

Connectivity Risk Analyzer: Development of an automated ETL Process and investigation of AS-Level data

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Abstract—This paper deals with Coria (Connectivity Risk Analyzer), a framework developed by Dr. Fabian and colleagues to analyze multiple indicators explaining the risk of connections in a network. In addition to this already existing framework we aim to improve the ETL process by adding a automation to its functionality. We furthermore investigate characteristics of nodes and edges of networks on the level of autonomous systems.

Index Terms—Coria, Risk Analyzer, ETL, Automation, AS, Autonomous System

Nur Notiz: Structure:

Introduction

Evolution of Coria (starting point, status quo, objectives) (maybe part of introduction)

Literature

Methodology

Theory: AS

Theory: ETL

Data: describe the data used for analysis Results: Caida

Analysis Results: ETL Automation Conclusion /Evaluationn /Outlook

I. INTRODUCTION

The CORIA framework is a project on which multiple developers already contributed to, in order to create a platform, which is able to analyze and visualize connectivity risks of graph structured data. Within this paper and project we would like to further contribute and improve specific aspects of CORIA. In the following we present investigate literature regarding network risk analysis especially on AS level. We investigate characteristics of these networks through some descriptive statistical methods and take a look at the time development of networks and its components. Then we present one approach for a automated ETL process, which shall improve and simplify the usage of Coria and ensure most recent data being available for analysis.

The internet presents one of the most important networks for today's world. Consequently major financial and economical

systems rely on its functionality and availability. In times of non-functioning of the internet, serious consequences for businesses and economies are the consequence. There are many reasons for such a scenario, such as threats caused by nature, i.e. hurricanes or earthquakes, or deliberate hacking attacks trying to remove nodes from the network. A study from... shows that....

Size of giant component refers to single largest component in the whole network Elimination of 8% of nodes in the network: giant component equals zero

The implication on the importance of the internet becomes very clear which gives high incentives to analyze the riskiness of networks, like the internet. Coria's mission is exactly that: to help analyze connectivity risks.

II. EVOLUTION OF CORIA

A. Starting Point

Analyzes connectivity risks for networks or organizations Distinguishes multiple metrics like Node Degree, etc. Calculates aggregated risk value Based on network graphs Offers different levels of granularity

Previous Versions of CORIA Status quo CORIA framework newest version CORIAv3 purpose: Analysis of connectivity risk and visualization functions and features: Usability all features are usable via one interface clear separation of ETL process, graph analysis and export usability of different data formats calculation of different metrics Performance Simultaneous execution / calculation of different metrics Development modular structure development without strong dependencies to specific technologies Software framework: ETL: still manually; no automation on a regular basis storage: MySQL, Database general? backend: Java, Python, Apache TomCat etc... client: ... Future Potential automation of the import process using different degrees of granularity usage of historical data and analysis of timely development improvement of technical features like NoSQL, Hadoop, etc for easier implementation of new databases in CORIAv3 compatibility

with more data sources Concrete Objectives focus on AS level data Emphasis on flawless usage of respective Caida data sets Automated downloads and imports on a regular basis Analysis of historical data development deploying the framework on a permanent uni server (dependent on the confirmation for the universitys server)

B. Status Quo

Status Quo Coria:

Status Quo Literature: In the following, we have picked literature and some first research papers that are relevant for our objectives. Note that this list is not complete yet and will be adjusted during the work process.

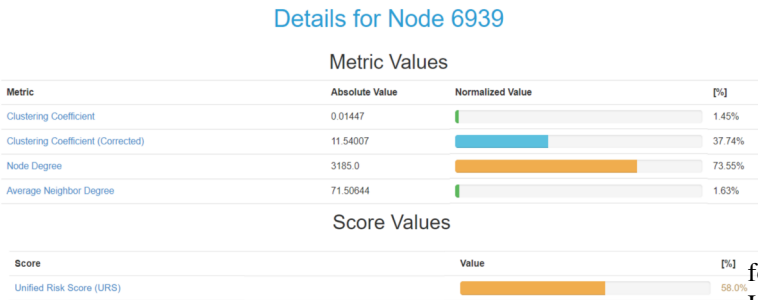


Fig. 1. Extract of Coria Dashboard

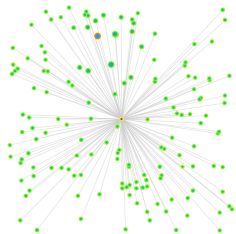


Fig. 2. Graph Presentation of Nodes in a Network

C. Objectives

(old?) Objective of our Work: The idea is to develop systems which have the possibility to load a wide range of datasets and transform them into one standardized format which can be handled by CoRiA. The challenge is how the large amount of different data can be transferred to make them comparable. Another challenge is that the alternation rate of the internet graph is very fast. Millions of systems go online and others disappear day after day. So, the ETL systems have to deal with this situation as well and need to be able to load permanently new data sets.

III. LITERATURE

IV. METHODOLOGY

V. THEORY: AUTONOMOUS SYSTEMS

Autonomous Systems (AS) represents one level of internet topology A set of routers under a single administration

Fokussing on connectivity risks on AS-level

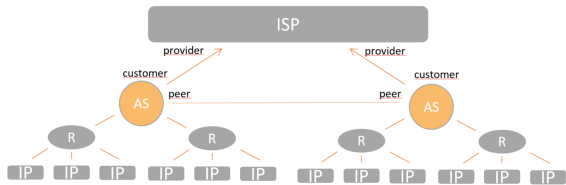


Fig. 3. Hierarchy of the Internet

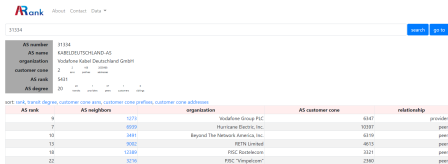


Fig. 4. Example of an AS and its characteristics (Source: Caida)

VI. THEORY: ETL PROCESS

Extraction: from data source(s), varying data formats Transform: convert different data into proper format, that is storable Load: load into target database

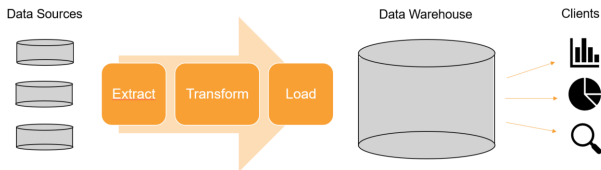


Fig. 5. Theoretical ETL Process

VII. RESULTS

VIII. CAIDA - DATA ANALYSIS

Regarding data sources our primary focus lies on AS level data, coming from caida.org. The existing CORIA framework is already capable of using data from different data sources. As one of our goals is to automate the import of data, we focus on Caida as a source.

For the purpose of investigating the characteristics of Ases itself and their network, we analyzed one recent data set of December 2017. First analytical aspect is the type of autonomous system. Caida distinguished here between three types: The first type are ASes that provide internets access or function as a transit. They make out 42.2% of all nodes in the network. Second type are ASes providing content hosting and distribution systems, like Dropbox or Google, with only 4,5% of all overall nodes. Third category are enterprises meaning organizations, universities or companies that are mostly users. They account for 53.3%. Insights we are gaining from this aspect is that most of the nodes are representing users of the internet, which makes intuitively sense. More interesting is the large amount of transits and access points needed to provide

the respective infrastructure. This hints to the internet's high complexity.

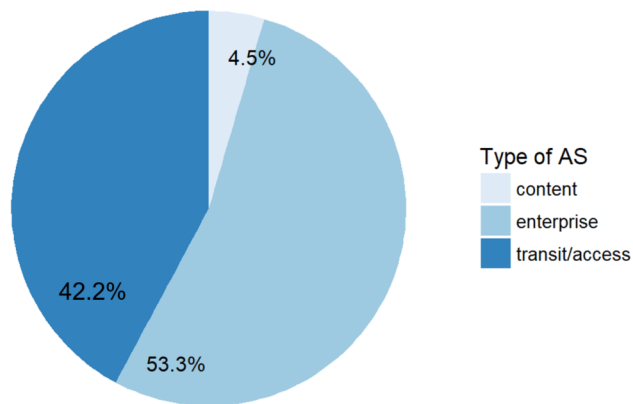


Fig. 6. Ratio of Autonomous Systems regarding their Type

As depicted in the theoretical part, autonomous systems have relationships. We took a look at this characteristic and noticed a quite balanced ratio of Provider-to-Customer relations and Peer-to-Peer relations. If we translate this into a graph, we imagine a balanced graph, which in terms of network riskiness, is rather robust.

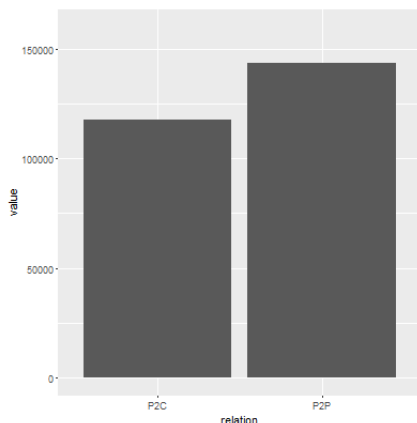


Fig. 7. Ratio of AS-Relationships

We furthermore built a graphs describing the distributional characteristics of autonomous systems. Figure ... shows the distribution of autonomous systems and how many outgoing connections the single nodes have. Approximately 5.500 sending nodes are contained within that data set. We ranked them on the x-axis. Wit the number of connections an AS is sending to on the y-axis, we obtain a very left centered distribution. A very small number of nodes in the network are sending traffic to a high number of other nodes. Take the first 30 (?): ... This top ranked 30 nodes send ... % of overall traffic of the whole network. Note that when we make statements of the whole network, we only refer to the data at hand as the whole network. That is the data collected by CAIDA. Information on

CAIDA's data collection process can be found in the Appendix .. (?).

Simultaneously, we drew the distribution of incoming connections per Autonomous System (Appendix ...) and received a similar result. With approximately 250.000 nodes, receiving traffic, only very few nodes are receiving traffic from a high number of nodes. The top ... ranked nodes are receiving ... % of the overall traffic in this network.

An important finding regarding connectivity risks of the network is, how vulnerable this network is. An attack targeting the most active and most influential nodes in the network, achieving a non-functioning of those quickly leads to wide shot-downs of the network. This again underscores the demand for Coria - a tool to analyze connectivity risks.

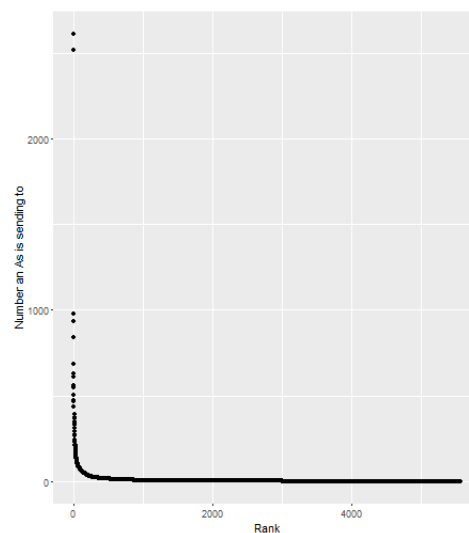


Fig. 8. Distribution of Outgoing Connections per AS

Next, we analyzed the geographic locations of autonomous systems and their flow to traffic. Figure ... symbolizes autonomous systems as organge points on a word map. We can see a high concentration of ASes in North America and Europe. The concentration of ASes is less dense in areas like South America, Africa or Asia. Insights that we can draw from that representaion are that more autonomous systems are situated in highly developed economies than they are in less developed regions. While we need to keep in mind that we are only analyzing one data set - with challenging data collection on top of that, we can interpret this result still as a representative sample of the overall network.(Remark: Difficult collection of AS-data and gathering through inference(?)) The results confirm the assumption that most traffic is taking place between parties of richer and more developed economies. (auf punkte ohne verbindung hinweisen?)

In addition to the analysis of a single point in time, we investigated the timely development of the network. Figure .. shows the number of traffic-sending autonomous systems from the beginning of 2007 until the end of 2017. Within these 10 years, there is a clear upward trend. In 2015 this upward trend vanishes and reaches a constant level of

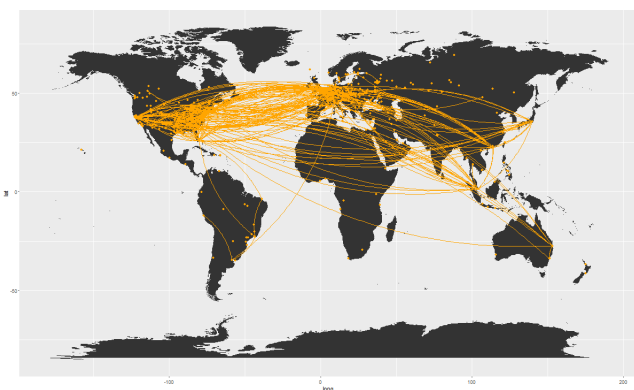


Fig. 9. Location of ASes and respective Streams of traffic

approximately 5.500 sending AS nodes within the network. (Note the consistency of results with respect to Figure .. 'Distribution of number of sending ASes'.) Striking in that graph are the multiple outliers appearing throughout the time series. A qualitative research about exceptional events happening on these dates that might have been the reason for a downtime of multiple nodes did not lead to reasonable results. As a consequence, we assume the outliers to be caused by monitoring and data collection problems of CAIDA. (hint to appendix with data collection problem).

With respect to Appendix (other time series graph) you can see a simultaneous development for the amount of nodes, receiving traffic - on a level of approx. 250.000 nodes of course.

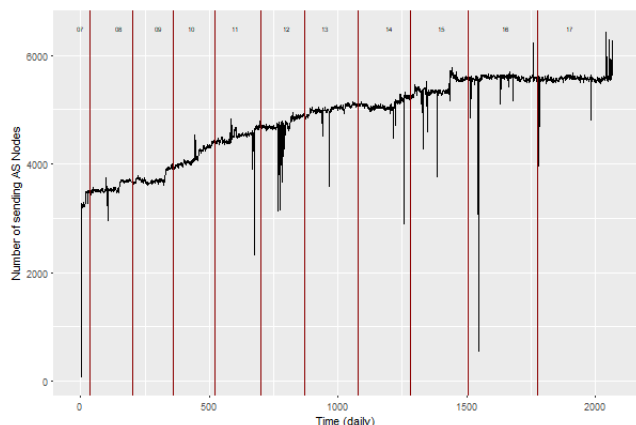


Fig. 10. Time development from 2007 - 2017: Number of sending AS nodes

IX. DEVELOPMENT OF AN AUTOMATED ETL PROCESS

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X. CONCLUSION

XI. EVALUATION AND OUTLOOK

Evaluation:

Validation of latest data files

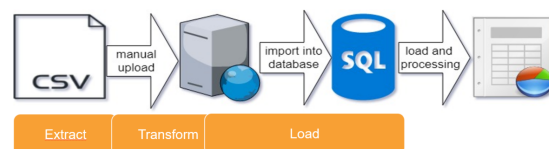


Fig. 11. A Theoretical ETL Process

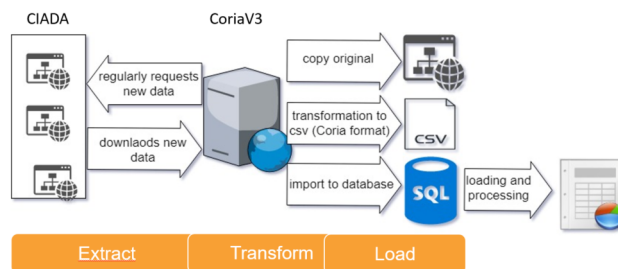


Fig. 12. ETL Process in the Coria framework

Copy of current data files

Transformation data to csv

Import data into the Coria MySQL database

Import scripts to the Coria framework (Python -; Java)

Data aggregation over time

Outlook:

Apply automated ETL process to further data sources Run Coria on a server (longtime evaluation) Documentation

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APPENDIX

Nummerierung vom Appendix stimmt noch nicht

Geographical Locations of ASes

Time development from 2007 - 2017: Number of receiving AS nodes

Data Collection Process of CAIDA

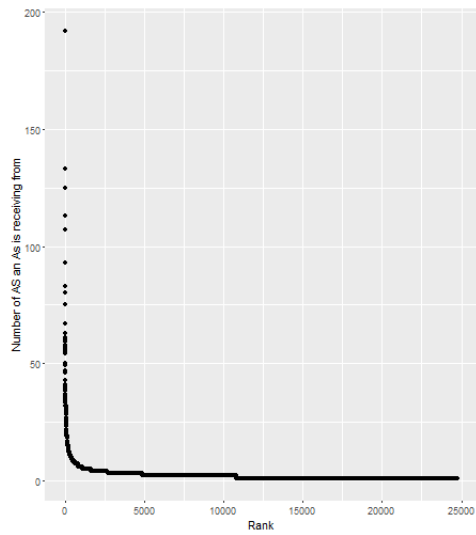


Fig. 13. Distribution of Incoming Connections per AS

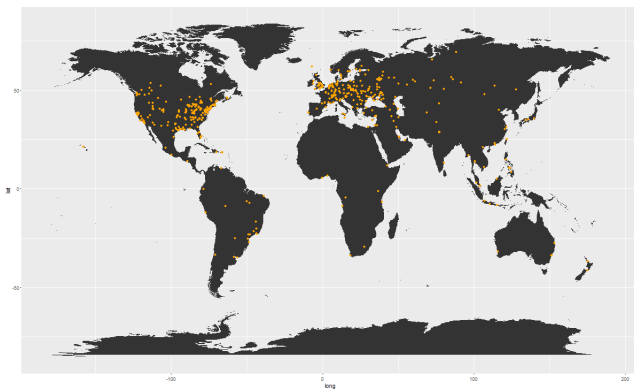


Fig. 14. Geographical Locations of ASes

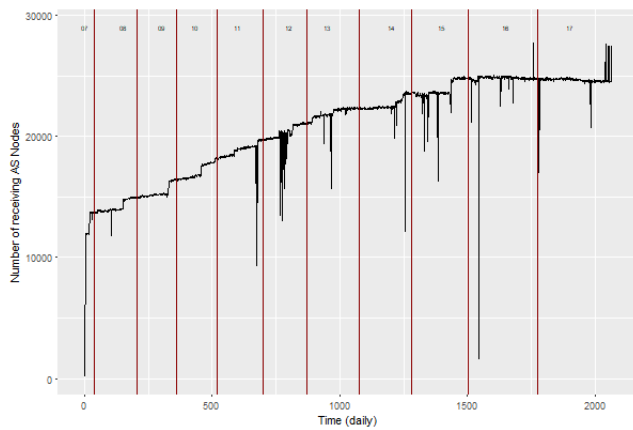


Fig. 15. Time development from 2007 - 2017: Number of receiving AS nodes