

Unlock the Box

By Nicholas Dwork

I teach a class in engineering to advanced high school students as part of Stanford's Pre-Collegiate Summer Institute program. It's an amazing program, and I have loved being a part of it. I start my class with an activity that I call "Unlock the Box." This document is a set of instructions to recreate that activity for your own classroom / party / event.

If you have any questions or suggestions, please feel free to email me at ndwork@stanford.edu. If you run the puzzle and have a story or two to share, I would love to hear those as well.

Setting up the Puzzle

Materials Required:

- A bag that you can lock on the outside (I was able to find a zipper bag that allowed me to put a small lock through the two zippers)
- 1 pair of nunchucks
- 1 yellow filter
- 2 small three digit combination locks
- 1 Master Lock Speed Dial Combination Lock (importantly, rather than using numbers, this lock gets unlocked by moving a disc in one of four different directions: up, down, left, or right)
 - https://www.amazon.com/Master-Lock-1500iD-Combination-Assorted/dp/B002TSN4SQ/ref=sr_1_8?ie=UTF8&qid=1470329100&sr=8-8&keywords=lock
- 1 lockable treasure chest
- 1 lockable box that unlocks with a small key (I found a pencil case that worked great)
- 1 Puzzle box with two compartments
 - https://www.amazon.com/DoSmart-Wooden-Secure-Secret-Drawer/dp/B01H6IKGSE/ref=sr_1_16?ie=UTF8&qid=1470329204&sr=8-16&keywords=puzzle+box
- 1 case that can be locked with the Master Lock (I used a small gun case for this)
- 1 invisible ink pen
- 1 very small blacklight
- Some 3x5 cards and some envelopes

Preparations:

The Master lock requires four directions in a specific order in order to get unlocked. Rather than up, down, left, right, the directions are revealed as north, south, west, east.

1) Lock the (empty) gun case with the master lock. Place this inside the bag.

2) Create a sheet that goes in the picture frame with the following text:

Somewhere in this bag is a locked box with a treasure inside. Your goal is to get to the treasure.

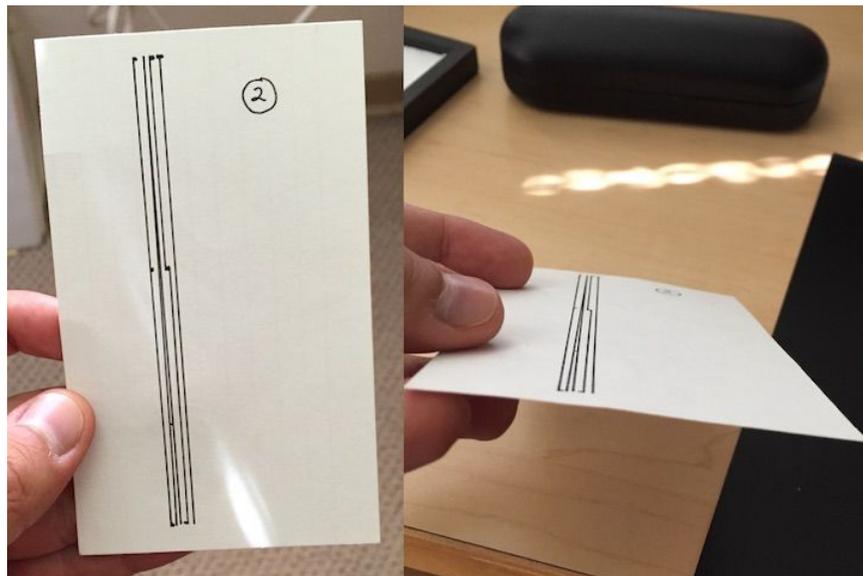
Investigate everything (but please don't break anything).

$$x^2 - 36x + 226$$

P.S. Calculators and phones are not allowed.

Place this sheet inside the picture frame.

Behind this sheet, will be placed a 3" x 5" card. Put a number 2 in a circle on the card. There is text written in long skinny letters on this card. When looked at normally, you can't read the text. But when viewed from an extreme angle, the text becomes clear. Here's what it looks like:



Place this card behind the sheet in the picture frame. Close the frame. It will be stood up behind the bag upon entrance.

The roots of the quadratic equation in the frame are 8 and 28. The code for the lock that will be used to lock the bag is 8-2-8.

- 3) On a piece of paper, write the following:
 Solve this to proceed:
 Find the value of $1 + 2 + 3 + 4 + 5 + \dots$
 Hint: the answer is not infinity.

At the bottom of this paper, in invisible ink write "There's nothing here to help you."

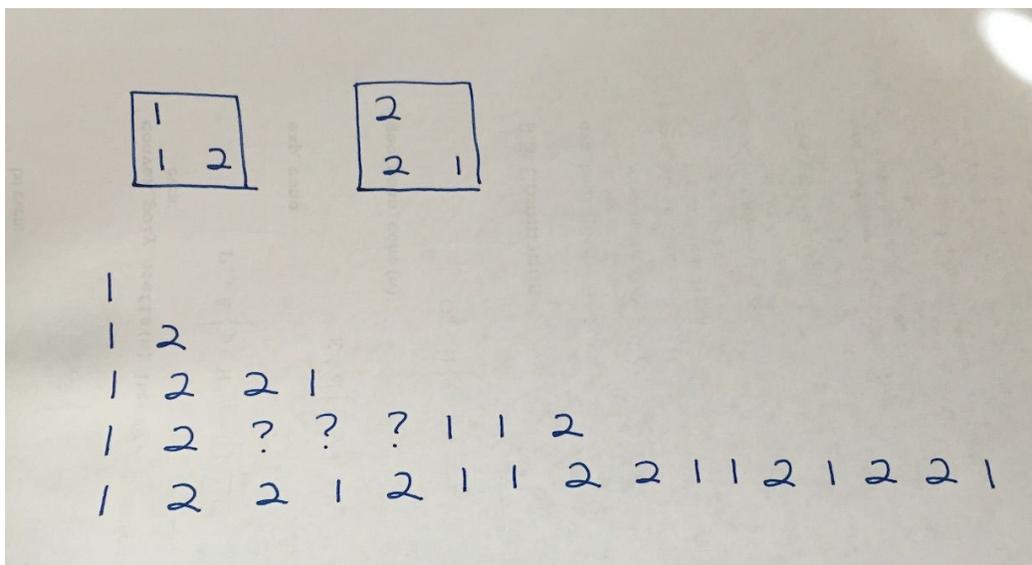
Fold this paper into an origami crane (or a paper airplane), and put this paper into the bag.

- 4) On a piece of paper write the following
 Chance has put in our path a most singular and whimsical problem, and
 its solution is its own reward.
 - Sherlock Holmes

At the bottom of this paper, in invisible ink write "Compress twice to clear"

Fold this paper, put it in an envelope and put the envelope in the bag.

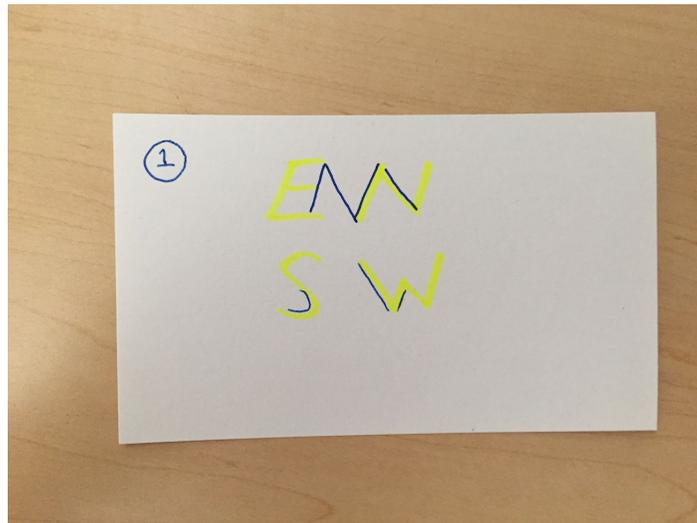
- 5) On another piece of paper, draw the following things:



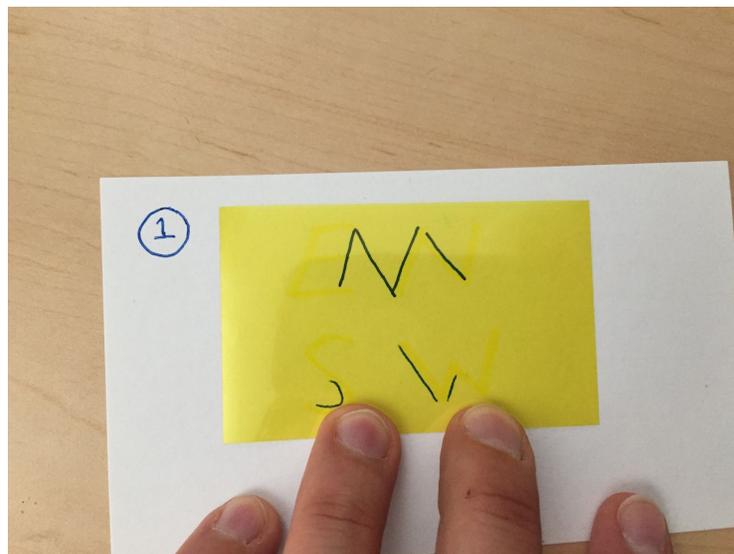
This is a mathematical construct called a Cellular Automata. (I've published an abstract on how to represent MRI signals using Cellular Automata.) The values that go in the question marks are 2-1-2.

- 6) Place the yellow filter in a treasure chest. Lock the treasure chest with a lock whose combination is 2-1-2.

7) Draw the following on a 3" x 5" card using a yellow highlighter and a blue pen.



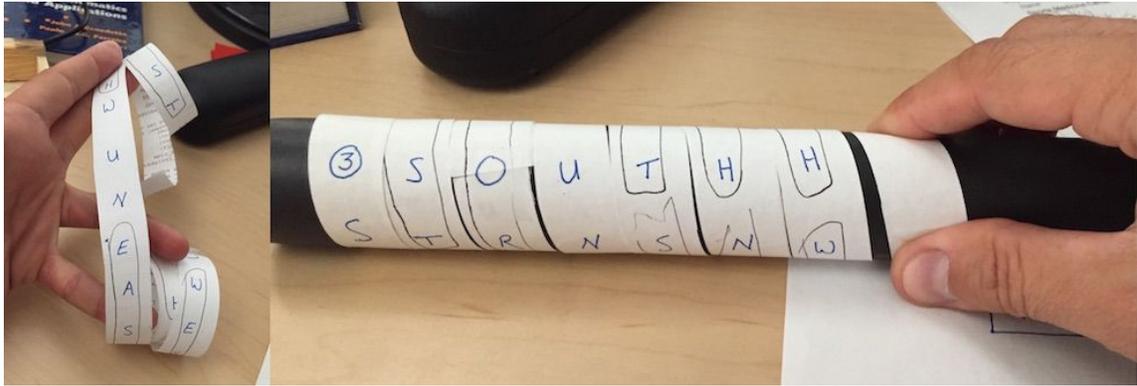
Now, watch what happens when the yellow filter is placed on top of the drawing.



The N, S, E, W disappear, and all that's left is this weird M. But M is just W upside down. So the first direction is West.

Place this card in the locked pencil box.

8) Create a long strip of letters from the words "East", "South", "North", and "West" that are evenly spaced. The more times you can write these words intact on the strip, the better. I did this by taping several cut pieces of paper together. The key is that when this strip is wrapped around a nunchuck, it displays the following:



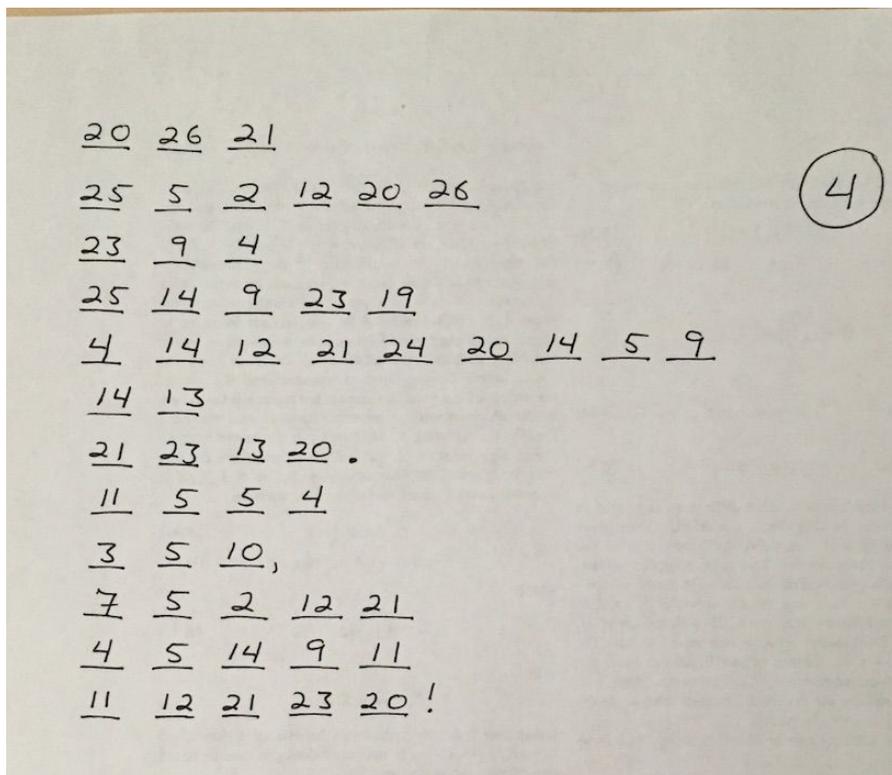
This is the clue that shows the third direction is South.

This is a very old type of encryption. Kings and lords would write letters to each other which you could only read if you had a rod of the same width.

Roll this paper up and put it in a compartment of the puzzle box.

Put the nunchucks in the bag.

9) Write the following on a piece of paper.



This is a simple cipher where there is one number for each letter in the english alphabet. Importantly, don't number the letters in order; that's WAY too easy.

Write the letters G, R, E, A, T under the last word of the message in invisible ink. With that, there's more than enough information to solve the puzzle.

The message reads, "The fourth direction is East. Good job, you're doing great!"

Fold this paper and put it in an envelope. Then put the envelope in the bag. This may be the toughest puzzle in the box. So if there's a pocket of the bag on the outside, put the envelope in there. Some players will be able to get to the code and start thinking about it early.

10) Place the black light in the other compartment of the puzzle box. And place the box inside the bag.

11) Place an impossibly difficult math problem on a sheet of paper and put it in the pencil box along with the clue.

12) Put a few random things inside the box. I used a medal from a race I was a part of, and a lanyard, and some clips, and some other gizmos. Beware, the players will find ingenious ways to get stuck on these superfluous items. They can consume a whole lot of the attention, so use them appropriately.

Put everything that remains inside the bag. Lock the bag on the outside with the lock that has combination 8-2-8.

Performing the Puzzle

The students will be given between 15 and 17 minutes to solve the entire bag. There should be about 5 minutes at the end for discussion. Though the puzzle is fun, it is greatly enhanced by several techniques.

1) Put the bag in the front of the room with the frame of instructions beside it, preferably on a table.

2) The bag and frame should be at the front of the room in plain sight of all of the students. Stand authoritatively near the front off to the side. The students will almost certainly dutifully

walk in and sit down in their seats. Don't say or do anything. Wait an uncomfortably long period of time. Just sit there and let everyone be silent. One of a few things will happen.

- A student will take the initiative to start solving the puzzle in spite of any lack of direction. In my experience, that student ends up performing very well in the class.
- A student will eventually ask something like, "So, what are we doing?" My response is something like, "I'm just standing here. But I don't know what you're doing when there's a puzzle right in front of you."
- The students will just sit there. After 60 or 90 seconds, I will say something like, "Ok, so why are you just sitting there?" At which point, the students will usually take the hint and get to work. If they don't, I have a short discussion about what assumptions they walked in with that led them to believe the best course of action was to sit there.

3) The students will ask all sorts of questions. Don't answer any of these. Don't even respond. Just let them ask and realize for themselves that you won't help them.

4) Almost inevitably, the students will be gathered around the table. They will be so congested that some students won't even have access to any puzzle. After about five minutes, I say something like, "There are a lot of puzzles in that bag, and you're not making much progress. Think about what's happening. What resources do you have available to you? Are you using those resources effectively? What do you personally have to do to better take advantage of these resources?"

5) At fifteen minutes without any warning I loudly announce "Everyone stop. It's over. Everyone put any part of the puzzle back on the table and sit down in your seats."

The true meaning and learning of the puzzle box comes during the discussion. Here are some highlights from my past experience:

- Ask them, "What just happened?" Listen to their responses; they will likely be interesting. Often, a student will answer "We failed." And I will say, "Why do you believe that? How do you measure success?"
- They come in with assumptions that makes them believe they should sit down and wait for instructions from a teacher. I say that these assumptions are amplified because "you are called a *student* and I am called a *teacher*. And I will tell you *the truth* and you will be tested on how well you remember the truths that I bestow upon you. But who am I? And why should you listen to me? Question everything.
- I ask the students what resources they have. They always say each other. I then asked if they effectively took advantage of that resource, and they never say that they did. Then we discuss why that was. After that, they struggle to identify resources. I inform them that the whiteboard in front of them, the papers and pens they brought in with them were resources, and the space of the classroom are extremely valuable resources that they didn't take advantage of. In particular, they didn't take advantage of the space, and this hindered them greatly.

- Often during the puzzle, a student will say a correct answer. But this won't be followed up; it'll disappear into the wind. Discuss this with them. Why didn't the group follow up on that particular idea? What would have had to happen in order to proceed with that idea?
- Sometimes, a student announces very creative and completely wrong ideas. This can lead to an interesting discussion.
- Sometimes, a student takes charge and effectively divides up the work among his teammates. This is beautiful to watch. Make note of this, and talk about how everyone felt while this was happening.

In general, there are lots of great discussions to be had. But, like the box itself, the goal is not to give them the ideas that you think are right. Instead, the goal of these discussions is just to prompt some ideas and get them thinking about these very unconventional thoughts.

Very importantly, don't give them any answers. Let them stew in their own discomfort of incompleteness. This alone has value. Later in the class, it gives you the opportunity to present the puzzle to them again. Every time I've done that, it's solved in just a few minutes. This leads to another interesting discussion; how was it solved so easily and why?

Finally, there is absolutely no wrong way to do any of this. The students will find exceptionally clever ways to solve some of these puzzles, or to get around solving some of these puzzles. Accept these surprising solutions as the gift that they are, and reward the students with a compliment for their creative thought during the discussion.

Best of luck! Again, if you have any thoughts or stories I would love to hear them. Please email me at ndwork@stanford.edu.