
Research Data Management
1: Introduction.
Georgina Parsons, Research Data Manager,
April 2018.

Workshop outline:

1. RDM definitions and importance.
2. Data access and organisation.
3. Data formats and backups.
4. Data documentation.
5. Data sharing and security.

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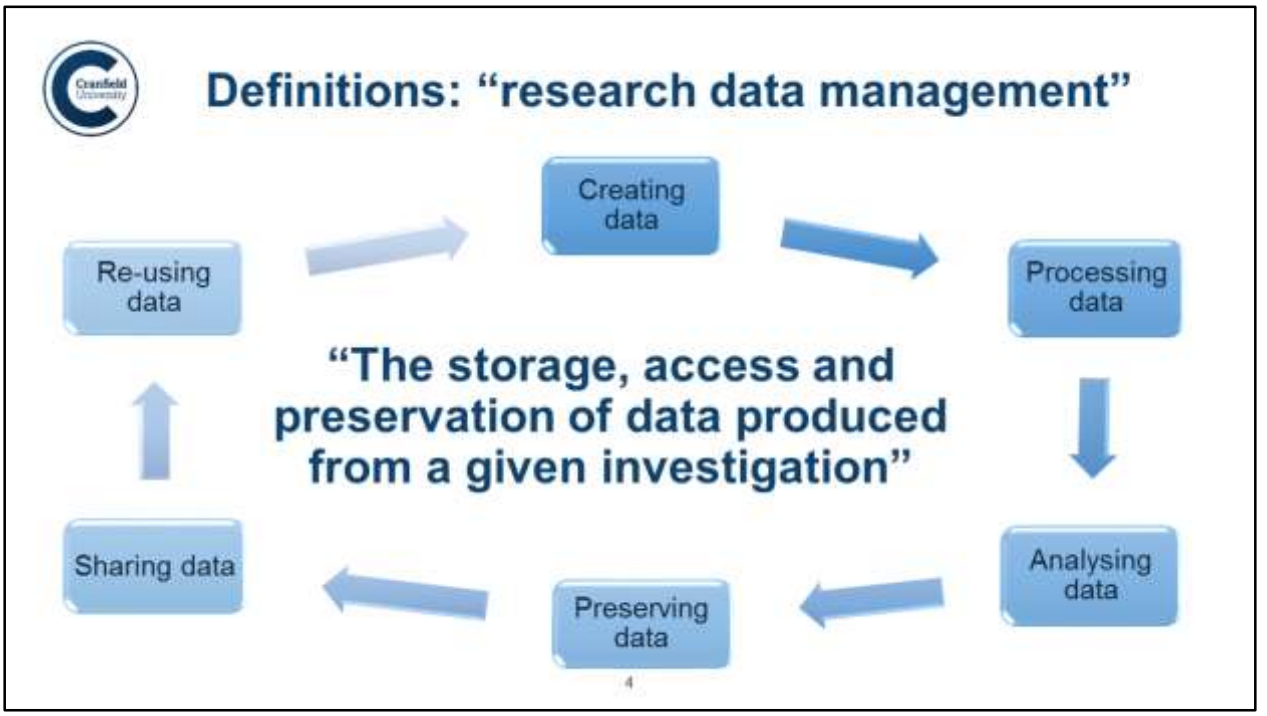
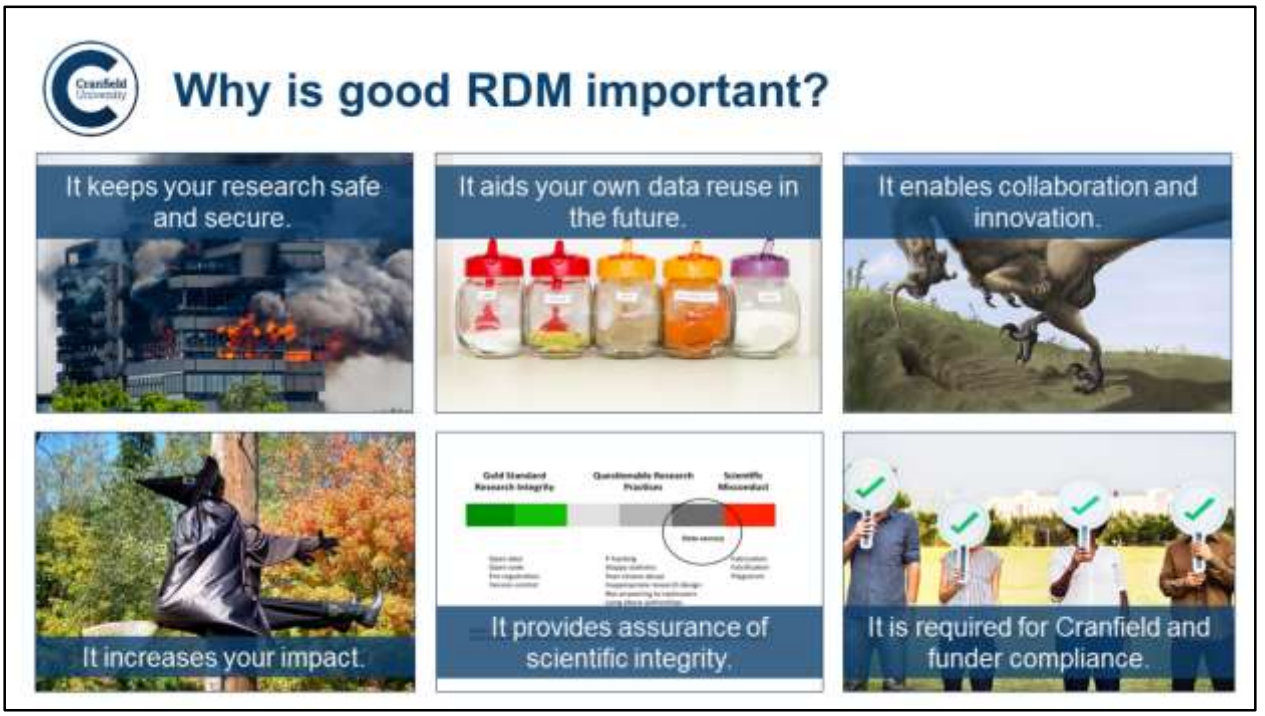


One possible definition. Data management practices cover the entire lifecycle of the data, from planning the research to long-term preservation of data after the research investigation has concluded.

Creating: design research, plan data management, collect data (experiment, observe, measure, simulate) and metadata
Processing: data entry, transcription, validation, anonymisation, description, storage
Analysis: interpretation, derivation, preparation for publication
Preservation: format migration, documentation, archival storage
Sharing: distribution, access controls, copyright/licensing
Re-use: follow-up research, teaching and learning

RD could include survey responses, interview transcripts, financial data, experimental results, images, interview videos, CAD files, statistical models, 3D models, software written during the project, laboratory notebooks. If experimenting on samples, it's the results, not the samples.

Research Information Network classification:
Experimental: data from experimental results, e.g. from lab equipment, often reproducible, but can be expensive e.g. chromatograms, microassays
Observational: data captured in real time, usually unique and irreplaceable e.g. brain images, survey data
Simulation: data generated from test models where model and metadata may be more important than output data from the model e.g. economic or climate models
Derived or compiled: resulting from processing or combining 'raw' data, often reproducible but expensive e.g. compiled databases, text mining, aggregate census data
Reference or canonical: a (static or organic) conglomeration or collection of smaller (peer reviewed) datasets, most probably published and curated e.g. gene databanks, crystallographic databases



RDM covers a lot of aspects of handling data so is important for a number of reasons…

1. A large element of RDM is keeping data secure and backed up, minimising the risk of data loss, whether that's through natural disasters such as fire or flooding, equipment theft, or technical failures.
2. Much like good referencing, being organised and following RDM best practice principles from the outset is well worth it. 'There is a discipline you need to teach yourself, I think, to do it at the time because if you don't, you regret it later if you have to go back' [Professor Haywood in https://www.youtube.com/watch?v=i2jcOJOFUZg].
3. RDM also covers data sharing, so whilst your data had one purpose, it may be used for others, even across disciplines, with potentially important consequences.

- The biomarkers for Alzheimer's were discovered after years of lack of progress, after researchers around the world agreed to "park their egos at the door" and immediately share their findings (http://www.nytimes.com/2010/08/13/health/research/13alzheimer.html?_r=1).
- More recently data was combined from a variety of earlier studies on excavated dinosaur teeth, and led to a new discovery about the evolution of theropod dinosaurs "that significantly advances science as a whole." (http://blogs.plos.org/paleo/2013/01/25/and-this-is-why-we-should-always-provide-our-data/)
- A model of e-resilience, to study the impact of online shopping on high street shops

and thus help them survive, was only possible because it drew on so many existing datasets to pull together to create this model and draw new conclusions, one project simply couldn't create all the data required (https://www.ukdataservice.ac.uk/use-data/data-in-use/case-study/?id=202).

4. Various studies have looked at whether sharing data affects citations of your papers – and all have found that it does increase citations. The effects were from 69% to 9% (independently of journal impact factor, date of publication, and author country of origin), all positive.* You also do not want a retraction to your name such as http://dx.doi.org/10.1016/j.scijus.2015.04.005 !

5. RDM has become a priority in universities recently due to a "reproducibility crisis" in research, and a resultant push towards open science, i.e. transparency of methods and data as well as just results. Some would say that not sharing data is misconduct, it's certainly becoming questionable behaviour, because it's an obvious 'safeguard'. If someone accuses you of having falsified data underpinning papers, how do you prove you'd done the work as described?

Also shift in attitudes due to increasing number of scandals: "What type of academic culture allowed Stapel to continue his misconduct for so long?" Multiple major scandals in the Netherlands have led the Dutch to fund an investigation into research integrity, costing 8million euros. With data routinely made available, it can still be fabricated but there's the acknowledgement that it will be checked for reproducibility, and with spreadsheets online, automated checks can be done (eg there are usually patterns in falsified data – people who falsify are lazy!).

Open data in particular makes people think twice before committing fraud, and think twice about the robustness of their research.

6. UKRI and other funding bodies have policies on how we must manage and share data. Notably, UKRI bodies are government-funded, so this is taxpayer money paying for the research: the principle is that publicly funded research data should be made publicly available in a timely and responsible manner (without damaging the research process). Funders are mandating good RDM because of the previous five reasons, not because they like giving extra work to researchers!

So RDM has a lot of benefits, achieved by adhering to best practice in data management.

Credits:
**Sharing Detailed Research Data Is Associated with Increased Citation Rate (DOI: 10.1371\journal.pone.0000308). See also: The enduring value of social science research (http://hdl.handle.net/2027.42/78307); On the citation advantage of linking to data (https://hal-hprints.archives-ouvertes.fr/hprints-00714715v2).*
Image: Labeling, CC-BY-NC by Paul Istoan
https://www.flickr.com/photos/vamapaull/5752351132/
Image: Scientific integrity,
http://blogs.lse.ac.uk/impactofsocialsciences/2015/07/03/data-secrecy-bad-science-or-scientific-misconduct

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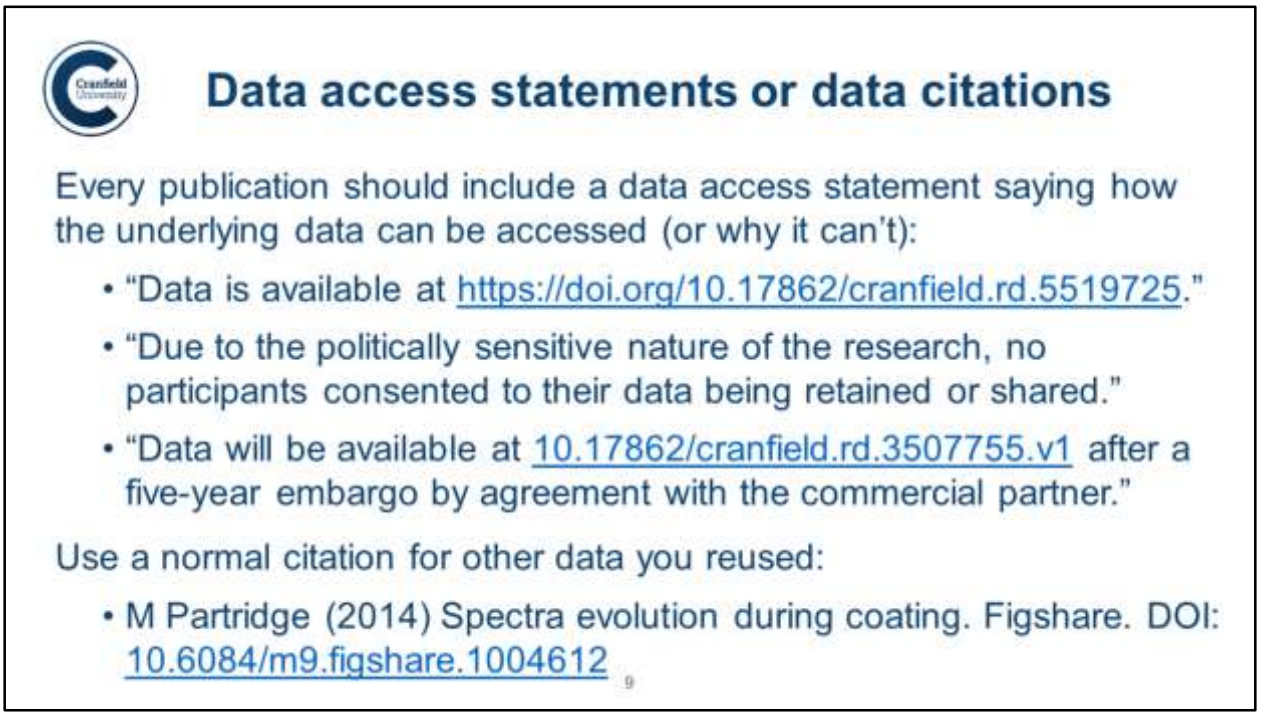
Data access and organisation

NYU Health Sciences Library (2012) Data Sharing, Part 1 of 3

While you watch it, think about the mistakes you can spot in the researcher's behaviour. We'll then go through the RDM best practice elements that would have prevented these problems.

…

We noted: "it was published in Science, which requires that you share your data" … "everything you need to know is in the article" … "it is on a USB drive" … "I forgot to label the boxes"



"Everything you need to know is in the article": it wasn't, as he was non-compliant with publisher requirements to share the data, and didn't include a data statement or citation. Our policy requests a data statement, and funders such as EPSRC are now compliance checking to ensure that a data access statement is present (you can just simply cite the dataset in your references list).

"on a USB drive in unlabelled boxes" – badly labelled folders are the same principle as unlabelled boxes.

Most people simply don't consider folder structure as a whole, but it's really important and makes your life so much easier down the line. So before you start data collection, do consider how you will organise your data.

The slide shows three examples. The left two are a real-life example from my work, when we migrated content from our library network drive to a collaboration site. The 'before' image shows that even librarians can easily get in a mess! Why are APCs (OA payments) separate from OA? Where would you look for OA statistics – in the OA folder or the Statistics folder? If you want procedures for adding OA articles to CRIS and CERES (this is done in one go), do you look in OA or in CRIS or in CERES? If you were looking for some project work, would you remember whether it was George or Sharon who worked on it and thus know which folder to check? At the time, it all made perfect sense, but that's the point:

During your project, you'll just know where things are as it's fresh, but when you come back to the files in the future (or when other researchers do), it can be very confusing if you haven't thought about a logical structure for your work. And it will

waste your time trying to find things.

The example on the right is for a PhD project rather than library work, but it's not "the right way", just an example. You might find this suitable, or if you're doing lots of experiments, you might decide you want one folder for each key experimental condition. Whatever you choose, keep a clear structure as you go along.

File and folder names should:

- describe the contents/subject;
- be short and concise;
- avoid special characters/spaces;
- use ISO-8601 date format: YYYY-MM-DD;
- append with v01, v02… for version control.

- E.g.: ✗ wind.dat
  ✓ tdf11-taux-july.csv

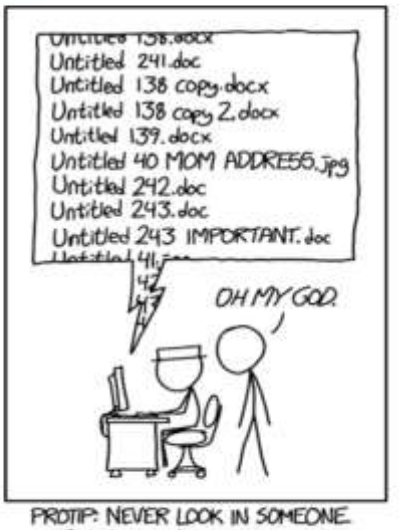


Image from XKCD: file name example discussion

Similarly, your file and folder naming should be clear - you should never have to open a file or folder to know what's in it. If you came back to a file called "experiment" or "questions" or "my talk", would you remember what they actually are? Data will expand but don't be tempted with things like 'new data', 'new new data', try to always use a date or version number. We all do it and think we can go back and tidy the files up later, but no-one really has time to do that, it's less painful to get into the habit of naming clearly as you go.

The example is from a video of a researcher lamenting his earlier poor naming practice, when he realised he could reuse data from an earlier project, but ended up spending a lot of time going through all the different files trying to figure out what they were. He had to rename them as he went, so they would be reusable in future. In the new name: 'tape data family 11' is the data source, 'tau-x' is the variable (wind stress), 'july' is the time period of the observation, csv is an open format. What is arguably still wrong with his renamed file? [The year is unclear; also, writing the month as a word means he can't sort chronologically, which he could do if files were tdf11_taux_2010-01, tdf11_taux_2010-02, etc.]

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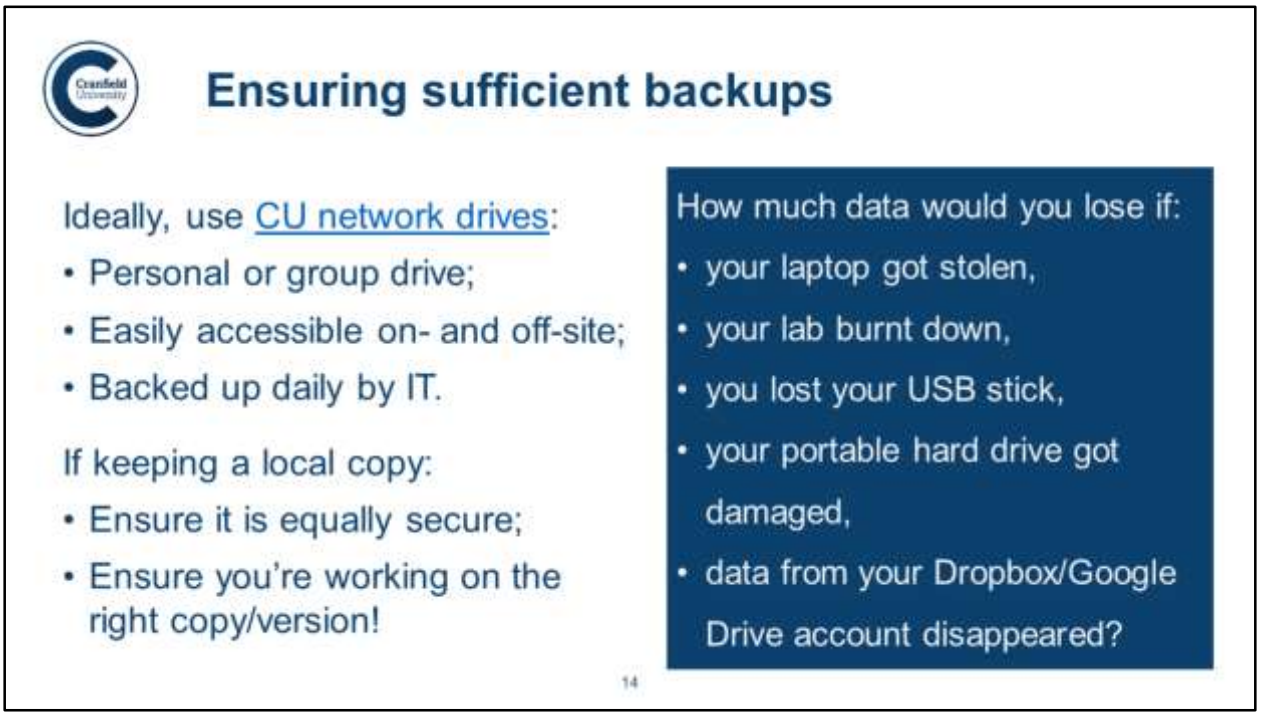
Data formats and backups

NYU Health Sciences Library (2012) Data Sharing, Part 2 of 3 https://www.youtube.com/watch?v=RtSv0gSbCP8

While you watch it, think about the mistakes you can spot in the researcher's behaviour. We'll then go through the RDM best practice elements that would have prevented these problems.

…

We noted: "I am not able to read hexadecimal" … "maybe you can buy the program on eBay" … "that is my only copy".



When thinking about where to store data *during* your project, we recommend the University filestore as it is fully secure and backed up. Follow the link for guidance from IT on remote access, recovering deleted files (up to 7 days after deletion on Windows), etc. You can request extra storage space via the IT Service Desk servicedesk@cranfield.ac.uk.

Also, remember to make full backups/take snapshots before any "transformations" such as data processing, cleaning, recoding, deriving.

Sadly we still hear of laptop thefts and USB losses here, from distraught students who have lost months of work due to only having copies on that one device – backups are essential!

Cloud storage – good or bad?

- Read the terms (you may be granting them permissions).
- Check where data is stored (European Economic Area required for DPA).
- Remember they don't guarantee data restoration.

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Public domain images from pixabay.com

Terms: with Drive or Gmail, you retain IP over the content, but grant Google and those they work with the rights to use/modify/publish your content to develop and promote Google services.
Storage: University storage is UK-based. For surveys, Qualtrics is on secure European servers, we also have a UK-based option in Blackboard.
iCloud terms: Apple does not guarantee or warrant that any content you may store or access through the service will not be subject to inadvertent damage, corruption, loss, or removal… It is your responsibility to maintain appropriate alternate backup of your information and data.

Preserving/sharing your finalised dataset

1. **Funder repository**: no compliance worries.
2. **Subject repository (re3data)**: best visibility of your data.
3. **Institutional repository (CORD)**: DOI and preservation.

If you're a student, talk to your supervisor; data is likely to go on CORD but you or your supervisor might upload it.
For anyone wanting to use CORD, you can register interest in a hands-on training session in DATES (https://webapps3.cranfield.ac.uk/DATES/Application/) or see the VLE (https://moodle.cranfield.ac.uk/RDM).
Why a repository? Data may be in your thesis/article but it's submerged and uneditable, whereas in e.g. csv in a repository, visibility and reusability is there, and you'll get clear metrics and altmetrics on its use.
Don't forget – share data when you're publishing, not before you've finished exploiting it. CORD can embargo data release and 12 months is pretty acceptable.

File formats: choose open

- Textual data: rtf, txt, xml, pdf/a
- Tabular data: csv, tab, por (SPSS)
- Databases: xml, csv
- Geospatial: shp, shx, dbf, geotiff
- CAD: dwg
- Video: mp4, mj2
- Audio: wav, flac
- Images: tif, png, svg, jpg

Image by N. Hussein on Flickr

"I am not able to read hexadecimal" … "maybe you can buy the program on eBay"
Data must be accessible long term, which means that files need to be opened in different software/versions. An open format is one where the spec is published, so new software can be designed to open it. Companies such as Microsoft use proprietary formats (e.g. docx, xlsx) and don't publish their spec, so other programs have difficulty opening them – so that people have to buy Microsoft products. Long-term these are not reliable, so you should avoid them as far as possible.
E.g. a Word file from pre Word 97 will not be openable in 2010.

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https://www.flickr.com/photos/motosclasicas/8399098374

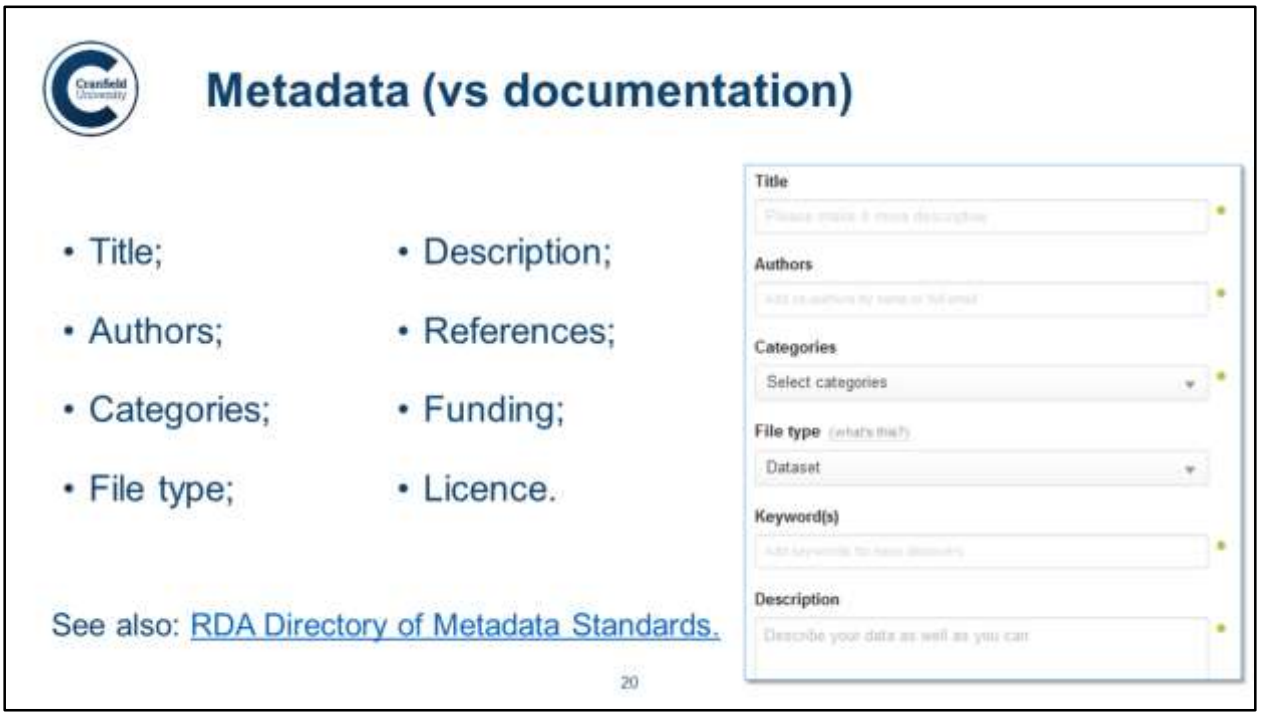
Data documentation

NYU Health Sciences Library (2012) Data Sharing, Part 3 of 3

While you watch it, think about the mistakes you can spot in the researcher's behaviour. We'll then go through the RDM best practice elements that would have prevented these problems.

…

We noted: "I do not understand the data" … "my co-author knows what the field names mean" … "he is in China, his name is Sam Lee"



When your data is stored or made available, it usually needs some extra information to make it usable – ie understandable without needing to track down a person. This extra information is generally considered in two parts: metadata (structured fields for computer use) and documentation (free text for human use).

CORD metadata fields are on screen – very simple, often using a schema (standardised set of choices) for integration and use in search/filter. Different repositories have different requirements, relating to the domain, e.g. requiring coordinates for geographic data, start/end dates for longitudinal studies, sampling methods or universe for social science studies, etc. Know what will be expected in your domain and be prepared to add it when sharing your data.

Metadata standard example: the ONS (Office for National Statistics) has the Standard Occupational Classification 2010: 9 types of occupation that you would use as your categories (and a mega spreadsheet of job titles saying which category they fall into).

Documentation (vs metadata)

- **Dataset information**: file names, acronyms, variables, units, codes, date/location of data collection, software needed.
- **Methodology information**: methodology, data processing, instruments used, precision, calibration, quality controls.

Readme.txt template
Example spreadsheet

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Public domain image from unsplash.com

Documentation is often just one text file and should include sufficient information to ensure that someone unfamiliar with your data could understand and use it without needing to contact you with questions. This will also help you if you come back to your data months or years later, when you may not remember these details as clearly. It can be useful to put this information into a file as you go, throughout the project, rather than spending a day at the end putting it together.

You might find that not all this information is needed if you look after your data well – e.g. if your spreadsheet has very clear column and row headings, many of these fields are redundant. Keep the data files tidy to make this easier (e.g. in spreadsheets, have one worksheet for the raw data, start a new worksheet for each function you work on).

Especially for experimental data, you might want to submit a readme file with your dataset at project end.

If you've used SPSS, you can export the data dictionary (variable labels, missing value codes, etc)…

Over to you…

Go to http://kahoot.it/

Enter game PIN:

7650967

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Before final section, have a break with another quiz to recap what we've just covered.

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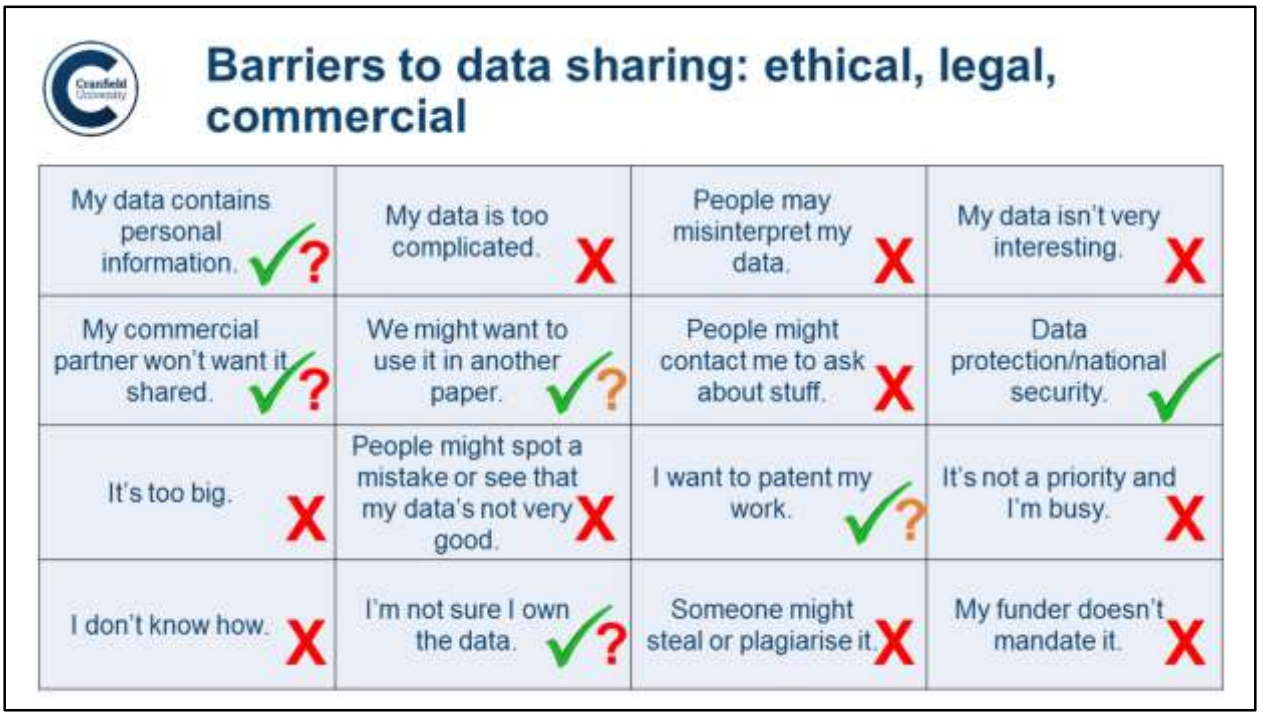

Wherever possible, you should be planning to make your data openly accessible, for all those reasons we looked at earlier (scientific integrity, enabling innovations, aiding your own reuse, improving your citation rate, compliance with requirements).

However, data sharing must be responsible – it's important to consider any ethical, commercial, or legal aspects. The bingo card on screen shows a variety of responses people have when asked to share their data. Which are valid reasons not to share, and which are excuses that would not be accepted by funders/publishers?

Tick – if a threat to national security or DPA says you legally can't share your data, you can't share.
Tick/orange Q – this is a valid reason to delay access to your data until you've finished exploiting it. You should use an embargo, rather than withholding your data entirely.
Tick/red Q – this might be a valid reason, but you might be able to overcome it. If you're collecting personal information, you should plan to anonymise it. If you have a commercial partner, you should check whether parts of the data could be shared. If you don't know if you own the data, can you find out?
Cross – these are excuses.

Passwords and encryption

Passwords (see Network Password Policy (pdf))

- Use a strong password (avoid dictionary words).
- Don't let others see you type it in.
- Don't enter it on untrusted computers/networks.
- Set up password recovery (CU password manager) with difficult security questions.

Encryption (see Encryption Guidelines (pdf))

- Institutional storage encrypts data by default.
- Also: MS Office: File > Protect > Encrypt with password.
- IT Service Desk can support additional encryption software.

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Your network password is only for University accounts, for security reasons.
Most security requirements are met by using network storage (network drives and collaboration sites) which has encryption at-rest and in-transit. If you want additional encryption using simple password protection, MS Office has this built in – but don't forget the encryption password!
Remember to take the same precautions if needing to transfer data – secure files before sending, and send files separately from the password/s needed to access them (Cranfield's Dropoff service may be preferable to email http://dropoff.cranfield.ac.uk/).

Anonymisation is all about managing risk: you can't make guarantees as you don't know what datasets/computational techniques will be available in the future.
Anonymisation techniques: remove identifiers e.g. names, generalise a variable e.g. change a postcode to a town or county, remove outliers e.g. 99yr old will be easy to identify.
If you're not confident that your data is sufficiently anonymised, make it restricted access.

How will I remember all this?!

Data management plans are mandatory for all doctoral students. They:

- use a template that walks you through all the elements we've discussed;
- help save you time throughout your project.

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Public domain image from pixabay.com

You should now sign up for a DMP workshop/webinar in the DRCD diary – before you start your data collection.