Blockchain Based Geostamping

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Objectives

The aim of this project is to establish an Ethereum blockchain based data marketplace where data submitted by observers will be geostamps of moving entities. In return of their data submissions observers will get paid. This problem is modelled as a time dependent graph.

Why Geostamps?

"A geostamp is a digital record of the geographic location of a transaction or, in other words, a timestamp with a geographic location attached". Dozens of potential uses cases are envisioned with the use of geostamps. For IoT sensors, geolocation of the produced data might come in handy for smart-city initiatives. Few other application areas are military intelligence applications, transportation, delivery systems and so on.

Quarternary Triangular System (QTS)

The Quaternary Triangle System divides the globe into a fixed grid of triangles and assigns a unique geocode to each triangle. Codes are generated from a latitude and longitude coordinate pair and a specified level n, which determines the scale of the grid. The code generated describes an area that contains the specified point.

Figure 1: QTS

Incentivization

Every data is public on the blockchain, so geostamps are no exceptions. If, after the submission of data by observers the data is going to be public who is going to pay for something that is already available to everyone? In this case the observers will not be incentivized to submit data to the martketplace. The solution offered to this problem is that the companies and institutions who are in need of the data to be submitted by observers will have to send some Ethers to the smart contract first. Observers who are notified by the reward will now be incentivized to collect and submit data since they will be paid for their data submissions.

Example Data

Block Number	Geocode	License Plate
5701322	BDLOS49C	34 BOUN 1863
5701324	BDLOQNNB	34 AZ 8460
5701326	BDLOQN8D	34 BOUN 1863
5701380	BDBRBN4A	34 BOUN 1863
5701383	BDBVVXAA	34 AZ 8460

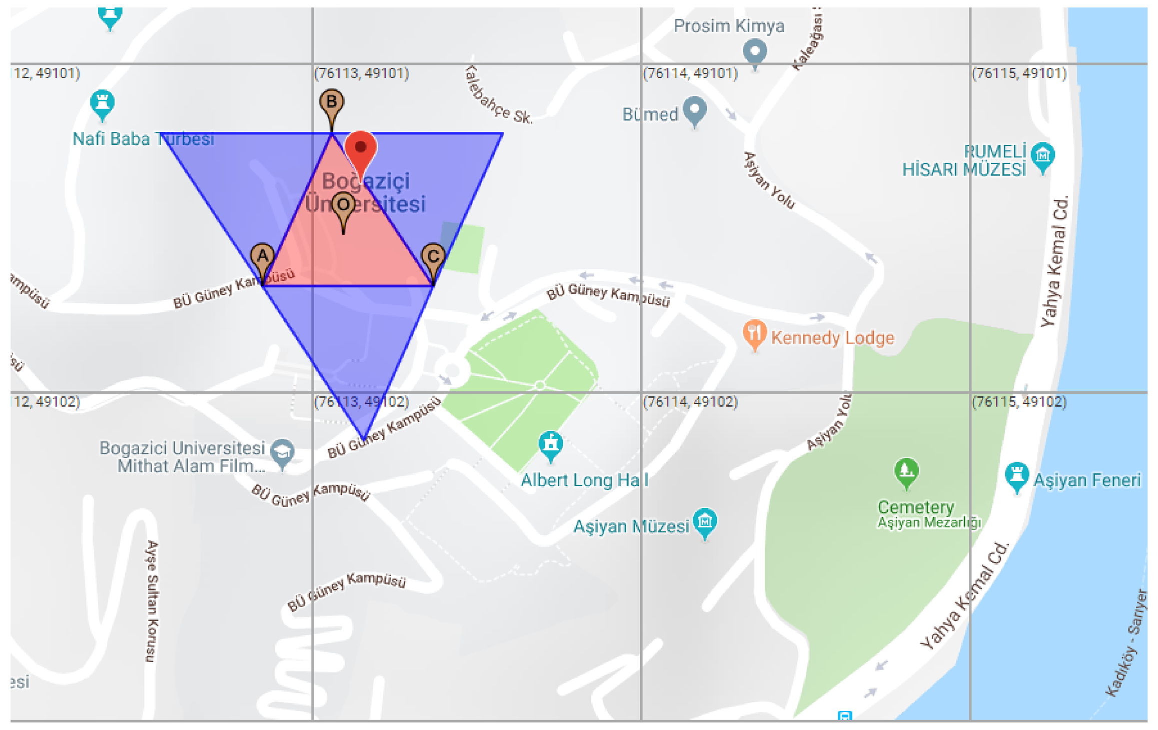

Figure 2: Geocode of Bogazici University

Results

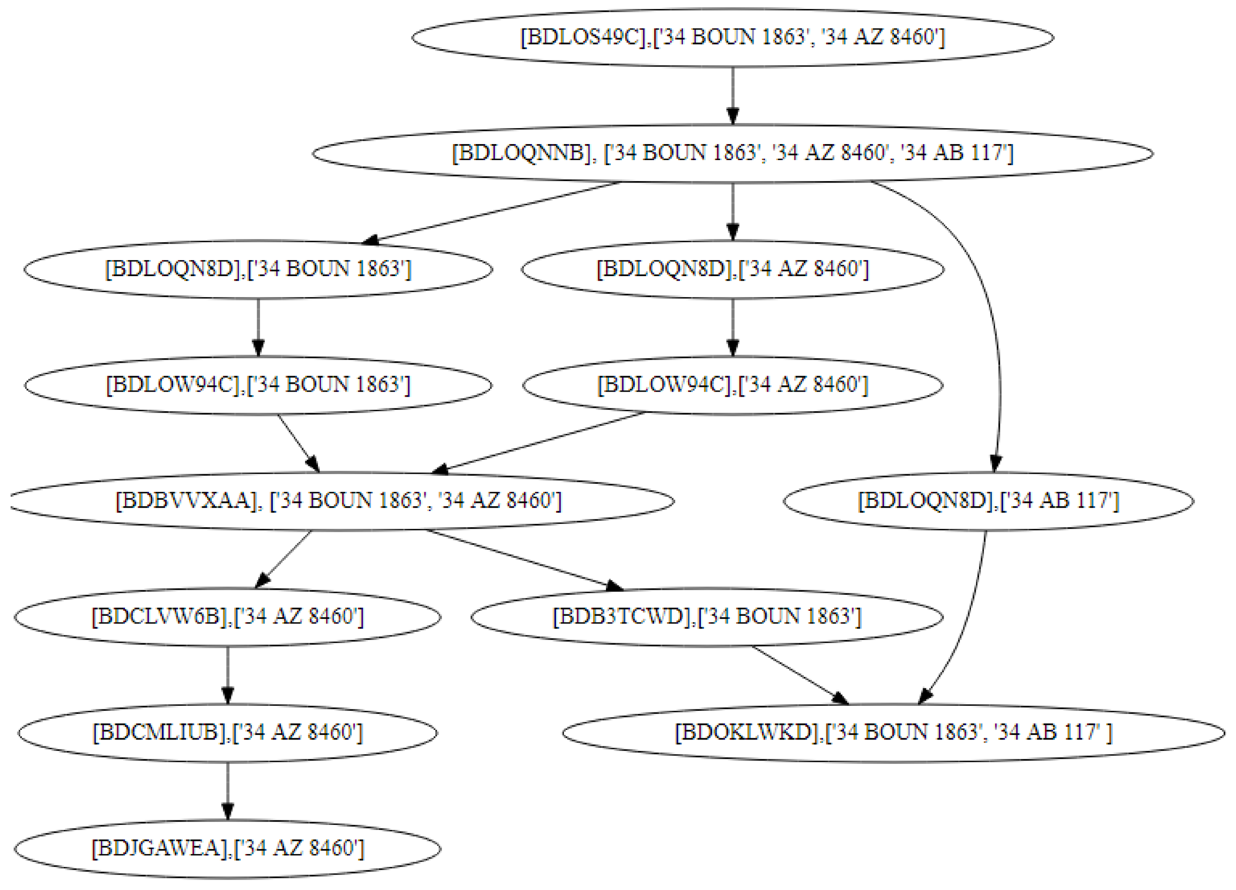

Figure 3: Time Dependent Graph

Fraud Detection

Using the time dependent graph we can detect fraudulent data the following way. On the graph vertices are ordered by their timestamps (directed graph), there is an edge from vertex V1 to V2 if the timestamp of V2 is greater than of V1 and they have the same license plate. If we traverse a path on the graph the vertices on the path will be ordered by time. We can check if the geocodes are ordered as well to see if the submitted geocodes are valid.

$$s_{i,j} = M - \sum_{k=1}^{n} |a_{i,k} - a_{j,k}|, \quad (M = 200)$$

Figure 4: Similarity matrix

Ordering of Geocodes

An advantage of QTS is geocodes of locations that are close to each other are similar. In order to order them an abundance matrix which is a matrix that reports the absolute or relative percentage number of objects belonging to a certain type (column) in a unit (row) is created. A similarity matrix is constructed from the abundance matrix and it's rows and columns are permuted such that larger values congregate to the main diagonal and the smaller ones dissolve far from it. Then the corresponding rows sequence in abundance matrix will near units similar in types.

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