Blockchain based Relief-Fund Distribution System

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***Abstract*: This paper proposes a novel idea of applying Blockchain technology to disaster-relief fund management systems. It also explores the possibility of integrating social media based risk predictions as an input to Blockchain smart-contracts. Further, it discusses the advantages of this approach and potential challenges faced by this model.**

***Index terms* - Blockchain Technology, Deep Learning, NLP, Weather Prediction, Disaster fund management system.**

1. Introduction

Every year millions of people are affected by both human-caused and natural disasters. It is estimated that the total yearly loss to be around 100-200 billions of dollars worldwide, not to mention the loss of precious human lives[1]. In the event of a disaster every second lost is a loss of life and timely help plays a big role in the above said circumstances.

In the current setup of disaster risk management, action is mostly taken only after the event has occurred. And is riddled with bureaucratic hurdles and opportunistic thieves, and the actual fund that was meant to reach the victims, disappears on the way only. The Handbook of Good Practices, released by Transparency International, mentions that a sudden increase of corruption in these unfortunate circumstance is not surprising, aid is often delivered in extreme and challenging environments. "The injection of large amounts of resources into poor economies, where institutions may have been damaged or destroyed, can exaggerate power imbalances and increase opportunities for corruption."[3]

Even though the humanitarian aid is provided, its proper distribution and maintenance is faced with challenges from corruption, paperwork and lack of proper implementation knowledge. However, blockchain technology solutions are emerging and can help with the distribution of financial aid, and solve the problem of lack of transparency.

In the Mid-term paper we have seen how promising the Blockchain technology can be in providing solutions to financial problems. It has potential to disrupt the entire finance Industry as we see today and is viewed as revolutionary technology. In this paper we go beyond the conventional applications of Blockchain technology and discuss its application to the relief fund distribution system. We also discuss about making use of social media data to predict/ascertain a disaster and use this data as input to Blockchain and trigger the event driven smart-contract mechanism present in Blockchain. More specifically, we would be considering news/weather data and train a deep learning based model on this data to make the predictions. Research in news/weather forecasting have shown that deep learning based models tend to predict with greater accuracy[4]. And also it naturally would make sense to use a deep learning based model in such data rich environment.

Blockchain technology coupled with forecasting technology makes it a formidable tool that can streamline the entire process starting from fund collection to the point of distribution of actual relief material, making it a faster and an efficient disaster fund management system.

2. Overview of Technology

The main components of the proposed model are:

a) Blockchain technology - Framework over which the relief fund distribution system is designed.
b) Active prediction system based on news/weather data - which provides continuous input to model.

Blockchain Technology:

As discussed in MidTerm paper blockchain technology is a model based on peer-to-peer (P2P)

communications and meets the following key requirements.

a) Making transactions whose authenticity is guaranteed (e.g, preventing duplicate payments);
b) Ensure traceability of data by enabling transparent transactions (i.e, making forgery difficult);
c) Maintaining this whole network against vicious attacks by any users by establishing a centralized/ decentralized controlling authority.

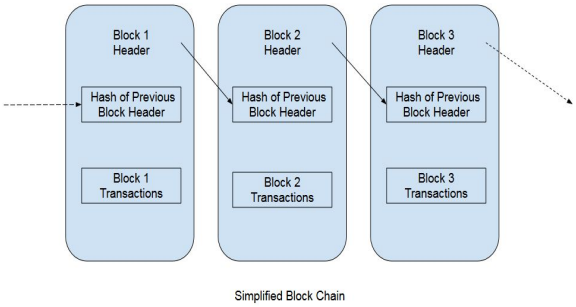


Figure 1. Block Diagram of simplified blockchain.

Most of the details about working of Blockchain are covered in Midterm paper, here we will focus on event driven smart contracts and international money transfer system which would be central to our model.

Smart-Contracts:

By definition smart contract is a programmable contract capable of automatically enforcing itself when a set of predefined conditions are met. Smart contracts can help with in the exchange of money, shares or anything of value between the users without the need of a middleman and that too in a transparent way.

Let us now see how this actually works. Consider Alice 'A' and Bob 'B'. A wants to sell her house and B is looking for a house to buy. In the normal scenario, this would involve brokers/middleman whom A/B would approach for selling or buying and middle man would charge a fee from both the parties and do the deal. However, the deal may not be transparent and the property that is involved might not be of clear title and legal issues may arise.

Consider an alternate scenario when both A and B are on a real-estate blockchain. A wants to sell the house and loads details like Expected Value with range - 'XXXX', Date of House availability and uploads a copy of digitized property ownership details. B will upload details like his budget range, and what is the target time he is looking at to make the purchase. The Smart Contract present on the blockchain matches A's requirements with B's and the deal is executed as soon as the conditions are met and funds from B's account are transferred into A's account and B is given a digitized copy of sale deed. The whole process is transparent and does not even involve the charges paid to middle man. This is how a typical event driven smart contract works.

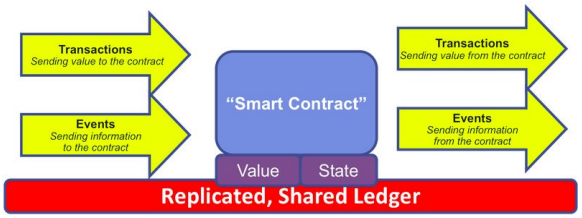


Figure 2. Working of a smart-contract

In the proposed model, the transactions include donations given for the disaster relief activities and the events are triggered based on inputs from the active prediction system which would be covered in detail in the subsequent sections. We have explored a bit and found that Ethereum based blockchain is easy to setup and tools for development are readily available in Microsoft Visual Studio via 'Solidity' plugin[5]. This makes writing smart contracts very easy.

International-Money transfers:

As the goal of the proposed model is to pool resources from across the globe and use this fund efficiently in case of a disaster, this makes International money transfer using blockchain critical to our model. Currently companies like 'Abra' and 'Align Commerce' offer instant remittance of money across borders (for some chosen locations) at a very nominal rates. The biggest advantage of this system is that one need not have digital currencies like Bitcoin to make the donations. Users can create a account on the proposed system and add money in their local currency to the wallet present in their accounts and can set certain conditions like one-time donation or monthly-donation, like the options that a normal banking website provides. Similarly in the distribution phase, the amount can be directly

remitted into the accounts of local NGO's account in their currency.

How this works:

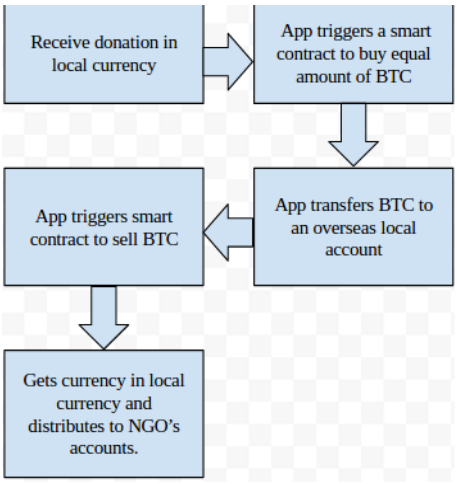


Figure 3. International Money Transfer based on Blockchain.

The above said model eliminates extravagant fund transfer rates and this saving could be used to save a few more lives in the emergency situations. Thus making the above model a very efficient one.

Active Prediction System using Deep Learning:

The next block in our model is an active prediction system which constantly takes in the news/weather data and keeps an eye out for any signs of disaster. In this paper we would be considering natural disasters only. A deep learned based model is proposed to be used based on "convolutional neural networks for nlp"[6].

Step 1: Data collection and Preprocessing: In this step the raw data from news feed or weather report is collected and fed into the model for cleaning and vector generation. Instead of image pixels the input to a NLP problem would be sentences or paragraphs. In Order to represent in the form of a input matrix - we need to break down our sentence or paragraph into words and build a vocabulary of words. Each row vector of the input matrix would correspond to a word. Generally these vectors are word embeddings like **word2vec**[7] or **GloVe**. For 15 word sentence using a 100 dimensional word embedding - our input matrix would have a 15x100 size.

Step2: Build and Train the model: Once our input is ready we would be using CNN based model with the following architecture to train our prediction model.

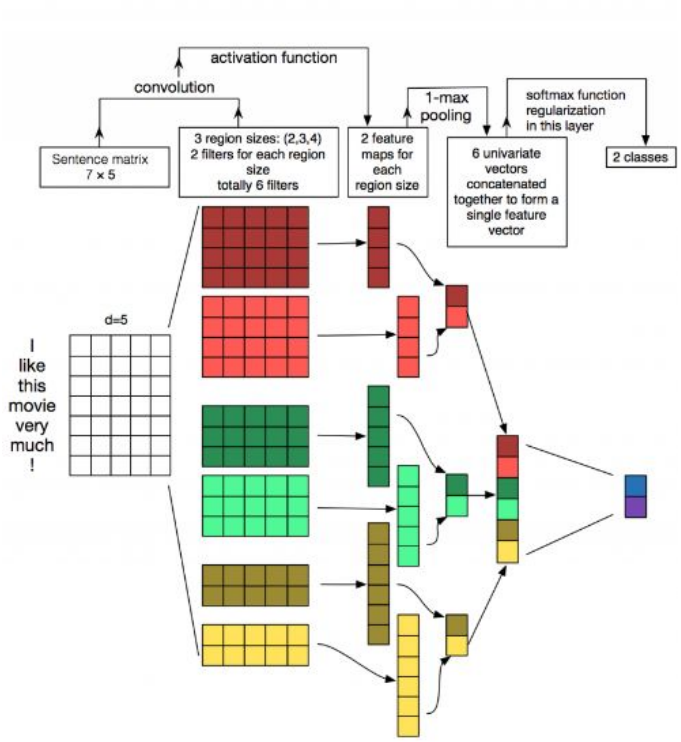
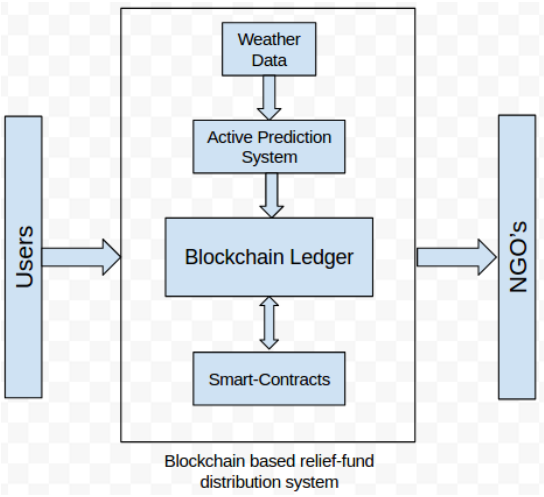


Figure 4. CNN architecture for sentence classification.

In vision the filter matrix is allowed to stride through the input, and the filter is generally smaller compared to the input, but in NLP we keep the length of the filter to be of same size as the row and slide through all the rows. In the above illustration we have 6 filters of varying regions and each of which produces a convoluted feature. Then we use max pooling and concatenate to get a single vector, which would be fed as input to the fully connected part of the network, which classifies the input sentence. In the above model we restrict ourselves to binary classification, though it can be easily extended to multi-class classification. As with any other Machine Learning model the proposed CNN should also be trained, and data for training can be readily obtained from weather sections of news repositories or from government meteorology departments. Once the model is trained, the CNN based NLP model is reported to give around 80% accuracy. High accuracy, compactness and fast speed of operation is the reason to choose this model over conventional N-gram based models.



Blockchain based relief-fund distribution system

3. Proposed Model:

a) Fund Collection:
This step involves collection of funds from individual users or any organizations. To do this we would use the above mentioned Blockchain based model for International Funds transfer.

Users who wish to donate an amount would need to create an account and log into to the their portal via app/website and there they would have the an option to add money from their local bank accounts or digital currency like bitcoins. Whenever a user donates the money this transaction is recorded on the blockchain ledger and all the users have "view" privileges and can actually see the where the funds are being used. This steps ensures transparency of the network. Dedicated channels can be established for U.N and other international organisations who play a major role in relief operations. It is estimated that every year U.N spends around 400-500 millions dollars on relief and rehabilitation operations.

b**) Reserve pool:**
All the funds collected above are put into a central reserve pool and kept as a buffer, waiting to be utilized whenever a disaster occurs. This fund can be maintained either in the form digitized currency or any other currency which would is easy to convert and transfer.

c) Active prediction system:
The term "active" refers to an ongoing process of continuously reading in the data and checking it for any signs of disaster. We would be obtaining weather data from reuters, national meteorology departments and any other news sources. The data thus obtained is first cleansed to remove any anomalies and outliers and is feed as input into the above mentioned prediction trained prediction model. The output from the prediction system is binary. '0' means no disaster and '1' means possible signs of disaster. Whenever '1' is given as output, a smart-contract present in the Blockchain is triggered.

For better accuracies, all the regions covered under the proposed model would have their own local prediction systems setup and these prediction systems are all linked with the global distributed ledger.

d) Smart-contracts:
As mentioned earlier these contracts are triggered whenever it receives '1' as input from the prediction system. There is about 20% chance that the prediction model may give false alarm or might not be able to detect an actual disaster, in that scenario an optional override power is given to the U.N body which is the central governing agency in the proposed model.

Whenever these contracts are triggered either automatically or manually they do the following:
i) Send out alerts to concerned authorities or disaster relief management teams or any other NGO's who would be associated with the relief work.
ii) It converts a predetermined fraction of the reserve pool BTC/traditional currency present in reserve pool to the local currency of the region and keep it ready for distribution.

d) **Operation style:**
The system follows typical operational style of a Blockchain network as discussed in MidTerm paper. Once the system is setup it works in an autonomous fashion, but still it needs a governing body to add/delete NGO's and issue override to smart contracts in case of a prediction failure.

4. Advantages:

The model was designed with the main intent of saving precious time and costs involved in the traditional relief-fund distribution system. Lets us explore and see its advantages in detail below:

a) **Time** - It saves the time in 3-folds. Firstly, it leverages the advantage of blockchain technology for a faster money transfer across borders. Secondly, the smart contract system makes the funds collection and distribution really simple. Thirdly, it uses the inbuilt prediction system and can forewarn about the impending dangers, which would enable us to be

better prepared and gives us a precious head-start. Thus, time which is very crucial in such circumstances is saved by 3-folds which in turn would translate to saving many lives.

b) **Cost** - Blockchain based model saves on hefty exchange rates that conventional institutions charge. It also saves on the losses incurred due to corruption and opportunistic thieves present in the conventional operating model. Since the Blockchain based model is based on transparency - corruption/money swindling is almost zero in this model. In addition to the above mentioned direct savings in costs, forewarning system helps prevent losses to property that could have cost millions of dollars.

5. Challenges:

Apart from the inherent challenges faced by Blockchain the proposed model faces the following challenges:

a) Compliance - Different countries have different laws, getting this system to be approved and setting it up in diverse regions would be an operational challenge, but once the model is in place it should be operating smoothly.
b) Security - Since the proposed model is a sort of centralized blockchain, the controlling nodes, like the one which can override smart-contracts, if compromised would place whole money present in reserve pool at risk. In order to overcome this risk, we need to distribute the controlling power among various governing bodies and if any change is required it should be approved and passed by majority voting.
c) Maintenance - As the systems starts growing, new regions should be added onto the ledger, that requires installing active prediction system in that area, and adding new NGO's. This whole thing requires a coordinated effort from the governing bodies involved and can prove to be hurdle in the model's success if not implemented properly.
d) Disaster Prediction Range - Active prediction system that we have proposed showed up to 80% accuracy in predicting heavy rainfall leading to floods but there are other disasters like Earthquakes and Volcanoes which are very difficult to predict as we do not have sufficient set of datapoints to train our CNN. This restricts our prediction system to floods only. However this shortcoming can be overcomed by factoring in data about Earthquake and Volcanoes from seismologists and building a hybrid model which can work in conjunction with the proposed model, thus increasing its prediction range.

6. Conclusion:

To sum up, despite the challenges that the proposed model faces, its benefits far outweigh the implementational hurdles. Blockchain technology coupled with AI/Machine learning is a very formidable technology and could potentially be tapped into to solve many problems be it in finance, healthcare, automobiles other humanitarian crises or in any sector. The proposed model is simple and can be extended easily to the above said areas.

7. References:

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