Buffon's Needle

Task 1

1. Generate some lines.
2. Rotate the lines by 90°.
3. Use the (X,Y) of the initial lines and the rotated line as a square.
4. Iterate through the planks.
5. Check if the plank's X value is in between the largest and smallest. If it is then it's an intersection.
6. Count up intersections and divide it by number of planks thrown to get our probability.
7. Use this formula to get π.

$$\pi = \frac{nL}{KP}$$

- L is the square's side length
- K is each plank's distance from another plank
- P is my probability
- n is the number of sides on a square

This only works when $L < K$, when $L > K$ we treat each side of the square as an individual needle.

1. Get the smaller and larger X values of the individual lines
2. Check if the vertical line is in between the two X values.
3. If they are then we count it as an intersection and calculate our probability.
4. Use this formula to estimate π

$$\pi = \frac{2(x - \sqrt{x^2 - 1}) + \operatorname{asec} x}{P}$$

- L is needle length
- K is each plank's distance from another plank
- $x = \frac{L}{K}$

Task 2

1. Plot squares
2. Check for intersections
3. Check for non-consecutive intersections
4. Use this formula to get $\sqrt{2}$

$$\sqrt{2} = 2 - \frac{P(A)}{P(B)}$$

- P(A) is the probability of an intersection.
- P(B) is the probability of an intersection on non-consecutive sides.

Each point of the square has been labeled from 1 to 4 to the lowest and highest X values.

- In square 1 the line intersects between point 1 and point 2.
- In square 2 the line intersects between point 3 and point 4.

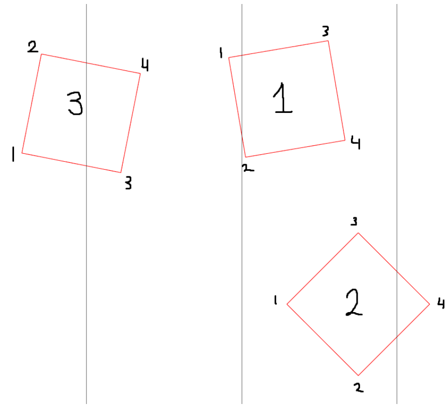

Figure 1: Consecutive Side Intersection

- In square 3 the line intersects between point 2 and point 3.

In both squares 1 and 2, the squares intersect on consecutive sides whereas on square 3 it's non-consecutive.

So, if a square intersects between point 2 and 3, then there's an intersection on non-consecutive sides.

Task 3

1. Plot random lines
2. Plot horizontal planks
3. Plot vertical planks
4. Test if vertical planks in between biggest/smallest X values
5. Test if horizontal planks in between biggest/smallest Y values
6. Count up intersections, calculate probability and use this formula.

$$\pi = \frac{4LK - L^2}{PK^2}$$

- L is the square's side length
- K is each plank's distance from another plank
- P is my probability

Task 4

Selecting needles

- If the user clicks on a needle select it
- If the user doesn't click directly on a needle:
  - Obtain the projection from the input vector (defined by mouse click) onto each line vector.
    - If projection is on the line vector use the distance from mouse click to the projected points.
    - If projection is not on the line vector use the distance from the mouse click to the line vector's points
  - Get the shortest distance and highlight that needle.

Selecting needles with a similar angle

1. When generating lines store angles.
2. Get angles.
3. Compare it to selected line's angle
4. If similar then highlight.

Computing needles producing the closest rays

1. Obtain projection from selected needle onto to every other needle
2. Find shortest projection(s).
3. Highlight the needles.

Drawing the rays

1. Get the needle's that produce the closest rays
2. Moved the needle to the origin
3. Extend the needle by a scale factor
4. Obtain X and Y values of the extended needle
5. Do the same for the mirrored needle
6. Plot the new X and Y values.

Task 5

- Generating triangles to estimate π.
- Plotting the estimates of π and $\sqrt{2}$ as we increase the number of plotted shapes.

Generating triangles

To generate triangles:

1. Generate a random line.
2. Rotate it by 60°.
3. Use that new line's end point as the final point.
4. Sort the X values from lowest to highest.
5. Check if the lines are in between the highest and lowest X values.
6. Use formula to calculate π

$$\pi = \frac{nL}{KP}$$

- L is the square's side length
- K is each plank's distance from another plank
- P is my probability
- n is the number of sides on a triangle

Plotting π and $\sqrt{2}$ as throws increases

For this I run many simulations and plot the results as the number of throws increase.

(a) π plot

(b) $\sqrt{2}$ plot

Figure 2: Plotting estimates from n = 10 to n = 10000