# Analyzing the Implicit Social Network from GitHub Activities

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## Abstract

We develop a method of mining GitHub event activity to construct an implicit social network between GitHub users encompassing their GitHub repositories and the connections between them. We then utilize this network for interesting visualizations, including shortest path between users and finding the most influential users.

## What are you trying to do?

Create an interactive UI with a graph that allows querying the activity of GitHub users and relations between GitHub users, in particular, find the shortest path between two users (edges are defined by co-activity on the same project), Similar to the Erdős number in Mathematics [22], rate users in terms of their distance from some of GitHub "celebrity" user, for example distance from Linus Torvalds and find the most influential users for a certain technology scope, e.g. D3.

Extracting implicit social graph structure has been suggested before, for example Lima et al. [15] created a followers and contributors graphs to calculate statistical measures such as the rich club coefficient [20]. Thung et al.[19] took a similar approach of mining GitHub's event history to build a graph and compute statistics for this graph, such as graph's connectivity, average shortest path and PageRank[18]

Identifying influential users or opinion leaders has its roots in sociology and in recent years has been implemented in different internet systems using, one interesting comparison between some of the methods is the focus of Liu et al. in [16] where China's social network "Sina" and a local cluster of 4k students in Shanghai University are used to compare the accuracy of three different opinion leaders discovery methods, PageRank, HITS[14] and Synthesized Centrality (invented by the authors).

Hu et al.[11] Through the usage of HITS analyzed graphs that show the influence and relationship between GitHub repositories and users. They studied how specific repositories influence the development of the code of other repositories, and study how repositories rank over time.

From a slightly different angle Batista et al.[3] studied the correlation between the properties that measure the strength of software social coding collaboration on GitHub; Several ways to measure collaboration were presented, for example, the Preferential Attachment (PA) which assumes that the more edges a node has (a user or a project), the more likely it will get more edges.

Hu et al.[10] focused on a very specific workflow of GitHub, namely the Follow-Star-Fork workflow and constructed a graph based on these activities. They implemented several quantitative measures, specifically UserRank (like PageRank), HITS, H-index[23], Betweenness centrality[5], Spearman rank correlation[24], and Borda Count voting[21] to measure the influence of a user.

Badashian and Stroulia[2] measured the influence of GitHub users and specifically defined and quantified what does influence mean in GitHub and whether the measured influence remains siloed to specific domain of content (e.g. technology or programming language).

Badashian et al.[1] combined two software development focused websites, GitHub and StackOverflow, to study the influence and contribution across these two networks. After studying the characteristics of each separate network a combination of the networks is studied as the correlation between the same user's activity in one network to the other.

## Today's status and limitations

We have not seen such interactive interface for GH as of today. What we have seen is statistical analysis of GitHub's graph data ([15], [11] and [3]) but none of the resources we have surveyed allows for interactive discovery.

There are databases with raw GitHub data ([7], [8] and [6]) and there is an API for GitHub's data[12] but again, a tool that structures this data in a social network structure to allow interactive discovery we did not find.

We plan to create an interactive interface such as the one studied by Hansen et al.[9] where a user usability study of the network analysis tool NodeXL is conducted and a set of guidelines of do's an don'ts is presented. We do not intend to use NodeXL specifically, yet user study conclusions are useful.

## Novelty in your approach and why will it be successful

It is a simple way to discover connection between software developers and perhaps discover software developer communities. This can be useful for businesses trying to reach out to certain communities and looking for thought leaders in those communities. It can also be useful to any GitHub user trying to assess her contributions within GitHubs' community.

## Who cares?

Businesses may care about community discovery for marketing purposes. Individuals may care about personal branding and achievements.

## What impact will it make, and how to measure it?

The project, if successful, would become a popular tool within developers and businesses looking to study the social graph implied by GitHub, in particular finding connections to other specific users and identifying communities and their thought leaders.

It has been claimed by Casalnuovo et al.[4] that there is evidence for socialization as a precursor to joining a project and so we believe that presenting the social graph would open doors to more cooperation between users.

A way to measure is by posting references to this project on reddit, twitter, hackernews and measure their popularity and engagement.

## What are the risks and payoffs?

There are several notable risks, in particular - data may be difficult to obtain at scale. Although there are multiple sources, from our research we know that no single source encompasses all the aspects we require so we will have to merge multiple sources. Merging successfully is risky as well as obtaining a complete view of the data at scale. We've seen reports of missing data, incorrect data, inconsistent data and obfuscated data (for privacy reasons)[13].

Data is large so there are scalability concerns including collection, preprocessing and serving. How to properly handle such large data and provide fast enough access for an interactive user experience may be challenging.

**Table 1: Plan of Work in high level**

| Work item | Who | Start | Duration |
|---|---|---|---|
| Proposal document | Ran | Oct 8 | 3 days |
| Proposal presentation | Jonathan | Oct 10 | 2 days |
| Proposal video | Ruzvidzo | Oct 10 | 2 days |
| Data Collection | Jonathan and All | Nov 1 | 4 weeks |
| Data Augmentation | Ruzvidzo | Nov 7 | 3 weeks |
| Web and UI | Ran | Nov 1 | 4 weeks |
| Progress report | All | TBD | 1 week |
| Final report | All | TBD | 2 weeks |
| * All team members contribute a similar amount of effort | | | |

Payoffs: first, community engagement. Later - perhaps a business opportunity.

## How much will it cost?

We will collect the data, process it (possibly on Spark) and store it for serving in a graph database (Neo4j[17]). Serving costs include the collector process (1 servers), a spark cluster (4 nodes or more), one Node4j server and a web server. Not counting networking and storage costs. Back of the envelope calculation, assume each server costs 40cent per hour (EC2 *m5.2xlarge*) and assume that for ongoing serving two servers are needed (Neo4j and Web) for 2 months (60 days) and for the collection we need 4 servers (for the collection period, let's say 1 month), we roughly have $\$0.4 \times 24 \times (2 \times 60 + 4 \times 30) = \$2304$. This is not cheap and we will look for ways to get funding and reduce costs.

A cheaper alternative is by not using Spark and instead use a single server for everything, processing, Neo4J and serving, this will cost between $300-600 for 60 days, depending on hardware.

## How long will it take?

Data collection and processing can complete within one month and writing the interface on top of it will take another month but these can be parallelized.

Table 1 summarizes the plan of work

## Final checks and progress measurement

The riskiest part is data collection and processing so we plan to handle it first and all team will work on that. Next up is the interactive UI. And finally and internal usability study and testing.

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