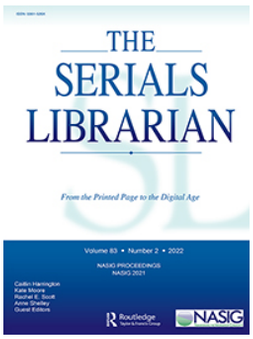

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Visual Research Discovery Using Connected Papers: A Use Case of Blockchain in Libraries

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Visual Research Discovery Using Connected Papers: A Use Case of Blockchain in Libraries

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ABSTRACT

The present study aims to highlight the features of Connected Papers, a visual tool that can help researchers find and explore academic papers in their literature search. The authors describe how Connected Papers allow to create a network of all the literature available related to a chosen paper. One can use Connected Papers to pull together related papers on a chosen topic and see prior and derivative works based on that topic. Using the Connected Papers tool authors attempt to visualize the key literature on the topic "Blockchain in libraries." To date, most Blockchain technology applications in libraries are still in the conceptual stage. However, sooner or later, the development and implementation of the technology are expected to facilitate the transformation of how libraries provide services and organize information. This study contributes to examining the research being done to explore the potential of Blockchain technology in libraries through mapping and visualization. The paper is original in terms of the Visual tool used "Connected Papers."

KEYWORDS

Connected papers; blockchain; research visualization; literature mapping

Introduction to Connected Papers

The traditional way of searching the database was using keywords and citation links to find the relevant papers for the research. Then, a few years back, a new tool has come up named Scite for providing graphs based on visualization of citation links to make the discovery of literature review more intuitive and interactive. Recently Connected Papers as a literature mapping tool has been invented by three Israeli researchers Alex Tarnavsky, Eitan Eddie Smolyansky and Itay Knaan Harpaz which was made freely available to the public in June 2020. They keep in mind the tiresome problem of searching a depth literature review by the researchers. Connected Papers is a unique, visual tool to help researchers and applied scientists find and explore papers relevant to their research field. It can be further used to try to find "Prior" and "Derivative works" (basically seminal works and survey/review papers) but other than that it is a remarkable simple tool with few options. Connected Papers also build the graphs based on the origin paper; however, its graphs are not citation maps but construct upon the strongest connections using a similarity metric. That means it may discover those related papers that could not be found via keywords or citation searches. It has come up as a powerful tool to help researchers and applied scientists explore relevant papers in a clearer visual way. Connected Papers analyses about 50,000 research papers to select a few dozen of the most cited papers for the user to peruse which are relevant and related to the origin paper and that have the strongest connection with it. Each research paper is represented by a circle, with similar papers clustered together in space and connected by strong lines. Less similar papers often clustered in their own groups are presented

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farther away in space. More frequently cited papers are represented as larger circles, and more recent papers are represented by a darker colour.[1]

Blockchain Technology

Blockchain is the core technology behind the creation of the crypto currency, Bitcoin, through the maintenance of immutable distributed ledgers in thousands of nodes proposed by Satoshi Nakamoto in 2008.[2] Blockchain 1.0 has been moved to Blockchain 3.0 since 2008. Blockchain 1.0 is referred to as the digital currency, Blockchain 2.0 bring up as digital finance and Blockchain 3.0 is raised as a digital society. It consists of a list of records termed as blocks that store data publicly and in chronological order. The information is put into code using cryptography to ensure that the privacy of the user is not compromised, and data cannot be altered.

Any kind of information could be shared via a Blockchain transaction. Libraries could share patron information with other libraries with these agreements. Schools or universities could share student information with other institutions using Blockchain. Wherever there is a need to exchange sensitive information that requires encryption, Blockchain technology may be a solution. In general, a Block consists of three things: Data, Hash, and Hash of the previous Block. So, every Block in a chain consists of a cryptographic hash of its own as well as of the previous one to stay connected in a chain. A hash is a unique alphanumeric number that is being calculated based on; Data of its own, a hash of the previous one, and its timestamp.[3]

Blockchain is a system of recording information in a safe and secure manner that has made it difficult to change, hack, or cheat the system. A Blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain. Each Block in the chain contains a number of transactions, and every time a new transaction occurs on the Blockchain, a record of that transaction is added to every participant's ledger. The decentralized database managed by multiple participants is known as Distributed Ledger Technology (DLT). Blockchain is a type of DLT in which transactions are recorded with an immutable cryptographic signature called a hash.[4] Blockchain technology is basically a shared database filled with entries that are confirmed and encrypted. A distributed ledger is simply a database that exists across numerous positions or among multiple participants. In order to add a Block into the chain, users must create a new wallet by generating a public key and a private key. This key is generated through asymmetric encryption. The public key can be shared to have a transaction, but the private key is meant to be kept secret. When any transaction happens on the Blockchain, that transaction is recorded in a block, and that block must be validated before adding it into the chain. The authenticity of a block must be verified through a consensus algorithm (proof of stack) in which the majority of nodes, as well as the nodes having the highest stack in the chain of the distributed network, must validate the block before adding to it in a chain. After the validation of the block, a unique, identifying code is generated, called the hash. By doing this, we do not need any third-party interference to validate or to do transactions.

Selected Potential Use Case for Blockchain by Libraries

Digital preservation and tracking; community-based collections to share objects, tools, and services; Blockchain-based currencies for international financial transactions; inter-library loan and voucher systems; library verification of credentialing (information literacy); library cards; archives/special collections where provenance and authenticity are essential; corporate library record keeping; and organizational data management of intellectual property for R&D.

Concluding remarks: Factors involved in implementing Blockchain in libraries:

- Project management: There are different factors which should be kept in mind while launching Blockchain projects such as programmers, project management team, and visionary staff from libraries.
- Resources and finance: Before launching Blockchain technology, proper resources, and finances are required. A Blockchain solution for data alignment might be affordable and feasible if libraries have sufficient funds for the project.
- Problem solution: Before implementing Blockchain technology, libraries night keep the solution to each problem in mind, libraries should train people inside instead of relying on third parties. Keep private or sensitive data secure with the help of decentralized mechanisms.[5]

Scope and Objectives

The scope of this study is to visualize the key literature on the topic "Blockchain in libraries" for which the powerful research visualization tool Connected Papers is used that helps in re-imagining the knowledge economy, empowering researchers with powerful techniques, and building communities of the future. For the present study, the topic "An Introduction to the Blockchain and Its Implications for Libraries and Medicine" is selected among the multiple papers shown by the literature mapping tool Connected Papers. The major area of this research work is the use of "Blockchain in the libraries."

Research Design Approach

Citation-based literature mapping and exploration app/tool Connected Papers (CP)[6] has been used in this study to explore the research on usage of Blockchain in libraries. CP accepts one or more relevant seed papers and uses various techniques (mostly citation-based) to recommend new ones that are similar to be added.

CP produces the map visualization of research corpus pertaining to Blockchain in Libraries through a graph containing scientific publication records, title, year, citation, as well as authors, Graph citation. CP suggests "Prior Work" (Which are referenced prior work) And Derivative Work (recent studies – papers that cite selected paper) other than those already in the collection list. The search keyword used was "Blockchain in Libraries" and the paper "An Introduction to the Blockchain and Its Implications for Libraries and Medicine" was selected as a seed paper from among the results retrieved.

Rem_note do all the Metadata collection automatically. In the graph, papers are arranged according to their similarity score. That means that even papers that do not directly cite each other can be strongly connected and positioned close to each other in the graph. Its graph is designed to make the important and relevant papers pop out immediately. Finding an important new paper in any field is as easy as identifying the dark large node at the center of a big cluster. With the layout algorithm, similar papers cluster together in space and are connected by stronger lines (edges). Popular papers (that are frequently cited) are represented by bigger circles (nodes) and more recent papers are represented by a darker colour.

Research and Discussions

Each node is an academic paper related to the origin paper. Papers are arranged according to their similarity. Node size represents the number of citations while its colour, the publishing year. Strong connecting lines and cluster together reflects similar papers. In the graph, papers are arranged according to their similarity. Even papers that do not directly cite each other can be strongly connected and very closely positioned. In the subsequent discussions, a similarity metric is based on the concepts of both Co-citation and Bibliographic Coupling which is based on the presumptions that two papers that have highly overlapping citations and references have a higher chance of treating a related subject matter. Based on above algorithm, a Force Directed Graph is built to distribute the papers in a way that visually clusters similar papers together and pushes less similar papers away from each other. Upon

node selection, the shortest path from each node to the original paper in similarity space gets highlighted. The Connected Papers (CP) database is connected to the Semantic Scholar Paper Corpus compiling hundreds of millions of published papers across many scientific fields. Once the graph of similar papers has generated, the "Prior Works" button or the "Derivative works" button are available to detect and analyse seminal works or review/survey papers, respectively.

Creating Graph with Seed Paper

Paper identifier gives five options to directly add seed papers: DOI, the paper's title, or the paper's URL from arXiv, PubMed, or Semantic Scholar (Figure 1). The search query with the keyword "Block-chain in Libraries" was executed on CP database to retrieve research focused on Blockchain, how it is currently being used, potential future uses that may be of interest to librarians and medical professionals, and some of the problems and barriers to implementation facing Blockchain systems. Out of the search results retrieved through this query, the paper titled "Application of Blockchain in Libraries and Information Centres" authored by Dr. Matthew B Hoy in 2017 was selected as the "Seed paper" (Figure 2). The visualisation of the seed paper is shown in Figure 3. Connected Papers builds a graph that consists of 100 papers containing similarity with the seed paper (Figure 4).

Graph History

Figure 5(a) is the visualization of the original paper (seed paper), "An Introduction to the Blockchain and Its Implications for Libraries and Medicine" (2017), authored by Matthew B Hoy having networked with the other associated papers with similar scope (Blockchain in libraries). As the paper database grows and citations keep on adding, the graphs for each paper are changed and evolved over time. The bar changes its colour (light blue to dark blue) to reveal the evolution of the research area of Blockchain in libraries from 2016 to 2022 i.e., from old to new ones connected to papers related to the original paper (seed paper).

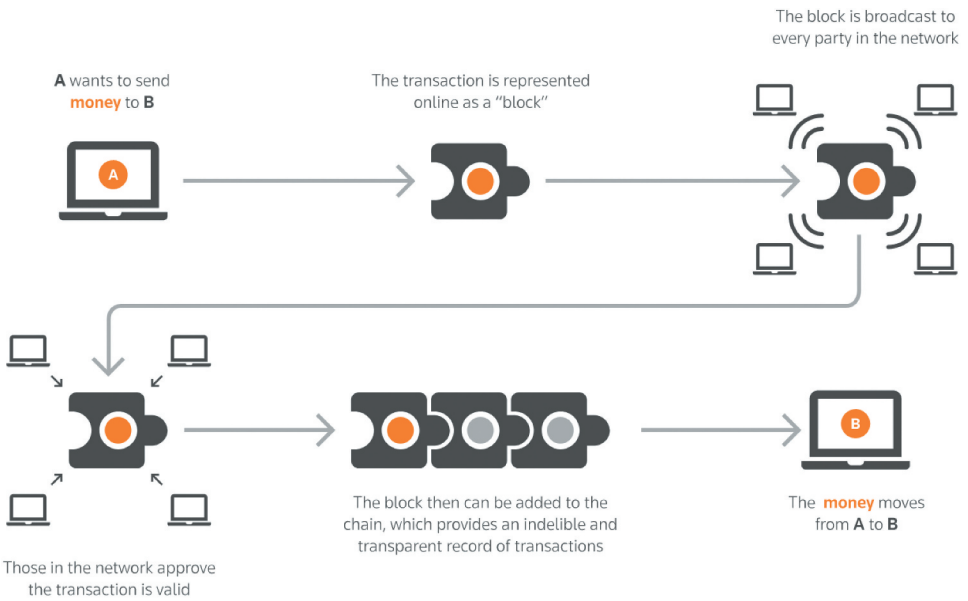

Figure 1. Blockchain technology working. Source: https://savvycomsoftware.com/wp-content/uploads/2018/09/how-blockchain-works1.png13

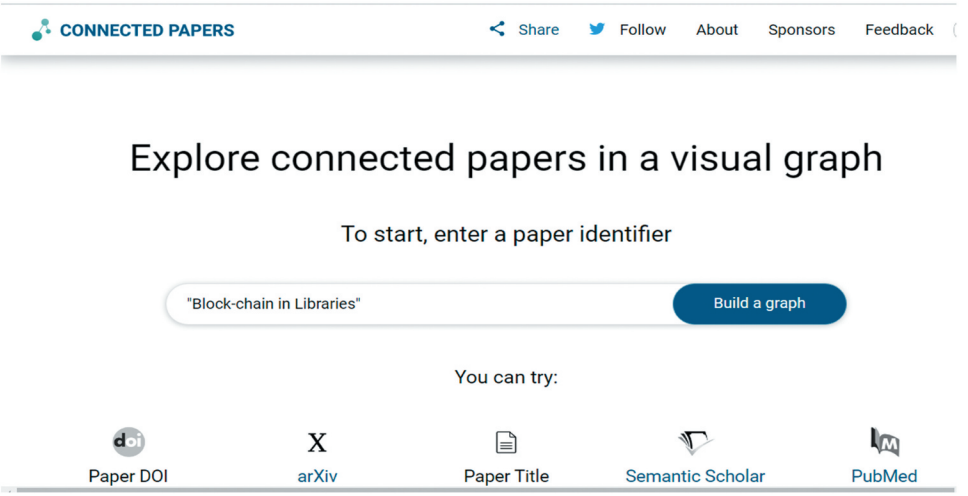

Figure 2. Exploring connected paper.

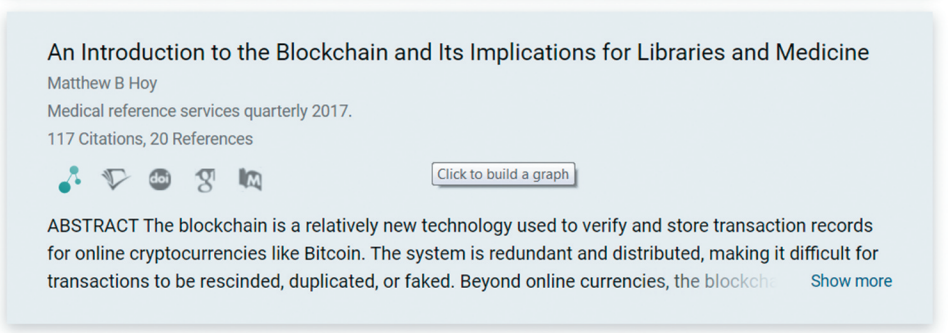

Figure 3. "Showing paper suggestions for Block-chain in Library."

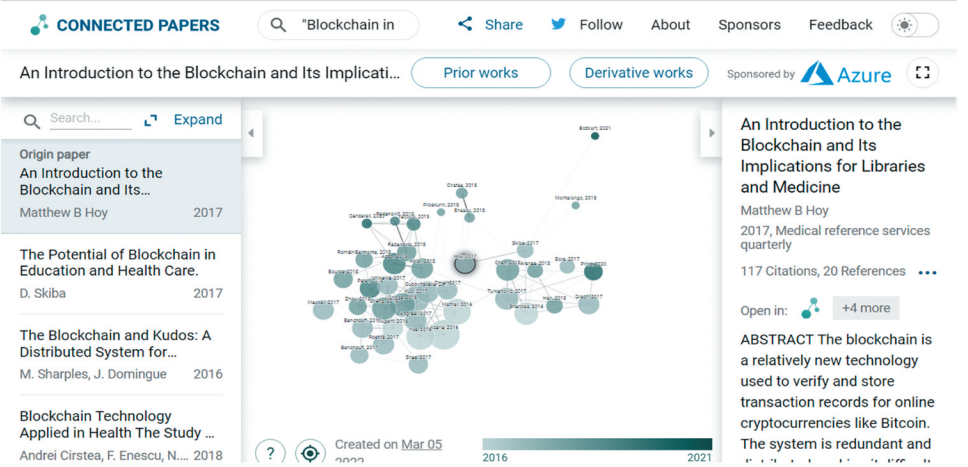

Figure 4. Graph of seed paper.

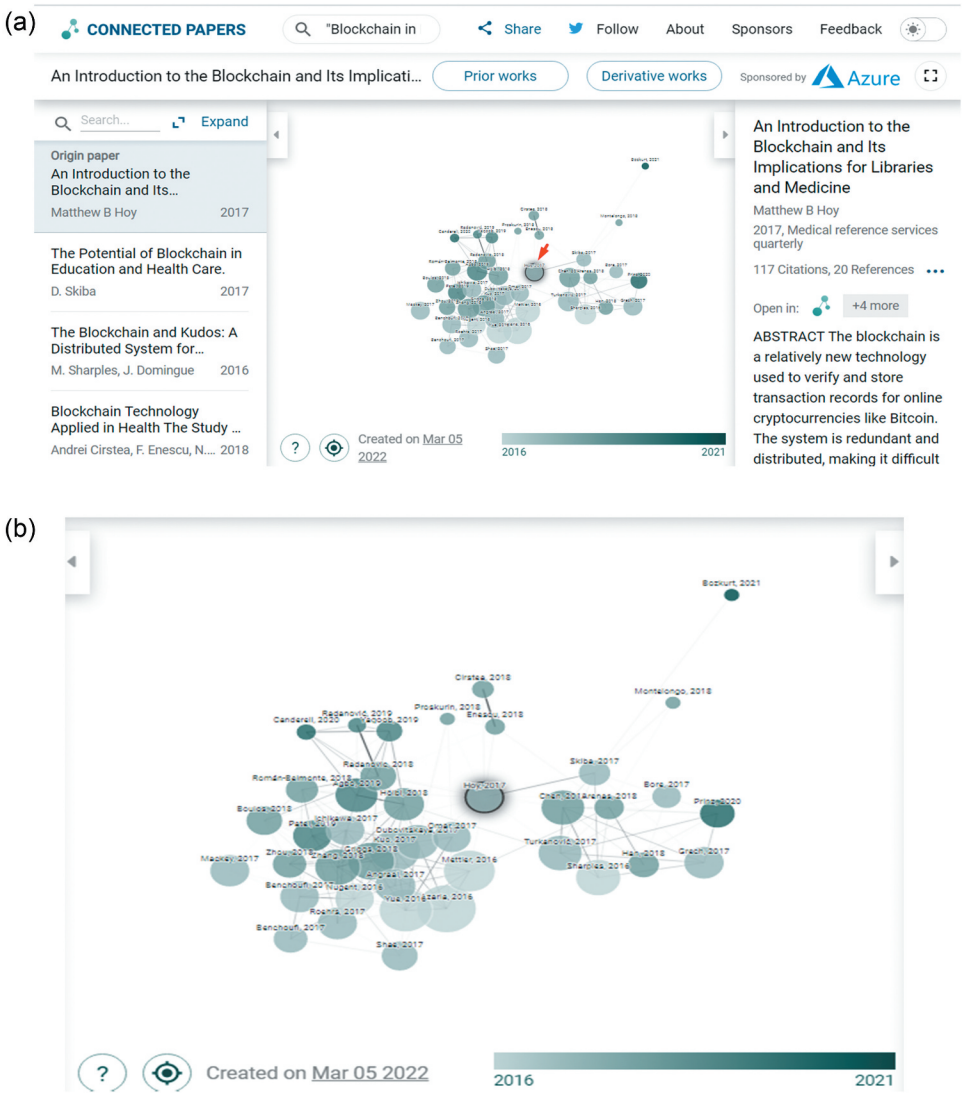

Figure 5. (a) Graph history of the seed paper. (b) Magnified view of the seed paper.

The resulting graph has included 41 publications, with the earliest one in 2016. The largest circle in the graph represents the paper of Asaph Azaria titled, "MedRec: Using Blockchain for Medical Data Access and Permission Management."

Figure 5(b) represents the magnified view of the seed paper (Figure 5(a)). Above research mappings displayed through a network, kinks include a total of 41 publications in two clusters of papers arranged based on similarity. The proximity of clusters of nodes implies that they are similar. In the graph, highly similar papers have stronger connecting lines and tend to cluster together. The colour of each paper depicts the chronographs of every paper. A dark node indicates that the paper is new and conversely faded nodes stand for relatively old papers. Each node is a research paper related to the seed paper. The size of a node represents the number of citations. "Outliners," such as "Aras Bozkurt, Hasan Ucar, 2021," might carry an approach to the topic different from the rest of the group as it is shown far away (isolated) from the rest of the cluster of authors. His paper "Blockchain Technology as

Table 1. Top 10 similar papers.

SN	Title	Authors	Year	Citations	References	Similarity to Origin
1	The Potential of Blockchain in Education and Health Care.	D. Skiba	2017	62	2	23.9
2	The Blockchain and Kudos: A Distributed System for Educational Record, Reputation and Reward	M. Sharples, J. Domingue	2016	320	19	10.2
3	Blockchain Technology Applied in Health the Study of Blockchain Application in the Health System	Andrei Cirstea	2018	7	10	10.1
4	Improving Data Transparency in Clinical Trials Using Blockchain Smart Contracts	Timothy Nugent, D. Upton, M. Cimpoesu	2016	170	11	9.9
5	Blockchain Technology Applied in Health the Study of Blockchain Application in the Health System	F. Enescu, C. Stirbu	2018	3	12	9.9
6	Opportunities for Use of Blockchain Technology in Medicine	Igor Radanovic, R. Likić	2018	120	38	9.6
7	Exploring Blockchain Technology and Its Potential Applications for Education	Guang Chen, N. Chen	2018	270	23	9.3
8	Blockchain Technology in Healthcare: The Revolution Starts Here	M. Mettler	2016	599	16	9.1
9	Mogućnosti upotrebe blockchain tehnologije u medicini	Igor Radanović	2019	1	36	8.8
10	MediBchain: A Blockchain Based Privacy Preserving Platform for Healthcare Data	A. Omar, S. Kiyomoto	2017	145	9	8.5

a Bridging Infrastructure among Formal, Non-formal and Informal Learning Processes" suggested that "Blockchain technology can be used to connect and interlink different educational experiences that occur in different educational modalities, enabling to evaluate educational processes holistically and thus promote lifelong learning through the use of cutting-edge technologies." His work is different in the sense that other authors have discussed the use of Blockchain technology in education, medical healthcare, clinical trials, and medical data access while Aras Bozkurt, Hasan Ucar has covered only the use of Blockchain technology in the education field only.

Similar papers

Table 1 describes linked network formed out of the seed paper and related papers with details including the name of authors, the year of publication, citations, and references along with similarity score.

It is clear from the above table that the paper "The Potential of Blockchain in Education and Health Care" written by D. Skiba has the highest similarity of 23.9% to the origin paper with 62 citations and two references, followed by "The Blockchain and Kudos: A Distributed System for Educational Record, Reputation and Reward" written by M. Sharples, J. Domingue having 10.2% similarity to origin paper with 320 citations and 19 references and "Blockchain Technology Applied in Health the Study of Blockchain Application in the Health System" written by Andrei Cirstea, F. Enescu, N. Bizon, C. Stirbu, V. Ionescu have 10.1% similarity to the origin paper with seven citations and 10 references. A high-quality paper is usually considered to be more prestigious based on the number of citations received. Out of 10 papers "Blockchain Technology in Health Care: The Revolution Starts Here" occupies first place with 599 citation is having 9.1% similarity to origin paper, followed by "The Blockchain and Kudos: A Distributed System for Educational Record, Reputation and Reward" obtained 320 citations with 10.2% similarity to origin paper and "Exploring Blockchain Technology and Its Potential Applications for Education" have received 270 citations with 9.3% similarity to origin, respectively.

Explore the graph

Prior work

Blockchain in Libraries wherein, CP suggests Prior Work (which are academic ancestors of this work) other than those already in the collection list.

Table 2. Prior work.

Title	Year	Last Author	Citations	Graph Citations
Healthcare Data Gateways: Found Healthcare Intelligence on Blockchain with Novel Privacy Risk Control	2016	J. Wei	661	19
Blockchain: Blueprint for a New Economy	2015	M. Swan	2064	18
Bitcoin: A Peer-to-Peer Electronic Cash System	2008	S. Nakamoto	5010	20
Med Rec: Using Blockchain for Medical Data Access and Permission Management	2016	A. Lippman	1119	15
Blockchain Technology in Healthcare: The Revolution Starts Here	2016	M. Mettler	599	14
Blockchain Distributed Ledger Technologies for Biomedical and Health Care Applications	2017	L. Ohno-Machado	557	12
Blockchain Technology: Applications in Health Care	2017	W. Schulz	210	9
Improving Data Transparency in Clinical Trials Using Blockchain Smart Contracts	2016	M. Cimpoesu	170	8
A Review of Existing and Emerging Digital Technologies to Combat the Global Trade in Fake Medicines	2017	G. Nayyar	180	7
Blockchain Technology for Improving Clinical Research Quality	2017	P. Ravaud	174	7

In Table 2, these are the research papers that are most commonly cited by the papers included in the graph. Selection of prior work highlights all graph papers referencing it in the left-side panel and selecting a graph paper highlights all referenced prior work. The above table is divulged that "Bitcoin: A Peer-to-Peer Electronic Cash System" and "Blockchain: Blueprint for a New Economy" are two highly productive papers having 5,010 and 2,064 citations, respectively. While improving data transparency in clinical trials using Blockchain smart contracts paper had only 170 citations in 2016. The highest number of the research papers were received a significant number of graph citations.

Derivative work

CP also suggests Derivative Work (recent studies) other than those already in the collection list.

Table 3 depicts those papers that can be scrolled through in the left panel. Highlights on the graph are visible while choosing a paper. By selecting a specific node, the graph can be navigated. Both options add extra details about the chosen paper to the right-side panel. Two buttons in the top left corner allow exploring papers that are not included in the graph but are probably relevant to the topic of choice.

"A Systematic Literature Review of Blockchain-based Applications: Current Status, Classification and Open Issues" is the most productive paper occupies the first place with 683 number of citations obtained. "Blockchain Technology in Healthcare: A Systematic Review" is the second most productive

Table 3. Derivative work.

Title	Year	Last Author	Citations	Graph Citations
Blockchain Technology in Healthcare: A Systematic Review	2019	J. M. Eklund	251	22
Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research	2019	R. Benlamri	144	17
Blockchain Applications in the Biomedical Domain: A Scoping Review	2019	E. Kaldoudi	77	16
Exploring Research in Blockchain for Healthcare and a Roadmap for the Future	2019	V. V. Graciano Neto	23	15
A Systematic Analysis on Blockchain Integration with Healthcare Domain: Scope and Challenges	2021	R. Khan	2	15
A Systematic Review of Blockchain in Healthcare: Frameworks, Prototypes, and Implementations	2020	G. Lalit	45	15
A Systematic Literature Review of Blockchain-based Applications: Current Status, Classification and Open Issues	2019	C. Petrakis	683	15
A Blockchain Framework for Patient-Centered Health Records and Exchange (Health Chain): Evaluation and Proof-of-Concept Study	2019	X. Zeng	44	15
Blockchain Affordances for Digital Health – A Conceptual Framework and Research Agenda (Preprint)	2021	R. Sharma	0	14
Use of Blockchain in Healthcare: A Systematic Literature Review	2019	A. Nadeem	23	14

paper with 251 citations, followed by "Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research" with 144 citations. "A Systematic Analysis on Blockchain" and "Blockchain Affordances for Digital Health – A Conceptual Framework and Research Agenda" (preprint) papers reveal very poor results having only two and zero citations respectively.

These are research papers that cited many of the graph papers. It probably means they are either recent relevant works or surveys of the field. Similar to prior works, "selecting a derivative work highlights all graph papers cited by it and selecting a graph paper highlights all derivative works citing it."

There is an "Open in" option to find a paper particular in a new window, to create a new graph based on this origin paper. Construction of the new graph sometimes take a few second, the progress bar shows how long to wait.

Benefits to the stakeholders

Connected Papers is a promising and useful tool for researchers for understanding their research areas visually through graphical representations. They can identify similar papers relevant to their studies. It also serves as a link among prior and derivative works. It is undoubtedly a unique tool for researchers. Library professionals are always looking forward to impart information literacy by sharing relevant information related to innovative tools and services which can enhance the productivity of their community. They can create subject guides and video tutorials and make them available on the library website for the benefit of the research community. Connected Papers can be one of the components of their on-going or new library research support programme as a value-addition. This way, libraries can help their academia in having more focused research while saving their precious time. It is pertinent to note that, LibGuides Community, a web-based integration of all existing LibGuides worldwide has over 150 mentions of Connected Papers in their posts.[7]

Publishers can also adopt Connected Papers to portray the semantic value of listed articles in respective research area giving the readers the freedom to derive deeper insight, otherwise unavailable. The visualization algorithm can also be applied to the references available at the end of each paper. It can be said that Connected Papers can benefit the academic stakeholders in their research endeavors significantly as a cutting-edge tool for scientific discoveries based on mapping and network visualization.

Conclusion

Connected Papers is a free, simple, hitherto powerful, one-stop visualization tool that uses a single origin paper (seed article). It is easy and very user-friendly tool to quickly identify similar papers with just one "Seed paper" (a relevant paper). Furthermore, it helps to detect seminal papers as well as review papers. It creates a similarity graph, not a citation graph and connecting lines (based on the similarity metric). The identified papers are then easily exported to most reference managers like Zotero, EndNote, Mendeley, etc.[8] It benefits its users to getting a visual overview of field of research and helps in effectively addressing the problem of conducting relevant literature review. It provides a quick glance to most popular papers as well as the various dynamics between the areas of study. It facilitates a list of papers that are missed doing research and helps to grow their reference list. The key paper helps in exploring the relevant papers in a bi-directional manner. Connected Papers lets the users discover the most important prior *and* derivative work in the area of interest.[9]

Blockchain play an imperative role in shaping the promising future of tech-based digital libraries. It is an essential ledger technology which uses cryptographic techniques and distributed consensus algorithms to get the features of traceability and immutability.[10] These features have been benefited the libraries for carrying out various operations like preserving and sharing authoritative information, preventing copyright issues and digital peer-to-peer sharing etc.[11]

Notes

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Glossary of Blockchain and Distributed Ledger Technology Terms

Bitcoin – Cryptocurrency was created by the person(s) named Satoshi Nakamoto in 2009. Introduced proof of work consensus for addressing the potential issue of double-spending of digital currency without a centralised form of authentication.

Blockchain – A form of DLT where blocks of data are added sequentially and linked together with representative hash values.

Cipher text – Information (text) that has been encrypted (made unreadable) using an algorithm known as a cypher. This information can only be used if the appropriate cypher key is possessed.

Consensus algorithms – An algorithm or protocol used to find consensus, or agreement, among multiple distributed nodes. Consensus allows nodes to agree on updates to the Blockchain itself. Examples include Proof of Work and Proof of Stake.

DApps – Decentralised Applications (DApps) are applications written on the Ethereum Blockchain with similar properties to a Blockchain. They run on a decentralised network and remove the need for trust in any one agency. Contributions in computation to keep a DApp running pay out in a similar manner to contributions to Blockchain nodes.

Distributed Ledger Technology (DLT) – A database shared through consensus and spread among multiple sites, or nodes, and lacking centralised data storage.

Ethereum – A Blockchain alternative to the Bitcoin Blockchain that introduces Smart Contracts, or scripting, and decentralised applications (DApps) by building in a Turing-complete programming language on top of the Ethereum Blockchain.

Fork – A split in the Blockchain that could be caused by consensus protocol change (difference of opinion within the community) or mining a different version of an existing block (attack) as examples. Forks can lead to small branches on the Blockchain that are quickly abandoned or to new Blockchain with their own supporters (Ethereum and Ethereum Classic).

Node – A devices participating in the Blockchain network. A Blockchain network is comprised of distributed nodes each with their own copy of the Blockchain's information.

Nonce – A random value is used once to ensure the correct hash value is set during Blockchain mining. This value is being mined to satisfy Proof of Work consensus.

Smart Contracts – Programs or scripts written on the Ethereum Blockchain that execute if a given set of specific requirements are met and that require no governing body to ensure their "pay outs" are met properly.[12]