Citation Networks and Impact Analysis

National Library of Medicine

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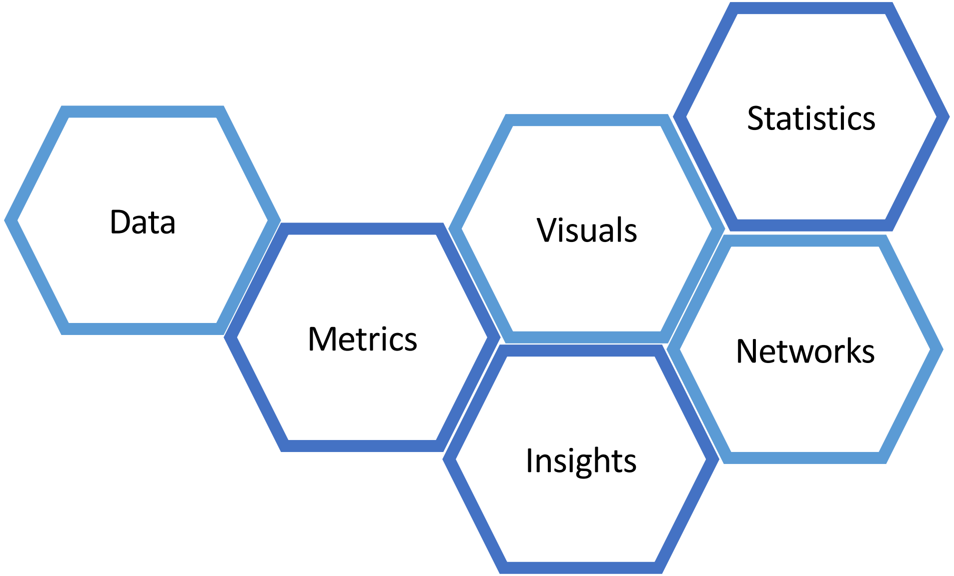
Kenneth Wilkins (NIDDK)



Data

Metrics

Visuals

Insights

Statistics

Networks

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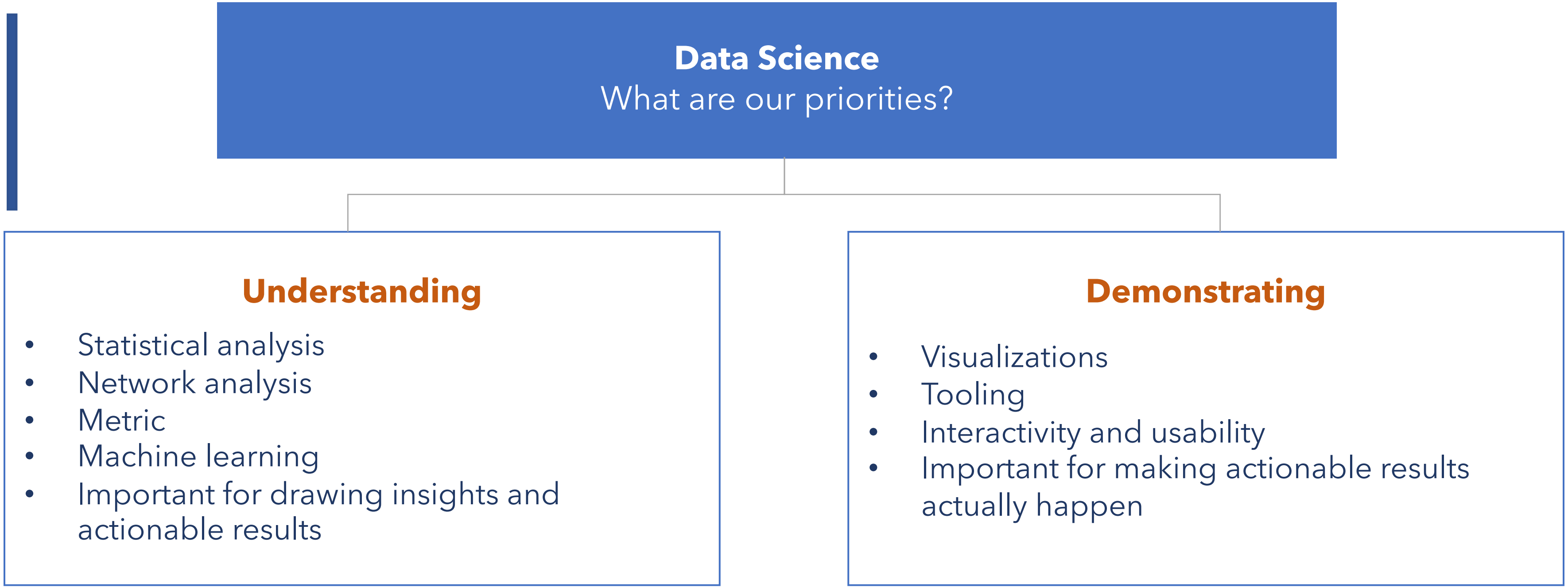
PROJECT OBJECTIVES

1. Aggregate public and private data sources to provide wholistic and selectively accessible information
2. Create multiplex citation graph pipeline for future research
3. Suggest new impact metrics for funding institutions with non-traditional risk profiles
4. Package the above into easily digestible formats for technical and non-technical users



Data Science
What are our priorities?

Understanding

- Statistical analysis
- Network analysis
- Metric
- Machine learning
- Important for drawing insights and actionable results

Demonstrating

- Visualizations
- Tooling
- Interactivity and usability
- Important for making actionable results actually happen

Key Takeaway

Data analysis can be a bit obtuse to those outside of a project, but those people are essential for generating insights.

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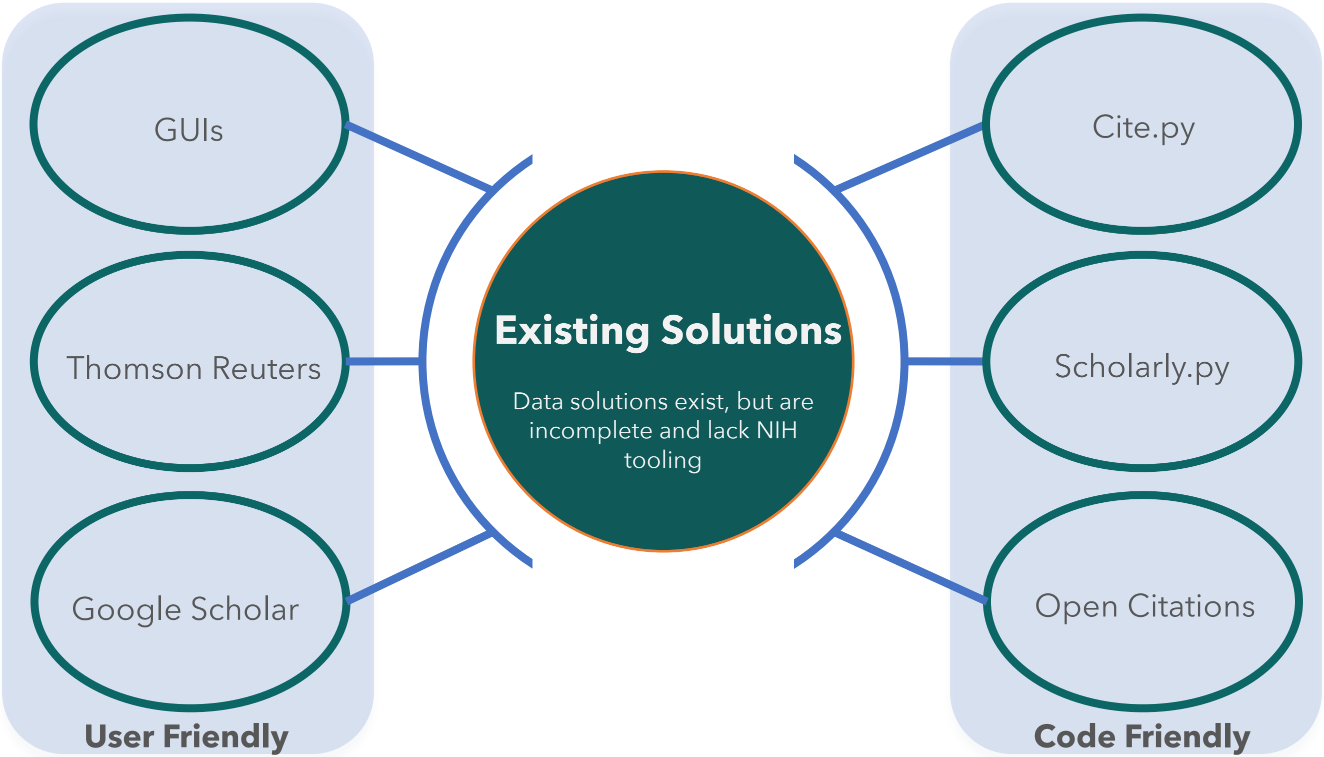
Step 1: Getting the Data

EXISTING OPTIONS



What to do :/

Introducing iCiteNLM

1. A library for curating all the data you need to build citation graphs
2. Accesses multiple pipelines including Google Scholar, Open Citations, and more.
3. Provides general tooling as well as NIH-specific functions, such as PMID to DOI conversions
4. Lots of room to expand and include NIH-specific resources like InCite

Introducing iCiteNLM

Curate

A library for curating all the data you need to build citation graphs

Private-Public

Accesses multiple open access pipelines including Google Scholar and Open Citations, as well as support for private options

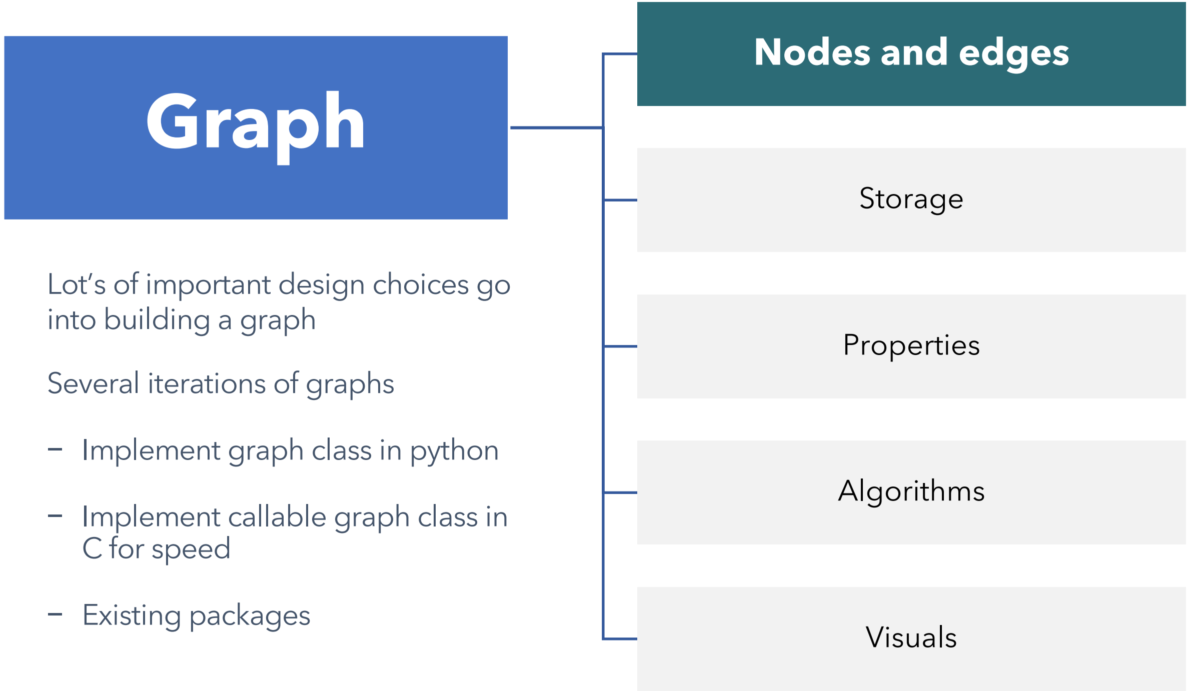
By NIH, for NIH

Provides general tooling as well as NIH-specific functions, such as PMID to DOI conversions

Now add it to the graph!

Step 2: Create the Graph

Graph Basics



Graph

Nodes and edges

Storage

Properties

Algorithms

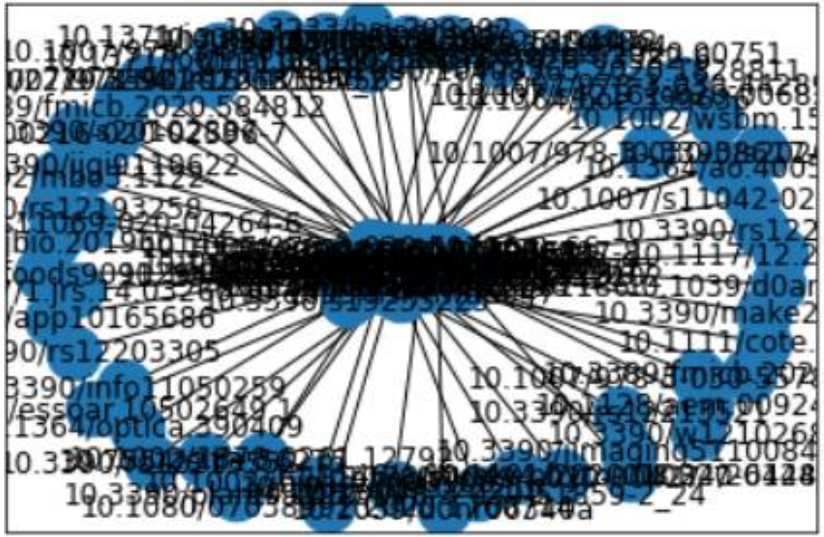
Visuals

- Lot’s of important design choices go into building a graph
- Several iterations of graphs
  - Implement graph class in python
  - Implement callable graph class in C for speed
  - Existing packages

Visualizing the Graph

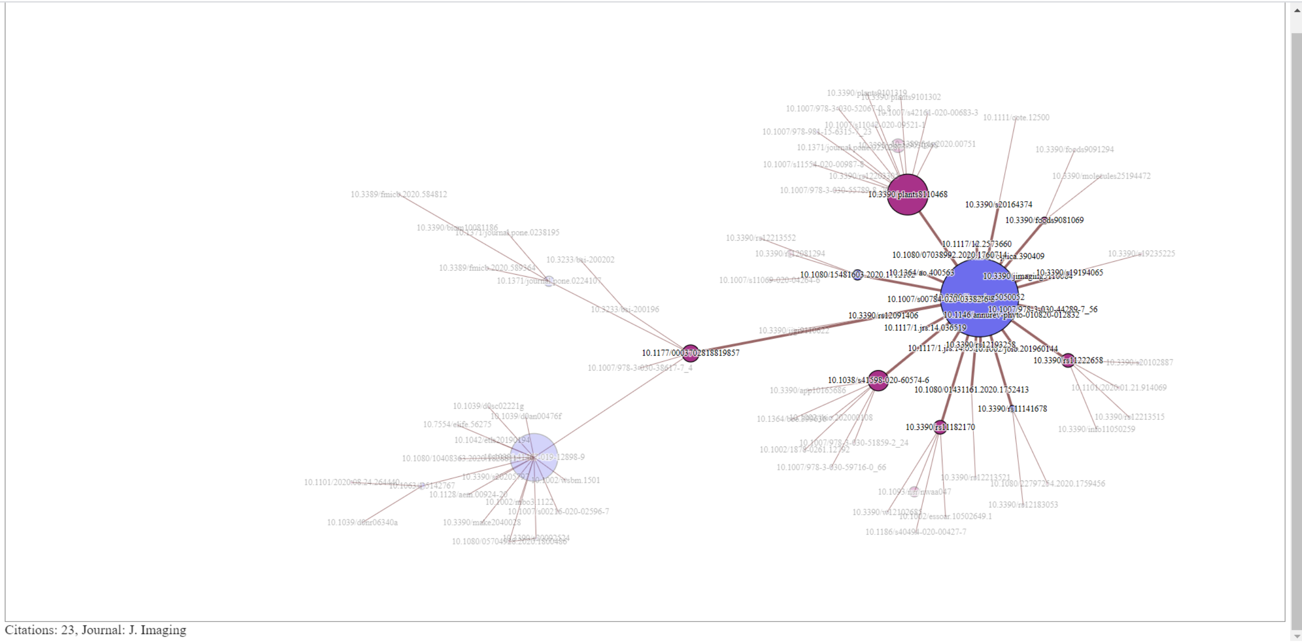
Pre-Built Solutions

- Most graphs used for **data science** are only displayed for exploratory purposes
- The accepted solution is matplotlib
- Hard to understand, only manipulatable using code, limited controllability
- Poor node positioning

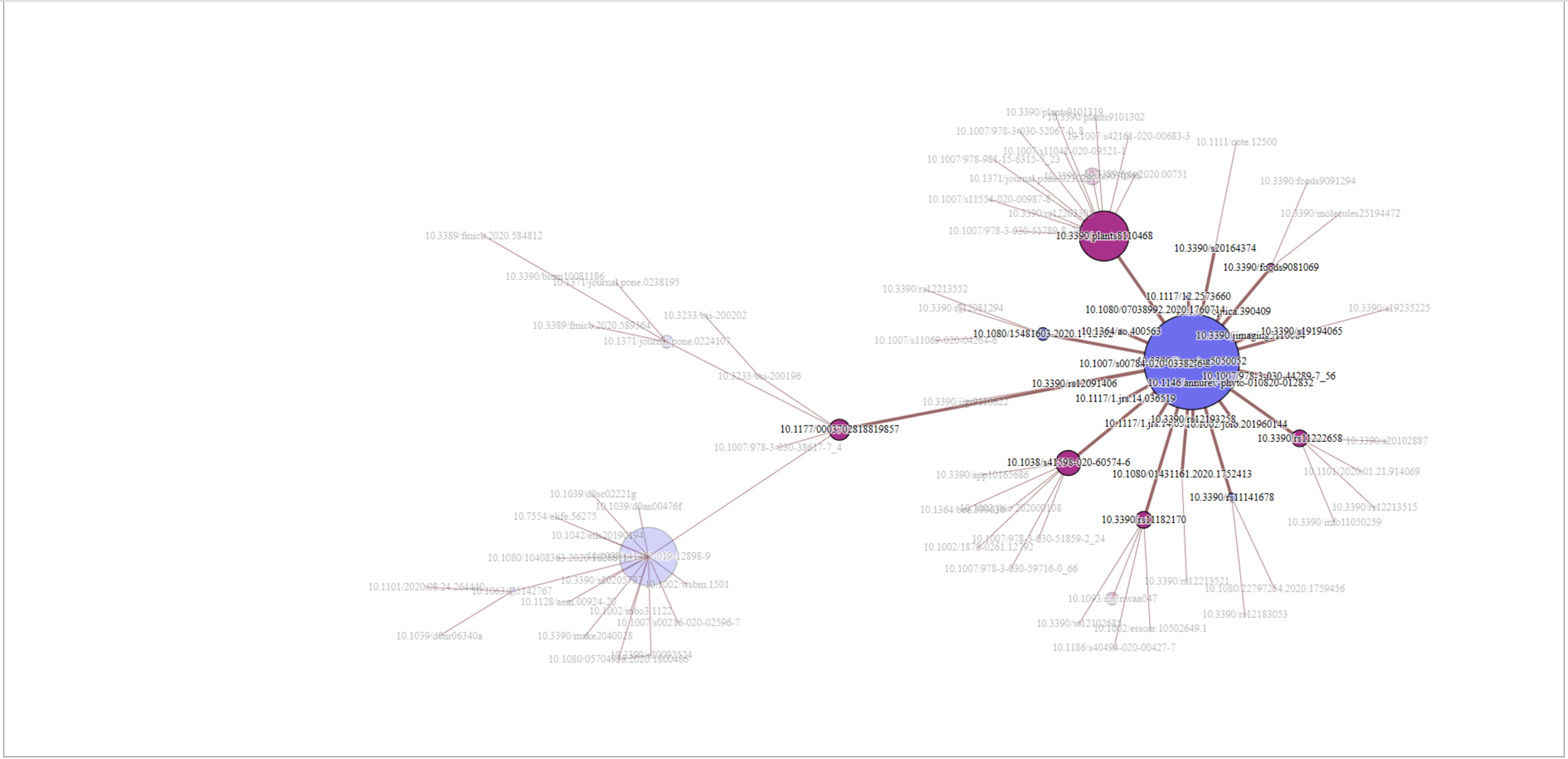


My Solution: Web-Server, HMTL, D3

- Looked for examples of the prettiest visuals and then found what they used
    - NYT + D3
    - Fell in love with the library
- A DOM-manipulator, making it easy to launch (as easy as launching a website)
- Any desired features can be added, or embed as part of a dash



Citations: 23, Journal: J. Imaging



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Step 3: Metrics

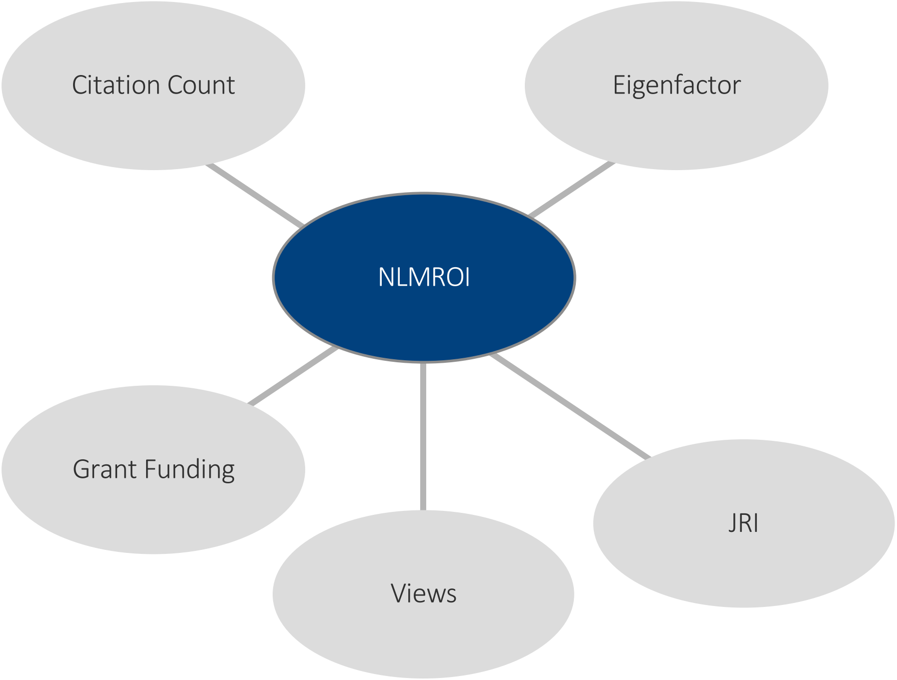
Introducing NLMROI

1. Citation count
2. Eigenfactor
3. JRI
4. Views and Web2.0 Metrics
5. Grant funding

The risk profile for governmental organizations necessitates a different metric

Existing Metrics

1. Citation count
2. Eigenfactor
3. JRI
4. Views and Web2.0 Metrics
5. Grant funding



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Introducing NLMROI

$$NLMROI = \frac{\sum C_i E_{c_i} + \sum \sqrt{C_j} E_{cj} + \sum \sqrt[3]{C_k} E_{c_k}}{\sum Funding}$$

- Government-specific metric
- Consistent with existing literature and metrics including Eigenfactor, JRI, Impact Factor etc.
- Helps account for differences in research areas (still best to compare within one area)

Now add it to the graph!

Step 4: Usability

Outputs

1. Graph written in D3 and hosted locally means it is easily web-publishable
    1. Open-source/publicly available options of iCiteNLM makes data privacy less of an issue and means anyone can access and see this data
2. For those interested, a host of algorithms were implemented on the graph including clustering, k-cliques, shortest-path, centrality, and more
    1. These can all be accessed through the python module
3. Excel file has been formatted for easy analysis

Next Steps

Only the beginning

1. Any metric you can imagine can be added to the graph
    1. Parallel graphs for co-authorship
    2. Weighing for small vs large teams
2. Include funding information for 2nd, 3rd degree nodes
    1. Validate metric using studies and experts
3. Host graph on data servers and expand to higher degrees
4. Any other graph analysis technique you would like!
    1. Causal inference
    2. Dominating sets
    3. Network flow

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Other Tail Ends

1. Topic modeling with Latent Dirichlet Allocation
2. NER with Bert-based machine learning models
3. Kleinberg burst-detection
4. Excel files

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Thank you to everyone for this opportunity!

Please reach out if you have questions/comments, or if you think any of these techniques could be useful in other areas!

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