Introduction to Research Data Management

Data Processing

http://hdl.handle.net/1969.1/164594

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TEXAS A&M UNIVERSITY

Introduction

Common data manipulations and tools for processing data.

Process your data in a manner that allows you to roll back changes if you make a mistake.

Preparing data for analysis

Processing data by:

- Subsetting
- Merging
- Manipulation

Data transformation

- Normalizing data collected by multiple people and/or instruments.
- Converting data to different units.
- Converting raw data into meaningful values.

711070500276000
711070600276000
711070700277003
711070800282017
711070900285000
711071000293000
711071100301000
711071200304000

date	time	air_temp_c	precip_mm
2007-07-11	5:00	27.6	0
2007-07-11	6:00	27.6	0
2007-07-11	7:00	27.7	3
2007-07-11	8:00	28.2	17
2007-07-11	9:00	28.5	0
2007-07-11	10:00	29.3	0
2007-07-11	11:00	30.1	0
2007-07-11	12:00	30.4	0

De-identification

Removing or obscuring any personally identifiable information from individual records in a way that minimizes the risk of unintended disclosure of the identity of individuals and information about them.

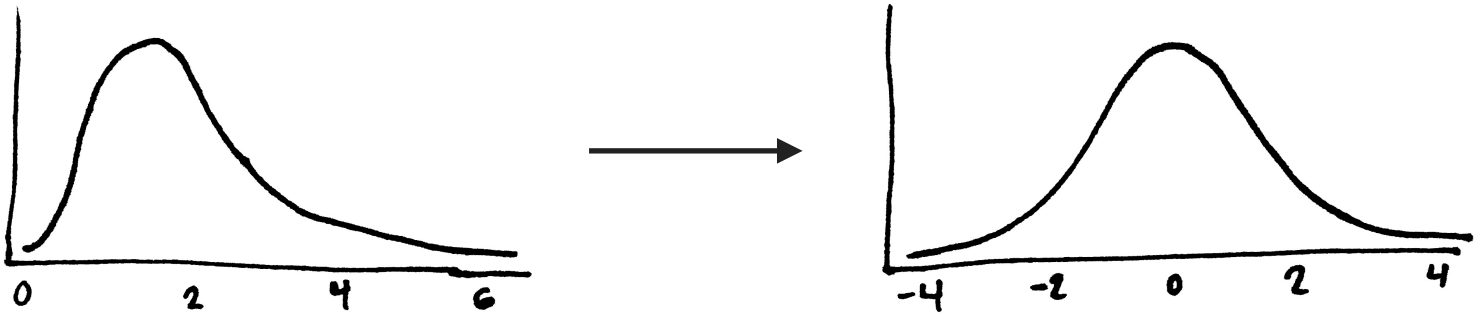
- Anonymization
- Aggregation
- Masking
- Shuffling
- Perturbation

De-identification tips

- Remove direct identifiers.
- Use pseudonyms or replacements.
- Reduce the precision and detail through aggregation.
- Generalize meaning of detailed text variables.
- Restrict upper or lower ranges to hide outliers.
- Use digital manipulation of audio and image files to remove personal identifiers.
- Avoid over-anonymization and exercise additional care when working as a team.
- Keep master log of all replacements, aggregations, and removals.

Statistics for analysis

- Descriptive statistics are traditionally applied to observational data.
- Conventional statistics are often used to understand experimental data.



Software for data manipulation and analysis

Microsoft Excel and Google Sheets: Data entry, manipulation, and graphing.

OpenRefine: Working with and cleaning messy data.

NVIVO: Powerful qualitative data analysis (QDA).

SAS: Advanced analytics, multivariate analyses, and predictive analytics.

SPSS: Logical batched and non-batched statistical analysis, data mining and text analytics.

STATA: General-purpose statistical analysis, graphics, simulations, regression, and custom programming.

Matlab: Numerical computing, matrix manipulations, plotting, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages

R: Statistical computing and graphics, and popular programming language for doing stats.

Python (NumPy, SciPy, Pandas): Object oriented programming language with several data analysis libraries.

Documentation reminder

Workflows allow you to give a precise and reproducible description of your procedure.

Show and describe:

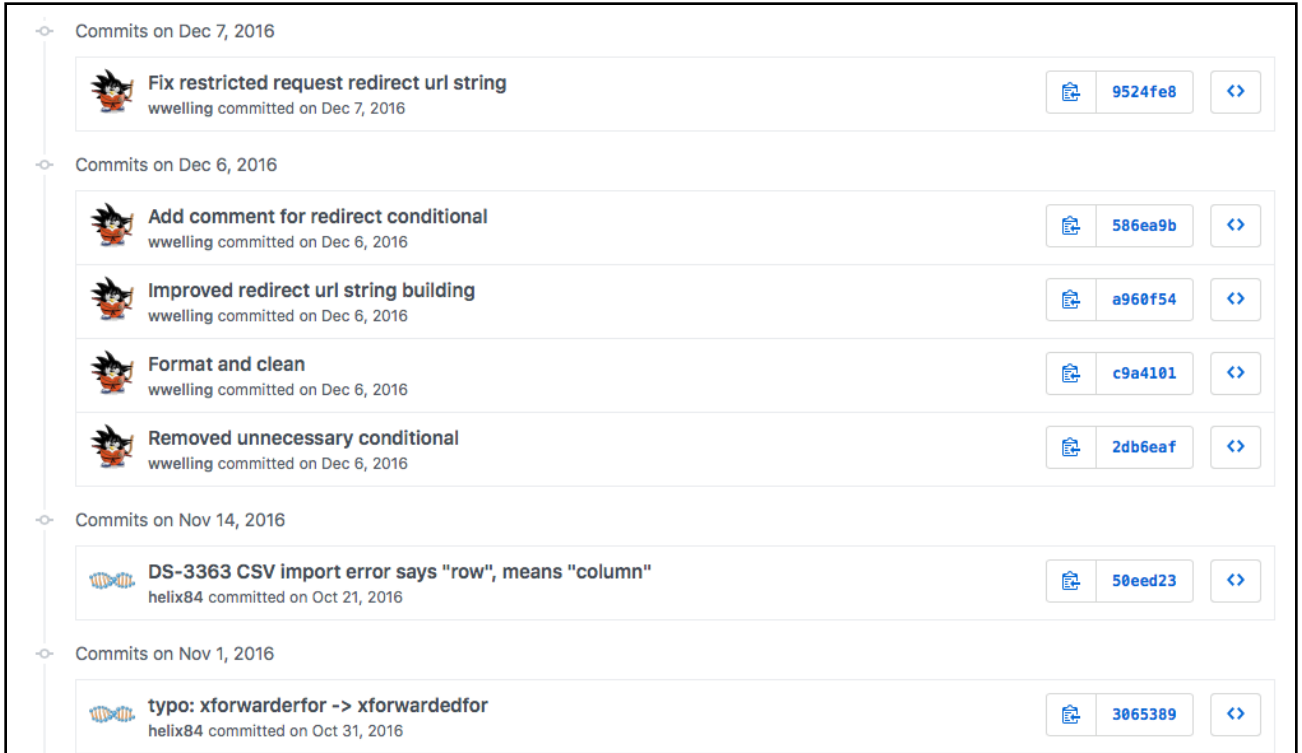
- Inputs
- Outputs
- Transformations

Informal workflows

- Well-described version history.
- Commented scripts.
- Flow charts.

Version history

- Showing changes you've committed over time.

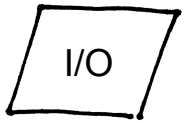


Commented scripts

- Explaining the input, output and function of code.

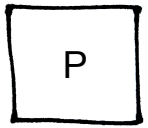
```
def trim(docstring):
    if not docstring:
        return ''
    # Convert tabs to spaces (following the normal Python rules)
    # and split into a list of lines:
    lines = docstring.expandtabs().splitlines()
    # Determine minimum indentation (first line doesn't count):
    indent = sys.maxint
    for line in lines[1:]:
        stripped = line.lstrip()
        if stripped:
            indent = min(indent, len(line) - len(stripped))
    # Remove indentation (first line is special):
    trimmed = [lines[0].strip()]
    if indent < sys.maxint:
```

Flow charts



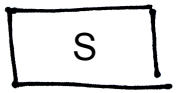
- **Inputs or outputs**

Include data, metadata, or visualizations.



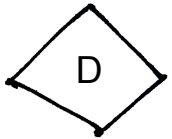
- **Analytical processes**

Include operations that change or manipulate data in some way.



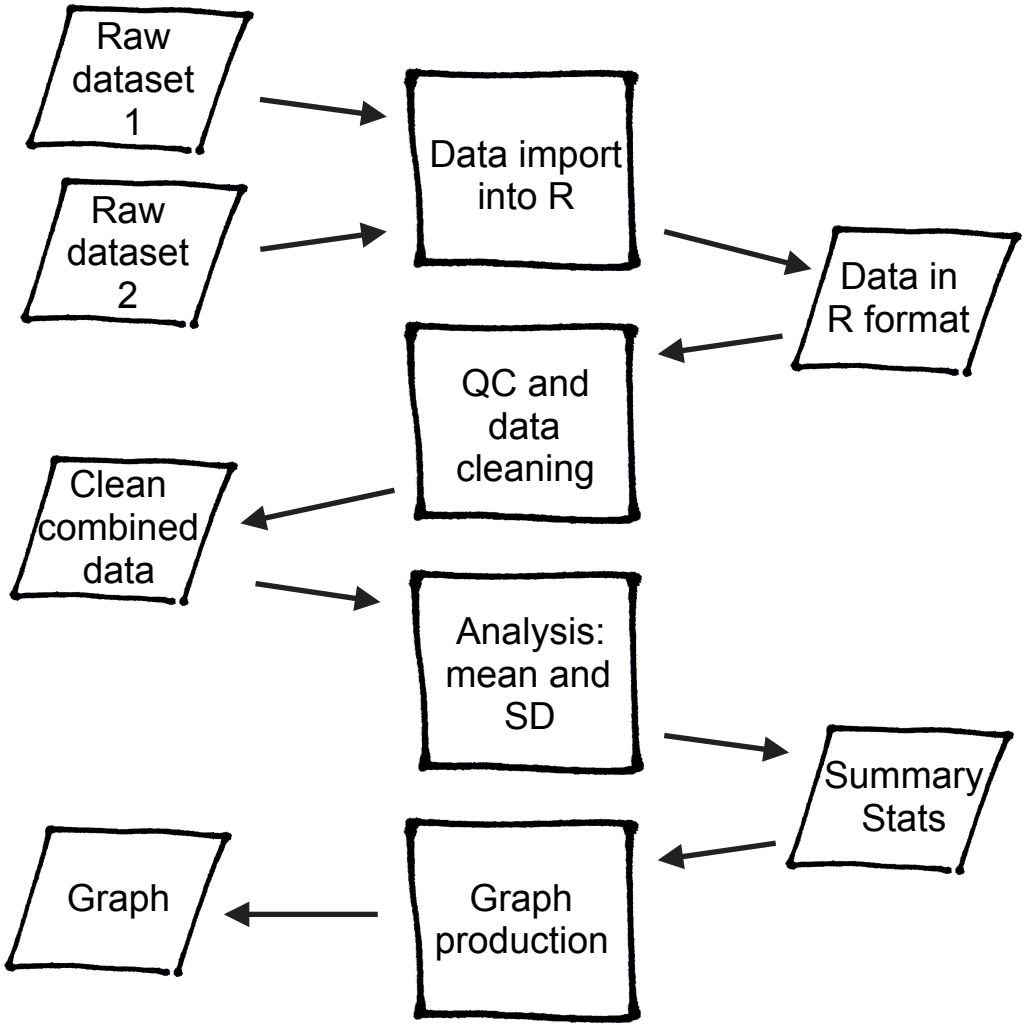
- **Subroutines**

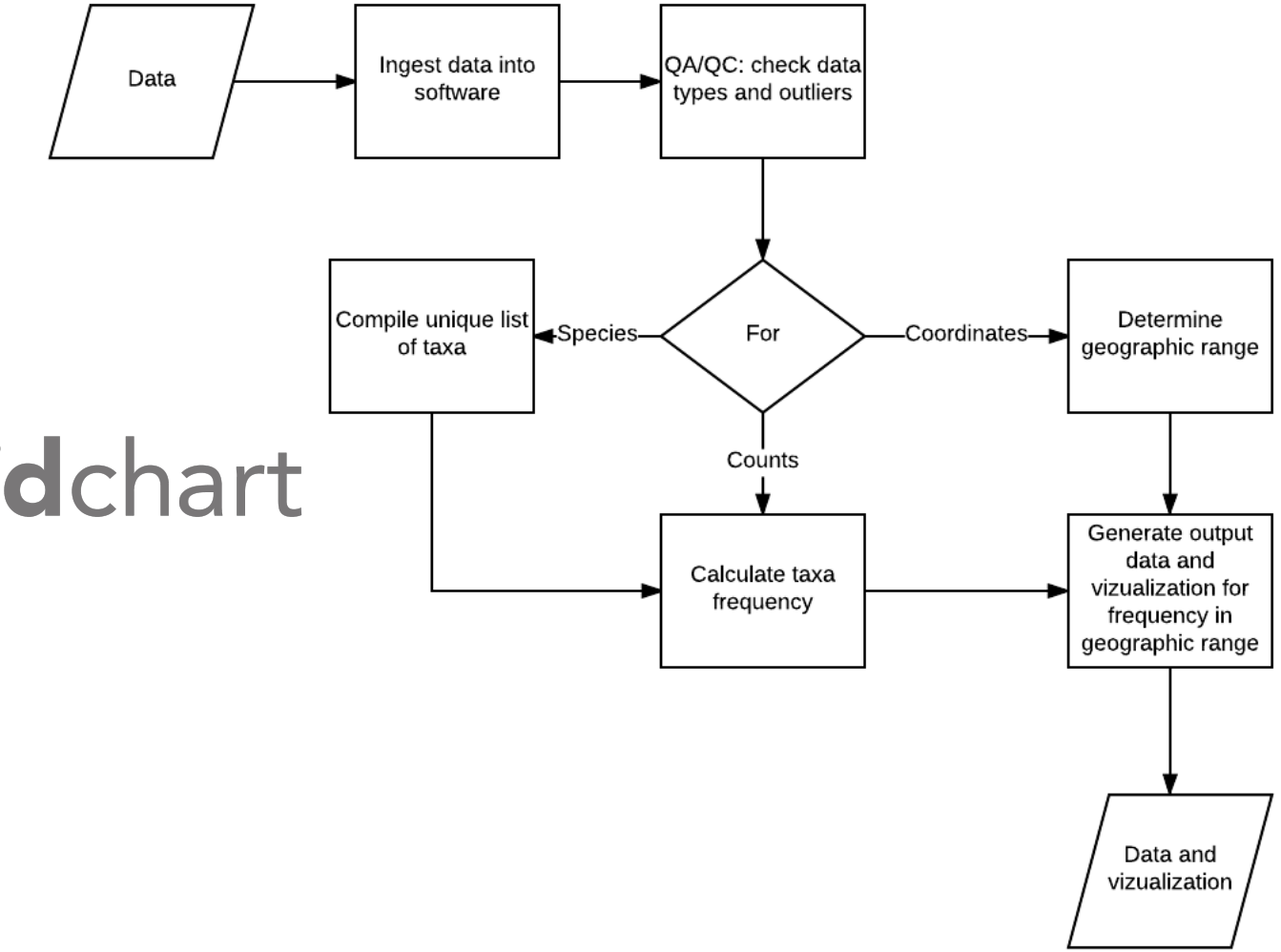
Predefined processes that specify a fixed multi-step process.



- **Decisions**

Specify conditions that determine the next step in the process.


Raw dataset 1
Raw dataset 2
Data import into R
Data in R format
QC and data cleaning
Clean combined data
Analysis: mean and SD
Summary Stats
Graph production
Graph


Data
Ingest data into software
QA/QC: check data types and outliers
Compile unique list of taxa
Species
For
Coordinates
Determine geographic range
Counts
Calculate taxa frequency
Generate output data and vizualization for frequency in geographic range
Data and vizualization

Lucidchart

Formal workflows

- **Kepler**: Designed to help scientists, analysts, and computer programmers create, execute, and share models and analyses

- **Taverna**: A suite of tools used to design and execute scientific workflows and aid in silico experimentation.

- **VisTrails**: Scientific workflow and provenance management system that provides support for simulations, data exploration and visualization.

Conclusion

- Discussed preparing data for analysis and documenting data processing using workflows.

References and resources

- DataOne. "Lesson 09: Analysis and workflows" [module](https://www.dataone.org/education-modules)
- Kepler [website](https://kepler-project.org)
- Taverna [website](http://www.taverna.org.uk)
- VisTrails [website](https://www.vistrails.org/index.php/Main_Page)