

Decentralized Mechanical Turk through Verified Reputation

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ABSTRACT

Centralized mechanical turk solutions are subject to significant shortcomings. Decentralized crypto solutions can optimize the mechanical turk market. Autonomous decentralized protocols for validating domain specific reputation of workers that perform tasks allow such micro task workers to stake tokens in order to prove the validity of their tasks and earn a reusable computed reputation score. Such decentralized crypto solutions enhance the cost-efficiency of mechanical turk work while democratizing access for reputation verified workers.

Key Words: Mechanical Turk, Micro Tasks, Decentralization, Blockchain, Distributed Ledger Technology, Regulation, Artificial Intelligence, Machine Learning, Data Science, Data Scientists, Innovation, Entrepreneur, Start-up, Big Data, Crypto Economics, Semada, Platform, Democratization

JEL Categories: K20, K23, K32, L43, L5, O31, O32

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Table of Contents



1 PROBLEMS IN CENTRALIZED MECHANICAL TURK.....	3
2 DECENTRALIZED SOLUTIONS FOR MECHANICAL TURK.....	8
3 SEMADA PLATFORM.....	11
3.2 REPUTATION STAKING MECHANISM	12
3.3 REPUTATION SCORE.....	12
3.4 PAYMENT SYSTEM.....	13
3.5 GAMIFICATION OF MICRO TASKS	14
4 INNOVATING THE MECHANICAL TURK MARKET	15
4.1 NO PLATFORM FEES.....	15
4.2 TRANSACTION COST REMOVAL.....	16
4.3 OPTIMIZED USER INTERFACE.....	16
4.4 WORKER ANONYMITY INCREASES PARTICIPATION.....	17
6 OUTLOOK	18

1 Problems in Centralized Mechanical Turk

The growth in freelance work is a global trend.¹ According to some studies, over 40% of the American workforce will be freelancers by 2020.² Freelance work allows individuals to pursue their passions, create flexible opportunities to make a living, and enables people to truly advance themselves and their families. Technology and automation play a much larger role in the workplace than even five years ago, rendering the traditional work schedule nearly obsolete across industries while maintaining operational efficiencies and reducing costs.³ Task performers or workers are no longer bound by geographical location and task requesters are able to hire from the growing global talent pool of freelancers.⁴ In the current freelancer market, leading centralized platforms Fiverr, Taskrabbit, Upwork, Crowdfunder and Mechanical Turk have their workforces distributed throughout the world. Micro Tasks freelance work is becoming increasingly important in the freelance market.⁵

Micro tasks are defined as small tasks that require human judgment, can be completed by humans independently over the internet, and are part of a

¹ Shoshana Deutschkron, *New Study Finds Freelance Economy Grew to 55 Million Americans This Year, 35% of Total U.S. Workforce*, UPWORK: PRESS (Oct. 6, 2016), <https://www.upwork.com/press/2016/10/06/freelancing-in-america-2016/>; *Self-employment rate*, THE ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD): DATA (Jan. 25, 2018), <https://data.oecd.org/emp/self-employment-rate.htm>; Nathan Heller, *Is the Gig Economy Working?*, THE NEW YORKER, May 15, 2017, <https://www.newyorker.com/magazine/2017/05/15/is-the-gig-economy-working>; [Aaron Smith, Shared, Collaborative, and On Demand: The New Digital Economy, PEW RESEARCH CENTER \(May 19, 2016\)](#), <http://www.pewinternet.org/2016/05/19/the-new-digital-economy/>; Sonal Khetarpal, *The Rise of the Freelancer*, BUSINESS TODAY (April 24, 2016), <http://www.businesstoday.in/magazine/features/companies-are-hiring-more-freelancers-than-ever/story/230742.html>.

² INTUIT, *Dispatches from the new Economy: The On-Demand Workforce*, (Second Annual Report, Feb. 21, 2017), <https://www.slideshare.net/IntuitInc/dispatches-from-the-new-economy-the-ondemand-workforce-72248688/1>.

Intuit 2020 Report: TWENTY TRENDS THAT WILL SHAPE THE NEXT DECADE, Intuit (Oct. 2010), http://http-download.intuit.com/http.intuit/CMO/intuit/futureofsmallbusiness/intuit_2020_report.pdf.

³ Jonathan Millet, *STORM Tokens in the Freelance Marketplace Enhances Efficiency and Profitability*, NEWSBTC (Dec. 7, 2017), <http://www.newsbtc.com/2017/12/07/storm-tokens-freelance-marketplace/>.

⁴ STORMX, INC. *Storm Token: White Paper, Market Research, Network Development Plans, and Marketing Materials* (Oct. 16, 2017), https://s3.amazonaws.com/cakecodes/pdf/storm_web/STORM_Token_White_Paper_Market_Research_Network_Development_vFINAL.pdf.

⁵ THE WORLD BANK, *FEASIBILITY STUDY: MICROWORK FOR THE PALESTINIAN TERRITORIES*, 2013, <http://documents.worldbank.org/curated/en/529481468140639204/pdf/ACS36850ESW0P1015B00PUBLIC00A9R7B83.pdf>.

larger unified project.⁶ Because of the necessity of human judgment that cannot currently be replaced by machines/computers, micro tasks enable organizations to build products or create outcomes that cannot be synthesized by machines/computers alone.⁷ For example, the Chinese government uses 2 million micro task workers to aid in censoring the internet.⁸ Internet companies, such as Google, Facebook, Twitter, Ebay, and LinkedIn optimize their production ready solutions and enhance their AI model training with micro task workers.⁹ Large scale distributions of machine learning researchers, among others, gather structured labeled data for artificial intelligence (AI) training purposes through the use of micro task workers.¹⁰

Billions of micro tasks are completed each year and the demand for micro task workers is increasing consistently. In an attempt to capitalize on the growing demand for micro task work, Amazon created Amazon Mechanical Turk (MTurk) in 2005.¹¹ MTurk is an online marketplace that allows requesters to pay workers for performing micro tasks online, thus crowdsource data collection. The World Bank concluded in a 2015 report, that the largest crowdsourced data collection platforms Amazon Mechanical Turk and CrowdFlower, a venture backed company that raised over \$58

⁶ AMNESTY INTERNATIONAL, Microtasking, THE ENGINE ROOM LIBRARY (last visited Jan. 25, 2018), <https://library.theengineroom.org/microtasking/>.

⁷ Cole, F., Sanik, K., DeCarlo, D., Finkelstein, A., Funkhouser, T., Rusinkiewicz, S., and Singh, M. *How Well Do Line Drawings Depict Shape?*, ACM SIGGRAPH (2009), 1–9; Callison-Burch, C. *Fast, Cheap, and Creative: Evaluating Translation Quality Using Amazon's Mechanical Turk*, in 1 PROCEEDINGS OF THE 2009 CONFERENCE ON EMPIRICAL METHODS IN NATURAL LANGUAGE PROCESSING 286 (2009); Horton, J. J., Rand, D.G. and Zeckhauser, R.J., *The Online Laboratory: Conducting Experiments in a Real Labor Market* (National Bureau of Economic Research, Working Paper 15961, 2010); Kittur, A., Chi, E., Suh, B. *Crowdsourcing User Studies With Mechanical Turk*, Proceedings of SIGCHI Conference on Human Factors in Computing Systems 453 (2008), http://delivery.acm.org/10.1145/1360000/1357127/p453-kittur.pdf?ip=140.209.181.61&id=1357127&acc=ACTIVE%20SERVICE&key=70F2FDC0A279768C%2ECD0A7109D1C458E3%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&_acm_=1517258739_5d051dc3294d8ac7c245ec3c954d350d.

⁸ Katie Hung & CY Xu, *China “Employs 2 Million to Police Internet”*, CNN (Oct. 7, 2013), <https://www.cnn.com/2013/10/07/world/asia/china-internet-monitors/index.html> (those who pass an exam will gather opinions and attitudes of Internet users, organize them into reports, and submit them to decision-makers. At present, there are about 2 million people in this occupation in the country); *China Employs Two Million Microblog Monitors State Media Say*, BBC NEWS, (Oct. 4, 2013), <http://www.bbc.com/news/world-asia-china-24396957>; Cate Cadell & Pei Li, *Team and Tiananmen: Inside China's new censorship machine*, REUTERS (Sept. 29, 2017, 1:32 AM), <https://www.reuters.com/article/us-china-congress-censorship-insight/tea-and-tiananmen-inside-chinas-new-censorship-machine-idUSKCN1C40LL>

⁹ CROWDFLOWER, *Success Stories*, <https://www.crowdfLOWER.com/success-stories/>.

¹⁰ Jason Pontin, *Artificial Intelligence, With Help From the Humans*, THE NEW YORK TIMES (Mar. 25, 2007), <http://www.nytimes.com/2007/03/25/business/yourmoney/25Stream.html>.

¹¹ AMAZON MECHANICAL TURK, www.mturk.com;

Paul Hitlin, *What is Mechanical Turk?* PEW RESEARCH CENTER (July 11, 2016), <http://www.pewinternet.org/2016/07/11/what-is-mechanical-turk/>.

million¹² and is focused on enriching data used for AI, would quadruple their revenue from 2013 to 2016.¹³

The increasing demand for micro task workers that came initially from data scientists and other academics is further increased by the growth of artificial intelligence (AI) and the increasing scope and scale of AI applications in a broad range of industries.¹⁴ Fortune 500 tech companies including Amazon, Apple, Google Alphabet, Twitter, and Facebook use AI and machine learning to improve their services and cut costs, thus increasing profitability exponentially.¹⁵ According to some estimates, Fortune 500 tech companies spent between \$20 and \$30 billion on the development and enhancement of their AI systems in 2016.¹⁶ More recent data for 2017 suggests that this trend is continuing and increasing.¹⁷ AI is already playing a significant role in consumer expectations and tech companies have the best possible set of incentives to keep investing in AI to fulfill such expectations and develop new products at marginal cost.¹⁸

¹² Julie Bort, *Founder of \$110 Million Startup CrowdFlower: I'm Forever Grateful to Travis Kalanick*, BUS. INSIDER (Oct. 15, 2017, 11:00 AM), <http://www.businessinsider.com/crowdfounder-founder-learned-from-travis-kalanick-2017-10>

¹³ Siou Chew Kuek et al., *The Global Opportunity in Online Outsourcing*, WORLD BANK GROUP (June 2015), <http://documents.worldbank.org/curated/en/138371468000900555/pdf/ACS14228-ESW-white-cover-P149016-Box391478B-PUBLIC-World-Bank-Global-OO-Study-WB-Rpt-FinalS.pdf>.

¹⁴ Jacques Bughin et al., *How Artificial Intelligence Can Deliver Real Value to Companies*, MCKINSEY & COMPANY (Jun. 2017), <https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/how-artificial-intelligence-can-deliver-real-value-to-companies>; Dmitry Matskevich, *Low-Wage Workers Drive the Global AI Labor Market*, VENTUREBEAT (Dec. 12, 2017, 12:10 PM), <https://venturebeat.com/2017/12/12/low-wage-workers-drive-the-global-ai-labor-market/>.

¹⁵ Cade Metz, *Google, Facebook, and Microsoft are Remaking Themselves Around AI*, WIRED (Nov. 21, 2016, 7:00 AM), <https://www.wired.com/2016/11/google-facebook-microsoft-remaking-around-ai/>.

Joe McKendrick, *Artificial Intelligence Doesn't Just Cut Costs, It Expands Business Brainpower*, FORBES (Jan 24, 2017, 12:03 PM), <https://www.forbes.com/sites/joemckendrick/2017/01/24/artificial-intelligence-doesnt-just-cut-costs-it-expands-business-brainpower/#29a22aa8535a>.

¹⁶ Bughin, *supra.*; Louis Columbus, *McKinsey's State of Machine Learning and AI, 2017*, FORBES (Jul. 9, 2017, 9:36 AM), <https://www.forbes.com/sites/louiscolumbus/2017/07/09/mckinseys-state-of-machine-learning-and-ai-2017/#30d75fbb75b6>.

¹⁷ INTERNATIONAL DATA CORPORATION (IDC), *Worldwide Spending on Cognitive and Artificial Intelligence Systems Forecast to Reach \$12.5 Billion This Year, According to New IDC Spending Guide* (Apr. 3, 2017), <https://www.idc.com/getdoc.jsp?containerId=prUS42439617> (worldwide revenues for cognitive and AI solutions are forecasted to continue to see significant corporate investment over the next several years).

¹⁸ Nick Johnson, *How Your Customers' Expectations Have Changed in the Age of the Customer*, SALESFORCE BLOG (Jul. 7, 2017), <https://www.salesforce.com/blog/2017/07/customers-expectations-in-age-of-the-customer.html>; Oliver Tan, *How AI Can Improve the Customer Experience*, FORBES

The evolution, improvements, and growth of AI is correlated with the evolution, improvements, and growth in micro task work. AI uses supervised and unsupervised as well as reinforcement machine learning. Because unsupervised and reinforcement learning are much more complex than supervised learning, supervised learning is to date more common and more relied upon for AI development. While this may change as unsupervised and reinforcement learning evolve, currently, supervised learning depends on labelled data that is produced via micro task work. The mapping function of the supervised AI learning process necessitates the analysis of labelled input variables x and corresponding output variables y . In the supervised learning training phase, the AI neural network examines the training dataset of labeled x input data to learn to classify the input data idealistically. The higher the quality and quantity of such labelled datasets the better the AI neural network's learning algorithm during the supervised training process.¹⁹ Accordingly, the evolution, improvements, and growth of AI is correlated with the evolution, improvements, and growth in micro tasks work.²⁰ But alas, microtasks platform systems are subject to significant limitations that inhibit the evolution of AI.²¹

The existing centralized marketplaces for micro task work cannot adequately fulfil the increasing demand for high quality micro task work for AI labelled training datasets. First and foremost, the cost structure for micro task work in centralized systems that necessitate intermediation results in significant overpricing without benefiting the micro task workers directly. The cost

(Aug. 9, 2017, 8:00 AM),

<https://www.forbes.com/sites/forbestechcouncil/2017/08/09/how-ai-can-improve-the-customer-experience/#4dcca41f757d>; Amit Sharma, *How Predictive AI Will Change Shopping*, HARV. BUS. REV. (Nov. 18, 2016), <https://hbr.org/2016/11/how-predictive-ai-will-change-shopping>.

¹⁹ Bernard Marr, *Supervised v Unsupervised Machine Learning: What's the Difference*, FORBES (Mar. 16, 2017, 3:13 AM), <https://www.forbes.com/sites/bernardmarr/2017/03/16/supervised-v-unsupervised-machine-learning-whats-the-difference/#47e947ea485d>.

²⁰ Hope Reese & Nick Heath, *Inside Amazon's Clickworker Platform: How Half a Million People are Being Paid Pennies to Train AI*, TECHREPUBLIC (Dec. 2016), <https://www.techrepublic.com/article/inside-amazons-clickworker-platform-how-half-a-million-people-are-training-ai-for-pennies-per-task/>.

²¹ Michel Dalle et al., *Microwork Platforms as Enablers to new Ecosystems and Business Models: The Challenge of Managing Difficult Tasks*, 75 INT'L J. TECH. MGMT. 55 (2017); Yang Gao, Yan Chen & K. J. Ray Liu, *On Cost-Effective Incentive Mechanisms in Microtask Crowdsourcing*, 7 IEEE TRANSACTIONS ON COMPUTATIONAL INTELLIGENCE AND AI IN GAMES 3 (Mar. 2015); Winter Mason & Duncan J. Watts, *Financial Incentives and the "Performance of Crowds"*, 11 ACM SIGKDD EXPLORATIONS NEWSLETTER 100-108 (2010), http://delivery.acm.org/10.1145/1810000/1809422/p100-mason.pdf?ip=140.209.181.61&id=1809422&acc=ACTIVE%20SERVICE&key=70F2FDC0A279768C%2ECD0A7109D1C458E3%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1517240131_111ce0376ad360b2b87eb813b5552142.

structure suboptimality can be traced back to several factors.²² All too human shortcomings of micro task works, such as limited attention span, irrationality, and inaccuracies result in verification requirements for micro task work. However, manual verification of micro task work is subject to the same human limitations. In an attempt to ensure quality of results and minimize the impact of the human limitations of their workers, requesters in centralized micro task structures set up teams of up to 15 workers to perform the same task in an effort to form a consensus.²³ The multiplication of work inherent in this process significantly increases the cost of micro task work. Requiring requesters to pay proportionally (e.g. up to 15 times) for work per project result in waste. The necessity of multiplication of work also subjects micro task workers to lower rates and lack of payment increases. Moreover, because unmanaged centralized micro task platforms do not supply consumer interfaces needed to accomplish specific tasks, requesters of micro task work are forced to either build their own tools²⁴ or pay large fees to

²² AMAZON, INC., *Amazon Mechanical Turk Pricing*, <https://requester.mturk.com/pricing> (intermediation necessitated by the centralized marketplace for micro task work harms both requesters and workers economically. To illustrate this point, Amazon charges requesters a minimum 20% fee on any amount paid out to workers and an additional 5% for requesting workers that have a good track record. Amazon charges an additional 20% fee for tasks with 10 or more assignments, totaling upwards of 40% in fees. With over half of MTurk workers earning less than \$5 an hour.); Paul Hitlin, *Research in the Crowdsourcing Age, a Case Study: How Scholars, Companies and Workers are Using Mechanical Turk, a 'Gig Economy' Platform, for Tasks Computers Can't Handle*, PEW RESEARCH CENTER (July 11, 2016), <http://www.pewinternet.org/2016/07/11/research-in-the-crowdsourcing-age-a-case-study> (Mechanical Turk pays its workers by the task completed and not by the hour, therefore it is not required to follow federal wage laws. The specific payments are determined by the requesters and not the site itself. This report does not explore how Mechanical Turk sets prices or pays workers). Ellen Cushing, *Amazon Mechanical Turk: The Digital Sweatshop*, UTNE (Jan/Feb 2013), <http://www.utne.com/science-and-technology/amazon-mechanical-turk-zm0z13jzfzlin> (Amazon's MTurk raises ethical concerns and some go as far as calling it a sweatshop of online crowdsourced labor); Louise Matsakis, *The Unknown, Poorly Paid Labor Force Powering Academic Research*, MOTHERBOARD (Feb. 4, 2016, 11:50 AM), https://motherboard.vice.com/en_us/article/8q8ggb/the-unknown-poorly-paid-labor-force-powering-academic-research; Vanessa Williamson, *On the Ethics of Crowdsourced Research*, PS: POLITICAL SCIENCE & POLITICS, 49(1), 77-81, <https://www.cambridge.org/core/journals/ps-political-science-and-politics/article/on-the-ethics-of-crowdsourced-research/B1BDFB1111B416DD0B71540CD6E7D94F>. CROWDFLOWER, *Plans*, <https://www.crowdfLOWER.com/plans> (CrowdFlower is currently no longer sharing their pricing structure publicly but rather is requiring possible customers to contact them for pricing directly).

²³ Neeraj Kumar, *Effective Use of Amazon Mechanical Turk (MTurk); Tips and techniques for better usage of Amazon Mechanical Turk for researchers*, NEERAJ KUMAR (May 2013, updated May 8, 2014), <http://neerajkumar.org/writings/mturk/>; Rory O'Reilly, *How the Gems Protocol Reduces Consensus by Redundancy*, GEMS (Nov. 27, 2017), <https://blog.gems.org/how-the-gems-protocol-reduces-consensus-by-redundancy-b151de80ecb8>.

²⁴ AMAZON, *Mechanical Turk FAQ*, <https://requester.mturk.com/help/faq>; Elena Simperl, *How to Use Crowdsourcing Effectively: Guidelines and Examples*, 25 LIBER QUARTERLY 18 (2015), <http://doi.org/10.18352/lq.9948>.

startups that hope to capture the enterprise market.²⁵ Both options are necessary in current centralized systems but also result in underutilization of resources. Most importantly, the circa 38% of the labor pool that is unbanked but skilled does not currently have access to the centralized micro task marketplaces.²⁶ Without a bank account, workers cannot contribute and profit from the existing centralized micro task marketplace. Furthermore, even for those in the labor pool who do have bank accounts, micro task work is often associated with practical problems such as high fees of intermediary financial institutions, lost or otherwise affected payments, lost checks, among other issues.²⁷ Finally, micro workers in centralized systems are faced with invasive, privacy challenging, time consuming, and unclear signup and approval processes that create market entry barriers for micro task workers.²⁸

2 Decentralized Solutions for Mechanical Turk

Decentralized crypto market solutions for the existing mechanical turk market can provide significant optimization while democratizing market access. Semada is an autonomous, decentralized, open-source protocol²⁹ that enables domain specific reputation verification for human task crowdsourcing, built on the ETHEREUM blockchain. The Semada Protocol,

²⁵ CROWDFLOWER, *How Crowdfower Can Work For You*, <https://www.crowdfower.com/use-cases/>; Paul Hyman, *Software Aims to Ensure Fairness in Crowdsourcing Projects*, 56 COMM. OF THE ACM 19 (Aug. 2013), http://delivery.acm.org/10.1145/2500000/2492015/p19-hyman.pdf?ip=140.209.181.61&id=2492015&acc=ACTIVE%20SERVICE&key=70F2FDC0A279768C%2ECD0A7109D1C458E3%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&acm=1517263106_bffc0ea8d50db54f894b596fc073b9aa.

²⁶ *The Global Findex Database 2014* 11 (World Bank Group, Policy Research Working Paper 7255, 2014), <http://documents.worldbank.org/curated/en/187761468179367706/pdf/WPS7255.pdf> 22 (38% of the world's population does not have a bank account).; Camilla Hodgson, *The World's 2 Billion Unbanked*, in *6 Charts*, BUSINESS INSIDER (Aug. 30, 2017 2:00 AM), <http://www.businessinsider.com/the-worlds-unbanked-population-in-6-charts-2017-8>; Karen Weise, *Why Half the World Doesn't Have Bank Accounts*, BLOOMBERG (Apr. 25, 2012 14:40 PM), <https://www.bloomberg.com/news/articles/2012-04-25/why-half-the-world-doesnt-have-bank-accounts>.

²⁷ Miranda Katz, *Amazon's Turker Crowd Has Had Enough*, WIRED (Aug. 23, 2017 6:55 AM), <https://www.wired.com/story/amazons-turker-crowd-has-had-enough/>; Mark Harris, *Amazon's Mechanical Turk Workers Protest: 'I am a human being, not an algorithm'*, THE GUARDIAN (Dec. 3, 2014, 9:41 AM), <https://www.theguardian.com/technology/2014/dec/03/amazon-mechanical-turk-workers-protest-jeff-bezos>; Kristy Milland, *Crowd-working for Amazon took a Physical and Psychological Toll for One Woman*, THE BALTIMORE SUN (Aug. 23, 2017, 10:50 AM), <http://www.baltimoresun.com/news/opinion/oped/bs-ed-op-0824-amazon-tasks-20170823-story.html>; Hyman, *supra*.

²⁸ Aniket Kittur et al., *The Future of Crowd Work*, 16th ACM Conference on Computer Supported Cooperative Work 1301 (Feb. 2013), <http://hci.stanford.edu/publications/2013/CrowdWork/futureofcrowdwork-cscw2013.pdf>.

²⁹ www.semada.io

Semada Platform, and the modules built on top of the Semada Platform are collectively known as the Semada Network.

The Semada Protocol facilitates producer (hereinafter known as workers or miners) and consumer (hereinafter known as requesters) access to the scalable power of micro tasks while eradicating the limitations of centralized micro task systems.

The Semada reputation token enables the incentive alignment for users of the Semada Protocol. The Semada reputation token is a multi-utility token that is associated with and a value proposition for worker and requester reputation on the Platform. The Semada Protocol uses its token mechanism to incentivize and enforce the behavior of all micro task participants. Through the reputation tokens, the Semada Protocol provides a micro task worker reputation staking mechanism that incentivizes high quality work and task completion by workers. The reputation staking mechanism via tokens also allows requesters to verify and track worker quality, integrity, and quantity. Moreover, the reputation staking mechanism only requires a minimal fee from the requester while enabling micro task workers not only to get paid for their work but also to capitalize on the quality and integrity of their work.

The Semada Protocol can reduce the cost structure of intermediation-requiring centralized structures for micro tasks in orders of magnitude. Through its domain specific reputation verification for human task crowdsourcing, the Semada Protocol removes the manual verification and the associated multiplication of micro task work necessitated by centralized systems, enabling its decentralized micro task workers to profit from the disintermediation.

In addition to the improvement of existing centralized mechanical turk solutions, existing decentralized solutions for micro task work are also largely enhanced by the Semada Protocol. The Semada Protocol provides coherent, attack resistant, and scalable solutions previously unprecedented by existing decentralized solutions for micro task work. Like other decentralized mechanical turk protocols, the Semada Protocol is designed to disincentivize malicious actors and reward fair players. However, unlike its decentralized competitors, the Semada Protocol ensures Sybil Attack and Tyranny of the Majority attack resistance. The Semada Protocol architecture and its incentive structure facilitates enhanced 51% attack resistance unlike any previous reputation verification attempts in decentralized and centralized networks. Moreover, unlike other decentralized mechanical turk companies, the Semada Platform does not charge fees, other than the gas needed, for the platform itself. Nevertheless, the Semada Platform significantly reduces transaction fees for the parties.

The Semada Platform provides a consumer friendly graphical user interface (GUI). The Semada Platform GUI allows micro work requesters to avoid building their own tools for micro work or hire startups. The Semada Platform GUI provides a free consumer interface that connects micro task requesters and workers, thereby freeing significant financial resources and enabling unprecedented scalable solutions for micro tasks.

The Semada Platform expands the labor pool of micro task workers in orders of magnitude and enhances the requester and worker experience and their respective profitability. The Semada Platform GUI gives access to anyone with an internet connection, including the unbanked. Thus, expanding the micro task labor pool by up to 40%. The Semada Platform GUI enhances the consumer experience by removing fees altogether, facilitating easy cryptocurrency payment functionality, removing the necessity of check etc. remittance that exist in centralized systems, and creating a quick and easy to use signup process. Applying the Semada Protocol, the Semada Platform removes socioeconomic barriers that exist in centralized mechanical turk systems, including large fees, accountants, other intermediation.

In summary, the Semada Network addresses the following primary pain points in existing centralized mechanical turk systems:

1. Disintermediation of centralized mechanical turk removes fee structure
2. Crowdsourced tasks verification improves cost structure further
3. User interfaces enable requesters and workers alike
4. Blockchain technology increases micro task labor pool
5. Reputation tokens and scores optimally incentivize requesters and workers alike

In addition to providing upgrades to existing centralized mechanical turk system, the Semada Network also addresses the following primary pain points in existing decentralized mechanical turk systems:

1. Attack resistant architecture
2. Scalable solution
3. No platform fees further reduce decentralized transaction fees
4. Gamification of micro tasks increases worker participation and accuracy

Given the qualitative and quantitative improvements over existing mechanical turk micro task platforms, the Semada Platform is uniquely positioned to facilitate and expand the future growth of AI in a broad array of industries. The Semada Platform supplies optimal micro task outputs that satisfy the increasing demand for labelled data via micro task work at higher quality while at the same time lowering cost for requesters and workers in

orders of magnitude. Through the quantitative and qualitative improvements of mechanical turk micro tasks, the Semada Platform provides unprecedented labelled training datasets that allow AI neural network learning algorithms to reach unprecedented levels of automation after the supervised learning process.

3 Semada Platform

The Semada Platform facilitates the efficient functioning of the micro task community and its extension. Through the Semada Platform GUI, requesters can engage in an easy and reliable deployment process for micro task workers. Through reputation scoring and validating micro tasks, the Semada Protocol enables workers to gain additional work and requesters to attract high quality workers.

A key design goal of Semada is to create a minimal and robust architecture that allows for creating much more complex and automated validation logic, as well as machine expert validators. For instance, experts could evolve from humans to smart contracts in order to allow for the automation of validation. In addition, the forum can support the creation of formal verification proofs and engines, which could be utilized by experts in their validation process.

Four components create the core functioning of the Semada expertise validation platform:

1. A dynamic list of system-generated sub-tokens, representing worker reputation pertaining to micro tasks performed.
2. The public **forum** of workers' micro task performance. Worker performance measures can be measured via a linked list of posts, where each list has a sub-token assigned to it, based on its root post, called the worker micro task reputation score.
3. The **bench** of workers. Workers are anonymous users who have the option to stake their respective sub-tokens to answer validation requests of other workers or proclaim their availability for off-platform work.
4. The **validation pool**. Workers may stake their expertise-specific tokens in order to validate or invalidate posts through a betting pool. This is used to answer validation requests. The validation pool intermediates between the bench and the forum to vest workers and requesters with verified reputation. The validation pool is valuable as it allocates power to influence the development of the expertise and enables gaining future reputational salaries.

In summary, micro workers from the bench stake their expertise specific reputation tokens to:

1. Announce their availability for micro work through public smart contracts by posting stakes of their reputation.
2. Evaluate posts with upvotes or downvotes,

In summary, Semada Platform

1. answers requester queries about the list of available micro task workers and each worker's availability stakes
2. answers validation requests, taking as input an ETHEREUM fee and the address of an ETHEREUM post, then
3. distributes the ETHEREUM as reputational salaries to the bench
4. opens a new validation pool
5. collects reputation stakes from workers on the pool
6. distributes the losers' stakes to the winners

3.2 Reputation Staking Mechanism

Instead of repeating work on given tasks to attain high quality work products for micro tasks, Semada uses an architecture of reputation verification that examines micro worker task performance and verifies the validity and quality of the work. The Semada reputation token staking mechanism, created through ETHEREUM-based smart contracts, allows the micro task constituents, e.g. requesters, workers, and verifiers to stake their reputation tokens on the validity of their work and/or against the validity of others' work.

The reputation token staking mechanism, provides well-calibrated incentives for workers and requesters to perform micro tasks correctly. The It helps maintain micro task quality and avoid micro task errors can be caused by malicious actors and simple human error. Malicious actors may attempt to get paid for micro task work they have actually not performed or not performed at the expected level of quality. Semada staking mechanism creates disincentives for malicious actors, enhancing the efficiency of the Semada Network and making it attack resistant.

Requesters in the Semada Platform specify whether they require a worker with a given reputation score or if they require verifiers for workers with lower reputation scores, including the number of verifiers before the work is deemed accurate. When staking their reputation tokens, workers assert that their micro task work was performed accurately and at the expected level of quality. Similarly, verifiers stake (a proportionally smaller) amount of reputation tokens because verifiers have a higher reputation score and are therefore less likely to be malicious actors.

3.3 Reputation Score

Every participant on the Semada Platform will have a reputation score linked to their ETHEREUM address. The Semada reputation score functions as a

readily available indicator of how reliable a worker or requester is on the Semada network. The micro task worker's reputation score is a measure of the worker's history of completing micro tasks on the Semada network qualitatively accurate, efficient, and consistently. The requester's reputation score is a measure of the requester's history of interacting with micro task workers on the Semada network including payment history for completed work, among other measures. The Semada reputation score is formed and linked to the respective network participant's ETHEREUM wallet address.

Market factors balance the equilibrium of supply and demand of micro work on the Semada Network based on the workers and requesters reputation scores. If requesters have a lower reputation score, workers become less likely to accept requesters' offers. In turn, low reputation scores for micro task workers result in a lower likelihood of retention for micro task work on the Semada Network. Requesters can select workers based on their reputation score, giving workers an incentive to keep the reputation scores high by performing micro tasks with high accuracy and efficiency. The reputation score mechanism and the building of reputation on the Semada Platform allows workers to graduate to the privilege of being a verifier. The reputation score mechanism helps discern malicious actors and simple mistakes. It also protects workers and verifiers from fraudulent requesters and suboptimally designed requests.

3.4 Payment System

The Semada Platform does not receive any fees. The Semada platform is designed primarily to ensure security, and encourage maximal productive cooperation, by valuing reputation over all else. A crucial element of ensuring this security and cooperation consist of requiring users who want validation to send *all* work fees to the platform to earn maximal reputation. Choosing to enforce a protocol where all fees are shared with the expertise creates a successful positive feedback loop: The more fees are sent to the platform, the more the reputation is worth; which means the reputation tokens will be more desirable to workers than one-time fees. This in turn means the system will be carefully policed by vested constituents. This makes the system more secure; so the platform will attract more public fees.

Unlike transactions on the Ethereum network that require gas uniformly, the ETHEREUM network requires payment only for posters, not for viewers. While some mechanical turk competitors on the Ethereum network are required allow for micro payments and staking without using gas through payment channels that unnecessarily complicate the operations, the Semada Protocol uses the ETHEREUM blockchain architecture which significantly simplifies the Semada Network's operations on the blockchain.

When starting a task, workers and verifiers send their stake via the Semada Platform payment GUI. If and when worker's micro tasks are verified and approved through the voting pool in the Semada Network, worker reputation earnings and stakes are released to workers and verifiers. To allow for cost-efficient staking and micro payments to workers, the Semada payment system allocates payments to its workers in as few transactions as possible. Workers and verifiers can receive the balance owed by requesters at any time. In turn, requesters can receive the balance of workers stakes they are owed through the Semada Platform at any time.

The Semada payment system on the ETHEREUM blockchain has significant advantages over the Ethereum payment systems via payment channels as utilized by decentralized mechanical turk competitors. The Semada Payment System will be used by requesters, workers, and verifiers to increase the cost efficiency of the network. It allows for secure off chain payments without using gas before transferring those payments on the ETHEREUM blockchain at a later date.

3.5 Gamification of Micro Tasks

The foundational principle of proof of work in the blockchain suggests that it is a lot easier to verify a game was played properly than it is to play it properly. The Semada Platform incorporates this philosophy into its gamification of micro task work through its user interface on the Semada platform. On the Semada platform, the forum establishes the game and the rewards, so the bench validators can verify the game was played properly almost completely automatically.

Gamification is defined as the process of adding games or game-like elements, such as a micro-task, to encourage active task worker participation, boost motivation, and increase user loyalty. Game mechanics for micro task work can be integrated via websites, apps, and services. Several examples illustrate the use of gamification and its benefits. Gamified services include language learning courses such as Duolingo and MindSpace.

Semada's primary objective of embedding gamification into the user interface is enhanced micro task worker incentives that enable faster platform growth. Gamification of micro tasks is an iterative process that incentivizes user game mastery. Users' desire of game mastery combined with their ability to earn a flexible income if and when they choose to create well calibrated user incentives and significant platform loyalty. Semada's user interface for gamification of micro tasks makes monotonous work much more enjoyable. Gamification facilitates the easiest and most enjoyable way for users to earn reputation and gain financial benefits associated with their enhanced reputation on the Semada Platform.

Unlike other decentralized gamification attempts for micro task workers that are monodimensional and only allow earning by playing the game, the Semada platform offers players multiple opportunities to earn by playing. Such multidimensional earning opportunities further optimize user incentives and build unparalleled user loyalty through the proper incentive structure.

4 Innovating the Mechanical Turk Market

Centralized freelance and mechanical turk markets are subject to significant inefficiencies and misalignment of incentives for their workers. These centralized platforms are intermediaries that make the global freelance market expensive and inefficient. Centralized industry leaders in the freelancer market, including Upwork, Amazon, and Fiverr charge up to 40% in transaction fees.

Similarly, centralized mechanical turk marketplace leaders act as rent seeking intermediaries that create numerous inefficiencies in the market. Market leaders in centralized micro task marketplaces include MTurk and Crowdfunder. Just to illustrate, on MTurk, tasks can range from clicking a link, going to a webpage and annotating an image, to completing a survey. Crowdfunder is particularly focused on enriching AI data. Freelance workers are deprived of participating in the profits charged by the centralized platforms.

By contrast, the Semada Platform not only allows increases of pay for workers but workers can also capitalize on the quality of their work and the associated reputation enhancement. Semada mechanical turk labor pool enhancement through the participation of the unbanked, decreased cost for requesters, and a user friendly quality management solution.

Unlike other decentralized mechanical turk platforms such as Gems, Bloom, and Storm, the Semada Platform provides an attack resistant platform ecosystem that grows in attack resistance as the platform grows. Unlike GEMS, which bans malicious actors detected through the GEMS trust mechanism from the platform, the Semada platform has a self-enforcement mechanism. Once the system reaches maturity, the users will be guided by the incentive system in the Semada architecture to avoid bad actors and workers with lower reputation scores.

4.1 No Platform Fees

Unlike Centralized mechanical turk marketplaces, Semada does not charge a centralized fee for micro transactions on the Semada platform. Centralized mechanical turk marketplaces such as Crowdfunder and MTurk charge

requesters for the right to submit tasks to their platforms. Such centralized fees add downward pressure on the platforms' worker compensation. By contrast, the only cost on the Semada Platform is gas used on the ETHEREUM blockchain for posters but not for viewers. The lack of fees on the Semada platform creates a more efficient marketplace for workers, verifiers, and requesters alike through the removal of the rent seeking intermediators. This lack of any centralized fees enables workers, verifiers and requesters to share the fees equally and increase the economic utility of their cooperation via the Semada Platform.

4.2 Transaction Cost Removal

The Semada platform removes transactions costs associated with micro task work. Unlike centralized mechanical turk platforms that require an existing banking relationship to receive account transfers for otherwise unbanked micro task workers, the Semada Platform operates entirely through crypto transactions utilizing its reputation tokens and other cryptocurrencies. This enables unbanked workers to avoid opening a bank account to receive payments on centralized mechanical turk platforms, such as Crowdfunder or MTurk.

The Semada Platform also improves the payment system for micro task workers in centralized mechanical turk platforms in orders of magnitude. Centralized mechanical turk platforms are subject to significant payment issues and payment timing for their workers. Workers are further burdened by high fees for intermediaries that facilitate the payment process such as Paypal. The fees make it only economically viable for higher volume workers who can at some point avoid the Paypal fees but create barriers to entry for new micro task workers.

The Semada Platform not only allows workers to get paid in Semada tokens but also to capitalize on their growing reputation stakes within the platform. The Semada Platform removes all non-Semada transaction fees for workers as only requesters post ETH to request micro task completion. Holding and storing Semada tokens does not necessitate a banking relationship. All that is needed for a micro task worker to earn a living on the Semada Platform is access to the Internet.

4.3 Optimized User Interface

Existing user interfaces for micro tasks require upgrades. In centralized micro task platforms, user interfaces require high computer literacy. Centralized mechanical turk interfaces are also outdated and create burdens for the users. Requesters on centralized platforms are required to expense

significant resources to build the infrastructure for more complicated projects. The lacking quality in mechanical turk user interfaces also significantly increases the time for workers to perform tasks and increases the error rate in performing tasks both of which significantly lower worker earning ability on such platforms. Another burden is the centralized use closed sourced software in mechanical turk that can only be limitedly reused.

The Semada Platform interface for micro tasks can be built on top of the Semada Platform and can provide a requester and worker friendly micro task performance environment. The Semada team works directly for early requesters to build reusable open source user interfaces modules on the Semada Platform. All open source software components of modules are reusable and enable future requesters to build new modules on existing ones, enabling superior network effects within the Semada Platform. These combined factors in the open source interface solution on the Semada Platform enable requesters to obtain high quality performance on micro tasks in less time and workers to earn more money in less time.

4.4 Worker Anonymity Increases Participation

Workers in the centralized micro task economy are required to pass an approval process before they can start work. According to a study by the World Bank, centralized approval processes and identity requirements for mechanical turk worker registration creates significant limitations for the registration of new workers for micro task platforms. However, centralized micro task platforms need to verify identity to prevent malicious actors from abusing the network and ensure work quality.

By contrast, on the Semada Platform, users do not need to verify their identity to complete micro tasks. The Semada Protocol architecture, and specifically its reputation token staking mechanism, make the Semada Platform attack resistant. This mechanism enables the Semada Platform to circumvent all the issues that are associated with centralized identity verification processes. Accordingly, workers in the Semada Platform are not required to expense money to qualify for centralized approval processes, don't experience delays, are not required to surrender their private information. Given those benefits, the Semada Platform enhances the labor pool of workers willing to provide micro tasks services.

The Semada Platform is built to facilitate such worker disclosures via posts on the Forum. Alternatively, existing decentralized onboarding processes, via Bloom and Ocular, among others, allow the verification of worker identity information. The Semada Platform integrates such verified identification information through post on the Forum in the user interface.

6 Outlook

Mechanical turk is an application of the Semada Protocol and the Semada Platform ecosystem. Other use cases will evolve on the Semada Platform over time and applications for the Semada Protocol that cannot currently be conceptualized will materialize. The Semada Platform architecture will evolve in any setting that supports the ethical advancement of the crypto evolution.