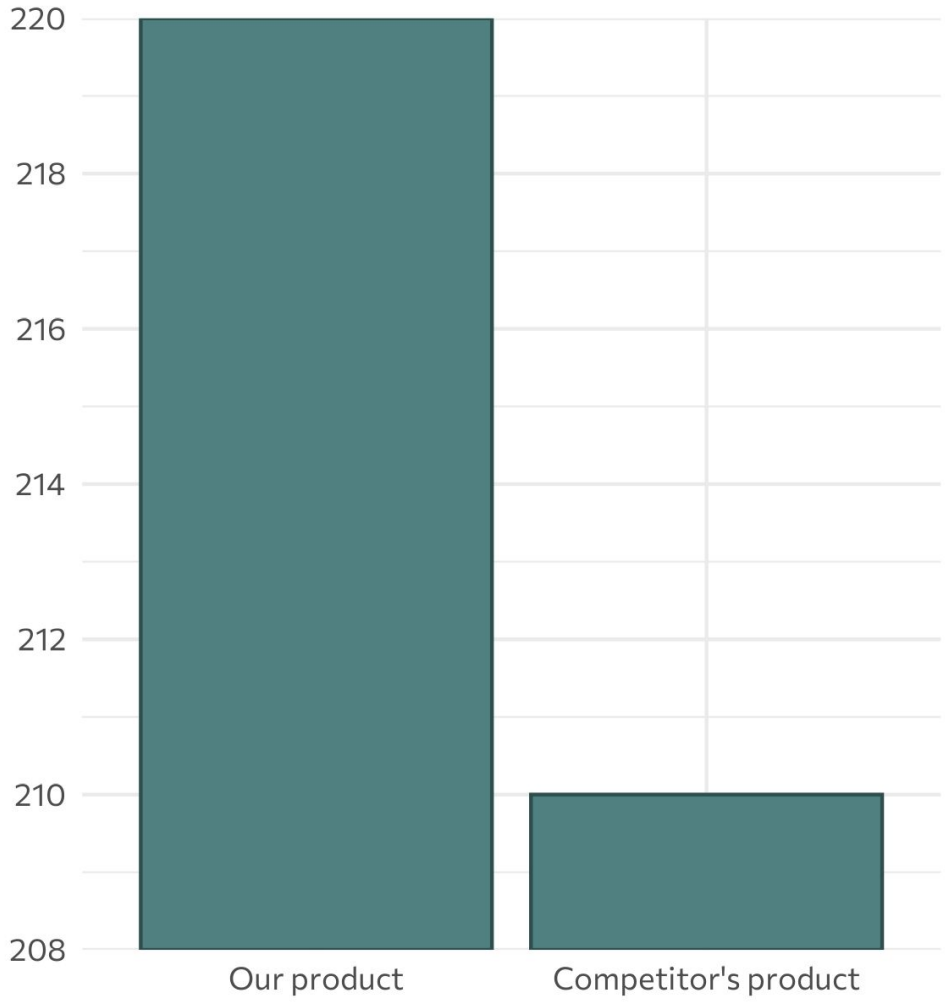


8.2?



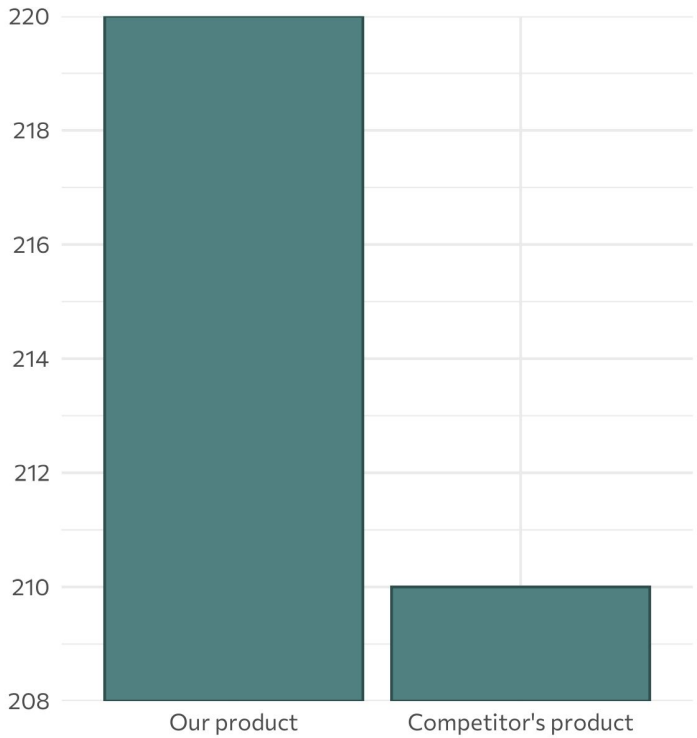
11.5?

How much bigger is the value on the left?

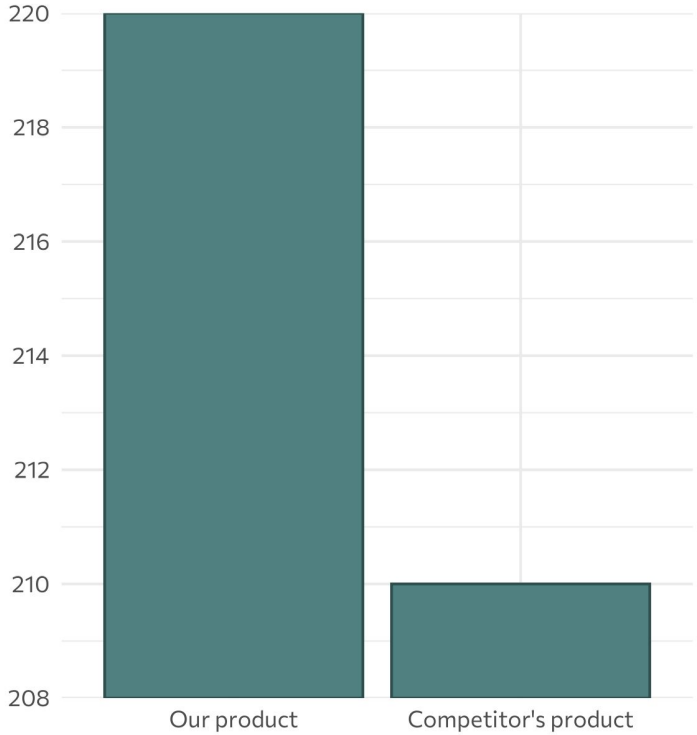

220
218
216
214
212
210
208
Our product
Competitor's product

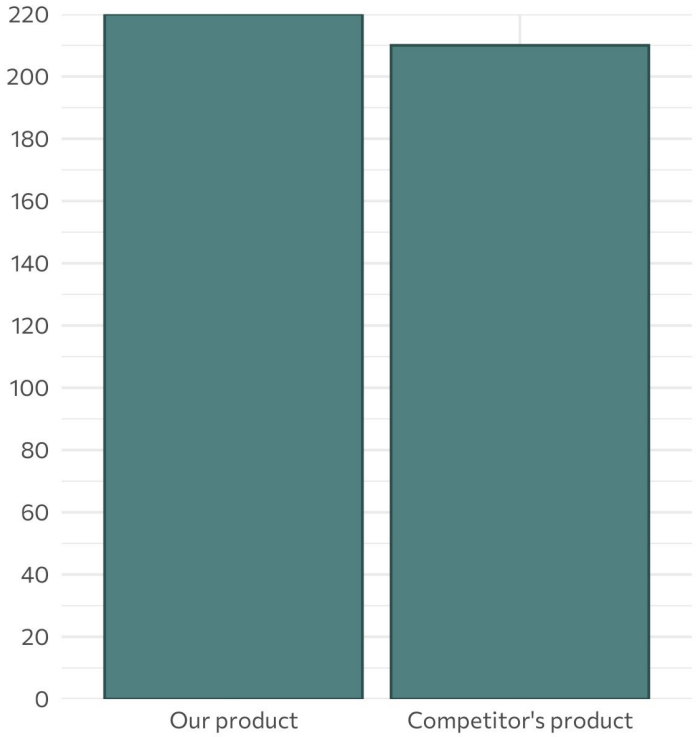
How much bigger was the value on the left?

How much bigger is the value on the left?



How much bigger is the value on the left?





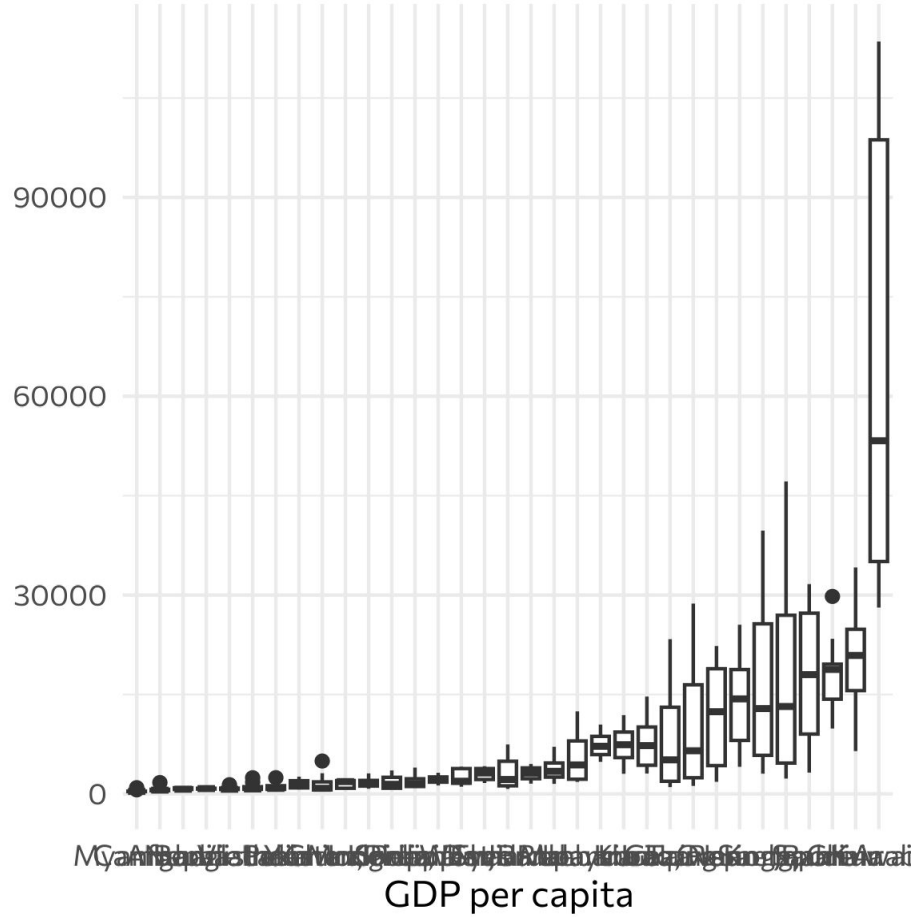
Is your visualisation accurate?

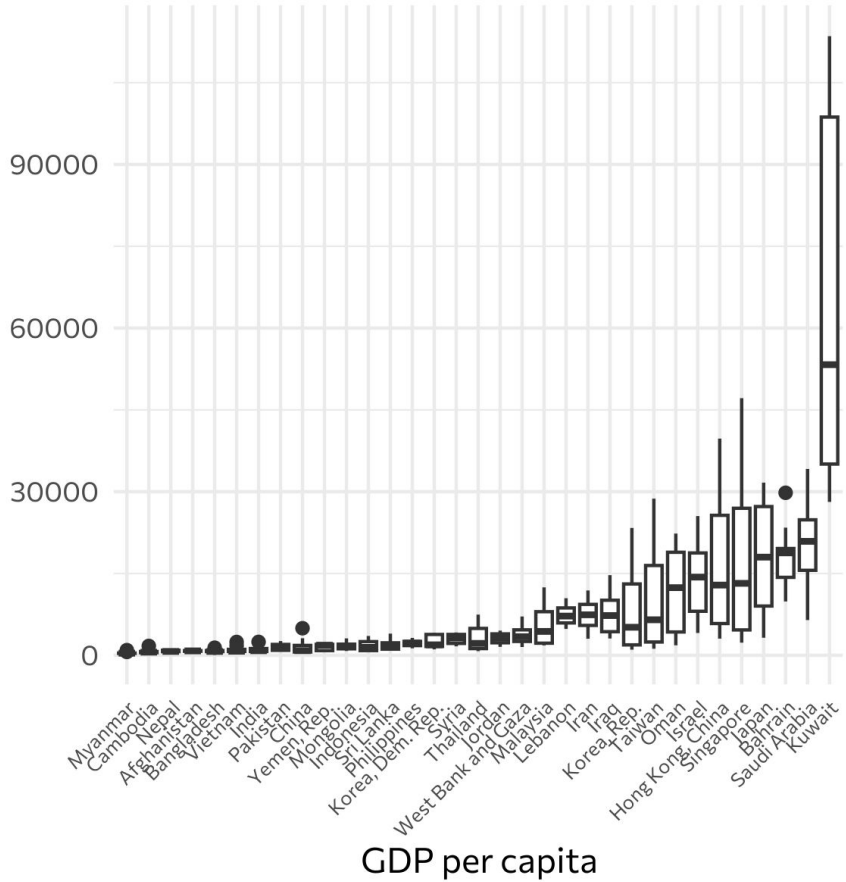
- ❑ Is the chart type appropriate?
- ❑ Are the axis ranges reasonable?
- ❑ Is it intuitive?
- ❑ Is the 5 second conclusion the same as the 5 minute conclusion?

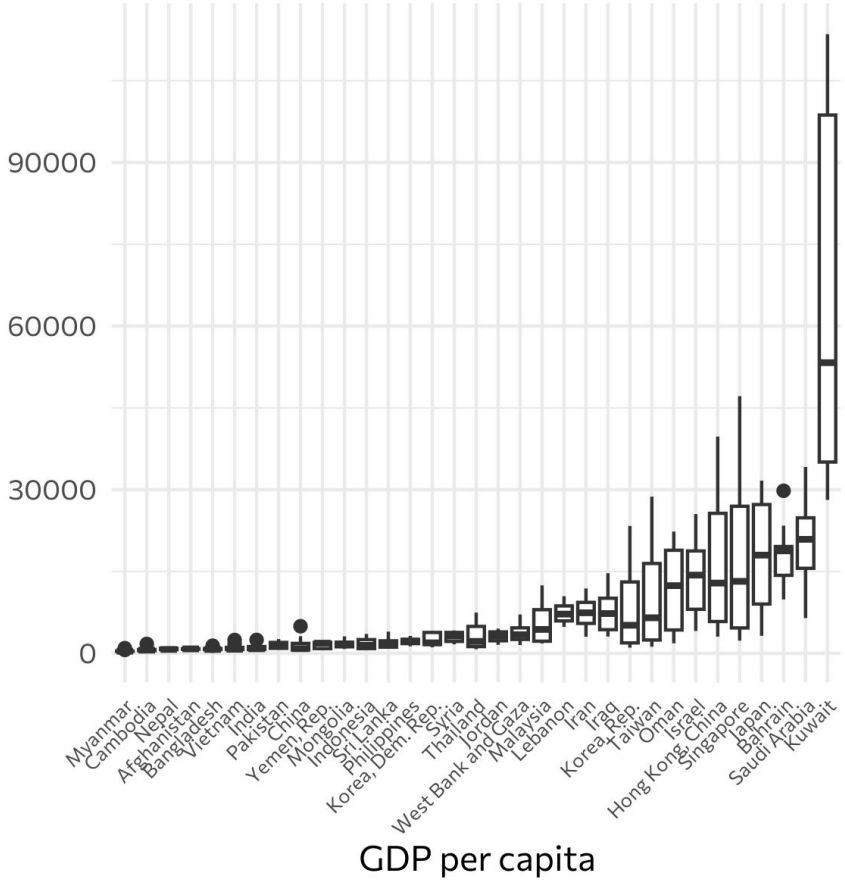
Design data visualisations that are

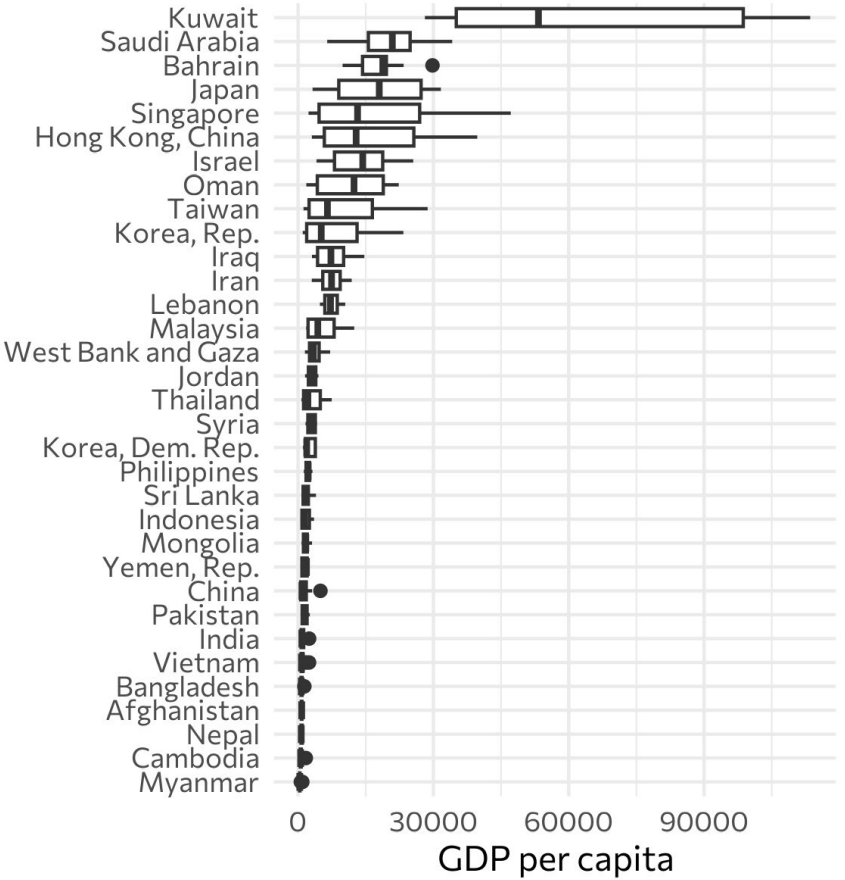
Comparative

Where does Malaysia rank in terms of GDP?

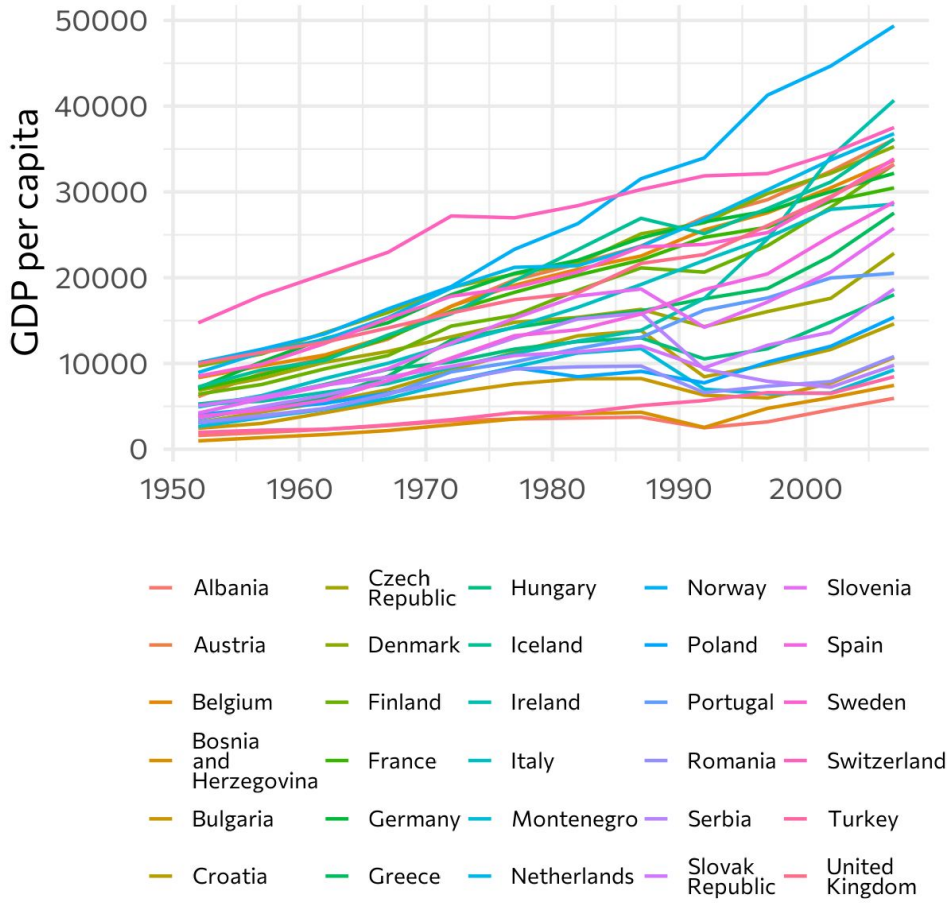


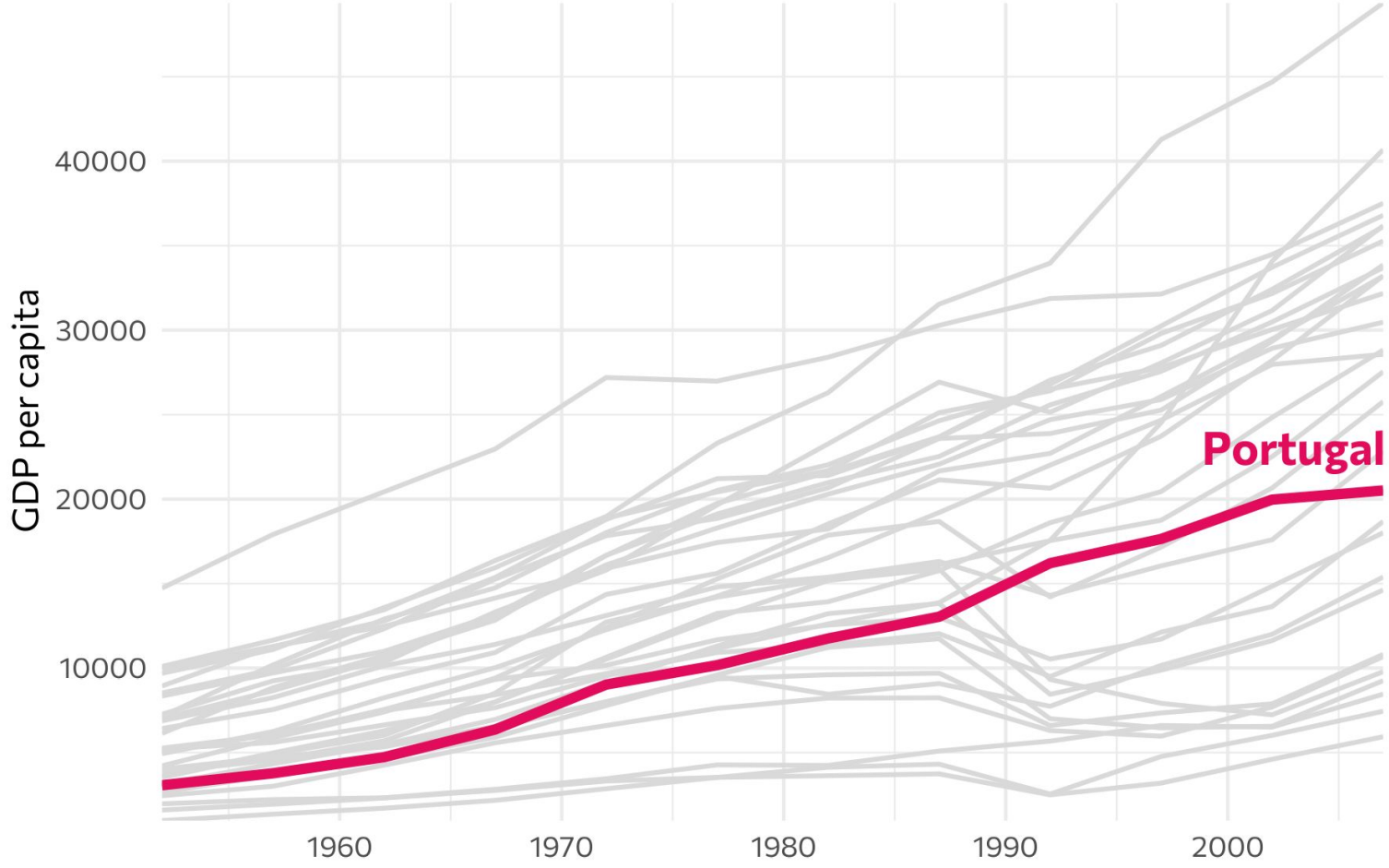

90000
60000
30000
0
Myanmar
Cambodia
Nepal
Afghanistan
Bangladesh
Vietnam
India
Pakistan
China
Yemen, Rep.
Mongolia
Indonesia
Sri Lanka
Philippines
Korea, Dem. Rep.
Syria
Thailand
Jordan
West Bank and Gaza
Malaysia
Lebanon
Iran
Iraq
Korea, Rep.
Taiwan
Oman
Israel
Hong Kong, China
Singapore
Japan
Bahrain
Saudi Arabia
Kuwait
GDP per capita


90000
60000
30000
0
Myanmar
Cambodia
Nepal
Afghanistan
Bangladesh
Vietnam
India
Pakistan
China
Yemen, Rep.
Mongolia
Indonesia
Sri Lanka
Philippines
Korea, Dem. Rep.
Syria
Thailand
Jordan
West Bank and Gaza
Malaysia
Lebanon
Iran
Iraq
Korea, Rep.
Taiwan
Oman
Israel
Hong Kong, China
Singapore
Japan
Bahrain
Saudi Arabia
Kuwait
GDP per capita

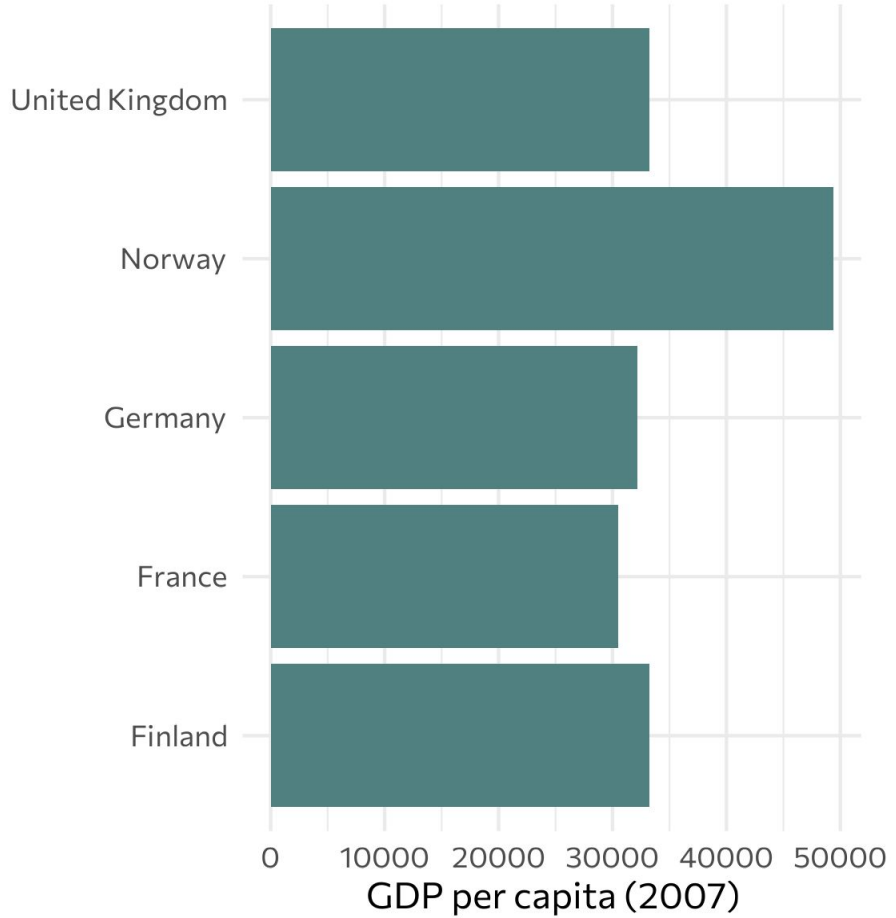

Kuwait
Saudi Arabia
Bahrain
Japan
Singapore
Hong Kong, China
Israel
Oman
Taiwan
Korea, Rep.
Iraq
Iran
Lebanon
Malaysia
West Bank and Gaza
Jordan
Thailand
Syria
Korea, Dem. Rep.
Philippines
Sri Lanka
Indonesia
Mongolia
Yemen, Rep.
China
Pakistan
India
Vietnam
Bangladesh
Afghanistan
Nepal
Cambodia
Myanmar
0
30000
60000
90000
GDP per capita

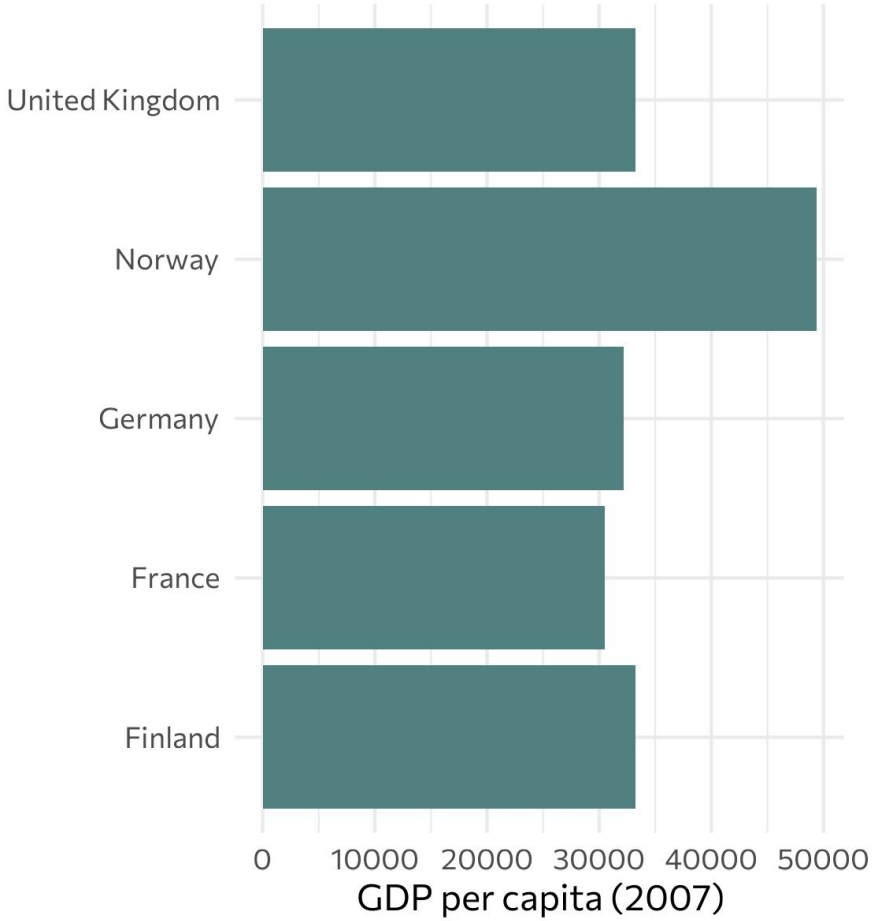
How does GDP in Portugal compare to other European countries?

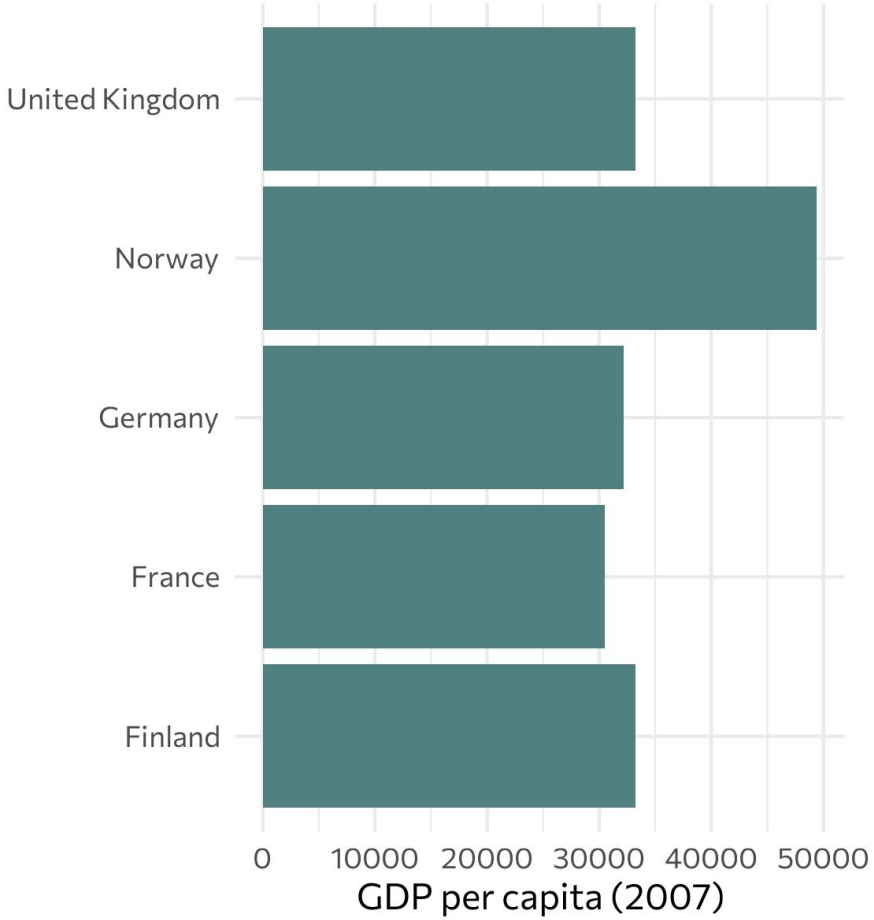


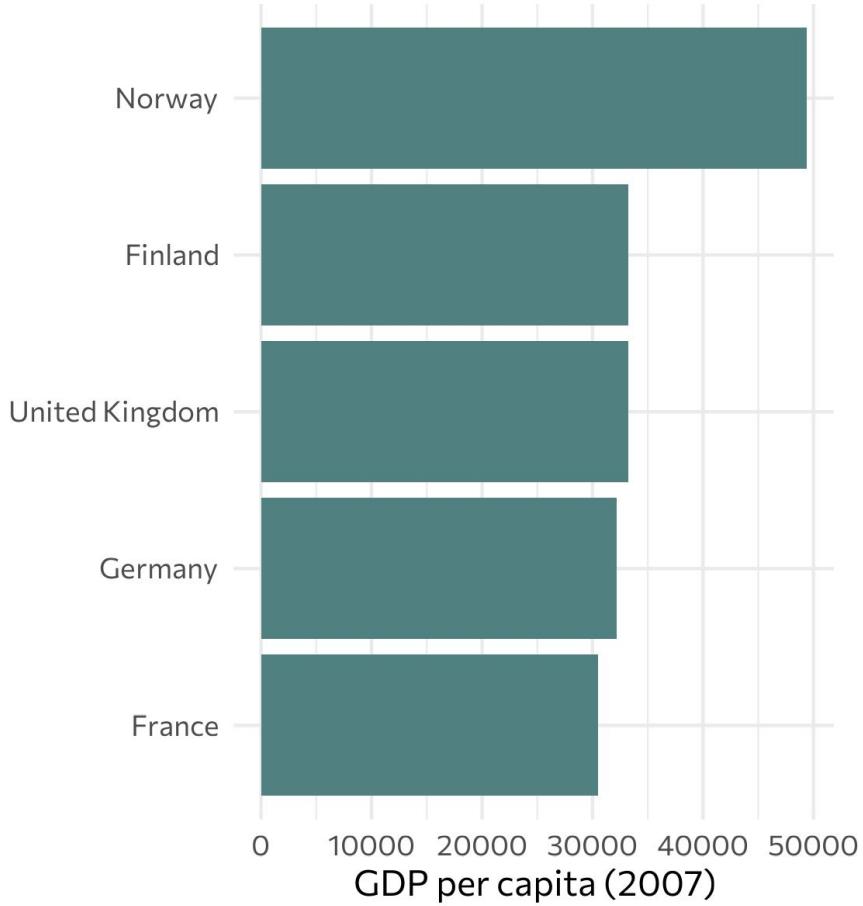

GDP per capita
40000
30000
20000
10000
1960
1970
1980
1990
2000
Portugal

Is Germany higher than the UK?



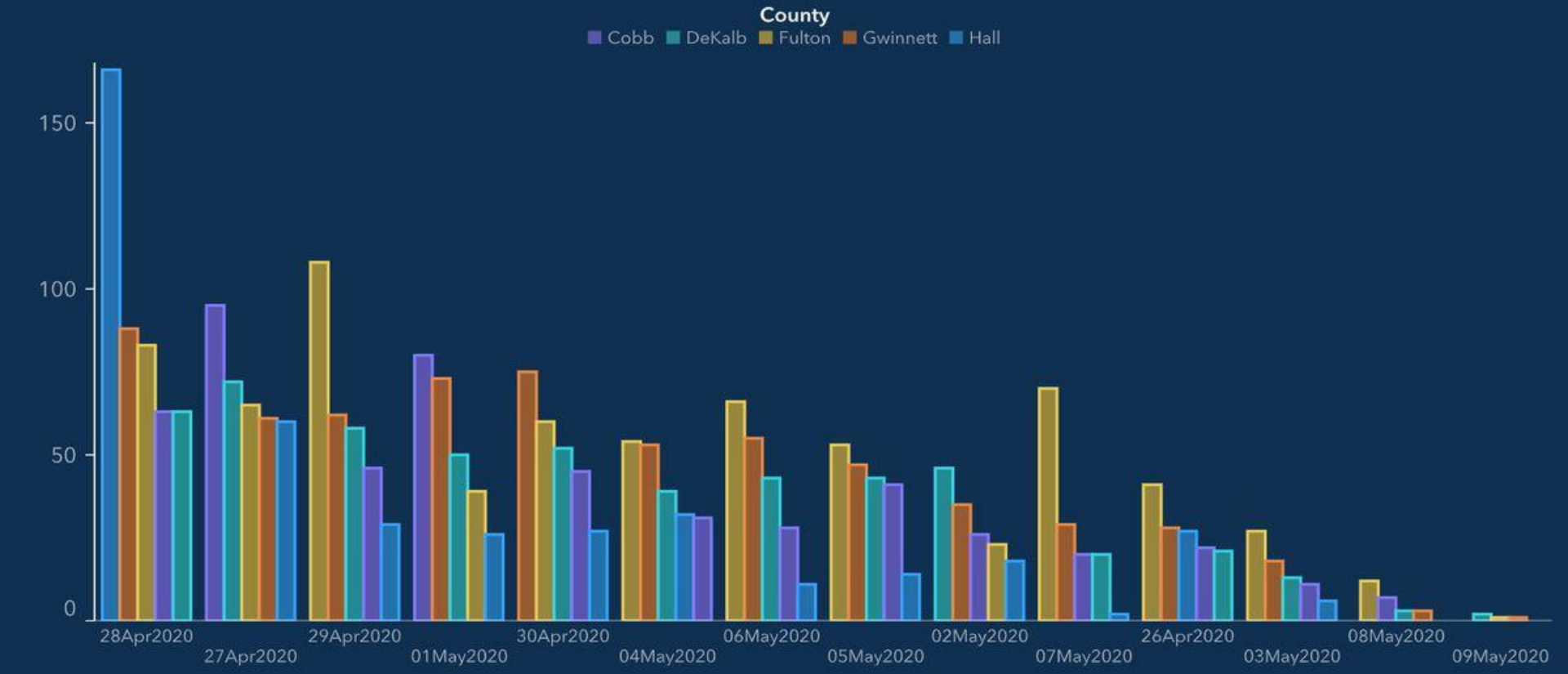

United Kingdom
Norway
Germany
France
Finland
0
10000
20000
30000
40000
50000
GDP per capita (2007)

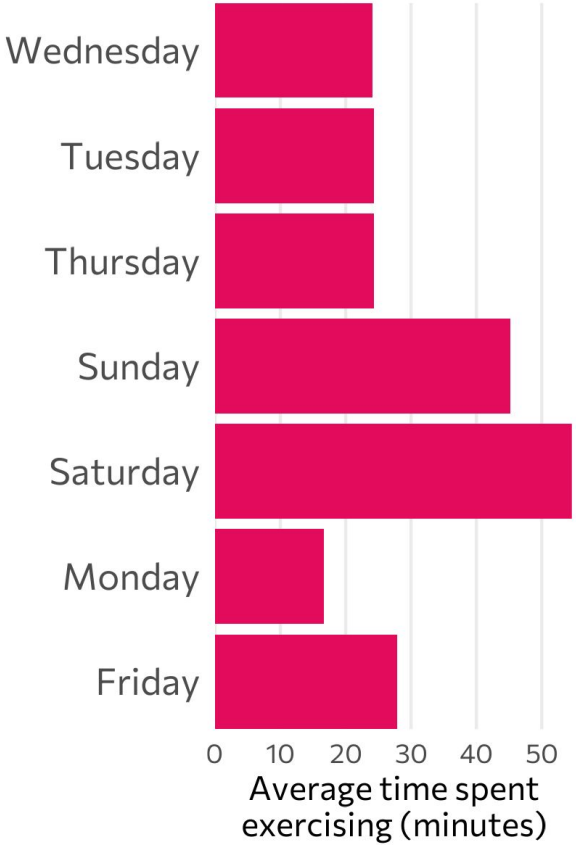

United Kingdom
Norway
Germany
France
Finland
0
10000
20000
30000
40000
50000
GDP per capita (2007)

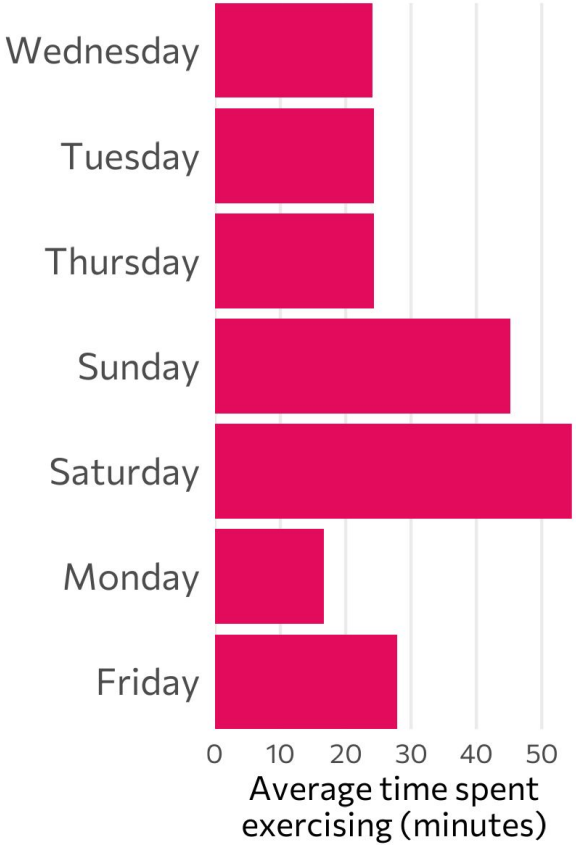

Norway
Finland
United Kingdom
Germany
France
0
10000
20000
30000
40000
50000
GDP per capita (2007)

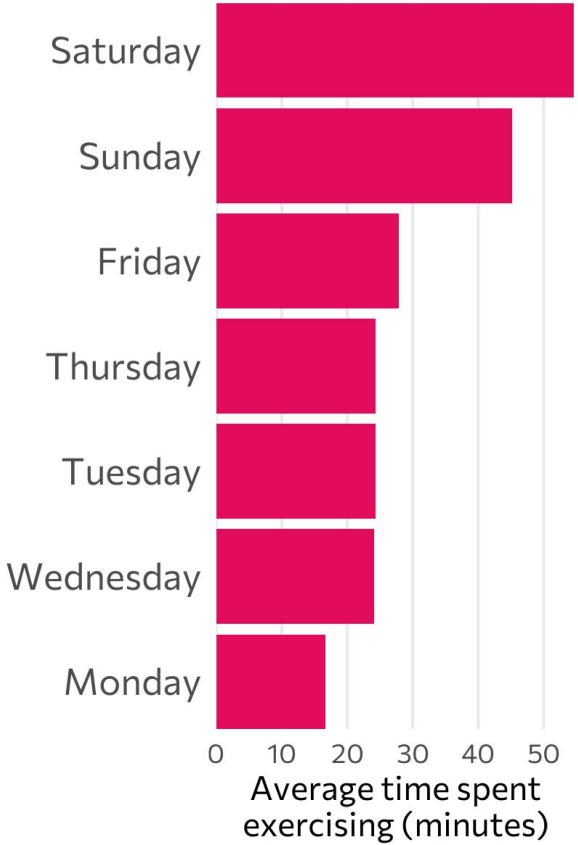
Top 5 Counties with the Greatest Number of Confirmed COVID-19 Cases

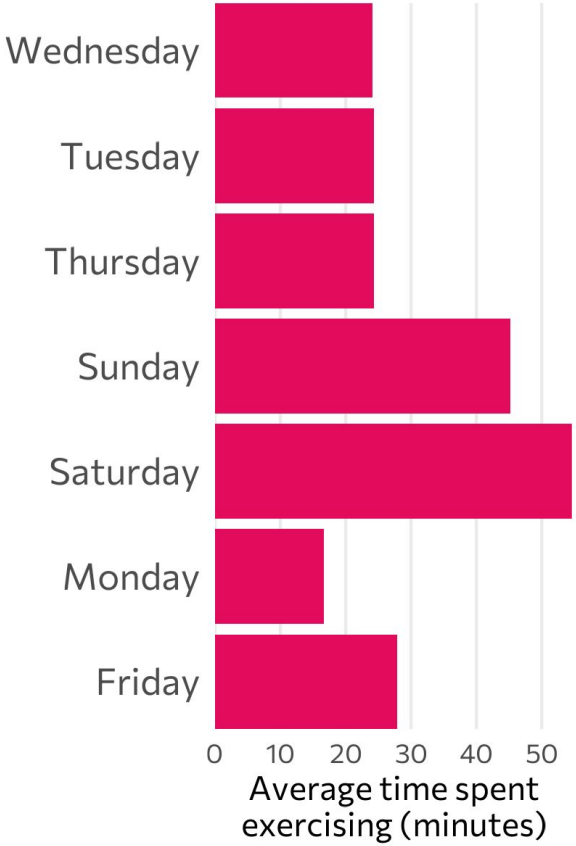
The chart below represents the most impacted counties over the past 15 days and the number of cases over time. The table below also represents the number of deaths and hospitalizations in each of those impacted counties.

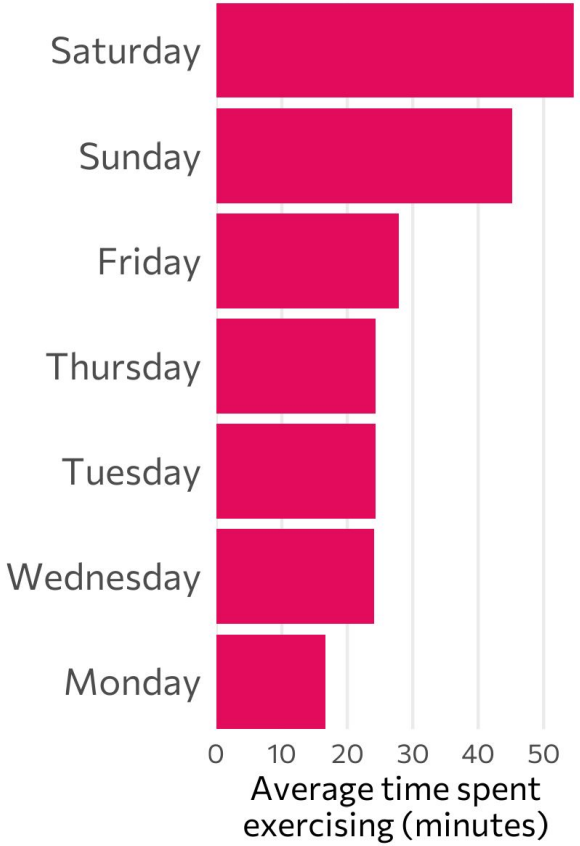



Wednesday
Tuesday
Thursday
Sunday
Saturday
Monday
Friday
0
10
20
30
40
50
Average time spent exercising (minutes)


Wednesday
Tuesday
Thursday
Sunday
Saturday
Monday
Friday
0
10
20
30
40
50
Average time spent exercising (minutes)


Saturday
Sunday
Friday
Thursday
Tuesday
Wednesday
Monday
0
10
20
30
40
50
Average time spent exercising (minutes)


Wednesday
Tuesday
Thursday
Sunday
Saturday
Monday
Friday
0
10
20
30
40
50
Average time spent exercising (minutes)


Saturday
Sunday
Friday
Thursday
Tuesday
Wednesday
Monday
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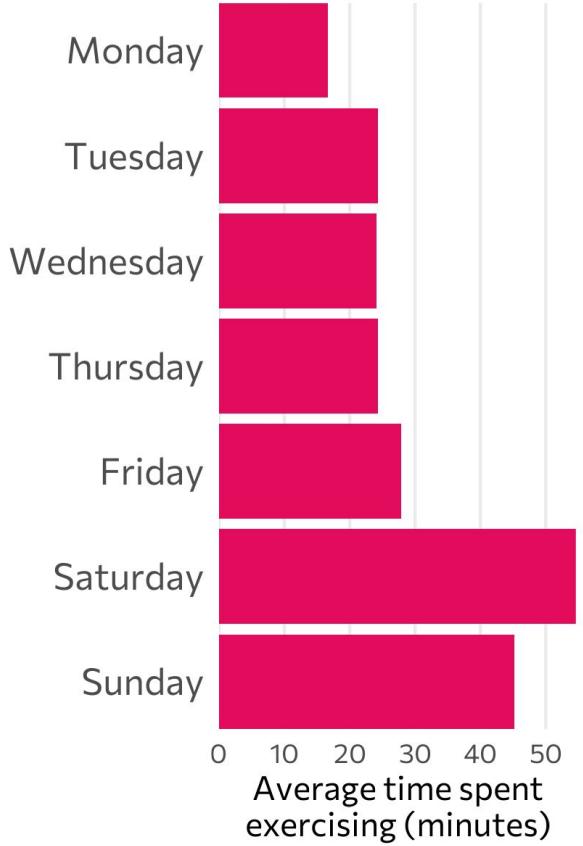
Average time spent exercising (minutes)


Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
0
10
20
30
40
50
Average time spent exercising (minutes)

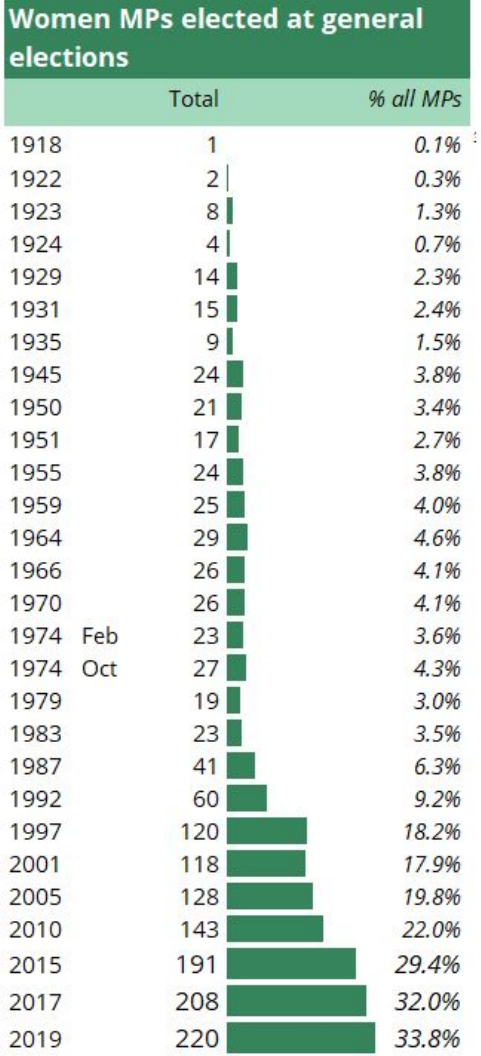
Is your visualisation comparable?

- ❑ Are categories sensibly ordered?
- ❑ Does the layout enable comparison?
- ❑ Is it easy to find information?

Design data visualisations that are

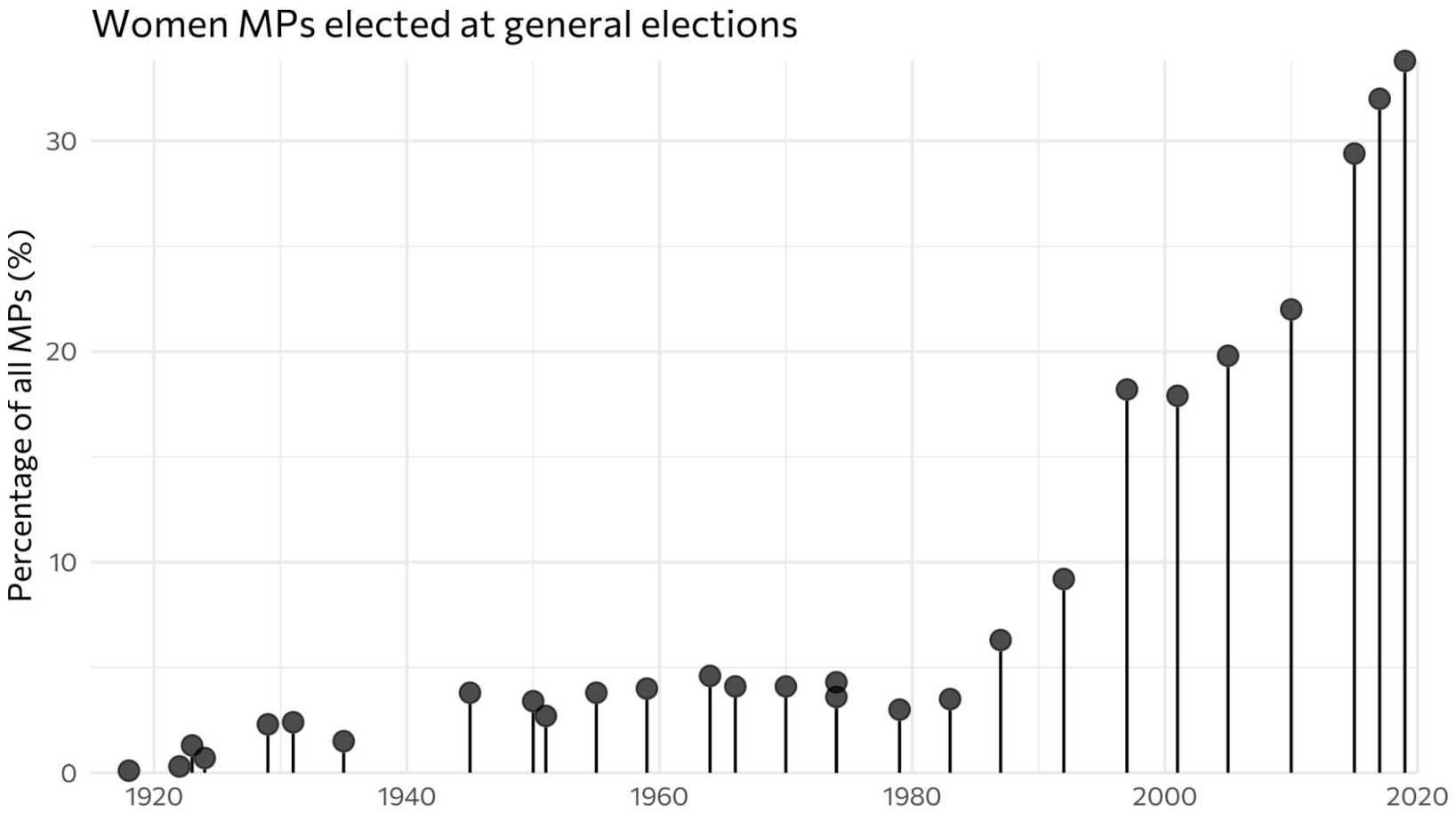
Contextualised

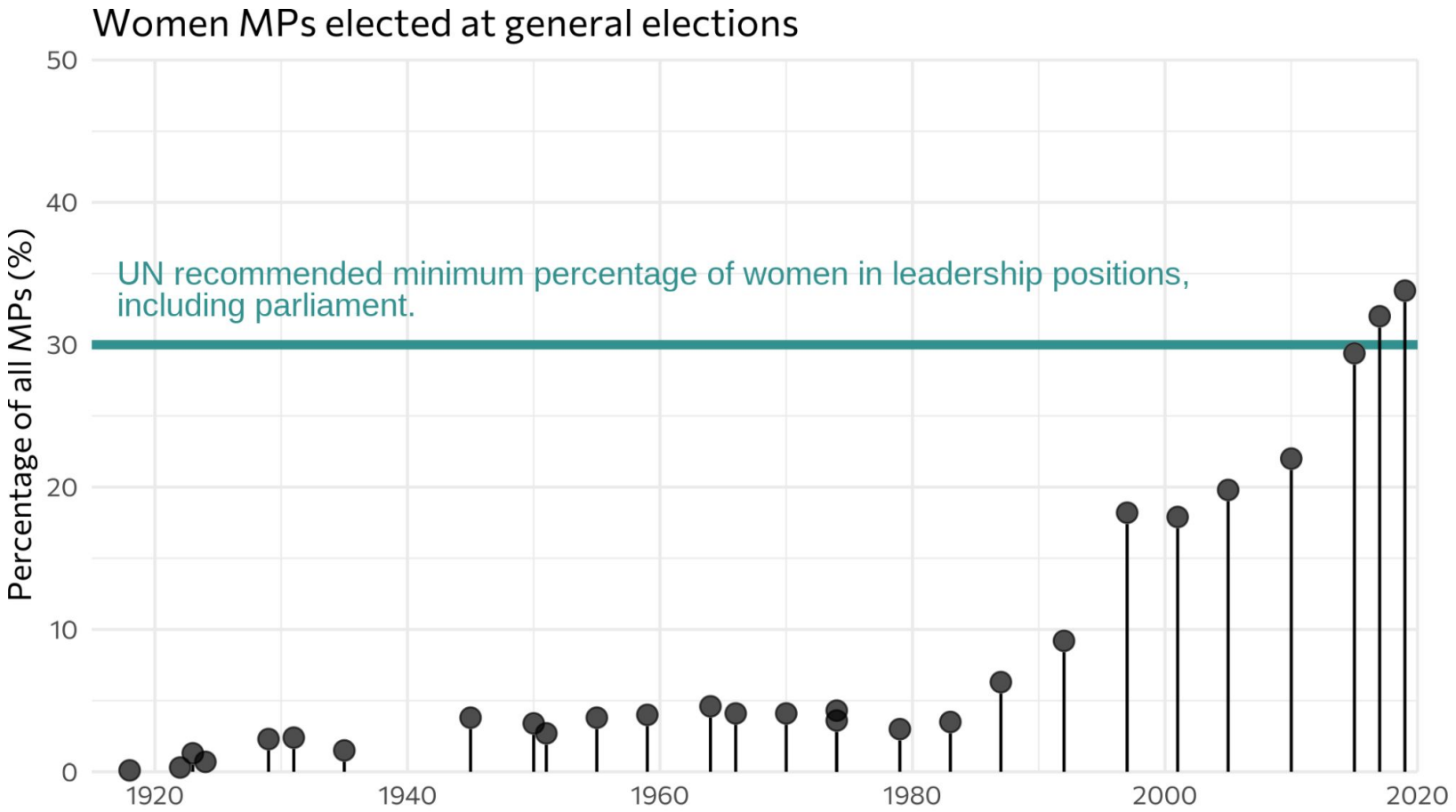
Is parliament becoming more equal?

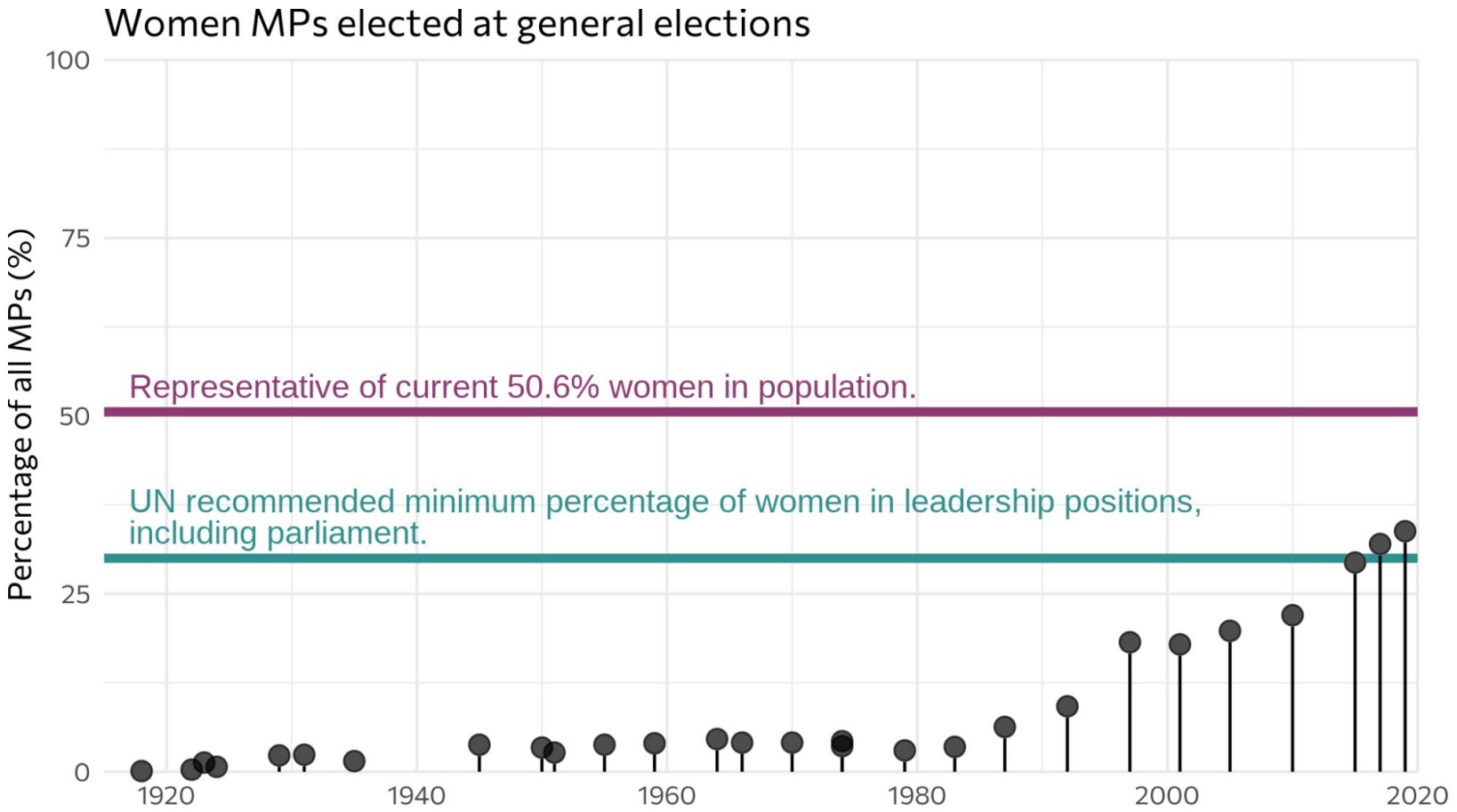


Women MPs elected at general elections

		Total	% all MPs
1918		1	0.1%
1922		2	0.3%
1923		8	1.3%
1924		4	0.7%
1929		14	2.3%
1931		15	2.4%
1935		9	1.5%
1945		24	3.8%
1950		21	3.4%
1951		17	2.7%
1955		24	3.8%
1959		25	4.0%
1964		29	4.6%
1966		26	4.1%
1970		26	4.1%
1974	Feb	23	3.6%
1974	Oct	27	4.3%
1979		19	3.0%
1983		23	3.5%
1987		41	6.3%
1992		60	9.2%
1997		120	18.2%
2001		118	17.9%
2005		128	19.8%
2010		143	22.0%
2015		191	29.4%
2017		208	32.0%
2019		220	33.8%


Women MPs elected at general elections
Percentage of all MPs (%)
0
10
20
30
1920
1940
1960
1980
2000
2020


Women MPs elected at general elections
Percentage of all MPs (%)
50
40
30
20
10
0
UN recommended minimum percentage of women in leadership positions, including parliament.
1920
1940
1960
1980
2000
2020


Women MPs elected at general elections
Percentage of all MPs (%)
100
75
50
25
0
Representative of current 50.6% women in population.
UN recommended minimum percentage of women in leadership positions, including parliament.
1920
1940
1960
1980
2000
2020

49

Billionaires in Australia

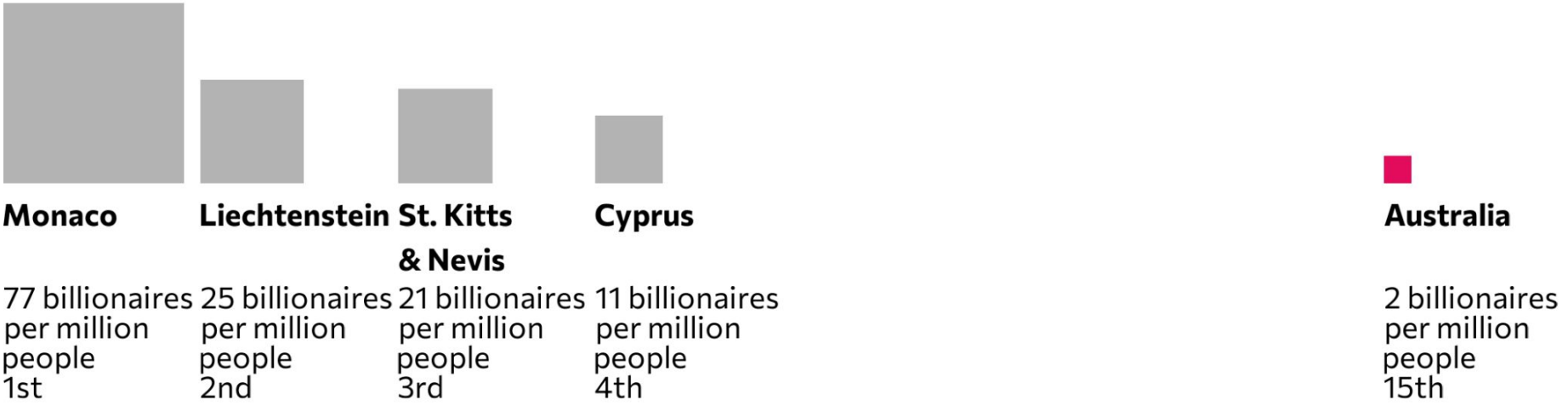
49

Billionaires in Australia

How does this compare?

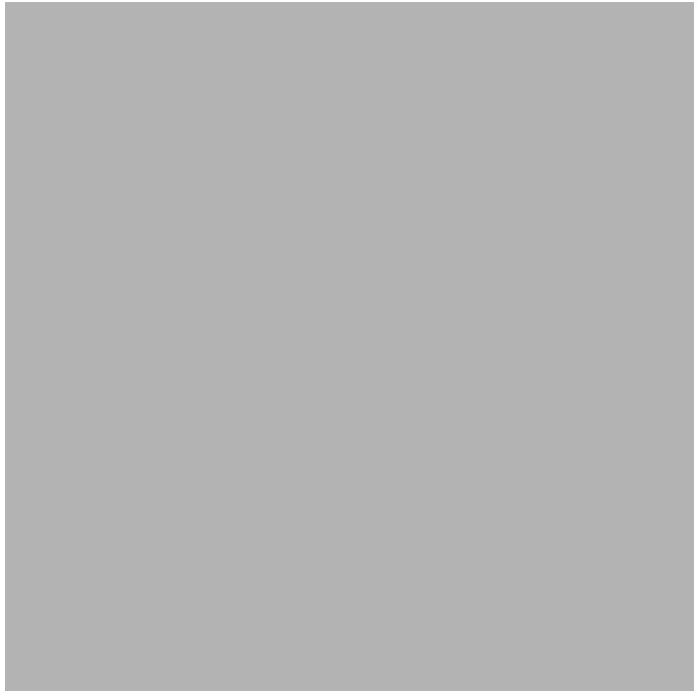
How many billionaires?

How many billionaires per capita?



Is a billion dollars really that much?

Is a billion dollars really that much?

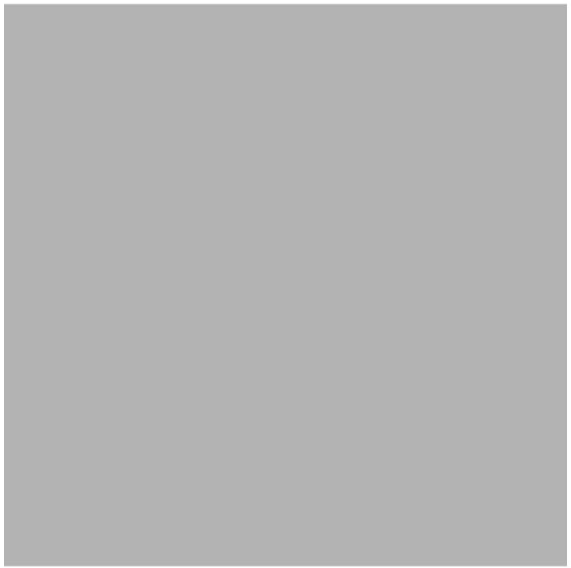


How wealthy is a billonaire?

How wealthy is the average Australian?

1 billion is the minimum to be a billionaire

1 billion is the minimum to be a billionaire



How wealthy is Elon Musk?

How wealthy is a billonaire?

How wealthy is the average Australian?

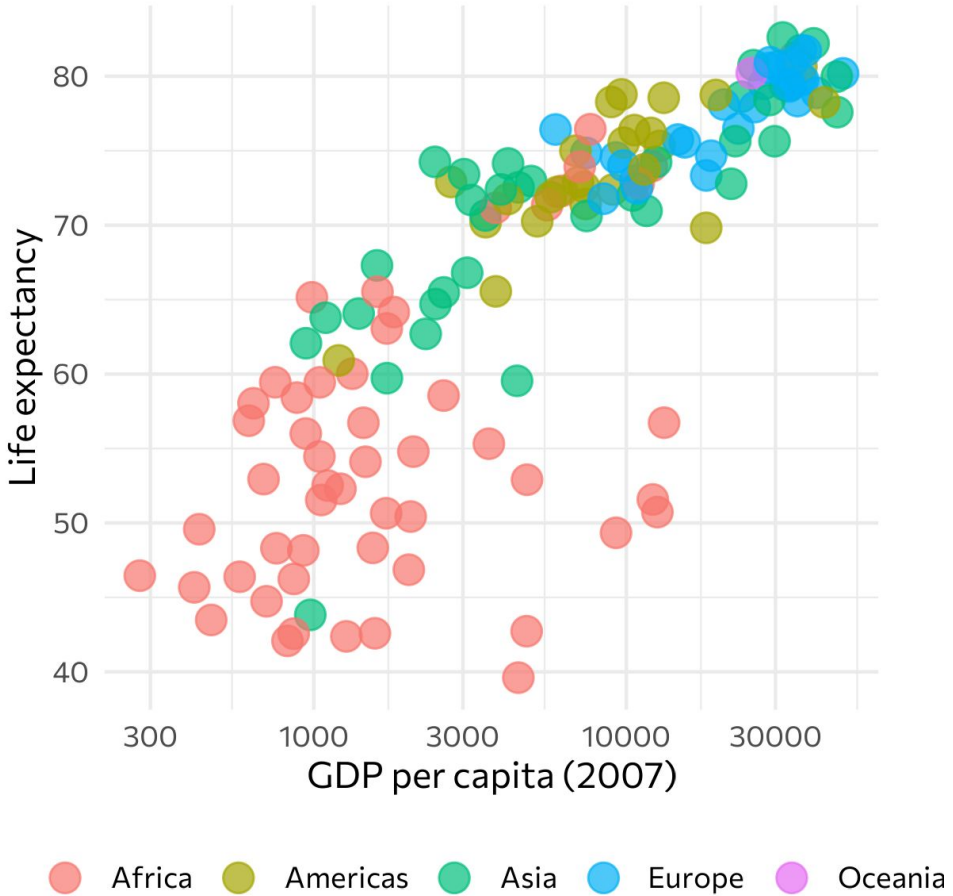
Is your visualisation contextualised?

- ❑ Are there policies that impact the data?
- ❑ Is there a target to reach?
- ❑ How easy is it to conceptualise the data?
- ❑ What are you actually comparing?
- ❑ Is there relevant information missing?

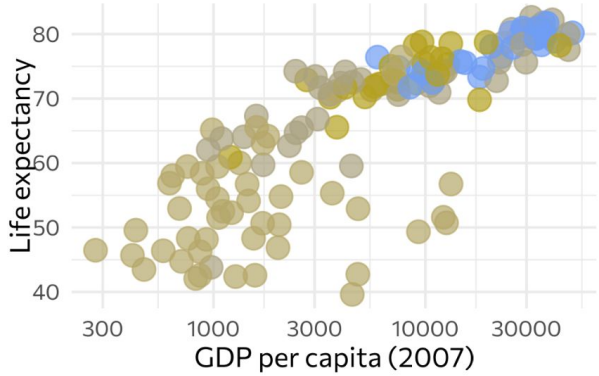
Design data visualisations that are

Accessible

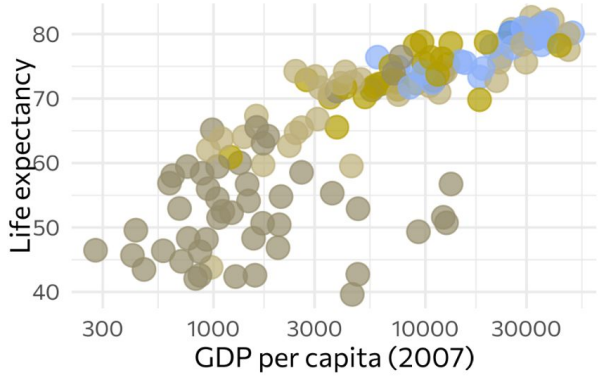
Are these colours okay?



Deutanomaly

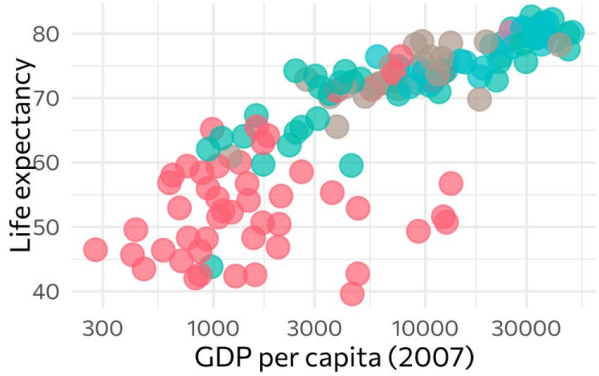


Protanomaly

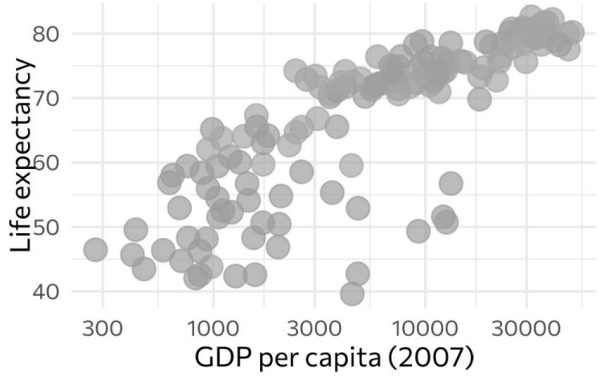


Africa Americas Asia Europe Oceania Africa Americas Asia Europe Oceania

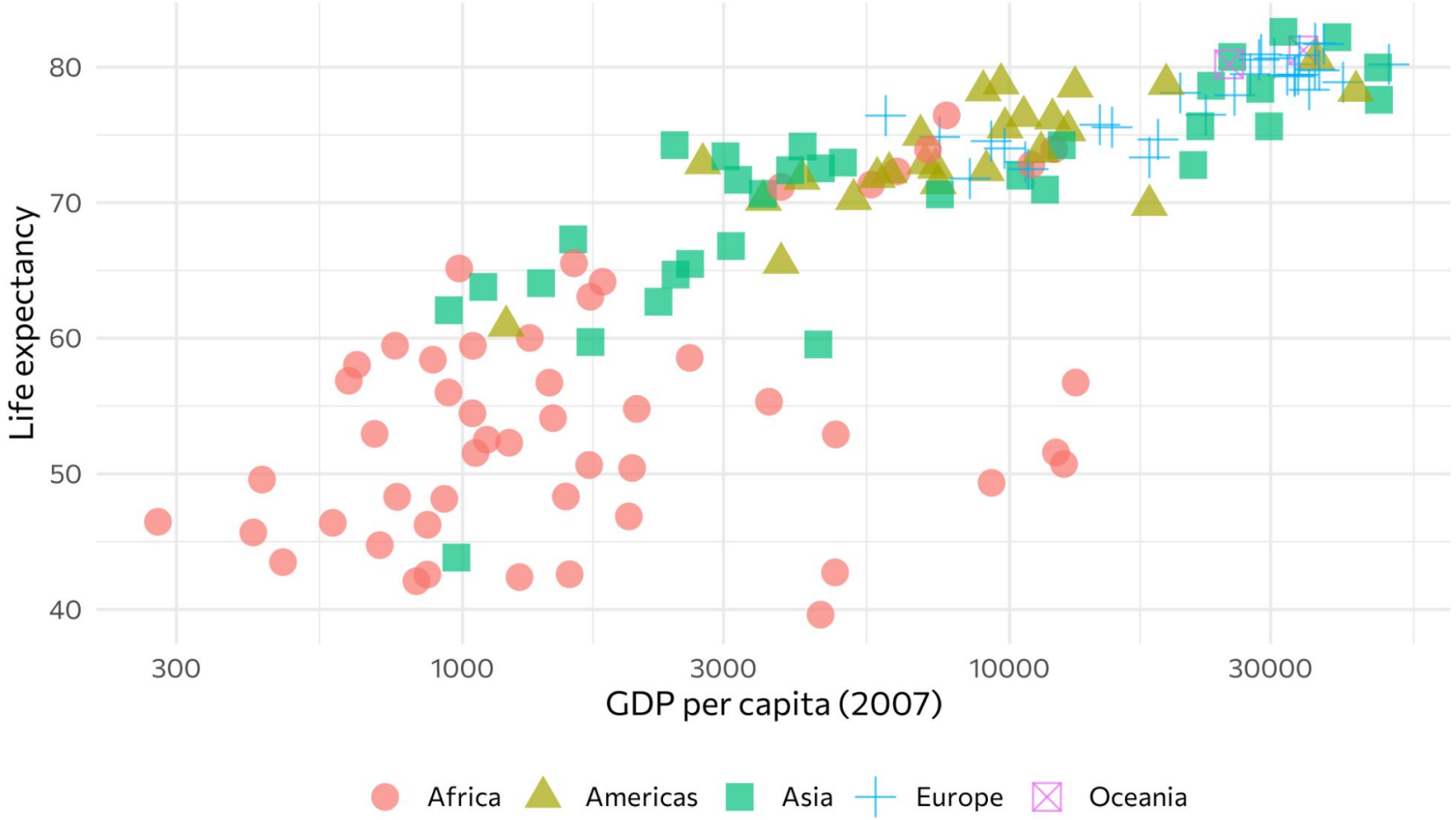
Tritanomaly

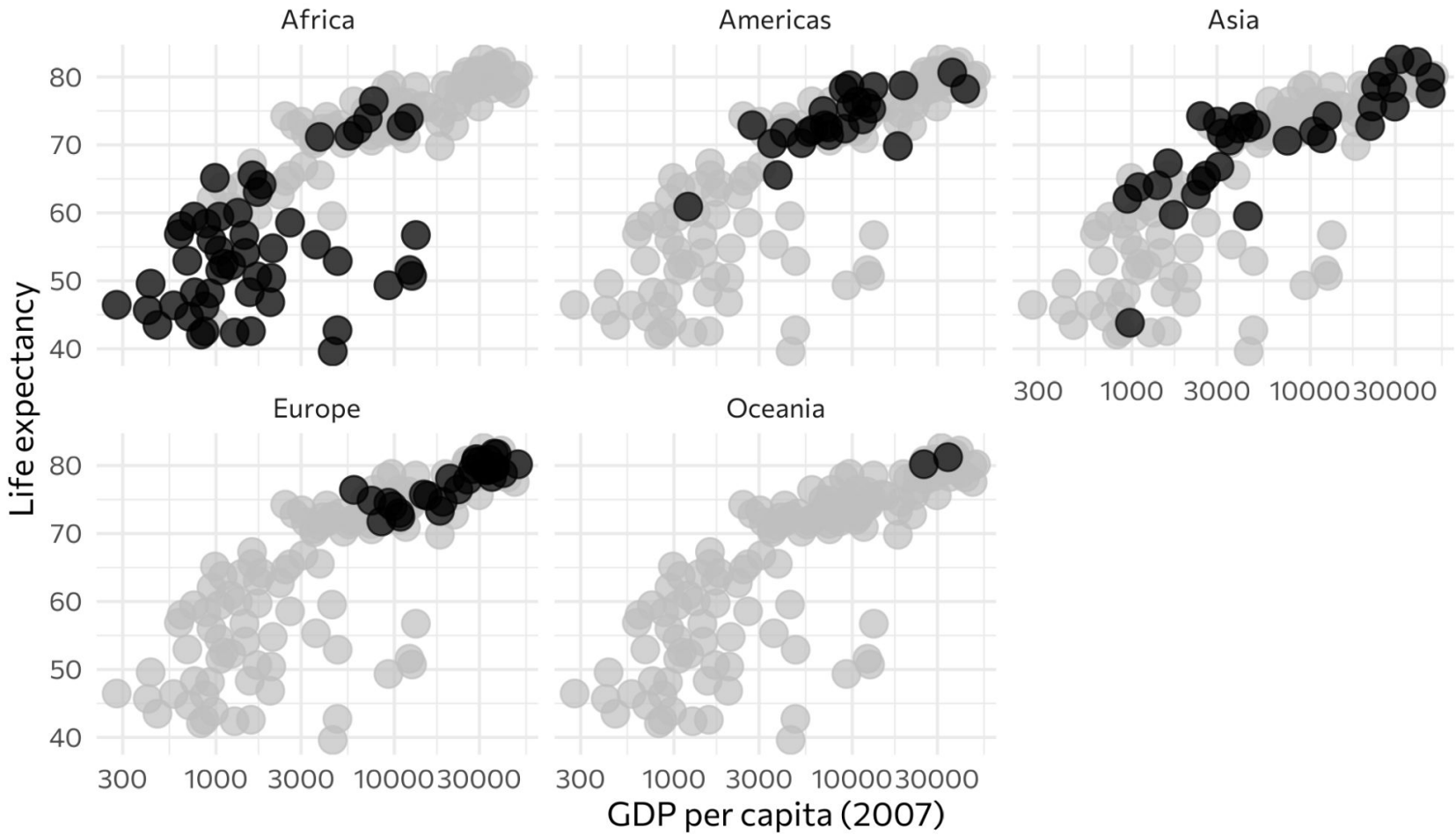


Desaturated



Africa Americas Asia Europe Oceania Africa Americas Asia Europe Oceania


Life expectancy
80
70
60
50
40
300
1000
3000
10000
30000
GDP per capita (2007)
Africa
Americas
Asia
Europe
Oceania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Americas
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Life expectancy
80
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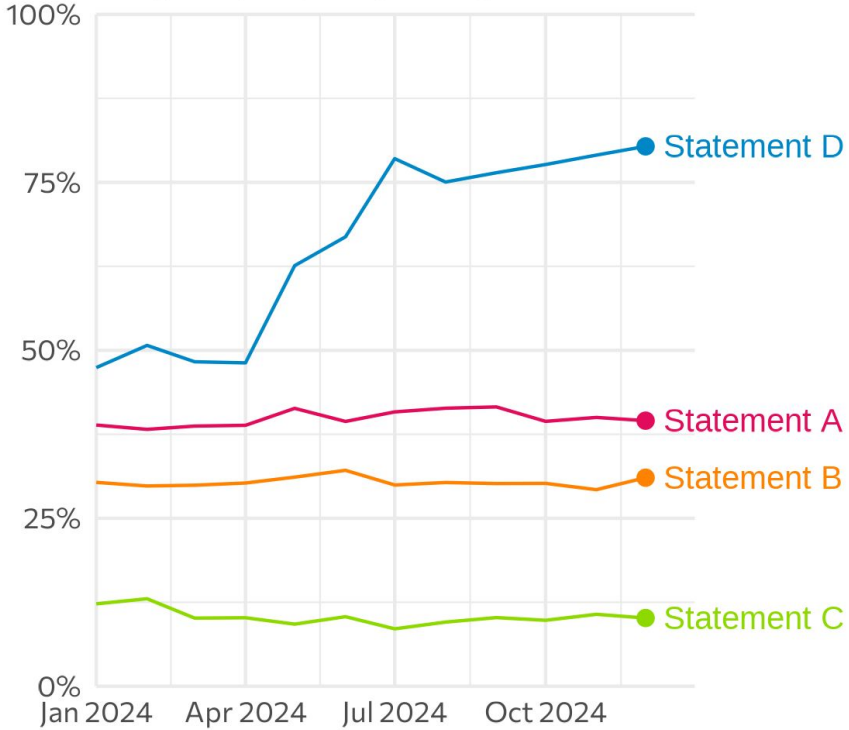
GDP per capita (2007)

Agreement with statement D increased during 2024

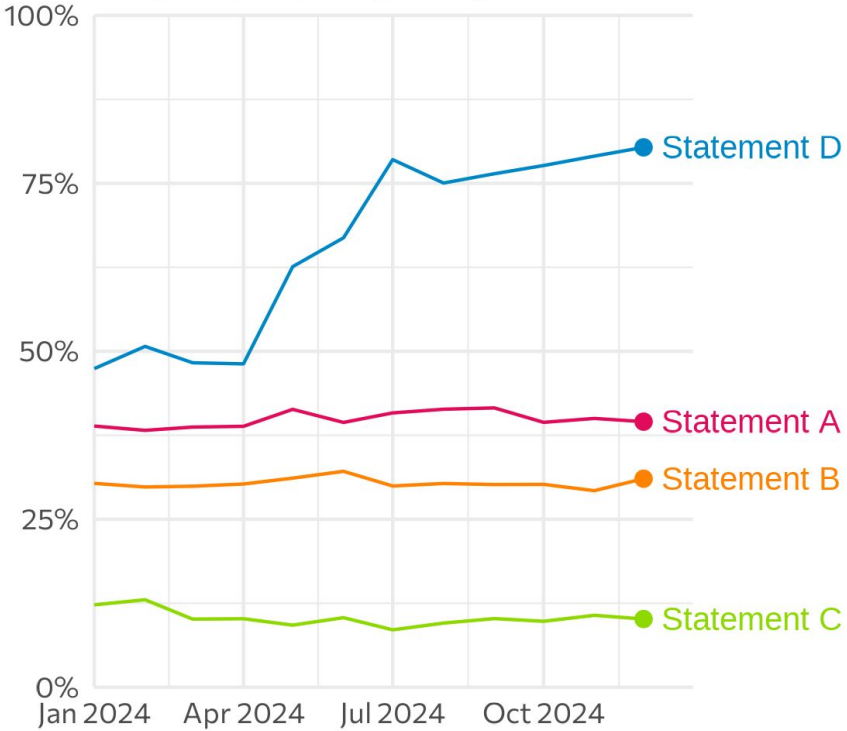
Percentage of people agreeing



Source: Data simulated from a Uniform distribution

Agreement with statement D increased during 2024

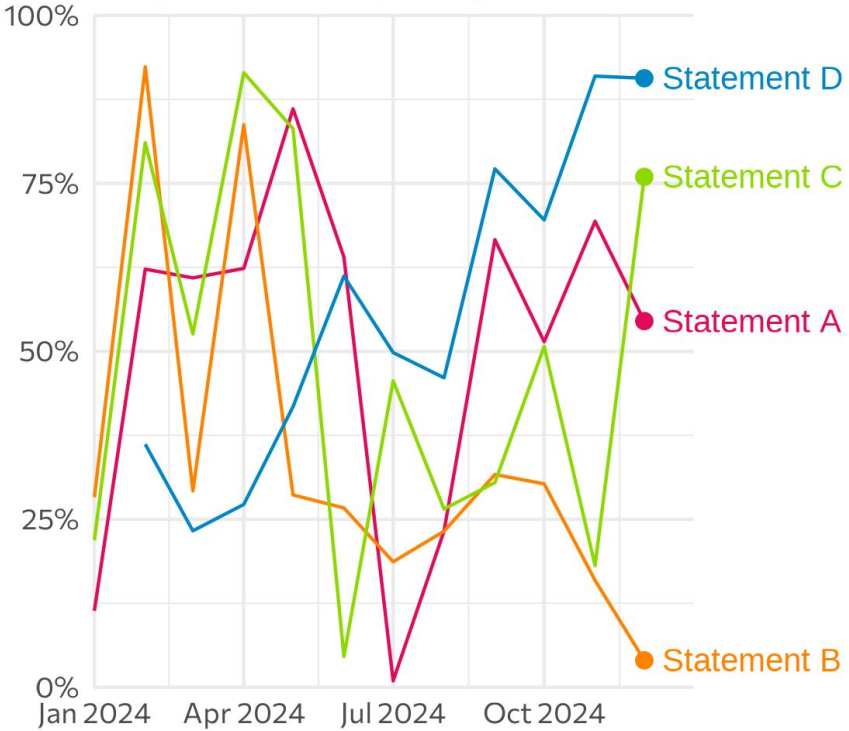
Percentage of people agreeing



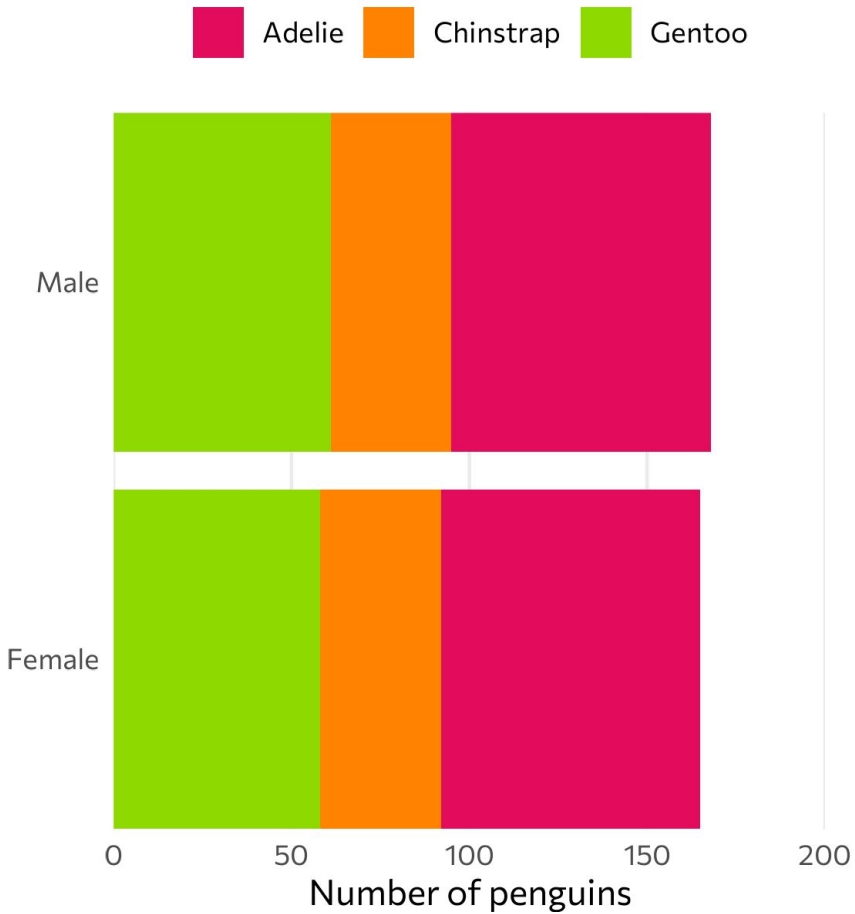
Source: Data simulated from a Uniform distribution

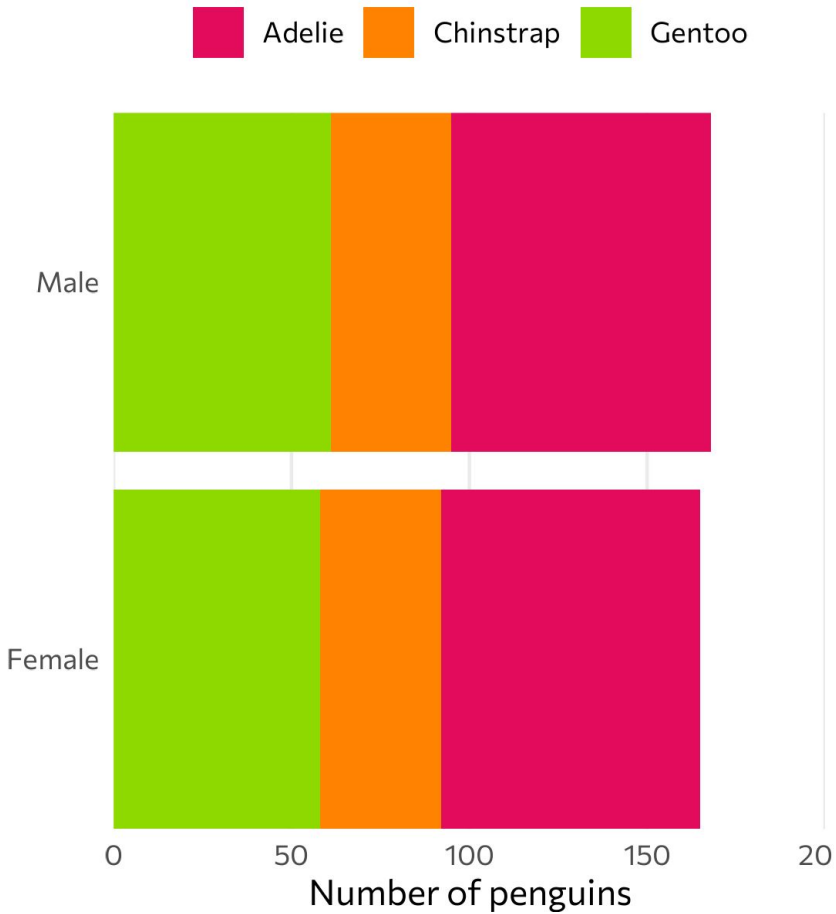
Agreement with statement D increased during 2024

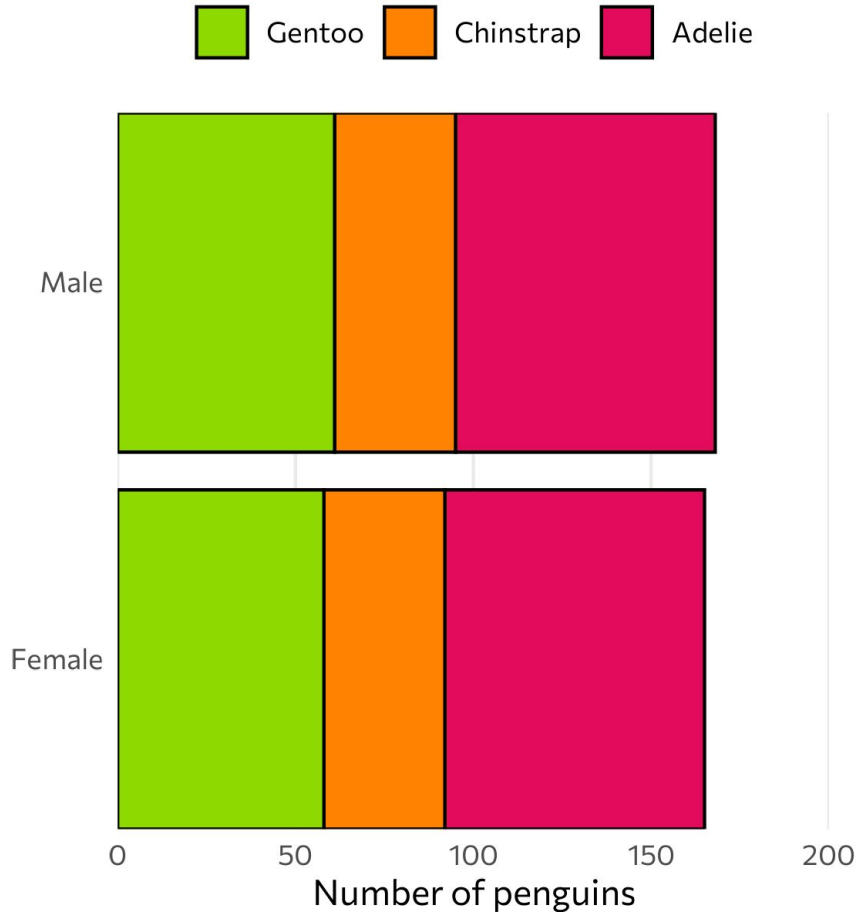
Percentage of people agreeing



Source: Data simulated from a Uniform distribution


Adelie
Chinstrap
Gentoo
Male
Female
0
50
100
150
200
Number of penguins


Adelie
Chinstrap
Gentoo
Male
Female
0
50
100
150
200
Number of penguins


Gentoo
Chinstrap
Adelie
Male
Female
0
50
100
150
200
Number of penguins

What symbol is this?

Choose readable fonts

l1l	I1l	*I1l*
ceo	ceo	*ceo*
qp db	qp db	*qp db*
0123456789	0123456789	*0123456789*

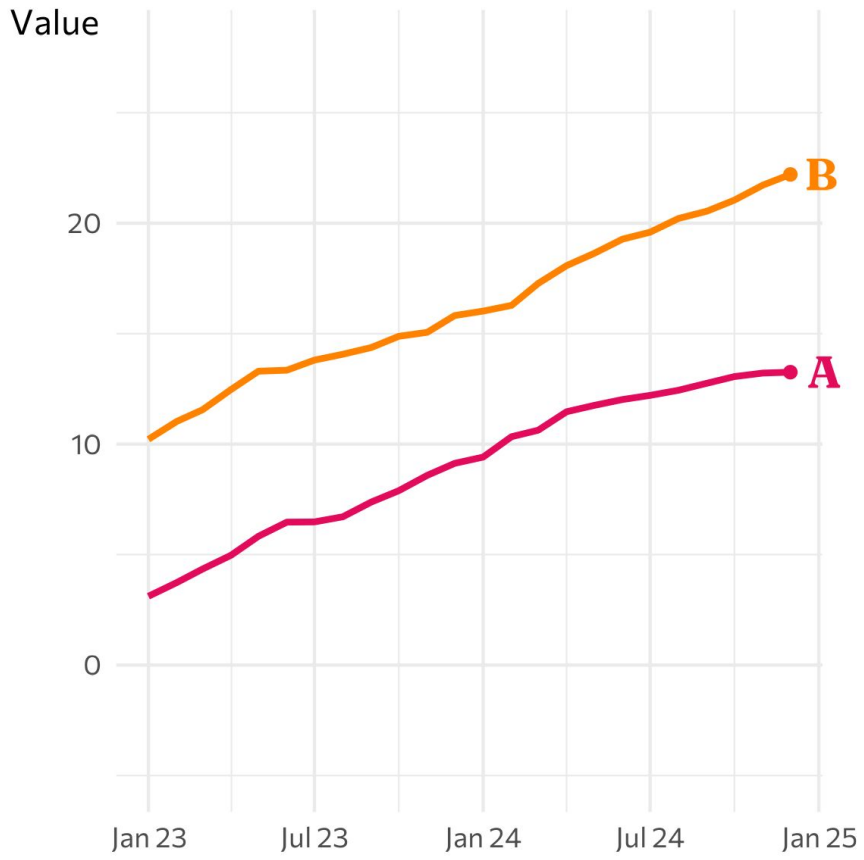
Is your visualisation accessible?

- ❑ Does the chart rely on colour?
- ❑ Do labels always stick to the data?
- ❑ Are letters and numbers distinguishable?

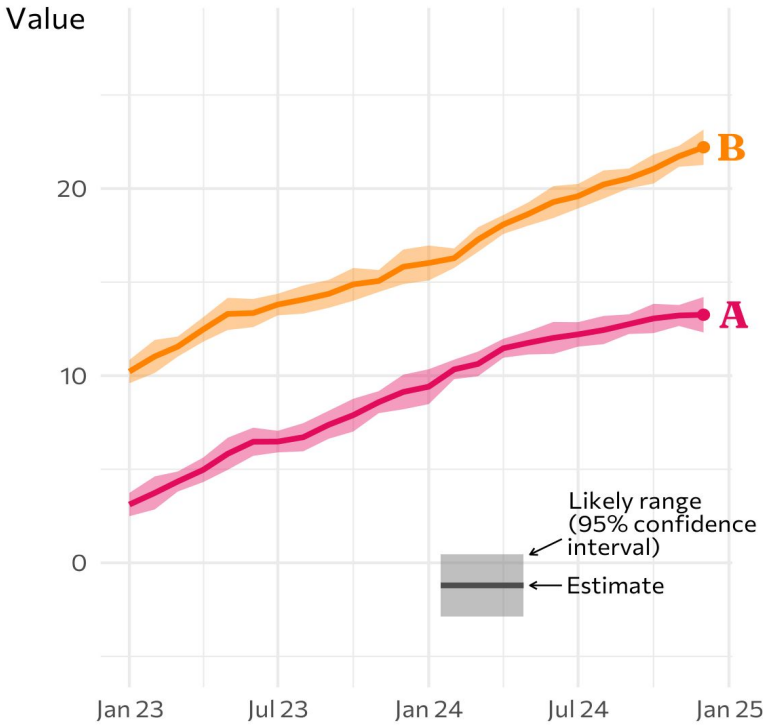
Design data visualisations that are

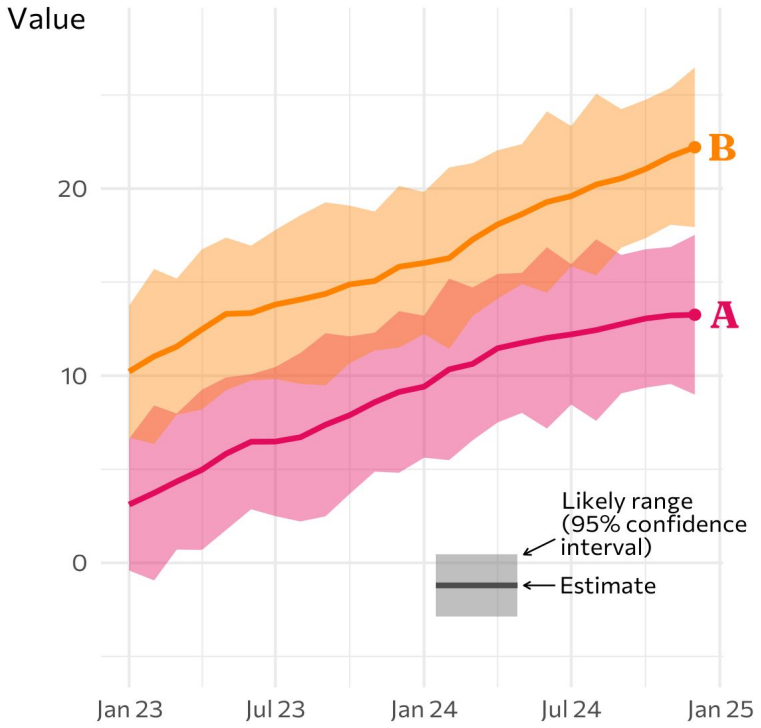
Informative

Is A lower than B?



It depends...


Value
20
10
0
B
A
Likely range
(95% confidence
interval)
Estimate
Jan 23
Jul 23
Jan 24
Jul 24
Jan 25


Value
20
10
0
B
A
Likely range
(95% confidence
interval)
Estimate
Jan 23
Jul 23
Jan 24
Jul 24
Jan 25

Inform, don't persuade

Five rules for evidence communication

Michael Blastland, Alexandra L. J. Freeman, Sander van der Linden, Theresa M. Marteau & David Spiegelhalter

Avoid unwarranted certainty, neat narratives and partisan presentation; strive to inform, not persuade.

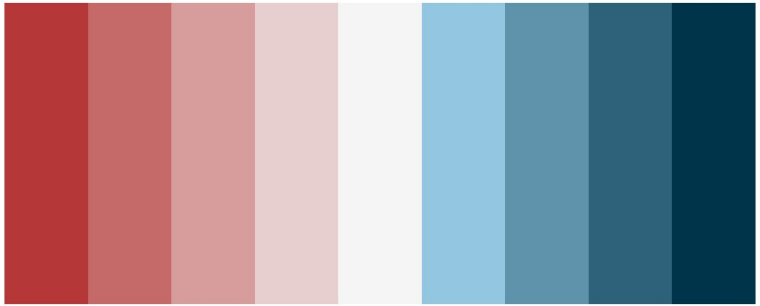
"Be persuasive", "be engaging", "tell stories with your science". Most researchers have heard such exhortations many times, and for good reason. Such rhetorical devices often help to land the message, whether that message is designed to sell a product or win a grant. These are the traditional techniques of communications applied to science.

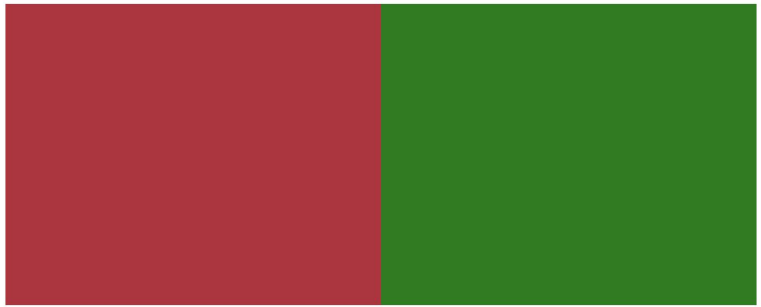
This approach often works, but it comes with danger.

There are myriad examples from the current pandemic of which we might ask: have experts always been explicit in acknowledging unknowns? Complexity? Conflicts of interest? Inconvenient data? And, importantly, their own values? Rather than re-examine those cases, we offer ideas to encourage reflection, based on our own research.

Our small, interdisciplinary group at the University of Cambridge, UK, collects empirical data on issues such as how to communicate uncertainty, how audiences decide

Colours have associations





Is your visualisation informative?

- ❑ Does the knowledge of uncertainty change the decision?
- ❑ Is the eye drawn to one category more than others?

“A graphic should not only show the leaves it should show the branches as well as the entire tree.”

Jacques Bertin

The Semiology of Graphics. 1983.

nrennie.rbind.io/talks/wombat-data-viz

nrennie.rbind.io

nrennie

nicola-rennie