CENTRAL DOSSIER

NEW PERSPECTIVES IN THE FIELD OF DOCUMENT MANAGEMENT

APPRAISAL: A strategic tool for modern recordkeeping

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In order to explain why the need for better, more strategic tools for recordkeeping professionals is so urgent, it is necessary first to consider the contemporary business and technological landscape, and how information is being made and managed in it. In doing so, we can understand how new forms of records are being made, kept and used, and the challenges that these present.

We live in a world characterised by diverse business frameworks comprised of multiple transactional systems and distributed business processes, which are breaking down and fragmenting the formerly consolidated organisational perspectives on projects, programmes, clients or transactions. We are seeing the increased commodification and commercialisation of information within third-party frameworks, and usually in the cloud. People expect instant access online, to any information they want or need, and there is a growing sense that if

it isn't online, it may as well not exist. Data creation is expanding exponentially. In 2012 David Rosenthal of Stanford University analysed the costs of storing all of today's data in the cloud. Based on industry figures he estimated that 'keeping 2011's data would consume 14% of the gross world product'.[1] He extrapolated based on rates of current data growth to estimate that by 2020, the cost of maintaining all the data created in 2020 would be 100% of the gross world product.[2] Such prolific and uncontrolled data growth is not sustainable, and is due in part to a lack of recordkeeping thinking in systems and process design. Innovations like blockchain technologies are presenting new paradigms for recordkeeping, by giving us the tools to build business environments in which the presence of a trusted third party to verify transactions is not required. This is having huge implications for the agency of individuals in their interactions with each other, and with the State. We are also living in the age of the rise of machine learning and artificial intelligence, with robots in our homes, our cars and workplaces and increasingly replacing human labour.

In this dynamic, rapidly changing world, the concept of a record can, to some, seem archaic. However, if we remember the core elements of 'recordness' – those of proof, or evidence of transactions, of contextuality and of being bounded in time and space – we can see that in fact records, in the form of combinations of data representing events in complex business systems, are a crucial part of the digital landscape today. Of course records continue to be made and managed in more familiar, documentary forms, as unstructured data, but anyone studying the trajectory of technology can observe the progression away from these forms towards a data-driven society. Groupings of data that drive and record business, whether they exist for a few seconds or a millennium, need to serve as good, reliable, available evidence. However, many of our practices and tools are not up to this task. We, as archivists and other recordkeeping professionals, can often be: Overly worried about destruction/deletion, which was a key driver when we had too much paper to store;

- Too concerned with assessing individual records for 'value', when we have massive volumes to consider;

- Stuck with assumptions about having custody and/or sole ownership and control over records; and

- Stubbornly continuing to apply practices that were developed for files and documents to data-based, dynamic systems.

In developing the revised International Standard on records management, we in the editorial group were aware of these problems with these and other ways in which our practices were not keeping pace with the changes to the information landscape, and decided to focus strongly in the new edition on describing approaches designed to address the challenges of the digital age. For us, this was not about rejecting core concepts and principles, but repurposing them. Accordingly, many of the basic concepts in the revised Standard remain familiar. Records are defined as: 'information created, received and maintained as evidence and as an asset by an organization or person, in pursuit of legal obligations or in the transaction of business.' The Standard reconfirms our understanding that records are an active embodiment of business,[3] along with its rules, its participants and its outcomes. Records are contextualized and controlled traces of events or transactions, made and retained – for a few seconds or a millennium – for a variety of purposes, and to meet the needs of a changing array of stakeholders, and with various degrees of rigor. In the Standard, records are understood not as static objects but as reliable, evidential business data that is constantly moving through new contexts and acquiring additional metadata and relationships involving people, organizations, functions, processes and systems. Records are always in the process of becoming – even the manuscripts in our collections – just as much as these sets of data flowing through modern business systems.

ISO 15489 also describes systems for records – which make, control and maintain records, and their metadata, over time. These can exist in any setting – in business units and in archives, in municipalities, schools, corporations and governments. At the most basic level, these systems are the same and do the same things; it's just that their context, requirements and stakeholders are different. Understanding this, and also understanding that these things change over time, is a core job of archivists and other recordkeeping professionals. Systems for records are not just document management tools. Indeed, the most critical recordkeeping requirements today are being met by systems that bear little resemblance to document-centric systems. Archivists and other recordkeeping professionals need to understand and work with any and all types of systems for records. They are simply technologies and practices that make and keep information (data) as evidence of something. They may do this very well, or very badly. All such systems are part of our responsibility. Increasingly, those systems that do not fall under the records professional's responsibility are in fact where the most important records are being made.

In this environment, any approach to ensuring the creation and keeping of adequate evidence and memory cannot be reactive, for lots of reasons. If we are to offer a viable approach to our job of ensuring accountability and memory, we need to be:

1. Thinking across the business and its systems, not focusing on lower-level outputs;

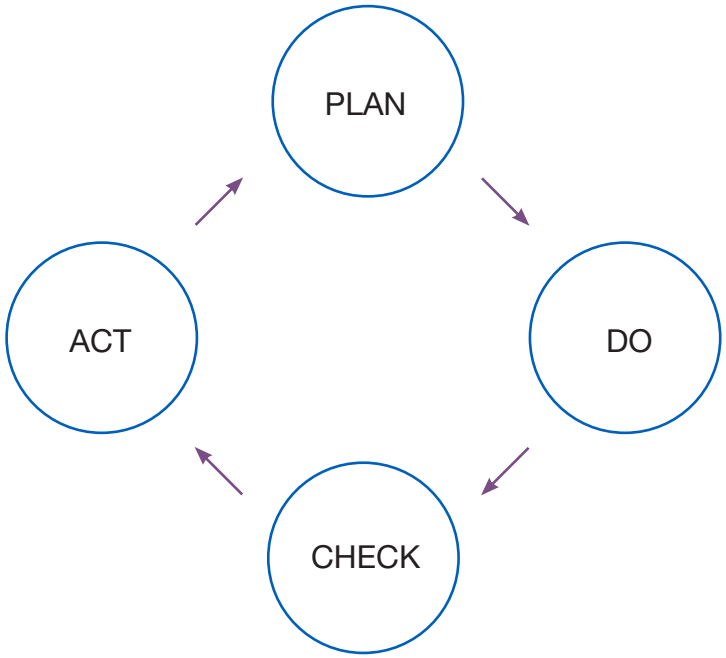
2. Applying risk management to ensure proportionate use of our time and expertise; and

3. Focusing on defining top-down identification of the recordkeeping requirements that our businesses must heed, for the immediate and the long term.

Too often the people we work with – the technology people, the risk managers, the business managers – come to us with questions about accountability in new and emergent technological environments, and our responses are unhelpful, based on old understandings of records as documents that we store ourselves. We are also, as a profession, too often guilty of favouring process and bureaucracy over outcomes. We need to break out of these mindsets and think: what do we have to offer that is unique? What skills can we bring to the table to solve evidence, accountability and memory problems in these new and dynamic environments? We are fortunate in that recordkeeping professionals already possess a robust approach to ensuring the creation and proper management of records of business activity for a given individual, community, organization or jurisdiction – in any format – in appraisal for managing records, as defined in ISO 15489 and in a forthcoming Technical[4] Report.

Appraisal for managing records, as explained in ISO 15489, is about understanding business activities to determine which records need to be created and captured and how they should be managed, over time. It combines an understanding of current business activities and its contexts with the identification of business, regulatory and societal requirements relating to records and the assessment of risks associated with creating and managing records. Work that is underway on the Technical Report to support ISO 15489:2016, currently titled 'Appraisal for managing records,' has produced a model, or way of understanding, appraisal that adopts a management tool, the 'PDCA' or 'Deming'[5] cycle. The use of this model has allowed the editorial group responsible for the Technical Report to

convey the recurrent nature of appraisal, as well as its flexibility and contingent nature. The phases of the cycle are shown in Figure 1.



En cada fase, el treball de valoració inclou l'anàlisi i les decisions que s'indiquen a continuació:

PLAN
Confirm purpose and scope
Analyse the business and technological context
Perform functional analysis
Perform sequential analysis
Identify agents
Identify risks
Identify records requirements

DO

Link records requirements to business functions and work processes

Assess risks associated with the implementation of records requirements

Build records controls

Design systems

Develop policy and procedures

CHECK

Monitor the operation of records systems, controls and processes

Review the appropriateness of records policy and procedures

Monitor the changing business and technological context

Monitor changing regulatory, business and societal requirements

Monitor changing risks

ACT

Identify purpose and scope for appraisal process to address changing needs

Commence new appraisal process

Underpinning all these phases are three important elements:

- Authorisation and leadership – to ensure the results of appraisal are validated and endorsed for implementation at the appropriate level.

- Stakeholder consultation – to bring in as many perspectives and requirements as needed for the business concerned.

- Documentation – for accountability in the appraisal process, as well as its outcomes.

The appraisal process described above can be applied to any scenario in which an archivist or other recordkeeping professional needs to contribute expertise on requirements and implementation options, from analysing an entire government jurisdiction for the purpose of making decisions about archival retention requirements, to deciding on access restrictions as part of new business systems design. The purpose of any instance of appraisal work directly influences the scope, and assessment of risk influences the depth and extent of the analysis. For example, the work to determine requirements for a system designed to keep digital records concerning the highest levels of public decision-making will be of a greater depth and intensity than a short and practical appraisal cycle to check record-making requirements for a low-risk area of public affairs, conducted at a local office. Regardless of whether the cycle takes a short or a long time, is in-depth or more superficial, the basic elements remain the same.

Appraisal sits at the heart of the recordkeeping professional's toolkit, and produces a variety of outputs, including rules for access, business classification schemes and rules for disposal. It is worth noting that in the past some of us have assumed disposal to be the only outcome of appraisal. This is not so, and indeed the concept and practice of disposal itself are also undergoing a necessary transformation. Disposal is, as it has always been, about the execution of appraisal decisions in relation to matters of retention, destruction/deletion and transfer of control over the record to another entity, such as an archival institution or a private successor. However, too many of us have implemented disposal via the application of very specific rules to classes of records for the purpose of ensuring their destruction/deletion by a particular date. In some cases, certainly, timely destruction or deletion is important – for example in the case of an agreement by a governmental body that personal information would be destroyed by a specific date – but in the digital world the implementation of

disposal and retention rules should be reframed. The emphasis for practitioners should not be on ensuring digital records are destroyed by a particular date, but rather that systems of digital records are maintained and managed accountably and that that system migrations are used as an opportunity to carry out disposal by leaving records 'behind', with reference to the most up-to-date appraisal decisions. By redirecting their energy to the building in of recordkeeping rules in new systems and services, or assisting technical teams in making decisions during system migrations, recordkeeping professionals can have far more impact in scope and scale than by worrying over the prompt destruction of documents in electronic document systems, covering only a small proportion of business activity.

By moving away from the burdens of paper-paradigm management tasks such as applying disposal rules to legacy records, and by refocusing our efforts on well-designed, proactive and strategic solutions for recordkeeping, based on accountable, thorough appraisal analysis, we can ensure that records of all sorts can be made and managed in much more appropriate ways, for all sorts of communities. One example can be found in the work currently underway in Australia on building better recordkeeping solutions for children who experience out-of-home care.

The Setting the Record Straight for the Rights of the Child (SRSRC) initiative, led by Monash University, was organized, in part, as a response by the Australian recordkeeping community and allied groups to the findings of the Royal Commission into Institutional Responses to Child Sexual Abuse.[6] The Commission, which completed its work in late 2017, served as a strong motivation for Australian recordkeeping professionals to examine their practices and professional contributions to better recordkeeping to support individuals under the care of State and non-State institutions. The partners in the initiative have stated: 'Recordkeeping and archiving systems are failing to meet the lifelong identity, memory and accountability needs of children who get caught up in child welfare and protection systems'[7], and also that: 'Children who experience out-of-home care need quality recordkeeping and archiving systems to:

- Develop and nurture their sense of identity and connectedness to family and community;

- Account for their care experiences, and

- revent, detect, report, investigate, and take action against child neglect and abuse.'[8]

In order to demonstrate how appraisal work can enable recordkeeping professionals to contribute to contemporary problems, the following sections of this article describe a hypothetical project to build a suitable and sustainable recordkeeping and archiving system for children in care. The first phase of such a project, in the 'Deming' cycle model that the 'Appraisal for managing records' Technical Report editorial group has adopted, is the 'Plan' phase. This involves, initially, an analysis of the context(s) in which the appraisal is being conducted, including business, technological, legal and societal factors. The contexts for the recordkeeping that supports and enables the progress of a child through a welfare or other out-of-home care system are multiple. In line with records continuum thinking they can – and do – exist simultaneously. In the case of designing recordkeeping solutions for children in out-of-home care, they may include, for example:

- The immediate socio-legal context of the child's interactions with the agency or agencies that serve as their legal guardian(s), and their interactions with caregivers, other children and related support agencies;

- The context of the family unit and community from which the child hails. In some instances, looking at this context may involve understanding, for example, the needs and expectations of Indigenous people or people from particular ethnic backgrounds;

- The wider societal context in which members of the community expect, particularly post-Royal Commission, that recordkeeping standards for children in such cases are improved, and that the records of their experience are available for purposes of redress should they be required; or

- The personal context of the child's life experiences, preferences and expectations. In a profession that has traditionally been geared towards institutional and government recordkeeping and archiving needs, this is a layer of context that has been largely ignored, and is lacking in proven methods for its analysis.

In the analysis of these context(s), questions that will assist in decision-making regarding the design of the system may include the following:

- Are there acceptable arrangements already in place for the long-term retention of the child's records, suited to the child and manageable in terms of costs?

- How readily can the child access the Internet? Is an offline component required in the solution that is developed?

- Which applications does the child use regularly to make or save records? Proprietary systems may present challenges to integration.

- What legislation and regulations apply to how the child makes and keeps their own records, if any?

- Who are the stakeholders in the business and in the recordkeeping and archiving solution? Can these stakeholders be consulted, or perhaps assist with user testing of the proposed solution?

- What expectations are there, if any, of usability and preservation of these records for purposes beyond the child's needs, and their needs as an adult?

The 'Plan' phase also involves an analysis of business activity and the agents involved. Here the focus of the analysis is on the expected or likely 'business' that the recordkeeping solution will be required to support. This will include identifying functions and activities at a higher level, as well as looking at specific processes and transactions at a lower level. In personal recordkeeping, definition of a fixed set of functions, activities or work processes can be problematic. Indeed, as noted by Sue McKemmish in her 1996 article 'Evidence of Me'[9], the formation of any 'rules' for recordkeeping personal, however generalized, may not be possible. However, by consulting with known agents in the processes and other stakeholders, including the children, caregivers and advocacy groups, it may be possible to arrive at a core set of customizable processes based on common interactions between identified agents, to which more ad hoc processes may be added. For example, a child may email family members regularly. Can we link this process to a functional context? Are there a set of steps typically taken, at which point the recordkeeping transaction of copying and registering the correspondence might naturally occur? Which agents are generally involved? (For example, these might include the child, the child's relatives, or other correspondents). To carry out this work, the analysis of processes, recordkeeping events and dependencies, as described in ISO TR 26122:2008: *Information and*

documentation — Work process analysis for records[10], an important part of any appraisal activity, is essential.

This phase also involves an analysis of requirements for records and an assessment of risks. Requirements for records of the child's experience will obviously derive from their personal expectations, but should also take account of regulatory and societal needs as well. In analysing documentary sources and consulting with stakeholders, consideration should be given to all aspects of recordkeeping, including questions on access, relationships between processes and their records, usability and metadata for contextualizing and managing the records.

Requirements should be determined in consultation with the most important stakeholders – children in care and adults who were formerly in care. The determination of agreed requirements should be informed by the extent to which they will manage identified and agreed risks. A useful approach to risk assessment for recordkeeping is available in ISO Technical Report ISO/TR 18128:2014, Information and documentation — Risk assessment for records processes and systems[11].

In the case of the recordkeeping needs of children in care, a high-level set of requirements for the records system(s) required already exists in the form of the SRSRC initiative's guiding principles:

- 'Child/person centred – Recordkeeping and archiving respectful of, and responsive to, the preferences, needs and values of the people who experience childhood out-of-home care. Respectful and nurturing rather than bureaucratic and officious.

- Participatory – Recognising children in out-of-home care and adult care leavers as participatory agents, not passive, captive subjects of the record.

- Accountable and transparent – Recordkeeping and archiving frameworks, processes and systems which hold themselves to the highest standards of accountability and transparency, respectful of multiple rights in records.

- Evidence based – Recordkeeping and archiving based on, and supportive of, evidence-based decision-making and action.

- Integrated – Records and recordkeeping integrated into processes rather than being a separate paperwork or filing activity.

- Connected and co-ordinated – Record-holding organisations acting as nodes in a network rather than organisational silos.

- Clever use of information technology – Recordkeeping and archiving systems that make the best use of digital capabilities[12].'

We may perhaps regard these as the beginnings of a set of functional requirements for personal recordkeeping as proposed by McKemmish (1996).

Other examples of requirements which might be identified could include:

- Control over access to, and sharing of, the records at a personal level by the child or a guardian – not by a government or institutional actor.

- Long-term use requirements for the records, potentially by the child's descendants or as part of a family archive.

- Robustness against intrusion or tampering, for cases in which wrongdoing has occurred.

- Metadata that properly contextualizes the child's interactions with caregivers, official guardians, family and others.

- Metadata that assists in identifying and linking related records of the child's experience to ensure the availability and usability of these over time. With regard to metadata, we have a starting point in the form of standards on metadata for records such as ISO 23081 Information and documentation - Metadata for records, but metadata specific to the experience of the child in care and the other contexts identified earlier should also be identified.

During the 'Do' phase of the cycle, the risks associated with records requirements are assessed, and this assessment helps with decisions about how the requirements should be met. For example, the risks associated with inadvertent release of private personal information belonging to the child in care indicate the adoption of a very robust technical architecture, using encryption for any transfer of the data. In this phase the rules for creation and retention

of records and for access to records are structured in a way that allows them to be deployed in the chosen technologies. Once, this meant applying rules in disposal schedules to files after they became 'inactive'. Here it is more likely to mean encoding a record creation point into a personal recordkeeping tool for the child. The rules themselves are maintained as records, along with systems design documentation, for accountability and future systems migration purposes.

The 'Check' phase concerns monitoring; monitoring of the operation of the personal recordkeeping system and of the context in which it operates. Requirements and risks will inevitably change. For example, the final report of the Royal Commission into Institutional Responses to Child Sexual Abuse regarding recordkeeping may result in new laws affecting how such systems should operate. Attitudes towards privacy and personal information evolve over time. New threats to identity emerge. All of these are part of the landscape that the recordkeeping professional must observe, and respond to when appropriate. The 'Do' phase is both an end and a beginning. It allows the recordkeeping professional to establish a new project to adjust existing systems, or to define a whole new scope. This is the recurrent nature of appraisal work.

The work of archivists and other recordkeeping[13] professionals – such as the work described in this case study – is about:

- Ensuring the creation of records to meet requirements for evidence of business activity, to protect rights and entitlements and for memory purposes; and

- Taking appropriate action to protect records' authenticity, reliability, integrity and usability, as their business context and requirements for their management change over time.

We conduct this work in a world that is always changing, and for people and organisations whose needs are always evolving. Digital business and technologies mean that our task must shift focus – away from managing the products of business to being a vital partner for the business and in the design of systems. As governments' and corporations' relationships with citizens and each other are renegotiated and the agency of the connected individual increases – or is threatened – our understanding of rights and requirements in recordkeeping becomes even more critical. Appraisal for managing records, as described in ISO 15489 and the forthcoming Technical Report on 'Appraisal for managing records, 'is a robust, tested approach that has been practiced in

Australia and other nations over decades. It allows us to come to the table and work in multidiciplinary teams with a unique and powerful contribution to make. It is going to be a critically important tool if we, as a profession, are to fulfil our mission and respond seriously to the challenges of the digital age.

NOTES

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11. ISO/TR 18128, *Information and documentation — Risk assessment for records processes and systems.*
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ABSTRACT

In the revised edition of ISO 15489-1:2016 Information and documentation: Records management, the concept of 'appraisal' takes on a wider scope than is perhaps familiar to some archivists. Rather than being limited to the examination and selection of extant records to make decisions about their permanent retention as archives, it is broadened to being a more comprehensive, 'up -front' analysis of context, business activity, requirements and risks to help make a wide variety of decisions about records and recordkeeping, including whether to create them, what metadata is needed to contextualize and manage them, who should have access to them and when, how long to keep them, and more. Done regularly and accountably, with appropriate stakeholder consultation, the information that this type of appraisal gathers is essential to a properly functioning program for making and managing records – in any environment, including online, collaborative and decentralised contexts. Opportunities now exist for archivists and other recordkeeping professionals to use this approach in conjunction with new technologies to solve pressing needs for better systems for recordkeeping systems for some of the most vulnerable people in our societies.

RESUM

En l'edició revisada de la norma ISO 15489-1:2016, Informació i documentació. Gestió de documents, el concepte de «avaulació» té un abast més ampli del que potser alguns arxivers coneixen. En lloc d'estar limitat a l'examen i la selecció de documents existents per prendre decisions sobre la seva conservació permanent en arxius, s'amplia a una anàlisi «inicial» més exhaustiva del context, les implicacions funcionals, els requisits i els riscos que ajudi a prendre moltes decisions sobre els documents i la seva gestió, com ara si s'han de crear, quines metadades calen per contextualitzar-los i gestionar-los, qui ha de tenir-hi accés i quan, durant quant temps s'han de conservar, etc. Si es fa amb regularitat i de manera responsable, consultant les parts interessades pertinents, la informació que s'obté mitjançant aquest tipus de'avaulació és essencial per a un programa d'elaboració i gestió de documents que funcioni bé (en qualsevol entorn, inclosos els contextos

en línia, col·laboratius i descentralitzats). Ara els arxivers i altres professionals de la gestió de documents tenen l'oportunitat de combinar aquest mètode amb les noves tecnologies per respondre a la necessitat urgent que hi hagi millors sistemes de gestió de documents per a algunes de les persones més vulnerables de les nostres societats.

Aquest article es basa en una presentació amb el mateix títol que es va fer al Congrés de l'Associació d'Arxivers-Gestors de Documents de Catalunya a Reus el maig del 2017.

RESUMEN

En la edición revisada de la norma ISO 15489-1:2016, Información y documentación. Gestión de documentos, el concepto valoración tiene un alcance más amplio de lo que quizás algunos archiveros conocen. En lugar de estar limitado al examen y la selección de documentos existentes para tomar decisiones sobre su conservación permanente en los archivos, se amplía a un análisis «inicial» más exhaustivo del contexto, las implicaciones comerciales, los requisitos y los riesgos que ayude a tomar muchas de las decisiones sobre los documentos y su conservación, como, por ejemplo, si se deben crear, qué metadatos son necesarios para contextualizarlos y gestionarlos, quién debe tener acceso y cuándo, durante cuánto tiempo se deben conservar, etc. Si se hace con regularidad y de manera responsable, consultando a las partes interesadas pertinentes, la información que se obtiene mediante este tipo de valoración es esencial para un programa de elaboración y gestión de documentos que funcione bien (en cualquier entorno, incluidos los contextos en línea, colaborativos y descentralizados). Ahora los archiveros y otros profesionales de la gestión de documentos tienen la oportunidad de combinar este método con las nuevas tecnologías para responder a la necesidad urgente de mejores sistemas de gestión documental para algunas de las personas más vulnerables de nuestras sociedades.

Este artículo se basa en una presentación con el mismo título que se hizo en el congreso de la Asociación de Archiveros-Gestores de Documentos de Cataluña en Reus (Cataluña) en mayo del 2017.

RESUMÉ

Dans l'édition révisée de la norme ISO 15489-1:2016 Information et documentation: Gestion des documents d'activité, le concept d'« évaluation » s'étend au-delà de la signification sans doute retenue par certains archivistes. Loin de se limiter à l'examen et à la sélection de documents disponibles afin de statuer sur leur conservation permanente à titre d'archives, la notion d'« évaluation » englobe une analyse plus complète et plus frontale du contexte, des implications commerciales, des exigences et des risques afin de prendre de multiples décisions de façon mieux éclairée en matière d'archivage. Il s'agit notamment de se pencher sur l'opportunité de créer une archive, sur les métadonnées nécessaires pour contextualiser et gérer les archives, sur la définition des personnes autorisées à y accéder et des périodes de consultation, sur la durée de rétention, ainsi que sur bien d'autres éléments déterminants.

Menée de façon régulière et motivée, avec une juste consultation des parties prenantes concernées, cette évaluation recueille des informations essentielles au bon fonctionnement d'un programme de création et de gestion d'archives, quel que soit son environnement, même dans les contextes en ligne, ou les démarches collaboratives et décentralisées. Les archivistes et autres professionnels de l'archivage peuvent à présent se fonder sur cette approche en exploitant les nouvelles technologies afin de résoudre le besoin urgent de systèmes d'archivage plus efficaces en faveur de certains des groupes les plus vulnérables de nos sociétés.

Le présent article s'appuie sur l'intervention du même nom, présentée lors de la conférence annuelle de l'Association d'archivistes-Gestionnaires de documents de Catalogne à Reus, en Catalogne (Espagne) en mai 2017.

OUTSOURCING RECORDS MANAGEMENT TO THE CLOUD: caveat emptor o caveat venditor?

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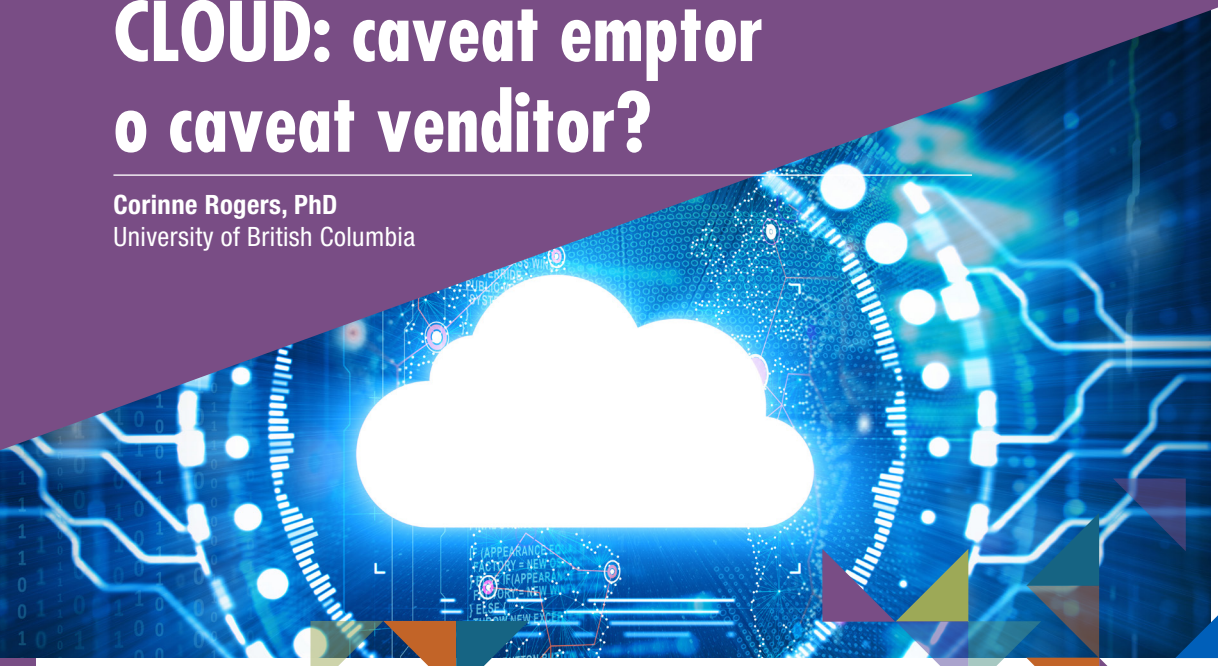

Corinne Rogers (PhD, UBC) is Project Coordinator for the international research project InterPARES Trust and an adjunct professor at the School of Library, Information, and Archival Studies at the University of British Columbia (diplomatics, digital records forensics, digital preservation). Corinne's doctoral research focused on the methods records professionals use to protect or assure authenticity of digital records in practice and how that differs from methods of proving or evaluating record authenticity. Other research interests include information ethics, and the application of digital forensics in archival practice.

INTRODUCTION

In 2017 most businesses, governments, and individuals are 'in the cloud' for various aspects of their professional, business, or personal activities. From the

original cloud service models of SaaS (software as a service), IaaS (infrastructure as a service), and PaaS (platform as a service), there now exist any number of 'as-a-service' offerings to tempt the user. The cloud has been promoted as a cost-saving opportunity for businesses and governments to streamline workflows and centralize IT services through outsourcing to giants like Amazon Glacier, Microsoft Azure, Google, AWS, and others. Cloud service providers promise greater security and lower costs than stand-alone IT shops through on-demand and measured service, broad network access, resource pooling, rapid elasticity and scalability. But have these promises been met? The latest research indicates that the promised cost-savings are illusive, and risks to security, privacy, and availability abound. Particularly for those responsible for records management and information governance, there are very real and urgent requirements for the management of records and data that were clearly understood in the analogue and even the pre-networked digital era, but which may be ignored or not met in the cloud.

Records professionals are facing increasing pressure to manage records and archives in online environments. Some organizations have developed a strategic cloud strategy; others may operate in an ad hoc fashion. Regardless of the degree of cloud readiness or sophistication, outsourcing the management of records and archives to the cloud raises a host of concerns for issues such as chain of custody, data privacy, records retention and disposition. Records managers and archivists, concerned with authenticity, reliability, and control of records and data across time and technological change, may find that cloud services do not meet core requirements.

This paper outlines the risks and challenges of managing records and archives in the cloud, and presents results of current research into these issues. It begins with an introduction to InterPARES (International Research on the Preservation of Authentic Records in Electronic Systems), and InterPARES Trust (Trust and Digital Records in an Increasingly Networked Society), followed by descriptions of several products of these projects that offer practical guidance to records professionals evaluating current cloud services or considering adopting new services for their organizations.

The InterPARES Project – Creating and preserving authentic, reliable digital records

International Research on Permanent Authentic Records in Electronic Systems, or InterPARES as it is commonly known, "[is aimed] at developing the knowledge essential to the long-term preservation of authentic records created and/or maintained in digital form and providing the basis for standards, policies, strategies and plans of action capable of ensuring the longevity of such material and the ability of its users to trust its authenticity" (InterPARES 2017). The project, directed by Luciana Duranti at the University of British Columbia, Vancouver, Canada, has involved researchers from around the world since its inception. It has been continuously funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) and has been conducted in four phases to date.

InterPARES 1 began in 1998 and ran for three years. The goal of the project was to develop a body of theory and methods necessary to ensure that digital records produced in databases and office systems could be identified as records, as understood by archival science, and demonstrated to be authentic over time. Why? The researchers realized that in both archival science and jurisprudence, the records created and used in the usual and ordinary course of business can be presumed authentic. However, in digital systems, these records are at risk of alteration or corruption, either intentional or inadvertent. How can we assess the authenticity of digital records when they are transmitted over time and across space? The researchers studied these digital records from the perspective of the preserver, asking how archives should approach these objects when they come into archival custody. Authenticity is assessed on the basis of evidence – what evidence is necessary in digital systems to make a presumption of authenticity? In the course of the project, researchers developed concepts about the necessary and sufficient components of a digital record, using diplomatic and archival theory, and developed templates for analysing digital material, and benchmark and baseline requirements for assessing and preserving authentic records over the long term (Duranti 2001; Duranti, Eastwood, & MacNeil2003; Duranti 2005; Duranti & Preston 2005b).

In the second phase of InterPARES (2002-2007), researchers expanded their scope of inquiry to the huge variety of records created in dynamic, experiential and interactive systems in the course of artistic, scientific and e-government activities. Researchers approached digital records this time from the perspective of the creator, asking what was required for records to be created in accurate

and reliable form and maintained and preserved in authentic form, both in the long and the short term, whether for the use of their original creator or of society at large, regardless of technology obsolescence and media fragility (Duranti & Thibodeau 2006; Duranti & Preston 2008).

All the products and dissemination resulting from these two projects are freely available under a creative commons license from the website, www.interpares.org. Key outcomes of InterPARES 1 include requirements supporting the presumption of authenticity of digital records, and the production of authentic copies of those records. The benchmark requirements supporting the presumption of authenticity are the conditions that serve as a basis for a preserver's assessment of the authenticity of a creator's digital records. Based on archival science and diplomatics and tested in digital environments, they include the elements of record identity and integrity determined necessary to assess authenticity – identity and integrity metadata. They also cover access privileges, security and protection against loss or corruption, establishment of documentary forms, means of authentication, and identification of authoritative records. It is rare that all of these conditions will be met – it is the degree to which they are met that allows the preserver to determine the strength of the presumption of authenticity (Duranti & Preston 2005a).

The baseline requirements supporting the production of authentic copies include the controls over record transfer, maintenance and reproduction, documentation of the reproduction process and its effects, and archival description necessary in order to be confident of producing copies of digital records that can be guaranteed authentic (Duranti & Preston 2005a). All of these requirements continue to be of importance when records are outsourced to the cloud, and two items in particular pose challenges:the requirement that unbroken chain of custody be maintained and demonstrable, and that security and control procedures are implemented and monitored.

InterPARES 1 and 2 were influential; their findings have been and continue to be implemented in organizations and governments worldwide. The impact of the findings is visible in legislation in Italy and China and in standards, including the DOD 5015.2 in the US, MoReq 2, OAIS, and most recently the Canadian General Standards Board 72.34, Electronic Records as Documentary Evidence, released on March 1 of this year. The findings have also been implemented in a wide variety of organizational policies and procedures, and in curriculum for continuing education and for university programmes.

InterPARES 1 and 2 also received criticism from some quarters for being presumed realistic only for large, resource-rich organizations.The question was posed: how can this research benefit small organizations with a single archivist, limited financial resources, and little or no support from management? This was taken on as a challenge in InterPARES 3 (2007-2012), which embraced the goal of putting the theory into effect in environments challenged by scarce resources (InterPARES 2017).

InterPARES Trust: Digital records online

The findings of the first three phases of InterPARES are relevant for all types of digital records in business systems and the interactive, dynamic systems of individuals and organizations. They are necessary, but not sufficient, for the records now being created, maintained and kept in the cloud. Phase 4 of InterPARES (InterPARES Trust 2013-2018) was approved by the Social Sciences and Humanities Research Council of Canada to investigate records in online environments – the records of social media, of open government, of citizen engagement, as well as business records created, managed, analysed, accessed, stored, and perhaps even preserved, in the cloud.

The researchers realized that the issues surrounding records and data online cut across disciplines as well as jurisdictions, and so the studies approved under the InterPARES Trust umbrella were organized in five research domains (infrastructure, security, control, access, and legal issues) and five cross-domains (terminology, resources, policy, social issues, education).

The research domains are:

Infrastructure: This domain considers issues relating to system architecture and related infrastructure as they affect records held in online environments. Examples include: types of clouds and their reliability; types of contractual agreements (service-level agreements or SLAs) and their negotiation, coverage, and flexibility; and costs, both up front and hidden.

Security: Topics in this domain include methods of securing records, issues of data breaches, audits and auditability, and risk assessment.

Control: The control domain focuses on the management of digital material, addressing issues of authenticity, reliability and accuracy, metadata, chain

of custody, and archival functions of retention and disposition, appraisal, description, and intellectual control.

Access: This domain includes issues related to open access and open data, intellectual rights, privacy, accountability, and transparency.

Legal: This domain concerns legal issues; of particular concern for records in online environments are issues of extra-territoriality, chain of evidence, and authentication, among others.

The research cross-domains:

Terminology: This cross-domain bridges disciplines by comparing common terms and their uses, developing a multilingual glossary of terms as used in the research, a multilingual dictionary with sources, and ontologies.

Resources: The research is supported by the development of annotated bibliographies and literature reviews of relevant published articles, books, case law, policies, statutes, standards, blogs, and grey literature.

Policy: The policy cross-domain considers policy-related issues emerging from the five research domains. In general, it addresses recordkeeping issues associated with the development and implementation of policies having an impact on the management of records in an online environment; policies can be broad, such as a national policy on information management, or very specific, such as a policy on adopting certain standards within an organization.

Social/societal issues: Research in this cross-domain analyses social change consequent to the use of the Internet, including the use/misuse and trustworthiness of social media, consequences of data leaks (intentional or accidental/force majeure), development issues (power balance in a global perspective), organizational culture issues, and individual behaviour issues.

Education: This cross-domain is concerned with the development of different models of curricula for transmitting the new knowledge produced by the project (InterPARES Trust 2017b).

GOALS

One of the key questions InterPARES Trust poses is: What is the impact of always-on, networked communication technologies and cloud computing services on records management and recordkeeping, maintaining trustworthy records, and on both client and citizen perception of the trustworthiness of these digital records? The project has articulated a number of goals to achieve its objective.

The first is to discover how current policies and practices regarding the handling of digital records in online environments affect the public's trust in these records – in other words, what are archivists and records managers doing when trying to maintain trustworthy records online? The second turns this around to ask what the public thinks – we know there is a waning level of confidence in online records and information – more so today than when this project began! What is the public's perception of the trustworthiness of institutional records?

Because of the international nature of this project, our third goal recognizes that we also must address how national or cultural contexts affect levels of trust, issues of trust, and solutions to trust issues. The fourth goal is to develop various instruments that will either assist or regulate the creation, management, storage, preservation, and access to digital records online. And finally, we recognize that it is not enough to make recommendations; our fifth goal is to test them in the field.

Archival and records management issues in the cloud

But why, really, is this necessary? If the findings of previous InterPARES projects apply to digital records regardless of their technical environment, why do we need another research project? The answer can be seen in industry statements about the cloud, in the rush of many organizations to embrace the latest technology, and the speed with which the technology develops and changes.

One does not have far to look to see how this new technology has been embraced:

"Enterprise adoption of the cloud has truly moved into the mainstream, with 68% currently using public or private cloud… a 61% increase over last year…"

"The greater the level of cloud adoption, the higher the level of business benefits achieved."

"On average, per application deployed on cloud, organizations studied are achieving $3 million in additional revenue… [and] $1 million in cost reduction… (Mahowald et al. 2016)"

These quotes speak to the speed of development and adoption as well as the focus on cost reduction and benefits optimization.

What exactly do we mean by "cloud"? There is a popular joke that says, "There is no cloud – it's just someone else's computer", and to a certain extent that is true. It reminds us that computing still relies on physical things – hardware, cables, and the laws of physics. However, it is also very superficial. Mary Branscombe, writing for ZDNet, responds: "if you're saying that, the joke is on you, because it means you don't understand what the cloud actually is" (Branscombe 2016).

The standard definition of cloud computing comes from the National Institute of Standards and Technology (NIST): cloud computing is "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell & Grance 2011). These services can be delivered in one or a combination of deployment models, each with specific benefits and costs. Public cloud infrastructure is made available to the general public over the Internet. By definition external to the customers' organization, public clouds are owned and operated by third-party providers and usage is subject to detailed service-level agreements. Concerns include privacy and security in a multi-tenancy environment, and multi-jurisdictional issues. These concerns are often addressed by adopting a private cloud infrastructure: this is operated for a single organization, that is, data in a private cloud does not share resources with data belonging to other individuals or organizations. A private cloud may be managed by the organization or by a third party and may be hosted within the organization's IT infrastructure or externally. Between these two models are community clouds and hybrid clouds. A community cloud infrastructure is shared by two or more organizations with common privacy, security, and regulatory considerations. It may be managed by the organizations or a third party and may be hosted internally or externally.

The most complex is the hybrid cloud, composed of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability. Branscombe simplifies the definition down to its essence – the cloud

isn't someone else's computer, but a data centre, full of identical hardware, where every deployment, update, investigation, and management process is automated (Branscombe 2016).

While IT personnel, senior management, and politicians may be eager to jump into the cloud, citing efficiency and financial benefits, there are challenges that must be addressed. Questions include issues of data security and protection of personal information, whether and how regulations and laws will be observed when data flows across jurisdictions, what guarantees are provided for continuity of service, and how data breaches will be handled. These speak to the trustworthiness of cloud service providers. Issues of trust are difficult to isolate and are often bound up with more easily identified issues of privacy, security, and jurisdiction.

When we think in terms of records, we bring another perspective to the challenges presented by cloud computing. We keep records as evidence of activity, and as memory of action, and we use them to prove accountability – in order to do this we must trust them. In archival terms, we trust records according to the degree to which we can demonstrate their authenticity, reliability, and accuracy. In legal terms, at least in common law countries, the trustworthiness of records is tested through the rules of admissibility of documentary evidence. In both cases, being able to demonstrate a chain of responsible custody is key.

Recordkeeping challenges are slightly different from data challenges – records are records largely because of their context and the expression of the relationships to their creators, the activities they participate in or document, and other records generated in the same activity – what we know in archival science as the archival bond (Duranti 1997; Duranti & Thibodeau 2006). This archival bond does not, generally, define data and information. So the questions we ask as records professionals have a different focus:

- Can the context of the records be protected?

- Can provenance be demonstrated?

- Can retention & disposition be carried out?

- Can access and usability be assured over time?

- Can intellectual rights be respected?

In order to begin to address these questions, we need to define what we mean by trust. InterPARES Trust, for the purposes of its research, has defined trust as the confidence of one party in another, based on an alignment of value systems with respect to specific actions or benefits, and involving a relationship of voluntary vulnerability, dependence, and reliance, based on risk assessment. This is a subjective value, existing on a continuum from absolute trust, to complete scepticism, or distrust.

With respect to records, we can outline a trust framework (see Figure 1). Records can be judged trustworthy if they can be shown to be authentic, reliable, and accurate. Authenticity is assessed on the basis of evidence that the record's identity can be determined and its integrity demonstrated. Authenticity must be continuously protected over time through monitoring and control. Reliability is the truthfulness of the record content, and is determined by the completeness of the record and the control exercised over its creation, and accuracy is part of reliability – the precision of the data that is the record content. Trustworthiness of records also depends on the trustworthiness of the records system (MacNeil 2001; Duranti & Thibodeau 2006; InterPARES Trust 2017a).

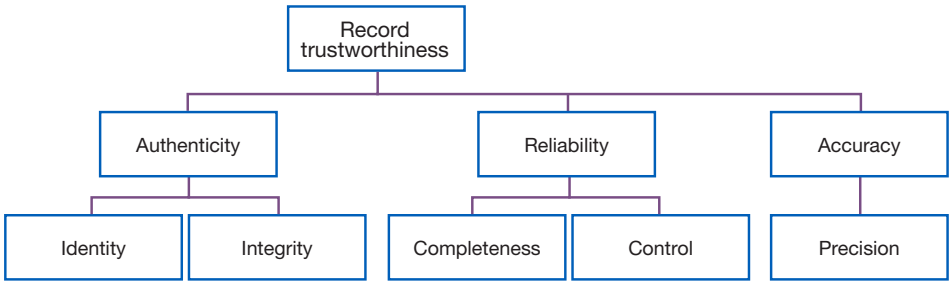

Figure 1. Trust Framework

And so this brings us back to the cloud – do cloud services meet our standards for trustworthy records systems? Whether you are managing records in paper-based in-house systems or managing digital records or other organizational

assets, a trustworthy system is a management framework consisting of the relevant laws and policies that are established for accountability, standards and practices, systems and technologies, the people, the organizational structure, and awareness and education and training.

The considerations for adopting cloud services, then, are not simply the responsibility of the IT department, but should be undertaken in a holistic way to include managerial concerns, including records management, financial issues, legal liabilities, security matters, and finally, technical solutions that meet the needs and resources of the organization.

Guidelines to assist decisions to outsource records to the cloud

The trust relationship most frequently studied in InterPARES Trust is that between consumers of cloud services – individually or as communities of users – and cloud service providers (CSPs) in the consumption of cloud services, and the vehicle through which trust is dictated is the service contract, service-level agreement, or terms of service. The relationship between CSPs and users often reflects an imbalance of power: the user is dependent on the services of the provider with little chance of negotiating the terms of the relationship. While a government or large organization has the capacity to negotiate the terms of their contract with these providers, most of us have no choice but to accept the boilerplate contracts written by the service provider. Boilerplate provisions are typically drafted by the dominant contractual party to suit its purposes and are non-negotiable.

In order for the contract to be an instrument of trust, its terms must be transparent, understandable, and comprehensive in terms of our needs. This demands that we articulate our needs and requirements at the outset. Unfortunately, the concerns of records managers – things like protecting the authenticity of records, implementing retention and disposition schedules, or the availability of metadata to prove provenance and chain of custody – are rarely at the top of decision makers' minds when outsourcing IT functions to the cloud.

The terms of cloud service contracts and the status of the relationship between CSPs and customers have been discussed in the information technology, legal, and archival literature (c.f. Bradshaw, Millard, & Walden 2011; Office of the Information & Privacy Commissioner for British Columbia 2012; Badger et al. 2012; The National Archives, UK 2014). Common themes of interest

include issues around storage and jurisdiction, data segregation, security, and accessibility. The records management literature is also concerned with issues specific to records: retention and disposition, protection of evidential capacity, and long-term viability (c.f. Barnes 2010; Baset 2012).

Researchers from the North American team of InterPARES Trust undertook two studies of several major service providers' boilerplate contracts, looking at the terms specifically from the point of view of records managers and archivists (McLelland & Hurley 2014; Bushey, Demoulin, & McLelland 2015; Bushey et al. 2015). As a result of these two studies, InterPARES Trust has issued a flexible and practical tool – a checklist of issues and terms that cover records and recordkeeping issues that should be considered when reviewing or negotiating a cloud service contract. The target audience of the checklist is records managers, archivists, chief information officers (CIOs), and others responsible for assessing cloud services. By identifying the common challenges and issues for recordkeeping in any context, the checklist can be used as a metric against which to measure existing contracts, or a guideline for negotiating new contracts. Its goal is to promote understanding of boilerplate cloud service contracts, and provide a tool for assessing the degree to which a given cloud service meets organizational recordkeeping and archival needs and requirements (Bushey et al. 2016).

The teams confirmed that several types of legal documents exist to govern the relationship between CSP and client: terms of service, service-level agreements, privacy policies, and acceptable use policies. They found little, if any, standardization of terms among and between these instruments, which are often "incomprehensible to the majority of users" (Bradshaw, Millard, & Walden 2011, p. 32). Most contain wide-ranging exclusions of liability that favour the provider, as well as a clause saying that terms may change, often without the need to provide notice to the client.

The researchers identified recordkeeping requirements through different instruments, including legislation, regulations, policies, standards, and guidelines, taking into account the variation in different jurisdictions, industry sectors, and professions. However, the fact that records serve as documentary evidence of legal transactions, support critical operations of an organization, and may contain personal, sensitive, or confidential information, means that, regardless of jurisdiction, sector, or profession, there are common risks, concerns, and requirements.

A review of legal literature revealed that, at the time of review, relatively few cases had been decided that deal specifically with cloud computing contracts. Of those that had, numerous well-established legal tenets apply and will likely be influential in the future. Traditional contract law has "a solid connection to cloud contract law". The issue of inequality of bargaining powers between CSPs and clients may arise through the traditional legal issue of unconscionability. The importance of privacy and security in relation to cloud computing, given the ease of sharing information across jurisdictional boundaries, cannot be understated. Furthermore, jurisdictions differ in their guiding laws, as do different industry sectors, and their case law precedents can change quickly. Finally, conflict of laws, which determines the jurisdiction of legal action, is another important issue to consider. Where boilerplate contracts are in force, it is the CSP who dictates the choice, with potentially serious implications for the client (Bushey, Demoulin, & McLelland 2015).

Issues of import to records managers and archivists were identified through a review of recordkeeping standards and the tenets of archival science. The researchers reviewed ISO 15489 (2001) – Information and Documentation-Records Management (ISO 2001), and ISO 14721 (2012) – Space Data and Information Transfer Systems – Open Archival Information System Reference Model (OAIS) (ISO 2012), as well as ARMA (Association of Records Managers and Administrators) International's Generally Accepted Recordkeeping Principles (ARMA International 2014).

Regardless of jurisdiction, sector, or profession, the researchers identified common risks associated with cloud computing: unauthorized access to information and records, breach of privacy, loss of access to and management of records (which impacts authenticity and integrity), lack of transparency of service and account management, server location, data destruction, and data recovery. They then identified seven key topics of interest for the customer considering cloud services arising from law and recordkeeping standards: data ownership; availability, retrieval and use; data storage and preservation; data retention and disposition; security, confidentiality and privacy, data location and cross-border data flow; and end of service/contract termination.

Through a comparative analysis of available boilerplate contracts mapped against recordkeeping and archival requirements for management and preservation of records that can be proven to be reliable and presumed authentic, the researchers

then developed the checklist to aid in a risk assessment for adopting cloud services. The checklist consists of questions grouped into eight sections:

- Terms of Agreement

- Data Ownership and Use

- Availability, Retrieval, and Use

- Data Storage and Preservation

- Data Retention and Disposition

- Security, Confidentiality, and Privacy

- Data Localization and Cross-border Data Flows

- End of Service; Contract Termination

The checklist, available in English, French, Spanish, and Dutch, has been integrated with other projects in InterPARES Trust, including a comprehensive tool to establish a Standard of Practice for archives, and checklists for ensuring trust in storage in IaaS and retention and disposition in a cloud environment (these and other products and reports are available at www.interparestrust.org/trust/research_dissemination). It was released for comment in the fall of 2015 and tested in several organizations, including the International Federation of Red Cross and Red Crescent Societies, which evaluated a SaaS recruiting tool for use in their human resources department.

The cloud is ubiquitous – at some point each of us will be faced with records in the cloud, whether in our personal or professional life. Industry advice may be basic: "Simply adopting the cloud is not enough; you should increase your cloud maturity level… Go with a provider you trust" (Mahowald et al. 2016). But how to increase your cloud maturity level, and how to evaluate the trustworthiness of a cloud service provider, may not be easy, particularly if your concern is for the ongoing authenticity and reliability of records over time. InterPARES Trust is one resource that can help.

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ABSTRACT

In 2017, most businesses, governments, and individuals are 'in the cloud' for various aspects of their professional, business, or personal activities. From the original cloud service models of SaaS (software as a service), IaaS (infrastructure as a service), and PaaS (platform as a service), there now exist any number of 'as-a-service' offerings to tempt the user. The cloud has been promoted as a cost-saving opportunity for businesses and governments to streamline workflows and centralize IT services through outsourcing to giants like Amazon Glacier, Microsoft Azure, Google, AWS, and others. Cloud service providers promise greater security and lower costs than stand-alone IT shops through on-demand and measured service, broad network access, resource pooling, rapid elasticity and scalability. But have these promises been met? The latest research indicates that the promised cost-savings are illusive, and risks to security, privacy, and availability abound. Particularly for those responsible for records management and information governance, there are very real and urgent requirements for the management of records and data that were clearly understood in the analogue and even the pre-networked digital era, but which may be ignored or not met in the cloud. Records managers and archivists, concerned with authenticity, reliability, and control of records and data across time and technological change, may find that cloud services do not meet these core requirements. This paper outlines the risks and challenges of working in the cloud, and presents results of several research studies conducted as part of InterPARES Trust that offer guidance for those evaluating current cloud services or considering adopting new services for their organizations.

RESUMÉ

En 2017, la plupart des entreprises, administrations et particuliers ont localisé divers aspects de leurs activités professionnelles, commerciales ou personnelles « en nuage ». Depuis les premiers modèles de services en nuage comme les logiciels, infrastructures et plateformes à la demande (respectivement, SaaS, software as a service, IaaS, infrastructure as a service et PaaS, platform as a service), un grand nombre d'offres « à la demande » toutes plus

prometteuses les unes que les autres sont maintenant proposées aux utilisateurs. L'informatique en nuage a été présentée comme une solution économique permettant de rationaliser les flux de travail et de centraliser les services informatiques des entreprises et des administrations en confiant certaines tâches à des géants comme Amazon Glacier, Microsoft Azure, Google ou AWS. Les fournisseurs de services en nuage annoncent une sécurité renforcée et des coûts inférieurs par rapport à des plateformes informatiques autonomes grâce à des services mesurés à la demande, un accès étendu au réseau, la mise en commun des ressources, une excellente réactivité avec beaucoup d'élasticité et une grande extensibilité. Mais ces promesses ont-elles été tenues ? Les études les plus récentes révèlent que les économies annoncées sont illusoires, tandis que les menaces pour la sécurité, la confidentialité et l'accessibilité sont légion. Des contraintes bien réelles et urgentes s'imposent pour la gestion d'archives et de données, notamment pour les responsables de la gestion des archives et de la gouvernance de l'information. À l'époque des systèmes analogiques et même du numérique (avant le développement des réseaux), ces exigences étaient clairement appréhendées, mais elles risquent d'être ignorées ou de ne pas être respectées avec des échanges en nuage. La tâche des gestionnaires d'archives et des archivistes consiste à s'assurer de l'authenticité, de la fiabilité et de la maîtrise des documents et des données au fil du temps, indépendamment des évolutions technologiques. Or, ces professionnels peuvent estimer que les services en nuage ne jouent pas le rôle fondamental qui leur est dévolu. Le présent article aborde les risques et les écueils du travail en nuage, avant de présenter les résultats de plusieurs études menées dans le cadre du programme de l'InterPARES Trust et offrant des orientations pour évaluer les services en nuage proposés actuellement ou pour envisager l'adoption de nouveaux services.chnologiques. Or, ces professionnels peuvent estimer que les services en nuage ne jouent pas le rôle fondamental qui leur est dévolu. Le présent article aborde les risques et les écueils du travail en nuage, avant de présenter les résultats de plusieurs études menées dans le cadre du programme de l'InterPARES Trust et offrant des orientations pour évaluer les services en nuage proposés actuellement ou pour envisager l'adoption de nouveaux services.

RESUM

El 2017 pràcticament la totalitat de les empreses, els governs i els individus era «al núvol» per diversos aspectes de les seves activitats professionals, econòmiques o personals. Des dels models de serveis en núvol originals, com SaaS (programari com a servei), IaaS (infraestructura com a servei) i PaaS (plataforma com a servei), ara hi ha una sèrie d'ofertes «com a servei» per temptar els usuaris. El núvol s'ha promogut com una oportunitat d'estalvi per a les empreses i els governs que agilitzen els fluxos de treball i centralitzen els serveis de TI mitjançant l'externalització a gegants com Amazon Glacier, Microsoft Azure, Google i AWS, entre altres. Els proveïdors de serveis en núvol prometen més seguretat i uns costos més baixos que les botigues d'informàtica independents gràcies a un servei mesurat i segons demanda, un ampli accés a xarxes, un agrupament de recursos i una elasticitat i una escalabilitat ràpides. Però s'han complert aquestes promeses? En les recerques més recents s'assenyala que els estalvis promesos són il·lusoris i que els riscos per a la seguretat, la privadesa i la disponibilitat són abundants. Especialment per als responsables de la gestió de documents i el control de la informació, hi ha necessitats molt reals i urgents pel que fa a la gestió de documents i dades que es comprenien molt bé en l'era analògica i fins i tot en l'era digital anterior a les xarxes, però que es passen per alt o no se satisfan al núvol. Els gestors de documents i els arxivers, que prioritzen l'autenticitat, la fiabilitat i el control dels documents i les dades al llarg del temps i amb l'evolució tecnològica, poden opinar que els serveis en núvol no responen a aquestes necessitats essencials. En aquest article es descriuen els riscos i els reptes de treballar en núvol i es presenten els resultats de diversos estudis de recerca duts a terme com a part del projecte InterPARES Trust, que ofereixen orientació per a les persones que avaluen els serveis en núvol actuals o es plantegen adoptar els serveis nous als seus organismes.

RESUMEN

En 2017 prácticamente la totalidad de las empresas, los gobiernos y los individuos estaban «en la nube» por diversos aspectos de sus actividades profesionales, económicas o personales. Desde los modelos de servicios en la nube originales, como SaaS (software como servicio), IaaS (infraestructura como servicio) y PaaS (plataforma como servicio), ahora hay toda una serie de ofertas «como servicio» para tentar a los usuarios. La nube se ha promovido como una oportunidad de ahorro para las empresas y los gobiernos que agilizan los flujos de trabajo y centralizan los servicios de TI mediante la externalización a gigantes como Amazon Glacier, Microsoft Azure, Google y AWS, entre otros. Los proveedores de servicios en la nube prometen más seguridad y unos costes más bajos que las tiendas de informática independientes gracias a un servicio proporcionado y a la carta, un amplio acceso a redes, un agrupamiento de recursos y una elasticidad y una escalabilidad rápidas. Pero ¿se han cumplido estas promesas? En las investigaciones más recientes se señala que los ahorros prometidos son ilusorios y que los riesgos para la seguridad, la privacidad y la disponibilidad son abundantes. Especialmente para los responsables de la gestión de documentos y del control de la información, existen necesidades muy reales y urgentes en cuanto a la gestión de documentos y datos que se comprendían muy bien en la era analógica e incluso en la era digital anterior a las redes, pero que se pasan por alto o no se satisfacen en la nube. Los gestores de documentos y los archiveros, que priorizan la autenticidad, la fiabilidad y el control de los documentos y los datos a lo largo del tiempo y con la evolución tecnológica, pueden opinar que los servicios en la nube no responden a estas necesidades esenciales. En este artículo se describen los riesgos y los retos de trabajar en la nube y se presentan los resultados de varios estudios de investigación llevados a cabo como parte del proyecto InterPARES Trust, que ofrecen orientación para las personas que evalúan los actuales servicios en la nube o se plantean adoptar servicios nuevos en sus organismos.

NEW TECHNOLOGIES APPLICABLE TO DOCUMENT AND RECORDS MANAGEMENT: Blockchain

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Digital documents can nowadays be created in two ways – they can be digitized from existing paper records or be born digitally. Digitization, in the broadest sense, is the transformation of an analog signal into a corresponding digital form. In a more narrow sense, it represents the transformation of different materials into digital format, turning them into binary code saved in a computer file. Digitization splits the notion of preservation into two parts – the preservation of the content or information recorded in a document and preservation of the physical object, i.e. the medium that carries the information. The information content is digitized and saved separately from the physical object (Stančič, Digitization of documents, 2000). It is important to note that every digitally preserved record should have its characteristics of authenticity, reliability, integrity and usability intact (ISO 15489-1:2016 Information and documentation – Records management – Part 1: Concepts and principles, 2016). The trustworthiness of a record refers to its

accuracy, reliability and authenticity (InterPARES Trust Terminology Database). Archiving and preservation represent a unique challenge due to the long-term nature of these activities. The problem of long-term preservation and maintenance of digital information can be interpreted as preserving records so that the technology they are based on does not become obsolete. Digital objects require constant and continuous maintenance and depend on a complex ecosystem of hardware, software, standards and legal regulations which are constantly changing, being amended or replaced. When compared to analog records, digital ones face greater risk of decaying, primarily because of the fast pace of information technology development. Preserving digital records is much more than the preservation of a computer file – the goal is to enable access to the content while at the same time ensuring that its important characteristics are maintained.

1.1. Digital signatures and digital seals

The result of e-business and digital communication is the creation of an ever-increasing number of digital documents and records which might also contain digital signatures or have digital seals attached to them. Therefore, it is necessary to analyze the challenges of the long-term preservation of such digital records.

While technically the same, the difference between digital signatures and digital seals is that a digital signature can be only associated with a natural person and the signing key must be under the sole control of the signatory, while a digital seal can be associated only with a legal entity and the signing key must be under the sole control of the process assigning a seal to ensure integrity and origin (What is an electronic seal?) (eIDAS, 2014).

In order to be preserved for the long term, digitally signed records must also have the basic characteristics of authenticity, reliability, integrity and usability, which require a more complex approach to preservation compared to digital records that are not digitally signed or stamped. Just as there is a difference between the short-term and long-term preservation of digital records, there is also a difference between the preservation of digital records which are digitally signed or sealed and those which are not. Digitally signed or sealed records contain one more level of complexity in the form of a digital signature or seal, making their preservation more complicated.

Even though digitally signed records can be preserved for a longer period, they may lose their legal validity if this record cannot be validated or if it loses its

property of non-repudiation. If an error occurs in the process of digital signature validation, the trustworthiness of the digital record becomes deprecated. This issue arises because a digital signature, and more precisely the certificate it is based on, has a limited lifetime and the validation of this signature requires a connection to the certificate authority (CA) which relies on the Public Key Infrastructure (PKI). If any of the elements of this system malfunction, digital signature validation will fail. This is especially important when preserving records that contain advanced digital signatures (Herceg, Brzica, & Stančič, 2015).

1.2. Digital timestamps

In the context of digital signatures, the digital timestamp plays an important role. It represents a digitally signed certificate of a timestamp issuer which confirms the existence of the data, documents or records to which the timestamp relates, at the time stated on the timestamp. The digital timestamp provides reliable proof that the data, document or record was created earlier or just before the time indicated in the digital timestamp. Any subsequent changes to data, documents, records or timestamp are not allowed and can be easily detected. Therefore, the digital timestamp confirms: 1) that the data, document or record at hand existed in that form at the time indicated in the timestamp, 2) that the data, document or record was not changed after the time indicated in the timestamp, 3) that the digital signature verification can be reliably performed even after the revocation or expiration of the certificate (in that case it can be verified that the data, document or record has not been changed, but the validity of the signature's certificate cannot be verified), and 4) that the data, document or record was sent or received at the time indicated in the timestamp. The Timestamping Authority (TSA) digitally signs the hash value of the data, document or record along with the time value (coming from a trusted source, e.g. it can be linked to Coordinated Universal Time), thus issuing a digital timestamp which is subsequently combined with the data, document or record and the signatory's private key to create the digital signature indicating the time of signing.

1.3. Long-term preservation of digitally signed records

Long-term preservation of digital records that are digitally signed or have a digital seal attached to them is a challenge for the archival profession. Such digital records are not easy to preserve, not only because of the constant technological advances, but also because the certificates they rely on have a limited duration. For example, the Financial Agency (FINA), a Certificate Authority (CA) in Croatia,

issues certificates valid for two years, while the Agency for Commercial Activities' (hrv. Agencija za komercijalnu djelatnost, AKD) certificates are valid for five years (used in e-identity cards). The root certificates of the issuer generally have a longer validity period, e.g. ten years. After the certificate expires, it will no longer be possible to check the validity of the digital signature, but it will still be possible to check the integrity of the record itself. Currently there are several approaches to long-term preservation of digital records that have digital signatures or seals attached to them.

According to PREMIS (Data Dictionary for Preservation Metadata: PREMIS version 3.0, 2015), preservation repositories use digital signatures in three main ways:

1. *For submission to the repository* – an agent (author or submitter) might sign an object to assert that they truly are the author or submitter.

2. *For dissemination from the repository* – the repository may sign an object to assert that it truly is the source of the dissemination.

3. *For archival storage* – a repository may want to archive signed objects so that it will be possible to confirm the origin and integrity of the data.

Only in the third case, where digital signatures are used by the repository as a tool to confirm the authenticity of its stored digital objects over time, must the signature itself and the information needed to validate the signature be preserved.

According to Blanchette (Blanchette, 2006), from the point of view of archives there are three possible options:

1. *Preserve the digital signatures*: This solution requires the deployment of considerable means to preserve the necessary mechanisms for validating the signatures, and does not address the need to simultaneously preserve the intelligibility of documents.

2. *Eliminate the signatures*: This option requires the least adaptation by archival institutions, but impoverishes the description of the document, as it eliminates the signature as one technical element used to ensure the authenticity of the documents.

3. *Record the trace of the signatures as metadata*: This solution requires little technical means, and records both the existence of the signature and the result of its verification. However, digital signatures lose their special status as the primary form of evidence from which to infer the authenticity of the document. Moreover, this approach requires the existence of a trusted third party to preserve and authenticate the metadata.

Certain authors argue that the only option is the first one, i.e. to develop a Trusted Archival Service (TAS) which could guarantee that the signature on a record can still be validated years later (Dumortier & Van den Eynde).

However, results of the previous InterPARES projects recommend the third option, i.e. to organize a digital archive so as to check the validity of the digital signatures at the ingest phase, add the validity information to the records' metadata, and preserve the records without addressing the digital signature's validity further. Thus, the issue of trust is shifted from the (digitally signed) record to the archive preserving digital records and the associated (validity) metadata. This follows the more traditional model of archival preservation, which stands in contrast to the underlying premise of blockchain and distributed ledgers technology as not reliant upon a trusted third party or preservation intermediary (Nakamoto, 2008).

The research results of the current InterPARES Trust project show that there is a fourth option based on the principles of blockchain and distributed ledger technologies, i.e. to register the validity of the digital signature in the blockchain. This approach will be explained below.

2. Blockchain

In order to fully understand how the blockchain and distributed ledger technologies can be used in the context of document and records management, the underlying principles will be explained.

A blockchain is a distributed database of (transaction) records storing hash values of data, information, transactions, documents or records and it is associated with the concept of distributed ledger technology (DLT). The name is composed of two terms – "block", which refers to the complete set of contents, and "chain", which refers to the interconnection of the blocks. This chain grows linearly, and the encryption of a new block, in the context of cryptocurrencies,

is called mining. Blockchain is implemented through a peer-to-peer network in which each connected computer (node) stores data on all transactions (a blockchain does not store data, only their hash values).

In order to better understand the blockchain and distributed ledger technologies, one needs to understand the underlying technologies and concepts. Therefore, hash algorithms, Merkle tree, distributed consensus, and finally, blockchain will be explained next.

2.1. Hash algorithms

Hash, or message digest, is a *one-way* function that quickly calculates a unique fixed-length string out of any data, information, document or record of any size. The one-way characteristic means that it is not possible to recreate the original document by knowing its hash. It is extremely difficult and nearly impossible to create "collisions", i.e. to have two or more meaningful records with the same hash value. That is why the resulting hash value is also referred to as a *digital fingerprint*. Figure 1 shows an example of an online hash generator using hash functions MD5 and SHA. If someone receives the. docx file with the summary of this paper and its corresponding hash value (s)he can generate the hash of the received file and compare it with the received hash value. If the two are the same, the file has not been changed, i.e. its integrity has not been compromised.

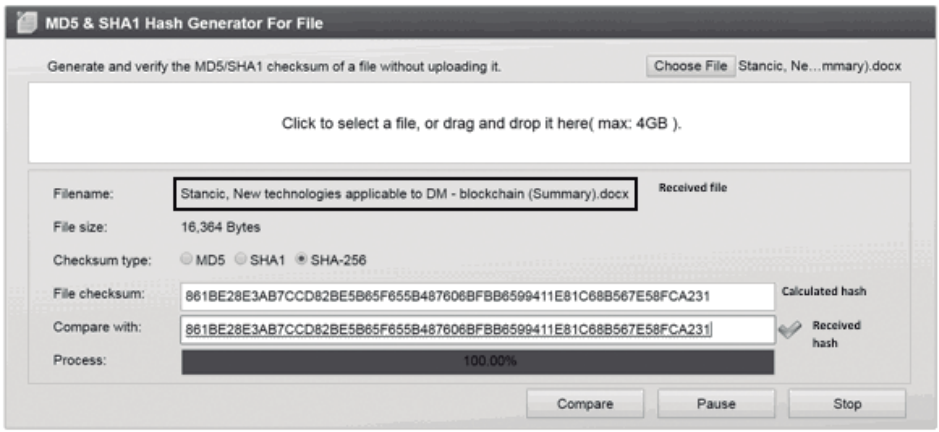

Figura 1. Comparació dels valors *hash* amb el generador de valors *hash* Online MD5, http://onlinemd5.com/

2.2. MERKLE TREE

Hash values may be grouped together to form one hash. This will be illustrated by the following example (Figure 2). A company creates a number of documents per hour. A hash value is calculated for each document. At every hour, all hash values from all documents are grouped and hashed together to get just one "hourly" hash. At the end of the eight-hour working day, for example Monday, all eight "hourly" hash values are hashed together to get one hash value for Monday. This hash is called root hash or top hash. This approach was first introduced in 1980 by Ralph C. Merkle (Merkle, 1980). Since the structure resembles a tree (upside-down), it was named the Merkle tree.

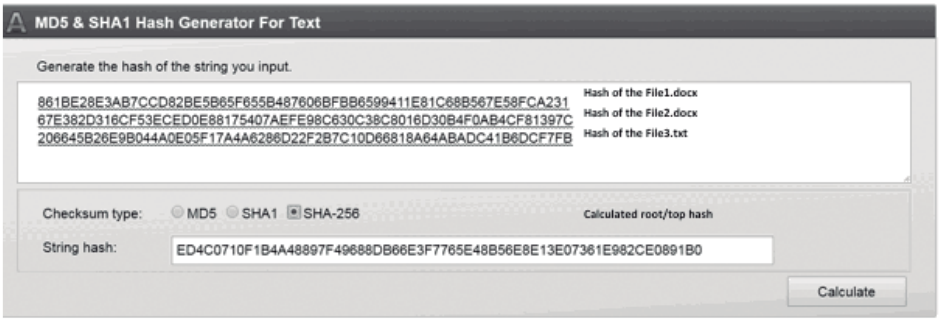

Figure 2. Creation of root/top hash

2.3. DISTRIBUTED CONSENSUS

Blockchain uses a distributed (peer-to-peer) network. The distributed network has no center(s) since all interconnected computers are treated equally. This type of network has no single point of control and therefore no single point of attack. Blockchain uses the principle of distributed consensus in which every participant (node) records every event in their ledger. Consensus is used in order to ensure that all ledgers are exact copies (i.e. are synchronized) and to determine the truth. The event (e.g. monetary transaction or registration of a document) is valid only if the qualified majority (50%+1 node) agrees.

Figure 2. Creation of root/top hash

2.4. CHAINING THE BLOCKS

The Merkle tree approach was used by Satoshi Nakamoto to create the virtual currency, or cryptocurrency, Bitcoin (Nakamoto, 2008). The rapid global spread of the popularity of Bitcoin and other cryptocurrencies has sparked wider interest and application of blockchain technology.

The blockchain creates a chain of linked blocks. This will be illustrated by extending the example explaining the Merkle tree and shown in Figure 2. The previously mentioned company can repeat the Monday hashing process for documents created every hour on Tuesday. This will result in two hash values – one for each day. Those two values could further be hashed together to create a new single top hash uniting single hashes from Monday and Tuesday. This single hash value could be further combined with the Wednesday hash value to create a new top hash, etc. Each new top hash is calculated from the day's hash and a previous top hash, thus linking the top hashes (Figure 3). Each new block is timestamped at the time of creation. This guarantees that the hashes, i.e. the data, documents or records, existed at the time of registration in the blockchain (Source: TRUSTER – Model for Preservation of Trustworthiness of the Digitally Signed, Timestamped and/or Sealed Digital Records, https://interparestrust.org/assets/public/dissemination/TRUSTERPreservationModel(EU31)-Finalreportv_1_3.pdf).

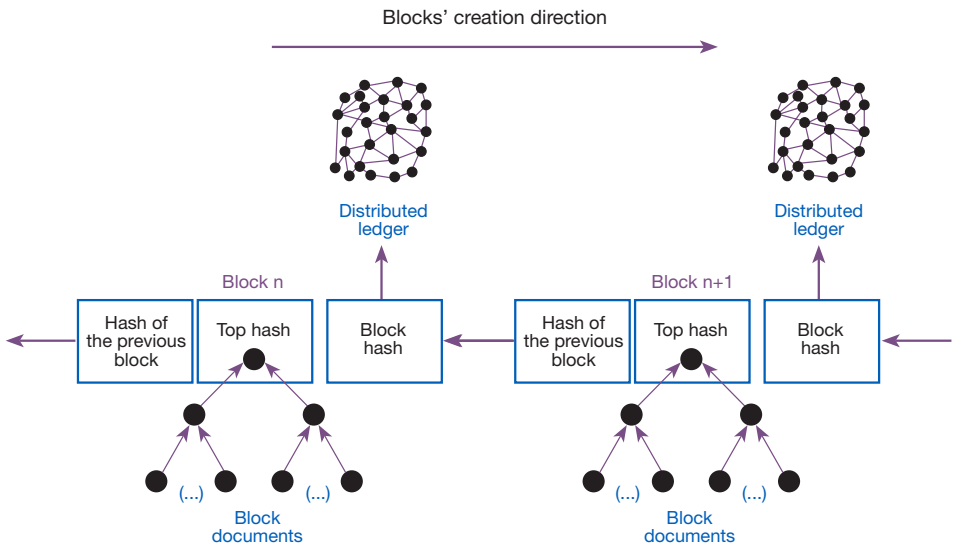

Figure 3. Blockchain creation

There are several strengths in the blockchain concept. First of all, only hashes are stored (registered) in the blockchain. The actual data, documents or records being hashed are stored in the institutional document or records management systems. Secondly, each additional block reinforces the preceding ones, since the blocks are chained together and each new block is dependent on the links of the previous blocks. Finally, modifying any block on the chain invalidates all subsequent blocks.

3. THE USE OF BLOCKCHAIN IN DOCUMENT AND RECORDS MANAGEMENT

Managing digital documents and records improves business productivity and organizational effectiveness. The most commonly used functions of document management are version tracking, tracing steps (where/when the document was/is) in the business process, verification of changes, document structure and contents as well as streamlined and trusted exchange of documents. Blockchain could be useful in several aspects of document management processes. For example, whenever a new document version is created, it could be registered on the blockchain. By doing that, and because each new block in the blockchain is timestamped, it becomes clear which document version was created when, and the changes made, document structure and contents could be traced back and verified if needed. Furthermore, in the course of business, documents are often sent to other parties. Registration on the blockchain could provide the necessary proof that a document was not tampered with, as previously shown in Figure 1.

On the other hand, documents are often digitally signed or sealed. Once they become records they should no longer be changed, and, in the course of records management and archiving, their authenticity, integrity, reliability and usability should remain intact, while some of them should also preserve the characteristics of non-repudiation, security and confidentiality. The problem, as indicated before, is that the certificates used in digital signatures expire in two to five years, leaving the record keepers and archivists with a situation in which the validity of digital signatures can no longer be confirmed. As part of the InterPARES Trust project, a TRUSTER VIP solution called TrustChain is being developed. The possibilities of using linking-based timestamping and blockchain technology for long-term preservation of digitally signed records are

being investigated. TrustChain is a blockchain-based model that can be used to register information about the validity of the digital certificates from digital signatures on the blockchain at the time of ingest of the digitally signed or sealed records in the archive while the digital certificates are still valid. Later on, when the validity period of digital certificates expires, one can:

1. Confirm that the digital certificate was valid at the time of ingest,

2. Confirm that the record did not change (by recalculating hash and comparing it with the registered one and the one found in the digital signature),

3. Infer that when 1 and 2 are correct it is as if the digital certificate were still valid.

The TrustChain concept was published in the INFuture2017 conference paper "A model for long-term preservation of digital signature validity: TrustChain" (Bralić, Kuleš, & Stančić, 2017). However, the model is still in an early, conceptual phase and is going to be developed further.

4. DISCUSSION

AImplementing blockchain in a document management process is not complicated. Enigio Time, one of the InterPARES Trust research partners who was also involved in the TrustChain model development, has developed a blockchain aggregator (Figure 4). The document management system (DMS) connects through an API to the blockchain aggregator, which in turn registers hashes on the blockchain. It also makes the registered hashes publicly available so that anyone can verify the integrity of the document. It should be mentioned once again that only hashes of the documents are registered and publicly available, while the documents themselves remain in the DMS. Blockchain is not storing the documents or records and that is why this concept is usable even in the case of business-sensitive or classified documents or records.

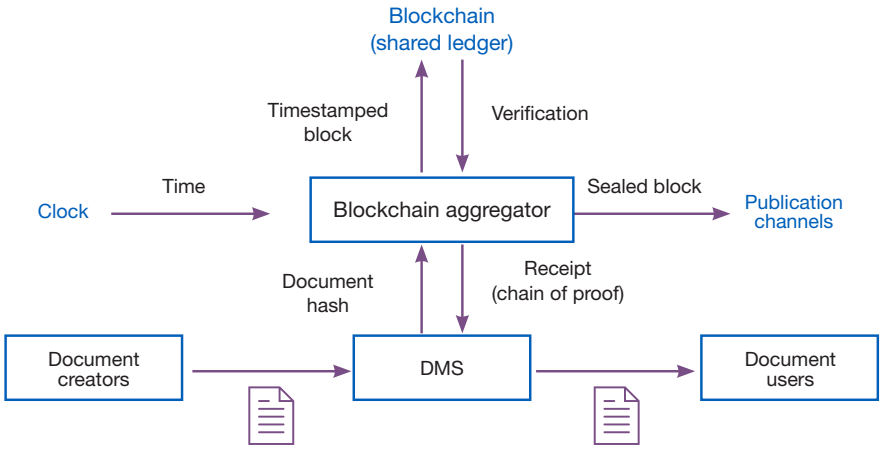

Figure 4. Connection of DMS to blockchain using blockchain aggregator

5. CONCLUSION

"Blockchain technology has attracted attention as the basis of cryptocurrencies such as Bitcoin, but its capabilities extend far beyond that, enabling existing technology applications to be vastly improved and new applications never previously practical to be deployed. Also known as distributed ledger technology, blockchain is expected to revolutionize industry and commerce and drive economic change on a global scale because it is immutable, transparent, and redefines trust, enabling secure, fast, trustworthy, and transparent solutions that can be public or private. It could empower people in developing countries with recognized identity, asset ownership, and financial inclusion" (Underwood, 2016). There are many blockchain applications that could transform society. Among them are blockchain-based financial services, smart property applications (e.g. registration of title to assets), smart contracts, applications in the healthcare or music sectors, notarization, tracking of provenance as well as e-government applications like public voting, identity management etc. Also, blockchain could find its use in establishing transparency of government and its communication with citizens.

In the context of document and records management, and taking into account all characteristics of the blockchain as well as its underlying technologies and concepts, it could be concluded that the blockchain can be used to:

- Confirm the integrity of a record,

- Confirm that a record existed or was created at a certain point in time (i.e. not after it was timestamped and registered in the blockchain),

- Confirm a sequence of records,

- Support/enhance non-repudiation of a record, and

- Improve the validation possibilities of digitally signed records during long-term preservation.

6. FUTURE WORK

Blockchain is in the process of fast-track standardization (started in April 2017) by the International Standardization Organization (ISO/TC 307) with the aim of supporting interoperability and data interchange among users, applications and systems. Also, CEN/CENELEC created a Focus Group on Blockchain and Distributed Ledger Technologies in order to identify specific European standardization needs in order to map these needs (including blockchain and DLT governance in the frame of General Data Protection Regulation – GDPR) with the current work items in ISO/TC 307 and to encourage further European participation in this ISO Technical Committee. The author has been appointed President of the Croatian ISO/TC 307 Mirror Technical Committee with the Croatian Standards Institute and will work on the standardization of blockchain terminology as a member of the ISO/TC 307 Terminology Workgroup.

Regarding the TrustChain model, future work will be focused on the full development of the model and on the creation of a working prototype.

7. ACKNOWLEDGEMENTS

The research presented here is part of a broader research study "Model for Preservation of Trustworthiness of Digitally Signed, Timestamped and/or Sealed Digital Records (TRUSTER Preservation Model)" which is part of the international multidisciplinary research project InterPARES Trust, http://www.interparestrust.org.

NOTES

1. *Croatian Encyclopedia* (Miroslav Krleža Institute of Lexicography, 2017)
2. The terms *electronic signature* and *digital signature* are often used interchangeably to mean the same thing. However, in this paper the term *electronic signature* will be used when referring to the signatures in which the identity of the signatory cannot be verified while the term *digital signature* will be used when referring to the signatures where the Certificate Authority (CA) confirms the identity of the signatory (except in the citations where the original terminology will be cited).
3. InterPARES Trust, http://interparestrust.org.
4. TRUSTER – Model for Preservation of Trustworthiness of the Digitally Signed, Timestamped and/or Sealed Digital Records https://interparestrust.org/assets/public/dissemination/TRUSTERPreservationModel(EU31)-Finalreportv_1_3.pdf
5. VIP – Validity Information Preservation
6. Enigio Time, https://www.enigio.com/
7. API – Application Programming Interface
8. ISO / TC 307, https://www.iso.org/committee/6266604.html
9. CEN and CENELEC's new Focus Group on Blockchain and Distributed Ledger Technologies (DLT), https://www.cencenelec.eu/news/articles/Pages/AR-2017-012.aspx

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RESUM

La cadena de blocs és una tecnologia relativament nova amb un gran potencial. Tot i que és més coneguda per ser la tecnologia subjacent a les monedes virtuals, pot tenir una gran influència sobre la gestió de documents. Els processos relacionats amb l'empresa i els organismes governamentals, com ara la signatura de contractes, els canvis en el cadastre o les votacions, poden millorar en l'entorn electrònic gràcies a l'ús de la tecnologia de la cadena de blocs. Podria augmentar la fiabilitat de l'intercanvi de documents, d'un nivell relativament insegur i poc fiable a un nivell nou, més segur i fiable. Una altra qüestió que cal tractar és la preservació a llarg termini de documents signats o segellats digitalment. Els certificats d'aquests documents solen vèncer al cap d'un període d'entre dos i cinc anys. Signar-los de nou o tornar a afegir-los un segell de temps pot resultar força complicat, però la cadena de blocs podria resoldre fàcilment aquest problema. Així doncs, l'autor investiga les qüestions identificades, informa de la recerca que s'ha dut a terme en aquestes línies en el marc del projecte internacional InterPARES Trust, explica els mecanismes que hi ha darrere els resultats que la recerca ha obtingut fins ara i suggereix accions que es poden emprendre per aplicar la tecnologia de la cadena de blocs a la gestió de documents.

Paraules clau: gestió de documents, cadena de blocs, signatures digitals, preservació a llarg termini.

RESUMEN

La cadena de bloques —o blockchain en inglés— es una tecnología relativamente nueva con un gran potencial. Aunque es más conocida por ser la tecnología subyacente a las monedas virtuales, puede tener

una gran influencia en la gestión de documentos. Los procesos relacionados con las empresas y los organismos gubernamentales, como la firma de contratos, los cambios en el catastro o las votaciones, pueden mejorar en el entorno electrónico gracias al uso de la tecnología de la cadena de bloques. Podría aumentar la fiabilidad del intercambio de documentos, de un nivel relativamente inseguro y poco fiable a un nivel nuevo, más seguro y fiable. Otra cuestión que debe tratarse es la preservación a largo plazo de documentos firmados o sellados digitalmente. Los certificados de estos documentos suelen vencer al cabo de un periodo de entre dos y cinco años. Firmarlos de nuevo o volver a añadirles un sello de tiempo puede resultar bastante complicado, pero la cadena de bloques podría resolver fácilmente este problema. Así pues, el autor investiga las cuestiones identificadas, informa sobre la investigación que se ha llevado a cabo en esta línea en el marco del proyecto internacional InterPARES Trust, explica los mecanismos que hay detrás de los resultados que la investigación ha obtenido hasta ahora y sugiere acciones que se pueden emprender para aplicar la tecnología de la cadena de bloques en la gestión de documentos.

Palabras clave: gestión de documentos, cadena de bloques, firmas digitales, preservación a largo plazo.

ABSTRACT

Blockchain is a relatively new technology with great potential. Although it is best known as the underlying technology of cryptocurrencies, it may have a profound influence on document and records management. Business and government-related processes, such as signing contracts, land registry changes, or voting, can be improved in the electronic environment by the use of blockchain technology. It could raise the reliability of exchanging documents and records from a relatively insecure and untrusted level to a new, more secure and trusted degree. Another issue to be discussed is the long-term preservation of digitally signed or digitally sealed documents. Their certificates usually

expire in two to five years. Re-signing or re-timestamping them might prove to be rather complicated, while the use of blockchain could solve this problem easily. Thus, the author investigates the identified issues, reports on the research carried out along these lines at the international project InterPARES Trust, explains the mechanisms behind the research results achieved so far, and proposes actions that may be taken to implement blockchain technology in document and records management.

Keywords: document management, records management, blockchain, digital signatures, long-term preservation.

RESUMÉ

La technologie de chaînes de blocs (blockchain) est relativement récente, mais elle présente un fort potentiel. Mieux connue comme la technologie permettant l'usage des cybermonnaies, elle pourrait influencer profondément la gestion des documents et des archives. Dans le monde numérique, les processus indispensables aux entreprises et aux administrations, comme la signature de contrats, les modifications d'enregistrement d'actes ou le vote peuvent être améliorés grâce à la technologie des chaînes de blocs. Cette dernière pourrait augmenter la fiabilité des échanges de documents et d'archives d'un contexte relativement peu sûr et peu fiable à un nouvel environnement, plus sécurisé et digne de confiance. Il convient également d'aborder la question de la conservation à long terme des documents signés ou cachetés numériquement. Leurs certificats expirent généralement au terme de deux à cinq années. Le renouvellement des signatures ou des cachets correspondants risque d'être très difficile, alors que les technologies de chaînes de blocs pourraient aisément résoudre ce problème. L'auteur étudie donc les problèmes identifiés, synthétise les recherches menées dans ce domaine par le programme international de l'InterPARES Trust, explique les mécanismes ayant conduit aux résultats obtenus et suggère des mesures qui pourraient permettre d'appliquer des technologies de chaînes de blocs à la gestion des documents et archives.

UNSUPERVISED MACHINE LEARNING FOR ARCHIVAL COLLECTIONS: Possibilities and limits of topic modeling and word embedding

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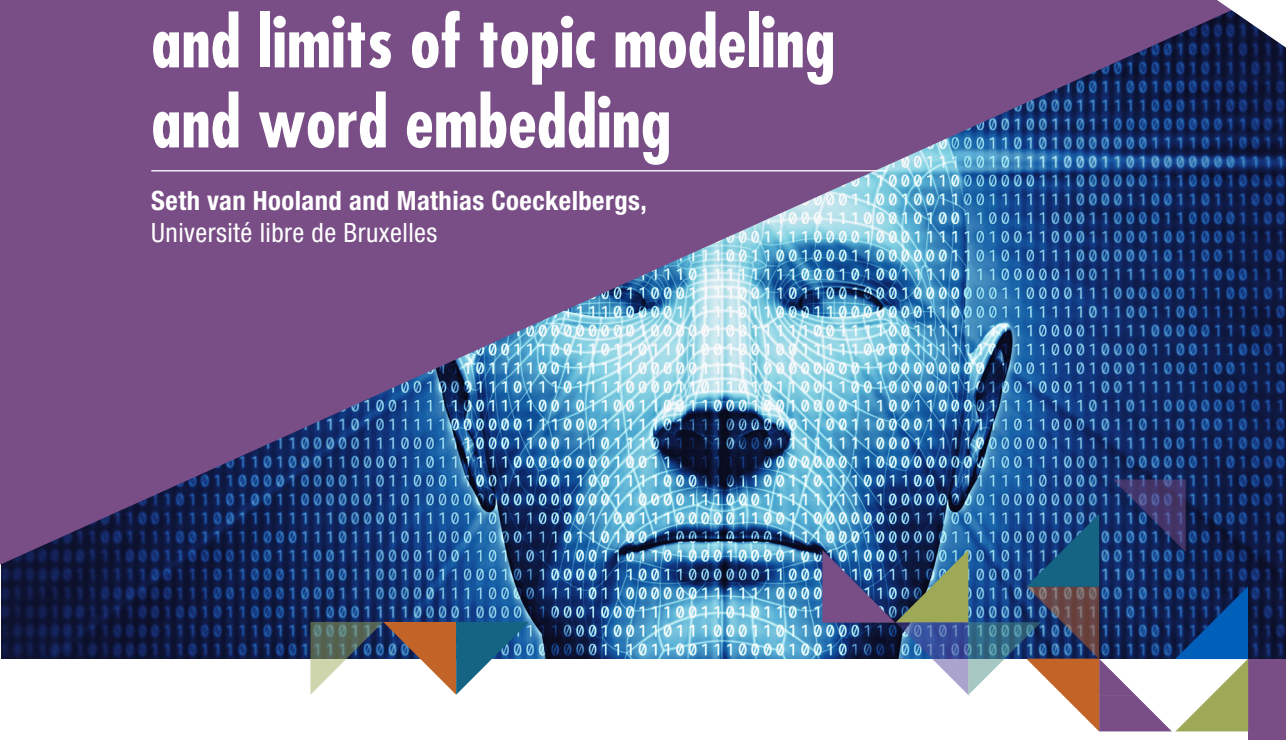

1. INTRODUCTION

From the detection of cancer to self-driving cars: if we may believe media such as the *New York Times*, artificial intelligence (AI) and machine learning techniques have the potential to automate a wide range of societal challenges[1]. Given enough content to analyze and practice on as a training set, algorithms can develop statistical models to replace decision-making ordinarily perceived as requiring human intelligence, such as driving a car in traffic or interpreting an X-ray scan. Commercial vendors, but also computer scientists, are currently waving the magic wand of statistics and machine learning to make sense of large volumes of non-structured archives. More and more data scientists are being hired to tap into content and metadata scattered across shared drives and legacy applications to discover trends and outliers for business intelligence. In this context, archivists can "function as a partner in the analytic process,

providing information about data's location, and improving the visual analyst's understanding and trust of data through explaining their context of creation, the history of their structure and semantics and their chain of custody" (Lemieux, 2014).

However, a lot of misunderstandings and false hope circulate among the archives and records management community on how we can use machine learning as a community[2]. This paper therefore wishes to give practitioners a better understanding of both the possibilities and limits of automation by focusing on two specific methods within the family of machine learning techniques: topic modeling (TM) and word embedding (WE). These machine learning methods are extensively used within digital humanities projects for the analysis of large non-structured corpora. The archival community is increasingly confronted with large volumes of non- or poorly structured content sitting on file servers with little to no metadata. As will be demonstrated in the case study, TM and WE allow results to be obtained relatively quickly, which then can be a trigger for thinking about the implementation of a linked data policy to create subject-based access spanning diverse holdings or to experiment with more complex and resource-intensive machine learning methods in regard to auto-classification.

In order to clarify some of the current confusion and vagueness regarding machine learning and automation, the first half of the paper develops a typology of the different approaches which have been in use for decades to automate particular aspects within the lifecycle of information. The latter half of the paper then focuses on a more detailed description of both TM and WE. In order to make the introduction to these techniques as pragmatic as possible, TM and WE are illustrated based on examples from an experimental case study on an archival corpus of the European Commission. The paper ends with ideas on how the results of TM and WE can be used as a stepping stone towards more subject-based access of large volumes of non-structured archives with the help of linked data.

2. AUTOMATING WHAT AND HOW?

Despite the ubiquitous usage of terms such as machine learning, semantic web or linked data, the archival literature has not yet provided much guidance on how these various approaches differ and how they might interact. The NARA

Directive's Automated Electronic Records Management Report/Plan has been a landmark document, acknowledging the necessity to embed automation as an essential aspect within a records management strategy[3]. The report distinguishes five different approaches to automation: no automation (manual management), rules-based automation, business process- and workflow-oriented automation, modular re-usable records management tools and auto-categorization.

The report provides a much-needed overview of the urgency of automation. However, NARA's typology mixes methods (manual, rules-based), implementation (modular re-usable records management tools) and functionalities (auto-categorization).

In order to clarify what automation methods can be used for what type of functionality, the next two sections will present an overview of how two different strands from computer science have the potential to make significant contributions to the archival community:

- **Rules:** based on an abstract model of the content and its application domain, decisions on content can be automated. NARA's Capstone approach to email is a simple example of this: from the moment someone reaches a certain position within the hierarchy of an organization, his or her email is automatically captured, for example.

- **Statistics:** based on an analysis of the content itself, making use of either supervised or non-supervised machine learning techniques. Auto-classification tools to categorize email as having business value or not, based on a training set, is a typical example of supervised machine learning.

Both approaches have their advantages and limitations, which will be pointed out. This article will focus on a presentation of machine learning, which falls into the "statistics" category. On the terrain, both rules and statistics can be combined, as will be discussed towards the end of the article.

2.1 DEFINING RULES: THE ROAD FROM ARTIFICIAL INTELLIGENCE TO RULES ENGINES AND LINKED DATA

Ever since the 1960s, the artificial intelligence community has developed methods to represent knowledge and algorithms which can infer new knowledge from a pre-defined set of rules. Rules-based systems require that the user define rules, so that the software can infer what to do in a certain situation. The danger of this approach is that if the rules miss a scenario, noise is generated as output, requiring ever more rules to be able to describe every possible scenario. In the 1980s, this strand of research culminated in the creation of the then-called expert systems. This type of software consisted of knowledge bases or ontologies containing a large amount of facts and statements connected by making use of formal logic. The drawback of this approach is the lack of adaptability: the system can only function based on the information it has. This implies that these systems can only be operational within well-delimited specialized application domains, such as a specific medical discipline. Also, the cost of creating and maintaining the rules tends to be prohibitive.

The complexity of developing and applying ontologies on a large scale across application domains has been illustrated by the difficulties of implementing the Semantic Web vision. Promoted by Tim Berners-Lee from 2001 onwards, the Semantic Web seeks to make information on the Web machine-readable by formalizing the meaning of data published on the Web through the use of the RDF data model and supporting ontologies. Due to the difficulty of implementing complex ontologies on a large scale, in 2006 Berners-Lee reformulated his vision to accommodate a more structured Web in a more pragmatic manner by rebranding the Semantic Web as the sum of linked data[4]. Throughout the 20th and 21st centuries, the library community has always been more advanced than the archival community in its level of data interoperability and technological developments. Therefore, it is interesting for archivists to observe how librarians have been implementing the linked data paradigm. For example, the Library of Congress has invested considerable effort in promoting Bibframe, a format which should allow the conversion of MARC files into RDF. Despite major efforts over the last few years, there is still no international consensus within the library world on the relevance and feasibility of the endeavor, due to the complexity of natively creating and maintaining very large volumes of data in RDF. The complexity of developing and applying ontologies is reflected in the efforts the archival community has made recently to gently head out into the linked data

territory. ICA has initiated the Records in Context (RiC) project, which aims to package the semantics of pre-existing ICA standards such as ISAD(G) and ISAAR(CDF) into one global ontology. An extensive comment on this project is outside the scope of this article, but Ross Spencer correctly points out the complexity of the approach by referring to the 73 potential record-to-record relationships (Spencer, 2017). The W3C's initiative under the name Architypes offers another approach, in the sense that the project tries to re-use existing mark-up from Schema.org and to limit the development of new definitions to a strict minimum. These are very much ongoing efforts and, for the time being, one cannot claim that there is one widely accepted manner of translating traditional archival finding aids into the linked data realm.

2.2 RELYING ON STATISTICS: MACHINE LEARNING

In the last two decades, we have seen a rise in not only the amount of data available and the volume of documents, but also in the variety of data types, complexity of sources and unstructuredness of information. This shift in the landscape has led to the rules-based methods which thrived in the 20th century becoming outdated at best and often even obsolete in the context of the surge of big data, leading Guruswamy to designate them "dinosaurs in the big data world"[5]. Hence, we see a shift from knowledge-driven methods to data-driven methods, which means that traditional rules are in general left behind, leaving room for statistical systems trying to find structure in the wealth of information available today. The tremendous advantage compared to the previous rules-based approach is that there is no need to develop an a priori model of an application domain, which is then used to apply the rules. Chris Andersons framed this change of paradigm boldly by stating that "with enough data, the numbers speak for themselves"[6].

When introducing machine learning algorithms, an important distinction has to be made between so-called supervised and unsupervised methods. Unlike the analogy with raising children, namely that first you develop methods of supervising them before they can acquire their own unsupervised methods of coping with the world, it is not the case that supervised methods would be prior to unsupervised ones in the development of machine learning. It is difficult to state where exactly machine learning practices have taken off, but many place it with Hebb's theory (Hebb, 2005), published originally in 1949, explaining the adaptation of neurons

in the brain during a learning process. Hebb describes an unsupervised process, known by the adage "cells that fire together wire together", which directly emphasizes one of the main characteristics of unsupervised methods, namely their bottom-up generation of results, whereby it is not known a priori which form the results will take. By contrast, for supervised methods we have to first give correct examples as training input, thereby determining the structure of the output in the number of categories we assign the input data to. It is therefore that one of the most important tasks of supervised learning is classification into a priori-designed categories, whereas that of unsupervised methods is clustering data together without knowing in advance what these clusters will represent. This makes unsupervised methods, among which topic modeling is one of the most prevalently used series of algorithms for textual data, suitable for dealing with large amounts of unknown data, to assist with tasks such as information retrieval or summarization. At the same time, it is evident that, since no "correct examples" are given to an unsupervised learning algorithm, evaluating the results is difficult, which will also become clear throughout the examples this article will present later on.

Over the last few years, the archives and records management community has almost exclusively experimented with supervised machine learning methods. For the past few years, large software vendors, such as OpenText for example, have been offering auto-classification tools that can automatically sort documents into predesigned categories. The software offers easy-to-use interfaces allowing records managers to select a test corpus, perform the manual classification of documents into a limited number of categories and then check the quality of the auto-classification based on sampling. However, vendors do not provide any benchmarking studies or clear methods to assess the quality of their tools in an objective manner. Vellino and Alberts published a recent and very detailed study on the possibilities and limits of automatically appraising email (Vellino, 2016; Hengchen, 2016). The article underlines the need to formalize the organizational context by conducting semi-structured interviews and cognitive inquiries, followed by a data analysis. Based on this input, an abstract classification model was built, consisting of two top-level categories: emails with and without business value, further divided into 13 sub-categories. This study makes it very clear that the application of auto-classification requires substantial efforts and is not as straightforward as vendors suggest.

As the application of supervised machine learning is not as straightforward as many believe, this article aims to highlight the possibilities of two unsupervised

machine learning methods for archival holdings: topic modeling (TM) and word embedding (WE). The term unsupervised is used because the process does not involve any pre-trained corpus. Let us first introduce topic modeling (TM), which has gained momentum over the last few years within the digital humanities to explore and interpret very large corpora of full-text documents (Klein, 2015). This generative probabilistic model clusters a determined number of keywords extracted from a document collection together in so-called topics. An example of a topic (topic 33 from our results) based on the archival holdings of the EC, which we will present in a moment, is the following cluster of ten terms:

Gas fuel energy electricity coal power
nuclear supply industry production

Upon reading the cluster of keywords, we understand that the subset of documents from our corpus with this topic probably address how the EC dealt with the usage and supply of energy resources. This example demonstrates the power, but also one of the problematic aspects of TM, namely the interpretation of the topics. As (Chang, 2009) has indicated, it is difficult to present objective standards to monitor which interpretations of the topic model are valid and which are not. The interpretational difficulty arises from the fact that it is psychologically attractive for humans to give a meaningful interpretation to a list of words they are presented with. Even when given several clear cases – which are often cherry-picked – we can see that a strong interpretation is sometimes possible, but it is difficult to discern where the grey area of interpretation is located. This results from an interpretational difficulty inherent in topic models, namely that we would like to find they represent concepts hidden within the text. Although we know that the clusters of keywords are merely a representation of their occurrence within the document collection, we expect them to correspond to clear-cut concepts. This is due to the distributional hypothesis within the field of linguistic semantics, which states that the meaning of a word is determined by the company it keeps. Expressed differently, this hypothesis understands words which occur in the same documents to have a semantic relatedness. In practice, topics are often difficult to interpret, as they cannot be mapped easily to one single concept, but rather as a combination of two or more concepts.

In contrast to topic models, which allow us to understand how documents are related to one another based on identified topics, word embedding (WE) is used to understand how words are related to one another semantically. The term was popularized by Mikolov's seminal paper (Mikolov, 2013) describing

Word2Vec, an online, freely available toolkit to either train WE on a corpus, or to use their pre-trained word vectors based on the Google Press corpus. Through a statistical analysis of a massive corpus, one can determine for example that the terms London and England have the same relation to one another as, for example, Paris and France. The algorithm is agnostic of the semantics of the relationship, just allowing us to monitor how these terms interact with one another in vector space, enabling semantic relationships like the aforementioned "is capital of" to be extracted. Due to the vectorial representation of these words, we can answer questions like "what is the capital of France?" by simply starting with the vector for "London", subtracting the vector for "England" and adding the vector for "France". The corresponding vector should lie closest to "Paris", hence answering our question correctly. Examples from an experimental case study will now demonstrate how an original method has been designed to apply WE to the results of TM, allowing the archival community to leverage the usage of unsupervised machine learning for archival holdings. Within this paper, the authors wish to give a global introduction and overview of the possibilities and limits of different machine learning methods for the archival community, without going into the details of a large-scale evaluation of the results.

3. 3. EXPERIMENTAL CASE STUDY: ARCHIVES OF THE EUROPEAN COMMISSIONQ

When and how did environmental considerations start to influence agricultural policy development at the European Commission (EC)? What are the key documents to analyze the debate on nuclear energy production from the 1960s onwards? These are two examples of typical research questions historians might have regarding the archival holdings of the EC. In this context, the mass digitization of the EC's archives offers new and exciting possibilities to query and analyze the archival corpus in an automated manner. However, there is a large gap between the promises made by big data advocates, who rely on statistics to discover patterns and trends in large volumes of non-structured data, and how historians can actually derive value from automatically generated metadata to explore archives and find answers to their research questions. Currently, researchers can only perform full-text queries in order to make sense of this massive corpus, as illustrated in Figure 1. In the context of a research

collaboration, the authors received a local copy of the corpus from the EC archives, allowing us to process and apply various machine learning methods.[7]

Figure 1. Search interface of the COM files of the EC archives, available at http://ec.europa.eu/historical_archives/archisplus/

3.1 DATA SET AND PREVIOUS WORK

The dataset, spanning a period ranging from 1958 to 1982, is multilingual: it contains documents in French, Dutch, German, Italian, Danish, English and Greek, as those were the then official languages of the what we now call the European Union. For this experimental case study, only the English corpus was taken into account, which represents a total number of 11,868 documents. In the context of the first exploratory study by Hengchen (Hengchen, 2016), latent Dirichlet allocation (LDA), which is the most popular TM algorithm, was applied to the corpus. As already mentioned, the dataset presents close to no metadata; apart from an XML file corresponding to each PDF and containing basic information such as a unique identifier, a creation date, the number of a reference volume and the language and title of the document, little additional information is given. There is no insight as to what the documents encompass in terms of topics and themes, which makes the dataset difficult for historians to use. In the context of this first exploratory study, the authors manually interpreted the topics, in order to attach a descriptor from the EUROVOC thesaurus. Figure

2 gives three examples of topics and the EUROVOC descriptors which were manually attached to the topics.

URI	label	tokens			
http://eurovoc.europa.eu/2965	agricultural aid	agricultural	areas	aid	measures
		premium	directive	number	eec
		farms	production		
http://eurovoc.europa.eu/852	ECSC aid	coal	steel	ecsc	aid
		industry	production	iron	decision
		measures	community		
http://eurovoc.europa.eu/1418	textile industry	fabrics	textile	woven	knitted
		crocheted	fibres	community	agreement
		products	yarn		

Figure 2. Manual labeling of TM results with Eurovoc.

It is important to underline that the authors in this first exploratory study were unable to attach a label to around 30% of the topics, due to either the very general nature of the terms (*e.g. agreement community parties negotiations*) or the fact that the authors were unable to find a semantic link between the terms (*e.g. lights bmw brazil eec coffee*). For some topics, OCR noise resulting in terms such as *cf, ii or ir* was the main cause.

However, the manual labeling of topics with descriptors from the EUROVOC thesaurus is of course suboptimal. One of the key problems is the interpretation of the clusters of terms which form a topic. Throughout the examples, one can sense that, in the majority of cases, topics do not point to one clear concept, but are often a combination of concepts. This aspect makes the manual labeling process inherently subjective and troublesome. Ideally, one would also want to perform an automated reconciliation process, as described in (van Hooland, Verborgh, De Wilde, & Hercher, 2013). Unfortunately, the semantic heterogeneity of topics also constitutes a stumbling block for this process, as there is no way to indicate in the reconciliation process how the different concepts within a topic should be tackled separately.

3.2 LEVERAGING WE TO BETTER ANALYZE TM OUTCOMES

As we have learned from the state of the art, TM can be viewed as a method to learn more about the topics addressed in a large corpus of documents, whereas (pre-trained) WE can be seen as a general, vectorial representation of language

itself, allowing us to understand the distance between words. In the context of his doctoral research, one of the authors designed an original methodology which brings together both sources of information[8]. As WE enables vectorial representations of language as a whole to be produced, this then allows us to estimate the semantic relatedness of terms found in the same topic. In other words, we wish to automate the identification of different concepts present in one topic.

We have found that two situations are present when applying word embedding to the results of topic modeling, which are dealt with in the following section. The results described below illustrate that some topics are used to mark a single concept, that is, topics as concepts, whereas others – and by far the largest amount of topics – are used to indicate a collocation of two or more concepts, which the paper will refer to as "topics as collocations".

3.3 RESULTS

LLDA was applied to the English-based subcorpus, as described above. The full results can be analyzed on Github. Within the data set, three different color codes are used, which help to visualize the following different outcomes of WE on the TM results:

- Terms in orange indicate a topic which represents one single concept.

- Blue and red are used to indicate the first and the second concept in a topic consisting of two different concepts.

- Terms in light-blue are terms that do not indicate a clear link with the terms from the topic surrounding them.

Using the vectorial representations of the key words within a topic, we discover that some topics indicate a general concept, represented by terms displayed in orange. A good example can be found in topic 17, indicating territorial authority. Since within our corpus the authority of several living structures are discussed, we discover them as terms in our topic, showing semantic relatedness, namely "community", "territory", "national", "country", "state" and "states". On the other hand, the different ways in which their authority can be discussed are found in the

words scoring highest in the semantic coherence hierarchy, namely “authorities”, “legal”, “rights”, “authority”, “undertakings”, “directive”, “provisions”, “rules” and “law”. We remark in passing that the words “authorities” and “authority” are not ranked next to each other, which we would expect for words having the same lexeme. However, in this case it is clear that both words have a vastly different usage, given that “authority” indicates the power of judgment and action a person or body possesses, whereas “authorities” can refer to this power as well as the institutions of authority themselves, such as the police department or the jurisprudential body.

In some cases, we see that the semantic coherence of terms is attested, but it does not pinpoint a clear concept. For example, in topic 31, the WE clusters together all ten terms, which are “vocational”, “labor”, “education”, “employment”, “health”, “social”, “migrant”, “worker”, “work” and “working”. One can assume that the topic relates to the social security of migrant workers, but the documents clustered under this topic might also relate more to the impact of education on the employment of migrant workers, for example.

This analysis brings us to the possibility that a topic is the collocation of two concepts, the first one represented in blue and the second one in red. This situation is by far more common than topics representing only one concept, depicted in orange. These collocations indicate that an important relationship between those two concepts exists, since they are prevalent throughout the document collection. Some clear examples of these collocations are found in the data. For example, topic 30 brings together two concepts, namely those of industry and studies. Hence, documents which have a high score for this topic can be attributed a high probability of dealing with industry studies, assessing the progress of markets and work. First, our methodology clusters together industry-related terms “project”, “development”, “market”, “industry”, “industrial”, “system”, followed by the study-related terms “study”, “survey” “data” and “statistic”. The concept of industry can be found multiple times within the topics. For example, next to topic 30, which we have just explained, in topic 33 we find the terms “industry”, “supply” and “production”, constituting the industry concept, which is collocated with the resources concept, expressed through the words “gas”, “fuel”, “energy”, “electricity”, “coal”, “power”, and “nuclear”.

However, WE does not always manage to group together terms from a topic into one concept. This is for example the case with topic 27. There are two distinct

concepts, the first one consisting of "price", "market" and "product", and the second one of "milk", "sugar" and "wine". Four terms are then displayed in light-blue, indicating terms which do not have a clear link with the terms from the topic which surrounds them: "production", "quality", "variety" and "marketing".

Based on the examples analyzed, there are definitely cases where WE does deliver a clear added-value to interpret the outcomes from TM. How can this help archivists? In future work, we plan to experiment with a reconciliation process between the terms from the topics and the EUROVOC thesaurus. The fact that we can automatically divide one topic into two different concepts will allow us to increase the relevance of the reconciliation results, as we will not be forced to automatically assign one label to a topic which actually represents two different concepts.

4. 4. CONCLUSIONS AND FUTURE WORK

AWith the help of an experimental case study, this paper has given a global introduction to the automation of archival holdings in general and the usage of unsupervised machine learning techniques in particular. With the exponential growth of digitized full text from archival holdings, the archival community needs alternatives to the manual creation of metadata. In the current hype surrounding the use of machine learning, most attention within the archival world is focused on how supervised machine learning methods can be used for auto-classification purposes. However, as was underlined in this paper, this approach requires a vast amount of expertise and resources in order to define a test corpus and to fine-tune the process during an iterative progression of testing the results. This paper therefore explored the possibilities offered by non-supervised methods such as TM and WE, illustrated with a real-life case study based on digitized archival holdings of the EC.

As the examples from the case study showcase, there are both reasons for enthusiasm and serious problem areas which underline the need for further work before archivists can actually start applying TM and WE on a large operational scale. Let us first start with the bad news. As already underlined in the existing literature from the computational linguistics domain, the interpretation of TM's results is complex and requires a manual analysis of how the various terms reflect a topic present in a large corpus. Also, the configuration of the k-parameter, the

number of terms per topic and the terms included as stop words all have a big impact on the results. The currently available scientific literature does not offer a clear examination of how these parameters affect the results, which underlines the "black box" character of the use of these methods. However, there are also enough reasons for archivists to keep a close eye on machine learning methods. By using WE, this paper demonstrated how the complexity of interpreting the outcome of TM can be simplified, as WE can help to automatically identify the different concepts hiding within one topic. This method holds the potential to facilitate at a later stage the automated labeling of topics with headings from a controlled vocabulary. Also, importantly, the method is language independent and can be applied across a wide variety of application domains.

All in all, this paper underlines the semi-automated nature of applying machine learning techniques. At crucial stages of the process, archival experts still need to make strategic decisions and intervene manually. We can therefore conclude that automation is a tool, and not a replacement for professional archivists.

NOTES

1. See articles such as https://www.nytimes.com/2016/10/17/technology/ibm-is-counting-on-its-bet-on-watson-and-paying-big-money-for-it.html.
2. We use the terms information governance and archives and records management interchangeably throughout this paper. The debate regarding the definitions and the exact boundaries of each discipline is outside the scope of this paper, but automation has a role to play in each one.
3. For a full overview of the report, please consult https://www.archives.gov/records-mgmt/prmd/automated-erm.html.
4. For a more in-depth overview of the development of linked data, please consult "Linked data for libraries, archives and museums" by van Hooland and Verborgh (Facet, 2004).
5. See http://bigdata.teradata.com/US/Articles-News/Data-Science--Machine-Learning-Vs--Rules-Based-Systems/.
6. See https://www.wired.com/2008/06/pb-theory/.
7. The dataset has been created following Council Regulation (EEC, Euratom) No 354/83 of 1 February 1983 concerning the opening to the public of the historical archives of the European Economic Community and the European Atomic Energy Commun ity. The legal text and all its amendments are available at http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1475395564392\&uri=CELEX\:31983R0354. After the signature of a Non-Disclosure Agreement (NDA), the MaSTIC research group of the Université Libre de Bruxelles obtained a 138.3-GB, 24,787-document corpus from the European Commission Archives.
8. Mathias Coeckelberghs is currently preparing an in-depth paper to present the usage of WE to interpret the results of TM.
9. The research results are available on https://github.com/MathiasCoeckelbergs/Concepts-

within-Topics.

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RESUM

L'enrenou que avui envolta l'aprenentatge automàtic ha provocat una nova onada d'esperança i entusiasme entre els arxivers, que fan servir algorismes per reduir el nombre d'intervencions manuals en la gestió i la valoració de grans volums de contingut no-estructurat. Els agents comercials promouen instruments ja preparats per a la classificació automàtica, però és tan fàcil integrar l'aprenentatge automàtic en un context de governança dels arxius i la informació com actualment s'assenyala en la premsa generalista i la bibliografia informàtica? D'altra banda, quina relació té l'aprenentatge automàtic amb el debat al voltant de l'ús de dades connectades per a les descripcions arxivístiques? En aquest article tenim l'objectiu d'aportar pragmatisme al debat sobre l'automatització de les descripcions arxivístiques tot oferint una descripció general de les possibilitats i els límits de l'aprenentatge automàtic des de la perspectiva arxivística. En l'àmbit de les humanitats digitals, dos mètodes han esdevingut considerablement populars: els models temàtics (MT) i els *word embeddings* (WE; representació de paraules com a vectors). En aquest article no només s'introdueixen aquests mètodes d'aprenentatge automàtic no-supervisat per al col·lectiu dels professionals de l'arxivística, sinó que també es demostra com es poden aprofitar els WE per interpretar els resultats dels MT d'una manera més efectiva, la qual cosa és una aportació innovadora. Per il·lustrar ambdós mètodes ens basem en un estudi de cas experimental dels fons digitalitzats de la Comissió Europea (CE).

RESUMEN

El actual revuelo en torno al aprendizaje automático ha provocado una nueva ola de esperanza y entusiasmo entre los archiveros, que usan algoritmos para reducir el número de intervenciones manuales en la gestión y la valoración de grandes volúmenes de contenido no estructurado. Los agentes comerciales promueven instrumentos ya preparados para la clasificación automática, pero: ¿es tan fácil integrar el aprendizaje automático en un contexto de gobernanza de archivos e información como actualmente se

señala tanto en la prensa generalista como en la literatura informática? Por otra parte, ¿qué relación tiene el aprendizaje automático con el debate en torno al uso de datos conectados para las descripciones archivísticas? En este artículo tenemos por objetivo aportar pragmatismo al debate sobre la automatización de las descripciones archivísticas ofreciendo una descripción general de las posibilidades y los límites del aprendizaje automático desde una perspectiva archivística. En el ámbito de las humanidades digitales, dos métodos han ganado considerable popularidad: los modelos temáticos (MT) y las *word embeddings* (WE; 'representación de palabras como vectores'). En este artículo no solo se introducen estos métodos de aprendizaje automático no supervisado para el colectivo de los profesionales de la archivística, sino que también se demuestra cómo se pueden aprovechar las WE para interpretar los resultados de los MT de una manera más efectiva, lo cual es una aportación innovadora. Para ilustrar ambos métodos nos basamos en un estudio de caso experimental de los fondos digitalizados de la Comisión Europea (CE).

ABSTRACT

The current hype surrounding machine learning has spurred a new wave of hope and enthusiasm amongst archivists, who are relying on algorithms to reduce the amount of manual intervention in the management and appraisal of large volumes of non-structured content. Commercial players promote out-of-the-box tools for auto-classification, but is the integration of machine learning within an archival and information governance context as straightforward as it is currently presented in both the popular press and computer science literature? Also, how does machine learning relate to the discussion regarding the usage of linked data for archival descriptions? This paper aims to bring a sense of pragmatism to the debate on the automation of archival descriptions by giving an overview of both the possibilities and the limits of machine learning from an archival perspective. Two methods have gained substantial popularity within the digital humanities: topic modeling (TM) and word embedding (WE). This paper not only introduces these non-supervised machine learning methods to the archival community, but also demonstrates how WE can be leveraged

to interpret the results of TM in a more meaningful manner, which is a novel contribution. Both methods are illustrated based on an experimental case study of digitized archival holdings of the European Commission (EC).

RÉSUMÉ

La forte médiatisation actuelle de l'apprentissage machine a fait naître de nouveaux espoirs et suscité beaucoup d'enthousiasme chez les archivistes, qui s'appuient sur des algorithmes pour réduire le nombre d'interventions manuelles lors de la gestion et de l'évaluation de gros volumes de contenus non structurés. Certaines entreprises proposent des outils clé en main pour la classification automatique, mais l'intégration de l'apprentissage machine dans un environnement d'archivage et de gouvernance de l'information est-il aussi simple que cela est actuellement présenté dans la presse grand public et la littérature de l'informatique ? Par ailleurs, comment l'apprentissage machine s'insère-t-il dans le cadre de la discussion sur l'utilisation du Web des données pour les descriptions d'archives ? Le présent article vise à contribuer au débat sur l'automatisation des descriptions d'archives avec pragmatisme en proposant un aperçu des possibilités autant que des limites de l'apprentissage machine appliqué à l'archivage. Deux méthodes ont énormément gagné en popularité dans le cadre des sciences humaines numériques : les modèles thématiques (topic modeling, TM) et le plongement lexical (word embedding, WE).
Après avoir présenté ces méthodes d'apprentissage machine non supervisé à la communauté des archivistes, le présent article démontre comment le plongement lexical peut être exploité pour interpréter les résultats d'un modèle thématique plus finement, ce qui constitue une contribution inédite. Les deux méthodes sont illustrées par une étude de cas expérimentale portant sur les archives numériques de la Commission européenne (CE).

Adheriu-vos a la declaració universal sobre els arxius!

A totes amb la DUA!

Associació d'Arxivers · Gestors de Documents de Catalunya