Congrès MATh.en.JEANS de NICE 2021
Jeudi 20 mai ou vendredi 21 mai

8.Volume of a tree

Lycée Val de Durance
Lycée Bellevue in Alès
Colegiul Național „Emil Racoviță”

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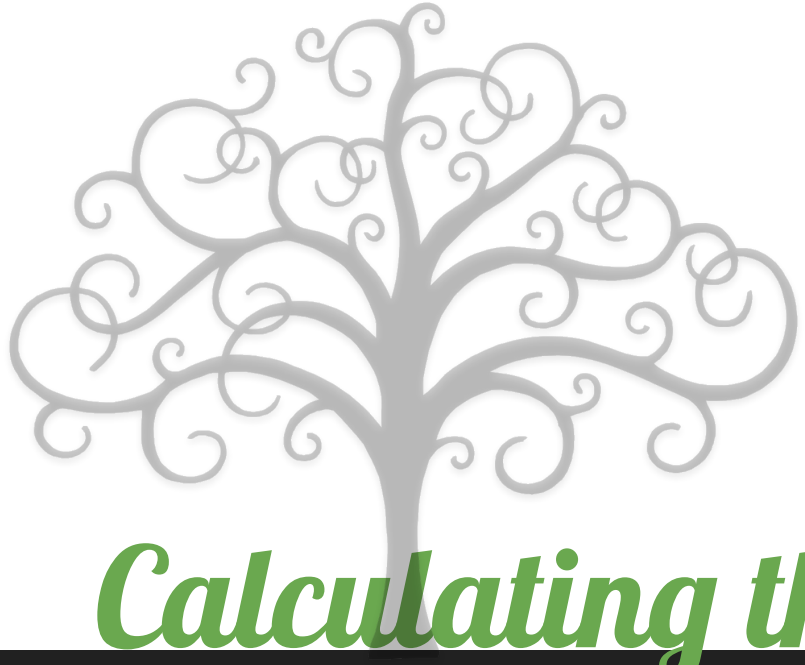
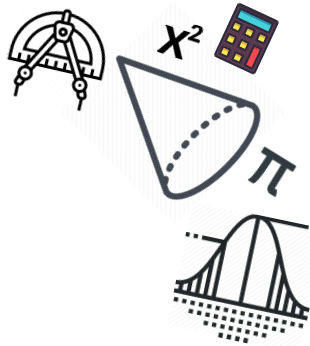
Anna COSTE, Laura SUMARRIVA, Jules GRASSO, Isaac MICHIELS, Tudor RADU, Amalia HAȚEGAN, Cătălin GAVRILĂ





Calculating the Volume of a Tree

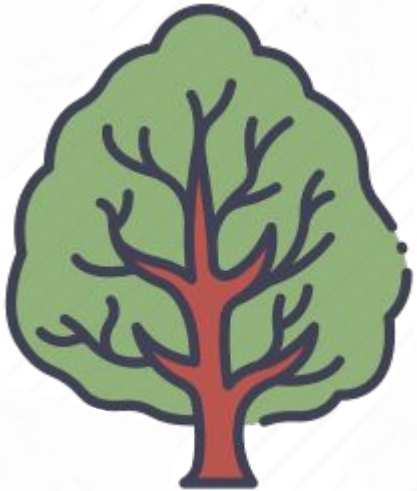
Hațegan Amalia
Gavrilă Cătălin
Radu Tudor

The Steps We'll Be Following

We will be calculating the volume of:

- ❑ the trunk
- ❑ the branches
- ❑ tiny parts of the tree
- ❑ leaves

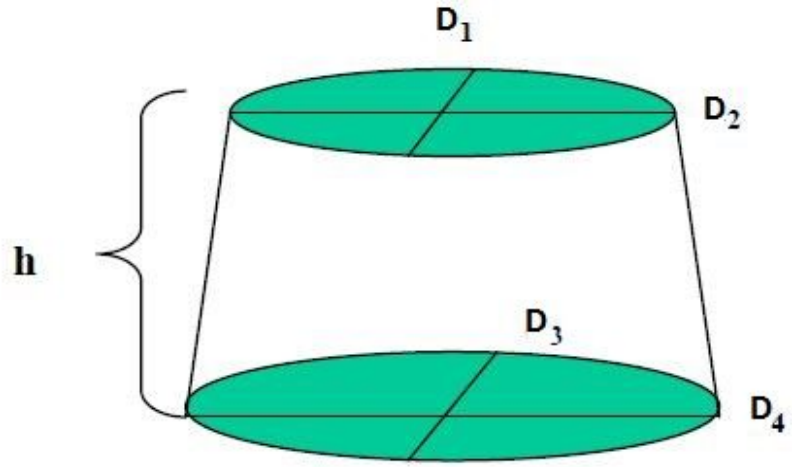
➽ To calculate the weight we will multiply the volume by its density



The volume of the trunk

- we will need this formula to calculate the volume of the trunk:

$$V_{Trunk} = \frac{\pi h}{3}(R^2 + r^2 + Rr)$$

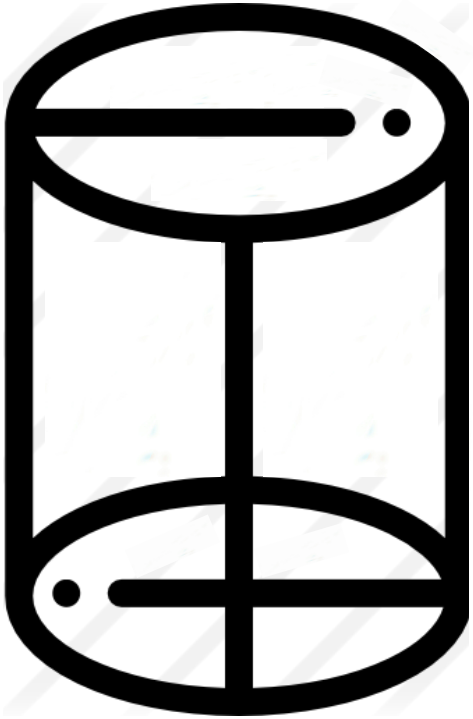


The branches

There are 2 possible shapes that a branch can have:

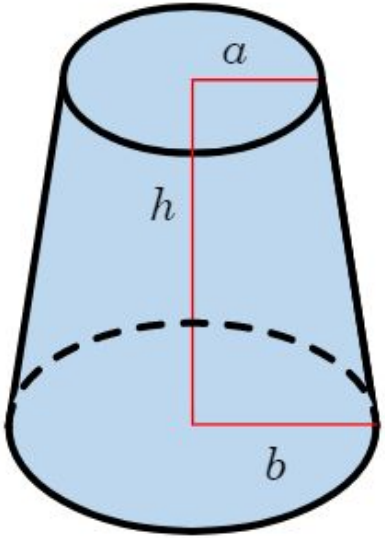
- ❑ cylindrical
- ❑ cone trunk

The volume of the cylindrical branches



$$V = \pi R^2 H$$

The volume of the truncated cone-shaped branches

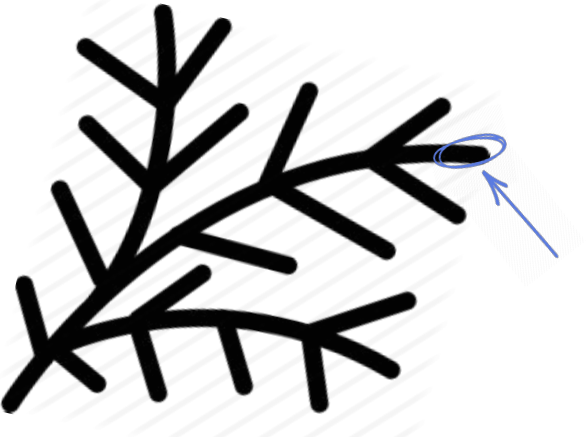


Formula used:

$$V = \Pi h(R^2 + r^2 + Rr)/3$$

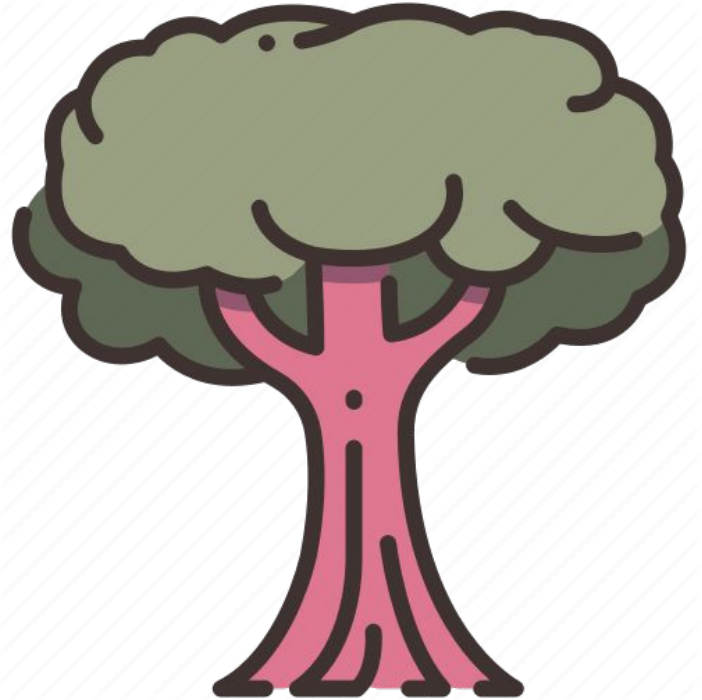
THE VOLUME OF TINY PARTS OF THE TREE

We consider that tiny parts of the tree are the bits that have the diameter of at least 1 cm and maximum the 0.25 times the diameter of the branch that it originates from.



$$V = \pi R^2 H$$

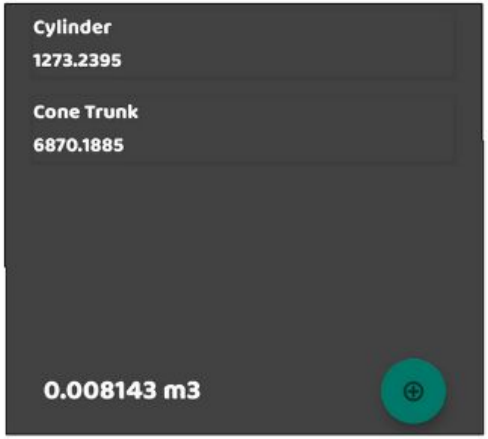
The volume of the leaves



After examining around 3 trees, we've found out that the volume of the leaves is roughly 10% of the volume of the tree.

$$V_{Leaves} = \frac{1}{10} * V_{Tree}$$

APP



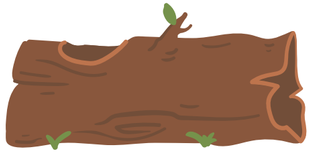
8. The volume of a tree

By Anna COSTE and Laura SUMARRIVA

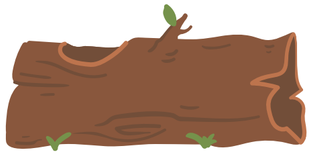
To calculate the volume of a tree, we have to determine the volume of :

1 . The trunk
2 . Branches
3 . Leaves and needles

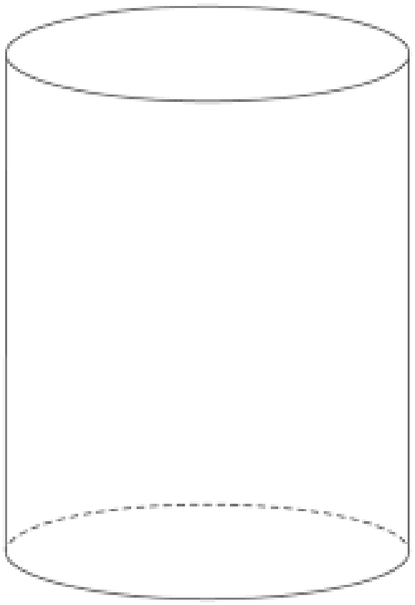
And then we will calculate its density



The trunk

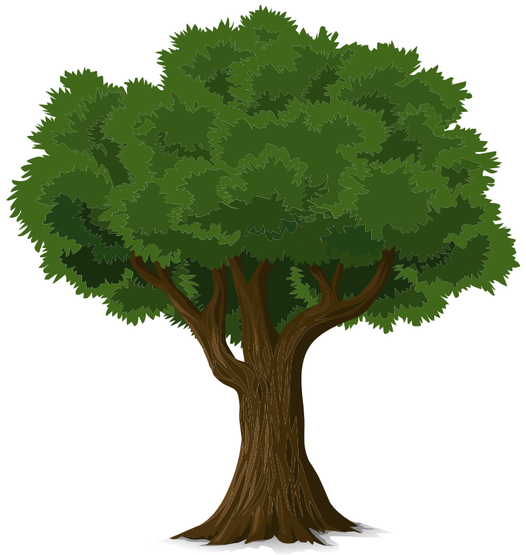


We spotted two trunk shapes :



Cylindrical

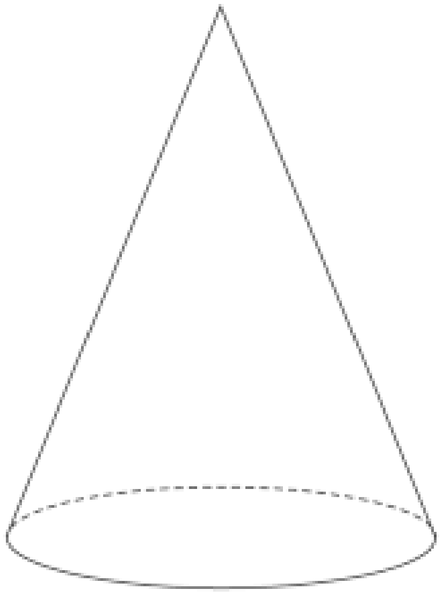
$$V = \pi \times R^2 \times h$$



Deciduous trees

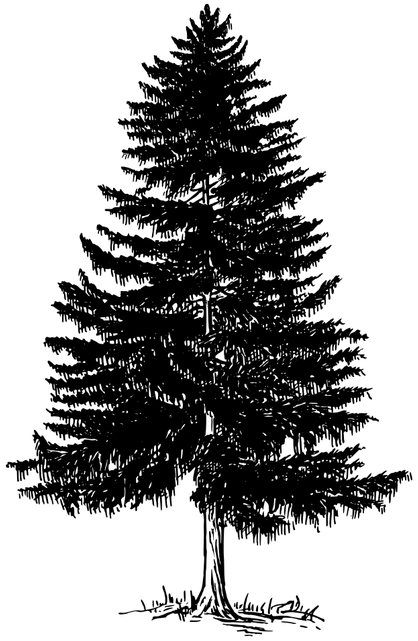
The trunk

We spotted two trunk shapes :



Conical

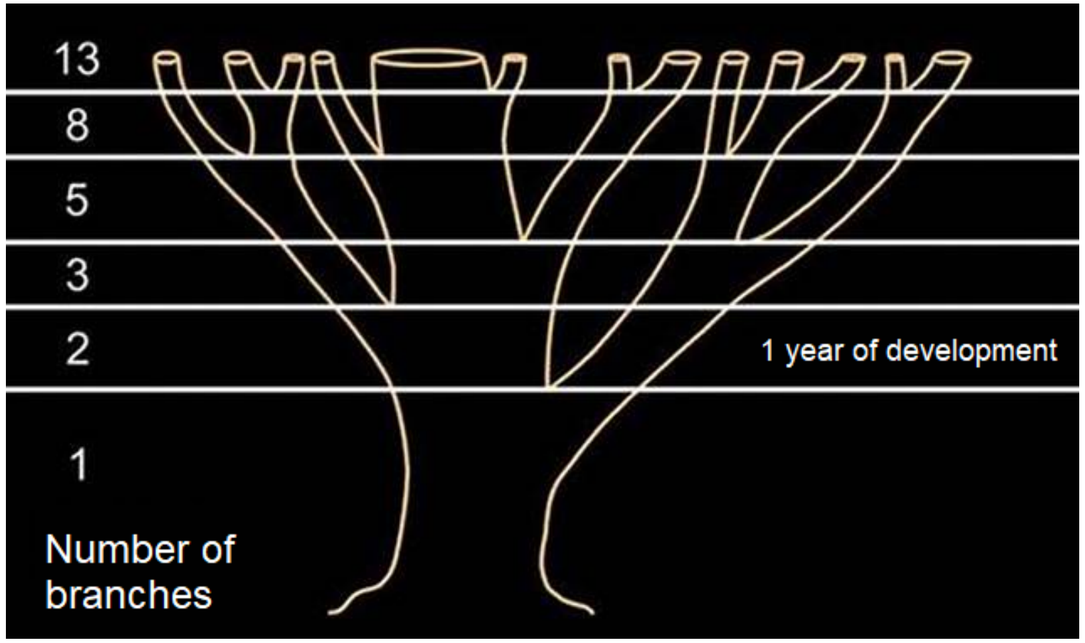
$$V = \frac{\pi \times R^2 \times h}{3}$$



Coniferous trees

The branches

To calculate the number of branches we use the **Fibonacci sequence**

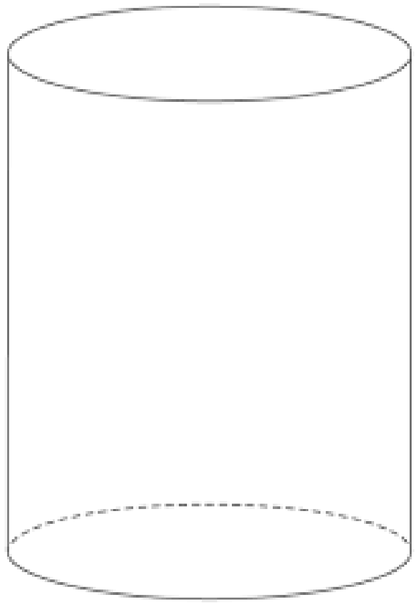


20 years is the age of maturity of trees, so we stop at 20 years

Age = circumference of trunk/pi x 2,5

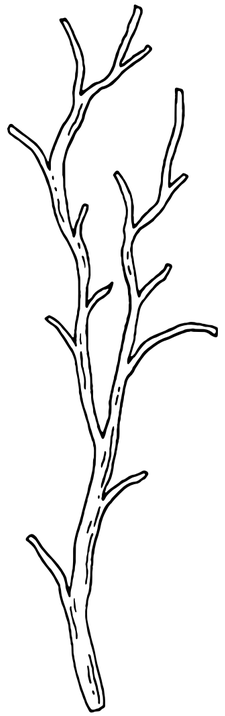
The branches

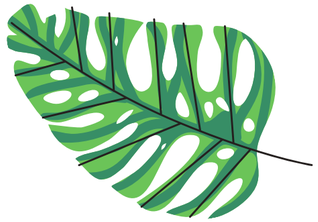
After the number, we want the shape...



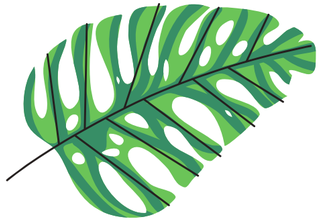
Cylindrical

$$V = \pi \times R^2 \times h$$

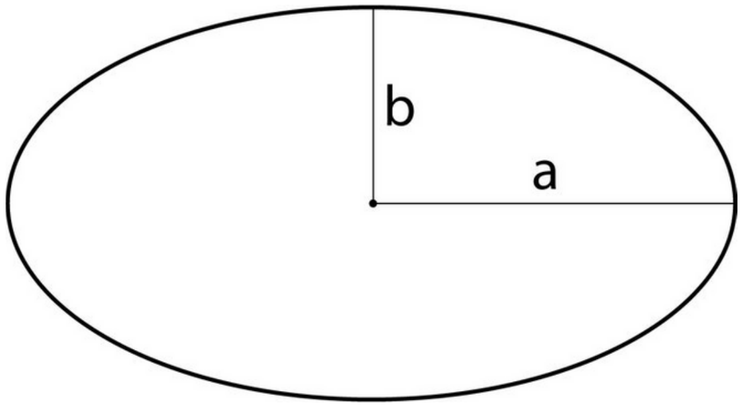




The leaves

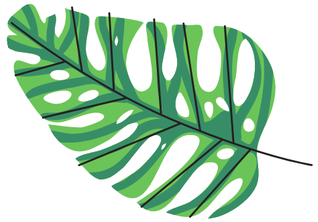


There are many shapes of leaves,
it depends on the tree

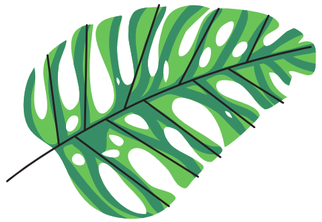


$$A = \pi ab$$

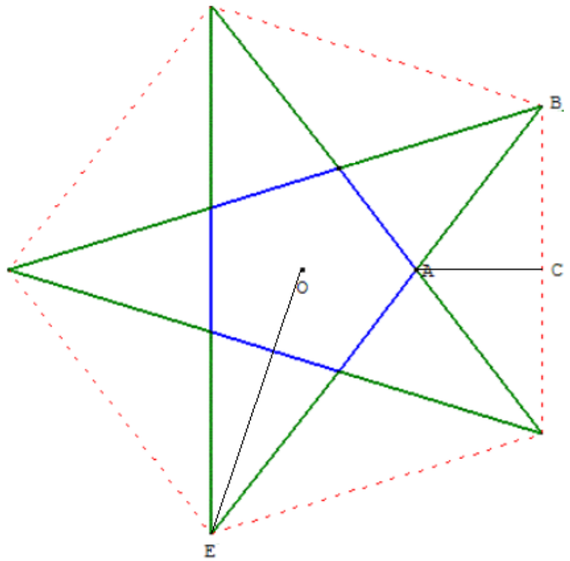
chestnut and horse
chestnut leaves



The leaves



There are many shapes of leaves,
it depends on the tree



A pentagon= 1/2 x P x apothem

Found the area of the triangle ABC

Multiply this area by 10

Subtract it from the area of the pentagon

maple leaves

The leaves

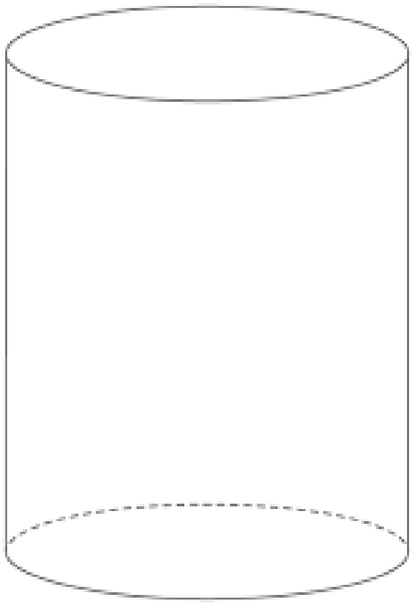
To calculate the volume of leaves we need also their thickness and the number

We estimate this thickness at 200µm so 0,02 cm.

We estimate the number at 50 leaves per branch.

The needles

We want again the shape



Cylindrical

$$V = \pi \times R^2 \times h$$

The needles

And the number of needles

We estimate the number
at 200 needles per branch.

The density

There are two types of wood :
the **green wood** and the **dry wood**.

Green wood is wood that is concentrated in moisture while dry wood is dead wood.

The density is therefore not the same.

The density

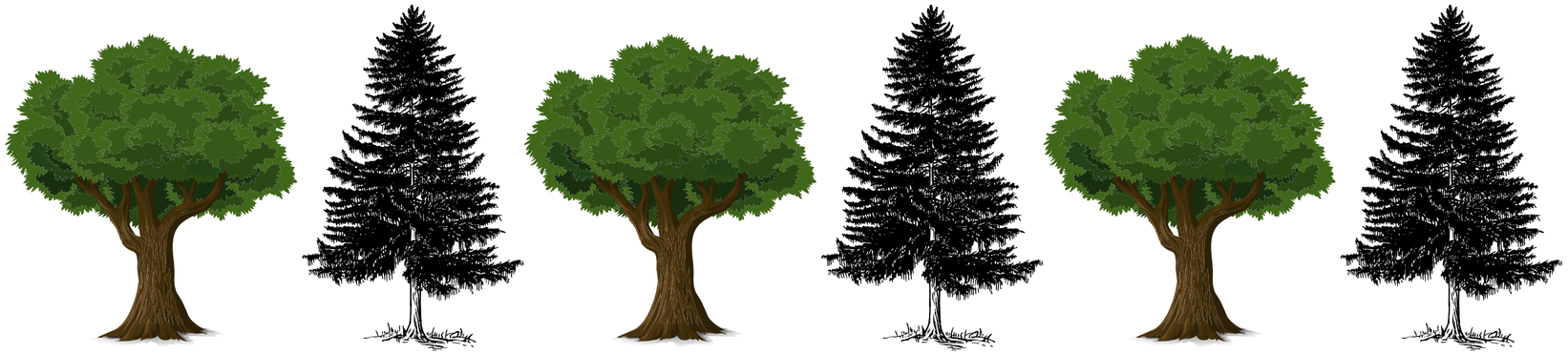
We calculated the density of the leaves and the needles ourselves by weighing them and this gave us around :

425 kg/m3 for the leaves

8,5 kg/m3 for the needles

The density

And finally we calculate the proportionality of the volume of wood and leaves/needles in the total volume then we deduced the density of the tree



Here is the program to calculate the volume of your tree!

(chestnut, horse chestnut, maple and pine)

```
from math import*
import math

#FUNCTIONS

def volume_cylinder (height,radius):
    cylinder = height*pi*(radius**2)
    return cylinder

def volume_cone (height,radius):
    cone = height*pi*1/3*(radius**2)
    return cone

def area_ellipse (lenght,width):
    ellipse = pi*lenght/2*width/2
    return ellipse

def fibonacci_sequence (perimeter):
    age = round(perimeter/pi*2.5)
    if age>20:
        age = 20                #20 years is the age
of maturity of trees, so to count the number of
branches we stop at 20 years
    n1=0
    n2=1
    for i in range(ceil(age/2)):
        n1 = n1+n2
        n2 = n2+n1
    if age%2==0:
        branches = n2
```

https://drive.google.com/file/d/1OdM8Ed7AgvYAzXe_y6efCi2Bq5Bbow4F/view?usp=sharing

For example
(horse chestnut)

IDLE Shell 3.9.4

File Edit Shell Debug Options Window Help

```
Python 3.9.4 (tags/v3.9.4:1f2e308, Apr  6 2021, 13:40:21) [MSC v.1928 64 bit (AM
D64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Users\Laura\Desktop\Lycée\Math_en_Jeans\volume and density of a tr
ee.py
What is the type of tree? horse chestnut
Have the leaves fallen? no
What is the height of the tree (in meters)? 9
What is the circumference of the trunk (in meters)? 2.15
What is the circumference of the lowest branch (in meters)? 0.75
What is the total diameter (in meters)? 10
Is the wood dry or green? green
The total volume of your horse chestnut is about 79.38 cubic meters.
Its total density is about 1036.46 kg/cubic meter.
>>> |
```

Lycée Val de Durance

Tree Volume Calculator

For

MATh JEANS

Web site:

https://my-demo-website-ca258.web.app/

GRASSO Jules
MICHIELS Isaac

HOW TO CALCULATE A TREE VOLUME ?

We've decided that the easiest and fastest way to calculate a tree volume, is to devellop a software capable of doing the boring repetetive calculations on a large scale.

To resolve this problem we splited it in different parts

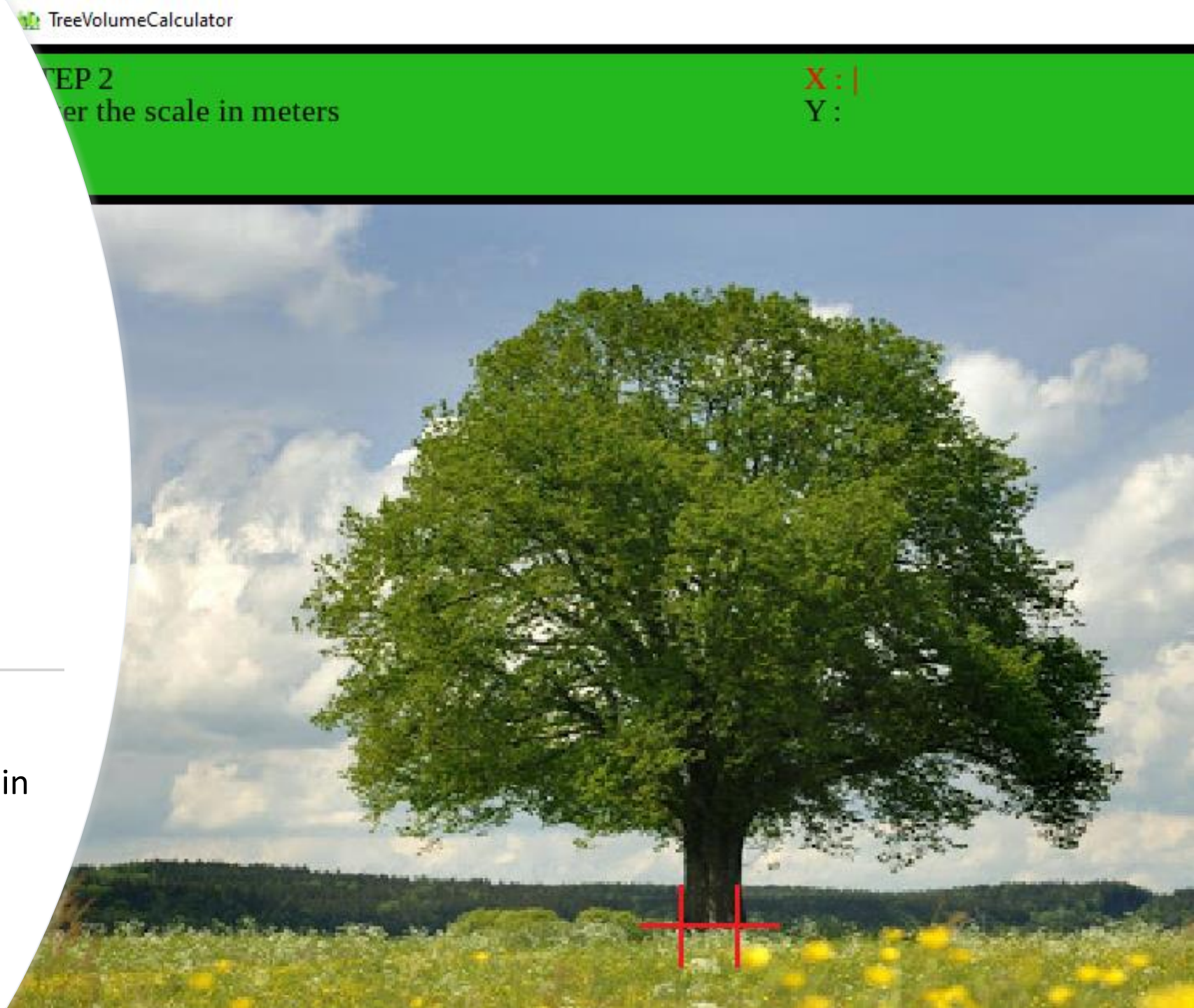
STEP 1 – GET THE SCALE OF THE IMAGE

STEP 2 – GET THE AIRE OF THE TREE

STEP 3 – LET THE COMPUTER CALCULATE !

STEP 1 – GET THE SCALE OF THE IMAGE

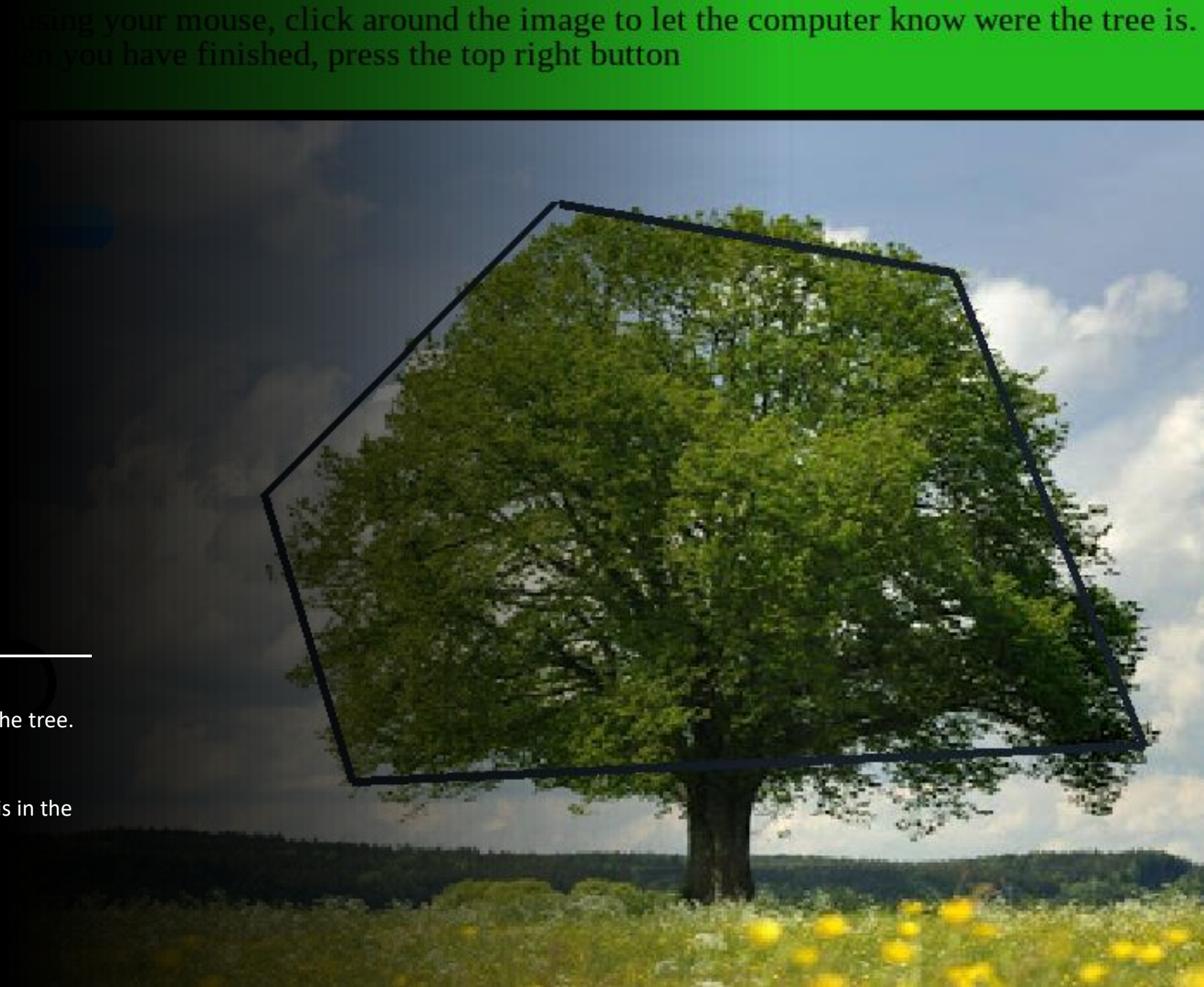
Here the user will have to precice how much pixel is equal to a certain lenght in meters



STEP 2 – GET THE AIRE OF THE TREE

To get the aire, the user will place points aroud the tree.

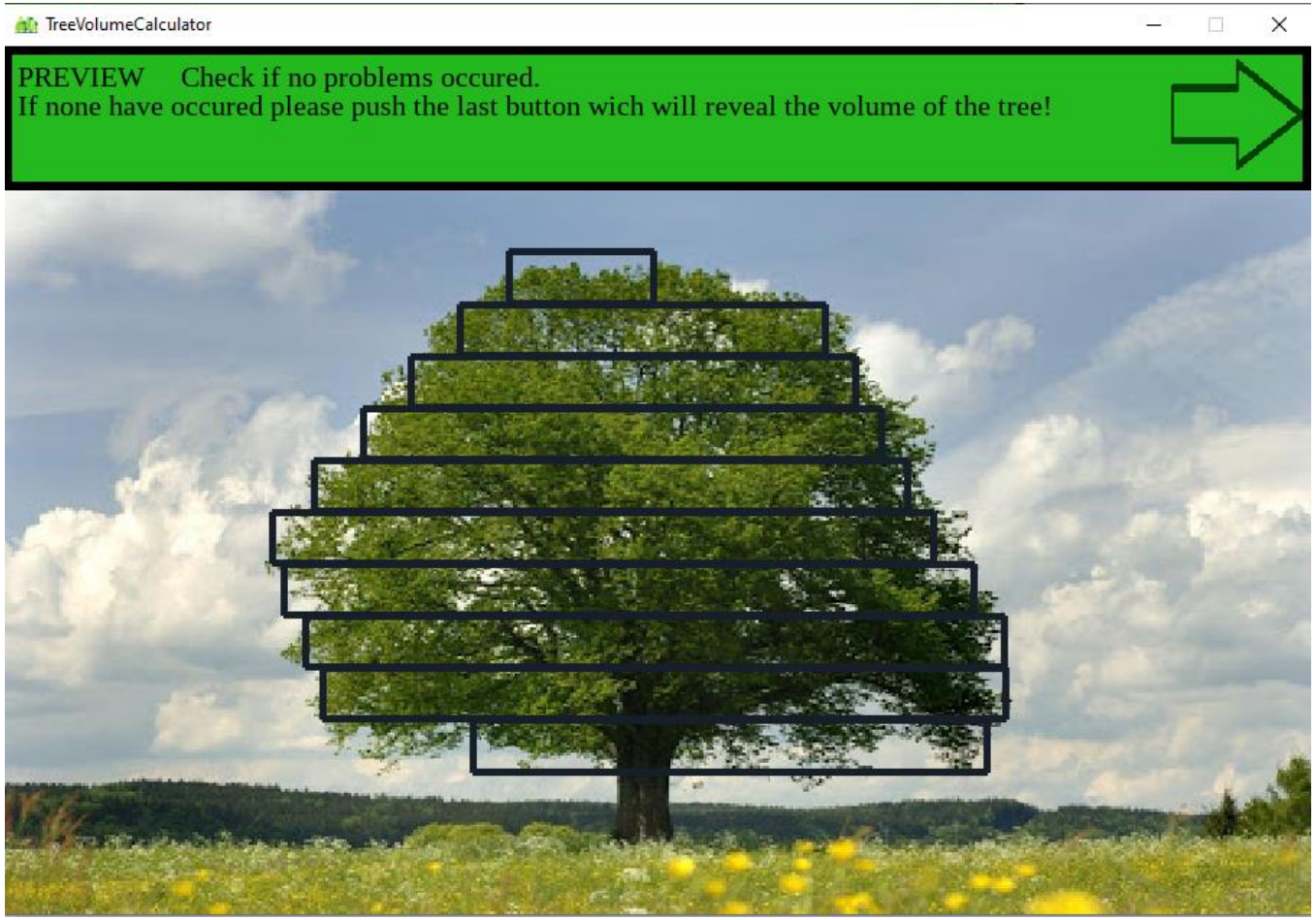
This will let the computer know where the tree is in the image



STEP 3 – LET THE COMPUTER CALCULATE !

This step doesn’t involves the user.

The computer will iterate thru a list of points and cut down the tree in several layers of disks. Then with a powerful algorithim, we will have the volume in m3



TREE VOLUME CALCULATOR-PART 2

Here is all the « behind the scenes » maths and calculations in our app

Website:

https://my-demo-website-ca258.web.app/

Michiels Isaac and Grasso Jules

OUR FIRST APPROACH

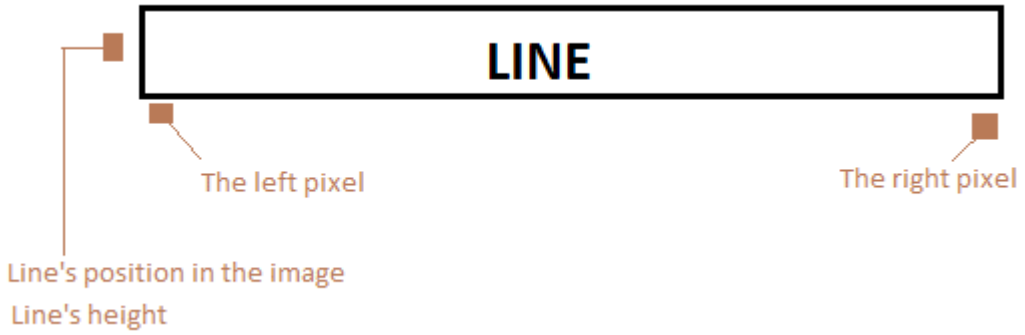
- Our first attempt was to calculmate the volume with one image.
- To make things simpler we input all the user data in a txt file.
- All the ones are the limit of the tree.

- 000000000000000111111111111000000000000000
  000000000000001100000000000110000000000000
  000000000011110000000000000001100000000000
  000000000100000000000000000000100000000000
  000000010000000000000000000000010000000000
  000000010000000000000000000000010000000000
  000000010000000000000000000000010000000000
  000000011110000000000000000000100000000000
  000000000001000000000000000001100000000000
  000000000000100000000000000011000000000000
  000000000000011111000000001100000000000000
  000000000000000000111111110000000000000000

OUR FIRST APPROACH

- We then « cut » the tree in a several number of parts. Each part is a disk.

- After a few algorithms we get the data regrouped in a variable. For each line(part), we have the line's position and height, the left pixel and the right pixel.



OUR FIRST APPROACH

- To get the final volume we iterate tru the lines and use this formula:

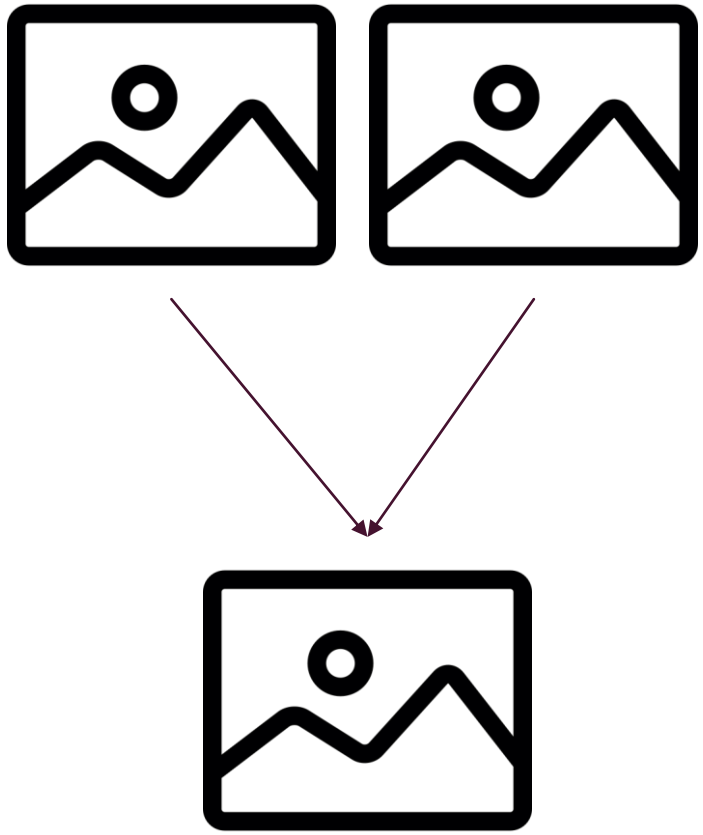
  Pi*rayon^2*height

We then sum up all the « micro » volumes to get the finall volume.

TAKING EVERYTHING TO THE NEXT STEP

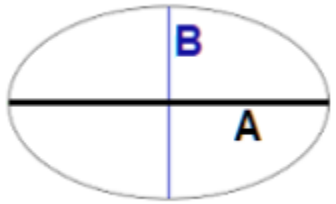
- Then we tried using two images instead of one, to make it more accure and at the same time more challenging.

- https://www.revetement-piscine-polyester.fr/calcul/volume-m3-piscine-ovale.php#oval



TAKING EVERYTHING TO THE NEXT STEP

- To do this ask the user to input two images instead of one.
- we get the data like we do with one image.
- With a formula found on the web, we calculate the volume of a oval.



- **<u>This is the formula:</u>**

  ((π x Lenght x Width) /4) x Height

The lenght is A, and the width is B.

- Finally we just sum up the volume of each line.

SUMMARY

- Thats how we calculate the volume of a tree.
- There are still bugs we need to fix , and note that if you calculate the volume with twso images, the volume might be false.

- With machine-learning the computer will be able to determine the tree. So later we're planning to integrate Tensorflow API so that the user won't have to manually precise were the tree is in the image.

Why not make the app avaialble to mobile?

Congrès MATh.en.JEANS de NICE 2021
Jeudi 20 mai ou vendredi 21 mai

Thank you for listening to us, we are ready to answer your questions.

You can find our work on the pages of this address
https://twinspace.etwinning.net/122026/home

Erasmus+