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Do androids dream of automatic theses? Integrating thesis examination with an institutional repository

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Abstract:
Moving from first generation to second generation institutional repository is an opportunity for Monash University Library to integrate the institutional repository into other University workflows to improve efficiency of collecting content. This paper documents a project to integrate a system to manage the examination of Doctoral and Masters Theses with the institutional repository. The outcome automatically and seamlessly integrates the passage of a thesis manuscript from submission for examination to archiving in a repository via collaboration with other administrative units and the use of API technology.

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"*The electric things have their life too*."

Dick (1968, p239)

Introduction

This paper heralds the end of the beginning of the life of electronic theses at Monash University. Theses in electronic or digital format now have a life of their own, no longer a satellite format orbiting in print's shadow, but the primary format, opening up better access, visibility and eventually impact for a significant part of the university's research output, the part that is under the long-term stewardship of the Library.

For nearly ten years, 2008 – 2017, Monash University Library has been operating a self-submission workflow for Doctoral and Master's theses students, to enable them to add their certified thesis manuscripts to the Monash University Research Repository. The repository is being refreshed and updated with new software platforms, and the necessary transition to a new workflow for submitting theses invited a rethink of the processes and practices. Fortunately, the repository upgrade coincidentally timed with the implementation of an online thesis examination system by Monash Graduate Research (MGR), which manages post-graduate candidature lifecycle and examinations at Monash. This mutual need to refresh systems and workflows invited collaboration and fresh thinking about the relationship between the two agencies of the University that steer a thesis manuscript through its lifecycle. The preferred solution arrived at is to automatically publish certified theses from the examination system into the new Research Repository, with minimal intervention by professional staff, thus reducing costs and timelines.

The transformation of the Monash theses collection from print to digital, from manually received and processed, to automatically published and shared globally, has been a process of engagement with institutional stakeholders, an embrace of technology and the courage to let go of control.

The results of this change are expected to deliver a significant lift in the visibility and impact of this research. Its success will introduce early career researchers to the concept of open access to research via institutional repositories, which can help to further professional progress in their careers.

Overview

Theses at Monash University

Monash University began operations in 1962 and accepted its first theses in 1965. Since then the University has awarded just over 10,000 degrees in the research category. All of the PhD theses and most of the Masters were held by the various branches of the Library that were the best related to the topics of the theses.

The Library is obligated by University regulation to receive and hold Doctoral and Master theses by research, but does not collect Honours, which are held at the faculty, if collected at all. Masters by research were only systematically collected by the Library after Monash Graduate Education (MGE) assumed the management of Masters from the faculties in 2012. The Library has never collected Honours theses systematically. This policy has been reviewed and reaffirmed on the grounds that retention of Honours is not required by any University regulation, the quality of the work varies significantly from discipline to discipline and the cost of processing, even with the savings of automation, will not be justified by the actual value of the documents. Honours theses are not part of the automatic submission project and their inclusion in the institutional repository may be considered at later date, perhaps in the context of voluntary submission of exemplary examples for prospective students.

Format – print

A professionally bound and printed version of the manuscript is the original format for the collection and was required for archiving at the Library up until 2015. Candidates where required to submit four copies for examination, one of which eventually went to the Library. Print only theses are all held in a secure offsite store and are selectively digitised on demand to supply document delivery requests. The digital copies created by this process are stored in the repository under a restricted access condition (see Access conditions, embargo and copyright below). Retrieval and consultation of print copies is not encouraged and rarely sought. There are no plans to retrospectively digitise the entire print collection due to the very high up front cost, estimated to be in the millions, and the very low demand for the older theses. That said, the collection is stored and catalogued so that it can be quickly prepared for a digitisation project, should a rational appear and funding become available.

Format - microfiche

The creation of a microfilm copy of the manuscript was introduced in the 1970s, allowing consultation access at all branches of the Library, no matter where the manuscript was shelved. An offsite service-provider performed the conversion of the paper into microfilm. Microfilm and microfiche ceased being created systematically in 2014 as the user preference, particularly for Document Delivery requests, was overwhelmingly for the digital version of the manuscript. While no new microfiche copies are being created, the microfiche format is retained in the collection because of its small physical footprint and useful property of being a backup of several decades of print-only theses. As confidence builds in the digital copy's long-term preservation, and perhaps when all the print-only theses are digitised the retention of the microfiche collection will be reviewed with a view towards disposal.

Format - digital

Starting in the 1990s, the Library began exploring ideas of accepting digital copies of the theses manuscripts, attracted by the obvious advantages of online access to an otherwise mostly unpublished research resource. A combination of the cultural and technological factors held up the practical implementation of an online system until 2004, at which point the Library was able to convince the governing university committee to introduce a mandatory digital thesis policy. The mandatory policy was developed in 2004 and adopted as compulsory for all doctoral candidates who enrolled after July 2005, with exemptions for certain degrees by performance, where an exegesis often substituted for a complete manuscript. Candidates enrolled before July 2005 were invited to submit a digital copy voluntarily. In time, Monash alumni, not subject to the new policy, would often supply, or request, a digital copy of their print thesis, granting the Library open access to the new digital copy.

Digital theses were introduced to the Library collection in 2008, with the adoption of a mandatory digital submission policy by the Library in negotiation with GRE and the university's research committee. Under the new policy, the candidate is required to submit an amended digital copy, after the examination of the paper copies. The print version was still submitted for examination, transported to the Library, catalogued and shelved, by Library staff, in a separate process to receiving the digital theses. The requirement to keep collecting the paper copies at this time was due to there being no desire to change the traditional examination process and to concern regarding the ability to ensure the long term preservation of the digital: a bound print manuscript on suitable archival quality paper was considered the ultimate backup by all concerned stakeholders. At this time the Library started a gradual process of moving the older print copies off the shelves and into a climate-controlled off-site storage facility for better protection and security.

The original institutional repository – ARROW

The thesis policy change was concurrent with the start of Monash's participation in the Australian Research Repositories Online to the World (ARROW) project. This federal government-funded project developed and implemented a fedora based research repository for the Australian university sector. The ARROW project selected the VITAL repository, which is based on the Fedora architecture with an interface, management layer provided by the VTLS Corporation (Payne, G 2005). For a detailed description of a very similar process and decisions made at the same time, in this case for a DSpace repository at Oregon State University Libraries, read Boock, M and Kund, S (2009).

The first type of content that the ARROW repository targeted was the PhD thesis. Self-submission software had been provided by the vendor company (Scherle 2005), and the ARROW user community contributed to the configurations and development of a successful workflow using the vendor's software (Groenewegen, D & Treloar, A. 2008). Implementation of this software was successful, if protracted, and it provided a solid basis for managing the university's publication evidence for various government reporting tasks and home for any open access work provided by academic staff.

The thesis submission process was finished by 2008, just as the first successful mandatory candidatures started to be awarded their degrees. The mandatory policy then drove a steadily increasing flow of theses into the repository as more and more post-2005 students finished their studies. The process was refined through the years 2008-2011, with staff from a cataloguing team brought in to run the day-to-day operation of the thesis submission workflow, allowing the combined repository team to move onto other collections and to support government quality- reporting exercises, such as Excellence in Research Australia (ERA).

By 2010, most submitted theses were subject to the mandatory digital policy and the number of paper-only manuscripts rapidly declined. By late 2015, the Library and GRE recognised that the time had come to remove the requirement to supply a print copy of the manuscript for the purpose of an examination. The driver for the change was a university-mandated review of the activities and work of all professional support roles to find efficiencies. The review encouraged examination of old practices for opportunities to increase the productivity of the existing roles, especially in the areas of the university that were experiencing increasing demand for services and resources. The review at GRE determined that the elimination of print produced significant savings in the time spent on manual handling.

The new institutional repositories

At the Library end of the new thesis workflow, the institutional repository is being split from a single repository into three separate types of repository platforms better tailored for the specific needs of different collections and communities. These repositories are recent developments in the management for the discovery, citation and reuse of open access research outcomes. Two of the repositories have an Application Programming Interface (API) that provides opportunities for the Library to integrate the repositories with systems and processes outside the Library that support research and learning in the University. The three repositories are Pure, Omeka and figshare. The rational and process for choosing each system is a topic for its own paper, but the following summarises their purpose.

MyResearch - Pure

MyResearch will store traditional academic publications, like books, chapters, journal articles, conference papers and some non-traditional outputs from the arts disciplines. My Research is a local branding of a Current Research Information System (CRIS) system using Elsevier's Pure software. (Elsevier 2017). Pure includes a publications repository in its broader research management functionality and while this was not a reason for its selection by the University, it did present an opportunity for the Library to argue that running duplicate repositories made no sense and to transfer responsibility for storing copies of publications to the Research Office, which already had responsibility for identifying and collecting eligible Monash publications on behalf of the faculties. Giving up this workload has allowed the Library to shift focus and some resources to research data management and open access initiatives as exemplified by the other two repositories.

Monash Collections Online - Omeka

The second system is branded locally as Monash Collections Online and it is an example of an Omeka repository (Roy Rosenweig Centre for History and New Media, 2017). Omeka strengths lie in the presentation of media and digital exhibitions and this will be used to demonstrate to best effect the Library's digitised holdings of significant works and other artefacts from the Rare Books, Asian and other special collections at Monash Library The purpose of this repository is to bring unique and historical items in the collection to the attention of a wider audience, particularly international scholars, which otherwise have no practical access to the physical collection.

monash.figshare – figshare for institutions

The third system is monash.figshare, an institutional instance of figshare.com, which will store and manage research data, grey literature, instrument data, and many types of media files; and is now the new home of Monash theses (figshare, 2012). Data stored in figshare can be private and privately shared with colleagues, or can be made public and published with a unique and permanent link, a Digital Object Identifier (DOI). The interface natively supports the best online presentation of different types of research files and provides tools for individuals to self-organise their research data, collaborate with teams and facilitate discovery via academic social media. While figshare is cloud based software all content is stored locally on university owned storage.

The Dashboard

Graduate Research Services - a division of (MGE) - has been working since 2016 on automating and otherwise updating the submission and assessment process for theses. The outcome of this work is a system called the Dashboard which is used to monitor and expedite the process of examining a thesis, principally by eliminating the manual handling of the four paper copies that have traditionally been submitted for examination. This single change has significantly reduced staff time committed to the organising of examinations. Going digital has allowed for rapid cloud-based access to the manuscripts by examiners anywhere in the world, and facilitated the tracking of the examination process through its various stages. Both these factors have led to significant reductions in the time taken to examine a theses. According to the Manager, Thesis Examination, MGE examinations team, the average has dropped from 6 months to 6 weeks - a fact much enjoyed by candidates and supervisors alike (R Hillman, personal communication, 21 July 2017).

Agile methodology

The development of the Dashboard has been managed using the Agile methodology. Agile is an umbrella term for a set of methods that allow self-organising cross-functional teams to collaborate quickly on solutions. Agile uses practices, such as user stories, to define functional increments to break up development tasks into daily/weekly jobs that are accountable to specific teams and people. The work is accomplished in sprints of development time, typically anything from two weeks to six weeks. Daily short meetings (stand-ups) are used to honestly

track progress and quickly identify unexpected issues and possible solutions (Agile Alliance, 2015).

First version of the Dashboard - 2016

The 2016 version of the Dashboard only covers the process up to the approval of the thesis for the award of degree. Candidates then have to submit a copy of the thesis to the repository via another web form, with slightly different form data and instructions from the form they used for the examination dashboard. Once received, Library team members check the thesis and communicate with Graduate Research to confirm it has been received and published into the repository; this last step is required before a candidate can graduate.

Second version of the Dashboard - 2017

The development of the dashboard system was recognised by the Library as an opportunity to integrate the repository's submission process with the examination workflow and eliminate a whole stage in the overall process. This thus improved the performance of both organisations, by shifting the focus of work from creation of metadata and the manual transfer of theses and their legal paperwork, permissions and licenses, to checking received submissions for accuracy and completeness.

Through 2016, the Library had been in discussion with MGE about linking the Dashboard system to the repository so that any thesis approved for graduation is automatically passed to the repository with its relevant metadata. After agreement on the goals of the project, resourcing and timelines the project was approved by the University leadership.

The work modified the existing examination system

- To allow the student to review their submission details for errors and resubmit an amended manuscript.
- Include new metadata fields that are mandatory for the figshare repository.
- Include access conditions and embargo end dates.
- Trigger repository publication when the head of examiners authorises the award of degree.
- Create a new record and copy metadata into a review stage of the figshare repository.

This work was project-managed by staff from Monash's central IT department, eSolutions, and coded by an external vendor responsible for successfully delivering the original Dashboard software.

Drivers for change

The key points for the change to automatic submission of theses:

- Migrating the repository to figshare was the right time to review the existing workflow and implement process changes in the new system.
- New submission system would leverage work done by MGE to streamline and automate the thesis examination workflow.
- Students would only have to learn one new system to complete their thesis submission, further reducing the potential for data entry errors and the subsequent work by staff to identify and correct them.
- In recent years, the university has substantially increased the number of Higher Degree Research students, which has placed considerable pressure on the Library team to keep up with the work required to monitor and process theses. Publication of theses has climbed from approximately 100 a year in 2001 to 700 a year in 2016, and that number is expected to continue to grow into the 2020s.

New repository software provides:

- Improved Google search exposure.
- Mints a Monash Digital Object Identifier (DOI).
- Application programing interface (API) tools to build automated scripts for standard functionality like creating metadata and new content.

The integrated workflow

Description

The workflow pushes metadata about the thesis from the Dashboard to the figshare repository and alerts a reviewer to its presence in the review buffer. Library staff are alerted to the arrival of a new thesis in the review buffer of the figshare account that owns and manages theses in figshare. Staff inspect each new thesis for obvious errors in the metadata and confirm that access conditions match those posted on the examination system's Dashboard. Staff either publish or return to the edit page to fix identified problems. Problems typically arise as inconsistencies between the system-supplied metadata and what is actually on the manuscript title page.

Stages from submission to publication

1. Candidate submits thesis manuscript to examination system, the Dashboard. The file is uploaded to a record created on candidature. Metadata, such as the title of thesis and author's name, are derived from data stored elsewhere.
2. Candidate provides other metadata fields, such as subject keywords, a short description and a category classification.
3. The system moves the manuscript through various examination stages, including delivery of the manuscript via cloud storage to the examiners.
4. Examiners approve the manuscript and provide feedback to the candidate for amendments to the manuscript (failure pathways are ignored in this description).

5. The Candidate resubmits the amended thesis and is required by the system to review metadata and update fields as necessary.
6. The amended version of the examined thesis is checked for receipt and then sent to the head of examiners for a final review and the award of degree.
7. The change of status to ‘awarded’ drives the Dashboard to push a copy of the metadata to the research repository via the figshare API scripts.
8. The figshare alerts the delegated approvers, via email, that the thesis is waiting in the curation review buffer. The thesis record can be viewed and accepted or just rejected at this point. Choosing acceptance publishes the thesis according to the pre-set access conditions. Rejection leaves the record in an unpublished state, while the Library team works on the issue that has caused rejection.
9. Publication generates a Monash DOI for the new thesis record, automatically added to the metadata. An embargo timer, if that is needed, is started and the record becomes available for harvesting via Google and other search services' protocols.

Access conditions, embargos and copyright

The research repository supports four variations on access to the digital theses. The access conditions are:

1. ***Open access, no Embargo***. Immediately available for download after publication to the repository.
2. ***Open access, Embargo.*** No access is provided to the thesis after publication for the term of the embargo. After the embargo expires, the thesis is immediately available open access.
3. ***Restricted Access.*** The thesis is not available for direct download, open access, but is available through a document-delivery request mechanism, where the requester has agreed to a statement that the manuscript is only being accessed for purposes of study and research. This is a permanent condition that can only be changed by the author.
4. ***Restricted Access, Embargo.*** The same conditions as restricted access, except that document delivery requests cannot be supplied during the embargo period.

Embargos are requested by the author but only granted by GRE after review of the reason supplied by the author. Three-year embargos used to be the norm, but they were replaced by one-year embargos in 2015-6 for any request related to the opportunity to publish, and this now represents the normal embargo period. Longer periods can be requested for special cases with a ten-year embargo being the longest granted to date. An embargo can be renewed or extended on request of the author, provided a convincing reason is supplied to GRE. Occasionally an embargo is rescinded early by an author, usually because a version has been published or publication is no longer sought.

By default, all theses are licensed as Copyright the author. This decision was made to streamline the submission process and to ensure the author protected their rights for future publication opportunities by not accidentally selecting an incompatible license. Creative Commons licenses are available for the author to select if so

desired, and the Library does encourage use of Creative Commons licenses through open access and research data management information and education activities.

Metadata

The transition to an automatic workflow involves some necessary sacrifice of metadata complexity but that need not require a sacrifice in quality. The monash.figshare research repository platform uses an internal figshare metadata schema to encode discovery and access information about its content. The figshare schema is roughly translatable into Dublin Core in terms of complexity and can be expressed in Open Archive Initiative Dublin Core (Cornall University Library, 2017) and DataCite (DataCite, 2017) schemas for sharing with other services via OAI and API harvesting. There is functionality to add custom metadata fields to any record in figshare, which allows coverage of the more specialist thesis fields like degree type and degree name. Custom metadata fields cannot be exported via OAI protocol with the current version of figshare, but it is hoped to develop this functionality in the future.

The figshare schema matches the top eight most commonly-used metadata fields as reported by a survey of repository ETD (electronic theses and dissertations) metadata schemas, and covers nine metadata fields of 25 surveyed fields in the same article (Steele, T & Sump-Crethar, N, 2016).

Metadata fields

The monash.figshare metadata fields are

- Title
- Author
- Categories
- Keywords
- Description
- License
- Principal supervisor *
- Additional supervisor *
- Year of Award *
- Department, School or Centre *
- Additional institution or Organisation *
- Campus location *
- Course Degree name *
- Degree type *

*custom fields created for the theses collection.

Metadata creation and quality control

All metadata is supplied by the student on either candidature or final submission of the examinable manuscript to the Dashboard. After examination, the student submits a revised manuscript to the dashboard and is asked to review the metadata before

completion. This metadata is currently reviewed by Library staff before publication of the thesis, because, for example, the thesis title and names of the supervisors have often changed since original candidature information was captured. A goal of the next iteration of the automation project is that this checking step by Library staff be eliminated. The emphasis on quality control will switch to fixing errors that are identified post-publication by the either users or the authors. A caveat on fixing errors will be that the metadata remains synchronised with the version of the metadata stored in student administration systems used to maintain the official record of the thesis' examination. A change of heart by the author as to title of the theses will not be a reason to fix the repository record and the author will be invited to publish a different version of the theses on any of the public scholarly publishing platforms that are available. It is not the policy of the Library to enforce exclusive access to the theses, only to ensure that the examined version is available for scholarly review.

The starting point to cease checking before publishing will be when the need to intervene in the metadata drops to an acceptable rate to risk publication. According to a recent article surveying ETD metadata, there is no accepted way of ensuring quality control for institutional metadata other than reviewing bu qualified Library staff. The authors of this article acknowledge that an institution's time and resourcing to check metadata is limited, and this affects the level of quality control that is possible with real world process (Steele, T & Sump-Crethar, N, 2016). The Library is considering what an acceptable rate is and what type of errors can be tolerated. The answer will be to redirect the current review of theses away from fast fixes, and towards identifying systemic problems in the examination process and negotiating the development of permanent fixes to the Dashboard's workflow, so that repeat occurrences are either eliminated or have their probability of occurring significantly reduced. There is also a need to accept that the process cannot be perfect and to be willing to accept individual failings, in exchange for an overall improvement.

Access data and alternative metrics

While it is still too early to accurately map the impact of our changes on the citation and reuse of the theses collection, there are some clear indications that the collection has good accessibility within the figshare repository. Access statistics for the period 1 January - 4 August 2017, the time frame in which all the past digital theses were transferred to the new repository and new theses were directly published into the same repository, report **255,973** views and **20,186** downloads.

Access statistics from the previous repository system are not able to be organised to report on just the theses collection over a specific date range, one of the reasons the old repository software is being replaced. The access statistics for individual theses records are being manually counted together and matched against the creation date of the theses in the old repository, with the idea of comparing theses that were online for a period of a year in the old repository against a new figshare theses that have also been online for a year - an event that occurs in December 2017. These data points will be compared for differences, assuming that a set of comparable theses can be identified and the results are not skewed by such factors as a more Google-friendly title in one set.

Altmetric badges are available in monash.figshare and Monash is implementing Digital Sciences' Altmetric for Institutions to provide analysis and reporting tools. Social media and other internet mentions of our theses can be tracked and reported back to the faculty, perhaps demonstrating the value of open-access theses over restricted and embargoed. Exploring this data source will be work for 2018 and beyond.

Benefits and issues

Benefits

The principal benefit of the new submission process is the reduction in time spent on checking and accepting the theses. The new workflow reduces the chance for errors of omission and revisions of previously-agreed values for the names of supervisors or even the title of the theses. Data passed from one system to the other has already been reviewed and checked during early stages of the submission and examination by several "official" eyes. The author has another chance to update or correct when reviewing the document metadata after uploading an amended version of the examined thesis. If there are no issues to immediately fix or expensively (in terms of time) chase the author for, then the time to process a theses is less.

Initial reports from the cataloguing team suggest that the time taken to process and publish a new theses has dropped from an average of 6 minutes to 2 minutes (J Fairweather, personal communication, 22 June 2017). A planned update to the automatic process will include the manuscript file along with the metadata; this will lead to a further reduction of time to perhaps under a 1 minute per theses. Time savings on staff processing that have been achieved to date have allowed the Cataloguing team to shift to other cataloguing tasks

Issues

At present the most common issue is incorrect supervisor names (as these sometimes change during the candidature, but are not always reflected in the GRS database). However, students and their supervisors will be encouraged by MGE to check this before completion of the submission.

Subject to analysis of the error rate in the system, after a period of operation in the production environment through to December 2017, any remaining source of error, or new sources introduced with the changes will be identified and either be addressed with a technical/procedural solution or be judged to be a tolerable risk. If the risk of publishing inaccurate metadata, or worse, publishing theses with incorrect access states, is deemed low enough, then the approval process may be eliminated entirely. Eventually the Library will trust that any metadata it receives is correct, and just not check it. Any errors that slip through can be identified by the author or other parties, such as the supervisor, or any reader will be referred back to the MGE team for correction to the record in the Dashboard and an update of the metadata be synchronised between the Dashboard and repository. New or unusual errors will be addressed by a qualified member of the repository team, fixed in both systems and documented for future occurrences and another opportunity to upgrade the software.

Work to be done

This project is not yet complete and there are a number of significant objectives still to be met in 2018. The key pieces of work to be done are:

- The new submission workflow is limited to transferring metadata only. A major update will be coded to include the transfer of the accompanying file. This will eliminate the need to manually copy files from one system to another.
- Transfer the remaining daily workflow tasks from the cataloguing team to repository team. The changes to the submission workflow have removed the traditional cataloguing tasks and this, along with elimination of the catalogue record for the print version, transform these tasks from requiring a specialist cataloguing role to a quality control role that can be performed by non-cataloguing staff.
- Eliminating manual submission of theses from outside the GRE Dashboard system. A number of masters and PhD in Arts and Performance subjects are not being managed by the Dashboard. GRE is planning an upgrade in late 2017 to add these remaining degree streams to the Dashboard. This will then allow the Library to stop maintaining alternative and highly manual submission forms to service these orphaned subjects.
- Refining the management of broken submissions that have slipped through the review stage of the Dashboard. This will be an ongoing conversation for the Library and MGE to jointly identify and agree to solutions for systematic errors arising out of the submission procedures – ideally by synchronising changes in the Dashboard so the correction occurs just once.
- Reporting tools in figshare to script the counting of the theses by faculty, school category and access conditions.
- Include permanent links to data and media related to the theses in the theses record. Educate and encourage candidates to store their research in figshare.

It is expected that most of this work will be completed in 2018 and the author will report on the most recent progress and outcomes at the presentation of this paper at the VALA2018 Conference.

Conclusion

Despite the unfinished state of the project, the experience has allowed the Library and Monash Graduate Education to understand each other's perspective and agenda, and then combine them for the greater benefit of the University. The outcome is an improved post-graduate experience and an ongoing, online impact for the early work of future research leaders.

The experience has taught the Library more about integrating separate software platforms with other parts of the university. The relative success of the project to date alongside other Library led projects to improve research data management and research and learning has allowed the Library to enjoy a reputation of being a professional and competent player, leading to further opportunities to innovate in the research data management and the education learning spaces.

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