Unit - 3 - blockchian

Blockchain Technology (Jawaharlal Nehru Technological University, Hyderabad)

Blockchain Science: Gridcoin, Foldingcoin

As blockchain technology could revolutionize the operation of other fields, innovators are starting to envision how the concepts might apply to science. So far, the main thread is related to peer-to-peer distributed computing projects for which individual volunteers provide unused computing cycles to Internet-based distributed computing projects. Two notable projects are SETI@home (the Search for Extraterrestrial Intelligence, which uses contributed computing cycles to help analyze radio signals from space, searching for signs of extraterrestrial intelligence), and Folding@home (a Stanford University project for which computing cycles are used to simulate protein folding, for computational drug design and other molecular dynamics problems).

Per blockchain technology, remunerative coin has been set up to reward participants in both the SETI@home and Folding@home projects. For SETI@home, there is Gridcoin, which is the remunerative coin available to all BOINC (Berkeley Open Infrastructure for Network Computing) projects, the infrastructure upon which SETI@home runs. For Folding@home, there is FoldingCoin, a Counterparty token that runs and is exchangeable to the more liquid XCP cryptocurrency (and therefore out to Bitcoin and fiat currency) via the Counterparty wallet (Counterwallet).

A more fundamental use of the blockchain for science could be addressing the wastefulness of the mining network, which consumes massive amounts of electricity. Instead of being used to crunch arbitrary numbers, perhaps the extensive processing power could be applied to the more practical task of solving existing science problems. However, a mining algorithm must meet very specific conditions, like generating code strings or hashes that are easily verifiable in one direction but not in reverse, which is not the structure of traditional scientific computing problems.

There are some cryptocurrency projects trying to make blockchain mining scientifically useful—for example, Primecoin, for which miners are required to find long chains of prime numbers (Cunningham chains and bi-twin chains) instead of SHA256 hashes (the random guesses of a specific number issued by mining software programs based on given general parameters). There is an opportunity for greater progress in this area to reformulate supercomputing and desktop grid computing problems, which have been organized mainly in a massively parallel fashion, into a mining-compatible format to take advantage of otherwise wasted computing cycles.

Gridcoin, if not solving the problem of using otherwise wasted mining cycles, at least tries to align incentives by encouraging miners to also contribute computing cycles: miners are compensated at a much higher rate (5 GRC versus a maximum of 150 GRC) for mining a currency block when also contributing computing cycles. A typical complaint about blockchain technology is the wastefulness of mining, both in terms of unused computing cycles and electricity consumption.

The media presents estimates of power consumption such as "the Eiffel Tower could stay lit for 260 years with the energy used to mine Bitcoins since 2009," and that in 2013 Bitcoin mining was consuming about 982 megawatt hours a day (enough to power 31,000 homes in the United States, or half a Large Hadron Collider), at a cost of $15 million a day. However, the comparison metric is unclear; should these figures be regarded as a little or a lot (and what are the direct economic benefits of the Eiffel Tower and the LHC, for that matter)? Bitcoin proponents counter that the blockchain model is vastly cheaper when you consider the fully loaded cost of the current financial system, which includes the entire infrastructure of physical plant bank branch offices and personnel.

They point out that the cost to deliver $100 via the blockchain is much cheaper than traditional methods. Still, there is concern over how Bitcoin could eliminate its wasteful consumption of electricity for mining while continuing to maintain the blockchain, and 3.0 innovations could be expected. One response is cryptocurrencies that are apparently more energy efficient, such as Mintcoin.

Blockchain Genomics

The democratization and freedom-enhancing characteristics of the blockchain seen in many projects also apply in the case of *consumer genomics*, which is the concept of uplifting organizations to the blockchain (to the cloud in a decentralized, secure way) to escape the limitations of local jurisdictional laws and regulation. That there is a need for this does not necessarily signal illegal "bad players" with malicious intent; rather, it indicates a lack of trust, support, relevance, and espousal of shared values in local jurisdictional governments.

Traditional government 1.0 is becoming outdated as a governance model in the blockchain era, especially as we begin to see the possibility to move from paternalistic, one-size-fits-all structures to a more granular personalized form of government. Genomics can be added to the list of examples of uplifting transnational organizations to the decentralized blockchain cloud like ICANN, Wiki Leaks, Twitter, Wikipedia, GitHub, and new business registrations as DACs. Transnational blockchain genomics makes sense in the context of the right to personal information being seen as a basic human right, especially given the increasing cost feasibility per plummeting genomic sequencing costs.

In one view, consumer genomics can be seen as a classic case of personal freedom infringement. In many European countries and the United States, paternalistic government policy prevents individuals from having access to their own genetic data. Even in countries where personal genomic information is used in health care, there is most often no mechanism for individuals to get access to their own underlying data. In the United States, prominent genomic researchers have tried to make a public case that the "FDA [Food and Drug Administration] is overcautious on consumer genomics," and established in studies that there is no detrimental effect to individuals having access to their own genomic data. In fact, the opposite might be true: in the humans-asrational-agents model, 80 percent of individuals learning of a potential genetic predisposition for Alzheimer's disease modified their life-style behaviors (e.g., exercise and vitamin consumption) as a result.

Other news accounts continue to chronicle how individuals are seeking their own genomic data and finding it useful—for example, to learn about Alzheimer's and heart disease risk. As a result of paternalistic purview, and no clear government policies for the preventive medicine era, US-based consumer genomics services have closed (deCODEme), directed their services exclusively toward a physician-permissioning model (Pathway Genomics, Navigenics), or been forced to greatly curtail their consumer targeted services (23andMe). In response, blockchain-based genomic services could be an idea for providing low-cost genomic sequencing to individuals, making the data available via private key.

One of the largest current transformational challenges in public health and medicine is moving from the current narrowband model of "having only been able to treat diagnosed pathologies" to a completely new data-rich era of preventive medicine for which the goal is maintaining, prolonging, and enhancing baseline health. Such a wellness era is now beginning to be possible through the use of personalized big data as predictive information about potential future conditions. Personalized genomics is a core health data stream for preventive medicine as well as individuals as knowledgeable, self-interested, action-taking agents.

In fact, as of November 2014, a blockchain genomics project, Genecoin, has launched an exploratory website to assess potential consumer interest, positioning the service as a means of backing up your DNA. Blockchain Genomics 2.0: Industrialized All-Human-Scale Sequencing Solution At one level, there could be blockchain-enabled services where genomic data is sequenced and made available to individuals by private key outside the jurisdiction of local governments. However, at another higher level, as a practical matter, to achieve the high-throughput sequencing needed for all seven billion humans, larger-scale models are required, and blockchain technology could be a helpful mechanism for the realization of this project.

Individuals ordering their genomes piecemeal through consumer genomic services is an initial proof of concept in some ways, but not an "all-human-scale" solution for sequencing. Blockchain technology, in the form of a universal model for record keeping and data storage and access could be the technology that is needed to move into the next phase of industrialized genomic sequencing. This applies to genomic sequencing generally as an endeavor, irrespective of the personal data rights access issue. Sequencing all humans is just one dimension of sequencing demand; there is also the sequencing of all plants, animals, crops, viruses, bacteria, disease-strain pathogens, microbiomes, cancer genomes, proteomes, and so on, to name a few use cases.

There is a scale production and efficiency argument for blockchain-based transnational genomic services. To move to large-scale sequencing as a "universal human society," the scope and scale of sequencing and corresponding information processing workloads suggests not just transnationality, but more important, heavy integration with the cloud (genomic data is too big for current forms of local storage and manipulation), and the blockchain delivers both transnationality and the cloud. Transnational regional centers for genomic sequencing and processing and information management of the sequenced files could be the best way to structure the industry given the cost, expertise, equipment, and scale required. This could be a more efficient solution rather than each country developing its own capabilities.

Blockchain technology might be used to achieve a high-throughput level of industrialized genomic sequencing—on the order of millions and billions of genomes, well beyond today's hundreds. In reality, blockchain technology might supply just one aspect of what might be needed; other issues are more critical in achieving industrialized genomic sequencing operations (information processing and data storage is seen as the real bottleneck). However, the blockchain ecosystem is inventing many new methods for other operational areas along the way and might be able to innovate in a complementary manner for a full solution to industrial-scale genomic sequencing, including recasting the problem in different ways as with decentralization concepts.

Blockchain Technology as a Universal Order-of-Magnitude Progress Model

Blockchain technology might be indicative of the kinds of mechanisms and models needed to achieve the next orders-of-magnitude progress in areas like big data, moving to what would currently be conceived as "truly-big-data," and well beyond. Genomic sequencing could be one of the first demonstration contexts of these higher-orders-of-magnitude models for progress.

Genomecoin, GenomicResearchcoin

Even without considering the longer-term speculative possibilities of the complete invention of an industrial-scale all-human genome sequencing project with the blockchain, just adding blockchain technology as a feature to existing sequencing activities could be enabling. Conceptually, this would be like adding coin functionality or blockchain functionality to services like DNAnexus, a whole-human genome cloud-based storage service. Operating in collaboration with university collaborators and Amazon Web Services, the DNAnexus solution is perhaps the largest current data store of genomes, having 3,751 whole human genomes and 10,771 exomes (440 terabytes) as of 2013.

The progress to date is producing a repository of 4,000 human genomes, out of the possible field of 7 billion humans, which highlights the need for large-scale models in these kinds of big data projects (human whole-genome sequencing). The DNAnexus database is not a public good with open access; only 300 worldwide preapproved genomic researchers have permission to use it. The Genomic Data Commons is a US-government-funded large-scale data warehouse and computational computing project being assembled to focus on genomic research and personalized medicine. In this case, the resource is said to be available to any US-based researcher.

This is a good step forward in organizing data into standard unified repositories and allowing access to a certain population. A further step could be using an appcoin like Genomecoin to expand access on a grander scale as a public good fully accessible by any individual worldwide. Further, the appcoin could be the tracking, coordination, crediting, and renumerative mechanism sponsoring collaboration in the Genome Data Commons community. Like the aforementioned *Wikinomics* example, the highest potential possibility for discovery could be in making datasets truly open for diverse sets of individuals and teams from a variety of fields and backgrounds to apply any kind of model they might have developed.

One benefit of "Bitcoin/blockchain-as-economics" is that the technology automatically enables embedded economics as a feature in any system. In the genomic sequencing and storage context, the economics feature could be used in numerous ways, such as obtaining more accurate costs of research with Genomecoin or GenomicResearchcoin. The economic/accounting tracking features of the blockchain further allows now other foreseen capabilities of the blockchain, such as attribution as an enabler for large-scale human projects (like attribution at the GitHub line item of committed code or digital asset IP-protected ideas). Attribution is a crucial feature for encouraging individual participation in large-scale projects.

Blockchain Learning: Bitcoin MOOCs and Smart Contract Literacy

Blockchain-based smart contracts could have myriad uses. One possibility is smart literacy contracts. Bitcoin MOOCs (massive open online courses) and smart literacy contracts encompass the idea of opening up emerging-market smart-contract learning to all individuals worldwide the same way that traditional MOOCs opened up educational courses to all individuals worldwide. Just as Bitcoin is reinventing the remittances market and bringing about financial inclusion, so too the foreign aid market can be reinvented with blockchain-based, peer-to-peer smart contracts.

The concept is like Kiva, Grameen microlending, or Heifer International 2.0, which could include peer-to-peer financial aid, but more importantly allows the configuration of peer-to-peer aid that is not currency-based but personal development-based. Blockchain Learning is decentralized learning contracts. One way to improve literacy in emerging markets could be via decentralized smart contracts for literacy written between a donor/sponsor peer and a learning peer. Much in the way that Bitcoin is the decentralized means of exchanging currencies between countries, a decentralized contract system could be helpful for setting up learning contracts directly with students/student groups in a similar peer-to-peer manner, conceptually similar to a personalized Khan Academy curriculum program.

Learners would receive Bitcoin, Learncoin, or the local token directly into their digital wallets—like 37Coins, Coinapolt, or Kipochi—from worldwide peer donors, and use this to fund their education expenses at school or separately on their own. A key part of the value chain is having a reporting mechanism to attest to learner progress. Rules embedded in learning smart contracts could automatically confirm the completion of learning modules through standardized online tests.

Satisfying the learning contract could then automatically trigger the disbursement of subsequent funds for the next learning modules. Blockchain learning contracts can be coordinated completely on a peer-to-peer basis between the learner and the learning sponsor; and really directly with the automated software contract. Again, the idea is like Kiva or Heifer International for blockchain literacy for individualized learning contracts.

Learncoin

Learncoin could be the currency of the smart contract literacy system, with schools, student groups, or individuals issuing their own token: MthelieLearncoin, Huruma Girls High School tokens, or PS 135 tokens. School fundraising in any area worldwide could be conducted with Learncoin and LocalSchoolName tokens. Just as physician RFPs make the health services market two-sided, students or student groups could post their open learning contracts to a Learning Exchange, which could be fulfilled by learning-funders on the other side of the transaction.

Learning Contract Exchanges

Learning contract exchanges could apply in a much broader sense—for example, as a universal learning model. This could apply to government workforce retraining, graduate students, and employees within corporations. Learning contract exchanges could be a way of reinventing or improving the orchestration of the continuing professional education (CPE) programs required for many fields like law, information technology, and medicine. Learning contracts in the development context could be extended to many use cases in emerging markets. There could be many categories of “literacy” contracts, such as basic reading for elementary school children, but also for every area of education, such as vocational learning, business literacy, social literacy, and leadership literacy.