



Visualisation of massive data from scholarly Article and Journal Database: A Novel Scheme

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Abstract: Scholarly articles publishing and getting cited has become a way of life for academicians. These scholarly publications shape up the career growth of not only the authors but also of the country, continent and the technological domains. Author affiliations, country and other information of an author coupled with data analytics can provide useful and insightful results. However, massive and complete data is required to perform this research. Google scholar which is a comprehensive and free repository of scholarly articles has been used as a data source for this purpose. Data scraped from Google scholar when stored as a graph and visualized in the form of nodes and relationships, can offer discerning and concealed information. Such as, evident domain shift of an author, various research domains spread for an author, prediction of emerging domain and sub domains, detection of journal and author level citation cartel behaviours etc. The data from graph database is also used in computation of scholastic indicators for the journals. Eventually, econometric model, named Cobb Douglas model is used to compute the journal's Modeling Internationality Index based on these scholastic indicators.

Keywords: Data acquisition methods, Web scraping, Graph database, Neo4j, Data visualization, Cobb Douglas model.

I. INTRODUCTION

Data visualisation is the visual representation of patterns in data. It can help to understand and relate to the data, communicate and represent data in a more comprehensive manner to others. Data visualisation can be as trivial as a simple table, elaborate as a map of geographic data depicting an additional layer in Google Earth or complex as a representation of Facebook's social relationships data. Visualisation can be applied to qualitative as well as quantitative data. Visualisation has turned into an inexorably well-known methodology as the volume and complexity of information available to research scholars has increased. Also, the visual forms of representation have become more credible in scholarly communication. As a result, increasingly more tools are available to support data visualisation.

A. Need for effective visualization of scholarly publications

Scholarly articles and journals have always been a subject of interesting research, mainly because of the stakes involved in the scholarly publications primarily in the world of academia.

These articles are weighed based on the credibility of the journals first and then the authors. Nevertheless there does not exist one complete solution which can provide complete visualization of the data at author, country, and journal and domain level for all the journals in the world. This data, when explored using right tools, has a tremendous potential to unearth interesting patterns which can expose illegitimate cartel behaviour at various levels

as well as enunciate out performing under mined authors and evolving journals.

Massive scale journals data can be used for the purpose of a data visualisation is analysis, communication, or both. Analysis requires careful attention to the parameters used. Different parameters reveal different patterns, and it is challenging to determine which are significant with respect to the key research questions.

B. Importance of data visualization

High impact visualization is like a picture speaking a thousand words. Selecting good visual technique to display the data holds key to a good impact. Fancy bubble charts, Time domain based motion graphs are possible now because of the languages such as python and R. However, selecting the one which can effectively represent the data to the audience is crucial. To begin with, in this paper we have visualized data using in-built D3.js script available with Neo4j Graph database. Further on we have used the pie chart, line graph and area graphs to represent the information concisely to overcome data overload through dynamic presentation in the initial stage. Fig 1 shows the flow diagram of the complete system. A huge data from Google scholar has been scraped using web scraping methodology to acquire the required dataset over a period of 2 Months [1]. Further this data is pre-processed and fed into Neo4j graph database using advanced cyphers. These cyphers deconstruct complex JSON documents and quickly turn them into a graph structure of rich relationships without duplication of information. In the next stage the data from the graph



database is queried using various cyphers to compute a few more scholastic indicators such as self-citations, total citations, international collaboration ratio etc.

journal-level self-citation is part of citation count when a citing article shares the Publishing journal name same as that of an article it is citing.

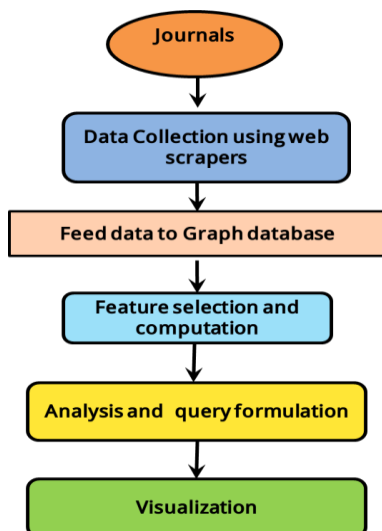


Fig 1 Flow diagram

These scholastic indicators are then created as the properties at article and journal level in the graph database. Finally, various questions are transformed into cypher queries to get the meaningful data from the graph database. This data is then visualized using various charts, graphs etc.

II. DATA CURING

Data accumulation, a first step in data curing, is an arduous task for any research project. For this research Google scholar has been used as resource as it provides a comprehensible and complete data required for good analysis. However, Google scholar does not provide any API. Hence web scraping methodology has been used to gather the data [1, 4]. Next, accumulated data is pre-processed, an intermediate task where the data is cured and made ready for further analysis. The scraped data, which is in JSON format, is first trimmed of any unwanted characters. Then, data is cleansed of Unicode characters. In order to provide interesting visualization patterns, few of the parameters had to be derived from accumulated data. Pre-processing also involves computation of these scholastic indicators/parameters. The scraped data, which is in JSON format, is in the pure textual form hence, cosine similarity string metric has been used for text comparison in place of pure string comparison operation for better results.

Using cosine similarity string metric, author-level and journal-level self citation, international collaboration ratio and other scholastic indicators are computed. Self-citation count is a part of citation count when a citing article shares at least one author name with the article it is citing.

III. COBB DOUGLAS MODEL FOR COMPUTATION OF 'INTERNATIONALITY'

A. Definition of 'Internationality' of a journal

Internationality has been defined and perceived as the degree to which a journal transcends local communities and boundaries, with respect to the quality of publication and influence. We define internationality of peer-reviewed journals as a measure of influence that spreads across boundaries and attempts to capture different and hitherto unperceived aspects of a journal for computing internationality. Internationality, y is defined as a multivariate function of x_i , $i=1, 2...n$. Internationality score varies over time and depends on scholastic parameters, subject to evaluations, constant scrutiny and ever changing patterns.

B. Cobb Douglas Model

In economics, Cobb-Douglas production function [2,5,6] is widely used to represent relationship of outputs to inputs. This is a technical relation which describes the Laws of Proportion, i.e., the transformation of factor inputs into outputs at any particular time period. This production function is used for the first time, to compute the internationality [3] of a journal where the predictor/independent variables, x_i , $i=1, 2...n$ are algorithmically extracted from curated data. Cobb-Douglas function is given by:

$$y = A \prod_{i=1}^n x_i^{\alpha_i}$$

Where, y is the internationality score, x_i are the predictor variables/input parameters and α_i are the elasticity coefficients.

The function has extremely useful properties such as convexity/concavity depending upon the elasticity's. The properties yield global extrema which are intended to be exploited in the computation of internationality or influence. For $n = 4$, x_1 to x_4 are the input parameters as described below.

- x_1 : other-citations quotient
= [1 - (self-citations / Total citations)]
- x_2 : International Collaboration
- x_3 : Source Normalized Impact per paper (SNIP)
- x_4 : Non-Local Influence Quotient
= [1 - (Journal's self-citations / Total citations)]

IV. GRAPH DATA MODELING

Data accumulated is rich, very well connected and has a lot of hidden information within it. Hence, we chose to visualize this data using graph database. A graph database



is a graph-oriented database, which is type of NoSQL database that uses graph theory to store, map and query relationships. It is basically a collection of nodes and edges. [1,7]

Graph data modeling [8] is the procedure in which a Neo4j user depicts a subjective space as a connected graph of nodes and relationships. From this description, a graph data model is designed to answer questions in the form of Cypher queries.

Scholarly articles and scientific journals make the most of our research area hence we identified the elements from these which can then be transformed into nodes and relationships. Few of the elements constitute properties as shown in the square boxes beside the oval shaped nodes. Fig 2 is the data model that has been designed using the Neo4j graph data modeling.

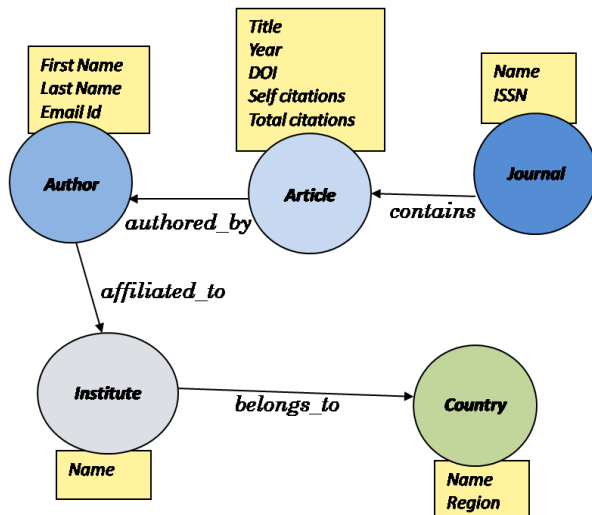


Fig 2 Data model for Graph database

V. DATA VISUALIZATION

Scraped data is imported into graph database of Neo4j. Few of the visualizations that are possible with our data model are:

- Author network
- Institute network
- Country network
- Spread of a domain in a country
- Collaboration network of an institute
- Extract year-wise publication trend of an author

This data when queried appropriately can help to visualize the shape of 'Internationality' of a Journal at various levels. Few of the visualization are as following.

A. Journal to Author to Country mapping

Figure 3 shows mapping of a journal to the Author and in turn to the Country, to which his/her Institution belongs to. The blue circles represent journal nodes, purple circles are author nodes, yellow represent article nodes and red ones

are country nodes. These links will help in identifying degree of contribution of countries and regions to a domain. Since we can identify spurious journals using journal's internationality modeling index (JIMI), we can now identify which regions are essentially contributing more to such nexus of fake and dubious journals.



Figure 3 Journal to Author to Country mapping

B. Author to Institute to Country mapping

Figure 4 shows mapping of the Author to Institute to Country. Blue nodes represent Institution, red represent country and purple represent author nodes. This mapping can help in identifying the contribution trends pertaining to a particular Institute and Country in particular.

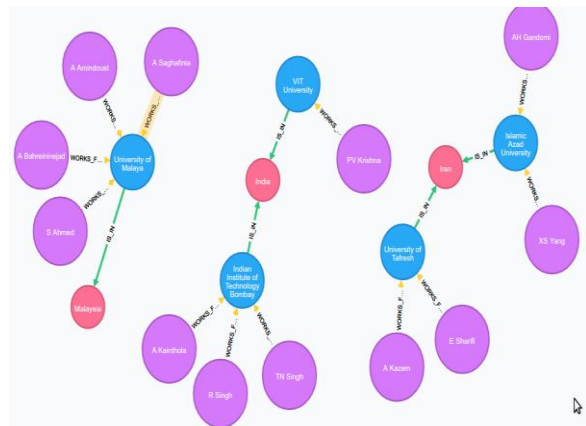


Figure 4. Author to Institute to Country mapping

C. Article to Author Mapping

Figure 5 is visualization of a particular author's contribution in totality. We can query this data based on year to visualize year by year contributions made. In the figure purple nodes are authors and yellow nodes are articles. For a rich and dense data we can provide visually appealing information about an author's reach and contributions using this visualization.

D. Institute to Country to Region mapping

Figure 5 is the data for all of the institutes belonging to a country, and countries belonging to a Region. These links



can help in identifying contribution of various institutes and repective countries to a domain

All the articles with a degree of Article impact, when measured using Singular value Decomposition for that domain and the journals with a measure of 'internationality' (computed using Cobb Douglas model) will define the degree of contribution made by any Institute and in turn Country to a particular scientific domain (to which that journal belongs to).

mapping. Following is the query on the graph database to extract the needed information for graph plotting.

Cypher Query:

```
MATCH (Journal)-[:PUBLISHED_IN]->(Article)
WHERE Journal.name IN ['Applied Soft Computing',
'Neurocomputing', 'Genetic Programming and Evolvable
Machines'] RETURN Article.year, Journal.name
```

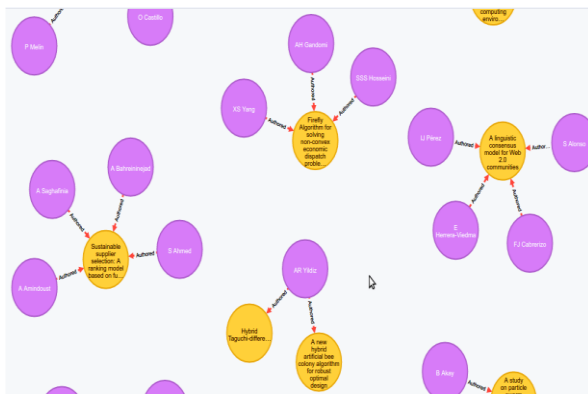


Figure 5 Author to Article mapping

In other words, these two measures i.e. Article impact and the journal's 'internationality' index can be used to define contribution of any Author, Institute, Country and Region to a particular domain.

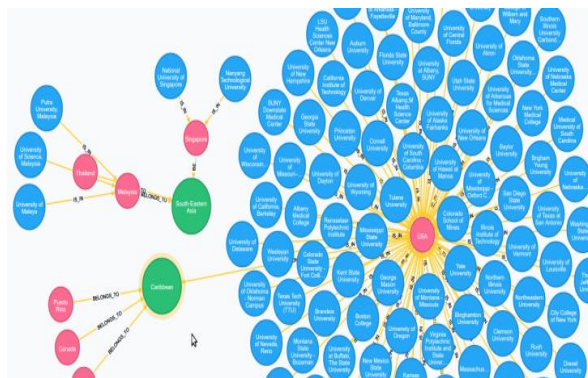


Figure 6. Institute to Country to Region mapping

Conversely these two parameters can be used as a scale to evaluate Authors, journals, Institutes, Countries and Regions. This scale can explain the growth and contribution made by all of these. When the data is large enough we can predict evolving field, most dominating country in a particular field/domain and increase or decrease of impact for any given journal.

VI. RESULTS

Following are the various cypher queries and resulting visualization from the graph database. Fig 7 depicts journal to Author and in turn to the country of affiliation

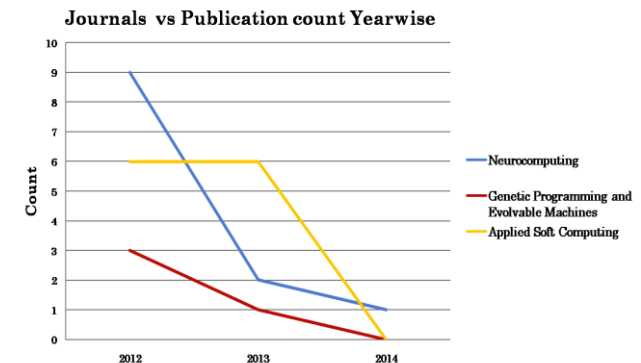


Figure 7. Line graph; Journal Vs Publication

Fig 8 shows the area graph of total citations vs. self-citations for all the articles and journals in the graph database. Following is the query which extracts this data.

Cypher query:

```
MATCH (n:Article) RETURN n.totalcites, n.selfcites
```

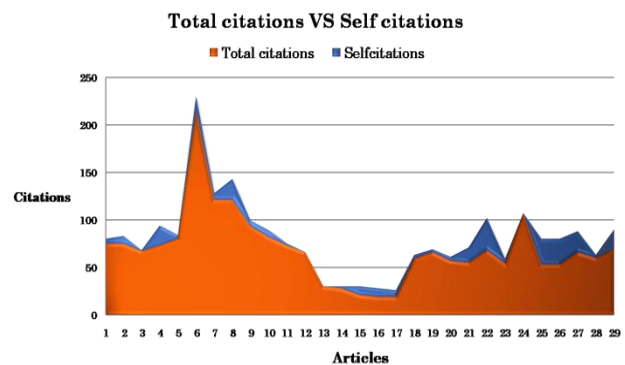


Figure 8. Area graph; Total citation Vs. Self citations

Article Publications per Country

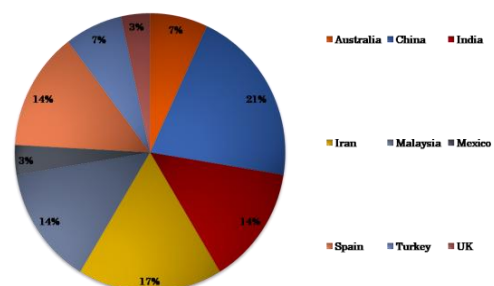


Figure 9. Pie graph; Article Publications per Country



Fig 9 shows the Pi graph of Article Publications per Country. Following is the query which is executed on the database to extract this data.

Cypher Query:

```
MATCH (Author)-[r:WORKS_FOR]->(Institute)-[s:IS_IN]->(Country) RETURN Author.name, Country.name
```

VII. CONCLUSION

Scholarly articles and scientific journal datasets need special type of database as the data is massive in scale and ever evolving. Various web-scraping and parsing techniques were used to create and develop a platform for ScientoBASE [7], a repository, which will consist of international journals by subject category with ranks and scores of internationality and necessary metric information. Graph database such as Neo4j, which is a NoSQL type of database is an emerging technology in the field of effective visualization and data storage. It not only provides a more meaningful method of data storage but also facilitates intelligent query formulation for the meaningful data extraction and analysis. In this research Neo4j has played a crucial role in finding the hidden patterns which can further enhance the usability of the information concealed within the huge databases maintained worldwide. This work will lead to software which will be an end-to-end product comparable with Scopus and ISI's Web of Science but positioned in a distinct space and cater to the needs of the underprivileged researchers in developing countries.

The extensive point of our exploration is to characterize a yardstick of scientific contribution and international diffusion; especially in niche areas such as Astroinformatics, Computational Neuroscience, Industrial Mathematics and Data Science from India, as well as other countries across the globe. The result of our examination will clear path for information and model approval and development of an information perception and web interface apparatus that will compute the scores and provide visualizations of every vital parameter of internationality. This tool can be used as a web toolkit to quantify the growth of Indian as well as worldwide Scientometry in cutting edge and rising territories in Science and Technology.

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