DIMACCS REU 2015
Exploration of OEIS

Mentor: Dr. James Abello
Presenters: Hadley Black, Branndon Mariscal, Daniel Mawhirter, Kevin Sun
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)

Right:
- **A129664**: Numerators of the greedy Egyptian partial sums for $L(3, \chi_3)$.
- **A129662**: Numerators of the Pierce partial sums for $L(3, \chi_3)$.
- **A129404**: Decimal expansion of $L(3, \chi_3)$.
- **A129405**: Expansion of $L(3, \chi_3)$ in base 2.
- **A129660**: Numerators of the Engel partial sums for $L(3, \chi_3)$.

Left:
- **A034491**: $7^n + 1$
- **A053539**: $n \times 8^{n-1}$
- **A074620**: $6^n + 8^n$
- **A000051**: $2^n + 1$
- **A062395**: $8^n + 1$
- **A178248**: $12^n + 1$
**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 $\mathbb{Z}_6$.

**A074438**: Number of 6-ary Lyndon words of length $n$ with trace 2 and subtrace 4 over $\mathbb{Z}_6$.

**A074424**: Number of 6-ary Lyndon words of length $n$ with trace 0 and subtrace 2 over $\mathbb{Z}_6$. 
Initial Findings (3)

**A242797**: Numbers \( n \) such that \((45^n - 1)/44\) is prime.

**A004023**: Indices of prime repunits: numbers \( n \) such that \(11\ldots111 = (10^n - 1)/9\) 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
TwitterMap, Proteins (in progress)

• Developed by John Ensley and 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

• We’d like to thank DIMACS, Dr. Fiorini, and everyone else involved in the DIMACS REU program.
References


Any questions?