TENSORBIT

WHITEPAPER

Table of Contents

Abstract

Today a unprecedented amount of data is being generated daily. In addition to this, computing power and storage are at levels never before seen which has given rise to machine learning to try and build value out of all of this data. Image recognition and artificial intelligence are emerging as two large industries that have unlimited uses in private and public sectors. Limiting factors in how fast innovations can occur in these areas are time and computing power which are required to train modern machine learning models. New blockchain technology offers an ideal solution. Blockchains are immutable and can offer the recording and compute power required to solve machine learning problems. TensorBit is the first company to develop a proof of work concept to solve these problems at speeds never before seen.

A Useful Proof of Work

Most current systems require that the individual clients do useless computational work such as solving hash functions. This results in massive amounts of electricity, which powers computers, to go to waste. A new hybrid form of neural network has been created to start utilizing individual clients across the blockchain network to solve machine learning computations which lead to the training of a tensor deep stacking and compound hierarchical-deep model. The amount of computational power is massive compared to what is achievable on a single physical machine. This results in extremely quick model training times. This is very important when large scale problems are solved. For example, for a company like Tesla, to train self driving car models, it can take days and/or weeks. The theoretical computational power that this solution provides could cut that down to seconds or minutes. Speed of innovation will greatly accelerate.

All useful proof of work systems have two essential features that the TensorBit architecture must satisfy.

1. To be considered work it must also be provable, that is work must always be provably not fake. If this were not the case then miners could potentially fake the protocol into getting paid.
2. To be verified, it must be done so in a reasonable way. That is, we cannot expect that more work is required to prove the equation is true than the

initial equation in the first place. This is essential in ensuring the protocol is viable.

Dealing with the proof of work is done through each viable miner candidate participating into the TensorBit blockchain. No single predictor will ever predict exactly what is going to happen, this is just the nature of statistics. This means that each client must be outfitted with the with the same calculations which will calculate the best score possible. This is essentially an ensemble and voting system for the overall outcome and also allows for a proof of work to be possible.

Why TensorBit?

The largest competitive advantage that TensorBit will offer over the competition is the speed in which it will be capable of solving machine learning computations. Currently high performance GPUs offered by Nvidia and ATI are very costly and can easily reach into the hundreds of thousands for a complete setup. Tensorbit is offering a solution which will be able to outperform these costly hardware solutions and still deliver the same results. This is HUGE! Companies will be able to derive insights quicker and save potentially millions of dollars by using our service and technology.

According to the private sector think tank, McKinsey Global Institute (MGI) - companies have invested 26 to 39 billion USD into machine learning and artificial intelligence in 2016. The industries which are adopting machine learning and artificial intelligence are mainly in the tech, automotive, and financial services where they hope to make huge gains in this space. Artificial Intelligence (AI) investment has turned into a race for patents and intellectual property (IP) among the world's leading tech companies. TensorBit is offering a service which will greatly speed up these companies and their ambitions for patent and intellectual property.

Figure 1.a. Server config: Dual Xeon E5-2699 2.6 ghz Performance measured on pre-production hardware. ResNet-50 Training on Microsoft Cognitive Toolkit for 90 Epochs with 1.28M imageNet dataset. A smaller bar is better.
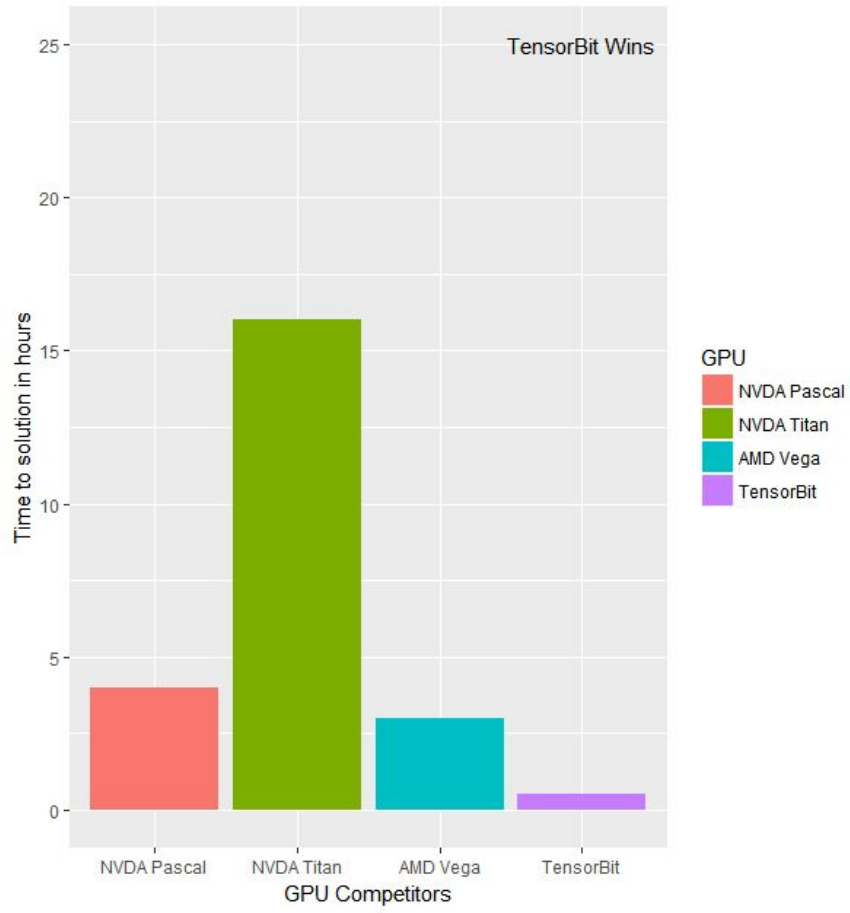
Figure 1.b. Speed test across 5000 randomly generated datasets. Models were built with a standard neural network and theoretical proof of work system for 90 epochs.
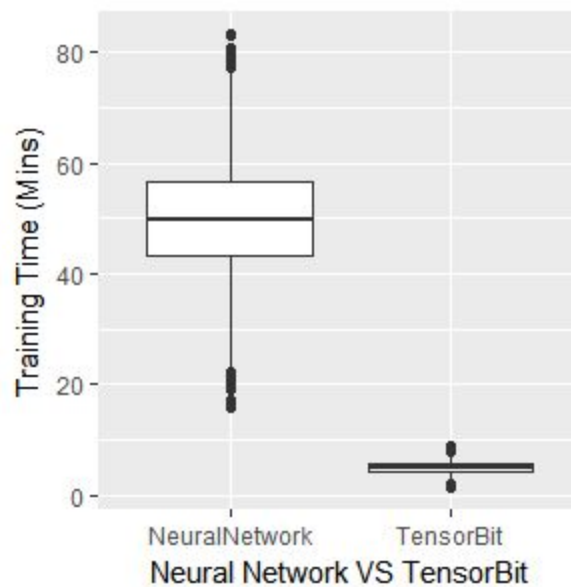

Figure 1a and 1b show that given the assumptions made in the performance of the proof of work system, TensorBit will greatly outperform a standard neural network trained on a normal hardware setup.

Principles of Operation

The functionalities of TensorBit will fall into several main areas. The first being the proof of work concept. Next an api layer will be created to allow companies to hook into this proof of work to solve machine learning equations. And finally a packaged library will be offered to companies to access the api and keep track of how many computations each company is consuming. Pricing will be determined in a metering based system of the service, and will depend on size of company and intended uses of the TensorBit platform.

Initially the product will only be accessible to data scientists or engineers as a software library. Further down the road consideration may be given to develop a more user friendly GUI application where many types of users might find it useful. Most companies who will be utilizing the TensorBit platform will already have a data science department in place who can hit the ground running without a GUI component.

TensorBit Goals

1. Develop proof of concept into useable alpha software library. This will most likely be created within python as it is a popular language for machine learning. Additional languages may be reviewed.

2. Open proof of concept to small group of individuals to start using the system and confirming that proof of work is being achieved.

3. Benchmark speed and quality of TensorBit network.

4. Build out beta version of service which will be opened up to all investors and other qualified third parties.

5. Using metrics gathered from previous phases start marketing the service to companies who would find this very beneficial.

6. Continue iterating on product to create more refined versions and to customize offerings as needed for clients.

TensorBit Tokens (TENB)

To fund the project, we will issues 100,000,000 TensorBit tokens (TENB). The tokens will be based on the Ethereum platform and managed using existing ETH solutions such as MyEtherWallet.

Token Pool Division:
- Crowdsale participants
- Pre-ICO buyer bonuses
- Development team
- Founders
- Initial miner incentives
- Corporation

Any unsold tokens will be destroyed. No additional tokens will be created in the future. Tokens will be listed on exchanges in 2017.

How TENB tokens Will be Used

Once the service is launched, clients who would like to use the service would need to purchase TENB tokens which are then used to pay miners who will be solving the computational equations. TENB token holders will be holding an appreciating asset which they can then start selling on an open exchange to clients.

For example: If company A would like to solve a machine learning problem, they would submit the data, requirements, and parameters to TensorBit using our interface. Once these requirements are sent, TensorBit will calculate the amount of computing power required to solve their problem with the cost in TENB tokens.

Parameters which the client can choose:
1. Equation to minimize
2. Time to problem solve (this depends on available computing power at any given time, the faster the solve the more TENB it will cost)
3. Hyper-parameters of the machine learning/AI algorithm
4. Hyper-parameter optimization through the TENB interface
5. Acceptable level of accuracy (or other evaluation metric of their choosing)

As the concept is proven to clients who use the service we see the TENB token becoming more and more valuable as the competition to buy the tokens will increase. As there is a fixed amount of tokens available supply and demand will eventually reach a market equilibrium. At this time it is impossible to say what the ultimate value of TENB tokens might be.

Platform and Overview of How TensorBit Works

Tensor deep stacking and compound hierarchical-deep model

Building upon the advantages of compound hierarchical-deep models and architecture of tensor deep stacked networks, a new type of neural network has been born. Blockchain technology, at its very core, uses mining and distributed trust to create the block chain. This new modeling technology will capitalize on the distributed trust with content-addressable memory neurons servicing as address encoders and decoders. A pointer network is essential to ensure that memory saving parameter reduction occurs and ensures fully differentiable end to end communication. Rather than incentivize miners to solve the useless block chain, tokens will be offered to miners to hook into this hierarchical-deep model which will ultimately power the model and subsequent model training sessions. Miners will be rewarded for solving the equations needed to run TensorBit.

The five key architectural elements of Tensor deep stacking and compound hierarchical-deep models.

1. Input Gate
2. Forget Gate
3. Cell
4. Output Gate
5. Hidden State Output

The elements presented here are what is passed using the Oracle Service built on top of the ethereum smart contracts and ultimately allows a proof of work to occur.

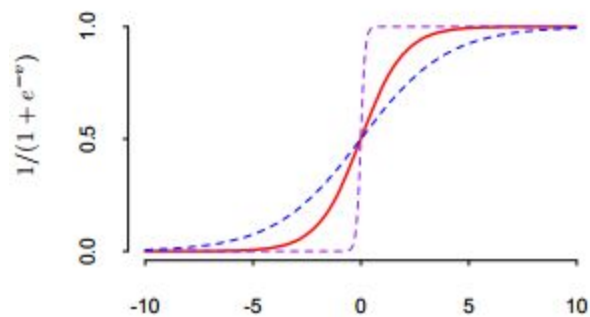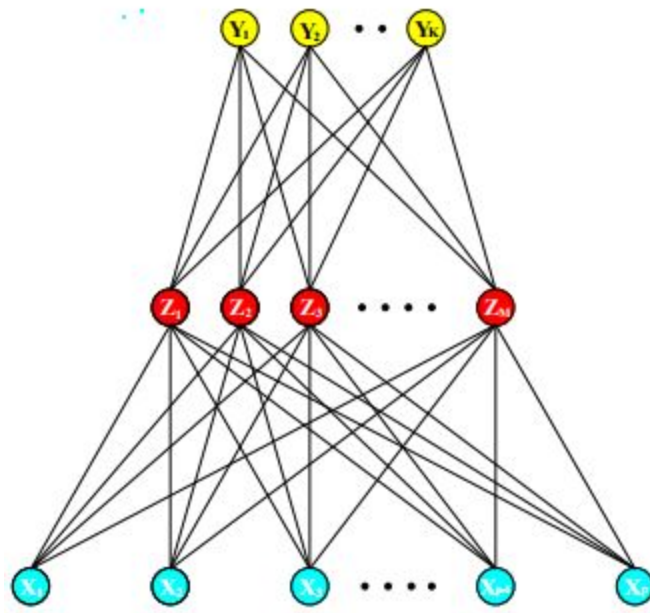Figure 1. Log probability function

Figure 2. Overview of typical neural network

Node Communication

All levels of the network can jointly maximize the hidden state output using a log-probability score. This allows us to harness the power of each individual node and generate a log-probability score which is vote averaged across all nodes. This is the key to deliver a proof of work. The actual node communication equations will not be shared in this white paper as to avoid outside competitors from gaining an advantage.

Data sharding to address excessive training time and resources.

A merkle tree will be used to facilitate node communication and implementation of the network topology. As previously described, this is the layer in which a log-probability score is generated and individual node voting will occur. This is what also interacts with the oracle service required to facilitate verifiable smart contracts.

Because log-probability scores are in their very nature compressed forms of information, this equates to being able to transfer what would traditionally be considered large data formats across the oracle service and ultimately resulting in hundreds of machine learning computations being solved by each individual miner.

Oracle Service

An oracle service is essential to making TensorBit work. The oracle service will take the external data (equations) to be solved by the blockchain.

Example Oracle Function:

```
function startPerceptronEquation(bytes8 cell, uint inputGate, uint
outputGate, uint forgetGate)
  onlyOracle
  returns(bool success)
{
  // store the data
  // initialize miner token
  return true;
}
```

Once the Oracle injects data using the example function above the miners can verify the blockchain and any further transactions as legitimate. Without revealing all of the key details to our competition, this is the premise of the oracle service.

The oracle service will be funded with the ethereum contributed to this ICO to distribute rewards and verify machine learning computations required for this to be a success. Please see section "**How TENB tokens Will be Used**" for more details.

Visual Overview of TensorBit Oracle Service

Figure 3.
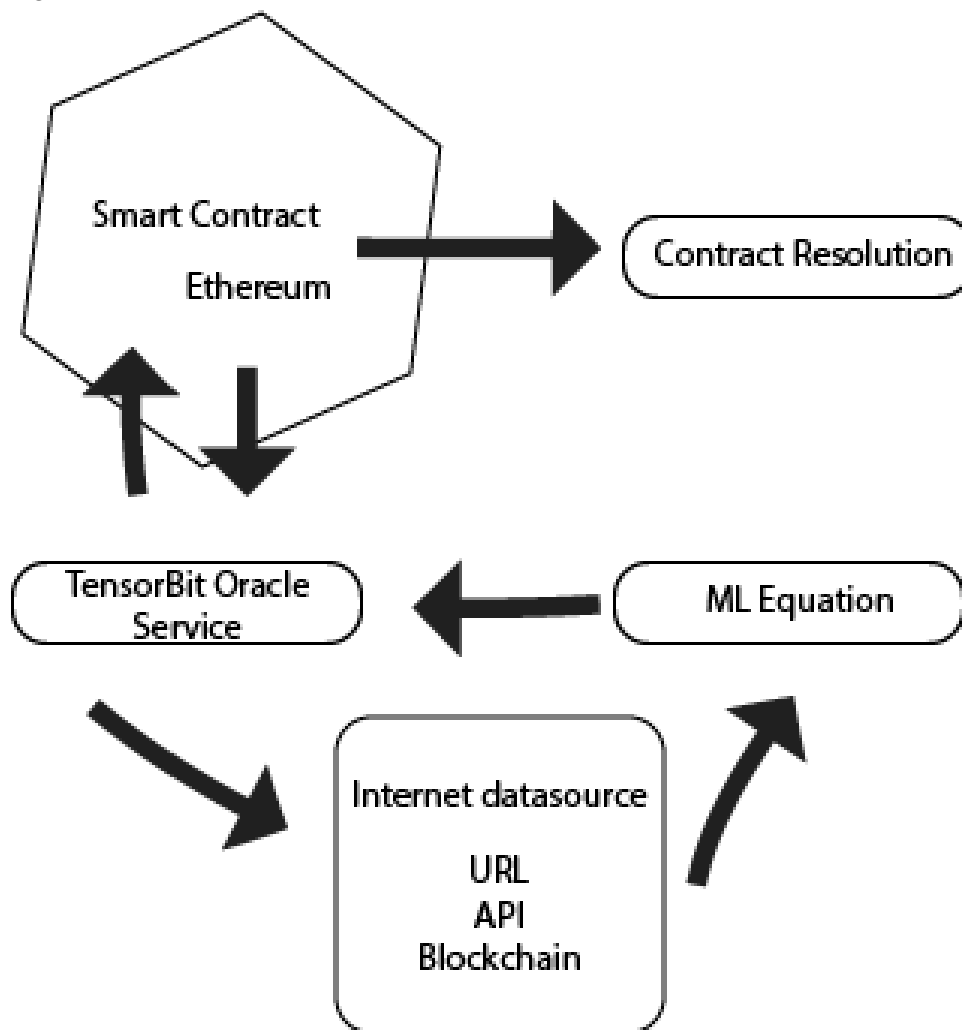
Oracle Vote Averaging Across the Blockchain

TensorBit will include a public facing data lake which will allow anyone to interact with the network. For more sensitive data, obfuscation algorithms will be used to satisfy any privacy requirements. The reason the data lake will be available for anyone to see is due to requirement of voting for different levels of importance of datasets. This allows companies to place extra emphasis on their machine learning problem, therefore further incentivizing miners to focus on their problem first. This also opens up the ability to adjust what features are needed to be predicted and how far into the prediction it is expected to go.

For each client using the TensorBit platform, they can make votes which chooses the amount of coin to spend on their particular problem set, as well as the amount of prediction data that they need. Voting is beneficial in this manner as it allows the blockchain to reach a consensus on what should be predicted and what prediction problem has the highest authority.

References

Acito, F., & Khatri, V. (2014, 09). Business analytics: Why now and what next? *Business Horizons, 57*(5), 565-570. doi:10.1016/j.bushor.2014.06.001

Al-Sayegh, S. (n.d.). Hybrid Neural Network. *The 2006 IEEE International Joint Conference on Neural Network Proceedings*. doi:10.1109/ijcnn.2006.1716172

Dannen, C. (2017). Smart Contracts and Tokens. *Introducing Ethereum and Solidity,* 89-110. doi:10.1007/978-1-4842-2535-6_5

Digital Disruption. (n.d.). Retrieved September 08, 2017, from http://www.mckinsey.com/global-themes/digital-disruption/

Morabito, V. (2017). Blockchain Value System. *Business Innovation Through Blockchain,* 21-39. doi:10.1007/978-3-319-48478-5_2

Shi-Nash, A., & Hardoon, D. R. (2016, 12). Data Analytics And Predictive Analytics In The Era Of Big Data. *Internet of Things and Data Analytics Handbook,* 329-345. doi:10.1002/9781119173601.ch19