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Online Data Research Repositories and Digital Scholarly Ecosystems: From Research Data and Datasets to Artificial Intelligence and Discovery

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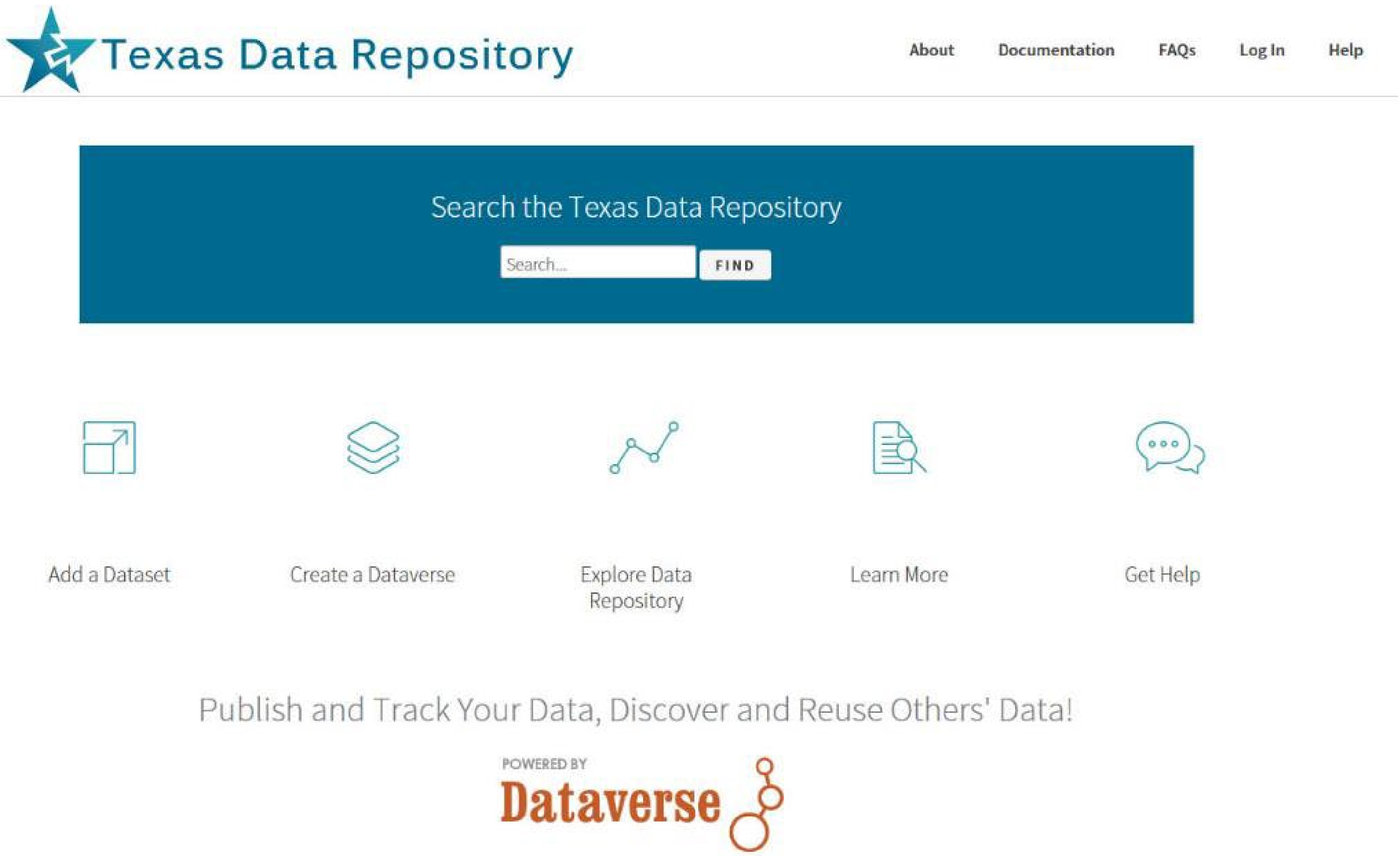
ABSTRACT:

Online networked data research repositories allow sharing and archiving of research data for open science and global research. This sharing opens data to modern interoperability and metadata for search, retrieval, and larger possibilities of open scholarly research ecosystems. Data research repositories are currently being leveraged to accelerate global research, promote international collaboration, and innovate on levels previously thought impossible. Research data repositories may also link data to further content from online publications and other digital communication and aggregation tools. This article pragmatically overviews such a data and content-centered ecosystem at Texas State University Libraries in the United States. The research then discusses the ecosystem's next level of planning and construction involving both bigger data possibilities for AI infrastructures\enabling researchers and their data towards Deep Learning (Neural Net) possibilities. The research uses examples of recent digitized medical image datasets for Cancer/melanoma detection through Deep Learning/Neural Net for global open science possibilities. These methodologies show large promise in making good use of online open data repositories, digital library ecosystems and online datasets. Recent AI research highlights the utility of several easily available online open-source digital library data repository and ecosystem components. An online data-centered research ecosystem accelerates open science, research and discovery on global levels. This open-source ecosystem and software infrastructure may be easily replicated by research institutions. Creating open online data infrastructures for research communities enables future global data and research, collaboration and the advancement of science, the academic research cycle on networked global levels.

Keywords: Artificial Intelligence, Neural Nets, Libraries, Big Data, Data Research Repositories, Online Research Ecosystems



Texas Data Repository, http://data.tdl.org

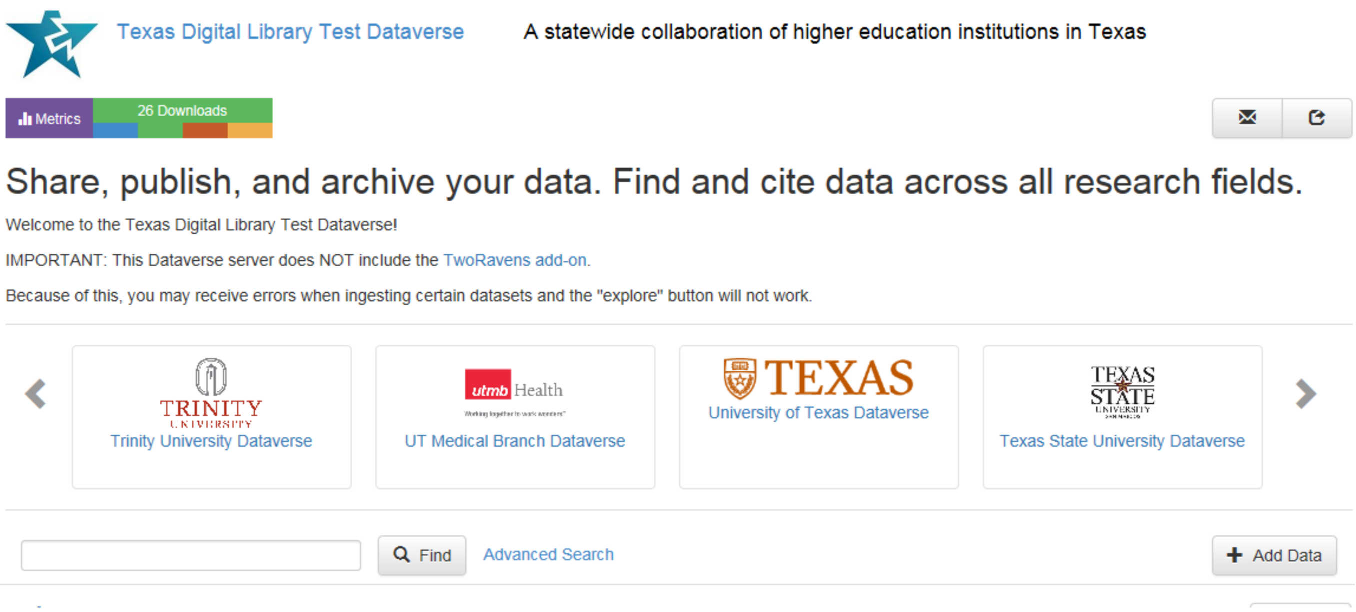
1 INTRODUCTION

The path from data and experimental research data to online data repositories, research ecosystems and artificial intelligence discovery is not overly clear. This research overviews necessary infrastructures from an online research data repository and digital scholarly ecosystem within currently globally occurring AI research discovery to present better clarity towards present necessities.

This paper uses the example of Texas State University Libraries research data infrastructure to overview rudiments of an online data repository and the utility for placing a data repository within a larger scholarly research ecosystem. Current possibilities of online data allow discovery within Artificial Intelligence, particularly Deep Learning and Neural Nets. This research illustrates this with two online medical related image dataset examples to foreground the importance of online data repository ecosystems towards open science and, particularly, Artificial Intelligence and new discovery. The first example is from a scientific deep learning neural net discovery towards cancer detection utilizing object recognition and big data for machine learning and neural net training from a US university (Stanford). The second example builds on the first model's methodology utilizing an undergraduate student theses from BRAC University from Dhaka Bangladesh. Examples begin with Stanford's large AI neural net model and then focus on data repository and ecosystem methdologies which continue to focus Stanford's AI neural net research with other smaller, online, openly available datasets. Both examples give compelling evidence illustrating the value of online open data research respositories and data-centered scholarly ecosystems towards the future progress of science and discovery in our new millenia. New potential for open science is enabled by the recent constellations of global networks, algorithmic Artificial Intelligence Neural Network Deep Learning models, online data research repositiories and increasing computing processing power and storage. Rudiments of an online data research repository, scholarly research ecosystem are outlined. Examples are then utilized to show how these new infrastructures may be used to enable the new potential for AI for scientific discovery in the 21st century.

2 WHAT IS AN ONLINE DATA RESEARCH REPOSITORY?

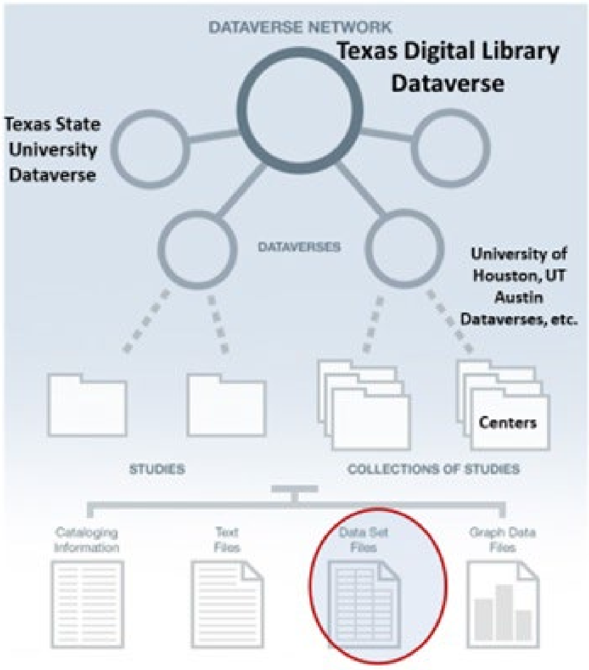
An online data research repository allows one to share, publish and archive a researcher's data. It is at once a platform to manage a researcher's and institution's data and metadata, a permalinking strategy for Data Citation, a way to manage increasingly mandated large grant compliance and an efficacious data archiving and sharing strategy.



Texas Data Research Repository, https://dataverse.tdl.org

The Texas Data Repository is a good example of a consortial data repository. It utilizes Harvard's open source Dataverse Software customized towards a consortial multi-university strategy.[1] The Texas Data Repository aggregates various individual university's data for search and retrieval and can be configured as a single instance for searching or to search across an entire group of institutions.

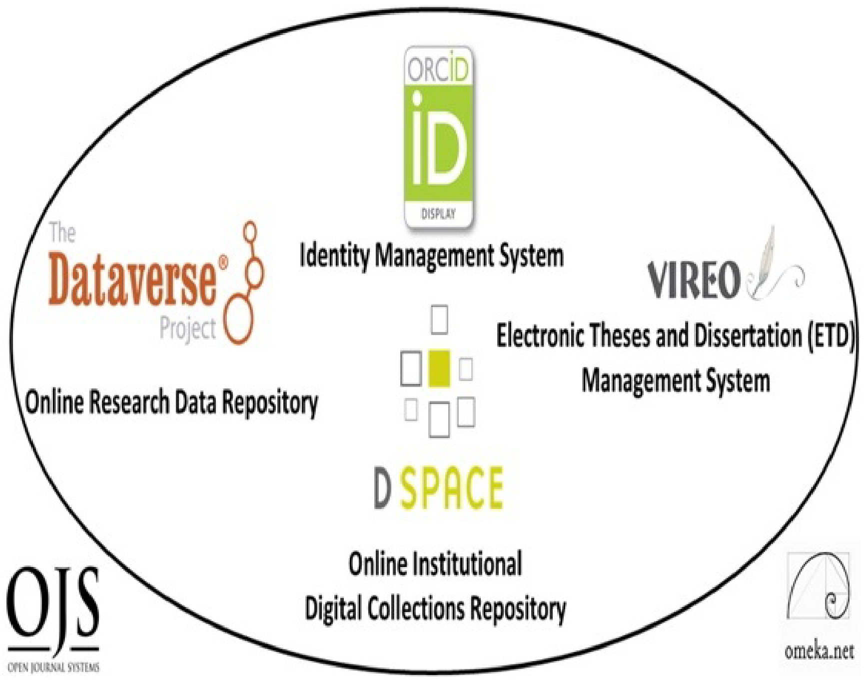
[1] See Uzwyshyn, Online Data Repositories (2016). https://www.researchgate.net/publication/304780954_Online_Research_Data_Repositories_the_What_When_Why_and_How



Texas Data Repository Consortial Architecture

3 DIGITAL SCHOLARSHIP ECOSYSTEMS

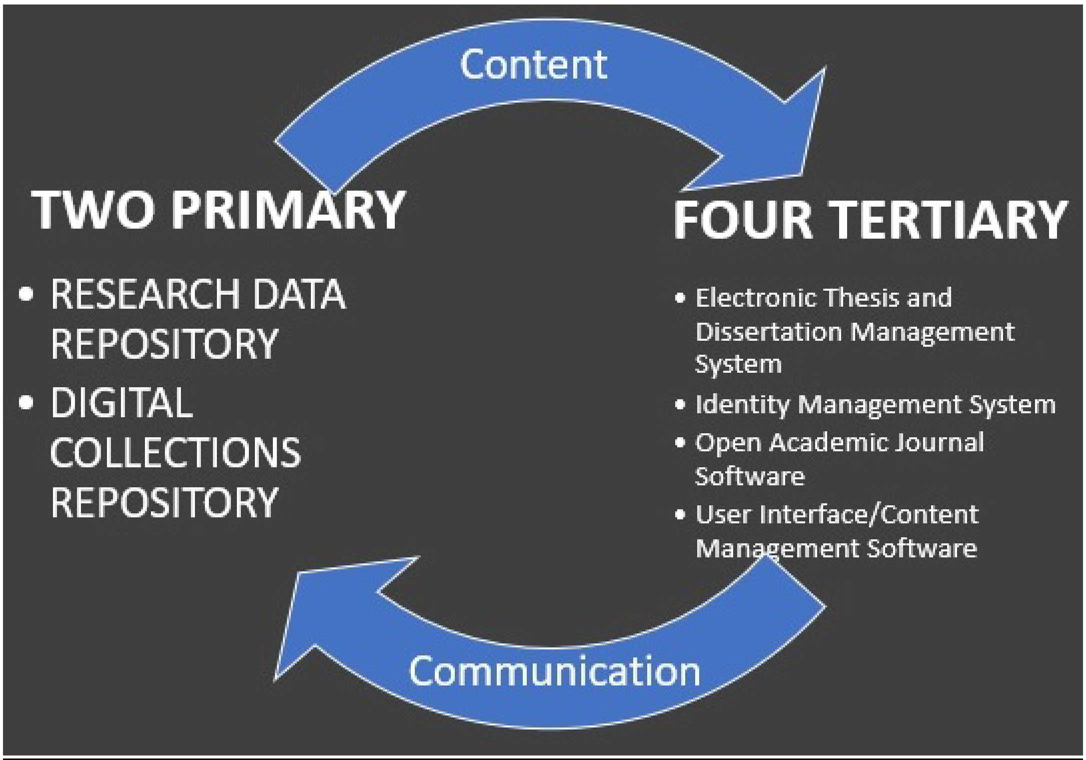
A Digital Repository may also be placed within a larger digital scholarship ecosystem which enables a wider horizon of content and global network communication.



The Texas State Digital Scholarship Research Ecosystem Consists of Six Components

The Texas State Digital Scholarship ecosystem utilizes the well-known open-source repository software, Dspace, for the university's digital collections repository. Four other tertiary components are also utilized by researchers to better enable online global communication and network possibilities. These four applications are an online electronic theses and dissertation management system, ETD System (VIREO), identity management system (ORCID), open academic journal system software (OJS3) and user interface content management software (OMEKA). Together, these function as a unified digital scholarship ecosystem. [2]

This ecosystem allows for great facility in enabling data-centered methodologies. It continues to build on strong foundations and provides foundational training data for later AI pathways that may be needed.



A Digital Scholarship Research Ecosystem is enabled by both Content and Communication Components

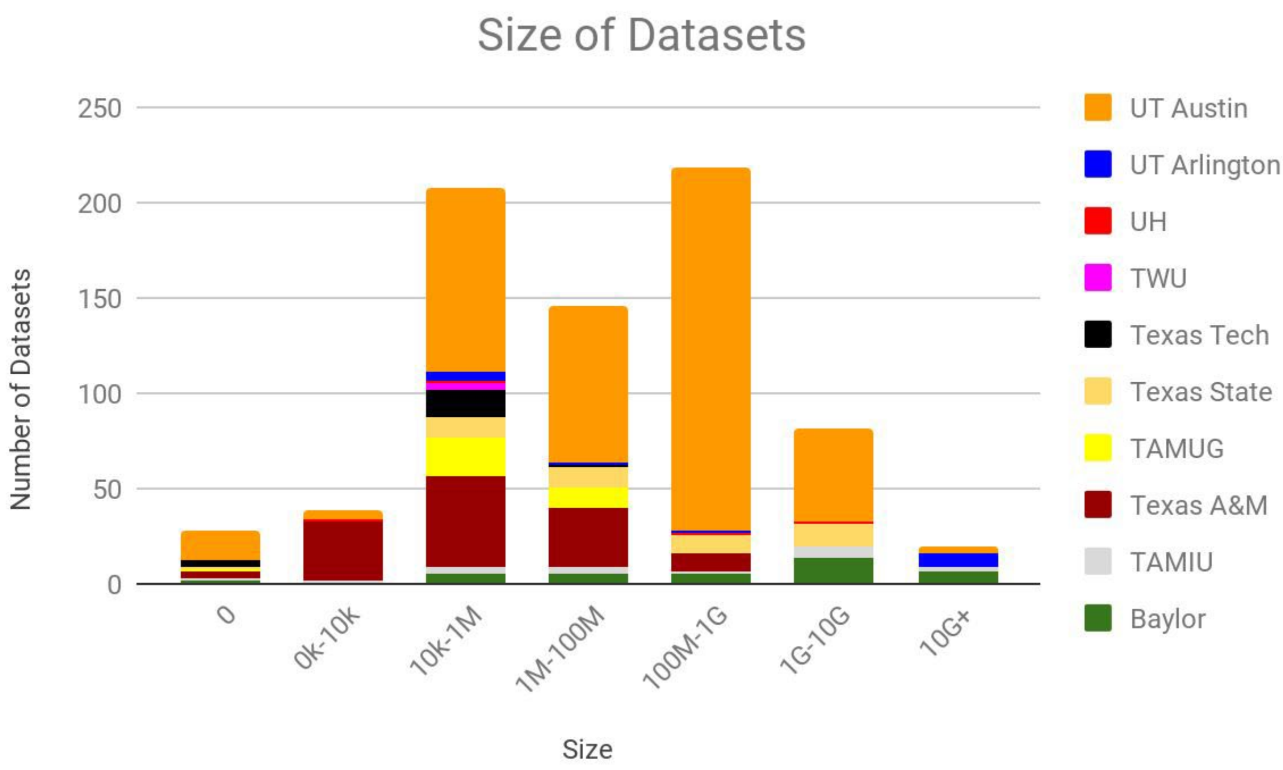
The general common characteristics for such a digital system are open-source software, active developer communities, communication and content repository components. The open-source software allows customizability and connection between components. Active developer communities for the software enable a lively exchange of new possibilities with regards to innovation. The open-source code allows bridges among systems. The sum of the system's capabilities exceeds separate parts. Collocating open-source digital components in a networked research ecosystem enables larger connections, network effects and many untapped possibilities.

Together, these digital ecosystem components enable a larger academic research cycle. This cycle moves from original search and retrieval of data and content to gathering and analysis of data, to later writing, publishing and sharing online.

[2] See Uzwyshyn, 2020. Available at: https://www.researchgate.net/publication/336923249_Developing_an_Open_Source_Digital_Scholarship_Ecosystem

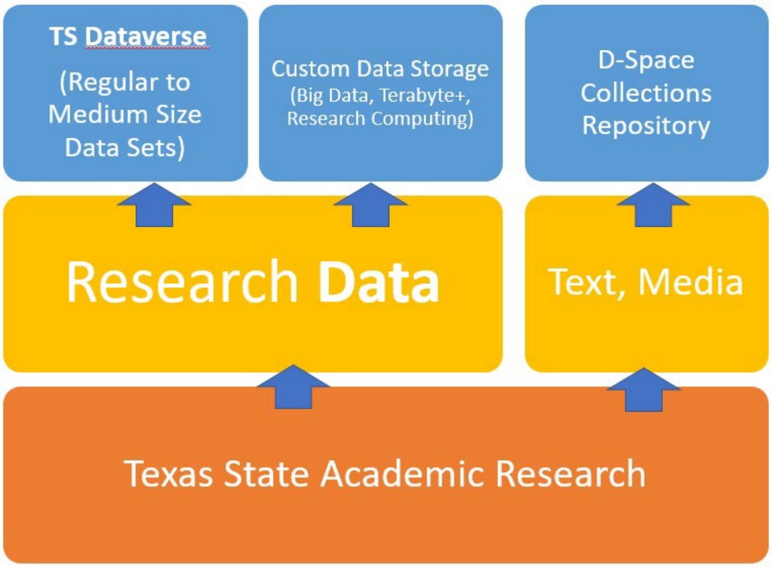
4 DATA, DATASETS, BIG DATA

Data comes in a variety of file types, formats, media, and sizes. For AI and particularly recent Deep Learning both labelled and unlabelled datasets become important for machine training. Within information science, metadata becomes key. Information science's disciplinary schema systems are very useful. One size also does not fit all for various data research repository project needs. There are many types of sizes for data projects and repositories. The Texas Data Repository utilizing Dataverse can upload currently up to 4GB data for individual files and 10GB Datasets. This may not seem large currently in terms of some recent examples of mammoth natural language processing datasets or image/video model massive datasets trained by Google's DeepMind or Microsoft's Open AI (see Mitchell, 2022). These more regular sized datasets utilize Terabytes and Exabytes of data. These serve the needs of most academic researchers and have served researchers well for the last five years (2017-2022).



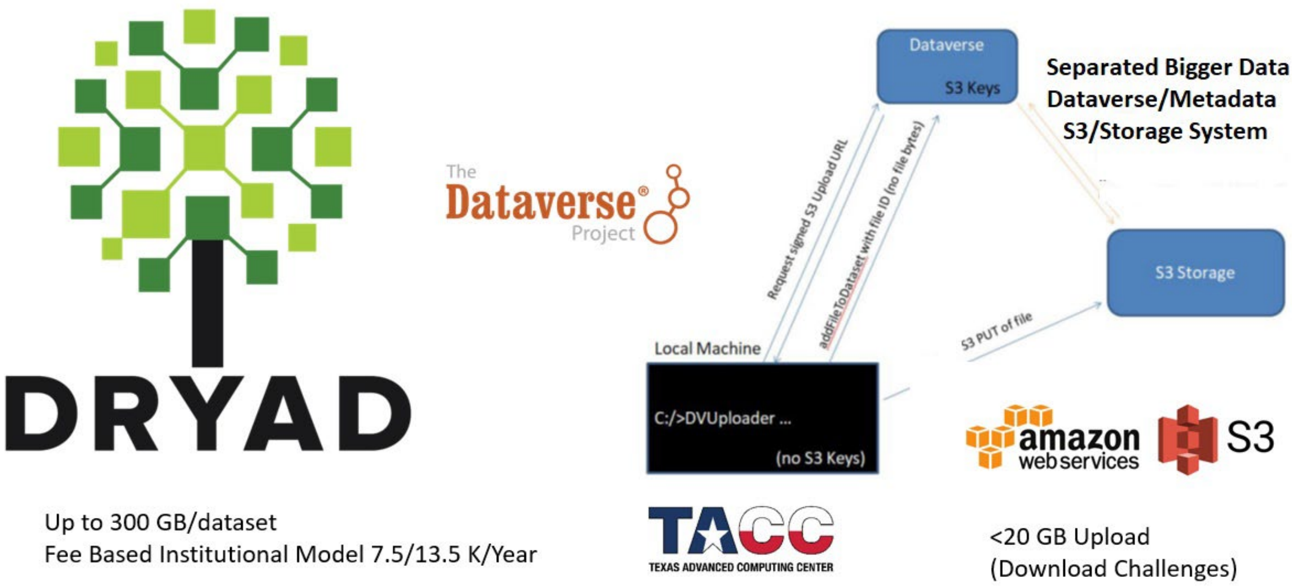
Sizes of Texas Data Research Repository Datasets (See Waugh, 2020)

Most researchers' collected datasets for upload are still in the 1< <1000 MB range. Currently, there is the growing recognition by researchers that 'bigger' data repositories are needed. These begin in the Giga and Terabyte ranges and prepare for the next phase of build. Many of these researchers are also on a leading edge with specialized media or GIS datasets. In these cases, for larger, bigger and custom data storage it is still not yet feasible to place these huge datasets online, especially those in the Terabyte or Exabyte range. Preferably, these are placed with university research computing data centers or the local area supercomputing center for custom data storage should these needs arise. This type of storage is usually worked out by researchers in preliminary grant applications expecting this level of data storage needed for research work.



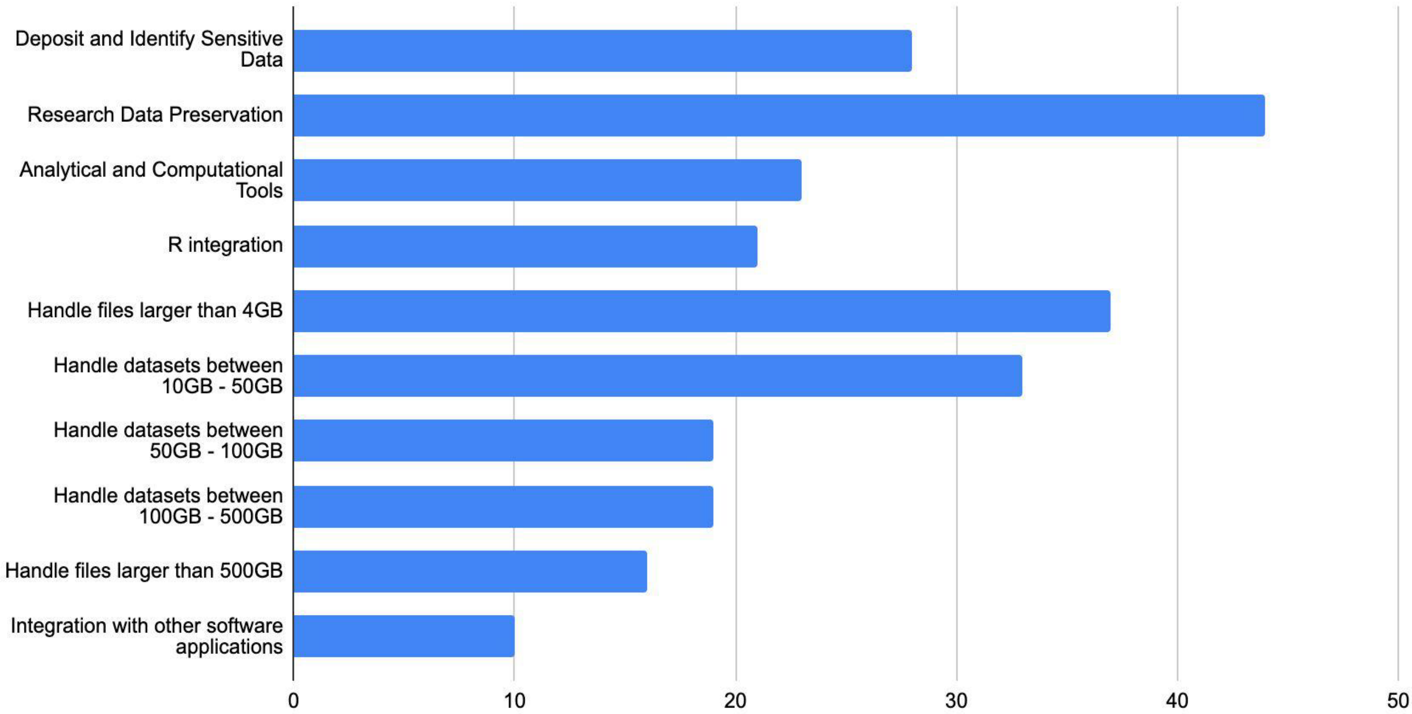
Texas State Universities Big Data Storage Model

Currently, beyond the few custom big data storage needs the requests for very 'big data' (Terabytes, Exabyte storage) are still few but these requests are increasing. In this regard, Texas State University Libraries have been exploring various 'bigger data options and beta prototypes (2020-2022). This ranges from 20GB expansions (Amazon Web Services S3 storage) and the Texas Advanced Computing Center) with separated metadata/storage pointer systems to more fee-based institutional models up to 300GB/dataset (Data Dryad).



Beta Prototyping Bigger Data Online Texas Data Repository Architectures. 2020-2022, TACC: https://www.tacc.utexas.edu/, Data Dryad https://datadryad.org/stash

Currently, ‘Big Data’ (Exabyte, Terabyte) is not at the top of the list of new data research repositories feature set requests that most researchers would like to see. Higher on this list of new features is long term research data digital preservation[3]. Also ranking high, is handling slightly larger data files (4-10 GB range) and datasets between the 10-50GB range as well as being able to safely deposit and clean sensitive data (i.e., Medical related etc., see data survey below). Greater support for analytical and computational tools also comes high on the list. Ranging from data analytics and visualization, these tool and data literacy requests, , help to enable researchers from non-Computer Science disciplines towards new AI methodologies such as those being forwarded currently through neural net and deep learning methodologies.



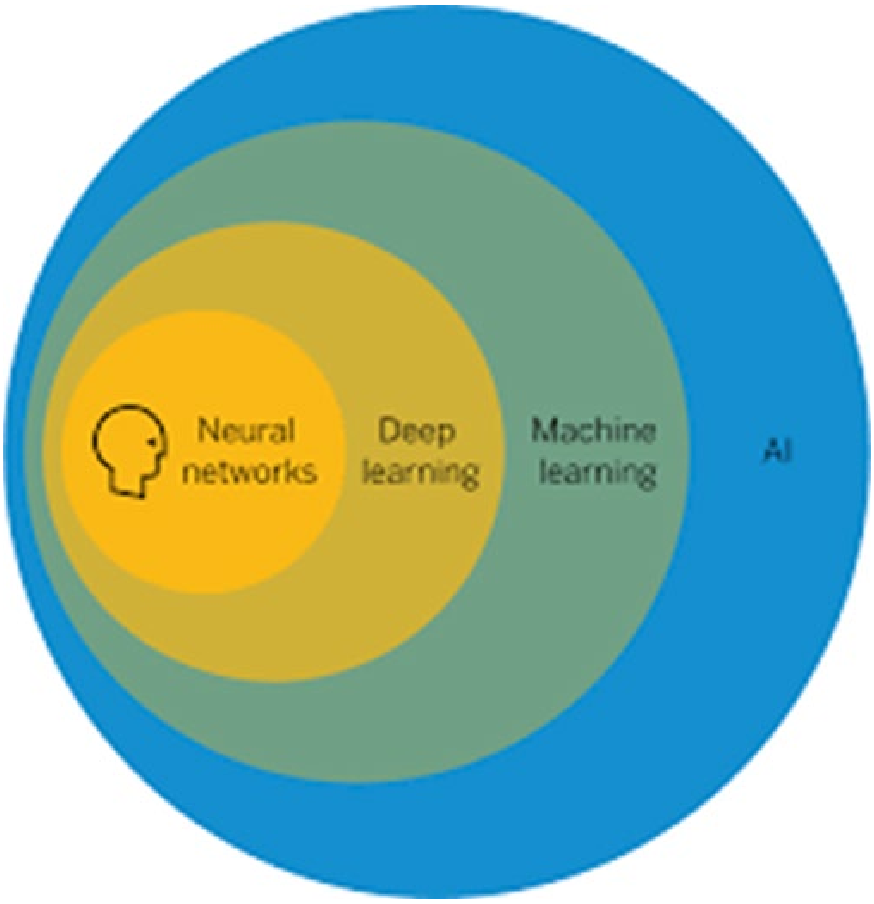
What New Data Research Repository Features Would Users Like to See? (Chan-Park, Sare and Waugh, 2022)

The final section of this research looks further at the ‘analytical and computational’ tools data feature-set request above, focusing upon current data-centered researchers. Two examples are utilized from Deep Learning AI and Neural Net computational research, highlighting how the datasets from these areas are being globally enabled and shared through present data research repositories and ecosystems.[4]

[3] See Uzwyshyn, 2021. Frameworks for Long Term Digital Preservation.

[4] Beyond the scope of this article but towards the need for ‘algorithmic’ literacy of researchers outside of Computer Science disciplines is enabling the vast potential of ‘other’ disciplinary area datasets towards the potential of insight and discovery possible through AI Scholarly communication possibilities of libraries. (See Uzwyshyn 2022; Kleinveldt, 2022)

5 DATA RESEARCH REPOSITORIES, DIGITAL ECOSYSTEMS AND AI



Relationships among AI and subdomains of Machine Learning, Deep Learning and Neural Nets

The last five years (2017-2022) have shown incredible progress and gains in analytical computations tools and discovery, particularly those tools and methodologies associated with new domains of Artificial Intelligence. Machine learning, deep learning and neural net scientific research has shown incredible potential for scientific breakthroughs. These breakthroughs range from Computer Vision (Facial/Object Recognition), Natural Language Processing (speech to text recognition and translation), Cybersecurity (Fraud Detection, Conversational Chatbots and Robotic Agents and Strategic Reasoning (AlphaGo, Game Theory). Breakthroughs have been enabled through a fortuitous combination of better algorithms greater computing processing power (Compute) readily available well-labelled metadata enabled online datasets and, increasingly, open-source research data repositories and ecosystems.

The following section utilizes recent discoveries from Neural Net object identification to illustrate how online data research repositories and online data research ecosystems are facilitating the next generation of global collaboration possible with networked ecosystems academic research, discovery, and open science.

6 CANCER DETECTION, IMAGE DATA REPOSITORIES & AI

In 2017, an innovative new cancer detection methodology was published in Nature by a Stanford University group proposing the use of Neural Nets (Esteva, Nature, 2017). The AI neural network was trained on big data and a dataset of 129,460 images of 2,032 diseases and larger dataset of AI training images (1.41 million) to classify skin cancer lesions with deep neural networks. After comparison, the neural net machine learning AI did equal to or better than 30 board certified dermatologists with decades of experience.

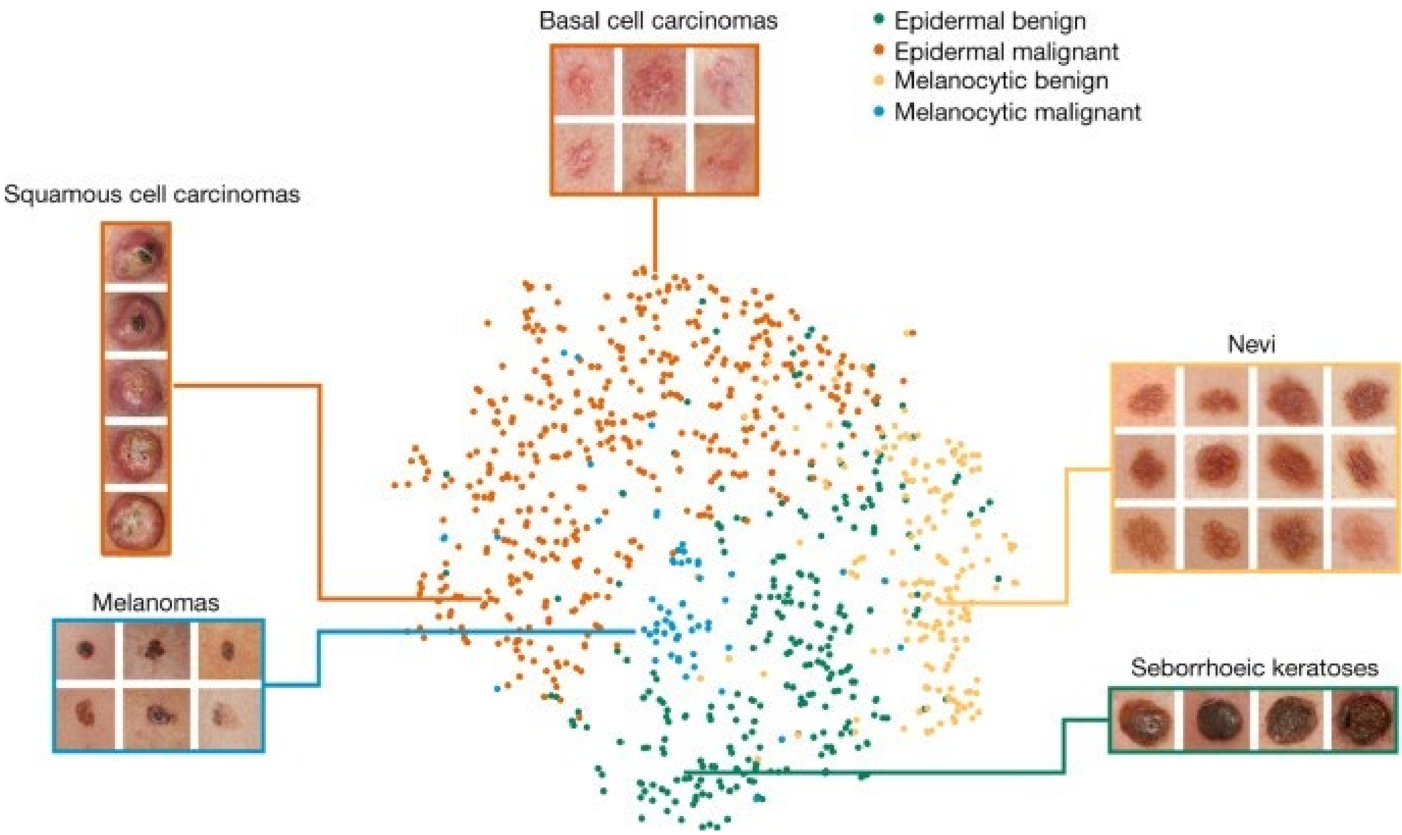


Image from Dermatologist Level Classification of Skin Cancer with Deep Neural Nets (Esteva et al, 2017) [5]

The neural net here was able to successfully classify epidermal lesions for early cancer detection into benign and cancerous (malignant) lesions better than 30-year board certified dermatologists This method involved pixel-level differentiation and training through a multi-level neural net AI model. The large relevance of the digital image data repositories for initial training and metadata labelling should not be underestimated for researchers. In a more recent article on Deep Learning in Cancer Pathology Surrounding a New Generation of Clinical Biomarker (Echle, 2020), the authors emphasize the need for organized digital libraries, data repositories, dataset preparation and metadata preprocessing for later accuracy in training, testing, and external neural net validation. The next example builds on the Stanford new discovery and possibility through possibilities now available through data repositories and digital scholarly ecosystems.

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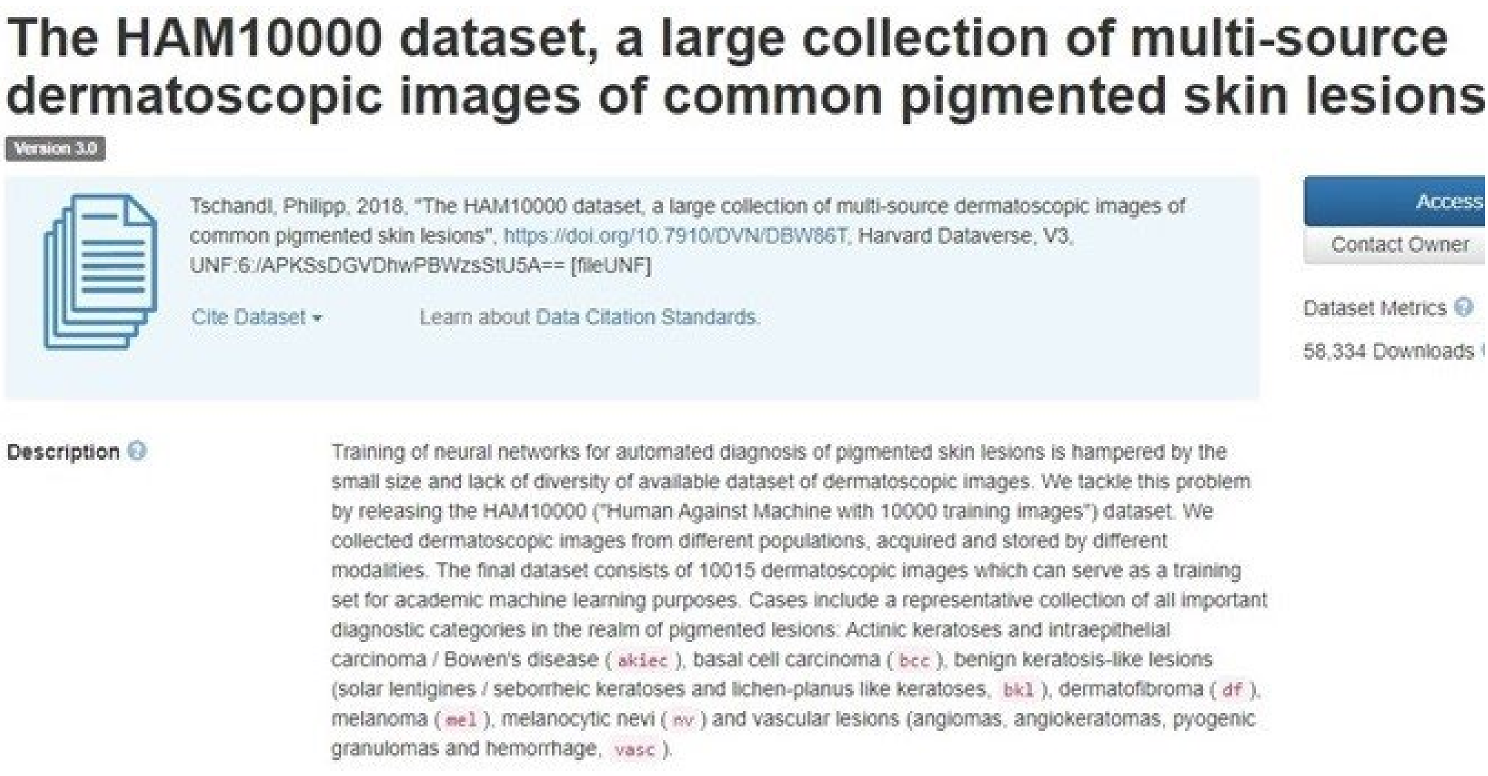
[5] See also, the original article from Nature. Esteva, A, Thrun, S. et al. Dermatologist-level Classification of Skin Cancer with Deep Neural Networks. Nature, Volume 542 (February 2, 2017). pp. 115-119. doi:10.1038/nature21056 and Eschle, 2020.

7 OPEN SCIENCE, AI AND DATA-CENTERED ECOSYSTEMS

Huge data sets like the Stanford example are not the only and most recent of those able to be utlized through AI and neural net methodologies. Innovative global open science and AI machine learning possibilities are also being forwarded efficiently through previous algorithmic training and application of regular sized datasets. New affordances are enabled through a confluence of data research repositories presently online and researchers' willingness to share their data sets. Research data libraries open search and retrieval allowing other researchers to apply algorithmic machine learning expertise to research data.

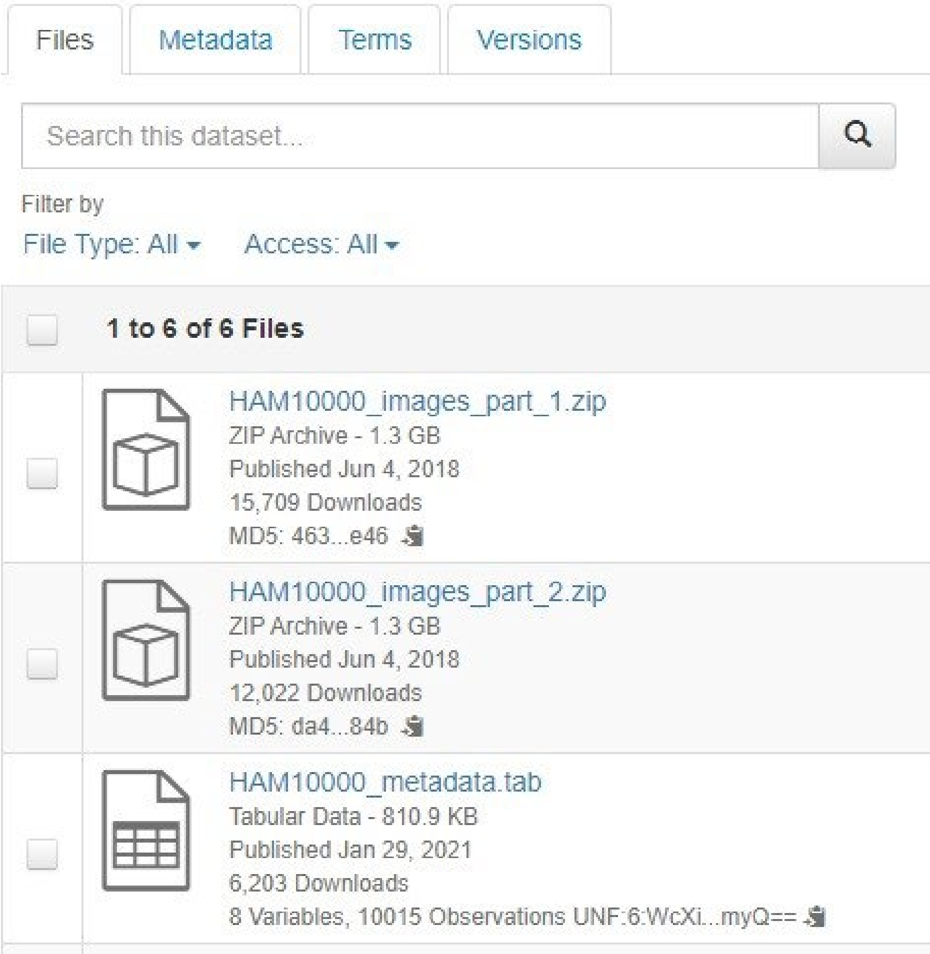
Harvard's Dataverse allows for the uploading of datasets from other universities globally. Appropriate research datasets may be uploaded for sharing later or use by researchers anywhere. If a university or research institution does not possess a Texas Data Repository or Harvard Data repository, and the researcher is carrying out valid academic research, they can utilize the Harvard repository. As mentioned, Dataverse is open source software and any research level libraries, institution and university should be enouraged to be setting up their own instances of data repository and digital ecosystems.

To trace an innovative example, the HAM10,000 image dataset below is a large collection of multi-source dermatoscopic images of cancerous skin lesions. This dataset was uploaded to Dataverse by Viennesse Dermatologist, Dr. Philip Tschandl, in 2018, a year after the Stanford Nature Neural Net algorithmic methodology article appeared.



HAM10000 Dataset in Dataverse Data Research Repository,
https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/DBW86T

As can be seen, the images, data and metadata can be easily downloaded, unzipped, and used by researchers for neural net training purposes.



HAM10000 Dermascopic Cancer Images, Harvard Dataverse Repository,
https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/DBW86T

The use of data research repositories to house data collections from around the globe, and later reuse by other researchers in other areas of the globe to train deep learning and neural net models, becomes very interesting with regards to possibilities for open science, globally dispersed academic researchers, and new possibilities for discovery and innovation.

Below is a cover page from BRAC University from Dhaka Bangladesh that uses DSpace as an institutional repository to house theses and dissertations from the School of Data and Sciences, Dept. of Computer Science and Engineering. Here, the computer science and engineering students had earlier downloaded Dr. Tschandl's uploaded dermatological cancer training images, metadata and datasets. They utilized the labelled image data as training material to train a deep learning neural net algorithm to recognize cancer growths with efficiency greater than, or equal to the 2017 board certified dermatologists for mobile devices. The example is very interesting for possibilities of telemedicine and global populations which may not have as quick access to trained specialists as those in the West.

This is a particularly good example of open science and AI possibilities operating on global levels through the enabling power of digital scholarship ecosystems and data repositories. Content and specialized image data sets, with highly specialized labelled metadata that otherwise would be unavailable, are brought together with new machine learning algorithmic techniques. New research and an exceptionally good thesis has been produced. Globally dispersed content and data, from three different continents, has been aggregated to advance the pursuit of knowledge and science with a speed and utility that would be unimaginable in other centuries.

BRAC UNIVERSITY Inspiring Excellence Institutional Repository

BracU IR / School of Data and Sciences (SDS) / Department of Computer Science and Engineering (CSE) / Thesis & Report, BSc (C / View Item

An efficient deep learning approach to detect skin Cancer

URI
http://hdl.handle.net/10361/15932

Abstract
Each year, millions of people around the world are affected by cancer. Research shows that the early and accurate diagnosis of cancerous growths can have a major effect on improving mortality rates from cancer. As human diagnosis is prone to error, a deep-learning based computerized diagnostic system should be considered. In our research, we tackled the issues caused by difficulties in diagnosing skin cancer and distinguishing between different types of skin growths, especially without the use of advanced medical equipment and a high level of medical expertise of the diagnosticians. To do so, we have implemented a system that will use a deep-learning approach to be able to detect skin cancer from digital images. This paper discusses the identification of cancer from 7 different types of skin lesions from images using CNN with Keras Sequential API. We have used the publicly available HAM10000 dataset, obtained from the Harvard Dataverse. This dataset contains 10,015 labeled images of skin growths. We applied multiple data pre-processing methods after reading the data and before training our model. For accuracy checks and as a means of comparison we have pre-trained data, using ResNet50, DenseNet121, and VGG11, some well-known transfer learning models. This helps identify better methods of machine-learning application in the field of skin growth classification for skin cancer detection. Our model achieved an accuracy of over 97% in the proper identification of the type of skin growth.

Keywords
Cancer detection; Convolutional neural networks; Image classification; Deep learning

LC Subject Headings
Machine learning; Cognitive learning theory (Deep learning)

Description
This thesis is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering, 2021.

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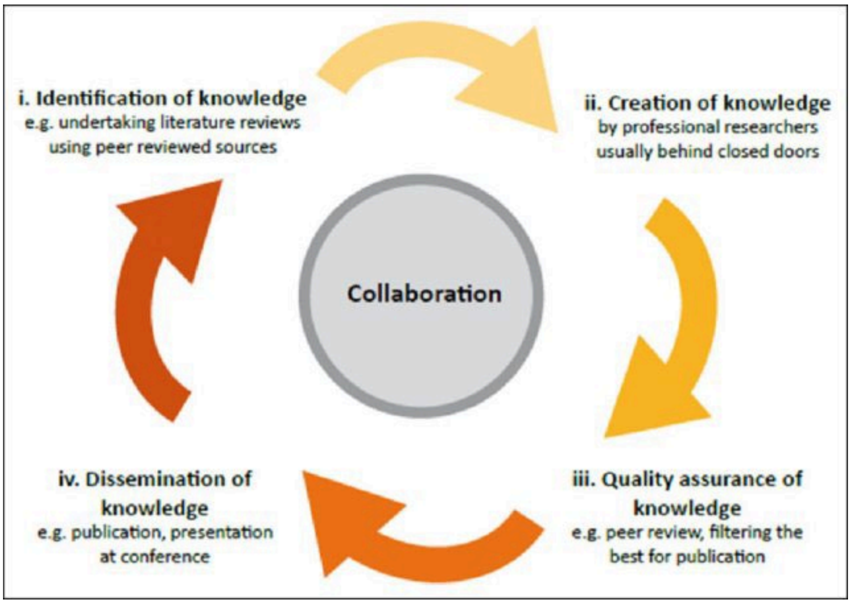
8 CONCLUSIONS – AI, DATA AND THE ACADEMIC RESEARCH CYCLE



The Academic Research Cycle, Cann, Dimitrious and Hooley, 2011.

New data repository and digital scholarly ecosystem possibilities are enabling the academic research cycle and progress of knowledge and discovery in our new millennia in amazing ways. Open science possibilities empower a new global networked generation towards incredible new science and knowledge discovery and creation Through the enabling power of data, data research repositories and digital scholarly ecosystems.

The creation of data and knowledge usually occurs behind closed doors, hidden away in research labs, file cabinets and, more recently, computer hard drives. Data sharing has now been enabled through possibilities of networked communication and content technologies. This sharing by researchers on a global stage also allows transparency towards the quality assurance of knowledge ranging from online peer review to availability of data and research for further citation, discovery download and pragmatic use.

Paired with other ecosystem possibilities such as open online academic research journals, theses and dissertation (VIREO) and online identity management systems (ORCID), and new multimedia user interface possibilities, these tools are able to facilitate large global collaboration and intrinsically human creative activities of discovery and invention, creating new innovation and building on the progress of previous and current generations of researchers and scholars.

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