



Office for Health
Improvement
& Disparities

The UK coronavirus dashboard: challenges and lessons learned

Clare Griffiths

**Head of Public Health Analytical Product Development
Department of Health and Social Care**

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Background, purpose and audience

What was coronavirus.data.gov.uk?

- Provided daily, transparent updates on the progress of the pandemic on gov.uk
- Whole UK and local information
- Latest information on cases, deaths, hospitalisations, testing and vaccination
- Accessible for the general public and professional audiences alike
- A single, trusted version of the truth

This talk

Challenges

- Data volume
- Daily demand
- Creating UK data

Lessons learned

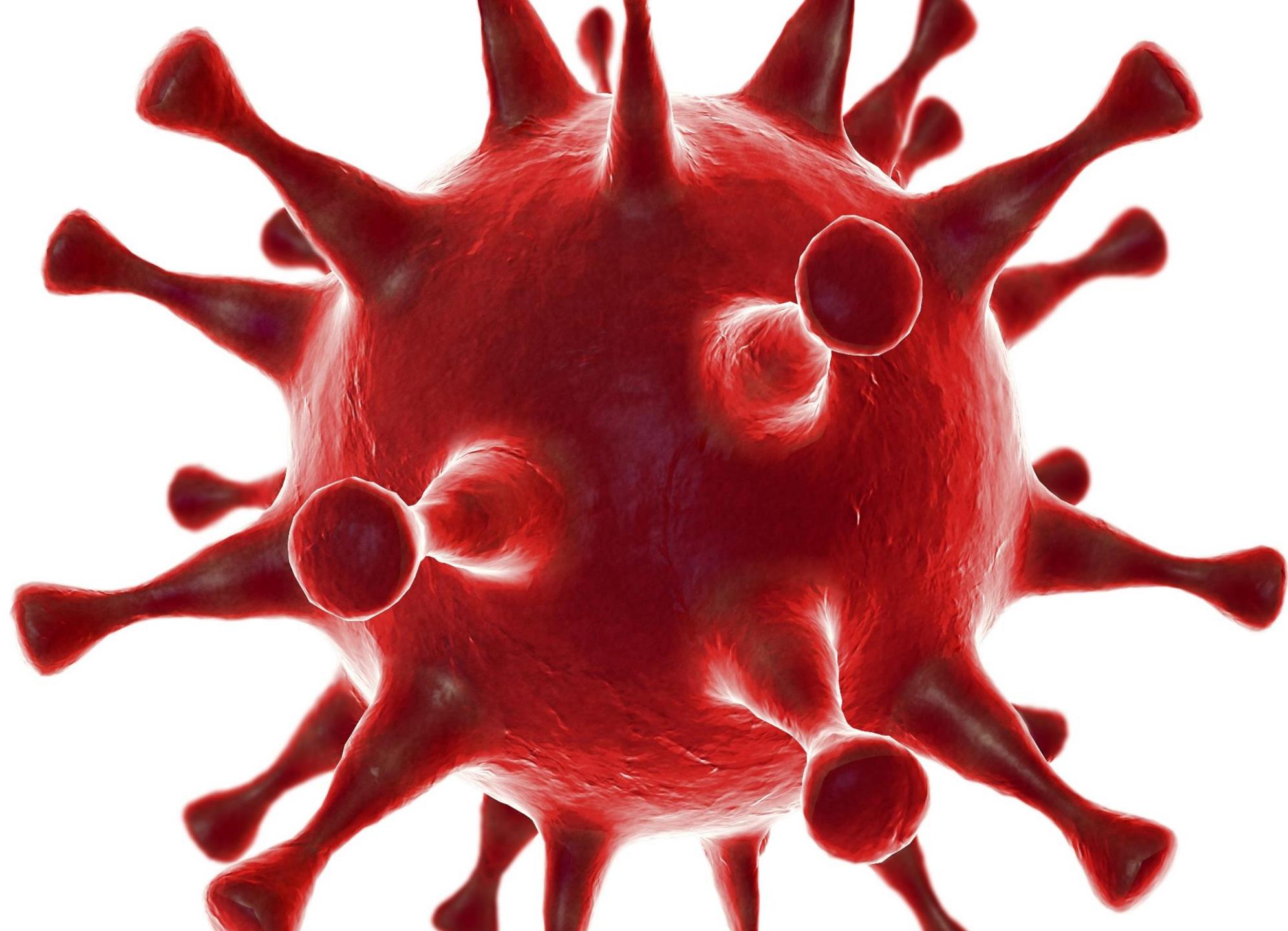
- Value of feedback
- Being open builds trust
- The need for reproducible analytical pipelines (RAP)

The problem....

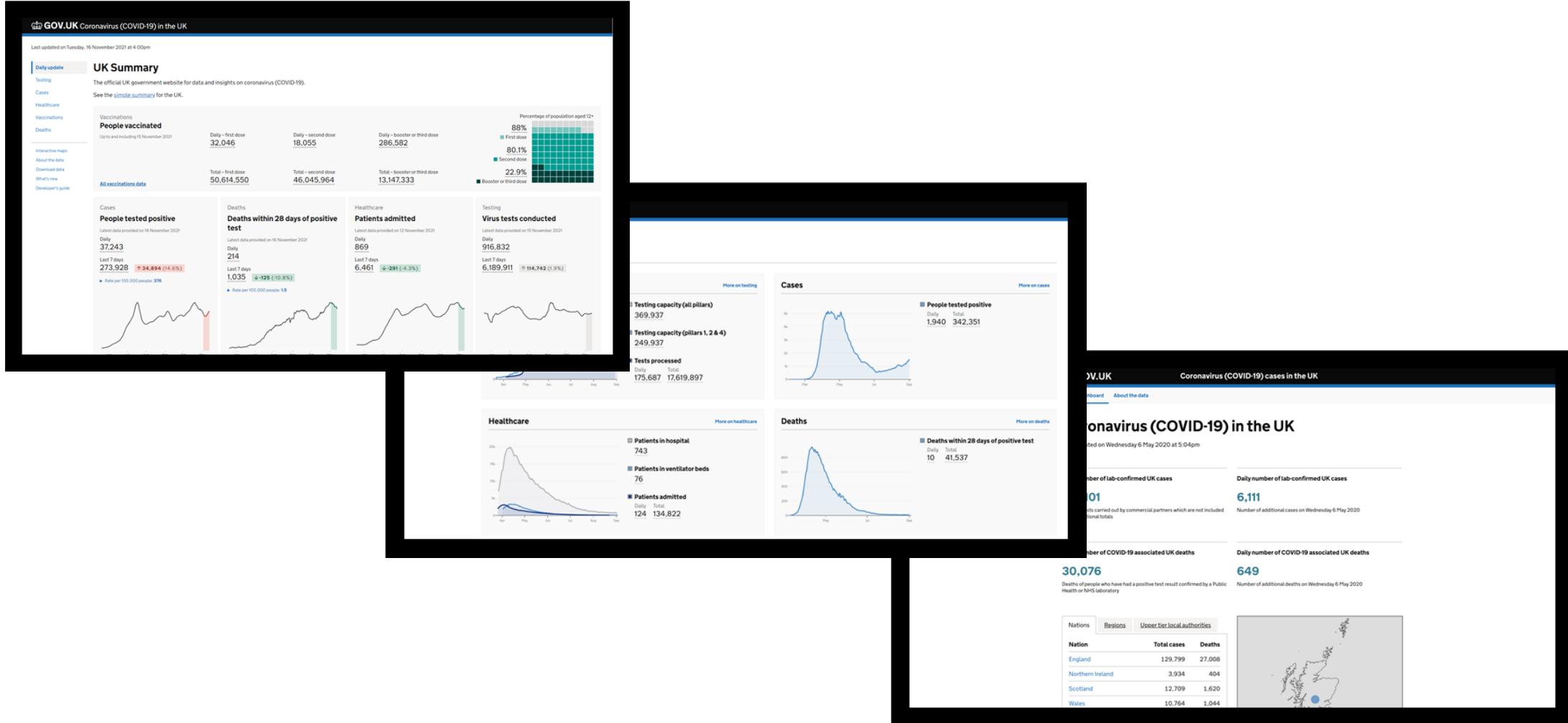
“

During the swine flu epidemic, there wasn't much real time data available on the spread and effect of the infection. Data managers in each PCT were left to devise their own monitoring system. If an equivalent to the COVID19 dashboard had been available in 2010, the epidemic would have been managed more efficiently.

David Lamb
Former Public Health Data Manager in a Primary Care Trust



The solution...



The team

Project management

Analytical

Pipeline

Research and
design

Tech

The data and daily processes

What was included?

Cases

- UK, nations, regions, LAs, MSOAs (Eng only)

Deaths

- Within 28 days of positive test; within 60 days of positive test or on death certificate (England only); on death certificate
- UK, nations, regions, LAs

Hospitalisations

- Admissions, people in hospital, people in mechanical ventilation beds
- UK, nations, NHS regions, NHS Trusts

Testing

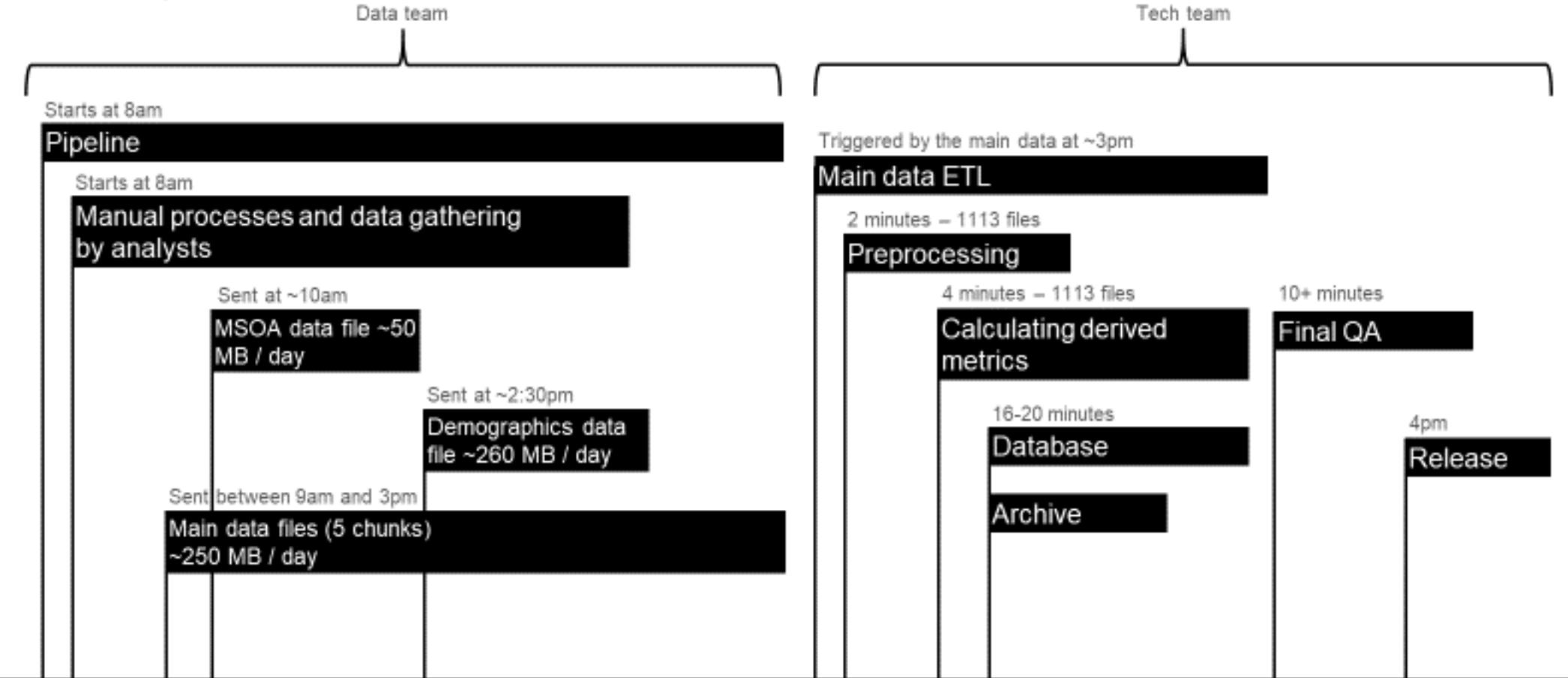
- UK, nations – by pillar and test type
- Positivity and LFD tests conducted for LAs

Later - Vaccinations

- 1st / 2nd dose: UK, nations, regions, LAs (Eng & Scot only), MSOAs (Eng only)
- 3rd / booster doses combined: UK, nations

Workflow

Daily processes



Complexities

Volume of data

Pipeline

26+ sources

~700+ million raw figures

~10 million figures

ETL

~50 million figures

Database

Main data: 3+ billion

Age demographics data: 3+ billion

Other demographics data: 30+ million

MSOA data: 180+ million

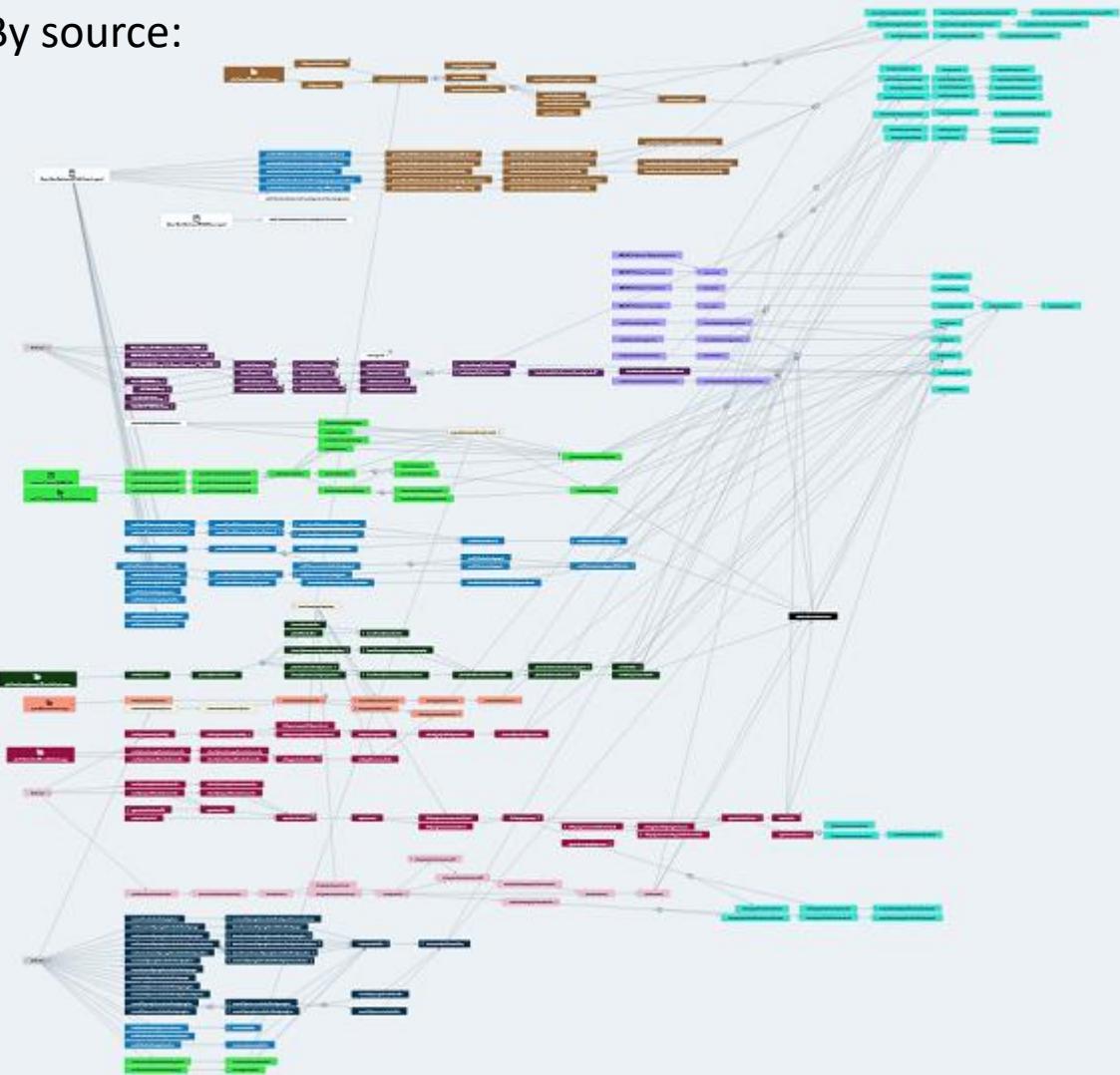
Total records: 6.5+ billion

The pipeline

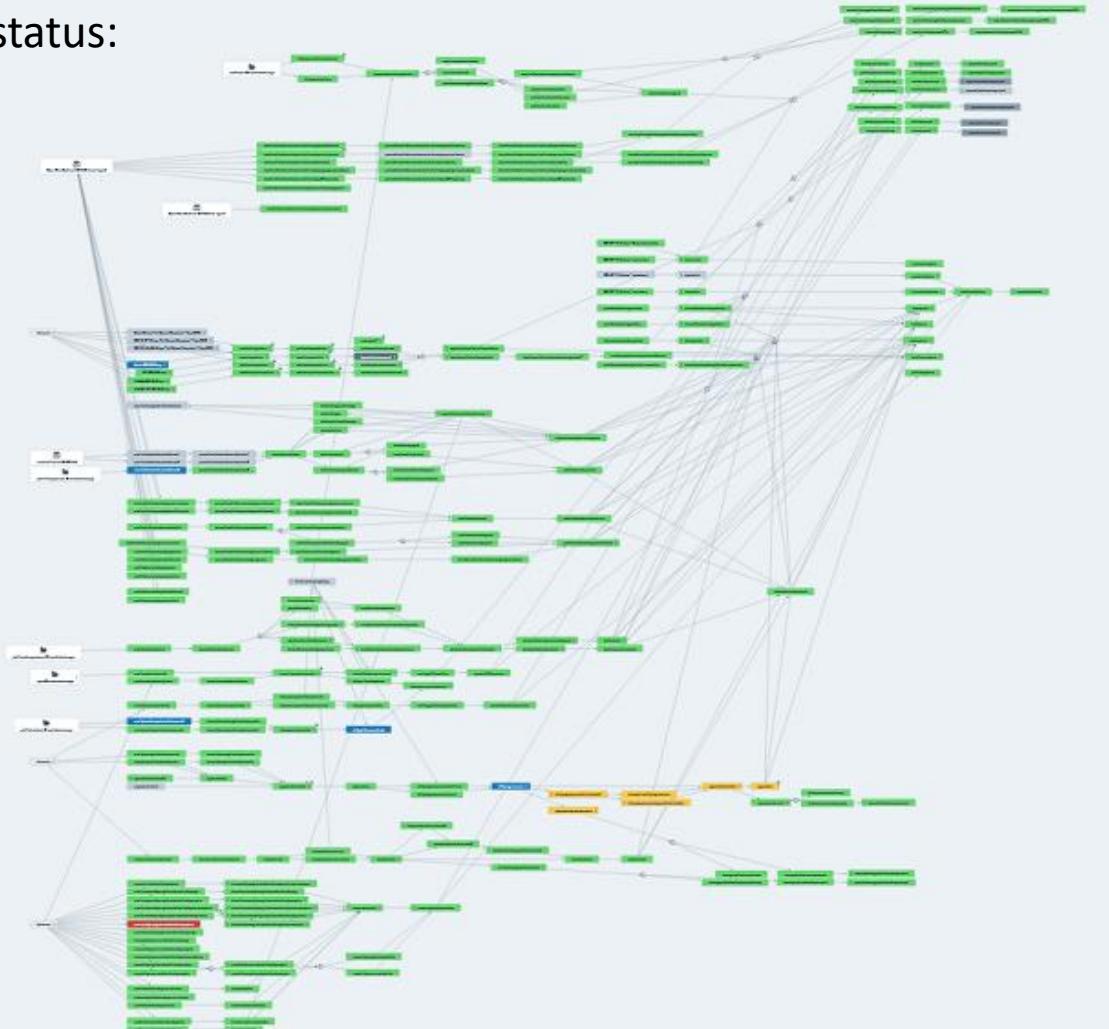
- Foundation = Reproducible Analytical Pipelines (RAP)
<https://gss.civilservice.gov.uk/reproducible-analytical-pipelines/>
- Lots of inputs (20+) sourced from UKHSA, NHSE/I, ONS, the nations (Northern Ireland, Scotland, Wales)
- Mixture of automated and manual inputs
- A series of transforms, coded using PySpark (python)
- Development and maintenance by development team of data engineers

The pipeline

By source:

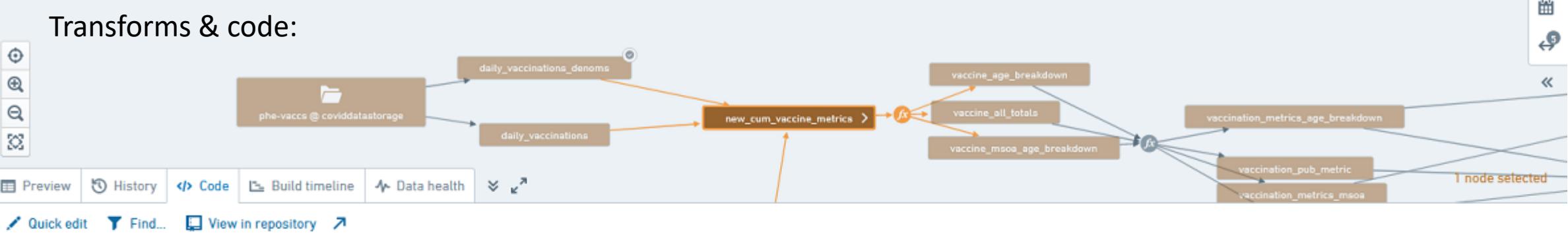


By status:



Transforms and Code

Transforms & code:



Quick edit Find... View in repository ↗

```
51 new_df_filtered = new_df \
52     .filter(~F.col('age_band')).isin(FILTER_AGE_BAND)) \
53     .filter(F.col('Sex_latest') == 'P') \
54     .filter(F.col('date') < F.current_date()) \
55     .join(vaccination_denominator, ['lsoa11', 'Sex_latest', 'age_band'], 'outer') \
56     .withColumn('age_band', F regexp_replace('age_band', ' years', '')) \
57     .withColumn('age_band', F regexp_replace('age_band', ' to ', '-')) \
58     .withColumn('age_band', F regexp_replace('age_band', ' years and over ', '+')) \
59     .withColumn('age_band', F regexp_replace('age_band', '90 and over', '90+')) \
60     .withColumn('newPeopleVaccinatedFirstDoseByVaccinationDate', F.when(F.col('date').isNull(), 0).otherwise(F.col('newPeopleVaccinatedFirstDoseByVaccinationDate')))\ \
61     .withColumn('newPeopleVaccinatedSecondDoseByVaccinationDate', F.when(F.col('date').isNull(), 0).otherwise(F.col('newPeopleVaccinatedSecondDoseByVaccinationDate'))))\ \
62     .withColumn('newPeopleVaccinatedCompleteByVaccinationDate', F.when(F.col('date').isNull(), 0).otherwise(F.col('newPeopleVaccinatedCompleteByVaccinationDate'))))\ \
63     .withColumn('date', F.when(F.col('date').isNull(), F.date_sub(F.current_date(), 1)).otherwise(F.col('date'))))\ \
64     .drop(*COLUMNS_TO_REMOVE)

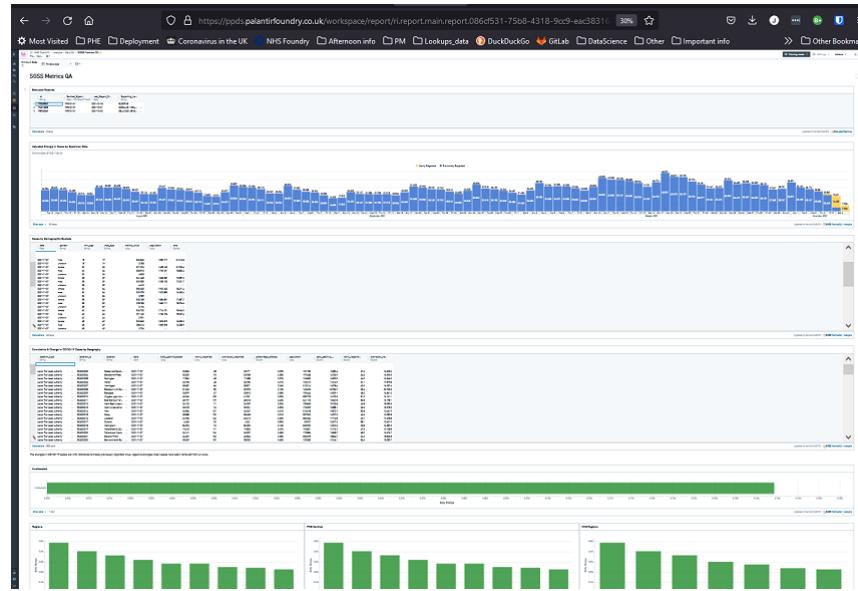
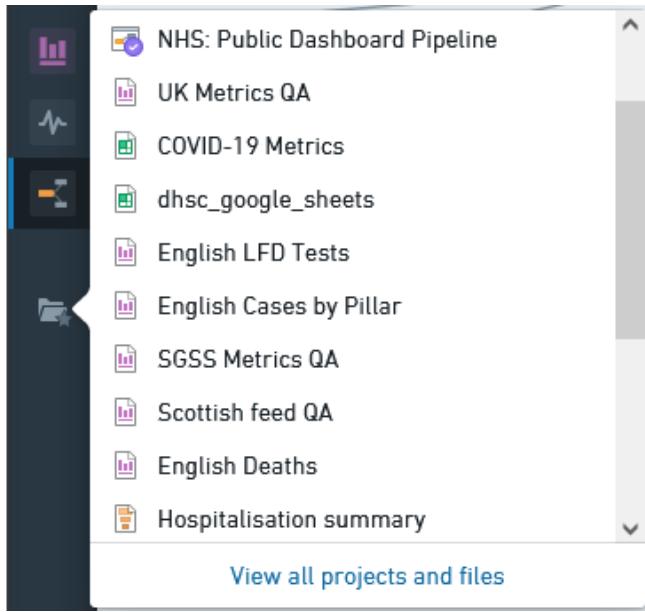
65
66 # adding the 12-15 age group to the final output.
67 add_12_15_age_groups_12 = new_df_filtered\
68     .filter(F.col("age_band") == '12+')\
69     .select(*(F.col(x).alias(x + '_12') for x in new_df_filtered.columns))

70
71 add_12_15_age_groups_16 = new_df_filtered\
72     .filter(F.col("age_band") == '16+')\
73     .select(*(F.col(x).alias(x + '_16') for x in new_df_filtered.columns))

74
75 add_12_15_age_groups_agg = add_12_15_age_groups_12\
```

Quality assurance

We had various QA reports used to ensure data looked sensible



These culminated in a QA of headline figures for the UK:

UK Metrics QA

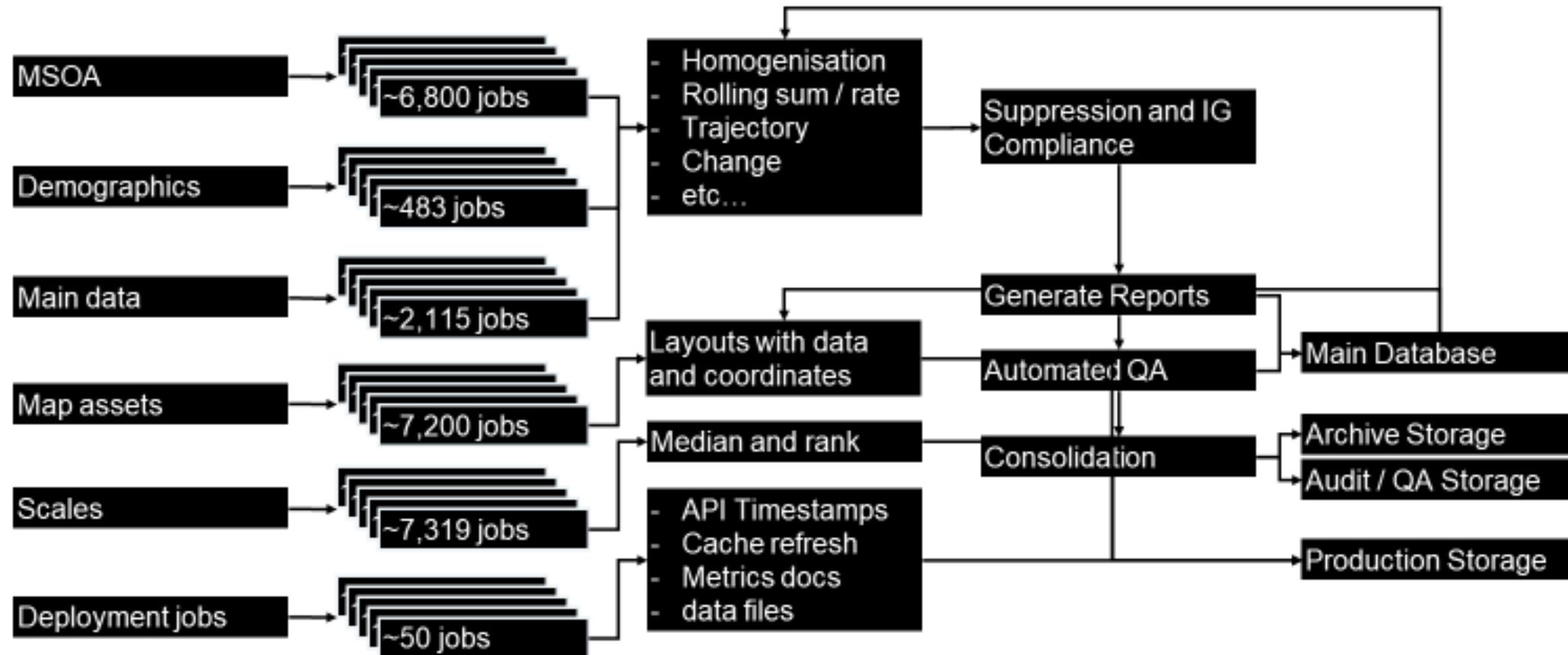
Reporting_Date	Metric	Figure	Diff_from_Previous
Date	String	Double	Double
1 2021-11-08	New positive cases	32,322.0	2,017.0
2 2021-11-08	Total positive cases	9,333,891.0	31,982.0
3 2021-11-08	New deaths within 28 days of a positive test	***	-5.0
4 2021-11-08	Total deaths within 28 days of a positive test	***	57.0
5 2021-11-07	Virus tests conducted	869,016.0	219,026.0
6 2021-11-07	PCR tests conducted	262,951.0	-75,281.0
7 2021-11-07	Antibody tests processed	305.0	-132.0
8 2021-11-07	PCR testing capacity	862,002.0	493.0
9 2021-11-07	Antibody testing capacity	122,400.0	0.0
10 2021-11-02	Patients admitted	1,054.0	-22.0
11 2021-11-05	Patients in hospital	8,966.0	-225.0
12 2021-11-05	Patients in ventilator beds	1,026.0	-8.0
13 2021-11-07	New people vaccinated — 1st dose	25,840.0	-10,908.0
14 2021-11-07	Total people vaccinated — 1st dose	50,262,735.0	25,840.0
15 2021-11-07	Vaccination uptake — 1st dose (%)	87.4	0.0
16 2021-11-07	New people vaccinated — 2nd dose	14,610.0	-9,890.0
17 2021-11-07	Total people vaccinated — 2nd dose	45,852,677.0	14,610.0
18 2021-11-07	Vaccination uptake — 2nd dose (%)	79.7	0.0
19 2021-11-07	New people vaccinated — Booster or 3rd dose	***	209,885.0
20 2021-11-07	Total people vaccinated — Booster or 3rd dose	10,302,544.0	209,885.0
21 2021-11-07	Vaccination uptake — Booster or 3rd dose (%)	***	17.9
22 2021-11-07	Daily vaccines given	250,335.0	-233,795.0
23 2021-11-07	Total vaccines given	106,417,956.0	250,335.0
24 2021-11-06	Patients admitted — England only	688.0	2.0
25 2021-11-08	Patients in hospital — England only	7,075.0	165.0
26 2021-11-08	Patients in intensive care — England only	81.0	0.0

Reproducible Analytical Pipelines (RAP)

- Essential for handling large volumes of data rapidly.
- Pipeline began on NHS Foundry and iteratively expanded over time to several hundred transforms covering billions of data points, from numerous different disparate sources.
- Benefits:
 - large number of metrics produced within tight time scales by providing a reliable foundation for daily processing
 - improved error checking via a modular approach; easier to identify source of issues and fix quickly
 - iterate over time to improve efficiency and test on branch first to ensure functioning as required
 - formalising pipelines on the system ensuring everything documented completely and in one place
 - collaboration between organisations through access to each other's pipelines

The service

The ETL



Data release

GOV.UK Coronavirus Dashboard - Admin

Home > Service admin > Releases

Select release to change

RECOVER DELETED RELEASES PURGE STORAGE CACHE REPOPULATE SUMMARY CACHE FLUSH DESPATCH CACHE FLUSH ALL CACHE ADD RELEASE +

Search 11 results (2665 total)

2022 8 February

Action: ----- Go 0 of 11 selected

ID	RECEIPT TIME	RELATIVE RECEIPT TIME	RELEASE CATEGORY	ETL STATUS	COUNT	DELTA	RELEASED	D
136591	Tue, 08 Feb 2022 – 15:29:08	–	Main	Completed	9,065,418	31,840	✓	1
136534	Tue, 08 Feb 2022 – 15:23:24	–	Cases	Completed	14,995,380	40,181	✓	1
136509	Tue, 08 Feb 2022 – 15:08:53	–	Healthcare	Completed	1,473,116	160	✓	1
136468	Tue, 08 Feb 2022 – 15:05:34	–	Testing	Completed	2,196,880	6,216	✓	1
136459	Tue, 08 Feb 2022 – 15:01:29	–	Age demographics: Deaths 28 days	Completed	6,987	10	✓	1
136410	Tue, 08 Feb 2022 – 14:52:50	–	Vaccinations	Completed	2,731,250	7,119	✓	1
136361	Tue, 08 Feb 2022 – 14:48:02	–	Age demographics: Vaccinations	Completed	230,124	539	✓	1
136360	Tue, 08 Feb 2022 – 13:08:57	–	MSOA: Vaccinations	Completed	61,119	0	✓	1
136319	Tue, 08 Feb 2022 – 12:32:34	–	Positivity & People Tested	Completed	673,636	0	✓	1
136277	Tue, 08 Feb 2022 – 11:07:30	–	Age demographics: Cases	Completed	331,874	474	✓	1
136318	Tue, 08 Feb 2022 – 10:20:06	–	MSOA	Completed	667,644	1,054	✓	1

GOV.UK Coronavirus (COVID-19) in the UK

DATA ISSUE 8 November 2021 — Delay in update to local vaccination data in England More

Last updated on Monday, 8 November 2021 at 5:45pm

Daily update Testing Cases Healthcare Vaccinations Deaths Interactive maps About the data Download data What's new Developer's guide

UK Summary

The official UK government website for data and insights on coronavirus (COVID-19). See the [simple summary](#) for the UK.

Vaccinations

People vaccinated

Up to and including 7 November 2021	Daily – first dose	Daily – second dose	Daily – booster or third dose
25,840	14,610	209,885	

Percentage of population aged 12+
87.4% First dose
79.7% Second dose
17.9% Booster or third dose

Cases

People tested positive

Latest data provided on 8 November 2021

Daily	Last 7 days
32,322	239,782

Rate per 100,000 people: 391.2

Deaths

Deaths within 28 days of positive test

Latest data provided on 8 November 2021

Daily	Last 7 days
57	1,191

Rate per 100,000 people: 1.6

Healthcare

Patients admitted

Latest data provided on 2 November 2021

Daily	Last 7 days
1,054	7,249

↑ 214 (3%)

Testing

Virus tests conducted

Latest data provided on 7 November 2021

Daily	Last 7 days
869,016	6,060,764

↑ 168,425 (2.9%)

What's the situation in your local area?

Search by postcode View data for your local area Enter a postcode For example SW1A 0AA Find a postcode on [Royal Mail's postcode finder](#)

UK interactive maps Explore maps for:

- cases
- vaccinations

[View maps](#)

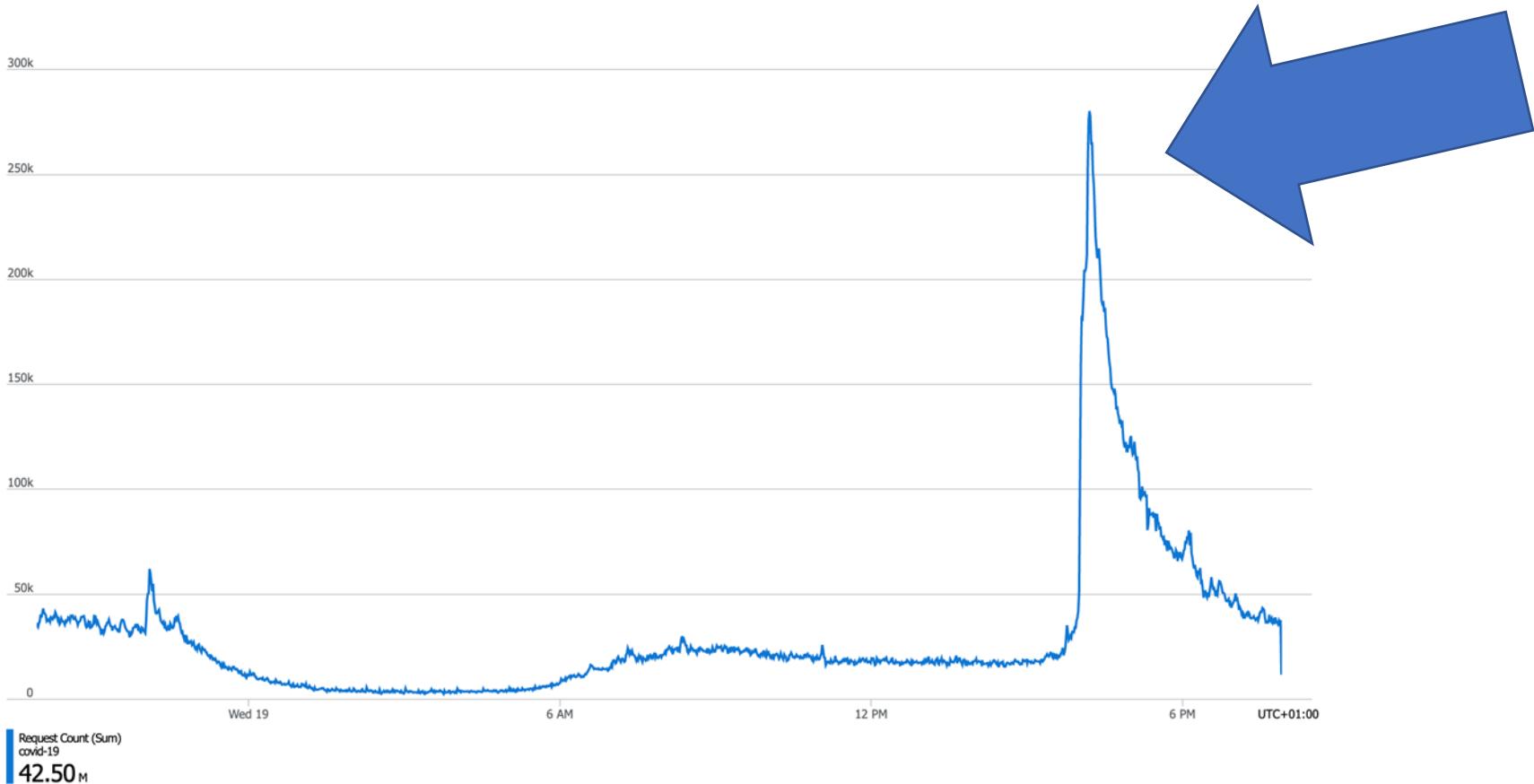


The service in figures

- Daily users: 1.5 million
- Weekly users: 4 million
- Weekly page views: 80 million
- Daily hits: 40 million
- Daily downloads of data: 1.5 million
- Concurrent users at peak time: 200,000

The 4pm surge...

Number of requests on 19 May 2021



Open data

Open Data

Advantages

- Helps people understand government decisions
- Accessible to millions
- Justifies decisions
- Improves trust
- We can't do it all
- *Rapid identification of mistakes*
- *Ever growing demand for data*

Disadvantages

- Room for misinterpretation
- Pressure to publish as soon as possible
- Limited time for QA
- No room for delays
- *Rapid identification of mistakes*
- *Ever growing demand for data*

Rapid identification of mistakes: 100k reviewers

Our mistakes were broadcast on national television within ~2 minutes.



Open Data

Rapid identification of mistakes: 100k reviewers

There's also this... well, it was a Sunday!

The collage consists of three screenshots:

- Top right:** A screenshot from Sky News showing a chart titled "UK TOTAL 1st DOSES" with the subtitle "42.2% OF ADULTS". Below the chart, a yellow box states: "Owing to processing issues for deaths in England, the numbers of deaths throughout the UK will be updated later. In the meantime, the number of newly reported deaths for 7 March 2021 may incorrectly show as zero." The date "7 March 2021" is also visible.
- Middle left:** A screenshot of a tweet from Haaretz.com (@haaretzcom) posted 2 hours ago. The tweet features a "BREAKIN NEWS" graphic with the "HAARETZ" logo. The text reads: "Britain reports no deaths within 28 days of positive COVID test ***". Below the tweet is a link to haaretz.com. The tweet has 4 likes, 11 retweets, and 21 favorites.
- Bottom right:** A screenshot of a tweet from Reuters (@Reuters) posted at 4:50 PM on Mar 7, 2021. The tweet reads: "Britain reports no deaths within 28 days of positive COVID test reut.rs/3sYpyiQ". It includes a photograph of a medical professional in blue gloves giving an injection to a patient's arm. The tweet has 86 retweets, 23 quote tweets, and 421 likes.

Text overlay on the middle-left tweet:

This is incorrect, @haaretzcom. Reuters has corrected its article. There is a delay in the processing of data.

Timestamps:

- Haaretz tweet: 6:36 PM · Mar 7, 2021 · Twitter for Android
- Reuters tweet: 4:50 PM · Mar 7, 2021 · True Anthem

Open Data

Rapid identification of mistakes: 100k reviewers

Our mistakes were broadcast on national television within ~2 minutes.

Vast majority of users told us about a possible problem: that helped us fix the problem.

A minority tried to catch us making a mistake to either ridicule us or justify an unfounded theory.



Both:

- Were our users
- Made equally important points
- Had equal right to see the data
- Deserved to be heard

They went about it in different ways.

Open Data

There is a different way to look at the second group.

Their points provided a unique opportunity to improve:

- design of user research sessions
- robustness of SOPs
- QA process
- the dashboard design

The API – v2 for high volume

- User interface
- Easy to use
- Informative
- Comprehensive

The screenshot shows the GOV.UK Coronavirus (COVID-19) data download page. At the top right, there is a callout box for a "Permanent link". Below it, the main page has sections for "Area type", "Area name", "Metrics", and "Data release date". A modal window titled "Select Metrics" is open on the right side, listing various metrics like "changeInNewCasesBySpecimenDate", "covidOccupiedMVBeds", etc., each with a "Latest record" date. An arrow points from the "Metrics" section on the main page to the "Select Metrics" modal.

Permanent link
This is the permanent link for your specific request. Click on the box to copy the link into clipboard.

<https://api.coronavirus.data.gov.uk/v2/data?areaType=nation&areaCode=E92000001&metric=newCasesBySpecimenDateAgeDemographics&format=csv>

Download data

You may download the data by clicking on the "Download data" button, or using the permanent link. Download requests are subject to the [Fair usage policy](#).

You must select an area type and at least one metric to enable the "Download data" button and create a link. You may further choose a specific area name to reduce the data to a specific location.

Area type
Required.
United Kingdom

Area name
Optional. Leave blank to download the data for all locations in your selected area type.
Select area

Metrics
Required. Select up to 5 metrics. Some metrics may not be available for your selected area type. Such metrics will still be included in the resulting document, but will not contain any data.
Records contain at least 4 additional metrics as follows: areaType, areaCode, areaName, date
Note that you can only request one metric at a time for demographics data.
Select Metrics

Data release date
Required. Note that when the "Latest" option is selected, the permanent link will always produce the data as they appear on the website — that is, the very latest release.
 Latest
 Archive

Supplementary downloads
Population dataset - excluding MSOs
[Latest ONS estimates](#)

Metrics
Required. Select up to 5 metrics. Some metrics may not be available for your selected area type. Such metrics will still be included in the resulting document, but will not contain any data.
Records contain at least 4 additional metrics as follows: areaType, areaCode, areaName, date
Note that you can only request one metric at a time for demographics data.

Select Metrics

changeInNewCasesBySpecimenDate
Latest record: 2021-09-27

covidOccupiedMVBeds
Latest record: 2021-09-28

cumAdmissions
Latest record: 2021-09-26

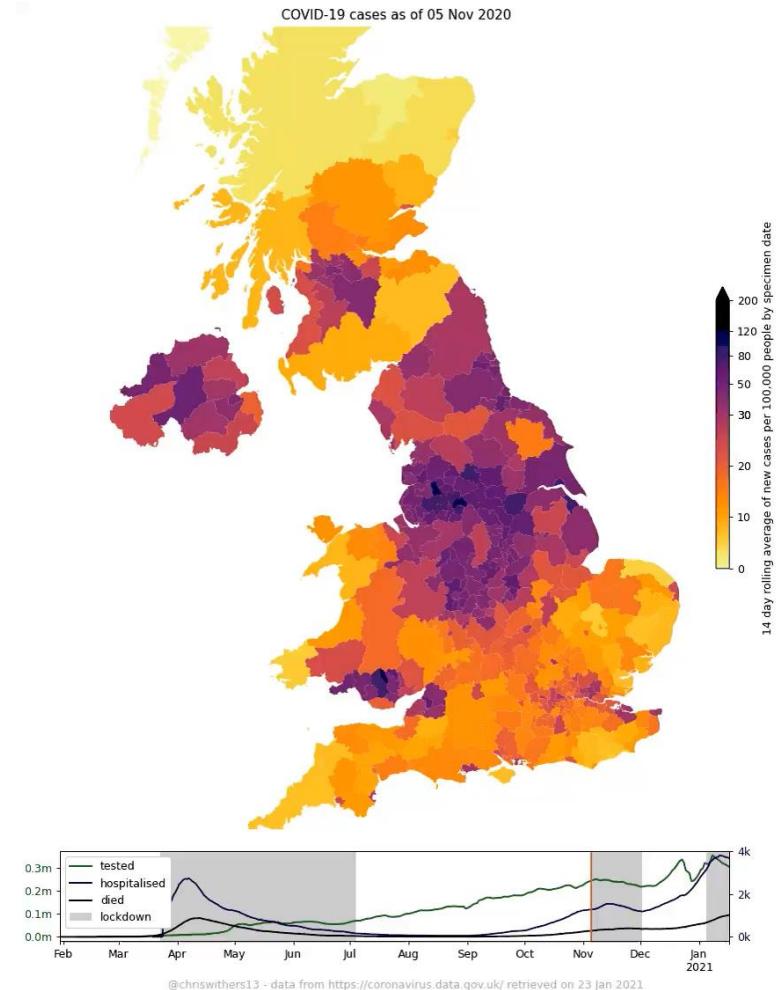
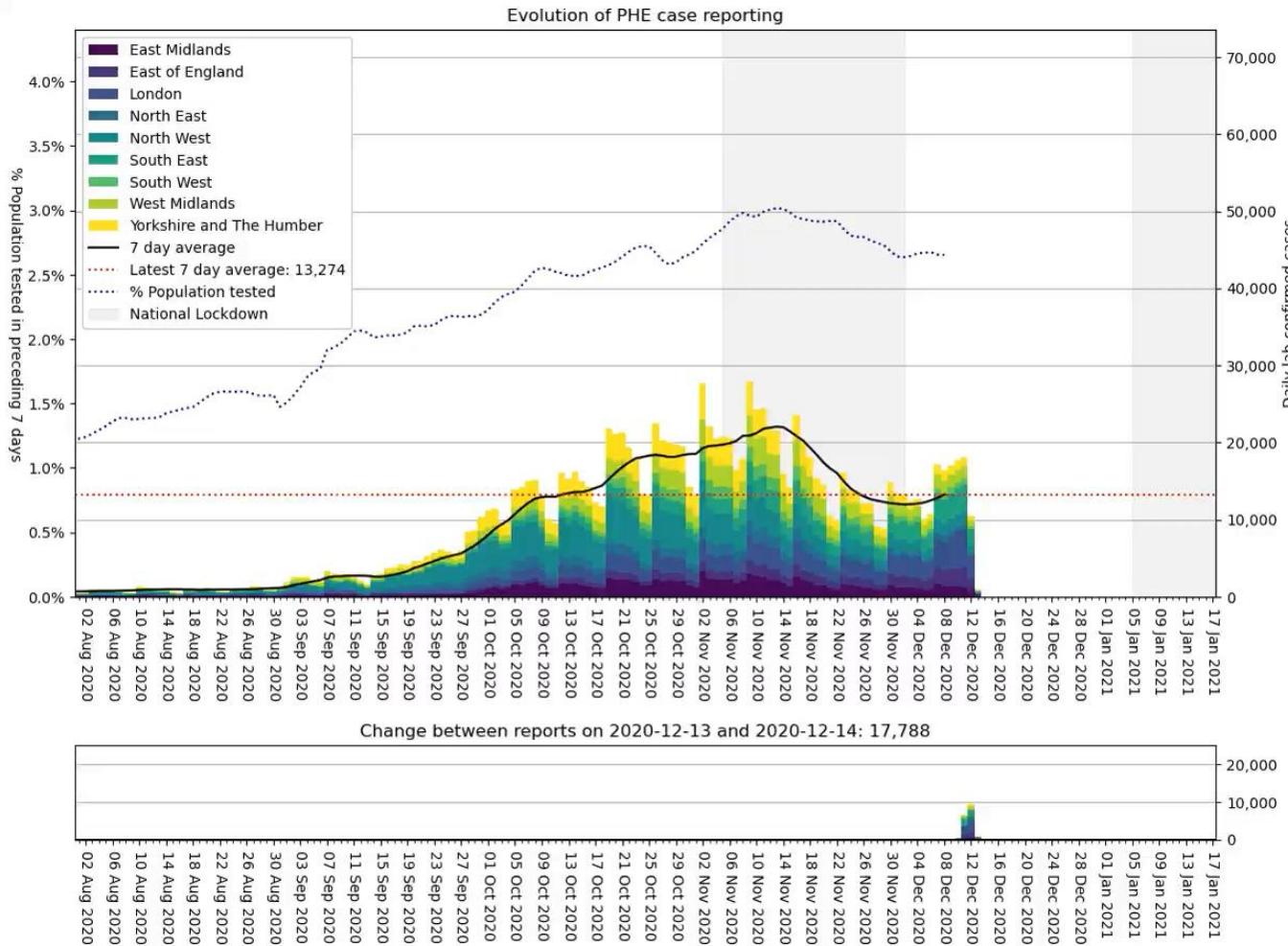
cumAdmissionsByAge
Latest record: 2021-09-26

cumAntibodyTestsByPublishDate
Latest record: 2021-09-27

cumCasesByPublishDate
Latest record: 2021-09-27

Open Data

We couldn't do it all.



Courtesy of Chris Withers - @chriswithers13

Open Data

Promoted collaboration

Websites created by members of the public

News outlets used the data to inform the public

International agencies used the data to derive policies

Researchers used the data for studies

National organisations used the service to obtain consolidated data

Examples

<https://coronavstats.co.uk>

Financial Times, Sky News

WHO

Imperial and Hopkins

JBC, Local authorities

User engagement and design

User engagement

Profiling our users

- Who were the dashboard users
- how the user base changed
- important to provide a good user experience.

Understanding interest in new topics over time

- Which were the areas of growing importance for our audiences.

Collecting feedback

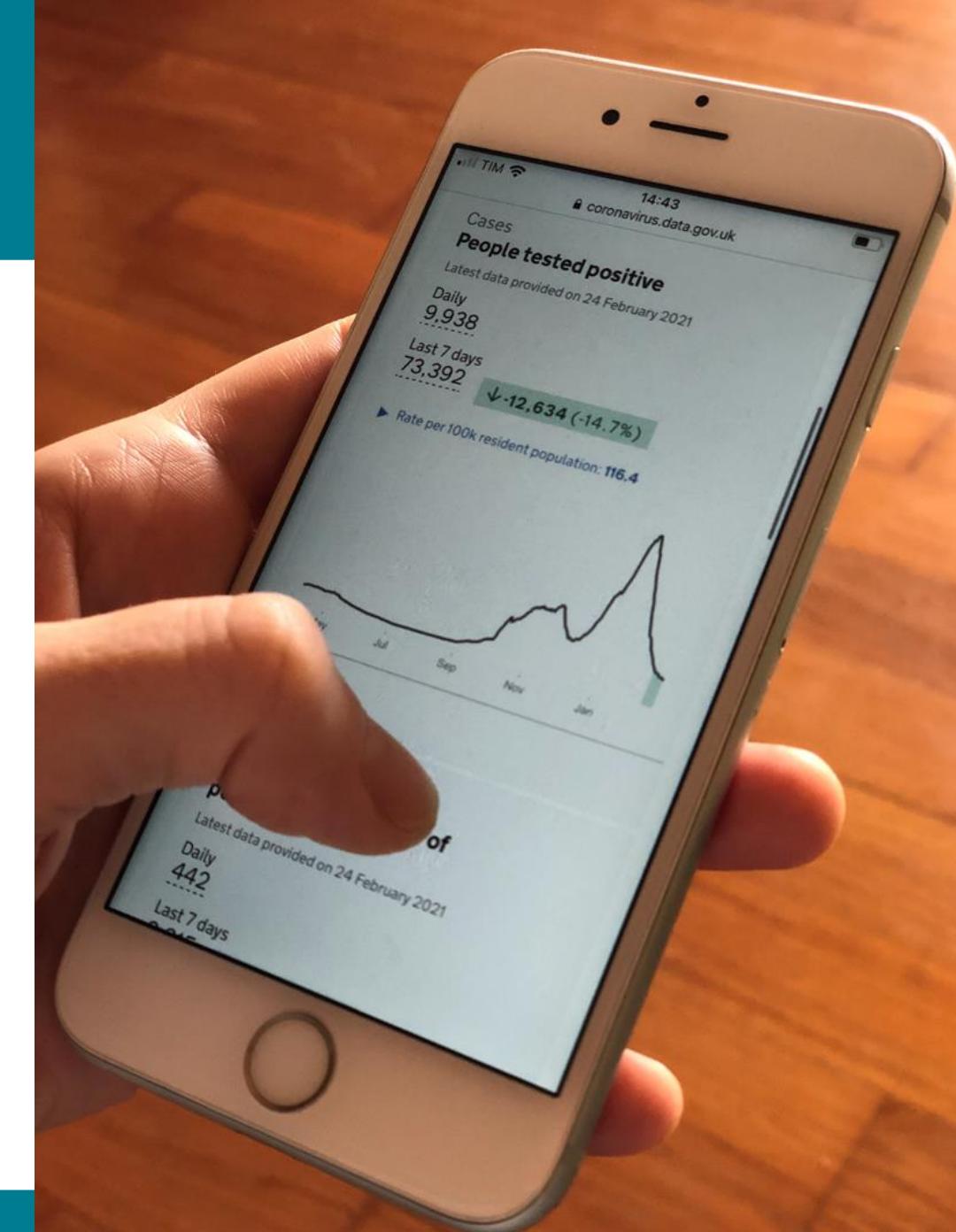
- Did users find what they need to understand what is happening with COVID-19?
- Did they understand the data and create a coherent narrative?

Monitoring trust and satisfaction over time

- This is in line with GDS standards for measuring success.

Understanding users' behaviour and feelings

- How did the dashboard make users feel and act?



Who were our users?

- 62% view the dashboard on **mobile devices**
- 54% use **Safari** and 30% use **Chrome**
- 89% visit the dashboard only for **personal use** and 11% for **professional use** or both
- 84% visit the dashboard **every day**
- **Peak time is 4:00pm** when the new data is published
- 66% are aged **40 to 69**
- 82% rate their digital skills as **confident or expert**
- 97% are in **England**

User engagement channels

User research sessions

- One-on-one user research sessions with members of the public, data professionals and users with disabilities – participants (over 120) recruited from pools of volunteers with the criteria of having a good representation of user personas

Online surveys

- Five user surveys (47,000 responses in the last survey)

Email tracker

- Analysed over 23,500 emails sent to the feedback email address

Google analytics

- Where did users go and when? Which devices and browsers did they use?

Social media

- Users (e.g. Twitter) spoke about what they thought of the dashboard



Dashboard design principles

- The dashboard was intended for everyone. 89% used the dashboard for personal interest rather than professional use.
- We needed to show detailed, sometimes complex data as simply as possible, using language and visualisations that everyone could understand.
- As a government website, we applied the Service Standard

Service Standard

4. Make the service simple to use

Build a service that's simple, intuitive and comprehensible. And test it with users to make sure it works for them.

Service Standard

5. Make sure everyone can use the service

Provide a service that everyone can use, including disabled people and people with other legally protected characteristics. And people who do not have access to the internet or lack the skills or confidence to use it.

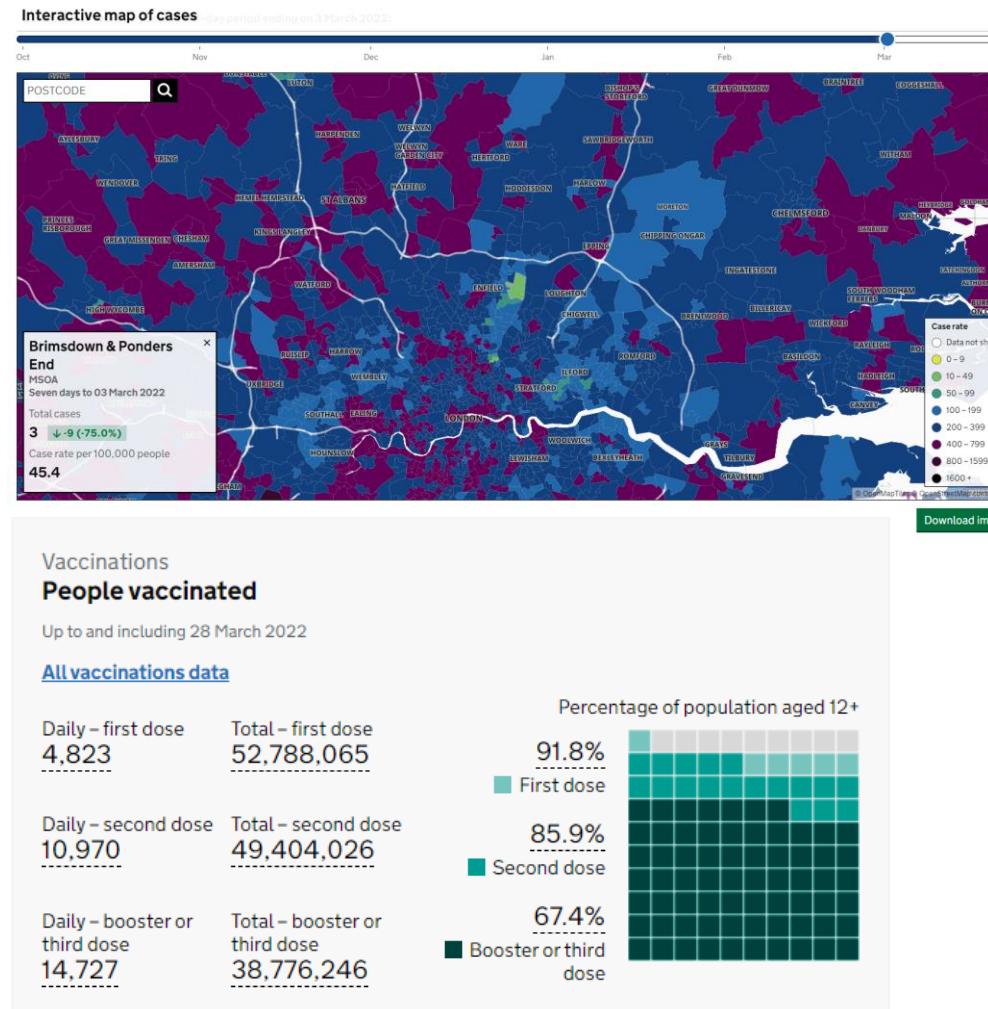
Design context – a rapidly changing situation

The COVID-19 pandemic was a fast-changing situation

This means we needed to constantly reassess users' interests and needs and ensure design and data reflected this.

For example:

- testing capacity – high interest in mid-2020 then much lower
- local data – interest grew when local restrictions were introduced
- vaccinations – interest grew quickly once the vaccination programme started



Accessibility

- One size doesn't fit all.
- Structural hierarchy is important.
- Accessibility is not only for people with visual impairment.
- Making a service accessible should not make it less useful to other users.
- It is always a work in progress...

[ARIA] Region aria-labelledby=last-update ←
Last updated on Sunday 27 September 2020 at 4:00pm

(landmark) [ARIA] Navigation aria-label=Side navigation

[ARIA] Current (location)
UK Summary

Testing
Cases
Healthcare
Deaths

About the data
Developer's guide

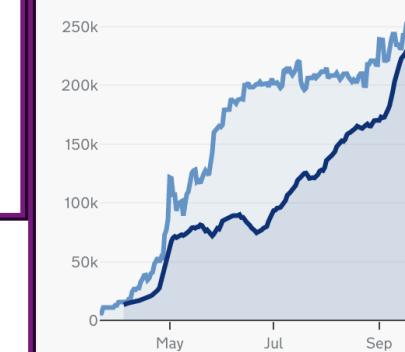
(unlabelled) (landmark) [ARIA] Main

[ARIA] Heading aria-level=1

[ARIA] Article aria-labelledby=card-heading-testing

[ARIA] Heading aria-level=2

Testing



More on

[ARIA] Region aria-label=Testing: Latest data

[ARIA] Heading aria-level=3

Button Testing capacity (pillars 1 & 2)

268,815

[ARIA] Button

[ARIA] Heading aria-level=3

Button Tests processed (pillars 1 & 2)

Daily

226,900

[ARIA] Button

[ARIA] Heading aria-level=4

Total

20,304,308

[ARIA] Button

Accessibility

It goes beyond the website.

The screenshot shows a Google search results page for the query "Coronavirus United Kingdom". On the left, there's a sidebar for "COVID-19" with sections like Overview, Statistics, Testing, Prevention, Symptoms, News, and Treatments. The main content area shows the "Top results" from <https://coronavirus.data.gov.uk>. The first result is titled "Daily summary | Coronavirus in the UK" and describes it as an "Official Coronavirus (COVID-19) disease situation dashboard with latest data in the UK". Below this, there are sections for "Vaccinations" (last updated 20 hours ago), "Cases", "Deaths", and "Healthcare". At the bottom of the result, there are links for "Deaths · Cases · Simple summary · Interactive Map" and a note about visiting the page many times. A large blue bracket on the right side of the main content area is labeled "Structured micro-data", indicating that the rich snippets and detailed information are examples of structured micro-data.

Google

Coronavirus United Kingdom

COVID-19

Coronavirus disease United Kingdom

Overview

Statistics

Testing

Prevention

Symptoms

News

Treatments

Share

Top results

<https://coronavirus.data.gov.uk>

Daily summary | Coronavirus in the UK

Official Coronavirus (COVID-19) disease situation dashboard with latest data in the UK.

20 hours ago - Vaccinations

Vaccines are currently given in 2 doses, at least 21 days apart. By the end of 23 May 2021, 126,357 people had been given a first dose and 252,139 a second dose. In total, 38,070,038 people (72.3% of the adult population) have received a first dose and 22,895,556 people (43.5% of the adult population) a second dose of a vaccine.

Additional info

20 hours ago - Cases

20 hours ago - Deaths

20 hours ago - Healthcare

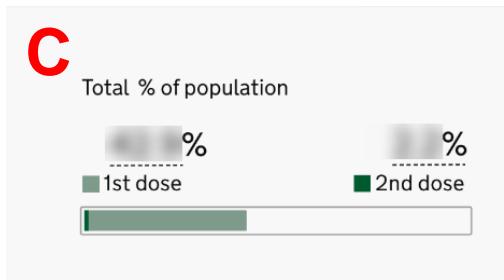
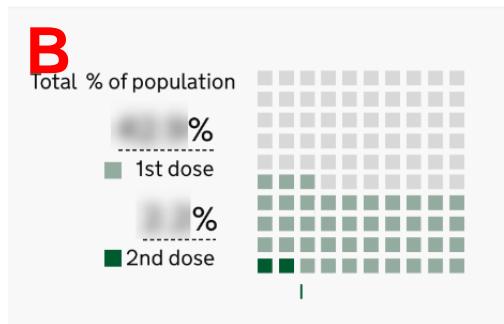
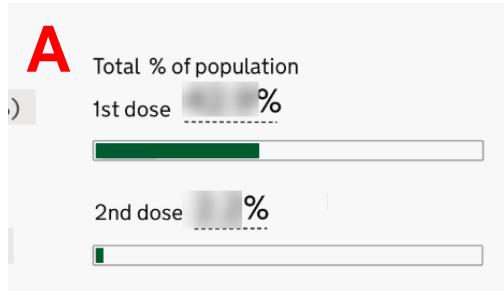
Deaths · Cases · Simple summary · Interactive Map

You've visited this page many times. Last visit: 14/05/21

Structured micro-data

User testing... with a twist

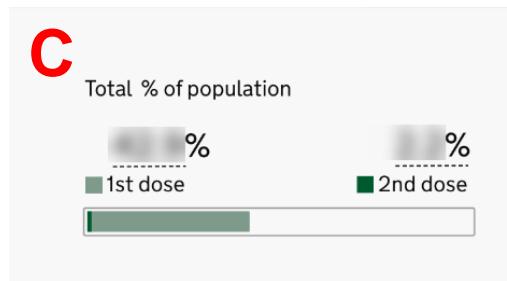
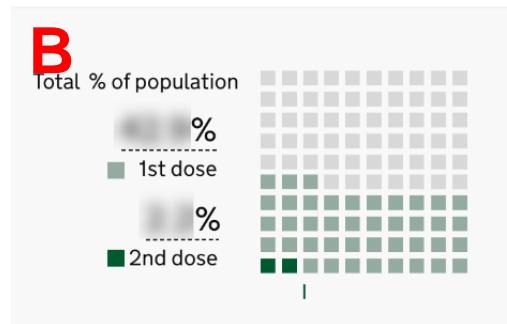
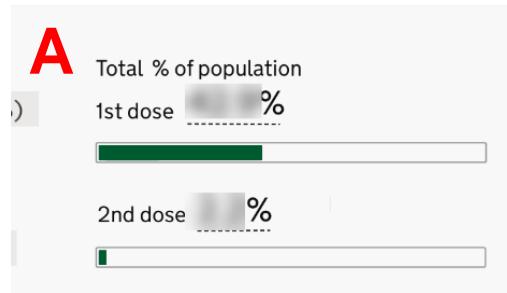
Is it always about which one the users like?



Type of graph	Users initial preference
A Double bar	60%
B Waffle	30%
C Single bar	10%

User testing... with a twist

Is it always about which one the users like?



30% Initially preferred waffle:

- “It is good as it fills till 100% of the population is vaccinated”
- “This is good to understand risks, as it is more precise (than the other 2 graphs)”

30% Initially preferred the double bars, but switched to waffle:

- “I get it now! I actually like it now”
- “I quite like this one but I’ve been influenced because I’ve already seen it”

60% Guessed the right % with waffle

10% Preferred the single bar :

- “I don’t find graphs useful anyway”

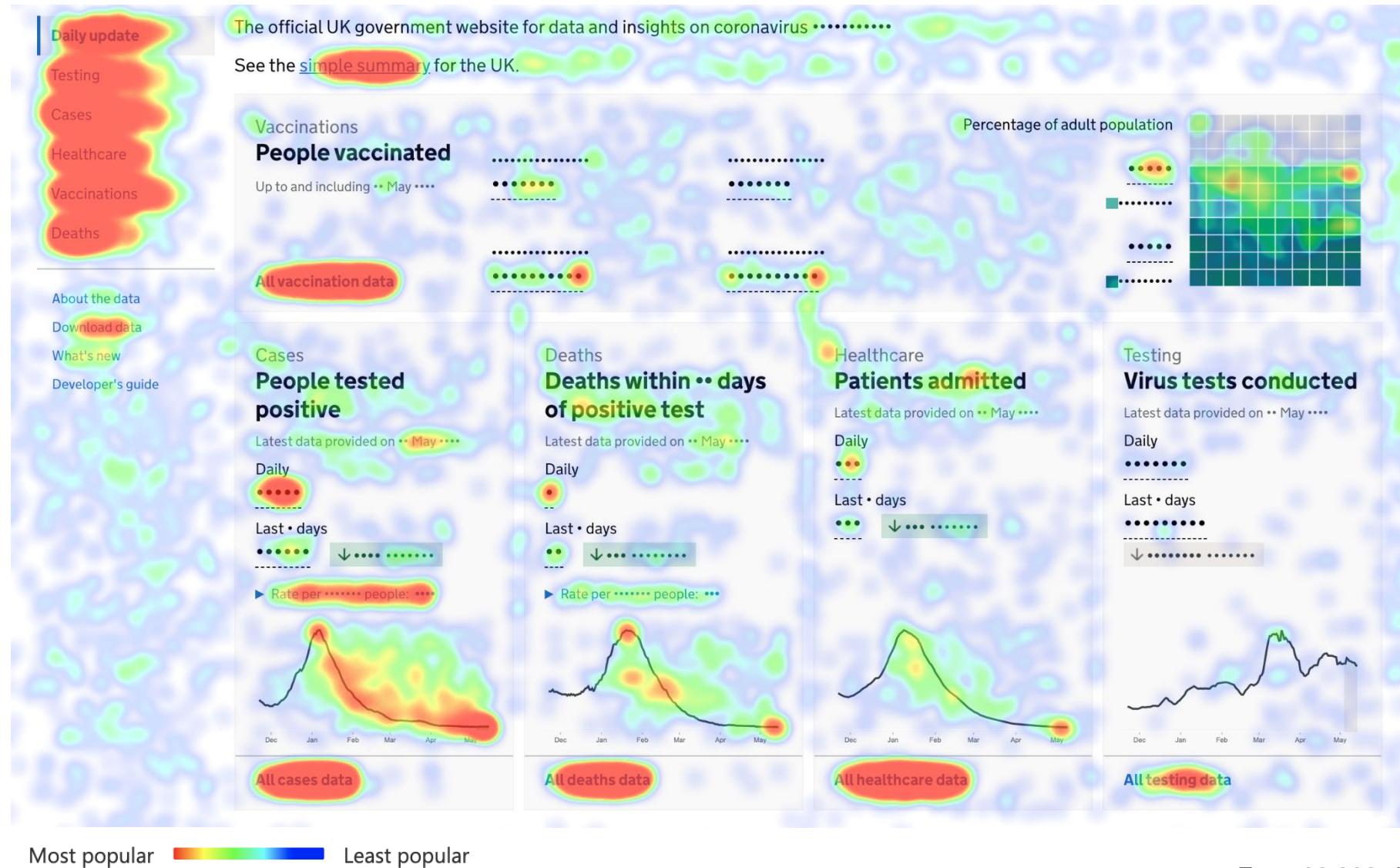
There is
a journey



Final result... 90% found waffles more useful.

- “My eye goes to the waffle straightaway”
- “The graph is the story for me”
- “Very straightforward and easy to read”
- “It tells me pretty well everything”

Build. Break. Build again.



An aside on the
UK... ■ ■

A cautionary word on UK data

- The health system in the UK is devolved
- Each nation has responsibility for its own data
- Work to different timescales
- Collect data in different formats to different definitions

- Crisis leads to collaboration, but as the crisis fades diverging requirements take over...

Conclusions and next steps

The ideal team?

1

Statistical

Analysts who understand the data and what is being presented

2

Engineering

Data engineers build and maintain pipeline; Web developers build the tool

3

Digital

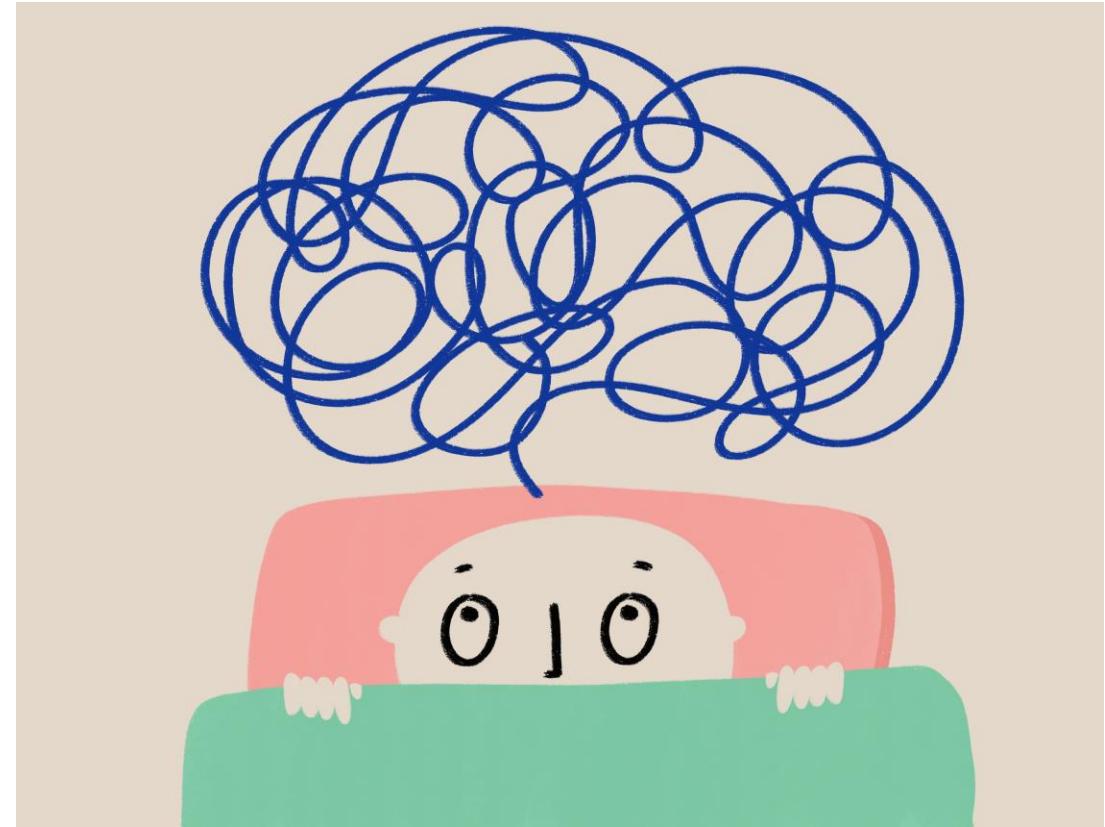
User researchers, content designers, product specialists make it work for users

The reality

Many government data products are built using only one or two of these domains of expertise

Data and digital skills are scarce in government for a variety of reasons

Need to be innovative in finding solutions to this



What's next?

- UKHSA have replaced the COVID dashboard with an all-purpose dashboard
 - <https://ukhsa-dashboard.data.gov.uk/>
 - More sustainable infrastructure
 - Working with routinely available data
 - Less pressured/crisis-driven development
- Within DHSC looking to build on lessons learned to present more user friendly data but hampered by lack of data infrastructure and resource
 - Watch this space for a new public health “dashboard” based on Fingertips <https://fingertips.phe.org.uk/>

Acknowledgements

Many people and organisations contributed to the service.

- Members of the Coronavirus dashboard team
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- Department of Health and Social Care
- National statistics organisations
- Devolved administrations
- Palantir
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- The public who engaged so enthusiastically and freely gave us so much feedback

Thank you

Questions?

