IYNT 2019

Topic 4
Sunflower spirals

Report

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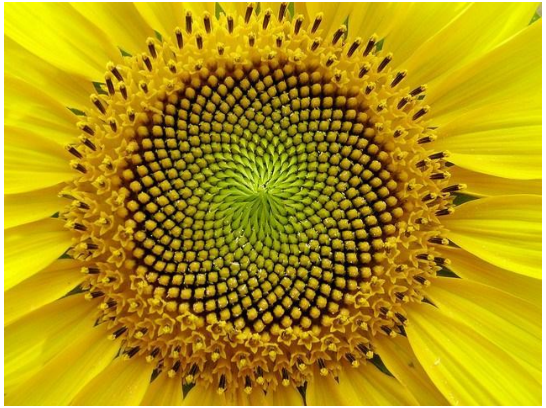
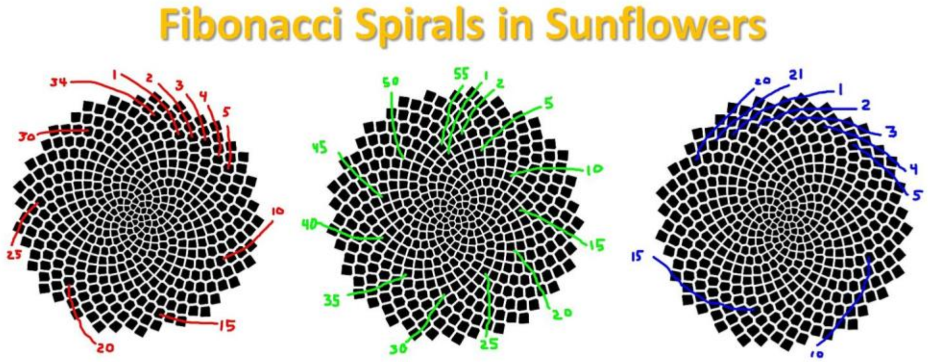
Topic

Patterns of seeds in the head of a sunflower have a very specific geometric structure. How can one describe and explain such a structure? What other plants demonstrate similar geometric patterns in their leaves or seeds?

Theoretical Background

- Sunflower seeds in the head of sunflowers form many spirals
- Depending on the slope, the spirals add up to a different number
- This number is a Fibonacci number





Theoretical Background

- A Fibonacci number is found by adding up the two preceding numbers
- Beginning with 0 and 1, which gives 1. Then 1 and 1, which gives 2, 2 and 1, which gives 3 and so on.

$$F_n = F_{n-1} + F_{n-2}$$

1+1=2

1+2=3

2+3=5

3+5=8

5+8=13

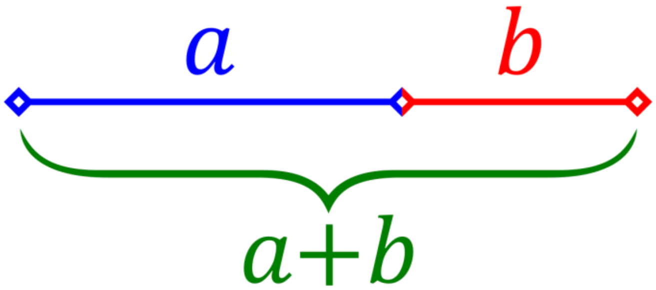
8+13=21 . . .

The Fibonacci sequence

1,1,2,3,5,8,13,21,34,55,89,144,233,377…

Theoretical Background

The **Golden ratio** is a special number found by dividing a line into two parts so that the longer part divided by the smaller part is also equal to the whole length divided by the longer part.



$a+b$ is to a as a is to b

$$\frac{a+b}{a} = \frac{a}{b} = \varphi$$

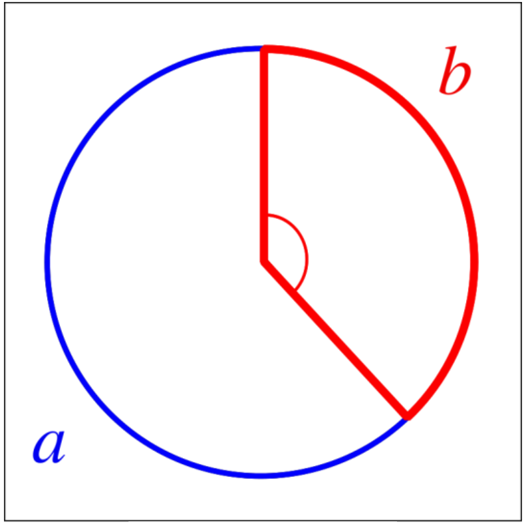
$$\varphi = 1 + \frac{1}{\varphi}$$

$$\varphi = 1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{\varphi}}}$$

It is equal to 1.61803…

Theoretical Background

The **Golden angle** is the smaller of the two angles created by sectioning the circumference of a circle according to the golden ratio.

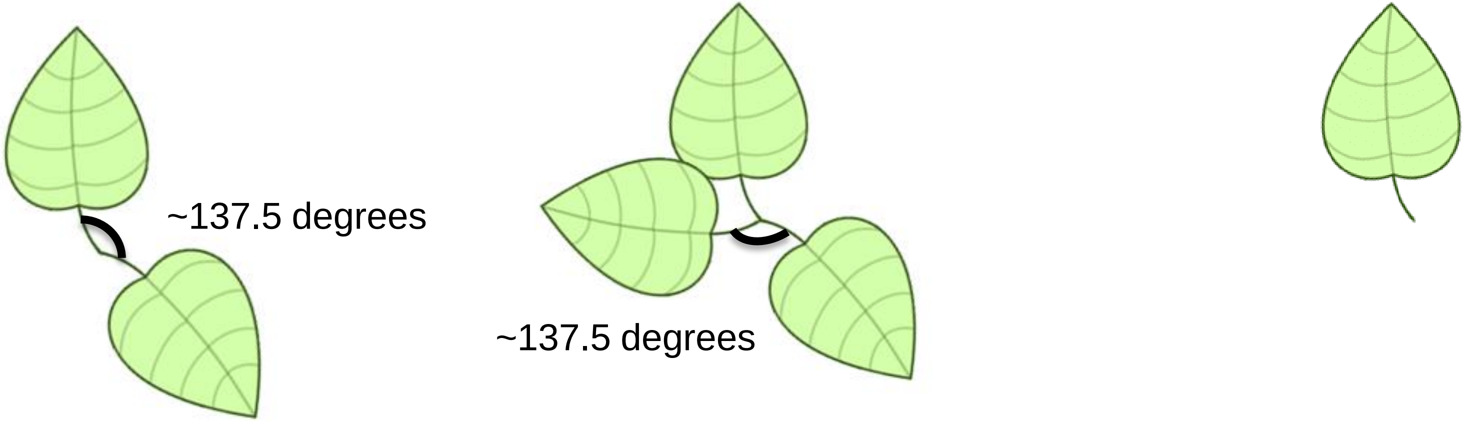


$$\frac{a+b}{a} = \frac{a}{b}$$

It is equal to 137.507…

Theoretical Background

- For a growing sunflower it is beneficial to push out each new floret as far as possible from the existing florets.
- That gives each floret the most space to grow.
- Each floret emerges at an angle of 137.5 degrees from the one that came before.



Experiment 1

Research Question

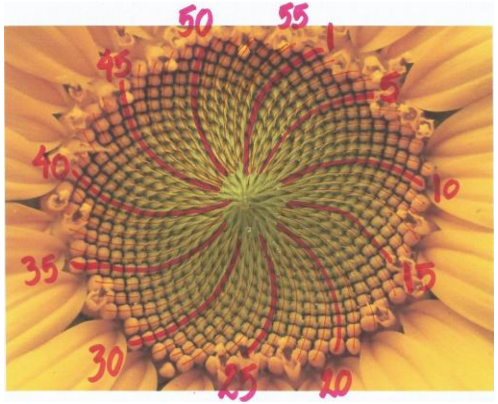
- Do the spirals found in sunflower heads follow the Fibonacci sequence?

Hypothesis

- Most sunflower heads create spirals that follow the Fibonacci sequence (they add up to a number of the Fibonacci sequence).

Method

1. 15 different sunflower images were found online and printed out
2. For each image, a slope was chosen
3. Continuing with the same slope, a line was drawn over each spiral with a colored pen
4. Every five spirals, the number of spirals counted was written
5. The total number of spirals for every image was compared against the numbers of the Fibonacci sequence



Results

Number of image	Clockwise # of spirals	Counter clockwise # of spirals
1	34	55
2	34	55
3	34	55
4	34	55
5	55	55
6	55	43
7	44	68
8	21	34
9	34	55
10	55	89
11	22	35
12	34	55
13	89	55
14	34	55
15	57	42

Conclusion

- 3 out of 15 sunflower heads did not follow the Fibonacci sequence
- This is simplified to ⅕
- This agrees with the results found by the Museum of Science and Industry in Manchester

Limitations

- The images used were taken from the internet – there was no access to living sunflowers
- Only 15 images were tested.

Experiment 2

Problem

Are the spirals created in sunflowers following the Fibonacci sequence due to the circular shape of the sunflower head?

Research question

Will a mechanical representation of this arrangement demonstrate the same behavior?

Experiment 2

round cake ring

Materials

- A round cake ring (maximum diameter = 30cm, height = 6cm)
- A petri dish (diameter = 10cm)
- Cylinder beads

Method

1. The beads were placed upright in both cake ring and petri dish in order to cover the full volume of the object.
2. Two different diameters were used in order to eliminate errors due to size.
3. The pattern was observed in search of spirals.

Qualitative Results

diameter = 30cm

diameter = 10cm

Conclusion

- No spirals were found in both models.

Limitations

- The beads (despite of their small size) were unable to cover the full volume of the cake ring and the petri dish.

Evaluation

- There must be a different reason to account for this symmetry other than the circular shape of the sunflower head.

Investigation

Research question

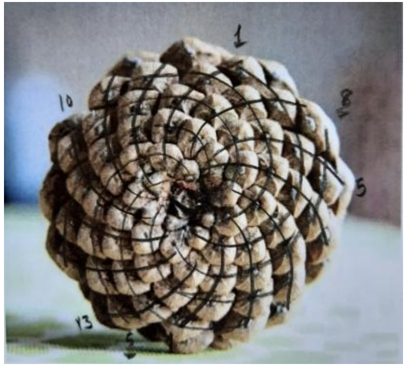
Are there other plants that exhibit the same pattern as sunflowers?

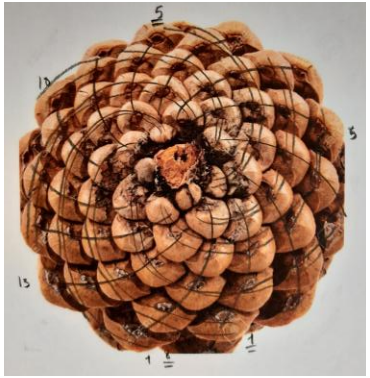
Method

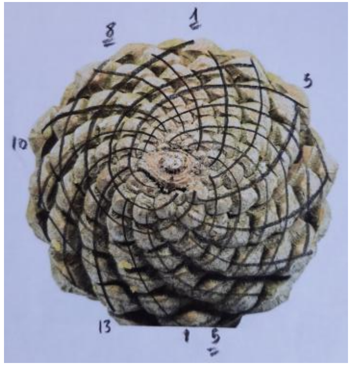
Images of the following types of plants were obtained online and the total number of spirals for every image was compared against the numbers of the Fibonacci sequence.

1. Dahlia flower
2. Pinecone

Images of Pine Cones







Images for Dahlia Flowers

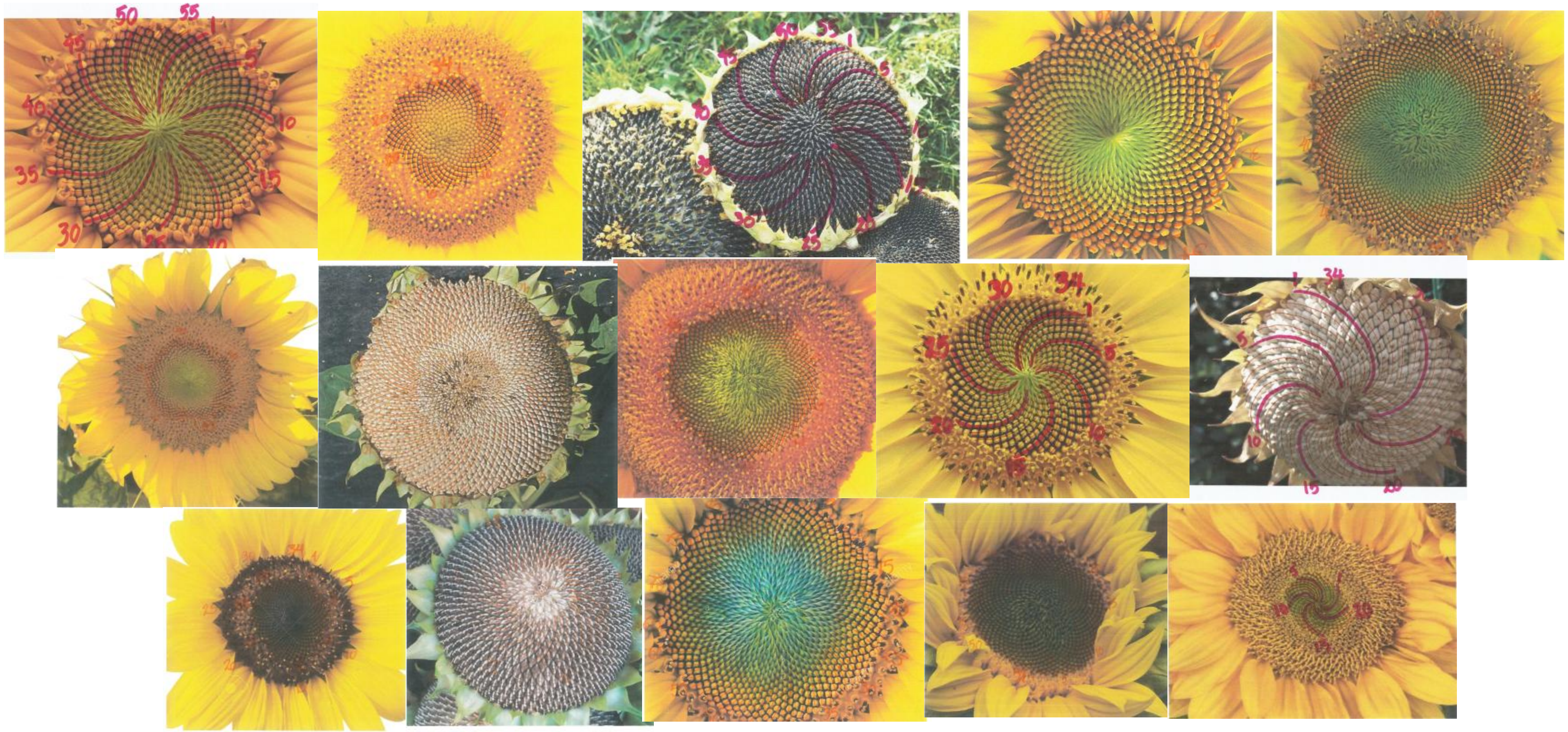
Results

- All images of other pants followed the Fibonacci sequence
- Similar results to sunflower images

Conclusion

- Other plants also follow the Fibonacci sequence

Sunflower images used



Bibliography

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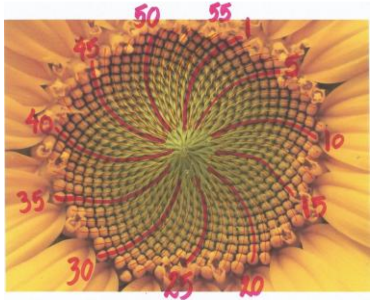
thank you

Sunflowers That Follow the Fibonacci Sequence

img. 1



img. 2

img. 3

img. 4

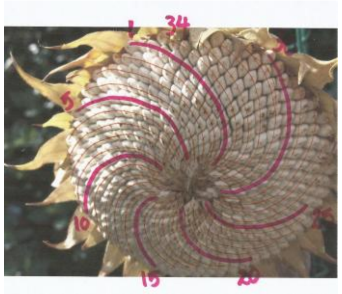
img. 5

img. 6

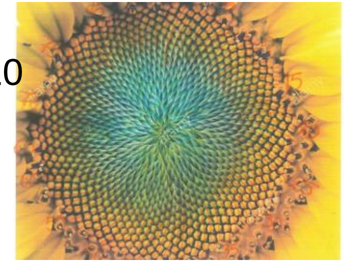
Sunflowers That Follow the Fibonacci Sequence

img. 8

img. 9

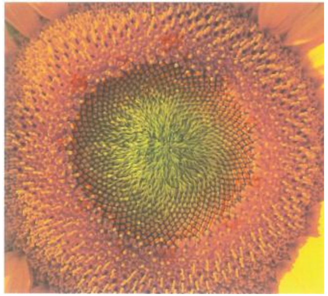


img.10



img.12

img.13



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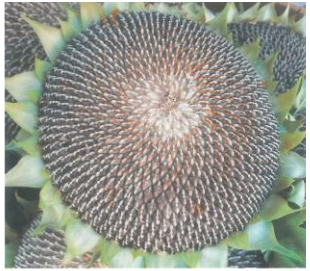

Sunflowers That Did Not Follow the Fibonacci Sequence

img.7

img.11

img.15

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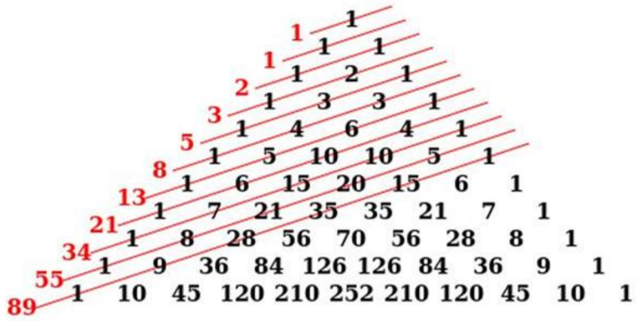
This is how to find Fibonacci numbers. The numbers in red are them



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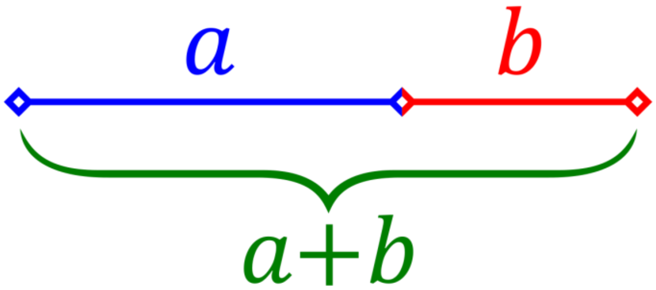

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