Topology: explaining memes and more

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Note: footnotes like [1] refer to the Sources section at the end.

1. Introduction

Picture 1: Topology meme of socks, cup of coffee, pants and shirt.

Take a look at this picture. Do you understand the joke? This essay focuses on **topology memes** similar to the image above, discussing the **definition of topology** and explaining **why topology is important**.

2. First of all, what is topology?

Topology

[, not to be confused with:

- **topography**, which is the study of land surfaces such as mountains, canyons, hills, plains, etc…
- **typography**, the art of arranging while changing letters and words to make them appealing or discernible, or
- **tautology**, referring to the repetition of unnecessary words, such as "free gift" (since gifts are always free) or "creative music" (since music is obviously, clearly, and plainly creative),]

is a branch of mathematics that studies the **properties** of a geometric object that are **preserved under continuous deformations**, such as stretching, twisting, or squishing.

Let me explain. Imagine that the object in question is made of a supernatural, infinitely stretchy clay that can be squished and pulled in any way possible, but cannot be cut, poked, or have two separate ends glued together. This will be our rule for today's explanations. [2]

3. Let’s get to the memes

“Wait no, I haven’t understood the definition of topology yet!”, you might think. Don’t worry, I’ll explain topology along the way and it will be much easier to understand with visual demonstration.

3.1 Socks

Picture 2: Topology meme of socks.

First, let's analyze the socks. Imagine an item made out of modeling clay in the form of a sock. Next, without cutting, poking a hole or gluing two separate ends together, squish it flat. Make sure to leave the opening of the sock intact so the two sides of the opening don’t close, which violates the rule that you can’t glue two ends together. Continue squishing until you have a disc shape, as shown in the picture.

Do you understand this part of the meme now? In topology, socks and flat discs are essentially the same.

Picture 3: Topology meme of Earth and Flat Earth.

In this meme, you can see that a clay Earth can be squished flat to make a flat earth without cutting, poking a hole, or gluing 2 separate ends together. Vice versa, a flat Earth can be stretched to make a spherical Earth.

French mathematician Poincaré concluded, if you took any shape (that has **no holes**), and it is **bounded** (does not go on forever), then you could squash it into a sphere. [2]

3.2 Cup of coffee

Picture 4: Topology meme of a cup of coffee.

Before I explain the joke to you, try to think how this joke makes sense.
A cup of coffee has a drinking portion, which doesn't have a hole, and the handle, which does.
Now try to squish the drinking portion like you squished the sock, leaving the handle intact. You will get a disc with a handle.
Then, if you press the disc down onto the handle, you will create a donut-shaped clay piece, just like in the picture. [2]
If you understood the joke above, you will understand the joke below too.

Picture 5: Topology meme of cup of coffee and donuts.

3.3 Pants (or trousers)

If you understood my explanations above, well done! It is going to be easy to understand the pants picture.

Picture 6: Topology meme of pants.

Try to explain this to yourself using the logic I have used above.
Method A: If we imagine pants made out of the supernatural clay mentioned before, we can compress the legs (the tubes where your thighs, knees and calves go) carefully so that the pants turn into the double-donut above.

Method B: Imagine wearing this clay double-donut like you would with normal pants, pulling it up to your waist (or hip, wherever you wear pants), and then stretching the clay around your leg down to your ankle to get stylish clay pants.

https://www.geogebra.org/m/yjtjxr2n
Try this simulation made by Sam Hartburn.

3.4 Shirt

Picture 7: Topology meme of a shirt.

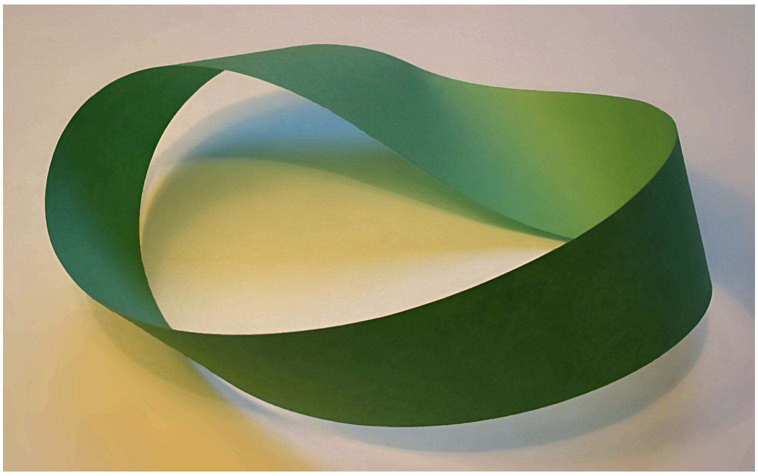
How the heck does a shirt have 3 holes? How??? They clearly have 4 holes, right?

Try thinking about how this works. It's gonna take some time.
By stretching the bottom opening, you can transform the clay shirt into a flat piece of clay with three holes.
To explain this in a simpler way, take a (real) shirt, put it on the floor and do the following steps:

1. Spread the bottom opening out on the floor, with the head-hole and sleeves facing upwards
2. Push the head-hole and sleeves down on the floor so that you can see all of them at once
3. You should be able to imagine a flat disc with 3 holes on top.

The arrangement of these holes in the picture above has simply been altered.

4. That weird loop (Möbius strip)



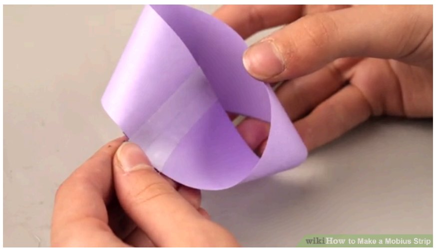
Picture 8: Möbius strip.

You might have seen this object. It's called the **Möbius strip**, but you might not understand why it has its corresponding properties.
First of all, isn't this just a donut?
Well no. For topology, the thickness of a Möbius strip is not significant and is not taken into account.
On the other hand, real life objects must have thickness. That means that Möbius strips in real life are just representations of the mathematical shape.
The properties of this shape:

4.1 The Möbius strip has only one face

Terminology: "strip" or "band" will be used to describe the Möbius strip, "piece" will be used for the initial, unlooped piece of paper, "face" is the surface of a 3D shape.

Before we start, cut a long piece of paper and fold 2 ends together BUT with 1 end upside down. Tape those ends together and you should get an object similar to the picture. The band should have ONE half-twist.



Picture 9 and 10:Pictures of Möbius strip being made. (credit: wikiHow)

Use a pencil and trace a line in the centre of the face of the strip. You will loop the band twice and will end your line where you started.

Notice that every side of the band is drawn. That is counter-intuitive but you just have to accept that the Möbius strip has one face only.

The reason for this property is that a face of the original piece of paper does a half-twist, joining with the other face of the paper.

4.2 The Möbius strip has only one edge.

Now use a highlighter to draw a line on the edge of the Möbius strip. You will loop the band twice and will end your line where you started, just like the centreline.

Notice that both edges of the band were drawn without you lifting your highlighter. This proves that Möbius strips have only one edge.

The reason for this property is that an edge of the original piece of paper does a half-twist, joining with the other edge of the paper.

5. Why is topology studied?

If topology is like a game for imagination and memes, why is it studied?

Topology is studied because it helps to understand the basic structure of objects, moving beyond rigid geometry. By focusing on connectivity rather than size, shape or colour, it allows researchers to simplify complex systems into their most basic forms.

In **robotics**, this helps map out feasible movement paths by identifying holes or obstacles in a configuration space.

In **biology**, the importance of knot theory lies in understanding the processes involved in the winding and unwinding of genetic molecules by enzymes.

TDA (topological data analysis) may be employed to detect hidden patterns within extremely large datasets that would otherwise go unnoticed by humans.

In **physics**, topology accounts for the stability of quantum states, thus laying the groundwork for computing. [3]

For instance, the 2016 Nobel Prize in Physics was awarded to scientists who utilized topology in studying unusual electrical properties in materials, eventually developing innovative quantum materials.

Möbius strips specifically are used for conveyor belts and recording tapes. Because they only have one side each, the band will wear evenly on both sides, making more durable belts. These shapes are also used in art and architecture, symbolising sustainability, infinity, or unity. [4)

Picture 11: Möbius strip at the Taichung Industrial Park.

Picture 12: Möbius strip as the symbol for recycling.

6. Conclusion

Thank you for reading to the end of the essay. I hope you learned something new today! Remember, what is mentioned here is just the tip of the iceberg of the wonderful branch of topology. If you're interested in topology, you could continue your journey with the Klein bottle, the three utilities problem, or the famous Königsberg bridge problem. Have fun exploring!

Here's an extra meme:

Picture 13: Topology meme of topology memes.

Sources

1. Prasolov, V V. Intuitive Topology. Providence, R.I., American Mathematical Society, 1995.
2. Berry, Nick. “Mathematics.” The Poincaré Conjecture, 2015, datagenetics.com/blog/may32015/index.html.
3. “What Is Topology?” Pure Mathematics, 16 Oct. 2015, uwaterloo.ca/pure-mathematics/about-pure-math/what-is-pure-math/what-is-topology
4. Keerthana Vengatesan. “Möbius Strip- a Two Dimensional Non-Orientable Surface – Shasthra Snehi.” Shasthra Snehi, 5 Oct. 2020, shasthrasnehi.com/Möbius-strip-a-two-dimensional-non-orientable-surface/.
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