Simple Archive Architectures

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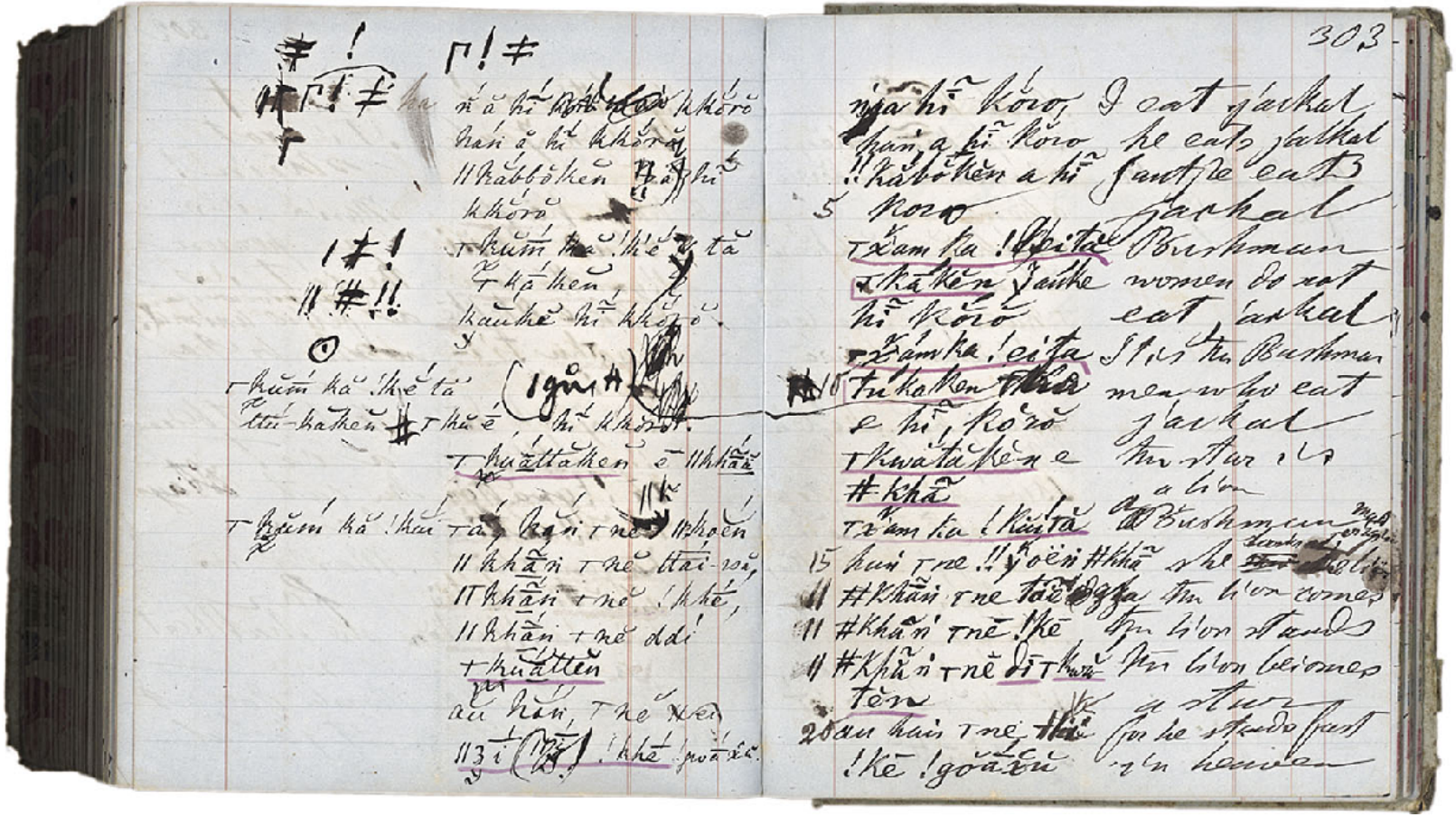
lloydbleekcollection.cs.uct.ac.za



Contextual Overview

- Problems and challenges
  - Preservation costs
  - Technical skills and expertise
  - Computing resources
- Proposed solution
  - Explicit simplicity and minimalism
  - Principled design of DL tools and services
- Motivation
  - Successes of minimalism---Project Gutenburg

Research goals

- Is it feasible to implement DLSes based on simple architectures?
  - How should simplicity for DLS storage and service architectures be defined?
    - Derivation of design principles
    - Simple repository prototype + case studies
  - What are the implications of simplifying DLS?
    - Developer user study
    - Performance evaluation
  - What are some of the comparative advantages and disadvantages of simple architectures?
    - DSpace 3.1 comparative evaluation

Claim #1: Simplicity for DL storage and services can be defined through derivation

Design Principles (1)

- Meta-analysis of popular software applications
  - 12 candidate tools were considered---even split between DL and non-DL tools
  - Tool attributes that potentially influenced design of tools identified
  - Pair-wise comparison done to assess most appropriate attributes
- Eight guiding design principles derived [1]
  - Applicable for simple and minimalistic architectures

Design Principles (2)

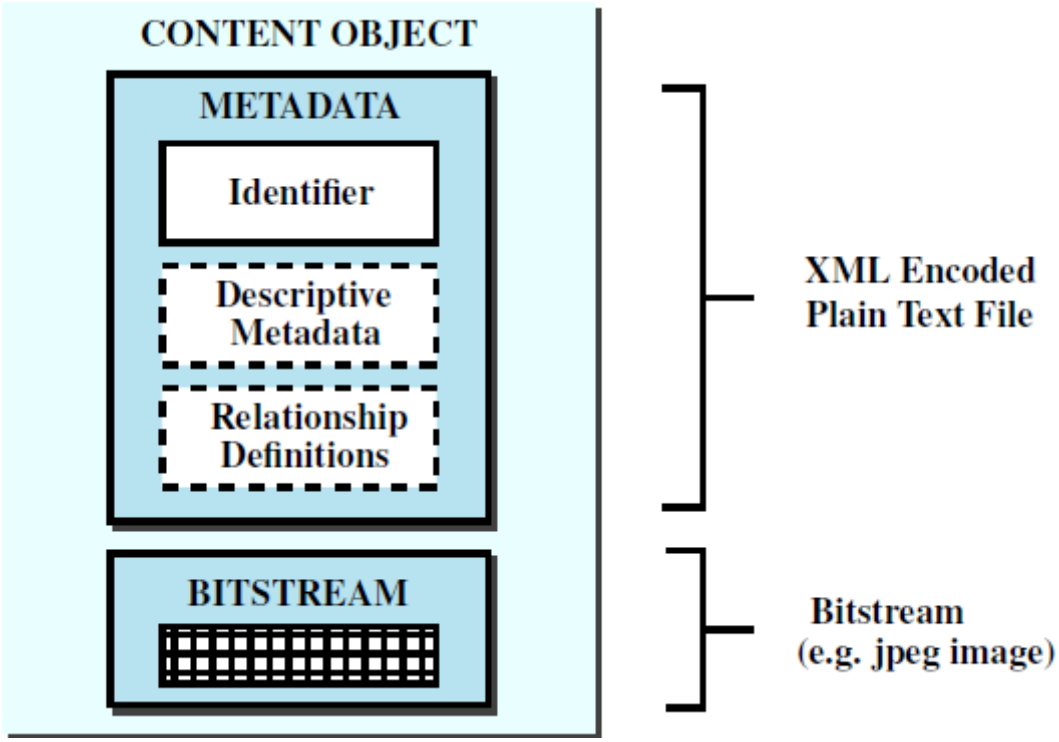
- Principles mapped to potential repository architectural design decisions
  - Applicable principles derived during mapping

Table 4-1. Simple repository persistent object store design decision

Element	Description
Issues	Principles 1, 2, 6 and 8
Decision	Store bitstreams on the local operating system filesystem
Assumptions	None
Alternatives	Store bitstreams as blobs in a database; store bitstreams in the cloud
Rationale	Backup and migration tasks associate to repository objects can be potentially simplified; operating system commands can be used to perform repository management tasks
Implications	None –most conventional tools and services use the same approach
Notes	None

Simple Repository Prototype

- File-based
  - Digital objects stored on OS
  - Hierarchical collection structure
- Metadata objects
  - DC plain text files
- Object organisation
  - Metadata stored along content
  - Nested objects

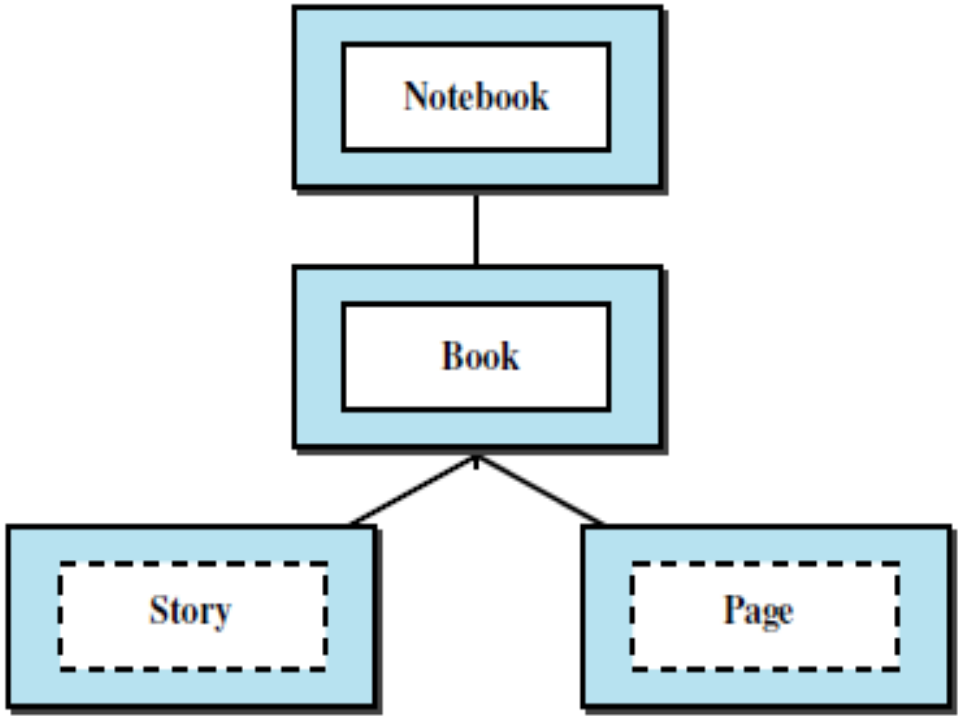


Case studies

- Two case studies involving two different collections
  - The Bleek and Lloyd Collection
    - Honours project: “Bonolo” [5]
  - SARU archaeological database
    - Honours project: “The School of Rock Art” [6]

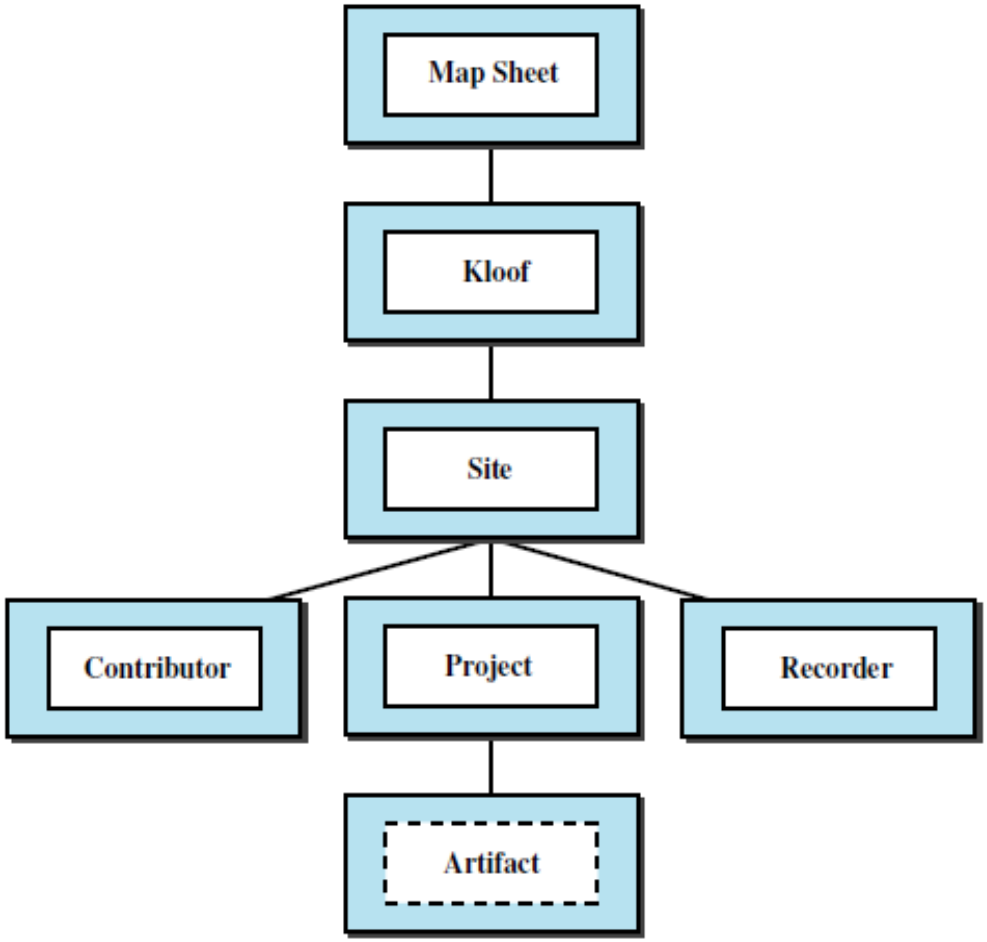
“The Digital Bleek and Lloyd”

- 18,924 content objects with a total size of 6.2GB
- Two-level collection structure
  - Virtual content objects representing stories
- “Bonolo” [5] DLS implemented using repository sub-layer



“SARU Archaeological database”

- 72,333 content objects with a total size of 283GB
- Four-level collection structure
- “The School of Rock Art” [6] implemented using repository sub-layer



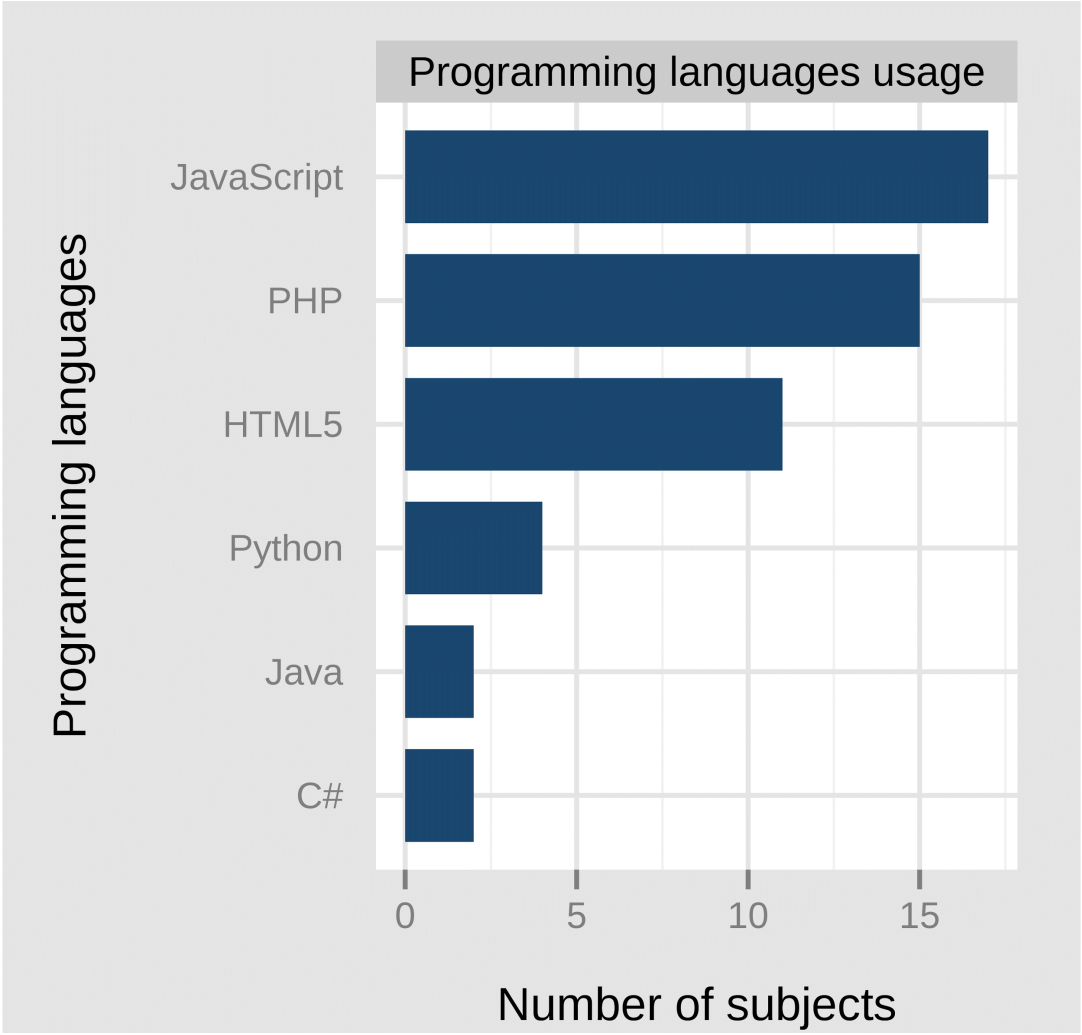
Claim #2: There are desirable features and advantages possessed by DL tools and services implemented using simple architectures

User Study (1)

- Developer-oriented study
  - Assess simplicity and flexibility of simple repository architecture
- Target population
  - 34 computer science honours students split into 12 groups of twos and threes
  - Basic developer skills and DL knowledge
- Approach
  - Participants tasked to build layered services using simple repository
  - Post-experiment survey

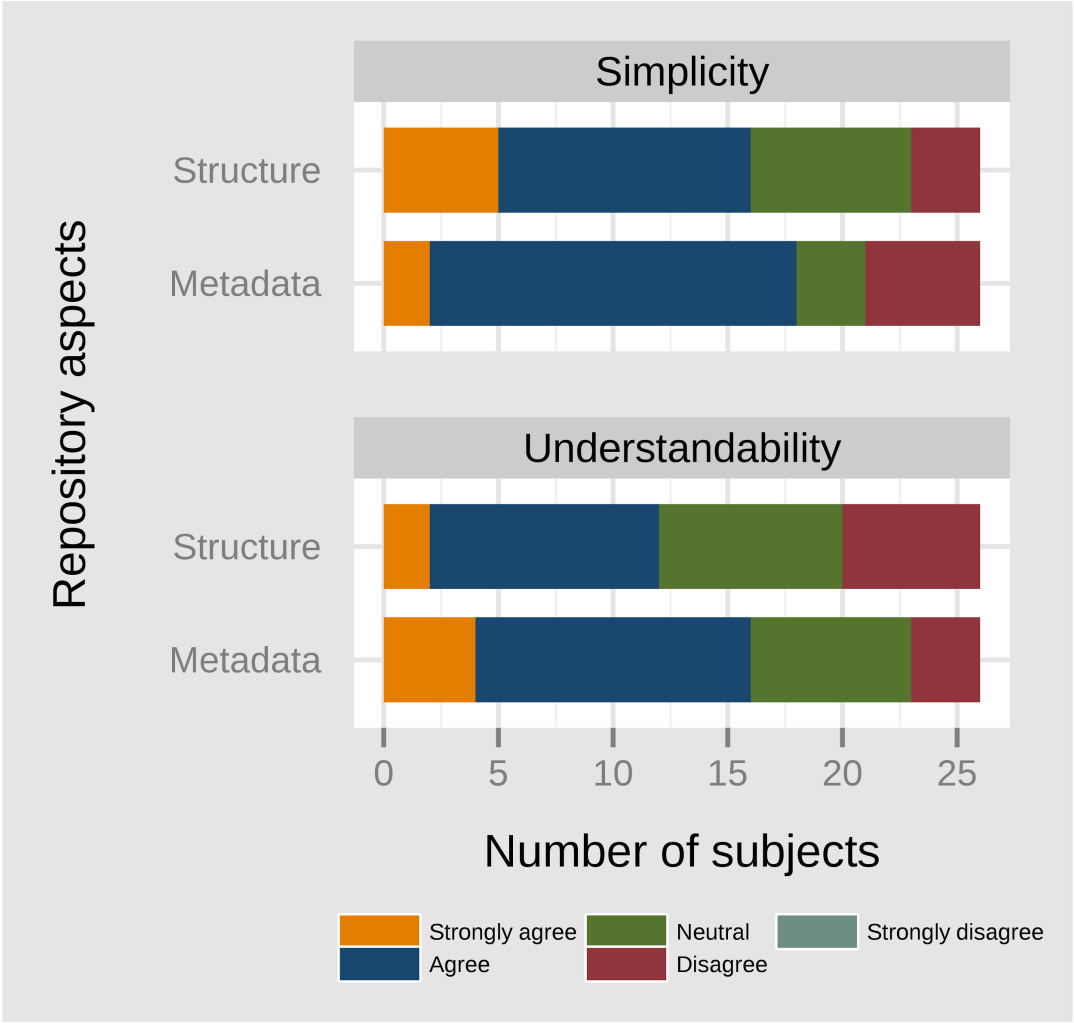
User Study (2)

- Wide variety of layered services
- Wide variety of programming languages used
- Choice of language not influenced by repository design; only 15% indicated that it did



User Study (3)

- Dublin Core XML-encoded files perceived simple& easy to work with
  - 69% and 61% respectively
- Repository perceived simple but not easily understandable
  - 62% and 46% respectively



User Study (4)

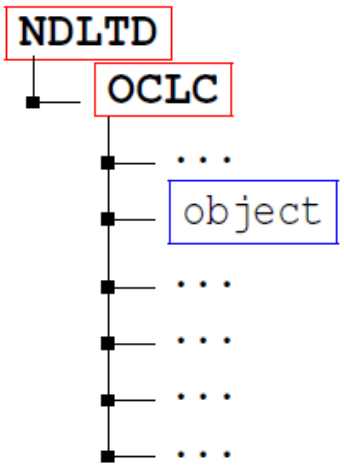
- Simplicity resulted in more understandable repository layer
  - Most participants found Dublin Core XML-encoded metadata files easy and simple to work with
  - Most participants found hierarchical structure simple but not easily understandable
- Flexibility of interaction with repository layer unaffected by simplicity
  - No influence on programming languages

Performance Evaluation (1)

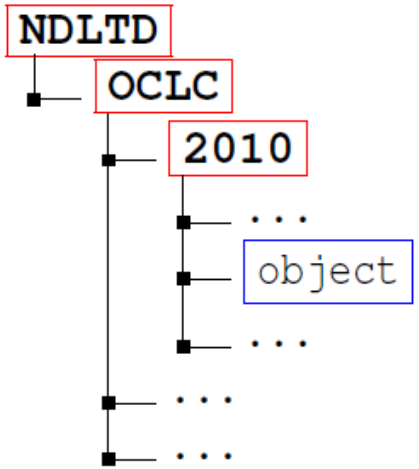
- Assess and benchmark performance relative to collection size
  - Typical DL service aspects evaluated. Ingestions, search, OAI-PMH data provider and feed provider
  - Log analysis of production repository informed aspects
- Comparative assessment with DSpace 3.1
- Experimental design
  - Metrics---Response time
  - Factors---Collection size and structure

Performance Evaluation (2)

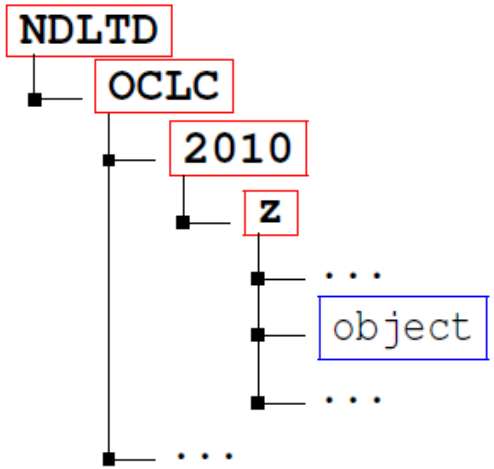
- Three datasets with 15 linearly increasing workloads; data from NDLTD Union Catalog
  - One-, two- and three-level collection structures
  - Varying objects in different collection structures



(a) Dataset#1 structure



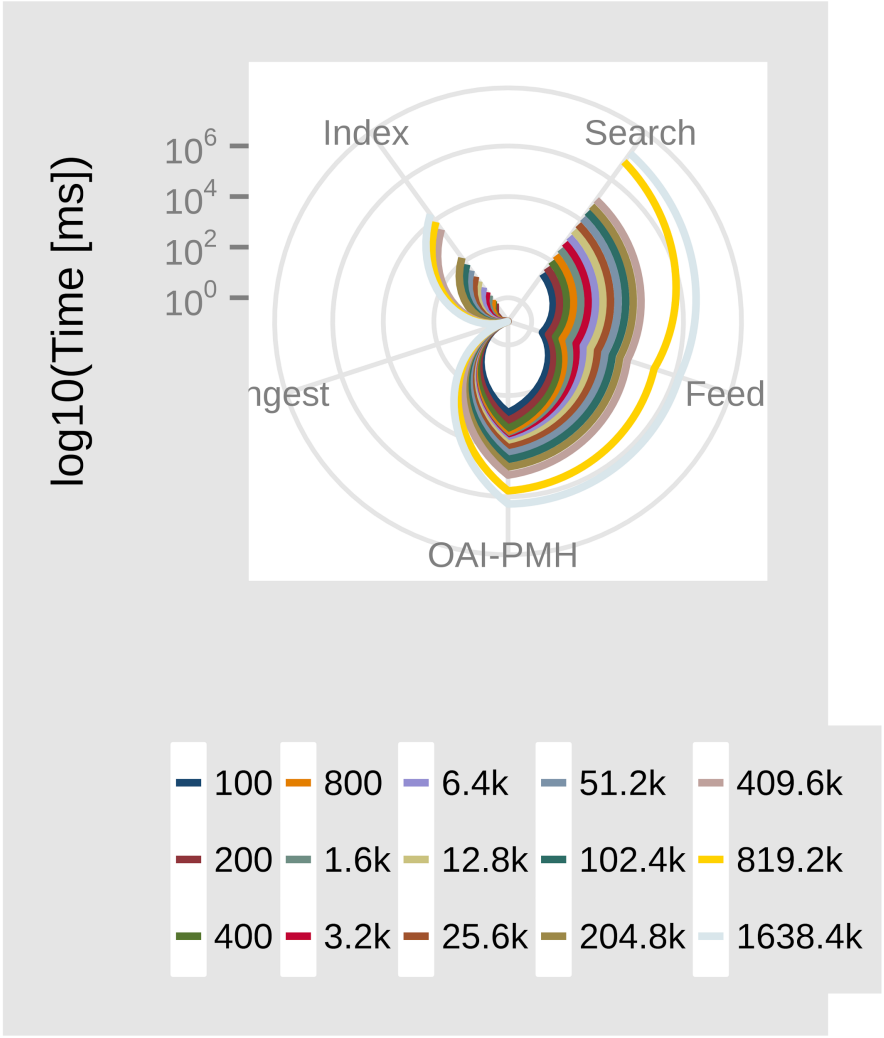
(b) Dataset#2 structure



(c) Dataset#3 structure

Performance Evaluation (3)

- Performance within acceptable limits for medium-sized collections
- Collections > 12,800 objects affected
- Information-discovery services---feed, full-text search and OAI-PMH data provider---affected



Performance Evaluation (4)

- Performance benchmarking
  - Performance within acceptable limits for medium sized collections
  - Performance degradation beyond 12 800 objects
  - Performance degradation adversely affects information discovery services; ingestion process unaffected by collection scale
- Comparison with DSpace 3.1
  - Ingestion performance outperformed DSpace 3.1
  - Information discovery services outperformed by DSpace 3.1

Conclusions

- Principled DL design approach undertaken
- Feasibility of simple DL architectures
- Minimalism does not affect flexibility and extensibility of DL tools and services
- Performance acceptable for small- and medium-sized collection
- Comparable results with well-established solutions

Bibliography

[1] Lighton Phiri and Hussein Suleman. *In Search of Simplicity: Redesigning the Digital Bleek and Lloyd*. DESIDOC '12 32(4): 306–312, 2012.

[2] Lighton Phiri et al. *Bonolo: A General Digital Library System for File-based Collections*. ICADL '12 7634:49–58, 2012.

[3] Lighton Phiri and Hussein Suleman. *Flexible Design for Simple Digital Library Tools and Services*. SAICSIT '13 160–169, 2013

[4] Lighton Phiri and Hussein Suleman. *Managing cultural heritage: information systems architecture*. Facet Publishing 13–134, 2015

[5] Stuart Hammar and Miles Robinson. *Bonolo Project* URL: http://goo.gl/EtblcR

[6] Kaitlyn Crawford et al. *The School of Rock Art*. URL: http://goo.gl/U092EH

Questions?

Additional information

http://dl.cs.uct.ac.za