# *Discrete Math Project 2: Integer Sequences*

*due: Friday, May 1, 2020 at 5:00 pm*

For this project, you (either by yourself, or in a group of *up to three*) will pick an integer sequence from the *Online Encyclopedia of Integer Sequences* and write an expository article about it. The goals of the project are the same as the goals for the first project:

- To solidify your understanding of course topics, by giving you an opportunity to integrate skills and concepts from the course in the context of a larger mathematical exploration. For example, sequences on the OEIS are often related to topics such as primes, recursion, combinatorics, and graph theory.
- To improve your writing skill in mathematics. Mathematics is an inherently social activity; communicating well is an essential part of the practice of mathematics. Clear writing also requires clear thinking: forcing yourself to clearly express your ideas often leads to improved understanding.

## *The Online Encyclopedia of Integer Sequences*

The Online Encyclopedia of Integer Sequences, `http://oeis.org`, began life in the mid-1960s as as collection of integer sequences on index cards, collected by mathematician Neil Sloane. The first website version was launched in 1996, making it one of the oldest sites on the web (which has existed in its more or less current form since 1991). Today, the OEIS holds over 320,000 sequences, with contributions from thousands of mathematicians and scientists (professional and amateur alike). The entry for each sequence in the database contains information such as comments and explanations, examples, references to other sequences, references to published literature and websites that mention the sequence, computer code, and more. I plan to make a short video introduction to the OEIS showing some of its features and how to use it.

## *Assignment*

Start by picking a sequence from the OEIS. You can either pick from the following suggested list, or you are free to choose your own.

- `https://oeis.org/A000217` (Triangular numbers)
- `http://oeis.org/A000045` (Fibonacci numbers)
- `http://oeis.org/A000204` (Lucas numbers)

- `http://oeis.org/A000108` (Catalan numbers)
- `http://oeis.org/A000055` (Unlabelled trees)
- `http://oeis.org/A005132` (Recamán sequence)
- `https://oeis.org/A000110` (Bell numbers)
- `https://oeis.org/A000396` (Perfect numbers)
- `http://oeis.org/A000668` (Mersenne primes)
- `http://oeis.org/A101273` (Gödel numbers of theorems in propositional logic)
- `http://oeis.org/A045917` (Goldbach conjecture)
- `http://oeis.org/A007318` (Pascal's triangle)
- `http://oeis.org/A002487` (Stern-Brocot sequence)

There are literally thousands of sequences on the OEIS to choose from, though not all are appropriate for this project. One way to try randomly stumbling on good candidates is to use the OEIS WebCam (`https://oeis.org/webcam`). If you pick your own sequence, you might want to run it by me to ensure it is a sensible choice (in particular, chosen sequences need to have something to do with one or more of the topics covered in the course).

After doing some appropriate research (*e.g.* by following some of the references contained in the OEIS database, or doing some web searches, or both), you should write a short article about your chosen sequence. Start by explaning the definition of the sequence, including an explanation or reminder of any needed background. Include examples, pictures, or anything else that helps the reader understand the sequence. Of course, you should be sure to include the sequence itself (at least the first 20 terms or so).

You should explain any connections the sequence has to things we have covered in class this semester. If it is interesting, you may also want to include some information about the history of the sequence or related mathematical ideas.

Finally, you should find at least one interesting mathematical fact about the sequence and present the proof in your own words. (Note that I do not expect you to come up with a fact or a proof on your own; this can come from your research as well.)

- As with the first project, you must use LaTeX to typeset your project.

- You should aim to produce a document that is 2–4 pages in length (longer than 4 pages is OK; if it's shorter than 2 pages, it's likely you have not included enough detail).
- As the *audience* for your document, you should imagine you are writing to other students in our Discrete Math class.
- Writing about mathematics does not necessarily have to be dry and technical. You are writing for other humans, not for math robots! Using stories, metaphors, or jokes[1] to make the document more interesting or help the reader understand better is not only allowed, but highly encouraged. If there is some aspect of your chosen sequence and its properties that you find exciting or fascinating, you should try to convey your excitement or fascination to the reader.
- You may include pictures or diagrams if you wish, though you are not required to.
- You should use sections to structure your document in some appropriate way.

[1] or unicorns

## *Academic Integrity*

The document you submit must be your own work (or the work of you and your group) and give credit where it is due. Specifically:

- You are free to discuss the project with classmates, but your writing must be your own. If you get some good ideas from a classmate, you should cite them!
- You are *expected* to find and refer to other sources about your chosen sequence. However, be sure that you cite any sources (books, articles, web pages . . . ) you reference, and that you do not simply copy and paste from other sources unless such copying is clearly marked as a quotation (either using quotation marks or `\begin{quote} ... \end{quote}` for longer quotations).

  LaTeX can manage and typeset a bibliography for you; see `https://www.overleaf.com/learn/latex/Bibliography_management_in_LaTeX`. However, you are not required to use a LaTeX bibliography; for this project it will suffice to simply explain in your document what sources you used.

  Note that you do not need to cite things we have done in class or anything in your textbook.

## *Grading rubric*

I will grade your project out of 40 points. A document earning 40 points will have the following qualities:

- Mathematics (15 points)
  - Proofs and explanations are free of logical errors or omissions.
  - Proofs and explanations contain an appropriate level of detail, neither glossing over tricky details nor spending excessive time explaining routine ones.
  - Symbols, notation, and terminology are used correctly.
- Writing (10 points)
  - The document is free of punctuation,, grammatically, and speling erors.
  - The prose flows naturally, using an appropriate variety of vocabulary and sentence structure.
  - The document uses complete sentences; even formulas and equations are included in sentences appropriately.
- Exposition and structure (10 points)
  - The document does not merely consist of a list of theorems but integrates the results into a coherent story, with each part building on previous parts.
  - The document makes appropriate use of stories, metaphors, *etc.* to engage the reader and help explain relevant concepts.
  - The document is structured in an appropriate way that gives the reader reference points to help them follow along.
- Formatting and typesetting (5 points)
  - LaTeX formatting is used consistently and appropriately; for example, variables, numbers, and other mathematical expressions are always typeset in "math mode" (using `$...$` or `\[...\]`); special LaTeX syntax is used for quotation marks; there is appropriate space between things.

If you are unsure whether your project meets these criteria, you are welcome to bring me a draft (even a partial draft) for some feedback prior to the due date!

### *Submitting your project*

When you are ready to submit your project, you should download the final PDF from Overleaf, and submit it electronically using the assignment submission form linked from the course website. If working with a partner, only one partner needs to submit; make sure both your names are in the document and on the submission form.

### *Revising your project*

I will return your graded project to you by Wednesday, May 6. If you wish, you may then submit a revised version of the project by the last day of final exams (Wednesday, May 13). Your final grade on the project will be the average of the original and revised grades.