

# **Decentralised Autonomous Organisations (DAOs) as Data Trusts: A general-purpose data governance framework for decentralised data ownership, storage, and utilisation**

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## **Abstract**

This piece investigates if and how principles of data trusts might apply to “Decentralised Autonomous Organisations” (DAOs) as a data governance structure for digital data trusts. In data trusts, a responsible party is legally appointed to act as the trustee over a group of people’s data. Their duty is to act on behalf of the preferences of the contributors and beneficiaries of data as an independent fiduciary steward of that data. The intent behind Decentralised Autonomous Organisations is to enable people to coordinate and govern themselves, mediated by self-executing rules encoded in software on a public blockchain. Rather than appointing a data steward to negotiate and enforce rules through legal mechanisms, rules in decentralised blockchain-based systems are inscribed in software code where they are transparent, verifiable, and enforceable, and digital tokens are used to align incentives among diverse stakeholders in the system. If DAOs were data trusts, then the DAO would have the fiduciary duty for data governance on behalf of the interests of participants. To explore this idea, I outline the fundamentals of trusts, the concept of data trusts as a data governance framework, and the idea of DAOs as data trusts to steward and utilise data on behalf of participants. I then explore possible use cases and early examples of this governance infrastructure in practice in blockchain communities. I find that DAOs are a promising digital governance infrastructure for people to operationalise the principles of data trusts where the promise of data stewardship is entrusted to software code and self-governance, rather than third-party legal representatives. This contribution lends itself to further scholarly research and industry practice to test the concept of DAOs as data trusts as a data governance model for greater individual autonomy, verifiability, and benefit over one’s data and how it is used.

## **Introduction**

Data utilisation and monetization is a critical challenge of the information age, as data is abstracted away from the individuals it belongs to and stored in silos, where corporates extract value without consent or benefit.<sup>1</sup> What is missing is a governance framework and institutional enforcement mechanism that places participants in control of their data to own, utilise, and benefit from it. A data trust is a relatively new concept, predicated on participatory, democratic, cooperative governance structures whereby a representative is legally appointed to act as an independent fiduciary steward of data.<sup>2</sup> Generally, data is pooled among participants in a data trust and a representative is legally appointed to represent the interests of members in the utilisation (for example, monetisation) of that data. Trusts have operated this way to look after and make decisions about common pool resources on behalf of a local community in other

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<sup>1</sup> Zuboff, Shoshana. 2019. *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*. 1st edition. New York: Public Affairs.

<sup>2</sup> Open Data Institute, “What Is a Data Trust? – The ODI.” 2018. Accessed January 4, 2022.  
<https://theodi.org/article/what-is-a-data-trust/>.

contexts, such as land and pension funds.<sup>3</sup> Meanwhile, “Decentralised Autonomous Organisations” (DAOs) are participatory governance structures for collective self-governance of digital resources where rules are arbitrated by software code.<sup>4</sup>

This piece explores an idea proposed in a recent working paper on if and how principles of data trusts might apply to “Decentralised Autonomous Organisations” (DAOs) as a decentralised data governance structure for digital data trusts, whereby software encoded rules of a protocol act on participants behalf, rather than an externally appointed legal representative as trustee, and by which users can own, store, and choose how their data is utilised.

I explore the fundamentals of trusts, the concept of data trusts as a data governance framework, and the idea of DAOs as data trusts to steward and utilise data on behalf of participants. I then explore possible use cases and early examples of this governance infrastructure in practice in blockchain communities. I argue that if DAOs were designed and programmed to operate like data trusts, then the DAO would have the fiduciary duty for data governance on behalf of the interests of participants, and this would be enforceable in the rules of the system. Thus, issues of enforcement around data use and abuse in the digital economy could potentially be mitigated. DAOs are a promising digital governance infrastructure for people to operationalise the principles of data trusts where the promise of data stewardship is entrusted to software code and self-governance, rather than third-party legal representatives.

This contribution invites further scholarly research and industry practice to test the concept of DAOs as data trusts as a data governance model for greater individual autonomy, verifiability, and benefit over one’s data and how it is used.

## **Data Governance: from Data Trusts to Data DAOs**

### *Legal trust structures*

Trusts have existed for centuries and are an important innovation in property rights law by separating properties’ legal ownership and control from its equitable ownership and benefits.<sup>5</sup> A trust is a legal relationship in which the holder of a right, known as a “beneficiary” or “trustor”, gives it to another person or entity, known as a “trustee”, to keep and use it on their behalf for another’s benefit.<sup>6</sup> Thus, the trustee is the legal owner of the property in trust and fiduciary on behalf of the beneficiary or beneficiaries, who are the equitable owner of the property of the trust. Trustees are generally compensated for performing their role and penalised through the legal system for breaching their fiduciary duty in a court of law. Examples of trusts include land trusts, testamentary trusts, purpose trusts, share ownership in employee trusts, and co-ownership.

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<sup>3</sup> Centre for International Governance Innovation. “What Is a Data Trust?” 2018. Centre for International Governance Innovation. October 9, 2018. <https://www.cigionline.org/articles/what-data-trust/>.

<sup>4</sup> Nabben, Kelsie and Puspasari, Novita and Kelleher, Megan and Sanjay, Sadhana. “Grounding Decentralised Technologies in Cooperative Principles: What Can ‘decentralised Autonomous Organisations’ (DAOs) and Platform Cooperatives Learn from Each Other?”. (December 6, 2021). <http://dx.doi.org/10.2139/ssrn.3979223>

<sup>5</sup> Scott, Austin. “Importance of the Trust”. *University of Colorado Law Review*. *U. Colo. L. Rev.* 39: 177. [doi:10.2307/1598930](https://www.jstor.org/stable/1598930). JSTOR 1598930.

<sup>6</sup> Hansmann, Henry, and Ugo Mattei. “The Functions of Trust Law: A Comparative Legal and Economic Analysis,” *New York University Law Review* 73, no. 2 (May 1998): 434-479.

While there are no one-size-fits-all solution data governance frameworks, data trusts are a novel data governance structure among others, including data collaboratives, data foundations, and data cooperatives.<sup>7</sup> The next section will explore the concept of data trusts.

### *Data trusts*

Data trusts are a relatively new concept, predicated on participatory, democratic, cooperative governance structures whereby a legal entity acts as an independent fiduciary steward of data.

Data trusts are a data governance and utilisation structure that allows individuals to state their aspirations for data use and mandates a trustee to represent those interests through the legal mechanism of trusts.<sup>8</sup> The trustee bears a fiduciary duty to exercise data rights on behalf of beneficiaries. The aim is to return power to individuals regarding the use of their data through data stewardship, meaning “the trustworthy and responsible use and management of data” to unlock the value of aggregated data in a fairer way.<sup>9</sup> In other words, data trusts aim to address dark patterns of data use that create vulnerabilities for individuals or groups as patterns of data collection and use continue to evolve.<sup>10</sup>

A key motivation behind data trusts is to distribute the benefits arising from data more equitably. According to Delacroix and Lawrence, to be effective, data trusts need to be representative of the concerns of data subjects. “A successful data Trust will be one whose constitutional terms better encapsulates the aspirations of a large part of the population.”<sup>11</sup> Data trusts can be built as highly participatory organisations that require systematic input from the individuals that set up the data trust, or delegate coordination to the data trustee the responsibility to determine what type of data processing is to the beneficiaries’ interest.<sup>12</sup> In either model, members pool their data and appoint a legal trustee, that is bound by a fiduciary obligation to exercise data rights on behalf of the trust’s beneficiaries. This includes negotiations between the data trustee on aggregated data on behalf of beneficiaries, and data collectors or analytics organisations on how the data is utilised or monetised, in accordance with the terms of the trust.<sup>13</sup> A data trust relies on regulatory instruments, such as the General Data Protection Regulation framework in the EU to confer rights, and for what type of data. “Like powers of attorney, data trusts are flexible and de facto global, meaning that they can be written in ways that create legally accountable governance structures. It’s helpful to think about a data trust as a container — one that can hold assets, define governance and manage

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<sup>7</sup> Ada Lovelace Institute and UK AI Council, Exploring legal mechanisms for data stewardship, <https://www.adalovelaceinstitute.org/report/legal-mechanisms-data-stewardship>.

<sup>8</sup> Sylvie Delacroix, Neil D Lawrence, Bottom-up data Trusts: disturbing the ‘one size fits all’ approach to data governance, *International Data Privacy Law*, Volume 9, Issue 4, November 2019, Pages 236–252, <https://doi.org/10.1093/idpl/ipz014>.

<sup>9</sup> Ada Lovelace Institute and UK AI Council, Exploring legal mechanisms for data stewardship, <https://www.adalovelaceinstitute.org/report/legal-mechanisms-data-stewardship>.

<sup>10</sup> Ada Lovelace Institute and UK AI Council, Exploring legal mechanisms for data stewardship, <https://www.adalovelaceinstitute.org/report/legal-mechanisms-data-stewardship>.

<sup>11</sup> Sylvie Delacroix, Neil D Lawrence, Bottom-up data Trusts: disturbing the ‘one size fits all’ approach to data governance, *International Data Privacy Law*, Volume 9, Issue 4, November 2019, Pages 236–252, <https://doi.org/10.1093/idpl/ipz014>.

<sup>12</sup> Ada Lovelace Institute and UK AI Council, Exploring legal mechanisms for data stewardship, <https://www.adalovelaceinstitute.org/report/legal-mechanisms-data-stewardship>.

<sup>13</sup> Sylvie Delacroix, Neil D Lawrence, Bottom-up data Trusts: disturbing the ‘one size fits all’ approach to data governance, *International Data Privacy Law*, Volume 9, Issue 4, November 2019, Pages 236–252, <https://doi.org/10.1093/idpl/ipz014>.

liabilities”.<sup>14</sup> The Open Data Institute describes the essential characteristics of a data trust as: a clear purpose, a legal structure (including trustors, trustees with fiduciary duties and beneficiaries), some rights or duties over stewarded data, a clearly defined decisions making process, an articulation of how benefits are shared, and a sustainable funding model.<sup>15</sup>

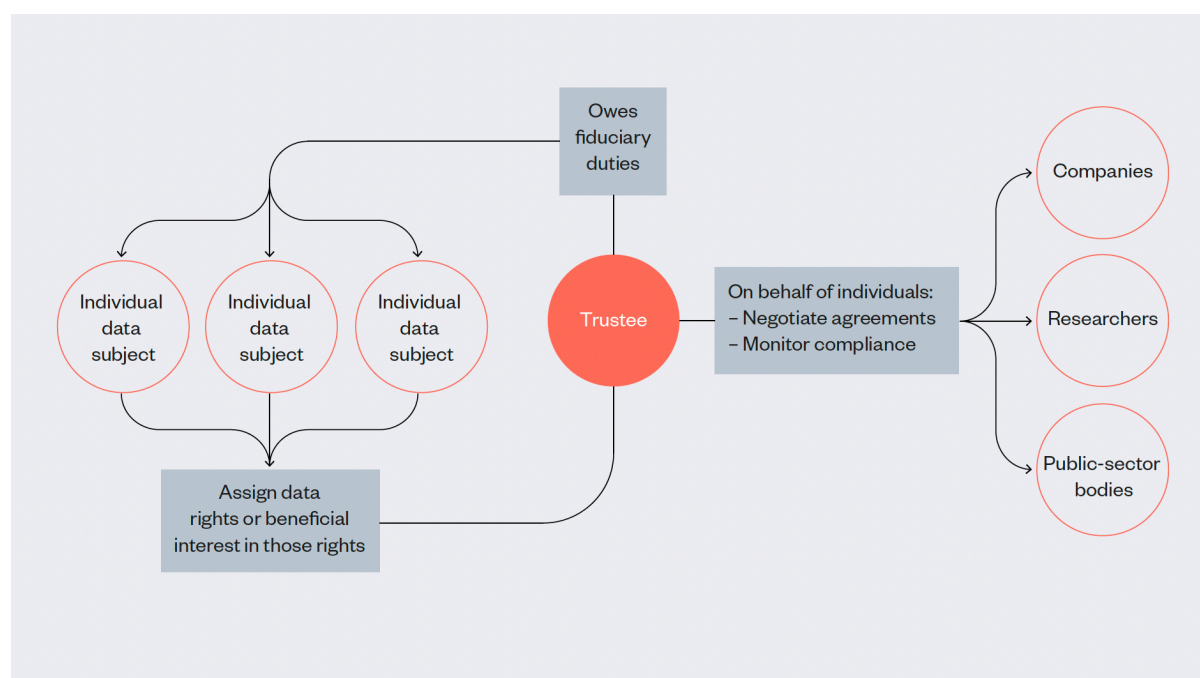


Diagram 1: “How data trusts work”.<sup>16</sup>

Data trusts create a vehicle for individuals to state their aspirations for data use and appoint a trustee to pursue these aspirations for stronger accountability to individuals regarding their data. Once data is pooled and governed under a data trust, it can be utilised in the interests of the constituents of the trust, who become both data providers, and data beneficiaries. In “bottom up” data trusts, beneficiaries are the data subject that pool their data and data trustees have a fiduciary responsibility to exercise their interests in data use and rights, such as entering into data sharing agreements on their behalf, negotiating terms with service providers, and monitoring compliance with terms of agreements by leveraging the negotiating power of pooled data in negotiations.<sup>17</sup> Uses of the data could include data monetisation through selling data or data mining, as well as donation, for example, medical research. This collective consent and bargaining structure which aims to protect the interests of individuals is viewed as an approach to realise the data mining potential of large datasets, without compromising the rights of individuals.

<sup>14</sup> Centre for International Governance Innovation. “What Is a Data Trust?” 2018. Centre for International Governance Innovation. October 9, 2018. <https://www.cigionline.org/articles/what-data-trust/>.

<sup>15</sup> Open Data Institute. “Defining a ‘Data Trust’ – The ODI.” October 19, 2018. Accessed January 5, 2022. <https://theodi.org/article/defining-a-data-trust/>.

<sup>16</sup> Ada Lovelace Institute and UK AI Council, Exploring legal mechanisms for data stewardship, <https://www.adalovelaceinstitute.org/report/legal-mechanisms-data-stewardship>. Pg. 30. Accessed 5 January, 2021.

<sup>17</sup> Sylvie Delacroix, Neil D Lawrence, Bottom-up data Trusts: disturbing the ‘one size fits all’ approach to data governance, *International Data Privacy Law*, Volume 9, Issue 4, November 2019, Pages 236–252, <https://doi.org/10.1093/idpl/ipz014>.

The benefits of data trusts are numerous. Beyond providing the structure of fiduciary governance (i.e. flexible vehicles that can minimise and contain the risks around experimenting with different models of governance), data trusts can act as a way for data rights holders to aggregate and build leverage towards collective bargaining for more balanced, publicly beneficial data relationships.<sup>18</sup> Data trusts are viewed as a potential structure for greater self-determination over data privacy after years of “weak consent based models” of check boxes and legal jargon.<sup>19</sup> Data trusts also form a solid basis for experimentation to solving problems that require data in the ability to adapt and develop the rules of governance and use according to specific use cases. Data trusts can continue to steward, maintain, and manage how data is used and shared, including access, who gets to define those terms, and penalties for misbehaviour. Scholars envision an “ecosystem” of data trusts with different rules and risk profiles so that individuals can choose and change how their data is utilised for public good purposes or financial returns.<sup>20</sup> Outlined case studies for data trusts include medical data, genetic data, social media data, financial data, and loyalty card data.<sup>21</sup>

### *Existing limitations of data trusts*

The drawbacks or contentions with data trusts are that flexibility in the preferences of beneficiaries and the rules of the trust mean that data trusts can’t make strong guarantees that rules will be enforceable in an efficient manner, that data will be well governed, or that appropriate business models will be applied to steward data in the individuals’ or public interest.<sup>22</sup> As data trusts develop from theory to practice, gaps in understanding about the form and function of these trusts remain, including where they fit in the broader data governance landscape in terms of their core capabilities, accountability and enforceability which is dependent on incumbent institutional safeguards, accessibility for broad participation and inclusion in design and decision-making, finance and sustainability, and implementation.<sup>23</sup> For example, technical architectural challenges, such as how an individual disentangles and extracts their unique data to “exit” a trust once it is collected and collated is difficult, if not impossible.

Next, this paper will explore Decentralised Autonomous Organisations as a data governance infrastructure that is analogous to data trusts, termed “Data DAOs”.<sup>24</sup>

<sup>18</sup> Centre for International Governance Innovation. “What Is a Data Trust?” 2018. Centre for International Governance Innovation. October 9, 2018. <https://www.cigionline.org/articles/what-data-trust/>.

<sup>19</sup> Ruhaak, Anouk. “How Data Trusts Can Protect Privacy.” February 24, 2021. MIT Technology Review. Accessed January 4, 2022. <https://www.technologyreview.com/2021/02/24/1017801/data-trust-cybersecurity-big-tech-privacy/>.

<sup>20</sup> Sylvie Delacroix, Neil D Lawrence, Bottom-up data Trusts: disturbing the ‘one size fits all’ approach to data governance, International Data Privacy Law, Volume 9, Issue 4, November 2019, Pages 236–252, <https://doi.org/10.1093/idpl/ipz014>.

<sup>21</sup> Sylvie Delacroix, Neil D Lawrence, Bottom-up data Trusts: disturbing the ‘one size fits all’ approach to data governance, International Data Privacy Law, Volume 9, Issue 4, November 2019, Pages 236–252, <https://doi.org/10.1093/idpl/ipz014>.

<sup>22</sup> Centre for International Governance Innovation. “What Is a Data Trust?” 2018. Centre for International Governance Innovation. October 9, 2018. <https://www.cigionline.org/articles/what-data-trust/>.

<sup>23</sup> Data Trusts Initiative (2020). Data Trusts: from theory to practice, working paper 1 [online] Data Trusts Initiative. Available at: <https://static1.squarespace.com/static/5e3b09f0b754a35dc4111ce/t/5fdb21f9537b3a6ff2315429/1608196603713/Working+Paper+1+-+data+trusts+-+from+theory+to+practice.pdf>. Accessed 04 Jan. 2022.

<sup>24</sup> Young, A., & Verhulst, S. G. (2020). Data collaboratives. In P. Harris, A. Bitonti, C. S. Fleisher, & A. Skorkjær Binderkrantz (Eds.), *The palgrave encyclopedia of interest groups, lobbying and public affairs* (pp. 1–5). doi:10.1007/978-3-030-13895-0\_92-1; Stalla-Bourdillon, S., Carmichael, L., & Wintour, A. (2021).



## A Proposal for “Decentralised Autonomous Organisations” as Data Trusts

### *Decentralised Autonomous Organisations*

The term “DAO” stands for “Decentralised Autonomous Organisation” and describes a blockchain-based system that enables people to coordinate and govern themselves mediated by a set of self-executing rules deployed on a public blockchain, and whose governance is decentralised from central control (although the term pre-dates blockchain technology and applications).<sup>25</sup> In a data trust, the “overriding aim of the governance structure [of data trusts] is to achieve trust” between participants and wider stakeholders.<sup>26</sup> Conversely, blockchain technology provides an infrastructure to distributed trust between disparate parties and enforce rules through software code for collective self-governance. Blockchain is sometimes referred to as “trustless” infrastructure.<sup>27</sup> This governance philosophy and technology emerges from the ideas of a distributed group of activists known as the “cypherpunks” that advocated for the use of encrypted technologies for greater individual rights in society.<sup>28</sup> From these origins, “DAOs” have been ideated and invented to facilitate the collective self-governance of cryptocurrencies, social tokens, decentralised finance protocols, and more.<sup>29</sup> “...instead of a hierarchical structure managed by a set of humans interacting in person and controlling property via the legal system, a decentralised organization involves a set of humans interacting with each other according to a protocol specified in code, and enforced on the blockchain” states co-founder of the Ethereum blockchain Vitalik Buterin in 2014.<sup>30</sup> Decentralised digital infrastructure is designed to address structural power imbalances and thus, natively decentralised institutional structures are relevant to explore pertaining to data governance.

What is required to design DAOs as data trusts is a clear purpose, an infrastructure of smart contracts and tokens, clear rights and duties over stewarded data, clearly defined decision-making processes, an articulation of how benefits are shared, and a tokeneconomic model for sustainable funding. With a DAO as a data trust, the DAO itself is the trustee with fiduciary responsibility for stewarding data towards beneficiaries, with rules represented and enforced in software code rather than sovereign jurisdictional legislation and legal enforcement mechanisms. In this crypto-institutional structure, blockchain-based digital tokens are

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Fostering trustworthy data sharing: Establishing data foundations in practice. *Data & Policy*, 3, e4. doi:10.1017/dap.2020.24; Bianchi, M., & Vieta, M. (2019). Italian Community Co-operatives Responding to Economic Crisis and State Withdrawal: A New Model for Socio-Economic Development. *UN Inter-Agency Task Force on Social and Solidarity Economy*. [https://asvis.it/public/asvis2/files/Italian-Community-Co-operatives-UN\\_paper.pdf](https://asvis.it/public/asvis2/files/Italian-Community-Co-operatives-UN_paper.pdf).

<sup>25</sup> Hassan, Samer, and Primavera De Filippi. 2021. “Decentralized Autonomous Organization.” *Internet Policy Review* 10 (2). <https://policyreview.info/glossary/DAO>; Nabben, Kelsie, Imagining Human-Machine Futures: Blockchain-based 'Decentralized Autonomous Organizations' (October 30, 2021). <http://dx.doi.org/10.2139/ssrn.3953623>.

<sup>26</sup> Reed, Chirs, BPE solicitors and Pinsent Masons, *Data trusts: Legal and Governance Considerations* (2019). <<https://theodi.org/wp-content/uploads/2019/04/General-legal-report-on-data-trust.pdf>> accessed 10 September 2019.

<sup>27</sup> Berg, Chris and Davidson, Sinclair and Potts, Jason, Blockchains Industrialise Trust (November 19, 2017). <http://dx.doi.org/10.2139/ssrn.3074070>.

<sup>28</sup> “Cypherpunk – BitcoinWiki.” n.d. Accessed January 4, 2022. <https://en.bitcoinwiki.org/wiki/Cypherpunk>.

<sup>29</sup> Nabben, Kelsie. 2021. “Experiments in Algorithmic Governance Continue.” Substack newsletter (blog). July 29, 2021. <https://kelsienabben.substack.com/p/experiments-in-algorithmic-governance>.

<sup>30</sup> Buterin, Vitalik. “DAOs, DACs, DAs and More: An Incomplete Terminology Guide.” *Ethereum Foundation*. 2014. Accessed January 4, 2022. <https://blog.ethereum.org/2014/05/06/daos-dacs-das-and-more-an-incomplete-terminology-guide/>.

leveraged as value to align incentives, such as a reward to beneficiaries for contributing data, as payment to fund the operations of the DAO and DAO labour, or as staked collateral which risks penalty upon misbehaviour to enforce good behaviour in the system.<sup>31</sup> Where rules or conduct are beyond the enforcement capabilities of the blockchain are suspected to be violated, DAOs are adopting a range of arbitration mechanisms, including decentralised, software-based “courts” such as “Kleros” and “Celeste”.<sup>32</sup> Software encoded data DAOs means that the rules pertaining to data governance, portability, erasure, access, and use can be verifiable and enforceable.

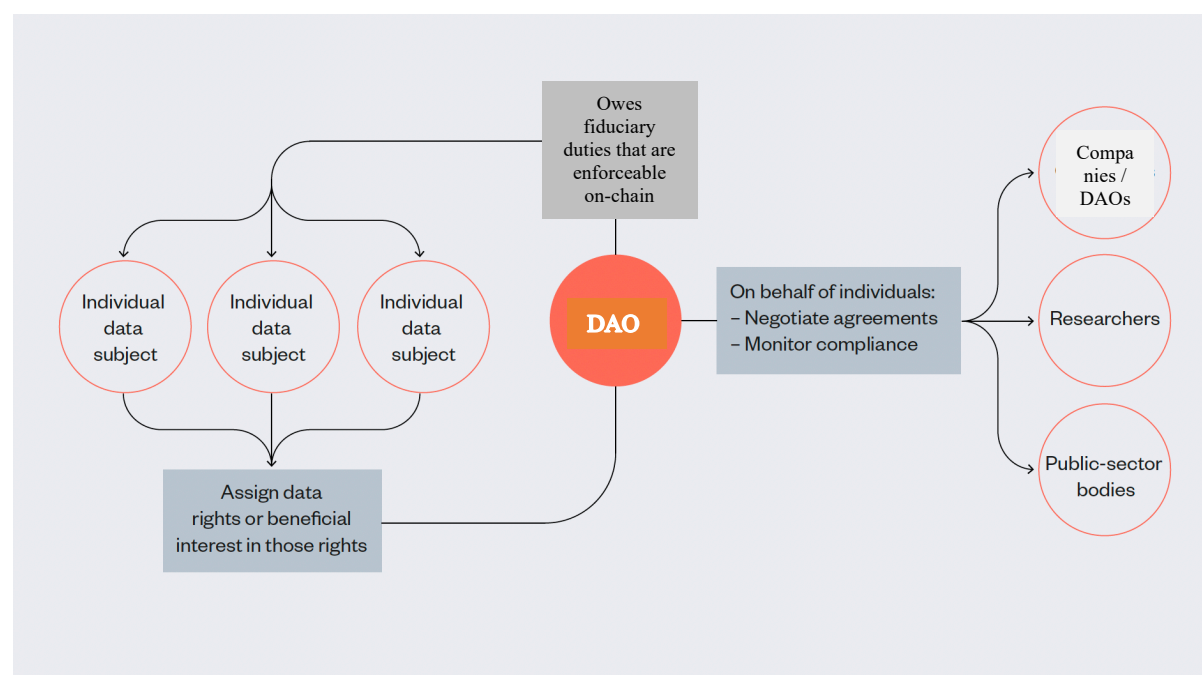


Diagram 2: How data DAOs work.

### *Potential benefits of DAOs as data governance vehicles*

The benefits of DAOs as data trusts include the ability to aggregate data and appoint code or labourers through the DAO to advocate on behalf of the use of the data to the benefit of contributors by engaging in collective bargaining power, while reducing attention costs. Based on the origins of blockchain technology and DAOs in the cypherpunk and cryptography communities, data DAOs are also inherently aligned with the priority of data trusts to preserve people’s privacy. Data can be encrypted-by-design in decentralised networks and stakeholders can choose to remain pseudonymous or anonymous in their interactions depending on the design of the protocol. Furthermore, DAOs are already an active site of experimentation in governance.<sup>33</sup> With a concentration of software engineering talent and governance researchers, rapid iteration on data governance rules, practices, and tools may be possible. This could aid

<sup>31</sup> Davidson, Sinclair and De Filippi, Primavera and Potts, Jason, *Disrupting Governance: The New Institutional Economics of Distributed Ledger Technology* (July 19, 2016). <http://dx.doi.org/10.2139/ssrn.2811995>

<sup>32</sup> Buterin, Vitalik. “Blockchain and the Future of Courts.” 2016. Bitcoinist. Accessed January 4, 2022. <https://bitcoinist.com/vitalik-buterin-blockchain-court/>; Nabben, Kelsie, *Imagining Human-Machine Futures: Blockchain-based 'Decentralized Autonomous Organizations'* (October 30, 2021). <http://dx.doi.org/10.2139/ssrn.3953623>

<sup>33</sup> Nabben, Kelsie and Puspasari, Novita and Kelleher, Megan and Sanjay, Sadhana. “Grounding Decentralised Technologies in Cooperative Principles: What Can 'decentralised Autonomous Organisations' (DAOs) and Platform Cooperatives Learn from Each Other?”. (December 6, 2021). <http://dx.doi.org/10.2139/ssrn.3979223>.

both beneficiaries of data DAOs, as well as traditional data trusts to innovate in data governance and utilisation practices. Furthermore, within the emerging area of research on relationships between DAOs and individuals, software enabled data trusts may provide greater optionality and low switching costs for people to choose the rules they would like to apply to their data and contribute to pooling their data with others within an ecosystem of data DAOs.

### *Implementing DAOs as data trusts*

Data DAOs could be implemented in a number of ways. There are ongoing efforts in various blockchain protocol communities to standardise data formats to be blockchain compatible and make this possible, such as ERC20 (fungible) and ERC721 (non-fungible) tokens.<sup>34</sup> The innovation of these token standards is that they effectively produce wrapped data as a collateral asset, so it can be utilised. Furthermore, a number of data storage protocols exist to coordinate the storage, querying, and retrieval of data in a decentralised manner to empower individual users, including Filecoin, Arweave, Storj, and others.<sup>35</sup> Here, rules about data storage and redundancy could be enforced as a local first data governance model that allows beneficiaries to set terms, participate by running a node in the network, or both. Then, through Data DAOs, data can be stored in a token standard on a decentralised data storage network, queried and pulled into data pools, and utilised according to the preferences of the beneficiaries, with data DAOs to coordination arbitration, rule enforcement, and distribution of benefits. From here, data could be utilised in numerous ways. Drawing on the principles of “decentralised finance” (DeFi) which are already being enacted through blockchain and DAO infrastructure, data could be wrapped, staked, yielded, farmed, and more. DAOs as data trusts offer the infrastructure for the DeFi of data. The infrastructure to make this possible is already being built, with programmable storage, such as virtual machine capabilities on Filecoin.<sup>36</sup>

The next section explores some possible use cases for data DAOs.

### **Use cases for data trust DAOs**

DAOs as data trusts could be applied to short and long-term use cases, such as training machine learning algorithms, to donating to medical research, to monetising creative expressions, or solving complicated problems in crisis.

Although a unifying data governance framework as outlined in this piece has not formerly been articulated, some projects have already begun exploring this concept, by linking the concepts and attributes of blockchain, DAOs, and DeFi, referring to the possible governance structure of these models as data coops or data unions.<sup>37</sup> Trent McConaghy, Founder of Ocean Protocol, a data management and computation marketplace states that “...we can repurpose DeFi infrastructure with data tokens to immediately enable data wallets, data exchanges, data

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<sup>34</sup> McConaghy, Trent. 2020. “Ocean Datatokens: From Money Legos to Data Legos.” Medium. October 31, 2020. <https://blog.oceanprotocol.com/ocean-datatokens-from-money-legos-to-data-legos-4f867cec1837>.

<sup>35</sup> Ocean Protocol Team. 2020. “Filecoin Storage Integrated with Ocean Protocol by Protofire.” Medium. July 27, 2020. <https://blog.oceanprotocol.com/filecoin-storage-integrated-with-ocean-protocol-by-protofire-896dd03a1f04>.

<sup>36</sup> Kripalani, Raúl. “Introducing the Filecoin Virtual Machine.” Nov. 11, 2021. Accessed January 10, 2022. <https://filecoin.io/blog/posts/introducing-the-filecoin-virtual-machine/>.

<sup>37</sup> Dutta, Diksha. 2021. “Datatokens, DAOs and NFTs.” Medium. December 20, 2021. <https://blog.oceanprotocol.com/datatokens-daos-and-nfts-14aedce1bba7>; Streamr Network, ‘Introduction to Data Unions’, *Github*. N.d. Available online: <https://streamr.network/docs/data-unions/intro-to-data-unions>. Accessed 20 December, 2021.



provenance, data DAOs, and other tools for a Web3 Data Economy”.<sup>38</sup> Ocean Protocol is pioneering the idea of “compute to data”, whereby algorithms and compute jobs are matched in a marketplace to buy and sell data without exposing the content of that data to preserve privacy.<sup>39</sup> Computation occurs without the data leaving the premises of the data holder, for privacy preserving analytics, AI modelling, and more. Other methods to privacy preserving data computation such as privacy preserving smart contracts and secure enclaves, known as “Trusted Execution Environments” have been proposed by Dawn Song, Founder of Oasis Protocol and others.<sup>40</sup>

When combined, what “data DAOs”, modelled on data trusts could enable is large scale, “special economic zones” for data where information can be pooled at utilised to benefit of constituents, whilst preserving data rights and privacy. Scholars have suggested that a city could build and own a DAO, with firms in the city able to access that data on terms governed by the DAO with token-mediated transactions and permissions.<sup>41</sup> The contribution of this paper on data DAOs has been to go beyond recognising decentralised digital institutional technology and data as a resource to more deeply explore a concrete data governance framework to operationalise the implementation of this proposal. By combining the proposal of data DAOs modelled on data trusts, with existing infrastructure and ideation on data pools and DeFi for data, an entire privacy preserving infrastructure exists for data utilisation, according to the preferences and benefit of providers of that data which is waiting to be tested.

What data DAOs at supra jurisdictional scale enable is a plethora of decentralised data possibilities that could bridge physical and digital spaces. Open microchips that reinforce individual ownership of cryptographic keys could be used to digitise physical assets that provide data in a city.<sup>42</sup> With developments in NFT tokens for verified credentials and permissioning, data becomes a medium of exchange for access and reputation, with both physical representations, such as gaining access to an event, and digital representations, such as NFTs for visiting certain checkpoints. Furthermore, data in physical locations can only be unlocked by parties with the correct permissions, or at certain time intervals. Physical data sites could be either static or dynamic, with dynamic data streams continuously contributing to data pools from IoT connected devices.<sup>43</sup> These continuous data streams also provide inputs as oracles by providing real-world information to smart contracts to inform transactions in digital spaces. The Cypherpunks predicted that the information age, combined with public key cryptography would be enablers for any and all information in words and pictures to be available in liquid “information markets”. The aim of DAOs as data trusts is to propose a

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<sup>38</sup> McConaghy, Trent. 2020. “Ocean Datatokens: From Money Legos to Data Legos.” Medium. October 31, 2020. <https://blog.oceanprotocol.com/ocean-datatokens-from-money-legos-to-data-legos-4f867cec1837>.

<sup>39</sup> Ocean Protocol Team. 2021. “Compute-to-Data Is Now Available in Ocean Market.” Medium. April 29, 2021. <https://blog.oceanprotocol.com/compute-to-data-is-now-available-in-ocean-market-58868be52ef7>.

<sup>40</sup> Hynes, Nick, David Dao, David Yan, Raymond Cheng, and Dawn Song. “A demonstration of sterling: a privacy-preserving data marketplace.” *Proceedings of the VLDB Endowment* 11, no. 12 (2018). 2086-2089. <https://doi-org.ezproxy.lib.rmit.edu.au/10.14778/3229863.3236266>; Oasis Protocol Project. “The Oasis Blockchain Platform”. June 23, 2020. Available online: <https://docsend.com/view/aq86q2pckrut2yvq>. Accessed 4 January, 2022.

<sup>41</sup> Potts, Jason and MacDonald, Trent, New Data City: The future of the digital CBD as a data pool on a DAO (July 23, 2021). <http://dx.doi.org/10.2139/ssrn.3892009>.

<sup>42</sup> Nabben, Kelsie. “‘Crypto-States’ Will Compete With Corporates in the Metaverse.” 2021. *CoinDesk*. Accessed January 6, 2022. <https://www.coindesk.com/business/2021/11/23/crypto-states-will-compete-with-corporates-in-the-metaverse/>.

<sup>43</sup> Streamr Network. <https://streamr.network/>. Accessed 6 January, 2021.

general-purpose design framework for the governance of this infrastructure to benefit the owners of that information.<sup>44</sup>

### *Potential Limitations of Data DAOs*

This approach of marrying the concepts of DAOs and trusts to govern data requires further research into the benefits and risks of this approach. DAOs are extremely experimental governance models as both the scholarship and tooling surrounding these governance infrastructures is constantly evolving through active research and development in decentralised technology communities. DAOs are heterogeneous, manifesting in many forms, for different objectives from shared investment vehicles, such as FlamingoDAO, to approaches to collective governance of platforms, such as GitcoinDAO. DAOs vary widely in legal structure, from registered legal entities for participation by U.S. accredited investors only, to completely unregistered, open-source software organisations. Different objectives mean that some DAOs optimise for a diversity of goals, including financial upside, ideologically driven aspirations towards decentralised software development, social engagement, or more complex social purposes. Furthermore, the role of people and algorithms across the variety of expressions of these software encoded assemblages remains to be determined, surfacing ambiguity about who governs who when someone has to design the rules of the infrastructure that determines governance and accountability for algorithmic decisions can be opaque.

On the other hand, trusts also have limitations. While some trusts may focus more provisioning some type of ‘public good’, such as making data freely available, other trust structures can tend to privilege value maximization of financial returns ahead of other values that participants might hold.<sup>45</sup> Trust structures can be both powerful in their approach to participatory ownership as well as limited in their reliance on trustees and clearly expressed rules of engagement. How rules are defined and expressed becomes critical when the execution of rules becomes automated in a DAO.

### *The Decentralised Digital Economy Requires New Data Governance Models*

Determining a data governance model largely comes down to the ontology and culture of a community. For some, more socially oriented communities that see human participation as critical to success, labour in the DAO could be incentivised through ownership in a more cooperative governance model for more participatory governance.<sup>46</sup> For communities more interested in automation and delegation of governance duties, trusts may be a more attractive model to explore, as rules can be encoded, delegated to algorithmic agents, and enacted. This is more in-line with the Bitcoin ethos of “code is law” or the idea that DAOs are autonomous through maximum automation and Artificial Intelligence.<sup>47</sup> These considerations are far more

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<sup>44</sup> May, Timothy C. “The Crypto Anarchist Manifesto”. Satoshi Nakamoto Institute. 1988. Accessed January 6, 2022. <https://nakamotoinstitute.org/crypto-anarchist-manifesto/>.

<sup>45</sup> Schneider, N. User trusts: broad-based ownership for online platforms. *Informatik Spektrum* 43, 9–14 (2020). <https://doi.org/10.1007/s00287-020-01242-x>.

<sup>46</sup> Nabben, Kelsie and Puspasari, Novita and Kelleher, Megan and Sanjay, Sadhana, Grounding Decentralised Technologies in Cooperative Principles: What Can 'Decentralised Autonomous Organisations' (DAOs) and Platform Cooperatives Learn from Each Other? (December 6, 2021). <http://dx.doi.org/10.2139/ssrn.3979223>.

<sup>47</sup> Hassan, Samer and De Filippi, Primavera, The Expansion of Algorithmic Governance: From Code Is Law to Law Is Code (December 31, 2017). Hassan, S. & De Filippi, P. (2017). The Expansion of Algorithmic Governance: From Code is Law to Law is Code. *Field Actions Science Reports: The Journal of Field Actions*. Special issue 17: Artificial Intelligence and Robotics in the City. Open Edition Journals,

significant than arbitrary system design questions. The settings of data governance in these new institutional structures are high stakes, as these decisions have the potential to steer the direction of digital infrastructure, data, and society. Further modelling, deep design consideration, testing, reflexivity, and feedback loops are essential in system design.<sup>48</sup>

## Conclusion and Next Steps

The information age has brought about significant changes in patterns of data collection and use, which are difficult to predict and respond to. In this context, society will need a range of governance tools to anticipate and respond to emerging digital opportunities and challenges. This paper has explored the fundamentals of data trusts and decentralised autonomous organisations to propose DAOs as a data governance framework and operational infrastructure for collective data pooling, governance, and utilisation.

Data trusts provide a general-purpose framework for DAOs to model data storage and utilisation design and implementation. By conceiving of DAOs as data trusts, the motivation of distributing the benefits of pooled data and data privacy is enacted through trust in code as the DAO stewards and negotiates as a trustee on behalf of the beneficiaries. This is a logical evolution of data governance with DAOs as a governance infrastructure for the digitally native. DAOs as data trusts un-silo data while allowing for persistent individual ownership, storage, governance, and utilisation to the benefit of those that contribute to the network.

Just as data trusts are one component of governance, which is interdependent on policies, politics, rights, other infrastructure, economics, and more, data DAOs are one approach to structuring data governance through DAO infrastructure. This paper presents generous scope for further research into the contexts in which DAOs are a suitable governance framework for data, DeFi for data, novel cryptography and privacy preservation mechanisms, and development of technical architecture for real-world sandboxes for functional decentralised data governance ecosystems.

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<sup>48</sup> Nabben, Kelsie and Zargham, Michael. “Techno-reflexivity: A creative methodology for software developer un-bias”. *Substack* (blog). Available online: <https://kelsienabben.substack.com/p/techno-reflexivity-cf1331278bdc>. Accessed 20 December, 2021.

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