Lab 1 - A^3 Framework

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1 Introduction

A³, or as it would be spoken aloud "A Cubed," is a framework for aggregating and archiving artifacts. A³ aims to bring a level of educational organization that would revolutionize the ways in which both instructors and students transfer information. In order to fully understand why A³ is a necessity for academic environments the current shortcomings of academic knowledge must be identified, discussed, and evaluated. First and foremost, formal artifact aggregation in traditional academic environments does not exist (Davenport, T.). In order to be truly centralized it is necessary to have tools that aggregate the artifacts being stored. There are a number of systems created for networking that have the ability to share items like academic artifacts, but those that do exist do not have the ability to track changes from version to version (Carroll, J.).

A direct example of the functionality lacking in formal aggregation can be seen at Old Dominion University (ODU). In interviews with Janet Brunelle it was detailed how the faculty of ODU can often be segmented as a result of their specializations or courses they were instructing at the time. This fragmentation made certain parties unable to access materials from various courses and other instructors without petitioning them directly (J. Brunelle, personal communication, March 2, 2020). Not only was there a layer of forced bureaucracy, but oftentimes resources could be lost as responsibilities changed hands. Brunelle directly noted

how a strong infrastructure for sharing material would benefit organizations such as ODU on a fundamental level to prevent these problems from occurring. Thomas Kennedy was also interviewed in the process of developing A^3 and noted other issues he had come across when developing aggregation tools in the past. Namely, that instructors have their information stored in a variety of formats that themselves are stored in a variety of resources, most notably Blackboard and PLE (T. Kennedy, personal communication, February 12, 2020).

These represent fairly diverse issues, but A^3 seeks to solve them as an all-in-one solution. A^3 will aggregate and store artifacts by normalizing them into Markdown and archive them into a dedicated database. In addition to storing artifacts the A^3 database will track changes, supply reports, and make information available to all individuals with access. With these artifacts normalized and widely available, A^3 will take things one step further with the ability to directly compare artifacts to one another or their previous versions. To do this, A^3 will store past versions of artifacts to show changes to course materials over time. A^3 will create an environment in which artifacts, as well as the repositories they are stored in, can be tagged for searchability and grouping.

2   Product Description

A^3 is a repository designed for teachers to upload and share artifacts with students and colleagues for reference material, notify when changes have been made to their artifacts, the normalization of artifacts, the ability to compare, and the ability to tag artifacts and repositories.

2.1 Key Features and Capabilities

A^3 in layman's terms connects users to a single, centralized repository. It allows users to create their own repositories, that can be tagged for searchability, to store artifacts that can be tagged as well. When artifacts are tagged they become directly searchable by those tags. An instructor being able to tag all of their course material with the course number or current topic of the course allows for intuitive grouping of those artifacts. Repositories will also share tagging functionality should instructors wish to make their repository itself viewed as a grouping of similar artifacts instead of part of a large, more diverse repository.

The reasoning for this is that some artifacts will not be universally available. Some artifacts and repositories will be private, only able to be viewed by appropriate parties. A^3 will also have a bookmarking feature for artifacts that are frequently referenced or needed by users. All of these features team up with the true core of A^3, normalization. Converting the artifacts that are uploaded to A^3 into Markdown allows users to see differences between artifacts that have been updated or changed over time. Comparing newer versions to older versions is necessary when creating learning environments. In addition to differentiating and showing changes among versions of artifacts, it is necessary for users to be able to search based on updates, become notified when updates have occurred, and set arbitrary amounts of time to request for updated materials as some artifacts need to be updated periodically.

2.2 Major Components

The A^3 Framework is not only a database. A^3 includes a GUI in addition to a command line interface. Users begin on the left hand side of the following diagram with their own personal computer. Using whichever user interface they choose they will connect to the university servers where A^3 will function. The ODU CS server hosts the authentication and storing of the A^3 database.
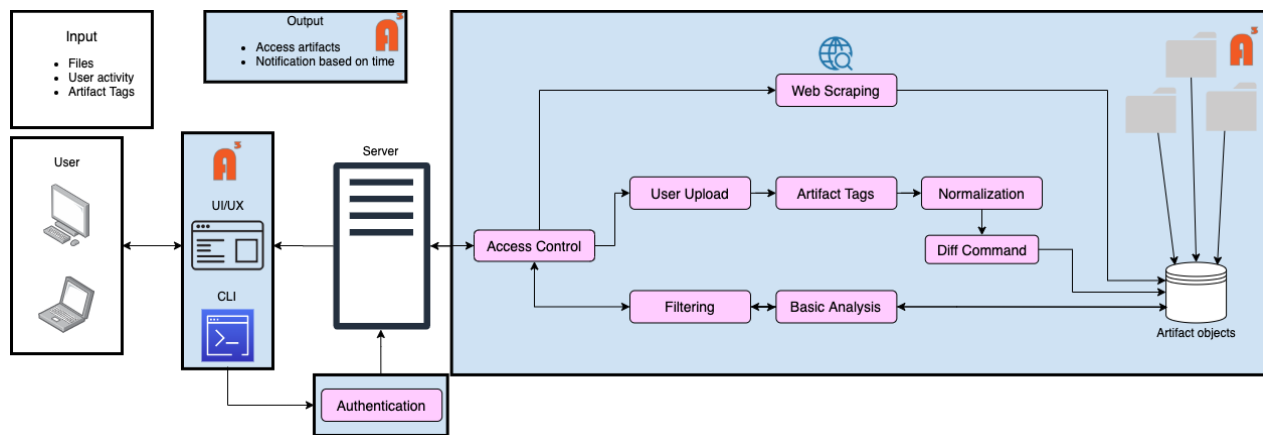
Figure 1 Major Functional Components Diagram

The majority of A^3 as a product is the software created to work in tandem with necessary hardware components. Python 3.8, or a newer version, will be used to create A^3 on the database level. HTML, CSS, and Javascript will be used when creating the Gui. For managing the Javascript frameworks of A^3 both Angular and React will be used. The creation of the software itself will occur on Visual Studio Code as it has a wide variety of support and development tools. The code created among the team working on A^3 will be shared via Git because of its widespread

use in the software development field. Documenting and tracking the code stored in GitLab will

occur through both pydoc and Sphinx.

will be deployed through Docker and Docker Compose to tie all the pieces of the project

together. The database will be managed by MySQL or MongoDB. A^3 will use the REST API.

REST will be used to maintain communication between each layer of A^3 while the configuration

will be handled with both tox and VirtualENV. Once A^3 is up and running on a functional level

both pycodestyle, formerly PEP 8, and Pylint will be used to analyze the system.

3   Identification of Case Study

Currently, A^3 is being developed for Old Dominion University (ODU). Its planned

functionality is to begin with the management of the Computer Science department's resources.

Upon the uploading of artifacts into A^{3}ODU students will be able to access information their

instructors have made available to them. Instructors and administrators will be able to track

changes, update artifacts, and save time on requests for information by having information

stored centrally.

The ODU Computer Science Department is simply the beginning for A^3. With the

resources that A^3 will be able to store and make available it has the ability to benefit an entire

host of individuals and organizations. General academia from other universities to research

foundations are all potential uses for A^3. More directly, A^3 has the ability to assist both students

and faculty on a personal level by saving time while having a greater host of resources

available. A^3 will be a new, effective way to store information while saving space and giving

greater functionality to those involved while simultaneously tracking changes and requesting

artifact updates as necessary.

4   A^3 Product Prototype Description

The prototype planned for A^3 will be implemented over the course of the summer

semester of 2020. This prototype will be modeled with a significant reduction in features to

concentrate on key features while keeping the system that will be implemented scalable. The

most notable features that will be trimmed off are artifact deletion, comments, sharing, and

contributor lists. There will also be a scaled back version of a few other features, should time

permit, namely web scraping and artifact tagging. The features in question are artifact searching,

web scraping, user authentication, and the graphical user interface. While capabilities such as

these are important for a live version of A^3, they are mostly for ease of use rather than core

functionality. Removing these features and reducing the others down to a manageable level

during the prototype implementation will allow for the development team to spend time

resources more wisely. An easier to interpret piece of reference material to outline the A^3

prototype versus the real world application can be found in Table 1.

Feature/Capabilities Comparison Chart		
Feature/Capability	**Real World**	**A³ Prototype**
Database Storage	X	X
Graphical User Interface	X	Limited
Command Line Interface	X	X
User Authentication	X	Limited
Access Control	X	X
Artifact Upload	X	X
Repository Creation	X	X
Artifact Normalization	X	X
Artifact Comparison	X	X
Artifact Update	X	X
Artifact/Repo Deletion	X	
Web Scraping	X	Limited
Artifact Charge Record	X	X
Artifact Exporting	X	X
Artifact/Repo Searching	X	Limited
Artifact Contributor List	X	
Artifact/Repo Sharing	X	
Artifact/Repo Tags	X	Limited

Table 1: Features and Capabilities Comparison Chart

The features and capabilities comparison chart shown in Table 1 demonstrates the goals of the A^3 development team over the course of implementation. Eight of the eighteen features aimed for wide release have been either removed or limited. The progress and implementation of these will be updated throughout the process.

4.1 Prototype Architecture (Hardware/Software)

The A^3 prototype will be completed with cross platform capabilities with the focus being in Linux as it will be based in ODU CS servers as well as Windows being that will be the development platform used by the implementation team. Python will be the primary

programming language used to develop the prototype. The other resources planned for use will

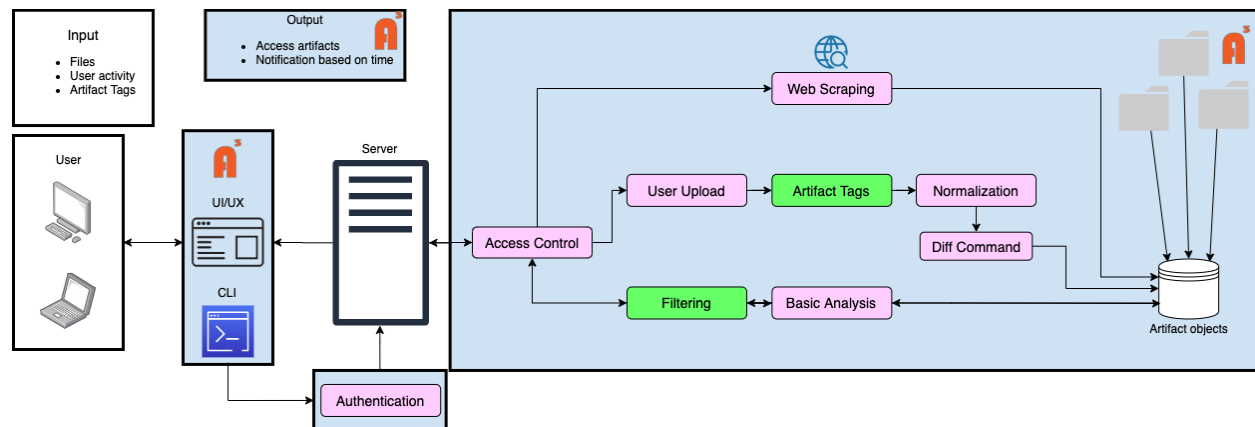be implemented at later stages for widespread release.

Figure 2 Prototype functional components diagram

Figure 2 is an outline of what parts of A³ will be implemented and deployed by the end of

the development phase. The algorithms that have color swapped to green are being omitted in

comparison to Table 1. All of these layered pieces will be deployed via ODU CS servers. The

development will be completed in Visual Studio Code while tracking of changes will take place

through the ODU CS Department's Gitlab. Visual interfaces will use Javascript while our

database features will be managed through mySQL.

4.2 Prototype Features and Capabilities

In general terms the A³ prototype will be proven a success once both the database and

artifact tracking features have been implemented. Graphical User Interfaces, searchability, and

other ease of use functionality will take a backseat. The ability for A³ to track, compare, and

archive artifacts effectively is the true goal. Showing the ability to do this with normalized

artifacts is the key part of proving the need and unique feature set of A³. Searchability, user

interfaces, and security have been heavily implemented throughout the years of program features. Implementing searchability, user interfaces, and security is not a question of possibility, but only of time. The A^3 development team will focus on the core functionality of A^3 to highlight its proprietary technologies.

In order to mitigate the future issues of A^3 the development team will tackle corruption of data, file type support, and ease of use. While ease of use will not be addressed immediately as artifact normalization and tracking are the foremost problems, it will be vital in a truly functional prototype. The functionality of web scraping will be limited through the prototype. The A^3 development team will not deal with porting items from Blackboard due to this. In addition to this, incorrect information input from users and reference material not being accurate will not be implemented. These issues are not suited for the prototype development cycle.

4.3 Prototype Development Challenges

A^3 has a number of unique features which have not been implemented in the market place as of yet. With any new technology the development team of A^3 will have to overcome compatibility issues, unique circumstances, and the resistance of adoption from new users. In addition to the problems surrounding the normalization and comparison functions, the A^3 team will also face the standard issues of security, database management, and time constraints. A^3 is being developed during the 2020 summer semester by a small group of computer science students with the overview of a single mentor. Such small teams have the ability to work quickly and effectively, but are capped by the number of person hours able to be invested in a project.

Glossary

Aggregate: Data that is composed of smaller pieces that form a larger whole.

Algorithm: Set of instructions designed to perform a specific task.

Angular: A framework for dynamic web apps. Allows for the use of HTML as a template language.

Application Programming Interface (API): Set of functions and procedures allowing the creation of applications that access features of an operating system, applications, etc.

Archive: Contains multiple files and/or folders. May be created by several different utilities and may be saved in different formats.

Artifact: Combination of arte, "by skill", and factum, "to make". A file or document.

Backlink: A hyperlink that links from a web page, back to your own web page or website.

Blackboard: A tool that allows faculty to add resources for students to access online.

Centralized: Type of network where all users connect to a central server.

Course Websites from Markdown (CoWeM): A system for building course websites, including notes, slides, and organizational pages, from Markdown documents.

Cascading Style Sheet (CSS): Used to format the layout of web pages. Defines text styles, table sizes, among other things that previously could only be defined in HTML.

Database: Collection of information, that is organized for rapid search and retrieval.

Data Loss: An instance in which information is destroyed by failures or neglect.

Diff: A line by line comparison of normalized artifacts.

Docker: Tool to create, deploy, and run applications by using containers. Allow developers to package up an application, with all parts needed, to be deployed in one package.

Export: Taking data from one program or computer to another.

GitLab: Used to provide internal management of git repositories. Is a self hosted Git-repository management system that keeps the user code private.

Graphical User Interface (GUI): User interface that contains graphical elements. Examples include windows, icons and buttons.

Hypertext Markup Language (HTML): A language used to create web pages. "Hypertext" refers to hyperlinks in a page, and "Markup language" refers to the way tags are used to define page layout.

Hyperlink: An element that links to another file or object.

JavaScript (JS): A language used in web development. While influenced by Java, It's syntax is more similar to C.

Knowledge Management: The management process of creating, capturing, sharing, retrieving, and storing data, information, knowledge experiences and skills by using appropriate information and network technology.

Markdown: A markup language that can be used to format plain text. Can be converted into another language.

Markup: A language that uses tags to define elements within a document.

MySQL: Open source SQL database management system. Developed and distributed by Oracle Corporation.

Normalization: Converting ingested objects into a small number of pre-selected formats.

Python: An interpreted, object-oriented language.

Personal Learning Environment (PLE): An interface used in flexible online courses. Designed by ODU's Center for Learning and Teaching.

pydoc: Automatically generates documentation from Python modules. Can be presented as pages of text on the console, served to a web browser, or saved to HTML files.

Pylint: A Python static code analysis tool. Looks for programming errors and warnings from within the code, as well as from an extensive configuration file.

React: A JavaScript library that is used to create User Interfaces for web applications.

reStructuredText: A plaintext markup syntax and parser system. Useful for in-line program documentation.

Secure File Transfer Protocol (SFTP): Secure version of File Transfer Protocol. Facilitates

data access and data transfer over a Secure Shell data stream

Sphinx: A Python documentation generator. Converts reStructuredText files into HTML websites and other formats.

Tags: Is a keyword or term assigned to a piece of information.

tox: Aims to automate and standardize testing in Python. Is a generic virtualenv management and test command line tool.

Visual Studio Code: A source code editor that runs on Mac, Linux, and Windows.

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