Embedded Humanities: The Khipu as Situated Information System

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Abstract

This paper examines the Incan ***khipu***, a pre-Columbian data-recording system composed of knotted cords, as a site for rethinking the epistemological and ideological assumptions underlying contemporary data infrastructures. Drawing on frameworks from feminist science and technology studies, postcolonial theory, and the history of computing, I argue that the ***khipu*** functions as a "situated storage" technology—an indigenous, distributed system of information encoding that both parallels and contests the logic of modern Western databases, particularly NoSQL and graph-based systems. By placing the ***khipu*** in conversation with the CAP theorem, the rise of NoSQL architectures, and the ideological work performed by computational abstractions, this paper develops a comparative critique of data logics: one that foregrounds embodiment, social relations, and political context over presumed universality and neutrality. Through close readings of theorists such as Wendy Hui Kyong Chun, Donna Haraway, and Jacques Derrida, I show how the ***khipu*** operates not only as a material technology of empire, but also as a counter-archive that resists the extractive and homogenizing tendencies of Western data regimes. In doing so, this study contributes to a growing body of scholarship that seeks to decolonize computation by elevating non-Western knowledge systems and reimagining what counts as data, logic, and storage.

"When designing distributed web services, there are three properties that are commonly desired: consistency, availability, and partition tolerance. It is impossible to achieve all three."[1]

The quote above is about an important challenge in contemporary computing. The paper in which the quote is published, *Brewer's Conjecture and the Feasibility of Consistent Available Partition-Tolerant Web Services* by Seth Gilbert and Nancy Lynch, explain and formalize the fundamental problems when dealing with large scale distributed data: that applications operating on *web-scale*[2], such as social networks or search engines could not expect a database management system to work as it did for traditional smaller-scale projects. To understand the nature of the problem in context, I look at the aforementioned paper, published in 2002. As Internet adoption and screen time increased in the early 2000s, the kinds of social and technical interactions on it proliferated as well. From a way to share static text, images, and links to other texts and images, the Internet started to become a site for interactive content production and consumer, as well business-to-business, commerce.

The role of the Internet expanded and data challenges multiplied. One, industry-focused, perspective on the challenges of data management was to think about changes in terms of three key concepts: *variety, volume, and velocity*[3]. This period was marked by a dramatic increase in all three of these concepts in regards to the web. As Internet users created their own content in the form of social posts, chain emails, or images, the sheer *volume* of data presented new challenges, not the least of which being where to store it all. To further

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[1] Gilbert, Seth & Lynch, Nancy. (2002). Brewer's Conjecture and the Feasibility of Consistent Available Partition-Tolerant Web Services. ACM SIGACT News. 33. 10.1145/564585.564601

[2] *Web scale applications use computing resources to ensure performance and functionality for millions of web users.* What Is Web-Scale IT? - Definition from Techopedia." Techopedia.com, www.techopedia.com/definition/31230/web-scale-it. Accessed 03 Dec. 2021.

[3] Laney, Douglas 3D Data Management: Controlling Data Volume, Velocity, and Variety. , META Group (2001).

complicate matters, user-created data has the potential to be far more diverse (increasing *variety*) than simple inventory logs or lists of users, which were more typical kinds of data stored at the time. Finally, Internet applications were not bound by local business hours, and this diverse data was now constantly being created and streamed to database systems, thus representing an unstoppable increased *velocity.*

As the increase in the *three V*s mentioned above put novel demands and strains on database systems, computer science researchers and industry programmers were desperate to understand and mitigate the challenges of what is now called big data. Assumptions which were previously taken for granted in database systems, such as the ability for all database users to get the most up-to-date content from the database (*consistency*) weren't true in this new ecosystem where data existed in different, distributed locales, often thousands of miles from each other. In some cases, even the expectation that a database system would be accessible at all is thwarted by problems of distributed data (*availability*). Finally, *partition tolerance* refers to the ability of a distributed database system to keep working after a part of it fails, or goes off-line. What Gilbert and Lynch's paper proves is the fundamental problem of handling data that is physically distributed. The conclusion is somberly that, when working with distributed data, you cannot assume the same rules as working with a single database, and thus have to give up socio-technical expectations which have become close to axiomized (getting the latest data, having the system be available, *etc*) in applied database systems. It is in this historical context in which NoSQL databases emerge, these databases, which I will return to later, were designed with polymorphic and distributed data in mind. Through new socio-technical expectations and mitigations, these databases represented a new context for data management, often invoking "practical compromise"[4] to deal with the impossibility of "commonly desired"[5] attributes in distributed data.

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[4] Gilbert, Seth & Lynch, Nancy. (2002). Brewer's Conjecture and the Feasibility of Consistent Available Partition-Tolerant Web Services. ACM SIGACT News. 33. 10.1145/564585.564601, 11

[5] Gilbert, Seth & Lynch, Nancy. (2002). Brewer's Conjecture and the Feasibility of Consistent Available Partition-Tolerant Web Services. ACM SIGACT News. 33. 10.1145/564585.564601, 1

Data management, however, is not unique to the computing age, nor Western societies. The Inca Empire, through invasion and economic influence, expanded greatly in the 15th and 16th centuries. At its height, it spanned over 2,500 miles and was composed of up to 10 million subjects[6]. The Incas spoke to each other in Quechua, which had no written component. However, like any large-scale organization, an empire needs to keep financial and operational records to manage and administrate across thousands of miles and millions of subjects. Additionally, Inca territory spanned diverse geographies: mountains, desert, and rain forest. Not only was mobility a concern in terms of distance, but also with regards to climate and terrain. The main data management tool used by the Incas in this endeavor was the khipu. The khipu is a portable recording device made of strings tied into cords (often cotton and llama wool) and strategically placed knots. It has been shown to document numerical and simple categorical data. It is also thought that khipus encode more complex data, such as categorical information, narratives, and military plans, however, more advanced encodings have not yet been deciphered. Due to the diversity of khipu components such as string color, ply direction, or color patterning, the potential for encoding complex and multidimensional data is high and motivates contemporary statistical and social science research[7].

Khipus have been found that likely represent credits and debits, as well as tax records, of the official Inca state. Khipus were deployed across the Inca Empire, known to its inhabitants as Tawantinsuyu (translated as the four parts together). In several cases, copies of data were stored at remote locations, with *masters* located in the Inca capital of Cuzco[8]. Khipus used knots, and their relative positions to each other to record numbers. All Inca Khipus found to date are believed to be using the decimal, base 10 system, however, older (pre-Inca) khipus

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[6] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 4

[7] See: Medrano, Manuel. "Khipu Transcription Typologies: A Corpus-Based Study of the Textos Andinos." Ethnohistory 68(2): 311-41. https://doi.org/10.1215/00141801-8801912.

[8] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 42

have been found using base 5, which Ashok Khosla finds intriguing because there is little usefulness gained using a base 10 system over base 5 "unless you like to quarter and half things. Doing 25%, 50% and 75% in base 5 is difficult. It's easy in base 10, where you have that factor of two built-in…"[9] The Incas indeed, as their empire name implies (the four parts together) were fond of halving and quartering things, from the capital city of Cuzco to granary buildings.

The transition from the use of base 5 to base 10 can be viewed as an example of how ideology can interpellate subjects, who internalize these modes' logics. Chun discusses this interpellation, a term borrowed from Althusser's discussion of the *Ideological State Apparatus,* using software as a (consciously) imperfect metaphor for ideology: "[software] interpellates a 'user': calls it and offers it a name or image with which to identify."[10]. However, as a large-scale data management tool, used for "political arithmetic"[11] the Khipu does seem to embody the same space as software does for Chun. Furthermore, mathematician Oliver Knill augments the case for viewing the khipu database software: "If one would compare the Khipu with files of modern computing, the analog of the internet was realized by Chaskis, the Khipu runners.[12]" The khipu enables a large-scale distributed data system. One often used to halve and quarter land, labor, and resources, and one which requires specialized labor to keep the recording and administrative system going. This labor is made easier by the use of a base 10, or decimal system. Thus, the switch from base 5 to base 10, although expressed as formal changes in a number system represents a socio-technical decision aimed at consolidating political power across

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[9] Khosla, Ashok. "Introduction." *Www.khipufieldguide.com*, www.khipufieldguide.com/notebook/Introduction.html#Cloth-as-a-Writing-Medium. Accessed 01 Dec. 2021.

[10] Wendy Hui Kyong Chun; On Software, or the Persistence of Visual Knowledge. *Grey Room* 2005; (18): 26–51. doi: https://doi.org/10.1162/1526381043320741, 43

[11] Urton, Gary. 2012. Mathematics and Accounting in the Andes Before and After the Spanish Conquest. In Alternative Forms of Knowing (in) Mathematics, ed. Swapna Mukhopadhyay and Wolff-Michael Roth, 17-32. Rotterdam: Sense Publishers. 19

[12] Knill, Oliver. The Inka Khipu Enigma. *https://people.math.harvard.edu/~knill/history/khipu/khipu.pdf* Dec 22, 2018

a distributed empire. As Donna Haraway notes, "it follows that politics and ethics ground struggles and contests over what counts as rational knowledge…in the exact, natural, social, and human sciences"[13]. Mathematician Marcia Ascher and anthropologist Robert Ascher describe the inevitability of bureaucrats and appear to strengthen Chun's argument that data technologies create subjects: "Hand in hand with massive construction, standing armies, and all the other attributes of the state, there is always a bureaucracy to administers its affairs"[14]. The Aschers' observation also supports Haraway's conjecture that "knowledge projects" ultimately owe their guiding structure to politics and ethics. Thus Khipu makers, known as Khipu-Kamayuqs[15] and those in charge of transporting khipus, Chaskis became necessary political actors in the Inca Empire. The identities and roles of the Khipu-Kamayuqs and Chaskis were motivated by technologies of political administration.

Khipu-Kamayuqs, always male, were trained in Cuzco and then sent throughout the empire, as political need dictated. Despite being subject to being moved around, the Khipu-Kamayuq was entrusted to "conceive and execute a recording [of data] in three dimensions with color… [and] worked with privileged information, so he was privileged."[16] The Khipu-Kamayuq was then, a numerate, highly educated person, who was privileged, but not among the elite who governed the Inca Empire and dictated which Khipus would be built. Furthermore, among the Khipu-Kamayuqs there was a hierarchy, with some working large khipus representing "larger units of organization within the Inca state" and others working on small khipus of local concern[17].

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[13] Harawy, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 587

[14] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 63

[15] Khosla, Ashok. "Introduction." *Www.khipufieldguide.com*, www.khipufieldguide.com/notebook/Introduction.html#Cloth-as-a-Writing-Medium. Accessed 01 Dec. 2021.

[16] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 62

[17] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 73

In contemporary society, there also exists a privileged, yet not necessarily bourgeoisie, type of information worker: the software engineer. Though not a state rule, most (now) tend to be men, and many work on web applications that do some sort of *political arithmetic.* From financial technology to bidding on governments contracts, software developers, like the Khipu-Kamyuqs, are important but "not as important as the *really important* men who held authority in the community" (emphasis mine) Archaeologists can confidently social place Khipu-Kamayuqs by studying their graves[18]; while today, a software developer's status is often tied to the prestige associated with how important or innovative their work is. Working directly with data and databases is more profitable and seen as more important than designing software interfaces, such as websites.

By the time Gilbert and Lynch's *Brewer's Conjecture* paper came out in 2002, software engineers, despite the professions' origin in associating itself with menial and thus feminized labor, were now important and male[19]. Here, Chun's discussion of software's interpellation helps underscore that technologies, from khipus to web-scale databases are created with users in mind, and without this user, the data is inaccessible. As social and financial trends increased the amount and types of data being created, (think of the *three V's* mentioned above) software engineers struggled with complex distributed data and started wanting more flexible, user-friendly options. Options that also corresponded with how data was being created and used in different ways than in the past.

The traditional way of storing data in computers is focused around the relational database model and Structured Query Language, known as SQL. In the relational model, software engineers must know how data will be structured ahead of time. Software engineers design tables with specific schemas, or templates, which pre-determine the data that is saved and searched (queried) in the table. Furthermore, to make relational

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[18] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 63

[19] Wendy Hui Kyong Chun; On Software, or the Persistence of Visual Knowledge. *Grey Room* 2005; (18): 26–51. doi: https://doi.org/10.1162/1526381043320741, 33

database systems efficient, it is often necessary to break up data in unintuitive ways, a process called normalization. As relational databases were designed for applications in which all data could fit in one location, working with distributed data caused unexpected problems in being able to access data efficiently, or at all[20].

While many relational databases evolved to try to meet the new challenges, and with varying success, the desire for fundamentally new ways of working with data also emerged. Thus, the image of the engineer who automatically uses relational databases was losing its dominance and no longer represented industry best practices. As Chun writes, one is not "aware of software's constant constriction and interpellation (also known as its "user-friendliness"), unless you find yourself frustrated with its defaults."[21] As data evolved to be more complex and distributed, software engineers found themselves at odds with its defaults, which directly impacted how they perform their labor. Relations databases proved to be not user-friendly for a large number of real-world data management challenges, and alternatives began to emerge. These databases, now collectively known as NoSQL databases, are built with contemporary issues, such as distribution and complex data forms, in mind. MongoDB, the most used NoSQL database, describes itself as a modern database that "supports a variety of workloads…programming languages, and cloud [environments]"[22]. MongoDB is based on an already popular web programming language, JavaScript. MongoDB, by using the existing, popular JavaScript also aimed at eliminating the need to hire software engineers to specifically work on databases. With the promise of needing to hire less specialized labor, it is perhaps no surprise that at the time of this writing, MongoDB has the largest

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[20] Harrison, Guy. Next Generation Databases: NoSQL, NewSQL, and Big Data. Appress. 2015. 22

[21] Wendy Hui Kyong Chun; On Software, or the Persistence of Visual Knowledge. *Grey Room* 2005; (18): 26–51. doi: https://doi.org/10.1162/1526381043320741, 43

[22] Why Non-Relational? Why MongoDB? https://docs.google.com/presentation/d/1eFGXUWjvW7CDJhdiUdFMjEJiNOuKzVVusfvpS3nNmJo/edit

market share of any NoSQL database, as high-level technological decisions, such as which database to use, are often based on fiscal concerns[23].

Aside from familiar techniques and cost-cutting methods, complex data analysis and highly networked data also spurred the development and use of databases that are founded on alternative mathematical models than those of relational databases. Graph-based databases, such as Neo4j, were developed to store and analyze data as a network of objects and their relationships. Graph databases are based on graph theory, a subset of mathematics that studies relationships between objects. They are also highly scalable and more performant than relational databases "if data structures are complicated"[24]

NoSQL databases emerged as a series of techniques to deal with complex and distributed data on the Internet and the khipu system was developed and iterated on to deal with the complexities of managing an empire at scale. As these technologies serve a general socio-political administrative purpose, but in vastly different contexts, in comparing each system's "semiotic technologies"[25] we can gain insight into the "politics and ethics" of each culture. Anthropologist Gary Urton, a khipu scholar investigates the Quechua number system, which was the basis for the khipu's numerical representation:

Numbers are not conceived of in Quechua ideology as abstractions whose nature and relations to each other rely on the predictions of pure logic, as in the West, Rather, numbers are conceptualized in terms of social—especially family and kinship…One consequence of their participation in social life is that all of the linguistic

[23] https://yalantis.com/blog/how-to-choose-a-database/

[24] Knill, Oliver. The Inka Khipu Enigma. *https://people.math.harvard.edu/~knill/history/khipu/khipu.pdf* Dec 22, 2018

[25] Harawy, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 579

formulations and grammatical constructions that are used to talk about inheritance, succession, dependence, and interdependence within a kin group…can be applied as well to number identities and numerical relations.[26]

So despite sharing the decimal system, Western and Pre-Colombian Quechua mathematics are based on fundamentally different understandings of what numbers can be. A familiar, post-Enlightenment position would celebrate Western abstraction, the reduction of numbers as the results of first-order logic. Quechua's association of numbers to social relations would be seen as the burden of specificity, while Western mathematics' numbers are universal and "promise transcendence"[27]. However, as Urton questions, could this burden of social relations also be a productive source of cultural insight into how a community thinks. Urton wonders if the cultural specificity of numbers in Quechua implies that the "Cartesian split between the real and ideal…represents an unnecessary sacrifice in our pursuit of the truth of mathematics." Certainly, Cartesian dualism brings about as many problems as it solves, so must our mathematics and data systems depend on it as a given? Urton would at least want to investigate further, while Haraway would not only find value in the Quechua number system's social ontology but perhaps even elevate it as an example of *situated knowledges,* as it "does not pretend to disengagement: to be from everywhere and nowhere, to be free from interpretation."[28] Quechua numbers and all they do are influenced by the social ties they can represent. It is this "partial view" which enables the connections and understandings which make situated knowledges productive: "Situated knowledges are about communities, not about isolated individuals. The only way to find larger vision is to be somewhere in

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[26] Nina Llanos, Primitivo, and Urton, Gary. The Social Life of Numbers: A Quechua Ontology of Numbers and Philosophy of Arithmetic. United States, University of Texas Press, 1997. 13

[27] Haraway, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 582

[28] Haraway, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 582

particular."[29] As data technologies are both produced by and enable modes of labor, a data system in which counting is inherently linked to community and social relations represents a model in which knowledge production is not subjected to Marx's notion of commodity fetishism. By being *situated,* the Quechua number system doesn't attempt to hide the social relations involved in producing knowledge.

A topic that is of great interest in the study of the khipu, aside from deciphering it completely, is whether or not the khipu counts as a writing system[30]. The khipu is distinct from speech, serves to preserve information, and fulfills many definitions of writing proper, but lacks the focus on inscription that is associated with written language. However, for philosopher Jacques Derrida, who in *Of Grammatology* uses writing as a tool to deconstruct linguistic and literary meaning, writing is used to "designate not only the physical gestures of pictographic or ideographic inscription but also the totality of what makes it possible…all that gives rise to inscription in general, whether literal or not"[31]. Derrida references Rousseau and Ferdinand de Saussure, a pioneer of semiotic linguistics, as proponents of the supremacy of speech over writing. Both Rousseau and Saussure view speech as more authentic than writing: "Writing is nothing but mere representation of speech" Derrida cites Rousseau from an unedited essay on languages[32]. Saussure pioneered the semiotic model in which a sign and meaning, in general, are constituted by the relationship between signified and signifier. Saussure viewed writing as derivative because it is a *re*presentation (emphasis mine) of speech, which has a more direct connection to the true meaning.

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[29] Haraway, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 590

[30] Cossins, Daniel. https://www.newscientist.com/article/mg23931972-600-we-thought-the-incas-couldnt-write-these-knots-change-everything/

[31] Derrida, Jacques. Of Grammatology. Baltimore ;Johns Hopkins University Press, 1998. 13

[32] Derrida, Jacques. Of Grammatology. Baltimore ;Johns Hopkins University Press, 1998. 27

While Derrida's signature technique is to use a text's logic to deconstruct it, the logic of the non-Western khipu also serves to problematize the distinction between writing and speech. Perhaps because Quechua numbers also represent social relations, there is no spoken word for zero. As numbers are supposed to able to be possessed and be possessed by other numbers, having a spoken term for zero would violate this important cultural norm, a problem roughly analogous to division by zero in our number system, in the sense that a value can be *undefined*. However, in a khipu, zero was visually represented by the lack of a knot on a cord at a specific location. Having a "written" term for a concept, or signified, which has no spoken word or signifier, thus refutes the view that writing is necessarily a derivative, less pure form of creating meaning than speech. Much like Haraway's privileging of feminist partial views as objective and grounding, applying deconstruction in the service of uncovering postcolonial logic works by underscoring the politics and ethics behind knowledge production and its labor. That zero exists in speech's supplement, but not speech itself contradicts the hierarchy upon which Western notions' of signification rely.

The khipu is conceptually similar to a class of NoSQL databases known as graph databases. Graph databases, mentioned earlier, utilize the mathematical rules of graph theory, developed in the early 17th century, to quickly and efficiently store and analyze highly complex, networked, information. Graph databases are highly scalable, for example, Neo4j, markets itself with the following: "high-performance distributed…architecture scales with your data and your business needs in real-world situations, minimizing cost and hardware while maximizing performance across connected datasets"[33]. The ability to add additional data quickly is prioritized when developing graph databases because they are meant to deal with complex, and dynamic data[34]. The khipu could also be easily scaled, the addition of a cord can extend the dimensionality or scale of the dataset. While researchers from across disciplines continue to discover new insights from khipus,

[33] https://neo4j.com/product/neo4j-graph-database/scalability/ Accessed 03 Dec 21

[34] Harrison, Guy. Next Generation Databases: NoSQL, NewSQL, and Big Data. Appress. 2015. 67

contemporary databases are, for the most part, well documented, which means that their functionality and use cases are available for reference. For example, Neo4j, as a graph database, is often used to store and analyze network data, such as social relationships. A central tenet of network science is that of homophily, often described as the doctrine *that similarity breeds connection*. Homophily is used to recommend social connections as well as content and products on social networks and commerce platforms. Homophily was normalized, however, by a 1954 study on racially segregated housing communities in which only white residents' responses were used for analysis[35]. That segregated housing was used as the model for studying natural connections among people, ignores the socio-technical, ethical, and political decisions involved in the construction of a segregated community, as well as how this planned culture of segregation may contribute to homophily as a "self-fulfilling prophecy"[36] interpellating subjects who prefer to live under institutional racism. Software applications, by expecting homophily, can through recommendations, contribute to the creation of segregated echo chambers. Prior to the emergence of NoSQL databases, complex data operations such as homophily-based friend recommendations would have to be programmed explicitly by software developers, who would need at least a superficial understanding of the ideas being deployed. However, Neo4j, an effort to be more user-friendly to the software engineer subject, has functionality built-in (pre-written code) which "allows [the Neo4j database system] to capture homophily or structural equivalence"[37]. By making it easier for software engineers to use homophily, enterprise database companies may create polarized online communities, instead of enabling connection. While there are no official documentation sites for the khipu, through statistical

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[35] Kurgan, Laura, et al. "Homophily: The Urban History of an Algorithm - Architecture - e-Flux." *e*, https://www.e-flux.com/architecture/are-friends-electric/289193/homophily-the-urban-history-of-an-algorithm/

[36] Ibid.

[37]" Graph Embeddings - Developer Guides." *Neo4j Graph Database Platform*, https://neo4j.com/developer/graph-data-science/graph-embeddings/.

and data science-informed methods, there is still hope to uncover embedded ideologies in the khipu recording system.

While I position the logic of the khipu as a means to critique the West's neocolonialist project, I do not seek to impose the Rousseau-style "god-trick"[38] and declare the Incan or pre-Colombian civilization noble savages, or human blank slates. Many *privileged* Khipu-Kamayuqs were conscripted from defeated tribes, and, while Inca governance allowed for some form of multiculturalism within the empire (local deities could still be worshipped as long as Inca gods were also worshipped and local governance structures were kept if they did not interfere with Inca state affairs), the Inca Empire expanded primarily through military conquest. Thus some of the political arithmetic performed using khipus must have been in service of colonizing neighboring communities[39]. I mention this not to imply that the West and colonized indigenous cultures are, in actuality, on the same footing, since both partake in colonization, but to avoid the trap of cultural relativism, which, as Haraway states, promises "vision from everywhere and nowhere equally and fully"[40]. I choose to compare these two data systems to learn about and investigate the ideological assumptions behind contemporary data systems currently in use in the West and investigate alternative data practices and their ideological implications.

While theories of difference may be productive and exciting, fundamentally different models of computing may not be the only insightful discovery, as Urton writes: "even if we do find a philosophy that does not disturb mathematical truths on our (Western) theorems, but does allow us to link mathematic, cultural

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[38] Haraway, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 584

[39] Ascher, Marcia, and Robert Ascher. Code of the Quipu: A Study in Media, Mathematics, and Culture. Ann Arbor: University of Michigan Press, 1981. Print., 54

[40] Haraway, Donna (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14 (3):575-599, 584

values, and social organization…why not peruse that philosophy…to discover what we can learn"[41] While khipu studies is a growing field, it is important to not allow the contemporary logic uncritical celebration of tech to validate the khipu because it is similar to important computing and software technologies. While both the khipu and NoSQL databases are used in similar contexts, identity-blind "technoliberalism", which is a dominant ideology of contemporary society, threatens to erase the specific social and material relations that guide Inca and contemporary globalized data management axioms.

Conclusion

The adoption and deployment of the Khipu as a means to manage the growing Inca Empire draw interesting parallels with the emergence of modern, multipurpose, NoSQL databases. By comparing the internal structuring schemas of the khipu and graph-based NoSQL databases, we can gain insight into ideological assumptions made in the deployments of either technology. Using the khipu to frame a conversation around non-Western or indigenous computing enables us to critically examine our techno-social data environment, from Haraway's "objective" standpoint. As the khipu provided a privileged position to analyze our own Western data management systems, khipu studies cannot be one-sided. Discussion of indigenous technologies cannot just be used for benchmarking Western ideologies but must serve to elevate indigenous frameworks and knowledge systems.

[41] Nina Llanos, Primitivo, and Urton, Gary. The Social Life of Numbers: A Quechua Ontology of Numbers and Philosophy of Arithmetic. United States, University of Texas Press, 1997. 19