Social Network Analysis of Twitter Bots

Davide Cremonini, Artificial Intelligence, 0001137778
Alessia Crimaldi, Artificial Intelligence, 0001145505
Fabio Giordana, Artificial Intelligence, 0001145924
Gabriele Nanni, Artificial Intelligence, 0001146107

1 Introduction

In the current historical moment, the widespread diffusion of AI systems designed to simulate human behaviour is increasingly evident. Our project aims to evaluate the effectiveness of these systems in the context of bot detection on Twitter, seeking to identify behavioural patterns that differentiate automated users (aka *bots*) from human ones. To this end, we make use of Social Network Analysis techniques.

2 Problem and Motivation

What are the problems you want to address? Why are those problems important (impact, theoretical and/or practical needs, etc.)? What are the main contributions of the project?

3 Datasets

What tools did you use 1) to handle (store, manipulate) the data and 2) to compute measures on the data?

We conducted our analysis using the TwiBot-22 dataset [2], which is publicly available on GitHub[1]. Since the dataset is already digitized, there was no need for any manual data collection or processing.

TwiBot-22 is a comprehensive, graph-based benchmark for Twitter bot detection, featuring the largest dataset available up to date. It offers a diverse range of entities and relationships within the Twitter network, and boasts significantly improved annotation quality compared to previous datasets.

Given the large size of the dataset, significant preprocessing was necessary. This involved splitting the .json files containing the tweets and the .csv file with the edges into smaller chunks, allowing for faster and more efficient manipulation of the data.

3.1 Adopted tools

networkx networkit

[1] https://github.com/LuoUndergradXJTU/TwiBot-22

3.2 Analyzed networks

- Large → Ukraine, Ai, Covid
- Medium → Nato, Deeplearning, Nftcommunity
- Small → Ruleoflaw, Feminist, Agenda2030

4 Validity and Reliability

How closely does the model of your dataset represent reality (validity)? How does the way you treat the data affect the reproducibility of the study (reliability)?

5 Measures and Results

What measures did you apply (brief explanation of how they work)? How do they relate to the intent of the study? Why are they relevant? What is the connection among the gathered data, the applied measures, and the properties found?

- **Centrality**:
  1. Degree centrality
  2. Betweenness centrality
  3. Eigenvector centrality
  4. PageRank
  5. Reputation [1].
- **Groups**:
  1.
- **Clustering**:
  1.
- **Redundancy**:
  1.
- **Equivalences**:
  1. Structural equivalence
  2. Regular equivalence
- **Homophily**:
  1.
- **Small-worldness**:

1.

- **Scale freedom**:

  1.

- **Cohesion**:

  1.

- **Connectedness**:

  1.

- **Compactness**:

  1.

- **Triad census**:

- **Core-periphery**:

  1.

The experiments were conducted on an NVIDIA GeForce RTX 3090 GPU (24GB VRAM).

6 Conclusion

Qualitative analysis of the quantitative findings of the study.

7 Critique

Do you think your work solves the problem presented above? To which extent (completely, what parts)? Why? What could you have done differently to answer your research problems (e.g., gather data with additional information, build your model differently, apply alternative measures)?

The *follower* and *following* connections may not represent meaningful relations for bot detection, as the TwiBot-22 dataset lacks a clear separation between human and bot accounts in this aspect.

References

[1] David M. Beskow and Kathleen M. Carley. You are known by your friends: Leveraging network metrics for bot detection in twitter. In Babak Akhgar, Hamid R. Arabnia, and Petra Saskia Bayerl, editors, *Open Source Intelligence and Cyber Crime*, pages 53–88. Springer, 2020.

[2] Shangbin Feng, Zhaoxuan Tan, Herun Wan, Ningnan Wang, Zilong Chen, Binchi Zhang, Qinghua Zheng, Wenqian Zhang, Zhenyu Lei, Shujie Yang, Xinshun Feng, Qingyue Zhang, Hongrui Wang, Yuhan Liu, Yuyang Bai, Heng Wang, Zijian Cai, Yanbo Wang, Lijing Zheng, Zihan Ma, Jundong Li, and Minnan Luo. Twibot-22: Towards graph-based twitter bot detection, 2022.