Board on 
Mathematical Sciences & Analytics

LIFE CYCLE DECISIONS FOR BIOMEDICAL DATA

The Challenge of Forecasting Costs
BOARD ON MATHEMATICAL SCIENCES AND ANALYTICS

Forecasting Data Costs for Storage Providers

Life Cycle Decisions for Biomedical Data: The Challenge of Forecasting Costs

Presented to the Public
August 27, 2020
Forecasting Data Costs for Researchers, Funders, and Storage Providers
August 2020 weekly webinar series, 12-1pm ET

Recordings available at https://vimeo.com/showcase/7444639

**August 13:** Forecasting Data Costs for Researchers

**August 20:** Forecasting Data Costs for Funding Institutions

**August 27:** Forecasting Data Costs for Storage Providers

This webinar series is sponsored by the National Library of Medicine of the National Institutes of Health

Watch webinar videos and learn more about BMSA at https://biomed-data-costs.eventbrite.com/
Forecasting Data Costs
for Storage Providers

Ilkay Altintas
(Moderator)
University of California San Diego

Clifford Lynch
Coalition for Networked Information

Brian Nosek
Center for Open Science

Alex Ropelewski
Pittsburgh Supercomputing Center

The National Academies of
SCIENCES • ENGINEERING • MEDICINE
Clifford Lynch

Executive director, Coalition for Networked Information

Forecasting Data Costs: Highlights for Storage Providers
Summary of my talk

Very brief overview of report & work (see video of earlier committee webinar for a more detailed review)

Closer look at Underlying Framework Foundation of Three Data States
Comments on State Transitions: ”Dehydration” and “Hydration”
Comments on Selected Sources of Uncertainty (“Disrupters”)
Thoughts on Strategies for State 2 Resources and Terminologies

https://vimeo.com/showcase/7444639
Context

- Biomedical researchers generate, collect, and store research data in increasing volumes and dimension.
- Sustained data access and preservation generate costs that are difficult to predict and allocate responsibility for.
- The biomedical data landscape is diverse and dynamic, requiring unique and innovative approaches.
National Library of Medicine of the National Institutes of Health asked for a framework for forecasting long-term costs for preserving, archiving, and accessing biomedical data.
Data Value

• The perceived value of data influences decisions regarding their life cycle.
• Data value does not necessarily correlate with the financial investment made to collect those data.
• The value of a data resource compounds if it sparks connections among diverse users.
Cost Forecasting Framework

• Helps forecaster identify major cost drivers

• Basis for a cost forecast (not a one-size-fits-all analysis tool)

• Will help forecaster identify decisions that impact short- and long-term costs and data value

• The forecaster is encouraged to think beyond the specific data state being developed or managed; about how decisions may affect the costs of data management and access in future data states, the transitions to those states, and the future value of data.

• Use Case: Estimating costs of a new data repository for the BRAIN Initiative
Cost Components of a Biomedical Information Resource

- **Labor**—direct salaries and benefits
- **IT infrastructure**—computer purchase, upgrade, and replacement; storage servers; networking equipment; software
- **IT services**—installation, operation, and maintenance of IT infrastructure
- **Media**—consumable storage (e.g., tapes, DVDs)
- **Licenses and subscriptions**—periodic payments for access/use of data, software, services
- **Facilities and utilities**—space for people and IT infrastructure, utilities (might be incorporated into institutional overhead)
- **Outside services**—consultants, external auditors, off-site media storage, training
- **Travel**—costs for outreach activities, to convene governing boards, and so on.
- **Institutional overhead**—indirect costs for administrative and other support (might be allowed in a contract or grant)
- **Other “soft” costs** (e.g., time users expend to use the data)

(Box 3.2 in text)
Cost Forecasting Framework: Cost Drivers

Data properties that affect the costs of data access and preservation

A. Content
B. Capabilities
C. Control
D. External Context
E. Data Life Cycle
F. Contributors and Users
G. Availability
H. Confidentiality
I. Maintenance and Operations
J. Standards, Regulatory, and Governance concerns
Framework Foundation: Three Data States

**State 1:** Primary research/data management environment; data are captured and analyzed

**State 2:** Active repository and platform; data may be acquired, curated, aggregated, accessed, and analyzed

**State 3:** Long-term preservation platform
Forecasting Data Costs
for Storage Providers

co-Founder and Executive Director,
Center for Open Science; Professor of
Psychology, University of Virginia

Open Science Framework

Brian Nosek
Open Science Framework

Cost Drivers and Forecasting

http://osf.io/

Brian Nosek, Center for Open Science

http://cos.io/

These slides: https://osf.io/zsqyp/
OSF: http://osf.io/

Launched 2012, free to use (deposit and access), open-source

Full research life-cycle project and data management and archiving

Private, controlled access, and open: Highly configurable

250,000 registered users “producers”; 250 new users/day

>8,000,000 files; 230 TB

>2,500,000 “consumer” users; 16.3M downloads in 2019, pace for 28M in 2020
How we can use the cost framework

Forecasting

Product Strategy: Sustainability

Product Strategy: Design

These slides: https://osf.io/zsgyp/
Number of Registered OSF Users

- 2012: 371
- 2013: 2,322
- 2014: 6,713
- 2015: 16,105
- 2016: 38,782
- 2017: 74,739
- 2018: 124,024
- 2019: 190,851
- 2020 Proj: [Graph data]

Number of OSF Study Registrations

- 2012: 38
- 2013: 317
- 2014: 1,208
- 2015: 5,075
- 2016: 5,582
- 2017: 11,798
- 2018: 21,987
- 2019: 356,775
- 2020 Proj: [Graph data]

These slides: https://osf.io/zsqyp/
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How we can use the cost framework

Forecasting

Product Strategy: Sustainability

Product Strategy: Design

These slides: https://osf.io/zsqyp/
OSF Use Cases

Prospective

Plan -> Preregister -> Manage Project/Data -> Archive/Share -> Report

Retrospective

Report -> Prepare Data -> Archive/Share

These slides: https://osf.io/zsqyp/
Using framework to inform product strategy

Prospective

State 1
Plan -> Preregister -> Manage Project/Data -> Archive/Share -> Report

State 2

Retrospective

State 2
Report -> Prepare Data -> Archive/Share

These slides: https://osf.io/zsqyp/
Using framework to inform product strategy

Prospective

Plan -> Preregister -> Manage Project/Data -> Archive/Share -> Report

State 1

State 2

aws
Google Drive
Box
GitHub
Dropbox

These slides: https://osf.io/zsqyp/
Using framework to inform product strategy

Prospective

State 1
Plan -> Preregister -> Manage Project/Data -> Archive/Share -> Report

State 2

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How we can use the cost framework

Forecasting

Product Strategy: Sustainability

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These slides: https://osf.io/zsgyp/
PLANNING
Explore existing research.
Preregister analysis plan.
Create time-stamped registration.

CONDUCTING
Open data management, collaboration, storage integration

REPORTING
Open data, materials, code.
Open access publishing.

DISCOVERY
Share work.
Improve discovery.
Aggregate findings.

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DISCOVERY
- Share work.
- Improve discovery.
- Aggregate findings.

These slides: https://osf.io/zsqyp/
Custom Collections and Repositories on OSF

nosek@cos.io

These slides: https://osf.io/zsqyp/
<table>
<thead>
<tr>
<th><strong>State 1</strong></th>
<th><strong>State 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Can receive direct input from data acquisition tools (Open Sesame)</td>
<td>Archiving and sharing data, protocols, code</td>
</tr>
<tr>
<td>Interacts with active analysis pipelines (osfr package; JASP Stats)</td>
<td>Interfaces/Collections for aggregating content</td>
</tr>
<tr>
<td>Collaborative teams do data management work on OSF (Privately or openly)</td>
<td>Custom curation/moderation processes</td>
</tr>
<tr>
<td>Integrations with live data environments (Dropbox, Drive, Box, GitHub, etc.)</td>
<td>Metadata and FAIR standards</td>
</tr>
<tr>
<td>Registration of research and data management plans prior to data acquisition</td>
<td>Open and Controlled Access</td>
</tr>
<tr>
<td></td>
<td>Integrations with state 2 repositories</td>
</tr>
</tbody>
</table>
Forecasting Data Costs
for Storage Providers

Director, Biomedical Applications Group, Pittsburgh Supercomputing Center; PI and Operations Director, Brain Image Library

Alex Ropelewski

The Brain Image Library: an NIH BRAIN Data Repository

The National Academies of
SCIENCES • ENGINEERING • MEDICINE
Mission: National public resource enabling researchers to deposit, analyze, mine, share and interact with microscopy datasets of the brain.

Scope:
• Permanent repository for high-quality brain microscopy datasets
  — Whole brain images of mouse, rat, other mammals and model organisms
  — Targeted experiments Including connectivity between cells and spatial transcriptomics ( *FISH)
  — Historical collections
• Provide HPC computing capability local to the data for pre-submission data processing and post-submission exploration
  — Enclave access to pre-release data
  — Research access to restricted-access, secured data
• Provide user access and support

Figure S1: Life Cycle Decisions for Biomedical Data: The Challenge of Forecasting Costs (2020) doi: 10.17226/25639
# Cost Drivers

## Content

<table>
<thead>
<tr>
<th>Now</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>● ●</td>
</tr>
<tr>
<td>Complexity/Diversity</td>
<td>● ●</td>
</tr>
<tr>
<td>Metadata</td>
<td>● ●</td>
</tr>
<tr>
<td>Depth vs Breadth</td>
<td>● ●</td>
</tr>
<tr>
<td>Processing/Fidelity</td>
<td>● ●</td>
</tr>
<tr>
<td>Replaceability</td>
<td>● ●</td>
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</tbody>
</table>

## Control

<table>
<thead>
<tr>
<th>Now</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Control</td>
<td>● ●</td>
</tr>
<tr>
<td>Quality Control</td>
<td>● ●</td>
</tr>
<tr>
<td>Access Control</td>
<td>● ●</td>
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<tr>
<td>Platform Control</td>
<td>● ●</td>
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</tbody>
</table>

## External Content

<table>
<thead>
<tr>
<th>Now</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource Replication</td>
<td>● ●</td>
</tr>
<tr>
<td>External Information Dependencies</td>
<td>● ●</td>
</tr>
<tr>
<td>Distinctiveness</td>
<td>● ●</td>
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</tbody>
</table>

## Contributors

<table>
<thead>
<tr>
<th>Now</th>
<th>Future</th>
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</thead>
<tbody>
<tr>
<td>Contributor Base</td>
<td>● ●</td>
</tr>
<tr>
<td>User Base</td>
<td>● ●</td>
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<tr>
<td>Training/Support</td>
<td>● ●</td>
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<tr>
<td>Outreach</td>
<td>● ●</td>
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</tbody>
</table>

## Availability

<table>
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<tr>
<th>Now</th>
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</tr>
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<tbody>
<tr>
<td>Outage Tolerance</td>
<td>● ●</td>
</tr>
<tr>
<td>Currency</td>
<td>● ●</td>
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<tr>
<td>Response Time</td>
<td>● ●</td>
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<tr>
<td>Local vs Remote</td>
<td>● ●</td>
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</tbody>
</table>

## Confidentiality

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</tr>
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<tbody>
<tr>
<td>Confidentiality</td>
<td>● ●</td>
</tr>
<tr>
<td>Ownership</td>
<td>● ●</td>
</tr>
<tr>
<td>Security</td>
<td>● ●</td>
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</tbody>
</table>

## Capabilities

<table>
<thead>
<tr>
<th>Now</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Annotation</td>
<td>● ●</td>
</tr>
<tr>
<td>Persistent Identifiers</td>
<td>● ●</td>
</tr>
<tr>
<td>Citation</td>
<td>● ●</td>
</tr>
<tr>
<td>Search Capabilities</td>
<td>● ●</td>
</tr>
<tr>
<td>Data Linking/Merging</td>
<td>● ●</td>
</tr>
<tr>
<td>Use Tracking</td>
<td>● ●</td>
</tr>
<tr>
<td>Analysis/Visualization</td>
<td>● ●</td>
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</tbody>
</table>

## Maintenance

<table>
<thead>
<tr>
<th>Now</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Integrity Check</td>
<td>● ●</td>
</tr>
<tr>
<td>Data Transfer</td>
<td>● ●</td>
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<tr>
<td>Risk Management</td>
<td>● ●</td>
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<tr>
<td>System Reporting</td>
<td>● ●</td>
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<tr>
<td>Billing</td>
<td>● ●</td>
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</table>

## Standards

<table>
<thead>
<tr>
<th>Now</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td>● ●</td>
</tr>
<tr>
<td>Regulatory/Legislative Environment</td>
<td>● ●</td>
</tr>
<tr>
<td>Governance</td>
<td>● ●</td>
</tr>
<tr>
<td>External Consultation</td>
<td>● ●</td>
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## Relative Cost Potential

- ●: Low
- ○: Med
- ●: High

Thank You!

Contact us at: bil-support@psc.edu

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Alan Watson (Microscope)
Forecasting Data Costs for Storage Providers

Please submit questions using the Q&A button in the zoom menu.

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