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The Impact of Blockchain on Image Management

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Abstract

Blockchain technologies have gained much attention due to their disruptive potential in a number of arenas. The art market is now on the horizon as the next field that will be affected by this innovation. In 2018, the art auction houses Christie's, Sotheby's, and other smaller houses and galleries began seriously looking at blockchain for its potential impact on decentralized art sales. Technology adoptions often follow a life cycle pattern and blockchain technologies, following this pattern, have experienced a great deal of hype. To separate the enthusiasm from the realistic applications, it is important to understand the basic structure of blockchain functionality. This paper explores what utility blockchain technologies may serve in the art market, the current implementation of blockchain in the art community, and the fundamentals of how these technologies operate. This article intends to ground the technology in relation to the art market and the distribution of digital art objects as of the current date.

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Author Bio & Acknowledgements

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Art Market

Many investors include art in a well balanced portfolio.[1] However, much like the stock market, the value of art can be subjective. Art appraisers act as market forecasters, while the value of a work of art can also fluctuate for unexpected reasons. Artists themselves may also comment on the art marketplace and even the inflation of value in certain circumstances. Recently, Maurizio Cattelan's *Comedian* (a banana duct-taped to a wall at Art Basel Miami) sold for $120,000.[2] Another duct-taped banana by Cattelan was later eaten by another artist, David Datuna, in a performance Datuna dubbed *Hungry Artist*.[3] In 2018, Banksy commented, perhaps more explicitly, on the transience of the art market during a Sotheby's auction for his work *Girl with Balloon*, which was partially shredded as the hammer fell following a winning bid of $1.4 million.[4] The event, evidently well planned by the artist, likely also echoes Banksy's overall feelings about the art market and art commercialization in general.[5] It might also be argued that the artist, known to spontaneously sell his art in Central Park for $60, is in favor of shaking up the current profit-driven system within the art world.[6] Banksy has also injected new pieces into the market with no provenance record. The shredding event at Sotheby's both generated attention and arguably made manifest the artist's contempt for one of the two largest art auction houses.[7]

Provenance

Sotheby's uses ten criteria when assigning the value of art.[8] Provenance is just one of their criteria; it is akin to the story of the ownership of a piece of art.[9] Linking the object to its connection to history also may lend value to that object. An unbroken provenance can allow even more value to be added. Provenance is important to the story of the object; it also shows the historical authenticity

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[1] "The reported returns are enough to catch anyone's eye: the index of fine art sales, used by art advisors to sell art funds, shows an average annual return of 10% over the past four decades." Arthur Korteweg and Roman Kräussl Patrick Verwijmeren, "Finance Research: Is Art a Good Investment?" *Insights by Stanford Business, Stanford Graduate School of Business* (blog) October 21, 2013, https://www.gsb.stanford.edu/insights/research-art-good-investment.

[2] Sarah Cascone, "Maurizio Cattelan is Taping Bananas to a Wall at Art Basel Miami Beach and Selling Them for $120,000 Each*," artnet news* (blog) December 4, 2019, https://news.artnet.com/market/maurizio-cattelan-banana-art-basel-miami-beach-1722516.

[3] Jordan Hoffman, "'It is something deeper': David Datuna on why he ate the $120,000 banana," *The Guardian* December 11, 2019, https://www.theguardian.com/artanddesign/2019/dec/11/david-datuna-120000-banana-interview-art-basel-miami.

[4] "Banksy video shows plan to shred entire *Girl with Balloon* artwork," *The Guardian*, October 17, 2018, https://www.theguardian.com/artanddesign/2018/oct/18/banksy-video-girl-with-balloon-shred-entire-artwork.

[5] Anny Shaw, "To be or not to Bbay: Will Banksy take control of his market with 'approved used dealership'?" *The Art Newspaper* October 16, 2019, https://www.theartnewspaper.com/news/is-banksy-launching-a-secondary-market-dealership.

[6] Ibid.

[7] "The global art market was valued at $67.4 billion in 2018, the second highest year ever. Sales at public auctions exceeded $29 billion last year[2019]. Two auction houses - Christie's and Sotheby's - compete head to head each year capturing more than 40% of global auction sales." Sam Rega, "Why Two Major Auction Houses Reign over the Billion Dollar Art Market," *CNBC* November 2, 2019, https://www.cnbc.com/video/2019/11/02/christies-and-sothebys-auction-houses-reign-over-art-market.html.

[8] "The Value of Art, Episode 4: Provenance," *Sotheby's Financial Services* Dec 20, 2016, https://www.sothebys.com/en/videos/the-value-of-art-episode-4-provenance

[9] Provenance is "the history of the ownership of a work of art or an antique, used as a guide to authenticity or quality; a documented record of this." "Provenance, n.," *OED Online* (Oxford: Oxford University Press), accessed March 22, 2020.

of the object. Computer and information science use the term data lineage to describe the origins of data in a manner that might be equated to provenance. This same concept is also used in modern-day logistics and supply chains. Pharmaceutical manufacturing requires careful tracking of the provenance of the medications being produced to ensure quality and authenticity.

The art market began seriously adopting blockchain technology in 2018 when a former Sotheby's employee, Nanne Dekking, founded a blockchain-based provenance tracking database.[10] Christie's then became the first auction house to apply blockchain technology for an auction, as a pilot collaboration with Artory.[11] However, these centralized blockchain databases do not have the years of trust engendered by Sotheby's and Christie's.[12] While the market still has a great deal of volatility, blockchain offers a method to mass distribute limited digital reproductions and also ensure the artist obtains a greater percentage of the profit.[13] Blockchain can provide an audit trail for supply chains, identifying where a forgery occurred. Though this will not stop individual cases, it will show a pattern that can be addressed. In the case of an art forgery, one piece can have a significant impact on the purchaser and undermine trust in the marketplace.

Copies and Forgery

Andy Warhol popularized pushing the boundaries of the commoditization and mass production of art.[14] The technological advances in photography and the assembly line may have helped in the evolution. In the digital age, artists are increasingly utilizing technology to create born-digital art. One could argue this is a net benefit to society as it puts art in the reach of the common citizen. Simultaneously, in some cases, even today, the limited access to validated and verified artworks is one way the artist controls the value and profit of their works.

Throughout history, forgery has caught the imagination of the population. High value commodities based only on perceived value, not intrinsic material properties, are particularly susceptible to forgery. For instance, in 1978, Konrad Kujau forged a multi-volume set of Hitler's supposed diaries. He used elaborate methods to legitimize his fakes, including German seals, ink, and hand writing techniques.[15] Consider the ramifications of producing a forgery such as this:

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[10] "Our Story," *Artory*, accessed December 15, 2019, https://www.artory.com/our-story/.

[11] Henri Neuendorf, "Christie's Will Become the First Major Auction House to Use Blockchain in a Sale," *Artnet News*, October 12, 2018, https://news.artnet.com/market/christies-artory-blockchain-pilot-1370788.

[12] Twelve blockchain startups are outlined in an article published December 25, 2018. By the end of 2019, three of the twelve startups were defunct. These include: Ink Labs Foundation, YAIR - Your Art is Reality, and Adappcity, Inc. CoinMarketCap was tracking 2,371 blockchain markets at the end of 2019. Sam Mire, "12 Startups Using Blockchain to Transform the Art Industry [Market Map]," *Disruptor Daily* (blog), December 25, 2018, https://www.disruptordaily.com/blockchain-market-map-art/.

[13] Jason Bailey, "Blockchain Art 3.0 - How To Launch Your Own Blockchain Art Marketplace," *Artnome* (blog), February 27, 2019, https://www.artnome.com/news/2019/2/27/blockchain-art-30-how-to-launch-your-own-blockchain-art-marketplace.

[14] Arthur C. Danto, *Andy Warhol*, New Haven: Yale University Press (2009): 55. See also: Finola Kerrigan, *Marketing the Arts: A Fresh Approach*, New York: Routledge (2010): 20.

[15] Adam Lusher, "The Hitler Diaries: How hoax documents became the most infamous fake news ever," *The Independent* May 5, 2018, https://www.independent.co.uk/news/uk/home-news/hitler-diaries-anniversary-sunday-times-extracts-hoax-fake-news-germany-a8337286.html.

nations could weaponize propaganda through false historical documents.[16] This is one example of the forger's intent to change history. In the modern era, with technologies such as deep fakes and the possibility of revisionist history, having the capacity to track and verify the authenticity of images may become even more important for image professionals.

Art is also undoubtedly a profitable area for unscrupulous individuals to exploit.[17]Art may have value, in some cases, due to the effort and skill necessary to create the object in question or as a result of the scarcity of the object. More specifically, the value of a work of art is assigned, again in certain cases, due to the verifiable authenticity of the original. In a historical context, the copy created by hand, perhaps in the master's studio for the sake of monetary gain, leant greater authority or "aura" surrounding the original work.[18] In the contemporary age, the art market has to struggle with not only the capacity for infinite born-digital – and questionably "authentic" – copies, but also the capacity for instantaneous distribution. Walter Benjamin noted that the "whole sphere of authenticity eludes technological…reproduction."[19] In fact, he argued, technological reproduction, in contrast to the copy made by hand – and usually deemed a forgery – does not necessarily follow the precept of the handmade copy as inferior or "less authentic."[20] If that is the case, then how does the artist control not only the monetization of their work that will incentivize a viable art marketplace, but also ensure the distribution and availability of only authentic copies? Blockchain technology has the opportunity to apply what Benjamin termed "exhibition value" – or value in being seen by many – to artwork that is infinite by nature.[21]

Blockchain Hype

In the past year, fervor surrounding cryptocurrencies has made it difficult to examine blockchain technologies as an isolated phenomenon.[22] Promotional literature has repetitively seized on the perceived transformational nature of the technology, exclaiming that blockchain would change all industries. Since then, blockchain has matured and expectations have peaked.

[16] "We must leave room for the imagination. History is not merely what happened: it is what happened in the context of what might have happened." Hugh Trevor-Roper, *History & Imagination: Essays in Honor of H.R. Trevor-Roper*, eds. Hugh Lloyd-Jones, Valerie Pearl, and Blair Worden, New York: Holmes & Meier Publishers, Inc., (1982): 364. Trevor-Roper had erroneously authenticated the Hitler Diaries.

[17] Experts must be cautious with historical pieces in general. Art can also serve as an important historical record and impact our modern understanding of how the past appeared. Art on the walls of Egyptian pyramids provides an understanding of our history as humans. Digital artworks produced today may leave a record of our culture for future generations, if properly preserved and authenticated, so we can access and trust these materials.

[18] Walter Benjamin, "The Work of Art in the Age of Its Technological Reproducibility: Second Version," in *The Work of Art in the Age of Its Technological Reproducibility, and Other Writings on Media*, eds. Michael W. Jennings, Brigid Doherty, and Thomas Y. Lennon; trans. Edmund Jephcott, et. al., Cambridge, MA: The Belknap Press of Harvard University Press (2008): 22.

[19] Ibid, 21.

[20] Ibid.

[21] Ibid, 25. In another context, the ability to make a digital object "one-of-a-kind" through blockchain technology has been applied to the world of gaming. See the description of the CryptoKitties digital game. "About," *CryptoKitties*, accessed July 1, 2020, http://www.cryptokitties.co/about.

[22] "Blockchain by its very nature presents a number of legal issues. The supposedly immutable nature of its contents, combined with the every-where and nowhere nature of DLT [Distributed Ledger Technology], make blockchain a very odd and uncomfortable fit into the existing legal schema of data ownership, control, and use." See Dan Blackaby, "Legal Considerations," in *Blockchain*, eds. Sandra Hirsh and Susan Webreck Alman (Chicago: ALA Neal-Schuman, 2020): 20.

Nevertheless, detailed information accessible to the general public explaining the functionality of the technology has begun to emerge. This pattern plays out regularly in the technology sector. A tool for understanding this regularly occurring pattern is the Gartner Hype Cycle.[23] This pattern is also similar to the business cycle curve. The Hype Cycle begins with an innovation trigger. During this phase, the technology is little understood by many and overhyped; the technology reaches a peak then falls. Visually, this looks similar to a standard bell curve but is cyclical with another rise (Fig. 1).
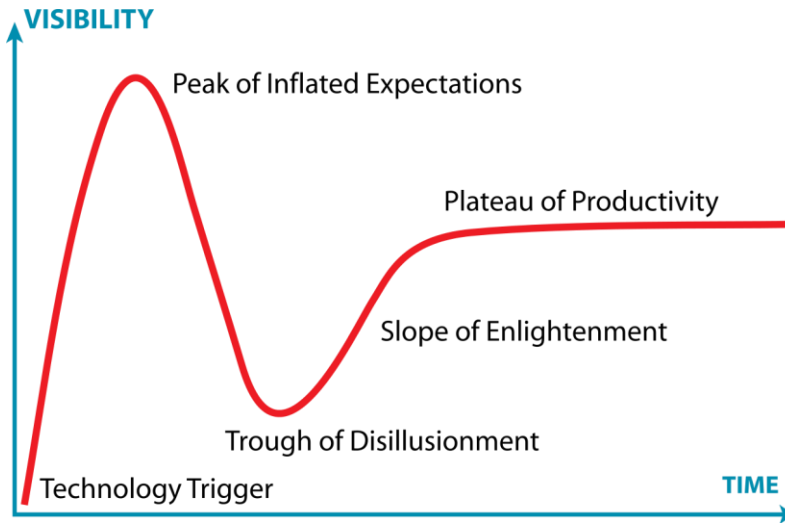

Figure 1. Gartner Research's Hype Cycle diagram, December 27, 2007. https://commons.wikimedia.org/wiki/File:Gartner_Hype_Cycle.svg.

The difficulty with this concept is that much of the literature is at extreme ends: either extremely technical or extremely abstracted. Many readers are interested in knowing what the applications are, without understanding how the tool functions. Likewise, blockchain is a tool that has many applications. Before attempting to understand the possible applications of the tool, it is important to examine key higher-level aspects that make up the technology.

Blockchain Technology at a High Level

Blockchain (most simply) is a technology that stores a hash value and a digital object. A hash is not a new concept, nor is it unique to blockchain.[24] In basic terms, a hash function is the permutation of a unique set of data computed through an algorithm that results in a standardized length output of data. The hash function works much like a cipher printed on the back of a cereal box. If you do not know the table, then you cannot decipher the message. The ability to decipher the message based on the table proves the authenticity of the message (Fig. 2).[25]

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[23] Jackie Fenn and Marcus Blosch, "Understanding Gartner's Hype Cycles," Gartner, Inc., August 20, 2018, https://www.gartner.com/en/documents/3887767.

[24] For a simplified definition of blockchain, see Michael Meth, "Blockchain in Libraries," *Library Technology Reports* 55, no. 8 (2019): 7.

[25] These types of deciphering tables are commonly known as Caesar ciphers, which is a type of simple substitution cipher.
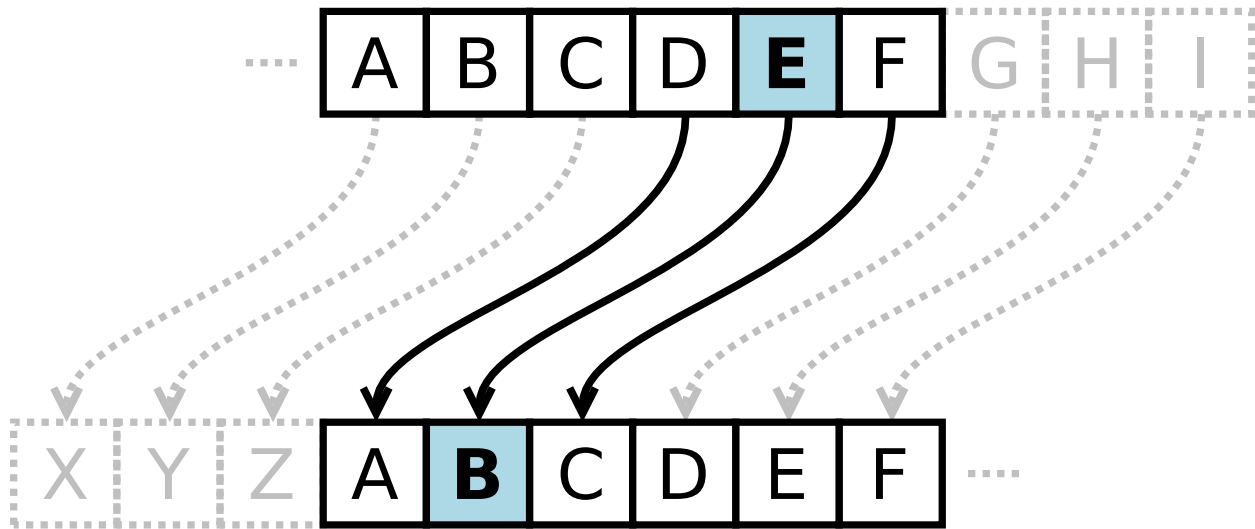
Figure 2. Matt_Crypto, Caesar cipher left shift of 3, February 8, 2013,
https://commons.wikimedia.org/wiki/File:Caesar_cipher_left_shift_of_3.svg

The digital object (for instance, a born-digital image file) can store metadata, like descriptions of a work or evidence of provenance. The blockchain only verifies the authenticity of the digital object through the hash value. The difference between the blockchain and any other hash-storing mechanism is the crowdsourcing of the hash value, ensuring the hash value cannot reasonably be forged.

While there are many competing blockchain technologies, Ethereum (a blockchain network) is one of the first to boast strong functionality outside of cryptocurrency itself. Ethereum's technology allows an exchange to occur. Some of the important strengths of Ethereum are that it stores the InterPlanetary File System (IPFS) hash pointing to data storage. It provides a mechanism for proof of work algorithm to verify the network. Each block stores a list of transactions which is a fully transparent audit trail. This audit trail becomes critical provenance data. Each block runs the smart contract. A smart contract operates through transfer of ownership, which occurs once a majority of the nodes agree on the computation of the data. At this point the smart contract terms are fulfilled. This is literally a contract that is fulfilled digitally, utilizing a democratic method of node verifications. In a way, all of the nodes vote whether the terms of the contract have been fulfilled. In certain cases, if the contract is fulfilled, payment is released to the seller.

The smart contract system is only one aspect of the brilliance of the technology. Ethereum implemented IPFS to manage non-collocated file storage.[26] Each time a transaction occurs with the stored data files, the peer system hosting the data receives an incentive in some form of token. This encourages peers to participate in the file sharing process.

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[26] The InterPlanetary File System, based on BitTorrent and a cooperative storage cloud, was released in 2015. It is a peer-to-peer distributed file system.

It can be helpful to contrast Ethereum with another blockchain technology – Hyperledger – that is similar but fills a slightly different role. Ethereum and Hyperledger are both blockchain networks. Ethereum's transactions are public and this is why it is considered a public blockchain network. This ensures complete transparency of the audit process.[27] Hyperledger, on the other hand, is a private transaction consortium blockchain network. This greatly reduces the level of transparency of the transactions.[28]

Hyperledger will be strong in private transaction situations such as business-to-business practices. Ethereum has the advantage in public transaction situations such as business-to-customer practices. Ethereum is highly decentralized and is unlikely to be adopted by large auction houses. A private model like Hyperledger is a more likely option as it will protect the privacy of its buyers and would allow the auction house control over provenance data. Auction houses will endeavor to gain and retain as much data as possible in the future. The auction house with the most complete (and perhaps proprietary) provenance data could be the house of choice when an object goes on sale. With all things being equal, users are generally attracted to more complete data sets when choosing between technology services with similar features and pricing. The art dealers then only need to ensure their features keep pace with the market and their pricing is competitive when there is viable competition. It is also certainly possible that blockchain will be a valuable resource for physical art objects utilizing technologies such as RFID or QR codes that are then associated with blockchain-based data storage and smart contracts. However, the born-digital art market is poised to take advantage of the promise of blockchain technology, given that born-digital artworks are currently difficult to monetize and track.

Digital Art

Currently, the utilization of InterPlanetary File System (IPFS) and smart contracts with digital art offer the most disruptive possibilities in the art marketplace.[29] The IPFS can provide a vehicle for the storage and transfer of digital art. IPFS is stored in pieces across several host nodes. This technology is called Distributed Hash Tables or Chord protocol (see Fig. 3 for a visual explanation).

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[27] "The distributed ledger combines the technology underlying distributed computing with the concept of the ledger used in accounting. The distributed ledger is a digitized version of the paper ledger where transactions are recorded as they occur, thus providing the accounting and documentation required to ensure that transactions have taken place." Meth, "Blockchain in Libraries," 8.

[28] Ethereum smart contracts is based on Solidity utilizing Golang and Python. Hyperledger is based on Chaincode and utilizes Golang and Java. The community backer for Ethereum is the Ethereum Foundation and Hyperledger is backed by the Linux Foundation. Martin Valenta and Philipp Sandner, "Comparison of Ethereum, Hyperledger Fabric and Corda," Frankfort School Blockchain Center Working Paper, June 2017, https://pdfs.semanticscholar.org/00c7/5699db7c5f2196ab0ae92be0430be4b291b4.pdf.

[29] For an early analysis of the impact of disruptive technologies in the market, see Joseph L. Bower and Clayton M. Christensen, "Disruptive Technologies: Catching the Wave," *Harvard Business Review*, January-February 1995, https://hbr.org/1995/01/disruptive-technologies-catching-the-wave.
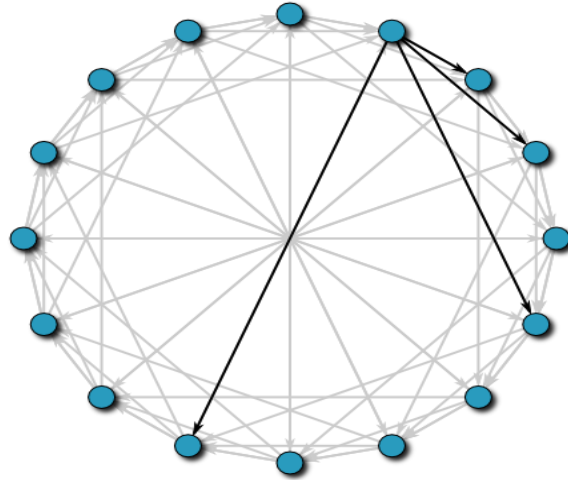
Figure 3. Seth Terashima (Tetra7 (talk)), CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0).

With the advent of blockchain smart contracts and IPFS, there now exists the ability to construct an attractive way to secure both the ownership of an immutable physical file and a market-fair pricing and payment system between the artist and collector.[30]

Distributed Hash Tables

The key aspect of the IPFS technology is the utilization of the Distributed Hash Tables (DHT). The distributed nature of this technology means that nodes across the network have a piece of the data. These nodes can be individuals all over the world, hosting a small piece of the total data, thus making it impossible for a sufficient number of the nodes to be compromised in order to forge the data. The DHT maintain a list of nodes responsible for the next nodes with data in a sequence. Each node has a small amount of the data and points to the next node to access the continuation of the data required.

The MerkleDAG\Merkle Tree is a type of distributed hash table used in blockchain technology. In the diagram (Fig. 4), L1, L2, L3, and L4 are leaf nodes. To find the parent hash, take the hash of L1 and the hash of L2, then concatenate. Next, repeat with both parent nodes to find the root node. If one of the leaf nodes is changed, the root hash will change quickly and show that the leaf has changed. The root hash acts as both an address and a verification.[31]

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[30] Bokang Jia, et al., "Opus - Decentralized Music Distribution Using InterPlanetary File Systems (IPFS) on the Ethereum Blockchain V0.8.3," White Paper, Opus Foundation 2016-2017, 2017, https://icosbull.com/whitepapers/1196/Opus_whitepaper.pdf.

[31] Rongyue Zheng et al., "BcBIM: A Blockchain-Based Big Data Model for BIM Modification Audit and Provenance in Mobile Cloud," *Mathematical Problems in Engineering* (March 18, 2019): 7, https://doi.org/10.1155/2019/5349538.
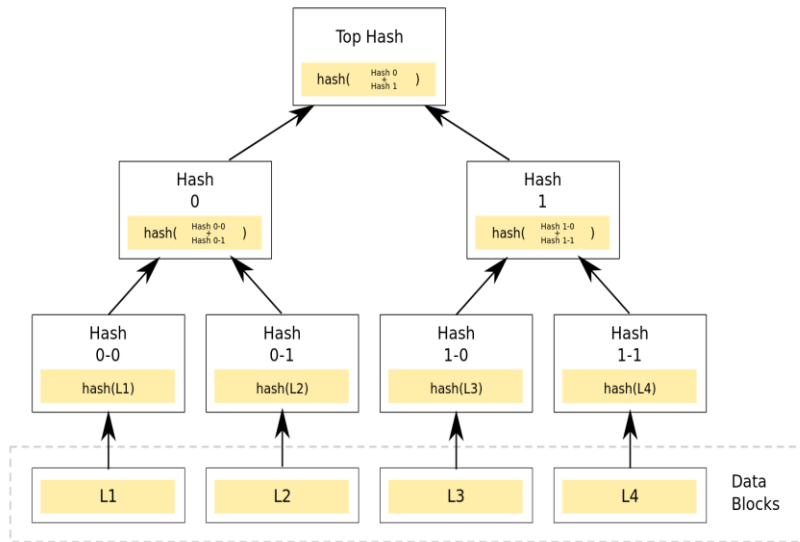
Figure 4. An Example of a Binary Hash Tree, January 25, 2012,
https://commons.wikimedia.org/wiki/File:Hash_Tree.svg.

The MerkleDAG\Merkle Tree is also used in the processing of smart contracts. The artist directly benefits from the smart contract of the automated sale of intellectual property. The smart contract can be configured with solidity to provide the profits of the sale to the artist alone or the artist can share a percentage of the sales with their patron investor, thus eliminating the need for an auction house. This is a critical point, since it cuts out the auction house as a middle man. Auction houses primarily connect buyers and sellers, yet they also play an important role in maintaining records of provenance. However, artists should be concerned since the auction houses are actively becoming involved in blockchain networks. The auction houses will favor private blockchain networks since they can be centrally controlled. Blockchain technology has the potential to allow auction houses to make this information proprietary to the owning organization. This eliminates the freedom of the decentralized transaction network. If the centralized network gains momentum, it might be difficult to convince the market to change, which would result in the same concentration of art sales in two auction houses.

Conclusion

Blockchain technologies had an initial period of being overhyped. These networks are considered to be disruptor technologies. The term "disruptive" is often associated with organizations that have non-competitive practices that shelter them from change. Legacy auction houses are interested in guiding the disruptive technology of blockchain. The technology was initially targeted at the financial sector due to the hyper-concentration of financial services. Art was an obvious target since it operates much like other commodities, and many investors have art in their portfolios. Given the value of art objects, forgery is prevalent, but it is not limited to art or currency. Some forgeries even have the ability to change history.

Blockchain technologies may be one more tool for professionals to use to authenticate works. The technology is evolving at a rapid pace, but will certainly have future implications for artists, auction houses, researchers, and image professionals. It is important that image professionals should be involved in the guidance of blockchain platforms to ensure the growth of the community through decentralized networks, rather than allowing auction houses or proprietary entities to retain sole influence.

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