

Non-fungible token

A **non-fungible token** (NFT) is a unit of data stored on a digital ledger, called a blockchain, that certifies a digital asset to be unique and therefore not interchangeable.^[1] NFTs can be used to represent items such as photos, videos, audio, and other types of digital files. Access to any copy of the original file, however, is not restricted to the buyer of the NFT. While copies of these digital items are available for anyone to obtain, NFTs are tracked on blockchains to provide the owner with a proof of ownership that is separate from copyright.

The NFT market value tripled in 2020, reaching more than \$250 million.^[2] During the first quarter of 2021, NFT sales exceeded \$2 billion.^[3]

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Description

An NFT is a unit of data stored on a digital ledger, called a blockchain, which can be sold and traded. The NFT can be associated with a particular digital or physical asset (such as a file or a physical object) and a license to use the asset for a specified purpose.^[4] NFTs (and the associated license to use, copy or display the underlying asset) can be traded and sold on digital markets.^[5]

NFTs function like cryptographic tokens, but, unlike cryptocurrencies like Bitcoin, NFTs are not mutually interchangeable, so not fungible. While all bitcoins are equal, each NFT may represent a different underlying asset and thus have a different value.^[6] NFTs are created when blockchains string records of cryptographic hash, a set of characters identifying a set of data, onto previous records therefore creating a chain of identifiable data blocks.^[7] This cryptographic transaction process ensures the authentication of each digital file by providing a digital signature that is used to track NFT ownership.^[7] However, data links that point to details like where the art is stored can die.^[8]

Uses

The unique identity and ownership of an NFT is verifiable via the blockchain ledger.^[9] Ownership of the NFT is often associated with a license to use the underlying digital asset, but generally does not confer copyright to the buyer: some agreements only grant a license for personal, non-commercial use, while other licenses also allow commercial use of the underlying digital asset.^[10]

Digital art

Digital art was an early use case for NFTs, because of the ability of blockchain technology to assure the unique signature and ownership of NFTs.^[11] The digital artwork entitled "Everydays – The First 5000 Days", by artist Mike Winkelmann, also known as Beeple, sold for US\$69.3 million in 2021.^{[5][12]} The purchase resulted in the third-highest auction price achieved for a living artist, after Jeff Koons and David Hockney. Another Beeple piece entitled "Crossroad", consisting of a 10-second video showing animated pedestrians walking past a figure of Donald J. Trump, sold for US\$6.6 million at Nifty Gateway, an online cryptocurrency marketplace for digital art.^{[13][14]}



This image, *Hashmask 15753* (1 of 16,384) by "Suum Cuique Labs GmbH", sold with an NFT on the Ethereum blockchain.

A 3D-rendered model of a home named "Mars House", created by artist Krista Kim, was sold as a piece of digital real estate on the NFT market for over US\$500,000.^[15]

Generative Art

Distinct from Digital Art, a new form called Generative Art incorporates algorithms developed by the artist that generate on-demand unique pieces when the token is minted. ^[16]Generative art is being experimented by projects such as Art Blocks, where Sotheby's sold 19 pieces totaling \$81,000. ^[17]

Collectibles

NFTs can represent digital collectibles like physical card collections, however in a completely digital format. In February 2021, a LeBron James slam dunk NFT card on the NBA Top Shot platform sold for \$208,000. ^[18]

Avatars (Profile Pictures)

NFTs are commonly used as avatars / profile pictures (PFPs) for social media and online identity. This trend originates from the 2017 project CryptoPunks which allowed the mint of 10,000 unique NFT characters. Brand ^[19] and celebrity acquisitions of rare NFTs has resulted in a surge of 10,000 piece NFT collections dedicated to generative avatars.

Games

NFTs can also be used to represent in-game assets, such as digital plots of land, which are controlled by the user instead of the game developer. NFTs allow assets to be traded on third-party marketplaces without permission from the game developer. In February 2021, Axie Infinity recorded a sale of \$1.5 million for digital land titles in a single sale. ^[20]

Virtual Worlds

Described as the Metaverse, virtual worlds such as Decentraland, Sandbox, CryptoVoxels and Somnium Space allow users to create galleries to show off NFT art, clothes, real estate and attend live events with friends online. They use NFTs to auction off limited objects such as virtual land. The open standards means users can seamlessly transact and bring external NFT objects onto their purchased land. In June 2021, a plot of virtual land sized 16 acres on Decentraland was sold for \$913,228.20. ^[21]

Music

Blockchain and the technology enabling the network have given the opportunity for musicians to tokenize and publish their work as non-fungible tokens. This has extended the list of options for musicians and artists alike to monetize and profit from their music as well as other content surrounding the themes of the music and the artists public image. Additionally, NFTs have provided the opportunity for artists and touring musicians to recuperate lost income due to the 2020 COVID-19 pandemic which resulted in music industry revenues falling nearly 85%. ^[22]

NFTs were utilized by artists to increase revenue during the COVID-19 pandemic. In February 2021, NFTs reportedly generated around \$25 million within the music industry (in an industry with annual revenue of over \$20 billion). ^[23] On February 28, 2021, electronic dance musician 3LAU sold a collection of 33 NFTs for a total of \$11.7 million to commemorate the three-year anniversary of his *Ultraviolet* album. ^[24] On March 3, 2021, rock band Kings of Leon became the first to announce the release of a new

album, When You See Yourself, in the form of an NFT which generated a reported \$2 million in sales.^[25] Other musicians that have used NFTs include American rapper Lil Pump,^{[26][27][28]} artist Shepard Fairey^{[29][30]} and rapper Eminem.^[31]

Film

In May 2018, 20th Century Fox partnered with Atom Tickets and released limited-edition Deadpool 2 digital posters to promote the film. They were available from Opensea.io and the GFT exchange.^{[32][33]} In March 2021,^[34] Adam Benzine's Oscar-nominated documentary Claude Lanzmann: Spectres of the Shoah became the first motion picture, documentary and Academy Award-nominated film to be minted and auctioned as an NFT,^{[35][36]} via the Rarible platform.^[34]

Other projects in the film industry using NFTs include the announcement that an exclusive NFT artwork collection will be released for Godzilla vs. Kong^[37] and director Kevin Smith announcing in April 2021 that his forthcoming horror movie Killroy Was Here would be released as an NFT.^[38]

Memes

A number of internet memes have been associated with NFTs, which were minted and sold by their creators or by their subjects.^[39] Examples include Doge, an image of a Shiba Inu dog whose NFT was sold for \$4 million in June 2021,^[40] as well as Charlie Bit My Finger,^[41] Nyan Cat^[42] and Disaster Girl.^[43]

Sports

NFTs have also been used in sports, in September 2019, NBA player Spencer Dinwiddie tokenized his contract so that others can invest into it.^{[44][45]} In addition, Dapper Labs, a blockchain technology-based company, has collaborated with the NBA to create "N.B.A Top Shot", a marketplace for digital highlight clips.^[13]

Fashion

In 2019, Nike acquired a patent that allows for blockchain technology to attach cryptographically secured digital assets in the form of NFTs to physical products, such as a pair of sneakers, under the name "CryptoKicks".^{[46][47]}

Pornography

Some porn stars have also tokenized their pornographic work, allowing for the sale of unique content for their customers, though hostility from NFT marketplaces towards pornographic material has presented significant drawbacks for creators.^{[48][49]}

Academia

In May 2021, UC Berkeley announced that it would be auctioning NFTs for the patent disclosures for two Nobel Prize-winning inventions: CRISPR-Cas9 gene editing and cancer immunotherapy.^[50] The university will continue to own the patents for these inventions, as the NFTs relate only to the university

patent disclosure form, an internal form used by the university for researchers to disclose inventions.^[50] The NFTs were sold on June 8, 2021 for 22 ETH (ca. \$55,000).^[51]

Utilities

Beyond the tokenization of a digital asset, new utilities on non-fungible tokens are emerging.

In fields such as notarization and attestation, the Singapore Government will issue digital certificates for graduates ^[52] using OpenCert that number 10,000 certificates a year to automate the 2,000 verification requests per year from employers and other schools.^[53] The Singapore Ministry of Health will also issue digital Vaccination Certificates for travel using OpenCert. ^[54]

NFT collection VeeFriends launched by Gary Vaynerchuk gives each token holder exclusive access to an in-person marketing and entrepreneurship conference called "VeeCon" in 2022, 2023 and 2024. ^[55]

Rules of access that grant rights to redeem intangible value is a rapidly growing utility. Community NFTs such as "Bored Ape Yacht Club" and "Pudgy Penguins" entitles token holders to benefits, including membership entry to a private Discord server by validating the NFT exists in the wallet against entry. ^{[56][57]}

Copyright

Ownership of an NFT does not inherently grant copyright to whatever digital asset the token represents.^{[58][59]} While someone may sell an NFT representing their work, the buyer will not necessarily receive copyright privileges when ownership of the NFT is changed and so the original owner is allowed to create more NFTs of the same work.^{[60][61]} In that sense, an NFT is merely a proof of ownership that is separate from a copyright.^{[59][62]} According to legal scholar Rebecca Tushnet, "In one sense, the purchaser acquires whatever the art world thinks they have acquired. They definitely do not own the copyright to the underlying work unless it is explicitly transferred."^[63] In practice, NFT purchasers do not generally acquire the copyright of the underlying artwork.^[64]

Standards in blockchains

Specific token standards have been created to support various blockchain use-cases. These include the Ethereum ERC-721 standard of CryptoKitties, and the more recent ERC-1155 standard.^[65] The FLOW and Bitcoin Cash blockchains support NFTs.^{[66][67]}

Ethereum

ERC-721^[65] was the first standard for representing non-fungible digital assets on the Ethereum blockchain. ERC-721 is an inheritable Solidity smart contract standard, meaning that developers can create new ERC-721-compliant contracts by importing it from the OpenZeppelin library. ERC-721 provides core methods that allow tracking the owner of a unique identifier, as well as a permissioned way for the owner to transfer the asset to others.^[68]

The ERC-1155 standard^[65] offers "semi-fungibility", as well as providing a superset of ERC-721 functionality (meaning that an ERC-721 asset could be built using ERC-1155). Unlike ERC-721 where a unique ID represents a single asset, the unique ID of an ERC-1155 token represent a class of assets, and

there is an additional quantity field to represent the amount of the class that a particular wallet has.^[69] The assets under the same class are interchangeable, and the user can transfer any amount of assets to others.^[69]

FLOW

The FLOW blockchain which uses proof of stake consensus model supports NFTs, for example NBA Top Shot is run on the FLOW blockchain. Cryptokitties plans to switch from Ethereum to FLOW in the future.^[66]

Tezos

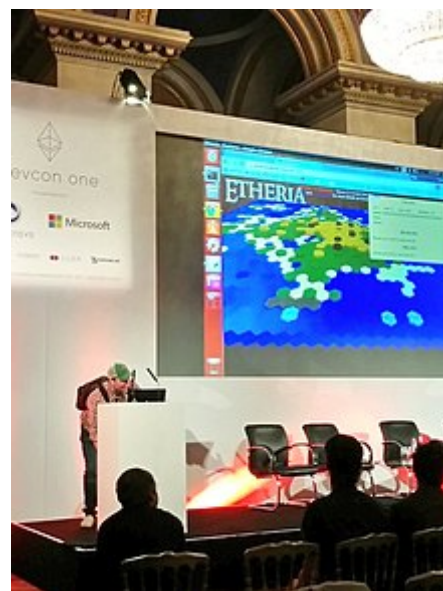
Tezos is a blockchain network that operates on proof of stake and supports the sale of NFT art.^[70]

History

Early history (2012–2017)

The first one-off NFT was created on May 3, 2014, by Kevin McCoy and Anil Dash, live at the Seven on Seven conference at the New Museum in New York City. This experiment represents the first time a non-fungible, tradable blockchain marker was explicitly, via on-chain metadata (enabled by Namecoin), linked to a unique work of art,^[71] standing in stark contrast to the multi-unit, fungible, metadata-less "colored coins" of other blockchains and Counterparty.

In October, 2015, the first fully-fledged NFT project, Etheria, was launched and demonstrated live at DEVCON 1, Ethereum's first developer conference, in London, UK, just three months after the launch of the Ethereum blockchain itself. Most of Etheria's 457 purchasable and tradable hexagonal tiles went unsold for more than 5 years until March 13, 2021, when renewed interest in NFTs sparked a buying frenzy. Within 24 hours, all tiles of the current version and a prior version, each hardcoded to 1 ETH (\$0.43 cents at the time of launch), were sold for a total of \$1.4 million.^[72]



Presentation of Etheria at DEVCON 1. November 13, 2015.

Public awareness (2017–2021)

In 2017, the Ethereum blockchain started to gain prominence over bitcoin based token platforms, due to Ethereum having a system for token creation and storage built right into its blockchain thus eliminating the need for third-party platforms like Counterparty, and was the company to coin the term non-fungible token. Also in 2017, the American studio Larva Labs released CryptoPunks, a project to trade unique cartoon characters, on the Ethereum blockchain.^{[73][74][75]} In late 2017, another project called CryptoKitties where players adopt and trade virtual cats was released and quickly went viral, raising a \$12.5 million investment and some kitties were selling for over \$100,000.^{[76][77][78]}

In 2018, Decentraland, a blockchain-based virtual world, raised \$26 million in an initial coin offering, and had a \$20 million internal economy as of September 2018.^{[79][80]}

In 2019, Nike patented a system called CryptoKicks that would use NFTs to verify the authenticity of physical sneakers and give a virtual version of the shoe to the customer.^[81]

In early 2020, the developer of CryptoKitties, Dapper Labs, released the beta version of NBA TopShot, a project to sell tokenized collectibles of NBA highlights.^[82] The project was built on top of Flow, a newer and more efficient blockchain compared to Ethereum.^[66] Later that year, the project was released to the public and reported over \$230 million in gross sales as of February 28, 2021.^[83]

The NFT market experienced rapid growth during 2020, with its value tripling to \$250 million.^[84] In the first three months of 2021, more than \$200 million were spent on NFTs.^[85]

NFT buying surge (2021–present)

In 2021, interest in NFTs increased. Blockchains such as Ethereum, Flow, and Tezos established specific standards to ensure that the digital item represented are authentically one-of-a-kind. NFTs are now being used to commodify digital assets in art, music, sports, and other popular entertainment, with most NFTs part of the Ethereum blockchain, while other blockchains can implement their own versions of NFTs.^[86] A number of high-profile sales were made just in the first few months of the year.^[87] In February 2021, the musician Grimes sold around \$6 million worth of tokens representing digital art on Nifty Gateway.^[88] Later that month, an NFT representing the meme animation Nyan Cat was sold in an Internet marketplace for just under \$600,000.^[89] On February 28, 2021, electronic dance musician 3LAU sold a collection of 33 NFTs for a total of \$11.7 million to commemorate the three-year anniversary of his *Ultraviolet* album.^[24] On March 5, 2021, the band Kings of Leon became the first to sell a newly released album, *When You See Yourself*, in the form of an NFT, generating a reported \$2 million in sales.^{[90][91]} On March 11, 2021, American digital artist Beeple's work *Everydays: The First 5000 Days* became the first NFT artwork to be listed at prominent auction house Christie's and sold for \$69.3 million.^{[92][93]} On March 22, 2021, Jack Dorsey, founder of Twitter and Square, sold an NFT representing his first tweet for over \$2.5 million.^{[61][94]}

The speculative market for NFTs has led more investors to trade at greater volumes and rates.^[93] The buying surge of NFTs was called an economic bubble by experts, who also compared it to the Dot-com bubble.^{[95][96]} By mid-April 2021, demand appeared to have substantially subsided, causing prices to fall significantly; early buyers were reported to have "done supremely well" by *Bloomberg Businessweek*.^{[97][98]} An NFT of the source code of the World Wide Web, credited to internet inventor computer scientist Sir Tim Berners-Lee, was auctioned in June 2021 by Sotheby's in London,^{[99][100][101]} and was sold for USD\$5.4 million.^[102]

Popular culture

Popularity

In 2017, NFTs circulated by CryptoKitties, a project developed by Dapper Labs to sell ownership of unique cat avatars, jumped so much in popularity that a surge in demand took up significant transaction space on the Ethereum blockchain and slowed the entire Ethereum network in December of that year.^{[103][104]}

NFTs became increasingly popular in the early months of 2021 because of numerous high-profile sales,^[87] including an NBA Top Shot video clip of LeBron James for \$208,000, a 3LAU album for \$11.7 million, and a piece by digital artist Beeple for \$69.3 million.^{[87][105][106]} NFT sales exceeded \$220 million in

March 2021 alone, making up nearly half of all-time NFT sales up to that point.^[107] This renewed interest in NFTs, particularly those in art, music, and sports, made way into public consciousness, especially amongst the younger generation.^{[108][109]} A comedy skit on the March 27, 2021 episode of *Saturday Night Live* satirized the popularity of NFTs; the skit was sold as an NFT itself for \$365,000 on April 6, 2021.^[110]

In 2021, many investors have been willing to pay high rates to secure and promote NFTs, anticipating them to be the biggest and most profitable collectibles in the future.^{[111][112]} In April 2021, venture capitalist David Pakman claimed that the growing value of NFTs was redefining the major entertainment industry.^[113] Investors like Mark Cuban have proposed new ways of implementing NFT technology to monetize sports tickets and merchandise sales.^[114]

Criticism

Storage off-chain

NFTs involving digital art generally do not store the file on the blockchain due to its size. The token functions in a way more similar to a certificate of ownership, with a web address pointing to the piece of art in question, making the art still subject to link rot.^[71]

Environmental concerns

NFT purchases and sales are enmeshed in a controversy regarding the high energy use, and consequent greenhouse gas emissions, associated with blockchain transactions.^[115] A major aspect of this is the proof-of-work protocol required to regulate and verify blockchain transactions on public networks, which consumes a large amount of electricity.^{[116][117]} Estimating the carbon footprint of a given NFT transaction involves a variety of assumptions about the manner in which that transaction is set up on the blockchain, the economic behavior of blockchain miners (and the energy demands of their mining equipment),^[118] as well as the amount of renewable energy being used on these networks.^[119] There are also conceptual questions, such as whether the carbon footprint estimate for an NFT purchase should incorporate some portion of the ongoing energy demand of the underlying network, or just the marginal impact of that particular purchase.^[120] An analogy that's been described for this is the footprint associated with an additional passenger on a given airline flight.^[115]

Some more recent NFT technologies use alternative validation protocols, such as proof of stake, that have much less energy usage for a given validation cycle. Other approaches to reducing electricity include the use of off-chain transactions as part of minting an NFT.^[115] A number of NFT art sites are also looking to address these concerns, and some are moving to using technologies and protocols with lower associated footprints.^[121] Others now allow the option of buying carbon offsets when making NFT purchases, although the environmental benefits of this have been questioned.^[122] In some instances, NFT artists have decided against selling some of their own work to limit carbon emission contributions.^[123]

Plagiarism and fraud

There have been examples of "artists having their work copied without permission" and sold as an NFT.^[124] After the artist Qing Han died in 2020, her identity was assumed by a fraudster and a number of her works became available for purchase as NFTs.^[125] A process known as "sleepminting" can also allow

a fraudster to mint an NFT in an artist's wallet and transfer it back to their own account without the artist becoming aware.^[126] This allowed a white hat hacker to mint a fraudulent NFT that had seemingly originated from the wallet of the artist Beeple.^[126]

See also

- List of most expensive non-fungible tokens

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External links

- ERC-721 Standard (<https://ethereum.org/en/developers/docs/standards/tokens/erc-721/>)
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Retrieved from "https://en.wikipedia.org/w/index.php?title=Non-fungible_token&oldid=1040899759"

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