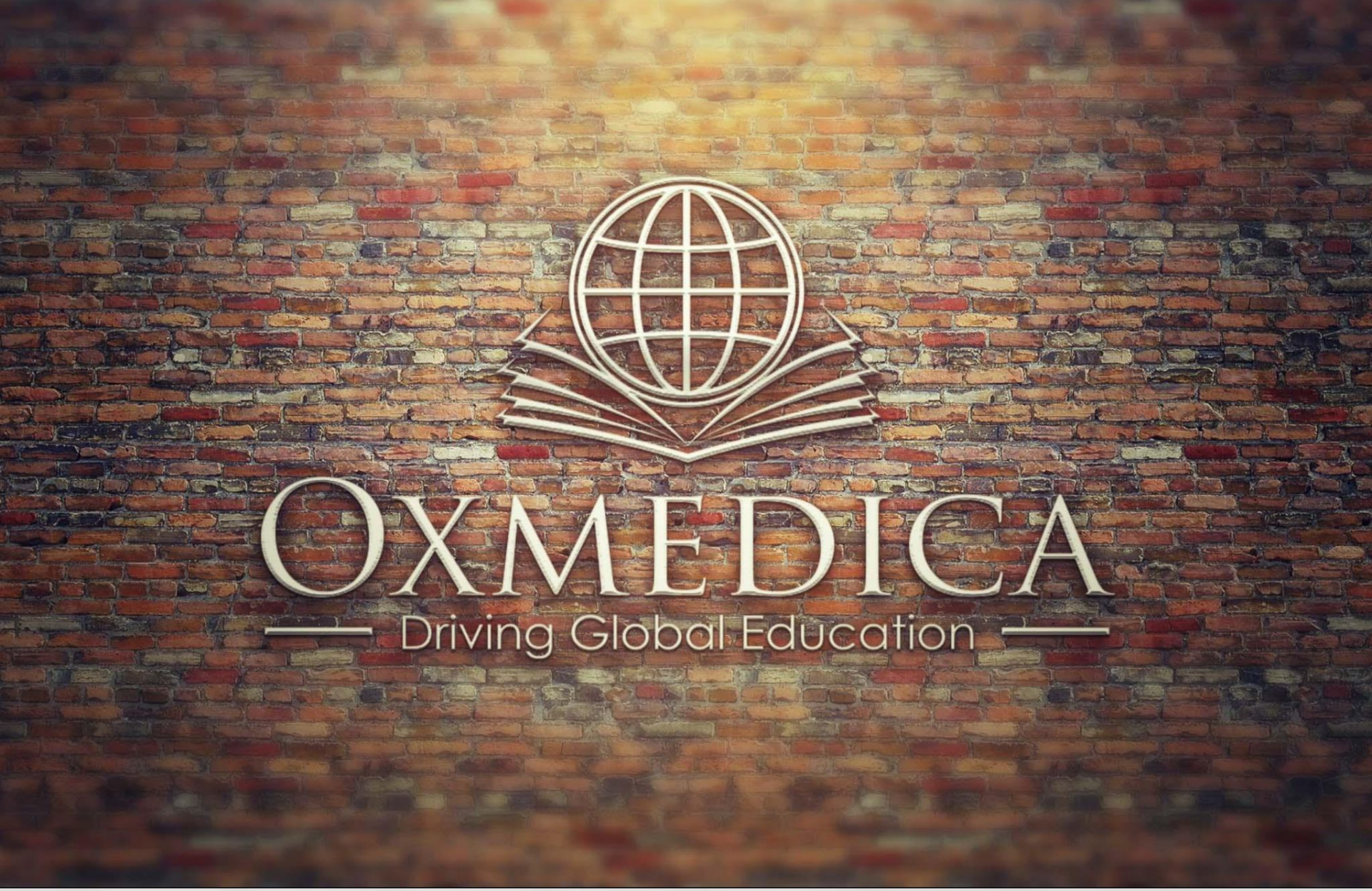


Day 8

Overview

1. Visualisations
2. Linear regression as a computational graph
3. An introduction to neural networks
4. Assessment feedback

Halfway point

30th June

18th July

Week 1	Week 2	Week 3
Introduction to the field and the relevant skills.	**Exploring algorithms with maths and code**	**Language models: theory and coding**

Name	Points
Ahmed K	24
Naser	20
Turki	18

Visualisations

Best Visualisations

1

HISTORY OF **PANDEMICS**

PAN-DEM-IC (of a disease) prevalent over a whole country or the world.

THROUGHOUT HISTORY, as humans spread across the world, infectious diseases have been a constant companion. Even in this modern era, outbreaks are nearly constant.

Here are some of history's most deadly pandemics, from the Antonine Plague to COVID-19.

Death toll

Antonine Plague 165–180 5M
Plague of Justinian 541-542 30-50M
Japanese Smallpox Epidemic 735-737 1M
Black Death (Bubonic Plague) 200M 1347-1351
Throughout the 17th and 18th centuries, a series of "Great Plagues" routinely ravaged cities across Europe.
Smallpox 56M 1520
17th Century Great Plagues 3M 1600
18th Century Great Plagues 600K 1700
Cholera 6 outbreak 1M 1817-1923
The Third Plague 12M 1855
Yellow Fever 100-150K LATE 1800s
HIV/AIDS 25-35M 1981-PRESENT
Asian Flu 1.1M 1957-1958
Hong Kong Flu 1M 1968-1970
MERS 850 2012-PRESENT
SARS 770 2002-2003
Ebola 11.3K 2014-2016
Swine Flu 200K 2009-2010
COVID-19 3.9M* 2019-8:20AM PT, JUNE 30, 2021 [ONGOING]
Spanish Flu 40-50M 1918-1919
Russian Flu 1M 1889-1890

1300 1400 1450 1500 1550 1600 1650 1700 1725 1750 1775 1800 1825 1850 1875 1900 1925 1950 1975 2000 2025

WHO officially declared COVID-19 a pandemic on Mar 11, 2020.

It is hard to calculate and forecast the impact of COVID-19 because the disease is new to medicine, and data is still coming in.

*Johns Hopkins University estimates

DEATH TOLL
[HIGHEST TO LOWEST]

200M
Black Death (Bubonic Plague)
1347-1351

The plague originated in rats and spread to humans via infected fleas.

The outbreak wiped out 30-50% of Europe's population. It took more than 200 years for the continent's population to recover.

56M
Smallpox
1520

Smallpox killed an estimated 90% of Native Americans. In Europe during the 1800s, an estimated 400,000 people were being killed by smallpox annually. The first ever vaccine was created to ward off smallpox.

40-50M
Spanish Flu
1918-1919

30-50M
Plague of Justinian
541-542

The death toll of this plague is still under debate as new evidence is uncovered, but many think it may have helped hasten the fall of the Roman Empire.

25-35M HIV/AIDS 1981-PRESENT
12M The Third Plague 1855
5M Antonine Plague 165-180
3.9M* COVID-19 2019-8:20AM PT, JUNE 30, 2021 [ONGOING]
3M 17th Century Great Plagues 1600
1.1M Asian Flu 1957-1958
1M Russian Flu 1889-1890
1M Hong Kong Flu 1968-1970
1M Cholera 6 outbreak 1817-1923
1M Japanese Smallpox Epidemic 735-737
600K 18th Century Great Plagues 1700
200K Swine Flu 2009-2010
100-150K Yellow Fever LATE 1800s
11.3K Ebola 2014-2016
850 MERS 2012-PRESENT
770 SARS 2002-2003

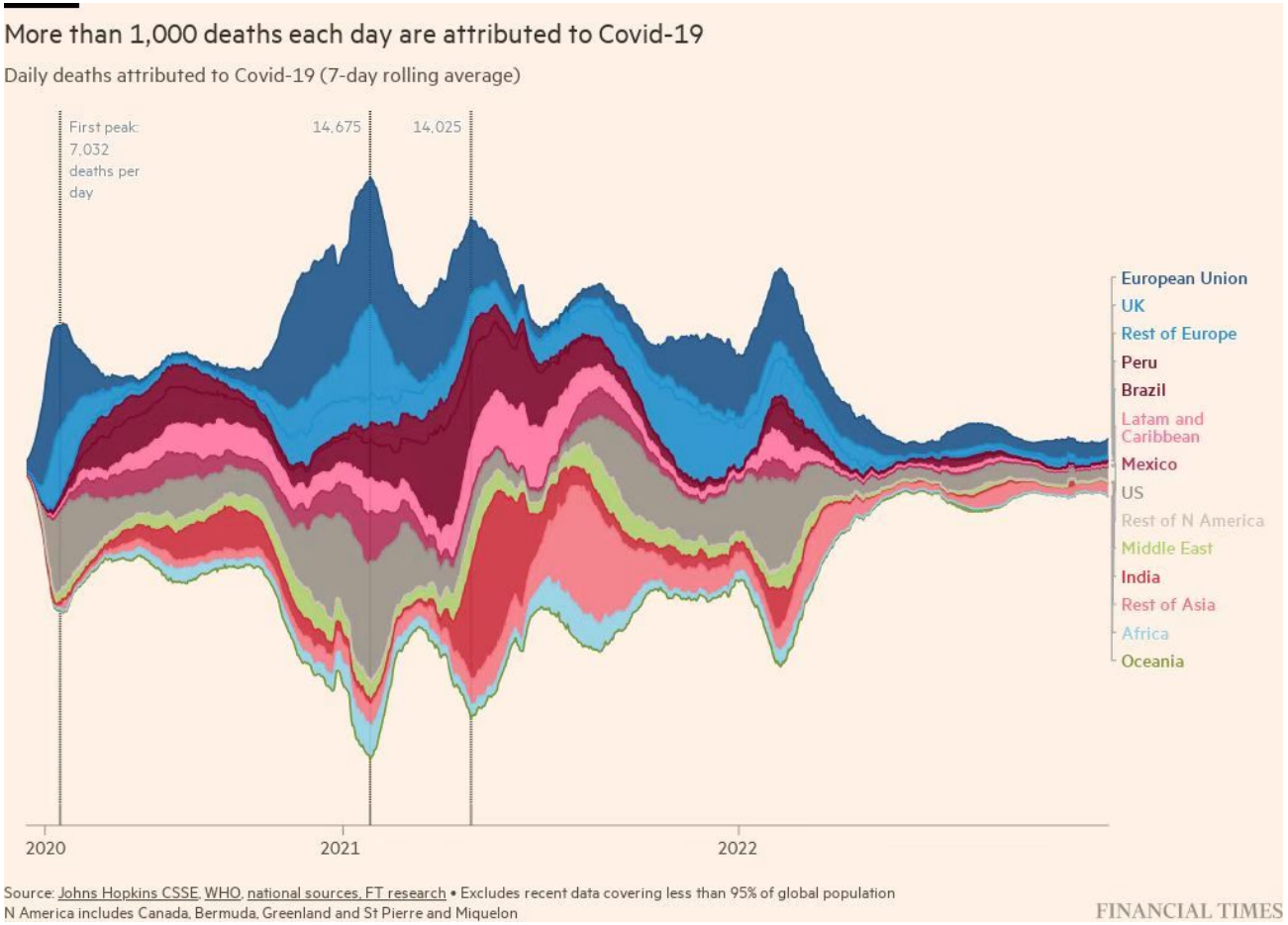
*Johns Hopkins University estimates

Sources: CDC, WHO, BBC, Wikipedia, Historical records, Encyclopedia Britannica, Johns Hopkins University

VISUAL CAPITALIST /visualcapitalist @visualcap visualcapitalist.com

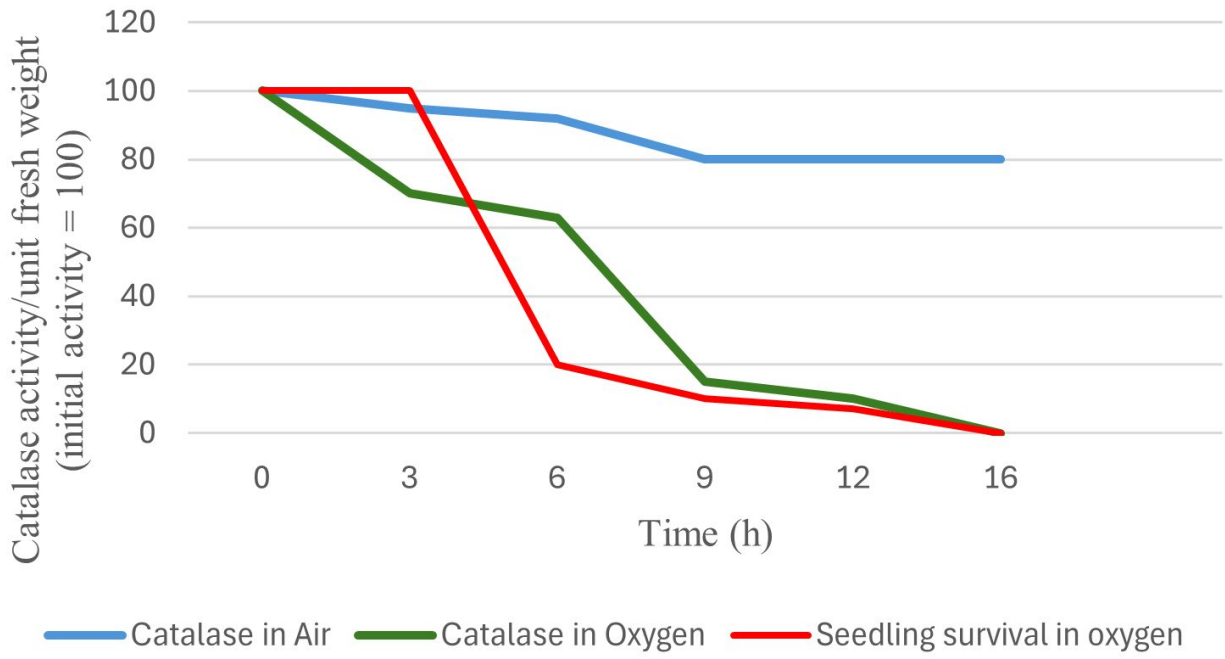
COLLABORATORS RESEARCH – WRITING Nick Loffler, Nick Routley | DESIGN Hanieun Schill | ART DIRECTION Hanieun Schill

2

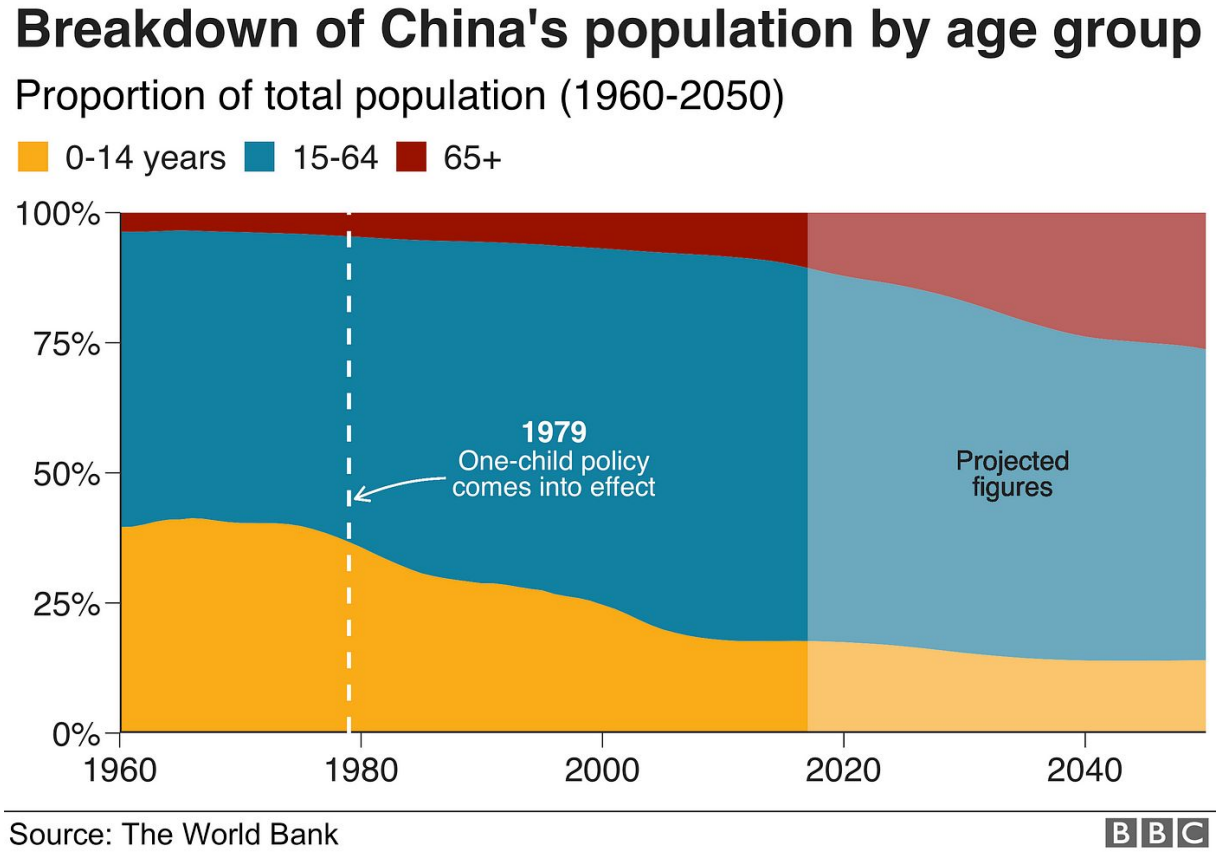

More than 1,000 deaths each day are attributed to Covid-19
Daily deaths attributed to Covid-19 (7-day rolling average)
First peak: 7,032 deaths per day
14,675
14,025
European Union
UK
Rest of Europe
Peru
Brazil
Latam and Caribbean
Mexico
US
Rest of N America
Middle East
India
Rest of Asia
Africa
Oceania
2020
2021
2022
Source: Johns Hopkins CSSE, WHO, national sources, FT research • Excludes recent data covering less than 95% of global population
N America includes Canada, Bermuda, Greenland and St Pierre and Miquelon
FINANCIAL TIMES

3

Figure 1. Effect of treatment with 10 atm. pure oxugen on catalase activity and seeding mortality of cress seedings.



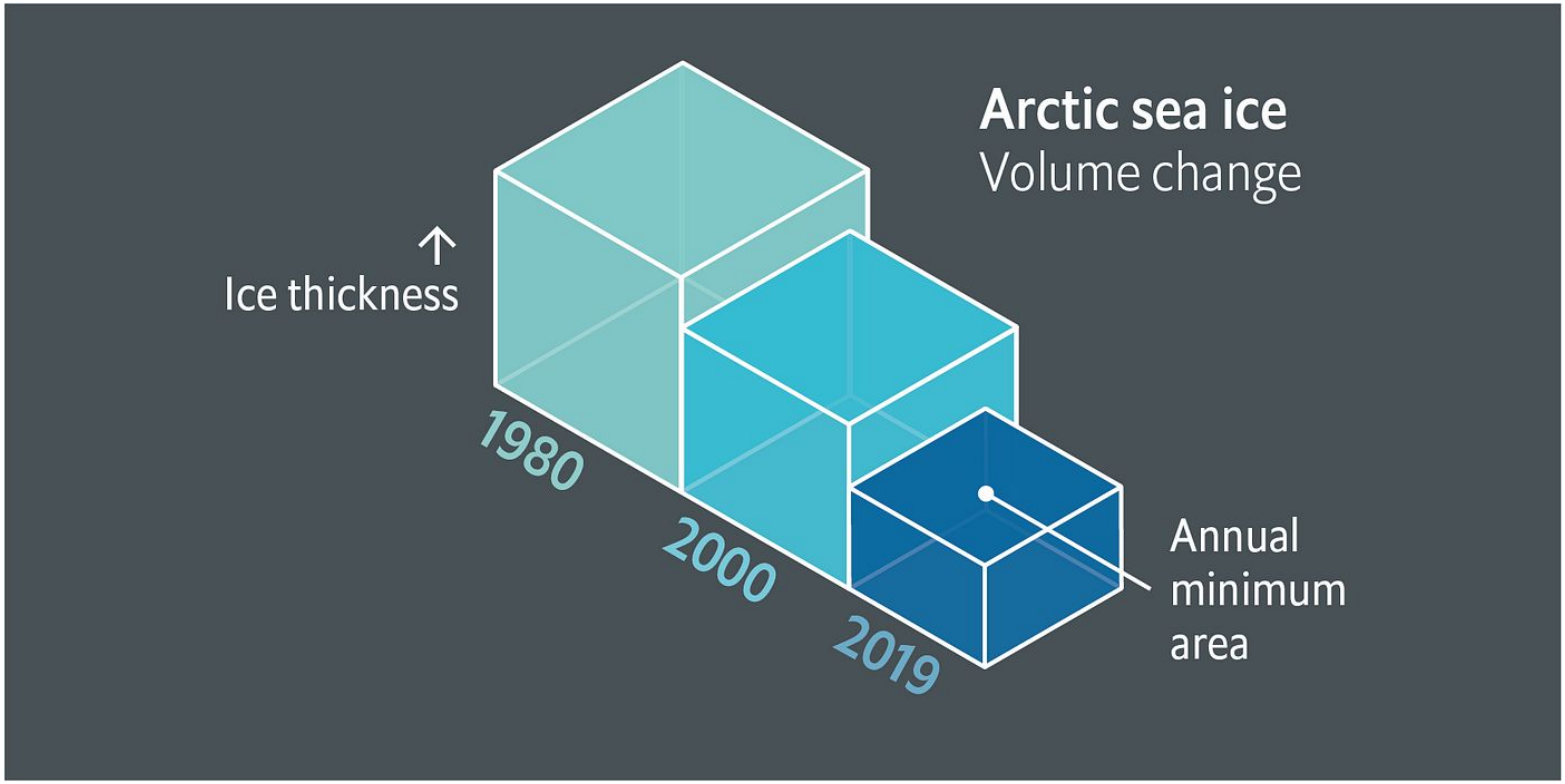
4


Breakdown of China's population by age group
Proportion of total population (1960-2050)
0-14 years
15-64
65+
100%
75%
50%
25%
0%
1960
1980
2000
2020
2040
1979
One-child policy
comes into effect
Projected
figures
Source: The World Bank
BBC

5


Area Chart
Combo Chart
Bar Chart
25%
50%
25%
Line Chart
Doughnut Chart
Radar Chart

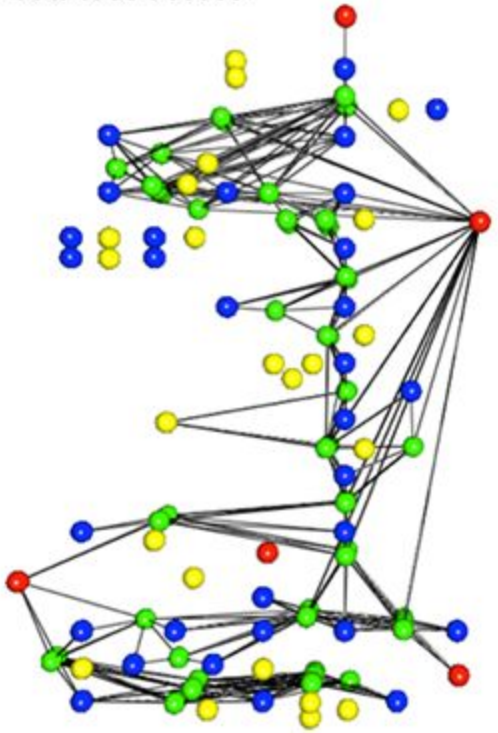
6

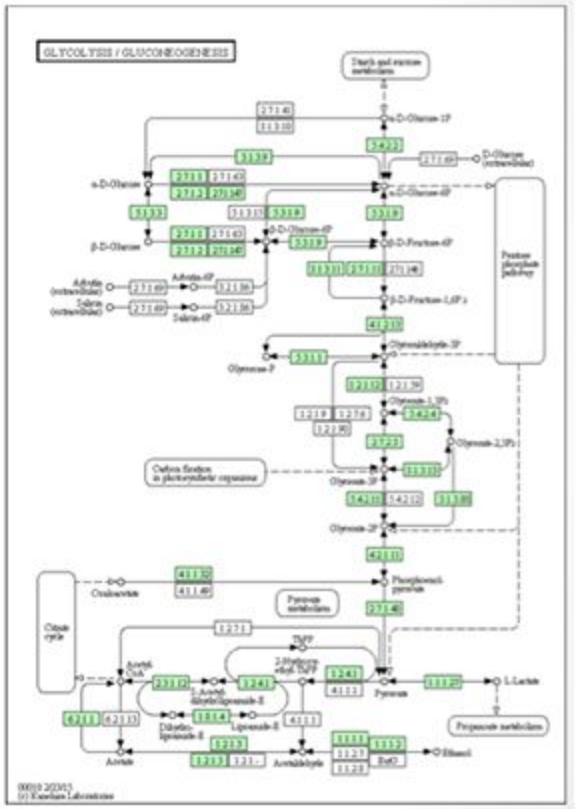

Arctic sea ice
Volume change
Ice thickness
1980
2000
2019
Annual minimum area

Worst Visualisations

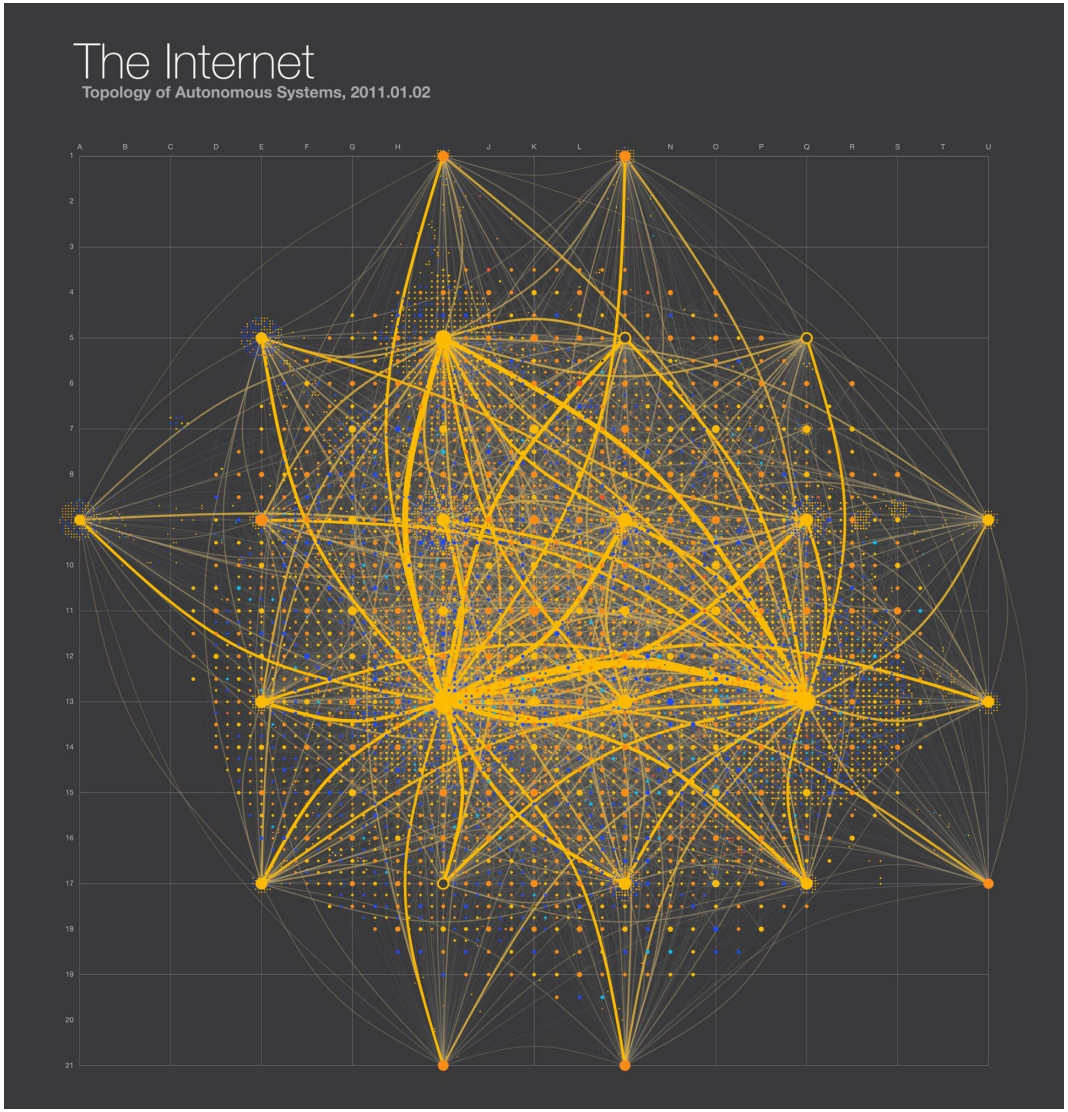
1

KEGG database access





2



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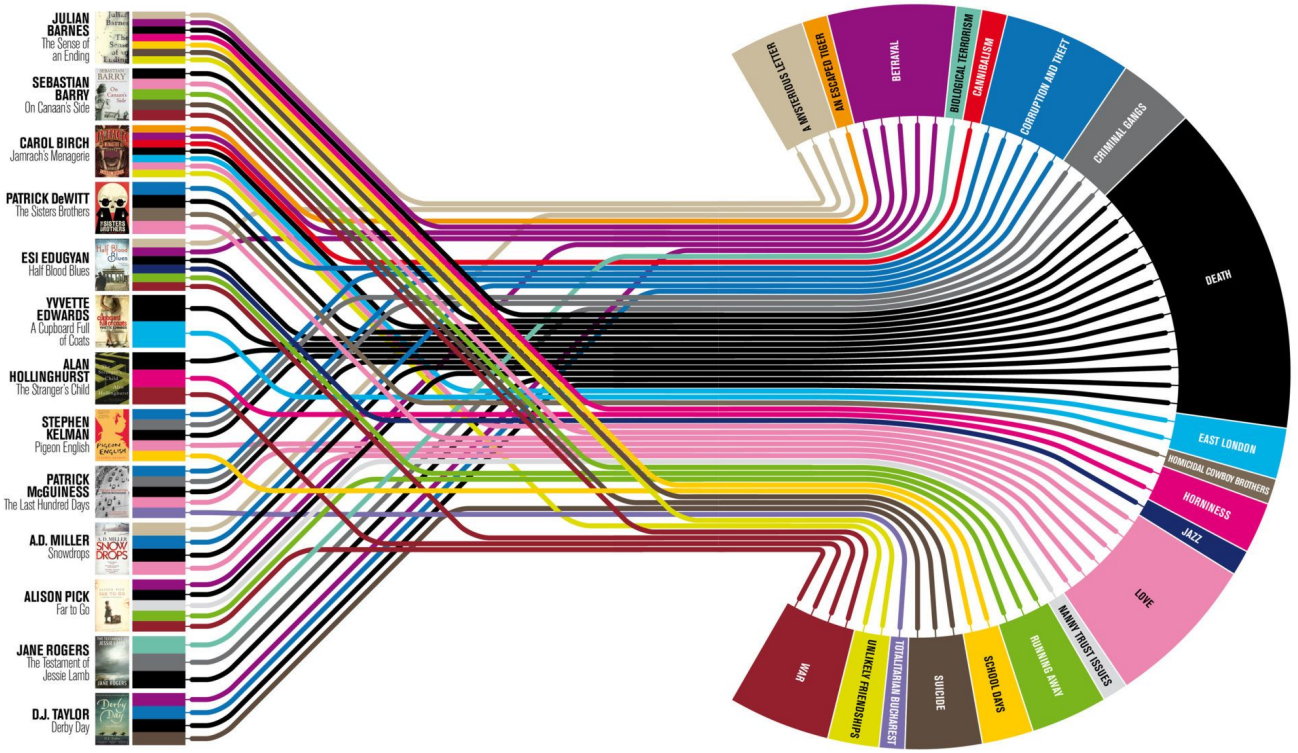
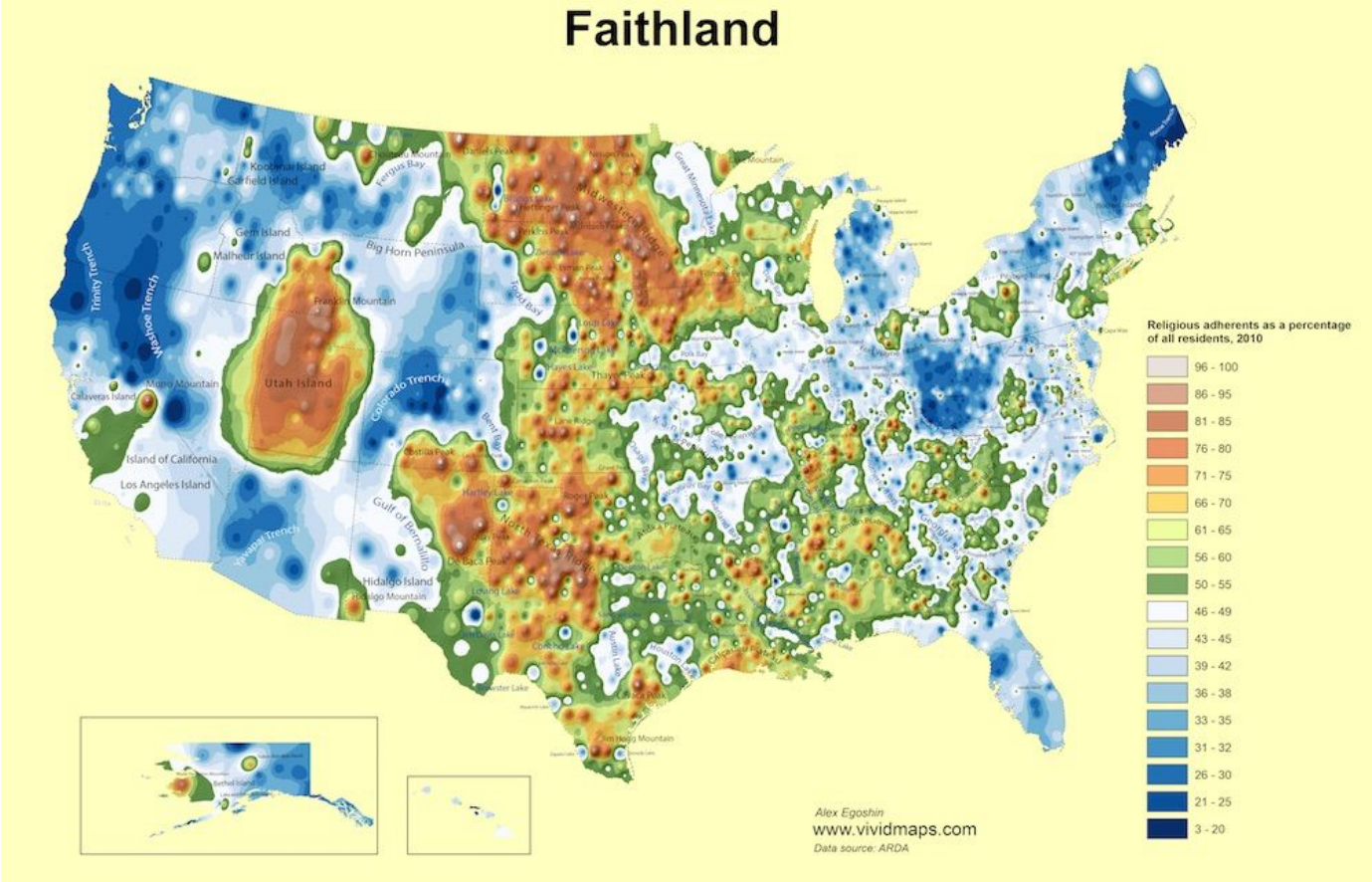


Plot lines

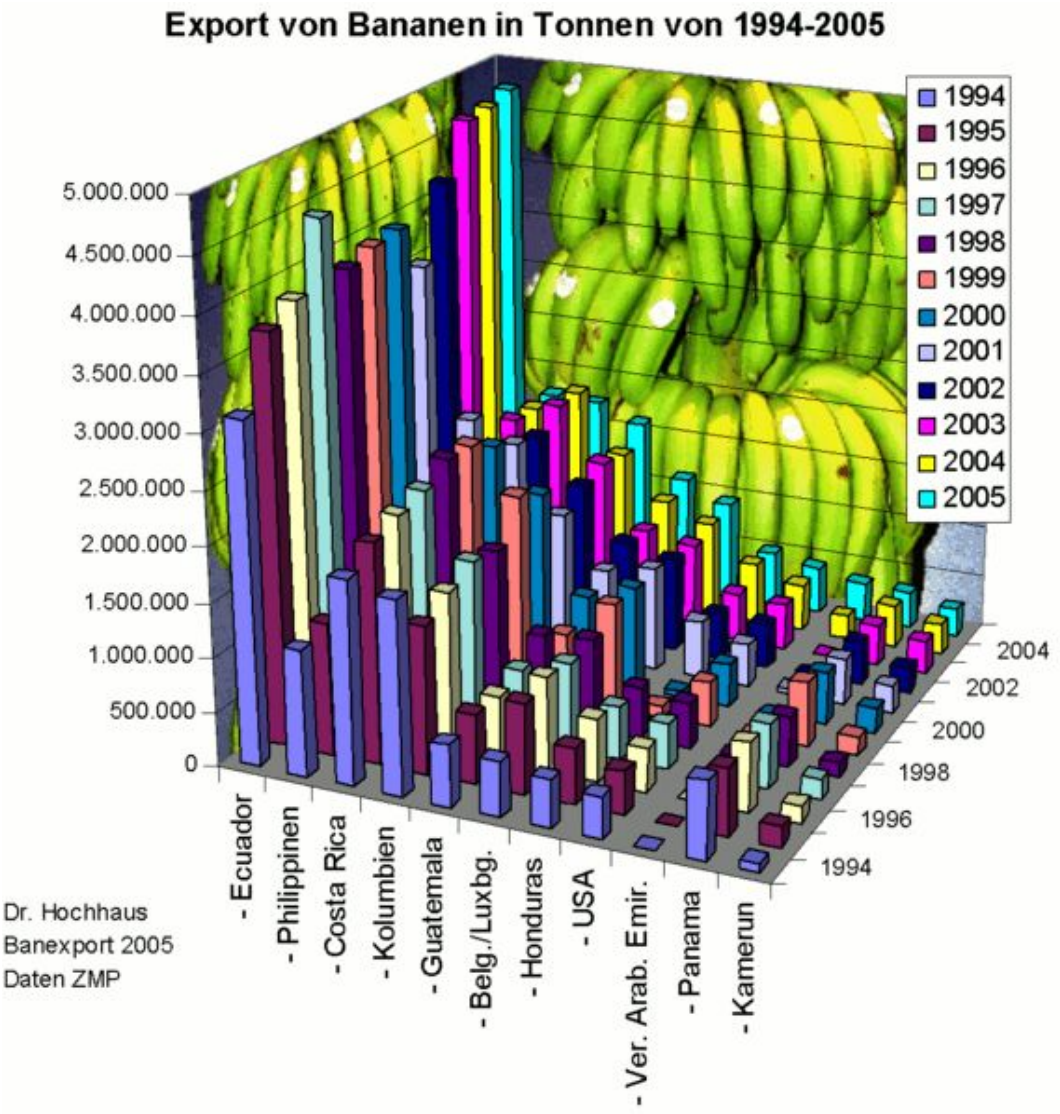
What makes a prize-winning novel? As Julian Barnes wins the Booker Prize, Delayed Gratification's Johanna Kamradt charts the themes of this year's longlisters.

Illustration: Christian Tate

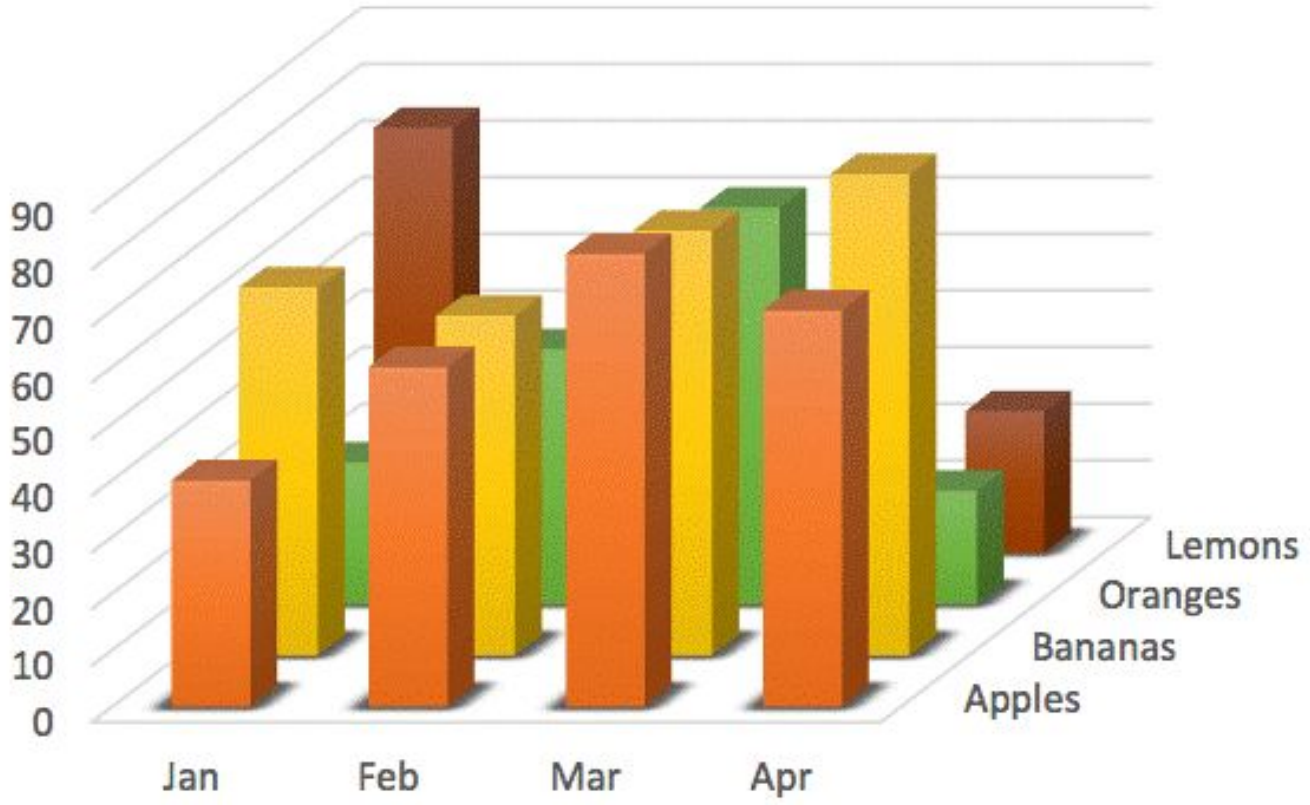
4


Faithland
Religious adherents as a percentage of all residents, 2010
96 - 100
86 - 95
81 - 85
76 - 80
71 - 75
66 - 70
61 - 65
56 - 60
50 - 55
46 - 49
43 - 45
39 - 42
36 - 38
33 - 35
31 - 32
26 - 30
21 - 25
3 - 20
Utah Island
Island of California
Los Angeles Island
Calaveras Island
Kootenai Island
Garfield Island
Gem Island
Malheur Island
Big Horn Peninsula
Fergus Bay
Fremont Mountain
Mono Mountain
Hidalgo Island
Hidalgo Mountain
Trinity Trench
Washoe Trench
Colorado Trench
Gulf of Bermudillo
Nevada Trench
Alex Egoshin
www.vividmaps.com
Data source: ARDA

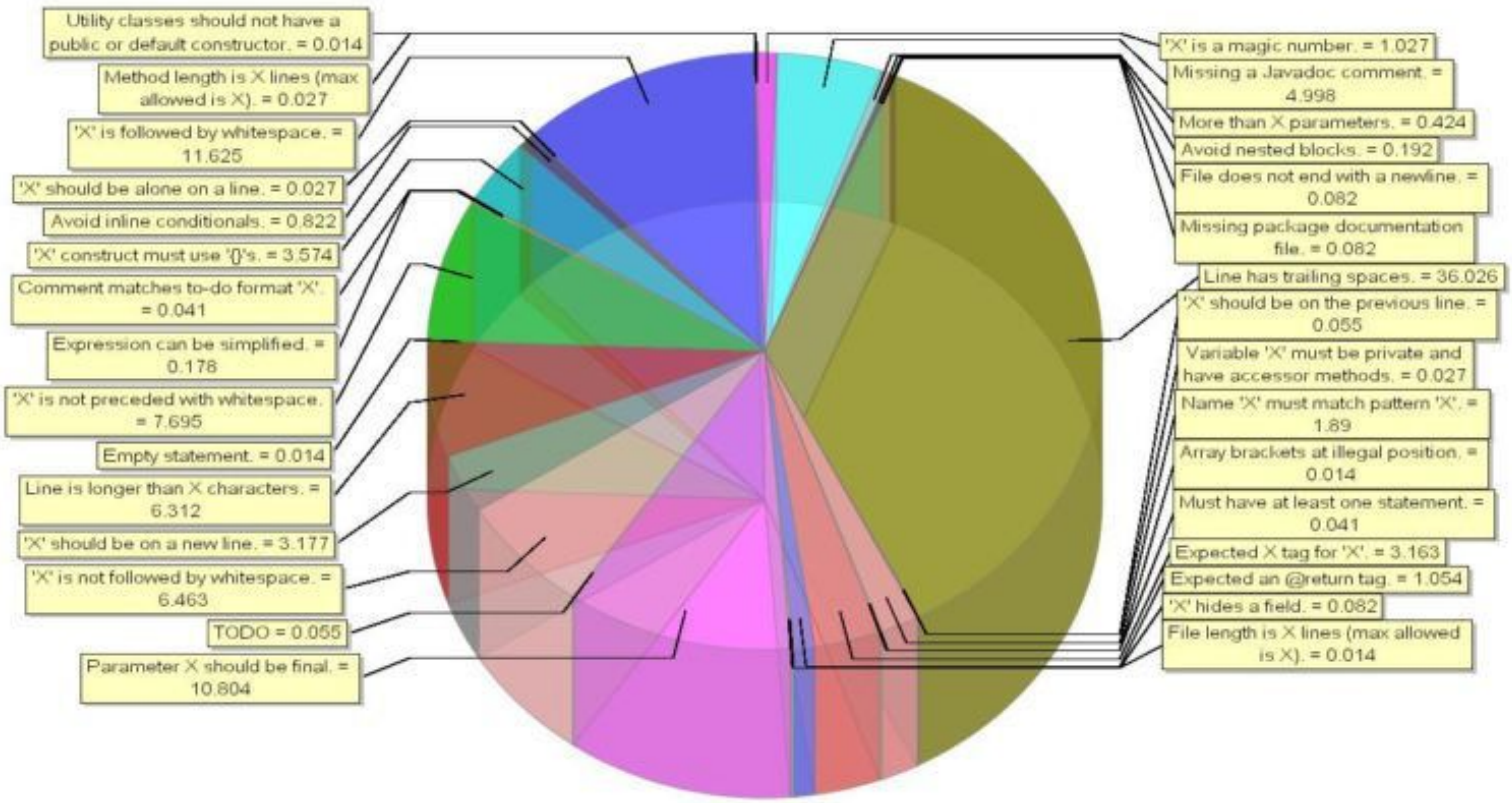
5



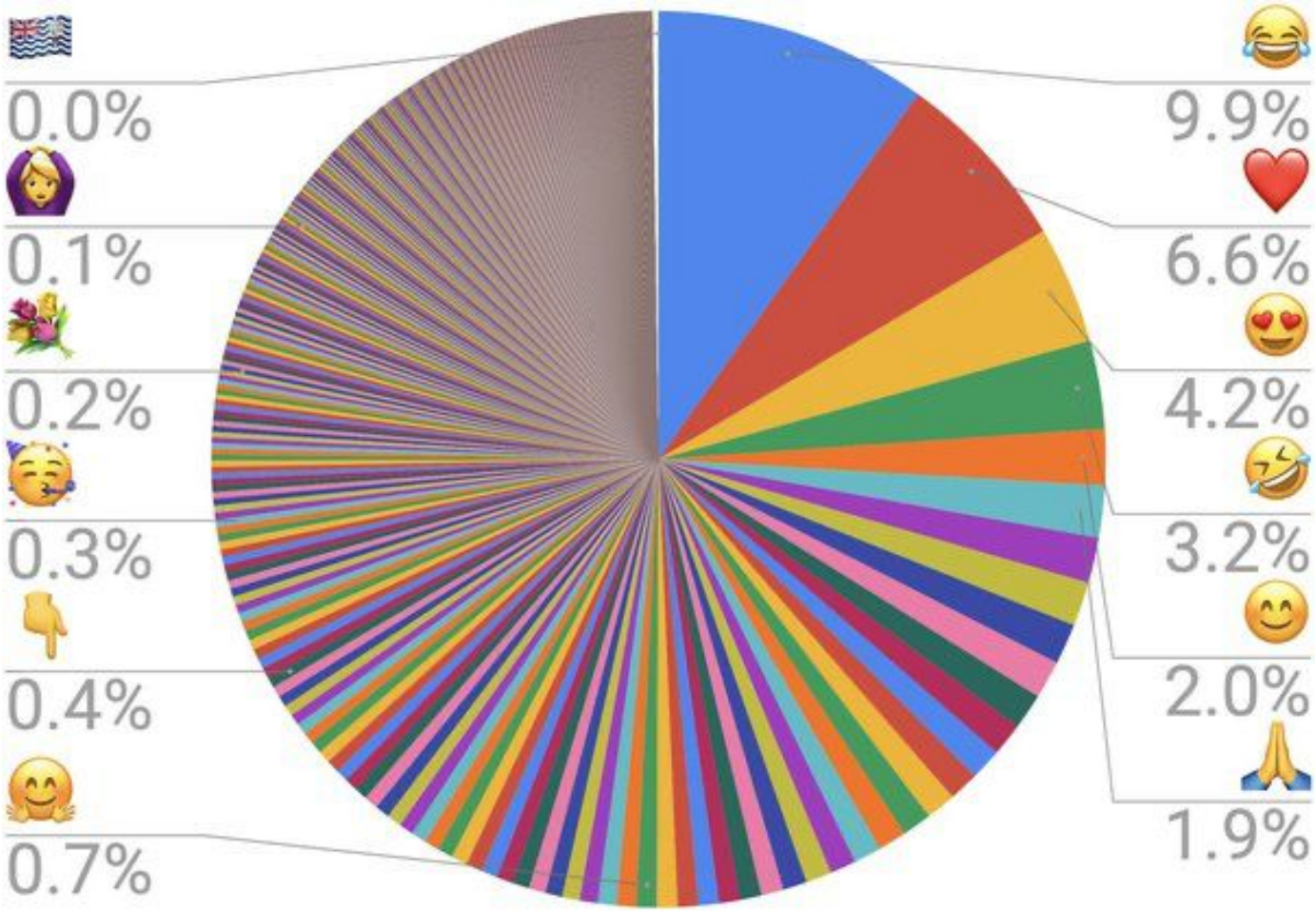
6


90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
Lemons
Oranges
Bananas
Apples

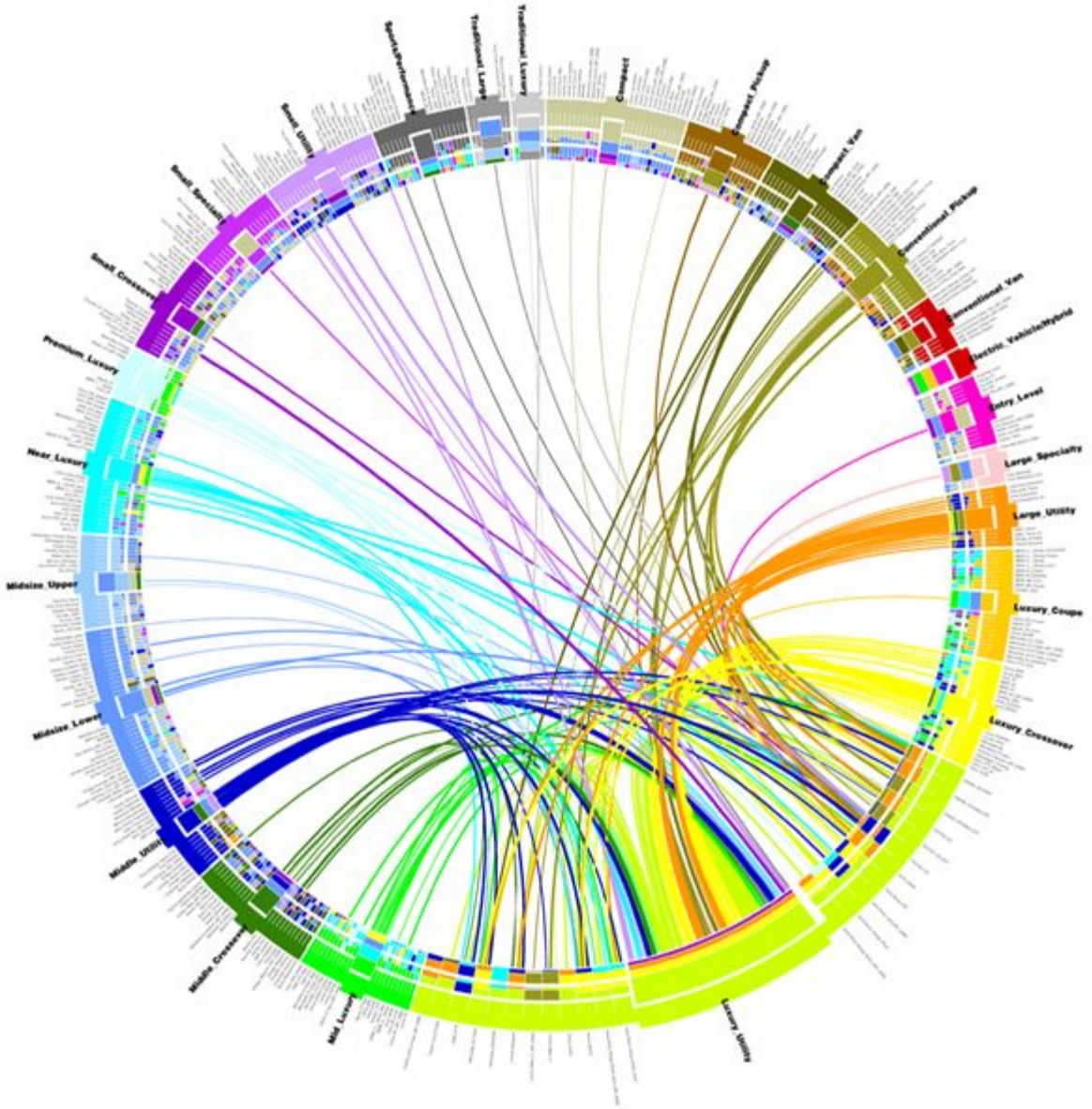
7


Utility classes should not have a public or default constructor. = 0.014
Method length is X lines (max allowed is X). = 0.027
'X' is followed by whitespace. = 11.625
'X' should be alone on a line. = 0.027
Avoid inline conditionals. = 0.822
'X' construct must use '{}'s. = 3.574
Comment matches to-do format 'X'. = 0.041
Expression can be simplified. = 0.178
'X' is not preceded with whitespace. = 7.695
Empty statement. = 0.014
Line is longer than X characters. = 6.312
'X' should be on a new line. = 3.177
'X' is not followed by whitespace. = 6.463
TODO = 0.055
Parameter X should be final. = 10.804
'X' is a magic number. = 1.027
Missing a Javadoc comment. = 4.998
More than X parameters. = 0.424
Avoid nested blocks. = 0.192
File does not end with a newline. = 0.082
Missing package documentation file. = 0.082
Line has trailing spaces. = 36.026
'X' should be on the previous line. = 0.055
Variable 'X' must be private and have accessor methods. = 0.027
Name 'X' must match pattern 'X'. = 1.89
Array brackets at illegal position. = 0.014
Must have at least one statement. = 0.041
Expected X tag for 'X'. = 3.163
Expected an @return tag. = 1.054
'X' hides a field. = 0.082
File length is X lines (max allowed is X). = 0.014

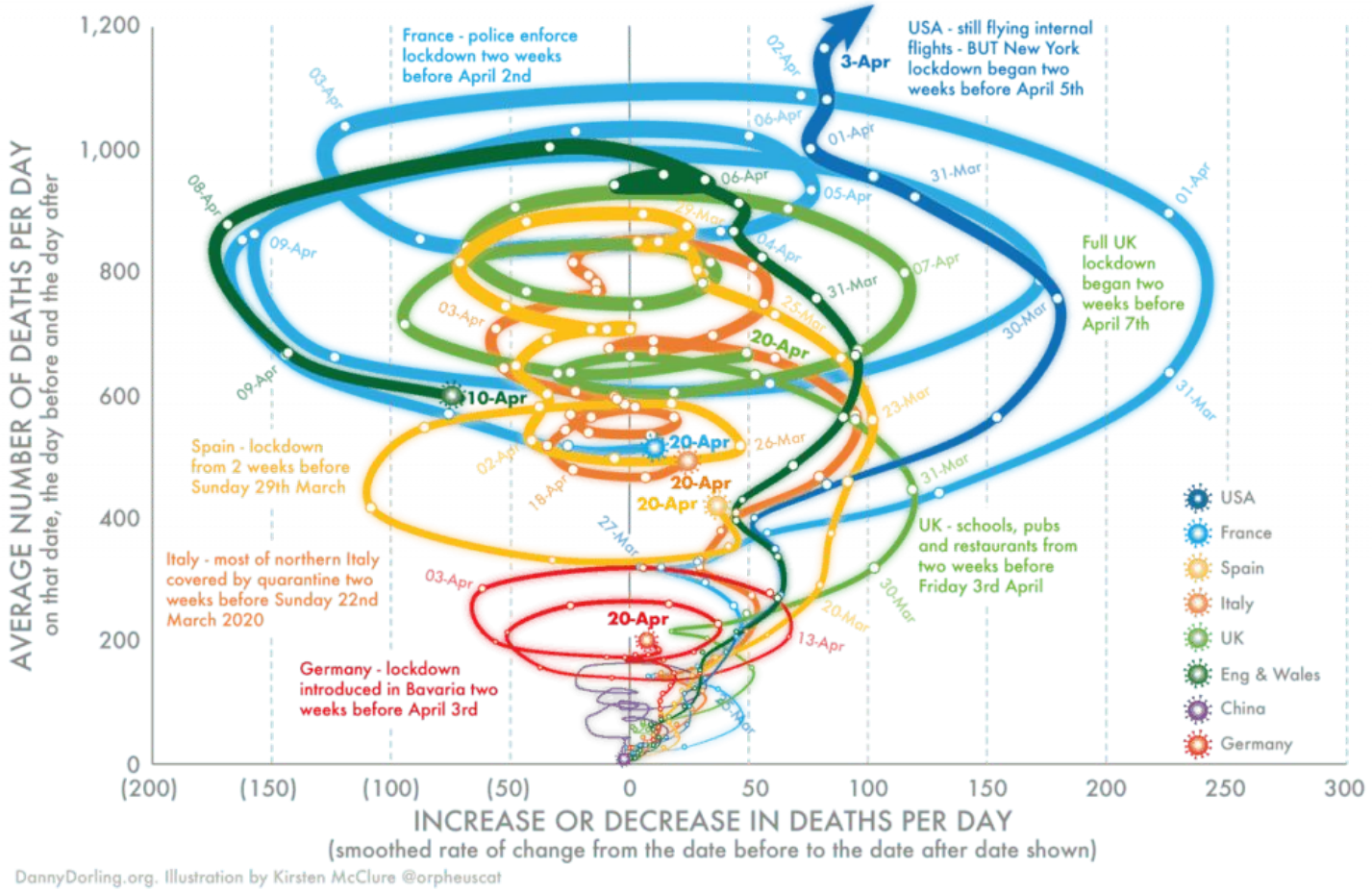
8



9



10


AVERAGE NUMBER OF DEATHS PER DAY
on that date, the day before and the day after
1,200
1,000
800
600
400
200
0
(200)
(150)
(100)
(50)
0
50
100
150
200
250
300
INCREASE OR DECREASE IN DEATHS PER DAY
(smoothed rate of change from the date before to the date after date shown)
France - police enforce lockdown two weeks before April 2nd
USA - still flying internal flights - BUT New York lockdown began two weeks before April 5th
Full UK lockdown began two weeks before April 7th
Spain - lockdown from 2 weeks before Sunday 29th March
Italy - most of northern Italy covered by quarantine two weeks before Sunday 22nd March 2020
Germany - lockdown introduced in Bavaria two weeks before April 3rd
UK - schools, pubs and restaurants from two weeks before Friday 3rd April
3-Apr
10-Apr
20-Apr
USA
France
Spain
Italy
UK
Eng & Wales
China
Germany
DannyDorling.org. Illustration by Kirsten McClure @orpheuscat

Computational Graphs

⚠️ A little warning ⚠️

Linear Regression as a Computational Graph

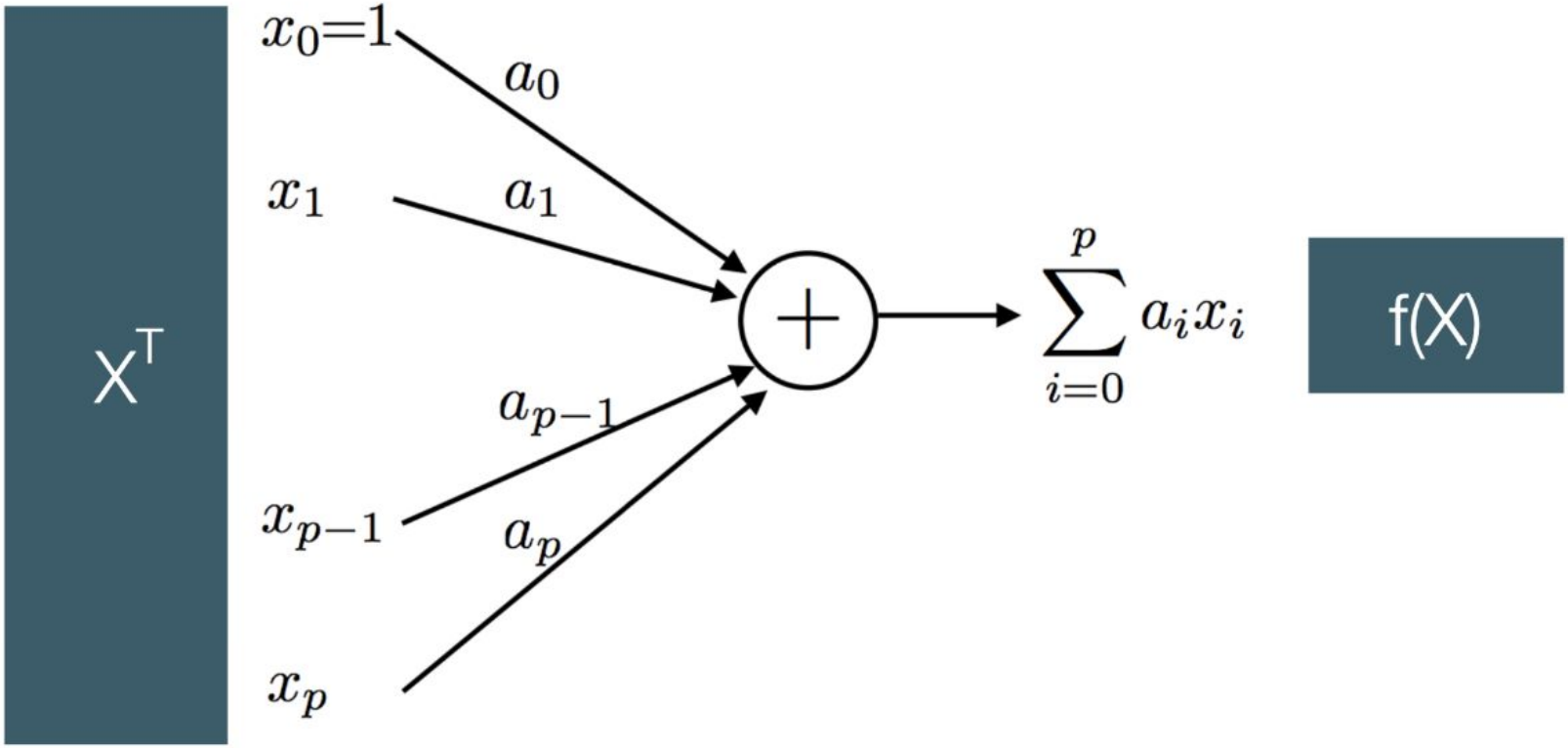
The very simple linear regression we know and love

$$\hat{y}^{(i)} = \hat{\alpha} + \hat{\beta}_1 x_1^{(i)} + \hat{\beta}_2 x_2^{(i)} + \hat{\beta}_3 x_3^{(i)} + \hat{\beta}_4 x_4^{(i)}$$

$$\hat{y}^{(i)} = \hat{\alpha} + \hat{\beta}_1 x_1^{(i)} + \hat{\beta}_2 x_2^{(i)} + \hat{\beta}_3 x_3^{(i)} + \hat{\beta}_4 x_4^{(i)}$$

- What are the parameters?
- What type of output does this model provide?

Visualising this as a graph



Activation functions

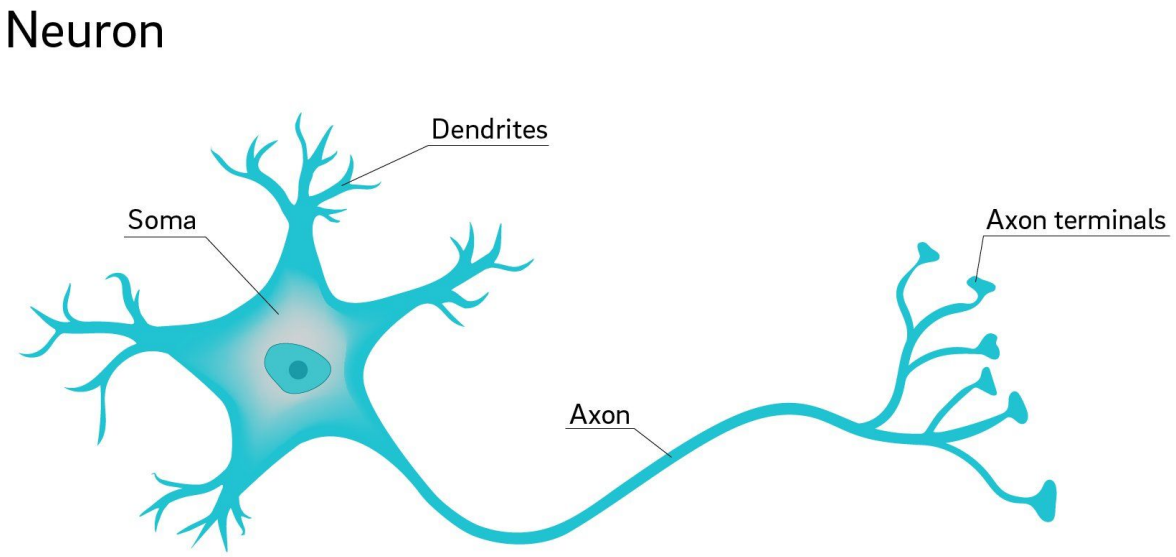
Whiteboard

An introduction to neural networks

The brain

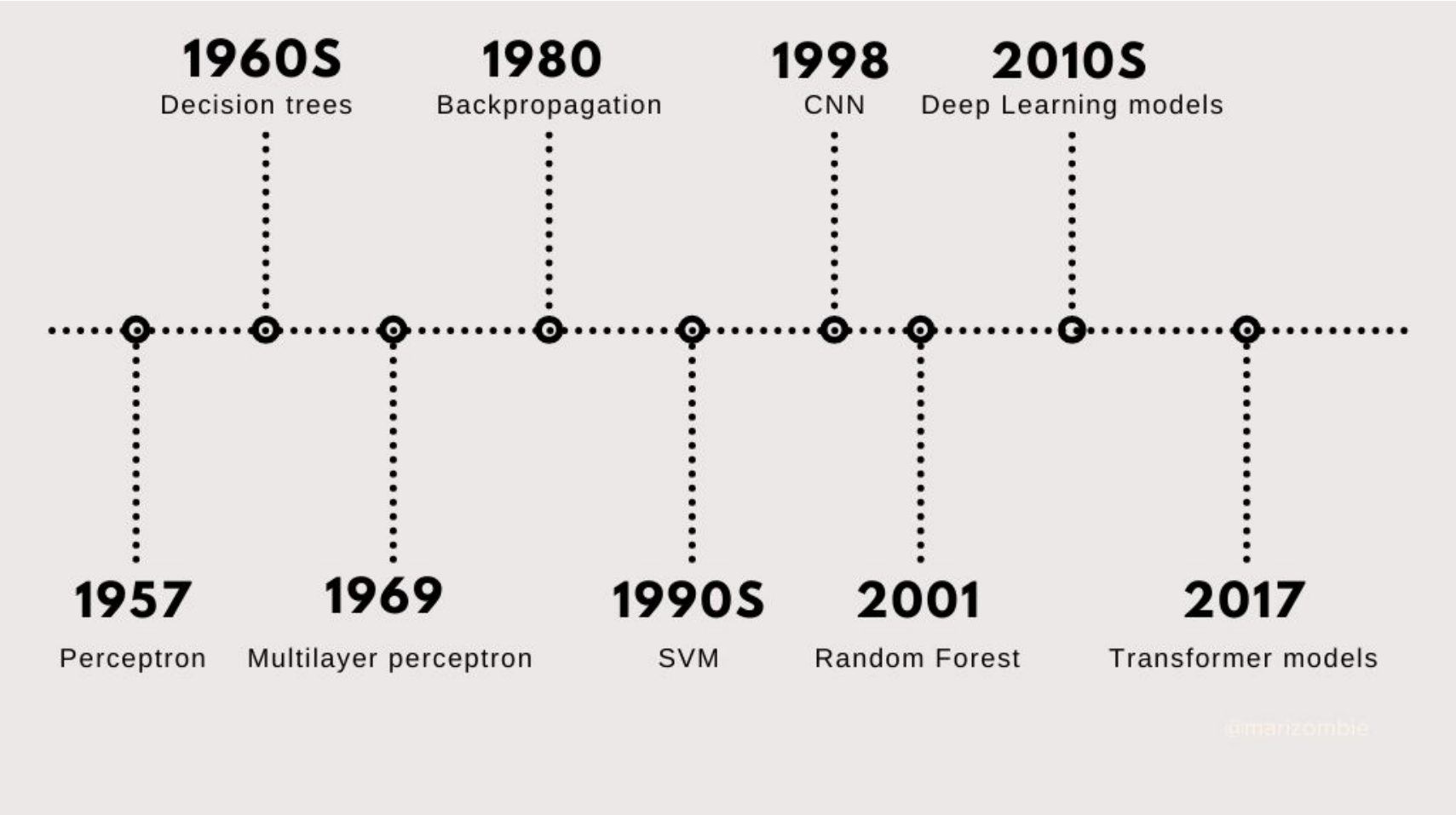
Source

Biological neurons



Source

History of trying to replicate this



Source

Artificial neurons

Whiteboard

From one neuron to two…

Whiteboard

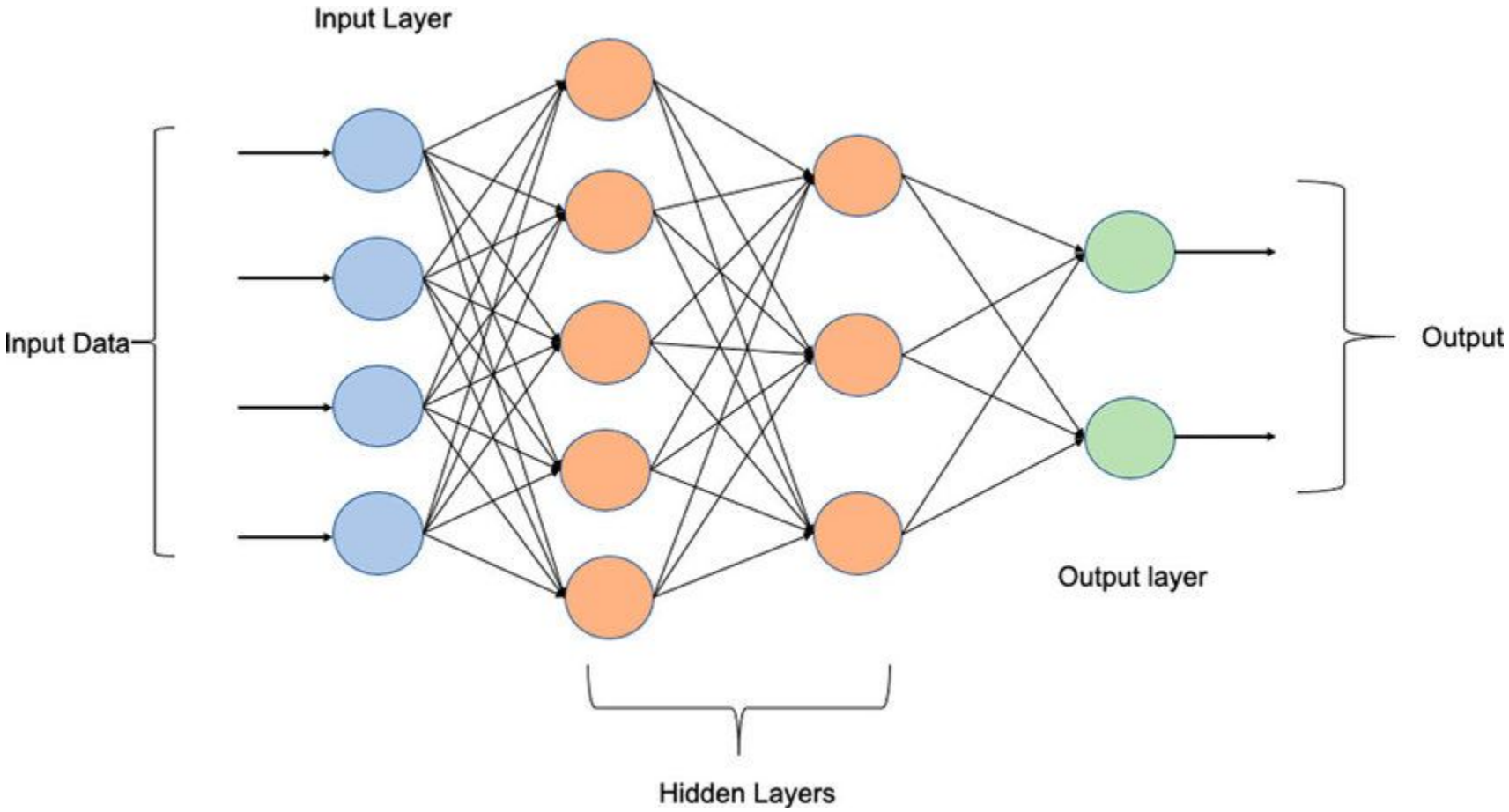
From two neurons to many neurons…

Whiteboard

From one layer to two…

Whiteboard

Turning this into larger networks



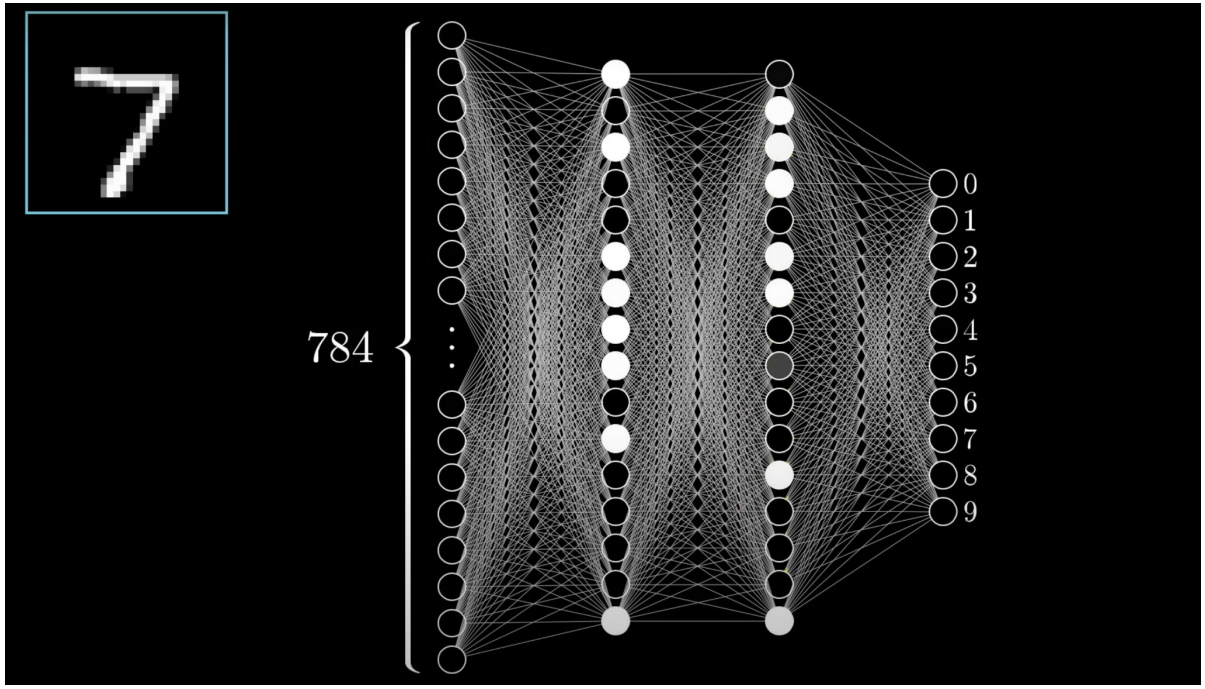
Source

A explanation for MNIST

[Video Comprehension]

An excellent explainer for the MNIST dataset

- Worth making notes on this!
- We'll discuss key questions afterwards
- https://www.youtube.com/watch?v=aircAruvnKk



Quick Quiz

Biological: Bigger is (approximately) better

TASK: Guess the average weights of all of these brains (in kgs)

Elephant: ???

Humans: ???

Monkeys: ???

Hampster: ???

Biological: Bigger is (approximately) better

TASK: Guess the average weights of all of these brains

Elephant:	5.71kg
Humans:	1.32kg
Monkeys:	0.115kg
Hampster:	0.001kg

Artificial: Bigger is better *(all else equal)*

Task: Guess the number of parameters in these models

GPT-1: ???

GPT-2: ???

GPT-3: ???

GPT-4: ???

Artificial: Bigger is better *(all else equal)*

Task: Guess the number of parameters in these models (in millions/billions/trillions)

GPT-1: 117 million

GPT-2: 1.5 billion

GPT-3: 175 billion

GPT-4: (unknown) 175 bn → >1 trillion

Scaling laws paper (Kaplan et al. 2020)

Scaling Laws for Neural Language Models

Jared Kaplan *
Johns Hopkins University, OpenAI
jaredk@jhu.edu

Sam McCandlish*
OpenAI
sam@openai.com

Tom Henighan
OpenAI
henighan@openai.com

Tom B. Brown
OpenAI
tom@openai.com

Benjamin Chess
OpenAI
bchess@openai.com

Rewon Child
OpenAI
rewon@openai.com

Scott Gray
OpenAI
scott@openai.com

Alec Radford
OpenAI
alec@openai.com

Jeffrey Wu
OpenAI
jeffwu@openai.com

Dario Amodei
OpenAI
damodei@openai.com

https://arxiv.org/pdf/2001.08361

Recap questions

1. What are deep learning models? How are the different from other machine learning models?

2. How can a linear regression be represented as a computation graph?

3. What is an activation function?

4. Draw a fully-connected neural network with 4 input features, one hidden layer with 6 neurons and 2 output neurons.

5. Explain the term ‘scaling’ in deep learning.