TENSORSNAP: A BLOCK CODING INTERFACE FOR MACHINE LEARNING

EXPEDITING THE DEMOCRATIZATION OF BLOCKCHAIN TECHNOLOGY

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A SOCIOTECHNICAL SYNTHESIS

The purpose of technological advancement is to liberate humanity from repetitive tasks to allow for focusing on more creative tasks, but the effects of technological advancement can only be maximized through equitable democratization. The democratization of one such technology, machine learning (ML), is hindered by accessibility issues; in particular, using ML typically requires text-based programming knowledge and powerful hardware. The technical portion of this project, TensorSnap, seeks to reduce the barrier-of-entry to ML by providing a web-based block-coding interface to ML. Another technology, blockchain, faces opposition in its path towards democratization; such opposition is primarily due to concerns over usefulness and consequences. The science, technology, and society (STS) portion of this project explores the specific reasons for such opposition among various social groups, how different groups shape one another's views, and potential ways to address this opposition. Therefore, the tightly coupled technical and STS topics both seek to expedite the democratization of new technologies.

ML is often used in applications that are difficult to address through traditional programming and are better addressed through practice and repetition, such as self-driving cars, image recognition, and natural language processing. Although the ML market is expected to grow from $21.17 billion in 2022 to $209.91 billion by 2029, the most popular ML libraries require a text-based coding background and high-performance graphics cards; yet, less than 0.5% of the world's population knows how to code, and many of those in third-world countries have difficulty sourcing such expensive hardware. To address these sources of inaccessibility and expedite the democratization of ML, TensorSnap allows users to use *Snap!*, a block-based programming language developed at the University of California Berkeley, to access and use the functionality of TensorFlow, an open-source ML framework developed by Google Brain.

TensorSnap was developed via an iterative process involving: (1) selecting high-priority TensorFlow functionality, (2) designing user-friendly interfaces in *Snap!*, (3) implementing interface functionality in JavaScript, and (4) connecting the interfaces to the implementations.

The development of TensorSnap resulted in a block-based ML platform that exposes the major features of TensorFlow and enables users to solve common ML problems. These features include defining, compiling, training, and using a deep neural network, and the ML problems include linear regression and classification. Moreover, custom pre-built models from Magenta, another library developed by Google Brain, were included to allow users to perform generative operations, such as neural style transfer and neural instrument transfer. Thus, it was concluded that TensorSnap can be used as both an ML learning tool and production tool for non-programmers, thereby lowering the barrier-of-entry to ML.

The major STS research question was "How do critics of blockchain technology oppose mass adoption?" The thesis claimed that the major reasons for opposition were concerns over blockchain usefulness and adverse consequences. Through the use of Callon, Latour, and Law's Actor Network Theory (ANT), a variety of sources were evaluated to produce a mapping of various social groups, their viewpoints on blockchain, and the ways in which they influence each other's viewpoints. Such sources include primary sources from certain social groups, technical research papers addressing the flaws of blockchain, and opinion pieces.

It was found that the major usefulness-related concerns are: (1) slow transaction speeds, (2) high transaction fees, and (3) high market volatility, the major consequence-related concerns are (1) high environmental costs and (2) an increased potential for criminal activity, and miscellaneous concerns include (1) forceful pro-blockchain regulations and (2) the use of celebrities to promote blockchain. Through ANT, it was found that the media plays a major role

in propagating opinions on blockchain, that the government has the power to address several of these concerns, and that new cryptocurrencies can be engineered to maximize usefulness and minimize harm. For instance, the government can regulate the use of celebrities to artificially inflate cryptocurrency prices, engineering can produce cryptocurrencies that require fewer computational resources and energy, and the media can provide transparency about the benefits and drawbacks of cryptocurrencies. Thus, it was concluded that the media, government, and engineering can be used together to address blockchain opposition and expedite democratization.

Consequently, both the technical and STS portions of this project seek to maximize the positive effects of new technologies. Future work can further the impact of this project by producing a tutorial for TensorSnap, keeping TensorSnap up-to-date as TensorFlow gains new features, analyzing new social groups and occupations using ANT, and considering other potential means of addressing blockchain opposition. Though engineering new technologies is often very technical, ensuring that such technologies are adopted by and beneficial to society requires not losing sight of a vital component in engineering: humanity.

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