

# *Graphic Design with ggplot2*

## **How to Create Engaging and Complex Visualizations in R**

**Cédric Scherer** // rstudio::conf // July 2022

# Welcome!

**HELLO**  
my name is

*Meet the  
teaching team!*

# THE Teaching TEAM



*Cédric Scherer*

Workshop Instructor (he/him)

# Cédric Scherer

Independent Data Visualization Specialist  
Computational Ecologist at IZW Berlin



Consulting

*Coaching*

Coding



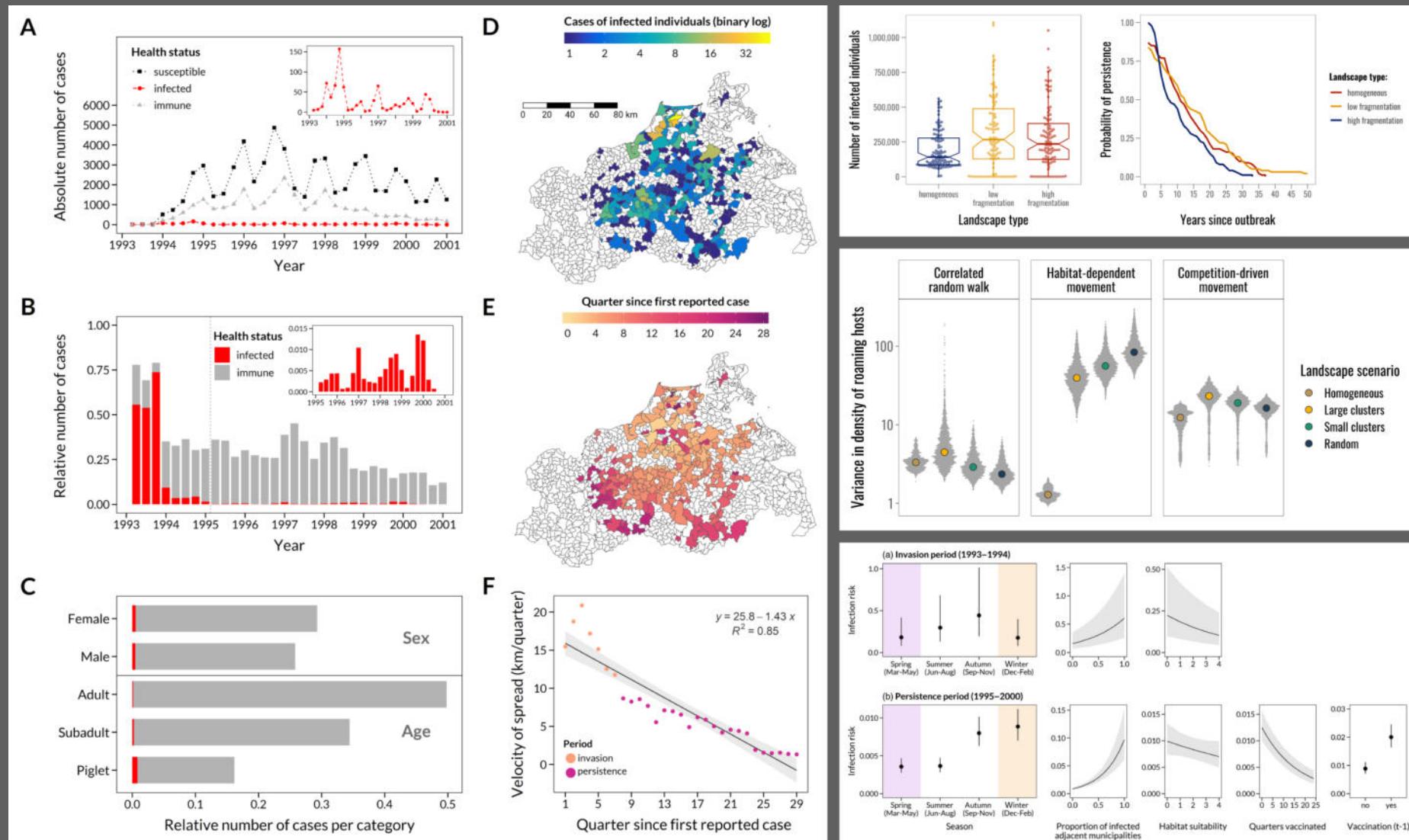
[cedricscherer.com](http://cedricscherer.com)

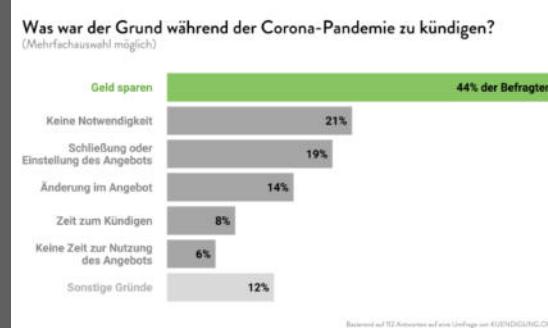
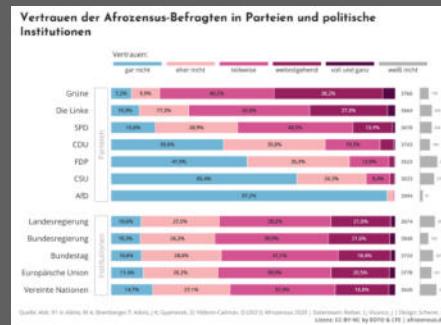


@CedScherer



z3tt





**Politiker rechnen bald mit einer Fortsetzung der Fußball-Bundesliga. Wenn auch nicht im Stadion, so ist es voraussichtlich bald wieder möglich Fußball im Fernsehen zu sehen.**

Ich habe **einen** Vertrag mit einem Anbieter für Sportübertragungen.



Ich habe **keinen** Vertrag mit einem Anbieter für Sportübertragungen.



## GRAPHIC SCIENCE

Text by Clara Moskowitz | Graphic by Cédric Scherer and Georgios Karamanis

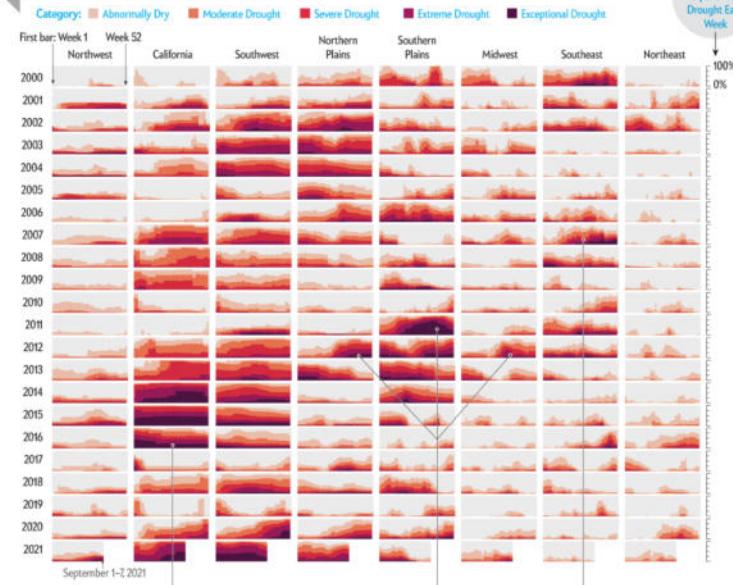
# Escalating Drought

Climate change is intensifying periods of extreme dryness, particularly in the U.S. West

For more than 20 years the National Drought Mitigation Center (NDMC) has been monitoring dozens of indices of drought around the country, including satellite measurements of evaporation and color in vegetation, soil-moisture sensors, rainfall estimates, and river and streamflow levels. Although the agency's weekly assessments have identified periods of exceptional drought before, lately dryness has been ramping up. "The changing climate is definitely contributing to more natural disasters, drought being one of them," says Brian Fuchs, a climatologist who oversees the weekly report at the NDMC. "We're seeing more frequent and high-intensity episodes. This year some of these areas in the West have been in drought more than they have been without drought."



### Drought Extent and Intensity by Region over Time

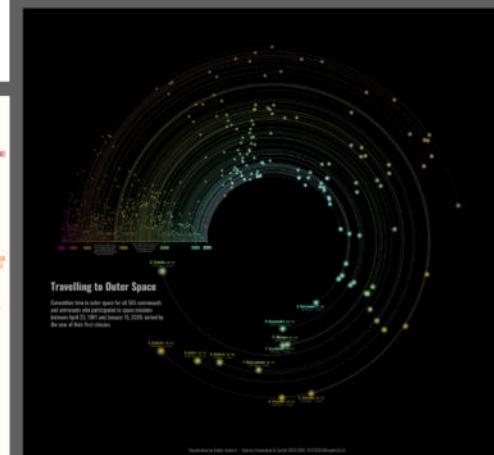
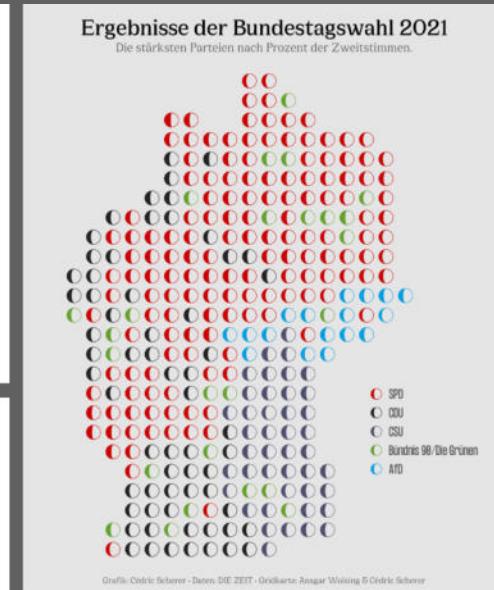
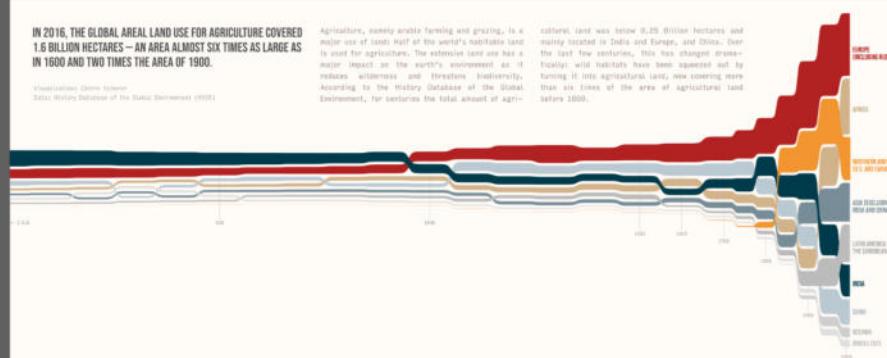
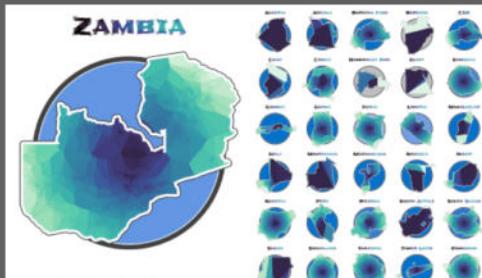
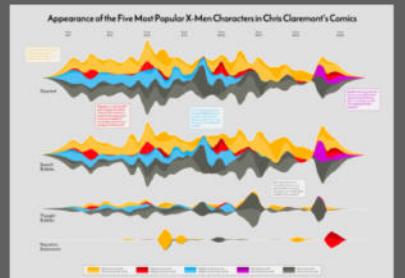
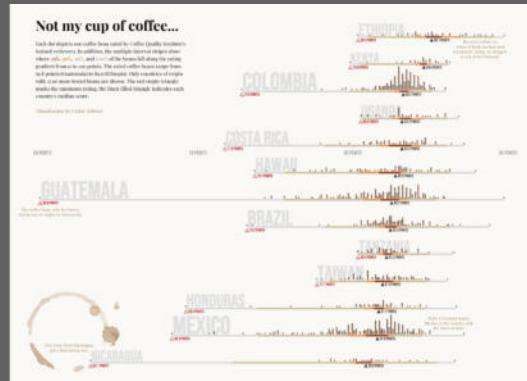
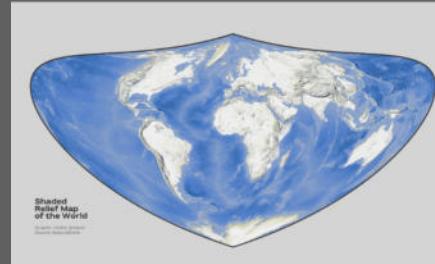
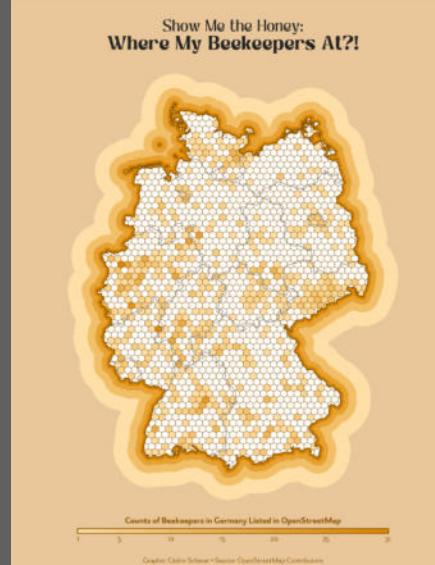
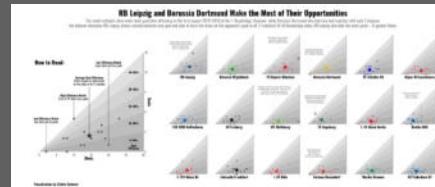


California experienced its hottest drought in recorded history from 2012 to 2016. A warming climate makes the atmosphere thirstier, which increases evaporation and boosts drought.

A drought that originated in the Southern Plains in 2011 eventually spread to the Midwest and Northern Plains when the moisture coming in from the Gulf of Mexico was absorbed by the parched South before it could reach the North.

The Southeast's driest year to date was 2007, when only 31.85 inches of rain fell in Atlanta, 62 percent of its average yearly rainfall.

Sources: U.S. Drought Monitor, produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln; U.S. Department of Agriculture, and National Oceanic and Atmospheric Administration Data



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*Ahmадou Dicko*

Teaching Assistant (he/him)

Africa fabric map

Traditional and non traditional African fabric randomly assigned to countries.



Data from NaturalEarth | Map by @dickoah

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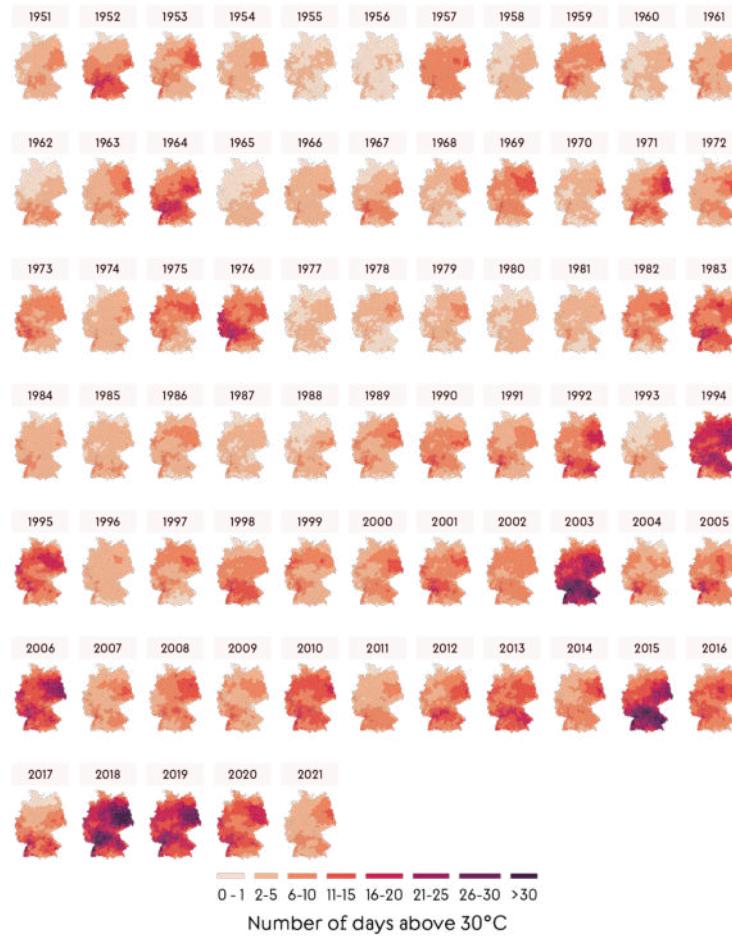
Teaching Assistant (he/him)



**Marco Sciaiani**

Teaching Assistant (he/him)

## Germany's heating-up



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*Ahmadou Dicko*

Teaching Assistant (he/him)



*Marco Sciaiani*

Teaching Assistant (he/him)



*Hassan Kibirige*

Teaching Assistant (he/him)

## The Periodic Table of Elements

1 H Hydrogen 1.00794	2 He Helium 4.002602
3 Li Lithium 6.941	4 Be Beryllium 9.012182
11 Na Sodium 22.98976928	12 Mg Magnesium 24.3050
19 K Potassium 39.0983	20 Ca Calcium 40.078
38 Rb Rubidium 85.4678	39 Sr Strontium 87.62
55 Cs Cesium 132.9054519	56 Ba Barium 137.327
87 Fr Francium [223]	88 Ra Radium [226]
21 Sc Scandium 44.955912	22 Ti Titanium 47.867
23 V Vanadium 50.9415	24 Cr Chromium 51.9961
25 Mn Manganese 54.938045	26 Fe Iron 55.845
27 Co Cobalt 58.933185	28 Ni Nickel 58.6934
29 Cu Copper 63.546	30 Zn Zinc 65.38
31 Ga Gallium 69.723	32 Ge Germanium 72.64
41 Nb Niobium 92.90638	42 Mo Molybdenum 95.96
43 Tc Technetium [98]	44 Ru Ruthenium 101.07
45 Rh Rhodium 102.90550	46 Pd Paladium 106.42
47 Ag Silver 107.8682	48 Cd Cadmium 112.411
49 In Indium 114.818	50 Sn Tin 118.710
51 Sb Antimony 121.760	52 Te Tellurium 127.60
53 I Iodine 126.90447	54 Xe Xenon 131.293
71 Lu Lutetium 174.95668	72 Hf Hafnium 178.49
73 Ta Tantalum 180.94788	74 W Tungsten 183.84
75 Re Rhenium 186.207	76 Os Osmium 190.23
77 Ir Iridium 192.217	78 Pt Platinum 195.084
79 Au Gold 196.966589	80 Hg Mercury 200.59
81 Tl Thallium 178.433	82 Pb Lead 207.2
83 Bi Bismuth 208.99040	84 Po Polonium [209]
85 At Astatine [210]	86 Rn Radon [222]
103 Lr Lawrencium [262]	104 Rf Rutherfordium [267]
105 Db Dubnium [268]	106 Sg Seaborgium [271]
107 Bh Bohrium [272]	108 Hs Hassium [270]
109 Mt Meitnerium [276]	110 Ds Darmstadtium [281]
111 Rg Roentgenium [280]	112 Cn Copernicium [285]
113 Uut Ununtrium [289]	114 Fl Flerovium [288]
115 Uup Ununpentium [293]	116 Lv Livermorium [293]
117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]

57 La Lanthanum 138.90547	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93032	68 Er Erbium 167.259	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.054
89 Ac Actinium [227]	90 Th Thorium 232.03806	91 Pa Protactinium 231.03568	92 U Uranium 238.02891	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]

metal      actinoid      alkaline earth metal      lanthanoid      metalloid      noble gas      nonmetal  
 alkali metal      halogen      metal      transition metal

**HELLO**  
my name is

*Meet each other!*

# Conversation Starters

- What's your name?
- Where do you feel home?
- When did you use R for the first time?
- What's your favorite animal / plant / color / typeface?
- Whom would you like to meet during the rstudio::conf?
- Which R package are you looking forward to try?

# Announcements

## WiFi

- Username: conf22
- Password: together!

## Course Materials

- Webpage: [rstudio-conf-2022.github.io/ggplot2-graphic-design](https://rstudio-conf-2022.github.io/ggplot2-graphic-design)
- Rstudio Cloud: [rstudio.cloud/spaces/235465](https://rstudio.cloud/spaces/235465)

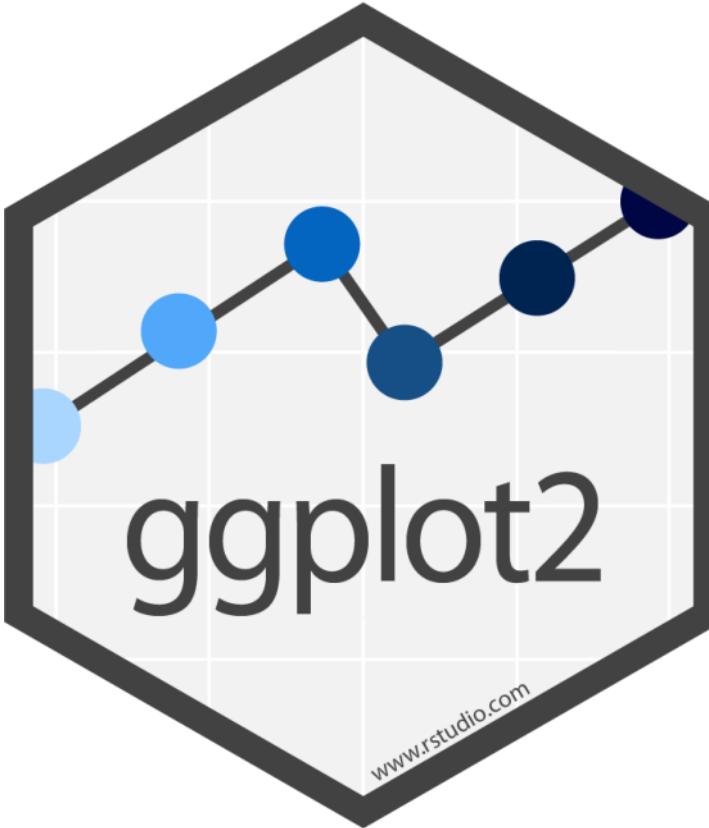
# Announcements

- gender neutral bathrooms by the National Harbor rooms
- meditation room is located at National Harbor 9, open 8am-5pm, Monday-Thursday
- there is also has a dedicated room behind the reception
- lactation room is located at Potomac Dressing Room, open 8am-5pm, Monday-Thursday.
- participants with red lanyards wish to be not photographed, please note everyone's lanyard colors before taking a photo
- The Code of Conduct and COVID policies can be found at [rstudio.com/conference/2022/2022-conf-code-of-conduct](https://rstudio.com/conference/2022/2022-conf-code-of-conduct), please review them carefully

# Communication Strategy

- **Green sticky note** – I am done with the exercise
- **Pink sticky note** – I need help or support
- You can ask questions / comment at any time during the course.
- Please avoid questions during the breaks to give us a chance to recover and reflect.
- Team up with your neighbors for exercises – and lunch!
- We will collect feedback twice during the day (more later).

# Introduction



**{ggplot2}** is a system for declaratively creating graphics,  
based on “The Grammar of Graphics” (Wilkinson, 2005).

You provide the data, tell **{ggplot2}** how to map variables to aesthetics,  
what graphical primitives to use, and it takes care of the details.

# Advantages of {ggplot2}

- consistent underlying “grammar of graphics” (Wilkinson 2005)
- very flexible, layered plot specification
- theme system for polishing plot appearance
- lots of additional functionality thanks to extensions
- active and helpful community

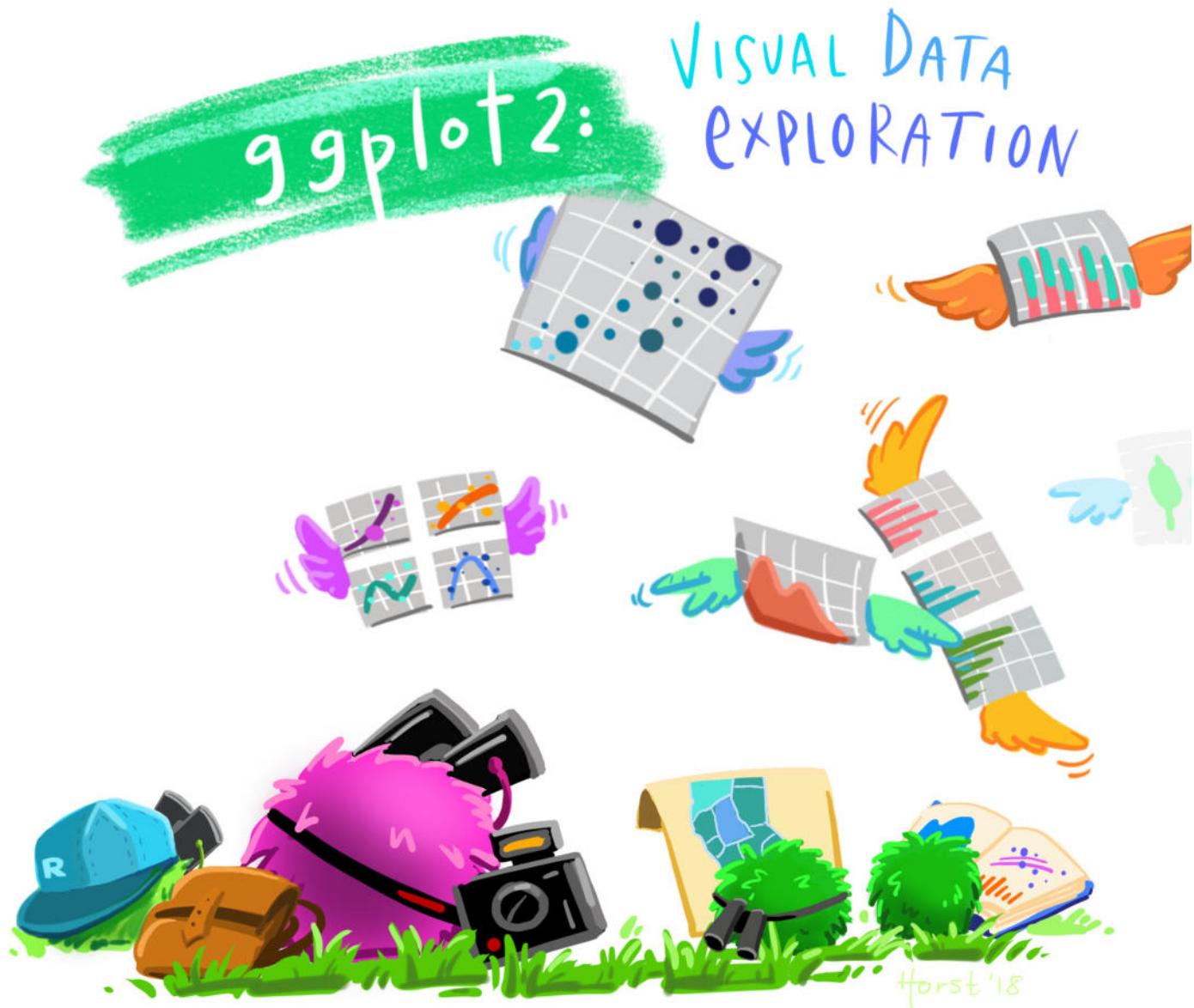
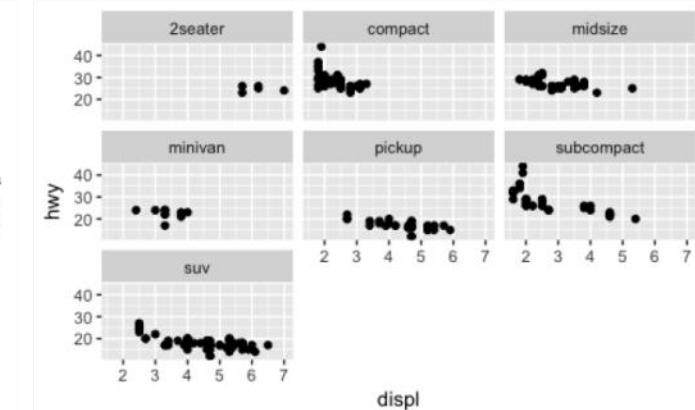
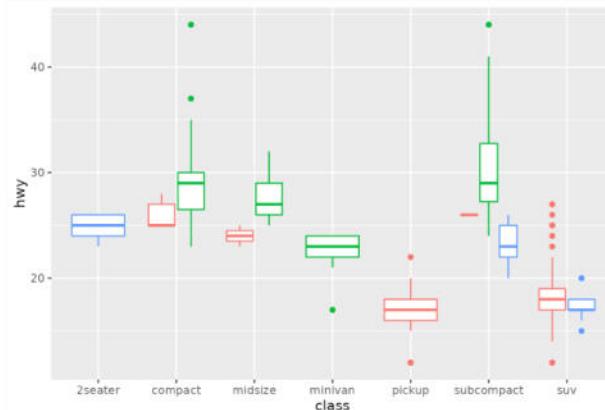
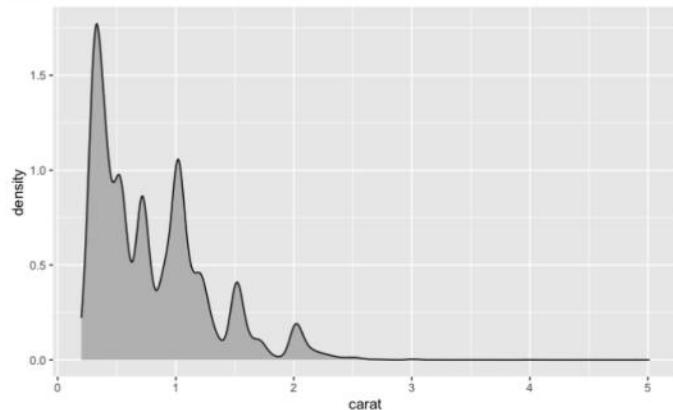
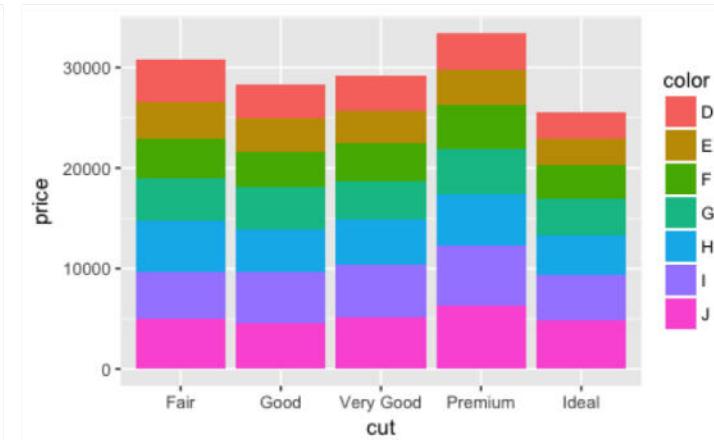
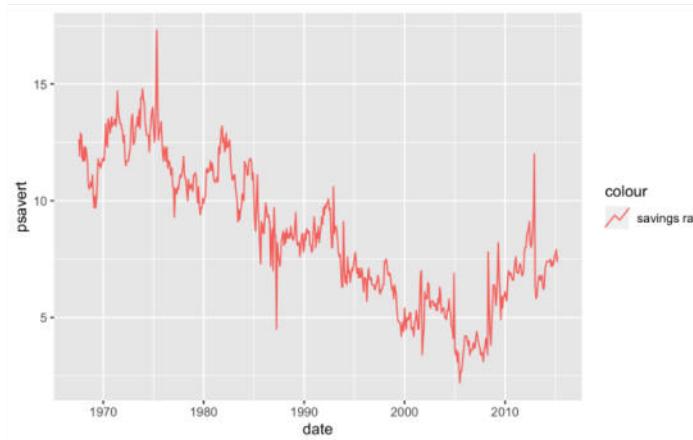
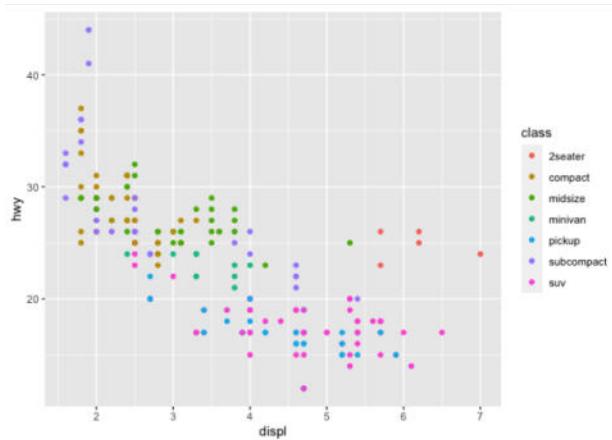
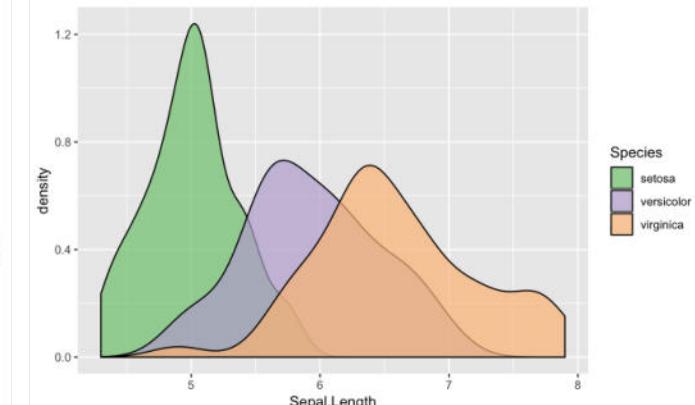
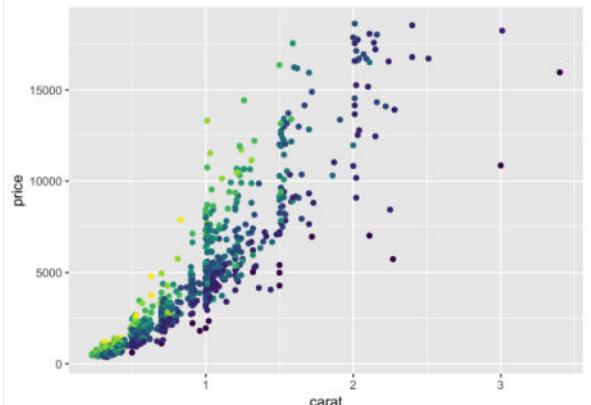
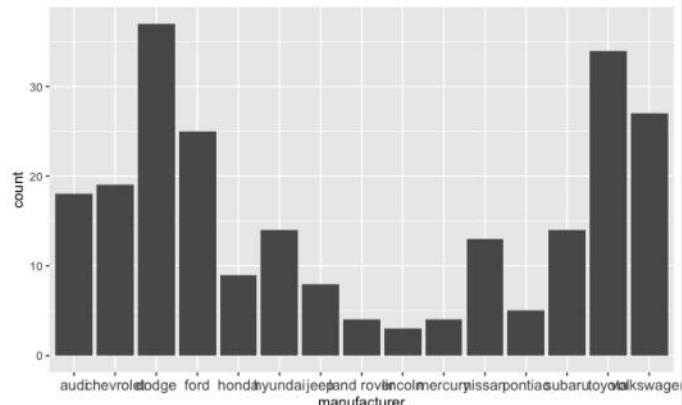


Illustration by [Allison Horst](#)

**Cédric Scherer** // rstudio::conf // July 2022



ggplot2 Examples featured on [ggplot2.tidyverse.org](http://ggplot2.tidyverse.org)

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# ggplot2:

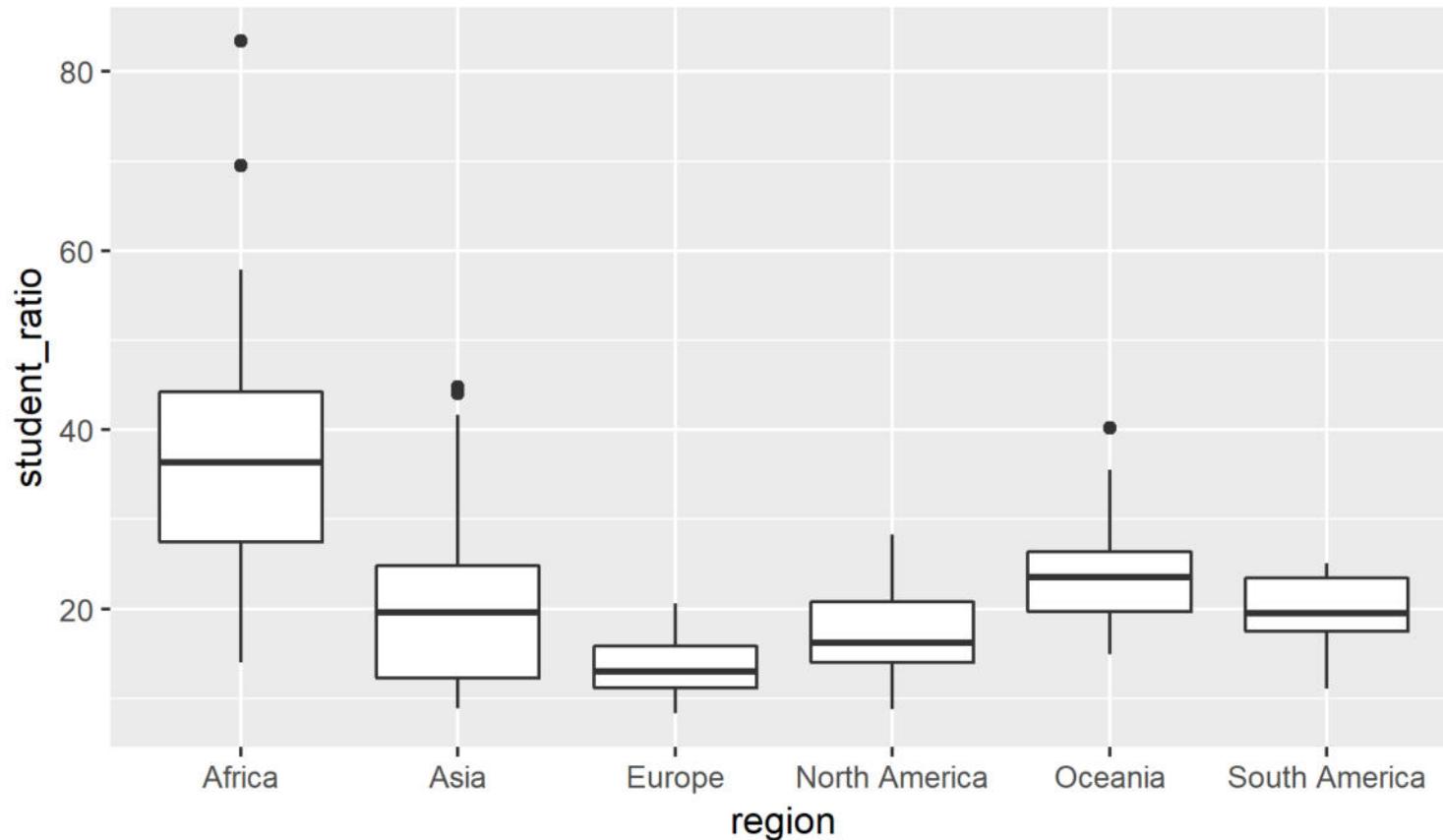
Build a data  
MASTERpiece



Illustration by [Allison Horst](#)

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# The Evolution of a ggplot



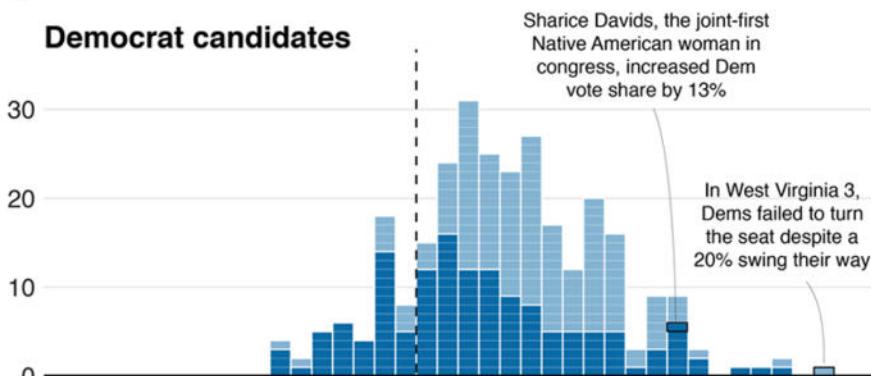
Data: UNESCO Institute for Statistics  
Visualization by Cédric Scherer

# The `ggplot2` Showcase

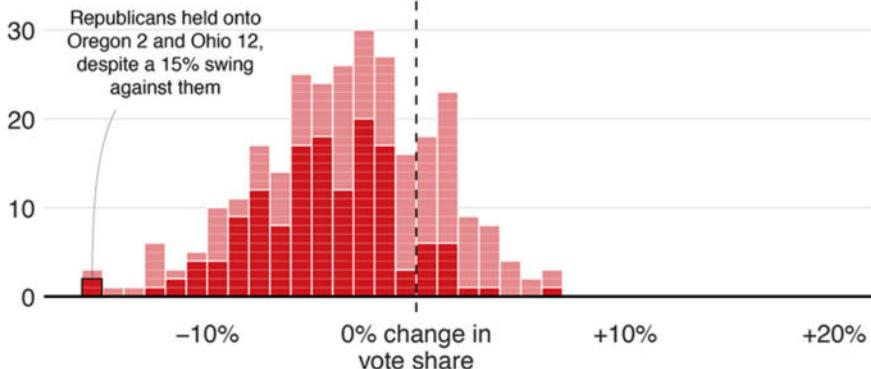
## Blue wave

■ Won seat ■ Didn't win

### Democrat candidates



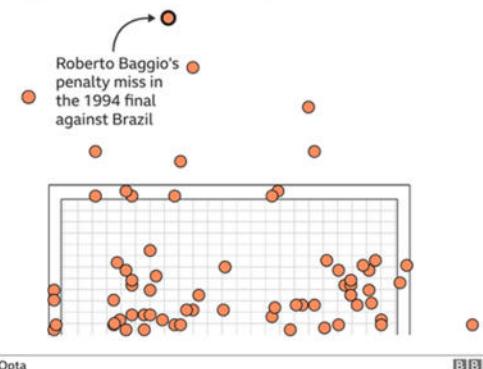
### Republican candidates



Source: AP, 19:01 ET

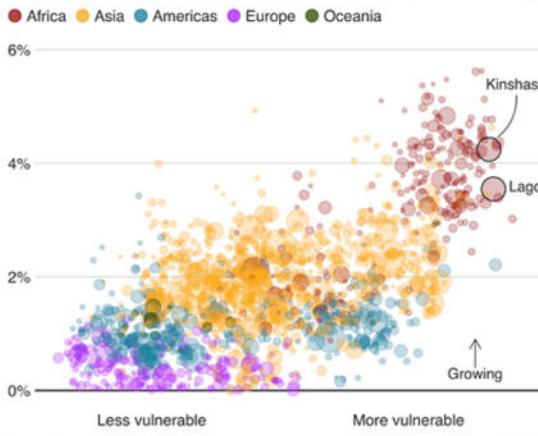
## Where penalties are saved

World Cup shootout misses and saves, 1982-2014



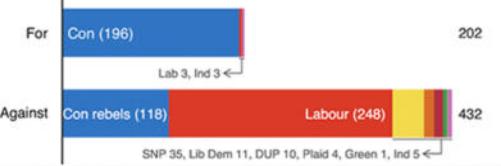
## Fast-growing cities face worse climate risks

Population growth 2018-2035 over climate change vulnerability



Source: Verisk Maplecroft. Circle size represents current population.

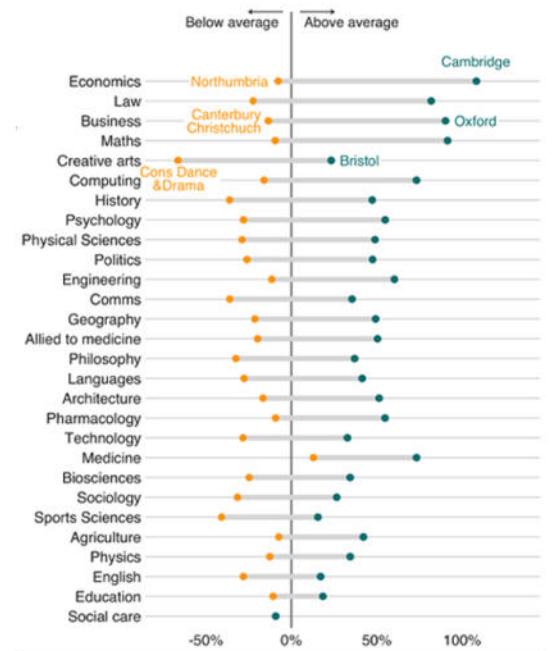
## MPs rejected Theresa May's deal by 230 votes



Source: Commons Votes Services. Excludes 'tellers', the Speaker and deputies

## Earnings vary across unis even within subjects

Impact on men's earnings relative to the average degree



Source: Institute for Fiscal Studies

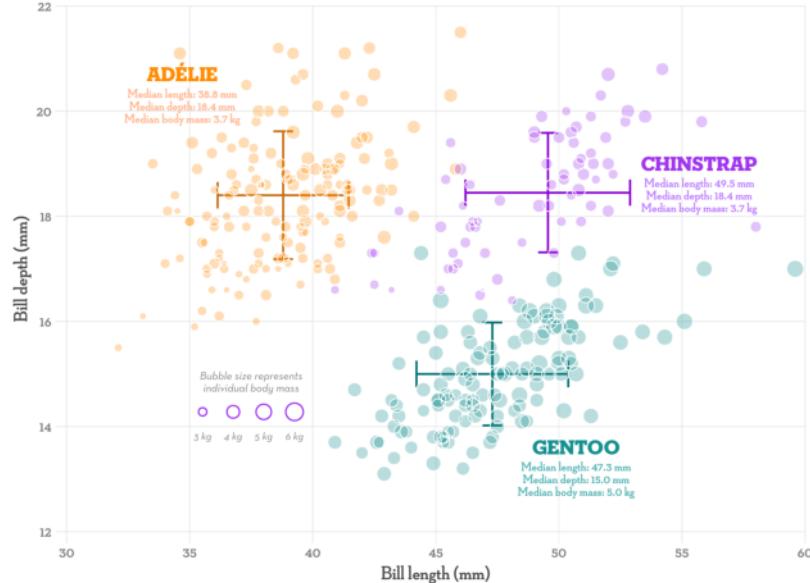
Collection of Graphics from the [BBC R Cookbook](#)

## BILL DIMENSIONS OF BRUSH-TAILED PENGUINS

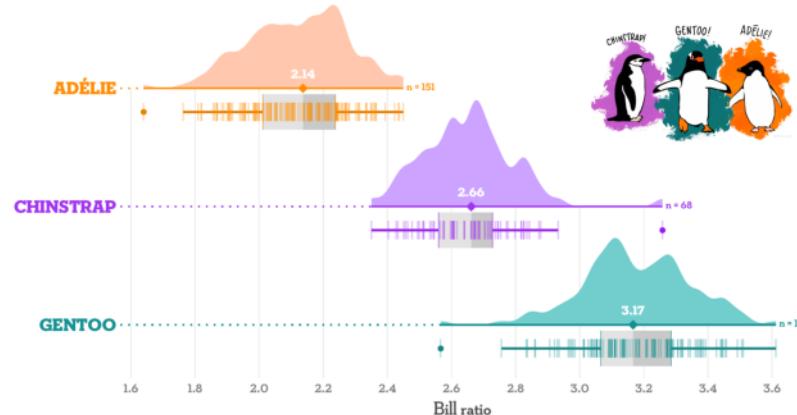
*Pygoscelis adeliae* (Adélie penguin) • *P. antarctica* (Chinstrap penguin) • *P. papua* (Gentoo penguin)



A. Scatterplot of bill length versus bill depth (median +/- sd)



B. Distribution of the bill ratio, estimated as bill length divided by bill depth



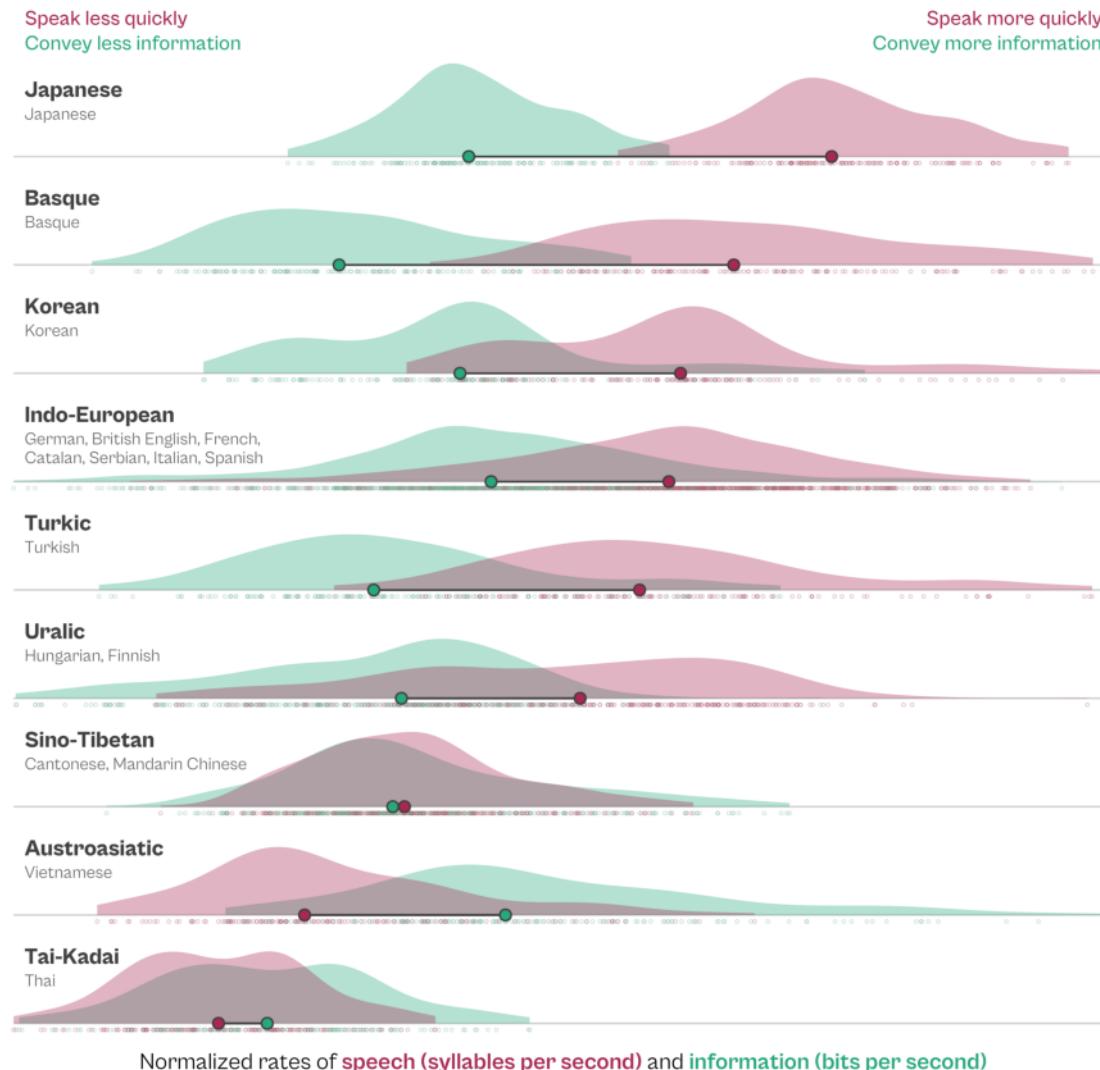
Note: In the original data, bill dimensions are recorded as "culmen length" and "culmen depth". The culmen is the dorsal (upper) ridge of a bird's bill.  
Visualization: Cédric Scherer • Data: Gorman, Williams & Fraser (2014) DOI: 10.1371/journal.pone.0090081 • Illustrations: Allison Horst

Contribution to #TidyTuesday Week 2020/31

Cédric Scherer // rstudio::conf // July 2022

## Communicating fast doesn't necessarily mean communicating more

Variation in speech and information rates across language families, shown as normalized rates for comparison. While there are stark cross-linguistic differences in speech rates, information rates are more similar.

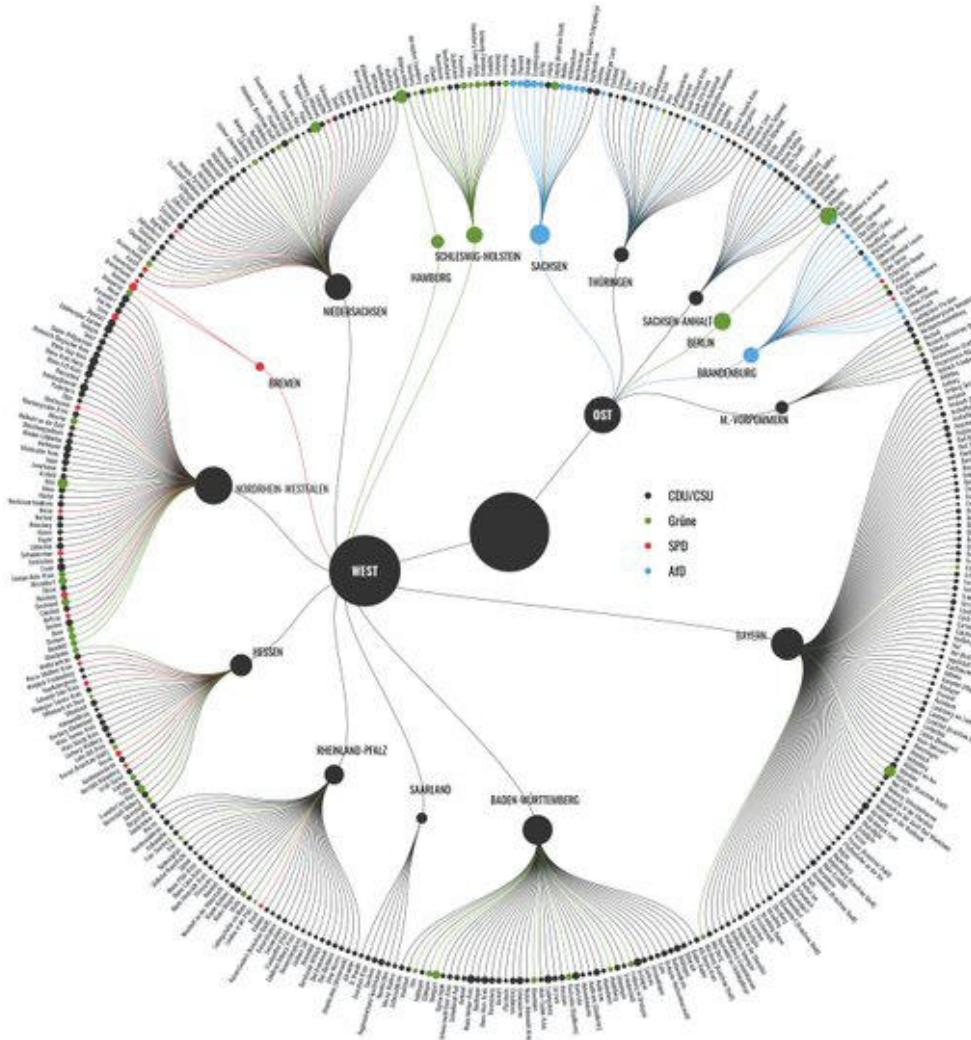


Source: Coupé et al. 2019 Science Advances 5(9). DOI: 10.1126/sciadv.aaw2594  
Graphic: Cédric Scherer • Large dots show the median rates for each language family. Small dots show single estimates.

My reinterpreted The Economist graphic

Cédric Scherer // rstudio::conf // July 2022

Europawahl 2019  
Wahlergebnisse Deutschland

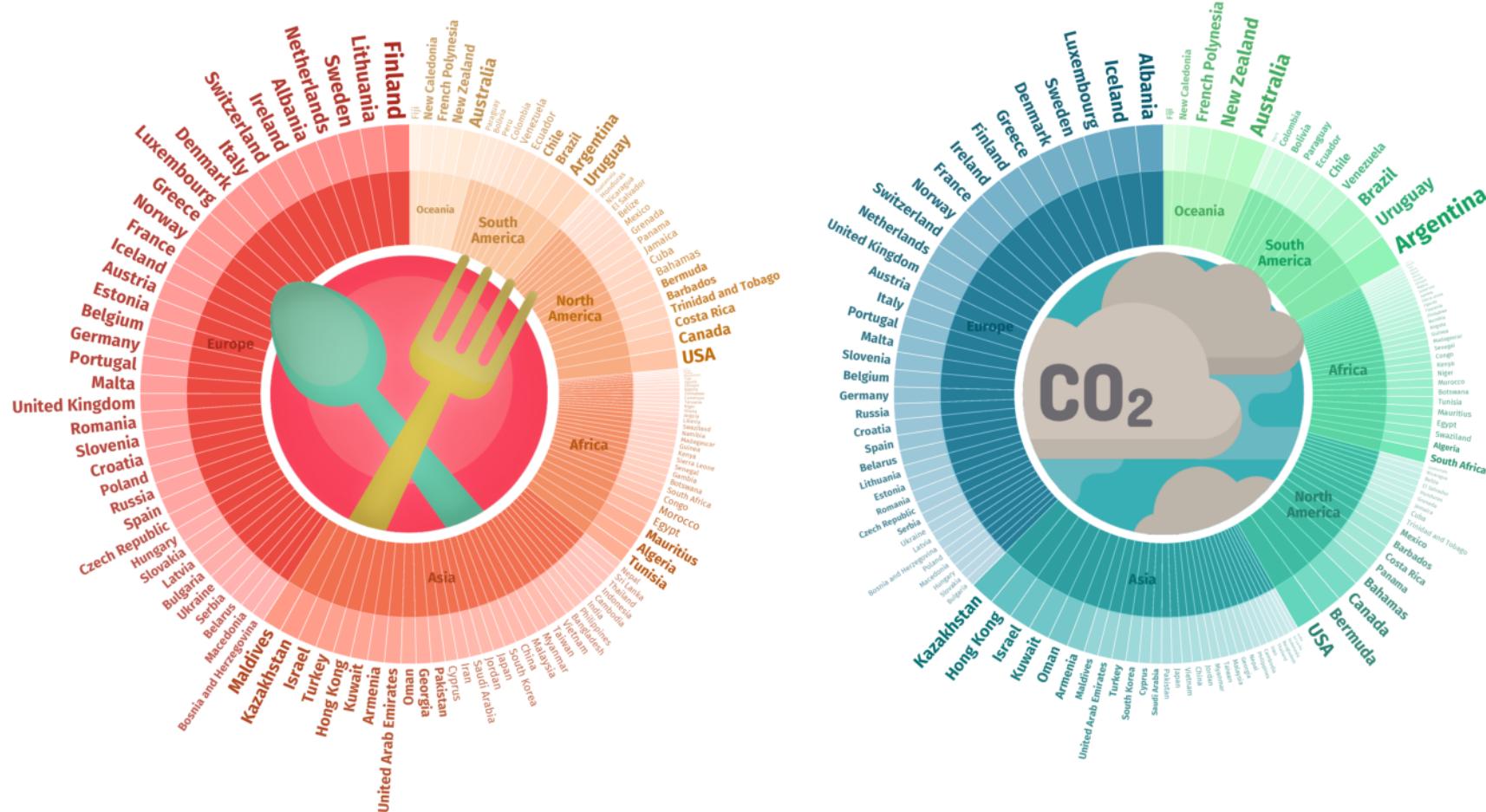


© 2019 [sprenger](#) | [Markus Sprenger](#) | [sprenger.info](#)

"European Elections" by Torsten Sprenger  
**Cédric Scherer** // rstudio::conf // July 2022

# Food Carbon Footprint Index 2018

Global comparison of different diets in terms of **Average Consumption (kg/person/year)** of both animal and non-animal products as well as **Carbon Emissions (kg CO<sub>2</sub>/person/year)** per continent and country. Font size and color intensity indicate each country's estimate with **countries printed in bold** belonging to the upper 50% of consumers and CO<sub>2</sub> emitters, respectively.



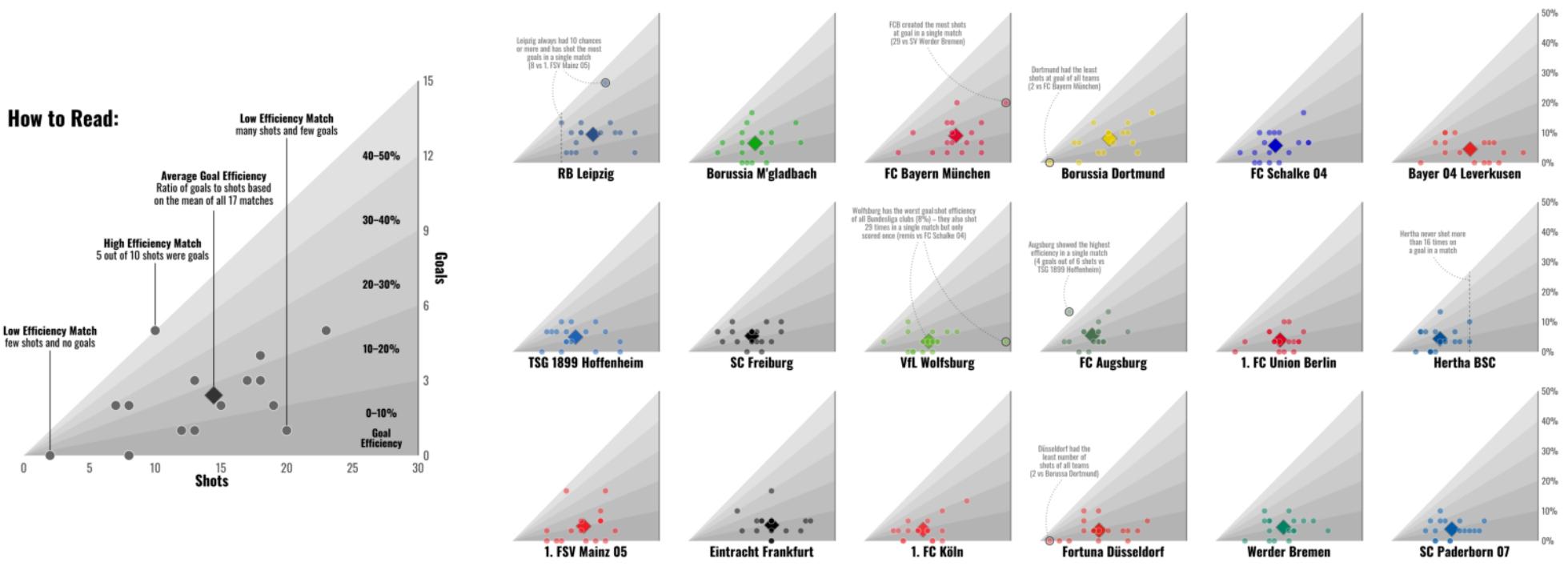
Visualization by Cédric Scherer • Data by Food and Agriculture Organization of the United Nations (FAO) via nu3 • Icons by FreePik

Contribution to #TidyTuesday Week 2020/08

Cédric Scherer // rstudio::conf // July 2022

# RB Leipzig and Borussia Dortmund Make the Most of Their Opportunities

The small multiples show each club's goal:shot efficiency in the first season 2019/2020 of the 1. Bundesliga. However, while Borussia Dortmund also had very bad matches with only 2 chances, the Autumn champion RB Leipzig always scored minimum one goal and shot at least ten times on the opponent's goal in all 17 matches! Of all Bundesliga clubs, RB Leipzig also shot the most goals – 8 against Mainz.

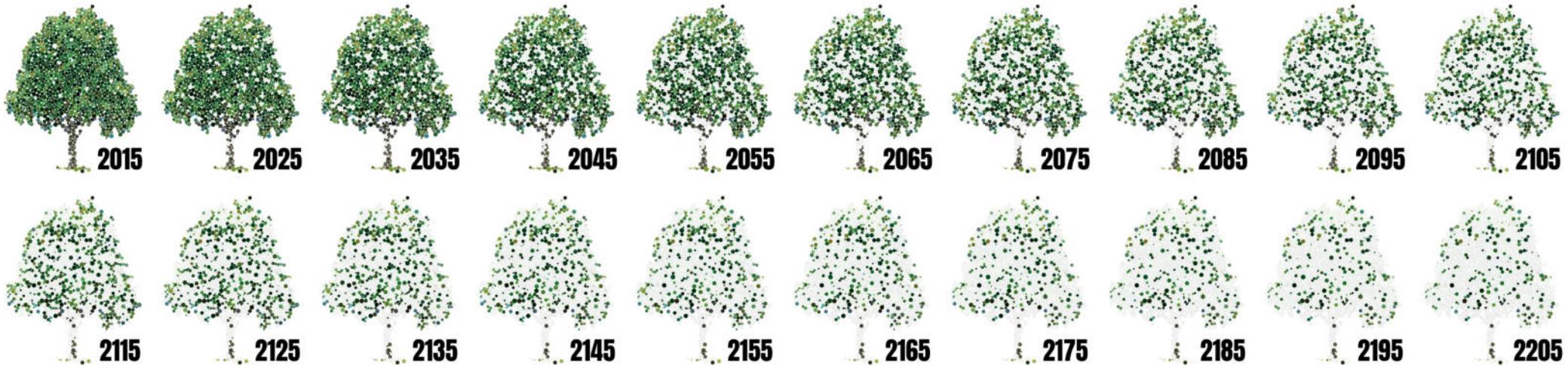


Visualization by Cédric Scherer

Contribution to the #SWDchallenge "Small Multiples"

# Unless someone like you cares a whole awful lot, nothing is going to get better. It's not.

In a 2015 study, published in Nature, Thomas Crowther and colleagues mapped tree density across the world. They estimated that there were approximately 3.04 trillion trees in the world. The authors also estimated that over 15 billion trees are cut down each year, and the global number of trees has fallen by almost half (46%) since the start of human civilization. Each dot on the trees below represent one billion trees. Each year 15 dots are faded out to illustrate the progressive loss. At this rate, our forests will evaporate within 200 years.

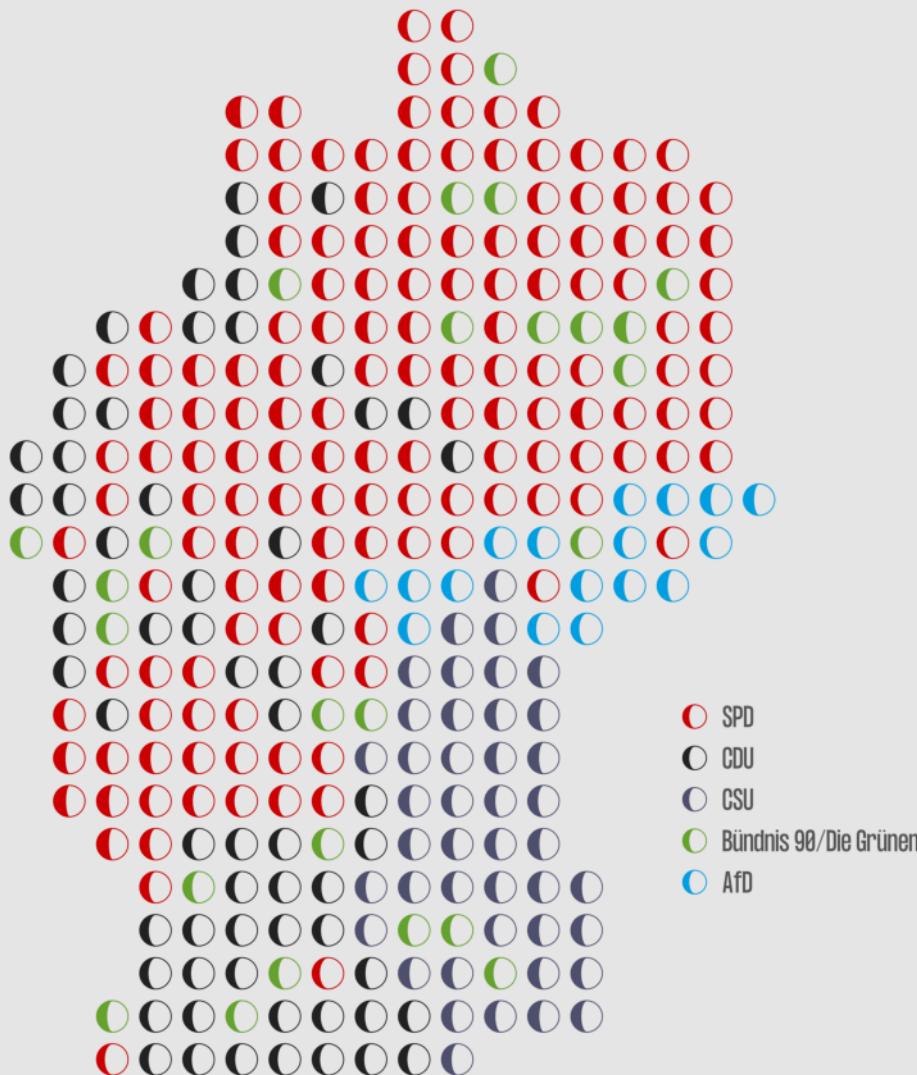


Data: ourworldindata.org/forests | Article: doi.org/10.1038/nature14967 | Graphic: @jakekaupp

Contribution to the #TidyTuesday Week 2021/15 x #30DayChartChallenge 2021 by Jake Kaupp

# Ergebnisse der Bundestagswahl 2021

Die stärksten Parteien nach Prozent der Zweitstimmen.



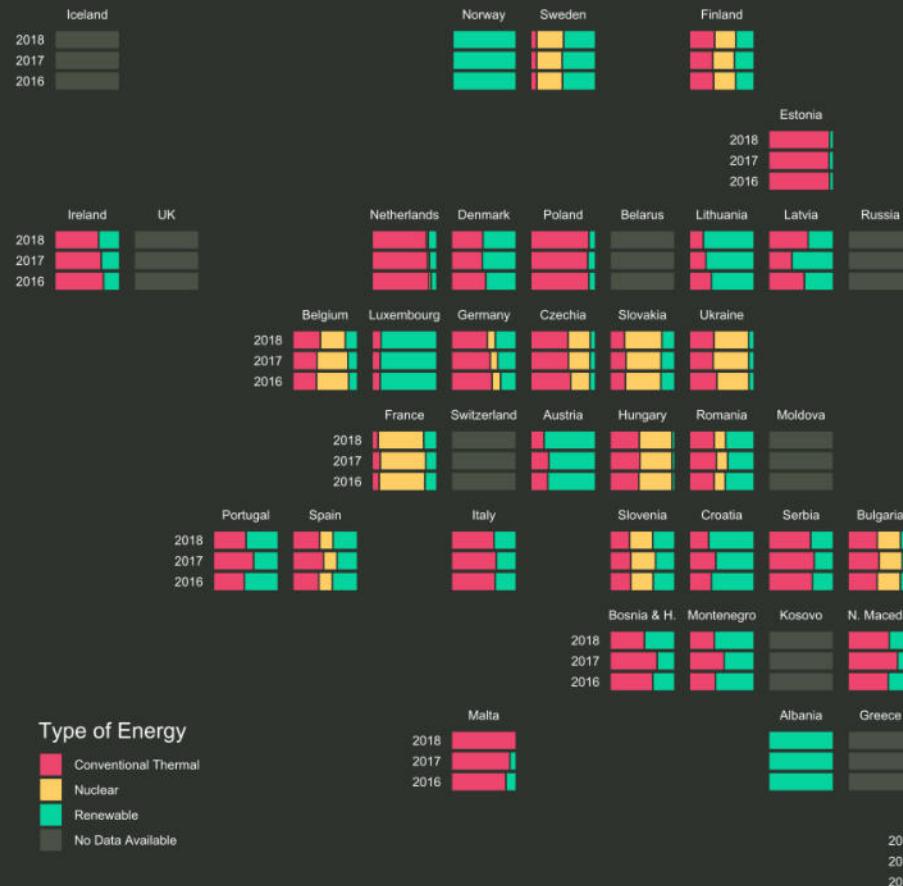
Grafik: Cédric Scherer · Daten: DIE ZEIT · Gridkarte: Ansgar Wolsing & Cédric Scherer

Moon Charts as a Tile Grid Map showing the 2nd Vote Results from the German Election 2021

Cédric Scherer // rstudio::conf // July 2022

# EUROPEAN ENERGY GENERATION

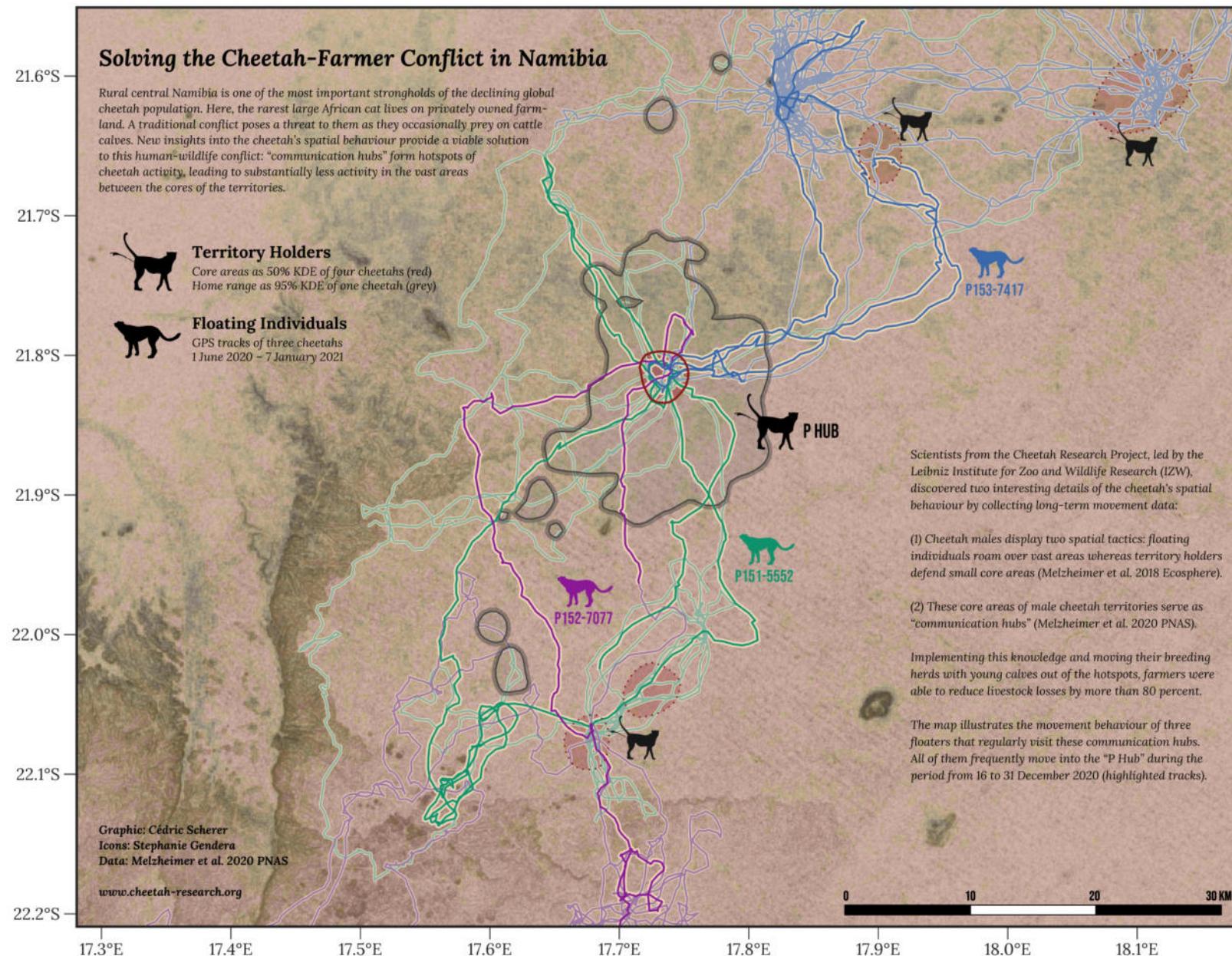
Each bar represents the **total energy generation** for each country per year.  
The colours represent the proportion of energy generated a) using **conventional thermal power plants**, which is to say those that use coal, oil or natural gas,  
b) using **nuclear power stations**, and c) using other **renewable sources**.



Data from 'Electricity generation statistics - First Results' ([ec.europa.eu/eurostat/statistics-explained](http://ec.europa.eu/eurostat/statistics-explained))  
Visualisation by [Jack Davison](#) ([@JDavison\\_](https://twitter.com/JDavison_))  
Code found at [github.com/jack-davison](https://github.com/jack-davison)

#TidyTuesday Contribution by Jack Davison

Cédric Scherer // rstudio::conf // July 2022

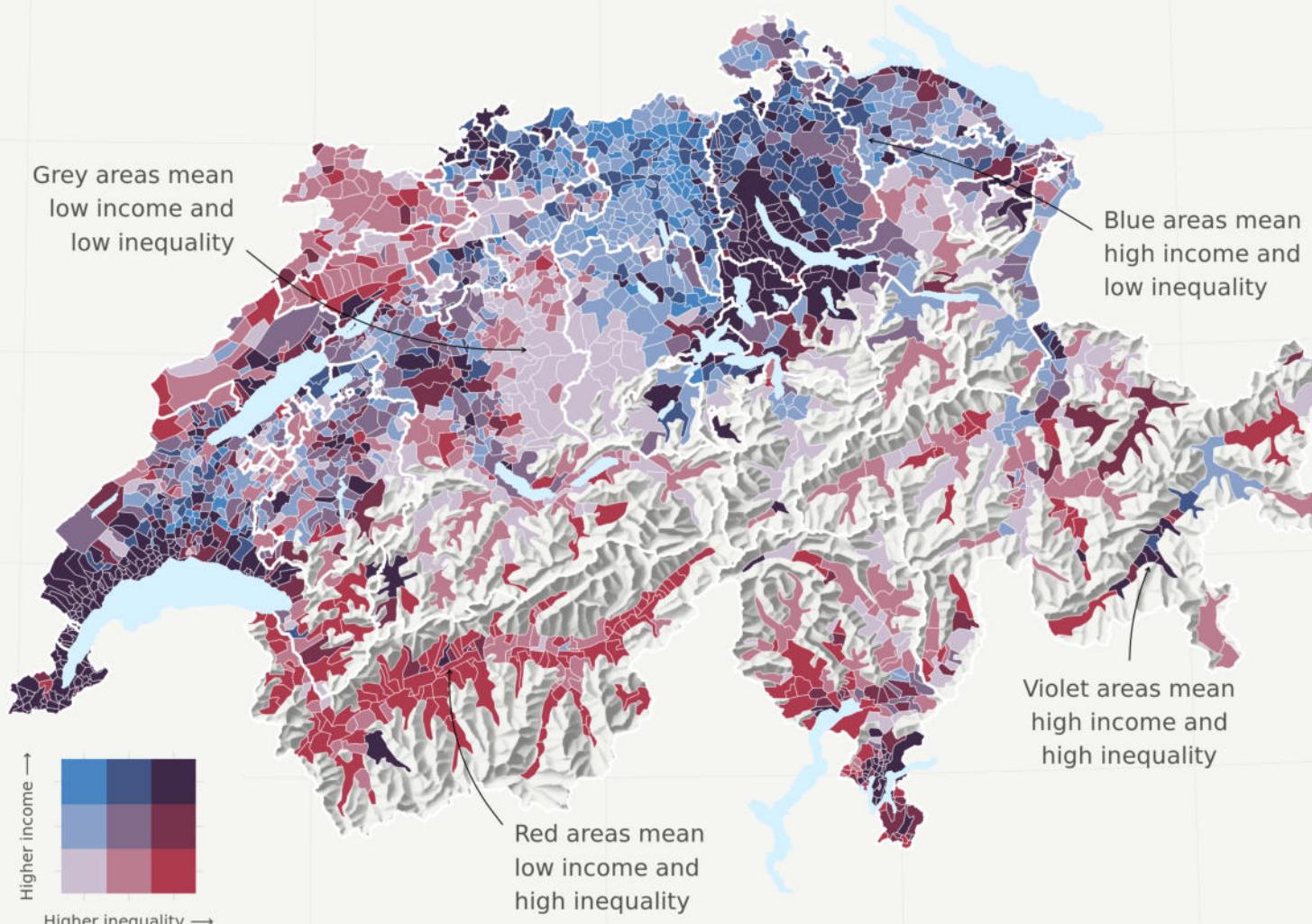


Our Winning Contribution to the BES MoveMap Contest

Cédric Scherer // rstudio::conf // July 2022

# Switzerland's regional income (in-)equality

Average yearly income and income (in-)equality in Swiss municipalities, 2015



Map CC-BY-SA; Code: [github.com/grssnbchr/bivariate-maps-ggplot2-sf](https://github.com/grssnbchr/bivariate-maps-ggplot2-sf)  
Authors: Timo Grossenbacher (@grssnbchr), Angelo Zehr (@angelozehr)  
Geometries: ThemaKart BFS and swisstopo; Data: ESTV, 2015

Bivariate Choropleth x Hillshade Map by Timo Grossenbacher

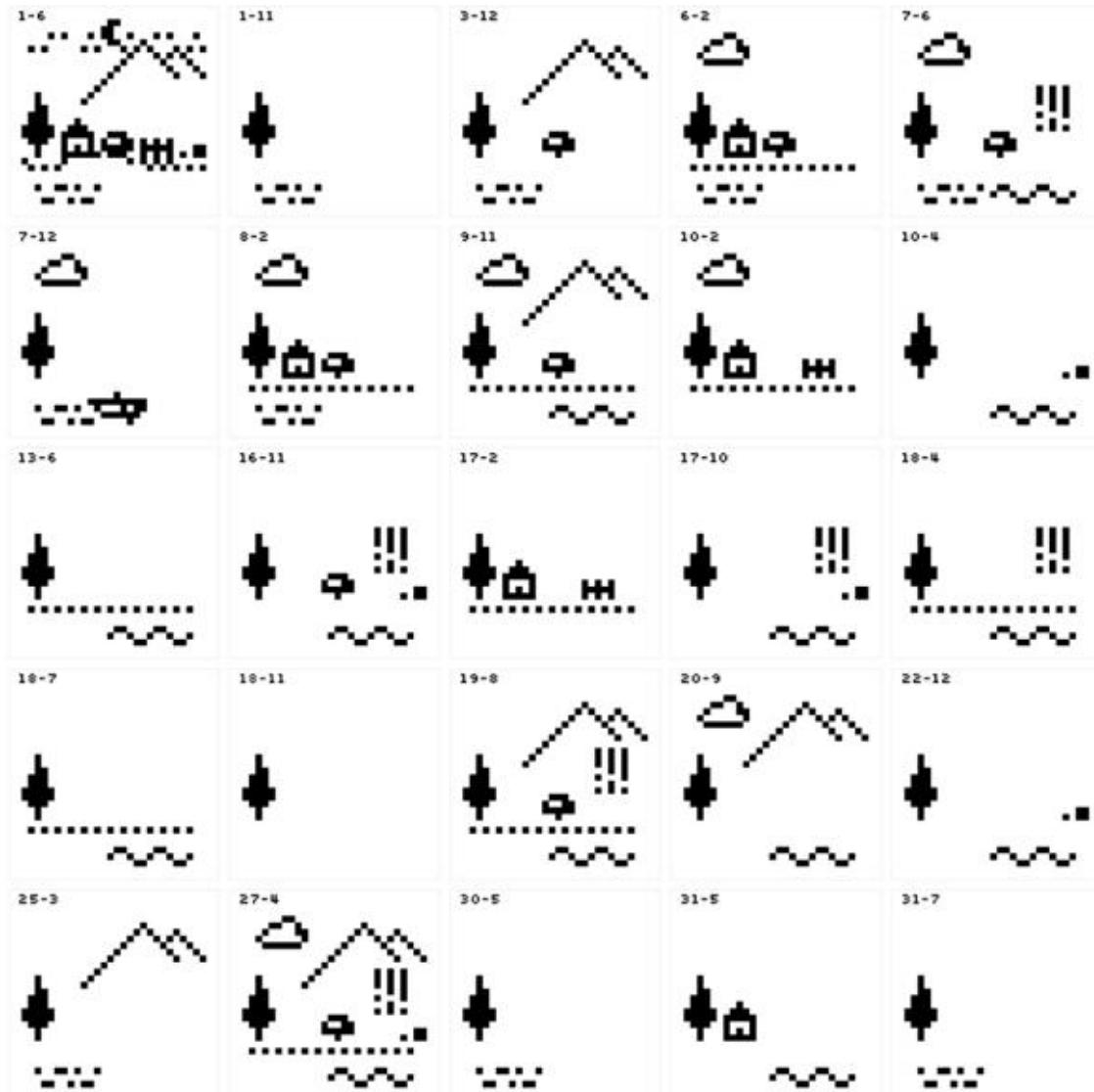
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## BOB ROSS - PAINTING BY THE ELEMENTS

GRAPHIC REPRESENTATIONS OF BOB ROSS' PAINTINGS WITH ELEMENTS IDENTIFIED IN THEM BY WALT HICKEY (FIVETHIRTYEIGHT). EACH ELEMENT REPRESENTS ONE OR MORE OCCURRENCES IN THE PAINTING. ONLY THE ELEMENTS IN THE LEGEND BELOW ARE DRAWN. TO THE RIGHT THERE ARE 25 RANDOM PAINTINGS THAT BOB PAINTED IN 'THE JOY OF PAINTING', WITH THE SEASON AND EPISODE NUMBER.



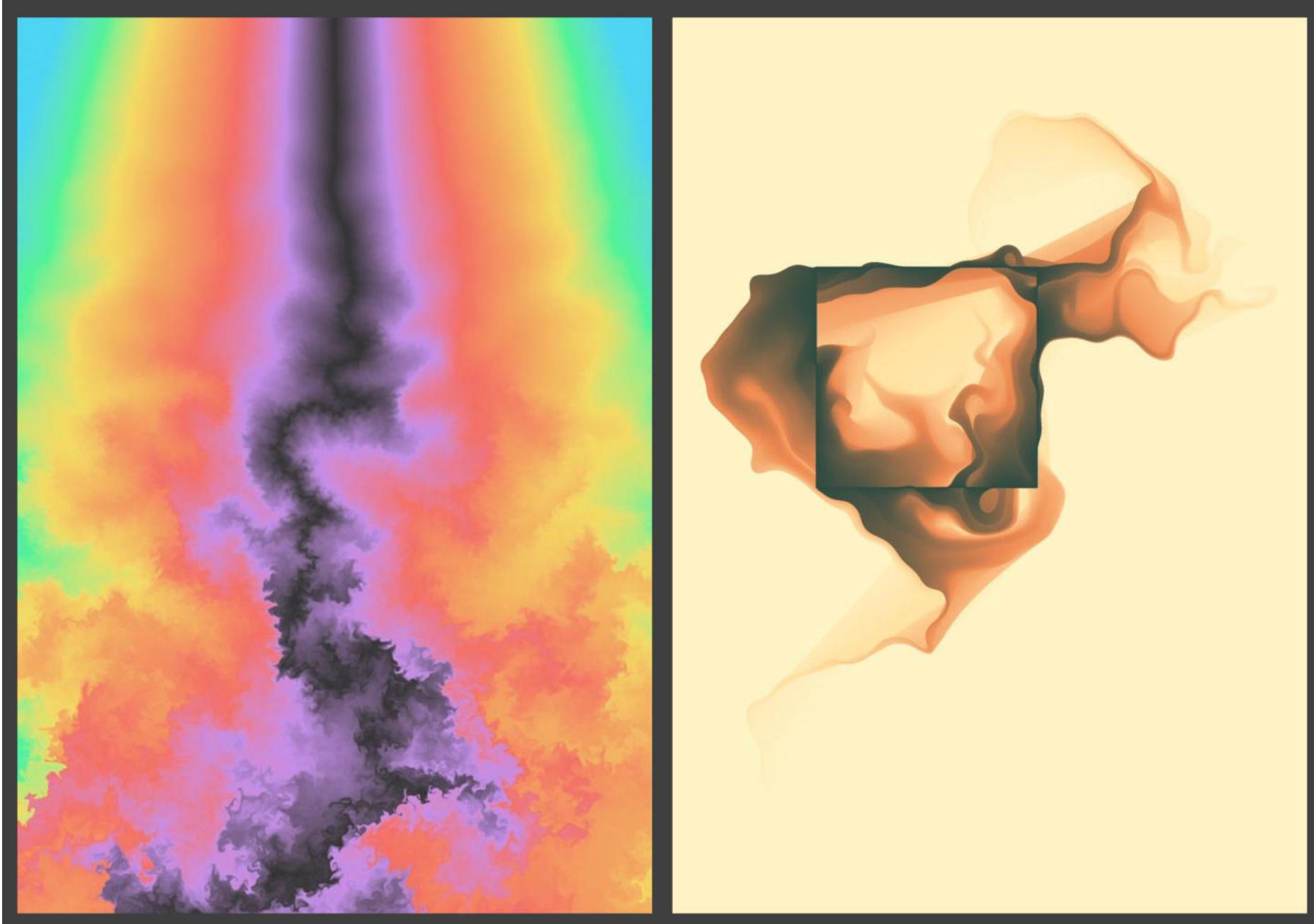
CLOUD (CIRRUS, CUMULUS), MOON, NIGHT, PALM TREE, SUN, MOUNTAIN (HILLS), CACTUS, LIGHTHOUSE, ROCKS, TREE (DECIDUOUS, CONIFER), BEACH, BOAT, CABIN (BARN, BUILDING, FARM), SEA (OCEAN, WAVES), BUSHES, FENCE, GRASS, WATERFALL, LAKE, RIVER



SOURCE: FIVETHIRTYEIGHT | PLOT: GEORGIOS KARAMANIS

Pixel Art by Georgios Karamanis

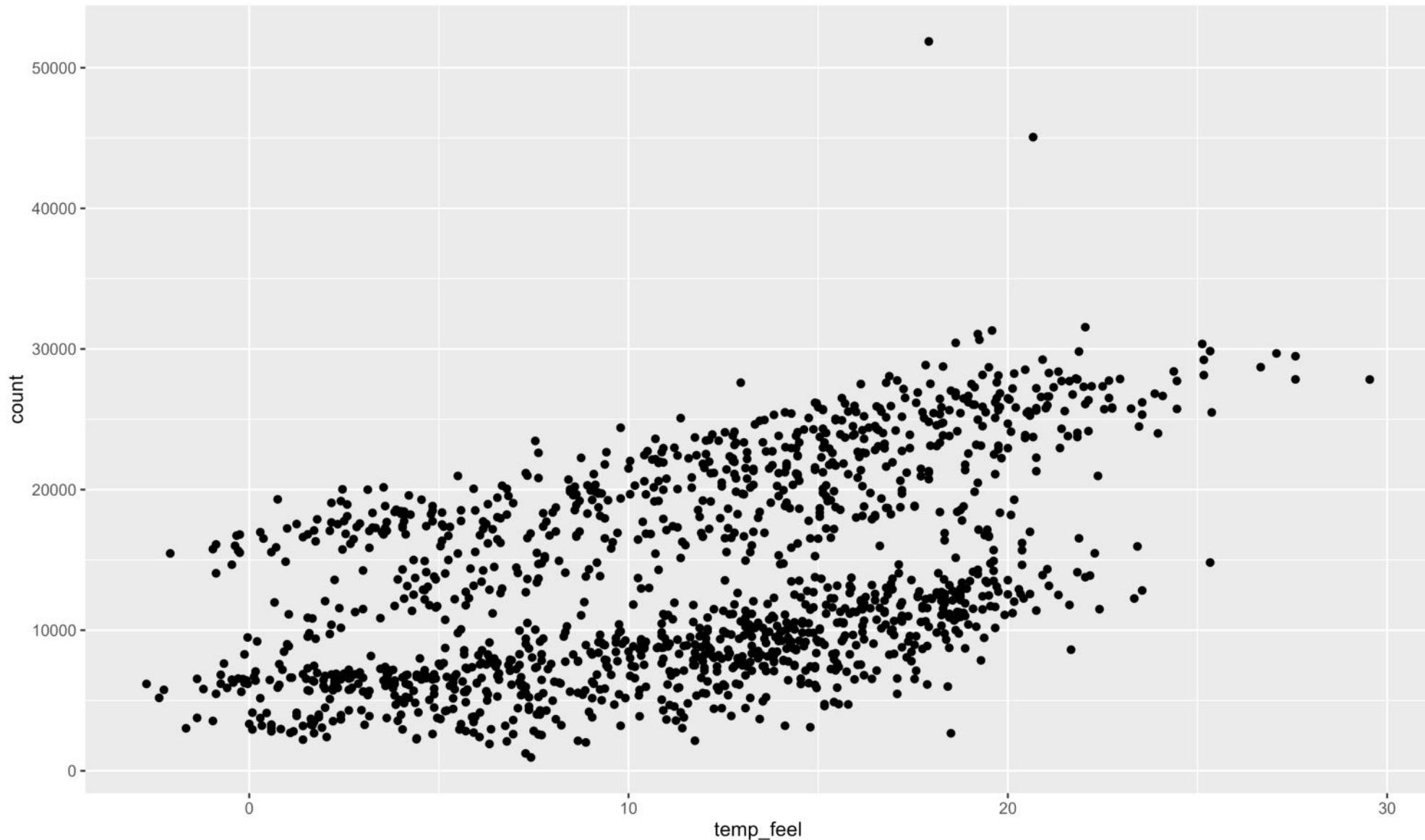
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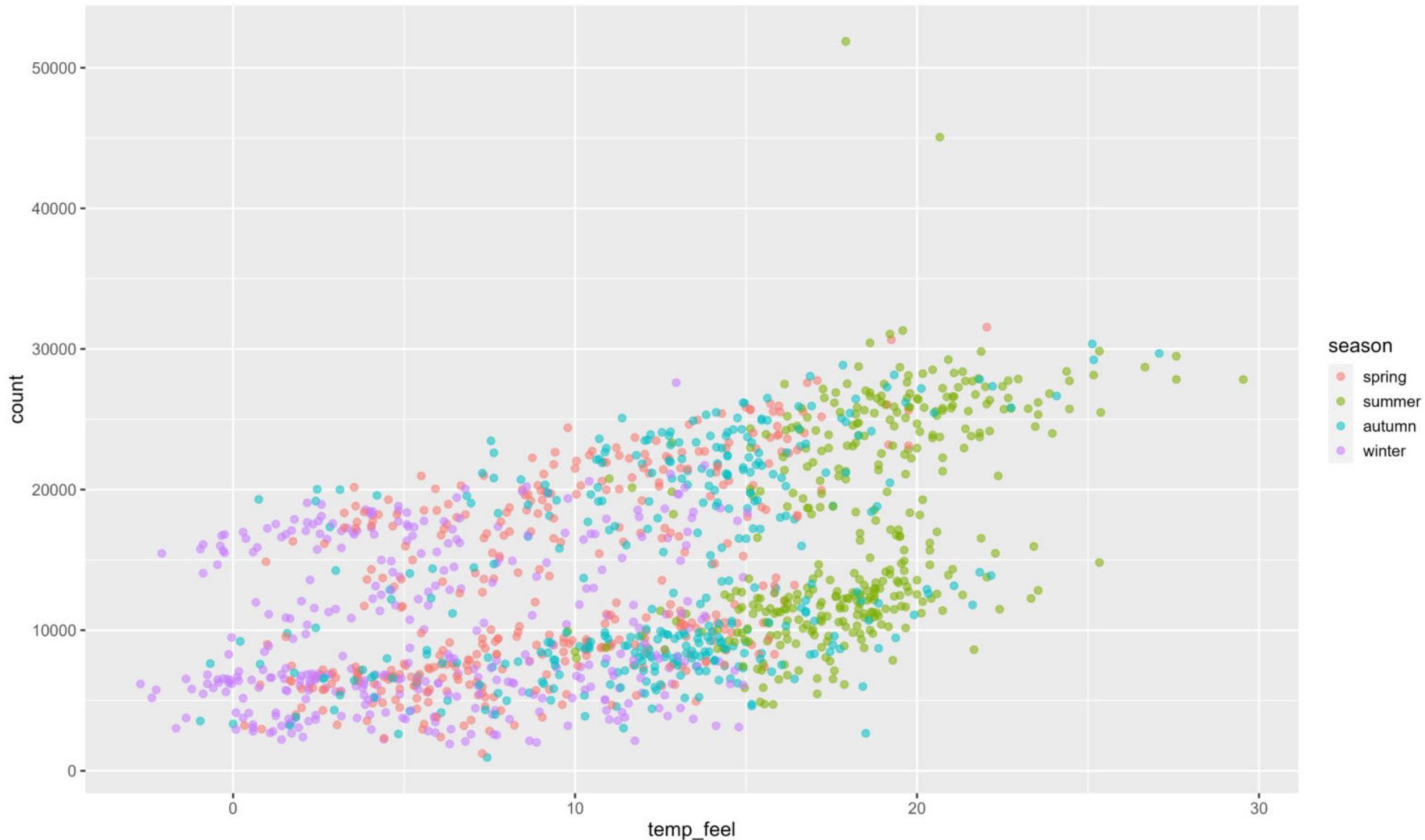


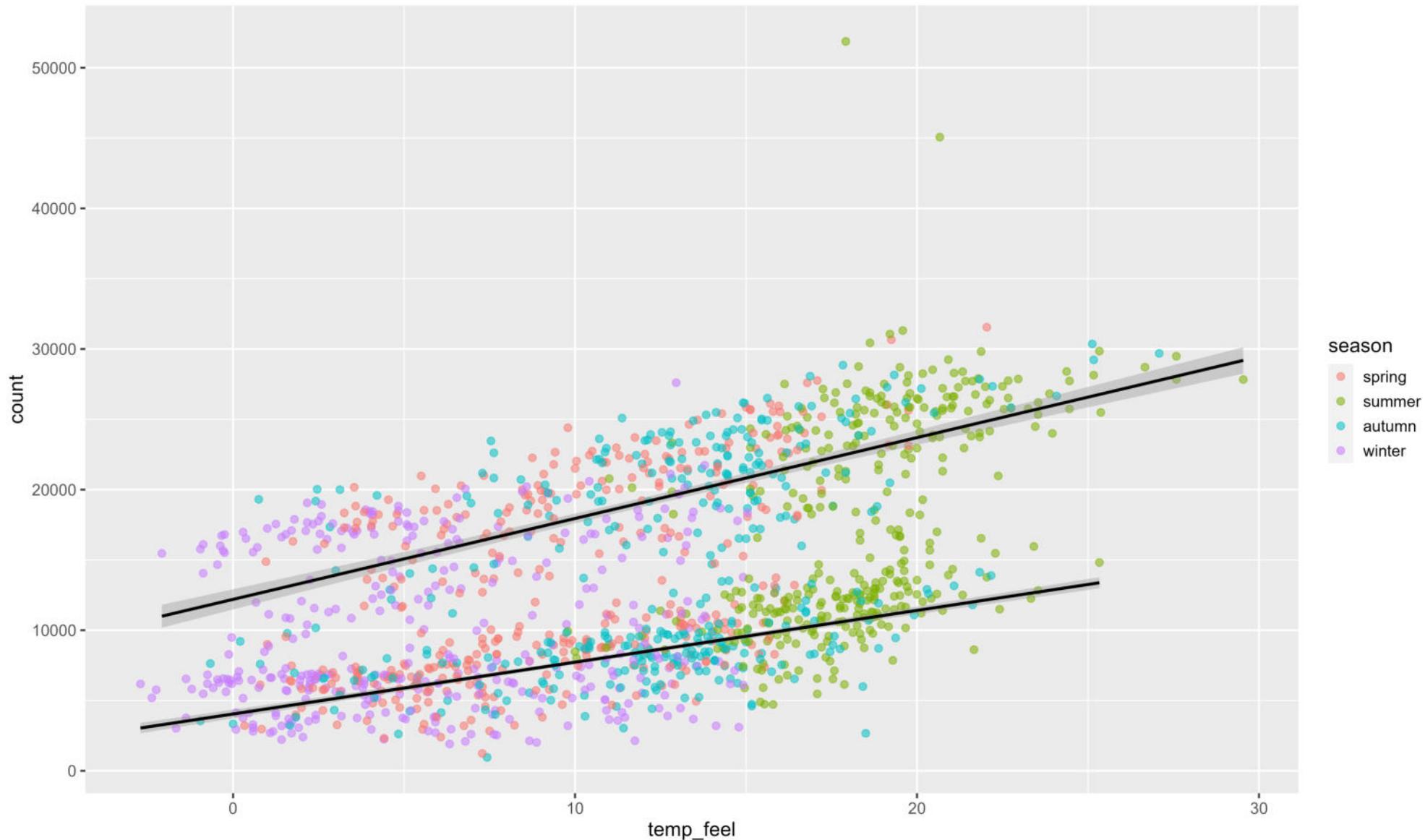
Generative Art by Thomas Lin Pedersen

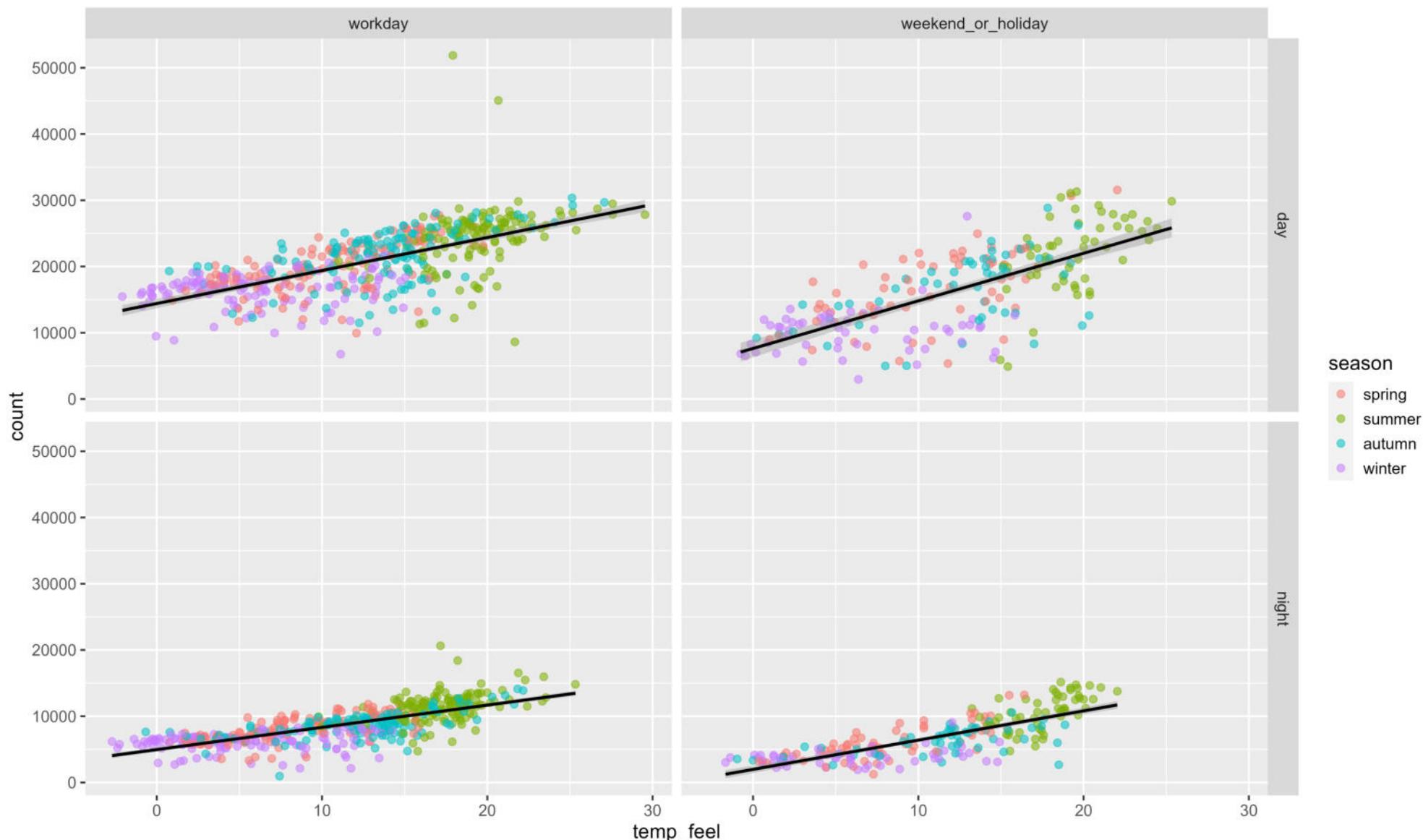
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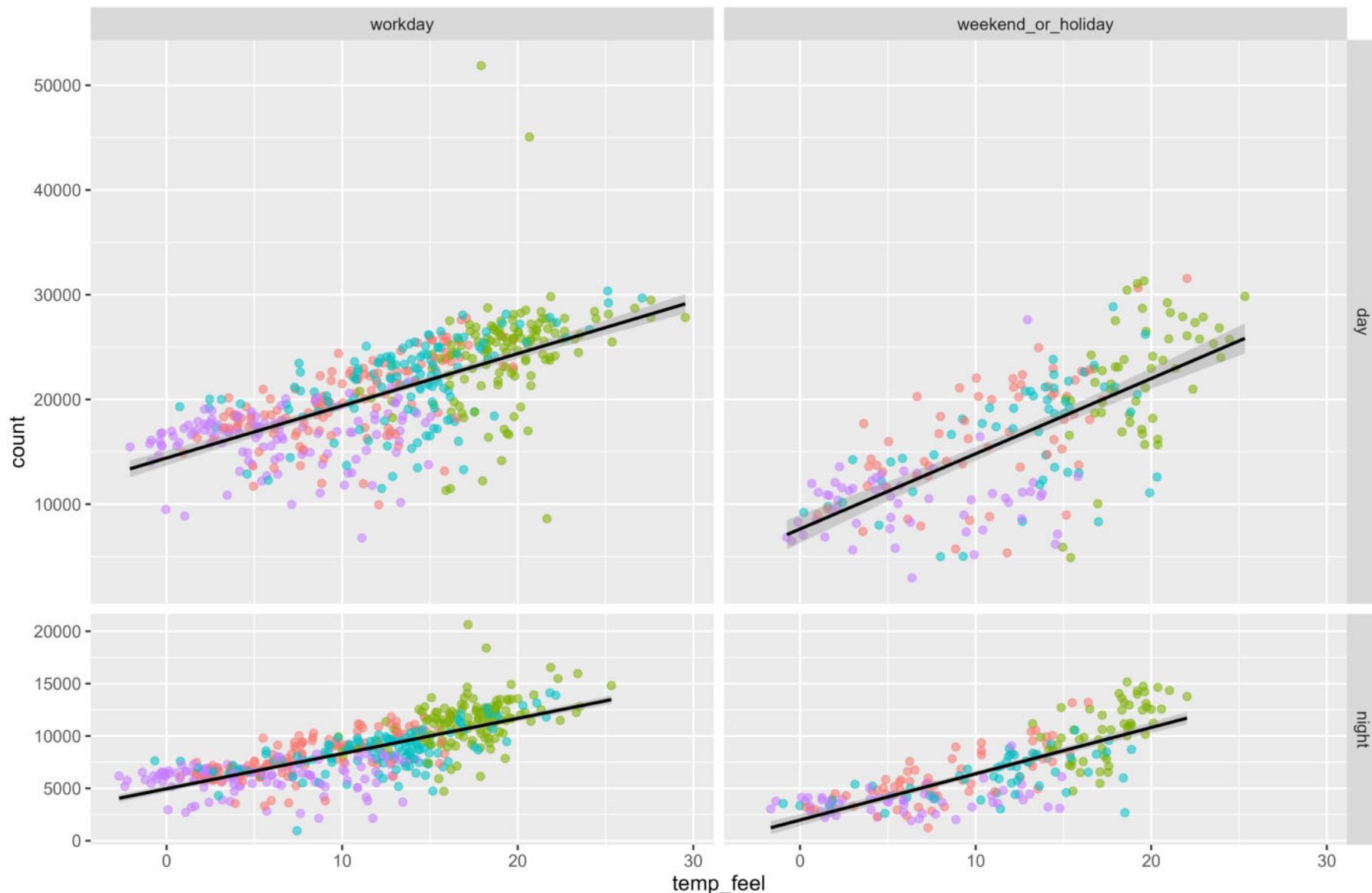
# A Motivational Example



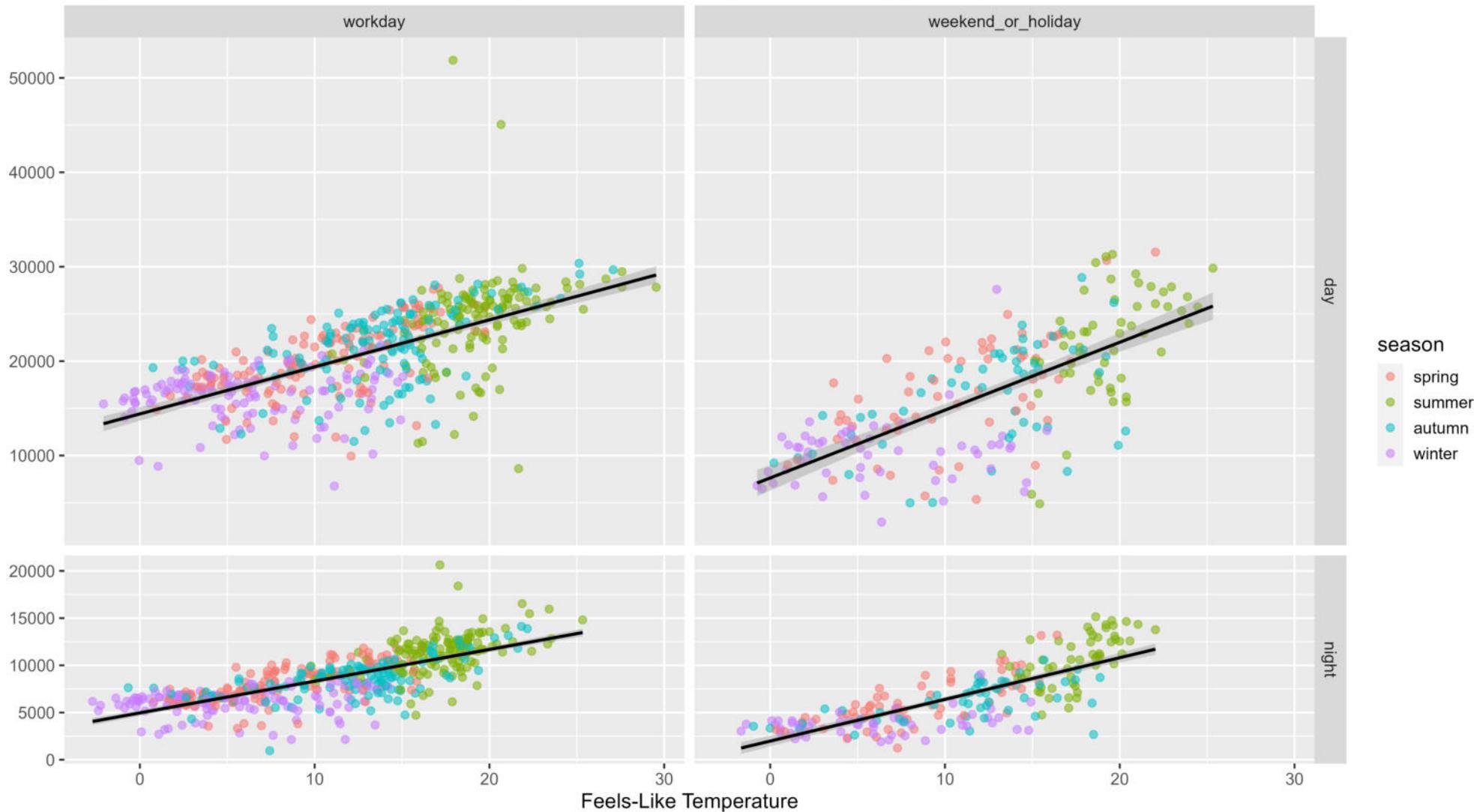






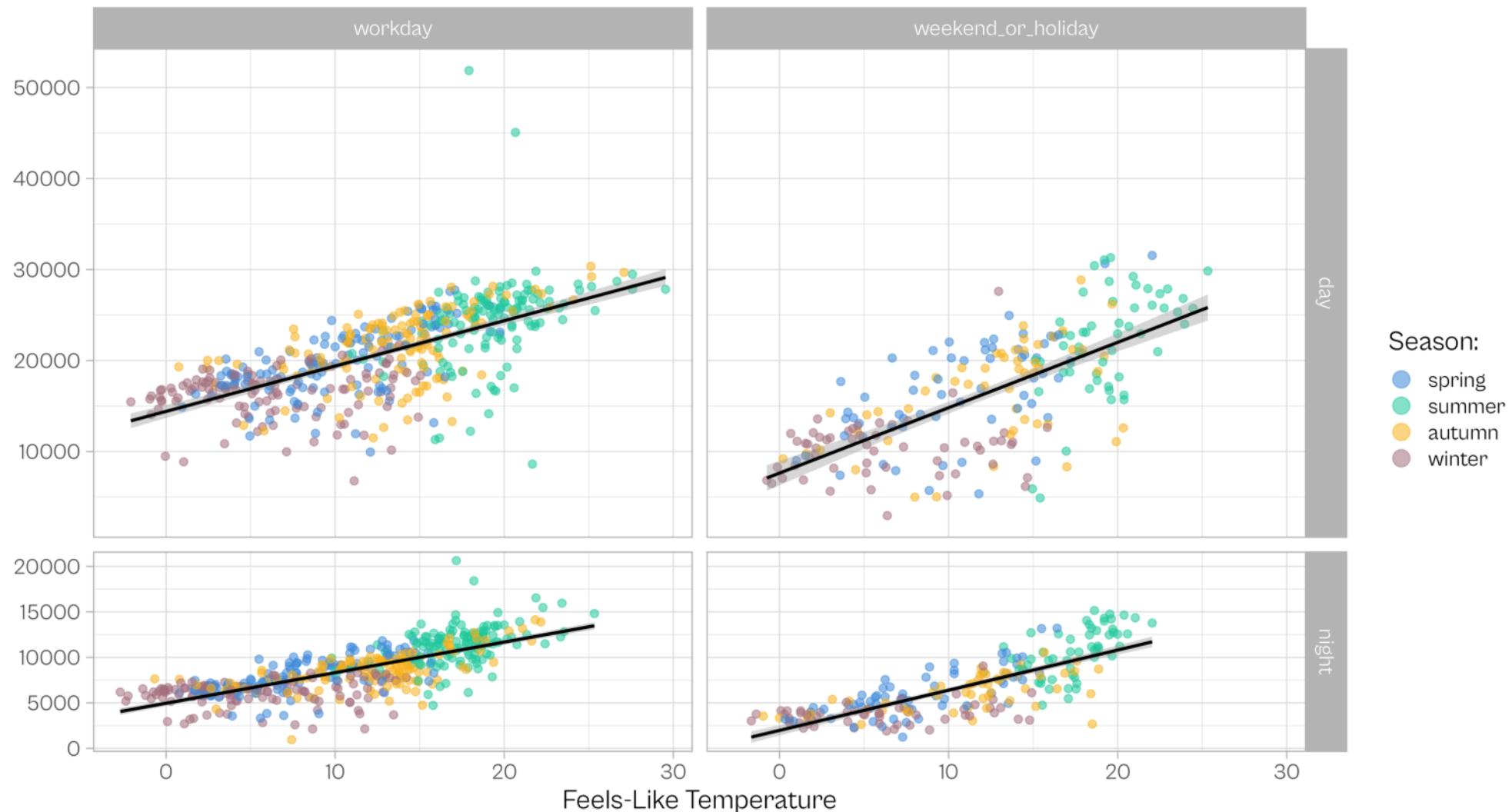


Reported bike rents versus feels-like temperature in London per time of day, period, and season.



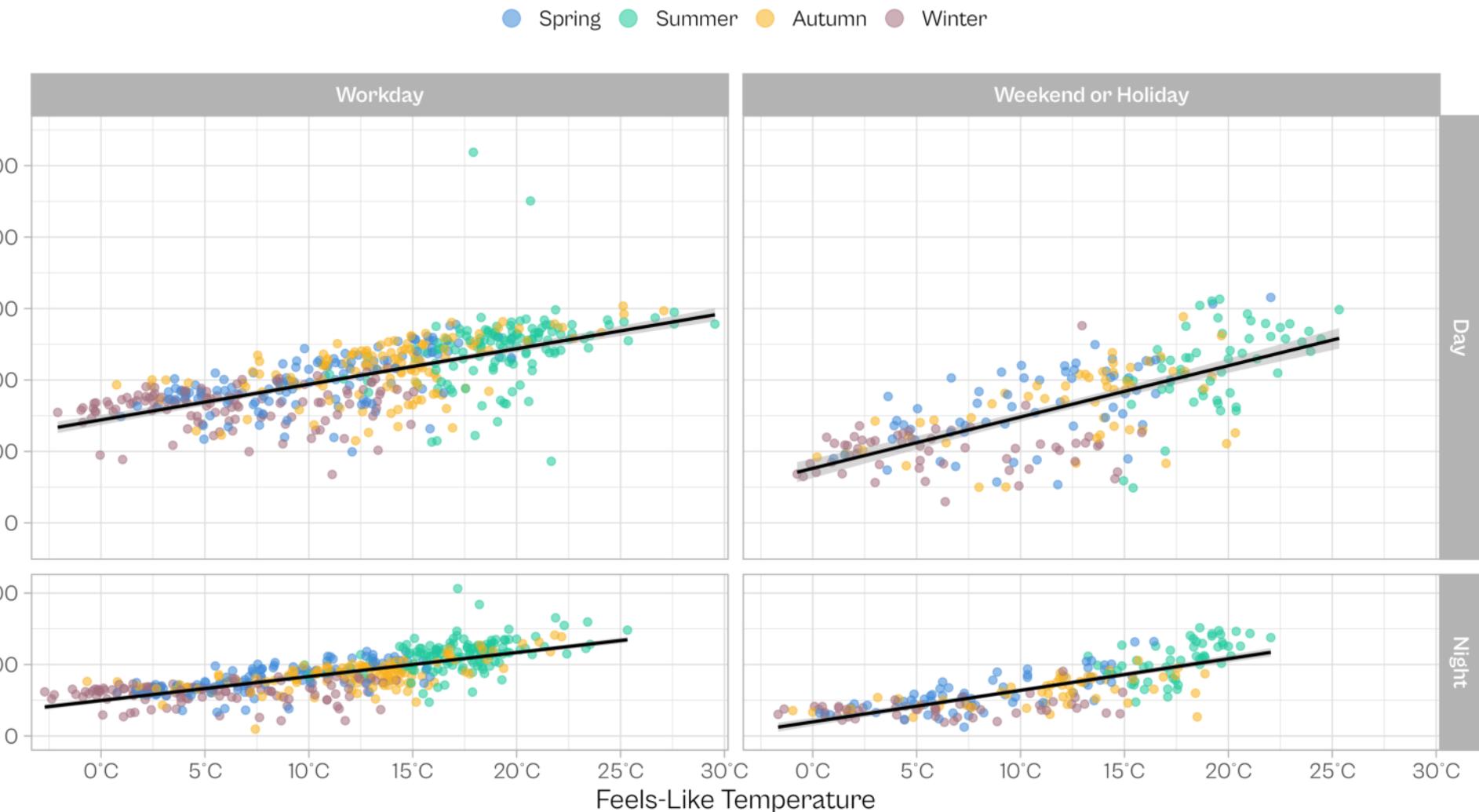
Data: TfL (Transport for London), Jan 2015 — Dec 2016

Reported bike rents versus feels-like temperature in London per time of day, period, and season.



Data: TfL (Transport for London), Jan 2015 – Dec 2016

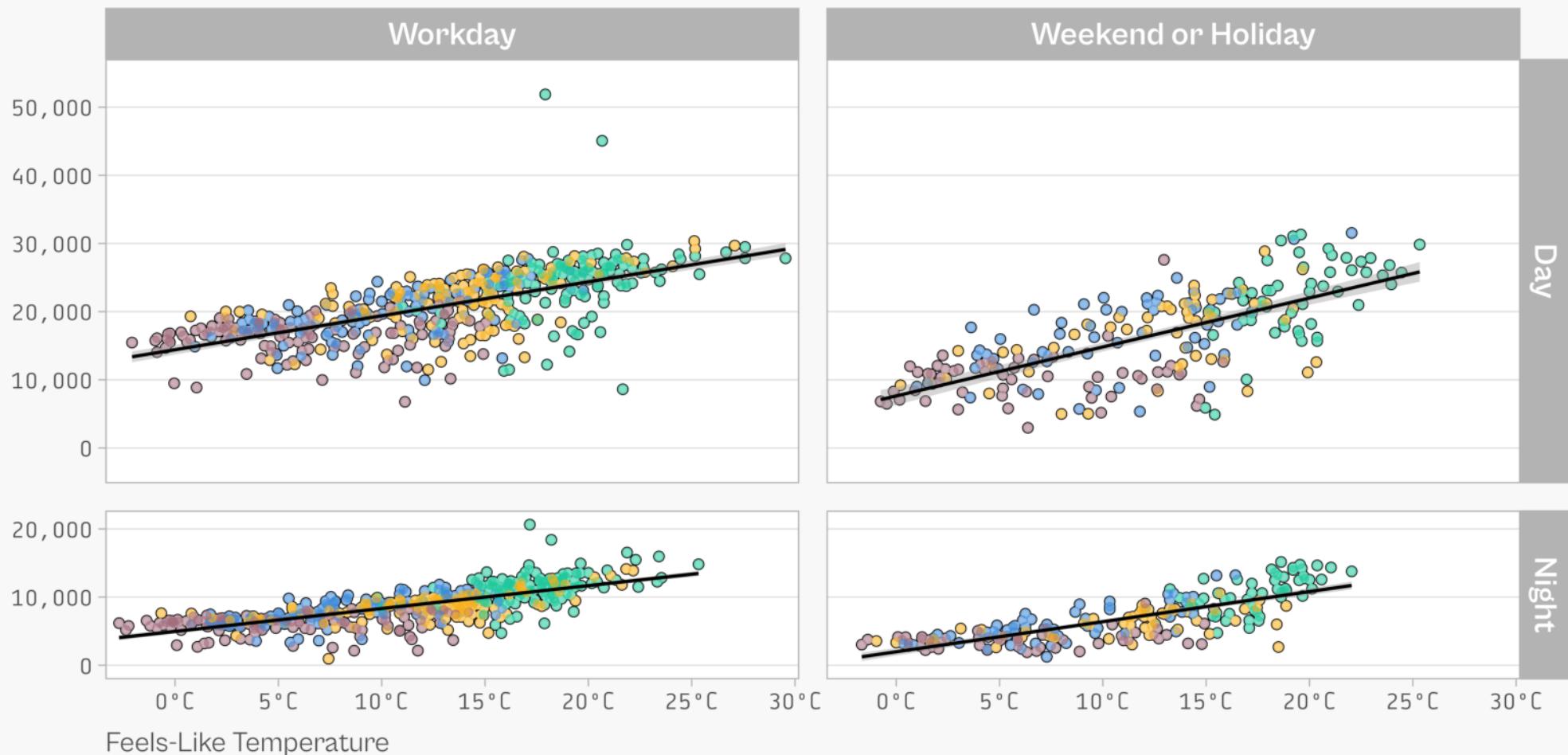
## Reported bike rents versus feels-like temperature in London per time of day, period, and season.



Data: TfL (Transport for London), Jan 2015 – Dec 2016

## Reported bike rents versus feels-like temperature in London per time of day, period, and season.

● Spring ● Summer ● Autumn ● Winter



Data: TfL (Transport for London), Jan 2015 – Dec 2016