Lovey-Dovey Mathematics: an experimental exploration

Tara Rutkauskas

April 2026.

1 Introduction

Did you know that you can quantify, in the form of a percentage, the strength of someone's affection for somebody else? It's true! While scrolling, as teens do, I stumbled upon this fun little algorithm.

You start by taking the names of the two people and choosing their order. Say, Joe and Jane, where we're looking for Joe's affection for Jane. Then, you go along the letters of Joe, marking down how many of each letter are found across the two names:

$$Joe \quad Jane$$

$$\cancel{J}\cancel{o}\cancel{e} \quad \cancel{J}an\cancel{e} \qquad 212$$

Here, we get the string of numbers 212 because j appears twice, o appears once, and e appears twice.

The next step is to repeat the process along the second name — this will essentially be adding as many 1's to the string as there are uncrossed-out letters left (with the exception of repeating letters in the second name returning values higher than one).

$$\cancel{J}\cancel{o}\cancel{e} \quad \cancel{J}\cancel{a}\cancel{n}\cancel{e} \qquad 21211$$

Here, the letters a and n contribute a number 1 to the sequence each, since they're not found in Joe's name. The next step is to combine numbers in a folding manner, where the first number combines with the last, the second with the penultimate and so on. If there is a single, unpaired number left, then it can be written down as is.

In our case, this means:

$$\cancel{2}121\cancel{1} \to 3$$

$$\cancel{2}\cancel{1}2\cancel{1}\cancel{1} \to 32$$

$$\cancel{2}\cancel{1}\cancel{2}\cancel{1}\cancel{1} \to 322$$

For the process to return our desired percentage, this step is repeated until two numbers are left:

$$\cancel{3}2\cancel{2} \to 5$$

$$\cancel{3}\cancel{2}\cancel{2} \to 52$$

Slapping on a percentage sign, we can, without a smidge of uncertainty, say Joe likes Jane 52%. Eek!

2 Patterns in distribution

The part of this system that piqued my curiosity the most was tracking whether a specific element ended up contributing to the 10's or 1's digit in the final percentage. This can, should, and will be demonstrated with an example.

Imagine a string of numbers, labeled x_1, x_2, x_3, and x_4.

x_1	x_2	x_3	x_4
1	2	3	4

Here, the numbers below our string represent each element's position, be that the first or last in the sequence. Using our folding algorithm from before, where would they go? Well, the first and the fourth elements are added together, and the resulting number is written down into the new string as its first element. Same goes for the second and the third. Here, an element is a number in a string.

	x_1	x_2	x_3	x_4
First string	1	2	3	4
Second string	1	2	2	1

$$\begin{array}{cccc} x_1 & x_2 & x_3 & x_4 \\ x_1 + x_4 & x_2 + x_3 & & \end{array}$$

On the left, observe the tracking matrix – it matched the lowest number with the highest, and then ordered them both as the first element in the second string. This is consistent with the process on the right, where the first and last elements are added together to form the first element in the new string.

Let's call this the **profile** of 4 – the 1221 string you see above. The profile of four tells us, that in a string of four numbers, applying the folding algorithm will have the first and last numbers add to the 10's digit, and the second and third – the 1's digit. For shorthand, you'll see "the profile of n" represented as $P(n)$

3 Even strings

For strings, where their length is an even number, a certain pattern can be observed. Take $P(6)$. Alongside that, observe $P(3)$. What do you notice?

	x_1	x_2	x_3	x_4	x_5	x_6
First	1	2	3	4	5	6
Second	1	2	3	3	2	1
Third	1	2	1	1	2	1

	x_2	x_2	x_3
First	1	2	3
Second	1	2	1

Well, I notice, that the profile of 6 is like the profile of 3, but repeated twice. Alongside that, $6 = 2 * 3$. Isn't that peculiar? Let's take another example – $P(12)$

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
First string	1	2	3	4	5	6	7	8	9	10	11	12
Second string	1	2	3	4	5	6	6	5	4	3	2	1
Third string	1	2	3	3	2	1	1	2	3	3	2	1
Fourth string	1	2	1	1	2	1	1	2	1	1	2	1

It seems, that for the profile of a number like twelve, which itself is $4 * 3$, it's simply just the profile of three...four times!

The pattern is as such: the profile of an even number, n, looks like the profile of n without all of its factors of two, which is repeated as many times as there are powers of 2. Why does this occur?

To understand how to simplify tracking matrices, things have to get *abstract*. Tracking matrices are produced by taking the first number and matching it with the highest number. Then, these two numbers are put in the first slot in the new string. By slot, I mean left-to-right order, where the first slot is the first number when read from left to right. In the example below, 1 is the lowest, and 6 is the highest. These two are combined, and in the second string, now fill the first slot.

	x_1	x_2	x_3	x_4	x_5	x_6
First	1	2	3	4	5	6
Second	1	2	3	3	2	1
Third	1	2	1	1	2	1

The next step is to take the second number and match it with the second highest number, putting it under the second slot in the new string. This process is repeated: the nth number and the nth highest number get put into the nth slot in the new string.

This occurs in two flipped strings of length $n/2$ being created, where n is the length of the original string. Here, that means two strings of length three, formed from the total of six.

The two new strings of length $n/2$ can be looked at and treated individually, either being divided by two if even or applying the algorithm if odd. In our example of $P(6)$, we completed the profiles of the two pairs of three just like we would do with just one string of length three. The two strings don't interact with each other – all that matters, is that there is a lowest number and a highest number to apply the folding algorithm on. In our example of $P(12)$, after ending up with two strings of length six, we divided once more, ending up with four instances of $P(3)$

Eventually, you end up with an odd string repeated by the amount of times you divided by two. Mathematically, this means that the profile of an even number n can be described by k repetitions of $n/2^k$, where k is the amount of powers of two that go into n.

4 Odd strings

Let's examine the pattern for odd strings. Side by side, look at the profiles for 5 and 6.

	x_1	x_2	x_3	x_4	x_5	x_6
First	1	2	3	4	5	6
Second	1	2	3	3	2	1
Third	1	2	1	1	2	1

	x_1	x_2	x_3	x_4	x_5
First	1	2	3	4	5
Second	1	2	3	2	1
Third	1	2	1	2	1

What do you notice? Well I notice, that $P(5)$ looks oddly like $P(6)$, with the middle column missing. Here, by middle I mean $n/2$ (so in our case, $6/2 = 3$). It's no good to go off of one example, though. Here's another:

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
First	1	2	3	4	5	6	7	8
Second	1	2	3	4	4	3	2	1
Third	1	2	2	1	1	2	2	1

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
First	1	2	3	4	5	6	7
Second	1	2	3	4	3	2	1
Third	1	2	2	1	2	2	1

Again, taking the middle (fourth) term out of $P(8)$ gives $P(7)$.

Imagine a string of odd length, m, and the even string after it, $m + 1$. The pattern observed here, is that $P(m)$ is equal to $P(m + 1)$, just without the middle column. To say it is one thing: how do we *prove* it?

For this to be true not only on paper, but in our heads as well, we must understand just one logical connection. This is the idea, that it doesn't matter, whether we have two elements or one in the last slot after folding once. The crucial part is that that slot exists.

Looking at the profiles for eight and seven, after the first fold, four new slots exist in both profiles. In $P(8)$, two elements, x_4 and x_5, inhabit the fourth slot, whereas in $P(7)$, only one element, x_4, inhabits the fourth slot. But at the end of the day, there are 4 slots, which will undergo folding identically. The only difference is that there's one less number in the last slot for $P(7)$ after folding once, meaning that there's one less column to consider.

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
First	1	2	3	4	5	6	7	8
Second	1	2	3	4	4	3	2	1
Third	1	2	2	1	1	2	2	1

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
First	1	2	3	4	5	6	7
Second	1	2	3	4	3	2	1
Third	1	2	2	1	2	2	1

5 Constructing every profile. Ever.

The brute force folding algorithm for constructing profiles is known to us already. However, say we want to find $P(51)$. Surely you wouldn't want to spend *all day* drawing strings to find out its profile?

Before, we defined that a string of even length, say n, can be profiled as a repetition of the profile of $n/2^k$ repeated k times, where k is the amount of factors of 2 found in k. We also defined that a string of odd length, say m, can be profiled as $P(m + 1)$, with the middle column removed.

That means that an even string is a repetition of an odd string. It also means, that an odd string is an altered version of an even string.

From that we can infer, that to figure out an unknown profile, we could enter a loop of adding one and dividing by two, hoping that we reach a "base profile" which we know for sure. What do we set our base profile to be? Could we get stuck in some loop, like in the Collatz conjecture? I boldly make the claim: knowing $P(4)$ and $P(1)$ everything else can be figured out.

This is the beautiful, gorgeous **profile of four**!

	x_1	x_2	x_3	x_4
First	1	2	3	4
Second	1	2	2	1

This is the trivial $P(1)$.

	x_1
First	2

Counterintuitively, it goes to the second, and not the first slot, because here, the second slot represents the 1's digit. Having just one number, say 5, the folding algorithm is completed instantly: you slap on a percentage sign, and you're done – 5%.

Dividing $P(4)$ by two, we come to $P(2)$:

	x_1	x_2
First	1	2

Removing the middle (second) column from $P(4)$, we get $P(3)$:

	x_1	x_2	x_3
First	1	2	3
Second	1	2	1

The first step to our proof is considering the operations that we are given:

- If a string is even, to profile it we divide it by two and look at what's left;
- If a string is odd, to profile it we add one and look at the even string one element longer than it.

We can divide by two multiple times in a row, such as in $P(32)$: $32 \to 16 \to 8 \to 4$. We cannot, however, add one multiple times in a row. Adding one to an odd string will make it even, meaning that afterwards we'll have to divide by two. This means there is an overall downward growth in string size – we can divide by two more often, and simply, dividing by two has more of an effect on a number than adding a one.

Next, we need to show, that during this downward process, we don't "skip" over four and land, on let's say, two.

5.1 P(1)

To obtain $P(1)$ from one of our functions, it would have had to be division by two, because addition would imply we reached $P(0)$ through addition and division beforehand – that is impossible. However, dividing $P(2) = 12$ by two gives 1 and not 2, meaning that $P(1)$ is unobtainable and therefore a trivial base case.

5.2 P(2)

$P(2)$ could not have come as a result from adding to $P(1)$ (as it cannot be reached), and therefore, must have come from the division of $P(4)$.

5.3 P(3)

$P(3)$ can be described as $P(4)$ minus the middle column.

5.4 Conclusions

Therefore, if $P(1)$ is unreachable, if $P(2)$ must have been reached from $P(4)$, and if $P(3)$ will reach $P(4)$, with a downward trend, every unknown profile will eventually be defined by our gorgeous base case: $P(4)$.

Let's take, as an example, the aformentioned $P(51)$

1. $P(51)$ is one off from $P(52)$;

2. $P(52)$ is two copies of $P(26)$;
3. $P(26)$ is two copies of $P(14)$;
4. $P(14)$ is two copies of $P(7)$;
5. $P(7)$ is one off from $P(8)$;
6. $P(8)$ is two copies of $P(4)$.
7. $\therefore P(51)$ is constructible from our base case.

Something as silly as a middle school love game I saw on TikTok took me on this wondrous journey, however, there were many avenues I didn't wander down. What happens when the sum of elements reaches above 9? Does it loop back? What does that entail? How does switching the order of the names change the final percentage? Is there a relationship between those percentages?

Then, do you see it? Do you see the beauty of mathematics, dear reader?

6 Revelations! Insights! Magic!

$$
\begin{array}{r}
Tara \quad Math \\
\cancel{T}\cancel{a}r\cancel{a} \quad M\cancel{a}\cancel{t}h \quad 231 \\
\cancel{T}\cancel{a}\cancel{r}\cancel{a} \quad \cancel{M}\cancel{a}\cancel{t}h \quad 23111 \\
\cancel{2}311\cancel{1} \to 3 \\
\cancel{2}\cancel{3}1\cancel{1}\cancel{1} \to 34 \\
\cancel{2}\cancel{3}\cancel{1}\cancel{1}\cancel{1} \to 341 \\
\cancel{3}4\cancel{1} \to 44\%
\end{array}
\qquad\qquad
\begin{array}{r}
Tara \quad Maths \\
\cancel{T}\cancel{a}r\cancel{a} \quad M\cancel{a}\cancel{t}hs \quad 231 \\
\cancel{T}\cancel{a}\cancel{r}\cancel{a} \quad \cancel{M}\cancel{a}\cancel{t}\cancel{h}\cancel{s} \quad 231111 \\
\cancel{2}3111\cancel{1} \to 3 \\
\cancel{2}\cancel{3}11\cancel{1}\cancel{1} \to 34 \\
\cancel{2}\cancel{3}\cancel{1}\cancel{1}\cancel{1}\cancel{1} \to 342 \\
\cancel{3}4\cancel{2} \to 54\%
\end{array}
$$

A compelling argument for me to study mathematics in the UK, and not *math* in the US...a compelling argument indeed.