Putting science on your 'wall': how research non-fungible tokens (rNFTs) can help finance science projects (preprint, do not cite without permission, any comments are welcome)

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Abstract

Science is the foundation of human society, contributing to our understanding of human identity and its relationship to nature. Furthermore, it is the basis of the technology on which we rely so closely. Sadly, many great scientific projects are unable to obtain funding due to the limited capacities of funding agencies. Here I wish to show that blockchain technology might serve science as an interesting channel for additional funding, through focusing on non-fungible tokens (NFTs). I am going to introduce the concept of the research non-fungible token (rNFT) and to show its potential benefits for both scientists and investors.

Keywords: non-fungible, NFT, science, research, blockchain, funding

Manuscript

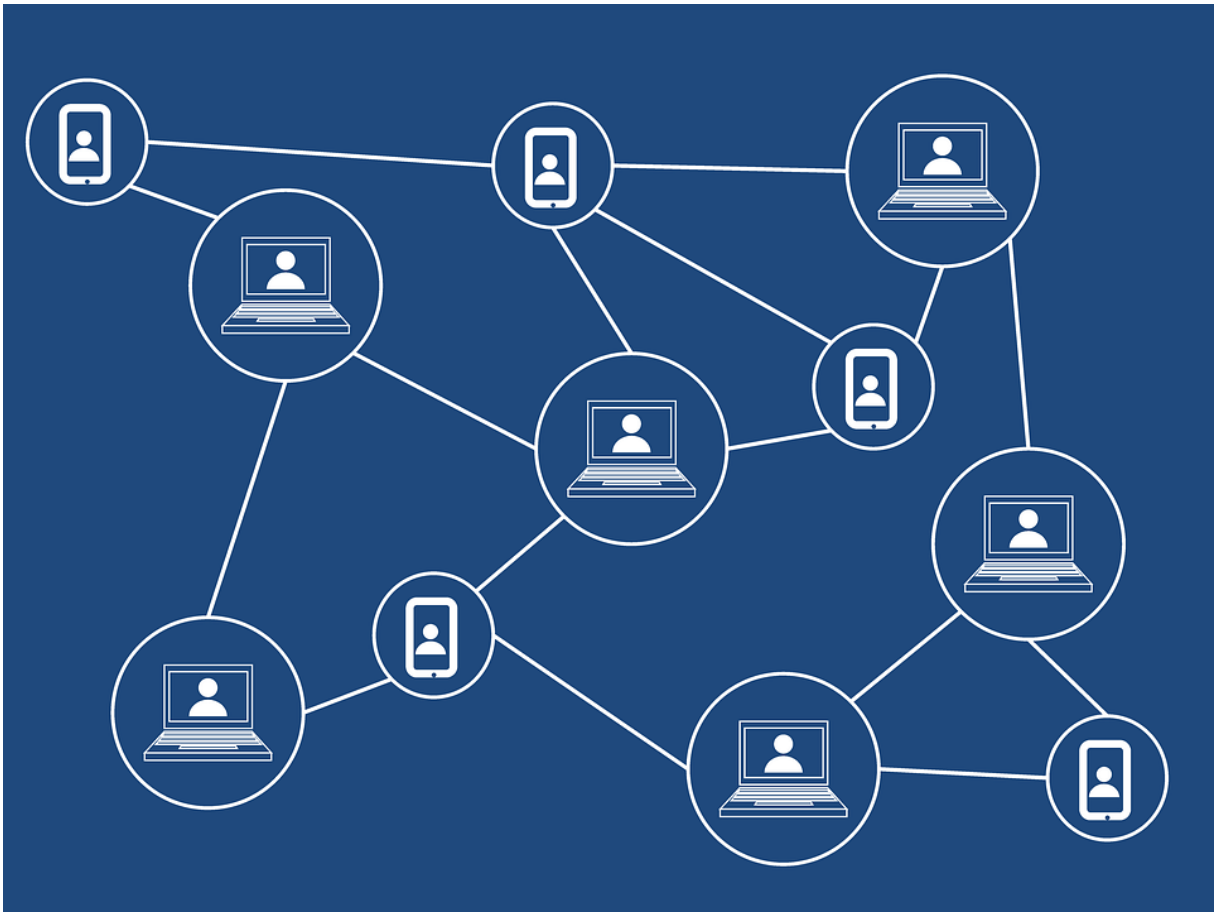
Owning art is great. Most of us would love to hang the original paintings of Leonardo da Vinci or Salvador Dalí on our walls, look at them proudly, and show them off to visitors every Saturday (sigh). Of course, art is not the only product of human culture that fascinates us. Science can mesmerise our minds as well. An even better example is the concept of the holobiont (For review see Suárez and Stencel 2020), which states that a multicellular host and its microbiomes constitute some sort of multi-species being. This changes our perspective by transforming our identity and our relationships to the world, and even influences the humanities, just as the works of famous artists do. For instance, inspired by this concept, the famous Polish Nobel laureate Olga Tokarczuk (2020, p. 15) writes in her new collection of essays:

> We are no longer a biont, but a holobiont, that is, a group of various organisms living together in symbiosis. Complexity, multiplicity, interaction, metasymbiosis – these are the new perspectives from which we view the world.

Wouldn't it be fantastic to own such discoveries, hang them on a wall, and delight in them the same way we delight in famous paintings? No doubt it's, however, it is hard to imagine this. Fortunately for our imagination, non-fungible tokens (NFTs) have come into existence in recent years, changing the way we think about owning art, music, etc. What is a non-fungible token?

Let's start by explaining a blockchain, the basis for NFTs. I will simplify, for a nice introduction read Lewis (2021). A blockchain is a decentralised ledger, hosted simultaneously by multiple participants (called *nods*): a constantly-growing list of records (arranged in blocks) of any sort of data whose constituent items are linked together using cryptographic

methods. A new record can be added to a ledger only after being verified algorithmically by independent participants in the system, each of whom own their own copy of the ledger. The fact that it is decentralised makes it nearly impossible to hack or cheat, as the prospective hacker would have to change the ledgers of every participant.



An NFT is a unit of data which is stored on a blockchain (typically on Ethereum). Even though this storage is based on the same technology used for cryptocurrency (such as Bitcoin or Ethereum), it is fundamentally different, containing extra information that makes it unique. As a result, whereas you can exchange one bitcoin for another, you cannot do the same with NFTs. Thus, when linked to a given digital asset (pictures, music), an NFT gives it a unique

identity (some people call it a digital 'passport'). That's because even thought the digital files themselves are infinitely reproducible, the NFTs representing them are tracked on their underlying blockchains. This property makes it a perfect candidate for service as a certificate of ownership of digital art; thus, it can be bought and sold.

We are currently experiencing a boom in the sale of digital assets; the number of transactions is peaking. The largest and most famous in recent weeks was the sale of Beeple's *Everydays: The first 5000 days* at Christie's for approximately $65 million. Another big winner in the market game was Jack Dorsey, who sold his first-ever tweet as an NFT for about $2.9 million. These are just two famous examples. In general people are selling very different digital assets, such as portions of music, short video clips, creative images, etc. (opensea and rarible are among popular markets). Scientists are also taking the opportunity to participate in this market (Jones 2021). The University of California, Berkeley, auctioned off NFTs based on documents relating to the work of James Allison, a cancer researcher who shared the Nobel Prize in Physiology or Medicine in 2018 with Tasuko Honjo, for more than $50,000. Similarly, George Church and the Nebula company are selling 20 NFTs, each associated with art related to Church, with a special discount for Nebula's whole-genome sequencing service.

Obtaining money to fund future research is one of the most important issues that scientists struggle with. Can we sell NFTs to fund future research? Very little has been done to date in this direction. However, it seems that there is room to use NFTs to fund research. As it was demonstrated by company Planck, guided by its founder Columbia University PhD student Matthew Stephenson, that managed to sell Open Source Science Manuscript 1 for about 13.5 ethereum (cryptocurrency worth approximately $24,000 at the time of auction), with the intention of funding a replication study of Seth Roberts's appetite theory. Another important milestone was reached very recently by VitaDAO, which is a decentralized autonomous organization (DAO) that aims to fund research on longevity. The idea is that investors buy

VITA tokens, providing money for funding research. Then, by owning tokens, can participate in decision-making, like governance of VitaDAOs assets and its research. For instance, they can vote which research project should be funded. In the last days they decided to fund the project run by The Scheibye-Knudsen lab for about $325,000, by owning The Longevity Molecule (IPNFT). For details read this blog post.

Currently I am trying to sell a 'graphic abstract' to fund the first-ever original noncommercial research project, 'The Ontology of the Holobiont' (see here), to be funded by means of the creation of an NFT. The aim of the project is to defend the idea that symbiotic microorganisms are more like host cells than like elements of the environment.

Based on the three examples above, I would like to introduce here the concept of research NFTs (rNFT). What, then, is an rNFT? It is a kind of 'credit token' that a scientist can issue to obtain funding for a project. It might be an open manuscript, video clips, data, graphical abstract (as I have done), music, etc. – whatever one considers the best way to represent one's project. In exchange for money, scientists would offer the performance of certain

research tasks. Thus, by buying these rNFTs, investors convert money to future value by trusting scientists. When the project is done, a reference to these rNFTs is placed in the source of funding section of a scientific paper. As a result, when the paper is published, the token becomes a certificate of project funding. Thus, in one sense, rNFTs are similar to the way worldwide funding agencies work, offering money and credit for scientists, who are then supposed to conduct the studies they have promised in their grant applications and, when the results are in, to acknowledge the agency.

The idea that NFTs can be used for science is not completely new. Previously, many have raised this possibility (see here or here) on internet blogs. However, these individuals were concerned mainly with the 'medium', e.g. determining the best digital medium for NFTs intended to serve science. For instance, the Planck company, founded by Matt Stephenson, argued for the use of digital manuscripts, which is of course a good idea. Investors quite often buy the original manuscripts of famous scientists. However, while I believe these are appropriate, there is no need to privilege one digital item over another. The digital world is a vast sea of possibilities, offering many items that can serve as research tokens. I personally think graphic abstracts constitute the best way of representing a project. A graphic abstract is where science and art meet. Designing a graphic abstract is a way to turn your science into art, because you have to decide how to capture the 'visual essence' of your research. An rNFT is simply a way to embrace the fact that different types of digital items might be used as certificates of financial support for a given project. An rNFT is simply any NFT created in order to obtain funding for a specific research project. rNFT is as well broader than IP NFT, which was used to represent full legal IP rights and data access control to biopharma research, because the former might cover cases of basic research that do not give any IP for investors. This makes IP NFT a special case of rNFT

Funding research through creating rNFTs has the potential to offer many positive aspects for scientists, who can thus attempt to obtain funding for projects of various magnitudes. In principle, there are no upper or lower limits. It is possible to create a single rNFT or a collection of them (for the latter DAOs, such as VitaDao, would be perfect). The former may be better for small projects, the latter for larger in cases where more investors are needed. Nor are there any limits concerning what can be bought using rNFTs, which enables the funding of certain expenses involved in 'novel' projects that conservative foundations would not be willing to cover. Furthermore, creating rNFTs may provide funds for replication studies, since some platforms offer royalties for authors for every resale of the token. So you might easily imagine a situation in which a given investor buys your rNFT and sells it to another investor for double the price he or she originally paid. As a result, you receive a commission, which you might use to finance a replication study.

Therefore, rNFTs may prove a valuable supplement to funding agencies. It is a well-known fact that most prospective studies fail to obtain funding due to the limited capacities of the public system. Therefore, often scientists need to deal with the private sector. Possibly, rNFTs will open up the private sector to an even greater extent, as single individuals or groups of individuals may fund research of interest to even small groups. Imagine that you are working on the geographic distribution of a very specific genus or on the work of a not particularly popular philosopher. Obtaining money from a funding agency may be difficult, unless you conduct your study using some form of trendy advanced technology. Or it may be difficult just because you are unlucky with reviewers – as we all are! But then, if you create rNFTs, you may obtain funding for your project because someone may be very interested in it, such as a private investor who finds your research relevant for their company, or someone who finds your topic entertaining or feels nostalgic about it. It should come as no surprise that emotions play an important role in every aspect of human life. Someone who feels

emotionally bound to your research may be happy to support you, and, indeed, may have certain personal reasons to invest money in a given project. In general, rNFTs open the doors for the introduction of 'citizen science' at a new level. Citizens no longer have to leave their houses in order to participate in building science.

Citizen science concerns the engagement of non-scientists in scientific work at many different levels, from funding to participating in research (Gura 2013). Here, people would contribute by buying rNFTs to contribute to funding science; in choosing specific projects, they would point out the direction in which science should go. This, however, raises an issue. Are non-scientists capable of choosing between science and pseudo-science? Distinguishing between the two is not easy, even for philosophers and scientists (see Hanson 2008). However, this obstacle might be easily solved through the interplay of creators of rNFTs and funding agencies through the use of 'blessed' rNFTs – an idea put forward by Vitalik Buterin (here). Simply put, certain trustworthy institutions would 'bless' tokens, thus providing a sort of justification for their purchase. We know that, while funding agencies deal with many good projects, they cannot fund all of them. This raises a philosophical problem: how should we finance science (e.g. Kitcher 2001)? In this context, a funding agency might bless some rNFTs based on projects which they have evaluated positively but decided to not finance themselves. In this way investors could be sure they were supporting financially sound projects.

This sounds promising, but you may ask 'what's in it for me?'. How would investors benefit from buying rNFTs? Actually, they may receive quite a few benefits. The first and most fundamental is 'the certificate of ownership' of an rNFT. In buying the token, an investor becomes the curator of a scientific project. The investor might post a certificate of the ownership on his or her firm's Facebook 'wall' to show that the firm is supporting a given scientific enterprise. Furthermore, investors might get some sort of rights over the intellectual

property that would result from the research, as in the case of aforementioned research on longevity, The Longevity Molecule (IPNFT). An investor may also benefit emotionally, since he or she is supporting a great scientific project that may change the way we think about a topic. Being proud is a great feeling. Can you imagine the feeling of having, for instance, an rNFT from Darwin's *Beagle* voyage on your Facebook wall? It would be great to know that the money you gave Darwin led to the discovery of one of the most important theories in history! I would pay a great sum to have this on my FB wall. This leads us to another benefit of investing in rNFTs. As opposed to other ways for the private sector to fund basic science, rNFTs offer a chance to make directly money on the success of the project in question. If the results are very interesting, the relevant rNFT increases in value and some people may be happy to buy it from investors, so they can tell everyone that they own the rNFT that financed these fantastic discoveries.

Overall, the use of rNFTs seems to be a good supplemental way to finance scientific projects, one which may provide benefits for investors as well. Of course, we should be aware that it is not free of defects. First of all, the blockchain technology requires a great deal of energy to prevent potential acts of corruption, and thus contributes greatly to the carbon footprint (Jones 2021). Another issue is that it also opens up possibilities for scientific fraud. Some may propose to finance projects and take the resulting money without ever proceeding with the project. This is to be expected, as cheaters tend to emerge in every system. However, here scientists have the upper hand over fraud. A scientific enterprise is based on trust. Of course, this trust sometimes 'collapses' (Roberts et al. 2013). Nevertheless, science possesses tremendous capital in terms of trust; therefore, if any group is capable of creating tokens that will grow in value and that are quite trustworthy, that group is composed of scientists. Trust is the true currency of the future; the use of rNFTs is just a way to embody the trust we put in science.

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