DIMACS REU 2015
Exploration of OEIS

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Project Goals

- To develop an application that enhances users' experience with OEIS
- To promote interest in the OEIS and the general applicability of the Graph Card abstraction
- To create a k-partite multigraph representation of the OEIS database, to facilitate the process of filtering data

Outline

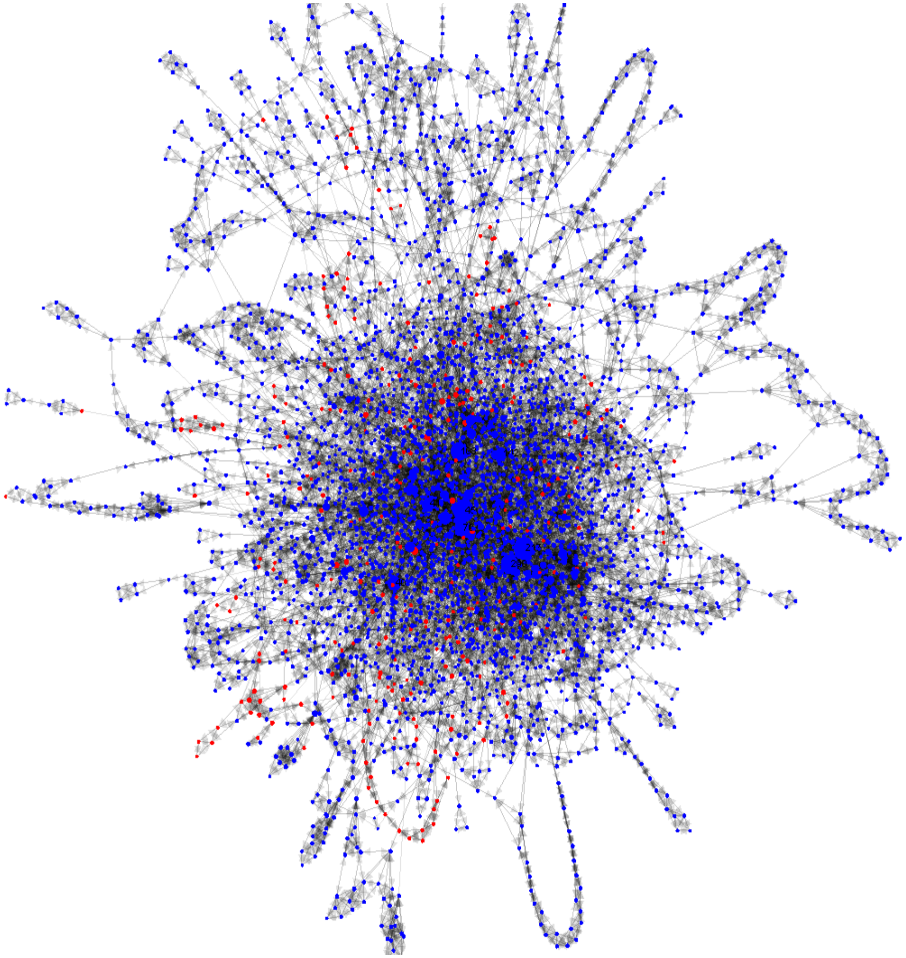
- Project Goals
- Description, Stumbling Blocks
- Sample Findings
- Past projects
- Summary

Description

- Develop graphical representation of OEIS: The On-Line Encyclopedia of Integer Sequences
  - Founded in 1964 by N.J.A. Sloane
- Explore various relationships among sequences
- Expand user capabilities when navigating OEIS

The Graph of OEIS

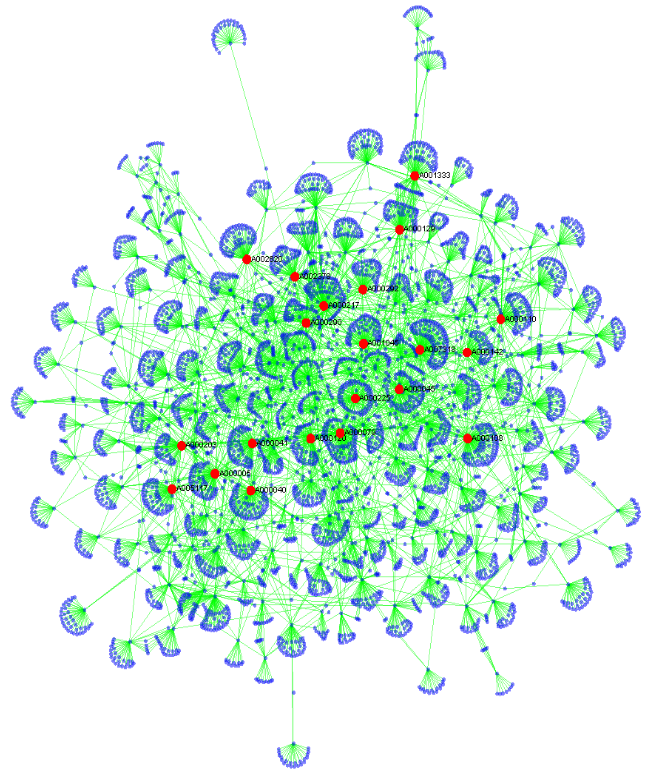
- ~260,000 files collected
- Used in various areas of research
- Use GraphStream for initial visualization
- Apply Graph Cards abstraction to create weighted edges based on attributes found on site



Graph of “hard” and “easy” sequences with PageRank and peeling algorithms on GraphStream.

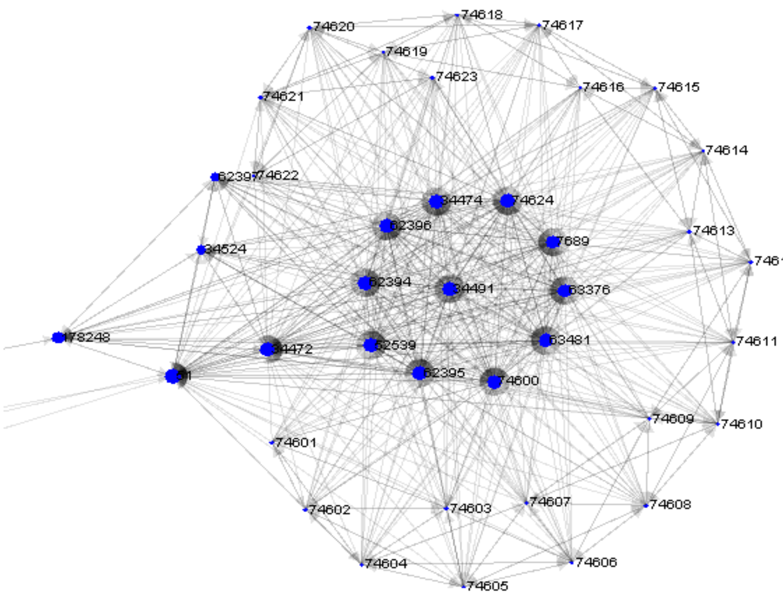
Stumbling Blocks

- Data collection
- Defining meaningful edge weights
- Graph Stream rendering
- Card creation



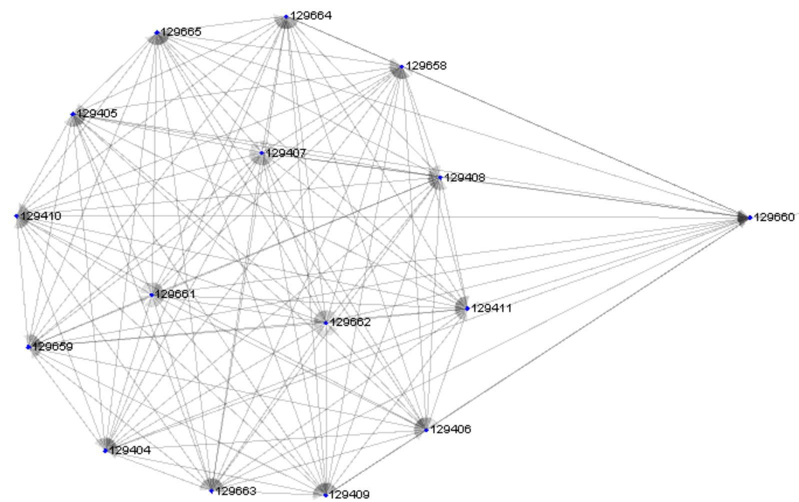
Above: Graph of “core” sequences with PageRank implementation on GraphStream.

Initial Findings (1)

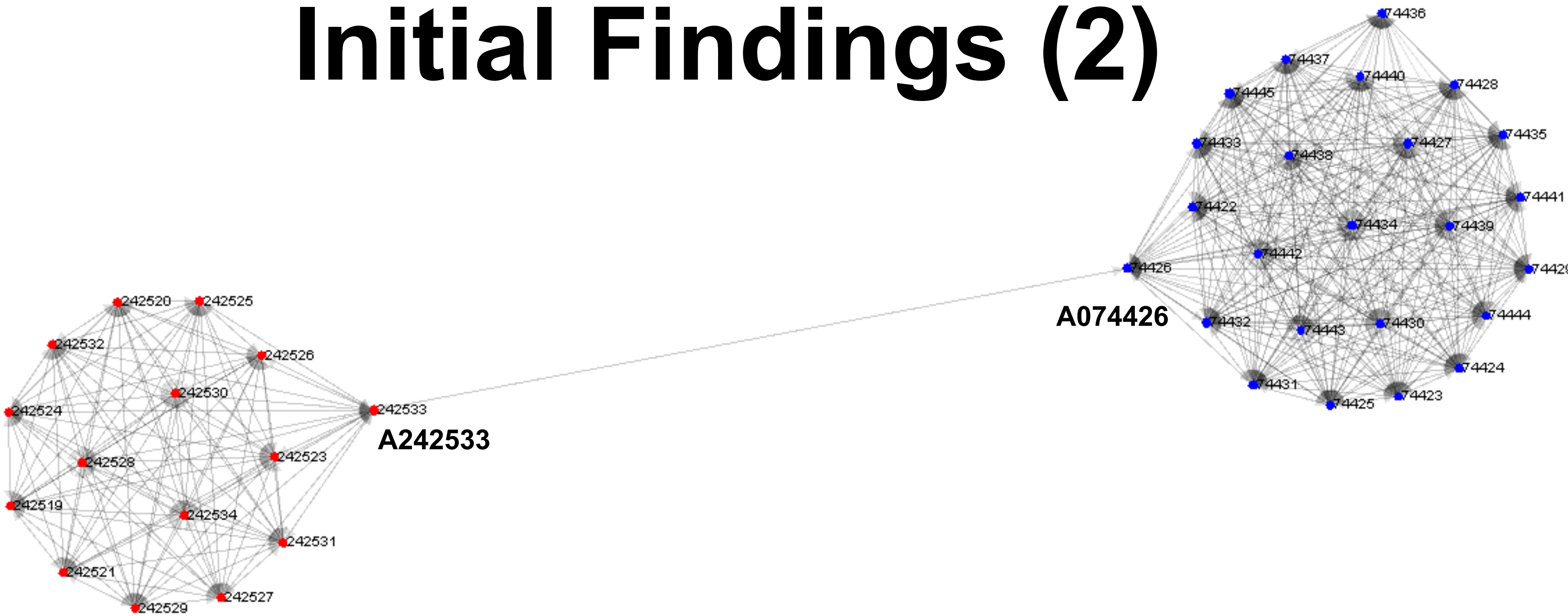


Left:
A034491: 7^n + 1
A053539: n * 8^(n-1)
A074620: 6^n + 8^n
A000051: 2^n + 1
A062395: 8^n + 1
A178248: 12^n + 1

Right:
A129664: Numerators of the greedy Egyptian partial sums for L(3, chi3).
A129662: Numerators of the Pierce partial sums for L(3, chi3).
A129404: Decimal expansion of L(3, chi3).
A129405: Expansion of L(3, chi3) in base 2.
A129660: Numerators of the Engel partial sums for L(3, chi3).



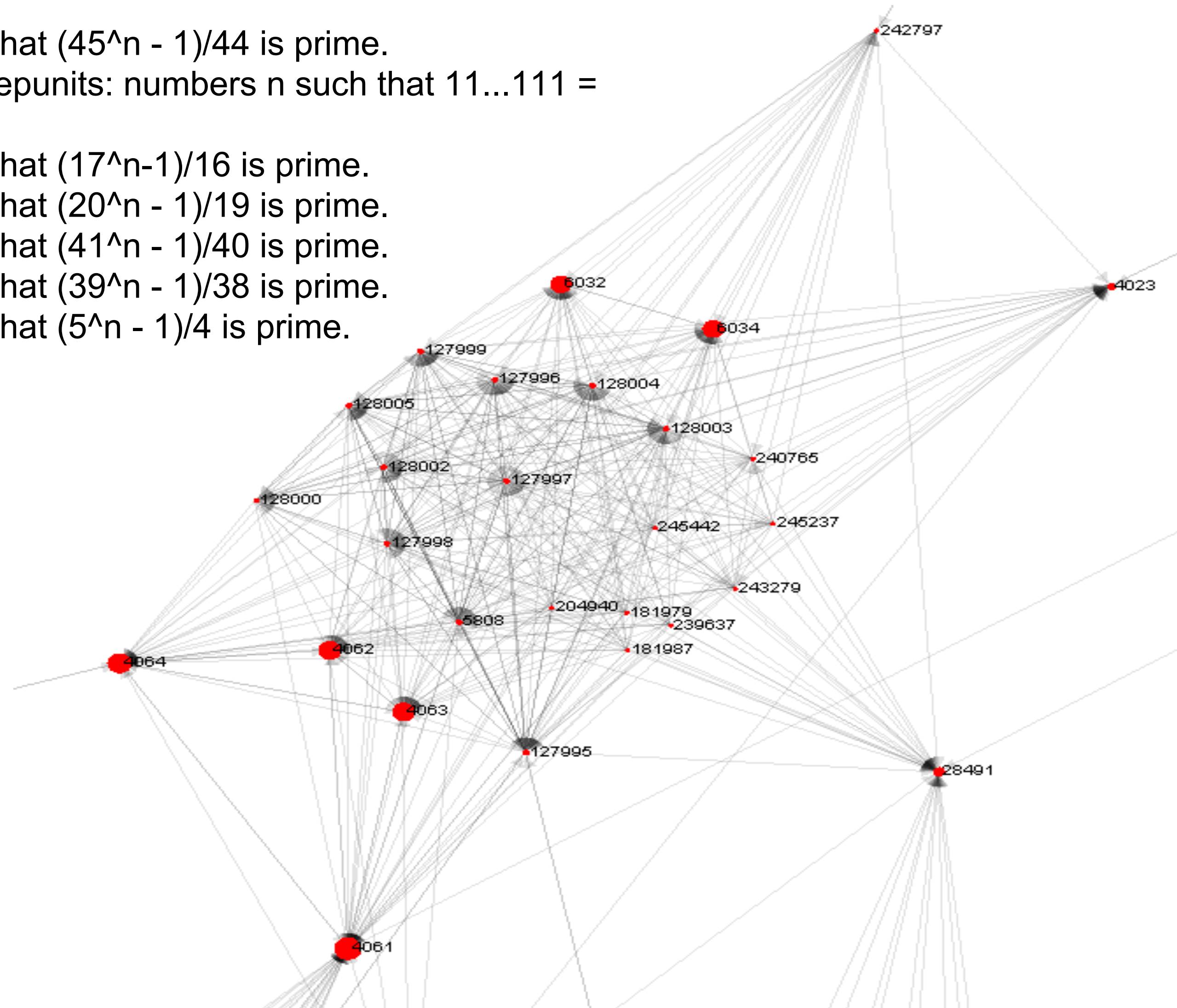
Initial Findings (2)



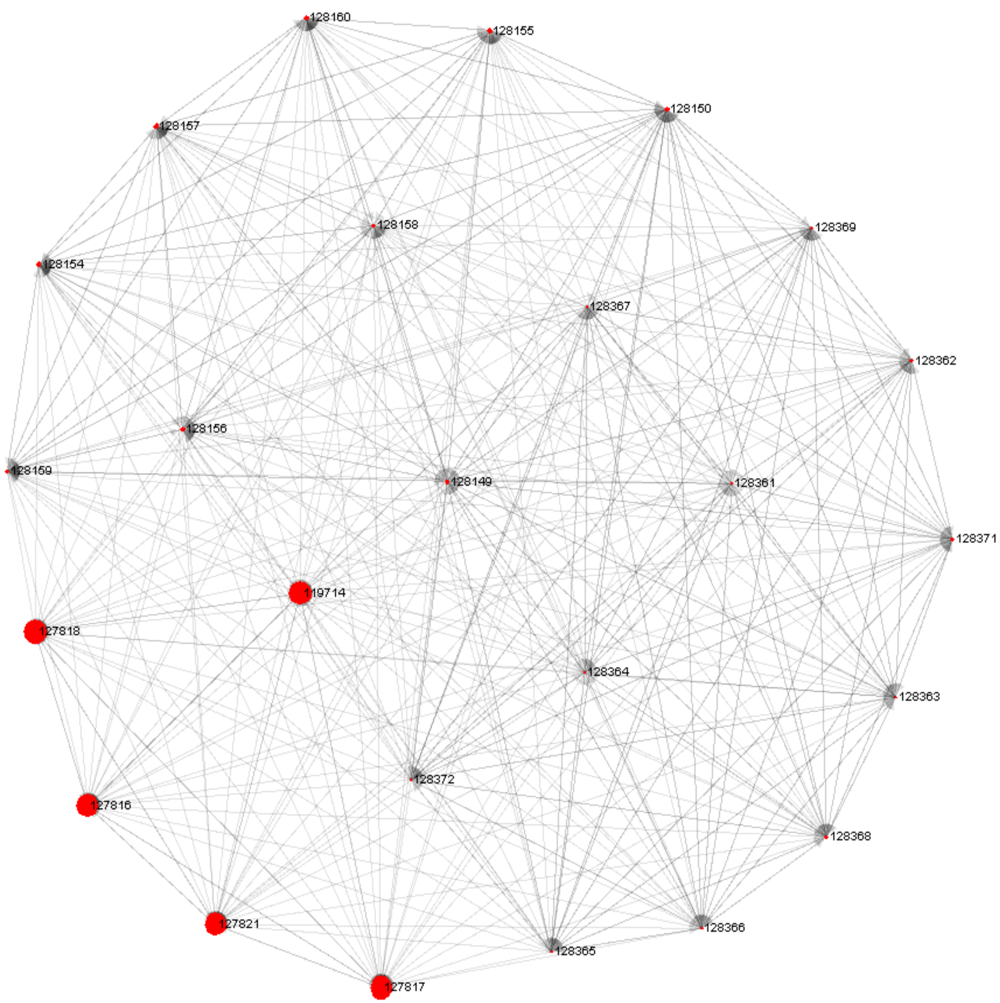
A242533: *Number of cyclic arrangements of S={1,2,...,2n} such that the difference of any two neighbors is coprime to their sum.*
A242530: *Number of cyclic arrangements of S={1,2,...,2n} such that the binary expansions of any two neighbors differ by one bit.*
A242521: *Number of cyclic arrangements (up to direction) of {1,2,...,n} such that the difference between any two neighbors is b^k for some b>1 and k>1.*
A074426: *Number of 6-ary Lyndon words of length n with trace 0 and subtrace 4 over Z_6.*
A074438: *Number of 6-ary Lyndon words of length n with trace 2 and subtrace 4 over Z_6.*
A074424: *Number of 6-ary Lyndon words of length n with trace 0 and subtrace 2 over Z_6.*

Initial Findings (3)

A242797: Numbers n such that (45^n - 1)/44 is prime.
A004023: Indices of prime repunits: numbers n such that 11...111 = (10^n - 1)/9 is prime.
A006034: Numbers n such that (17^n-1)/16 is prime.
A127995: Numbers n such that (20^n - 1)/19 is prime.
A239637: Numbers n such that (41^n - 1)/40 is prime.
A181987: Numbers n such that (39^n - 1)/38 is prime.
A004061: Numbers n such that (5^n - 1)/4 is prime.



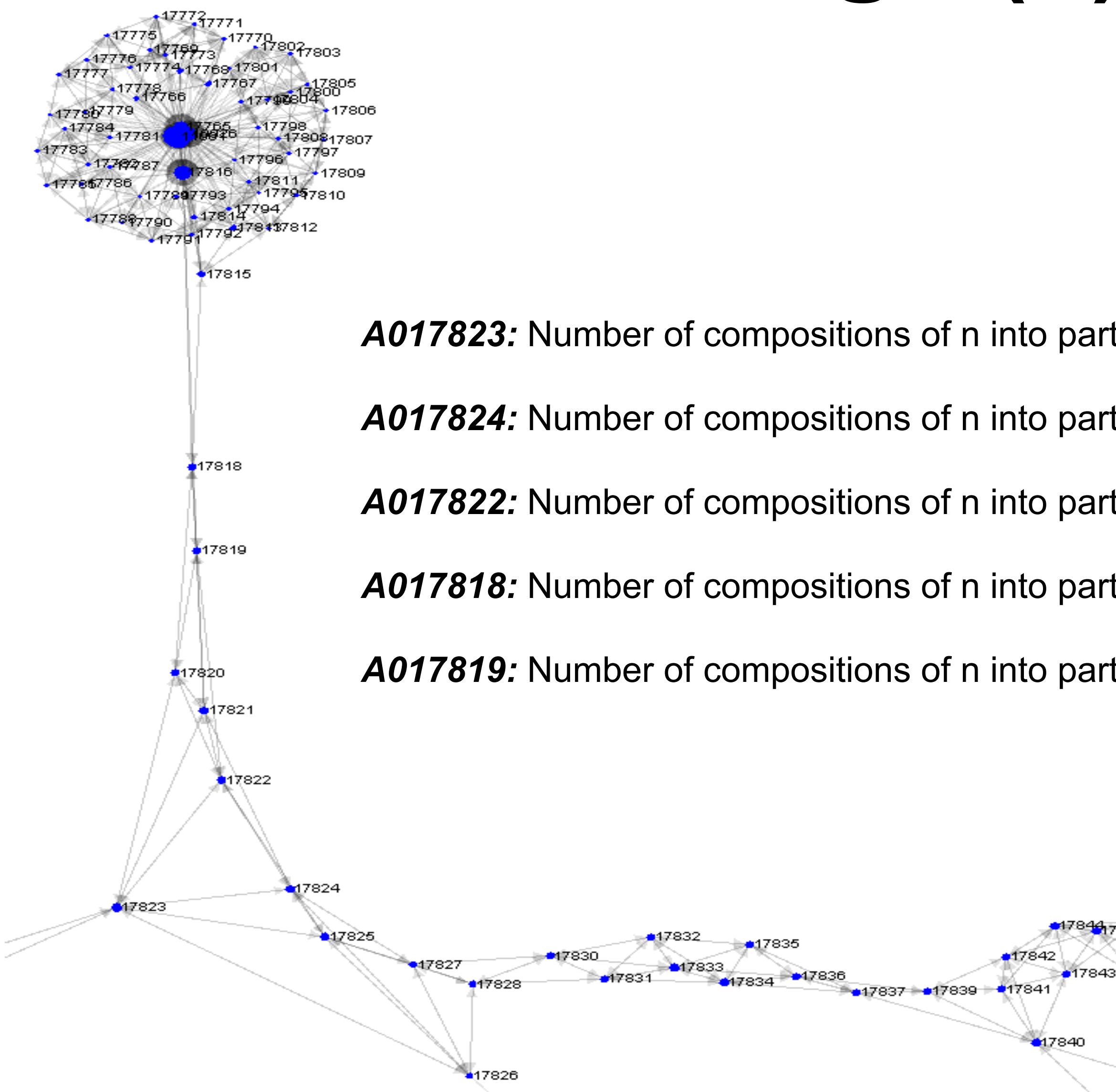
Initial Findings (4)



A128149: Least k such that n^k mod k = n-1
A127818: least k such that the remainder when 10^k is divided by k is n
A128365: least k such that the remainder when 25^k is divided by k is n
A128361: least k such that the remainder when 21^k is divided by k is n
A128150: Least k such that n^k mod k = (n-1)^2, or 0 if no such k exists
A128160: least k such that the remainder when 20^k is divided by k is n

Note: Many of these sequences have the same author (Alexander Adamchuk)

Initial Findings (5)



A017823: Number of compositions of n into parts p where 3 <= p <= 10.

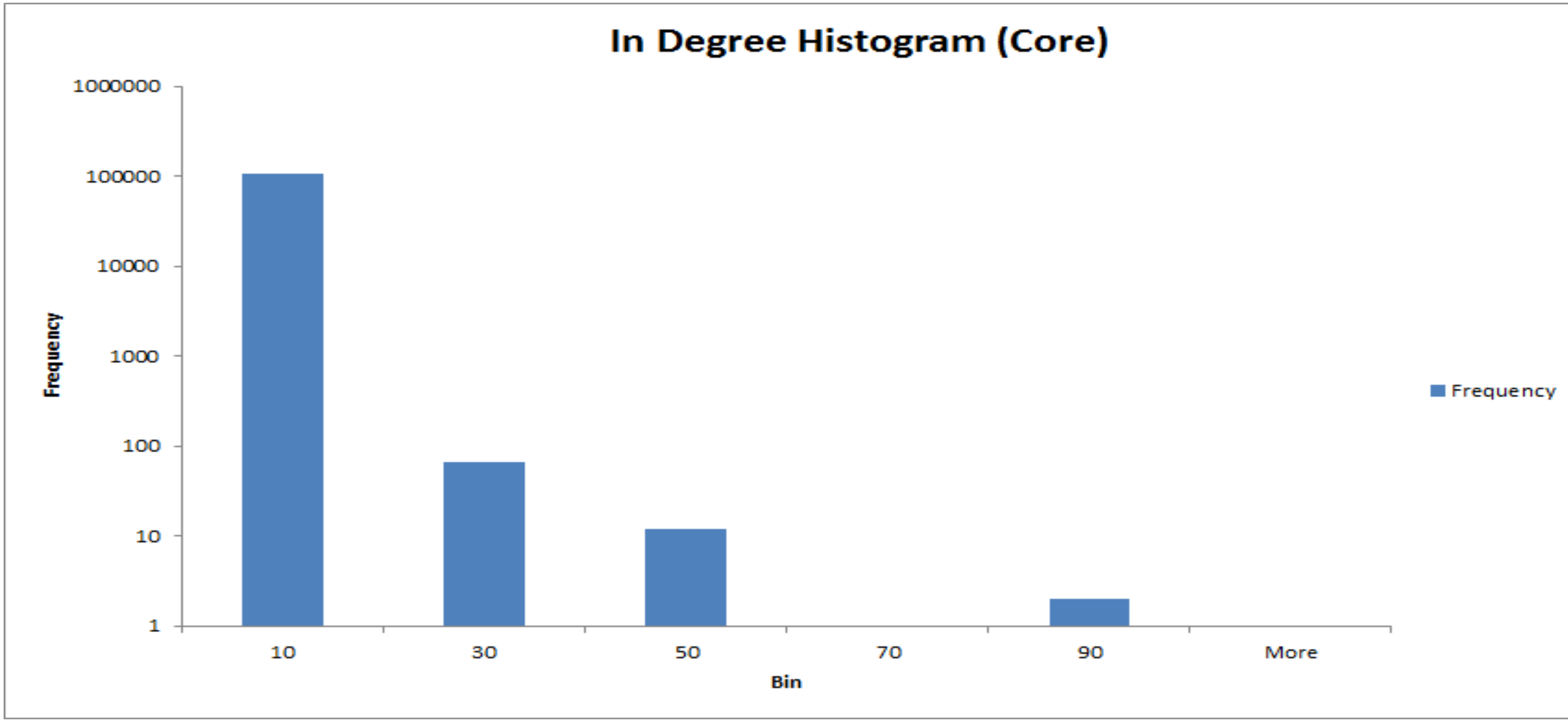
A017824: Number of compositions of n into parts p where 3 <= p <= 11.

A017822: Number of compositions of n into parts p where 3 <= p <= 9.

A017818: Number of compositions of n into parts p where 3 <= p <= 5.

A017819: Number of compositions of n into parts p where 3 <= p <= 6.

Statistical Findings



Above: Amount of times the sequence shows up in cross references (core sequences)

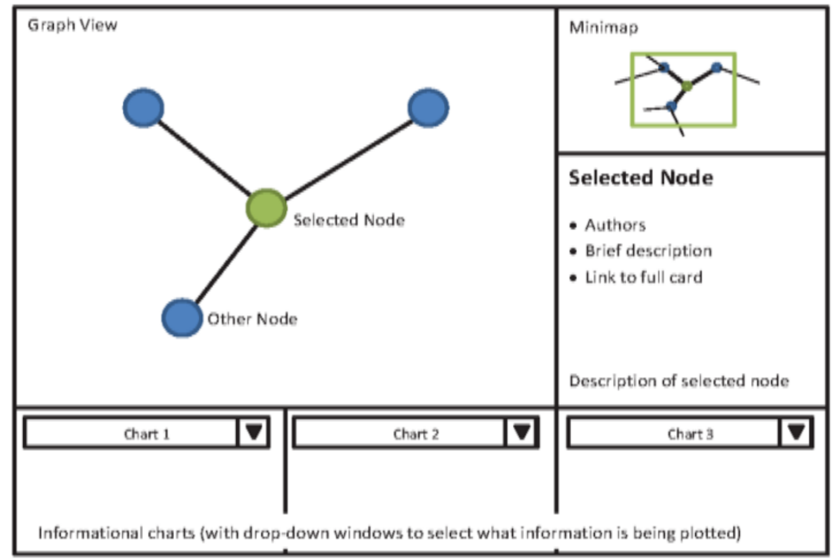
Sequences with high in degree:

- Triangular numbers (A000217)
- Catalan Numbers (A000108)
- Fibonacci sequence (A000045)

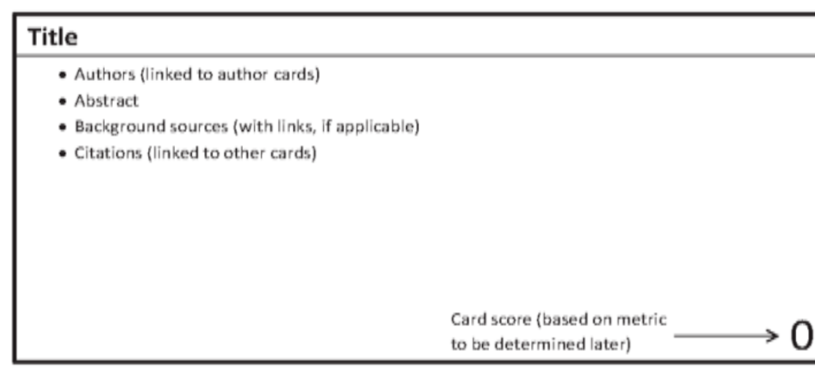
Graph Cards

- Developed by Dr. Abello and David DeSimone (2014)
- “Theme” of Dr. Abello’s projects this summer
- World Cup, REU projects, Railroad Data

Graph of the Cards:

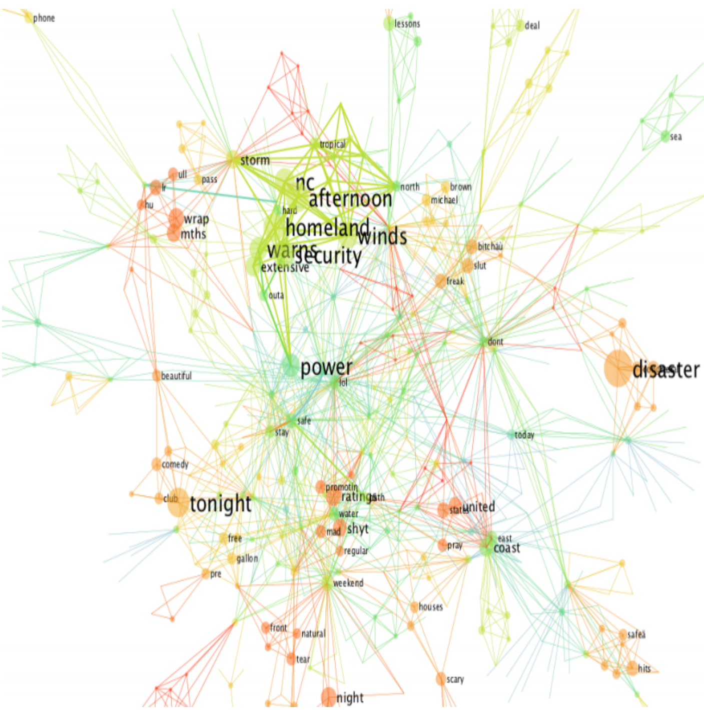


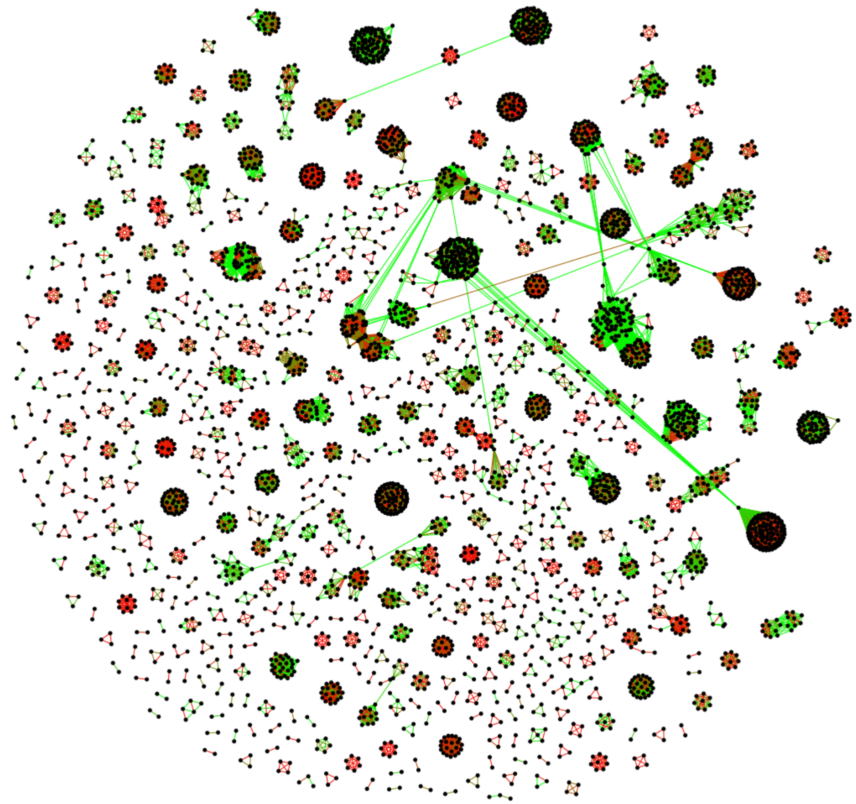
Example Card:



TwitterMap, Proteins (in progress)

- Developed by John Ensley a
  Mika Sumida (2013)





- Joint work with
  Dr. Yana
  Bromberg

Summary

- Graph Cards abstraction
- Application to OEIS to enhance user experience
- Exploring the underlying relationships between sequences
- Develop ideas from related projects

Acknowledgements

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References

[1] **The On-Line Encyclopedia of Integer Sequences (OEIS)**, http: //oeis.org.

[2] ***Ask Graph View*: The Design of a Large Scale Graph Visualization System** by J. Abello, F. Van Ham, N. Krishnan, 2006.

[3] ***The State of the Art in Visualizing Dynamic Graphs*** by Beck, Burchm Diseh and Daniel Weiskopt, Appeared in Eurovis 2014.

[4] ***(Semi-)External Algorithms for Graph Partitioning*** and Clustering by Akhremtsev, Sanders, and Schulz. 2014.

Any questions?