LindaHealthCoin: Cryptocurrency for Blockchain-based Medical Machine Learning & Virtual Assistant

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Abstract

Linda is your Virtual Medical Assistant. Linda is not a human. She's an artificial intelligence (AI) bot. Any time you need answers to medical primary care questions, Linda is there for you instantly, in real time, as a two-way interactive communication on your mobile phone. Linda personalizes your conversation using your Personal Health Record (PHR) set up from the first conversation she has with you, and with the accumulation of your medical questions makes Linda's AI smarter over time. Your PHR is securely stored and accessed in the blockchain. Through trustless Machine Learning Contracts on the Ethereum Blockchain, you the patient automatically gets rewarded with extra tokens when your data has improved our machine learning model and provided successful medical outcomes when it's aggregated with millions of anonymous PHR in our blockchain. You can access Linda by purchasing our CryptoHealthInsurance, Linda Healthcare. The only way to purchase Linda Healthcare CryptoHealthInsurance is with our cryptocurrency LindaHealthCoin. Any time you need access to Linda and medical help you can use LindaHealthCoin as part of your CryptoHealthInsurance. Linda Healthcare is cheaper than traditional fiat insurance and human-based healthcare because of the scale of economies that artificial Intelligence provides and the efficiencies that blockchain technologies offer. For Initial Coin Offering buyers of LindaHealthCoin the cryptocurrency serves as a financial investment because if you are healthy at any given time and don't need to use your LindaHealthCoins to keep purchasing the CryptoHealthInsurance every month, you are rewarded by the financial value of your LindaHealthCoins going up over time. As a community in Linda Healthcare, not everybody will be sick and use their LindaHealthCoins to pay LindaHealthcare; as new patients want to join our CryptoHealthInsurance community and demand more LindaHealthCoins, there will be sometimes less supply of LindaHealthCoins for Linda Healthcare to sell depending on the level of health or sickness in the community. This will result in token appreciation, while the price of using Linda in dollars is the same. You pay in LindaHealthCoins for prices of using Linda Healthcare always set in dollars. This means you will be protected from inflation, fiat currencies, and skyrocketing healthcare system costs. Our cryptocurrency is also a financial investment in Linda Healthcare's AI medical technology and new digital health insurance model as more people demand the cryptocurrency to have access to CryptoHealthInsurance. Our framework removes the hassle of dealing with expensive human doctors and the expensive health insurance premiums unable to scale healthcare. Faster, cheaper, cutting out the middleman.

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1. The Problem & Opportunity

1.1 Scalability and Costs in Medicine

According to the non-profit health care organization National Quality Forum, approximately $38 billion is wasted annually in the US alone on unnecessary emergency room visits that could have otherwise been performed with a virtual primary care visit [1]. Over 120 million annual emergency visits are potentially avoidable and can be taken care of in primary care. But if a patient needs to speak with a primary care nurse triage or physician, the visit can be **expensive** because of the ever-increasing demand by patients in primary care services provided by a **limited number of nurses and doctors** in clinics and hospitals (Providers of healthcare), resulting in **limited time** spent per patient, **long wait times** or delays, limited to **no follow-up** by medical providers after a patient goes home, and in some cases, resulting in **lower quality of care**. Many individuals don't have access to affordable health insurance, making their visit even more expensive or they simply decide they can't visit a doctor. Also, when you move from city to city, or from state to state, patients have **difficulty accessing their Personal Health Record** (PHR) history from the previous doctor office or clinic because it is not stored in a ubiquitous distributed data storage. In some instances, the **opinion of only one** nurse triage or doctor is not enough and the patient needs the opinion of the entire body of knowledge in medicine. However, this problem is obviously not possible to solve with scalability using only humans. Telemedicine or eHealth saves time to the patient from physically going to the doctor's office, but the aforementioned problems are still present, making telemedicine only changing the interface of communication but little else.

Given the aforementioned circumstances, insurance companies (Payers of healthcare) have no choice but to hike the price of the insurance premiums to **cover these inefficiencies,** or in other cases, **inflate prices artificially** for hefty profits. According to discoveries by journalist Rick Ungar of claims filed with the Center for Medicare & Medicaid Services, the average amount charged by the Bayonne Hospital Center, located in New Jersey, for the treatment of COPD is $99,690 per patient, while the Lincoln Medical and Mental Health Center in the Bronx, New York—approximately 20 miles away—charges just $7,044 per patient for the identical services and procedures [2]. According to Ungar, "When the dance between hospitals and health insurers began, if a hospital's actual cost plus reasonable profit totaled $1,000 for a given procedure and the insurer demanded a 50 percent discount, the hospitals simply negotiated towards doubling the price from $1,000 to $2,000 in order to make it all work out. But over time, hospitals began to include other charges into the cost of a procedure, including their unpaid collectibles from patients who were uninsured and could not pay, losses in unrelated hospital divisions, inefficiency in how the hospital was being operated, etc. As time has progressed, this approach has grown so out of hand that any **rational explanation for pricing** no longer appears to exist." Who pays for all of this? You the patient. The healthcare needs to **emphasize value, not just cost.** Many times, the **patient doesn't even know the price** of the service they are getting until after their insurance has spoken and dealt with the health provider.

Finally, on top of costs, patients haven't been able to find ways to make a profit out of the value of their sensitive medical data because they aren't aware that's possible, or they are afraid of revealing their identity. If there was a way for a patient to make money out of their medical data, in an anonymous, secure and transparent way, their medical costs could drop or even make them a profit.

1.2 Security

One of the main problems in healthcare is the security and vulnerability of healthcare records. HIPAA (Health Insurance Portability and Accountability Act of 1996), is a United States legislation that provides data privacy and security provisions for safeguarding medical information, particularly in hospitals and clinics' Electronic Medical Records (EMR).

While federal laws and incentive programs have made health care data more accessible, the vast majority of healthcare systems still can't easily (or safely) share their data. As a result, **doctors are spending more time typing than talking to patients**. And it's wearing on them; physician burnouts jumped from 45 to 54 percent between 2011 and 2014, according to a Mayo Clinic study [3]. The number one thing those doctors would change? Streamlining the EHR process for standardization.

Another problem in healthcare is the security and vulnerability of healthcare records. **98 percent of compromised healthcare records are due to hacking** [4]. Insurance and hospitals don't pay patients when their data is stolen or hacked, and advertisers and medical data companies don't pay you for your data or when your data is used. The patient has already surrendered their rights to their own data on existing systems and they are paying for the privilege to view their own data stored in electronic medical record systems (EMR) such as Epic, Cerner, and AllScripts. It's the patient's data and the patient should have control and the decision-making power of their own medical data.

Also, social networks and medical networks essentially own all of your photos, content, and data when you post to them. These social networks continue to get bigger and bigger by riding off the backs of you, the user, giving away rights to your content, getting nothing in return. These networks are centralized in every way, literally deciding what you will see and not see through their algorithms on your feed, and completely lacking transparency.

Finally, as mentioned in the section before, a patient making a profit out of their medical data to cover medical costs or even make a profit is impossible if the patient can't trust a secure system or mechanism to share anonymously their medical data for a virtual medical marketplace to use on aggregate with millions of other PHR to achieve medical outcomes with machine learning models.

1.3 Market Opportunity

Primary care demand in the US and western countries is at an all-time high. In poor countries, it is easier than ever to see a medic and diagnosing doctors. But it is still hard to find one who will make you better [5]. At the Peeragarhi clinic in west Delhi, a woman takes a fold of her gold sari and wipes her brow. She is the 140th patient of the day and Dr. Alka Choudhary shows no signs of flagging. The doctor poses questions ("Have you been sick?"; "Do you ache?"), gauges the patient's blood pressure and checks for rashes. The illness may be dengue fever, a viral infection common in the surrounding slum. She takes a blood sample, prescribes oral rehydration tablets and tells the woman to return soon.

Before the mohalla (community) clinic opened in 2015, many of Dr. Choudhary's patients would have queued all day at a hospital or gone untreated. Now, like thousands who attend the 158 such clinics that have opened over the past two years in Delhi, they receive free, comprehensive medical care, all under one prefab roof.

According to the World Bank, primary care—the generalist, front-line form of medicine practiced by Dr. Choudhary—can deal with 90% of health problems. A survey of 102 developing countries in 2015 found that those with established primary-care systems had higher life expectancy and lower infant mortality. Recent roll-outs of primary care, for example in Brazil, Rwanda, Sri Lanka and Thailand, have been followed by falls in child mortality.

In 2015 governments across the world pledged to expand primary care as part of the UN's "sustainable development goals" to be met by 2030. A similar aspiration was expressed in 1978, but little was done. The renewed ambition reflects a recent change in approach to health care in developing countries.

For the past two decades policymakers and donors have mostly focused on specific diseases. Fully 86% of children are now immunized against diphtheria, tetanus and pertussis (whooping cough). The Global Fund, a multi-billion-dollar philanthropic effort, reckons it has helped save 22m lives from HIV/AIDS, malaria and tuberculosis since 2002.

Yet health experts worry about the failure to build on that success and create primary-care systems to deal with the growing burden of chronic illness in poor countries. **Primary care is "not flashy,"** says Dr. Asaf Bitton of Ariadne Labs, a research group, so it gets less attention. The result is a big gap between the care people need and what they get.

It's hard to quantify how big that gap is. Researchers have tended to estimate the number of people who cannot get access to any of a list of "essential health services", such as contraception, antenatal visits or treatment for tuberculosis. Using this measure the **World Health Organization (WHO) thinks 400m people globally lack access to primary care.**

But this definition is unsatisfactory for two reasons. The first is that it ignores non-communicable diseases such **as cardiovascular disease and diabetes. By 2020 these will account for about 70% of deaths in developing countries.** The World Bank and WHO reckon that in most countries outside the OECD, a club that contains nearly all the developed ones**, more than half of people with hypertension are unaware of their condition**. The share receiving treatment to manage their blood pressure varies by country, and ranges from 7% to 31%. Between 24% and 62% of diabetics are undiagnosed and untreated—as are an estimated 82% of people with mental illnesses in the developing world.

The second problem is that the WHO definition largely ignores quality. New research suggests that**, increasingly, the problem is not finding a health-care provider but what happens next. Without understanding why quality is so poor, the potential of primary care will remain unrealized**.

In India, for example, there are plenty of health-care providers and patients visit them often. Indians in rural areas visit a doctor on average six times a year. City-dwellers do so five times a year. For Americans, the annual average number of visits is just three. Nor do Indians have to travel far to find a clinic. In a survey of seven neighborhoods in Delhi, Jishnu Das of the World Bank and Jeffrey Hammer of the University of Princeton found an average of 75 providers within a 15-minute walk. The Centre for Policy Research, a Delhi-based think-tank, estimates that there are about 4.4 providers per village.

But few of the visits are to doctors with modern training. In rural India 50-80% are to "informal providers," including traditional healers, drug dispensers and people who served apprenticeships with doctors but did not qualify. The picture is similar elsewhere, according to a paper by May Sudhinaraset of the University of California, San Francisco, and colleagues published in 2013. In Bangladesh 65-77% of visits are to informal providers. In Thailand, the share is 55-77%, in Nigeria 36-49% and in Kenya 33%.

Markets for this type of care are much freer than in rich countries. Providers are typically paid directly by the patient. About a third of total health spending globally is paid out of pocket; in India, the share is closer to 70%.

Dozens of studies have tried to work out whether public or private clinics do a better job of providing primary care, without much success. Two systematic reviews published in the past two years used many of the same papers—and came to opposite conclusions. Most of the research has failed to consider what actually happens in clinics. But a few researchers have used **"standardized patients"—people coached to describe symptoms of specific ailments, for example angina, or to say that they have a child at home with diarrhea**. Afterwards researchers quiz the mock patients and assess the quality of their treatment.

The results are startling. **In India, the average consultation lasted three minutes, a quarter as long as those in OECD countries. A third lasted less than a minute and involved no examination and just one question from the clinician: "What's wrong with you?" The correct treatment was given in 30% of cases, and unnecessary or harmful treatment in 42%.**

Patients fare little better in China. A team led by Sean Sylvia of Renmin University of China sent standardized patients to clinics in Shaanxi province. Health workers spent an average of 96 seconds with patients. **They gave a correct diagnosis in just 26% of cases, and an outright wrong one in 41%.** Inept treatment is not because providers are too busy. According to the World Bank, in India, Kenya, Senegal and Tanzania each one sees just eight to ten patients a day. Those in India spent just 40 minutes a day on average seeing patients.
A better explanation starts with the fact that many clinicians have received little training and do not know what they are doing. In India and China more medical training is (reassuringly) associated with making fewer mistakes. And a recent Kenyan study using standardized patients found that clinicians in Nairobi made "significantly better" diagnoses than Indian and Chinese ones, who had less training.

The blockchain's distributed ledger technology aided by cryptography to accomplish trust with strangers is the perfect solution to provide patients and consumers with a secure, anonymous ways of sharing their data with a medical marketplace aggregated with millions of other PHRs for the goal of building new machine learning models able to find successful medical outcomes.

The blockchain's related cryptocurrency can be utilized as the reward mechanism to the patient when their PHRs has been used in ML models that have discovered new medical pieces of information and new medical outcomes.
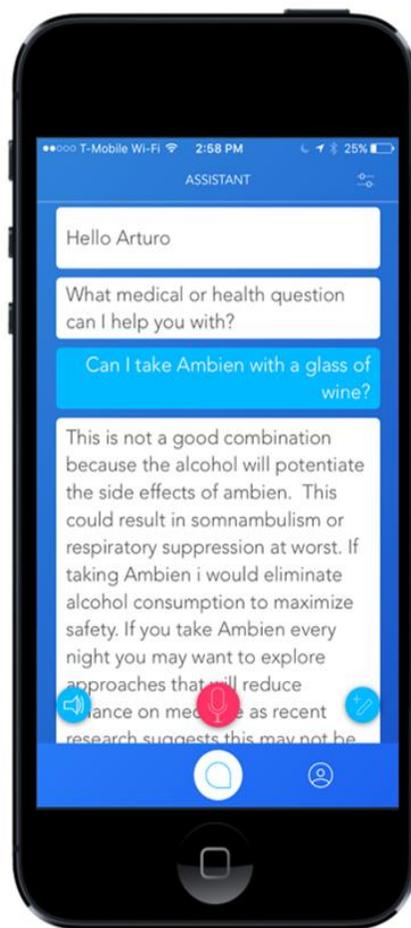
2. Solution

2.1 Linda Healthcare

Linda Healthcare is named after Linda Richards, the first professionally trained American nurse. She established nursing training programs in the United States and Japan, and created the first system for keeping individual medical records for hospitalized patients.

Linda Healthcare is a healthcare platform that offers a conversational AI Virtual Medical Assistant, a blockchain-based cryptohealthinsurance to cover the usage of Linda Virtual Medical Assistant, and a health cryptocurrency to pay for the platform's services while simultaneously investing in the growth of the platform and preserving monetary value to pay for healthcare. Thus, Linda Healthcare can be broken down into three elements:

1. Linda, Linda Healthcare's Virtual Medical Assistant
2. Linda Healthcare CryptoHealthInsurance and PHR
3. LindaHealthCoin, Linda Healthcare's cryptocurrency

ASSISTANT

Hello Arturo

What medical or health question can I help you with?

Can I take Ambien with a glass of wine?

This is not a good combination because the alcohol will potentiate the side effects of ambien. This could result in somnambulism or respiratory suppression at worst. If taking Ambien i would eliminate alcohol consumption to maximize safety. If you take Ambien every night you may want to explore approaches that will reduce reliance on medicine as recent research suggests this may not be

2.1.1 Linda Virtual Medical Assistant

Do you have medical questions? Ask Linda! Our Deep Learning team is teaching Linda the language of medicine to train the first generation of conversational robo-docs for medicine.

The bot will be able to have encrypted medical and health conversations about:
- •Primary care or triage (triage is not diagnosis)
- •Post-operation and pre-operation questions
- •Medications
- •Health & wellness
- •Treatment info & prevention
- •Personal fitness data
- •Information, education and research

Primary care will be the core capability of the bot but Linda will be taught all other conversation types. 90% of health is primary care. With AI Virtual Healthcare the number of human health professionals or physical locations doesn't matter anymore. There are no costs associated with maintaining physical infrastructure.
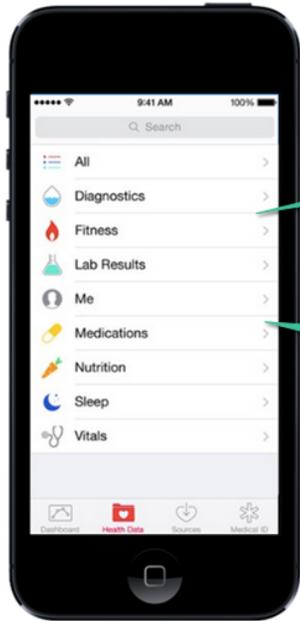
The Linda Healthcare app will be available for free on web and mobile in iOS and Android.

After our team finishes building the Linda Virtual Medical Assistant in 8 months, Linda will spend 3 months building capabilities to offer at an affordable extra charge. LindaHealthCoin capabilities include:

- Virtual Consultation with a live doctor
- Order over-the-counter meds prescription via online pharmacy for you, and can order a lab at home health testing and Linda tells you results and interpret results with Deep Learning.
- Access your medical records in the blockchain with your own private key

After registration and entering a command on a mobile device, patients will be linked to a healthcare professional.
The patients are then clinically assessed before receiving validated responses from the doctors through cutting edge monitoring and diagnostic tools.
Medical prescriptions through their cell phones follow and purchases of medication from a nearby pharmacy can be made. All videos, audios, notes, images and messages are stored for record purposes.

2.1.2 CryptoHealthInsurance with Blockchain Smart Contracts

Linda Healthcare's CryptoHealthInsurance is the way to access the Linda Virtual Medical Assistant. The only way to purchase the CryptoHealthInsurance is with LindaHealthCoin. We use Ethereum blockchain smart contracts to automatically reconcile your monthly premium payment and to permit access to Linda or our network of doctors. **This provides an accountability method with the smart contract free of financial intermediaries, human-based administration costs, and fees. The result is cheaper health insurance for primary-care due to the aforementioned factors.** Also, the result is a faster and more secure transaction. Thus, using smart contracts is a 'smart' alternative to traditional insurance transaction processing.

With Linda Healthcare, there are no fiat health insurance and no human-based hospital gimmicks with changing prices or unknown prices. Price is in the smart contract in the blockchain and cannot be changed.

Operation that modifies data in the blockchain is a transaction that's controlled by the smart contract (code/software). There are no costs for looking up data in blocks. Operations that modify the blockchain (add/edit health record or cryptohealthinsurance) is a transaction and it costs gas.

Linda Healthcare also uses the Ethereum blockchain to store and encrypt your health data to protect you from hackers. This also means that we prevent advertisers making money from your data.

If the price of LindaHealthCoin goes up, you are protected because the price of the CryptoHealthInsurance is set in dollars.

Two key characteristics of LindaHealthCoin are:
1. The relationship between our token and US dollars is favorable, you spend less if the token goes up.
2. You are rewarded if you stay healthy and don't need to buy the CryptoHealthInsurance

2.1.3 LindaHealthCoin cryptocurrency

By purchasing LindaHealthCoin you can buy Linda Healthcare's CryptoHealthInsurance to have access to our services. The value of LindaHealthCoin will appreciate as the network of users, patients, and healthcare systems using Linda grows. The price to buy CryptoHealthInsurance will be set in dollars. The price in dollars of our CryptoHealthInsurance will remain the same because of the deflationary and scalable nature of using Artificial Intelligence to provide Virtual Care. More people using our AI doesn't increase our fixed costs. The price of the CryptoHealthInsurance will always be lower than human-based primary care services. This means that over time patient's will require less LindaHealthCoins to purchase, thus being protected from inflation and the

devaluing of fiat currencies over time. Organic growth will stimulate massive institutional interest and offerings. LindaHealthCoin it will be safer, faster, and cheaper to transact.

2.1.4 Reward Mechanism and Solution

Trustless Machine Learning Contracts, Evaluating and Exchanging Machine Learning Models on the Ethereum Blockchain is an important element of making Linda Healthcare's patient reward mechanism work.

Patients become data providers, stake data and make it available to Linda Healthcare modelers.

Our modelers choose what data to use and create models. Training is done using a secure computation method which allows models to be trained without revealing the underlying data. Models are staked as well. A metamodel is created based on an algorithm that takes into account the staking of each model. Creating a metamodel is optional—you can imagine models that are used without being combined into a metamodel. Using the metamodel A smart contract takes the metamodel and trades programmatically through decentralized exchange mechanisms on-chain. After some time period passes, medical decisions that use the models produce profit or loss. This profit or loss is divided up amongst patient data contributors to the metamodel based on how much smarter they made it.

Computation for each step is verifiable and challengeable using a verification game. Data and models are either hosted nodes in a secure multiparty computation network.

Incentives to attract data are the most potent part of the system as data tends to be the limiting factor for most machine learning. In the same way Bitcoin created an emergent system with the most compute power in the world through open incentives, a properly engineered incentive structure for data would cause the best data in the world for your application to come to you. And it's nearly impossible to shut down a system where data is coming from thousands or millions of sources.

Competition between algorithms Creates open competition between models/algorithms in places where it previously didn't exist. Data and model providers can see they are getting the fair value of what they've submitted since all computation is verifiable, making them far more likely to participate.

Multi-sided network effects from users, data providers, and data scientists make the system self-reinforcing. The better it performs, the more capital it attracts, which means more potential payouts, which attracts more data providers and data scientists, who make the system smarter, which in turn attracts more capital, and back around again.

Another major feature is privacy. It allows people to submit data that otherwise would be too private to share and prevents the economic value of the data and models from leaking.

If left unencrypted in the open, the data and models will be copied for free and used by others who have not contributed any work (the "free rider" problem).

A partial solution to the free rider problem is to privately sell data. Even if buyers choose to resell or release the data, its value decays with time. However, this approach restricts us to short duration use cases and still creates typical privacy concerns. As a result, the more complicated but powerful approach is to use a form of secure computation.

2.2 Medical Artificial Intelligence

Linda is built with Artificial Intelligence. Our team uses supervised and unsupervised machine learning, Deep Neural Networks like Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), Natural Language Processing, Medical Ontologies, Medical Decision trees, and taxonomies. We train a deep neural network to do the same as a doctor, based on lots of training examples. It becomes as good or better than the best competitor and will rival human performance.

The training data we use are medical information from the web, patient's Personal Health Information (PHI), telephone triage conversations from partner hospitals, medical taxonomies and ontologies, sensor data from patient's mobile phone, and medical protocols like triage protocols or post-operation aftercare protocols.

We have partnered with NVIDIA, an important company in the AI space offering us Graphical Processing Units (GPUs) for faster execution of our Deep Neural Networks, technical advisors and other resources.

We also have partnered with important hospitals in the United States to have access to medical data and medical conversations between doctors and nurse triage with patients. These conversations are part of the training data we use to teach Linda medical conversations.

2.3 Blockchain for Healthcare

Before going over the history of blockchain and the application for healthcare, it's important to bluntly say that identity and PHI theft is virtually impossible with blockchain and cryptocurrency. Linda Healthcare uses the blockchain to store and encrypt your health data to protect you from hackers. This also means that we prevent advertisers making money from your data. Now that's taken care of, let's talk about the blockchain technology potential in healthcare.

The technology behind the bitcoin digital currency, blockchain's birth is traced to Satoshi Nakamoto. Since 2009 blockchain has gained more widespread use in the finance industry, with a variety of new blockchain-enabled businesses and services entering the market. Blockchain's technology is used to share a ledger of transactions across a business network without control by any single entity. The distributed ledger makes it easier to create cost-efficient commercial relationships where virtually

anything of value that can be tracked and traded without requiring a central point of control. The technology puts privacy and control of data in the hands of the individual. Trust and integrity is established without reliance on third-party intermediaries. Identity theft is virtually impossible with cryptocurrency. Blockchain technology can use used as an alternative to traditional transaction processing. The blockchain is safer, faster, cheaper to transact.

The blockchain is a generic tool that keeps secure data in a distributed, encrypted ledger—and controls who has access to that ledger. Rather than having one central administrator that acts as a gatekeeper to data—a list of digital transactions—there's one shared ledger, but it's spread across a network of synchronized, replicated databases visible to anyone with access. Which gives it unprecedented security benefits. Hacking one block in the chain is impossible without simultaneously hacking every other block in the chain's chronology.

Patients will be able to store and protect their encrypted health data from hackers in the Linda Healthcare blockchain.

Using blockchain technology, it is possible to create contracts that offer a reward in exchange for a trained machine learning model for a particular data set. This would allow users to train machine learning models for a reward in a trustless manner.

The smart contract will use the blockchain to automatically validate the solution, so there would be no debate about whether the solution was correct or not. Users who submit the solutions won't have counterparty risk that they won't get paid for their work. Contracts can be created easily by anyone with a dataset, even programmatically by software agents.

This creates a market where parties who are good at solving machine learning problems can directly monetize their skillset, and where any organization or software agent that has a problem to solve with AI can solicit solutions from all over the world. This will incentivize the creation of better machine learning models, and make AI more accessible to companies and software agents.

A consequence of creating this market is that there will be a well defined price of GPU training for machine learning models. Crypto-currency mining also uses GPUs in many cases. We can envision a world where at any given moment, miners can choose to direct their hardware to work on whichever workload is more profitable: cryptocurrency mining, or machine learning training.

2.4 Business Model

The price of Linda Healthcare CryptoHealthInsurance will be $1/month or 100 LindaHealthCoins set at .10cents token price. That will give you access to Linda Virtual Medical Assistant and our services.

There will be monthly premiums of $1 for 12 months each year.

You pay healthcare with fiat currency at a specific price each year, but fiat currency every year loses value because of Central Banks printing of more fiat currency. As a result, your purchasing power to buy health insurance or pay for primary care healthcare is diminished as you need to have more fiat currency to buy the same level of healthcare services. What if you could preserve the value of your money? What if you truly had access to healthcare? What if there was a way to buy health insurance through the blockchain smart contracts and get primary care level healthcare with a cryptocurrency that retains its value and in many cases, goes up in value? What if there's a way to not pay more for healthcare every year? What if your PHR is yours to access anytime in an encrypted secured network database and you keep control of it?

The product will be so high in demand, the demand of the token will make the service cheaper over time. Protection to inflation. We have a pool of tokens to sell after ICO depending on demand for product for users that have access to Linda.

In summary, Linda Virtual Assistant is the health provider, Linda cryptohealthinsurance is the smart contracts payer, and lindahealthcoin is the currency to pay the cryptohealthinsurance.

Reward in LIND for data being used

3. LindaHealthCoin Token

3.1 What does the token do?

Users will pay with LindaHealthCoin tokens (LNDs) for Linda Healthcare's cryptohealthinsurance monthly premium to have access to the various services as they use them. The token will power the entire primary-care ecosystem, giving an instant business model and return on investment to many healthcare organizations that can tie in. This is the beauty of a token: you may need a service exactly once and you won't need to sign up for it, you'll just pay in LindaHealthCoins and you're done.

3.2 Marketing & Partnerships

Ask anyone who has created a successful platform—it's every bit as much about communication and education as it is about building a quality service. We believe the LindaHealthCoin token will be the viral component. The more patients use Linda and the more healthcare organizations that integrate their services and uses our token, the more it becomes a standard, and the more people will want it. We plan to dedicate serious resources to education, marketing, and communications. We want the Linda medical assistant to be ubiquitous. We will have a partnership program with government health organizations, the WHO, Melinda Gates Foundation, UN, and non-profits.

3.3 Governance

Token governance is more complex than many people realize. The Virtual Medical Assistant will become part of hundreds of millions of people's lives, and the LindaHealthCoin token will be making things work. As there are a fixed number of tokens after the token sale, market forces will determine prices and behavior. However, anyone with a large supply of LindaHealthCoins will be able to move markets and influence policy. Therefore, we plan to take stewardship of this token very seriously and watch for any potential issues that need attention. We will lower the price and the number of tokens required to buy the cryptohealthinsurance of Linda if need be. This is a new area of commerce. Most open-source projects have governing bodies, but they don't have to think about tokens. We hope to show the way forward in token governance and teach other groups what we have learned. There are small things we can do to manage the token's fiscal and monetary policies. We could be market makers, we can purchase tokens, and we can burn or ice tokens. We will be very transparent about our plans and include all stakeholders in our discussions

# 4 Execution Plan

4.1 Team building

We don't believe in resumes or interviews. We have a community approach to building the necessary team for all our projects. Our approach is to invite people to work with us and see who is aligned with our purpose. In general, we prefer creative generalists who can go with the flow rather than specialists who can only see a narrow problem and narrow solution. We will hire mostly generalists and use our existing core team as the specialists. We have experts in Artificial Intelligence and Medicine from Stanford University and Harvard University.

4.2 Architecture

Our team uses Theano, Caffe, and Tensor Flow for Deep Learning. We use Java for most of our back-end, and some Python and JavaScript. For data structures, we use a combination of SQL and MongoDBWe use SCRUM development methodologies. Most of our NLP is proprietary and we use some off the shelf technologies like Stanford CoreNLP and Python NLTK.

Group	Technology
Systems and Networking	Linux
	IPv4 / TCP / UDP / HTTP
	SSL / TLS
	Shell scripting

	Amazon AWS
	Azure Web Console
	Docker
	Apache server
	Tomcat servlet container
Programming languages	Java
	PHP
	Python
	JavaScript
	SQL
Databases	MySQL
	NoSQL (Virtuoso, MongoDB or Neo4J)
Mobile development	Android or iOS
Web development	Backend
	Frontend
	REST API
	SOAP services
	HTML
	CSS
	Jquery / Node.js / Angular.js
Software design, development methodologies	Agile methodologies
	UML
	Design patterns
	Testing
Natural Language Processing	Proprietary NLP, Stanford CoreNLP, NLTK
Blockchain	Ethereum
Machine Learning	Proprietary, Scikit-learn / Tensorflow / Theano / Caffe
	Azure ML
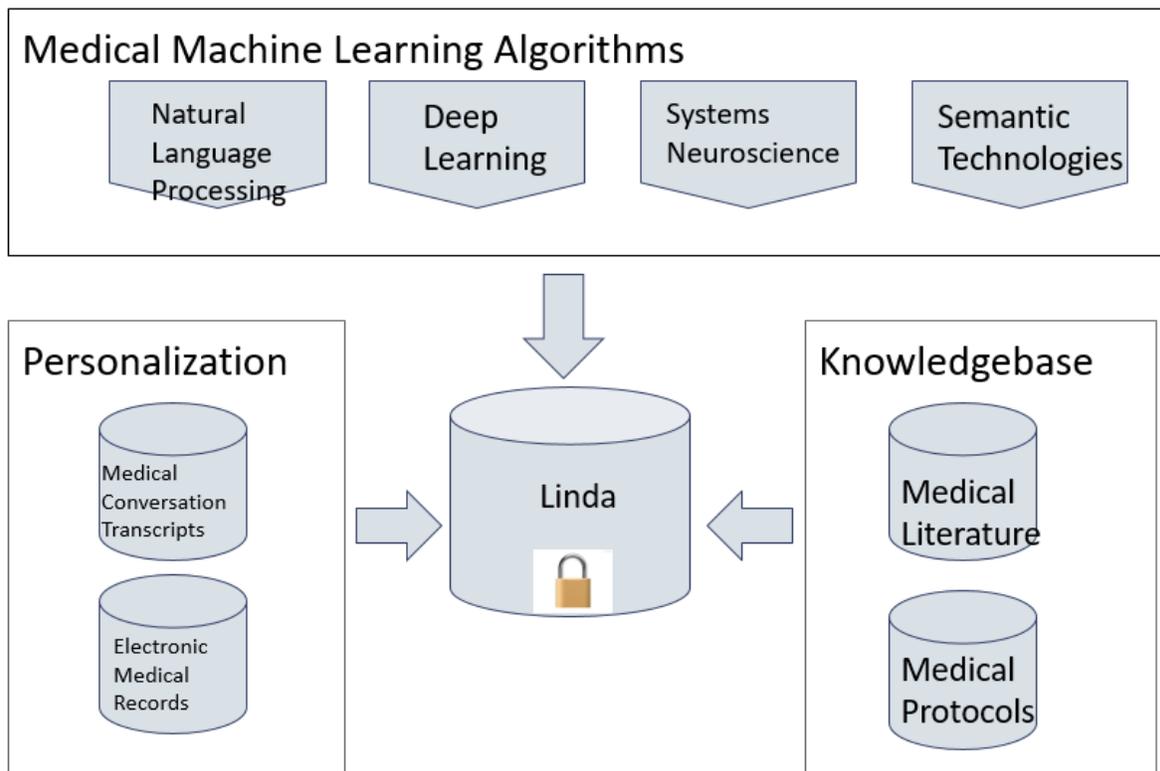
4.2 Data Security

We take data security very serious. Linda Healthcare is HIPPA compliant and uses the Ethereum Blockchain and servers from Amazon AWS and Microsoft Azure Cloud for the processing and storage of health information and to store and leverage of many of our software code and technologies.

All the current development around blockchain-based data involves atomic ownership. This is a very active area of research and development.

5. Financials

5.1 Use of Proceeds

We are well aware of the difficulties of large-scale software development and the failure of most projects to communicate and document clearly what has been produced. We will need to evangelize and promote our wallet, get as many customers as possible to use it, and explain the value of the token to people many times. This project will have its own P&L, which will be available on the project's website and updated quarterly. The team will be based in San Francisco to start. This is an agile business. We can't know or plan how things will work out. We will have to launch and learn. For that reason, many parameters of this ecosystem are left intentionally unspecified.

5.2 Planning Fallacy

It would be great if we could script each month of the next five years and connect the dots to success. Every new venture is a lottery ticket, a chance to build a network that may or may not materialize. Most won't. Too many project plans suffer from over-precision. We keep Eric Schmidt, chairman of Alphabet's words in mind:

"One of the biggest reasons for our success, though, is that the plan we delivered to the board that day in 2003 wasn't much of a plan at all. There were no financial projections or discussions of revenue streams. There was no market research on what users, advertisers, or partners wanted or how they fit into nicely defined market segments. There was no concept of market research or discussion of which advertisers we would target first. […] We left that out for the simple reason we didn't know how we were going to do it."

That said, it's worth the exercise to get started. Here is our proposed budget for five years, realizing that we will learn as we go.

5.3 Budget

Any budget or forecast is a work of fiction. Given the magnitude of the project, we believe these numbers are realistic and conservative. We are here to change the world. If we are doing enterprise deals, we could double these numbers:

Linda Healthcare Expenses	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Central Services						
Head Count	5	5	7	7	7	
Expense	390,000	429,000	513,900	565,290	621,819	
Rent, Software, Legal, etc.	95,000	106,500	118,900	129,790	141,769	
Product						
Headcount	6	7	10	15	17	
Expense	544,000	738,000	832,240	1,139,964	1,249,011	
Marketing						
Headcount	2	2	3	3	3	
People	120,000	228,000	286,800	315,480	347,028	
Events and Contractors	30,000	60,343	90,343	103,132	115,323	
Governance	60,000	66,000	132,600	145,860	160,446	
Total Headcount	13	14	20	25	27	
Total Expenses	1,239,000	1,627,843	1,974,783	2,399,516	2,635,396	9,876,538

5.4 Beyond Budgeting

What we know from start-up data is that running out of cash is one of the number one causes of failure (for the other three causes, see David's talk on entrepreneurship). All companies should do rolling, agile forecasts and budgets, as described in the amazing book, Future Ready, by Steve Morlidge and Steve Player.

With that in mind, we believe that to create the world's most powerful, most successful Healthcare platforms it will take a combination of spirit, persistence, skill, cash, and luck. We will have to spend smart and work hard to promote and evangelize Linda Healthcare. We can't be too specific on how the next several years will play out.

We will use rolling forecasts as a tool and teach other start-ups how to apply Beyond Budgeting principles to their projects.

5.5 Money Management

We expect to raise enough money for five years. We plan to diversify our holdings. We will purchase our own index tokens, to help diversify. We also plan to participate in the pre-sale of projects that will fit into Linda Healthcare. This will be a small portion of our holdings, but it should help create an ecosystem around Linda Healthcare.

5.6 Transparency

We will put all progress on our web site and update it once a month. We will post a financial report once a quarter.

6. About Linda Healthcare

Linda Healthcare, Inc. is a United States Delaware C-Corp.

LindaHealtCoin is a utility token that purchases a service and thus is not subject to SEC securities regulations laws.

6.1 Culture

No matter how much money we raise, we will always adhere to our guiding principles (laid out in an essay called The Culture Deck):

- HOW matters.
- Stay lean—no fat salaries, no fancy offices
- Work in the same room as much as possible.
- Take care of each other, build a family culture. Employees first, customers second.
- No HR, no management, no board
- Continuous delivery in one-week cycles. Keep the code working.

- Continuous improvement—make things better every day.
- Use Kanban—make Kanban your religion. Create joy at work.
- Invite everyone to join us. Our community is our foundation.
- Give to the crypto community. We plan to give research grants, do free events, publish, and more.
- Communicate, communicate, communicate. Don't underestimate what it takes to get people to learn and try something new.

6.2 Founders

Arturo Devesa - Arturo is a data scientist researcher and medical entrepreneur. He's a Research Scholar at Stanford University School of Medicine. He has participated in the Stanford University startup accelerator StartX and StartXMed. Arturo has a Bachelors in Finance '06, an MBA '09, and a Master's of Science in Economics and Econometrics '11 all from Florida Atlantic University. Arturo was a teaching assistant and later an adjunct faculty academic teaching statistics and information technology from 2008-2011 at Florida Atlantic University. Arturo moved from Florida to Palo Alto in 2012 to research and develop medical AI technology at Stanford University.

Julian Kates-Harbeck, PhD – Julian is a fourth year PhD student and candidate in Machine Learning at Harvard University. His research focus is artificial intelligence, Long-Short Term Memory Recurrent Neural Networks, training and teachings systems learn conversation, and physics.

Sasi Madigula, MD/PhD - Sasidhar Madugula is a fourth year MD/PhD student at Stanford Medical School, in neuroscience. Prior to that he completed a Masters in Clinical Neuroscience at Oxford, and a Bachelors in bioengineering at the University of Illinois at Chicago. He currently works on retinal electrophysiology with Professor E.J. Chichilnisky.

Dr. Oliver Aalami – Dr. Aalami is a Clinical Associate Professor of Vascular Surgery at Stanford University School of Medicine. He's also a Medical Director of Wound Clinic and Medical Director of Vascular Laboratory of Veterans Affairs Palo Alto Healthcare Center. Dr. Aalami has years of experience building digital health applications, seeing patients, advising medical startups and developing entrepreneurship in Silicon Valley.

Akshay Pradhnis - Akshay is a computer scientist having a Master of Science with a specialization in Artificial Intelligence from The University of Texas at Dallas. His interests are Information Retrieval, Natural Language Processing, Machine Learning and Software Engineering. He did his Bachelor's in India and also holds an award from G.H.R. Labs and Research Centre for his contribution in an Intelligent Tutoring System that teaches C language.

6.3 Advisors

Dr. Mark Musen - Dr. Mark Musen is a professor of medicine and a biomedical informatics researcher. He's a member of Stanford's Bio-X and Director of Stanford Center for Biomedical Informatics Research since 1992. Dr. Musen is a principal investigator at the National Center for Biomedical Ontology (2005 – Present). His awards and recognitions include: General Chair, Association for Computing Machinery Conference on Knowledge Capture (K-Cap '11) (2011), Elected Member of Association of American Physicians (2010), Donald A. B. Lindberg Award for Innovation in Informatics, American Medical Informatics Association (2006). His education includes a Ph.D. from Stanford University, Medical Information Sciences (1988), an M.D. from Brown University, Medicine (1980), and a Sc.B. from Brown University, Biology (1977). You can learn more about Dr. Mark Musen at https://med.stanford.edu/profiles/Mark_Musen

Fernando Macho – Spanish tech investor and entrepreneur with over 30 years of business experience in every industry imaginable. Based out of Bilbao, Spain, Fernando helps Linda Healthcare leverage his European connections in finance and technology.

Alberto Diaz, PhD – Alberto is a Professor in the Computer Science department at the University Complutense of Madrid, Spain. He's holds a PhD in artificial intelligence and his research focus is in languages in computer systems.

Serena Yeung, PhD – Stanford University Artificial Intelligence PhD candidate

Eric Gibbons, **PhD** - Stanford University Computational Biology PhD candidate

6.4 Partners

We look forward to working with the following groups (and many more) as our platform develops:

- Stanford University Medical School
- Stanford University Hospital
- Harvard University
- StartX – Stanford University accelerator
- Microsoft
- NVIDIA
- Orange Silicon Valley

6.5 Open Source Steering Committee

We plan to involve many people and groups in this project. We will set up a steering committee for the software and the token. Initial members include Arturo Devesa, Akshay Phadnis, and Julian Kates-Hardbeck

6.6 Silicon Valley Office

Our team is all over the US and the core team is in Silicon Valley. Our office is in San Francisco with a second office at Stanford University.

7. Crowdsale

THE LINDAHEALTHCOIN CROWDSALE will take place over 30 days, from 8am ET on November 5th to 8pm ET December 5th. During this time, the price will be fixed in ether. In fact, the actual time of the sale will be measured in blocks, not minutes, and our website will keep an updated count of blocks with an estimated time until the sale ends. We will put the price on the website in November, so people can plan their allocations.

Each token will be an ERC20 token on the Ethereum blockchain—we will use a smart contract and return tokens to the buyer's ether address. In the case of not meeting our minimum, we will return ether instead.

Purchase methods accepted: Only ether ETH is accepted

Method of Purchase: myetherwallet.com

Refer to the Terms and Conditions document for final details. This is a summary …

$50 dollars Minimum, No maximum

7.1 Token Allocation

A total of 210 million tokens will be issued. This is how it breaks down in dollars during planning—the actual price in ether is subject to change (blue means an input):

LindaHealthCoin Token Allocation	Category	Percent	Tokens	Dollars	
Total	Valuation	100%	210,000,000	$	21,000,000
			One token =	$	0.10
For Sale	Pre-sale	4%	8,400,000	$	840,000
For Sale	Sale	45%	94,500,000	$	9,450,000
Allocated	Ecosystem Incentivation	31%	65,100,000	$	6,510,000
Allocated	Founders & Team	20%	42,000,000	$	4,200,000
		100%	210,000,000	$	21,000,000

Here are details of the above chart:

The presale will take place using a smart contract and an ether address that will be sent with instructions by email and may or may not be on a web page. The presale is limited to 8 million tokens. Several of the people working on the project will be purchasing at this time.

The token sale will offer 210,000,000 tokens to the public. They will be sold using a smart contract until all 210 million have been sold, or 30 days, whichever comes first. The price will be set in ether. Buyers will receive ERC20 tokens at the conclusion of the sale.

All unsold tokens from both the presale and the sale will immediately go on ice for ten years using a smart contract. They can't be touched during that time. We expect they will be transferred to a nonprofit that will govern the tokens before then, but until that time they will remain property of Linda Healthcare. After ten years, they may be sold, re-iced, or burned according to our token-management directives, which will evolve along with the system.

The minimum raise for presale and sale combined will be around $100,000, set ahead of the sale and priced in ether.

The target is roughly $10 million at the sale-time ether price

7.2. Token Sale

The sale will take place over 30 days, beginning on November 5th at 08:00 ET. Tokens will be priced immediately before the sale in ether. The sale will take place at that fixed price over 30 days (measured in blocks on the Ethereum blockchain) or until all 200 million are sold. There will be no discounts. At the end, all unsold public tokens will be put on ice for ten years, as described above.

7.3 Token Trading

We expect to list our tokens on an exchange as soon as possible after the close of the crowdsale. We will put this information on our website as soon as it is available.

Thank you for reading the Linda Healthcare White Paper—we hope you'll join us on our journey to change the world. Please come to the website www.linda.healthcare and sign up for our mailing list.

8. References

[1] National Quality Forum (2010) Reducing Emergency Department Overuse. https://www.qualityforum.org/NPP/docs/Reducing_ED_Overuse_CAB.aspx

[2] Ungar, R. (2013) The Great American Hospital Pricing Scam Exposed-We Now Know Why Healthcare Costs Are So Artificially High. Forbes Magazine.

[3] http://www.mayoclinicproceedings.org/article/S0025-6196(15)00716-8/abstract

[4] http://www.hipaajournal.com/how-are-hackers-accessing-hipaa-covered-data/

[5] https://www.economist.com/news/international/21727062-it-still-hard-find-one-who-will-make-you-better-poor-countries-it-easier

[6] https://algorithmia.com/research/ml-models-on-blockchain