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.
Sample 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:** $n \cdot 8^{(n-1)}$

**A074620:** $6^n + 8^n$

**A000051:** $2^n + 1$

**A062395:** $8^n + 1$

**A178248:** $12^n + 1$
**Sample 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 \( \mathbb{Z}_6 \).
Sample 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.
Sample 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)
Sample Findings (5)

**A017823**: Number of compositions of \( n \) into parts \( p \) where \( 3 \leq p \leq 10 \).

**A017824**: Number of compositions of \( n \) into parts \( p \) where \( 3 \leq p \leq 11 \).

**A017822**: Number of compositions of \( n \) into parts \( p \) where \( 3 \leq p \leq 9 \).

**A017818**: Number of compositions of \( n \) into parts \( p \) where \( 3 \leq p \leq 5 \).

**A017819**: Number of compositions of \( n \) into parts \( p \) where \( 3 \leq p \leq 6 \).
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
Acknowlegdements

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


Any questions?