Managing your digital research data

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About the module

• Thinking about key issues that may affect your research
  • On a day-to-day basis
  • In the long term
• Providing sources of further information
• Helping you with data management planning in the future
• Fill out a postcard with:
  1. Something you’ve learned
  2. Something you’ll find out more about
  3. Something you’ll do
• Put your name and University address (department or college) and we’ll return it via UMS
What is ‘data’?

- How do you define ‘data’?
- Does it matter how ‘data’ is defined?
- What is the difference between ‘data’ and ‘information’?
- What is your data?
- Do data have to be digital?

From ‘C3PO vs. Data’ by JD Hancock on flickr: http://www.flickr.com/photos/jdhancock/461775990/
What is ‘data’?

“A reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing.”

Digital Curation Centre
What is ‘data’?

Any information you use in your research
Why are we talking about data management?

“The whole thing is incredibly dull.”

“PhD students lose material all the time…and they are exactly the people who want to be backing up. These are people who are creating data which are life and death important to them”
Why data management is important (I)

DON’T LET THIS BE YOU!

Why data management is important (II)

What would happen to your data if there was a fire in the department?

“It is a block we use for undergraduate teaching and some research activities so there will be some loss of course work.”

David Duncan, University of York registrar & secretary

http://www.bbc.co.uk/news/uk-england-york-north-yorkshire-16857952

“At this stage we aren't looking for any suspicious or deliberate cause”

Trevor Lunn, North Yorkshire Fire & Rescue

Things can happen which are outside your control but affect your ability to carry out your research
Why is it important?

- Good data underpin high quality research
- Help you - and others - find and understand your data
- Credible and verifiable interpretations
- Important for validation
- Long-term preservation
- Academic and professional recognition and reputation
- Sharing leads to more collaboration and citations – greater impact
- Funding body requirements, legal, and ethical codes of conduct
Why is it important?

To help you finish your research project on time and with the least stress.
“Ideas and knowledge derived from publicly-funded research must be made available and accessible for public use, interrogation and scrutiny, as widely, rapidly and effectively as practicable…The outputs from current and future research must be preserved and remain accessible for future generations.”

Research Councils UK

Funding body requirements

<table>
<thead>
<tr>
<th>Funding body</th>
<th>Published outputs</th>
<th>Data</th>
<th>Data Plan</th>
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<tbody>
<tr>
<td>Arts &amp; Humanities Research Council</td>
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<td>ESRC Economic &amp; Social Research Council</td>
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<td>MRC Medical Research Council</td>
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<td>Natural Environment Research Council</td>
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<td>Science &amp; Technology Facilities Council</td>
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- Several funding bodies mandate depositing data with an appropriate repository, eg ESRC
- Others recommend depositing data, eg Leverhulme Trust

Taken from DCC ‘Overview of funders' data policies’
http://www.dcc.ac.uk/resources/policy-and-legal/ overview-funders-data-policies
Your Data Management Plan won’t be perfect

It is not a static document
  • Change and update it as your research progresses and you understand more about your data

Think about key issues that might affect your data…
  o …while you work on them
  o …in the future

It’s better to have a plan that covers some aspects than no plan at all

Ask for advice if you’re uncertain
Exercise: Defining Research Data

Things to think about:

• What is/are the core dataset(s) of your research project?

• What will you do with the data (both physical and digital data)...

  • …during the project?

  • …at the end of the project?

• Do you know of any ethical or IPR issues?
Defining your digital research data

1. Please answer the questions on the form
2. Discuss your research project and research data in groups of 3-4

Questions:
• Define research topic
• List physical data you will work with: existing research documents (eg theses, published reports), physical objects (eg samples, images), etc.
• Data origin: published material, physical archive held in a library, data collected at another institution, etc.
• Types of digital data you will derive from the physical data: text documents, scans, spreadsheets, databases, etc.
• What types of data will you create digitally?
• Where will your data end up after the project?
• How do you look after your data?
• Any other issues for management and curation of your digital data? Risks? Ownership? Sharing?
Data Lifecycles

• Good way to see your research and data in part of a wider context

• Help you think about how different parts of your research are connected
  • This should help you plan

• Knowing some of the jargon will help you find guidance and advice in the future
Data Lifecycle

Preservation & Re-use

Data Creation

Data Use

Selection & Evaluation

Data Management

Planning

Data Distribution & Archiving

Evidence:
Mónica Pinheiro,
http://www.flickr.com/photos/monica_andre/4994971717/

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Archives des députés allemands:
www.flickr.com/photos/hamadryad/es/2549161782/

Genizah project: T-S_12.146,r

Anders Sandberg: equation
http://www.flickr.com/photos/arenamontanus/5369316039/

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Anders Sandberg: equation
http://www.flickr.com/photos/arenamontanus/5369316039/

Mónica Pinheiro,
Evidence: fieldnotes
http://www.flickr.com/photos/monica_andre/4994971717/

Archives des députés allemands:
www.flickr.com/photos/hamadryad/es/2549161782/
Jargon explained

Digital Data...

…Capture
Data that are derived from a physical data object, eg:
- measurements of physical objects
- scans of drawings or manuscripts

…Creation
Data that are ‘Born Digital’ and *not* derived from a physical data object, eg:
- digital photographs and film
- analysis readouts
- documents produced on a computer
Jargon explained

**Documentation**

Explains:
- how data were created or digitised
- what the data mean
- what their content and structure are
- any manipulations that may have taken place
Metadata ("data about data")

Explains:
- purpose
- origin
- time references
- location
- creator
- access conditions and terms of use of a data collection

PROVIDES STANDARDISED, STRUCTURED INFORMATION
Data storage / Back-up
System used for looking after digital data during the life of a project

BACK-UP IS NOT PRESERVATION
Digital Preservation

Long term curation of digital data so that it will be accessible in the future

Long term
Period over which changing technologies, formats, media impact upon the access to and use of digital resources

Ingest
Process by which digital data are archived by a digital depository
Jargon explained

**Emulation**
Techniques for imitating obsolete computer systems to retrieve digital data.

**Migration**
Transfer of digital resources from one hardware/medium and software/file format generation to the next.
Give your data a structure…

…it makes it easier to find things
Structuring your files

What primary data define your research?

• Think about:
  • Chronology
  • Experiment type (e.g., equipment used, analytical techniques)
  • Sample type
Deciding on a file structure

Choose categories that will help you find what you need more easily

By jemsweb via flickr
Something to try:

Use post-it notes to create a map of your file structure

- Write each existing file and folder name onto a post-it
- Arrange folders on your desk in a sensible hierarchy
- Put your ‘files’ into ‘folders’
- Do you need new folders?  Do you have too many?
Exercise: Create a file structure

How would you plan to organise these data?

- 5 different, but related, samples (a separate experiment will be run on each)
- Information about how sample was obtained
- Information about on how each experiment is run
- Raw data on sample generated by equipment
- Initial data processing (automatically performed by equipment)
- Analytical model derived from processed data
- Numerical outputs derived from analytical model
- Images generated from the model

You hope to use the data to produce a poster for a conference, a research article and a chapter of your thesis
What’s in a name?

• **Names tell us what a file is** (contextual information)

• Use a combination of different types of information to make context and content clear, eg

  • Author (or Initials)
  • Date
  • Data source
  • Theme
  • Experiment
  • Sample

• …But try not to let file names get too long
Make it easier to find the file you need

- **Numbers order files** (making things easier to find)
  - It can help to use zeros before digits:
    - 001, 002, 003, etc will order files up to 999

- **Dates** are useful for ordering files and version control
  - YY-MM-DD (12-02-08) orders files of same name by date
  - Year first is good for ordering files

- **Capitals** in file names sometimes affect ordering – be consistent

- **ALL CAPITALS** CAN BE HARD TO READ
Working on different operating systems

• **Spaces** within file names cause havoc with some programs; use `underscores`_

• `/` Slashes `\` in file names can cause problems too

• `. Full stops` can also be problematic

• If in doubt, **avoid punctuation marks**

• **These guidelines apply to folders as well as files**
Examples

Some good examples
• Decoding_BL_100727_CW.ppt
• why_you_need_a_DMP.jpg
• readme.txt

Some not so good…
• [your name].doc
• Abstract.doc
• Interview_summary.xls

Remember that context is important
How (not) to organise files...

[Image of file organisation]

- DataTeam
- Dummy Project
  - DMY 11_Copied from Field Laptop
  - 2011
    - Artifacts
    - Ceramics
    - Drawings
    - Field Log
    - Field Notes
    - Photographs
  - DMY 11_Report
  - DMY 11_Assets
  - DMY 11_Liberty
  - DMY 11_Personal
  - DMY 11_Photographs
  - Dummy
  - Dummy Project 2011 Contracts
  - Dummy (Project) Notes
  - DMY 11 Planning
  - Map
  - PHD_Chapter_3
  - Radiocarbon
  - Dummy Project 2010
    - Maps
    - Project 2009
    - Samples
    - Endnotes_Libraries
    - Fieldwork_Templates
    - Funding Applications
    - Misc.
  - Images
  - Job Applications
  - Maps
  - McDonald
  - My GRC
  - PhD
  - Publications
  - Radiocarbon
  - Search

- 2010 Drawings
  - Artifacts
  - Ceramics
  - Drawings
  - Field Log
  - Field Notes
  - Photographs
  - Dummy Project Museum Finds 2010
  - Field Observations
  - GTS
  - Images
  - Maps
  - People
  - Radiocarbon

- Letters to Patent
- Personal
  - Research
- Personal
  - Medical Details

[Image of file organisation]
Version control
Set aside time regularly to evaluate your file structure and file names
It won’t be around for ever…

By Marcin Wichary on flickr: “My first punched card”
File formats
• Manuscripts produced on computers
  • Conference notes, articles, books, theses, etc.
• Scanned printed material often made into a PDF file
  • Good for printing and archiving
  • Can be difficult to edit
• Marked-up formats
  • eg HTML for web pages
## Common Text File Formats

<table>
<thead>
<tr>
<th>Format</th>
<th>Description / Properties</th>
<th>Usage and Archival Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>.doc</td>
<td>Microsoft Word document (2003) Proprietary binary format. Can be read by OpenOffice. Easily converted into PDF format.</td>
<td>Accepted for archiving because it is so widely used. However, will soon become obsolete.</td>
</tr>
<tr>
<td>.rtf</td>
<td>Rich Text Format (Microsoft) Tagged plain text format.</td>
<td>Formatting issues when using opened in different software. Large file sizes mean that .docx or .odt file formats are preferred.</td>
</tr>
<tr>
<td>.pdf</td>
<td>Portable Document Format (Adobe) Proprietary binary format. Aims to retain document formatting. Can store embedded data: raster and vector images (e.g. Adobe Illustrator files)</td>
<td>Highly suitable for dissemination. PDF creators and readers freely and widely available. Retain original text document and embedded objects. (e.g. images, tabular data, etc).</td>
</tr>
<tr>
<td>PDF/A</td>
<td>Portable Document Format / Archive (Adobe) Open ISO standard format for long term archiving. Formatting data self-contained in file.</td>
<td>Widely accepted as viable format for long-term archiving. Retain original text file and embedded objects separately. (e.g. images, tabular data, etc).</td>
</tr>
</tbody>
</table>
Important features of text files

Architecture and Deployment
ChemicalTagger has been developed in a modular manner using the Java framework, making individual components such as tokenisers, vocabularies and phrase grammars easily replaceable. This facilitates the study of a wide range of chemical subdomains which vary in syntactic style, vocabulary and semantic abstraction. Moreover, it is possible to convert ChemicalTagger’s output into CML [22] using a ChemicalTagger2CML converter. Thus, identified phrase-based chemistry such as solutions, reaction and procedures can converted into computable CML. This then allows for the construction of machine-processable synthesis information and searchable indices [23].

Table 2 shows a the up by all four annotators alongside the number of Action phrases marked up by ChemicalTagger.

http://www.jcheminf.com/content/3/1/17
Digital Images

- Convey information and support interpretations
- Contain data and are often analysed to reach interpretations
- Image documentation and preservation is important for future re-use of project archives

- **Raster Images**
  - Matrix of dots/pixels containing information
  - Eg photographs, scans, etc

- **Vector Images**
  - Formed by points, lines, polylines, polygons …
  - Eg graphic illustrations
Digital Images

Think about the purpose of the image:

- Publication or reference
- Print or screen viewing
  - Illustration, photograph for display, item on website…
- Black and white, greyscale, colour

**If in doubt, assume you want a high-quality, full colour image for printing**

Manuscript fragment © Cambridge University Library. For more information see the Taylor-Schechter Genizah Research Unit webpages
Raster images

- Raster images are **resolution dependent**
- Each pixel contains information eg about colour
- Most cameras and scanners produce raster images

**Resolution**

- Higher than you think you need
- Minimum 600dpi for photos
- 300dpi is often required for publications

**Compression**

- Uncompressed: GIF, PNG, TIFF
- Compressed: JPG (lossy), TIFF (lossless)
Images – key tips

• Assume you want a high-quality, full colour image for printing

• Where possible, save a high resolution colour TIFF as archive copy

• If using JPEGs, keep a master copy as an archive version
  o Do any editing on copies
Why create documentation?

• Creating documentation might seem like a waste of time

• Good documentation will include a lot of information that might seem obvious

www.flickr.com/photos/smutjespickles/2434418686/
NASA and the metric mix-up

- Mars Climate Orbiter, 1999
- Burned up in Mars’ atmosphere
- Flight system software written to calculate thruster performance in metric units (newtons)
- Course correction and thruster data entered using imperial units (pound-force)

Image credit: NASA/JPL-Caltech
http://www.jpl.nasa.gov/missions/details.cfm?id=5907
What’s obvious now might not be in a few months, years, decades...

MAKE SURE YOU CAN UNDERSTAND IT LATER

Image: http://www.flickr.com/photos/archer10/5692813531/
Make research reproducible

• Detailing your methodology helps people understand your research better

• Explaining your algorithms, search methods etc makes your work reproducible

• Conclusions can be verified

Image by woodleywonderworks on flickr: http://www.flickr.com/photos/wwworks/4588700881/
Make material reusable

- Material may be re-used by someone in a different discipline
- Provide context to minimise the risk of it being misunderstood/misused
Metadata are:

- Machine readable
- Written according to standards

“I guess it makes sense for a robot to read an e-book [401]” by brianjmatis on flickr
Make material findable

- Comprehensive descriptive metadata allows relevant material to be discovered more easily
- Related materials can be located
What to include (I)

• **Who created it, when and why**

  ![Profile](profile.png) ![Calendar](calendar.png)

• **Include:**
  • **Description of the item**
  • **Methodology**
  • **Units of measurement**
  • **References to related data**

**Description n.**
A set of characteristics by which something can be recognised

**Materials and Methods**

Vector construction, virus production

The lentiviral vector plVPRT-tTRKRAE [23] wa and plVPRT-tTRKRAE-PP10-EGFP for inducible sequence of human (mutated rabbit) PP10 a pEGFP-C1-PP10 [24] was subcloned between constructs were sequenced before virus pr

www.flickr.com/photos/68114781@N04/6639571065/

www.texample.net
What to include (II)

- **Define** jargon, acronyms and code

  CC Gavin Llewellyn
  http://www.flickr.com/photos/gavinjllewellyn/6826303487/

- **Provide technical information about the file** (may be generated automatically)
Spreadsheets and Databases

Data consistency
- Document file names and codes in a separate file
- Document relationships of database tables

Embedded objects
- Store embedded objects (images, charts, figures) separately
- Document analysis/search procedures used to produce figures

Non-data content (presentation formatting)
- Document formatting of tabular data (eg fonts, colours, cell borders)
- Document data input forms and search query results (‘reports’)
Documenting Audio and Video files

Technical Information

• Software and hardware used to make recordings, incl. KHz, sample bits, frames per sec. (and reasons for those choices)
• Length of recording (min, sec)

Contextual Information

• Date
• Location
• Creator
• Brief description of recording (people, occasion etc)
• Copyright holder and clearance status
• Transcripts of audio content (Y/N)
Document your data as you go

If you don’t, it may become impossible for you – or someone else – to understand and re-use data later on.

Question Mark Sign by Colin_K on flickr: http://www.flickr.com/photos/colin_kinner/2200500024/
Good documentation guidelines

• Provide meaningful information (eg titles, keywords)
• Be comprehensive and detailed
• Facilitate data discovery and re-use
• Help make detailed metadata for archiving
• Contain both contextual and technical information
Backing up

- Lots Of Copies Keeps Stuff Safe (LOCKSS): make multiple back-ups

- Keep back-ups in a separate place to the original

- Use different types of storage media, eg CDs, pen drives, networked storage, external hard drive

From: “Copy Copy Copy” by David Goehring (CarbonNYC) via flickr
Backing up

- Back-up regularly; back up often
- Check your back-ups periodically
- Refresh back-up media every few years

Photo by Cennydd via flickr:
http://www.flickr.com/photos/cennydd/2687237902/
Tip

Have a back-up strategy:

• **When** you will back up
• **What** you will back up to
• **Where** you will keep your back-ups
Data sharing and security

- Wikis, VLEs, cloud storage (e.g., DropBox) can all be ways of sharing data with colleagues, supervisors, etc.
- Think about encrypting your data if it contains sensitive/personal information.
- Use password protection or make files read only to help control who can access and change them.
Cloud-based storage & sharing

- Examples: GoogleDocs, Dropbox, SpiderOak …
- Often provide some free storage
- Good for sharing documents with colleagues
- Good for accessing files using multiple devices or from different locations
- Not all cloud-based storage solutions are secure
  - Avoid use with sensitive information
  - Consider using encryption to increase security
- Using cloud providers for back-up may break the terms of your grant if data need to be stored in the UK or EU
Open Access

- Gain more impact
- Increase the chance of funding
- Comply with funder mandates
- Research accreditation
- Changing business models in the publishing industry

Open share icon: www.shareaholic.com/openshareicon
Consider what data need to be kept – and for how long

Consider what data need to be destroyed – and why
A hard drive after 6 years’ research

113 Gb
42,699 Files
3,466 Folders
Selection strategy

Consider:

• Cost (time and/or money)
• Legal
• Future use
• Career importance
• Emotional attachment

• Are you making a controversial claim/claim that is likely to be disputed?
  • It may be very important that you can justify your conclusions with the raw and/or processed data, algorithms, etc)

• If in doubt, wait till your viva
  • Your examiners may ask to see your raw data to help verify your conclusions
What to keep

Raw data vs Processed data
Finalised copies vs Drafts
Models vs Methods/algorithms
For everything you keep....

Make sure you can:
• find it again later
• understand later
And now for something a bit different

By raincrystal on flickr
http://www.flickr.com/photos/catherine_rain/50054101/
• Important disclaimer – what follows is a very basic introduction
• These issues are important in regard to research data
• Think how they may affect your research and research data
• Consult further information:
  • digital repository websites
  • publishers’ copyright policies
  • JISClegal website
  • contract of employment
  • Etc…
“All research should be conducted to the highest levels of integrity, including appropriate research design and frameworks, to ensure that findings are robust and defensible. Researchers should also adhere to the highest level of research ethics, in line with requirements set out by national and international regulatory bodies, professional and regulatory research guidance and research ethics frameworks issued in appropriate areas.”

Research Councils UK  Policy and Code of Conduct on the Governance of Good Research Conduct
Personal & Sensitive Personal Data
Data Protection Act (UK) 1998

Personal Data
• Data relating to living individuals which identifies them: name, age, sex, address, etc.

Sensitive Personal Data
• Data that may incriminate a person:
  • Race, ethnic origin, political opinion, religious beliefs, physical/mental health, sexual orientation, criminal proceedings or convictions
Confidential Personal Data

Personal Data that may be considered confidential

- Data connected to the person providing them
- Data which identifies a person (e.g., name, addresses, occupation, photographs)
- Data given in confidence, or agreed to be kept confidential (i.e., not released into public domain)
- Data covered by ethical guidelines, legal requirements, or research consent forms
“Intellectual property rights, very broadly, are rights granted to creators and owners of works that are the result of human intellectual creativity”

- **Copyright**: Creative works fixed in material form.
- **Designs**: Appearance and shape of product
- **Patents**: Inventions – things that make things work
- **Trademarks**: Signs that distinguish goods and services

- **Moral Rights**:
  - Right to be attributed for your work
  - Right to object to derogatory treatment of your work
Creative works fixed in material form

**Musical works**
Multiple types & holders
Composition, song lyrics, etc.
Creator’s life + 70 years

**Film**
Multiple types & holders.
70 years after death of last surviving principal director, screenplay authors, composer of film music

**Dramatic works**
Creator’s life + 70 years

**Broadcasts**
Multiple types & holders
50 years from broadcast date

**Literary works**
Published and unpublished works
Creator’s life + 70 years
Unknown creator: 70 years from creation

**Artistic works**
Including illustrations, photos, etc.
Creator’s life + 70 years

**Sound recordings**
© held by both recorder & recorded
50 years from creation

**Typographic arrangements**
Layout of text, tables & arrangement of database etc.
25 years from publication of work
Think about using Creative Commons licences
Copyright - Online Guidelines

University Guidelines

• Different countries have different copyright law
• Students who are not employed by an institution own the copyright of the work they produce
• Students who part of a larger research project should check the terms and conditions of their contract

JISC Legal (www.jisclegal.ac.uk)
– Legal guidance for information communication technology use in education, research, and external engagement

Intellectual Property Office (http://www.ipo.gov.uk)
– Official governmental copyright summary
Any person can request any data held by public authorities – including universities.

The data does not have to have been produced by the university:
- They just need to hold the data
- Potential issue for collaborative projects where multiple copies of data are held in different institutions and countries

A request must specify what data are sought.

There are exemptions to releasing information:
- Planned publication of results and data
PhD Theses and Copyright

- May include copyrighted material
- A paper manuscript thesis remains an unpublished literary work
- A digital e-thesis which is available online is a published literary work and has to comply with copyright law
  - Copyright material can be placed in a restricted appendix
  - Copyright material in the paper manuscript can be withdrawn (redacted) from the online e-thesis version
  - An embargo can be placed on the dissemination of the thesis
- Consult e-theses and copyright guidelines of university libraries or digital repositories
E-Theses: Things to consider

Advantages:

• Make your findings available to all – often indexed and searchable by Google
• Raise your profile in the research community
• Persistent URL with DSpace@Cambridge
• Handy for CVs and professional profiles

Problems:

• Publication plans for thesis - check regulations of publisher
• Thesis contains sensitive data
• Requirements of project sponsor (eg industrial applications of research)
• Thesis contains significant quantity of 3rd party copyright material

Discuss your options with your supervisor
Consult digital repository website for information
Make plans early
DSpace@Cambridge

- University of Cambridge’s Institutional Repository
- Accepts:
  - PhD theses
  - Journal articles
  - Software code
  - Research data
  - Multimedia files
  - Images
  - Etc…
- Searchable online
- Items will receive a persistent URL
- Items will be preserved in the long term
Where do you go from here?

Make a plan for how what you are going to do with your material (digital and analogue)…

… both during the project and once it’s finished
Remember…

“A good plan implemented today is better than a perfect plan implemented tomorrow”

George Patton

Start your data management planning now!
Writing a Data Management Plan

1. Formalises the definition of your research data
2. Documents the contextual and technical details of your data
3. Check on File Structure / Naming
4. Plans for data sharing, access and archiving
Other useful resources

DSpace@Cambridge:
- Main repository page: http://www.dspace.cam.ac.uk/
- Research data management support: http://www.lib.cam.ac.uk/dataman/

University Computer Service:
- DS-Fileshare: http://www.cam.ac.uk/cs/desktop-services/ds-filestore/
- Help & Support: http://www.cam.ac.uk/cs/support/

Digital Curation Centre: http://www.dcc.ac.uk/resources

UK Data Archive:
- Brochure: http://data-archive.ac.uk/media/2894/managingsharing.pdf
Managing your digital research data

Open Access Post-Graduate Teaching Materials for Research Data Management
Adapted by Anna Collins (2012) from modules created by Lindsay Lloyd-Smith (2011) for post-graduate training in Archaeology

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