Quantinar: a blockchain p2p ecosystem for honest scientific research

Raul Bag ∗, Bruno Spilak †, Julian Winkel ‡, Wolfgang Karl Härdle §

November 22, 2022

Abstract

Living in the Information Age, the power of data and correct statistical analysis has never been more prevalent. Academics, practitioners and many other professionals nowadays require an accurate application of quantitative methods. Though many branches are subject to a crisis of integrity, which is shown in improper use of statistical models, p-hacking, HARKing or failure to replicate results. We propose the use of a peer-to-peer education network, Quantinar, to spread quantitative analysis knowledge embedded with code in the form of Quantlets. The integration of blockchain technology makes Quantinar a decentralised autonomous organisation (DAO) that ensures fully transparent and reproducible scientific research.

Keywords: Blockchain  JEL classification: C6, C70, I20, I21, L26, L86, O31, O36

*corresponding author, IRTG 1792, School of Business and Economics, Humboldt-Universität zu Berlin, Dorotheenstr. 1, 10117 Berlin, Germany. Email: bagcrist@hu-berlin.de
†IRTG 1792, School of Business and Economics, Humboldt-Universität zu Berlin, Dorotheenstr. 1, 10117 Berlin, Germany
‡IRTG 1792, School of Business and Economics, Humboldt-Universität zu Berlin, Dorotheenstr. 1, 10117 Berlin, Germany
§Humboldt-Universität zu Berlin, BRC Blockchain Research Center, Berlin; IRTG 1792, School of Business and Economics, Humboldt-Universität zu Berlin, Dorotheenstr. 1, 10117 Berlin, Germany; Sim Kee Boon Institute, Singapore Management University, Singapore; WISE Wang Yanan Institute for Studies in Economics, Xiamen University, Xiamen, China; Yushan Scholar National Yang-Ming Chiao Tung University, Dept Information Science and Finance, Hsinchu, Taiwan, ROC; Charles University, Dept Mathematics and Physics, Prague, Czech Republic; Grant CAS: XDA 23020303 and DFG IRTG 1792 gratefully acknowledged
List of Tables

1  Quantinar’s features ......................................................... 8
2  Graph weights ................................................................. 16
3  Performance Measures conditional on initial Wealth Distribution per proposed Paper . .  19
List of Figures

1. Courselet: Pricing Kernels ......................................................... 8
2. Course: Digital Economy and Decision Analytics .......................... 9
3. Software Architecture Overview ................................................. 10
4. Contribution graph ................................................................. 13
5. Contribution graph over periods ............................................... 14
6. PageRank score of Quantinar’s users ........................................ 16
7. Epoch nodes score for one user (in % of the total score, $c = 1$) .... 17
8. Sharpe Ratio conditional on amount of Paper Proposals ................. 19
9. Sharpe Ratio conditional on amount of Stakers ............................ 19
10. Number of users ................................................................. 20
11. Number of courselets per instructor ......................................... 20
12. Users location ................................................................. 21
13. Courselet category distribution ........................................... 22
14. Word occurrence in courselet description .................................. 22
15. Quantlets programming language ........................................ 23
Abbreviations

R  The Ratio $\frac{TrueRelationships}{NotRelationships}$ among all those studied in a specific field.
MVP Minimum Viable Product
MVC Model-View-Controller Software Architecture
CNCF Cloud Native Computing Foundation
## Contents

1 Introduction ............................................. 2

2 Why Quantinar? ........................................ 2
  2.1 Modern academics publish small p-values ............... 3
  2.2 Research Reproducibility in Econometrics ............... 4
  2.3 Can the peer review process ensure quality? ............ 4

3 What is Quantinar? ..................................... 6
  3.1 Content ............................................ 6
  3.2 Features ........................................... 7
  3.3 Applications ....................................... 7
  3.4 Case Study: Prosumer ................................. 7
  3.5 Case Study: Extending a course ......................... 9

4 How? Blockchain, a technology for Open Science ............ 9
  4.1 Technology .......................................... 9
  4.2 Open Access and IPFS ............................... 10
  4.3 Ownership and copyrights: Courselet NFT ................. 11
  4.4 Reward and Reputation system ......................... 12
    4.4.1 Reputation score evaluation ..................... 12
    4.4.2 Reward based on reputation score ............... 15
  4.5 Quantinar CredRank dynamics ......................... 15
    4.5.1 Case study .................................... 15
  4.6 An auction based open peer-review (OPR) ............... 16
    4.6.1 Simulation .................................... 18

5 Quantinar in numbers ................................... 19
  5.1 Community .......................................... 20
  5.2 Content ........................................... 21
### 1 Introduction

The invention of the transistor in 1947 is commonly regarded as the first step into our modern era: The Information Age. Shortly before this point in time, important scientific advances have been accomplished by people such as Ronald Fisher, Egon Pearson and Jerzy Neyman. The interplay between their scientific methods and the means of their efficient application through computation, have paved the way for the inauguration of statistics in various scientific disciplines. The added value through hypothesis testing, causal inference techniques (...) to medicine and psychology (clinical testing), social sciences, economics and policy-making, (...) could hardly be overstated. With the ever-growing influence of statistics, new ways must be explored to preserve and produce knowledge, evaluate ideas and to educate the growing amount of practitioners. We believe that the necessity for a unified platform, that combines these features is evident and that its content should be created, consumed and owned by its community.

Naturally, the concept of a platform economy is not new. There are many top-down approaches that provide single elements of the combined approach that we propose. Journals are a proven way of retaining and furthering knowledge. Yet they are limited in capacity, such as the amount and speed of reviewers. They are also subject to the publication bias, meaning that papers with insignificant results are unlikely to be published, thus skewing research results. The existence of the publication bias is well studied, such as in (Ioannidis, "Methods Matter", ...). Common means of spreading knowledge are available in educational platforms. The search for a fruitful mixture of both theoretical and practical approaches has created many platforms in the education business, like Coursera, EdX, Youtube, etc. all of which share many common strengths and weaknesses. However, they are typically top-down approaches that do not provide ownership for creators (or only under severe limitations) and they fail to connect the creators of knowledge with its consumers and to pave the way for today’s consumers to be tomorrow’s creators.

There have been multiple attempts to define the problem that is lack of quality in quantitative research as enumerated by (van Zwet and Cator; 2021). However, defining the problem is only part of the solution, while creating a framework for quality, reproducible research is another.

**Quantinar** is a peer-to-peer (p2p) platform that strengthens research collaboration and reproducibility in different areas like Fintech, Blockchain, Machine Learning, Explainable AI, Data Science, Digital Economy, Cryptocurrency and Maths & Stats. Its aim is to provide a better integration of scholarly articles, the studied data and the code of the implemented analysis to ensure the reproducibility of the published results, while also providing educational content.

Quantinar’s philosophy is Open Science and its main pillars are the transparency, accessibility, sharing and collaborative-development of knowledge that can be nowadays implemented thanks to Blockchain technology and smart contracts via a decentralized autonomous organisation (DAO) with a tokenized ecosystem. With the recent developments of Web3 technology, Quantinar makes it possible to spread the benefits of AI by equalizing the opportunity to access and monetize data, code and scientific ideas.

The first part of this paper explains the need of Quantinar by reviewing the literature and stating the current problems in modern academics, then the technology used is presented and how Quantinar tries to solve some of the enunciated problems. Finally, the current status of Quantinar is presented with its goals.

### 2 Why Quantinar?

According to Albright (2017), we are living in a so-called post-truth, or fake-news era, where the masses can be manipulated via different information channels. Despite the peer review process, elements of false information are also present in research publications - in the shape of publication bias (Ioannidis; 2005) or HARKing. Thus, a methodology that improves research reproducibility and reliability is much needed.
in today’s academic environment.

First, a clarification of the concept of reproducibility in scientific research is necessary. Goodman et al. (2016) provide a good definition of reproducibility by emphasizing the difference between reproducibility, replicability and repeatability. The authors propose a new terminology:

- the methods reproducibility refers to the provision of enough detail about study procedures and data so the same procedures could, in theory or in actuality, be exactly repeated.
- the results reproducibility refers to obtaining the same results from the conduct of an independent study whose procedures are as closely matched to the original experiment as possible
- finally, the inferential reproducibility refers to the drawing of qualitatively similar conclusions from either an independent replication of a study or a reanalysis of the original study.

Inferential reproducibility might be an unattainable ideal since their might be competing models. However, the desired state of today’s research, namely a framework in which authors can make arguments for or against one’s research can be designed by ensuring a transparent research process, thanks to extensive reporting of the scientific design, measurement, data and analysis. Quantinar offers to integrate an open access to scientific publication with code and data to allow for the result reproducibility and direct communication channels between researchers.

2.1 Modern academics publish small p-values

Along their careers, academics and researchers face nowadays more and more pressure to publish articles, for example: being eligible as a candidate for a PhD student, being eligible for tenure at some universities, or just mere pressure from a funding private entity. This reduces the liberty of choosing the research topic and time to complete the study and can strongly impact the quality of the research process by forcing the researchers to make questionable methodological decisions that would produce "significant" results i.e. with small p-values (Harvey; 2017).

By studying articles in the field of medicine, Ioannidis (2005) concludes that probably most of today’s research findings are biased or even false. Considering \( p = \frac{R}{R+1} \) the probability of a study being true in a specific field where there is either only one true relationship between all those that could be hypothesized, or the chance of finding any of the existing true relationships is the same , he defines the Positive Predictive Value (1) of any given field of study as the post-study probability of it being true, as:

\[
PPV = \frac{(1 - \beta)R}{\beta R + \alpha}
\]  

(1)

The conclusion drawn from this equation is that a study is considered to be true if \((1 - \beta)R > \alpha\). Since usually a study is considered to be true in the academic environment when \(\alpha = 0.05\), this results in it being true if \((1 - \beta)R > 0.05\) (Ioannidis; 2005).

This brings a lot of pressure on the researchers to use unethical practices such as \( p \)-hacking, or HARKing in order to publish their research according to what the academic environment expects of them. \( p \)-hacking refers to all the practices that could result in significant outcomes, that is having a \( p \)-value small enough for a null hypothesis to be rejected. Such practices could be, for example, using only a subset of the data for the estimation, choosing dependent variables post-factum or adding data points if the final estimates are not significant (Bruns and Ioannidis; 2016). HARKing is more specific and probably harder to prevent. It is defined as, "presenting a post-hoc hypothesis (i.e. based or informed on one’s results) in one’s research report as if it were, in fact, an a priori hypothesis" (Kerr; 1998). While
top journals are considered to act as guarantor of quality, they fail at better mitigating the problem, especially in Economics (Brodeur et al.; 2020).

The costs of such practices span from the range of ethical issues that might arise especially in fields like medicine, to a general lack of trust in the field of science, but the literature seems to agree that research reproducibility practices could lower these kinds of practices.

To strengthen even further the main idea presented by Ioannidis, Fanelli (2010) creates a hierarchy of scientific fields, based on the reported support for the tested hypothesis of the published papers in these fields (cf p.5 in Quantinar’s P-hacking courselet). The author draws the conclusion that the scientific fields that have fewer constraints for their biases (psychology, social science, etc.), usually report more positive values than the fields where these constraints are higher (space science).

2.2 Research Reproducibility in Econometrics

Scholarly literature in Econometrics has been long criticized for its lack of reproducibility (Leamer; 1983). The impossibility of sample randomization and control, which are usually not present in empirical studies, highly contributes to misplaced true hypotheses. Based on this critique, Ioannidis and Doucouliagos (2013) argue that problems like the broad flexibility of econometric models and the lack of accounting for multiplicity are still strong problems in empirical Econometrics. To even strengthen the case, Angrist and Pischke (2010), who brought a solid improvement in the econometrics methods, argue that the Leamer’s critique is only part of the problem, the other part being the selective reporting bias. However, when taking those issues into consideration, the conclusion is that "strengthening the reproducibility culture with emphasis on independent replication, conducting larger, better studies, promoting collaborative efforts rather than siloed [...], and reducing biases and conflicts" are ways in which contemporary research in Econometrics can be improved.

On top, since empirical studies are hard to realize in Econometrics, researchers strongly rely on data. In particular, data hungry methods such as machine learning and non-parametric statistics are used more frequently and cannot be reproduced since the data is often private because of cost of building, curating, maintaining, storing, etc. QuantNet (Andriyashin and Härdle; 2007; Borke; 2017), the Blockchain Research Center or PapersWithCode are platform that already promote data and code accessibility as open access libraries. On top, solutions such as CASCaD, ReplicabilityStamp and Code Ocean are trying to address the reproducibility problem by providing a reproducibility stamp to scholarly publications. However, a larger integration between data, code, information and researchers is necessary.

2.3 Can the peer review process ensure quality?

Finally, the last problem Quantinar tries to address concerns the peer review process. The peer review process should ensure quality of the research produced by top journals, however its necessity and effect on scientific research has been discussed and criticized since decades (Ziman; 1968; Spier; 2002; Rowland; 2002; Ware; 2011). The goal of this paragraph is not to give another extensive review of it, but to give a short summary of the literature. Ross-Hellauer (2017) gives a good definition of the generic peer review process as the formal quality assurance mechanism whereby scholarly manuscripts (e.g. journal articles, books, grant applications and conference papers) are made subject to the scrutiny of others, whose feedback and judgements are then used to improve works and make final decisions regarding selection (for publication, grant allocation or speaking time). Its function is twofold: evaluating the validity and assessing the innovation and impact of the submitted work.

The peer review process is used across various disciplines and it is widely agreed that it participates in maintaining the overall quality of the scholarly literature (Rowland; 2002) in particular in medical
Nevertheless, multiple surveys have identified a widespread belief that the current model is sub-optimal (ALPSP; 1999; Ware; 2008) which is caused by the multiple critics against the peer review process. Ross-Hellauer (2017) distinguishes 6 categories among those critics:

- the unreliability and inconsistency of the reviews which is inherent to human judgement
- the delay between submission and publication which slows down the research progress and the expenses associated with the peer review process
- the lack of accountability of the involved agents (authors, editors and reviewers) and risks of subversion introduced by the anonymity of the reviewers (in particular for single blinded reviews)
- social (gender, nationality, institutional affiliation, language and discipline) and publication biases (preference of complexity over simplicity, conservatism against innovative methods, preference for positive results against negative or neutral ones which leads to P-Hacking or HARKing defined in Section 2.1)
- the lack of incentives for reviewers
- and finally the wastefulness: the "black-box" nature of the process hides discussions between reviewers and authors that could benefit younger and future researchers.

Moreover, Heckman and Moktan (2020) show that the top journals in Economics fail to ensure a higher quality of their publications. By comparing cumulative citation counts (measured as of 2018) of articles published in the top5 and those published in 25 non-top5 journals over the ten year period 2000–2010, the authors argue that non top5 journals can produce as many if not more influential articles than the top5, concluding that, whether an article is published in the top5 or not, is a poor predictor of the article’s actual quality in the Economics literature. Finally, Ellison (2011) argues that with the development of Internet the necessity of peer review has lessened for high-status authors by observing a decline of publication from Economists in top-ranked university departments between the early 1990s and 2000s.

Indeed, with the development of Internet and in response to those critics, multiple solutions have been suggested for disseminating research as part of the Open Science movement and in opposition to the traditional science publication process. Vicente-Saez and Martinez-Fuentes (2018) identifies the core elements of Open science, which are the transparency, accessibility, sharing and collaborative-development of knowledge and defines Open science as "transparent and accessible knowledge that is shared and developed through collaborative networks". Platforms such as arXiv or SSRN gather pre-print versions of scientific articles. Academia or ResearchGate are community based platform that act as social medias for researchers where they can upload their articles to gain visibility, connect with other researchers to communicate and increase their network. On top, researchers can easily share their code on CRAN network as R packages or simply as a repository on GitLab or GitHub in any language, which considerably help the associated research reproducibility. Finally, communities such as Hugging Face or Kaggle allow users to collaborate with each other on common tasks by sharing pretrained models, code or datasets in the machine learning universe.

Nevertheless, the previously cited platforms have a centralized infrastructure usually controlled by a private institution which interests do not necessarily align with the community they represent. On top, the data storage is often centralized via a cloud solution such as AWS or Google Cloud and the institution can revoke that access at any time. Finally, Open science cannot free itself from the need for quality control of information via the peer review process. While the literature provides multiple proposals around Open peer review (Ross-Hellauer; 2017) (see section 4.6) and nowadays, many scholarly journals employ versions of open peer review practice, including BMJ, BMC, Royal Society Open Science, Nature
Communications, the PLOS journal, (PLOS), there is no solution that engage a scientific community in an open manner where the researcher and his/her ideas are at the center.

As we have outlined in the previous sections, independent solutions addressing specific issues exist. Our goal is to integrate those ideas into a single platform, namely Quantinar, that should set a new standard for scholarly publications thanks to a vertical integration of article, code and data to allow and verify research reproducibility, a fair and transparent open peer review process, a full control for the researcher over his publications.

3 What is Quantinar?

Quantinar is a peer-to-peer (p2p) platform that strengthens research collaboration and reproducibility in different areas like Fintech, Blockchain, Machine Learning, Explainable AI, Data Science, Digital Economy, Cryptocurrency and Maths & Stats. Its aim is to provide a better integration of scholarly articles, the studied data and the code of the implemented analysis to ensure the reproducibility of the published results. The conceptual architecture of Quantinar, it’s called C5 and it stands for Creation, Content, Consumption, Coins, and Chain. Blockchain technology (chain) and smart contracts via a decentralized autonomous organisation (DAO) with a tokenized ecosystem (coins) can be used today to to promote Open Science, transparency and accessibility of research and collaborative-development of knowledge (Tenorio-Fornés et al.; 2019). In this section, we will present the features, applications, infrastructure and technology of Quantinar.

Quantinar is organized as a Decentralized Autonomous Organization (DAO), an online community that jointly controls the organisation’s funds to pursue common goals (Ethereum’s white paper, 2014 article from Vitalik Buterin). As described in 4.4, the Quantinar DAO will represent a P2P platform for knowledge sharing that will have a reputation based governance, meaning that only active contributors in the academic environment will be able to control the update of the platform and the management of it’s funds. Quantinar’s main goal is to enforce scientific research reproducibility by creating a new digital publication platform that requires more input from scholars, namely giving access to the code, data, results and extra information provided by courselets (see Section 3.1). Moreover, the peer-review process described in 4.6 ensures the quality control needed by an academic journal. On top of that, Quantinar plans to become an integrated solution for presentation, data loading and exploration, code execution and computing power. By creating an integrated research environment, the platform will also offer a marketplace for Datalets, Models or Quantlets (see Section 3.1) that aims to connect the academic environment to the industry. This will generate the revenue needed for the growth of the platform, and for other causes like funding research that the community decides it’s needed. The governance process and tokenomics research of Quantinar will be described in a separate publication. At time of writing, Quantinar (quantinar.com) is a website that manages the following:

3.1 Content

The main content on Quantinar is a "Courselet". A courselet is a scientific research study in the form of slides with a presentation video and the associated PDF file of the slides for reading. If applicable, it must be accompanied by a Quantlet and a Datalet, the associated implementation and data. Any user of Quantinar can create a courselet which will have three status: unverified, verified and peer-reviewed. The unverified status is the default status obtained at the time of publication on Quantinar. The verified status is given if the courselet contains the slides with the link to the verified Quantlet and Datalet, ensuring that the research results can be reproduced. The peer-reviewed status can only be obtained after passing the open peer review process defined in Section 4.6. Finally, a simplified pre-publication
review will be used in order to verify that the uploaded content complies with the platform’s rules, using e.g. AOBDL to avoid offensive content.

The choice of the presentation video format for the Courselet publication is not insignificant. Indeed, it allows a faster sharing of research studies compared to scholarly articles and gives emphasis on scientific ideas and results generation, not formal writing. On top, it does not replace scholarly articles that can always be referred to in the Courselet, but rather motivates reaction and direct communication between Quantinar community members via our discussion channels (see Section 5.1).

Finally, the authors keep their copyright and full ownership of their creation as each Courselet is mapped to a Non-Fungible Token (NFT) (see Section 4.3). They give an open access licence instead.

3.2 Features

Quantinar’s features are designed to benefit the scientific community as a whole. The main planned or already implemented features are summarized in Table 1. In particular, Quantinar answers the needs of three main categories of users. By offering open access of courselet and certification, students and professionals are able to acquire more skills necessary for their careers. By offering a classroom and the possibility to reuse other users’ courselets, universities and professors can attract more students and gain online visibility. Finally, researchers increase their reputation by creating transparent and reproducible research, reviewing other users publications and share knowledge via a simplified publication and communication channel.

3.3 Applications

Quantinar’s purpose is to become a platform that can be used by any person that works in the field of data science, namely students, teachers and researchers.

It can be seen as a student platform, because student’s can easily understand individual research problems in the form of courselets that offer slides and presentation videos accompanied by code examples that are already implemented by top researchers. Moreover, students can enroll into courses that tackle a wider range of subject and get a certification after passing a series of tests to verify their knowledge. Running algorithms in the cloud, exploring datasets and models and sharing their work will all be integrated under the same platform to make studying interactive and accessible.

Quantinar is a teacher platform as much as it is a student one. Teachers can create courselet flowers which link other courselets to their own courses, in order to compose more complex and more complete teaching environments. Apart from that, teacher’s can also get coins, reputation and citations when others use their courselets, feature which is thoroughly described in 4.4.

For researchers, Quantinar delivers the ability to publish courselets that represent their research articles and projects. By doing so, they gain coins, reputation and citations when other people use their research (see Section 4.4). Quality is ensured by a P2P review process that is later described in 4.6. By publishing their work in the form of courselets, researchers have to publish a video presentation, code and data (when possible), on top of the article itself, which strengthens the reproducibility of the results.

3.4 Case Study: Prosumer

Quantinar aims to be a prosumer platform. This means that students can become teachers by creating courselets of their own. Researchers are also encouraged to post their preliminary results and get feedback from the community while also contributing to its’ growth. In Figure 1 we can find an example of a courselet, that represents work done by one of the authors of this paper.
| Feature’s Type       | Feature                          | Status         |
|----------------------|----------------------------------|----------------|
| Content creation     | Upload Courselet                 | Done           |
|                      | Link QuantLet                    | Backlog        |
|                      | Link DataLet                     | Backlog        |
|                      | Make a course from multiple Courselet | Done       |
|                      | Make a classroom                 | Backlog        |
|                      | Start a blog                     | Backlog        |
| Content consumption  | Explore Courselets               | Done           |
|                      | Explore QuantLets                | Backlog        |
|                      | Explore DataLets                 | Backlog        |
|                      | Read Courselet slides            | Done           |
|                      | Watch Courselet video            | Done           |
|                      | Obtain a course certificate      | In Progress    |
|                      | Experiment with code and data    | Backlog        |
|                      | Read blogs                       | Done           |
| Community            | Comment Courselet                | Backlog        |
|                      | Likes and other reaction         | Backlog        |
|                      | Discuss on Discord               | In progress    |
|                      |                                   |                |
| Open peer review     | Call for reviews                 | Backlog        |
|                      | On chain review process          | Backlog        |
|                      |                                   |                |

Table 1: Quantinar’s features

**Pricing Kernels and Risk Premia**

Bitcoin Pricing Kernels are inferred using a novel data set from Deribit, one of the largest Bitcoin derivatives exchanges. This enables arbitrage-free pricing of various instruments. State Price Densities are estimated with Bookley's method.

8 Rating 5 Reviews 20 Students Enrolled
Created by Julian Willen Last Updated 7th November 2023 English

**Figure 1: Courselet: Pricing Kernels**
3.5 Case Study: Extending a course

As we briefly mentioned in Section 3.3, another goal of Quantinar is to become a platform for teachers. Teachers can compose courses using both their own content, and courselets that are already posted on the platform by other prosumers. As we can see in Figure 2, the courselet created in Figure 1 was made available in the Statistics of Financial Markets (SFM) Course. Of course, the other courselets that are available in the SFM course can be further linked to develop courses that are more suitable for other teacher’s visions.

![Figure 2: Course: Digital Economy and Decision Analytics](image)

4 How? Blockchain, a technology for Open Science

4.1 Technology

The Quantinar P2P platform will have most of its operations on-chain, since having decentralization in its core is a strong suit compared to most educational platforms. However, as for academic journals, Quantinar must ensure that each user is indeed a real person and cannot transfer or sell its wallet addresses, and with them, its acquired reputation. In order to do so, a centralized software component with specific capabilities is required, as illustrated in Figure 3.

Indeed, as accountability in the OPR process cannot be achieved without an immutable online identity, the centralized component should be able to provide identity management features such as a Single Sign On or BrowserID solution. (Fett et al.; 2014)
That way, Quantinar can integrate all the different components of the platform under the same umbrella. For this, the Keycloak project (RedHat; 2014) is going to be used, with a simple MySQL Database. An extra layer of information will be sought from the users by using a KYC solution, as for example MouseKYC (MouseBelt; 2019).

Except for identity management, a minimal gateway is needed in order to provide flawless document uploading to an IPFS chain and validate the uploaded content in order to filter out forbidden items or spam. Articles will be uploaded on a public IPFS chain like Filecoin’s (Labs; 2019), while presentations, videos, and other types of content will be uploaded on a private IPFS chain managed by the Quantinar DAO. More information about IPFS can be found under section 4.2.

The Quantinar DAO will be hosted on the Ethereum blockchain, as it is one of the most stable and predictable technology. Moreover, the recent adoption of Proof of Stake and the upcoming implementation of sharding by Ethereum improves its competitiveness with respect to other blockchains. On top, the planned launch of SoulBound tokens, announced in early 2022 by Vitalik Buterin (vitalik.ca/soulbound) comes in good time. SoulBound tokens are special NFTS with immutable ownership and pre-determined immutable burn authorization. Quantinar is a perfect application for SoulBound tokens via the various certifications obtained when passing a course.

Finally, the whole Web3 side of the platform will be written using the Aragon framework (aragon.org), one of the most popular DAO framework on Ethereum. The centralized side of the infrastructure will be hosted on an openstack cloud fully installed and managed by the Quantinar Team.

4.2 Open Access and IPFS

At the center of Quantinar is the Open Access to its content. Nevertheless, it is not enough to guarantee the Open Access of content if it is controlled by a centralised institution such as an online academic Journal. Indeed, the access can be revoked at any time, or even worse, ransomware attacks could take place which would render all of the data on the servers useless.

The InterPlatenary File System (IPFS) is a peer-to-peer protocol that distributes data storage in its network in a decentralised manner, firstly described in "IPFS - Content Addressed, Versioned, P2P File System" as an ambitious vision of new decentralized Internet infrastructure, upon which many different kinds of applications can be built (Benet; 2014). It builds on top of common ideas collected from pieces of software like BitTorrent or Git, to create a protocol that manages Merkle DAG’s containing file data over a network.
There have been multiple attempts at building an IPFS-based storage solution that is ready for solving real-world challenges like decentralizing medical data, as described by (Kumar et al.; 2021), and even more attempts of building IPFS networks for academic data, like the share of databases used for research (Meng and Zhang; 2021), some of which tackled issues like availability, immutability, transparency and security (Kumar et al.; 2021), and even open access to academic research (Marjit and Kumar; 2020).

Decentralisation makes it difficult to restrict the network’s data access. On top of this, thanks to content addressing, files stored using IPFS are automatically versioned (https://ipfs.io/). Thus, by using a decentralised storage system such as IPFS, one cannot revoke the access to the authors' publications or delete an open peer-review article, as Quantinar’s content is shared across an IPFS network. Finally, at times of writing, Filecoin costs are extremely low compared to standard centralized cloud based solutions (<1$/month/TB and 23$ for Filecoin and AWS respectively, source Filecoin and AWS). Quantinar’s network and reputation system is then truly resilient.

We do not propose implementing our own IPFS network, at least not in the beginning and for the open resources of the platform like the papers, videos or accompanying PDF’s. That should all be public information. On top of that, easy access to a completely decentralized, readily available IPFS network is required in order for the platform to take off, this being the second main reason for the usage of the Filecoin network ((Labs; 2019)). The capabilities of token generation of the Quantinar DAO (cf ??), can help support the filecoin storage on a pay as you grow basis.

Of course, private data use cases will be developed in a future phase of the platform that would require a private IPFS network with access control (as seen in (Steichen et al.; 2018)). This will be designed specifically for holding private databases, original LaTeX files or other information which might be seen as sensitive in the eyes of the researchers, companies or universities. Thus, all of the actors will have the power to decide who can access this information. More research and development is required for developing such a feature, which is planned to happen in the second phase of the project.

4.3 Ownership and copyrights: Courselet NFT

Collective NFT (multiple authors)

One goal of Quantinar is to make sure that the researchers keep the copyrights and ownership of their publication. For that goal, Quantinar offers to create a non-fungible token (NFT) for each courselet on the platform and transfer it to the courselet author(s). A NFT is a unique cryptographic token created from a specific smart contract standard (e.g. ERC-721 on Ethereum blockchain) that provides functionalities such as ownership transfer or ownership verification. Thanks to this NFT, any authors can claim ownership on a specific courselet on Quantinar platform by providing the unique hash of the NFT associated to it.

While smart contract and NFT makes it easy to verify ownership of a digital object on the blockchain, copyrights exist in the non-digital world and are governed by state law. Thus, in order to truly ensure copyrights protection, each courselet will be secured with an Open Source license such as MIT or GNU. Finally, authors will keep ownership of the intellectual property (IP) on their work allowing them to publish their study in external academic journals.

Some information such as authors’ identity, courselet title, link to the courselet content, review score and link to reviews will be stored onchain, while in order to reduce storage cost the courselet content and actual reviews will be stored offchain on Quantinar IPFS network defined in the previous section 4.2. Having a courselet NFT with immutable link to versioned content and reviews help to open the iterative publication process during the peer-review feedback loop and protect the integrity of the authors reputation score defined in 4.4.1. Thus, on top of the courselet metadata, all contribution logs will be accessible directly on the blockchain ledger or on the IPFS network ensuring transparency.
4.4 Reward and Reputation system

Since the development of online P2P communities, multiple proposals have been made to ensure trust between members and quality of members contributions in order to develop sustainable p2p platforms. Such a sustainable ecosystem determines the global trust value of each member while making sure that evaluations cannot be gamed in favor of malicious agents.

A well known technique is PageRank algorithm (Page et al.; 1999). While it was originally built for ranking web pages in the context of improving search engines, it serves also as an indicator of the trustworthiness of a website. Since its publication, it has been widely studied (the reader can refer to (Chung; 2014) for a short survey or (Langville and Meyer; 2011)) and extended for example, EigenTrust (Kamvar et al.; 2003) evaluates trust in a distributed-manner within P2P file-sharing communities. Some alternatives have been proposed such as PeerTrust (Xiong and Liu; 2004) which evaluates the members reputation based on specific contextualized parameters such as contribution feedback, number of contributions and credibility of the feedback source. However, PageRank is not famous only because it was created by the founders of Google, but its simplicity, generality, guaranteed existence, uniqueness, and fast computation are the reasons that it is used in many other applications than Google’s search engine and still very popular today. In fact, Gleich (2015) shows how PageRank can be applied to biology, chemistry, ecology, neuroscience, physics, sports, and computer systems.

To estimate the reputation of each member, we propose to use CredRank, an algorithm inspired by PageRank and developed for blockchain based communities by SourceCred (sourcecred.io). We can estimate the value of each contribution relatively to the marginal value it brings to the community as a whole and engage the community by effectively rewarding Quantinar contributors for the labor they provided in order to produce their own contribution. SourceCred provides an algorithm for distributing rewards with a community which is abstract enough to be used in any DAO thanks to the concepts of Grain and Cred. Cred refers to the reputation score defined in the next Section 4.4.1 which is mapped by a utility token that is not transferable and can be gained by contributing to the community. In the Quantinar DAO, the Cred token will be named QNAR. The second concept of SourceCred’s algorithm is Grain, represented by the Quantlet token, QLET, in Quantinar DAO. This token is meant for the creation of an internal research-based economy and will be tradable on external exchanges. It will be used for the payment of developers to generate new features for the platform, gaining access to private courselet components or as payment for consulting top-level researchers inside the platform (see Section 4.4.2).

4.4.1 Reputation score evaluation

Explain why course + courselet nodes, explain linked courselet and minting process (no mint for course, mint for courselet)

In details, all contributions and community members are mapped into a directed graph \( G = (\mathcal{V}, \mathcal{E}, \mathcal{W}) \) where \( \mathcal{V} = \{v_i\}_{1 \leq i \leq n} \) is the set of \( n \) unique vertices mapping contributions and contributors which are connected with \( m \) directed edges, \( \mathcal{E} = \{e_{ij}\}_{(v_i, v_j) \in \mathcal{V}^2} \), where \( e_{ij} \) denotes the edge from parent vertex \( j \) to child vertex \( i \) and \( \mathcal{W} = (w_{ij})_{e_{ij} \in \mathcal{E}} \) with \( w_{ij} \geq 0 \) is the set of \( m \) edges weights which are chosen by the community members in a heuristic manner. The weights have a strong influence on the final PageRank computation and they must ensure that contributions which require a lot of labor gets rewarded more than simpler ones and that they get rewarded when they are validated or reviewed by the community. Indeed, if a contribution \( j \) has multiple children, its score should be propagated forward to the most important child. Figure 4 shows such a graph with 3 community members, John, Alice and Bob, who are connected via the edges between their contributions and interactions. We can clearly see that the rank of courselet \( CL_0 \) will mostly be propagated to its author Alice \((1/(1 + 1/16 + 1/16) = 0.89)\). The following non-
exhaustive list of contributions will be mapped into the graph: creating a courselet, quantlet or datalet, viewing, citing and reviewing a courselet, enrolling as a student into a courselet, actively participating in the discord channels, voting in the DAO decision process and helping other community members with their research.

A simple definition of the PageRank score of vertex $i$ is given in the original paper as:

$$pr(v_i) = \frac{\sum_{j=1}^{n} A_{ij} pr(v_j)}{\sum_{k=1}^{n} A_{kj}}$$

where $A$ is the adjacency matrix of the graph $G$. Based on the random surfer model, where from any node, a user either returns to a random seed node with probability $\alpha$ or continues to a linked node with probability $1 - \alpha$, PageRank is then defined as the stationary distribution of a random walk on the graph $G$ defined by the equation:

$$pr = \alpha s + (1 - \alpha) pr P$$

where $s$ is the n-vector $(1/n, \ldots, 1/n)$, $pr$ is the vector of PageRank score $pr = (pr(v_i))_{1 \leq i \leq n}$, $P$ is the transition probability matrix defined by $\forall 1 \leq i, j \leq n P(i, j) = \frac{w_{ij}}{d_i}$ where $d_i = \sum_j w_{ij}$ is the degree of $v_i$. PageRank can easily be estimated locally on large graphs (Lee et al.; 2013) or globally using the power iteration method if the graph is small enough.

Thanks to PageRank, we can easily evaluate each node score by using the score of all nodes that are directed to it, that way, for each researcher, having backnodes that are highly valuable improves its score more than having backnodes that are less important. This evaluation motivates Quantinar’s members to produce research of high quality.

In our context, since contributions such as "review" or "order" are not at the source of Quantinar’s value, the personalized PageRank is used to define $s$ instead of a uniform distribution over all contributions where $s_i = \frac{pr(v_i)}{\sum_{j \in U} pr(v_j)}$ if $i \in U$ else $s_i = 0$ where $U$ is the set of user and courselet vertices.

Moreover, in order to ensure that new contributors do not suffer from a strong "newcomer effect" having their score undervalued because of "old-timer" score domination, we propose to use the latest CredRank algorithm from SourceCred to evaluate the scores on a discretized historical graph as it is represented in Figure 5.

First, each vertex $i$ is indexed by a timestamp $t$ corresponding to its appearance in Quantinar and
denoted as $v^t_i$. The history is then discretized in $T$ fixed length periods (for example a week). We define $A_k = \{v^t_i, 1 \leq i \leq n, 1 \leq t \leq k, v^t_i$ is a contribution$\}$ as the set of vertices including all contributions until the date $k$. We can easily retrieve the set of new contributions during the period $k \geq 1$ with $A^{new}_k = A_k \setminus A_{k-1}$ and $A^{new}_0 = A_0$. At each period $k$, we create the epoch contributor nodes that authored the new contributions in $A^{new}_k$, that is $C^{new}_k = \{v^k_i, 1 \leq i \leq n \text{ if } e_{ij} \in E \text{ where } v_j \in A^{new}_k\}$. Thus the set of epoch contributor nodes until period $k$ is defined as $C_k = \bigcup_{1 \leq t \leq k} C^{new}_k$. We also add directed edges from the contributions in $A^{new}_k$ to their respective author(s) in $C^{new}_k$.

For any $k$, $1 \leq k \leq T$, we define the epoch contribution graph as $G_k = (V_k, E_k, W)$ where $V_k = A_k \cup C_k$ and $E_k = \{e_{ij}\}_{(v_i, v_j) \in V_k^2}$. The graph update is then given by:

$$G_k = G_{k-1} \oplus \Delta G_k = (V_{k-1} \oplus \Delta V_k, E_{k-1} \oplus \Delta E_k, W)$$

That way, for each contributor $i$, the relative value of its new contributions with respect to past contributions is easily available and given by the score of nodes with index $i$ in $C_k$. In order to compute the global score at a given period, a weighted sum with discount factor is used: at each period $k$, PageRank is evaluated on $G_k$ and the global score for any contributor $v^t_i$ is given by:

$$S^*_i = \sum_{t=1}^{k} c^{k-t} pr(v^t_i)$$

where $c$ is a decay factor.

The above formula is valid for any vertex $v_i$ in the contribution graph. However, every contributions should not be rewarded and since the reputation score is the first step for computing the associated reward, the score is modified to reflect the distribution of the reward more accurately. On top, since $pr(v_i)$ is a probability, $S_i$ defined above can be very small as $n$ increases. That is why SourceCred propose to normalize the score and scale it by the total amount of Cred token minted at a given period.

In order to do so, SourceCred introduces weights for each nodes in the graph which define how many Cred tokens are minted at a given node. The weights are determined by the community based on what the community values in Quantinar. Any node $i$ that have a strictly positive weight $w_i > 0$ will mint $w_i$ QNAR tokens. Let us denote $M_k = \sum_{i=1}^{n} w_i$, the following definition of the reputation score at period $k$
for any contributor $i$ is then used:

$$S_i = \frac{S_i^*}{\sum_{j \in C_k} S_j^*} (M_k + \text{base})$$

(4)

where $C_k$ is the set of original contributor nodes in $G_k$ and $\text{base} = 1000$ is a constant that serves as reference level. With definition (4), the reputation score will increase as the relative contributor page rank score and the total number of contributions that are valuable increase. Finally, it is clear that this reputation system favors competition on the long term because in order to maximise ones reputation score, one needs to maximise the long term value of ones contributions.

### 4.4.2 Reward based on reputation score

SourceCred proposes three types of grain-generation strategies, these being: IMMEDIATE, BALANCED and RECENT. The IMMEDIATE strategy mints one QLET, for each QNAR gained in the past week. The BALANCED strategy mints QLET based on the weights that are given to each action inside the DAO at a given moment. For example, if creating a courselet changed it’s weight from 1 to 2, the QLET target will be recalculated for each author and they will be payed extra for the next contributions inside the platform, in order to catch up. The converse is also true. The last strategy of generating QLET is RECENT. This strategy refers to a weekly weight decay of a certain percentage.

For the Quantinar DAO, the BALANCED strategy will be used, since the concept of a decentralized P2P recent platform is very new, which makes it is more equitable in the long run, for all the contributors, and it allows for a continuous fine-tuning of weights used for QNAR/QLET generation by the whole community.

### 4.5 Quantinar CredRank dynamics

#### 4.5.1 Case study

Quantinar has already implemented certain features and collected some statistics. To illustrate the dynamics of CredRank algorithm for the platform, we made an experiment including:

- Courselet publication as an author
- Courselet enrollment (ordering a courselet as a user)
- Courselet review (grading or commenting a courselet as a user)
- Courselet page view

The graph is created with the contributions {"courselet", "order", "review", "view"} and users nodes. The weighted edges and weighted nodes are defined respectively in Table 2a and 2b and an example of such graph is represented in Figure 4.

Our dataset contains the production SQL dataset from Quantinar platform and Google Analytics statistics of quantinar.com from the inception date on 2021-09-13 to 2022-10-25.

Thanks to the graph structure defined above, the relative contributions value can be measured over time. We can identify various effects. In Figure 6, it is clear that the past score have inertia and participate to the new period score, which ensures that yesterday’s important contributors still have a high score today even if they are not as active. On top, as past contributions become more popular, the share of the past epoch nodes score within the total score will increase, which incentivize community members to appreciate the long term value of their contributions. Indeed, in Figure 7, the most important epoch in July 2022 for the user is 2022-01-31 which contributes with more than 20% to the total score.
Manipulation and Gaming

4.6 An auction based open peer-review (OPR)

An open peer-review process using IPFS and decentralization has already been conceptualized by (Tenorio-Fornés et al.; 2019). Such a process ensures the seven traits of the open peer-review process identified by Ross-Hellauer (2017):

- **Open identities**: Authors and reviewers are aware of each other’s identity.
- **Open reports**: Review reports are published alongside the courselet and versioned using IPFS
- **Open participation**: The wider community are able to contribute to the review process. This is ensured by a the open call for review from the courselet author.
- **Open interaction**: Direct reciprocal discussion between author(s) and reviewers, and/or between reviewers, is allowed and encouraged. Since the authors and reviewers identities are revealed to

| Edge                | Weight |
|---------------------|--------|
| (view, courselet)   | 1e-5   |
| (courselet, user)   | 1      |
| (user, courselet)   | 1/8    |
| (order, courselet)  | 5      |
| (courselet, order)  | 1/16   |
| (user, order)       | 1/8    |
| (order, user)       | 1      |
| (user, review)      | 1/8    |
| (review, user)      | 1      |
| (review, courselet) | 2      |
| (courselet, review) | 1/16   |

(a) Edges weights

| Edge  | Weight |
|-------|--------|
| courselet | 10    |
| review   | 1      |
| order    | 1      |
| view     | 0      |
| user     | 0      |

(b) Contribution weights

Table 2: Graph weights

Figure 6: PageRank score of Quantinar’s users
each other, they are encouraged to chat in a specific Discord channel which is open for reading the community.

- **Open pre-review manuscripts**: Courselets are made immediately available on Quantinar in advance of any formal peer review procedures.

- **Open final-version commenting**: Review or commenting on final courselet publications is allowed directly on the courselet page on Quantinar.

- **Open platforms**: Quantinar is open by design

In Quantinar, on top of addressing the above issues, we propose a new peer-review process that incentivizes community members to review publications in a time effective and fair manner. Let there be a set of entities and smart contracts that governs the game defined with stake owner $S_i$ with stakes $s_i$, paper proposer $P$, paper acceptance status $S$ (Accepted, Denied), auction type $T$, maturity $M$, payoff function $f$, voting function $v$, token QNAR, inflation rate $I$.

The goal of the game is to find a democratic and fair peer-review for a proposed paper and to incentivise publication. While the latter can be achieved through token rewards, a due process is designed for the former. A democratic and fair review is to be defined as one that is simultaneously qualified and aligned with the majority of the network. Since the majority of decision makers is not necessarily objectively right, an incentive structure must be created that assigns a larger weight to those decision makers, who have a history of being right or to publish knowledge which is deemed right (see Section 4.4).

Inflation rate, time to maturity, auction type and payoff function are defined as global variables, whose status can be set by the DAO. The payoff function is in its simplest form a function that sums all bids and assigns a positive (negative) bid-weighted share to each winner (loser). Additionally, each participant receives token units according to the inflation rate after each iteration. A multitude of auction types are possible. Auctions are conducted in terms of a First-price sealed-bid, implemented in a smart contract (Proebsting; 2018). Other classes of auctions might be employed in the future.

Let there be a proposal for a new paper by proposer $P$. The acceptance of the proposal is treated as an auction which inherits above defined global variables. Stake Owners $S_1, S_2, S_3$, of Token QNAR are given the opportunity to participate in the auction. Let’s assume that each Stake Owner enters the auction
as a player. Having reviewed the paper each on their own, the players must decide on the Acceptance Status $S$ in a blind auction. They submit a bid, which is a subset of their stake, encrypted with their public key and their voting decision (Accepted or Denied) as an input to a smart contract. When the auction closes at maturity, all players must publicly disclose their bid. Since their public keys are known, verification of their bid is trivial. In case of a false claim, the player automatically loses their (locked up) bid. Due to the strict negative payoff, there cannot be any incentive to make a false claim.

$$r = \frac{\sum_{j \in L} s_j}{\sum_{i \in W} s_i}$$

$$P(S_i) = \frac{s_i}{\sum_{j \in W} s_j} \times r$$

where $P(S_i)$ is defined as the profit of Staker $S_i$. The index $L$ and $W$ correspond to stakes on a game’s losing or winning side. The ratio of the sum of stakes on either side of the bet balances diminishes the bet’s payoff if a structural imbalance exists.

As an example, use a voting function $v$ for the acceptance status, e.g. meaning that "Accepted" is assigned 1 and "Denied" is assigned -1. Then, at the close of the auction, the voting decision is defined according to the sign of the bid-weighted average of votes. Let player $S_1, S_2$ vote "Accepted" with a stake of 1 and 2 QNARs, whereas player $S_3$ votes "Denied" with 2 QNARs. Then the sum of bids, is 5 QNARs. The voting decision is $1 + 2 - 2 = 1$. The potential payoff for the winners are restricted by the ratio of stakes on each side of the game. This is an optional function that aims to dampen the effects of a strong imbalance of betting forces. It achieves this goal by decreasing the marginal payoff for each Staker to join the stronger side. The sum of bids is then distributed proportionally to the players $S_1$, who receives $(1/3) \times 5$ and $S_2$, who receives $(2/3) \times 5$.

The rate of minted tokens determines the general degree of incentive that potential reviewers have; that is independent of their own abilities. Since only people who participate in reviews receive additional tokens, non-participants bear the cost of inflation. Hence the rate of minted tokens should be decided by the network. In order to prevent proposers to employ trivial strategies to profit from minting, an anti-spam strategy needs to be enforced. We suggest that each proposer is required to submit a minimum bid with each paper. The bid size should also be decided by the network.

4.6.1 Simulation

A simulation study is conducted in order to assess the minimum amount of participants required for a stable system, their time of survival and expected changes in wealth (stakes) conditional on the initial distributions.

An artificial paper acceptance probability is introduced and assumed to be 0.5. Inflation per iteration is 1Q. The aggregate behavior of stakers is simulated. A staker’s Acceptance or denial of a paper is a Bernoulli-distributed random variable with probability 0.5. For each type of initial stake distribution, pareto and uniform, staker’s performances are evaluated for a set of 5, 10, 50, 100, 1000 participants after the rounds 10, 50, 100, 1000, 10000. One round is counted as the proposal of a paper, meaning the submission and subsequent acceptance or denial of a paper.

We find the system to be stable for as little as 5 players. Figure 9 shows that Sharpe Ratios are generally high and positive when there are few stakers. Sharpe Ratios decrease with growing competition, yet stay positive even for large amount of stakers. This behavior is independent of the initial distribution, whether it is uniform- or pareto-distributed. Consequently, reviewers are incentivised to offer their expertise especially when there is a lack of it, because that is when their potential payoff is the highest.
This incentive holds under real-world, uneven distributions such as of the pareto type. Table 3 show the expected return, standard deviation and Sharpe Ratio per round, i.e. per paper proposal conditional on a different type of initial distribution. Under both types of distribution, stakers are strongly incentivised to participate due to the high expected return. While stakers generally earn less under an initial pareto-distributed stake than under a uniform distribution, Sharpe Ratios and expected returns remain high.

![Figure 8: Sharpe Ratio conditional on amount of Paper Proposals](image)

![Figure 9: Sharpe Ratio conditional on amount of Stakers](image)

| Initial Distribution | Expected Return | Standard Deviation | Sharpe Ratio |
|----------------------|-----------------|--------------------|--------------|
| Uniform              | 0.0846          | 0.4127             | 0.2604       |
| Pareto               | 0.0284          | 0.3472             | 0.2059       |

Table 3: Performance Measures conditional on initial Wealth Distribution per proposed Paper

5 Quantinar in numbers

Quantinar ecosystem gather an international community of researchers that produces quality research on diverse scientific topics using modern technologies. At the time of writing, Quantinar already has...
an important community and can offer high quality content with multiple courselets, especially since Quantinar was not officially launched yet.

5.1 Community

Quantinar community consists of 516 users with 51 instructors and 459 simple users. Without a marketing campaign, Quantinar has experienced an important growth in the last months as it is shown in Figure 10.

Still, at the time of writing, only a few instructors contributes most to the courselet creation, as it is shown on Figure 11.

On top, most users are affiliated to Humboldt-Universität zu Berlin and ASE Bucuresti where the platform was originally built. Nevertheless, Quantinar has already attracted users from multiple countries.
and continents (Germany, Romania, United States, China, Singapore, Taiwan, etc.), as it is shown on Figure 12.

![Users' affiliation and Sessions by country](image)

Figure 12: Users location

Thanks to its Discord channel (https://discord.gg/ebS3Bf6gfS), Quantinar’s community is alive, members can follow the latest updates from the platform and interacts.

### 5.2 Content

At time of writing, Quantinar gathers 137 courselets and 5 courses in 8 categories (see Figure 13). The top most views courses are DEDA Digital Economy & Decision Analytics, Statistics of Financial Markets and Advanced Mathematics.

The most recurrent topics are related to cryptos, clustering, price, prediction, marketing or finance, as the world cloud in Figure 14 suggests it. Quantinar’s courselets come with their respective implementation code in Quantlet using mostly R or Python programming languages (see Figure 15).
Figure 13: Courselet category distribution

Figure 14: Word occurrence in courselet description

References

Albright, J. (2017). Welcome to the era of fake news, *Media and Communication* 5(2): 87–89.
Figure 15: Quantlets programming language

ALPSP (1999). What authors want: The ALPSP research study on the motivations and concerns of contributors to learned journals, Association of Learned and Professional Society Publishers, Worthing, UK: ALPSP.

Andriyashin, A. and Härdle, W. (2007). QuantNet, Humboldt-Universität zu Berlin, Wirtschaftswissenschaftliche Fakultät.

Angrist, J. D. and Pischke, J.-S. (2010). The credibility revolution in empirical economics: How better research design is taking the con out of econometrics, *Journal of Economic Perspectives* 24(2): 3–30. URL: https://www.aeaweb.org/articles?id=10.1257/jep.24.2.3

Benet, J. (2014). IPFS - content addressed, versioned, P2P file system, *CoRR* abs/1407.3561. URL: http://arxiv.org/abs/1407.3561

Borke, L. (2017). GitHub API based QuantNet mining infrastructure in r, *SSRN Electronic Journal*. URL: https://doi.org/10.2139/ssrn.2927901

Brodeur, A., Cook, N. and Heyes, A. (2020). Methods matter: p-hacking and publication bias in causal analysis in economics., *American Economic Review* 110(11): 3634–60.

Bruns, S. B. and Ioannidis, J. P. A. (2016). p-curve and p-hacking in observational research, *PLOS ONE* 11(2): 1–13. URL: https://doi.org/10.1371/journal.pone.0149144

Chung, F. (2014). A brief survey of pagerank algorithms, *IEEE Transactions on Network Science and Engineering* 1(1): 38–42.

Ellison, G. (2011). Is peer review in decline?, *Economic Inquiry* 49(3): 635–657. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7295.2010.00261.x

Fanelli, D. (2010). “positive” results increase down the hierarchy of the sciences, *PLOS ONE* 5(4): 1–10. URL: https://doi.org/10.1371/journal.pone.0010068
Fett, D., Küsters, R. and Schmitz, G. (2014). An expressive model for the web infrastructure: Definition and application to the browser id sso system, *2014 IEEE Symposium on Security and Privacy*, pp. 673–688.

Gleich, D. F. (2015). Pagerank beyond the web, *SIAM Review* 57(3): 321–363.

[URL: https://doi.org/10.1137/140976649]

Goodman, S. N., Fanelli, D. and Ioannidis, J. P. A. (2016). What does research reproducibility mean?, *Science Translational Medicine* 8(341): 341ps12–341ps12.

Harvey, C. R. (2017). Presidential address: The scientific outlook in financial economics, *The Journal of Finance* 72(4): 1399–1440.

[URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/jofi.12530]

Heckman, J. J. and Moktan, S. (2020). Publishing and promotion in economics: The tyranny of the top five, *Journal of Economic Literature* 58(2): 419–70.

[URL: https://www.aeaweb.org/articles?id=10.1157/jel.20191574]

Ioannidis, J. and Doucouliagos, C. (2013). What’s to know about the credibility of empirical economics?: Scientific credibility of economics, *Journal of Economic Surveys* 27.

Ioannidis, J. P. A. (2005). Why most published research findings are false, *PLOS Medicine* 2(8): null.

[URL: https://doi.org/10.1371/journal.pmed.0020124]

Kamvar, S. D., Schlosser, M. T. and Garcia-Molina, H. (2003). The eigentrust algorithm for reputation management in p2p networks, *Proceedings of the 12th International Conference on World Wide Web*, WWW '03, Association for Computing Machinery, New York, NY, USA, p. 640–651.

[URL: https://doi.org/10.1145/775152.775242]

Kerr, N. L. (1998). Harking: Hypothesizing after the results are known, *Personality and Social Psychology Review* 2(3): 196–217.

[URL: https://doi.org/10.1207/s15327957pspr0203_4]

Kumar, S., Bharti, A. K. and Amin, R. (2021). Decentralized secure storage of medical records using blockchain and ipfs: A comparative analysis with future directions, *SECURITY AND PRIVACY* 4(5): e162.

[URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/spy2.162]

Labs, P. (2019). Filecoin: A decentralized storage network.

[URL: https://ethereum.org/en/whitpaper/]

Langville, A. N. and Meyer, C. D. (2011). *Google’s PageRank and Beyond*, Princeton University Press, Princeton.

[URL: https://doi.org/10.1515/9781400830329]

Leamer, E. E. (1983). Let’s take the con out of econometrics, *The American Economic Review* 73(1): 31–43.

[URL: http://www.jstor.org/stable/1803924]

Lee, C. E., Ozdaglar, A. and Shah, D. (2013). Computing the stationary distribution locally, in C. Burges, L. Bottou, M. Welling, Z. Ghahramani and K. Weinberger (eds), *Advances in Neural Information Processing Systems*, Vol. 26, Curran Associates, Inc.

[URL: https://proceedings.neurips.cc/paper/2013/file/99bfcfd754a98ce89cb86f73acc04645-Paper.pdf]
Lock, S. (1985). A difficult balance: Editorial peer review in medicine, *London: Nuffield Provincial Hospitals Trust.*

Marjit, U. and Kumar, P. (2020). Towards a decentralized and distributed framework for open educational resources based on ipfs and blockchain, *2020 International Conference on Computer Science, Engineering and Applications (ICCSEA),* pp. 1–6.

Meng, N. and Zhang, S. (2021). University education resource sharing based on blockchain and ipfs, in M. Atiquzzaman, N. Yen and Z. Xu (eds), *Big Data Analytics for Cyber-Physical System in Smart City,* Springer Singapore, Singapore, pp. 1808–1813.

MouseBelt (2019). Mousekyc.

URL: [https://github.com/mousebelt/mousekyc](https://github.com/mousebelt/mousekyc)

Page, L., Brin, S., Motwani, R. and Winograd, T. (1999). The pagerank citation ranking: Bringing order to the web., *Technical Report 1999-66,* Stanford InfoLab. Previous number = SIDL-WP-1999-0120.

URL: [http://ilpubs.stanford.edu:8090/422/](http://ilpubs.stanford.edu:8090/422/)

PLOS (n.d.). [https://plos.org/resource/open-peer-review/](https://plos.org/resource/open-peer-review/). Accessed: 2022-06-17.

Proebsting, T. (2018). Writing a sealed-bid auction contract.

URL: [https://programtheblockchain.com/posts/2018/03/27/writing-a-sealed-bid-auction-contract/](https://programtheblockchain.com/posts/2018/03/27/writing-a-sealed-bid-auction-contract/)

RedHat (2014). Keycloak.

URL: [https://www.keycloak.org/](https://www.keycloak.org/)

Ross-Hellauer, T. (2017). What is open peer review? a systematic review, *F1000Res* 6(588).

Rowland, F. (2002). The peer-review process, *Learned Publishing* 15(4): 247–258.

URL: [https://onlinelibrary.wiley.com/doi/abs/10.1087/095315102760319206](https://onlinelibrary.wiley.com/doi/abs/10.1087/095315102760319206)

Spier, R. (2002). The history of the peer-review process, *Trends in biotechnology* 20(8): 357–8.

Steichen, M., Fiz, B., Norvill, R., Shbair, W. and State, R. (2018). Blockchain-based, decentralized access control for ipfs, *2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData),* pp. 1499–1506.

Tenorio-Fornés, A., Jacynycz, V., Llop-Vila, D., Sánchez-Ruiz, A. and Hassan, S. (2019). Towards a decentralized process for scientific publication and peer review using blockchain and IPFS, *Proceedings of the 52nd Hawaii International Conference on System Sciences.*

van Zwet, E. W. and Cator, E. A. (2021). The significance filter, the winner’s curse and the need to shrink, *Statistica Neerlandica* 75(4): 437–452.

URL: [https://onlinelibrary.wiley.com/doi/abs/10.1111/stan.12241](https://onlinelibrary.wiley.com/doi/abs/10.1111/stan.12241)

Vicente-Saez, R. and Martinez-Fuentes, C. (2018). Open science now: A systematic literature review for an integrated definition, *Journal of business research* 88: 428–436.

Ware, M. (2008). Peer review: Benefits, perceptions and alternatives, *Publishing Research Consortium* 4.
Ware, M. (2011). Peer review: Recent experience and future directions, *New Review of Information Networking* **16**(1): 23–53.
URL: https://doi.org/10.1080/13614576.2011.566812

Xiong, L. and Liu, L. (2004). Peertrust: Supporting reputation-based trust for peer-to-peer electronic communities, *Knowledge and Data Engineering, IEEE Transactions on* **16**: 843 – 857.

Ziman, J. M. (1968). *Public Knowledge: An Essay Concerning the Social Dimension of Science*, London: Cambridge University Press.