



**Dementias
Platform^{UK}**

DPUK Data Portal Annual Report 2022

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Welcome



Few things bring me more satisfaction than seeing a transformative scientific project come to maturity. Such is the case with the Dementias Platform UK Data Portal.

Due to the visionary foresight of Professor Ronan Lyons, the technical genius of Professor Simon Thompson, and the dedication of their team, the Data Portal has become a world-leading data repository. It has data discovery, access, and analysis capability for 60 cohorts with individual level data for 3.5m research participants.

In DPUK we approach the research environment as a data driven economy, where access to data at-scale and pace is critical to increasing opportunity and accelerating progress. The Data Portal has been central to realising these goals. A programme of curating data to research readiness, streamlining access procedures, making access free at point of use, and hosting user-led analytic capability, has enabled the Data Portal to support high-end science globally. Whether you live in Manchester or Malawi, all you need is an internet connection to test your ideas on some of the best data available.

I am most excited over our multi-cohort, multi-modal analysis capability. This is a world first and due in no small measure to the generous sharing of ideas and expertise between DPUK partners especially Swansea, Oxford, and Cardiff. By developing pre-processing pipelines, complex and sensitive data can be made accessible to specialists and generalists alike. An example is our image processing pipeline where imaging data are onboarded 'as is', curated to a common format (BIDS), and processed for image derived phenotypes; with each level of data being available on request.

There remains much work to do. Pipelines for epidemiologic data and imaging data have been established, and work is well underway for 'omics' data. Work is beginning on linkage to electronic health records and device data. We are also re-structuring our offer to specific research communities to enable them to have specialist hubs within the Data Portal. We anticipate machine learning will play an increasing role in all aspects of the Data Portal particularly in relation to the analysis of higher-order data.

The future of dementia research is collaborative. As you read this report, we invite you to consider how the Data Portal might support your research, and how we might improve it to better support your needs. We look forward to hearing from you.

A handwritten signature in black ink, appearing to be 'JG' followed by a stylized flourish.

Professor John Gallacher, PhD AFBPsS CPsychol FFPH
Director of DPUK



"It has been a really exciting year for the Data Portal and it has been wonderful to be part of such a dedicated and driven team. The successful acquisition of multimodal data for researcher access has created a rich repository for advanced data analysis and has resulted in an increase in applications for access to this data. I look forward to seeing the outputs of the work being undertaken with the data and how these results will shape dementias research in the future."

EMMA SQUIRES, DATA PORTAL MANAGER, DPUK

About the Data Portal



The Data Portal is a world-leading Trusted Research Environment (TRE) that researchers use to access data to find new ways of detecting, treating and preventing dementia. A focus for 2022 has been the acquisition and provisioning of imaging, genomics and proteomics data. Combined with existing epidemiologic data, this enables multimodal multi-cohort analysis to test realistically complex hypotheses. This has resulted in a growth in requests to access multimodal data; informing the development of the Data Portal to support the computationally heavy analysis of these large and complex datasets.

DPUK is developing ways to maximise the scientific value of the platform to increase the impact of MRC funding. We now offer specialist communities their own hub within the Data Portal. Hubs provide a focus for innovation and specialisation, increase data integration across modalities, and increase the persistence and sustainability of scientific assets.

The Data Portal is also exploring cutting-edge capabilities for federated data analysis, providing multiple options for data federation both within and across TREs.

Moving into 2023, the Data Portal will look to further develop our multimodal data offerings and further explore federation. Work will begin on facilitating linkage of cohort data with NHS digital data to create a more enriched data repository. A Research Hub has been developed to support researchers and will feature a specialised mentoring hub.

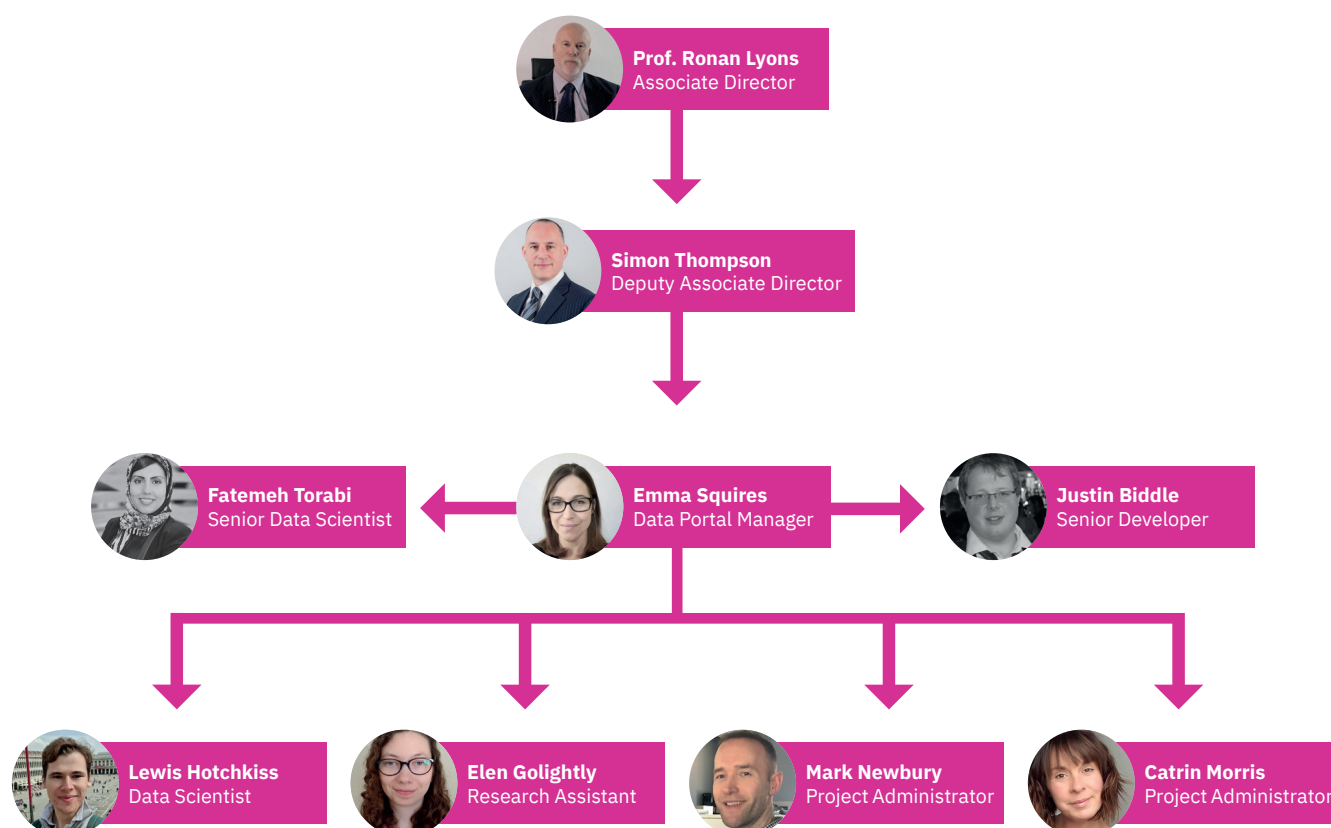
Swansea Data Portal team

The Informatics team in Swansea builds and maintains the Data Portal, and expanded during 2022 by welcoming three new staff members.

The team now has additional capacity to administer the portal, support applicants, and co-ordinate project applications. New reports and dashboards have been created to help streamline the application process.

Additional expertise in Neuroimaging has seen the creation of an infrastructure for advanced neuroimaging analysis.

The team now has additional expertise in machine learning, mathematical epidemiology and advanced computational methods. This has enhanced our ability to explore, analyse and harness health data. These skills will be a factor in developing DPUK's federated data analysis capabilities.



Oxford and Cardiff data portal teams

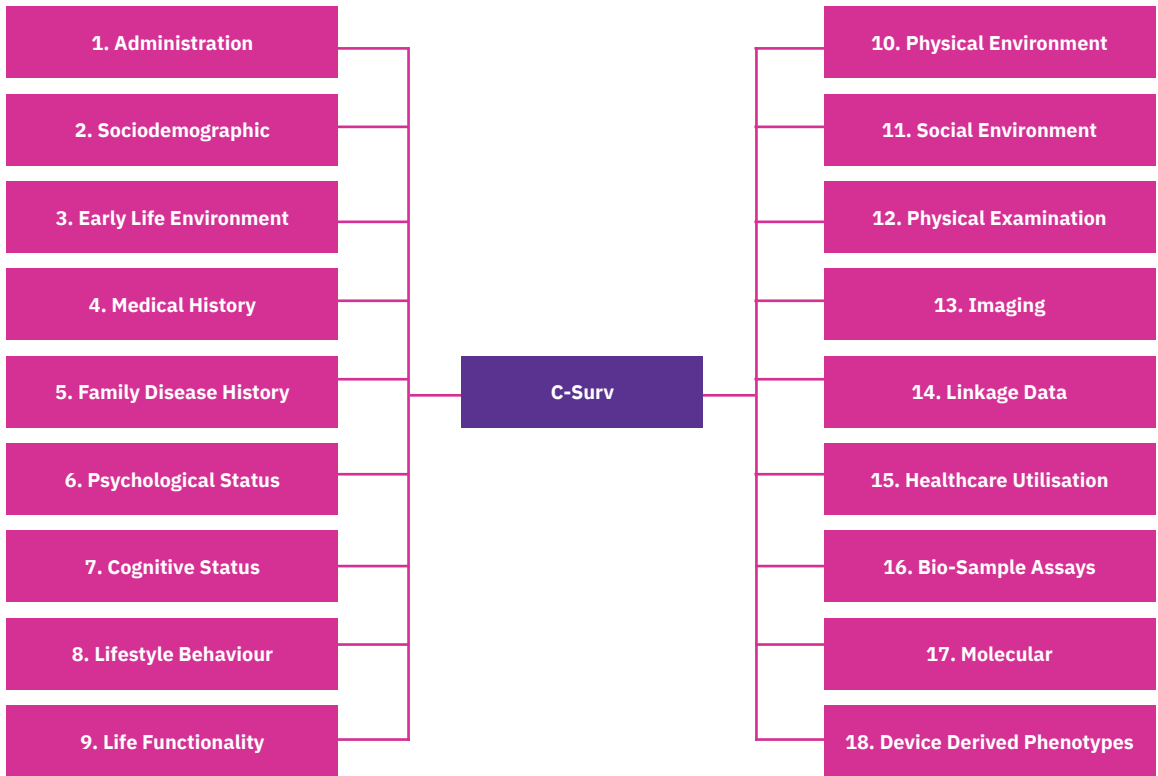
To prepare research-ready data for analysis and research-ready metadata for data discovery, data are curated to a common data model, by our Oxford Team using the C-Surv ontology. The C-Surv data model developed by DPUK Oxford, is optimised for data discovery and provides a 4-tier nested structure based on 18 data themes. Standardised variable naming conventions are applied to variables enabling comparability between cohorts. Using C-Surv obviates the need for repeated data curation by researchers and provides a common framework for developing our suite of data discovery tools including the Cohort Matrix, Cohort Directory, and Cohort Explorer.

DPUK’s data curation team in Oxford works closely with Swansea University’s data portal team to deliver standardised datasets for cohort owners and researchers.



Cardiff team

The Genomics pipeline is being developed by Professor Valentina Escott-Price (*top left*) who is working alongside Sarah Bauermeister (*top right*) in the development of Polygenic risk scores that can be applied across multiple datasets. This is in support of multi-modal multi-cohort analyses.



Data Portal Overview 2022

Use of the Data Portal increased in 2022 with 76 new project applications and 268 dataset access requests. Of these 76 projects, 51 requested access to multimodal data. Since the start of 2022, requests for multimodal data has more than doubled. Publications resulting from analyses completed using data within the data portal have increased to 14 this

year (see appendix 1). The top 3 cohorts requests in users' applications are Memento, BioFIND and Whitehall II. All of these cohort studies have provided multimodal data to the Data Portal for researcher access.



268

Dataset Access Requests



76

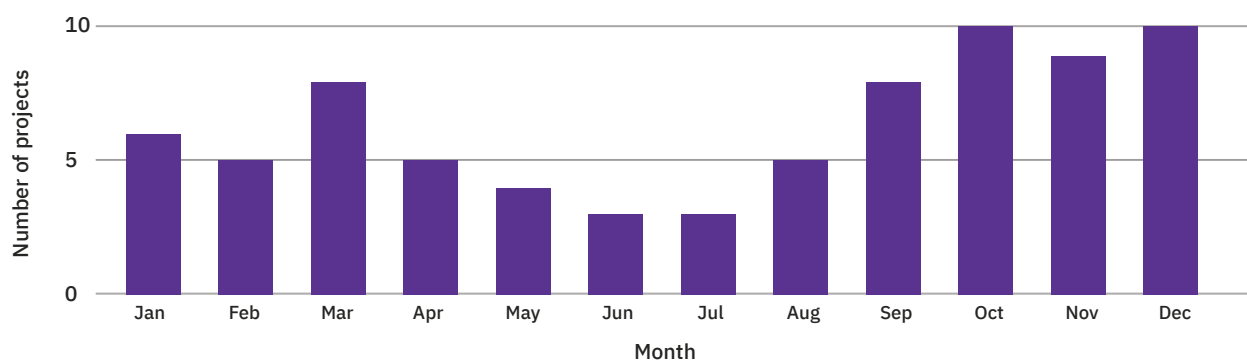
Project Applications



182

New users

Number of project applications by month



Publications using data portal



+14

Genomic datasets acquired



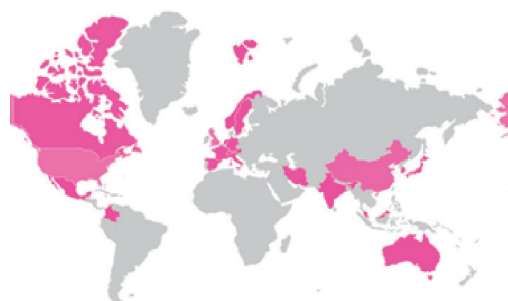
+6

Imaging datasets acquired

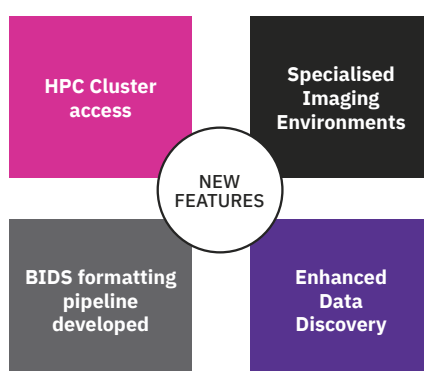
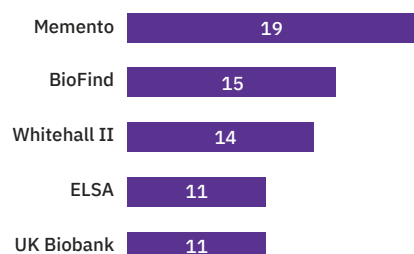


+12

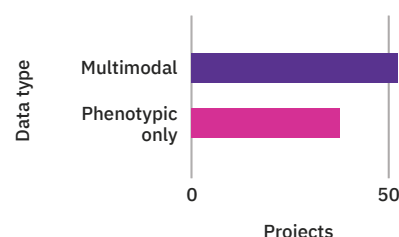
Data access requests by region



Top 5 dataset and number of requests



Number of applications by data type



DPUK Hubs

As a mature trusted research environment (TRE), DPUK has the ambition to establish and support start-up TREs, utilising its already established SeRPUK infrastructure.

The advantage of a new TRE being hosted inside an existing one is that identity can be maintained without the design and build being duplicated.

At DPUK this is achieved by providing each hub with its own identity (branding), web-presence, and hub-specific utilities, whilst making available the governance, data processing and data analysis pipelines that have already been developed in DPUK.

The advantages for new projects include

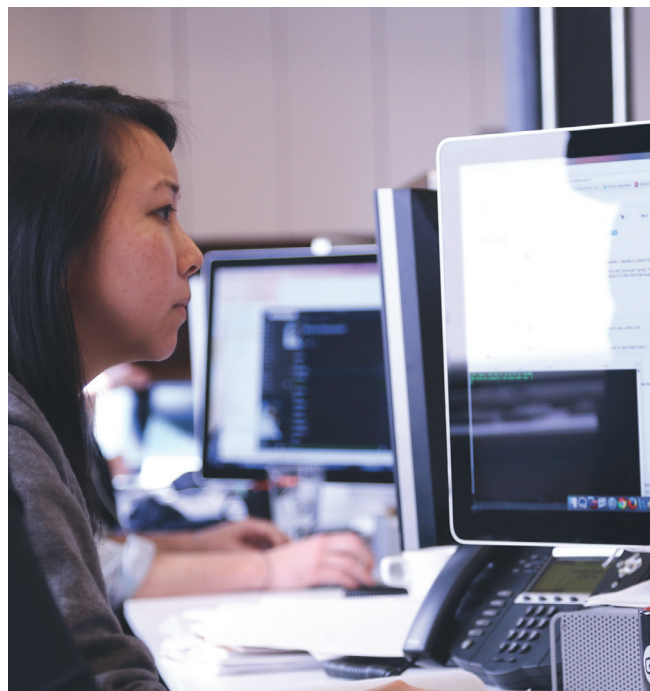
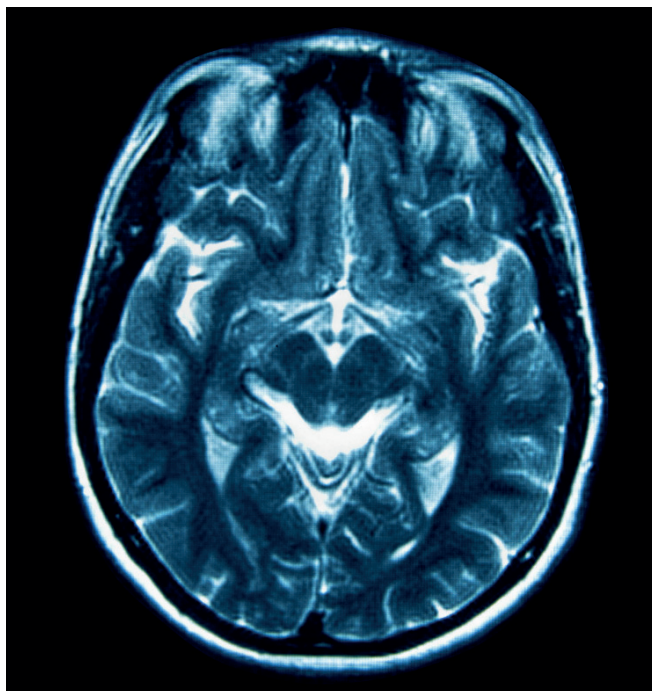
- Lower development risk
- Shorter development time
- Lower cost.

An imaging hub has been created at DPUK and it is developing hubs for genomics, the IPMAR Stem cell platform, and the UK Tissue Bank Network (UKTBN).

In addition, further hubs may be developed to support research in Parkinson's disease, traumatic brain injury, and motor neurone disease.



Imaging Hub



New raw imaging datasets

In 2022 DPUK acquired and can provide access to 12 new imaging datasets including:

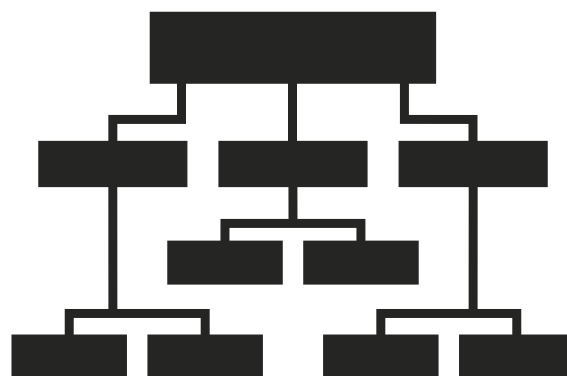
- **BioFIND**
- **Whitehall II**
- **Ample**
- **Nimrod**
- **Memento**
- **Imperial APC**

Full list: <https://portal.dementiasplatform.uk/AnalyseData/ImagingMatrix>

BIDS standardisation of Datasets

Variations in file structures, formats and labelling conventions across datasets are a barrier to multi-cohort analysis. These differences require repeated data pre-processing, hindering the development of automated analysis. In response to these challenges, imaging datasets are transformed into Brain Imaging Data Structure format.

BIDS standardises both structure and naming conventions for imaging datasets. This allows researchers to more easily identify the data type and variables across multiple datasets, and then develop standard code for their analysis. Each file comes with JSON sidecar files which include important metadata on image acquisition and machine set-up.



Imaging Discovery tool

Showing 19 cohorts

Cohort	Age Range	Participants	Controls	S-MRI - T1w	S-MRI - T2w	S-MRI - FLAIR	F-MRI - Rest	F-MRI - Task	D-MRI	MEG - Rest	MEG - Task	PET	Ultrasound	Data Insight report link
AMPLE	60-95	80	20	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	
BioFind	52-95	324	166	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	
CAM-Can	60+	0	700	✓	✓	✗	✓	✓	✗	✓	✓	✗	✗	
CHARIOT	60-85	225	225	✓	✗	✗	✓	✗	✗	✗	✗	✓	✗	
DPP	60+	24	0	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	
EPIC Norfolk	40+	67	67	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	
Gen_scot_imaging	18+	1500	1500	✓	✗	✗	✓	✗	✓	✗	✗	✗	✗	
GENFI	18+	129	129	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	
ICICLE-PD		318	99	✓	✗	✗	✓	✗	✓	✗	✗	✓	✗	
Imperial		351		✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	
Memento	60+	1997		✓	✓	✓	✓	✗	✗	✗	✗	✓	✗	
MRC NSHD	72-72	500	500	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓	

Text Search

S-MRI - T1w
All

S-MRI - T2w
All

S-MRI - FLAIR
All

F-MRI - Rest
All

MEG - Task
All

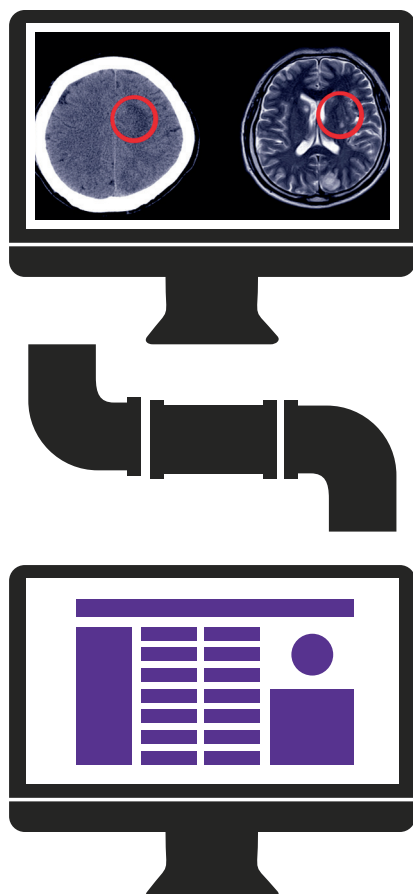
D-MRI
All

MEG - Rest
All

MEG - Task
All

PET
All

Clear filters



Imaging Pipelines

The DPUK Portal team in Swansea are developing state-of-the-art brain MRI analysis pipelines and work is already underway to adapt them for inclusion as imaging data within DPUK. These pipelines will automate image quality control. Image-derived phenotypes will be generated.

IDPs enable the integration of imaging with data from other modalities in order to allow researchers to test complex multi-modal hypotheses.

As part of a collaborative initiative, the Image Processing team in Oxford is adapting state-of-the-art brain MRI analysis pipelines, including the UK Biobank imaging pipeline, to the imaging data in DPUK. This involves actively collaborating with the UK Biobank pipeline developers to adapt it to work with the Brain Imaging Data Structure format. Automated quality control (QC) software has been developed and tested on pilot datasets to provide quality metrics for structural MRI scans as well as generate dataset-specific features that could be used for data harmonisation.

Imaging Hub



Specialised Imaging Environments

To enable advanced imaging analyses within the Data Portal, DPUK has created specialised imaging environments.

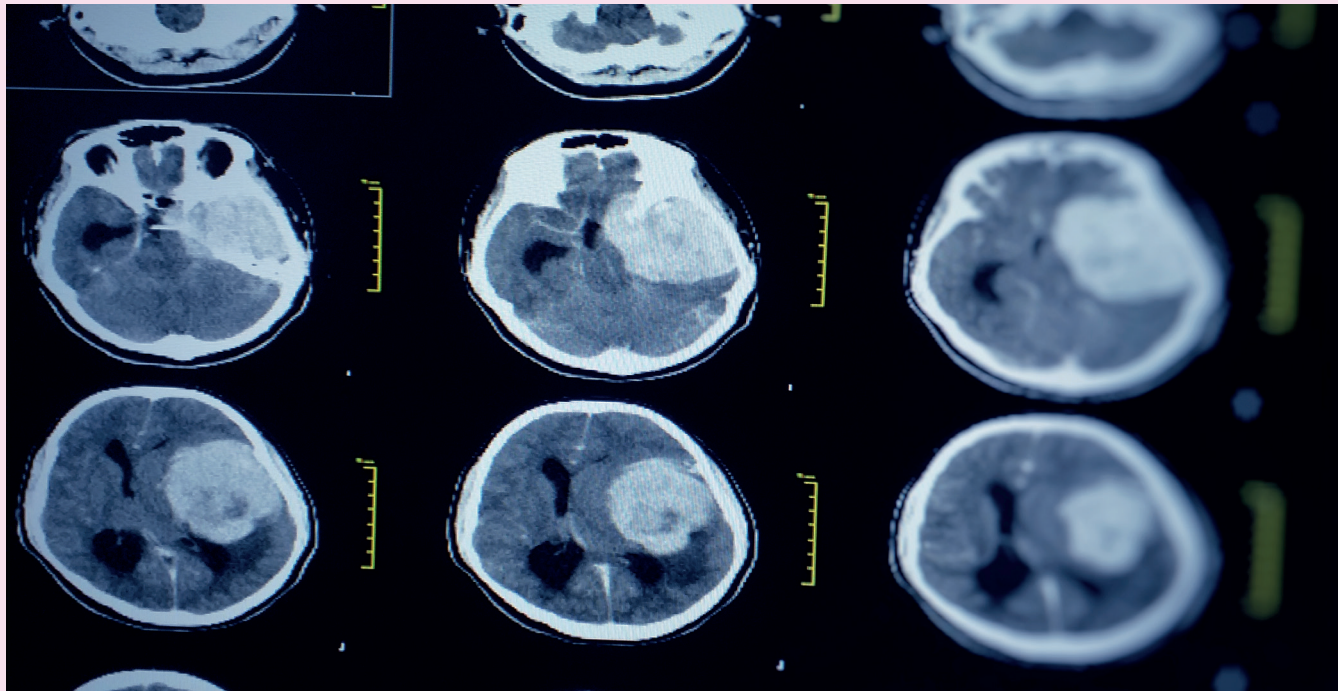
Researchers can now choose between Windows and Linux virtual machines. These machines come pre-installed with imaging software including Matlab, Fressurfer, OSL, FSL, Python and newly released Jupyter Hub. To facilitate collaboration, projects may be organised according to consortium membership; enabling all researchers on a project to access a shared environment.



Advanced Infrastructure

DPUKs underlying infrastructure is provided by SeRPUK, who have worked with DPUK to develop a more robust and enhanced imaging storage and compute system. The new infrastructure incorporates S3 buckets to create an imaging data lake. This allows DPUK to store data more efficiently; allowing more researchers to access larger quantities of imaging data without causing congestion. Implementation of Jupyter Hub will also provide more advance compute options for researchers.

Spotlight



AI & ML in neuroimaging

The data imaging hub has enabled Swansea University researcher Lewis Hotchkiss to begin an investigation into the effects of

mental health disorders on the brain and their possible associations with dementia.

By identifying regions of the brain associated with depression, we can gain insight into underlying factors causing depression which could offer novel targets for treatments.

The study uses the Memento dataset within the DPUK data portal. It is a large dataset with a total of 2,323 participants. The huge scale of the data available makes it possible to apply complex machine learning from image-derived phenotypes.

The research is training a decision-tree classification model from phenotypes derived from images in the cohort using an extreme gradient boosted classifier.

The most important features used by the decision-tree in reaching its conclusions will allow the process to be used in biomarker discovery.



Imaging Dementia Networks from Resting State MEG with Advanced Machine Learning Techniques

This study explored electrophysiological features from MEG resting states that are unique to Alzheimer's disease and those with cognitive impairment compared to the normal population. These features have been used to train machine learning algorithms to classify the cognitively impaired subjects from the healthy ones. The team were interested in spectral and connectivity features and identifying useful biomarkers of Alzheimer's.

"The DPUK Data Portal has been easy to access and use" according to Professor Sheraz Khan at Harvard Medical School.

"Without the comprehensive DPUK Data Portal our study could not have been undertaken. The BIOFIND database has been critical for our study and includes structural MRI, MEG resting state recordings, memory assessment (MMSE scores: mini-mental state examination), and other useful demographical information. Ultimately, our findings are more trustworthy as they are drawn from the 320+ subjects in the database".

The team report that the DPUK portal is one of the largest in the field making it possible for researchers to discover useful features that will ultimately help the early detection of mild cognitive impairment (MCI) cases.

Genomics Hub



New Genomic datasets

Over 2022, DPUK has acquired and are able to provide access to 6 new Genomic datasets :

- **ELSA Genomics**
- **Airwave**
- **Memento**
- **DFP**
- **GSA**
- **Gerad**

In collaboration with Valentina Escott-Price in Cardiff and Sarah Bauermeister in Oxford, work is underway to develop pipelines for integrating complex genomics datasets. These pipelines will be available in early 2023. Combining genetic data from different studies is important due to the increase in power this provides. However, this presents an extra challenge because of the differences in genotyping arrays and the lack of overlapping variants.

Within the DPUK platform genome-wide data from 6 studies has been curated and harmonized:

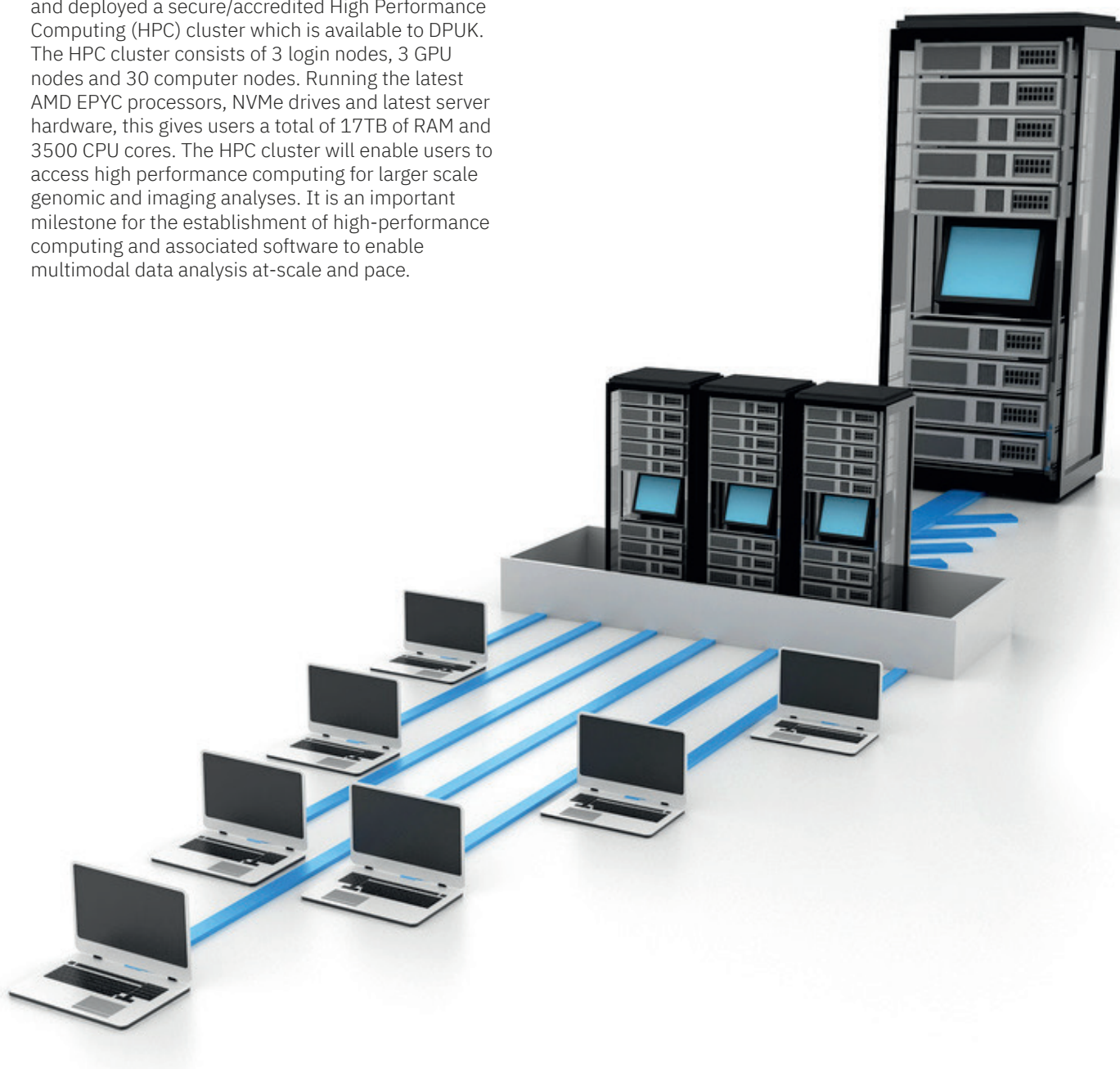
- **Brains for Dementia Research**
- **EPIC Norfolk**
- **Generation of Scotland**
- **Airwave-chip 1**
- **Airwave-chip 2 - 2 cohorts**
- **MRC National Survey of Health Development (NSHD)**

A pipeline was created that performs rigorous quality-control (QC) analysis and imputes genetic variance with the 1000 Genome reference panel, using the minimac algorithm. In addition, standard pruning and thresholding Polygenic Risk Score (PRS) have been generated with 5 summary statistics related to neurodegenerative diseases (clinical AD, clinical/proxy AD, FTD, ALS, PD) for all 6 studies separately and for the combined dataset.

Research-ready imputed genetic data that have undergone QC and the PRS - based upon the latest neurodegenerative GWAS - are available for the 6 cohorts separately, and for the combined dataset of 60,670 individuals.

HPC Cluster Access

UKSeRP (our TRE platform) has procured, installed and deployed a secure/accredited High Performance Computing (HPC) cluster which is available to DPUK. The HPC cluster consists of 3 login nodes, 3 GPU nodes and 30 computer nodes. Running the latest AMD EPYC processors, NVMe drives and latest server hardware, this gives users a total of 17TB of RAM and 3500 CPU cores. The HPC cluster will enable users to access high performance computing for larger scale genomic and imaging analyses. It is an important milestone for the establishment of high-performance computing and associated software to enable multimodal data analysis at-scale and pace.



Welcome to the Data Portal

The DPUK Data Portal brings together records of over 3 million people in a **free-to-access** resource.

Researchers can identify which cohorts are relevant to them, apply for access to the data and then analyse it in a secure, remote environment complete with data linkage and analysis packages.

Explore Cohorts

Apply for Cohort Data Access

DISCOVER

Use the Cohort Matrix to quickly discover the cohort studies which collect the data that you need.

Search the Cohort Directory to get more detailed information on the data that interests you and compare the cohorts side-by-side.

ACCESS

Apply for access to data from different cohort studies in a **single application**.

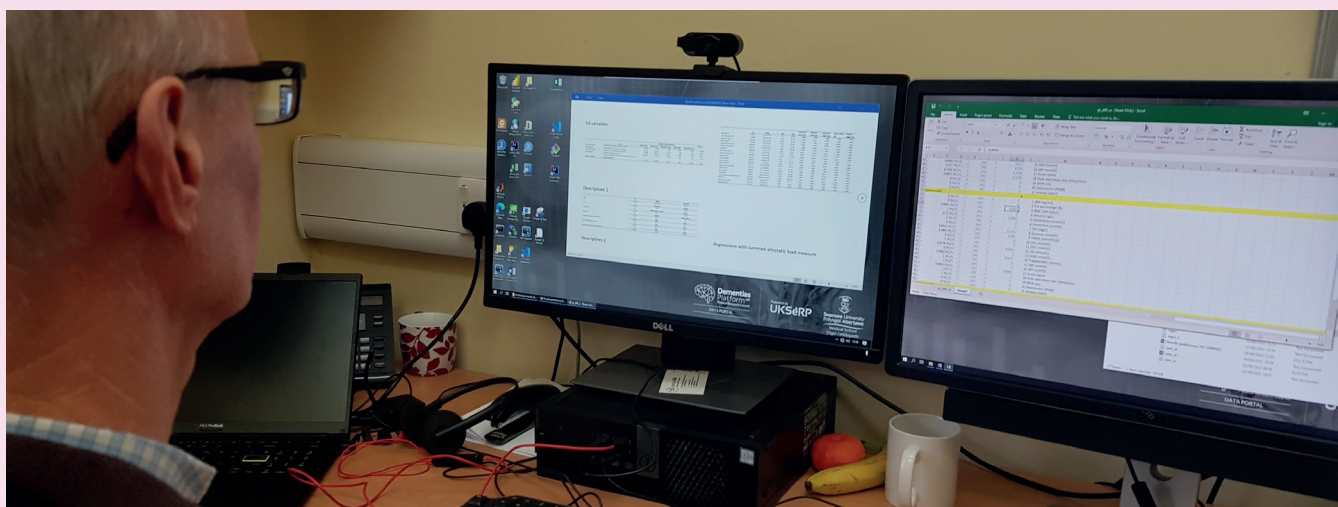
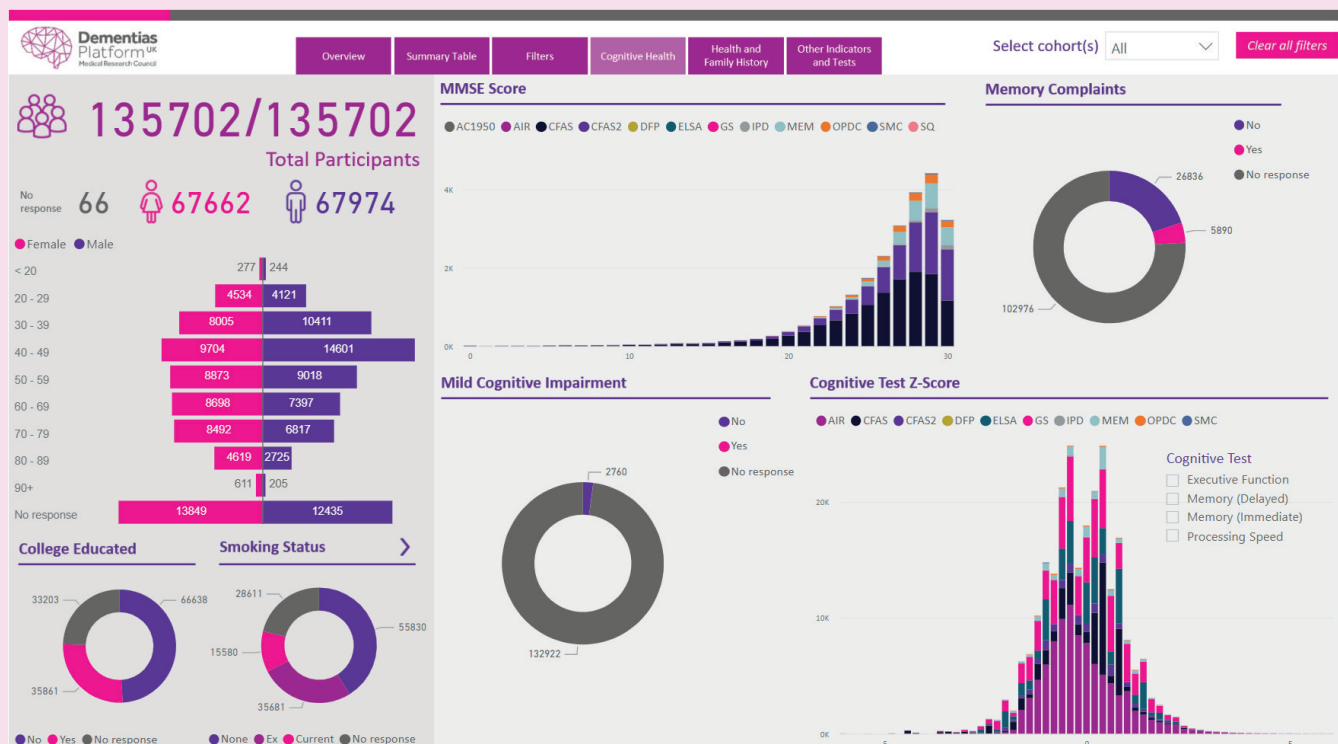
Receive a response to your data application in a target of 28 days and access data online in a target of 90 days if your application is approved.

ANALYSE

Work with cohort data in the Data Portal's secure analysis area - accessible anywhere with an internet connection.

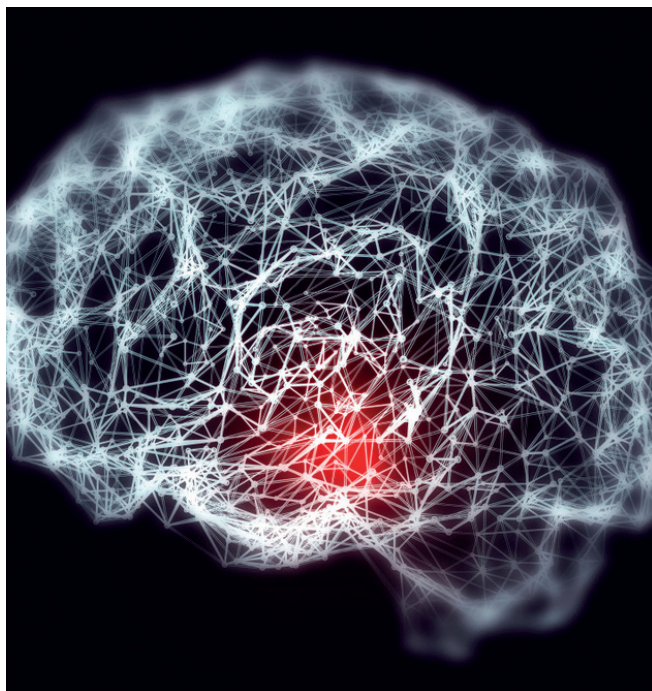
Process and analyse large datasets on DPUK servers at no cost to you or your institution.

> [Analysis Environment](#)



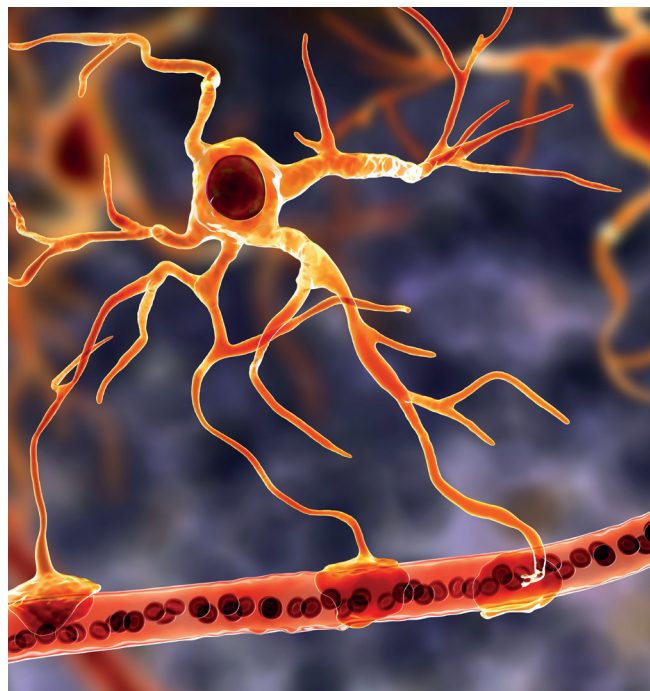
The Data Portal is a secure Trusted Research Environment (TRE) with over 60 data sets and data on over 3.5 million individuals.

UKNTNB Hub



The UK Neurological Tissue Bank Network (UKNTBN) is an initiative to establish a coordinated national network of UK brain tissue resources (banks) for researchers to use. The banks store post-mortem brain and central nervous system (CNS) tissue donated by the public for diagnosis and research into disorders. Data associated with the biological samples collected by the network will be stored and managed within the DPUK Data Portal. Researchers will be able to apply for access to the tissue samples and the data about the donors, and can access the data within the Data Portal.

IPMAR HUB



The iPSC Platform to Model Alzheimer's Disease Risk (IPMAR) project aims to create and validate up to 60 human-derived iPSC lines for generating models with high and low polygenic risk for Alzheimer's. The cell lines generated, and associated data, will be hosted on the DPUK Data Portal. Researchers will be able to apply to the European Bank for Induced Pluripotent Stem Cells (EBiSC) to select relevant lines created from IPMAR and enrich their studies.

Multimodal research



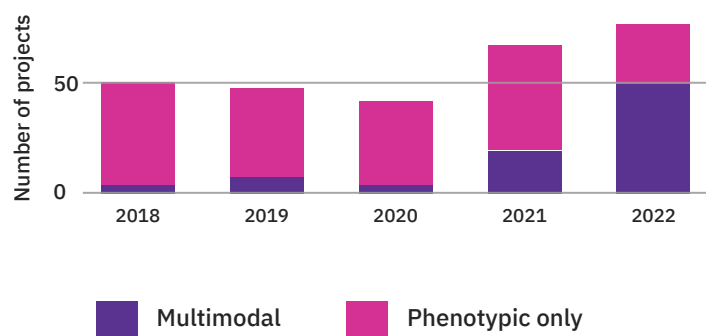
The focus during DPUK's first phase brought together phenotypic data in the dementia landscape, enabling researchers to carry out analysis using multiple datasets. The programme was extremely successful. 50 datasets were acquired and over 150 projects undertaken using the data.

A major focus for DPUK Phase 2 is to further enhance the data: bringing together phenotypic data from these cohort studies with raw imaging, genomic and biological samples collected by these studies. This will allow researchers to conduct multimodal analyses across different resources, creating deeper and more informed analyses and providing the participant numbers required for advanced analysis techniques such as Machine Learning (ML) and Artificial Intelligence (AI).

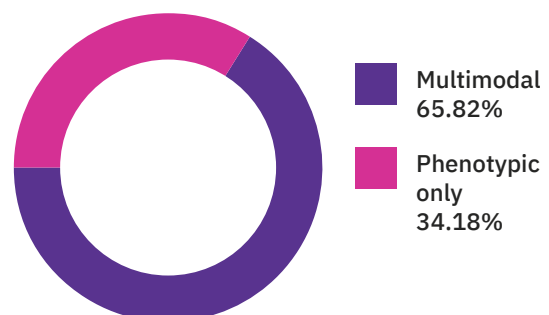
This is an ambitious task and each additional resource comes with significant challenges. Work undertaken during 2022 included:

- **Increasing storage and analysis capabilities for large datasets**
- **Defining governance processes**
- **Developing discovery tools and application processes**
- **Creating data tailored standardisation/curation methods**
- **Work with data providers to ensure that the data remains safe and secure within our SeRP Iso27001 and DEA accredited infrastructure**

Access Requests by Year



Data Access Requests by Data Type



Data Federation



DPUK has explored approaches which provide federated access to data across global repositories. Working with the US based Alzheimer's Disease Data Initiative (ADDI), data held within DPUK have been configured to allow federated analysis with other global datasets available through ADDI's workbench.

Funding has been secured from ADDI to further develop the platform and to enable more datasets to be available.

DPUK are also exploring a Privacy Enabling Technology (PET) platform which will provide a different method of enabling federated analysis across repositories.

Work is underway to create a pop-up TRE between DPUK and Dementias Platform Australia (DPAU) which will provide an intermediate TRE. This will overlap both country TRE's allowing data to be accessed for federated analysis. The Pop-up TRE will be used to run imaging pipelines developed by DPAU across datasets in both organisation's TREs.

Researcher Support



DPUK is committed to optimising use of its resources and the Data Portal supported two academies and a 5-day researcher Datathon training event in 2022.

Run by DPUK Senior Data Scientist, Dr Sarah Bauermeister, they give participants core skills needed to use the multi-faceted platform.

- DPUK Spring Academy focused on providing training for beginners in data analysis
- DPUK Autumn academy which provided a more in-depth programme aimed advanced data analysis techniques using longitudinal health research cohorts
- Run over 5 days, our Datathon enables researchers to collaborate in groups and work on 6 cohorts. Each Datathon presents a themed research question and mentoring is provided throughout the week before culminating in a presentation. In 2022, the Memento Datathon was run by the University of Bordeaux. Using data from Memory Clinic patients, imaging data and neuropsychological tests researchers focused on predicting loss of autonomy.

For each training event, remote virtual environments were created for every participant. All their analysis was undertaken within the Data Portal, allowing researchers to access data in a controlled environment.

Plans for 2023



Multimodal Data

Convert all raw imaging datasets to BIDS, enhance discovery of genomic data, and support integration of genomic processing pipelines.



DPUK Hubs

Support disease specific data repositories and tissue platforms by providing hubs within DPUK.



Researcher Hub

Incorporating a mentoring hub, user forum, project explorer and enhanced data discovery tools.



Federation

Enable data to be brought together across global repositories via federated solutions.



NHS Digital Linkage

Exploring opportunities and strategies to enhance cohort data collections by linking with NHS digital data.

Selected Publications

Jönsson, L., Tate, A., Frisell, O. and Wimo, A., 2022. The Costs of Dementia in Europe: An Updated Review and Meta-analysis. *PharmacoEconomics*, pp.1-17.

Ackley, S.F., Calmasini, C., Swinnerton, K.N., Bouteloup, V., Chêne, G., Dufouil, C. and Glymour, M.M., 2022. The Added Value of Global Amyloid Burden in Predicting Cognition in the MEMENTO Cohort. *Alzheimer's & Dementia*, 18, p.e063459.

Bauermeister, S., Bauermeister, J.R., Bridgman, R., Felici, C., Newbury, M., North, L., Orton, C., Squires, E., Thompson, S., Young, S. and Gallacher, J.E., 2023. ready data: the C-Surv data model. *European Journal of Epidemiology*, pp.1-9.

Buerger, T., Steinfeldt, J., Ruyoga, G., Pietzner, M., Bizzarri, D., Vojinovic, D., Upmeyer zu Belzen, J., Looch, L., Kittner, P., Christmann, L. and Hollmann, N., 2022. Metabolomic profiles predict individual multidisease outcomes. *Nature Medicine*, 28(11), pp.2309-2320.

Tsang, R.S., Gallacher, J.E. and Bauermeister, S., 2022. The long arm of childhood socioeconomic deprivation on mid-to later-life cognitive trajectories: A cross-cohort analysis. *Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring*, 14(1), p.e12322.

Sinclair, L.I., Ball, H.A., Bauermeister, S., Gallacher, J.E. and Bolea-Alamanac, B.M., 2022. Recurrent depression has persistent effects on cognition but this does not appear to be mediated by neuroinflammation. *Journal of Affective Disorders*, 306, pp.232-239.

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Mank, A., Rijnhart, J.J., van Maurik, I.S., Jönsson, L., Handels, R., Bakker, E.D., Teunissen, C.E., van Berckel, B.N., van Harten, A.C., Berkhof, J. and van der Flier, W.M., 2022. A longitudinal study on quality of life along the spectrum of Alzheimer's disease. *Alzheimer's Research & Therapy*, 14(1), pp.1-10.

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