

CIP Survey of Biomedical Imaging Archives

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Definition of project

The goal of this project is to create a survey of Publicly Available InVivo Medical Imaging Archives and the underlying software capabilities. It is generally agreed that there is a need for public medical imaging archives to provide the biomedical research community, industry, and academia with access to images that support:

- Lesion detection and classification
- Accelerated diagnostic imaging decision
- Quantitative imaging assessment of drug response

The purpose of this project is to provide a practical guide for the community which allows them to:

1. to assess existing software and instantiations that are appropriate to their research or clinical needs.
2. to locate relevant publicly available data for research

We encourage any feedback from the wider community that may help improve this information or correct any misconceptions stated below. The survey is divided into two sections:

1. Publicly hosted biomedical imaging archives which are populated with actual data which researchers, teachers, industry, etc may wish to utilize
2. Image archive software solutions which one could download and use to host their own DICOM image data sets

Please contact Justin Kirby (kirbyju@mail.nih.gov) or John Freymann (freymanj@mail.nih.gov) with any questions, error reports, updates, additions, etc.

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Publicly Hosted Biomedical Imaging Archives

The following table attempts to summarize publicly accessible biomedical image archives. This survey originally initiated in August of 2010. Information in the tables are being updated periodically.

NOTE: Due to the large size of this table you may need to use the horizontal scroll bar at the bottom of the table to view some of the archives listed furthest to the right.

| | The Cancer Imaging Archive (TCIA) | NBIA | NIAMS | XNAT Central | Image Data Archive | Function BIRN Data Repository | Give A Scan | Optical Society of America (OSA) | Insight Journal (MIDAS) | National Database for Autism Research (NDAR) | Pediatric MRI Data Repository | FITBIR | NITRC-IR |
|---------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------|
| Supporting Institution(s) | NCI Cancer Imaging Program | NCI Center for Bioinformatics and Information Technology | NIAMS, NCI Center for Bioinformatics and Information Technology | WUSTL, BIRN | Lab of Neuroimaging UCLA (LONI) | FBIRN Institutions | Lung Cancer Alliance, Kitware | Optical Society of America, Kitware | Kitware, Insight Software Consortium | NIH, NIMH, NINDS, NICHD, NIEHS | NIH, NIMH, NICHD, NIDA, NINDS | NINDS, DoD | NIH Blueprint, NIBIB, NINDS, NIMH, NIDA |
| Content Type | In Vivo Cancer Imaging, phantom imaging and related metadata (see full Collection list) | Demo instance for showing the latest features of NBIA. All data are re-used from The Cancer Imaging Archive. | Osteoarthritis | Biomedical images, meta data, other phenotypic data (behavioral, clinical, etc) | ADNI (Alzheimers), CRYO (histology), ICBM (Brain mapping), AIBL (Autralian Aging) | FMRI/MRI images, behavioral data, and clinical data from schizophrenics and healthy volunteers. Willing to accept data on other neurological disorders. | Patient-contributed Lung Cancer Medical scans | Optical, digital holography, 2D/3D modalities, etc | Biomedical images, meta data, and journal articles | Autism - standard phenotypic data, imaging and genomic /pedigree data related to human subjects | Normal brain development | TBI related data: imaging, phenotypic and some genomics; human but expanding to preclinical models | Neuroimages |

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|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Archive Software | NBIA, AIM Data Service (XML image metadata), and a Clinical Data relational database | NBIA | NBIA | XNAT | Image Data Archive | Human Imaging Database (HID) | MIDAS | MIDAS | MIDAS | custom | Same as NDAR (custom) | Biomedical Research Informatics Computing System (BRICS) NIH developed - custom | XNAT |
| Login account required | No. Public data is accessible without logging in. Some special restricted-access data sets do require free registration. Register on the TCIA website. | For advanced site features or limited access data sets, but is not required for accessing public data. Click here to register. | Yes. Register on the NIAMS website. | For accessing limited access data sets, but not for public data | Yes, via web https://ida.loni.ucla.edu/login.jsp | No (email requested) | No | For accessing limited access data sets, but not for public data | Only for submitting data. | Yes | Yes | Yes | For accessing limited access data sets, but not for public data |
| Explicit data sharing policy | Yes with options for uploading fully open or limited access data sets | Yes, with options for uploading fully open or limited access data sets | Yes, found here | No, data is made public or restricted as specified by the user who uploads it. | Yes. IDA User Manual. | All data is made publicly accessible. | All data is made publicly accessible. | Yes, found here | All data is made publicly accessible (varying licenses) | Yes, found here | Similar to NDAR but there is no explicit policy | Yes, https://fitbir.nih.gov/jsp/about/policy.jsp | No |
| Number of Registered Users (or NA) | 6,117 | 2,712 | 46 | ~1,000 | >1,000 | N/A | N/A | | 2,657 | 60 for data access 100-200 for data submission | ~30 | 15 – just starting | 1976 users as of April, 2015 |
| Accepting new data | Yes, proposals are accepted via email and reviewed monthly by the TCIA Advisory Committee. Acceptance criteria is summarized here: Requesting Permission to Upload your Data | No | More data is being added as part of the official initiative, but external proposals are not being accepted. | Yes, users can register accounts and upload data | Yes, see section 9 in the Appendix of the LONI Policies & Procedures | Yes, https://www.bimcommunity.org/about/contact/ | Yes, through Lung Cancer Alliance. Learn more here | Yes, new data may be added as part of future Optical Society of America publications are released. | Yes, users can register accounts and upload data. | Yes, learn more here | No | Yes, FITBIR has established a two-tiered submission strategy to ensure high quality and to provide maximum benefit to investigators. See the Data Submission Procedures for more information. | Yes. Community-generated data sets may be suggested for inclusion. Contact moderator@nitrc.org . |
| Central curation/review | Yes, a multiple tiered de-identification and QC process is utilized involving both human review and systematic analysis. The process is summarized in detail on the TCIA De-Identification Knowledge Base and What to Expect as an Image Provider | No | Yes, performed by NIAMS staff. | No | Collaborators strip all personal info from data prior to submission to LONI. Then LONI auto filters again, to ensure that there are no PHI in the files (especially if the data is binary) and stores the data in quarantine, until it's approved for posting to the web interface. | PHI must be removed by the submitting institution prior to giving the data to the FBIRN. FBIRN also performs a review to make sure there aren't any de-identification problems. | Yes, performed by Lung Cancer Alliance | Yes, performed by the Optical Society of America | Yes, some QC performed by Kitware staff and peer reviews. Most data is de-identified by the submitter prior to upload. | Sites do their own de-identification any way they prefer, so long as it meets their IRB's approval. Pre-validation is performed to ensure all data conforms /harmonizes to the autism data dictionary. QA is also performed by NDAR staff to check for identifiable information. | Archived project, no longer receiving new data. | Yes, pre-validation is performed to ensure all data conforms to the NINDS CDEs. QA is also performed by staff to check for personal identifiable information. | Yes, performed by NITRC. |
| Availability/Uptime | ~99%, hosted on a redundant production system at WUSTL | ~99%, hosted on a redundant production system at NCI CBIIT | ~99%, hosted on a redundant production system at NCI CBIIT | ~99% | Continuous (no exact % specified) | Continuous (no exact % specified) | ~99.9%, hosted on a production server at Kitware | ~99.9%, hosted on a production server at OSA | ~99%, hosted on a production server at Kitware | ~99%, imaging data hosted on Amazon and metadata hosted by NIH. | ~99%, hosted by NIH. | ~99%, hosted by NIH. | ~99.9%, hosted on production servers at UCSD. |
| Project - or Collection-based groupings? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Size of Current Volume | TCIA: 2.26 TB NLST-LSS: 6.5 TB NLST-ACRIN: 4.8 TB Total: 13.56 TB | ~21GB | ~7.5TB | 1 TB | 0.7 PB | ~2TB | 33GB | ~50GB | ~60GB | ~2TB | ~2TB | 0.5TB | 1.5 TB |
| Number of patients/subjects with imaging | TCIA: 5,997 NLST-LSS: 17,043 NLST-ACRIN: 9,211 Total: 32,251 | 32 | 4,796 | 3,494 | > 120,000 | ~300 | 37 | N/A | > 200, plus some non-patient data | 2500 NDAR | 550 (migrated into NDAR) | 200 | 6854 subjects |

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|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of DICOM Tags queryable | 2 via the Simple Search, ~90 via the Advanced Search, and all DICOM metadata can be queried using the Text Search option. | 2 via the Simple Search, ~90 via the Advanced Search, and all DICOM metadata can be queried using the Text Search option. | ~90 | ~50 | 50 | 0 | 22 (imaging parameters in query interface) | N/A | 22 (imaging parameters in query interface) | 9, with full listing from data dictionary . (4 NDAR, 5 Pediatric MRI) | 9, with full listing from data dictionary . (4 NDAR, 5 Pediatric MRI) | 10 | N/A |
| Metadata Availability | Wide variety of clinical, genetic, and image segmentation /annotation available is available for various data sets. Full summary can be viewed here in the "Supporting Data Available" column. | None | None | Various clinical and other metadata | Biospecimen, clinical, pathological, neuropsychiatric, and demographic. | Yes, extensive behavioral data and clinical data. | Some unstructured clinical data such as patient age, cancer stage, recurrence, and treatment information. | Associated articles, figures, publication-specific metadata, etc | Unstructured clinical data as well as publication-specific metadata | NDAR contains all human subjects data related to autism research funded by the NIH and others. Outside of the NDAR data dictionary, Metadata supporting project definition and research results are provided (see data from papers). | | Yes, all metadata is collected using NINDS CDEs | Gender, age, handedness, diagnosis, and MR acquisition parameters. Various cognitive assessments and other rich metadata available for some data. |
| Data submission /download methods | Submission via DICOM or HTTPS protocols using CTP . Download via Java Webstart client. A REST API is also available with documentation . | Submission via DICOM or HTTPS protocols using CTP . Download via Web (zip), FTP, Java Webstart client | Submission via DICOM or HTTPS protocols using CTP . Download via Web (zip), FTP, Java Webstart client | Submission via Web UI or DICOM protocol. Download via Web (zip) or Java applet. | Secure web upload | Downloads via Web UI, Submissions via https://www.bimcommunity.org/about/contact/ | Submission via Web UI, Download via Web (zip). | Submission via Web UI, Download via Web (zip). | Submission via Web UI, DICOM push, MIDASDesktop. Download via Web (zip), MIDASDesktop | A custom Java Webstart application allows SFTP /Amazon S3 transfers. MIPAV is offered as an optional method for de-identification. Submission is harmonized to the autism data standard using custom data validation software. Download methods include multithreaded download from the Amazon Cloud or push to cloud computational pipeline. | Not applicable. | They can use MIPAV for submitting images. Submissions must conform to FITBIR Data Dictionary (NINDS CDEs). A custom Java Webstart application allows SFTP transfers. | Upload by arrangement. Downloaded via Web (zip), Java applet, or REST API. |
| Helpdesk Support | Yes, the TCIA Helpdesk supports both end users and submitters. They provide phone and email support during regular business hours Mon-Fri. | Yes, CBIT Application Support | Yes, CBIT Application Support | Via XNAT discussion group | dba@loni.ucla.edu | Yes, via https://www.bimcommunity.org/about/contact/ | Technical issues can be sent to midas@public.kitware.com or click here for Administrative support and other questions | Contact infobase@os.a.org . | Contact midas@public.kitware.com | Yes, available at ndarhelp@mail.nih.gov . | Yes, pedsmri@mail.nih.gov . | Yes, FITBIR-help@mail.nih.gov | Contact moderator@nitrc.org . |
| Affiliation with Journal | Not directly, but Digital Object Identifiers can be provided for integration with publications. TCIA is also a recommended repository for Nature's Scientific Data journal. | No | No | No | Yes, Neuroimage | No | No | Yes, Optics Info Base | Yes, Insight Journal | No | No | No | No |
| Intended Audience(s) | Cancer researchers, engineers and developers, professors | Anyone interested in testing the functionality of the NBIA software. | Osteoarthritis researchers | All imaging research | Neuroimaging and genetics research | Neuroimaging research | Lung cancer researchers | Optical Society of America subscribers | All imaging research | Autism researchers (clinical /phenotype /genomic), both those receiving autism related NIH grants and other investigators sponsored by an NIH recognized institution with a current federal-wide assurance. | Neuroscientists interested in normative brain study of child development. | TBI researchers | Neuroimaging research |

Image archive software solutions

Below is a list of image archive solutions that can be deployed by interested parties wishing to build their own DICOM based biomedical image archive. This list omits some of the archives above in cases where we could not find any information about how one might download and deploy their own instance of the software.

| Software Name and Web Site | NBIA GForge project | XNAT | MIDAS |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Interface /GUI | Web | Web | Web/Desktop Application |
| Query types /flexibility | Simple (9 parameters), Advanced (10 more parameters), Dynamic (boolean query of up to 90 DICOM tags) | Extensible set of DICOM tags as well as linked quantitative biomarkers, linked clinical data, and other non-imaging data. | Customizable, search by any tags registered in the system |
| Role Based Security | Yes | Yes | Yes |
| Public access option (no login req) | Yes | Yes | Yes |
| Active Development | Yes, NCI CBIIT | Yes, WUSTL Neuroinformatics Research Group | Yes, Kitware |
| License | Open source - NBIA License Agreement Details | Non-restrictive (BSD) open-source license - XNAT License Agreement Details | non-restrictive (BSD) open-source license |
| API available | Yes, REST | Yes, REST | Yes, REST, OAI-PMH |
| Supported image formats | DICOM | Automated import of DICOM and ECAT. Custom importers can be implemented for other formats. Any file type can be uploaded through the API and web interface. | DICOM and other ITK-based format |
| Supported metadata formats | XML, Zip | XML, CSV. Custom data import logic can be implemented via pluggable Groovy and Python scripts. | XML |
| Transfer protocols (import /export) | DICOM, HTTPS | DICOM, HTTPS | DICOM, HTTPS |
| Controlled Vocabulary | Follows caBIG standards (caDSR/EVS) | XNAT Schema | NIH Mesh and Dublin Core |
| Deployment Support | Yes, CBIIT Application Support or via NBIA User Listserv | XNAT Google Discussion group, monthly developer toons, biannual user conference. Commercial technical support provided by Radiologics. | Yes, MIDAS mailing list |
| Support Operating Systems | Linux, Windows, Mac | Linux, Windows, Mac | Linux, Windows, Mac |
| Data submission options | Submission to NBIA is performed by a java tool called CTP developed by John Perry at the RSNA. CTP has options to import data from a hard drive or directly from a PACS or DICOM Workstation. | Direct upload is available through the web UI, direct DICOM transfer, scripts using REST API, optimized CTP workflow | Direct upload via web UI, direct DICOM transfer via push, MIDASDesktop transfer (includes command line tools), WebDAV support. |
| Standard of De-Identification | Incorporates DICOM de-identification standards from The Attribute Confidentiality Profile (DICOM PS 3.15: Appendix E) via CTP. | Built-in de-identification language based on DICOM Browser can be configured to comply with DICOM PS 3.15: Appendix E and other standards. | No, but pre-storage filters can be run automatically |
| Support for multi-site submissions | Yes | Yes | Yes |



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