Undergraduate Thesis Prospectus

TensorSnap: A Block Coding Interface for Machine Learning

(technical research project in Computer Science)

"Blockedchain": Why Critics Oppose the Mass Adoption of Blockchain Technology

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How can the democratization of new technology be expedited?

The promise of technology, according to Forbes Councils Member Mihir Shukla, is to liberate humanity so that "people are no longer relegated to being robots" (Shukla, 2019). In other words, technology should serve human advancement. The digital revolution, now characterized by developments in machine learning and blockchain technology, may serve human advancement (Stoecker, 2020). Yet technology is not equally accessible to all. To use cloud computing or machine learning requires skills that many have no practical opportunity to develop. Online tutorials often assume that users have a text-based coding background (Rao, 2020); less than 0.5 percent of the world's population knows how to code (Prenda, 2016). In developing countries, access to computers and training is generally scarce. Technological developments such as artificial intelligence may therefore broaden the global digital divide (Alonso et al., 2020). On a global scale, before technology can serve the liberating purpose that Shukla proposes, access to it must be democratized.

TensorSnap: A Block Coding Interface for Machine Learning

How can a machine learning platform be developed for block programming languages?

TensorSnap is overseen by N. Rich Nguyen, an assistant professor teaching Machine Learning in the computer science department at the School of Engineering and Applied Science. This is a team capstone project in which myself and Harsh Padhye, a student in the College of Arts and Sciences, collaborate.

TensorSnap aims to expedite the democratization of machine learning (ML). By allowing users to build, compile, fit, and run ML models using block coding, TensorSnap enables those without formal experience in a text-based programming language to study and leverage ML.

The overarching goal of TensorSnap is to produce a block-based API for TensorFlow, an open-source ML platform developed by Google. Additionally, we aim to provide a "Model Zoo" of the leading open-source transfer learning models (such as GPT-3), which users can leverage as foundations for their models. Accomplishing these goals, along with providing usage examples, will allow for the development of a curriculum for an ML course for non-programmers.

The current state-of-the-art in block-based machine learning is eCraft2learn, developed at Oxford University (Kahn et al., 2018). This project, similarly, combines TensorFlow and Snap! to provide a block-based "interface to both AI cloud services and deep learning functionality". Though eCraft2learn allows for the definition of custom neural networks in addition to providing functionality for standard ML tasks (such as image recognition), it lacks access to some of the more complex options afforded by TensorFlow (such as model layer types and training metrics). Another project, AI Blocks, provides multiple pre-trained machine learning models (including a text classifier) but, similarly, limits users to only the most basic TensorFlow features.

Developing TensorSnap involves developing a web application using the JavaScript programming language, the React.js web application framework, and numerous libraries. Such libraries include Snap! (a visual, block-based programming language developed at UC Berkeley) and TensorFlow. Development follows an iterative approach. First, a common machine learning function from TensorFlow, such as model architecture definition or model training, is selected. Next, the block-based interface is designed, with user learnability, understandability, and

efficiency in mind. Afterwards, the algorithms, data structures, and software organization necessary to power this interface is produced. Finally, the interface is linked to the code, and the process begins anew.

Upon completion, TensorSnap will enable users without a text-based programming background to learn, perform, and leverage machine learning, thereby expediting the democratization of new technology.

"Blockedchain": Why Critics Oppose the Mass Adoption of Blockchain Technology

How do critics of blockchain technology oppose mass adoption by businesses and individuals?

One of the fastest growing fields in technology over the past ten years is blockchain, a means of storing and accessing data in a decentralized, distributed virtual ledger (Iredale, 2020). Since the advent of Bitcoin in 2008, many cryptocurrency projects have emerged that use such a ledger and cover a myriad of use cases. Bitcoin, for instance, is used primarily as a means of exchange and a store of value, granting it the nickname "digital gold." Ethereum, on the other hand, powers countless decentralized applications (dApps), which are run on the computers of network participants (or "miners"), who are rewarded with Ethereum. With the global cryptocurrency market capitalization approaching $2.6 trillion - greater than the market capitalization of Microsoft, Apple, Google, Amazon, and silver, but less than gold - many compare the cryptocurrency boom with the dotcom boom of the 1990s (Robertson, 2021).

Proponents have likened the potential impact of blockchain to that of the internet, citing freedom, security, privacy, and constant up-time as the major driving forces for its adoption in numerous fields (Higginson et al., 2018). Such fields include cross-border banking, identity verification, supply chain monitoring, and provable ownership (Daley, 2021). However, such

growth is not without opposition. Opponents emphasize slow transaction speeds, the potential for destructive hacks, high energy demands, and regulatory risks as obstacles to widespread adoption (Iredale, 2021).

Researchers have attributed COVID-19 vaccine hesitancy to "lack of confidence in the need for vaccines" and "aversion to the risk of side effects" (Shen et al., 2021). Similarly, blockchain critics question its practicality and perceive it as risky and dangerous. They note, for example, that blockchain is energy intensive (Küfeoğlu & Özkuran, 2019); in 2017, when it hit peak power consumption, Bitcoin mining consumed power equivalent to the installed electrical capacity of Finland (16 GW). In response, proponents such as the International Youths Organization for Peace and Sustainability (IYOPS) point out that the traditional banking system currently consumes 139,000 GWH per year to run servers, ATMs, and physical branches (Eugenia, 2021). Furthermore, they argue that scaling up cryptocurrency usage would not result in significant energy cost increases, as the current cryptocurrency infrastructure is already sufficient to maintain global cryptocurrency networks.

Another point of contention is the slow transaction speeds associated with many blockchain projects. For example, the Bitcoin network can now process only 5 transactions per second, while Visa's network can handle 1,700 per second (Griffin , 2020). However, researchers are developing a "parallel proof of work" system, which lets several different "miners" handle blockchain transactions cooperatively instead of a random individual "miner" (Shahriar Hazari & Mahmoud, 2020).

Similarly, opponents claim that high transaction costs will deter usage of certain cryptocurrencies, such as Bitcoin. However, proponents argue that even with high transaction costs, cryptocurrencies offer a more secure and trustworthy alternative to currencies in fragile

nations (van den Berg, 2018). According to van den Berg, “modern fragility combines dysfunctional governance with often high levels of technological adoption.” This trend is exemplified by Somalia’s longlasting civil war producing high mobile phone coverage and relatively low telecommunication costs. Thus, cryptocurrencies are expected to follow this trend.

Proponents point to El Salvador’s recent Bitcoin Law, which gave Bitcoin the status of legal tender, as a sign of blockchain’s increasing adoption and ability to combat inflation (Hanke, 2021). However, the Cato Institute compares the Bitcoin Law - which made Bitcoin not only legal tender, but forced tender - to Article 175 of the Soviet Union’s civil code and other forced-tender laws, which are common during military occupations. Hanke points out that Nayib Bukele, President of El Salvador, has a history of totalitarian activity - firing the attorney general who initiated investigations into corruption in Bukele’s government, replacing five judges who attempted to apply the rule of law upon Bukele, and more. Hanke claims that enacting the Bitcoin Law is just another action to add to this list, since it would allow Bukele to more easily facilitate money laundering and corruption without immediate punishment from the Financial Action Task Force (FATF). In contrast to the claim that blockchain fosters corruption, Yang et al. offer increased election integrity as a benefit of blockchain; by providing encrypted, unmodifiable vote counts on a public ledger, election results can be made indisputable and verifiable (Yang et al., 2020).

Proponents of blockchain include The Blockchain Advocacy Coalition (BAC), Fedex, and the Enterprise Ethereum Alliance (EEA). BAC “is committed to educating legislators and regulators about blockchain technology” (2018). The CIO of Fedex, Rob Carter, emphasizes the significance in making shipping data - including certificates of origin and commodity-specific licenses - transparent on a blockchain-enabled public ledger (Mearian, 2019). The EEA claims

Ethereum can revolutionize the telecommunications roaming system by reducing authentication delays when switching between providers, improving security, and reducing infrastructure costs (Fromm, 2019).

Yet the International Monetary Fund (IMF) claims that the value of crypto assets is “too volatile” and “unrelated to the real economy” (Adrian & Weeks-Brown, 2021). Jerome Powell, Chair of the cryptocurrency-opposing Federal Reserve, similarly believes that the volatility of crypto assets “undermines their ability to store value” (Al Jazeera, 2021). Janet Yellen, Secretary of the Treasury, warns of criminals using cryptocurrencies for illicit financing, money laundering, and black market activity (Lennon, 2021).

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