Universität Bielefeld

CITEC

CONQUAIRE

Towards an architecture supporting continuous quality control to ensure reproducibility of research.

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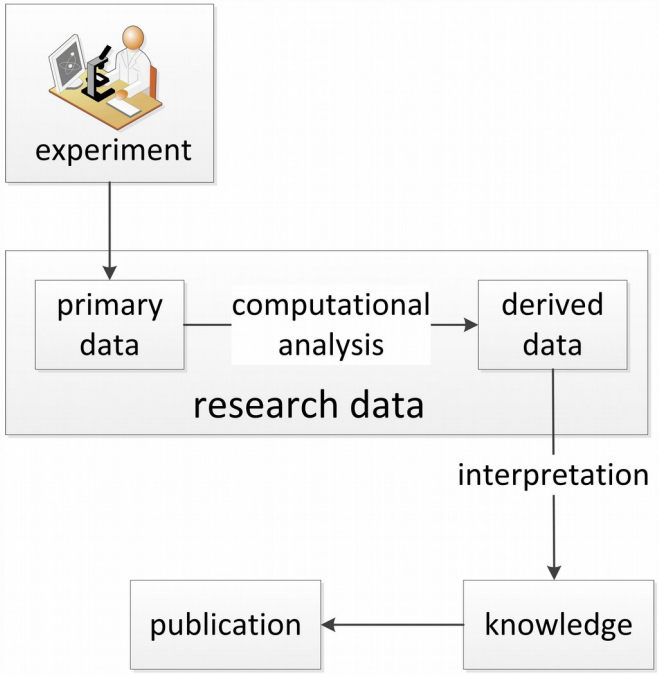
OUTLINE

- Introduction
- Irreproducibility
- Objectives
- Data Desiderata
- Case Studies
- Research Lifecycle
- VCS : Advantages Vs. Disadvantages
- Architecture
- Quality Control
- Conclusion
- ThankYou! (Questions? / Contact)

INTRODUCTION

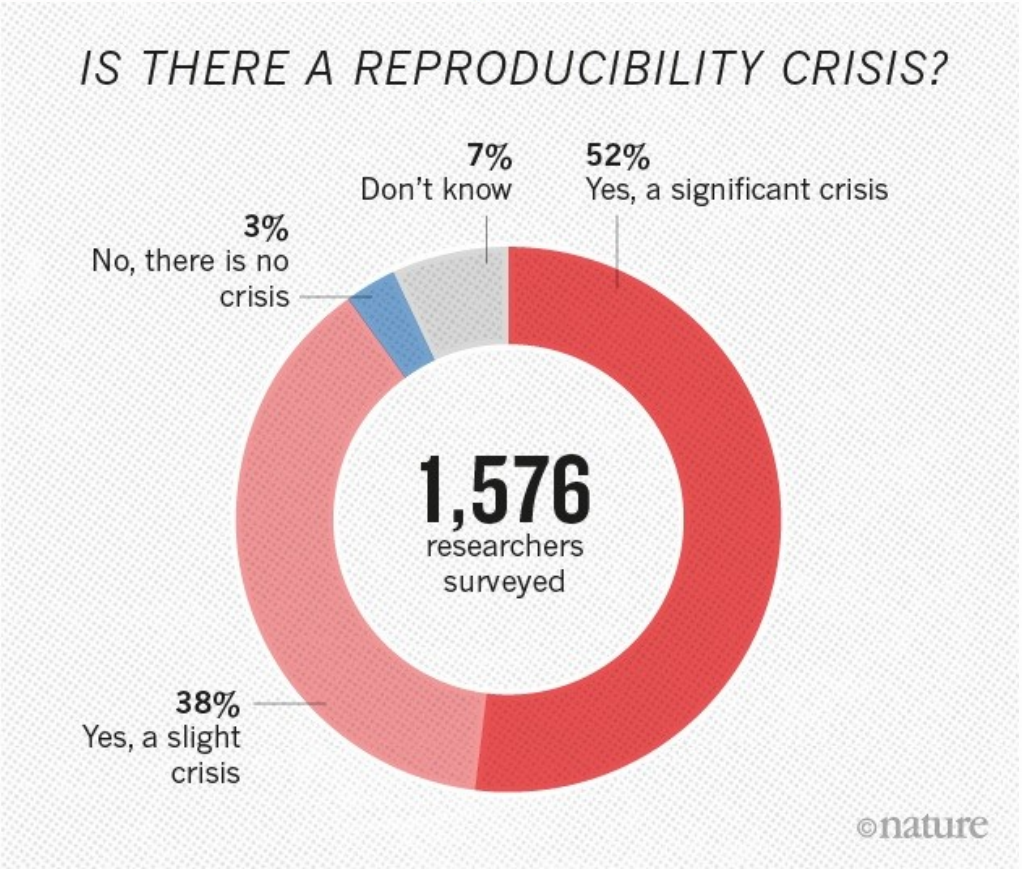
- DFG funded
  - February 2016 – January 2019
- CITEC + Bielefeld University Library



- Replication Vs. Reproducibility
- Analytical Reproducibility = Mathematical!
- Continuous quality control

IRREPRODUCIBILITY

- Metastudies
- Computer Science, Psychology, Medicine
- Failure rates :
  - 70% others research
  - > 50% own research
  - < 31% failure = wrong result



Credits: Baker M., Is there a reproducibility crisis? Nature, 2016.

OBJECTIVES

- Infrastructure - research reproducibility
- Research Data Management System (RDMS)
- Storage + Versioning => Not Enough
- Data = quality + open formats
- Data Validation = raw + results
- Computational analytical reproducibility
- Manage scripts

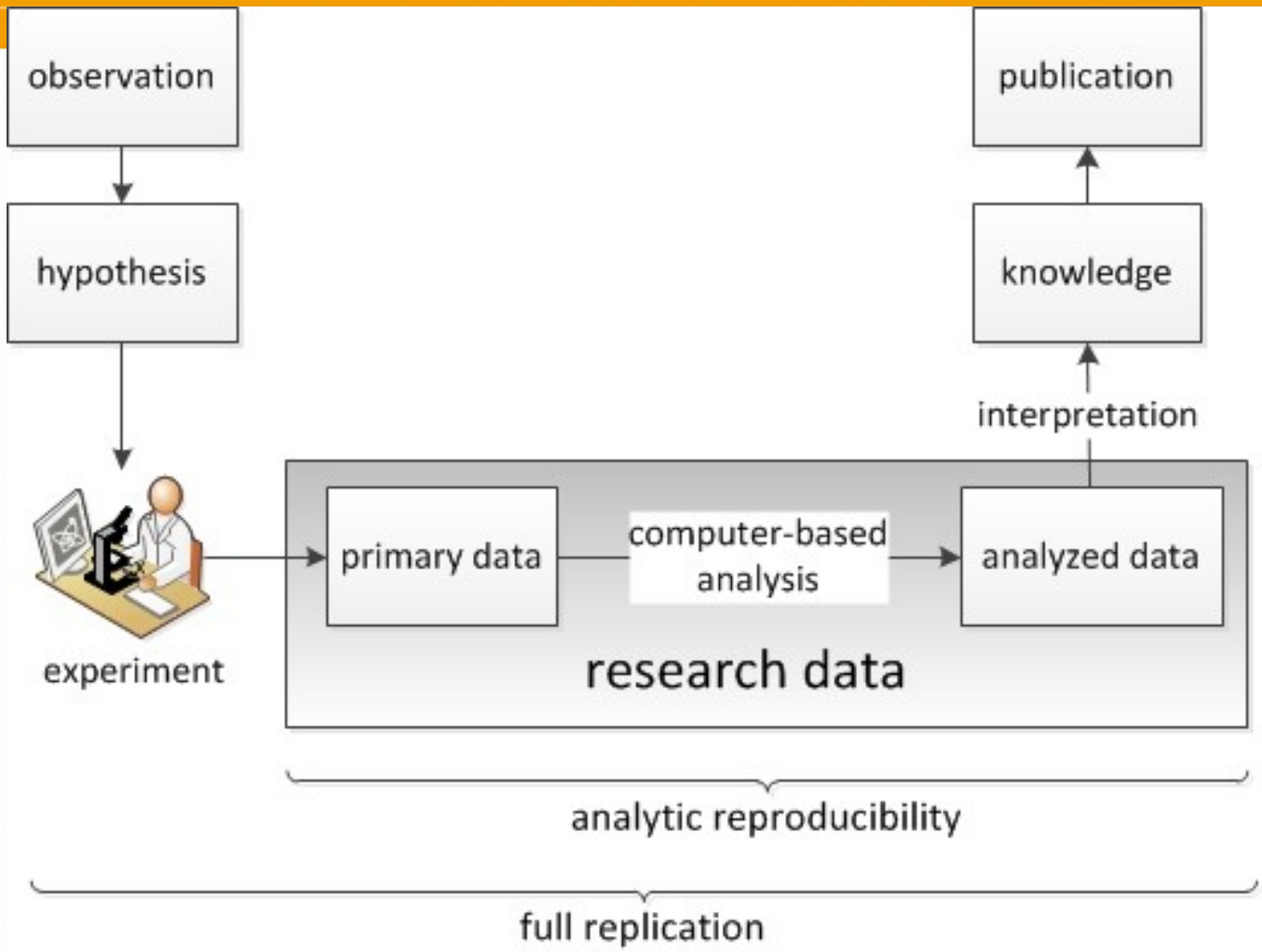
DATA DESIDERATA

- Common format research data : download / inspect
- Syntactically valid open format data
- Documentation : data, scripts, experiment condition
- Third party researcher : data element semantics / understand / reproduce
- Analytical procedures - data processing
- Independent researcher / analyst
  - re-run analytical pipeline
  - verify published results
  - Free and Open Source Software (FOSS)

CASE STUDIES

- **Pilot project**:
  - 9 research partners
  - Interdisciplinary + InterUniversity
- **Disciplines**: Applied Computational Linguistics, Biology, Computer Science, Chemistry, Economics, Linguistics, Neurobiology, Psychology, Sports Science
- Varied data formats/ experimental tools/ software
- Data Management Plan (DMP)

RESEARCH LIFECYCLE



VCS
Advantages Vs. Disadvantages

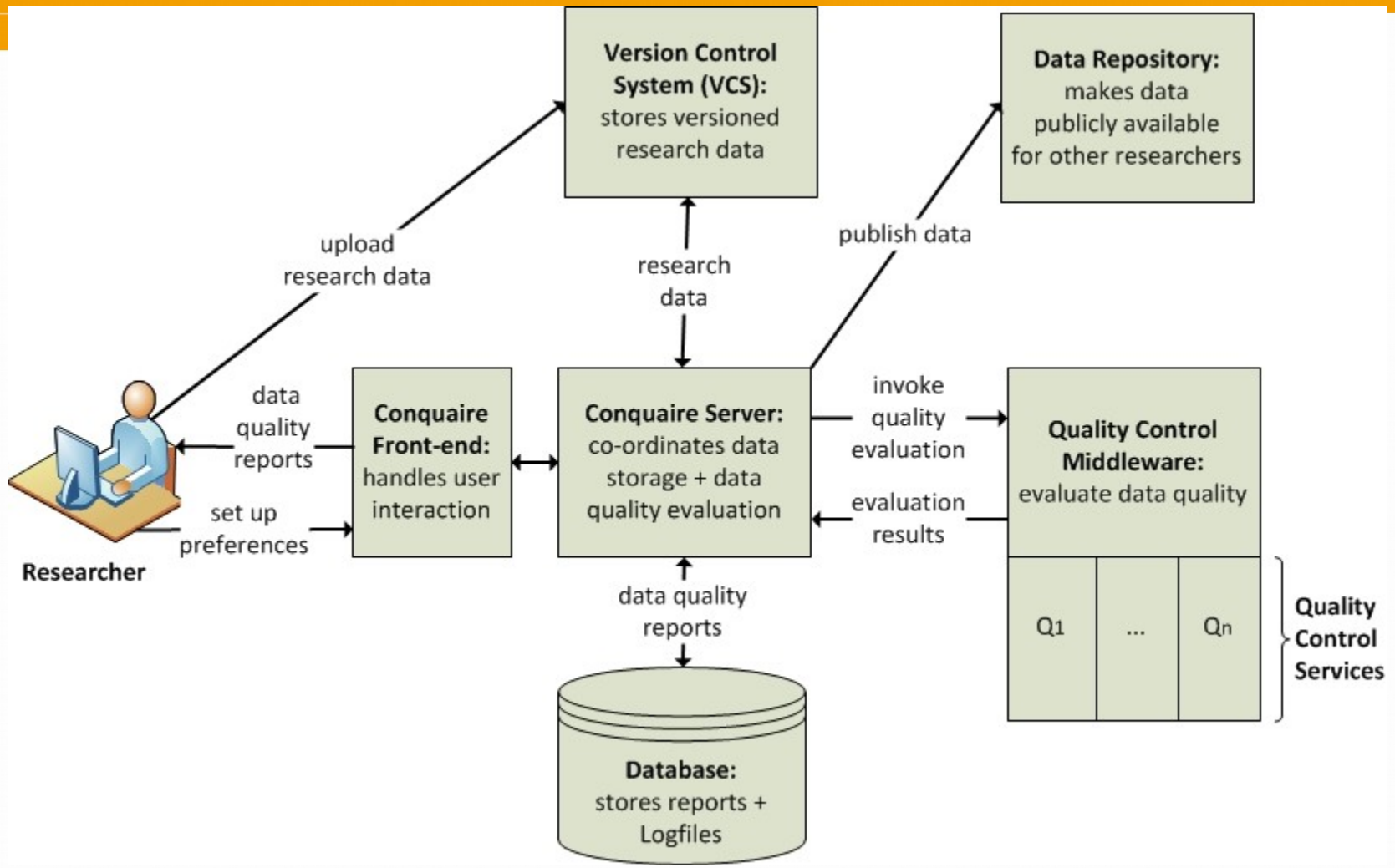
- Solves data tracking problem
- Access to data revisions
- Timestamps : data + scripts
- Commit : Revision, Diffs, Merges, Branch.
- Objects : compressed, SHA1 hash
- Stored as 'pack-file'
- CI (runners), daemons, loggers

- 3-5 years : data loss
- No support for change tracking
- Manual file comparison
- Data sharing challenges
- Dropbox, Sciebo, Google Drive, private servers/ disks
- Cloud services => Privacy concerns, no backups
- Data changes over time

ARCHITECTURE

- Front-End GUI : repo status, badges, analysis reports
- Back-End Architecture :
  - VCS Server : research artefacts
  - Conquaire Server : Stateful Process Logic
  - Quality Analysis Middleware Server
    - Data management / curation
    - Continuous Integration (CI)
    - Quality analysis / processing
    - Monitor project data / metadata
    - Standards : ISO, IETF, W3C
  - Database
- Front-End : PUB (Publications at Bielefeld University) paper downloads
  - Trusted Data Repository integration (Back-End)

ARCHITECTURE



QUALITY CONTROL

- Analysis : compute statistical functions
- Documentation, Scripts, Primary/Secondary data (raw + results)
- Support multiple data exchange formats
- **.csv** sample implementation
  - Metadata schema standard : YAML format

- Standards specification : **RFC 4180**
  - data type matching
  - records (one per line)
  - column headers
  - range of values : metadata
  - field delimiters (reserved character: comma, semicolon, or tab)
  - column textual definition : warn < 5 tokens
  - out of range value / NAN / Null
  - character set such as ASCII, various Unicode character sets (e.g. UTF-8), EBCDIC

CONCLUSION

- Conquaire : Infrastructure for research data management system (RDMS)
  - Support continuous data quality control
  - Enable analytical reproducibility

- Collaborators – Bielefeld University research partners
  - Store research artefacts (data, analytical workflows, software, publications)
  - Improve research methods and workflow tools

- Current Architechture status
  - Created pre-alpha implementation
  - Quality System functionality – ex. CSV

THANK YOU!

- Questions?

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