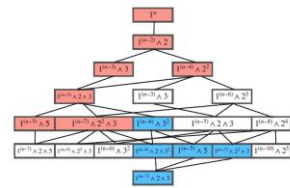




THE FIBONACCI SEQUENCE AND MATH OUTREACH



Steven J Miller, Williams College: sjm1@williams.edu

Joint with Cameron and Kayla Miller, Anna Mello and her classes, and SMALL 2022

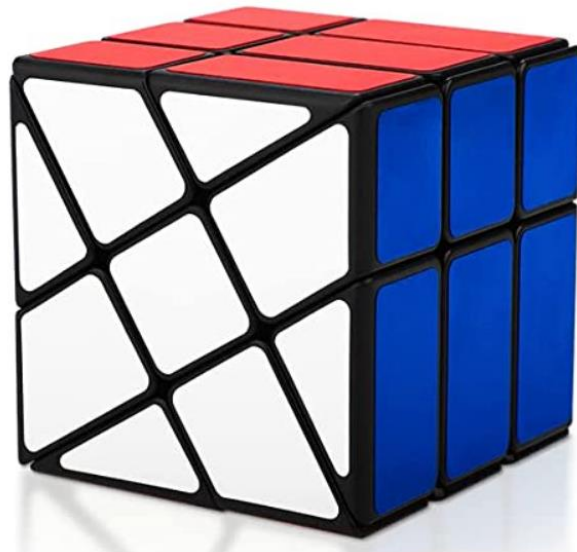
The 20th International Fibonacci Conference, Sarajevo, July 29, 2020

https://web.williams.edu/Mathematics/sjmiller/public_html/math/talks/talks.html

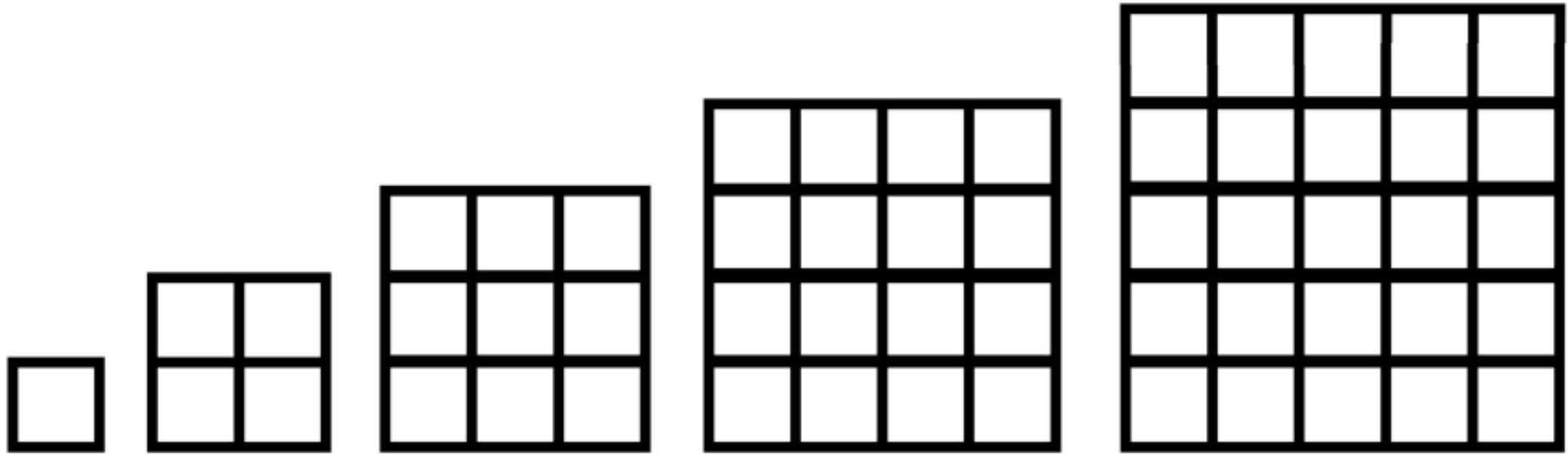


Outline:

- Discuss efforts to engage/excite young students.
- Highlight interplay of math outreach and math research.

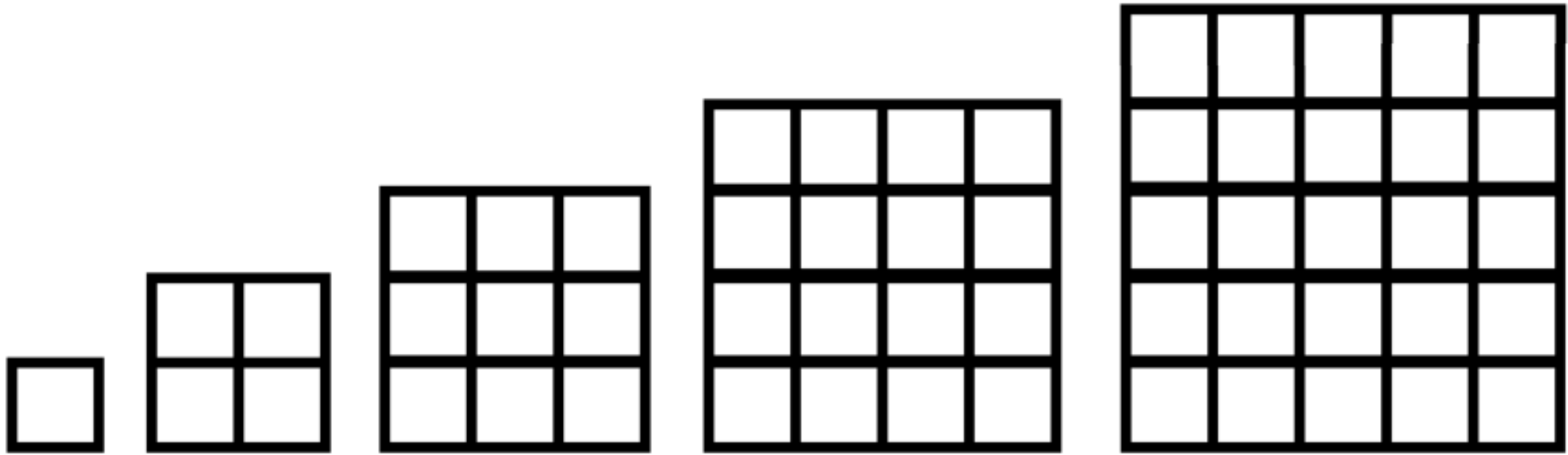


Have $n \times n$ square for each n , place one at a time so that shape formed is always connected and a rectangle.



If you can place two you win!

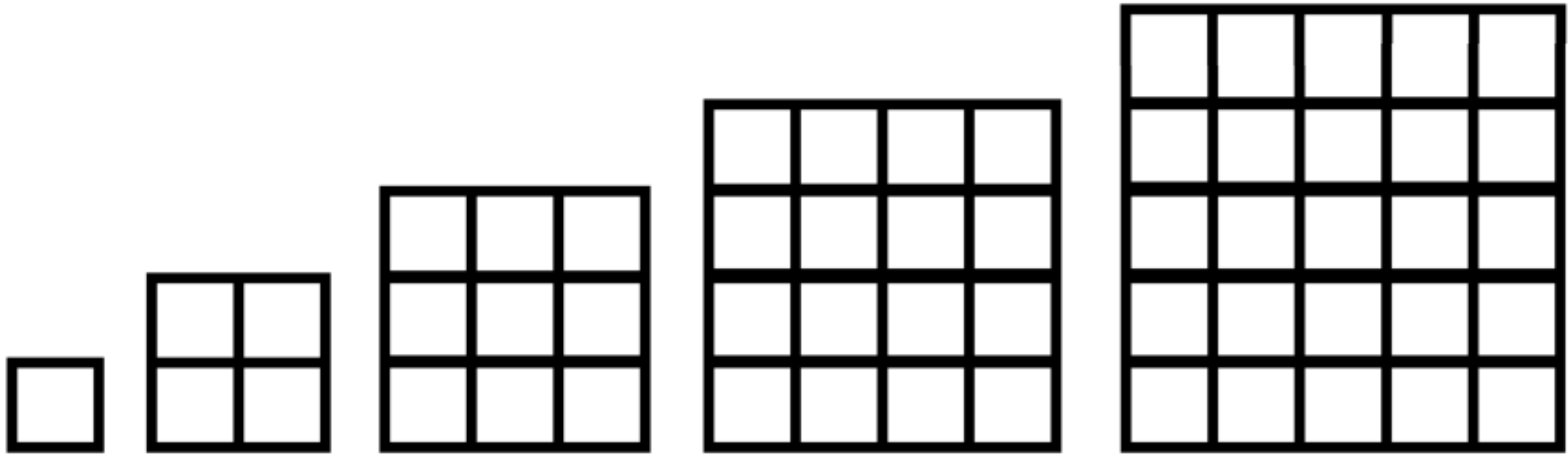
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IMPOSSIBLE: Need more, and I'm *cheap*!

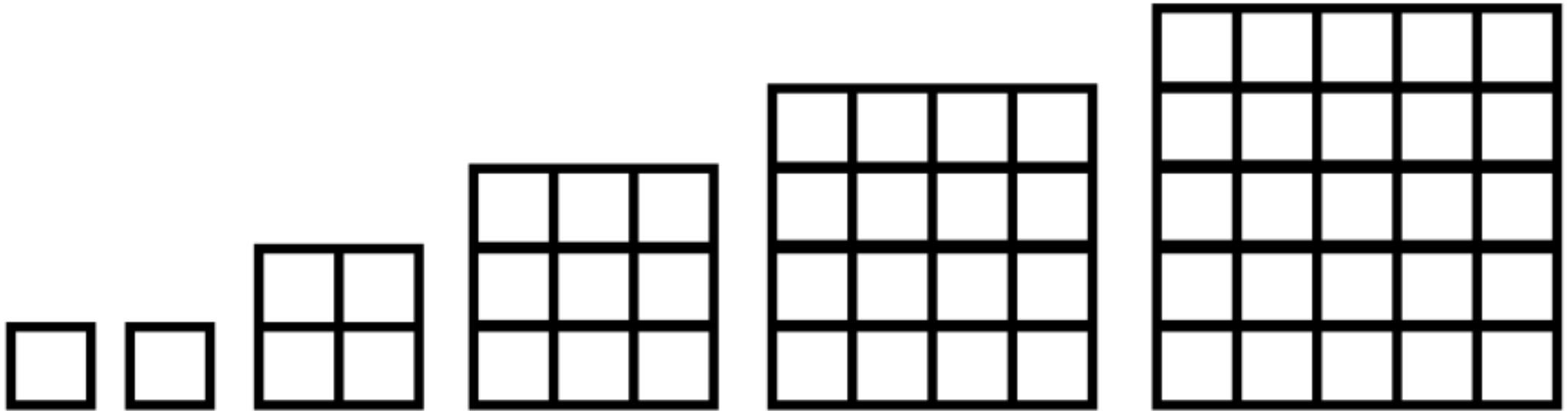
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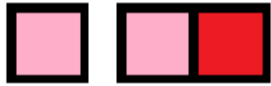
(Well, when it's my money: 21st FibConf will be well supported....)

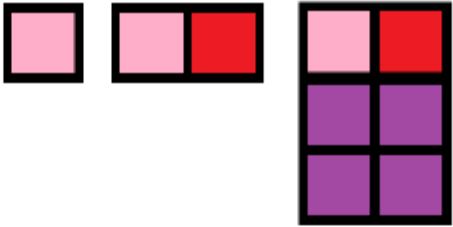
Have $n \times n$ square for each n , extra 1×1 square, place one at a time so that shape formed is always connected and a rectangle.



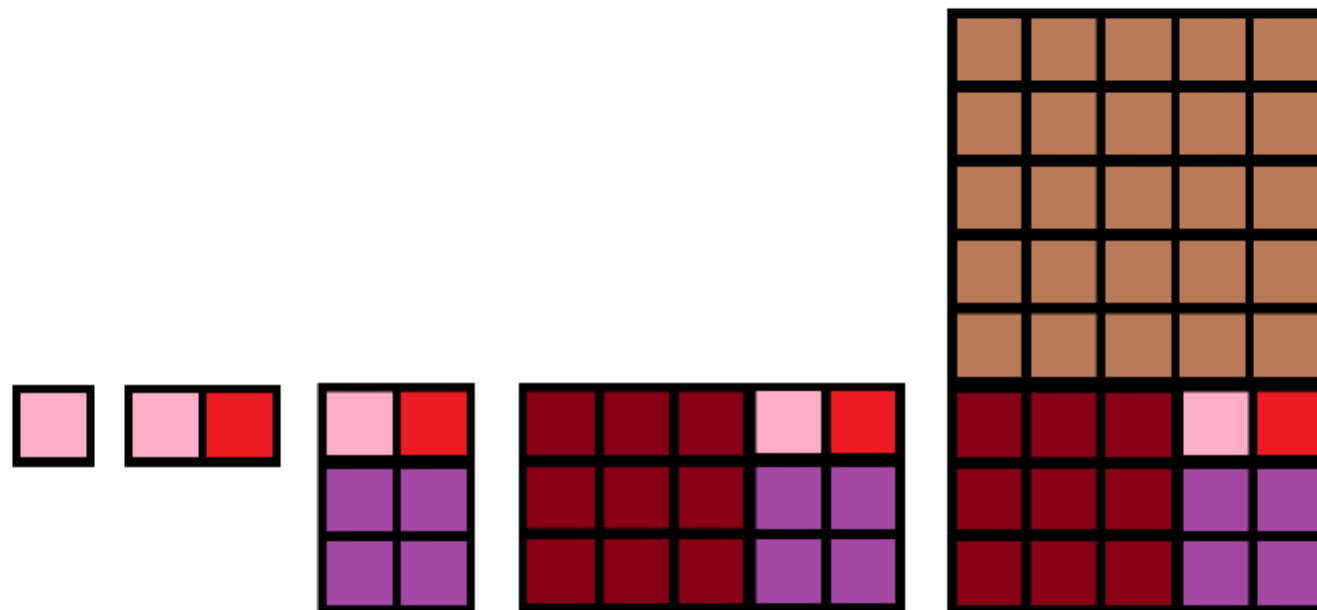
Needed more, added smallest amount possible....



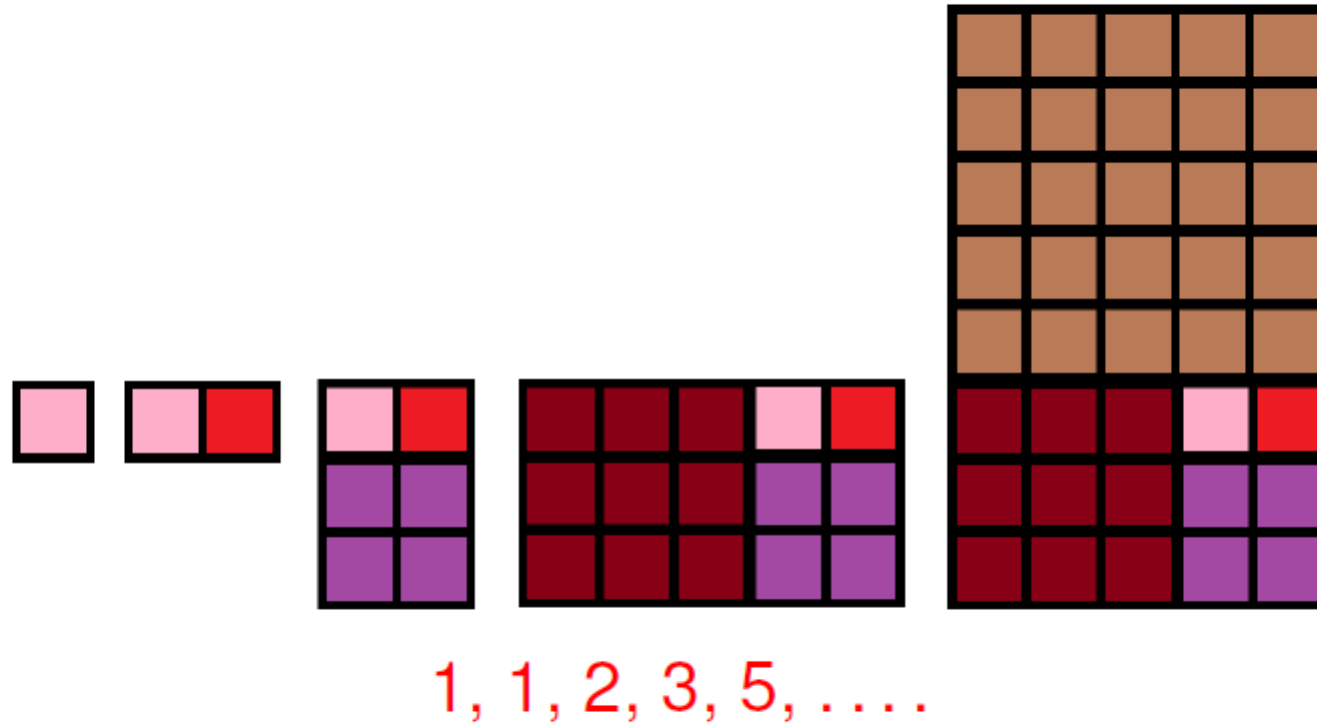








1, 1, 2, 3, 5,



Talk about freedom in where to put boxes.

Show beautiful video *Nature by Numbers*:

<https://www.youtube.com/watch?v=me6DnI2DOtM>



<https://math.williams.edu/to-bead-or-not-to-bead/>



<https://math.williams.edu/to-bead-or-not-to-bead-ii/>



What do you observe? 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89...

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- Odd, odd, even.
- Sum of previous two.

The pattern goes even even odd for every sequence if you start with 1,1 or any odd numbers. If you start with an even number like 3,2 the sequence is shaken up so it goes odd even, odd, but after that it goes back to the other odd odd even sequence. If you start with two even numbers it will always be even. If you make a diagram it goes in a shell that matches a nautilus shell.

-**William**

- Why is the Fibonacci sequence everywhere?
- What is the purpose of the Fibonacci sequence?
- Why do the Fibonacci sequence numbers sound so good on instruments?
- Can the Fibonacci sequence be found in other shapes than a swirl?
- Can Fibonacci be found in technology like phones, laptops, or TVs? -**Maddie**

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Note: often introducing kids to

- notation (such as F_n),
- seeing how notation matters / helps,
- Spreadsheets (to generate list)....

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One of my college research student (Justin Cheigh):

Does every Fibonacci number have a 1, 2, 3, 5 or 8 as one of its digits...?

Math outreach led to an interesting (and new?) question.

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Question: Given a base B , for what subsets S of $\{0, 1, \dots, B-1\}$ must either all or all sufficiently large numbers always have at least one digit in S ? What if S is a set of pairs of digits?

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Partial Answer: all Fibonacci numbers contain:

- *a digit in $\{0, \dots, 9\} \setminus \{6\}$*
- *a digit in $\{0, \dots, 9\} \setminus \{4\}$*
- *a digit in $\{0, \dots, 9\} \setminus \{2\}$ (disregarding $F_2 = 2$, so all sufficiently large!)*

SMALL '22 (especially Guilherme Zeus Dantas E Moura, Annika Mauro, Zoe Mcdonald, Santiago Velazquez).

HV ALA!



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