


MorphoSource's approach to describing, preserving and managing complex representational data

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- 3D data can be viewed as a microcosm for representational data more broadly
 - Direct representation of object, but...
 - High metadata load
 - Lack of easy software support
 - No best practices for linkages
 - Data produced by many people in many ways
- Solutions for 3D data can possibly be instructive for representational data more broadly

- Similarly, MorphoSource reflects challenges of representational data repositories
 - Supporting challenging type of data (3D)
 - Providing platform for individuals and groups
 - Archiving and serving access to data
 - Demonstrating value of data represented in archive
- Describing MorphoSource's journey and design to both seek feedback for self-improvement and hopefully say something about broader issues at play

- MorphoSource 1 (MS1) Development Timeline
 - How was the site built?
 - What stressors were experienced?
- MorphoSource 2 (MS2) State of the Refactor
 - Development
 - Tour of features
- Integrating MorphoSource with Other Resources



MORPHO SOURCE
BY DUKE UNIVERSITY

[ABOUT](#) | [BROWSE](#) | [DASHBOARD](#) |
[LOGIN/REGISTER](#)

Getting Started


Find & Download Datasets

[BROWSE](#) or

[LOGIN OR REGISTER](#)

Useful Info

- [About MorphoSource](#)
- [Information for Users](#)
- [Information for Contributors](#)
- [Terms](#)
- [User Guide](#)

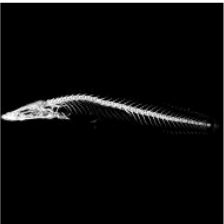



foot of Daubentonia madagascariensis scanned at 38micron resolution at Duke Evolutionary Anthropology department's new high resolution microCt facility. [Click here if you are interested in details on the facility](#)

Recently Published

A new genus and species of clingfish from the Rangitahua Kermadec Islands of New Zealand

[See all project specimens](#)
[Read the published article](#)



Welcome

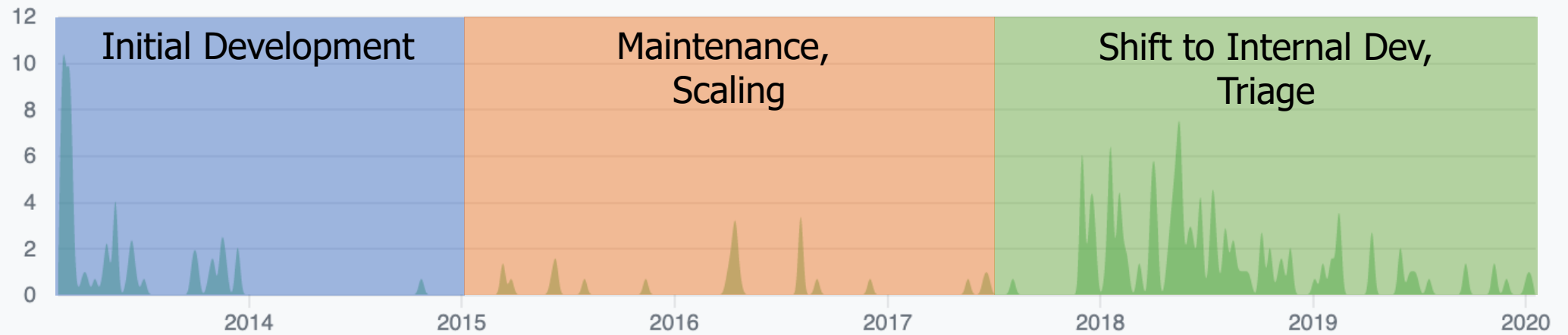
MorphoSource is a project-based data archive that allows researchers to store and organize, share, and distribute their own 3d data. Furthermore any registered user can immediately search for and download 3d morphological data sets that have been made accessible through the consent of data authors.

The goal of **MorphoSource** is to provide rapid access to as many researchers as possible, large numbers of raw microCt data and surface meshes representing vouchered specimens.

File formats include tiff, dicom, stanford ply, and stl. The website is designed to be self explanatory and to assist you through the process of uploading media and associating it with meta data. If you are interested in using the site for your own data but have questions about security or anything else contact the site administrator. Otherwise please download whatever data you need and check back frequently to see what's new.

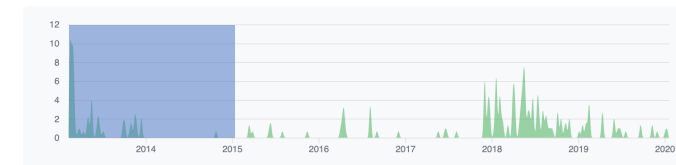
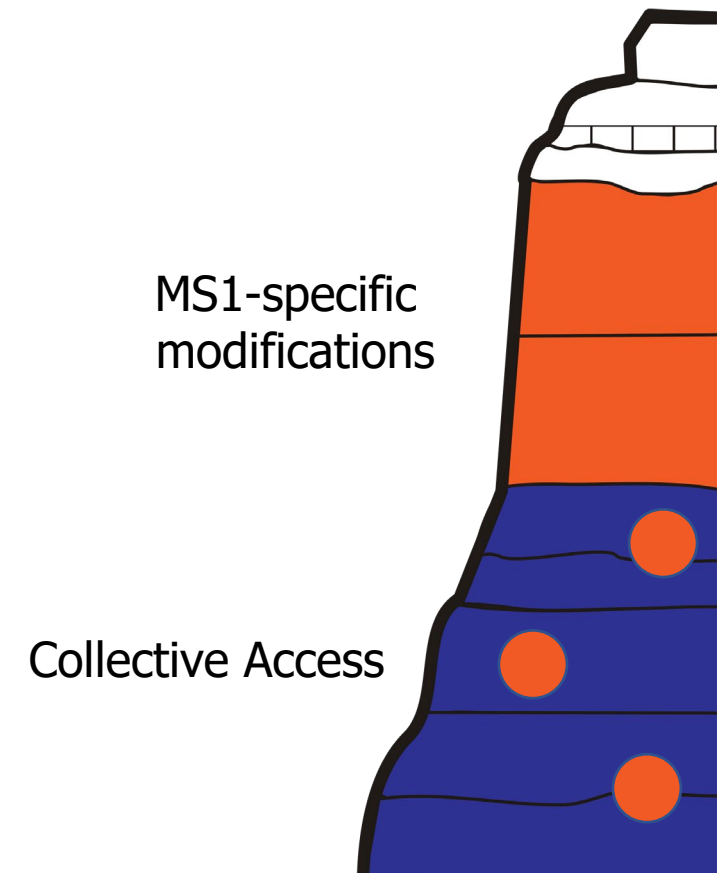
MorphoSource 1 Development Timeline

Number of code
contributions

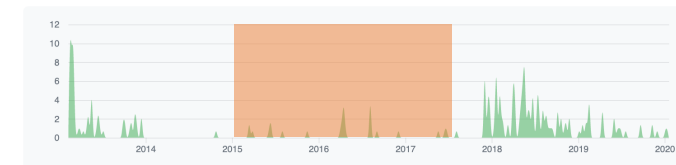
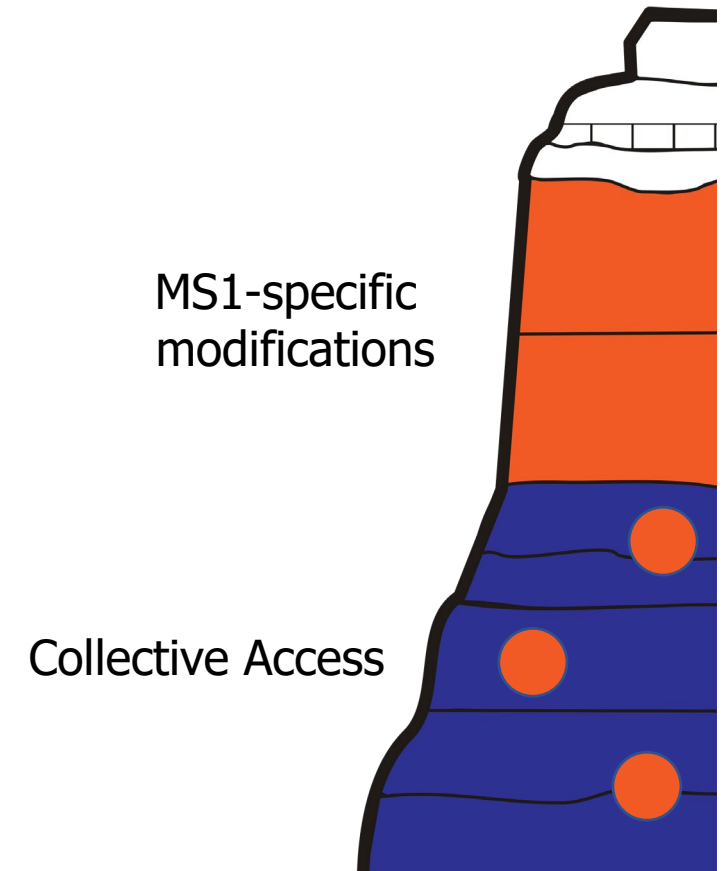


Time

- February 13, 2013: First Code Contribution
- MS1 built on Collective Access
 - Open-source software for managing and publishing museum and archival collections
 - jQuery/PHP
 - Significantly customized to support 3D and media data model
 - Proof of concept

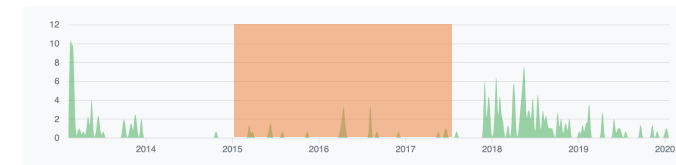
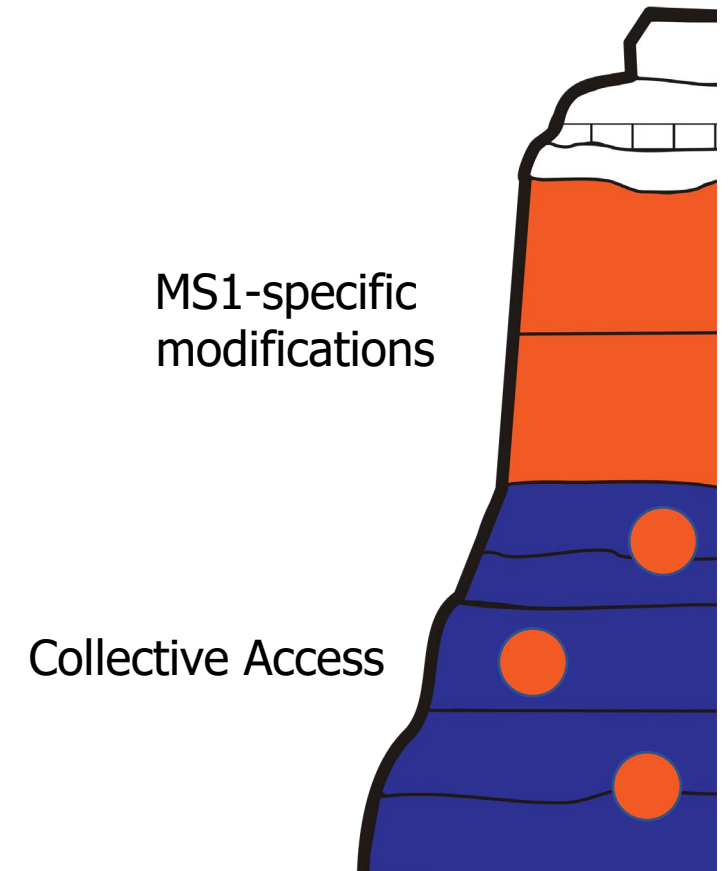


- New Features
 - Media Cart
 - DOIs
- Scaling and Stressors
 - “Publication Packet” model
 - Media ownership
 - More institutional users and use cases
 - Aging UI

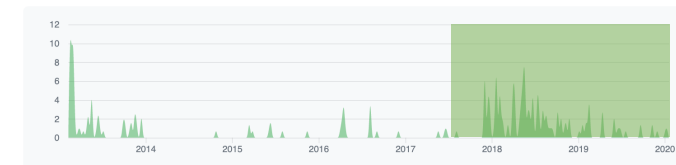
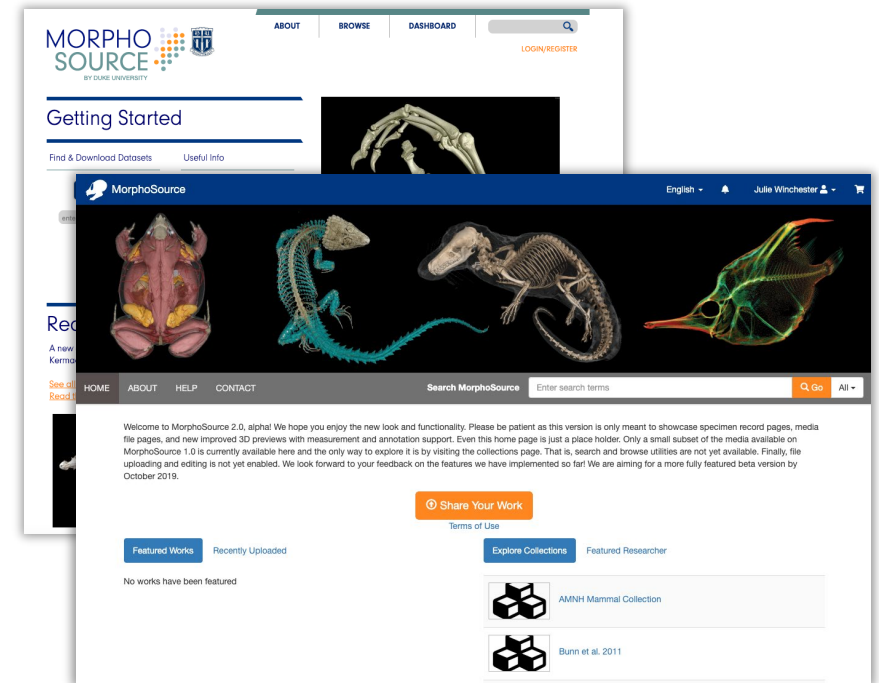


Aging technical stack (and UI) makes improvements more difficult

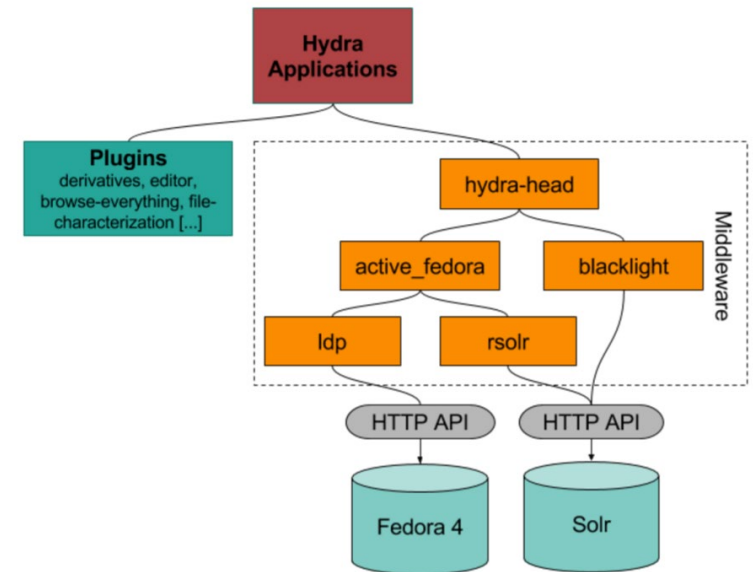
- Tech debt: Code accretion, lack of modularity, loose separation of powers
- Unable to update core framework
- jQuery/PHP: modern “web application” solutions difficult to impossible
- Server-side Meshlab a nightmare



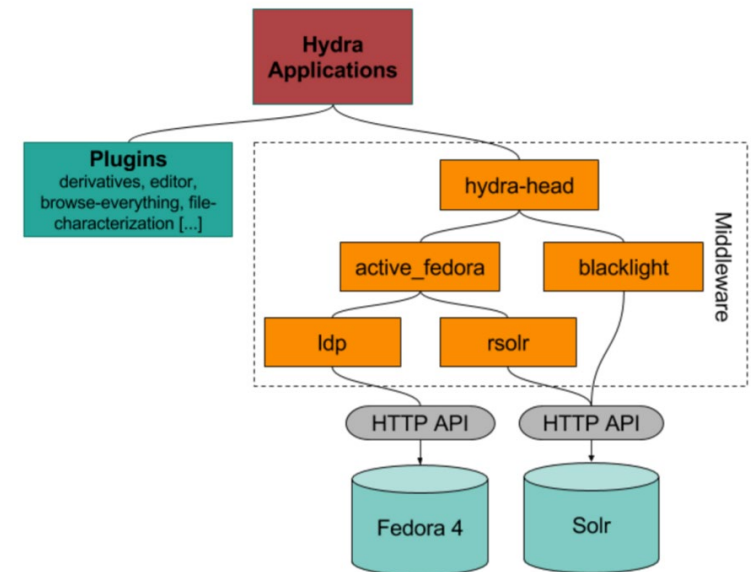
- Shifting to internal development (funding!)
 - More code contributions, more regular small-scale feature updates
 - New features: project dashboard UI revamp, file upload interruption protection, automated data reporting to institutions...
- Acceleration of scaling
 - oVert
- 2018: Beginning development of MS2



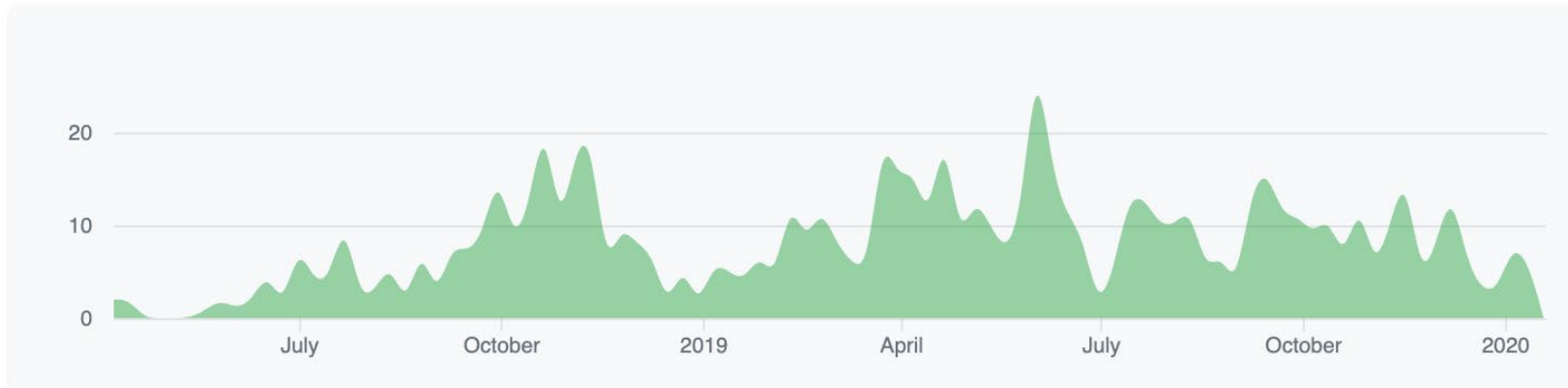
- MS2 is a Hyrax application
 - Open-source Samvera-powered repository solution
 - Ruby on Rails
 - Large, active community ecosystem
 - Relatively fresh tech stack



- Why Hyrax?
 - Standardize with existing Library repositories
 - Background job queueing
 - Robust multiple file upload, cloud plug-ins
 - Built-in derivative generation
 - User and group support
 - Storing records (media) in multiple collections (projects)
 - Modular design with solid design principles
 - Universal Viewer (+IIIF) for record preview by default
 - Google analytics
 - More suitable for automated deployment

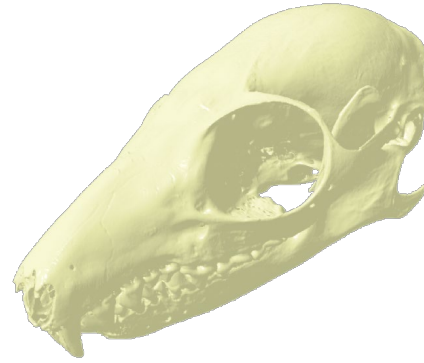


- Starting with...
 - MS1
 - Appreciation for future needs
 - Vanilla Hyrax (significant customization)
 - Minimal working back-end AND front-end
- Rough development procedure (cyclical!)
 - Identify user needs via user stories
 - Implement back-end features
 - Make features accessible via front-end
- Logistics
 - Agile Sprints
 - Jira Issue Tracker





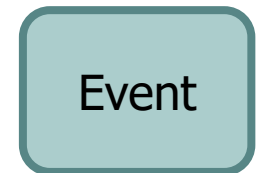
Specimen
Occurrence ID: a2770...

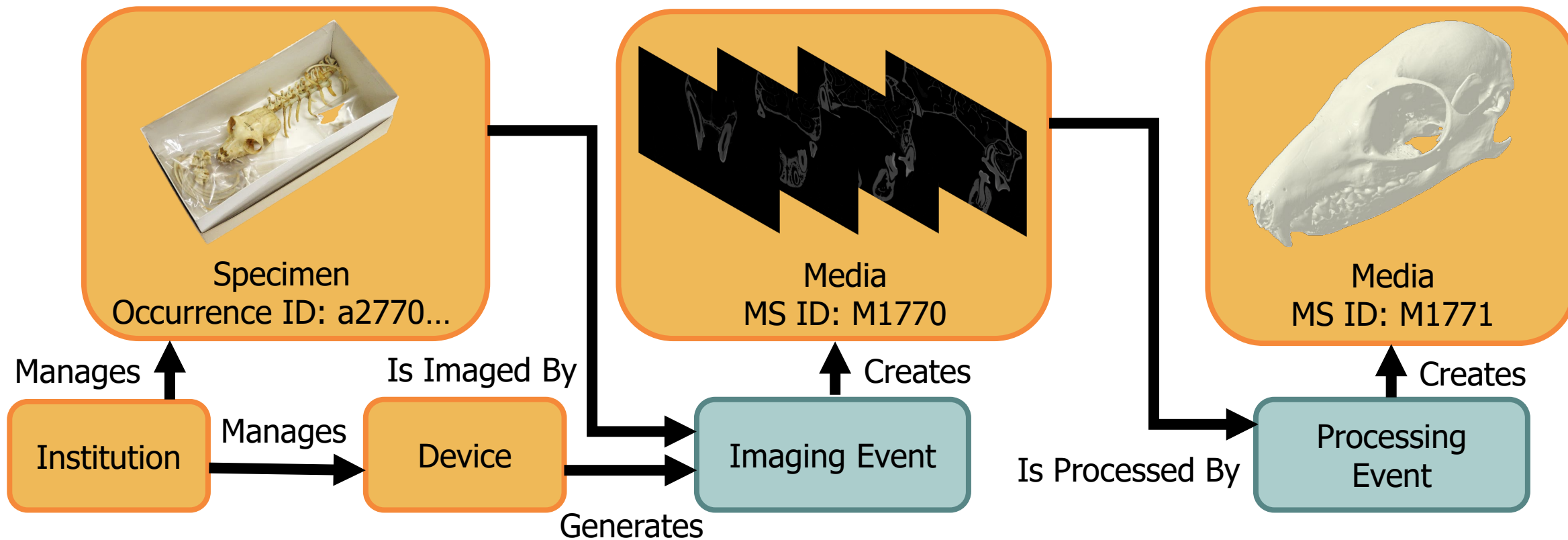


Media
MS ID: M1771



Media
MS ID: M1770





Specimens and media organized by "project" containers, by institution or collection, by tagging



Significant processing without intermediate media



Process
Event

1. Smoothing
2. Simplification
3. Hole Filling

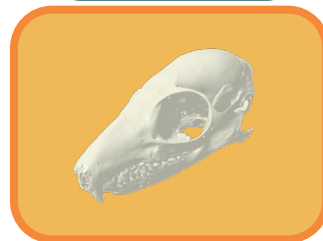


Significant processing with intermediate media



Process
Event

1. Smoothing



Process
Event

2. Simplification

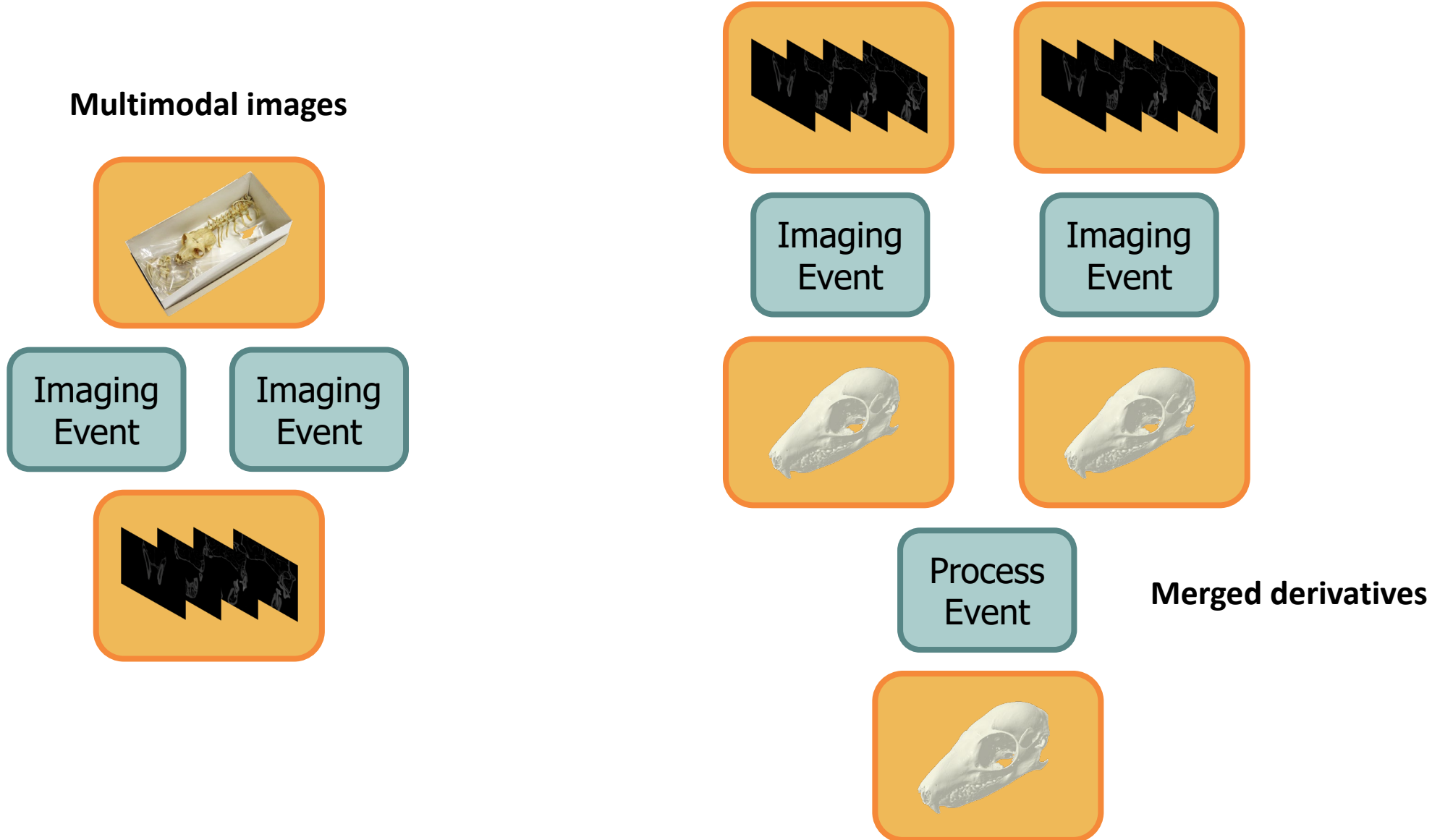


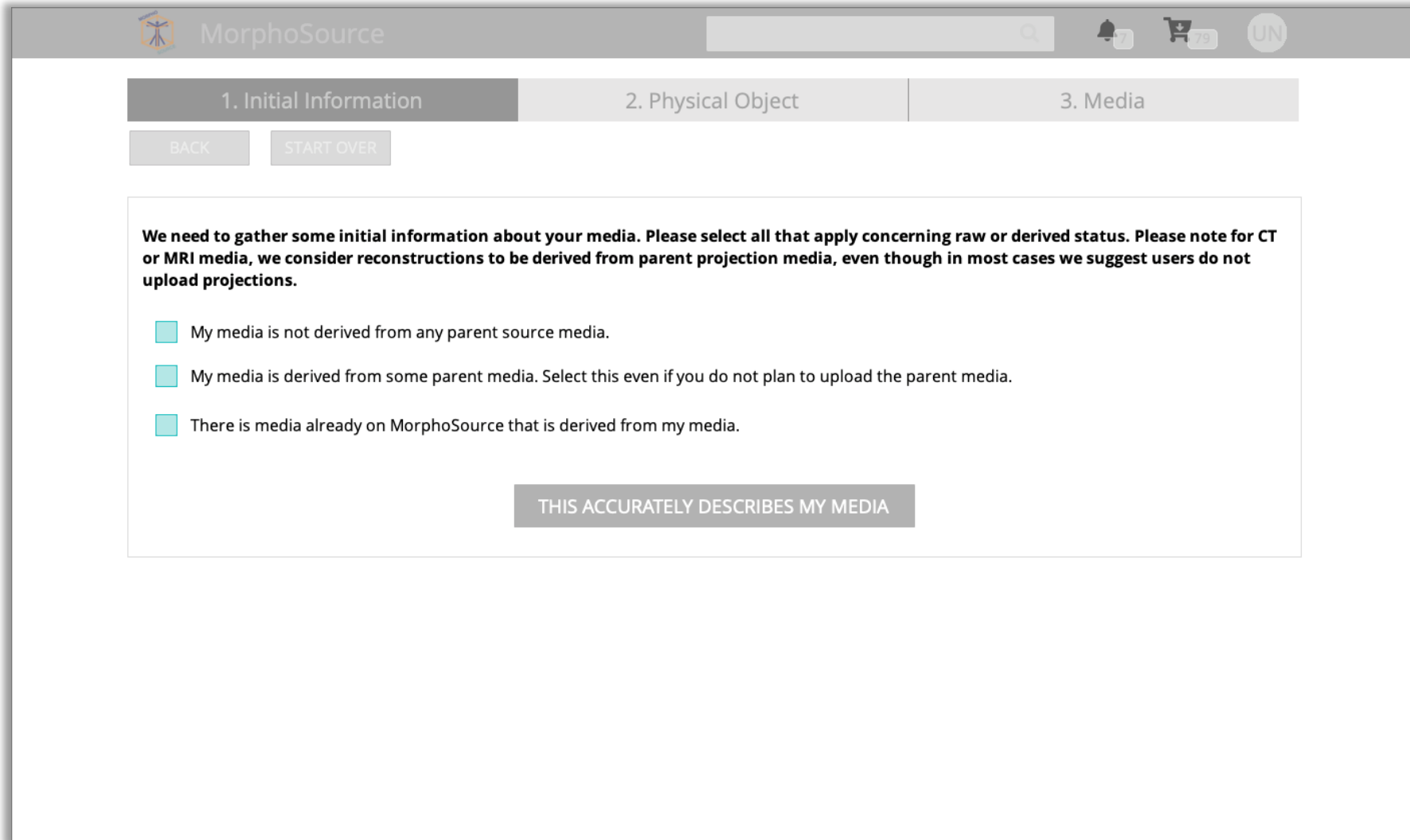
Process
Event

3. Hole Filling



Multimodal images





The screenshot shows a web browser window with the MorphoSource logo and navigation icons at the top. The page is divided into three steps: 1. Initial Information, 2. Physical Object, and 3. Media. The first step is active. Below the step indicators are 'BACK' and 'START OVER' buttons. The main content area contains a text block with instructions and three checkboxes, followed by a 'THIS ACCURATELY DESCRIBES MY MEDIA' button.

MorphoSource

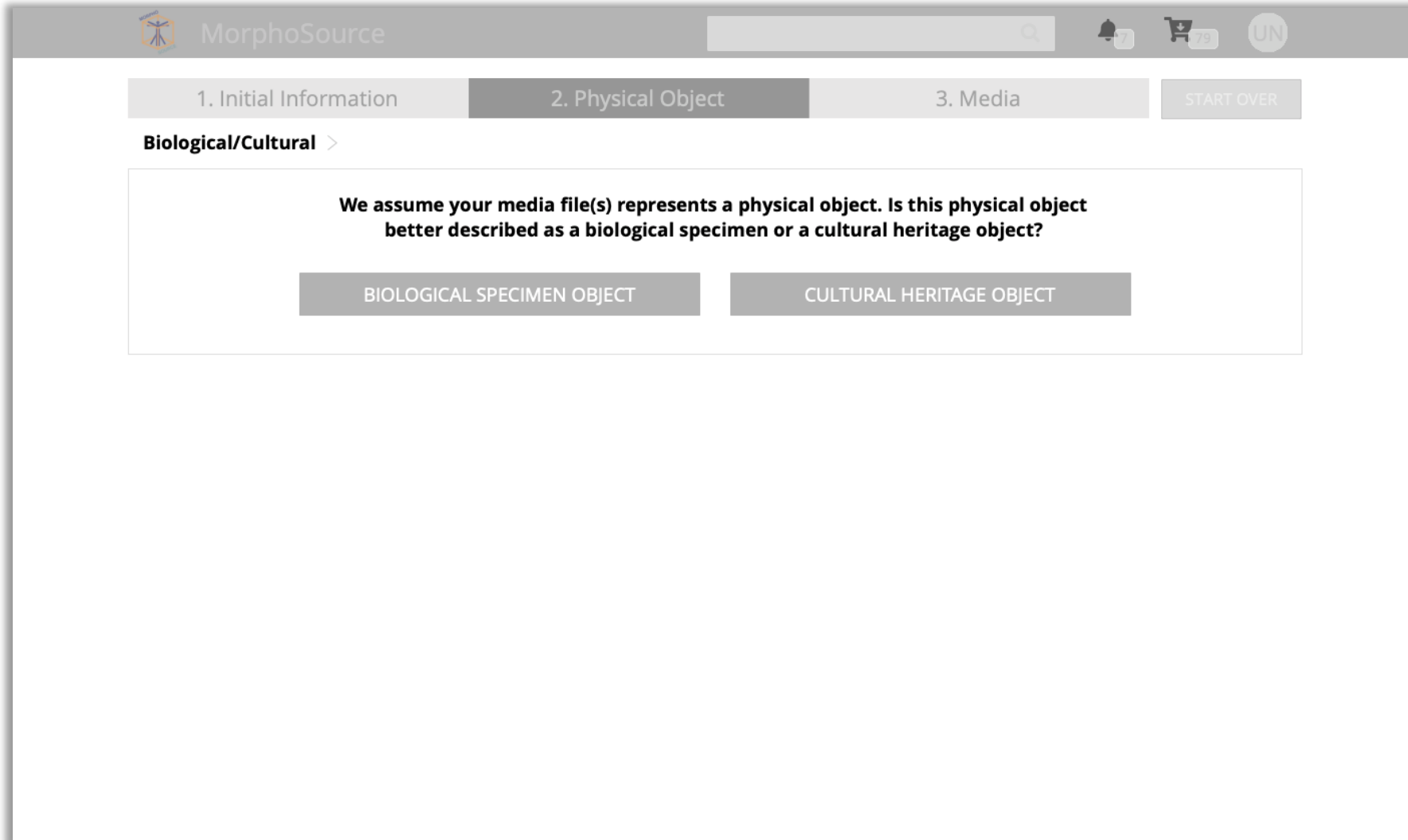
1. Initial Information | 2. Physical Object | 3. Media

BACK START OVER

We need to gather some initial information about your media. Please select all that apply concerning raw or derived status. Please note for CT or MRI media, we consider reconstructions to be derived from parent projection media, even though in most cases we suggest users do not upload projections.

- My media is not derived from any parent source media.
- My media is derived from some parent media. Select this even if you do not plan to upload the parent media.
- There is media already on MorphoSource that is derived from my media.

THIS ACCURATELY DESCRIBES MY MEDIA



The screenshot shows a web browser window with the MorphoSource logo and navigation icons (search, notifications, shopping cart, user profile) in the top bar. Below the navigation bar is a progress indicator with three steps: "1. Initial Information", "2. Physical Object" (which is highlighted), and "3. Media". A "START OVER" button is located to the right of the progress indicator. The main content area is titled "Biological/Cultural >". It contains a text box with the question: "We assume your media file(s) represents a physical object. Is this physical object better described as a biological specimen or a cultural heritage object?". Below the text box are two buttons: "BIOLOGICAL SPECIMEN OBJECT" and "CULTURAL HERITAGE OBJECT".

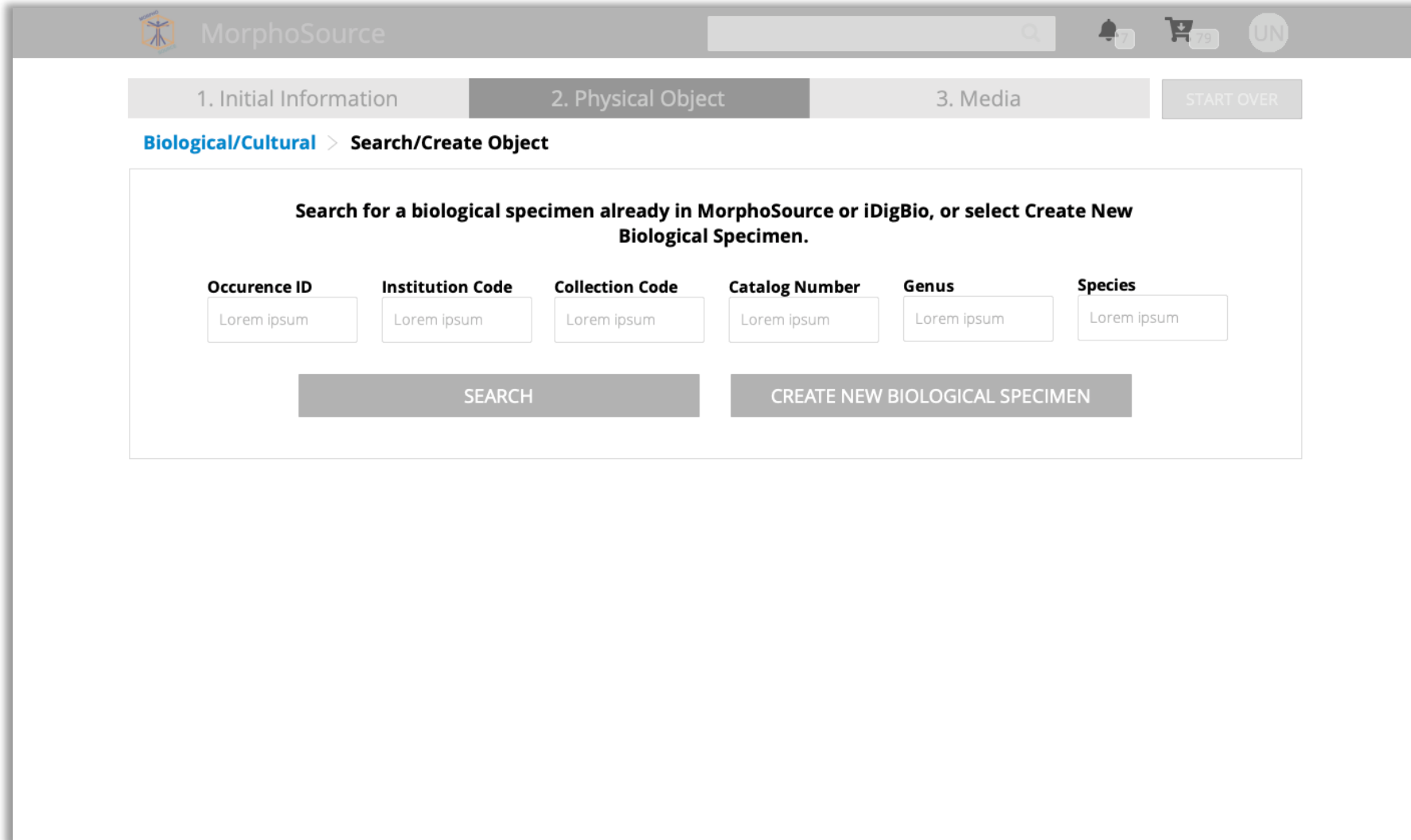
MorphoSource

1. Initial Information 2. Physical Object 3. Media START OVER

Biological/Cultural >

We assume your media file(s) represents a physical object. Is this physical object better described as a biological specimen or a cultural heritage object?

BIOLOGICAL SPECIMEN OBJECT CULTURAL HERITAGE OBJECT



The screenshot shows a web interface for MorphoSource. At the top, there is a navigation bar with the MorphoSource logo, a search bar, and icons for notifications, a shopping cart, and a user profile. Below the navigation bar, there are three tabs: "1. Initial Information", "2. Physical Object", and "3. Media". The "2. Physical Object" tab is currently selected. To the right of the tabs is a "START OVER" button. Below the tabs, there is a breadcrumb trail: "Biological/Cultural > Search/Create Object". The main content area contains a form with the following text: "Search for a biological specimen already in MorphoSource or iDigBio, or select Create New Biological Specimen." Below this text are six input fields: "Occurrence ID", "Institution Code", "Collection Code", "Catalog Number", "Genus", and "Species". Each field contains the placeholder text "Lorem ipsum". At the bottom of the form are two buttons: "SEARCH" and "CREATE NEW BIOLOGICAL SPECIMEN".

MorphoSource

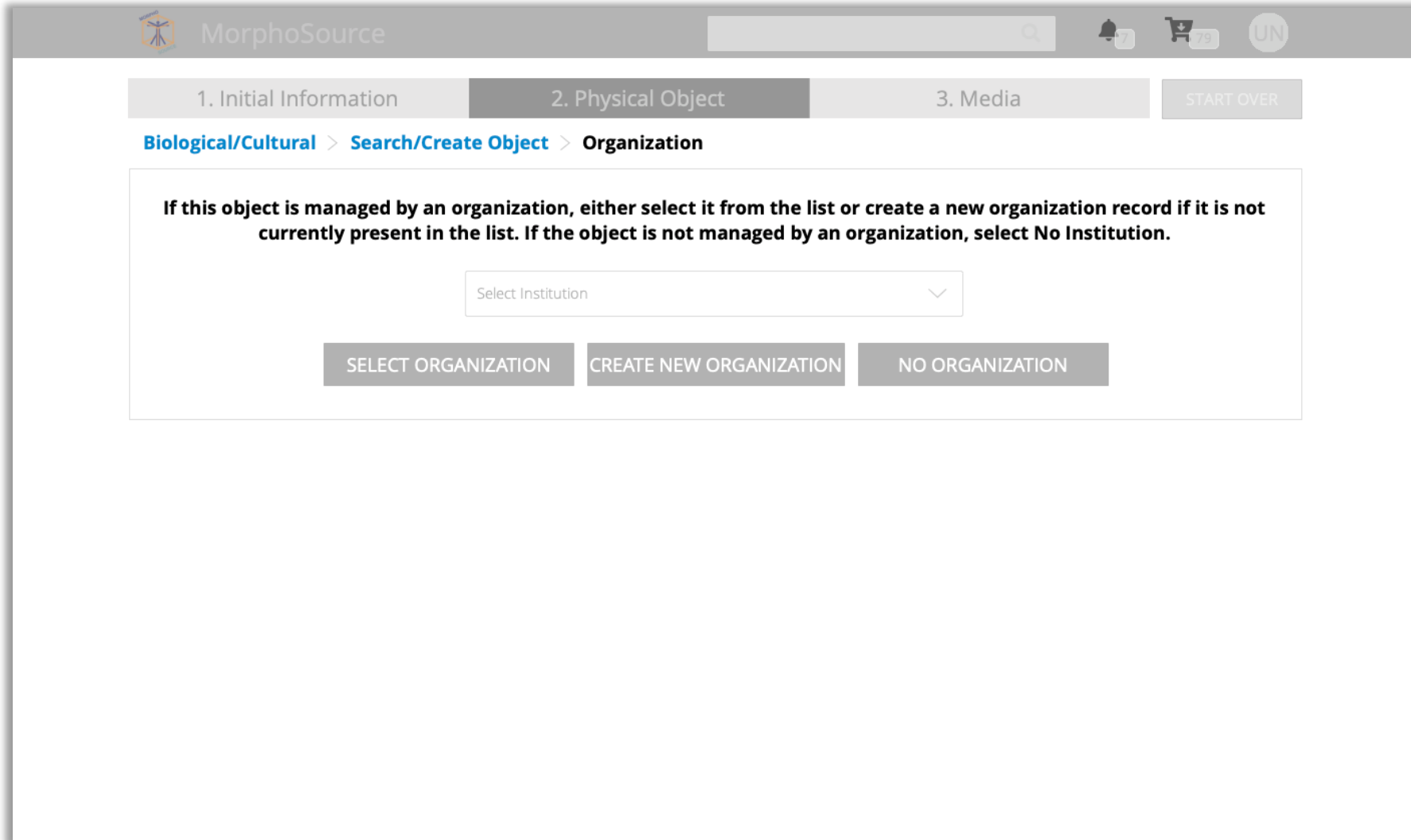
1. Initial Information | 2. Physical Object | 3. Media | START OVER

Biological/Cultural > Search/Create Object

Search for a biological specimen already in MorphoSource or iDigBio, or select Create New Biological Specimen.

Occurrence ID	Institution Code	Collection Code	Catalog Number	Genus	Species
Lorem ipsum	Lorem ipsum	Lorem ipsum	Lorem ipsum	Lorem ipsum	Lorem ipsum

SEARCH | CREATE NEW BIOLOGICAL SPECIMEN



The screenshot shows the MorphoSource web interface for MS2 Media Submission. The top navigation bar includes the MorphoSource logo, a search bar, a notification bell with a '7' badge, a shopping cart with a '99' badge, and a user profile icon labeled 'UN'. Below the navigation bar are three tabs: '1. Initial Information', '2. Physical Object' (which is active), and '3. Media'. A 'START OVER' button is located to the right of the tabs. The breadcrumb trail reads 'Biological/Cultural > Search/Create Object > Organization'. The main content area contains a text box with the instruction: 'If this object is managed by an organization, either select it from the list or create a new organization record if it is not currently present in the list. If the object is not managed by an organization, select No Institution.' Below this text is a dropdown menu labeled 'Select Institution'. At the bottom of the form are three buttons: 'SELECT ORGANIZATION', 'CREATE NEW ORGANIZATION', and 'NO ORGANIZATION'.

MorphoSource

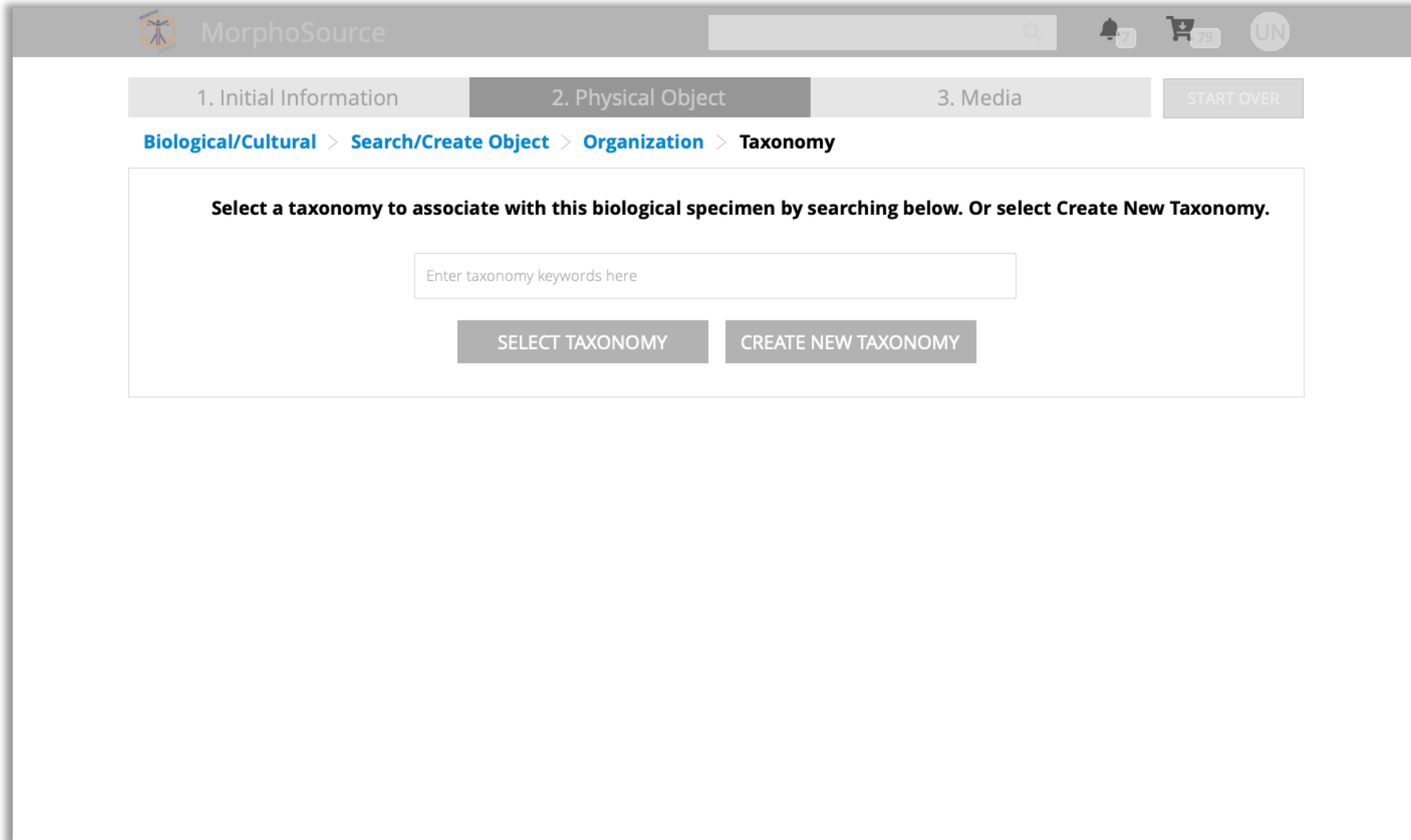
1. Initial Information | 2. Physical Object | 3. Media | START OVER

Biological/Cultural > Search/Create Object > Organization

If this object is managed by an organization, either select it from the list or create a new organization record if it is not currently present in the list. If the object is not managed by an organization, select No Institution.

Select Institution

SELECT ORGANIZATION | CREATE NEW ORGANIZATION | NO ORGANIZATION



The screenshot shows a web browser window with the MorphoSource logo and navigation icons (search, notifications, cart, user profile) in the top bar. Below the navigation bar is a progress indicator with three steps: "1. Initial Information", "2. Physical Object" (which is highlighted), and "3. Media". A "START OVER" button is located to the right of the progress indicator. Below the progress indicator is a breadcrumb trail: "Biological/Cultural > Search/Create Object > Organization > Taxonomy". The main content area contains a bold instruction: "Select a taxonomy to associate with this biological specimen by searching below. Or select Create New Taxonomy." Below this instruction is a text input field with the placeholder text "Enter taxonomy keywords here". At the bottom of the form are two buttons: "SELECT TAXONOMY" and "CREATE NEW TAXONOMY".

MorphoSource





1. Initial Information 2. Physical Object 3. Media START OVER

Biological/Cultural > Search/Create Object > Organization > Taxonomy

Select a taxonomy to associate with this biological specimen by searching below. Or select Create New Taxonomy.

Enter taxonomy keywords here

SELECT TAXONOMY CREATE NEW TAXONOMY









 MorphoSource   

1. Initial Information | **2. Physical Object** | 3. Media | [START OVER](#)







[Biological/Cultural](#) > [Search/Create Object](#) > [Organization](#) > [Taxonomy](#) > [Everything Else](#)

Finish creating a new biological specimen by filling in the following fields and selecting Create Biological Specimen.

SPECIMEN IDENTIFIERS AND EXTERNAL LINKS




Vouchered?  Req	Select
Institution Code  Req	Select
Collection Code  Recommended	Collection Code
Catalog Number  Recommended	Catalog Number
Occurrence ID  Recommended	Occurrence ID
Other Identifier(s) 	Other Identifier 
External Object URL 	External Object URL

GENERAL DETAILS

Description 	<input type="text"/>
Sex 	Select
Is Type Specimen 	Select
Source Of Record 	iDigBio
Data Created 	Date Created
Date Uploaded 	February 19, 2019






COLLECTIONS PHYSICAL OBJECT BELONGS TO

[ADD](#)


- [American Museum of Natural History Mammalogy Collections](#) Organizational Collection
- [Cercopithecoids of West Africa](#)  
- [Winchester 2016: Dental topography of extant cercopithecoids](#) 


PHYSICAL OBJECT TAGS


[ADD](#)

- [Lorem ipsum](#) 
- [Dolor](#) 
- [Sit Amet](#) 
- [Sapien etiam](#) 
- [Nunc amet dolor ac odio](#) 

BIBLIOGRAPHIC CITATIONS FOR THIS PHYSICAL OBJECT

Add DOIs to associate citations to physical object 

- [Winchester 2016: Dental topography of extant cercopithecoids](#) 


MorphoSource

🔔
🛒 79
UN

1. Initial Information
2. Physical Object
3. Media
START OVER

Device >
 Image Capture >
 Image Processing >
 Upload File >
 Everything Else

Finish creating new media by filling in the following fields and selecting Create Media.

<div style="background-color: #f0f0f0; padding: 5px; margin-bottom: 10px;">GENERAL DETAILS</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Media Modality ? Required</td> <td style="width: 70%;">Select ▼</td> </tr> <tr> <td>Media Type ⓘ Required</td> <td>Select ▼</td> </tr> <tr> <td>Element Or Part Of Object ⓘ</td> <td>Element Or Part Of Object</td> </tr> <tr> <td>Side ?</td> <td>Select ▼</td> </tr> <tr> <td>Orientation ⓘ</td> <td>Select ▼</td> </tr> <tr> <td>Short Description ⓘ</td> <td>Short Description</td> </tr> <tr> <td>Full Description ⓘ</td> <td>Full Description</td> </tr> </table> <div style="background-color: #f0f0f0; padding: 5px; margin-top: 10px;">OWNERSHIP, PERMISSIONS, AND ACKNOWLEDGEMENTS</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Data Managed By ?</td> <td>Julie Winchester</td> </tr> <tr> <td>Download Permission ?</td> <td>Select ▼</td> </tr> <tr> <td>Usage License ?</td> <td>Select ▼</td> </tr> <tr> <td>Copyright Statement ?</td> <td>Select ▼</td> </tr> <tr> <td>Custom Terms Of Use ?</td> <td>ATTACH</td> </tr> <tr> <td>Additional Usage Agreement URL ?</td> <td>Additional Usage Agreement URL</td> </tr> <tr> <td>Commercial Use Permitted ?</td> <td>Select ▼</td> </tr> </table>	Media Modality ? Required	Select ▼	Media Type ⓘ Required	Select ▼	Element Or Part Of Object ⓘ	Element Or Part Of Object	Side ?	Select ▼	Orientation ⓘ	Select ▼	Short Description ⓘ	Short Description	Full Description ⓘ	Full Description	Data Managed By ?	Julie Winchester	Download Permission ?	Select ▼	Usage License ?	Select ▼	Copyright Statement ?	Select ▼	Custom Terms Of Use ?	ATTACH	Additional Usage Agreement URL ?	Additional Usage Agreement URL	Commercial Use Permitted ?	Select ▼	<div style="background-color: #f0f0f0; padding: 5px; margin-bottom: 10px;">COLLECTIONS MEDIA BELONGS TO</div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <input style="width: 90%; border: none;" type="text" value="Search Collections"/> ADD </div> <ul style="list-style-type: none"> <li style="margin-bottom: 5px;"> American Museum of Natural History Mammalogy Collections Institutional Collection <li style="margin-bottom: 5px;"> Cercopithecoids of West Africa ✎ ✕ <li style="margin-bottom: 5px;"> Winchester 2016: Dental topography of extant cercopithecoids ✕ <div style="background-color: #f0f0f0; padding: 5px; margin-bottom: 10px;">MEDIA TAGS</div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <input style="width: 90%; border: none;" type="text" value="Enter Tag"/> ADD </div> <ul style="list-style-type: none"> <li style="margin-bottom: 5px;"> Lorem ipsum ✕ Dolor ✕ Sit Amet ✕ Sapien etiam ✕ <li style="margin-bottom: 5px;"> Nunc amet dolor ac odio ✕ <div style="background-color: #f0f0f0; padding: 5px; margin-bottom: 10px;">FILE OBJECT DETAILS</div> <p style="font-size: small; margin: 0;">Please Note: If uploading a DICOM image stack, fields with the 🔍 icon will be parsed automatically. Otherwise, enter this information.</p>
Media Modality ? Required	Select ▼																												
Media Type ⓘ Required	Select ▼																												
Element Or Part Of Object ⓘ	Element Or Part Of Object																												
Side ?	Select ▼																												
Orientation ⓘ	Select ▼																												
Short Description ⓘ	Short Description																												
Full Description ⓘ	Full Description																												
Data Managed By ?	Julie Winchester																												
Download Permission ?	Select ▼																												
Usage License ?	Select ▼																												
Copyright Statement ?	Select ▼																												
Custom Terms Of Use ?	ATTACH																												
Additional Usage Agreement URL ?	Additional Usage Agreement URL																												
Commercial Use Permitted ?	Select ▼																												


Live Demo

MorphoSource English Jocelyn Triplett

Home / Dashboard / Collections / Duke Lemur Center Division...

Team

Duke Lemur Center Division of Fossil Primates Public Team Edit collection Add to collection Delete collection



[Public view of Collection](#)

The Division of Fossil Primates (DFP) is a research collection used to understand our evolutionary journey as primates.

Organization:

- Title:** Duke Lemur Center Division of Fossil Primates
- Institution Code:** DPC
- Description:**
- Address:** 1013 Broad Street
- City:** Durham
- State/Province:** NC
- Country:** United States
- Institution Name:** Duke University
- Collection Code:**

Team:

- Total Items:** 6
- Size:** 117 KB
- Location:** Durham, NC
- Related URL:** <https://lemur.duke.edu/discover/division-of-fossil-primates/>

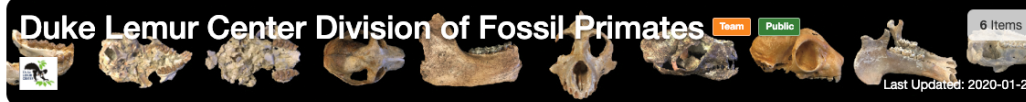
Search subcollections and works in this collection Go

MorphoSource English Jocelyn Triplett

Home About Help Contact Search MorphoSource Enter search terms Go All

Home / Dashboard / Collections / Duke Lemur Center Division...

Duke Lemur Center Division of Fossil Primates



Team Public 6 Items Last Updated: 2020-01-21

The Division of Fossil Primates (DFP) is a research collection used to understand our evolutionary journey as primates.




Collection Details

- Total Items:** 6
- Size:** 117 KB
- Location:** Durham, NC
- Related URL:** <https://lemur.duke.edu/discover/division-of-fossil-primates/>

Search subcollections and works in this collection Go

Works (6)

Sort by: relevance Results per page: 10 Refresh

Title	Date Added	Visibility
 Element Unspecified [Image] [Etc] Is part of: Duke Lemur Center Division of Fossil Primates	2020-01-21	Public
 Element Unspecified [Image] [Etc] Is part of: Duke Lemur Center Division of Fossil Primates	2020-01-21	Public
 Element Unspecified [Image] [Etc]	2020-01-21	Public



Integrating MorphoSource with other resources

Julie M. Winchester / Product Manager & Lead Dev.
Doug M. Boyer / MorphoSource Director
Tim Ryan / Professor PSU Anthropology
Tim McGeary / Duke Associate Librarian of IT

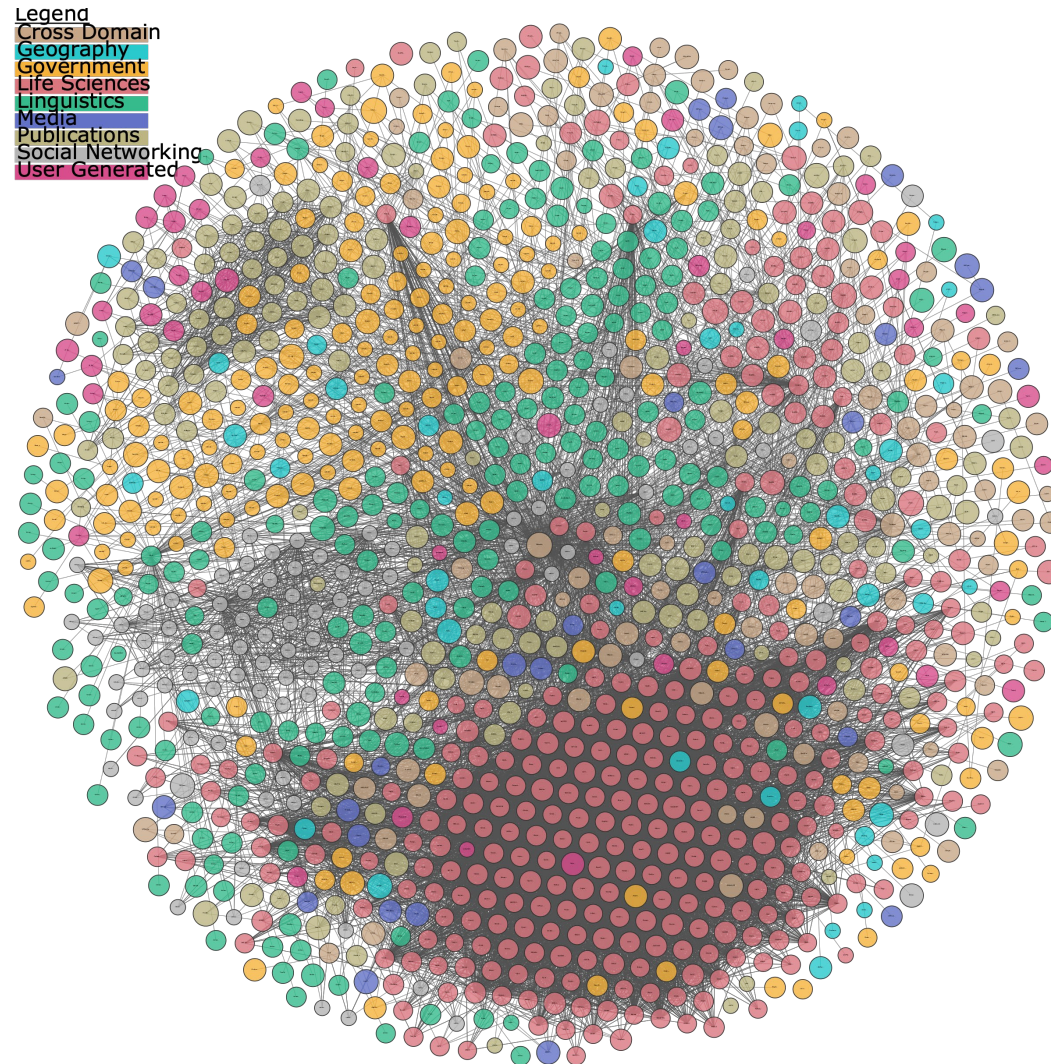
Linked Data (Berners-Lee, 2006)

- Use URIs (**uniform resource identifier**) as names for things
- Use HTTP URIs (AKA URLs) so people can look things up
- HTTP URIs should provide useful information when looked up
 - Machine readable
 - Standardized (RDF)
- Each URI resource should have links to other URI resources
- If resource is freely available, Linked Open Data



Tim Berners-Lee,
Inventor of the World Wide Web

Linked Open
Data Cloud
(www.lod-cloud.net)



- Does MorphoSource meet those goals?
 - Absolutely not!
- Part of the reason for this workshop, to move forward together
- Simple goals belie complexity and nuance of implementation







Federation Characteristics

- Restricted data and use case domain
- Centralized authority, fewer groups for buy-in
- High ability to dictate uniformity
- Deep but narrow

Confederation Characteristics

- Broad and varied domain
- Decentralized authority, buy-in from many groups
- Community-wide solutions
- Need for translation/normalization
- Wide but shallow



Integration of 3D data resources

- Connecting existing data to/from MorphoSource
- Making MorphoSource 3D archival software more available

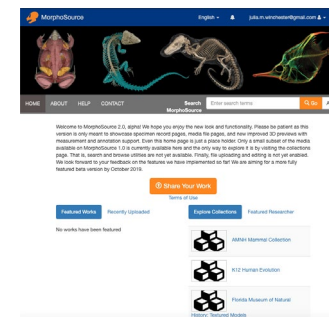
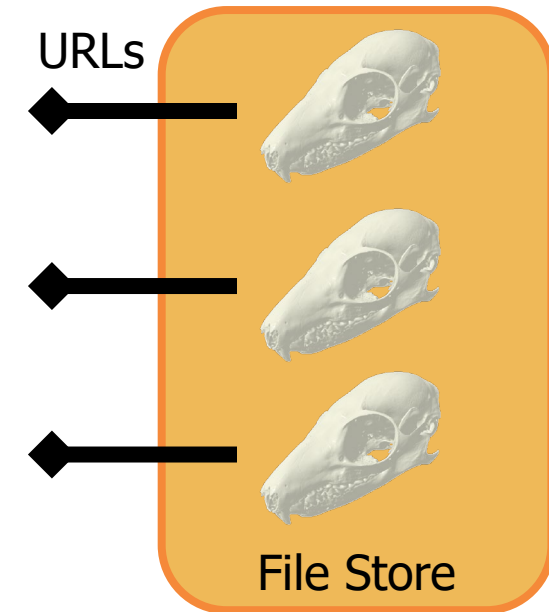
Integration with wider data world

- Connecting MorphoSource 3D data to...
- Specimen repositories
- Taxonomy resources
- Other data archives

- Metadata-only MorphoSource records
 - Data linkages
- MorphoSource-compatible 3D data archive instances
 - Automated deployment strategy
 - Turnkey solutions
 - Design complexity

- Use case
 - MorphoSource user has data in web-accessible storage
 - Wants to make these data available in MorphoSource...
 - ... but for many possible reasons, does not want to re-store that data in MorphoSource

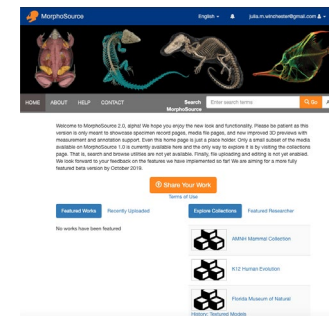
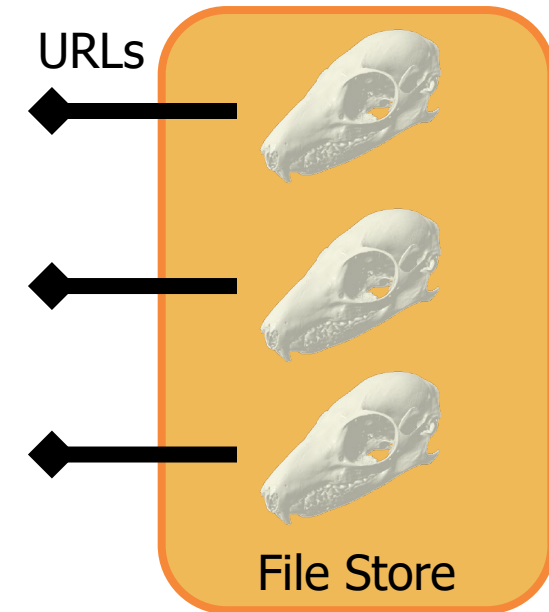
- Solution
 - Metadata-only MorphoSource records that point to remote resource



MorphoSource.org

Requirements for basic version

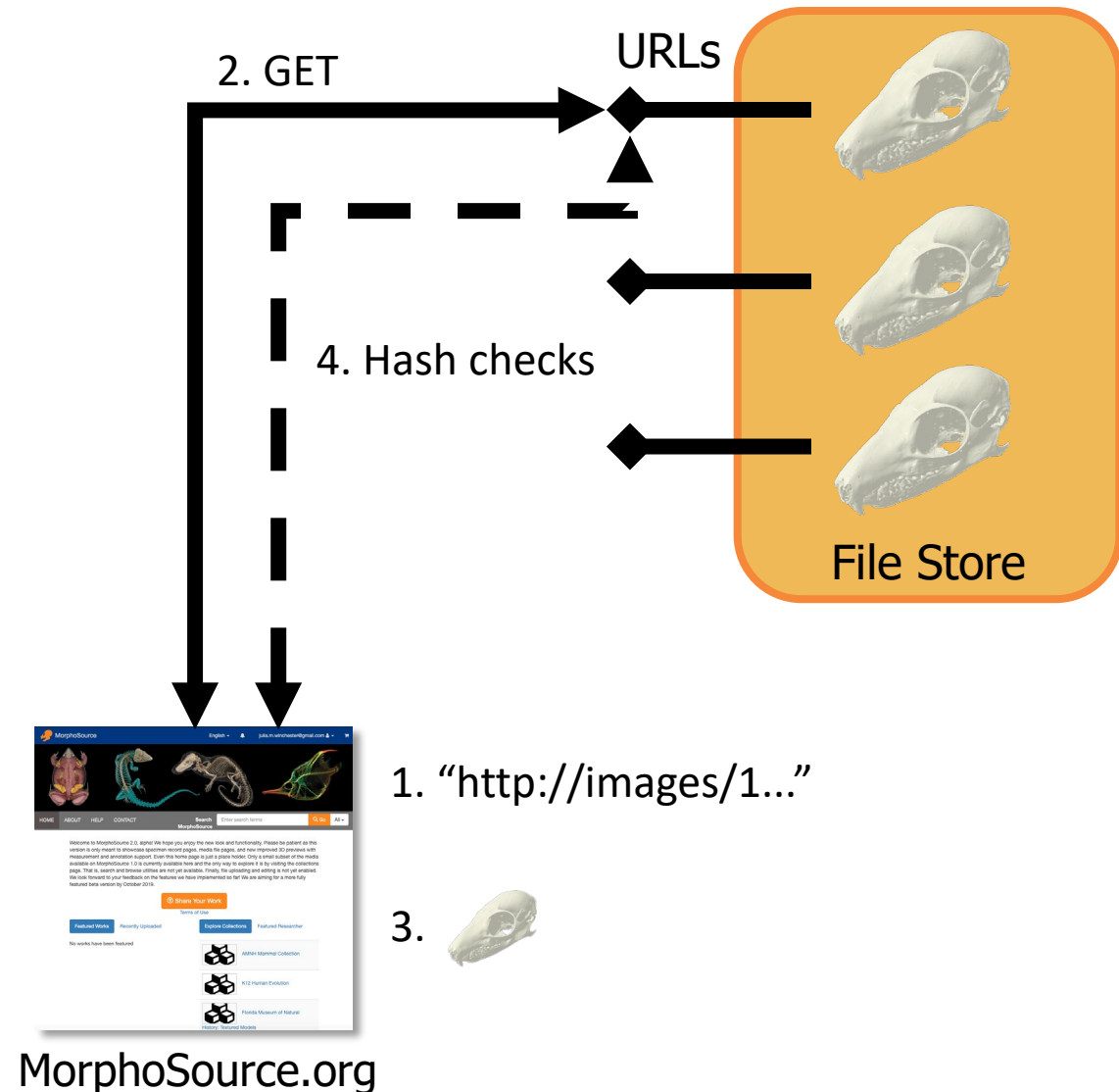
- HTTP URL for individual media (mesh, CT stack, etc.)
- File binary accessible at HTTP URL
 - Ideally for routing users to download
 - At minimum, for derivative generation and fixity checks
- Machine readable metadata
- All of the above persistent and reliably accessible



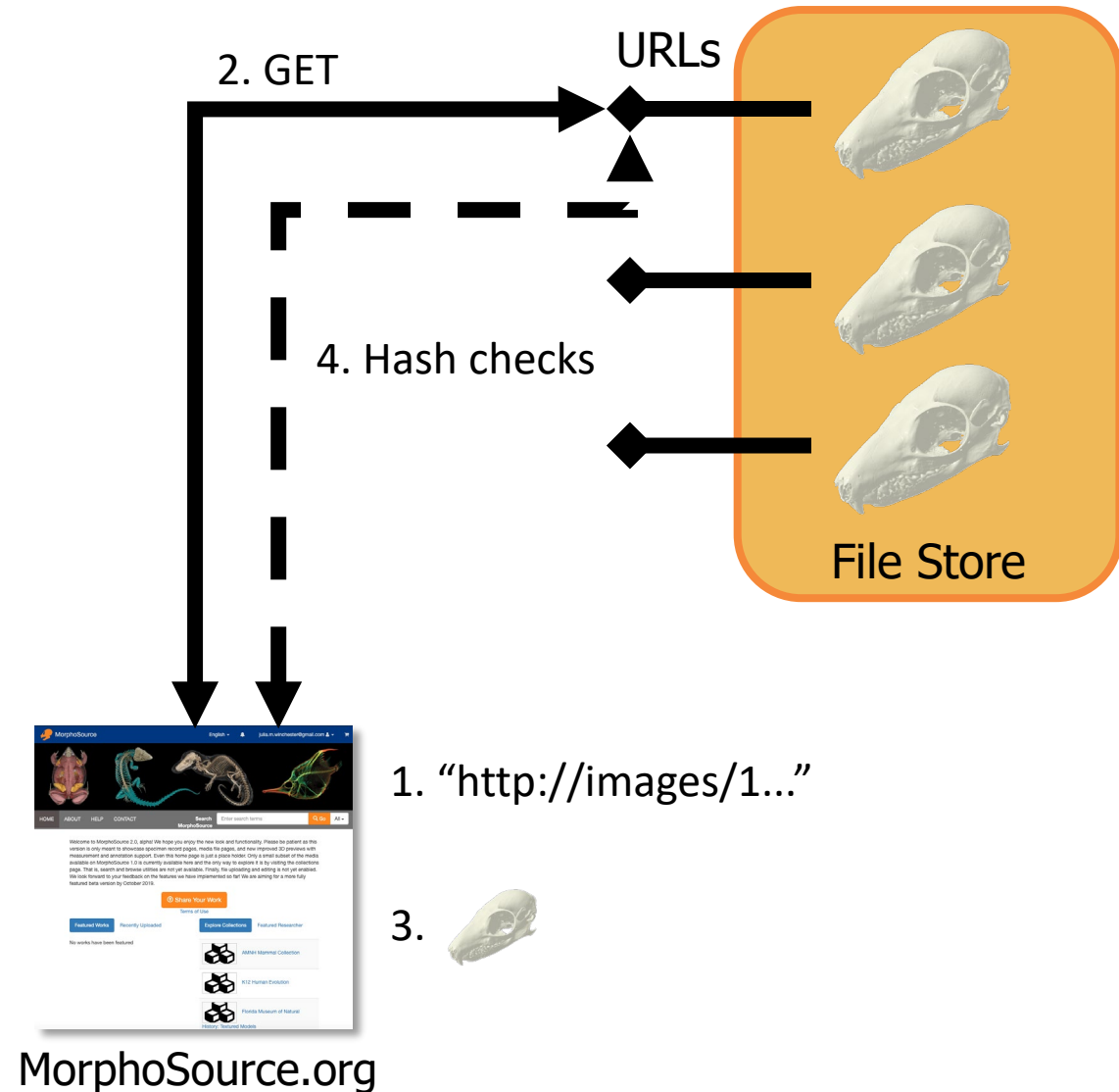
- Ingest
 1. URL is specified for ingest
 2. MS GETs remote file and metadata
 3. Automated file characterization and derivative generation

- Fixity Checking
 4. On a regular basis, metadata and file integrity are verified
 5. Automated process for error reporting

- Access
 6. Users informed of remote nature
 7. Routed to remote file as appropriate



- The Future
 - Proof of concept for a standardized biodiversity repository media linkage system?
- Pros and cons
 - Pro: sustainability
 - Pro: community investment
 - Con: fragile
 - Con: bespoke, at least to start with



Use cases

Infrastructural resources > Funding resources

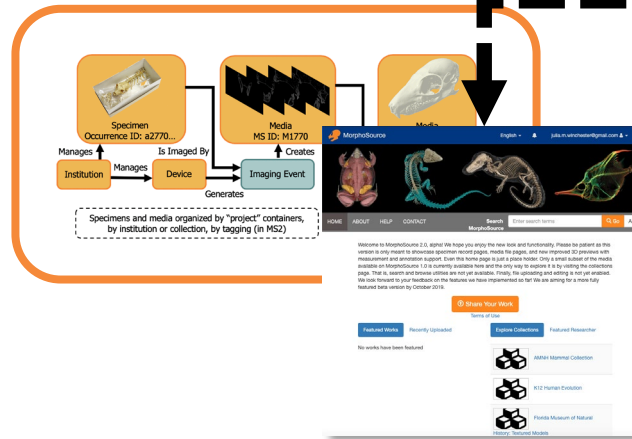
OR

Want to use MS data model and share data but store own data

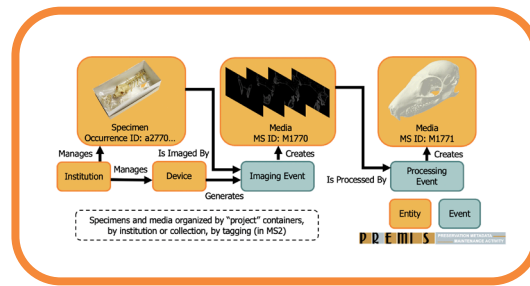
OR

Want private/dark 3D data repository

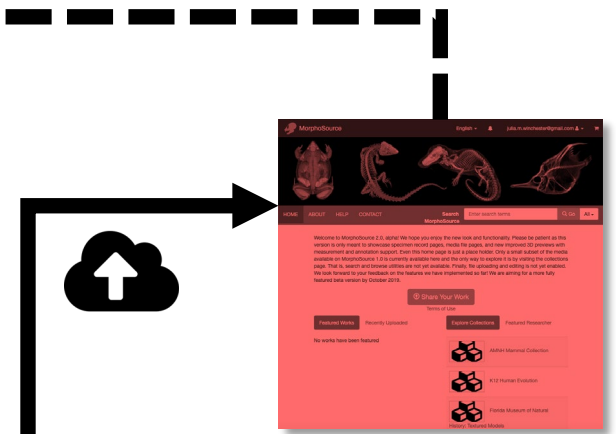
Repository Container



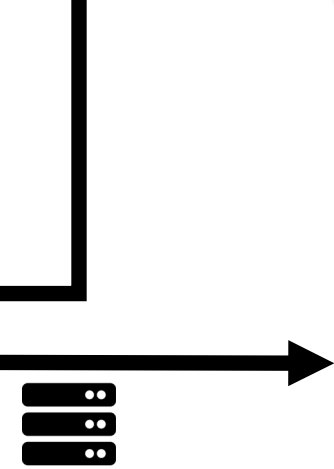
MorphoSource.org



Repository Container

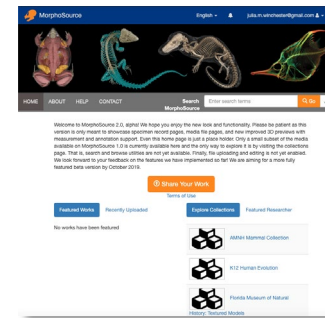


XNHM 3D Data

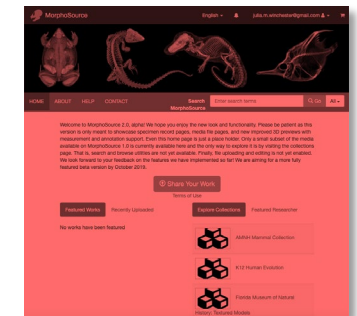


MCX 3D Data

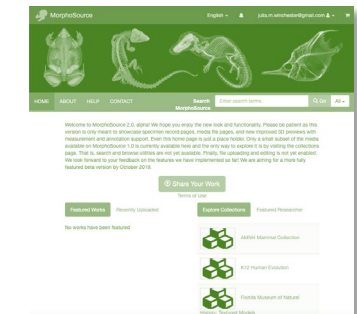
- Advantages of this work outside the MorphoSource domain
- Automated deployment and/or containerization could be used to make biodiversity repository technology more portable and easy to use
- Enables use across a diversity of terrains, from cloud to local hardware



MorphoSource.org



XNHM 3D Data

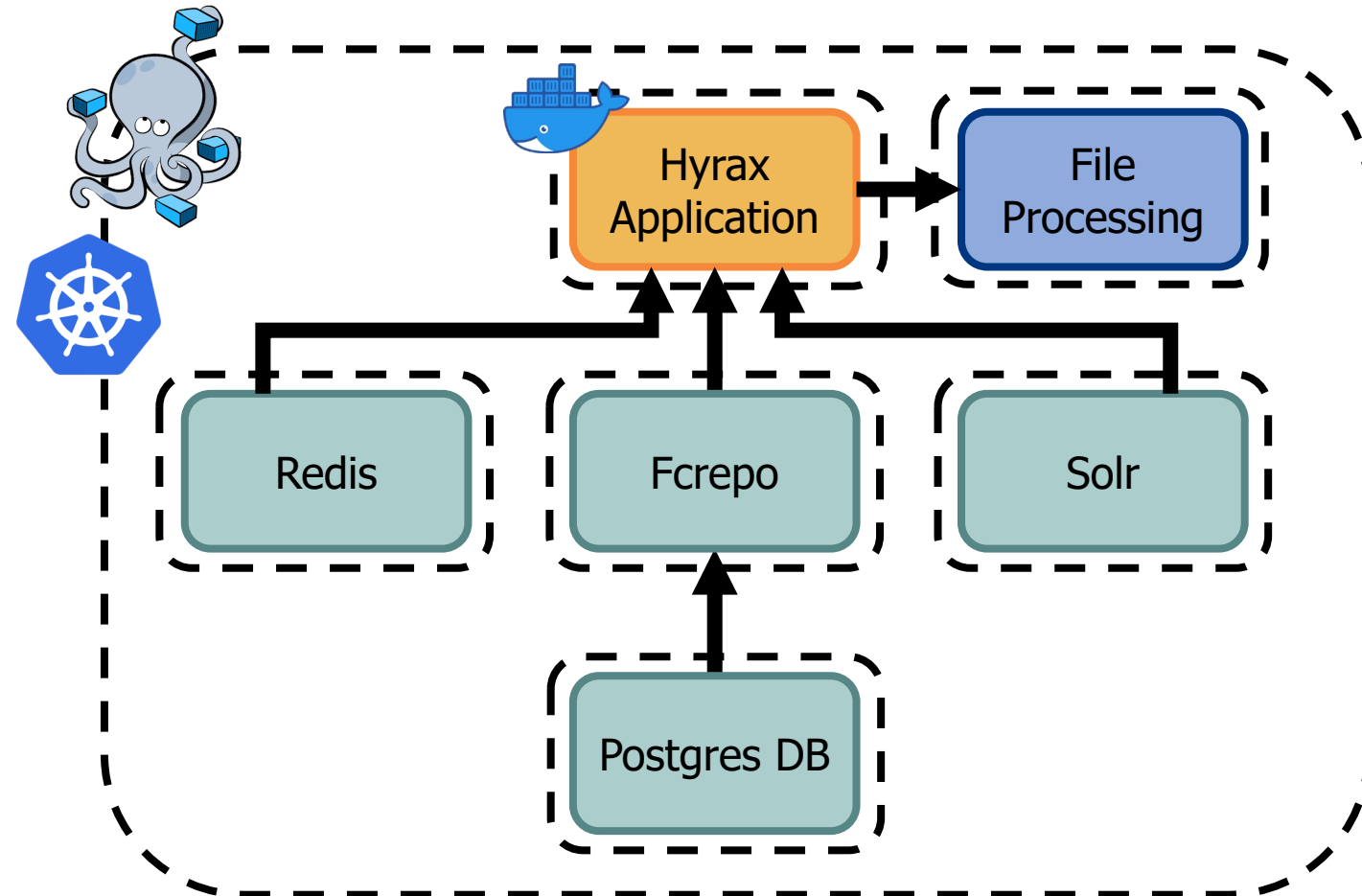


MCX 3D Data

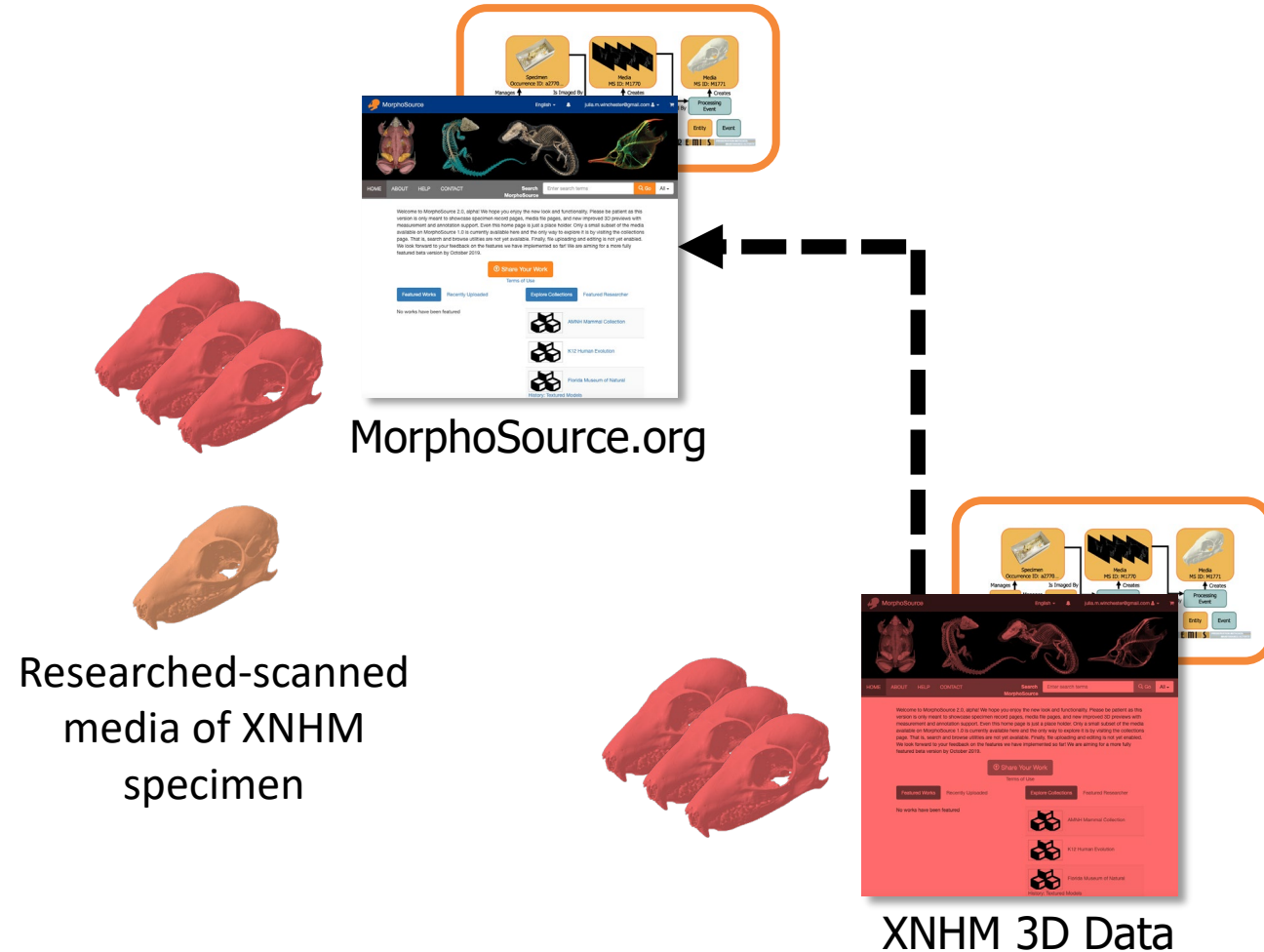
Containerization: Encapsulating a software application (or software application components) into its own environment, so it can run uniformly and consistently on any infrastructure.

Procedure

- Start with component application modules
 - Docker
- Connect containers
 - Docker compose
- Orchestrate containers in an automated way
 - Kubernetes

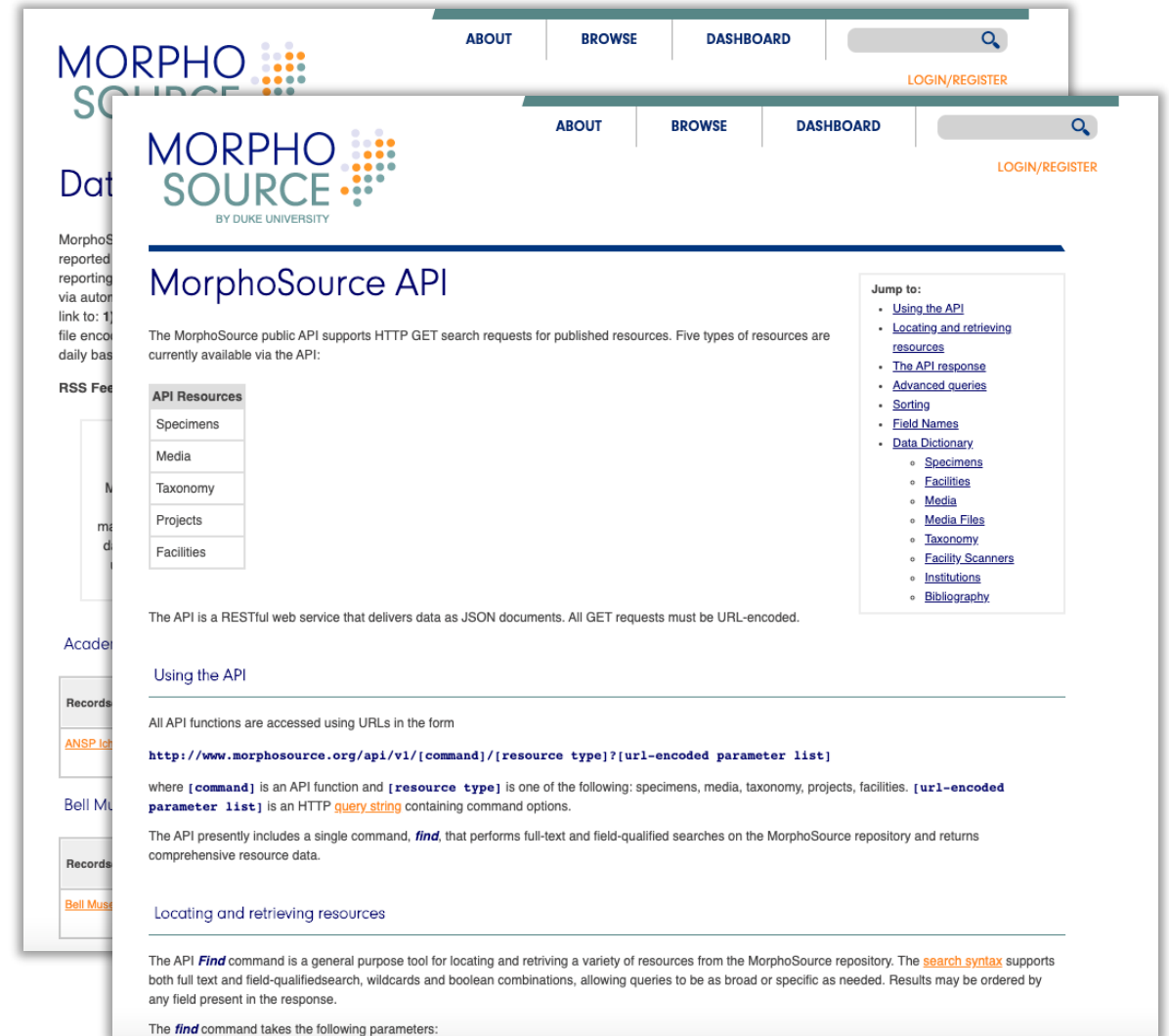


- XNHM has own MorphoSource instance
- Indexes instance-local media in MorphoSource.org
- Should XNHM be able to edit that media from MorphoSource.org?
 - Balkanization versus increasingly complex dynamics
- How about for researcher-scanned media of XNHM?



Examples of work previously completed

- Automated data reporting
- iDigBio specimen integration
- API



The screenshot shows the MorphoSource API documentation page. The page has a navigation bar with links for ABOUT, BROWSE, and DASHBOARD, along with a search bar and LOGIN/REGISTER options. The main heading is "MorphoSource API". Below the heading, there is a table of API Resources:

API Resources
Specimens
Media
Taxonomy
Projects
Facilities

The page also includes a "Jump to:" section with a list of links: Using the API, Locating and retrieving resources, The API response, Advanced queries, Sorting, Field Names, and Data Dictionary. The Data Dictionary section is expanded, showing links for Specimens, Facilities, Media, Media Files, Taxonomy, Facility Scanners, Institutions, and Bibliography.

The API is a RESTful web service that delivers data as JSON documents. All GET requests must be URL-encoded.

Using the API

All API functions are accessed using URLs in the form

```
http://www.morphosource.org/api/v1/[command]/[resource type]?[url-encoded parameter list]
```

where [command] is an API function and [resource type] is one of the following: specimens, media, taxonomy, projects, facilities. [url-encoded parameter list] is an HTTP query string containing command options.

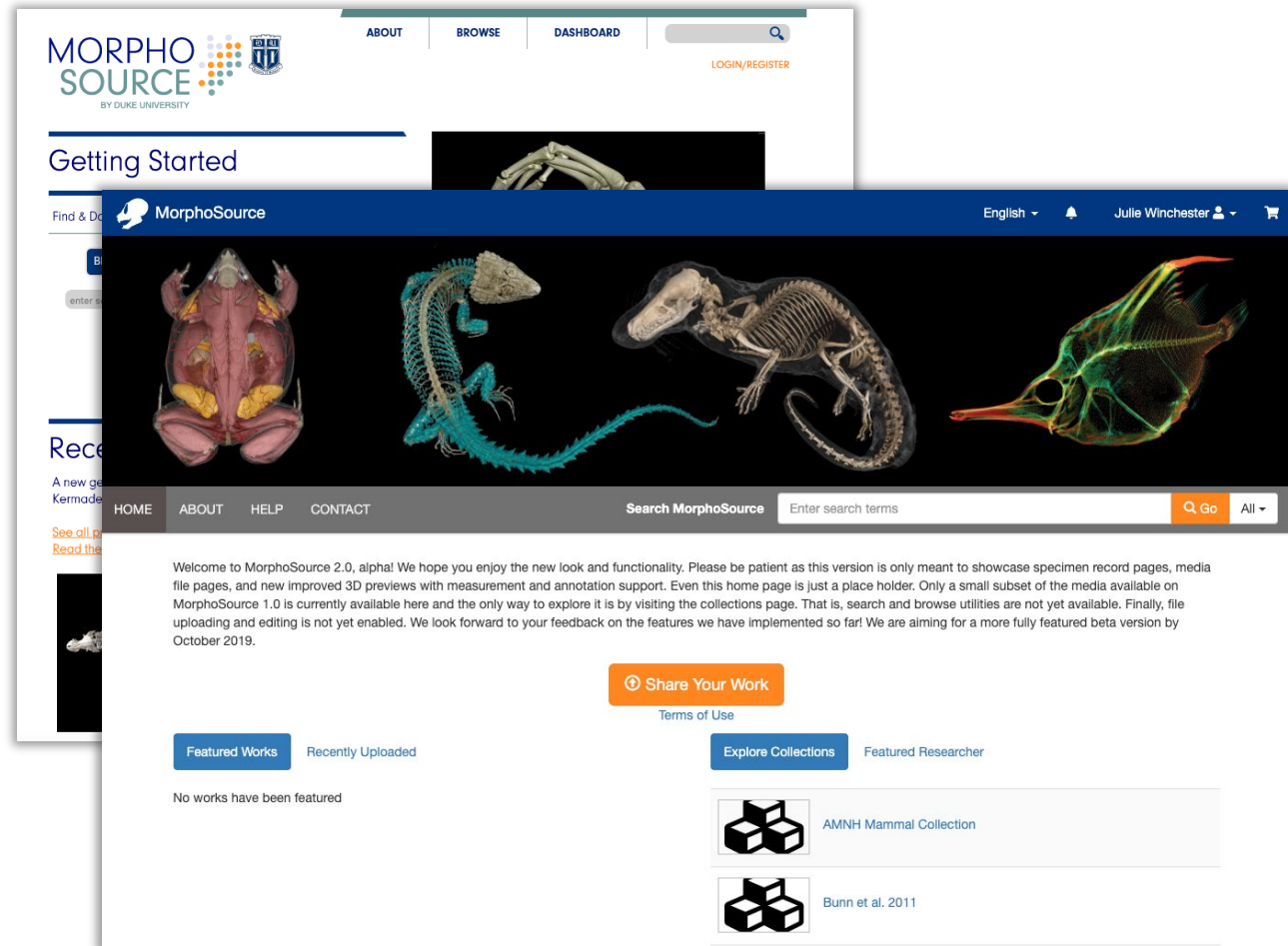
The API presently includes a single command, *find*, that performs full-text and field-qualified searches on the MorphoSource repository and returns comprehensive resource data.

Locating and retrieving resources

The API *find* command is a general purpose tool for locating and retrieving a variety of resources from the MorphoSource repository. The *search syntax* supports both full text and field-qualified search, wildcards and boolean combinations, allowing queries to be as broad or specific as needed. Results may be ordered by any field present in the response.

The *find* command takes the following parameters:

- Possible Future Directions
 - Finish MS2 (so we can move on to new things!)
 - Not just APIs, but standardized machine-readable metadata at URLs
 - Connecting media to specimen repositories
 - Better importation from specimen and taxonomy resources
- Priorities largely determined by feedback from this community!



Dave Blackburn, Ed Stanley, Jon Blundell, Gary Motz, Eric Delson, Gil Nelson, Natalia Lopez Carranza, Jessica Maisano, Ruth O'Leary, Holly Little, Sharon Grant, Kate Webbink, Larry Witmer, Claudia Grant, Callum Ross, Hilmar Lapp, Jennifer Moore, Adam Rountrey, Cody Thompson, Zach Randall, Nathan Hall, Ingrid Daubechies, Joshua Wisor, Catherine Early, Matthew Gage, Greg Watkins-Colwell, Nelson Rios

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NSF DBI-1701714



NSF DBI-1661386

NSF DBI-1661132

MorphoSource/Duke Team

Primary Developers: Jocelyn Triplett, Simon Choy



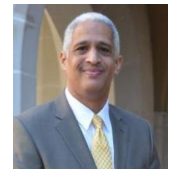
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DevOps: David Chandek-Stark, Jack Hill



Project Support: Will Sexton, Ed Gomes



Additional Duke Support: Charley Kneifel, Sophia Lafferty-Hess, Tracy Futhey, Mark DeLong



All MorphoSource contributors and users!

