Hyvmind

A Research-to-Earn (R2E) Dapp for Tokenising Annotations

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***Abstract*—While the superiority of language models over traditional search-engines has become clear in recent years, their 'generativity' remains a serious concern for policymakers. On the input side, it is generally acknowledged that most large models are trained on unethically sourced data. And on the output side, their tendency to hallucinate and misinform makes them unfit for domain-specific work. This paper takes the view that explainability and transparency cannot be achieved simply by putting 'a human in the loop'. Taking legal work as a concrete site, it proposes Hyvmind – an architecture that puts 'humans in the centre' by recording and rewarding semantic labour through tokenised annotations. Its novelty lies in conceptualising legal research as a set of four interconnected functions (source, watch, frame and curate) around a common data-object (source-text). By storing and rewarding annotative-work through a distributed ledger system with nested states, it creates a secure, ethical and organic pathway for generating high-quality datasets for the next generation of domain-specific language models.**

keywords: tokenised annotations, semantic labour, reciprocal produsage, nested state, legal research, ontological plurality, distributed ledger

AGLI	Artifically Generated Legal Information
AVC	Annotation Value Chain
CC	Curation Contract
CID	Content Identifier
CNFT	Curation NFT
FNFT	Frame NFT
FT	Fungible Token
HDAO	Hyvmind's Decentralised Autonomous Organisation
IAA	Inter Annotator Agreement
ILP	Intellectual Labour Practice
LC	Location Contract
LNFT	Link NFT
LO	Legal Ontologies
NFT	Non Fungible Token
NLP	Natural Language Processing
NNFT	Nested NFT
ST	Source Text
TNFT	Text NFT
UTS	Utility Token System
UVS	Unrealised Value Space

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"In exchange the action is social, the mind is private."
- Alfred Sohn-Rethel

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I. Vision

A. Token Economy

1. The *Encyclopedia of Personality and Individual Differences* defines a token economy as "a system of behavior modification based on operant conditioning that utilizes systematic reinforcement of a target behavior. Tokens are given contingent on performance of the desired behavior, which then can be exchanged for reinforcers within a predetermined economy system."[1] This tells us that the portmanteau 'tokenomics' hides as much as it reveals. Over the last century tokens have been studied not as building blocks for creative economic infrastructures, but as tools of behavioural change. They entered the crypto lexicon after having travelled a long and instructive road from trade to education via psychology.[2] In this context, blockchain[3] projects may find it useful to ask: *what sort of behaviour are we looking to change?*

B. Behavioural Change

2. Quite often in the crypto world such questions remain unarticulated or underthought. Many new projects end up replicating harmful engagement models inherited from the pre-blockchain era. Sedgwick (2019), for instance, asks if we would 'accept tokens for viewing adverts?' without pausing to ask whether advertisement-watching can be said to constitute a sustainable target behaviour. As Dixon (2024) tells us, tokens themselves "provide *a new way to skip advertising* and acquire customers through peer-to-peer evangelism."[4] While terms such as 'evangelism' and 'customers' are outmoded in this context, his larger point is compelling – tokens[5] are 'self-marketing' because they "bake *community ownership* into their core design."[6] Sustainability is transformed from an intrinsic attribute into an ethical dimension when behavioural change meets community ownership. That is to say, a crypto economy becomes self-sustaining when its members develop a deep and abiding conviction that a particular form of behaviour must not only be preserved but encouraged. Notions such as alignment and moral innovation, which have a certain currency in the crypto space, are best understood in this context.

C. Beyond Tokenomics

3. The foregoing may have suggested to the reader that this is not a 'tokenomics' paper. To be sure, its immediate goal is not to specify a new token's issuance and distribution numbers.[7] Its starting point may in fact be said to lie *beyond* tokenomics, in a region which Wuollet (2023) prefers to call 'tokenology'. Before entering this realm however, we must ask: (a) how should tokenomics be understood?, (b) what are its limits?, and (c) why is it necessary to move beyond it? Wuollet's general response is this: tokens exist beyond the sphere of pure economics because they are capable of representing multidimensional values. In his own words,

> "[v]alue is an abstraction and most folks conflate 'value' and 'money'. Tokens let you make value explicit without being money. I'd argue that because the modern western economy denominates value almost entirely in U.S. dollars, it loses information by reducing a high-dimensionality vector into a scalar."

D. Value & Money

4. This claim and its presuppositions may be restated as follows:
   a) money and value are distinct concepts,
   b) value is a richer and more 'high-dimensional' concept than money,
   c) value can be turned into money but this transformation entails some sort of information loss,
   d) pure economics is restrictive because it deals with low-dimensional monetary aspects, and
   e) tokens are high-dimensional because they are closer to the concept of 'value' than 'money'.

5. Such reasoning moves along a value-money spectrum with an indeterminate middle zone.[8] The 'information loss' Wuollet alludes to arises because money translates qualities into quantities. In its purest form it is unidimensional because its movement is restricted to the number line.[9] Value on the other hand can be *qualitatively expressed*[10] in distinct ways[11] and therefore requires a multidimensional space for representation. That said, we agree with the view that tokens transform a pre-existing unidimensional space[12] into a 'rich[13] new design space'. They render the intermediate zone of the value spectrum not just visible but, more importantly, *customisable*.

E. Design Space

6. Our own responses to the questions posed above are:
   a) tokenomics conveys much more than 'token plus economics',
   b) presently it has ventured too far towards the quantitative end of the spectrum and lost track of qualitative-value,[14]

[1] Matson, Estabillo, and Matheis (2016).
[2] See Ayllon and Azrin (1968), Ayllon and Roberts (1974).
[3] 'Blockchain' and 'crypto' have been used interchangeably throughout the paper.
[4] Page 136, emphasis added.
[5] Hereinafter 'tokens' refer specifically to blockchain tokens.
[6] Page 140, emphasis added.
[7] Unfortunately this is what tokenomics has been reduced to today.
[8] This middle zone is the space of tokenisation (refer table I).
[9] In a section titled 'The Quantity of Money as its Quality' Simmel (2004, 260) writes: "Since money is nothing but the indifferent means for concrete and infinitely varied purposes, its quantity is its only important determination as far as we are concerned. With reference to money, we do not ask what and how, but how much."
[10] At its simplest, this may be reduced to the binary formulation: 'good' and 'bad' value.
[11] Refer table II.
[12] One with its own distinct history and logic.
[13] See Freni, Ferro, and Moncada (2022) as an illustration of this richness.
[14] Refer table I.

c) it is important to challenge its current usage, i.e. to go *beyond* tokenomics in order to expand its meaning.

In concrete terms, going beyond tokenomics implies (a) denying the existence of 'pure' economics, (b) welcoming the constitutive impurities of political, cultural, legal, psychological and historical factors, and most importantly (c) realising that the question of 'money' is not the exclusive preserve of economic theory. As Simmel (2004) highlights in his philosophical sociology, money is nothing less than "a reification of the general form of existence according to which things derive their significance from their relationship to each other."[15] Maurer (2006) similarly observes, "[modern money] provides a universal yardstick against which to measure and evaluate the universe of objects, relations, services, and persons."[16] From a technological lens Alden (2023)'s recent work attempts to unify the commodity and credit theories of money in a ledger-centric framework,[17] and from a critical-legal perspective Rahmatian (2020) claims that "there does not seem to be a real conceptualisation of money in microeconomics."[18] Simply put, there are as many cross-disciplinary perspectives on money as one is willing to find.

7. It is not necessary for our present purposes, however, to enter this dark forest. Suffice to say that our understanding of tokenomics includes not just token and economics but also two previously hidden variables, i.e. behavioural change and community norms. At any rate, it may be preferable going forward to use the term 'token design' to situate this paper since (a) it avoids both formalism and confusion, (b) is well accepted, and (c) conveys the experimentative openness we seek.[19]

F. Spatiality, Generally

8. Abstract distinctions between value and money will be utilised throughout the paper by means of successive approximations under the broad rubric of 'spatiality'. This is because the related notions of 'direction' and 'dimension' presuppose – if not invoke – some form of space; and while the latter may at present appear formless we can be certain that it *has value*.[20] Dixon and Gabriele (2022), for instance, compare the value potential of 'blockspace' in the 2020s with that of personal computing and broadband in the 1990s and 2000s; while Saneel and Zhang (2022) call it 'the foundational commodity of the metaverse'. In this paper we treat tokenspace[21] and blockspace[22] as analytically distinct but practically intertwined concepts, because a token's attributes determine the nature of the blockspace[23] while its axes of circulation delimit its unique economy. Said differently, we subscribe to the Government of Australia (2023)'s position that a "crypto asset is a 'token system' that is intrinsically linked to a specific crypto token. The intrinsic link means the term 'crypto asset' is effectively an umbrella term for a crypto token and each of the benefits provided by its token systems."[24]

G. Cryptoeconomics

9. Before moving further it may be useful to briefly compare 'tokenomics' with 'cryptoeconomics'. Unlike the technology they refer to there is no consensus around either term. Some tend to think of the latter as a 'formal discipline' even as others draw on interdisciplinary economics, and still others view it as a governance practice.[25] Brekke and Alsindi (2021) describe it as an "[interdisciplinary, emergent, experimental and] embryonic field at present [which] can be taken to include several areas of focus: information security engineering, mechanism design, token engineering and market design". In practice, *tokenomics* refers to the architectural details of a particular token economy while *cryptoeconomics* constitutes an inchoate field which aims to study such systems in their generality. The latter is a rapidly expanding area with rich and heterogenous perspectives none of which can be characterised as 'purely' economic. This is because token economies are complex systems[26] which call on a host of scientific disciplines, both natural and social. Unsurprisingly therefore the development of this proto-field seems to mirror the movement of science in general, at least in its haphazard oscillations between disciplinary adherence and interdisciplinary deviation.[27] Because of its ability to confound many disciplines at once, we might even say that the notion of a 'crypto economy' constitutes an *anomaly* for social science today.[28]

10. The ongoing shift towards 'design thinking'[29] may be seen in this context as the expression of an inner tendency in cryptoeconomic literature to branch outward into non-economic planes only to return to, and reimagine, the economic. This tendency is certainly not accidental.

[15] Page 127.
[16] Page 16.
[17] See Chapter 4.
[18] Page 105.
[19] For an overview of token classifications and taxonomies see Freni, Ferro, and Moncada (2022, sec. 4.1). They conclude that 'a de facto standard has not emerged yet'.
[20] See for instance O'Dair (2018) and Katende (2018).
[21] The blank canvas of token engineering and design.
[22] 'The representative unit of a shared layer of computation and state across multiple users' (Saneel and Zhang 2022).
[23] A block is a bunch of transactions carrying an internal reference to a previous block.
[24] Para 42.
[25] See Zamfir (2015), Voshmgir and Zargham (2020) and Nabben (2023) respectively.
[26] Voshmgir and Zargham (2020, sec. 2) write: "Complex systems differ from other systems in that the system level behaviour cannot be inferred from the local state changes induced by individual network actors (Parrott and Lange 2013). Modeling approaches that ignore such difficulties will produce models that are not useful for modeling and steering those system. Properties such as emergence, nonlinearity, adaptation, spontaneous order, and feedback loops are typical to complex systems (Bar-Yam 2002)."
[27] See for instance Blockscience.
[28] Kuhn (2012).
[29] See for instance Norman, Smith, and Caramiha (2023).

TABLE I: Value Spectrum

Quality	Tokenspace	Quantity
Value (in use)	Value (in use and exchange)	Money (in exchange)
High-dimensional	customisable	Unidimensional
Vector	customisable	Scalar
Information-rich	customisable	Information-poor
Context-rich	customisable	Decontextualised

Nakamoto (2008) famously added an arbitrary string to the first transaction of Bitcoin's genesis block referring to the 2008 financial crisis, while Buterin (2023) is more direct,[30]

> "...we are not here to just create isolated tools and games, but rather build holistically toward a more free and open society and economy, where the different parts - technological, social and economic - fit into each other."

H. Purpose

11. Clearly, both the vision driving cryptoeconomies as well as the obstacles to their realisation are grand. Token engineering can in fact be seen as a form of *social engineering* in which designers propose concrete social change by means of experimental economies.[31] Over the years in this collective endeavour a few broad guidelines have emerged, such as (a) Mougayar (2017)'s trifold framework,[32] (b) Euler (2018)'s five angles,[33] and (c) Oliveira et al. (2018)'s four attribute-types.[34] Despite such attempts it is important to recognise that 'there is serious demand in theoretical frameworks which contribute towards comprehensive token classification and token design'.[35] This is attributable in equal measure to the grand ambitions of the general enterprise as well as the concrete challenges of adapting it for particular ends. Since the ground between new tokenomic developments and the cryptoeconomic 'field' is not without friction,[36] this paper must also be approached with the caveat that "it constitutes a synoptic and functional representation of the complexity surrounding tokens as value-capturing incentive systems."[37]

12. The central purpose of this paper is to combine the two meanings of 'token economy' discussed earlier in order to create a novel economy for research-labour. Notably although *purpose* is a key category in the approaches listed above, it is understood within them mostly at the level of *tokens* as opposed to the overall *project*. We begin, in contrast, with the latter and then proceed to clarify the former. This is because Hyvmind's internal economy is composed of nested tokenspaces whose unified purpose is to construct a secure, immutable, transparent, distributed and incentive-driven architecture for ontologically plural research.[38] Put another way, our system is built on the conviction that by recognising different kinds of Intellectual Labour Practice (ILP)s associated with research, and by tokenising them as distinct data-objects, it is possible to overcome the current paradigm's inefficiencies.[39]

I. Current Inefficiencies

13. These may be outlined as follows:
    a) *Duplication*: individual researchers working on the same material usually find, read and annotate it separately, creating unnecessary duplication of labour. The time saved here could be used in higher level work such as entity recognition, frame definition, ontology[40] construction etc.
    b) *Siloisation*: structured and semi-structured annotations are stored by default in silos unless the researchers involved are active collaborators.[41] Even in such instances, mainstream cloud-platforms prevent the ownership, decentralisation and organic expansion of collected annotations.
    c) *Dormancy*: non-collaborating researchers are by and large unable to discover annotations of interest until these are published in some form, or cite semantically-rich, live datasets without worrying about their authenticity and provenance.
    d) *Unproductivity*: the task of generating insights from structured or semi-structured data usually falls to individual researchers or small groups working in isolation. In most instances access to such materials remains restricted to a privileged few, which arrests alternative interpretations at source.
    e) *Disincentives*: researchers tend not to share their notes before publication due to plagiarism risks and uncertain copyright enforceability.

J. Annotations

14. If the aim of token design is 'to make implicit values explicit' then it is important to conceptualise an Unrealised Value Space (UVS) which – through tokenisation –

[30] Elsewhere he argues that because 'economics is not everything' blockchain projects must be able to 'work well under a variety of models and assumptions' (Buterin 2016).

[31] This is what allows *behavioural change* to be combined with *community norms*.

[32] It focuses on a token's role, features and purpose.

[33] Purpose, legal status, utility, underlying value and technical specifications.

[34] Purpose, governance, functionality and technicality.

[35] Oliveira et al. (2018, 15).

[36] In our view cryptoeconomics is better imagined as a sprawling project rather than as scientific field with identifiable boundaries. The latter can be seen as a retroactive generalisation of innovations which are found to have a wider application. Bitcoin itself emerged as a trustless form of e-cash, not a store of value or a registry for digital collectibles.

[37] Freni, Ferro, and Moncada (2022, sec. 9).

[38] As discussed later, we propose an economy in which one Fungible Token (FT) mediates the tokenspaces of four different Non Fungible Token (NFT)-types.

[39] In technical terms, the larger tokenspace is defined by a FT which can be used for exchanging specific NFTs. For details, refer table 3.

[40] An "[o]ntology is an explicit specification of a conceptualisation" (Gruber 1995 (section 2)). Refer para 41 for more details.

[41] Physical institutions may succeed in breaking these silos through formal (workshops, conferences etc.) and informal (dinners, reading groups etc.) methods to an extent. But they are constrained by the natural limits of physical and temporal interaction such as synchronicity and contiguity, both of which can be overcome through technological means.

becomes realised. *Annotations* can be taken as the objects of tokenisation because they are (a) the building blocks of research, and (b) capable of generating a plurality of domain-knowledges through semantic organisation. In short, the ILPs of annotative-work can function as Hyvmind's target UVS. Presently, such labour dissolves unvalorised into a static 'final document' in which its semantic richness is lost. It becomes a stone in an inert mosaic which must not only be re-excavated but re-chiselled by each new sculptor. This is because of the current paradigm's systemic bias in favour of closed outputs over open processes, which is in itself a function of intermediate interests.[42] In other words, there are structural reasons why until now there has been no systematic and trustless way to value, acknowledge and reward a researcher's contributions to her domain other than through her publications. Now that web3 has given us ownership privileges[43] it is possible to extend them to the micro and meso levels of the research process.[44]

15. Rehbein, Ruppenhofer, and Sporleder (2012) discuss the the role of human annotations in Natural Language Processing (NLP) in the following way:[45]

    "Many recent advances in areas such as part-of-speech tagging, parsing, co-reference resolution, and semantic role labelling have *only been possible because of manually annotated corpora*, which then serve as training data for machine-learning based NLP tools. However human annotation of linguistic categories is *time-consuming and expensive*. While this is already a problem for major languages like English, it is an even bigger problem for less used languages. This *data-acquisition bottleneck* is a well known problem and there have been numerous efforts to address it on the algorithmic side."

16. Generally speaking, expert annotations are considered the 'gold standard' for training language models.[46] But despite this recognition there is a severe shortage of high-quality datasets in the current paradigm (especially for domain-specific models) because the labour required to produce them is considered 'time consuming and expensive'. And this is the nub of the problem: *while it is widely recognised that human annotated datasets are important, not enough attention has been paid to building adequate incentive-structures for generating them*. Since such datasets are widely considered to be indispensable for training, benchmarking and evaluation, it follows that annotative-work is a rich source of 'implicit values' which must be made explicit through tokenisation.[47]

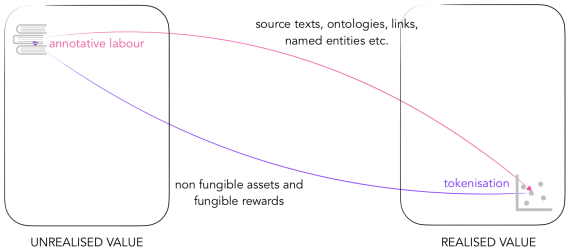

Fig. 1: Tokenising Unrealised Value

K. Recentering Labour

17. In our view, data-acquisition is not a 'bottleneck' but an opportunity to recognise and reward the centrality of human labour. To think of it as something that must be 'solved on the algorithmic side' is to privilege short-term growth over long-term sustainability.[48] As the ongoing lawsuits against OpenAI testify,[49] it is of utmost importance to recognise "the role of collective knowledge and labour as the primary source of the very 'intelligence' that AI comes to extract, encode, and commodify."[50] It is also worth highlighting that due to its unavoidable nature annotative-work is *already being carried out* by researchers in all domains, albeit in a non-incentivised and siloed way. This means that Hyvmind's behavioural shift is surprisingly minimal as it does not target the *substance* of pre-existing ILPs, merely their *form*. We can safely assume that if certain social tasks are performed regardless of their valorisation then, all other variables remaining the same, a pathway which *does* valorise them will eventually be preferred over one which does not.

18. To be precise, the architecture proposed in Part II revolves around the tokenisation of four kinds of annotative-labour associated with legal research. These are (1) sourcing the reference text, (2) verifying, updating and maintaining domain-informed 'locations' for the said text, (3) creating frames, links and entities around it, and (4) using framed-annotations to curate libraries with custom ontologies.[51] From a pragmatic standpoint, narrowing the paper's focus to the legal domain in this way has four advantages. It gives us:

    a) a concrete instance of the vision outlined in this part,
    b) an architectural guardrail against the growing threat of Artifically Generated Legal Information (AGLI),

[42] On predatory publishing, see Beall (2012), Shen and Shah (2023). On the political economy of the publishing industry and the struggles of open access, see Fuchs and Sandoval (2013), Eger and Scheufen (2018), May (2019), Puehringer, Rath, and Griesebner (2021) and Tammisto and Wilenius (2023).

[43] Dixon (2024) convincingly shows that web1 gave us *read* privileges over the internet, web2 extended it to *write*, and web3 further extends it to *own*. See also Stackpole (2022).

[44] In this context *micro* refers to annotations, *meso* to entities, frames, ontologies and curations, and *macro* to published papers/articles. Web3 publishing is already a fairly well established use-case (see for instance Mirror, Paragraph and T2).

[45] Pages 1-2, emphases added.

[46] See for instance Saravanan, Ravindran, and Raman (2009), Saravanan and Ravindran (2010), Tubis (2023).

[47] Refer figure 1.

[48] See Mazzucato and Strauss (2024) on 'algorithmic short-termism'.

[49] See Gillham (2024).

[50] Pasquinelli (2023, Introduction).

[51] The associated roles are labelled *sourcers*, *watchers*, *framers*, and *curators* throughout the paper.

c) a rich professional field of untapped semantic values, and
d) the logical next step in the evolution of legal ontologies.

L. The Human Element

19. To begin with the second, Eliot (2023) shows how the use of AI in law can lead to 'legal nonsense' through 'computational overinterpretation',[52] while Perlman (2023) and Roose (2023) respectively note their potential to generate 'false, misleading' and 'psychologically manipulative' information. Despite such cautions their use within the legal fraternity continues to grow.[53] A recent survey of western firms reveals that while a significant majority of lawyers are confident that AI *could* be used for legal work, roughly half of them remain unsure whether it *should*, citing concerns around accuracy, privacy, confidentiality and security.[54]

20. The Delhi High Court (2023) observes in this context that "at the present stage of technological development, AI cannot substitute either human intelligence or the humane element in the adjudicatory process."[55] This position is reminiscent of Searle (1980)'s critique of strong AI, viz., that 'formal symbolic manipulations' are capable of generating only 'syntax but no semantics' because they lack 'intentionality'.[56] His reasoning behind this claim is as follows:[57]

> "According to strong AI, instantiating a formal program with the right input and output is a sufficient condition of, indeed is constitutive of, intentionality... the attributions of intentionality that we make to the robot in this example have nothing to do with formal programs. They are simply based on the assumption that if the robot looks and behaves sufficiently like us, then we would suppose, until proven otherwise, that it must have mental states like ours that cause and are expressed by its behavior and it must have an inner mechanism capable of producing such mental states. If we knew independently how to account for its behavior without such assumptions we would not attribute intentionality to it especially if we knew it had a formal program."

21. Essentially he distinguishes 'outer' behaviours from 'inner' mental states and argues that correlations in the former cannot establish causalities with the latter. Any claim about the intentionality of a robot or machine is, for him, no more than an 'attribution' of this sort. While such a position is not easily falsifiable because of its anthropocentrism, it is nonetheless valuable for us because intentionality is central to law. After all it is *a particular kind of intention* that gives to any promulgation the force of law, viz., the intention of the legislator. Equally importantly, in criminal law the notion of 'mens rea' determines culpability and in contract law the 'meeting of minds' acts as a necessary precondition of a valid agreement.[58] We highlight below why the presence or absence of such intentionality is best treated as a sociological – and not a philosophical or algorithmic – question.

M. Intentionality

22. The value of Searle's argument for us lies not in its ability to convince, but rather in its ability to provide an internal limit to the intentionality debate. There is no way of knowing with full certainty whether a particular machine has developed 'intentions', and because of this unbridgable chasm the force of law cannot be passed on to AGLI. To extrapolate the Delhi High Court's observation, law *is and must remain* a fundamentally human affair because it operates in the 'field of pain and death'.[59] In other words, it is not enough for a computational system which claims to produce *legal* truths to mimic human intentionality. Rather it must be founded on it.[60]

23. As Bourdieu (1987) writes, "[i]f legal language can allow itself to use a word to name something completely different from what that word designates in ordinary usage, it is because the two usages are connected by linguistic stances that are as radically exclusive as are perceptive and imaginary conscience according to phenomenology."[61] Hart (1972) refers to these linguistic stances as the 'internal aspect' of rules, whereas Dworkin (1986) and Fish (1982) use the notions 'community of principle' and 'interpretive community' respectively. In the final instance, these seemingly disparate ideas converge on the sociological fact that language becomes 'legal' only when it is recognised and accepted within a more or less determinate community (that of legislators, officials, lawyers, judges, legal scholars and so forth). Ehrenberg (2016) uses Searle's distinction between 'social facts' and 'brute facts' to explain this:[62]

> "Recall that Searle distinguishes social facts, which are mind-dependent, from brute facts, which are not. That a given object is made of wood and metal is a brute fact; that it is a hammer is a social fact, dependent on *collective intention* at some level. *Institutional facts* (which are usually facts about or created by institutions, although it is possible to

[52] In the context of image models Carter et al. (2021, sec. 1) define overinterpretation as 'true statistical signals' leading to 'false semantic salience'.
[53] See for instance Dixit (2023) and D'Cruze (2023) in the Indian context.
[54] Thomson Reuters (2023).
[55] CS(COMM) 583/2023, para 28.
[56] Page 421. See also Chinese Room Argument, Chomsky, Roberts, and Watumull (2023).
[57] Page 421.
[58] See for instance Lucke (1967), Hepple (1970), Malle and Nelson (2003), Ekins (2012), Matczak (2017), Vetrovsky (2018).
[59] Cover (1986, 1601).
[60] In this context it is also interesting to note the emergence of 'intent-based' architectures which aim to capture user intentions via declarative programming. See for instance Kilbourn and Konstantopoulos (2023), Leivadeas and Falkner (2023).
[61] Page 829.
[62] Page 104, emphases added.

have institutional facts without pre-existing institutions) are a subset of social facts, and one of the important advantages of institutions... is that they allow for relations, rights, and duties among people that *do not depend directly upon the intentions of those people*... So intentionality is important, just not the particular intentions of the immediate participants."

24. In design terms, therefore, the legal fraternity performs four critical roles in our architecture. It:
    a) grounds the formal shift in target behaviour,
    b) provides the 'intention condition'[63] for legal truths,
    c) acts as the source of unrealised values, as well as
    d) the destination for tokenised values.

II. Architecture

N. Semantics as a Service

25. It is clear from Part I that the UVS we seek to explicate can be thought of as a rich but unvalorised *semantic space*. Annotative-labour is capable of realising value by making implicit semantics explicit[64] but this potential remains untapped due to the current paradigm's reliance on intermediation and published outputs. We therefore propose a five-fold approach which,
    a) recognises the atomic potential of semantic annotations,
    b) treats research as a continuous and collaborative process,
    c) allows the incentivised and trustless sharing of annotative-labour,
    d) acknowledges the author's right over such labour by giving her control over its use and circulation, and
    e) privileges dynamic curations over static documents.

26. Vargo, Koskela-Huotari, and Vink (2020)'s 'service dominant logic' offers us "a processual view, through which exchange in pre-industrialized, industrialized, and post-industrialized economies, can all best be understood in terms of *service-for-service exchange*. What varies is the extent to which service exchange is direct – i.e., an actor applies their resources for the benefit of another actor in person – or indirect – i.e., an actor applies their resources for the benefit of another actor through, for example, a good, which acts as a vehicle for service delivery."[65] Relying on this approach K. Bruns and Jacob (2016) propose seven kinds of values that may emerge during consumption, viz., hedonic value, proficiency, personal self-fulfilment, self-expression, productivity, professionalism and social value.

27. Table II maps their measurability based on the analytical level and discipline involved. It highlights that those value-dimensions whose locus is the individual researcher are difficult to measure with a high degree of accuracy.[66] Productivity, professionalism and social value can on the other hand be measured within a more or less accurate range, for they signify how useful a particular labour-output is *to others*. It is therefore helpful to reorganise K. Bruns and Jacob (2016)'s seven dimensions into two broad camps:
    a) inward-facing-values (or intrinsic motivations), and
    b) outward-facing values (or extrinsic motivations).

TABLE II: Measurability of Bruns & Jacob (2016)'s Value Dimensions

Value Dimension	Analytical Level	Relevant Discipline	Measurability
Hedonic Value	Individual	Psychoanalysis	Difficult
Self-fulfilment	Individual	Psychology	Difficult
Self-expression	Individual	Humanities	Difficult
Proficiency	Boundary	Education	Moderate
Productivity	Community	Economics	Easy
Professionalism	Community	Sociology	Easy
Social Value	Community	Cultural Studies	Easy

28. Forms of annotative-labour which do not rely on explicit valorisation – such as open source publishing and preprint releases – may be seen as functions of intrinsic motivations. We can use a binary parameter (v_1) to denote the existence or non-existence of a particular ILP's inward-facing value,[67] and a continuous parameter (v_2) to denote its outward-facing value. A value-function can then be defined as $f_v(a_{ij}) \equiv v_1 \times v_2$ where a_{ij} denotes annotation *j* by annotator *i*.

29. Annotations having $v_1 = 0$ and $v_2 \in (0, \infty)$ may be called *private* since they allow us to cover instances where:
    a) a contractual researcher or intern is required to undertake annotative-work for another private party,[68]
    b) the work involved is confidential, and/or
    c) the researcher simply does not intend to share (valorise) it in its current form.

    In all such cases Hyvmind's vault can serve as a private notebook whose contents may be made public at a later stage by the owner.[69] When $v_1 = 1$ and $v_2 \in (0, \infty)$ the annotation may be called *public*.[70]

O. Right to Append

30. Since private annotations cannot be treated as the bedrock of a collaborative economy, we need only concern ourselves with public annotations. Doubtless the

[63] Burazin (2019, 233).

[64] See for instance Francesconi (2016)'s work on semantic annotations from the perspective of Hohfeldian relations. More generally, see Casanovas et al. (2016).

[65] Section 1.

[66] This is because they are *self-relational* as opposed to *other-relational*.

[67] True (1) when intrinsic motivations exist, and false (0) when they do not.

[68] Such labour can be considered private because annotative-labour is generally not covered by research contracts.

[69] This can be done by giving the annotator control over each annotation's binary parameter. Such a decision must be treated, however, as *irreversible* because of downstream value-dependencies. Note also that a researcher may keep her annotative-work private despite knowing that it has value for herself and others. The binary parameter (v_1) is therefore closer to a *single use control switch* than a formal representation of inward-facing value.

[70] In a sense, all unverified chunks can be said to have $v_1 = 1$ and $v_2 = 0$. We return to this later.

creator can irreversibly switch the former into the latter at any stage, but delaying this process reduces the value-potential of the concerned annotation. This is because it prevents the communal utilisation of a collected resource leading to siloisation and duplication. Said otherwise, if A and B have different annotations on the same topic and they choose to keep their work private, it can be assumed that they foreclose and/or delay the possibility a potentially fruitful collaboration.[71]

31. Where both annotations[72] are public, Hyvmind allows A and B to not only discover each other's work but also provide consumptive rights over their own, thus unlocking value for both. If B makes certain value additions to A's work, she may extend its rights to C for a higher price without affecting A's original authorship.[73] This will allow C to organically discover A's annotations and decide whether they are better suited for her research. In this way non-utility in an Annotation Value Chain (AVC) can be addressed simply by recording each researcher's assets and ILPs in a secure and provable way.

32. This approach may be called 'reciprocal produsage'[74] because each transaction *enhances* the value of the transacted assets. Unlike ordinary exchange where an object leaves the (public) sphere of circulation to enter a (private) sphere of consumption, blockchain transactions allow us to create overlapping spheres through a set of controlled duplications. This in turn allows us to harness productive-forces at the previously unreachable level of consumption itself. When for instance B uses A's annotation to create an alternative frame or linked-entity, she creates a new asset which re-produses the first on a higher semantic plane, thus raising its value. But in order to gain the *right to append* valuable information to A's asset she must first compensate him for the original labour.

P. Nested NFTs

33. Let us assume that B offers a few native FTs called '₹law' to A in exchange for the right to append information to his annotation. If A accepts this offer, a provable copy of the original annotation can be transferred to B's vault as an NFT with a *reproducibility parameter* ($p_{r1} \in [0, \infty]$) limiting the number of times it may be reproduced downstream. For example $p_{r1} = 2$ can denote that B may enhance A's annotation once and transfer it to C, who may in turn enhance it once and transfer it to D.[75]

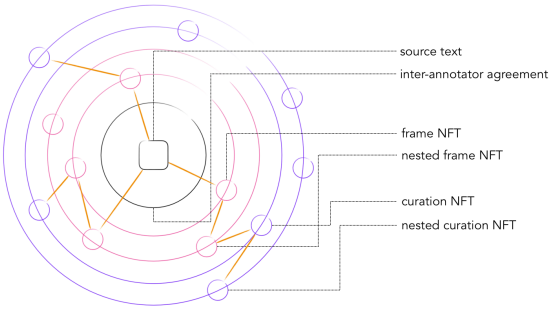

Fig. 2: Annotation Value Chains

Thus in simple terms we can say that p_{r1} represents the length of an AVC who's originator is A. Additionally, he may include a *royalty parameter* ($p_{r2} \in [0, 25]$) in order to decide the percentage of minting value that will accrue to him every time his annotation is transferred.[76]

34. Taken together, these elements can generate an ecosystem of Nested NFT (NNFT)s in which each value-addition gets recorded as a distinct asset belonging to a distinct produser. Its core will be constituted by a unique Source Text (ST) around which different interpretations, comments, frames and links are clustered.[77] Mediated barters can be set up between different NNFTs such that all transfers carry with them customisable privileges over the senders' resources, allowing recipients to use and enhance them in their own way. Ideally, this would be sufficient to create a self-sustaining ecosystem in which 'the value of the produsued resource is greater than the sum of its parts',[78] but as A. Bruns (2006) notes, in such 'classic models of community-led content produsage contributions must still be financed somehow'.[79] This is why we need ₹law as a mechanism to (a) reward ground-level roles, and (b) limit a recipient's consumptive rights to the value of his own contributions. In other words, we need to ensure that the only direct way of *earning* ₹law is by becoming either a sourcer or watcher (ideally both).[80]

Q. Utility System

35. Before moving further it may be useful to cull out a few design principles from our exploration thus far. First, if token economies are to become 'value-capturing incentive systems'[81] then they must focus on designing tokenspaces that transform unrealised values into realised values. Second, our UVS can be defined as a rich semantic

[71] That said, we are aware that there may be a multitude of legitimate reasons for keeping annotative-labour private. Hyvmind's private notebook feature must be seen as a necessary corollary of its first principle, i.e. turning annotations into assets. This can be represented as the irreversible permission flow: annotation ➔ private asset ➔ public asset.

[72] For simplicity's sake, from here on 'annotations' also refer to 'sets of annotations'.

[73] We utilise a system of nested-NFTs to ensure that minting value-added annotations downstream generates royalties upstream.

[74] A creative reformulation of Sohn-Rethel (2021)'s 'reciprocal solipsism'. On 'produsage' see A. Bruns (2006), A. Bruns (2008) and Toffler (1980).

[75] In this instance, while D will be unable to transfer the twice-appended asset any further, he will still be be able to use it in his private curations.

[76] Note that the minting value will rise after each transfer in the AVC. After a certain point therefore the transferee may prefer to mint the source-text directly from the watchers and perform the value-additions himself.

[77] Refer figure **??**.

[78] A. Bruns (2006, 5).

[79] Page 6.

[80] Produsers must be prevented from becoming *sourcers* and *watchers* in the same location in order to prevent conflicts of interest.

[81] Freni, Ferro, and Moncada (2022, sec. 9).

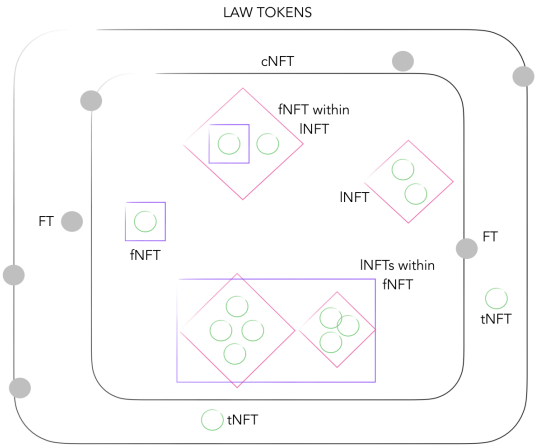

Fig. 3: NFT Wrappers

space of annotative-work which is both necessary and undervalorised. Third, for a project such as this which aims to create a *specific* token economy for a professional domain,[82] it is best to subordinate all other dimensions to 'utility'.[83] And fourth, since peer-review is a well-established practice within research communities, utility itself can be transformed into a *socially decidable attribute*.

36. Lambert, Liebau, and Roosenboom (2020) show that utility tokens provide 'consumptive rights' in a cryptoeconomy since they can be 'used and spent akin to vouchers'.[84] On a similar tangent Caliskan (2023) claims that 'data money' refers to the 'right to send data' over blockchains. Combine these insights with the Govt. of Australia's view on crypto assets clarifies that a utility token is simply the right to participate in a Utility Token System (UTS). To distinguish such a system from a speculative economy we can rely on Silberholz and Wu (2021)'s instructive approach wherein 'utility transactions' are identified by measuring token movements 'between the end users and/or the platform'.[85] In other words, a crypto economy can be said to constitute a UTS if it can attract regular users without promising quick monetary gains.

R. Sourcers

37. As indicated earlier, the behavioural shift Hyvmind seeks to effect is purely formal. In concrete terms this implies that instead of disrupting the work[86] legal researchers ordinarily do, it seeks merely to *visiblise* and *organise* it such that it becomes valuable for others. Since a legal professional routinely deals with statements of positive law, we need a minimal frontend[87] which can transfer chunks of marked up text automatically to her vault as private assets. In order to make a specific chunk 'public' she can simply switch its v_1 parameter and assign locational data.[88]

38. It must be emphasised that these chunks[89] cannot yet be used to create distinct STs because they are unverified, i.e. they may contain large or small inaccuracies which would make them unsuitable as NNFT cores. In terms of our stated formalisation their $f_v(a) = 0$ because $v_1 = 1$ but $v_2 = 0$. That is to say, despite being labelled 'public' they are yet to prove their value *for others*. Assuming that there are, for a given time, *n* annotators sending unverified annotations to the same location *l*, we can assess their similarity using the Jaccard coefficient: $J_l(c_1, c_2, ..., c_n) = \frac{|c_1 \cap c_2 \cap ... \cap c_n|}{|c_1 \cup c_2 \cup ... \cup c_n|}$, where $c_1, c_2, c_3 ... c_n$ represent n-gram sets of the respective chunks. After a minimum *n* value (say 15),[90] J_l can be calculated for every new chunk sent to the location: $J_l(c_m) = \frac{|c_m \cap (c_1 \cup c_2 ... \cup c_{m-1} \cup c_{m+1} ... \cup c_n)|}{|c_1 \cup c_2 ... \cup c_n|}$ and the chunk with the lowest coefficient can be discarded. This process can be repeated until $J_l(c_1 ... c_n)$ reaches a value of 1 for the threshold *n*, signifying perfect Inter Annotator Agreement (IAA)[91] and giving us a reliable ST for that location.

S. Watchers

39. Watchers are researchers who are attached to a particular location (e.g. article 39 of the Constitution of India, paragraph 459 of the Kesavananda Bharti judgment, or section 57 of the Reserve Bank of India Act). Unlike sourcers who are by and large immersed in their own workflow watchers have a higher commitment to the health of the overall ecosystem because errors in one location may get replicated in others. Any produser can become a watcher by staking 25 ₹law on a specific location on the black chain.[92] This will add him to a multisignature Location Contract (LC) through which he can perform (and vote on) a number of critical functions including:
    a) recording and updating the *location state*,
    b) opening and closing state-channels as well as requests for chunks,
    c) receiving STs from the verification function and deciding their value-increment,[93]
    d) converting them into TNFTs and then distributing them,

[82] As opposed to *general* token-economies for decentralised finance and/or computation.
[83] We follow Oliveira et al. (2018, 6) conceptualisation of utility as "a high-level description of those tokens which are neither tokenised securities nor cryptocurrencies."
[84] Page 7.
[85] Page 2.
[86] From hereon 'work' specifically implies 'annotative-work'.
[87] An extension for a browser and/or a plugin for a PDF-reader.
[88] See table III.
[89] Chunks and unverified annotations have been used interchangeably throughout the paper.
[90] A robustness condition.
[91] We prefer perfect IAA because small divergences in the ST can create big interpretive confusions downstream. On the versatile uses of IAA see Kim and Park (2023).
[92] A play on 'blockchain', so named because it stores location-wise data on 'black-letter' law.
[93] A *value-increment* function raises the floor price for a new batch of Text NFT (TNFT)s by a certain number. In order to prevent extractive behaviour, it can be made immutable and range-bound.

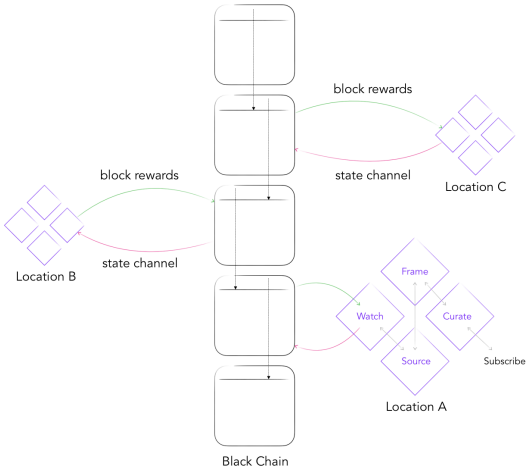

Fig. 4: The Black Chain

e) allowing TNFT holders to mint Frame NFT (FNFT)s, Link NFT (LNFT)s and Curation NFT (CNFT)s,
f) creating (local) and verifying (global) blocks,
g) version controlling STs,
h) creating and managing sublocations if necessary,[94]
i) suggesting and voting on improvement proposals, and
j) deciding the n value for IAA in the location.[95]

40. We propose the use of state-channels for maintaining and updating locations because of their scalability and ease of use. They are designed such that 'participants are able and incentivized to perform the majority of the operations off-chain'.[96] The ₹law tokens used to create an LC can serve as staked state-deposits performing the triple function of securing the chain, earning yield for stakers, and enforcing penalties for location manipulation. Once a produser becomes a watcher at location A (l_a) he may be disallowed from acting as its sourcer and framer in order to prevent conflicts of interest. This is because a watcher's main role is to create suitable preconditions for semantically valuable tasks at a specific location by providing computational, monetary and governance resources, instead of performing these tasks himself. In order to prevent cartelisation and location-squatting a proof of personhood implementation may be required which can be coupled, at a later stage, with institutional credentials.[97]

T. Legal Ontologies

41. Before discussing the remaining ecosystem roles it will be instructive to explain the fourth motivation behind this paper's law focus. For the most part, AI & law scholars agree that legal-knowledge systems acquire value through the human element. Historically, the use and development of Legal Ontologies (LO) as 'terminology boxes'[98] and 'representational vocabularies'[99] grew in the subfield's *second decade*, "driven by the need to organise and access the dramatically increased quantity of information made publicly available on the world wide web."[100] Breuker, Valente, and Winkels (2004) explicitly identify 'domain understanding' as a key ontological role,[101] and Ghosh et al. (2017) highlight that no ontology would be 'complete and satisfactory' without engineers and experts.[102] Distinguishing between these roles Denaux et al. (2011) propose a 'holistic' methodology that underscores the importance of domain experts. Casellas (2011) similarly notes that "legal professionals and legal experts have *a central role* to play in the successful development of legal ontologies and legal semantic applications."[103] On a more general level, Eldred, Zysman, and Nitzberg (2019) claim that "the critical underpinning of firms most successful in using AI to solve problems [of a particular industry] is expertise in the relevant problem."[104] This is why 'knowledge acquisition' forms a key stage in the ontology construction process.[105]

42. For our purposes the vast literature on this topic may be divided into two simple categories: (a) LO that focus on specific sub-domains such as criminal law, consumer law, tax law etc., (b) and those that focus on legal categories in general.[106] While the latter often look to *legal theory* for solid conceptual foundations,[107] their common shortcoming is the failure to acknowledge that such foundations are built on shifting sands.[108] In other words, "[an] ontology describes how some domain is 'committed' to a particular view: not so much by the collection of the terms involved but in particular by the way these terms are structured and defined."[109] Based on a high-level comparison of four LO, Visser and Bench-Capon (1998) aptly conclude that "the difference in the ontologies is not so much a difference in types of legal knowledge distinguished in the ontologies but it is more a *difference in priorities* between these knowledge

[94] The clearest examples of sublocations would be subclauses within a clause, or subparagraphs within a paragraph.
[95] Important locations such as Constitutional provisions may prefer to keep a high n value in order to eliminate the possibility of error.
[96] Close and Stewart (2018, sec. 1.1).
[97] Accounts with better credentials may be awarded higher voting powers.
[98] Breuker, Valente, and Winkels (2004, 243).
[99] Chandrasekaran, Josephson, and Benjamins (1998, sec. 1).
[100] Bench-Capon (2022, 477).
[101] The rest are: (a) organisation and structuring information, (b) reasoning and problem solving, (c) semantic indexing and search, (d) semantic integration and interoperation.
[102] Page 476.
[103] Page 255, emphasis added.
[104] Page 3.
[105] See for instance Pinto and Martins (2004).
[106] See this list of resources by Liquid Legal Institute. Breukers and Hoekstra (2004) call the second group 'core ontologies'.
[107] Note simply the significant differences between Francesconi (2016)'s formalism-dependent and Breukers and Hoekstra (2004)'s common-sense-dependent approaches.
[108] As Visser and Bench-Capon (1998, 45) put it, "[b]riefly stated, there is no golden standard for the comparison." For an introductory survey of the complex historicity of legal theory debates, see Freeman (1994).
[109] Breuker, Valente, and Winkels (2004, 242).

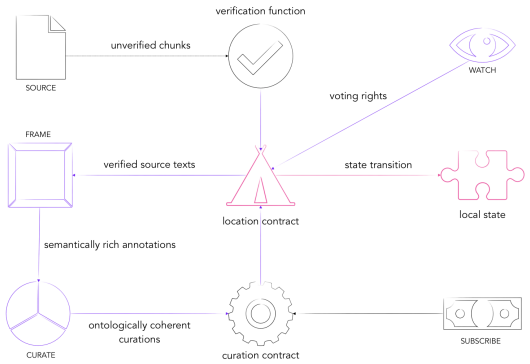

Fig. 5: Centrality of Location Contracts

types,"[110] and recommend 'the creation of libraries of legal ontologies' built 'from a plurality of perspectives'.[111]

U. Framers

43. Hyvmind's basic goal is to provide an open infrastructure for legal researchers to not only create but *own* such libraries. By taking STs as archimedean points around which different interpretations can cluster it enables organically expanding NNFT ecosystems. Let us now outline this process in more detail. In the example considered above we assumed that A is the sole owner of his annotation simply because he identified its constituent text-chunk. This assumption is problematic because A's chunk may never get verified. Since an annotation turns into an ST only after verification it would be inaccurate to think of it as an asset in and of itself. More accurately, it *becomes* a community asset after passing through a verification process which evaluates its IAA. Said differently, an ST is not a private asset because no isolated annotator can convert his chunk into it without (a) a pre-existing LC which determines 'where' this chunk should go, and (b) other annotators who send similar chunks to the same location for comparison and evaluation.

44. As per our earlier formulation an unverified chunk does not have any value because its $v_1 = 1$ but $v_2 = 0$. After verification the latter must therefore be updated to '1' and stored in the LC.[112] As a reward for their labour each watcher and (successful) sourcer can be given a tokenised copy of the ST called ac{tnft}. This means that in our earlier example A does not exchange a private asset but rather a $\frac{1}{n+w}^{th}$ copy of a public asset, where n represents the total number of (successful) sourcers and w the number of watchers in that location. This scheme allows us to bake ontological plurality into the architecture by allowing $n + w$ degrees of interpretive freedom at source. Holders of such TNFTs may,
    a) exchange them for ₹law,
    b) create FNFTs and LNFTs on top of them,
    c) stake them with the LC, or
    d) store them for later use.

45. Through FNFTs holders can describe a custom frame and identify specific words or phrases in the TNFT as *entities* such that – taken together – they represent a contextual instantiation of a legal concept. These descriptions may be simple (e.g. instance_of 'right_seller') or complex (e.g. instance_of 'sentencing_mitigation_criteria') depending on the researcher's purpose. Every time a new frame is created it can be added to Hyvmind's vocabulary with a starting weight of 1.[113] LNFTs on the other hand can function as semantic triples allowing holders of two TNFTs to connect them using custom definitions.[114] These two NFT-types may be combined to generate collections with custom ontologies.[115] Produsers who focus on creating new FNFTs and LNFTs can be called 'framers', and those that purchase and recombine them into collections can be called 'curators'.

V. Curators

46. It may seem at first glance that unlike sourcers and watchers, framers and curators are independent of a particular location. Assuming a system in which the block rewards earned by watchers are shared with sourcers in an algorithmically determined proportion, framers can get ₹law tokens in one of only three ways: (a) becoming sourcers, (b) becoming watchers, or (c) creating frames for curators.[116] The 'double-spend' problem can be solved by marking all issuances of ₹law at source with their respective locations.[117] Since frames and curations require ownership over underlying NFTs, and since such ownership can be won only by performing the required ILPs or by exchanging them for ₹law, we can see that curators and framers are also dependent on locations, albeit indirectly.

47. Any produser who holds a set of underlying assets[118] can combine them into a Curation Contract (CC) and open it up to subscribers. There are three preconditions for doing so: (a) the combined assets must be owned by

[110] Page 50, emphasis added. Here 'knowledge types' refer to conceptualisations for organising legal knowledge such as actions, agents, norms, facts, definitions, duties, rights, powers, facts, structures, functions and so forth.

[111] Page 55.

[112] Its floor price will therefore become $v_1 \times v_2 = 1$ ₹law.

[113] The weight can be increased by 1 every time the frame is involved in a transaction. Also note that the frame itself is independent of the FNFT which is an *instance* of it. Once the former is defined anywhere, in other words, it can be used by framers everywhere.

[114] These relations could be semantic (e.g. 'notwithstanding', 'subject_to', 'read_with' etc.) or logical ('subclass_of', 'instance_of', 'sibling_of' etc.).

[115] Since in our architecture ontologies are relations between frames, they will also become part of the general vocabulary and carry specific weights.

[116] If Hyvmind is built as a layer-2 or layer-3 appchain, this premium may be paid in the native currency of the base chain.

[117] This is easy to do because blocks for a particular location can be proposed only by its corresponding LC.

[118] These can not only include STs, FNFTs, LNFTs but also other curations through CNFTs.

TABLE III: Locational Data

Key	Values
in force	yes/no
location type	e.g. section, subclause, paragraph
location number	e.g. 148, 35(a), 66(9)(12)(zz)
source type	e.g. statute, notification, case
source identifier	e.g. 'ica_ind' for the Indian Contract Act
jurisdiction identifier	e.g. 'ind' for India
jurisdiction level	international/national/federal/municipal

the curator, (b) the curation's subscription price must be higher than the cumulative floor price of the combined assets, and (c) the CC must respect the reproducibility and royalty parameters of the combined assets. Like an annotation, a curation can also be kept private, but unlike an annotation it does not require community validation. Further, it can be made 'live' by specifying a recurring fee of which a pre-agreed percentage is shared with the LCs involved.

W. Nested State

48. An LC in Hyvmind is a *node* on the black chain which acts as a:
    a) sequencer,
    b) data availability committee, and
    c) multisig account for managing its local state-channel.[119]

    This is possible because of the unique way in which 'locations' have been used in the architecture. They can be imagined as public bookmarks *without a book*, i.e. as flags which serve to orient, organise and display produser-activities on a dynamic canvas. Such an approach rids us of the need to store, unpack and interpret static documents by zeroing in on microsites which are of immediate interest to researchers.[120] From a subscriber's perspective this may appear as a disadvantage because the database may not, at a given time, have the specific information he is seeking.[121] But from a researcher's perspective this is an advantage because it tells her that a locational opportunity is not only open but valuable. Re-emphasising an earlier point, the formal shift we seek is in the (presently fragmented) *workflow of an individual legal researcher*.[122]

49. LCs cannot perform these pivotal roles unless duplication is avoided and produsers are incentivised to become watchers in *some* location. If the floor price of each verified ST is fixed at 1,[123] then an individual produser need only submit 25 accurate chunks to join or open a location.[124] Moreover, once an LC is opened it must be preserved in order to maintain the integrity of the black chain. If shown to be malicious, Hyvmind's Decentralised Autonomous Organisation (HDAO) may freeze local activity until dishonest members are identified and removed. Ordinarily such actions would fragment the chain into forks, but in our architecture it is possible to imagine the global state as a snapshot of local substates[125] which may be overwritten in extreme situations without pausing activity elsewhere.[126] Since all four roles are tied to particular locations, 'fixing' a bad block is merely a matter of closing its substate-channel, tracing contagion and proposing a fresh block (with *reverse_contagion* transactions) for the same location .[127]

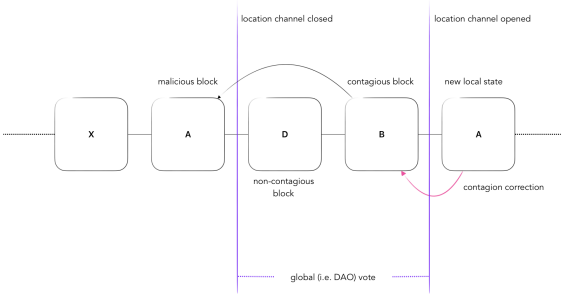

Fig. 6: Local State Correction

50. This brings us to another unique feature of Hyvmind's architecture, viz., that a node[128] can *validate* blocks from other locations but it can *propose* blocks only with respect to its own. Such a limitation will be useful not only in the extreme cases mentioned above, but also during routine functions such as updating memberships and controlling ST versions.[129] Additionally, it will allow the architecture to scale better because of parallelised state-transitions. Block-validation can happen through a two-third majority

[119] Refer figure 5.

[120] These microsites can provide rich semantic subgraphs for training domain-specific language models.

[121] In such instances subscribers can simply open a 'request for curators' which will, in time, attract produsers to downstream roles. This would be analogous to hiring researchers for particular projects.

[122] Practically speaking, this means that the project must not directly aim at attracting subscribers until it reaches sufficient scale. Once suppliers of a particular service shift to a new terrain, consumers will invariably have to adapt. In truth, however, an architecture such as ours which is built around reciprocal produsage need not worry about subscriber-crunch because the primary consumers of research-labour are other researchers.

[123] Refer para 44.

[124] Since this contribution is calculated in terms of ₹law, the chunks submitted may belong to any location.

[125] 'Substates' and 'local states' have been used interchangeably throughout.

[126] It must also be stressed that since each location functions as a validator node, watchers are by default incentivised to keep the location faultless. In order to further minimise the chances of malicious behaviour, (a) a reputation system may be developed which would allow watchers in l_a to vouch for the work of l_b, and (b) a low entry barrier can be combined with a high state-transition barrier (such as 4/5th majority for changes in the state-channel component of the contract).

[127] Refer figure 6.

[128] I.e. a location contract with set of dedicated watchers.

[129] A ST which is valid at time t may be declared invalid at time $t+1$. In order to reflect this change, the permission to update the 'in_force' key can be determined through watcher-votes. Notably, the location will not lose relevance in such a case because statements of positive law continue to carry historical value. In case of amendments to the ST, a new 'request for source texts' can be opened because small changes may lead to significant interpretive differences. In both instances, watchers will be able to specify a new 'version' of the ST which will in turn create a fresh NNFT in live curations.

of total LCs such that heavier (more valuable) locations are treated at par with lighter ones.[130]

51. Assuming that the underlying data-objects are written in JSON & JSON-LD,[131] we can use IPFS & IPLD to construct a nested state architecture using the following scheme:
    a) create (empty) directories corresponding to locational data *keys*,[132]
    b) create (empty, hashlinked) directories corresponding to locational data *values*,
    c) create unique (empty, hashlinked) directories for every new LC corresponding to its specific *key-value combination*,
    d) encrypt their Content Identifier (CID)s and transfer decryption keys to relevant LCs,[133]
    e) after receiving confirmation from an LC about a particular ST's verification, upload and encrypt it within a new (non-empty, hashlinked) directory,[134]
    f) transfer its decryption keys to every watcher and successful sourcer as a TNFT,[135]
    g) every time the LC confirms a transaction involving such a TNFT, withdraw its decryption key from the transferor and send it to the transferee,
    h) give TNFT key holders the right to create NNFTs as encrypted IPLD subgraphs stored in new (non-empty, hashlinked) directories,[136]
    i) when an FNFT or LNFT is transacted, update its metadata (descriptions, frames, entities, links) and weights in the vocabulary,
    j) manage the distribution of their decryption keys as instructed by the relevant LC and CC,[137]
    k) follow a similar pattern for live and nested curations.

X. Gamification

52. The four main roles in our system – source, watch, frame and curate – are not only supplementary but co-dependent. This is because they are functional personifications of the most important points in an AVC which, in itself, represents the organic unity of the research process. It is therefore important to ensure that there is a rough balance of power and responsibility between them. If, say, in a long and complex location[138] the number of watchers far outweighs its sourcers, then there is a high likelihood that the integrity and accuracy of its STs will be compromised. This is because the former may find it difficult to build consensus around key questions such as (a) the cadence of state-channels, (b) the structure and number of sublocations, (c) the n-threshold for each sublocation, and so forth.

53. Members of such a fledgling community may soon discover that their on-chain deposits are going to waste, and decide to unstake their ₹law. This may antagonise the few interested sourcers who could start avoiding that particular location, which may in turn result in a negative feedback loop where the location is neither productive nor erasable. To avoid such situations, as well as to reward active members, gamification schemas can be proposed and developed by HDAO such that each role fits into a distinct *level*. Since STs are the bedrock of an NNFT ecosystem, sourcing and watching can be treated as the game's *ground-level*. High-scorers may be allowed to move to the *second-level* (framers), and from there to the *third-level* (curators), on the precondition that they continue to make minimal contributions at the ground-level.[139]

Y. Illustration

54. This section provides a general illustration of how different AVCs, or NNFT ecosystems may be constructed using the same ST. Consider section 148 of the Indian Contract Act 1872 which reads as follows:

> "A 'bailment' is the delivery of goods by one person to another for some purpose, upon a contract that they shall, when the purpose is accomplished, be returned or otherwise disposed of according to the directions of the person delivering them. The person delivering the goods is called the 'bailor'. The person to whom they are delivered is called the 'bailee'.
>
> *Explanation.* If a person already in possession of the goods of another contracts to hold them as a bailee, he thereby becomes the bailee, and the owner becomes the bailor of such goods, although they may not have been delivered by way of bailment."

55. For simplicity's sake let us assume 21 sourcers, 9 watchers, an *n-threshold* of 15 and a *value-increment* of 0.2. This means that the verification function closes as soon as it receives 15 identical chunks, and sends them to the LC to be stored as an ST with 24 certified TNFTs.[140] Let us further assume that each of these 24 holders set *royalty* to 10 percent and *reproducibility* to 7. We therefore get a maximum spread of 168 NNFTs divided into 24 AVCs.[141] Some framers may be quick to observe that the above section can be broken into two constituent parts, i.e. the *body* and the *explanation*, because their semantic differences are significant. Say such a framer

[130] This is an anti-centralisation measure. Locations with higher stakes will, at any rate, have a semantic advantage in Hyvmind's vocabulary because of higher weights.

[131] An interoperability condition.

[132] Refer table III.

[133] This will ensure that no other entity can produce valid hashes from it.

[134] For the top three levels we use empty directories because in IPFS a directory's ID changes every time the content within it changes. Their sole purpose is to provide verifiable hashpaths for particular locations and sublocations.

[135] This can be reflected in the 'storage root' of an individual's vault, allowing him to access the resource but not to modify it.

[136] This *right to create* is indistinguishable from the *right to append* discussed above.

[137] The merkle proofs of the storage roots of all accounts (along with other relevant information such as their balances and the contract codes of curations) can be used to generate a 'state root' for the LC.

[138] Such as the definition of 'deposit' in section 2(1)(c) of the Companies (Acceptance of Deposits) Rules 2014.

[139] The best quantitative metric for ecosystem growth is the number of new locations it covers in a given time.

[140] Since n = 15 and w = 9, a total of 24 copies will be created. See para 44.

[141] Maximum number NNFTs for an AVC = its TNFT's reproducibility.

approaches a TNFT holder with an offer to purchase his asset at the floor price (1 ₹law), and the latter agrees. Now the purchaser can create an FNFT which describes a frame ('bailment') with two subframes ('goods_delivery' and 'goods_possession') in order to highlight the semantic difference between the two parts of the section.

56. A second framer may now approach the first and offer to purchase his FNFT for 1.4 ₹law because he sees that it can be further enhanced by linking it with the definition of 'goods'.[142] Because such a transfer is (a) within reproducibility limits, and (b) profitable for the first framer[143] he may decide to go ahead with it. After nesting the received FNFT within a LNFT the second framer may decide to sell it to a curator at, say, 1.7 ₹law. The purchaser may be an individual researcher working on Indian contract law or a domain-specific language model with a broad mandate to curate a high-quality dataset for 'a general comparison of bailment laws in common law jurisdictions'. In the latter case, it may be worthwhile to make the curation 'live' by agreeing to send a recurring fee directly to the location. If by this time all 168 of the original NNFT slots are exhausted, the purchaser will need to create a 25^{th} AVC by minting a fresh TNFT from the LC at a higher floor (1.2 ₹law).[144]

Z. Next Steps

57. As may have become clear, the watcher-LC relation is in many ways the spine of our architecture. Since each location is unique (and therefore non-erasable) it makes sense to subject every decision which has a bearing on substate determination to high scrutiny. Foremost among these are interrelated questions around security, fairness and governance such as the following:
    a) Which actions should be made subject to simple majority watcher-votes?
    b) Which actions should be made subject to super majority watcher-votes?
    c) Which actions should be insulated from watcher-votes altogether?
    d) How should the initial membership of HDAO be decided?
    e) Should watchers be allowed to delegate votes for global decisions?
    f) Under which specific conditions should HDAO be allowed to override a substate?
    g) What proportion of block rewards should go to successful sourcers?
    h) Which numbers – apart from issuance – should ₹law's monetary policy make immutable?
    i) Should HDAO maintain a separate treasury for global functions?
    j) Should the *n-threshold* and *value-increment* be range-bound?
    k) Should the *reproducibility* and royalty *parameters* be range-bound?
    l) What other functions can staked tokens perform apart from providing security and yield?

    These will be discussed and clarified in the next version of the paper.

[142] Section 2(7) of the Sale of Goods Act 1930.

[143] After accounting for 10 percent royalty, the initial framer can get 1.4 - (1 + 0.1) = 0.3 ₹law as compensation for his labour.

[144] floor_new = floor_old + value_increment.

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