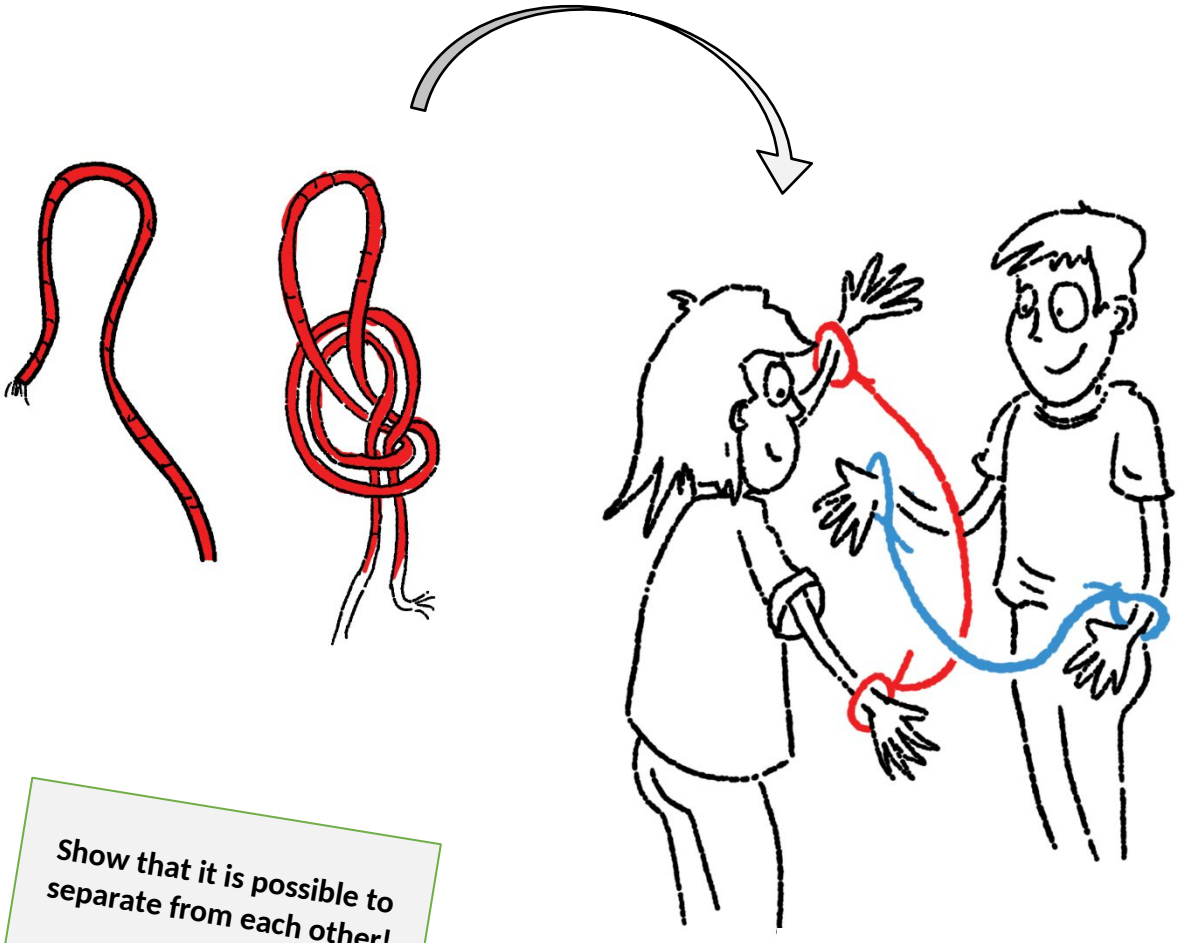
Crazy shapes

In this week's Pop-up Science edition, we are dealing with topology! Topology is a branch of mathematics that studies the deformation of bodies and their properties, so to say the science of crazy shapes. For example, it investigates which bodies can be transformed into other shapes by deformations such as squeezing, stretching, or pulling.

Game idea: Can you outwit topology? Prepare two ropes with a loop at each end. Two players then tuck their hands through one loop each. It is important that the ropes are placed on top of each other as shown in the picture below. Now, show that it is possible to separate from each other! You must not cut the ropes, and you must not take the hands out of the loops!



Show that it is possible to separate from each other!

Illustrations by Andy Gray, http://kidzministry.org/2010/03/assembly-idea-being-there-for-one-another-help-working-together-community/

A. Read the following text and underline the most important pieces of information

Did you at the beginning also think that the riddle cannot be solved and that you cannot separate from each other? It looked like you were connected like chain links. Without cutting one rope, separation seemed impossible. But did you discover the trick? Were you able to separate?

Here is the trick:

Thread a loop of red rope through the loop of the blue rope with one hand tucked in. Then put this red loop over the hand and pull it through the blue loop. Now you are free without having to cut a rope!

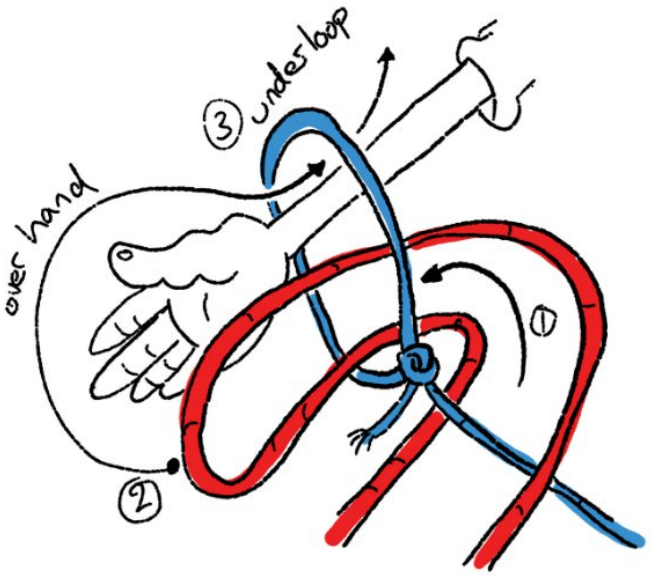


Illustration by Andy Gray, http://kidzministry.org/2010/03/assembly-idea-being-there-for-one-another-help-working-together-community/

You were not connected like chain links at all. You were separated all the time! The ropes were just wrapped around your hands in a way that it was hard to see! A topologist would say that your topology remained the same.

Topology deals with mathematical forms and tangled knots to better understand things. Everything that can be deformed into one another is equivalent. Equivalent here means equal in topology. In geometry, shapes play an important role. In topology, on the other hand, it is important that edges, knots and meshes are in a certain connection to one another. The shape itself is not so important. For this reason, a coffee cup can also be shaped into a donut! As different as these two objects are, they do have one thing in common. They both have a hole! In a coffee cup it is the handle and in a donut it is the hole in the middle. A donut can thus be

formed into a cup by stretching, compressing, and bending it. And vice versa! You can see here how this would look like:

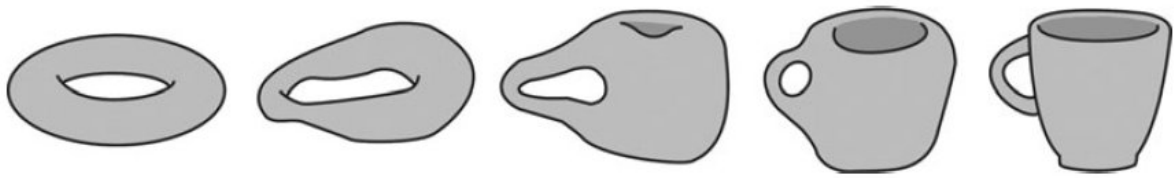


Illustration by Amin Saied, https://aminsaied.github.io/topology-and-data-analysis/introduction

Do you remember our video about crazy shapes on Monday? There it was different: we cut something, which changed the shape of the object completely. If you liked our video, you find a paper strip puzzle for advanced players on the following page!

B. Melinda and the magic stars

Once upon a time there was a fierce king who had no wife. Melinda was the most beautiful lady in all the land. The king had her brought to him. He wanted her to be his wife. But Melinda did not want to marry the king, because she had already promised her hand to another young man. So the king locked Melinda up in the dungeon. She was desperate, but then she remembered her grandmother. When Melinda was a little girl, her grandmother often enchanted her with fantastic stories and riddles. Then Melinda had an idea.

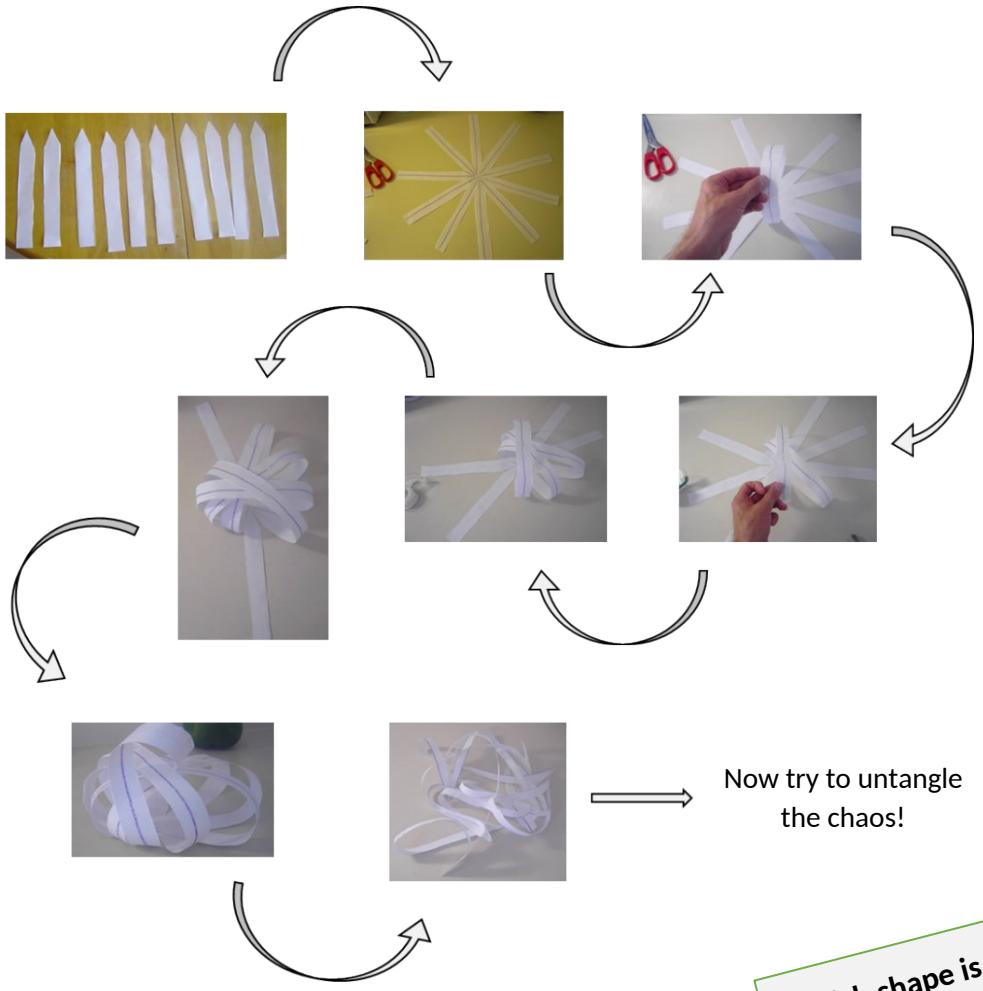
Melinda called the king to her and told him: "Your Majesty! Your power is greater than that of the stars in the sky. But what if I can conjure two stars from one star?" The king replied that this was impossible. Melinda offered him a bet : "Give me some paper and some scissors. If I can make two stars out of one, you will set me free. If I fail, I will marry you." The king agreed and sent his servants to bring her paper and scissors.

Melinda made a star, the rays of which she then entangled in a strange way. Then she began to cut the paper carefully with scissors. The king had to laugh, because the more she cut, the more tangled the paper strips became. He could already see that the beautiful lady would lose the bet. Melinda's hands trembled. But she thought of her grandmother, who had shown her the star puzzle when she was a little girl, and she calmed down again. Carefully she began to unravel the paper chaos.

When she had finished, she held two stars, which were linked together, in her hands: "That's my fiancé and me. We are meant for each other." Then the king realized that the beautiful lady had won the bet and he released her. Melinda married her fiance, and they lived happily ever after, looking at the stars together.

Can you transform one star into two, like Melinda did? Here's how it works:

1. Cut out 10 strips of paper of equal length. Then cut a tip at one end on each strip.
2. Draw a line along the middle of each strip and place them so that all the tips touch one other and a star is formed. Tape this star in the middle.
3. Now, glue the ends of opposite pairs of stripes together with tape. **Move forward in clockwise direction!**
4. When you have four of the five opposite pairs taped together, it gets tricky! The last pair needs a **full twist**. Turn the upper stripe that is facing towards you in a **counterclockwise direction, do a full turn**.
5. Now, cut along the drawn lines. Watch out that you do not cut a strip through!
6. This all looks like a big mess now. But if you untangle it, you will get two shapes! These shapes are linked! This link is called the **Hopf link**.



Now try to untangle the chaos!

Which shape is hidden in the mess?

Bearbeitet von https://toomai.wordpress.com/2008/05/25/more-experimental-topology-and-experiments-in-topology/

C. Try to answer the following questions.

Check the correct answers.

1. What is the meaning of equivalent?

   ☐ different ☐ equal ☐ similar

2. In geometry shapes play an important role.

   ☐ true ☐ false

3. In topology it is important that edges, knots and meshes are in a certain connection to one another.

   ☐ true ☐ false

4. In topology, a donut can be formed into a cup by stretching, compressing, and bending it. What is the important commonality of the two objects?

   ☐ Both objects have the same diameter.

   ☐ Both objects have the a hole. In a coffee cup it is the handle and in a donut it is the hole in the middle.

   ☐ Both objects have the same surface.

5. What is the name of the interface where both shapes from the paper strip puzzle are linked to one another?

   _____

6. Which shape did you get after untangling the paper strip puzzle?

   _____

D. Word search

Can you discover all the hidden word in our word search this time?

DEFORMATION	COFFEECUP	HOPFLINK
SHAPE	BENDING	COMPRESSING
TOPOLOGY	DONUT	MATHEMATICS
OBJECT	EQUIVALENT	STRETCHING

Circle each word. Good luck!

Z	X	J	Z	O	U	X	T	K	U	E	X	B	S	P	H	P	M	M	G
I	N	B	M	M	Y	K	H	Z	G	V	T	A	Z	U	K	U	H	H	D
S	Y	U	U	R	M	A	T	H	E	M	A	T	I	C	S	W	U	L	L
T	H	H	R	S	T	O	P	O	L	O	G	Y	B	E	P	E	Z	K	T
O	X	J	K	N	S	N	W	T	T	A	P	T	S	E	L	E	A	B	N
X	W	V	F	J	G	Z	P	U	U	D	C	C	I	F	D	F	R	G	E
M	N	D	H	O	P	F	L	I	N	K	M	X	Y	F	R	F	B	B	L
E	S	A	C	D	G	T	I	V	O	J	M	Q	R	O	O	L	H	C	A
A	T	R	E	B	A	C	U	L	D	I	A	Z	Y	C	E	Y	S	N	V
D	R	O	S	B	K	R	Q	N	G	Y	A	J	W	O	L	V	H	S	I
G	E	O	A	T	J	P	U	Z	N	S	L	N	R	G	B	M	U	N	U
U	T	F	Z	W	F	L	S	T	I	U	B	M	H	T	Z	J	A	A	Q
C	C	Q	O	N	O	C	Y	O	S	H	A	P	E	H	H	R	E	K	E
W	H	I	V	R	T	C	F	D	S	S	B	W	W	V	F	L	A	C	R
S	I	W	R	W	M	U	Q	Q	E	O	U	E	P	I	N	X	I	J	T
K	N	S	S	Q	E	A	U	Z	R	R	W	M	N	E	H	E	V	G	W
O	G	B	L	H	D	O	T	A	P	Y	R	T	U	D	B	Z	Y	Q	Q
C	G	M	V	K	B	X	S	I	M	V	S	U	C	F	I	V	V	G	F
R	S	G	I	R	J	L	O	H	O	R	O	S	G	D	H	N	X	N	J
D	K	X	Y	V	K	J	A	J	C	N	W	R	L	T	H	R	G	W	E

Source: https://www.suchsel.net