

(I)

- TAKE OUT YOUR LAPTOP / CELL
- GO TO [HTTPS://EVAL.OLT.UBC.CA/SCIENCE](https://eval.olt.ubc.ca/science)
- FILL OUT EVALUATION FOR MATH 104

WE WILL FINISH COURSE ON WEDNESDAY
 ↙ HAVE A REVIEW NEXT WEEK

$$\frac{d}{dx}(\arcsin(x)) = \frac{1}{\sqrt{1-x^2}}$$

LAST TIME

$$\frac{d}{dx}(\arctan(x)) = \frac{1}{1+x^2}$$

$$\frac{d}{dx}(\arccos(x)) = \frac{-1}{\sqrt{1-x^2}}$$

TODAY WE WILL DEVELOP OUR CREATIVITY

BY DISCUSSING ONE OF THE TOPICS

CALCULUS LEADS TO: TOPOLOGY

(THE ONLY PREREQUISIT WILL BE: IMAGINATION)

TOPOLOGY

TOPOS GREEK FOR PLACES

IS THE STUDY OF THE SHAPE

OF ABSTRACT SPACES

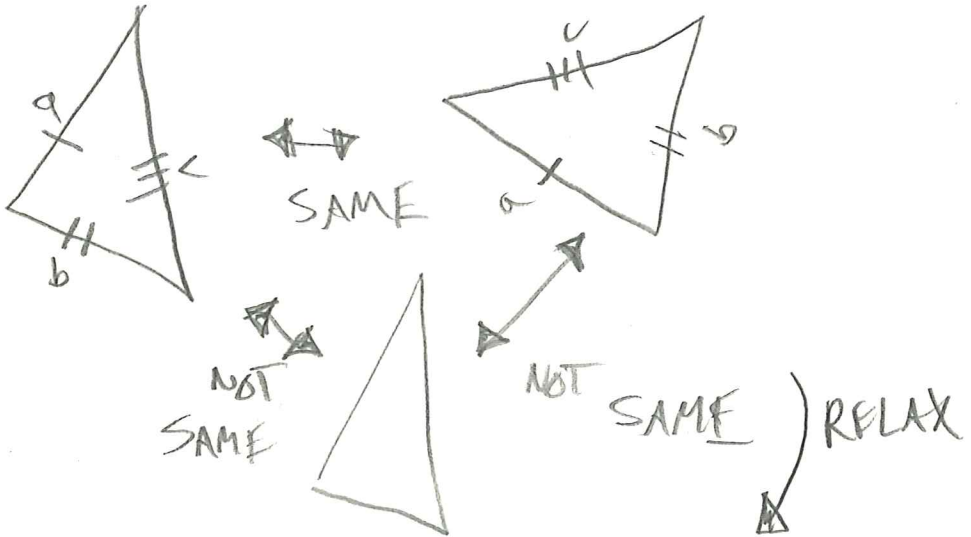
↳ A "RELAXED" VERSION OF GEOMETRY

WHERE DOES IT COME FROM?



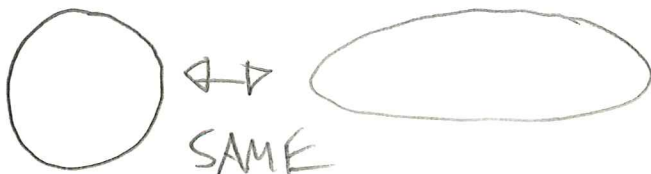
EUKLIDEAN GEOMETRY (NORMAL GEOMETRY)

TWO THINGS ARE THE SAME IF
THEY ARE CONGRUENT

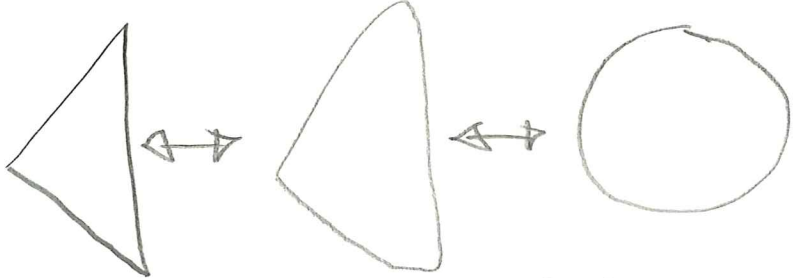


PROJECTIVE GEOMETRY

TWO THINGS ARE THE SAME IF THEY
ARE "VIEWS" OF THE SAME OBJECT



IN TOPOLOGY, WE SAY TWO THINGS ARE THE SAME IF (IMAGINING THEY ARE MADE OUT OF STRETCHY & CONTRACTIBLE PUTTY) THEY ARE CONTINUOUS DEFORMATIONS OF EACH OTHER (NO TEARING ALLOWED)



ALL SAME
 ↗ NOT SAME

RIGID MOTIONS vs CHANGE POV vs CTS DEFORMATIONS

—————▷ RELAX AXIS

[Q] WHAT IS AN ABSTRACT SPACE ANY WAY?

EX THE REAL LINE

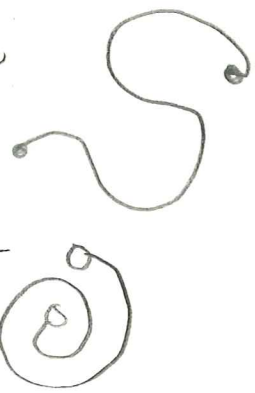
(IV)



A CLOSED INTERVAL

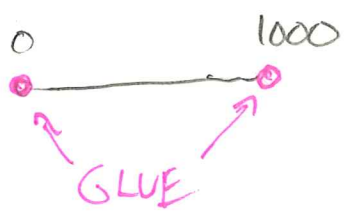


AN OPEN INTERVAL



THE SPACE OF VALUES YOUR CAR ODOMETER CAN TAKE

SAY ZERO TO 500,000
THEN IT CIRCLES BACK



THE SPACE OF POSITIONS

A NEEDLE ON A CLOCK CAN TAKE

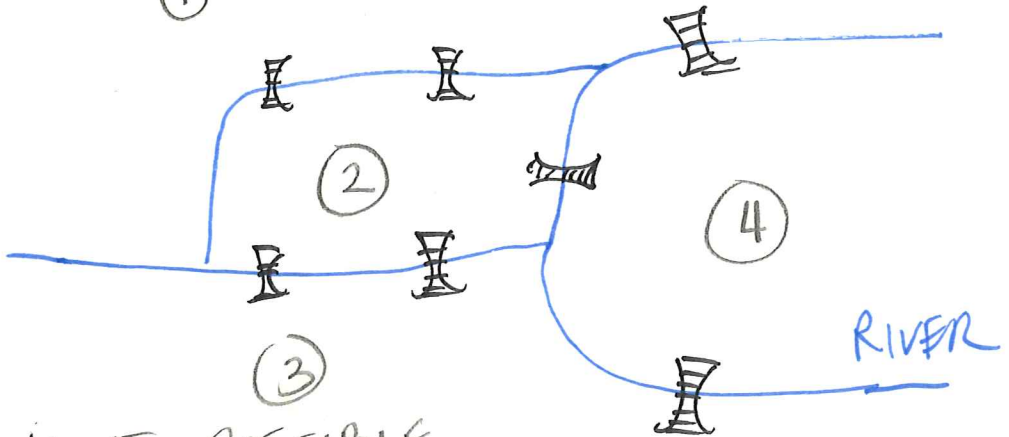
!!!
BOTH
A CIRCLE

TRAVELLING SALES MAN



↳ 1735 SEVEN BRIDGES OF KÖNIGSBERG

①

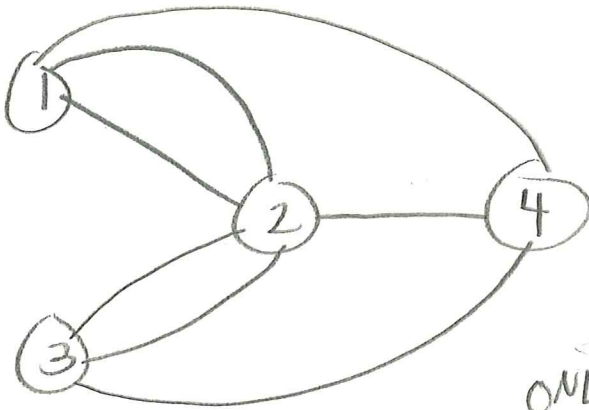


IS IT POSSIBLE

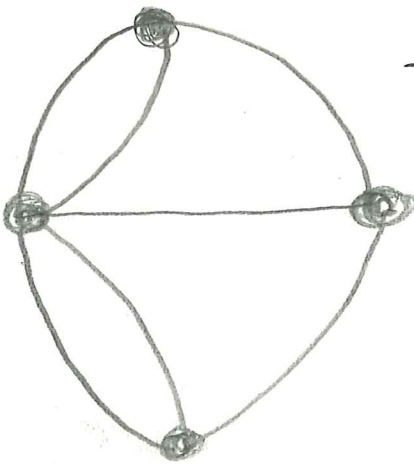
TO WALK THROUGH THE CITY AND
CROSS EACH BRIDGE EXACTLY
ONCE? (VISITING EVERY LAND MASS)

- OBSERVATIONS:
- PATH THROUGH EACH LAND MASS IS IRRELEVANT
 - ONLY THE SEQUENCE IN WHICH CROSS BRIDGES IS IMPORTANT

↳ BUILD A SPACE TO MODEL SITUATION

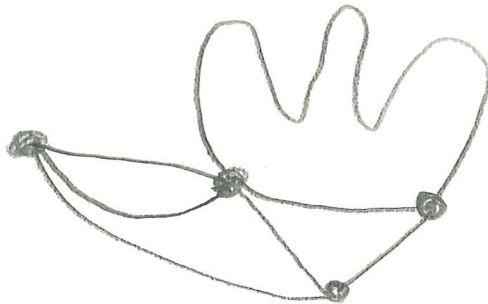


ONLY THE
PRESENCE / ABSENCE



OF EDGES
MATTERS

↳ NOT
THEIR
LENGTHS



OK ... BUT CAN WE SOLVE
THE PROBLEM NOW?

OBSERVE: EVERY TIME YOU

VII

ENTER A VERTEX BY A BRIDGE

MUST LEAVE THE VERTEX BY

A BRIDGE

⇒ FOR ANY PATH

$$\frac{\# \text{ TIMES ENTER}}{\text{A NON-TERMINAL VERTEX}} = \frac{\# \text{ TIMES LEAVE}}{\text{NON-TERMINAL VERTEX}}$$

⇒ IF A PATH CROSSING EVERY BRIDGE
ONCE EXISTS, EACH VERTEX

(EXCEPT INITIAL & TERMINAL)

MUST HAVE EVEN # OF BRIDGES

TOUCHING IT

⇒ IMPOSSIBLE

PROBLEM → ABSTRACTSPACE → SOLUTION

CRANK THINGS UP A NOTCH

VIII

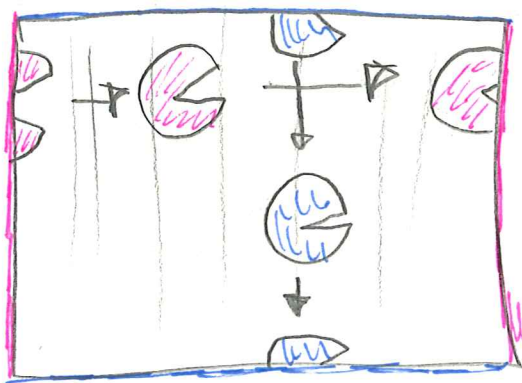
BEEEN TALKING ABOUT

1-DIM SPACES (BUILT FROM
PIECES OF LINES)

PASS TO 2-DIM SPACES

(BUILT FROM PATCHES OF PLANES)

EX) OLD SCHOOL ARCADE GAMES

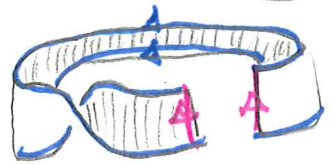
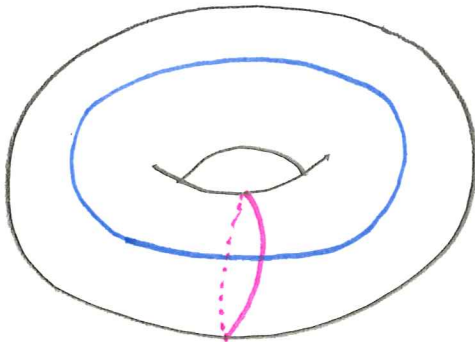
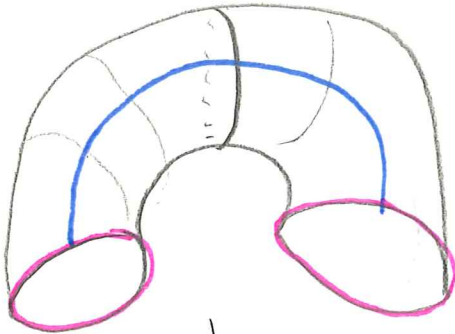
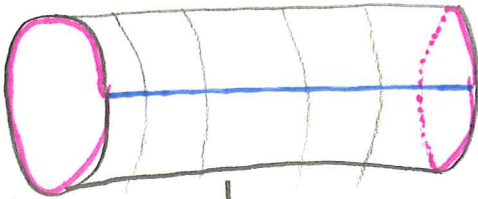
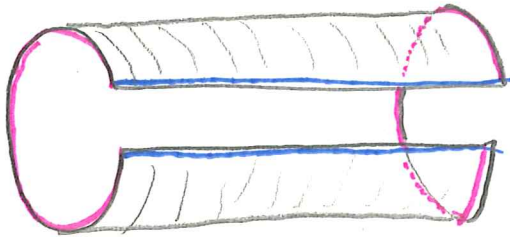


WHAT DOES PAC-MAN'S WORLD LOOK LIKE?

BLUE SIDES ARE GLUED

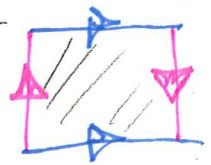
PINK SIDES ARE GLUED

WHAT DO WE GET?



CHALLENGE

↳ WHAT DO YOU
GET IF YOU
GLUE BLUE LIKE
HERE BUT FLIP
THE PINK
BEFORE YOU GLUE
THEM



PAC MAN
HAPPENS ON
THE SURFACE
OF A
DOUGHNUT₀₀₀

WE CAN PLAY SAME GAME



IN 3D IM ...

TAKE A SOLID CUBE (CLASSROOM)

& GLUE OPPOSITE SIDES

↳ MAYBE THE UNIVERSE IS A
3D TORUS !?! (NO ONE
KNOWS)

JOKING APART, TOPOLOGY IS ABOUT

CUTTING DOWN TO THE ESSENCE

OF THINGS; ONCE YOU

REMOVE UNNECESSARY "NOISE"

IT'S EASIER TO "SEE" WHAT

WAS IN FRONT OF YOU

ALL ALONG.

(OR, THERE'S MORE TO MATHEMATICS
THAN JUST NUMBERS)