For All Intents And Purposes: On The Agency And Duties Of Solvers

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Abstract

The Ethereum blockchain network is moving away from an expectation that its users interact with it by fully defining their will, and towards a model wherein users describe the rough shape of their desired outcome and defer the implementation (and execution thereof) to specialised third parties known as 'solvers.' This model — under active development at the time of writing — is known as the 'intent-based' framework, and at present enjoys limited retail use in applications such as asset swaps.

The primary question which this dissertation seeks to answer is whether a solver performing such a swap — having volunteered or otherwise been selected to execute an associated intent — becomes an agent for the user which made the request. If so, what authority is given or can be inferred? Moreover, whether such agency manifests, which obligations (if any) apply?

This dissertation describes the current approach to executing transactions within Ethereum, the general design of the intent-based model and how it can implement asset swaps. Thereafter we review the concepts of agency, authority, fiduciaries and fiduciary duties within English law before analysing the implications of the two systems colliding. In doing so, we earn a brief glimpse at some of the inevitable future battlelines concerning whether code is law within the realm of decentralised finance.

Contents

1 Introduction

Ethereum is a global computer. [1]

More specifically, Ethereum is a blockchain launched in 2015 which exists primarily to maintain and update a global state of affairs using the Ethereum Virtual Machine (EVM) as the execution model. [2] In contrast to its forebear Bitcoin, which was — at the time — constrained to just sending Bitcoin to and from its users, [3] Ethereum was designed to enable the execution and recording of *arbitrary computation* in a trustless, adversarial environment. [4]

The above may seem like so much techno-jargon to the uninitiated, but the upshot of this definition is that Ethereum allows its users to write and deploy scripts — via a language such as Solidity — that persist on the Ethereum blockchain and that other users can pseudonymously interact with. The term 'smart contracts' was adopted for these scripts (an act that irritated both software engineers and lawyers alike), [5] which gave rise to the creation of the decentralised finance (DeFi) movement. [6]

To misquote Douglas Adams, this has made a lot of people very angry. [7] Much ink has been spilled in court filings, [8] books, [9] Law Commission reports, [10] and blogposts [11] alike regarding the way in which misdeeds in DeFi — enabled via smart contracts — map onto the existing legal system and how such an ecosystem should be regulated, if such a thing is even possible.

Such discourse has centred around a model wherein individuals using Ethereum interact with it *themselves*, specifying precisely which smart contract(s) they want to engage with and how. However, as both DeFi and Ethereum itself have matured, the ability to ask *others* to engage with the network on your behalf has emerged. This is referred to in the round as the 'intent-based' framework, [12] and includes those mechanisms by which one user can specify their *desired result* and incentivise others to assist or operate on their behalf to make said desire manifest.

This brings us neatly to a question which has heretofore received zero academic treatment as of the time of writing. The entities operating Ethereum addresses that engage with each other in such a fashion are typically persons (be they natural or legal), and a framework that invites people to 'offshore' tasks to others must recognise that it may be introducing ties that bind. We ask then — in a constrained analysis — whether any legally enforceable relationships or duties can be imposed upon the party executing an intent under English law.

[1] Paul Dylan-Ennis, '*Absolute Essentials of Ethereum*' (Routledge 2024) 1.
[2] Gavin Wood, 'Ethereum: A Secure Decentralised Generalised Transaction Ledger: Paris Version 705168a' (*GitHub.com*, 2024) <https://ethereum.github.io/yellowpaper/paper.pdf> accessed 27 March 2024.
[3] Satoshi Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (*Bitcoin.org*, 2008) <https://bitcoin.org/bitcoin.pdf> accessed 27 March 2024.
[4] Vitalik Buterin, 'Ethereum: A Next-Generation Smart Contract and Decentralized Application Platform' (*Ethereum.org*, 2014) <https://ethereum.org/en/whitepaper> accessed 28 March 2024.
[5] Maria Vigliotti, 'What Do We Mean by Smart Contracts? Open Challenges in Smart Contracts' (2021) 3 Front Blockchain <https://www.frontiersin.org/articles/10.3389/fbloc.2020.553671> accessed 27 March 2024.
[6] Raphael Auer and others, 'The Technology of Decentralized Finance (DeFi)' (BIS Working Papers No 1066, 2023).
[7] Douglas Adams, *The Restaurant At The End Of The Universe* (Pan Books 1980) 1.
[8] *United States v Eisenberg* (2023) 1:23-cr-00010 (United States); *United States v Ahmed* (2023) 1:23-cr-00340 (United States); *Cicada 137 LLC v Medjedovic* 2021 ONSC 8581 (Canada).
[9] Joseph Lee, *Crypto-Finance, Law and Regulation: Governing an Emerging Ecosystem* (Routledge 2022); Allan Hutchinson, *Cryptocurrencies And The Regulatory Challenge* (Routledge 2024); Charles Kerrigan, *Crypto And Digital Assets Law and Regulation* (Sweet & Maxwell 2023).
[10] Law Commission, *Smart Legal Contracts: Advice To Government* (Law Com No 401, 2021); Law Commission, *Digital Assets: Final Report* (Law Com No 412, 2023).
[11] Gabriel Shapiro, 'A Functionalist Framework for DeFi Regulation' (*Substack.com*, 2022) <https://lexnode.substack.com/p/a-functionalist-framework-for-defi> accessed 9 April 2024.
[12] Quintus Kilbourn and Georgios Konstantopoulos, 'Intent-Based Architectures and Their Risks' (*Paradigm.xyz*, 2023) <https://www.paradigm.xyz/2023/06/intents> accessed 28 March 2024.

Before we go further, an apology to future readers. While the English common law surrounding this topic is frequently mentioned and often ancient, the documentation describing the technical aspects is currently bleeding-edge and rarely submitted to traditional academic repositories such as journals. To that end, many citations rely on direct URLs to websites that may not survive the passage of time. *Mea maxima culpa*: they were all available in April 2024.

2 Primer: An Ode To Vending Machines

As any student of contract law will appreciate, we are taught that we enter daily into legal agreements without thinking, even in circumstances involving machinery. [13] For our sins, we will revisit the concept here via the humble vending machine, mapping its functionality to that of a smart contract — although we are not the first to do so [14] — before stretching the analogy to introduce intents in their most simple form.

Picture yourself standing in front of such a vending machine. You insert coins (or tap a card), select a desired item, and then receive it alongside any change due. Such offer and acceptance as to make a legally binding contract can be inferred under English law in such a partially automated context, [15] the 'partial' coming from the fact that someone still occasionally must stock it. Interestingly, Russia has very specifically included contractual obligations relating to vending machines in their Civil Code. [16]

We can describe vending machine interactions in pseudocode. For example —

```
function processOrder(Credit c,
                      ItemChoice i)
public {
  require(c.value >= i.price, "Not enough credit");
  bool available = checkInventory(i);
  if (available) { dispenseItem(i); }
  returnChange(c.value - i.price);
}
```

— describes the logic of checking if a selected item is available and dispensing both the item and any change, subject to the requirement that there is enough credit in the machine available to pay for it. The language used to represent the above is an example of Solidity: people can — and frequently *do* — write smart contracts representing vending machines as part of their education, and this exact code would not cause any concern if it appeared on Ethereum after being translated down to instructions within the EVM.

The above framing of *you* operating this vending machine is intentional. The expectation here is that you are the one making the choice, rendering payment, and receiving your item. Mapping to a smart contract setting, *you* determined your desire and engaged the functions independently.

This is how Ethereum has worked since inception.

Picture now the situation wherein you are being given a tour around an area by a friend of yours that lives there, with several dozen vending machines dotted around. All the machines have different items available, all at different prices, and you *really* want a specific soda X. You turn to

[13] *Thornton v Shoe Lane Parking Ltd* [1971] 2 QB 163 [1971] 2 WLR 585 (CA).
[14] Jonathan Rohr, 'Smart Contracts in Traditional Contract Law, Or: The Law of the Vending Machine' (2019) 67 Clev St L Rev 67.
[15] *Thornton* (no 13).
[16] Civil Code of the Russian Federation (Part Two), art 498 (Russia).

your friend, and say "Would you mind getting me an X? You know your way around here; you can keep the change." They agree, you hand them five pounds and they walk around a corner: you hear a few beeps, and then they return, handing you the soda.

What you have done here is expressed an *intent*, and your friend has *solved* it for you. You did not know which machine to approach, instead relying on the expertise of your friend: expertise which was rewarded by the change now in their pocket. Assuming that you would have rejected a different brand of soda and demanded your money back, this anecdote neatly encapsulates the idea of the intent-based framework: you crafted your constraints, broadcast it, and someone took you up on the offer.

Shifting back to Ethereum, 'intent-based mechanisms allow users to specify precise conditions or covenants under which their transactions can be executed.'[17] These conditions, crafted by users — or *seekers*, as we will call them going forward — are subsequently publicised in the hopes that another — a *solver* — will execute a transaction for them which meets said conditions. We could equally well have expressed our above desire in pseudocode as —

```
constraints {
  desired: 1 X,
  offered: 5 GBP
}
```

— and shouted it at a crowd: the change from £5 may not be enough to entice a random passerby, but there is certainly a price point at which *someone* engages, assuming X costs less than the amount being offered.

Herein lay the motivation for intent-based frameworks. A seeker just wants to get something done and is willing to defer the execution to someone incentivised to find the most efficient path. As it goes with any business opportunity, a cottage industry of specialised operators (solvers) has formed as a result.

But what types of transactions are in scope for intents? The answer is — in theory — all of them. The concept has been floating around in various guises for years, but in the paper by Anoma which popularised the term, an intent is framed as a 'signed message that encodes which state transitions a user wants to achieve.' [18] This is a definition with extremely broad reach: *all* transactions on Ethereum involve state transitions per the EVM, even those that avoid smart contracts. [19]

With that said, for all the potential for abstraction, the execution of *limit orders* — instructions to buy or sell assets at a given price or better — via smart contract is the most common usage of intents at present. As the application which most cleanly maps to a 'real-world' interpretation, and as a matter of space, we constrain our analysis to limit order intents alone.

[17] Tarun Chitra and others, 'An Analysis of Intent-Based Markets' (*arXiv.org*, 2024) <https://arxiv.org/abs/2403.02525v2> accessed 1 April 2024.

[18] Christopher Goes, Awa Sun Yin and Adrian Brink, 'Anoma: A Unified Architecture For Full-Stack Decentralised Applications' (*GitHub.com*, 2022) <https://github.com/anoma/whitepaper/blob/main/whitepaper.pdf> accessed 2 April 2024.

[19] Wood (no 2).

3 Limit Order Intents In Practice

Platforms such as UniswapX, [20] CoW Protocol, [21] 1inch Fusion [22] and Bebop [23] are live on Ethereum at the time of writing and enable intent-driven limit order swaps, albeit occasionally using different terms (e.g. filler, resolver) to describe the same concept of a solver.

A seeker models the desired trade they wish to make via a user interface, and the trade parameters are converted into a data structure representing an intent which a solver can interpret. Such a request may look like this: [24]

```
{
  "id":          1337,
  "sellTokens":  ["USDC"],
  "buyTokens":   ["WETH"],
  "sellAmounts": [10000],
  "slippage":    0,
  "receiver":    ["0x42..."]
}
```

Each platform is supported by multiple solver candidates, who can either be anonymous (having posted a non-trivial bond to the platform up front) or subjected to due diligence and subsequently explicitly permitted to operate. The mechanism by which a solver 'wins' the right to execute an intent — or batch of them — varies, but frequently relies on either polling each solver and scoring their responses, [25] or:

- Offering the right to solve an individual intent via a Dutch auction, with the execution price starting slightly over the current market price and decreasing until it is either accepted by a solver or runs afoul of any minimum constraints, [26] or
- Aggregating and settling a cluster of intents into a group and running a 'batch auction', which is won by the solver providing a solution which offers the highest excess ('surplus') over the average execution price(s). [27]

Whether or not an accepted intent is immediately executed or not *also* varies. Some platforms require that a seeker provide permissions for an arbitrary solver to utilise their assets in advance by approving a transaction stating as such, [28] whereas others return a solution to the seeker which they must subsequently sign before the solver can execute. [29] Solvers are unfettered in the *way* in which they honour such execution: they may have their edge via fast/efficient trade execution across a variety of sources, may be entirely reliant on private inventory, or a blend of the two. [30]

Thus concludes the technical content for now. Let us turn now to the law.

[20] Hayden Adams and others, 'UniswapX' (*Uniswap.org*, 2023) <https://uniswap.org/whitepaper-uniswapx.pdf> accessed 2 April 2024.
[21] 'CoW Protocol Documentation' (*Cow.fi*) <https://docs.cow.fi/cow-protocol> accessed 9 April 2024.
[22] '1inch Network Docs: Fusion Swap' (*1inch.io*) <https://docs.1inch.io/docs/fusion-swap/introduction> accessed 9 April 2024.
[23] Mo Nokhbeh and Katia Banina, 'Bebop JAM: An RFQ Based Meta-DEX Aggregator' (*GitHub.com*, 2023) <https://github.com/bebop-dex/jam-whitepaper/blob/master/Bebop-JAM-Whitepaper.pdf> accessed 2 April 2024.
[24] ibid.
[25] ibid.
[26] 1inch Network (no 22).
[27] CoW Protocol (no 21).
[28] 'Permit2' (*GitHub.com*, 2023) <https://github.com/Uniswap/permit2> accessed 2 April 2024; Adams (no 20).
[29] Nokhbeh (no 23).
[30] Adams (no 20).

4 Agency & Fiduciary Duty In English Law

At this point, we have set out the goal of intents (abstracting away the implementation details of a user interacting with Ethereum) and introduced the mechanisms by which intents relating to limit orders are currently executed. The legal question that begs itself at this juncture is: does the execution of such an intent give rise to a principal-agent relationship between seeker and solver; and if so, what authority and which duties might we expect to be attached to that relationship? Before we attempt to answer this, we first engage in a brief review of the legal principles of agency and fiduciary duties in English law. Once we are on solid ground there, we *should* have sufficient hooks upon which to attempt to hang the intent-based model.

4.1 Agency In English Law

The *concept* of agency does not have a statutory definition in English law but arose out of the general principles of the law of contract. [31] In short, an agent is 'a person who is authorised by law to exercise on behalf of another person...any power possessed by that other person of entering into a contract or other agreement, or of doing any other act in law.' [32] As you might imagine, this is a term with incredibly wide scope: an agent can equally be an solicitor performing legal tasks for a client, [33] a broker seeking credit for a customer, [34] a commercial tracer performing investigative work on behalf of a potential buyer, [35] or a realtor trying to rent or sell a property for its owner, [36] all without doing disservice to the term.

With that said, the concept of *commercial agent* has been fleshed out — via EU directive transposed into English law — as a self-employed person with 'continuing authority to negotiate the sale or purchase of goods on behalf of another person (the 'principal')', [37] this is as good a definition as any for our present purposes, and one we will return to. These regulations exhort both principal and agent to act 'dutifully and in good faith' with the other, [38] although notably there is no definition in statute as to what precisely this entails. [39]

Given the scope of the term, there is no prescribed set of actions that must be performed to establish someone as an agent of a principal. [40] Generally, the establishment — and extent — of such a relationship must be determined via a contract entered by the counterparties, although such a contract may be *inferred* through the behaviour of both principal and agent. [41] Note that it appears unlikely that parties are permitted act on behalf of others 'in financial markets' without the existence of a contract of agency, [42] although this appears constrained to regulated activities under the scope of the Financial Conduct Authority. [43]

Having briefly defined the concept (while noting that there are far better resources for an all-encompassing summary) [44] we now consider the way powers are granted to an agent by a principal.

[31] Alistair Hudson, *The Law Of Finance*, (2nd edn, Sweet & Maxwell 2013) para 18.65.
[32] John Salmond and Percy Winfield, *Principles Of The Law Of Contracts* (Sweet & Maxwell 1927) 340.
[33] *Financial Services Authority v Martin* [2004] EWHC 3255 (Ch), [2004] 12 WLUK 686.
[34] *McWilliam v Norton Finance (UK) Ltd (In Liquidation)* [2015] EWCA Civ 186, [2015] 1 All ER (Comm) 1026.
[35] *Burberry Group Plc v Fox-Davies* [2015] EWHC 222 (Ch), [2015] 2 WLUK 247.
[36] *Wells v Devani* [2019] UKSC 4, [2019] 2 WLR 617.
[37] Commercial Agents (Council Directive) Regulations 1993, SI 1993/3053 (CAR 1993) s 2.
[38] ibid ss 3-4.
[39] Andrea Tosato, 'Commercial Agency and the Duty to Act in Good Faith' (2016) 36(3) OJLS 661.
[40] *Heard v Pilley* (1869) 4 Ch App 548 (Ch).
[41] *Garnac Grain Company Inc v HMF Faure & Fairclough Ltd* [1968] AC 1130 (HL).
[42] *Clearcourse Partnership Acqireco Ltd v Jethwa* [2023] EWHC 1122 (Ch), [2023] 5 WLUK 144; Hudson (no 31) 292.
[43] *SimplySure Ltd v Personal Touch Financial Services Ltd* [2016] EWCA Civ 461, [2016] 5 WLUK 360.
[44] Peter Watts and Francis Reynolds, *Bowstead and Reynolds on Agency* (23rd edn, Sweet & Maxwell 2023).

4.2 The Authority of Agency

An agent is only permitted to act for (and bind) their principal to the extent that they have been given the *authority* to, and the agent that oversteps such authority may have restitution sought against them under either breach of contract or tort. [45] Authority can be either *actual* or *apparent*. [46]

Actual authority is the internal aspect of an agency relationship, the 'legal relationship between principal and agent created by a consensual agreement to which they alone are parties,' [47] and consists of explicit and implicit variants. Explicit authority involves those powers that are (unsurprisingly) either explicitly communicated to an agent either through a contract or which otherwise necessarily arise through a course of dealing or trade practice. [48] Implicit authority, on the other hand, is that power which must necessarily be granted to allow an agent to act upon the explicit authority they have been given. [49] In the past, if the precise extent of actual authority was unclear (and it was impractical for the counterparties to communicate) the agent was permitted to apply a reasonable interpretation. [50] In the age of modern communications, however, it is expected that the limits to authority will be sought out. [51]

Conversely, apparent authority is the *external* aspect of the principal-agent relationship, 'the authority of an agent as it appears to others.' [52] Such authority serves to convince a reasonable third party that said agent is acting in accordance with the desires of a principal, including acts not considered when the agency was established. [53] Apparent authority is a form of estoppel, serving to protect third parties from being held liable if they engage with an agent in a situation where no actual authority exists. [54]

Let us now introduce another similarly abstract but related topic, namely that of fiduciaries.

4.3 Fiduciaries And Their Duties

On occasion, a two-party relationship goes beyond the simple rendering of a service to a customer — such as paying a roofer to repoint a chimney — and shifts into the realm of one party acting on behalf of another 'in a particular matter in circumstances which give rise to a relationship of trust and confidence.' [55]

A relationship formed on such a basis marks the person thus engaged as a *fiduciary*, and the definition given above has intentionally been left open-ended by the courts to grant them flexibility in applying the label on a case-by-case basis. [56] Examples of common relationships where the label is applied include company directors, [57] solicitors (once engaged), [58] trustees, [59] and agents, [60] however this list is non-exhaustive. [61]

[45] *Habton Farms v Nimmo* [2004] QB 1, [2003] 3 WLR 633.
[46] *Freeman and Lockyer v Buckhurst Park Properties (Mangal) Ltd* [1964] 2 QB 480 (HL) [502].
[47] ibid.
[48] ibid.
[49] *Hely-Hutchinson v Brayhead* [1968] 1 QB 549 (CA).
[50] *Ireland v Livingstone* (1872) LR 5 HL 395 (HL).
[51] *Woodhouse AC Israel Cocoa Ltd v Nigerian Product Marketing Co Ltd* [1972] AC 741 (HL).
[52] *Hely-Hutchinson* (no 49).
[53] *Freeman and Lockyer* (no 46).
[54] Tang Cheng-Han, 'Estoppel In The Law Of Agency' (2020) 136(Apr) LQR 315.
[55] *Bristol and West Building Society v Mothew* [1996] EWCA Civ 533 (CA) [18].
[56] *Lloyds Bank Ltd v Bundy* [1975] QB 326 (CA) [341].
[57] Companies Act 2006 (CA 2006), ss 170-177; Bhullar v Bhullar [2003] EWCA Civ 424, [2003] 2 BCLC 241.
[58] *Belsner v CAM Legal Services Ltd* [2022] EWCA Civ 1387, [2023] 1 WLR 1043.
[59] Paul Watchman, Jane Anstee-Wedderburn and Lucas Shipway, 'Fiduciary Duties In The 21st Century: A UK Perspective' (2005) 19(3) Tru LI 127, 129.
[60] Howard Bennett, *Principles of the Law of Agency* (Hart 2013) 89-104.
[61] Sukhninder Panesar, 'The Nature Of Fiduciary Liablity In English Law' (2007) 12 Cov LJ 1, 2.

Per Edelman, there are myriad ways in which a fiduciary can be 'created,' [62] and a (circular) argument goes that the label belongs to anyone to whom *fiduciary duties* apply, which are in turn derivable from the role performed by the would-be fiduciary. [63] Another argument goes that it is not the case that someone must adhere to fiduciary duties due to their role as a fiduciary, but rather that someone becomes a fiduciary *because* they are in a situation where these duties apply. [64] Such duties sit atop the zenith of duty-of-care exhortations, and lay at the heart of English equity, 'molding themselves flexibly around other legal structures, and sometimes filling the gaps.' [65]

The flexibility of the term fiduciary can be further observed amidst those examples provided above (e.g. a solicitor providing legal advice versus a trustee managing assets). [66] The common thread running through the list is that 'the principal is entitled to the single-minded loyalty of his fiduciary.' [67] As such, a doctor can be argued to be a fiduciary for their patient, [68] as can a parent for their child: [69] relationships that are often not as voluntarily entered as Edelman demands in his analysis. [70]

However, here we are only interested in fiduciaries and their duties as far as they might apply to solvers. In the remainder of this section, we explicitly identify the most important duties which can arise.

4.3.1 The 'Duty' Of Loyalty

We have already identified that the loyalty of a fiduciary is their 'distinguishing obligation,' [71] and said requirement has recently been affirmed in dicta for both company directors [72] and solicitors. [73]

The precise bounds — and interpretation — of this duty waver, [74] but it is taken to mean that a fiduciary is expected to 'bend his exertions [in] the service of his beneficiaries' interests,' [75] with the discretion of how to do this left to their judgement. [76] However, when framed like this, loyalty is more of a guiding principle rather than a fixed rule, and an argument has been put forth wherein loyalty 'is best understood as the summation of the various doctrines that are applied peculiarly to fiduciaries, rather than as a legal duty that is directly enforceable in its own right.' [77]

For our purposes, the most interesting — and relevant — aspect of this is how 'single-minded' such loyalty should be: solicitors often have multiple clients at once, and someone acting as a professional services director can be a director of potentially dozens of companies simultaneously,

[62] James Edelman, 'When Do Fiduciary Duties Arise?' (2010) 126 LQR 302.
[63] *Henderson v Merrett Syndicates* [1995] 2 AC 145, [1994] 3 WLR 761 (HL) [206]; Donal Nolan and John Davies, 'Torts And Equitable Wrongs' in Andrew Burrows (ed), *Principles Of The English Law Of Obligations* (OUP 2015), para 2.328.
[64] Paul Finn, *Fiduciary Obligations* (Carswell 1977) 9.
[65] Law Commission, *Fiduciary Duties of Investment Intermediaries* (Law Com No 350, 2014) para 3.11.
[66] James Penner, 'Distinguishing Trust, Fiduciary and Accounting Relationships' (2014) 8 Journal of Equity 202; Duncan Sheehan, 'Identifying Fiduciary Relationships: A Hohfeldian Analysis' (2023) 37(3) Tru LI 2023 141.
[67] *Bristol and West Building Society* (no 55).
[68] British Medical Association, 'Ethics Toolkit: The Doctor-Patient Relationship' (*BMA.org.uk*, 2024) <https://www.bma.org.uk/media/nalcxoal/the-doctor-patient-relationship2024.pdf> accessed 6 April 2024.
[69] Lionel Smith, 'Parenthood Is A Fiduciary Relationship' (2020) 70 UTLJ 395.
[70] Edelman (no 62) 313-318.
[71] *Bristol and West Building Society* (no 55).
[72] *Item Software (UK) Ltd v Fassihi* [2004] EWCA Civ 1244, [2005] 2 BCLC 91 [41].
[73] *Hilton v Barker Booth & Eastwood* [2005] UKHL 8, [2005] 1 WLR 567 [31].
[74] Lionel Smith, 'Fiduciary Relationships: Ensuring The Loyal Exercise Of Judgement On Behalf Of Another' (2014) 130(Oct) LQR 608.
[75] Finn (no 64) 15.
[76] ibid 21-23.
[77] Matthew Conaglen, *Fiduciary Loyalty: Protecting The Due Performance Of Non-Fiduciary Duties* (Hart Publishing 2010) 269.

which appears *prima facie* problematic under both the duty of loyalty and statute alike. [78] In these cases, the fiduciary is expected to be working 'for' one client at any point in time, and while there is precedent permitting carve-outs via express authority for agents to act for multiple principals at once, [79] in a fiduciary setting they 'cannot act at the same time both for and against the same client.' [80] The key phrasing here is 'at the same time,' and we will return to this idea when discussing the concept of batch solving.

4.3.2 The Duties Of No-Profit and No-Conflict

The loyalty demanded of a fiduciary gives rise to a pair of related requirements, as illustrated by Lord Heschell: 'a person in a fiduciary position...is not, unless otherwise expressly provided, entitled to make a profit; he is not allowed to put himself in a position where his interest and duty conflict.' [81]

The 'no-profit' rule which results states that a fiduciary cannot make a profit — beyond that which is explicitly agreed to [82] with fully informed consent [83] — from their role, be it through opportunity or information that arises. [84] The intent is to ward fiduciaries away from temptation that may arise in the execution of their work, and as such the duty carries strict liability: even if the fiduciary acts honestly and the principal profits as a result, the profit derived by the former can be claimed by the latter via constructive trust. [85] As we shall see later, the environment in which solvers operate has the potential to turn this duty into a minefield. For a solver, no-profit breaches may arise as an unintentional consequence of performing their work. Worthington has recently argued that the rule may *not* apply if the breach is not self-serving, [86] and dicta in *Murad v Al-Saraj* posited that the time is now right for courts to relax this rule, [87] however subsequent judgments are enforcing it as is. [88]

The latter rule, that of 'no-conflict,' was first described as a requirement that 'no one having [fiduciary] duties ... can have, a personal interest conflicting, or which may possibly conflict, with the interests of those whom he is bound to protect.' [89] This broad principle was further distinguished via dicta into the 'self-dealing' and 'fair-dealing' rules. [90]

The self-dealing rule is an intuitive one and is intended to prevent action when there is a 'real, sensible possibility of conflict' between the interests of the fiduciary and the principal. [91] Briefly, a fiduciary is barred from acting for both their principal and themself when it comes to assets over which duties are owed. [92] As we shall see, solvers may — much like with the no-profit rule — find themselves unable to avoid such a breach, although liability for such breaches can be waived

[78] Edward Brown, 'A Case Of Split Loyalty? Multiple Directorships And Conflicts Of Interest Under The Companies Act 2006' (2010) 25(10) JIBFL 584.
[79] *Rosetti Marketing Ltd v Diamond Sofa Company Limited* [2011] EWHC 2482, [2012] 1 All ER (Comm) 18.
[80] *HRH Prince Jefri Bolkiah v KPMG* [1999] 2 AC 222, [1999] 2 WLR 215 (HL); Law Society, 'Conflict Of Interests' (*LawSociety.org.uk*, 2023) <https://www.lawsociety.org.uk/topics/client-care/conflict-of-interests> accessed 7 April 2024.
[81] *Bray v Ford* [1896] AC 44, [1895] 12 WLUK 68 (HL) [51].
[82] *Boardman v Phipps* [1967] 2 AC 46, [1966] 3 WLR 1009 (HL) [117]; Trustee Act 2000 s 29.
[83] *O'Donnell v Shanahan* [2009] EWCA Civ 751, [2009] 7 WLUK 583.
[84] *Keech v Sandford* (1726) Sel Cas Ch 61.
[85] *FHR European Ventures LLP v Cedar Capital Partners LLC* [2014] UKSC 45, [2015] AC 250; *Bhullar* (no 57).
[86] Sarah Worthington, 'Fiduciaries: Then And Now' (2021) 80(Supp) CLJ S154.
[87] [2005] EWCA Civ 959, [2005] 7 WLUK 945.
[88] *FHR European Ventures* (no 85).
[89] *Aberdeen Railway Company v Blaikie Bros* (1854) 1 Macq 461, 1 WLUK 1 [471].
[90] *Tito v Waddell (No 2)* [1977] Ch 106, [1977] 2 WLR 496 (Ch); Sarah Worthington, 'Fiduciaries: Following Finn' in Tim Bonyhady (ed), *Finn's Law: An Australian Justice* (Sydney 2016) 51-53.
[91] Matthew Conaglen, 'A Re-Appraisal Of The Fiduciary Self-Dealing And Fair-Dealing Rules' (2006) 65(2) CLJ 366, 368.
[92] *Wright v Morgan* [1926] AC 788, [1926] 7 WLUK 41 (PC); Len Sealy, 'Some Principles of Fiduciary Obligation' (1963) 21(1) CLJ 119.

by a principal. [93] In contrast, the fair-dealing rule is concerned with transactions that involve the fiduciary and their principal acting in their independent capacities. [94] Fair-dealing permits a principal to unwind such transactions unless the fiduciary 'has taken no advantage of his position and has made full disclosure to the beneficiary, and that the transaction is fair and honest.' [95] While fair-dealing is *less* applicable to our context, it has the potential to arise if a solver makes use of private inventory which the solver operator owns.

4.3.3 The 'Duty' of Care and Skill

Finally, someone taking on the role of fiduciary should be — at the very least — competent to do so. Lord Browne-Wilkinson has suggested that 'it is the fact that they have ... assumed responsibility for the property or affairs of another which renders them liable ... not the description of the trade or position which they hold.' [96] The reasoning here is simple: someone who does not possess the requisite skills or information to adequately perform a task should not place themselves in a position to act as fiduciary in the first place. We note, however, that this is not a fiduciary duty in and of itself, but rather a general duty of care: not every duty performed by a fiduciary is a fiduciary duty. [97] Rather, such a requirement is but one component of the requirement of loyalty to act in the interests of their beneficiary, [98] and the Law Commission has echoed the view that the duty is not a fiduciary one. [99] Nonetheless, we mention it here because within the context of solvers, there exist some footguns which can be set off that may lead to liability in tort. [100]

4.4 The Imposition of Fiduciary Duties

As alluded to previously, the way someone becomes a fiduciary is not circumscribed to a particular set of relationships. [101] While there is case law abound on *banks* being retroactively found to have had a fiduciary duty, [102] more interesting for our purposes is the borderline case of the financial intermediary. [103] Two examples are particularly relevant for our purposes:

- In circumstances where an entity is obliged to find the best execution price for a transaction, such an obligation is a fiduciary one, [104], and
- Whereupon somebody goes beyond the bounds of providing advice and assumes direct control of assets, they may become a constructive trustee because of that control and hence inherit a fiduciary duty. [105]

The solver-savvy reader may be overcome with a sense of foreboding having read the above: however, as we shall discuss, what seems straightforward is anything but.

With the legal theory established, we now turn to considering how these principles collide with the reality of solvers executing limit order intents.

[93] *Ex parte Lacey* (1802) 6 Ves 625.
[94] Conaglen (no 91) 373-374.
[95] *Tito* (no 90) [241].
[96] *Henderson* (no 63) [205].
[97] *Foskett v McKeown* [2000] UKHL 29, [2001] 1 AC 102 (HL).
[98] George Beaton, 'Can Mere Incompetence Constitute A Breach Of Fiduciary Duty?' (2019) 5(1+2) Dundee LR 1.
[99] Law Commission (no 65) para 3.13.
[100] Sarah Worthington, 'Fiduciaries: When Is Self-Denial Obligatory?' (1999) 58 CLJ 500, 502.
[101] Sheehan (no 66).
[102] Finn (no 64) 102.
[103] Dick Frase, 'Fiduciary Duties And The Financial Intermediary: Part 2' (1992) 7(11) JIBFL 572.
[104] *Reading v Attorney General* [1949] 2 KB 232, [1949] 2 All ER 68 (CA).
[105] *Mara v Browne* [1896] 1 Ch 199, [1895] 12 WLUK 56 (CA).

5 On The Agency Of Solvers

At this point, our crystal ball clouds up. As with all interesting legal scenarios, there are ways to argue for and against all topics which follow. Given there is nothing by way of statute or precedent regarding this topic within English law, what follows is an attempt at reasonable analysis from a cypherpunk perspective.

5.1 Can A Solver Be An Agent?

Let us start by considering the headline question: *is a solver an agent of their seeker when executing an intent-driven asset swap*? On the face of it, the answer would appear to be no, for three primary reasons.

Firstly, a predicate of the doctrine of identification found in criminal law is that the courts must be capable of explicitly identifying those persons — typically company directors — 'directing (the) mind and will' [106] of a corporate entity to assign criminal liability for the actions of the latter while in service of the former. [107] Despite the recent broadening of its' scope to include 'senior managers,' [108] (and the law more generally moving on towards a 'failure to prevent' offence) [109] the fact remains that the ability to identify a specific person *acting as an agent* is key. [110] Given that the doctrine hinges around the concept of principals and agents, it seems to follow that there is an expectation that for such a relationship to exist, a principal themselves must have knowledge of the *identity* of the person that is to serve as an agent. While literature exists on the concepts of *undisclosed* agents [111] and principals, [112] the concept of parties being *unidentifiable by the other* appears underexplored.

Within the setting of an intent-driven swap, no current asset swap platform presents a seeker with the public key address corresponding to the solver attempting to execute a transaction on their behalf prior to engaging. Even if they did, such an address does not immediately reveal any meaningful information: a hexadecimal string of the form 0x82f98... provides no insight as to the jurisdiction, legal name, or nature of the solver. For platforms which perform KYC checks on solver candidates in order to onboard them, such data *could* be made available, but this is an obligation that would have to be forced upon the platform itself: at present, in the absence of intent-driven blockchains such as those proposed by Essential [113] and SUAVE, [114] seeker-solver pairs currently rely on such platforms to be introduced.

Secondly, the definition of commercial agent introduced previously — an entity with 'continuing authority' [115] — may well not be applicable depending on how far a court is willing to stretch the word 'continuing.' Depending on the platform in question, swap intents are broadcast into a platform-specific pool, whereupon solvers can either pick them up and execute in full, [116] partially

[106] *Tesco v Natrass* [1971] UKHL 1, [1972] AC 153 (HL).
[107] Mark Dsouza, 'The Corporate Agent In Criminal Law - An Argument For Comprehensive Identification' (2020) 79(1) CLJ 91.
[108] Economic Crime and Corporate Transparency Act 2023 (ECCTA 2023).
[109] Steven Montagu-Cairns, 'Corporate Criminal Liability And The Failure To Prevent Offence: An Argument For The Adoption Of An Omissions Based Offence In AML' in Katie Benson, Colin King and Clive Walker (eds), *Assets, Crimes and the State: Innovation in 21st Century Legal Responses* (Routledge 2020).
[110] *R v Barclays PLC and Barclays Bank PLC* [2018] 5 WLUK 736, [2020] Lloyd's Rep FC 325.
[111] Tan Cheng-Han, 'Undisclosed Agency And Damages' (2013) 8 JBL 799.
[112] Tan Cheng-Han, 'Undisclosed Principals And Contract' (2004) 120(Jul) LQR 480.
[113] Liesl Eichholz, 'Essential: The First Declarative Blockchain' (*Essential.builders*, 2024) <https://blog.essential.builders/essential-the-first-declarative-blockchain> accessed 4 April 2024.
[114] The Flashbots Collective, 'The Future Of MEV Is SUAVE' (*Flashbots.net*, 2022) <https://writings.flashbots.net/the-future-of-mev-is-suave> accessed 4 April 2024.
[115] CAR 1993 (no 37).
[116] Adams (no 20).

fill depending on appetite, [117] or return their proposed solution pending approval from a seeker. [118]

Actual execution — and transfer of resulting assets to the seeker — requires the solvers' transaction to be picked up from the Ethereum memory pool and included in a block but is instantaneous thereafter: the state transitions involved within the EVM corresponding to the actions within that block are atomic. [119] Thereafter, it is impossible for the solver to engage in any further action on behalf of the seeker, as they will be missing either the requisite signatures or smart contract level approvals from the latter. It is unclear as to whether such a short engagement between the two parties is enough to be referred to as 'continuing' for the purposes of classifying a solver as a *commercial* agent. As an aside, a similar argument can be made for the concept of 'negotiating' sales or purchases when operating over a precise intent. [120]

Finally, at the crux of the debate, we consider what it means to *be* an agent. As a matter of time sensitivity alone, a solver must be a fully automated system: a lattice of off-chain scripts and interfaces and on-chain smart contracts that interface with Ethereum to query *other* smart contracts and submit transactions. The public key address associated with a solver which holds Ether to pay for transaction execution (as well as any settlement fees accrued), can indeed be accessed by a person, but those actions the solver makes while solving intents are purely algorithmic. A principal-agent relationship is fundamentally a contract, and as such requires intention to be legally bound: a requirement that cannot be met 'absent an inferred objective intention' which software alone is incapable of putting forth. [121] More specifically, a recent dictum suggested that 'only a person with a mind can be an agent at law,' [122] a point made in a case which revolved around a 'pre-arranged, automated system,' [123] which describes a solver to a tee. This position would be in line with that taken across the Atlantic, wherein an automated system exercising a task *non compos mentis* similarly cannot, as a rule, legally bind a principal. [124]

This was certainly the desire of Szabo when he first framed smart contracts — a necessary component of any solver, albeit not in the form he envisaged — as a tool to 'minimize the need for trusted intermediaries like banks or other kind of agents.' [125] But is there any wriggle room here? Could we — *should* we — distinguish between the solver in their role as the *person that designed and maintains the solver* (the would-be stocker of a vending machine, topping it up with Ether to execute transactions) and the solver as the *fully automated system itself*, in our efforts to impose agency? Discourse around this topic is ongoing in the context of consumer protections in English law, [126] with an argument that the law should consider focusing on the authors of smart contracts as part of 'law's audience,' [127] with all the wrangling over the liberty to author code to follow.

Solvers may turn out to be servants, [128] or they may be independent contractors. [129] They may be something else entirely. But at present, in English law, they are not agents.

[117] 1inch (no 22), CoW Protocol (no 21).
[118] Nokhbeh (no 23).
[119] Wood (no 2).
[120] Andrew McGee, 'Relations Between A Commercial Agent And His Principal' (2013) 5 JBL 534, 535.
[121] Vincent Ooi, 'Contracts Formed By Software: An Approach From The Law Of Mistake' (2022) 2 JBL 97.
[122] *R (Software Solutions Partners Ltd) v HM Customs & Excise* [2007] EWHC 971 (Admin), [2007] 5 WLUK 49 [67].
[123] Karsten Paetzmann, 'Challenges Of Blockchain Technology In Financial Services: Use Cases, Smart Contracts And Governance' (2022) 37(8) JIBLR 294.
[124] Anthony Bellia, 'Contracting with Electronic Agents' (2001) 50 Emory LJ 1047.
[125] Nick Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (1996) 18 Journal of Transhumanist Thought 16.
[126] Mateja Durovic and Chris Willett, 'A Legal Framework For Using Smart Contracts In Consumer Contracts: Machines As Servants, Not Masters' (2023) 86(6) MLR 1390.
[127] Laurence Diver, *Digisprudence: Code as Law Rebooted* (Edinburgh University Press 2022).
[128] Robert Heuston and Richard Buckley, *Salmond and Heuston on the Law of Torts* (21st edn, Sweet & Maxwell 1996) 434; *Hewitt v Bonvin* [1940] 1 KB 188, [1939] 10 WLUK 29 (CA) [191].
[129] Philip Landon, *Pollock's Law of Torts* (15th edn, Stevens & Sons Ltd 1951) 63; *Honeywill & Stein Ltd v Larkin Bros Ltd* [1934] 1 KB 191, [1933] 10 WLUK 40 (CA) [196].

5.2 On The Authority Of Solvers

Let us briefly, for the sake of argument, imagine a future in which a concept of 'electronic agency,' as argued for overseas by Kerr [130] and Chopra and White, [131] is recognised in English law. If a solver performing an asset swap can be designated as an agent under this framing, the immediate question facing attempts to parse such a relationship is that of the bounds of a solvers' authority.

At present, there is no standardised format via which intents are broadcast on Ethereum, although work is ongoing for two distinct Ethereum Request for Comment (ERC) standards — ERC-4337 [132] and ERC-7521 [133] — that aim to improve consensus on their interpretation. In their absence, swapping platforms encode intents idiosyncratically based on their specific setup.

As such, the actual express authority that a solver can follow starts and ends with the parameters encoded within the intent that they accept. [134] Woe betides the seeker that makes a fat-finger error (i.e. one zero too many), as the solver will take their direction very literally: indeed, they are typically *required* to do so as a prerequisite to being granted the right to act as solver. [135] In turn, the actual implicit authority that can be derived to enable an intent to be executed is hardly implicit at all. Parameters of the intent aside, the only other components that a seeker *can* provide are either an explicit transaction to a contract granting a solver access to their assets [136] or usage of their private key to approve a set of signatures returned by a solver representing their proposed solution. [137] The hyperliteral EVM leaves no room for anything of importance to be implied in this context.

As a point of interest, the expectation that clarity is sought from a seeker in the event of confusion as to the bounds of actual authority is unrealistic in this setting. [138] The seeker-solver pairing is too brief to allow any opportunity for clarification, and there is no manner enshrined within Ethereum with which the owners' addresses can synchronously communicate. Doing so is *possible* via messaging network protocols such as XMTP, [139] but these require third-party platform integration and for both parties to utilise the platforms' user interface. [140] As an automatic system, solvers do not make use of these, and as such they may be permitted to make a 'reasonable interpretation' per *Ireland*, [141] of which there can be only one: the exact terms of the intent received.

Finally, whether apparent authority exists in this setting is almost irrelevant. While it has been argued that if 'a user makes it appear that a bot is acting on the user's behalf to form contracts, the bot has apparent authority to contract on behalf of the user,' [142] such an argument fails when the solver is interacting with smart contracts such as automated market makers (AMMs) to satisfy an intent. [143] The latter are performing the actual swaps, typically operating according to a pre-defined mathematical function such as a constant product. [144] Many of these AMM smart

[130] Ian Kerr, 'Ensuring the Success of Contract Formation in Agent-Mediated Electronic Commerce' (2001) 1 Electronic Commerce Research 183.
[131] Samir Chopra and Laurence White, 'Artificial Agents And The Contracting Problem: A Solution Via An Agency Analysis' (2010) University of Illinois Journal of Law Technology & Policy 363.
[132] 'ERC-4337 Documentation' (*ERC4337.io*) <https://www.erc4337.io/docs> accessed 5 April 2024.
[133] Stephen Monn, 'Introducing ERC-7521: Generalized Intents for Smart Contract Wallets' (*Essential.builders*, 2023) <https://blog.essential.builders/introducing-erc-7521-generalized-intents> accessed 5 April 2024.
[134] Ooi (no 121) 103.
[135] Adams (no 20); Nokhbeh (no 23).
[136] Permit2 (no 28).
[137] Nokhbeh (no 23).
[138] *Woodhouse* (no 51).
[139] Matt Galligan, 'XMTP Litepaper' (*GitHub.com*) <https://github.com/xmtp/litepaper> accessed 6 April 2024.
[140] ibid.
[141] *Ireland* (no 50).
[142] Ian Kerr, 'Spirits In The Material World: Intelligent Agents As Intermediaries In Electronic Commerce' (1999) 22 Dalhousie LJ 190, 243.
[143] Massimo Bartoletti, James Chiang and Alberto Lluch-Lafuente, 'A Theory Of Automated Market Makers In DeFi' (2022) 18(4) LMCS 1.
[144] Guillermo Angeris and others, 'Constant Function Market Makers: Multi-Asset Trades Via Convex Optimiza-

contracts are immutable by design (they cannot be adjusted or disabled by any party) [145] and can neither recognise nor insist upon any concept of apparent authority.

Within our constrained setting of solvers operating within DeFi, the nuance of agent authority seems a round peg destined for a square hole, but we defer further analysis on this topic for those following our footsteps. We move now to whether fiduciary duties can apply to a solver and — if so — some ways in which they are currently being breached.

6 On The Fiduciary Nature Of Solvers

As previously highlighted, the label of 'fiduciary' is not one that applies in a finite set of relationships. [146] The question here is: do solvers performing asset swaps act in such a way that the label is appropriate? We posit that the answer is *potentially*.

6.1 Can A Solver Be A Fiduciary?

In Section 4.4 we identified two situations wherein a financial intermediary can become a fiduciary: having an obligation to find a best execution price, and going beyond providing advice and taking direct control of assets. It is debatable whether a solver classifies as a financial intermediary in the traditional sense, as the label requires the prior existence of obligations between parties, [147] but we will follow the thread for a while.

The first requires some pedantry for a solver to defend against. Per *Reading*, 'a "fiduciary relation" exists ... whenever the plaintiff entrusts to the defendant a job to be performed ... *and* relies on the defendant to procure for the plaintiff the best terms available' (emphasis added). [148] Within platforms that implement auctions on the execution price when broadcasting intents, [149] solvers only engage at the point where they are confident they can make a profit, whereas in those which poll-and-select solver solutions, a solver can simply not respond. [150]

The emphasised word '*and*' in that judgment is important here: a seeker cannot place any 'legitimate reliance' on best execution given the market forces that bring the pair together. [151] A solver will engage at the price that makes economic sense for them, which can be impacted by exogenous factors such as network congestion which drives up the cost of a transaction. [152] Moreover, prices obtained for assets via DeFi lag those that can be obtained on a centralised exchange operating a limit-order book such as Coinbase or Binance: [153] were best execution mandatory, a solver would avoid AMMs altogether. Come what may, under a strict reading of the conjunction, reliance on best execution is necessary to use *Reading* as authority to label solvers fiduciaries, and no such obligation can be placed upon them in advance.

We further note that 'simply giving advice is not a fiduciary duty,' [154] 'nor is simply acting under

tion' (*arXiv.org*, 2021) <https://arxiv.org/abs/2107.12484> accessed 6 April 2024.

[145] Hayden Adams, Noah Zinsmeister and Dan Robinson, 'Uniswap v2 Core' (*Uniswap.org*, 2020) <https://uniswap.org/whitepaper.pdf> accessed 6 April 2024.

[146] Sheehan (no 66).

[147] Hudson (no 31) para 5.21.

[148] *Reading* (no 104) [236].

[149] Adams (no 20); CoW Protocol (no 21); 1inch Network (no 22).

[150] Nokhbeh (no 23).

[151] Financial Conduct Authority, 'Best Execution And Payment For Order Flow' (TR14/13, 2014) 44.

[152] Dimitrios Koutmos, 'Network Activity and Ethereum Gas Prices' (2023) 16(10) J Risk Financial Manag 431.

[153] Lioba Heimbach, Vabuk Pahari and Eric Schertenleib, 'Non-Atomic Arbitrage In Decentralized Finance' (*arXiv.org* 2024) <https://arxiv.org/abs/2401.01622> accessed 13 April 2024.

[154] Paul Miller, 'The Fiduciary Relationship' in Andrew Gold and Paul Miller (eds), *Philosophical Foundations of Fiduciary Law* (OUP 2014) 84.

instructions fiduciary so brokers who simply act as order-takers are not fiduciary.' [155] There is an implication in the latter quote that exercising any discretion with regards to how the order should be carried out — which is precisely what a solver does in terms of deciding which smart contracts to interact with — *does* imply fiduciary duties. Observe that the quote refers to *brokers* rather than financial intermediaries, and while we do not make the claim that solvers assisting with asset swaps are brokers, the shoe of 'transaction facilitator' fits. [156]

The second situation is more complicated. In *Mara v Browne* it was held that 'if one, not being a trustee and not having authority from a trustee, takes upon himself to inter-meddle with trust matters *or* to do acts characteristic of the office of trustee, he *may* therefore make himself what is called in law trustee of his own wrong - i.e., a trustee de son tort, or, as it is also termed, a constructive trustee' (emphasis added). [157] As parties acting 'under an arrangement to control property on behalf of another,' trustees are the fiduciary archetype. [158] The question to answer is whether a solver handling an asset swap does, in fact, control property on behalf of another. To do this, we need to consider both 'control' and 'property' separately.

Regarding control, a solver is required to take temporary title to the seekers' assets in order to effect a swap for them: they are the party deciding where and how the swap should take place as well as incurring the transaction execution cost (at the time of writing, account abstraction proposals — which enables third-party sponsorship of such costs — are not in effect). [159] Such notions of control and relativity of title for digital assets are currently under heavy scrutiny by the Law Commission and academics alike, [160] a 'correct' interpretation of which we do not dare to put forth here. Suffice it to say that even if only for a heartbeat, a solver can meet the initially proposed definition of factual control: they can exclude others from ownership of such assets, use them 'for what they are capable' and attest to having both powers. [161] Interestingly, Dubai adopted the Law Commission digital asset report as statute almost verbatim. [162]

Regarding property, it is now commonly accepted in English law that cryptoassets are considered as such, [163] although the *category* under which they should fall in English law is currently being heavily debated: whether they are *choses in possession*, *choses in action* or a novel 'third thing' remains to be settled. [164] Some debate exists as to whether cryptoassets are property at all, [165] but as far as current law is concerned, a solver is working with property. [166]

Under a strict reading of *Mara*, a solver has the *potential* to create an ephemeral trust over which they are constructive trustee. Such an idea is only novel in the sense that it may apply to a solver, as cryptoassets are already accepted as being capable of being held on trust in English law. [167]

[155] Arthur Laby, 'Selling Advice and Creating Expectations: Why Brokers should be Fiduciaries' (2012) 87 Washington L Rev 707.
[156] ibid.
[157] *Mara* (no 105) [209].
[158] David Hayton, *Underhill and Hayton: Law Relating to Trusts and Trustees* (15th edn, Butterworth 1995) 1.
[159] 'EIP-3074' (*GitHub.com* 2020) <https://github.com/ethereum/EIPs/blob/master/EIPS/eip-3074.md> accessed 14 April 2024.
[160] Duncan Sheehan, 'Digital Assets: Why The Law Commission Are Wrong About Control' (2023) 39(1) JIBFL 3; Duncan Sheehan, 'Digital Assets, Blockchains and Relativity of Title' (2024) 1 JBL 78.
[161] Law Commission, *Digital Assets* (no 10) para 5.12.
[162] Digital Assets Law (DIFC Law No 2 Of 2024) (Dubai).
[163] *AA v Persons Unknown, Re Bitcoin* [2019] EWHC 3556 (Comm), [2020] 4 WLR 35; *Vorotyntseva v Money-4 Ltd* [2018] EWHC 2598 (Ch), [2018] 9 WLUK 501.
[164] *Colonial Bank v Whinney* [1885] 30 Ch D 261, [1885] 7 WLUK 82 [285]; Law Commission, 'Digital Assets As Personal Property: Short Consultation On Draft Clauses' (*LawCom.gov.uk* 2024) <https://lawcom.gov.uk/document/digital-assets-as-personal-property-draft-clauses> accessed 14 April 2024; Lodewijk Van Setten, 'Cryptographic Tokens: Three Categories Of Personal Property?' (2023) 38(2) JIBFL 102.
[165] Robert Stevens, 'Crypto Is Not Property' (2023) 139(Oct) LQR 615.
[166] Kelvin Low, 'Bitcoins As Property: Welcome Clarity?' (2020) 136(Jul) LQR 345.
[167] *Wang v Darby* [2021] EWHC 3054 (Comm), [2022] WTLR 327; Gilead Cooper, 'Virtual Property: Trusts

We note that it is unclear whether the assets in question need to already be held in trust for this situation to arise, but that 'it is no defence for such an intermeddler to show that he acted in good faith and without negligence.' [168] This strict liability is surprising, as the word 'may' in the *Mara* excerpt suggests that for this situation to arise, the solver must act wrongfully. [169] Whether such an argument would succeed in court depends on the facts at hand: for example, a solver routing assets through a smart contract sanctioned by OFAC — tainting both seeker and solver with strict liability — may well breach a duty of care. [170]

There is no clear answer either way here, which naturally means that we are destined to read several hundred pages of discourse on the topic over the next ten years as English law catches up with digital assets and the myriad ways they fail to comport with precedent from the time when electric streetlamps were first brought to London. We may also avoid the question entirely by either Parliament or the courts recognising the notion of electronic agency presented in Section 5.2, given that agents are fiduciaries by default. [171]

6.2 On DeFi-Specific Breaches Of Fiduciary Duty

To conclude our analysis, let us make a sweeping assumption: however it comes about, a solver dealing with an asset swap intent is a fiduciary. In this setting, what are some of the DeFi-specific ways in which a solver might violate the duties that they owe their seeker?

The primary concern involves a solver breaching the no-profit rule by keeping any funds beyond those fees agreed up-front by a seeker, which would classify as 'money which the servant ought not to be allowed to keep, and the law says it shall be taken from him and given to his master, because he got it solely by reason of the position which he occupied as a servant of his master'. [172]

The most direct way that this can arise is where *positive slippage* arises when a trade fills at a better execution price than quoted. [173] Such surplus should be returned to the seeker, but given that asset swap platforms currently encode intents idiosyncratically, there is no general *requirement* that this happens: the only fixed condition is that the execution price is honoured. [174] Historically, and controversially, some platforms (rather than solvers themselves) retained this surplus, although this practice has ended. [175]

Another route to breaching no-profit is one that is unique to DeFi: airdrops. Smart contract ecosystems are often governed by DAOs (decentralised autonomous organisations) that reward early users by issuing them governance tokens through which holders can vote on DAO-related matters. [176] Such airdrops are occasionally predicated on swap volume routed through the AMMs which a solver might make use of and may on occasion even reward competitor usage. [177] The

Of Cryptocurrencies And Other Digital Assets' (2021) 27(7) T&T 622; Steven Baker and Julia Bihary, 'From Cryptic To (Some) Clarity: English Law And Policy Rising To The Challenge Of Cryptoassets' (2022) 37(9) JIBLR 311, 313.

[168] Charles Harpum, 'The Stranger As Constructive Trustee: Part 1' (1986) 102 LQR 114, 114-115.

[169] Lynton Tucker, Nicholas Le Poidevin and James Brightwell, *Lewin On Trusts* (18th edn, Sweet & Maxwell 2010) 42–74.

[170] US Department of the Treasury, 'U.S. Treasury Sanctions Notorious Virtual Currency Mixer Tornado Cash' (*Treasury.gov*, 2022) <https://home.treasury.gov/news/press-releases/jy0916> accessed 15 April 2024.

[171] Bennett (no 60).

[172] *Reading v Attorney General* [1951] AC 507, [1951] 1 All ER 617 (HL) [514].

[173] Scott Brown, Timothy Koch and Eric Powers, 'Slippage And The Choice Of Market Or Limit Orders In Futures Trading' (2009) 32(3) Journal of Financial Research 309.

[174] Adams (no 20).

[175] 1inch Network, 'The 1inch DAO Discontinues Swap Surplus Collection' (*1inch.io*, 2023) <https://blog.1inch.io/the-1inch-dao-discontinues-swap-surplus-collection> accessed 18 April 2024.

[176] Darcy Allen, Chris Berg and Aaron Lane, 'Why Airdrop Cryptocurrency Tokens?' (2023) 163 Journal of Business Research 113945.

[177] Robert Stevens, '1inch Exchange Airdrops $84 Million To Crypto Community' (*Decrypt.co*, 2021) <https://decrypt.co/57575/1inch-exchange-airdrops-34-million-to-uniswap-users> accessed 18 April 2024.

strict nature of the no-profit rule suggests that any airdrop tokens voluntarily claimed by a solver must be distributed pro-rata to the seekers whose intents qualified the solver for the airdrop.

Another DeFi-specific quirk has the potential to lead a solver into breaking both the no-profit and self-dealing rules simultaneously. The liquidity associated with an AMM is sourced from entities ('liquidity providers,' or LPs) providing the assets on both sides of a pair in exchange for a token representing their share of that liquidity (an 'LP token') and receiving pro-rata fees on volume routing through that AMM in exchange. [178] Envisage a situation where a solver receives — as settlement fee for an intent — a widely traded token such as the Curve 3pool LP, which represents liquidity for three widely traded stablecoins. [179] A literal reading of fiduciary duties precludes the solver from subsequently routing *any* intent through the Curve 3pool AMM — such as exchanging `USDT` for `USDC` — *even if that is the most efficient venue for the swap to take place.* In doing so, the solver would be receiving fees beyond a settlement fee *and* acting simultaneously for both the seeker and themselves as LP. [180] This example is admittedly contrived but is indicative of the potential for clashes between the intent-based framework and the strict liabilities of the law as it currently stands. In the event of a judgment declaring the above to be true, one could send a trivial amount of common LP tokens to every major solver address simply to cause trouble, something that Ethereum users are already proficient at doing in protest. [181]

One final potential tripwire lay with the loyalty owed to seekers in situations where intents are settled in batches rather than individually. [182] The solver that wins an auction for a batch intent would be expected to offer a single execution price to each seeker therein, [183] but if they make use of an AMM to solve it, they are guaranteed to incur a strictly worse price due to slippage than if they solved each intent individually. [184] This is unlikely to be considered acting 'against' any seeker, [185] and protocols supporting intent-batching currently ensure that the price a seeker receives is at least equal to what they would receive from an AMM *given demand at that time*, [186] but this is worth bearing in mind as intents become more widespread.

Of course, the law is only as effective as it is enforceable, and for those solvers operating on platforms which do not require them to pass a KYC check, their jurisdiction is unknowable short of performing extensive tracing. [187] Moreover, as intent-based mechanisms become further enshrined in Ethereum the need for such platforms will gradually disappear altogether. This is likely to render the above analysis void: English law has retained EU regulation stating that a contract for services is governed by the jurisdiction of the residence of the service provider, [188] but if a solver cannot be identified — even if their operator and servers are resident in London — there is no realistic path to recourse in the courts. Code is not law, but the law can also be impotent. [189]

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7 Conclusion

The techniques our children will use to interact with blockchain networks are not our own.

Ethereum is proving as such by bringing the intent-based model to the fore. In this model, parties who would previously be expected to act on their own volition are able to describe the shape of their desired outcome (as a 'seeker') and pay a specialist (a 'solver') to bring that outcome into being. Such a relationship *looks like* agency regardless of the task, and in the context of one party exchanging property on behalf of another, it *looks like* the relationship infers fiduciary duties.

And yet, as with most things bleeding-edge in technology, English law does not have a ready answer. Throughout this dissertation, we have presented the definitions of agency, authority, fiduciaries, and their duties as they stand and analysed their applicability to the most popular form of retail-driven intent currently utilised on Ethereum: limit order asset swaps.

We conclude that at present, a solver — as an automated system — cannot be an agent, although it is an open question as to whether a connection creating such a relationship can — or should — be drawn between the solver itself and the party that built and operates it. In exploring the assumption that such systems *can* be designated as agents, we highlighted that the nature of intents — plus the nuances of the Ethereum network — renders most concepts of authority associated with a principal-agent relationship near meaningless.

We further conclude that there appear to be paths to labelling solvers as fiduciaries other than agents, although they may rely on wrongdoing (i.e. negligence) by the solver to manifest. In exploring the assumption that a solver *can* be designated as a fiduciary, we presented several scenarios unique to DeFi in which they would breach their resulting duties of no-profit and no-conflict.

It is worth re-emphasising that our analysis has focused very narrowly on using intents to drive the swapping of one asset for another, and that intents — as envisaged — are a near-universal mechanism for engaging with each other for arbitrary purposes. A court judgment or piece of legislation marking all solvers as being agents, fiduciaries, or anything in the vein will be immediately met by protests from those making use of intents for more workaday tasks such as pushing weather data into a blockchain.

Significantly more research is required to categorise more broadly what is an emerging technique for co-operation, and it is our hope that the Law Commission continues what has been an excellent streak of work in their consideration of digital assets when they arrive at intents. One recommendation is that a determination is made quickly as to whether an automated solver system stands apart from its creator in English law or if they are a mutation of a *corporation sole*, given that the pair present to the network as a single public address derived from a single private key.

The Ethereum network is constantly evolving in service of an effort to better itself as a global computer, and the way that intents and solvers manifest will be markedly different from what has been presented here mere months from the time of writing. Those responsible for stewarding English law should be encouraged to engage with that evolution: not to keep its development within the rails of what it considers to be 'correct,' — an effort that would be doomed to fail — but rather to be better able to understand the powers that are realistically available to the law as the two systems continue to encounter each other.

Which they will.

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