Math Diversion 1043

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> The greatest killer of creativity is interruption.
> — John Cleese

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Source: https://www.youtube.com/watch?v=ptHnqpKn2s0
Title: Can You Find the Numbers in This Impossible
    -Looking System?
 Presenter: Math Queen
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1 Problem

Let a, b, c be elements of the nonnegative integers (i.e., $a, b, c \in \mathbb{Z}_{\geq 0}$). Find definitive values for a, b, c consistent with

$$a + bc = 2024\,, \tag{1a}$$
$$ab + c = 2023\,. \tag{1b}$$

2 Solution

What heuristic applies here? We could perform some operation that gets rid of the big integers for a smaller integer and then trust to our luck that that will lead us to the answer. (If not, we can try something else.)

So, we could subtract (1b) from (1a), to get

$$a + bc - (ab + c) = 1\,, \tag{2}$$

which, after a bit of algebra, reduces down to

$$(a - c)(1 - b) = 1\,. \tag{3}$$

Great! This is wonderfully constrained. Both factors are either $+1$ or -1. We must be on the right path.

If both factors are equal to unity, then $b = 0$ is forced, and that makes $a = 2024$ and $c = 2023$. But if both factors are negative one, making $b = 2$, then the original equations morph into two equations in two unknowns, which can be algebraically solved, to get $a = 674$ and $c = 675$.