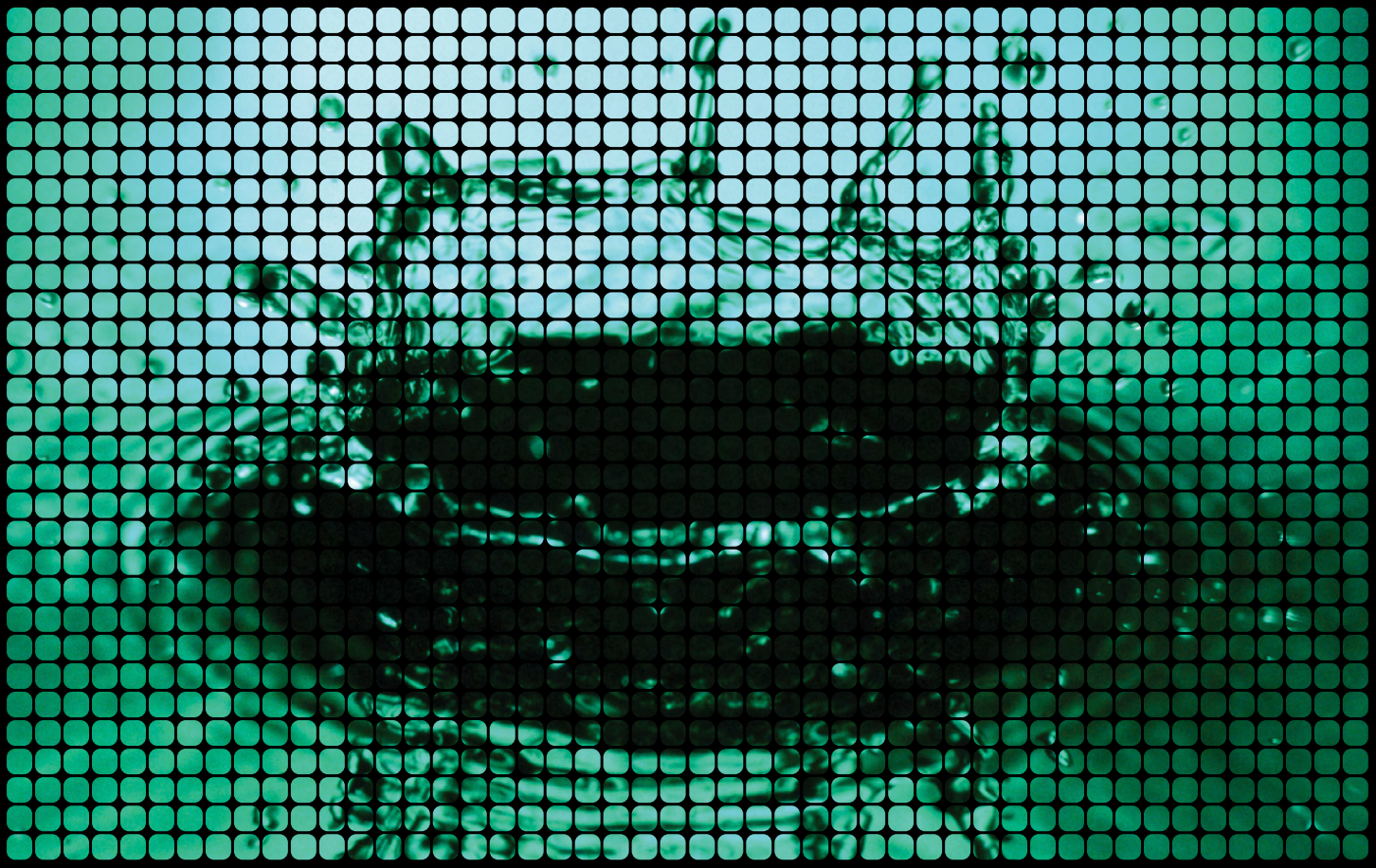

Digital Research Reports

The Diversity of UK Research and Knowledge

Analyses from the REF impact case studies

Jonathan Adams, Tamar Loach and Martin Szomszor

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DIGITAL science

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The diversity of UK research and knowledge

Research has many outcomes. New information from UK case studies of research impact tell us about the spread and diversity of those outcomes. In this report, we show innovative visualisations of the networks among the case studies and the underlying research.

Research creates huge benefits for wealth creation and for the quality of life. Governments invest in research because they are confident that it underpins economic competitiveness. It delivers knowledge that leads to innovation in processes and products, and enriches an environment in which people develop competencies and skills of wide value.

Until now our tools for assessing the context and value of research outcomes have been limited to just the academic aspects. Most performance indicators focused on publications, particularly citations to journal articles. This told us about the value of research to researchers but little about social, economic and cultural value, nor about how value was achieved.

REF2014 included a total of 6,975 case studies submitted by 154 universities and colleges and grouped into 36 disciplinary units of assessment (UOAs1) in four overarching subject panels: A, life sciences (green); B, engineering and physical sciences (red); C, social sciences (blue); and D, arts and humanities (yellow). Each study included underpinning research, details of the impact itself and corroborative materials. Expert panels assessed the case studies, judging their 'reach and significance'.

Text mining of case studies pulls out frequently used words and highlights common clusters and patterns. A rich and diverse picture emerges with no apparent limitation on what part of society or the economy any particular discipline might impact. It is not just the applied sciences and engineering subjects that contribute: most case studies cross research areas and deliver multiple types of impact.

In the interactive online version of the network on this page – which visualises case study content to show clusters with a higher degree of similarity – the user can access the specific case studies in each cluster directly on the REF website. The text of each case study contains links to people, institutions and disciplines; information about beneficiaries; and references to when research took place and where impact was realised.

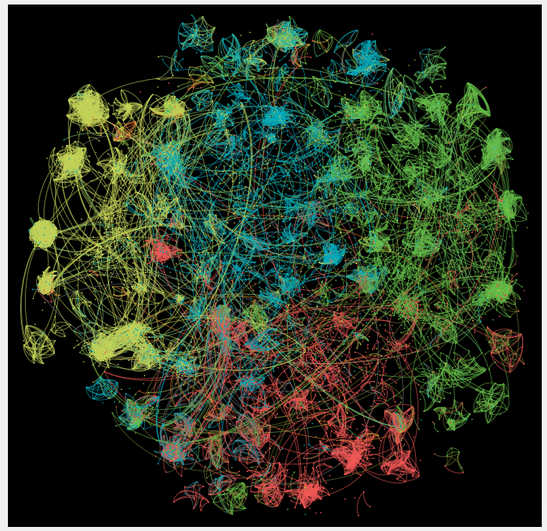


FIG 1. This network of the REF impact case studies draws on an analysis of text similarity in the case study research sections. Colours indicate main REF panels, e.g. the red cluster among the yellows are studies about public outreach in science. An interactive version is accessible at www.digital-science.com/visualizations/ref-case-study-similarity-network

The 2014 Research Excellence Framework (REF2014) was the first attempt in the world to gather information on publicly funded research with socioeconomic impact. It did so by asking researchers to produce case studies linking their research to subsequent impact achieved in other sectors. These case studies are now available for further analysis and a report produced jointly with the Policy Institute at King's College London (2015) has described a great deal of background.

There are 365 case studies that refer to mental health, of which 98 (27%) were submitted in UOA4 (Psychology, Psychiatry and Neuroscience) with a spread around other health UOAs. Significant numbers in UOA22 Social Work and in UOA29 English Language & Literature reflect other contexts in which mental health can be a research focus. There are 424 case studies that refer to climate change, with 74 in UOA17 Geography & Environmental Studies and 58 in UOA7 Earth Systems & Environmental Sciences. Climate research case studies occur everywhere except UOA26 (Exercise Sciences, Leisure and Tourism.)

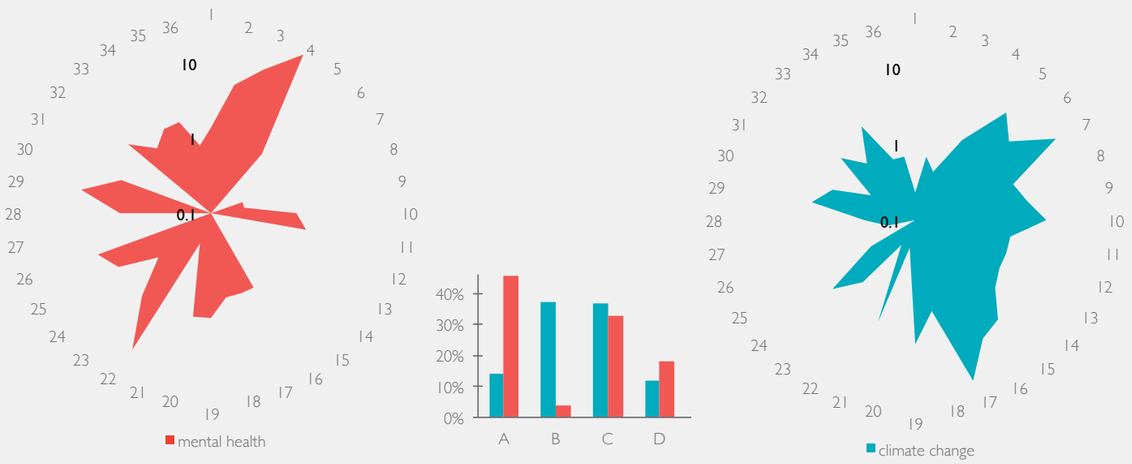


FIG 2. UOA research profiles for topics of policy interest: 'mental health' and 'climate change'.

UK research assessment usually focuses on a short census period, but for case studies the time frame for supporting evidence and publication references was taken from 1993 to 2013. This reflects early work that showed that it can take much time for innovative research to mature into tangible impact (see Griliches:1986 and Mansfield:1990). Case study references have publication dates that are skewed to recent years. More than half fell into the REF2014 census period back to just 2008. The data contain many spurious dates, but after cleaning and adding trackable DOIs – not all references are to journal articles – the representative dataset will allow further exploration of this supporting evidence and a comparative analysis with other REF submissions.

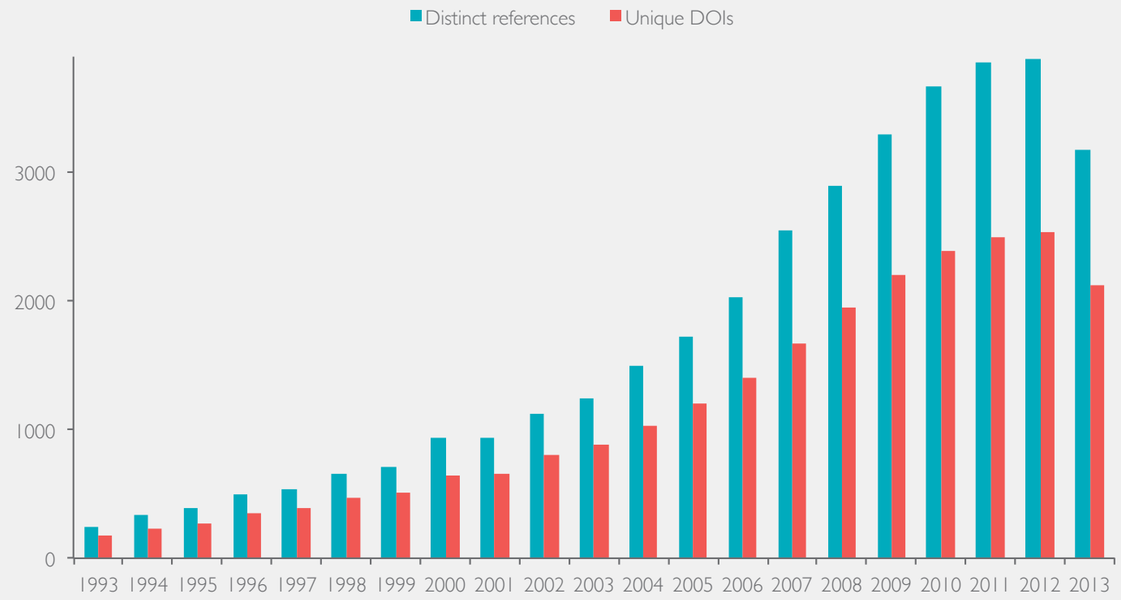


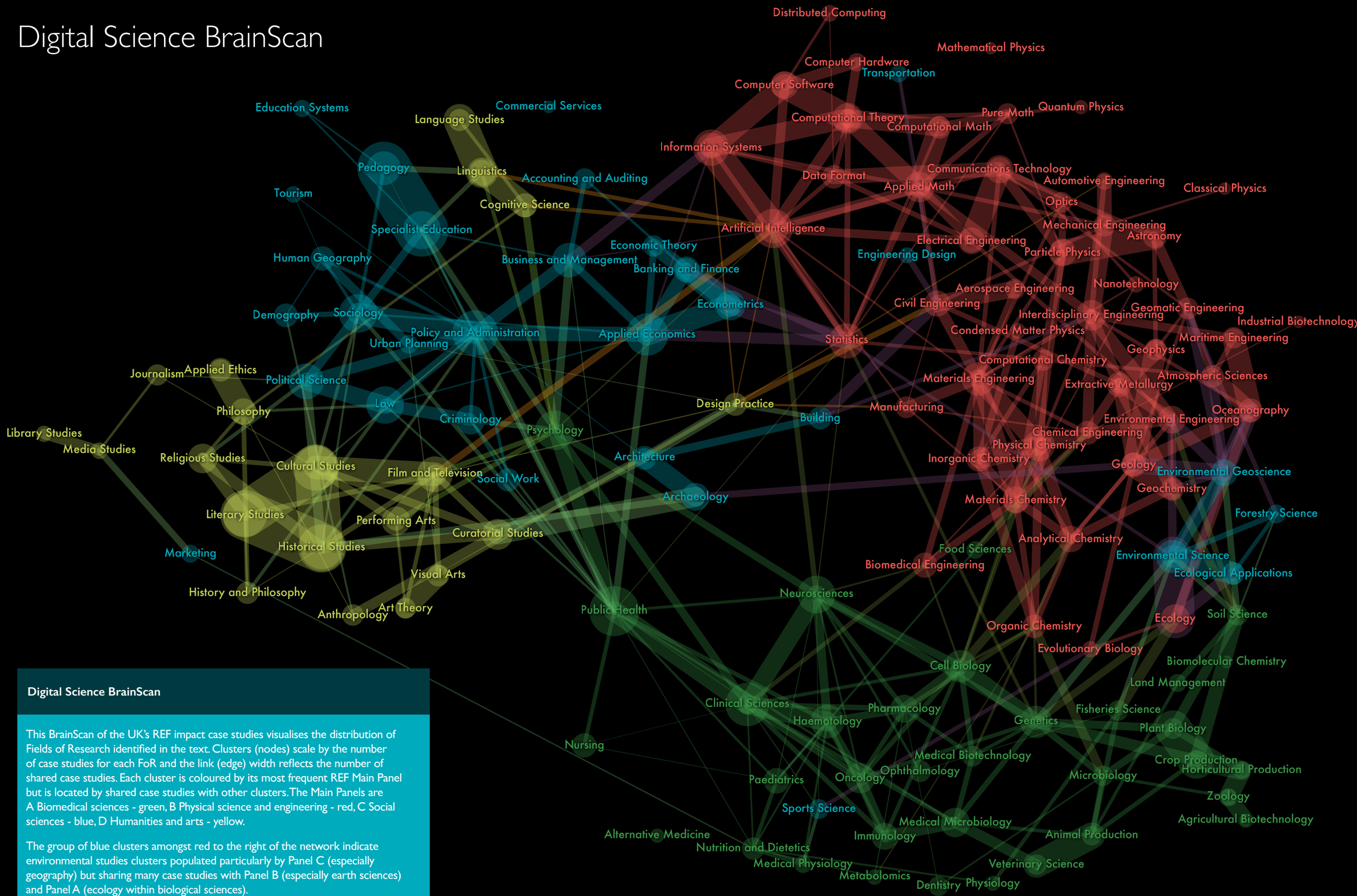
FIG 3. Time-based spread of case study references: total references and articles with DOIs

Figure 1 visualised similarity between case studies. We can also picture the knowledge structure of the UK research that delivers this impact (two-page spread on next pages).

In REF2014 case studies are grouped into four main panels and 36 UOAs but these reflect University structures, not underlying research. To explore the network of research links across these structures we analysed the text used by researchers to describe the research background to their case study. We then categorized that content in terms of the Fields of Research (FoRs) in the Australia-New Zealand Standard Research Classification, which hierarchically assigns research to 22 Divisions and 157 Groups. Each case study was assigned up to three FoRs.

The Digital Science BrainScan is the outcome of this analysis. In the network graphic on the next two pages, each circle is an FoR, scaled by the number of case studies it captures. FoRs are linked where they have case studies in common. The colours identify the four main panels. This picture immediately shows the degree to which most UK research projects are innately interdisciplinary. The links (edges) between the brain-cells (nodes) are a nerve network sparking the flow of national knowledge.

Digital Science BrainScan



Digital Science BrainScan

This BrainScan of the UK's REF impact case studies visualises the distribution of Fields of Research identified in the text. Clusters (nodes) scale by the number of case studies for each FoR and the link (edge) width reflects the number of shared case studies. Each cluster is coloured by its most frequent REF Main Panel but is located by shared case studies with other clusters. The Main Panels are A Biomedical sciences - green, B Physical science and engineering - red, C Social sciences - blue, D Humanities and arts - yellow.

The group of blue clusters amongst red to the right of the network indicate environmental studies clusters populated particularly by Panel C (especially geography) but sharing many case studies with Panel B (especially earth sciences) and Panel A (ecology within biological sciences).

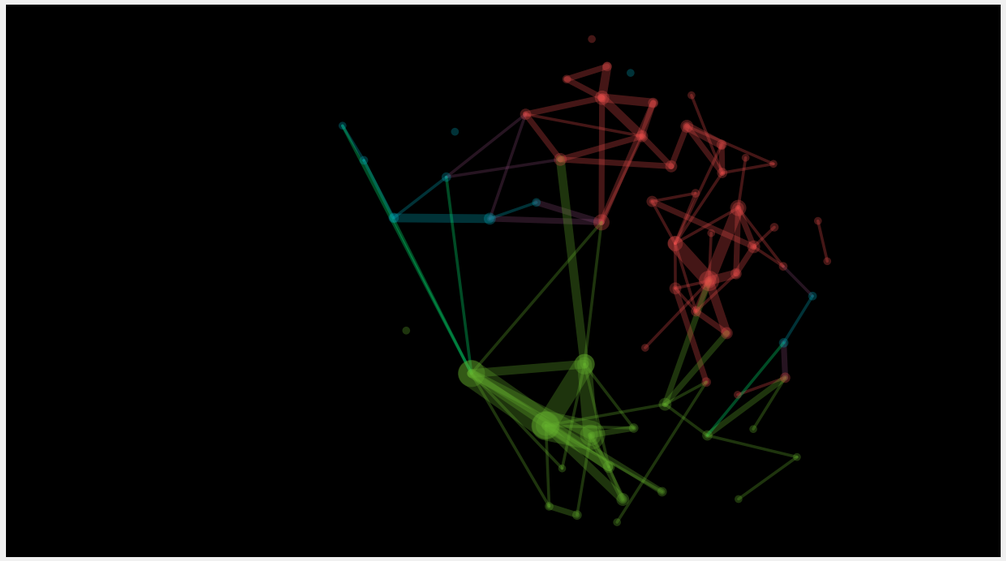
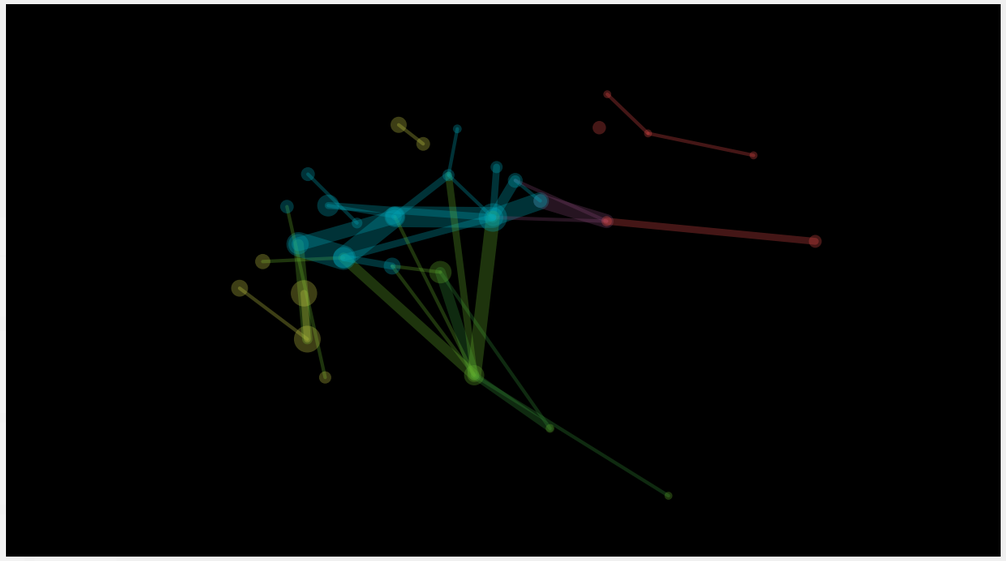


FIG 5. BrainScan for Imperial College

The BrainScans for two world-leading institutions demonstrate the contrasts and complementarity in their research portfolios. Imperial College London is *the* College of Science, Technology and Medicine. Its Digital Science BrainScan is grounded in the physical and technological sciences of REF Panel B (red) and in the clinical and biomedical sciences of Panel A. The more applied biological subjects – fisheries and crops – sit near the interface. Environmental sciences/ studies emphasise the cross-over to Panel C. The London School of Economics has a global reputation for social and economic sciences which is captured in the primary focus around Panel C fields. However, its underlying research interests extend into all other panels. The two BrainScans together show both the different focus of the two institutions and the diverse range of research that develops from their core academic departments.

FIG 6. BrainScan for London School of Economics



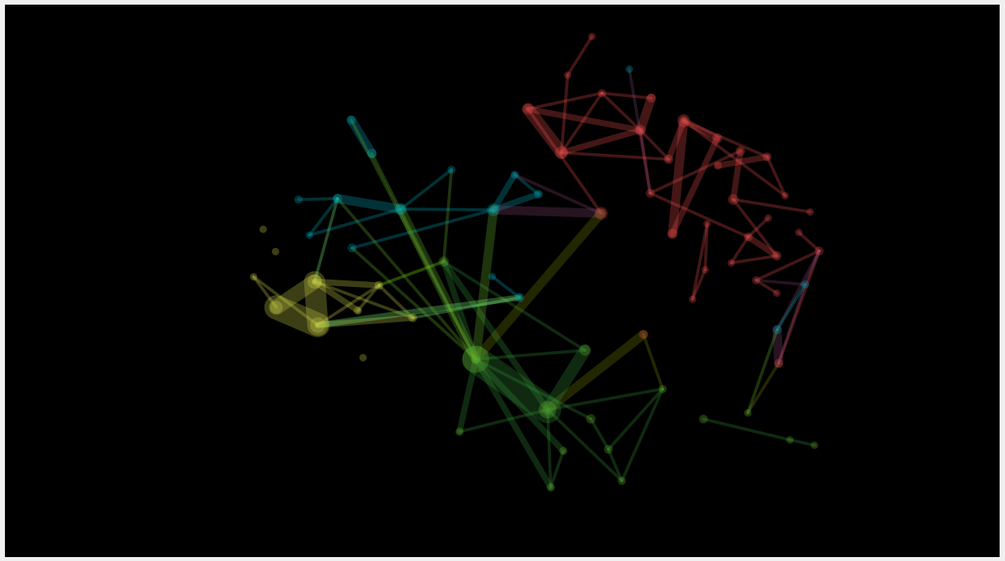
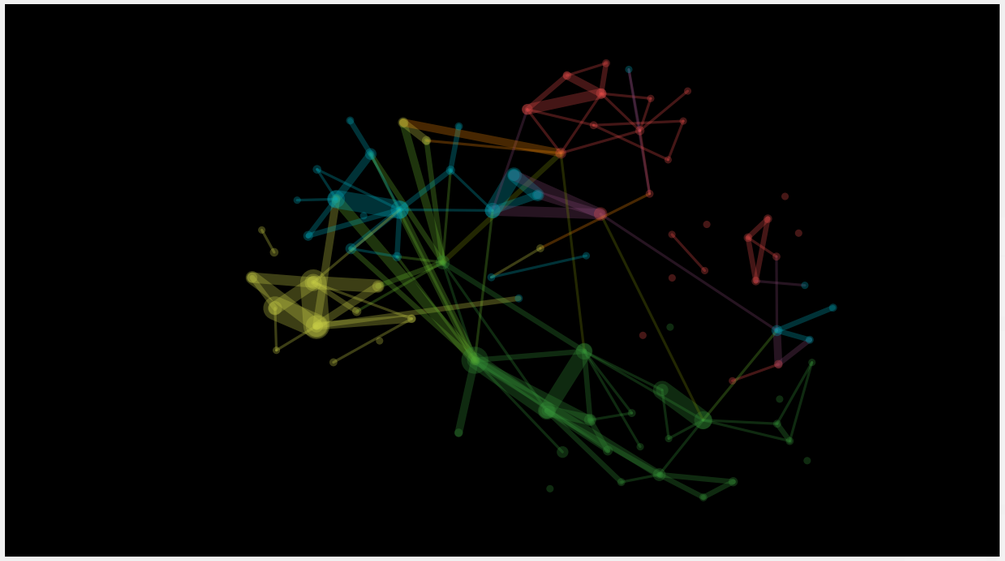


FIG 7. BrainScan for University of Southampton

The BrainScans on this page capture two large, well established civic research universities, members of the Russell Group, with a global reputation and a long research history. Edinburgh was founded in 1583. Southampton was founded in the 19th century and became a University College of London and a fully fledged independent university in 1952. They both have a diverse complement of research activity across all four panel areas and both have large medical schools, but they are by no means the same. Edinburgh submitted 227 case studies, almost twice Southampton's 123. That is reflected in the difference in density and the size of nodes. The BrainScan picks out Southampton's strengths in computing and Edinburgh's strengths in earth sciences and environment. It also shows stronger links between the same areas in one scan compared to the other.

FIG 8. BrainScan for the University of Edinburgh



Discussion

The simple graphics in this report reveal the breadth and scale of UK research, but they are just a very light skim from the incredibly rich range of information that is now available – and while they provide some interesting new descriptions of the spread of research that delivers impact they hardly touch on the key content around 'impact' itself.

Key policy topics – we looked at mental health and climate change – are supported by research drawn from a very wide diversity of main disciplines – in our examples almost every UOA contributed input. This is excellent evidence to counter the view that only a few key disciplines are required to solve the grand challenges. Major problems really do benefit from multiple perspectives.

The time spread of the references attached to the case studies is a little odd, because it is so skewed and so recent, and it will need further analysis. There may be a tendency to refer preferentially to more recent research output that explored earlier findings and delivered the key results that enabled the main impact described by the case study. However, it is unfortunate that most case studies do not provide a fuller audit trail that describes that research pathway more clearly (some individual case studies did provide a staged series).

The benefits of UK-sourced research are felt across the entire globe. The depth of the impact is unclear and, like the time spread for search, more detailed evidence would support a better audit. But the volume of data pointing to this spread of benefit is unquestionable. The UK is an excellent world-citizen and research investment brings a range of return benefits through contact, information and influence.

The Digital Science UK BrainScan is a powerful visualisation of both the diversity and the interdisciplinary structure of UK research. There are links running everywhere. The national BrainScan also provides a reference structure, a template onto which other 'offspring' networks can be mapped and compared. The complementary structure of Imperial College and the LSE is no surprise but it is valuable to have it reified in this form.

The comparison between two 'big civic' universities is equally interesting: they both have a rich and diverse portfolio, and well founded research strengths, but they are not doing the same thing. This institutional diversity will be replicated across the research base and is a key source of strength for UK national performance. There are not just a lot of research institutions. There are a lot of different research institutions delivering a lot of different impacts. The evidence in the case studies reflects the economic, social, technological and cultural benefit that the UK gains.

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1 http://www.ref.ac.uk/panels/unitsofassessment/

2 https://github.com/dbpedia-spotlight/dbpedia-spotlight/wiki

3 http://www.geonames.org/