CosmosAnalyzer

Exam Project

Blockchain and Cryptocurrencies

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Github repo: **CosmosAnalyzer**

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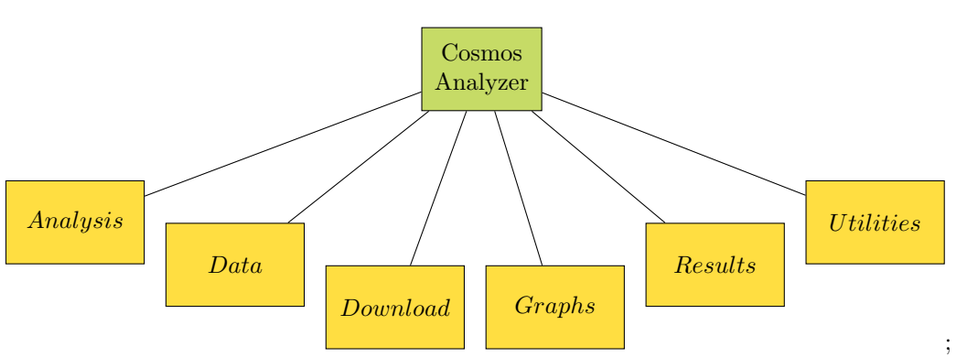
1 Introduction

This project should be intended as an extension of the DiLeNA [11] [1] project developed by the AnaNSi research group which provides a software able to retrieve the transactions stored in the distributed ledger of different DLTs, create an abstraction of a network and then measure some related metrics. The project is composed of two main components:

- **Graph Downloader**: it is in charge of downloading the transactions of the examined DLT, generated during the time interval of interest. Then, a directed graph is built, that represents the interactions among the nodes. The vertices of the graph correspond to the addresses in the DLT and, for each transaction, an edge directed from the sender to the recipient of the transactions is made (if not already existing)
- **Graph Analyzer**: is in charge of calculating the typical metrics related to the obtained graph. Among the others, the tool is able to measure the network clustering coefficient, as well as to compute some metrics, such as the average shortest path. Moreover, the tool makes it possible to check whether the network is a small world, by comparing it with a corresponding random graph (with the same amount of nodes and edges)

Starting from the software already available, this specific extension project provide further studies on a different crypto. In particular, the focus is on the Cosmos ecosystem, a decentralized network of independent parallel blockchain powered by BFT consensus. Among the blockchain present within the ecosystem, the *cosmos-hub* blockchain will be analyzed: it is the first Hub launched in the Cosmos Network and it is a Proof-of-Stake public blockchain whose native token is called ATOM, and where transaction fees are payable in multiple tokens.

2 Structure of the project



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The project is composed of 6 pakages:

- **Analysis**: this is the core package which contains the programs to build the graph of transactions and to analyze it.

- **Data**: data folder containing, for each specified day, the list of files in the form `hh.txt` where "hh" stands for a specific hour between 0 and 23. Each file contains the list of transaction from `hh:00:00` to `hh:59:59`. It also contains a sub-folder `merged_data` with a unified version of the txt files for a specific day.
- **Download**: contains the download functions to retrieve the set of transactions from the endpoint.
- **Graphs**: this folder is an archive of the adjacency between nodes of the graphs, obtained as outputs of the `nx.write_adjlist()` NetworkX function.
- **Results**: results folder containing, for each specified day, the results of the analysis.
- **Utilities**: it contains the file merger and other support functions.

3 Graph Downloader

As for the download of transactions, the entire download architecture has been revised in order to obtain the information related to the cosmos-hub transaction sequence. First of all, it is necessary to find the first block and the last block of the sequence corresponding to the specified time period (usually a specific day). This uses two specific functions that make http requests to the endpoint *"https://api.cosmos.network/blocks/[height]"* to retrieve the timestamp of the block [5] [6]. It is possible to compare the latter with the specified time interval to find, thanks to an iterative process of http requests, the first and last block in the desired interval.
At this point, another function is exploited to retrieve all the transactions from the first block to the last one. The principle is the same: an http request is sent to the endpoint to retrieve the information of a specified block whose contain the list of validated transactions [12]. In the following subsection some technical implementation details are discussed more in depth since, at the moment, the official REST and RPC endpoints of cosmos-hub are down.

3.1 Practical issue: cosmos-hub official endpoint unavailable

As mentioned earlier, during the practical implementation of the project, a major problem occurred: the official endpoints are not available since they are temporarily offline. I managed to solve the problem by searching for an alternative endpoint inside the "cosmos.directory/cosmoshub" [4] webpage that contains a sequence of information related to the cosmos-hub blockchain including a series of "public archives" [2] nodes that can be used as endpoints, as suggested by the developers community moderators of the Cosmos Network [10].
The endpoint used is *Chainlayer* (`"https://cosmos-rpc.quickapi.com:433"`) which provides a set of APIs similar to the official ones [9].

4 Graph Analyzer

This section provides an overview of the analysis process of the graph. First of all, in order to build a suitable graph starting from the set of pairs `sender - recipient`, the Python NetworkX library is exploited, i.e. a software library containing tools for the analysis and the manipulation of complex networks. It is possible to generate directed and non-directed graphs, as well as weighted and unweighted graphs. Moreover, the analyzer is able to compute different metrics [14] related to the graph, e.g.:

- Average Clustering Coefficient (ACC): measure of the degree to which nodes in a graph tend to cluster together (the higher is the value the more clustered is the graph) [13]
- Average Shortest Path Length (ASPL): average number of steps along the shortest paths for all possible pairs of network nodes

It is also possible to check if the network has small world properties [15] by means of generating an equivalent random graph. The graph features small world properties if the average clustering coefficient is significantly higher than the random one and the average shortest path length is similar (or smaller).

5 Results

This section provides an overview of the results obtained from the analysis process described before. As for the "cosmos-hub" blockchain, different lists of transactions were downloaded. This is done to check whether it is possible to notice different "behaviours" inside the transactions' distribution.
First, it can be seen that the distribution of transactions does not reveal any particular differences between days, and so the considered metrics are substantially similar for each result obtained.

At this point, I thought it might be a good addition to the analysis to define a "printer" function also to visually show the generated graph [7]. This plot shows an interesting pattern which is reported in the image below:

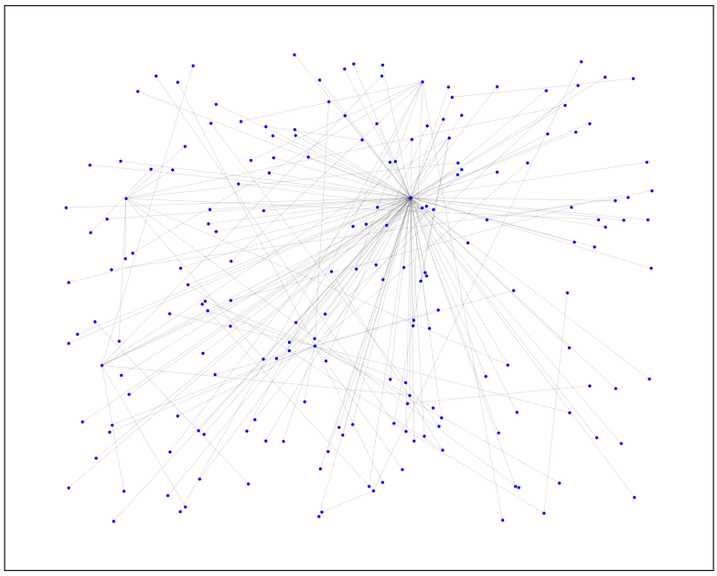

Figure 1: Example graph of 00.txt (2023-04-01)

As we can see in the image above, there is a specific node which is involved in a good percentage of the total amount of transactions. This node corresponds to a particular account (`cosmos1jv65s3grqf6v6jl3dp4t6c9t9rk99cd88lyufl`) [8] which is known as the community pool address [3] of the "cosmos-hub" blockchain. This is a community treasury fund dedicated to stimulating development and promoting the adoption of the chain.
Then, knowing this particular feature which occurs frequently (and also with other community funds), we can look at the results obtained by the analyzer. The following print shows an example of a result for 2023-04-01:


```
{"metadata": {"day": "2023-04-01",
              "directed": true,
              "weighted": false},
 "number_of_nodes": 17067,
 "number_of_edges": 21598,
 "clustering_coefficient": 0.02958768273317763,
 "num_cpus": [8],
 "sample_size": [17067],
 "num_links": [3638787],
 "time": [52.98429584503174],
 "ASPL": [5.217157805609396]
}
```


Since the Average Clustering Coefficient of the equivalent random graph is 0.00004883 and the ASPL of the random graph is higher ($\sim$28) we can state that the cosmos-hub network has small world properties.
Exploiting the printer function discussed before, we can also print the macro-graph related to set of transaction of the whole day. Please note that, due to the large number of nodes considered (e.g 17067), the value of the print parameters has been changed in order to make it more understandable and to allow a better comprehension of it.

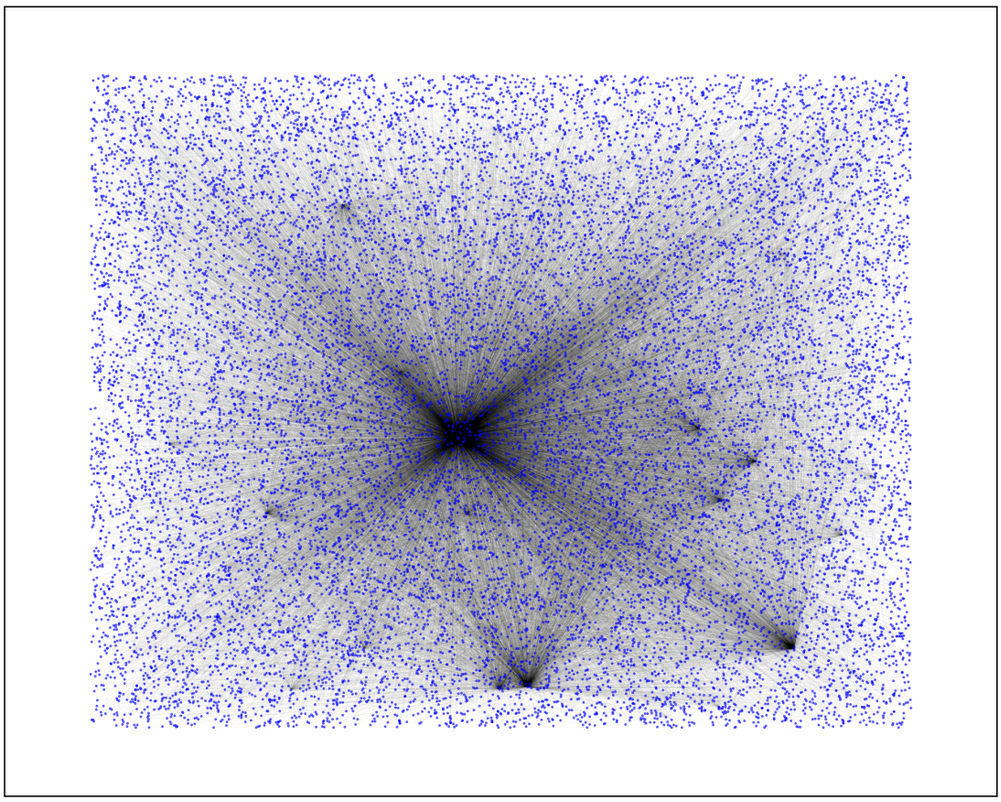

Figure 2: Example graph (2023-04-01)

6 Conclusions

In conclusion, this extension of the DiLeNA project to the Cosmos ecosystem provided valuable insights into the structure and behavior of the "cosmos-hub" blockchain. By implementing the Graph Downloader and Graph Analyzer components for the cosmos-hub blockchain, it is possible to analyze the network clustering coefficient and average shortest path of the network.
Focusing on the specific results of the analysis of the "cosmos-hub" blockchain, we can see that the majority of the transactions involve a community pool address, which may not be common in other blockchains. Moreover, by analyzing the network metrics, we can state that it has small world properties.
Further research could explore other networks within the Cosmos ecosystem and compare their properties to those of the "cosmos-hub" network.

References

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