Cambridge Home School Online
Think Big

Think Big Presents:

The Think Big Journal

Edition 1
Summer Term 2023

Presented by:

Cambridge Home School Online
The Think Big Committee

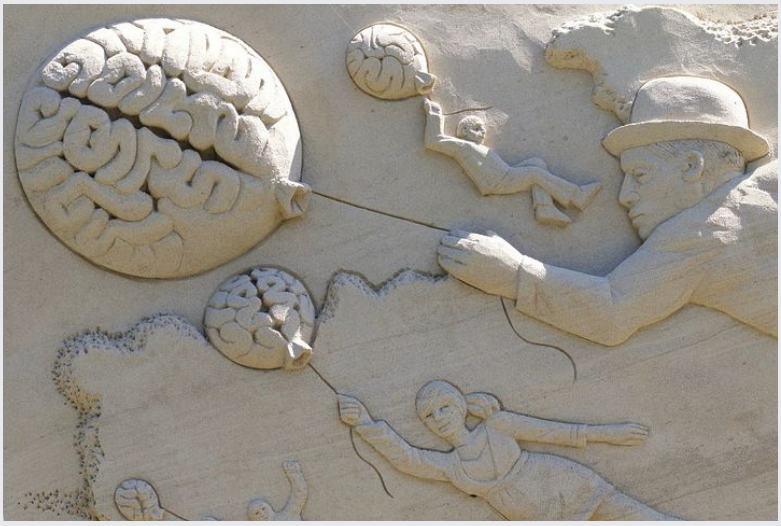
Edition 1

Summer Term 2023

ABOUT US

Think Big is Cambridge Home School Online's Academic society dedicated to broadening students' knowledge. The program is an excellent way to stay informed, engaged, and most importantly:
Think Big!
We have had an exciting year so far introducing: The Big Book Club, The Big Chat, The Big Talks and The Big Debate. All of our Thursday sessions have been enhanced by our Speaker Programme and our Online Library. We know that inspiring pupils to find their passion starts with reading widely, collaborating with others in discussions and listening to the experts!
Furthermore, we have developed a wonderful new incentive called The Think Big Journal. In this publication, students present their research on a variety of topics. which may have been inspired by aspects of the curriculum, the Think Big events or their own wider reading and listening. We hope you are all excited by our first Academic Journal and please think about contributing to the Autumn edition.

OUR TEAM



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EDITORIAL LETTER

BY MRS. TRAFFORD

When I first considered how to give CHS students the opportunity to stretch their brains in all sorts of directions, I knew that in order to enable them to become curious and passionate learners, reading and listening must be at the heart of our academic enrichment programme. I imagined feeding the school with all sorts of smartness. But, as with any organism, the Think Big committee has taken on a life of its own and given birth to Cambridge Home School's own academic journal.

I am impressed by the commitment of the committee (you can see why that word has commit in it now!). They have worked tirelessly to promote the journal and encourage contributions. I am grateful to all the students who have put in the effort to enter national competitions and submit their own writing for this, our first edition.

Where would we be without Mathematics? Aside from having a much shorter journal, the Mathematical contributions from Adelyn, Conrad, Jude and Phillip in our first edition of the Think Big Journal impress upon us all the central role that numbers play in our world and our lives. From an analysis of the place of logarithms to the applied mathematics of coding and understanding a human disease like Alzheimer's, the articles on Maths offer much to inspire all our students. I'm sure our artists and budding computer scientists, like me, will be bowled over by the world of fractals.

Pondering the Big Questions in life, Persephone in L1 tackles the age old problem of Free Will and Determinism. An impressive start to 'thinking big' from one of our youngest contributors. Exploring this concept has an impact on our ethics in every aspect of our daily lives. Can we hold anyone truly accountable if they are psychologically and behaviourally determined to act in a certain way? Maybe there is an algorithm out there to explain how humans make decisions – we will need to ask Adelyn!

Flavia's entry for Cambridge University's Fitzwilliam College is quite literally a work of art (and mathematics)! Her original watercolours combine with digital graphics to perfectly illustrate her unique design for a new building to inhabit their central quadrangle. Good architecture must understand how humans like to inhabit spaces, and Flavia intelligently takes us through her rationale for a sleek and eco-friendly structure.

Collaboration is also one of the pillars of increasing intelligence – yes, it really is – working on a group project does something in your brain that increases understanding and skills in a way that solo working doesn't touch. Just take a look at the wonderful end results of the collaborative work on 'The Big Issue' by Ms Jaami's L3 class. Read all about it! This magazine started when I was at University and it was such a radical concept back then – to offer dignity and a place to our homeless citizens - still going strong today.

Our first issue closes with an interview from Nira Chamberlain, who we were fortunate enough to host at the Cambridge Lecture Series last term. We only have these fantastic answers because you all asked such fascinating questions at the event. My greatest wish for next year, is to see full attendance at the Lecture Series – don't miss out on becoming a much more inspired you that THINKS BIG :)

Look out for a call for papers to our Autumn edition of The Think Big Journal in our Team channels.

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Logarithms

Adelyn Chung, L1

Introduction to Logarithms

Logarithms are used in mathematics to find how many times a number needs to be multiplied by itself to form a product. It is, in simple terms, the inverse function of exponents.

Exponents are the number of times a number is multiplied to itself. For example,

$$4^6 = 4\times4\times4\times4\times4\times4$$

Real Life Application of Logarithms

Logarithms are mainly used to solve exponential problems, to measure the pH level of chemicals, the magnitude of earthquakes, the loudness of sound and noise, and in radioactivity.

Notation and Calculation of Logarithms

Let us call the answer to the equation *a*; the base (the number we will be multiplying to itself) *b*; and the argument *c*. Using these three variables, we can demonstrate a logarithm by using this formula:

$$\log_b c = a$$

We could interpret this equation as "$b^a = c$".

Let's say $b = 10$ and $c = 1000$. The question can now be rephrased to "10 to the power what is 1000?"

$$10^3 = 1000$$

If we change back the numbers to their variables, it would work like this:

$$b^a = c$$

Therefore, the answer to the question is 3, and $a = 3$, as we said a would represent the answer. We can, therefore, use this information to create a logarithm.

$$\log_{10} 1000 = 3$$

So why should we learn how to calculate logarithms ourselves when calculators exist?

A standard scientific calculator has a "$\log_a b$" and 'log' button; however, the latter is only for base 10 calculations. Notice that when you use the button, you don't need to input a base. Instead of typing the whole logarithm we just created, you only need to enter this:

$$\log 1000$$

The calculator will give you 3. So, you don't have to input as much, however, there is no option to calculate logarithms of other bases.

But isn't base 10, the decimal system, what we use? Why would we need to use other bases?

One example of why you may need to use another base for a logarithm is because Base 2 is used for Computer Science, and as you might now, computers are made up of only 0s and 1s. For example, a logarithm using base 2 would be something like this:

$$\log_2 16 = 4$$

So where did the 4 come from? Again, let us ask ourselves the same question: "2 to the power what is 16?"

$$2^4 = 16$$

Now we will do one last example together, and then you can try out a few questions by yourself. The last example is…

$$\log_3 243$$

So we need to figure out the answer to the equation. We repeat what we have done for the previous two examples:

$$3^5 = 243$$

Hence,

$$\log_3 243 = 5$$

Before we start doing some practise questions, we need to go over some more rules of logarithms that you need to know at this stage.

If no base is given, then it means it is base 10. There is a pattern in base 10 logarithms, as shown below:

$$\log 10000 = 4$$

$$\log 1000 = 3$$

$$\log 100 = 2$$

$$\log 10 = 1$$

$$\log 1 = 0$$

$$\log 0.1 = -1$$

$$\log 0.01 = -2$$

$$\log 0.001 = -3$$

$$\log 0.0001 = -4$$

etc.

<u>Did you spot the pattern?</u>

The number of 0s in the argument determines the result. If there are six 0s, that means that the answer of the logarithm will be either 6 or -6.

So how do we find out whether the answer is negative or positive? Of course, this does not apply to the logarithm of 1, since 0 is neither negative or positive, but for everything else, you can see whether or not the answer is negative or positive by seeing if the argument is greater or less than 1.

If the argument is greater than 1, it means that the answer is positive.

If the argument is less than 1, it means that the answer is negative.

You may be wondering: Why does log 1 = 0? It is because assuming that the base is not equal to 0, a number to the power 0 will be 1. Therefore, when the base is not 0, log 1 must be 0.

Note: $\log_0 1$ is undefined because if $\log_0 1 = 0$, it implies that $0^0 = 1$ which is mathematically undefined. Therefore, we can only have non-zero base.

So let us get started with a few practise questions on what we have learned so far!

1. $\log_2 1024$
2. $\log_5 125$
3. $\log_3 81$
4. $\log 100000$
5. $\log_{13} 169$
6. $\log 0.0001$
7. $\log 0.001$
8. $\log_4 256$

The answers for the logarithm questions are:

1. $2^{10} = 1024$ so $\log_2 1024 =$ **10**
2. $5^3 = 125$ so $\log_5 125 =$ **3**
3. $3^4 = 81$ so $\log_3 81 =$ **4**
4. $10^5 = 100000$ so $\log 100000 =$ **5**
5. $13^2 = 169$ so $\log_{13} 169 =$ **2**
6. 0.0001 has 4 zeros, and the argument is less than 1, therefore $\log 0.0001 =$ **-4**
7. 0.001 has 3 zeros, and the argument is less than 1, therefore $\log 0.001 =$ **-3**
8. $4^4 = 256$ so $\log_4 256 =$ **4**

Fraction

I would now like to talk about logarithms when the argument is a fraction and how to solve these logarithms; we have only briefly covered base 10 when the argument is in decimal form.

So let us begin with something very simple:

$\log_4 1/16$

Firstly, I would like you to ignore that the logarithm is a fraction and instead calculate $\log_4 16$.

$$4^2 = 16$$

$$\log_4 16 = \mathbf{2}$$

So now let us return to the original question, remembering that we know $\log_4 16 = \mathbf{2}$.

$$\log_4 16 = \mathbf{2}$$

$$\log_4 1/16 = \mathbf{-2}$$

But why is it -2? As we said at the beginning, logarithms are the inverse function of exponents. And in exponents, when the index (power) is negative, the answer will be a fraction.

$$4^{-2} = 1/16$$

Now, let us have another example of a logarithm, except this time we will swap the base and the argument.

$$\log_7 49 = 2$$

$$\log_{49} 7 = \tfrac{1}{2}$$

In logarithms, when we swap the base and the argument, the answer will result in a fraction. Let us see another example of this.

$$\log_5 125 = 3$$

$$\log_{125} 5 = 1/3$$

So how does this work? It is simpler than you think…

$$5^3 = 125$$

$$\log_5 125 = 3$$

And…

$$125^{1/3} = 5$$

$$\log_{125} 5 = 1/3$$

So now I will give you a practise question to make sure you understand these examples.

$$\log_{81} 3$$

You can find the solution to this logarithm by finding the answer if you swap the base and the argument, then make that answer a fraction.

$$\log_3 81$$

$$3^4 = 81$$

$$\log_3 81 = 4$$

Therefore…

$$\log_{81} 3 = \frac{1}{4}$$

Conclusion

In conclusion, logarithms are the inverse function of exponents. They are mathematically used to find out how many times a number needs to be multiplied by itself to form a certain answer. However, the use of logarithms is not limited to mathematics – it is instead an area of mathematics that is frequently used in the real world.

This Essay is also used for:

Teddy Rocks Maths Essay Competition

Linear Algebra Approach To Quadratic Sequences & Generalisation

Ka Hoi Conrad Ho, L3

Overview

In this essay, I shall demonstrate an alternative method for solving a general Term n equation of a quadratic sequence and the further application of using the matrix.

I will start off by introducing sequences in general, followed by quadratic sequence and a so-called 'Textbook Method' for solving for the equation of T_n. After that, I shall demonstrate and prove the 'Linear Algebra Method' as well as its generalisation and application towards the end.

Acknowledgement

This discovery would not have been possible without my Mathematics teacher, Mrs. Smith, who once set a homework containing few questions in relation to sequence which made me come up with an alternative method for solving the equation of Term n for completing my homework. The due day of my homework was coincidentally the same as the day when I started this essay. I would like to give credit to my father for proof-reading the use of language of this paper as well.

I am utterly delighted to discover this approach as opposed to the textbook method, and I hope you shall find it interesting as much as I do.

Introduction

A *sequence*[1] is where a collection of number, known as a *set*, that are formed followed by a pattern in a particular order and each number formed by the pattern is called a term.

Examples of a linear sequence could be:

$$(2n)_{n\in\mathbb{N}}$$

such that,

$$T_1 = 2(1) = 2$$

$$T_2 = 2(2) = 4$$

$$T_3 = 2(3) = 6$$

$$T_4 = 2(4) = 8$$

$$T_5 = 2(5) = 10$$

$$\vdots$$

[1] Harvard *'Mathematical Sequences'* https://people.math.harvard.edu/~engelwar/MathS305/Sequences%20An%20Introduction.pdf

A *quadratic sequence* is a subset of sequence where it follows a general equation of

$$(An^2 + Bn + C)_{n\in\mathbb{N}}$$

where A, B and C are real numbers.

An example of a quadratic sequence could be:

$$(n^2 - 5n + 10)_{n\in\mathbb{N}}$$

such that,

$$T_1 = (1)^2-5(1)+10 = 6$$

$$T_2 = (2)^2-5(2)+10 = 4$$

$$T_3 = (3)^2-5(3)+10 = 4$$

$$\vdots$$

Another example of a quadratic sequence could be:

$$(5n^2 + 10n - 3)_{n\in\mathbb{N}}$$

such that,

$$T_1 = 5(1)^2+10(1)-3 = 12$$

$$T_2 = 5(2)^2+10(2)-3 = 37$$

$$T_3 = 5(3)^2+10(3)-3 = 72$$

$$\vdots$$

Solving Term n Equation - Traditional Method

In the previous chapter, we have encountered two examples of a quadratic sequence. To find a general equation for any given set of a sequence, traditionally we use a method similar to the one below:

The value of the first 5 terms of the sequence:

$$T_1 = 6$$

$$T_2 = 4$$

$$T_3 = 4$$

$$T_4 = 6$$

$$T_5 = 10$$

Firstly, one must work out the 'first difference' of the result of each term.

$$T_2 - T_1 = 4\text{-}6 = -2$$

$$T_3 - T_2 = 4\text{-}4 = 0$$

$$T_4 - T_3 = 6\text{-}4 = 2$$

$$T_5 - T_4 = 10\text{-}6 = 4$$

Then, we have to work out the 'second difference' which is the difference between the 'first difference'.

$$0-(-2) = 2$$

$$2\text{-}0 = 2$$

$$4 - 2 = 2$$

The ‘second difference’ can be represented as the sum of 2A where term A is the term A from the general form of a Term n equation of a quadratic sequence, such that

$$2A = 2$$

By rearranging,

$$A = 1$$

By substituting $A = 1$ into the general form, we get:

$$n^2 + Bn + C$$

By substituting the term number as n, we get:

$$T_1 = 1 + B + C = 6$$

$$T_2 = 4 + 2B + C = 4$$

$$T_3 = 9 + 3B + C = 4$$

$$\vdots$$

To solve A, B and C, we just have to solve the any 3 equations above as a simultaneous equation.

However, for the purpose of this essay, I will not demonstrate the steps of doing so. One might also notice that this is the 1st example of a quadratic sequence from the previous chapter where:

$$A = 1$$

$$B = -5$$

$$C = 10$$

Solving Term n Equation – Linear Algebra Method

An alternative approach, or a rather linear algebra approach is to use the following matrix, one that could compute the answer to the term A, B and C, as given in the following and to be proven in the next chapter:

$$\begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix}^{-1} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} = \begin{bmatrix} A \\ B \\ C \end{bmatrix}$$

Using the example from the previous example,

$$T_1 = 6$$

$$T_2 = 4$$

$$T_3 = 4$$

$$\vdots$$

Substitute the values of the first three term into the matrix,

$$\begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix}^{-1} \begin{bmatrix} 6 \\ 4 \\ 4 \end{bmatrix} = \begin{bmatrix} 1 \\ -5 \\ 10 \end{bmatrix}$$

Substitute A, B and C as 1, -5 and 10 respectively into the general equation and simplify,

$$T_n = (n^2 - 5n + 10)_{n \in \mathbb{N}}$$

Comparing to the result we get in the previous, we know that the answer we get from using this linear algebra approach is indeed correct.

<u>Proof For the Linear Algebra Method</u>

To prove that:

$$\begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix}^{-1} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} = \begin{bmatrix} A \\ B \\ C \end{bmatrix}$$

The general form for the equation T_n of a quadratic sequence:

$$(An^2 + Bn + C)_{n\in\mathbb{N}}$$

where A, B and C are real numbers.

By substituting the term numbers into the general form as given above,

$$T_1 = 1A + B + C$$

$$T_2 = 4A + 2B + C$$

$$T_3 = 9A + 3B + C$$

which can be represented by,

$$\begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix} \begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix}$$

By multiplying both side with the inverse matrix,

$$\begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix}^{-1} \begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix} \begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix}^{-1} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix}$$

Simplify and get,

$$\begin{bmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{bmatrix}^{-1} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} = \begin{bmatrix} A \\ B \\ C \end{bmatrix}$$

Q.E.D.

Generalisation

A similar approach of polynomial sequence to any degree which conventionally are denoted by the following form[2],

$$\sum_{k=0}^{\infty} a_k x^k$$

However, for the purpose for this essay, in accordance with the variables shown earlier, we shall use other symbols to represent, so that we get a general equation of:

$$An^k + Bn^{k-1} + Cn^{k-2} \ldots + c$$

Where c is some constant of the polynomial equation and where $k \in \mathbb{N}$.

To solve each coefficient of the T_n of the polynomial equation:

$$\begin{bmatrix} (1)^k & (1)^{k-1} & & 1 \\ (2)^k & (2)^{k-1} & & 1 \\ (3)^k & (3)^{k-1} & \cdots & 1 \\ \vdots & \vdots & & \vdots \\ n^k & n^{k-1} & & 1 \end{bmatrix}^{-1} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ \vdots \\ T_n \end{bmatrix} = \begin{bmatrix} A \\ B \\ C \\ \vdots \\ c \end{bmatrix}$$

This generalised equation could then be used to solve any polynomial sequence. This might be useful in predicting or estimating, for example, growth in such pattern. More on this will be discussed in the next chapter.

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[2] Jiwen He 'Lecture 27 11.7 Power Series'
https://www.math.uh.edu/~jiwenhe/Math1432/lectures/lecture27_handout.pdf

Real-Life Application

An obvious example of application is to estimate or predict a polynomial sequence of certain system, such as growth in interest rate or population as mentioned in the previous chapter. The matrix shown is generalised for all polynomial sequence and it can thus be used in applied mathematics such as optimising a program that requires identifying a polynomial sequence.

Comparison of both methods in computation time using Python:

```
1 import sympy as sym
2 import numpy
3 import time
4 #only B and C is required to solve as A will be solved as shown in line 12
5 B,C = sym.symbols('B,C')
6 sequence = [6,4,4]
7 def calculation():
8   start = time.time()
9   dif1 = numpy.diff(sequence)
10   dif2 = numpy.diff(dif1)
11   #2A=dif2, so A is dif2/2
12   A = dif2[0]/2
13   eq1 = sym.Eq(A+B+C,6)
14   eq2 = sym.Eq(4*A+2*B+C,4)
15   result = sym.solve([eq1,eq2],(B,C))
16   end = time.time()
17   runtime = end - start
18   print(f"Time taken: {runtime:.10f} seconds")
19 for i in range(10):
20   calculation()
```

Figure 1: The code for the ‘Textbook Method’

```
import numpy as np
import time
def calculation():
    start = time.time()
    sequence = np.array([[6], [4], [4]])
    matrix1 = np.array([[1, 1, 1], [4, 2, 1], [9, 3, 1]])
    ABC_matrix = np.linalg.inv(matrix1)
    solution = np.matmul(ABC_matrix, sequence)
    end = time.time()
    runtime = end - start
    print(f"Time taken: {runtime:.10f} seconds")
for i in range(10):
    calculation()
```

Figure 2: The code for the ‘Linear Algebra Method’

Result:	Textbook Method	Linear Algebra Method
Trial 1	0.0427830219	0.0000000000
Trial 2	0.0044887066	0.0010790825
Trial 3	0.0049839020	0.0000000000
Trial 4	0.0040054321	0.0000000000
Trial 5	0.0067546368	0.0000000000
Trial 6	0.0039668083	0.0000000000
Trial 7	0.0049824715	0.0000000000
Trial 8	0.0051715374	0.0000000000
Trial 9	0.0068042278	0.0000000000
Trial 10	0.0044145584	0.0000000000
Median	0.0049831868	0.0000000000
	Difference:	0.0049831868

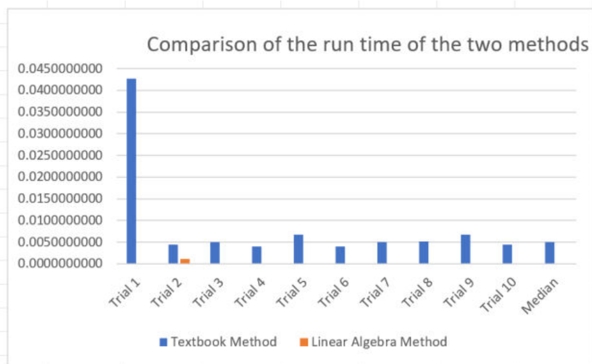

Figure 3: The results in the comparison of the run time of both methods

It is evident that the ‘Linear Algebra Method’ is relatively faster by 0.0049831868 seconds when comparing the average speed of the two respective methods. Although this might seem like a small advancement, the difference could be significant in a larger scale program.

<u>Other Examples</u>

Polynomial sequence is also used along with *Ordinary Differential Equation* (O.D.E.) in computing for optimisation in order to find, for example, maximum volume of an object with the least surface area. This might be used for companies trying to produce a container with the most volume for storage while having the least surface area, meaning least material cost.

This is often used in Physics and approximation theory. Some notable examples [3] include Laguerre polynomial, Chebyshev polynomial etc.

[3]Wikipedia *‘Polynomial Sequence https://en.wikipedia.org/wiki/Polynomial_sequence*

References

i. Harvard *'Mathematical Sequences'* https://people.math.harvard.edu/~engelwar/MathS305/Sequences%20An%20Introduction.pdf

ii. Jiwen He 'Lecture 27 11.7 Power Series' https://www.math.uh.edu/~jiwenhe/Math1432/lectures/lecture27_handout.pdf

iii. Wikipedia *'Polynomial Sequence'* *https://en.wikipedia.org/wiki/Polynomial_sequence*

This Essay is also used for:

Teddy Rocks Maths Essay Competition

The Mathematics of Alzheimer's

Jude Josephine Abou Mechrek, L6

Abstract

Comparing this new method to existing machine learning approaches is more effective at diagnosing Alzheimer's disease. It was put to the test using actual data from the Alzheimer's Disease Neuroimaging Initiative (ADNI) data set by Aviles-Rivero and her colleagues. They discovered that their technique outperformed all others by including all the various types of data and capturing high-order linkages within this multi-modal data.

Alzheimer's is a horrific disease, and both the sufferer and their loved ones find the diagnosing procedure stressful. The goal of Aviles-Rivero and her team's research is not to take the position of the specialist who cares for these patients. Instead, the framework for machine learning that has been built intends to assist clinicians, freeing up more important time to perform tasks that only humans can execute. It's evident that mathematics is linked to every aspect of life as indicated in the above research study, it undoubtedly acts as a problem-solving tool for medical diseases

Introduction

A shell of their former selves-withering people with jumbled minds; confined memories without the approval of their owners. This is the monstrous face of Alzheimer's. Alzheimer's has been the subject of many excellent works of memoirs and journalism (some favourites are Diane Keaton's "Then Again", John Bayley's "Elegy for Iris", Thomas Debaggio's "Losing My Mind: An Intimate Look at Life with Alzheimer's, and David Shenk's "The Forgetting: Alzheimer's: Portrait of an Epidemic") it is a disease that distinctively impedes our ability to comprehend it through orthodox methods of investigation. In Shenk's book, Alzheimer's is essentially a radically slowing of death-"what is usually a quick flicker we see in super slow motion." In DeBaggio's first-person story, you can feel the agonising beginnings of that gradual loss of self-awareness; in Bayley's and Keaton's, you can see the outward signs of late-stage Alzheimer's. Nevertheless, when I ponder about individuals who are prone to Alzheimer’s, I’m left with unknown inquiries that can only seem to be addressed in fiction: How does it feel to lose oneself whilst still being alive? Is there a core component of selfhood that endures to the end? Patients in the middle to late stages are unable to communicate it to us due to their aphasia thus it becomes an unexplained phenomenon.

More and more fiction writers are striving to enter that esoteric zone as baby boomers approach their seventies and Alzheimer’s grows more prevalent. The release of Matthew Thomas’s visionary and challenging “We Are Not Ourselves,” considered one of the best Alzheimer’s novels, seems like a good opportunity to re-evaluate the burgeoning genre and determine what its authors can and cannot tell us about the fate of the self as it succumbs to a disease that attacks the very core of selfhood.

Alzheimer’s, a fatal condition that develops gradually but steadily worsens with the progression of time. Early diagnosis offers the best possibility of decreasing the disease’s course and enhancing the patient’s quality of life. Regrettably, there isn’t a quick fix (an early detection test) to identify Alzheimer’s. Doctors use a battery of tests and attempt to rule out other disorders with comparable symptoms to determine whether a patient has the disease. An automated system that can assist with the diagnosis has been created by a multidisciplinary team at the University of Cambridge to lessen the workload.

Making use of multiple data sources

The team’s approach, which was created under the direction of the mathematicians Carola-Bibiane Schönlieb and Angelica Aviles-Rivero, tries to identify the illness before any noticeable symptoms have surfaced. Their machine learning framework makes use of the numerous types of data that may be accessible to a patient, offering new approaches for analysing this substantial body of information while requiring minimal human involvement. This approach beats current machine-learning algorithms for the early diagnosis of Alzheimer’s disease, according to tests conducted on real patient data.

The diagnosis of Alzheimer's disease requires a wide range of patient data. A patient's brain can be seen in medical imagery such as PET scans and MRIs. Non-imaging data, such as genetic data and identifying details like the patient's age, also include important information. Analysing the pertinent data to see if it has hidden patterns that could aid in the task at hand-in this case, identifying a disease-is one strategy frequently utilised in machine learning. Avilies-Rivero and her co-workers intended to use all the various forms of information that are available about specific patients, whereas this stratagem often concentrates on only one sort of data. How can they combine this wealth of heterogeneous data, consisting of an array of data modalities, as well as obtain a meaningful understanding from it?

Firstly, analysing each source of data separately. In substantial sets of images, significant features can be automatically detected using existing image analysis techniques. This may be due to the existence of specific patterns of geometric structures in the image, which, in the case of these MRI images, may represent the state of particular brain regions in Alzheimer's patients. The feature space, a high-dimensional mathematical space where each axis of the space corresponds to a certain image characteristic, is defined by these features. Images that share a certain feature are positioned close to one another in the direction of that axis in the feature space since the images are represented as points in it.

By creating a hypergraph, the researchers can use this sort of depiction of the MRI scans to capture the correlations between various elements in these images. A typical graph is essentially a network made of nodes, or points, connected by edges. The advantage of the hypergraph is that it may depict more intricate connections between the nodes. Whereas a hypergraph's hyperedges can connect an unlimited number of nodes, a graph's edges can only connect exactly two nodes at a time. In order to find any structure in the MRI data, the researchers connect the points that are close to one another in the feature space with a hyperedge.

Additionally, they can create a separate hypergraph just for the structure of the PET imaging data in the same way.

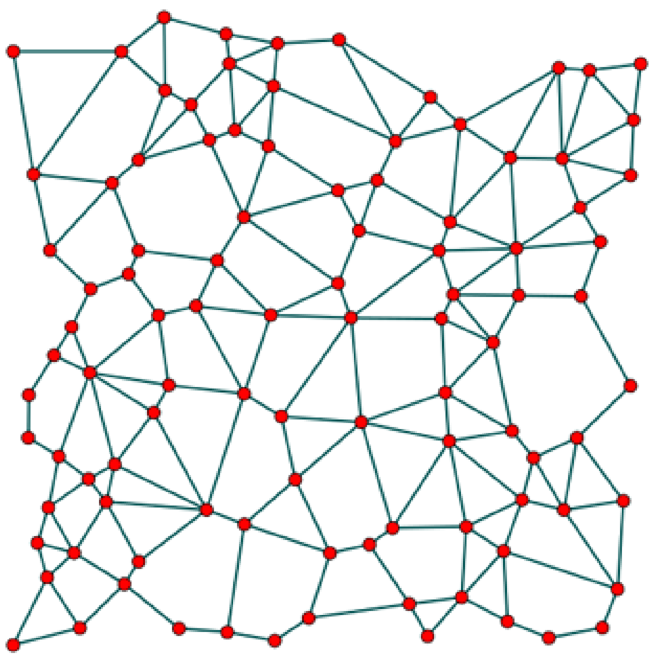

Figure 1: A complex-looking graph, where each edge relates exactly two nodes – represented by a line joining those two nodes.

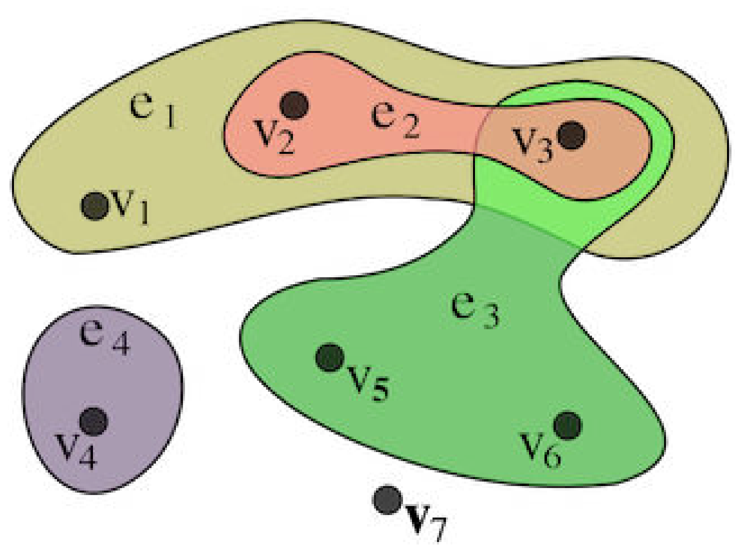

Figure 2: Example of a hypergraph where the hyperedges can relate any number of nodes. Now the hyperedges (e_1, e_2, e_3 , and e_4) are represented by coloured groupings; and can connect any number of nodes.

Image analysis approaches fail when it comes to non-image data, such as genetic information, but Aviles-Rivero and her colleagues were able to utilise the proper mathematical measurements of similarity to create hypergraphs of each of these various forms of data as well. Lastly, by connecting all the various samples for each patient in a hyperedge, all the hypergraphs for the various data modalities-the imaging and non-imaging data-are brought together. The multimodal hypergraph that is produced allows for the capture of the highly intricate linkages between all the various data. According to Aviles-Rivero, "the hyperedges allow us to create higher-order connections in the data, to go beyond pairwise data interactions."

Robust enough for the world

Aviles-Rivero states:" We hope to develop automatic tools that are reliable enough for diagnosing patients in a genuine clinical context." Yet in order to accomplish this, these technologies must be equipped to deal with actual data.

For instance, although two medical scans of the same individual, such as two MRIs, should have the same information about their brains, they won't always be identical. Two MRIs acquired by separate machines may have tiny differences, slightly different orientations, or minor distortions as a result of handling or digitally saving the image.

It's brilliant how the scientists construct their mathematical models of the patient data since they
Are inherently robust to these real-world data issues. The framework automatically creates a rendition of the image data as points in the analogous feature space as previously mentioned. Next, it repeats this procedure with a modified data set in which the images have undergone

minor modifications. A machine learning technique called contrastive self-supervising learning is used to compare the generated representations. This shows how to precisely map the images to the feature space so that, even with such minute changes in the images, the final representation is as similar as possible. In spite of any minuscule variations in real-life data, they may be confident that the hypergraph they created from this representation accurately reflects the meaning contained in the image data.

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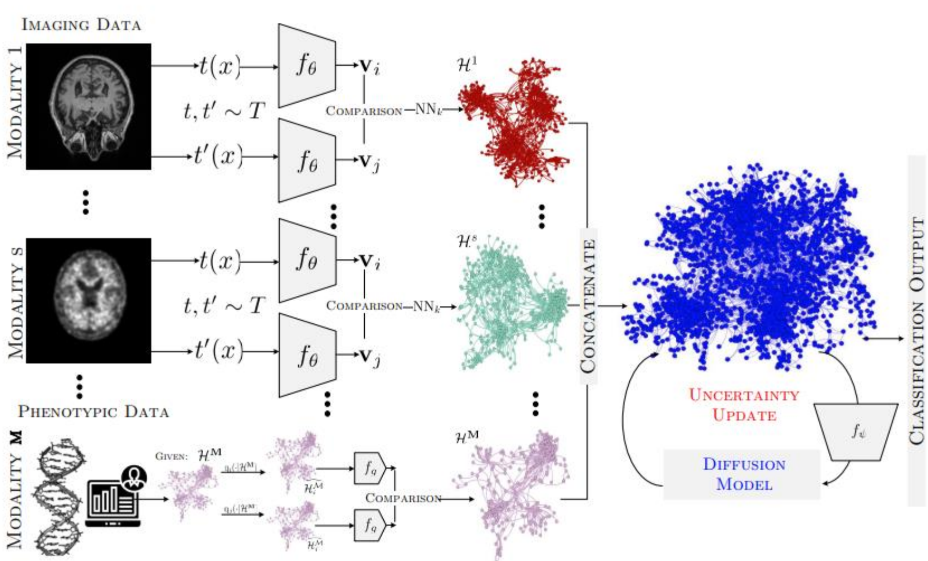

Figure 3: A visual overview of the machine learning framework.

The meaning captured inside an image as a whole is not significantly altered by a small modification to the pixel data or the direction of the image. To ensure that the representation of the non-imaging data is also robust, a distinct adaptation to the method is required because even little changes to genetic data might notably alter the data's significance. Instead, Aviles-Rivero and her associates investigate if slight modifications to the corresponding hypergraphs themselves affect the overall structure and meaning of the data.

According to Aviles-Rivero, "Our framework offers several benefits, one of which is the building of a robust hypergraph. These technological benefits improve the performance for diagnosing Alzheimer's disease."

Starting with a smaller label set

To date, the algorithm has effectively extracted meaning from different available data sets without any supervision. Yet, a patient's diagnosis does require some human input. Instead of explicitly teaching a computer how to perform a task (as in a standard computer program), machine learning algorithms permit the computer to learn by doing the task itself numerous times.

One choice, known as supervised learning, is a set of data for patients who have already undergone an evaluation by a physician for Alzheimer's disease. Based on this training data, the algorithm can try to diagnose the patients, and then compare its findings to the accurate diagnosis provided by the doctor. (You may see it as the computer being in school and comparing responses to those provided by a teacher.) In this manner, the algorithm discovers patterns in the data that point to the presence of the disease in the patient.

Although supervised learning produces good results, it requires sizeable training data sets that have been labelled with the desired output. "Labelling training data is always time-consuming, but it is even trickier in the medical domain because of the clinical expertise that is required," says Aviles-Rivero. "(The problem) is how to develop (machine learning) tools that rely less on labeling." Instead, semi-supervised learning has been the subject of the ingenious techniques created by Aviles-Rivero and her associates. Compared to the greater quantity of unlabelled training data, only a very small number of human-labelled training data are provided in semi-supervised learning.

The algorithm then takes as much structure as it can from the labelled and unlabelled data, creating in this instance a robust multi-modal hypergraph for the patient data. The algorithm then propagates the labels across the entire data set using this structure. "Only 15% of the total data set is labelled when they begin," according to Aviles-Rivero. Next, "they propagate these labels to the entire hypergraph by taking advantage of the links in the data. "Imagine doing this by giving each piece of the labelled data a colour that corresponds to their specific diagnosis (for example, green for "healthy," blue for "mild cognitive impairment," and red for "Alzheimer's disease"), and then having these colours diffuse through the connections in the hypergraph to the unlabelled data, much like a drop of coloured dye spreading through paper. The researchers employ a brand-new mathematical diffusion model that is motivated by a certain hypergraph property. Although this issue is not new, they offer an alternative approach to the hypergraph diffusion problem.

The two phases that have just been described-creating the hypergraph from the data and then dispersing the labels through the hypergraph-are looped through in their semi-supervised technique, with each step improving the one before it. Aviles-Rivero says: "This is a hybrid model. It takes advantage of the mathematical modelling and the (machine) learning techniques. It takes the best of both worlds."

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i. Aviles-Rivero, A.I., Runkel, C., Papadakis, N., Kourtzi, Z., Schönlieb, CB. (2022). Multi-modal Hypergraph Diffusion Network with Dual Prior for Alzheimer Classification. In: Wang, L., Dou, Q., Fletcher, P.T., Speidel, S., Li, S. (eds) Medical Image Computing and Computer Assisted Intervention – MICCAI 2022. MICCAI 2022. Lecture Notes in Computer Science, vol 13433. Springer, Cham. https://doi.org/10.1007/978-3-031-16437-8_69

ii. Figure 1: Wikipedia

iii. Figure 2: (Image by Kilom691-CC BY-SA 3.0)

iv. Figure 3: (Image from the paper Multi-Modal Hypergraph Diffusion Network and Dual Prior for Alzheimer Classification)

This Essay is also used for:

Teddy Rocks Maths Essay Competition

The Math In and Around Us: Fractals

Phillip A. Schaffron, L6

Abstract

When we think of math what comes to mind for most of us is a textbook, assignments, fixed slots of time in our timetables, a subject we struggle with or anxiety due to an upcoming assessment. The least of us, however, think of math as being relaxing, peaceful and even beautiful perhaps? This essay is an attempt to bring awareness to the math that lies beneath the beauty we perceive everywhere around us from a little flower to towering trees; from a peaceful river delta to raging storms; from the intricate details in our bodies to the vastness of the universe.

Pattern Similarity: Visual Examples

Take a look at these images:

Figure 1: Illustrations of fractals

The pattern similarity is unmistakeable, isn't it?

If we take a closer look at the fern leaf, it is intricately detailed with each leaf being a reduced copy of the whole. This pattern is seen everywhere in nature from branches of trees to lightning, capillary network in our bodies, dendrites in our brains and even a Romanesco broccoli in the grocery section of a supermarket.

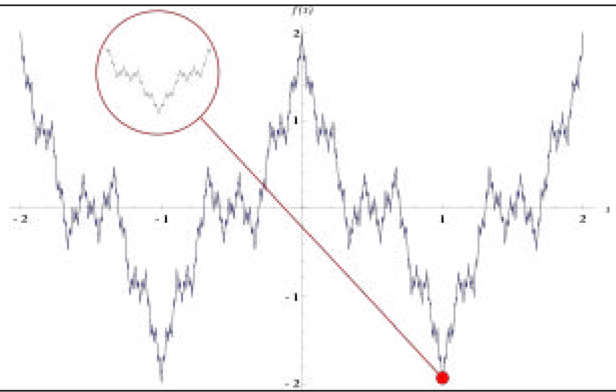
If we can precisely determine the shape and size of objects that we have encountered in geometry, such as a square, a circle or a cube what exact shape does a fern leaf have? And we see that Euclidean geometry is unable to answer this question! Squares, rectangles, triangles and the rest may be great for modelling the shapes of man-made technology but there are few regular shapes to be found in the natural world. This begs the question; how can we describe something like a fern as a precise mathematical shape with all the rough lines and surfaces?

This brings us to the colourful, intriguing world of fractals that enable us to explore dimensions in between the Euclidean types of forms.

A Brief History

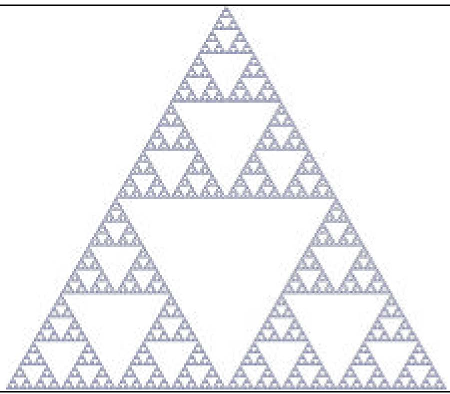
Fractals are a never-ending pattern that repeats itself at different scales with two key characteristics: self-similarity and non-integer dimensions which I will explain in detail later.

Although fractal methods were developed by many mathematicians in the 19th and 20th centuries – Georg Cantor (1845-1918); Helge von Koch (1870-1924); Waclaw Sierpinski (1882-1969); Gaston Julia (1893-1978), Weierstrass was the first to create a fractal curve. The zigzag Weierstrass constructed was so jagged, it was an unending “staccato” of corners. His line had irregular details on every possible scale – a key feature of fractal shapes. Weierstrass’ line was labelled pathological and lacking all common sense as it defied the mathematically well-established method of calculus that had achieved infallible reputation over the previous centuries. The key to solving this problem was only found with modern computing methods (Gleick, 1998).



Plot of Weierstrass function over the interval [−2, 2]. Like some other fractals, the function exhibits self-similarity: every zoom (red circle) is similar to the global plot.

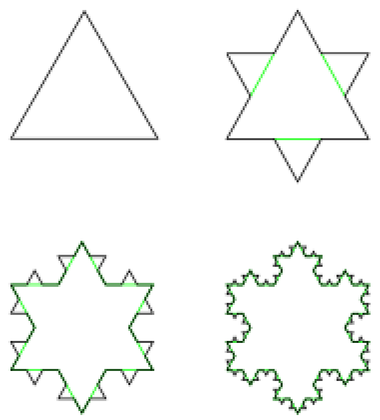
Figure 2: The Weierstrass Curve



Sierpinksi Triangle

a fractal attractive fixed set with the overall shape of an equilateral triangle, subdivided recursively into smaller equilateral triangles.

Figure 3: The Sierpinski triangle



The first 4 iterations of the Koch curve
a fractal curve and one of the earliest fractals to have been described.

Figure 4: The Koch Curve

It was, however, Benoit Mandelbrot who coined the term and popularised it with the creation of the Mandelbrot Set by performing iterations on a simple equation thousands or millions of times. It is no wonder, therefore, that he could only create the Mandelbrot Set, and was at a colossal advantage compared with his predecessors, when he gained access to the immense computing power at IBM in the 1960s.

The term fractal was coined by Mandelbrot as he famously thumbed through his son's Latin dictionary one afternoon and found the Latin adjective "fractus" from the Latin verb "frangare" which means broken or fractured and resonated with the English term fraction (Gleick, 1998).

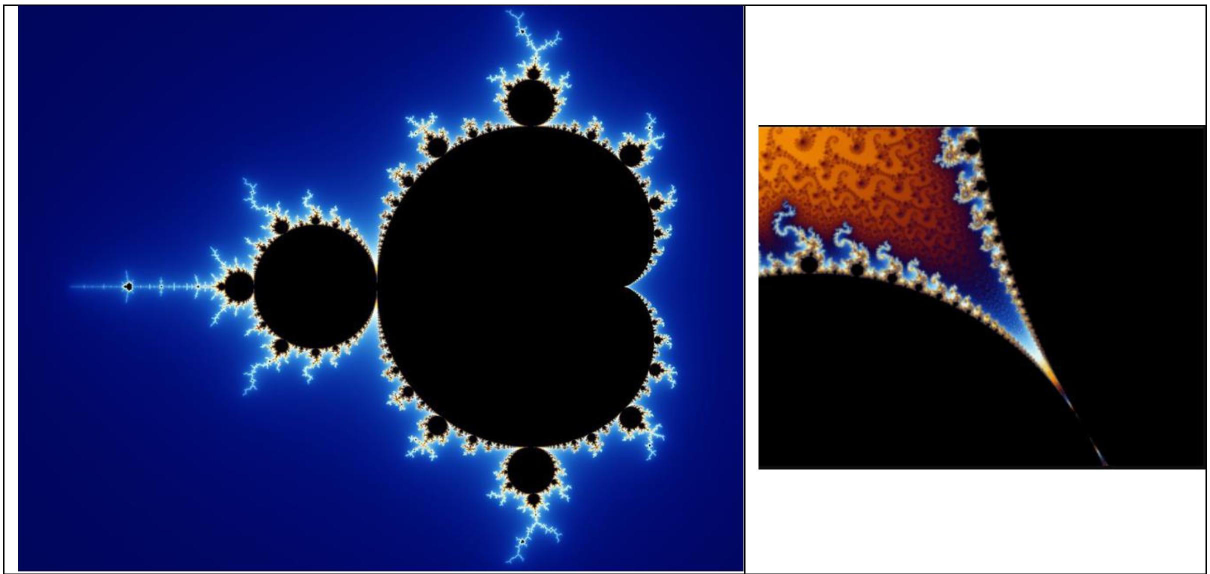
The Mandelbrot Set: Method and Formula

The Mandelbrot Set is the set of points on a complex plane. To build the Mandelbrot set an algorithm based on the recursive formula:

$$Z_{n+1} = Z_n^2 + C$$

where $Z \in \mathbb{C}$ and $Z_0=0$.

is used separating the points of the complex plane into two categories - points inside and points outside the plane, i.e., for different values of C, the trajectories either stay near the origin or “escape”. The points of the Mandelbrot set have been coloured black and are points that are not in the Escape set. The colours of the points outside depend on how many iterations have been required to determine that they are outside the set.



Mandelbrot Set | Self-similar copy

Figure 5: Mandelbrot Set and Zoomed of Edge

The Mandelbrot Set is not only aesthetically appealing but was at the time a dramatic demonstration that extremely simple rules can produce extremely complex results (up until this time, you needed complex rules to produce complex results). When you zoom into it, the reduced copies are not identical but only similar (Quasi self-similarity in contrast to exact similarity in the Koch snowflake).

The common techniques to generate fractals include Iterated function systems, L-systems, Escape-time fractals and Random fractals which I will not explain here so as not to exceed the maximum number of words for this essay.

Main Characteristics

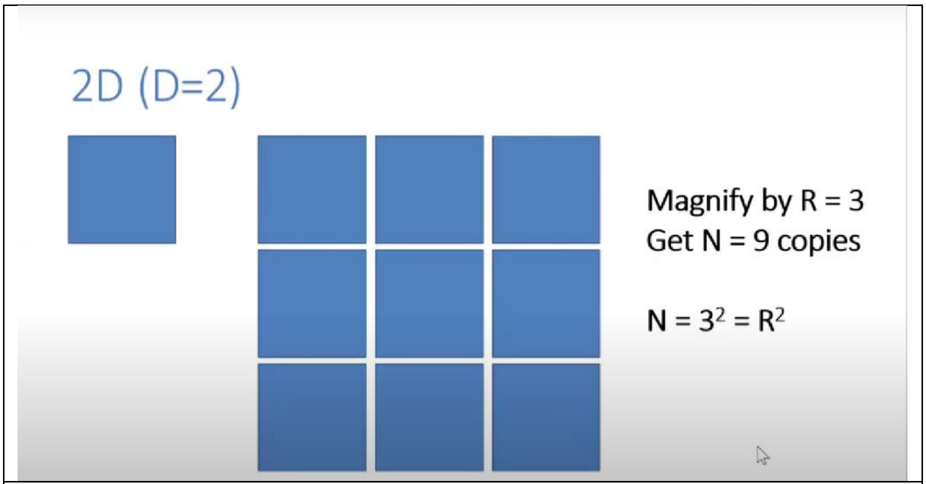
Self-similarity:

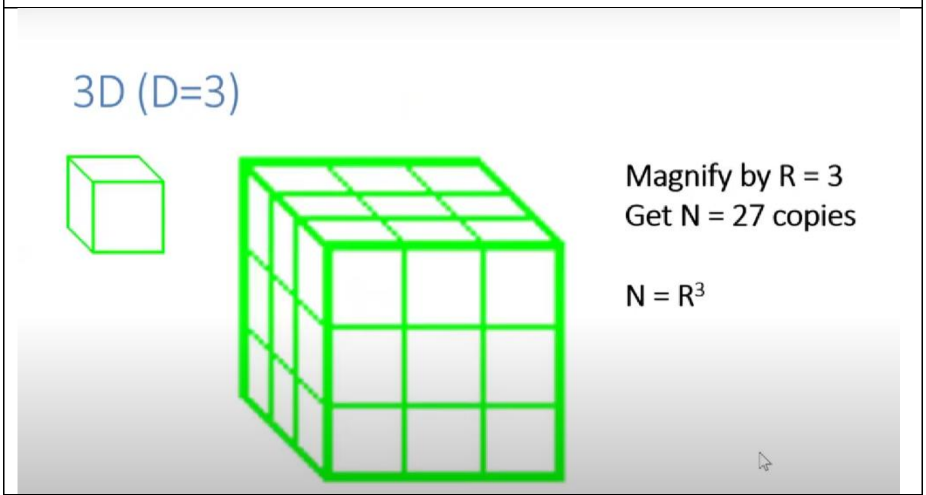
Self-similarity is symmetry across scale. It implies recursion, pattern inside of pattern. Even gigantic shapes such as the Koch curve display self-similarity as the patterns look alike even under high magnification.

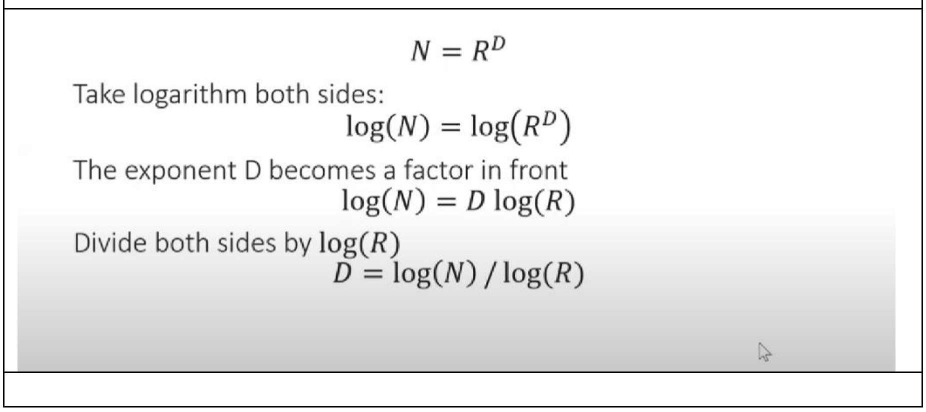
Non-integer Dimensions:

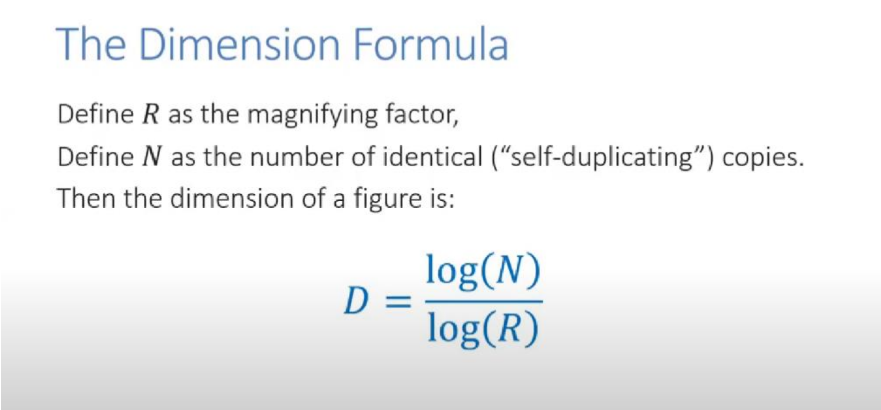
The most striking characteristic of fractals is that they are not whole dimensions of 1, 2 or 3 but somewhere in between. Intuitively, I think of dimension as a measure of how well an object fills up the space around it. This is best illustrated using a simple sheet of paper which is 2-dimensional. Compared with this sheet of paper, a sphere is 3-dimensional. Now if we crumple this sheet of paper it fills up more space than the sheet but less that the sphere and has a dimension of approximately 2.5. This principle is applied everywhere in nature. An example for this is the fact that the bronchioles in our lungs if spread out would occupy the surface area of two tennis courts but crumpling them up enables them to occupy a small volume of just two or three tennis balls! By packing such a huge surface area into our bodies, nature has ensured we get the needed oxygen supply; vital to keep us alive (lungs have a fractal dimension of 2.97). It also enables structures like the Eiffel Tower to remove weight as it gets higher, without removing structural strength.

Calculation

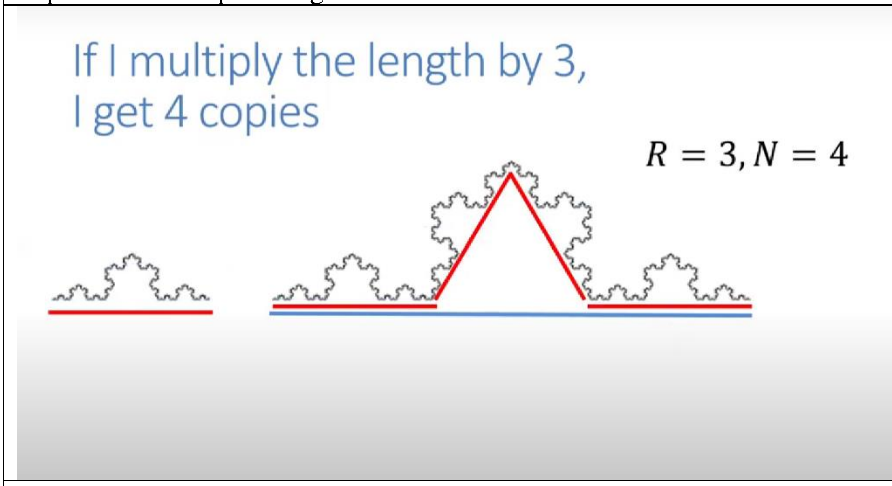








A practical example using the Koch curve:



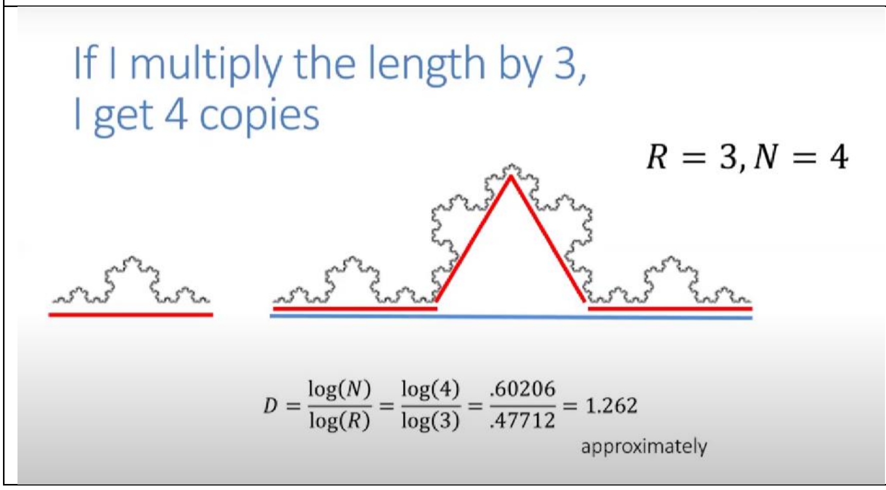


Figure 6: Calculation using the Koch Curve

As fractal mathematics capture the infinite complexity of nature, it helps understand many of the systems we live in better, that exhibit complex chaotic behaviour. In other words, it gives us new insight with things that are effectively impossible to predict or control like turbulence – in weather or the stock market.

Fractals in Art

When humans put fractals to intentional use in order to prove or disprove; gather empirical data or find new interconnections; postulate theories or explain concepts we call them scientists. But when humans unintentionally use fractals as a means of self-expression creating in the process a unique artifact that will keep generations to come awestruck, we call them artists.

Fractals have been used long before they were termed as such by artists in the form of Mandalas (spiritual symbols said to represent different aspects of the universe and used to enlighten the brain and heal from within) and in architecture of the ancient world. Jackson Pollock, a creator of Abstract Expressionism and one of the best-known fractal artists, has created works of art that according to neuroscientists induce stress reduction (F. Williams & Aeon, 2017).

Figure 7: A Jackson Pollock Painting

A Scientific Study: Role of Fractals in Stress Relief

A fascinating study by a physicist, Richard Taylor, mesmerized by Pollock's art as a child, went on to explore the reasons why people were so drawn to his art. So, Taylor along with an environmental psychologist, Caroline Hägerhäll, ran experiments to see what the physiological response viewing these images and similar fractal geometries evoked. He measured people's skin conductance (an indirect measure of sympathetic autonomic activity that is associated with both emotion and attention) and found that they experienced a 60 percent higher stress relief when viewing computer images with a fractal dimension between 1.3 and 1.5, i.e., the fractal dimension of large, coarse patterns (coastline from a plane, main trunk of tree to Pollock's big patterns) to fine ones (dunes, rocks, branches, leaves and Pollock's fine patterns).

Further research showed an astonishing connection leading to an interesting theory by Taylor and Hägerhäll and that is, in addition to lungs, capillaries and neurons the visual system as expressed by the eye's retina branched into fractals as well. Using tracking mechanisms to see where people were focusing on projected images, the search pattern used was itself fractal! The eye first scanned the big elements in the scene and then made micro searches in smaller versions of the big scan – all in the range of 1.3 to 1.5! Even foraging patterns when tracked see this fractal pattern of search trajectories. The scientists, therefore, conclude that our visual cortex feels most at home alongside natural features we have evolved. It also shows that being surrounded by Euclidean built environments; we risk losing connection to our natural stress reducer of visual fluency (Taylor, R.P., 2006). And doesn't this explain why we need to make our cities and living spaces greener and get outside more often? Or why looking at a green tree every now and then is the most natural way of relieving stress instantly?

Uses of Fractals

Fractals in Astrophysics:

Astrophysicists believe that the key to how stars were formed and ultimately found their place in the universe lies in the fractal nature of interstellar gas. The hierarchical structure of turbulence that shapes clouds and gives them an irregular but repetitive pattern is what could give us clues about celestial bodies.

Fractals in Biology:

Scientists have discovered that chromosomes depict tree like architecture and consists of mini chromosomes and can, therefore, be treated like a fractal (fractal dimension 2.34). As self-similarity can also be found in DNA sequences and can be used to solve evolutionary relationships in animals.

Fractals in Computer Graphics:

For the gamers among us (no pun intended), fractal forms are used to create graphical representations of textured landscapes such as mountains, coastlines etc. for computer games as they display the complexity from simplicity characteristic. The shape of the fractal can be completely achieved by a small list of mappings that defines exactly how the smaller copies are arranged to form the whole fractal. Special effects can be seen as the geography of the moon in the Return of the Jedi and to draw the outline of the famous Death Star.

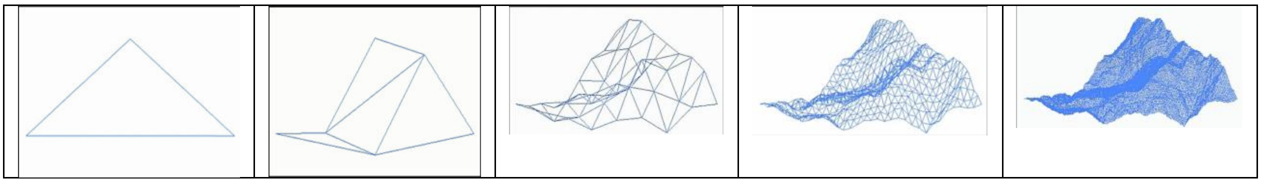


Figure 8: Generation of a Computer Landscape using Fractals

Many image compression schemes use fractal algorithms to compress computer graphics files into less than a quarter of their size. Self-similar branching patterns seem to be nature's invention to minimize friction and maximize growth (in plants or organs) or progress (in flow).

If this topic has interested you, I urge you to look up the many different fractal sets, their creation and beauty on http://fractalfoundation.org/.

Conclusion

This essay is only a fraction, an appetiser so to say, of the countless examples of math in us and around us as infinite forms in nature lead us to appreciate not only the obvious but further explore the unseen beauty of math that lies beneath.

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Fig 1: Lightning: https://en.wikipedia.org/wiki/Lightning
River delta: https://en.wikipedia.org/wiki/River_delta
Fern leaf: https://en.wikipedia.org/wiki/Silver_fern
Tree with fractal clouds: Photograph by Author, Cambridge, UK.

Fig 2: https://en.wikipedia.org/wiki/Weierstrass_function

Fig 3: https://en.wikipedia.org/wiki/Sierpi%C5%84ski_triangle

Fig. 4: https://en.wikipedia.org/wiki/Koch_snowflake

Fig 5: https://en.wikipedia.org/wiki/Mandelbrot_set

Fig 6: Vu, H.-N. Fractal Dimensions What, Why, How To. *Vu Do Math.* https://www.youtube.com/watch?v=v273ElS1TRU

Fig. 7:
https://www.theguardian.com/artanddesign/2015/jun/19/why-jackson-pollock-painting further referenced as: Jackson Pollock, Number 34 1949. Courtesy of The Pollock-Krasner Foundation ARS, NY and DACS, London 2015/Munson Williams Proctor Arts Institute/Art Resource, NY/Scala, Florence.

Fig. 8: https://en.wikipedia.org/wiki/Fractal

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Teddy Rocks Maths Essay Competition

Predeterminism

Persephone Baker, L1

Abstract

Most people believe that humans have the fabulous gift of free will. Free will gives people choices over what they can do, say, whether they eat a bagel for breakfast or a slice of toast. The contradictory view is *predeterminism* which is the subject of this academic journal. *Predeterminism* is a theory that a chain of events have already been ascertained. It claims that everything has already been decided. Upon further inspection of this theory, one can find themselves asking: "Do I have free will or is my life already decided?"

Views of Predeterminism

Different philosophers have different views on this concept. R. E Hobart[1] said: "*I am not maintaining that predeterminism is true… it is not here affirmed that there are no small exceptions, no slight undetermined swervings, no ingredient of absolute chance*." Philippa Foot[2] said "*The idea that free will can be reconciled with the strictest determinism is now very widely accepted. To say that a man acted freely is, it is often suggested, to say that he was not constrained, or that he could have done otherwise if he had chosen, or something else of that kind; and since these things could be true even if his action was determined it seems that there could be room for free will even within a universe completely subject to casual laws.*"

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[1] R.E. Hobart (1934) "Free Will as Involving Determination and Inconceivable Without It" *Mind, Volume XLIII, No. 168*

[2] Phillipa Foot "Free Will as Involving Determinism", *The Philosophical Review,* Volume LXVI

Could Free Will and Predeterminism Co-exist?

My view on this topic is that free will and predeterminism co-exist, that there is room for predeterminism in the universe though that we have small choices which affect our life. That we have no control over things that happen externally though we have control over things that happen internally, for example, our thoughts and reactions we have control of. To question theological determinism, it is a sin to think to harm our neighbour though if everything is predestined by God himself and God considers it a sin to think about the harm of others, wouldn't he have predestined that nobody think of something bad or sinful? However, I believe that murdering and crime-committing was also predestined as a way of punishing bad souls (whether they be who committed the crime or the victim), or a way to take somebody out of this existence.

Conclusion

We can never know whether predeterminism is real as there is no way of scientifically proving it, just as where is no way of proving that "God" exists. It is up to our own thoughts and beliefs to prove to ourselves that it is real, if we can do this, it is as real as the ground underneath us.

Reference

1. R.E. Hobart (1934) "Free Will as Involving Determination and Inconceivable Without It" *Mind, Volume XLIII, No. 168*
2. Phillipa Foot "Free Will as Involving Determinism", *The Philosophical Review,* Volume LXVI

The Nest

Flavia Faraon-Pogaceanu, L5

The Nest is my attempt at designing an interaction hub suitable both for people looking for an open, casual meeting area, and for those searching for a quieter place to study. It is located right outside the auditorium and the Grove, intruding as little as possible on any of the pre-established courts or shrubbery patches on the college grounds.

Originally, I was inspired to design the building to incorporate one of the ancient site trees (the tip of the Nest would encircle the trunk of the tree, as it was designed with a hole running through each layer). However, I could not find a suitable location for the building with a tree, so the feature was omitted.

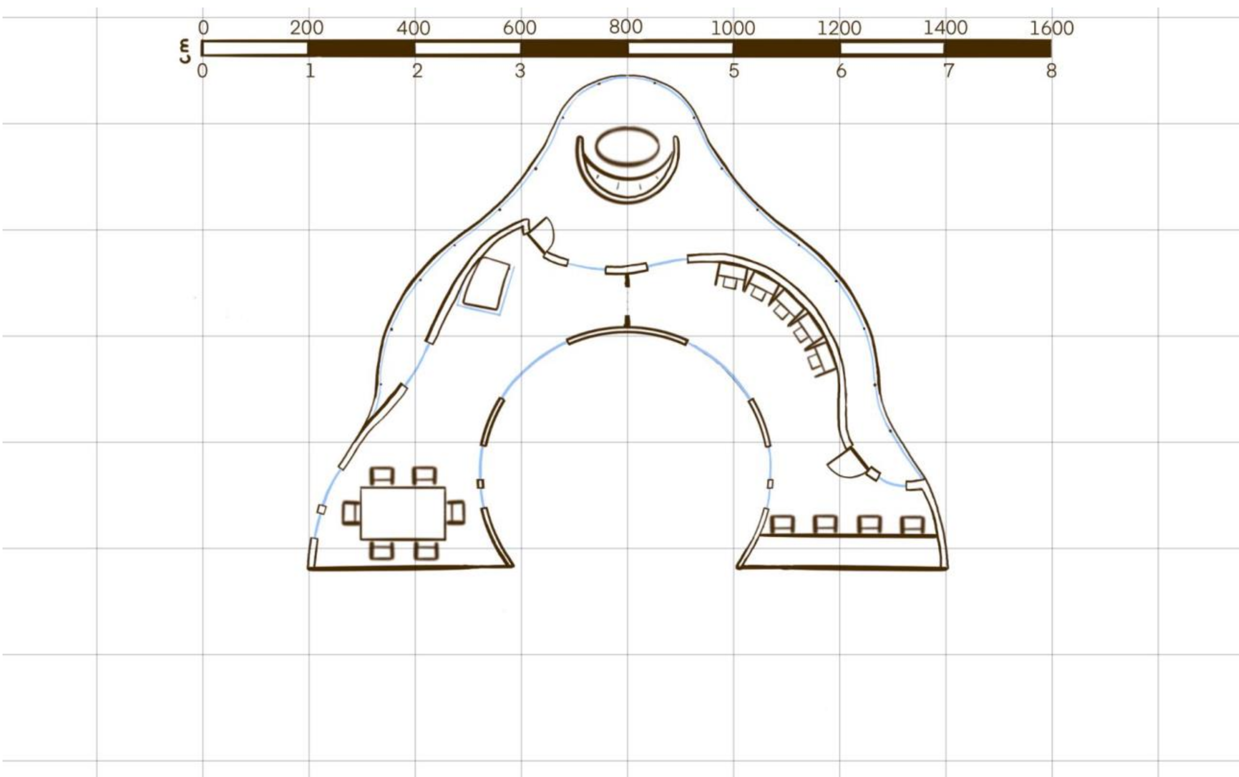
I researched the other Fitzwilliam edifices for inspiration and style, as I wanted my building to integrate smoothly into the college despite its unique shape. My final design is less traditionally gridded and more abstract, so I strived for more sympathetic material choices and design details.

The Nest's base is constructed with Fitz's signature Lasdun-palette brickwork, with the accenting upper floor made of light wood (such as white oak or fir, after the Olisa library and the Gatehouse). Fitzwilliam's other signature trait, the white course banding featured on the New Court, the Chapel and more, is subtly included along the edges of the balcony floor and the roof. The canopy's dark theme emulates that of the Grove and New Court, but could alternatively be turned into a living feature by blanketing it in grass.

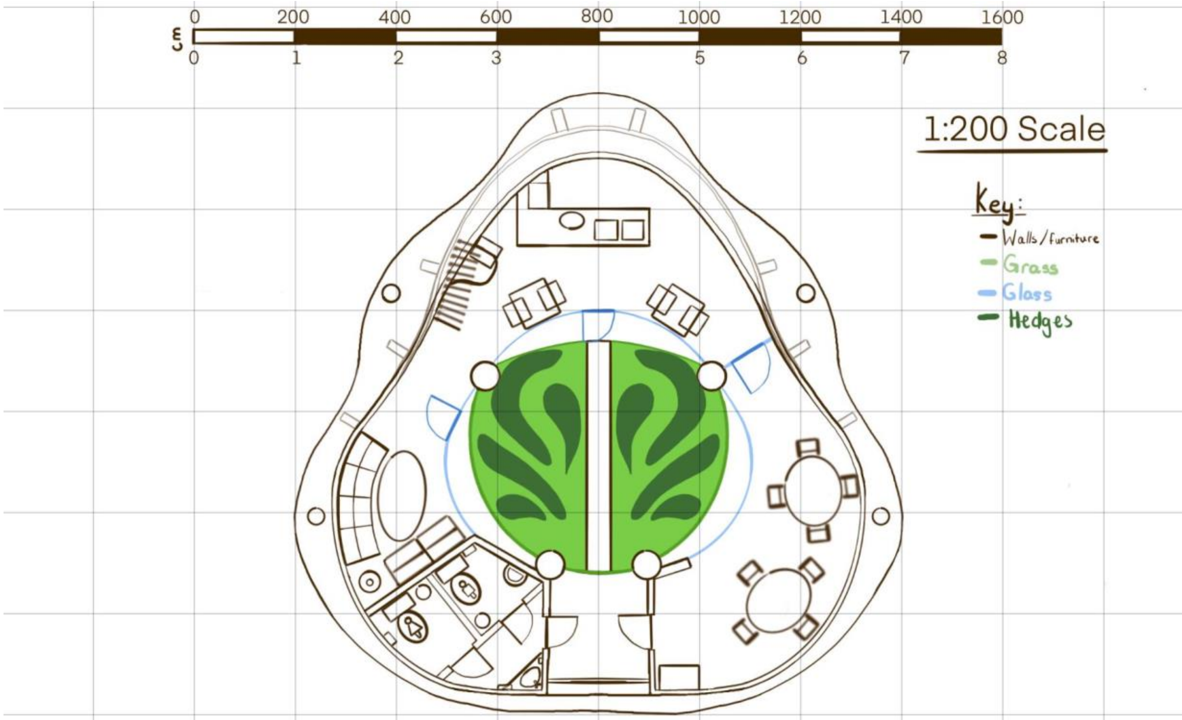
Lining the small interior court, the ground-level glass walls are supported by (and decorated with) thin metal beams mirroring the Chapel's front facade. Along both exterior and interior of the elevated floor, the windows follow the library's thin-and-thick pairing, contrasting the curvature of the walls with straight interruptions.

I separated the interior of the Nest by level: the ground floor is an open social space, while the upper floor is dedicated to quieter private study. These aspects are reflected in the structure's walls, with the base's floor-to-ceiling windows allowing much natural light to enter and clear visibility from one end of the building to the other. This area of the building also contains a small cafe bar, which can accommodate an average fridge, a sink, and any usual countertop cafe equipment. As one enters, directly to the left are the restrooms, to the right is an entrance to the communal meeting room, and straight ahead is the path leading through the court and to the cafe. The court's low hedges are arranged in such a way so that one can cut to the left, beyond the toilets, through a shortcut to the lounge.

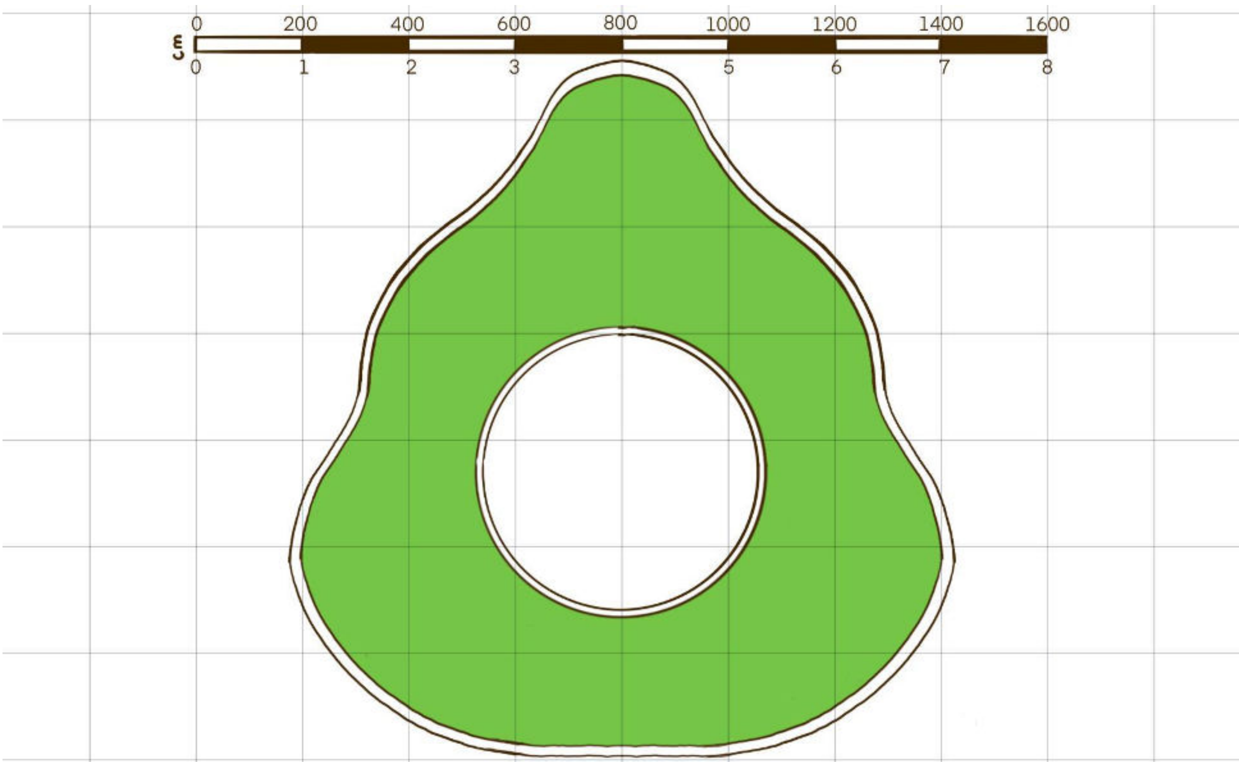
In the first floor's interior you will find another meeting table on the stairwell side (left) and many individual study cubicles and a wall-spanning workdesk on the right. Outside on the balcony, a semilunar couch and accompanying table are shielded from the commotion of the traffic flow by a ceiling-reaching backboard partition.



First Floor Plan

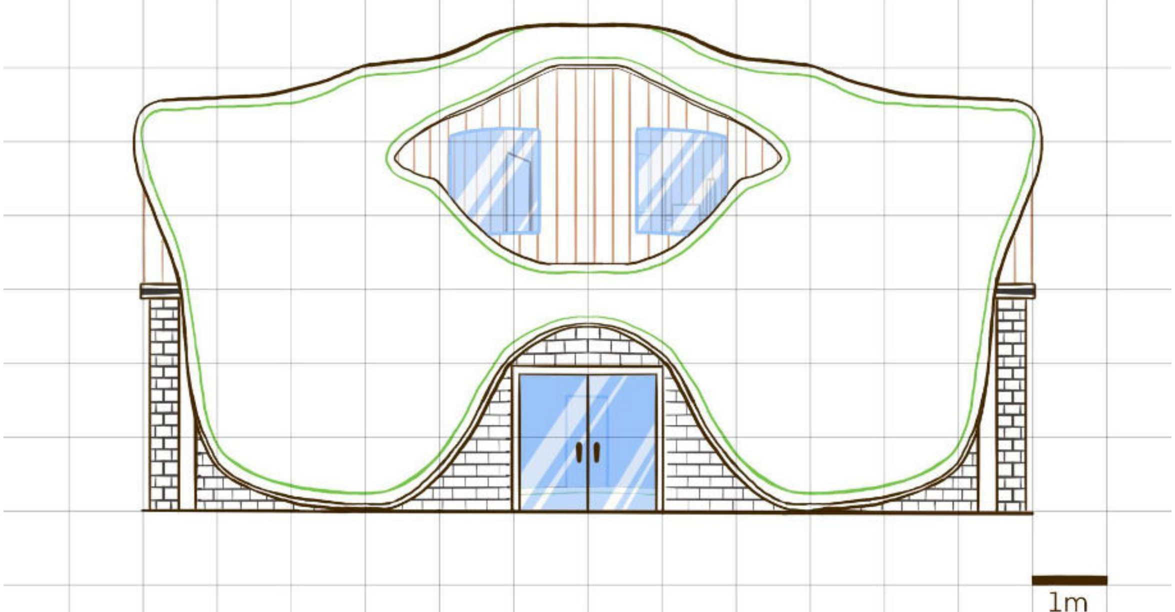


Ground Floor Plan

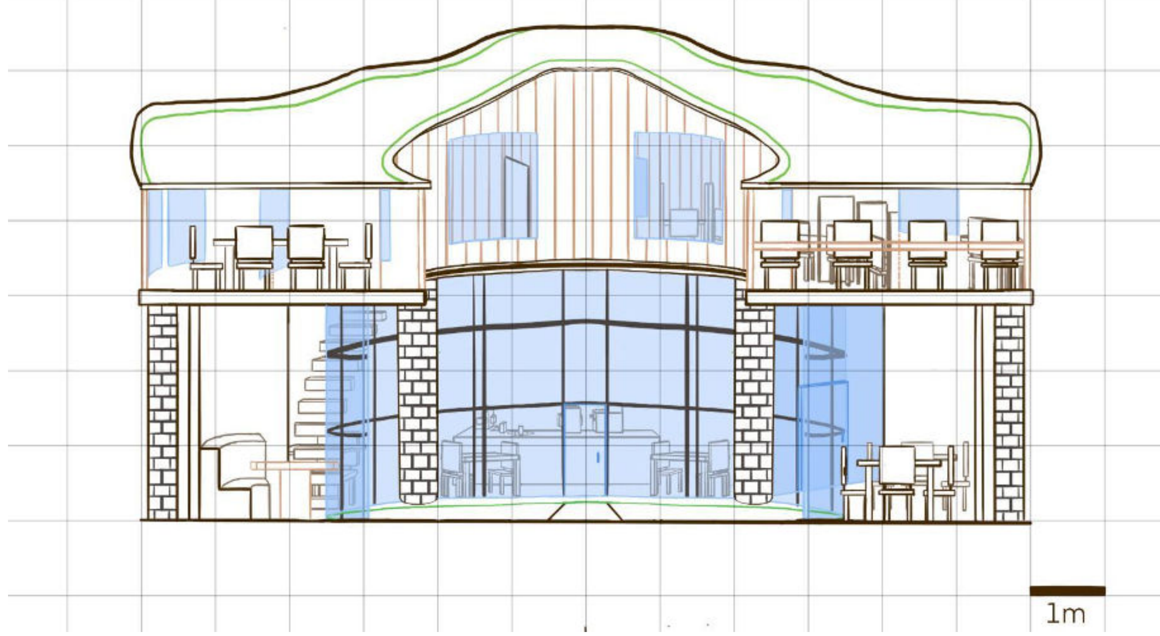


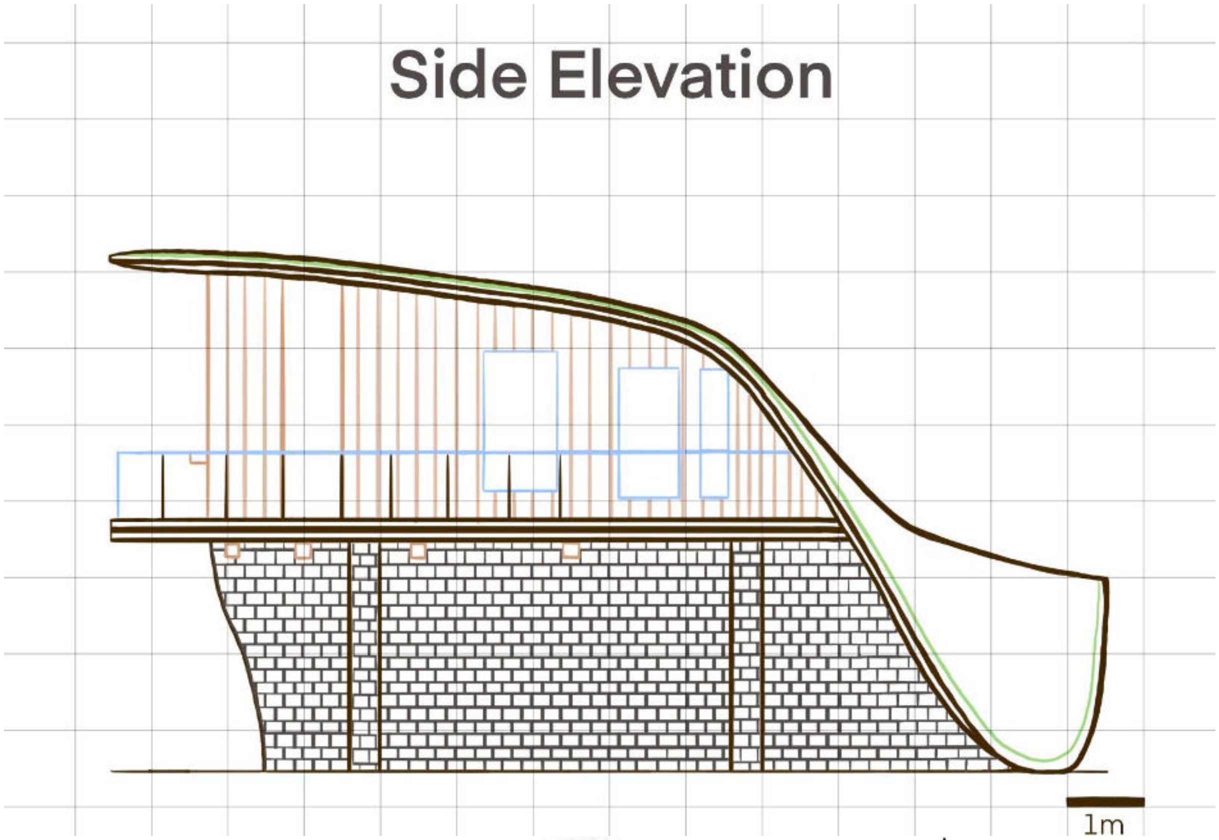
Ceiling

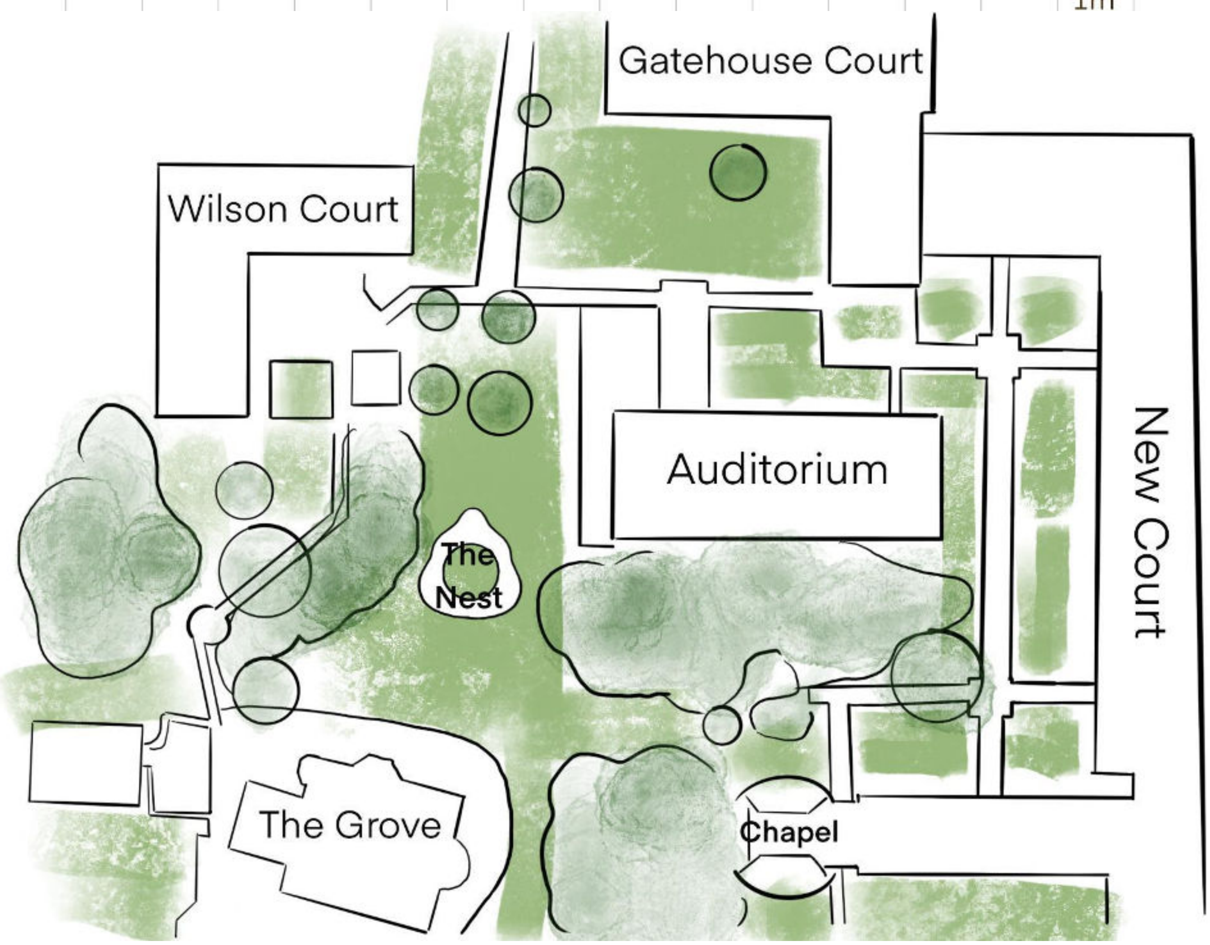
Front Elevation



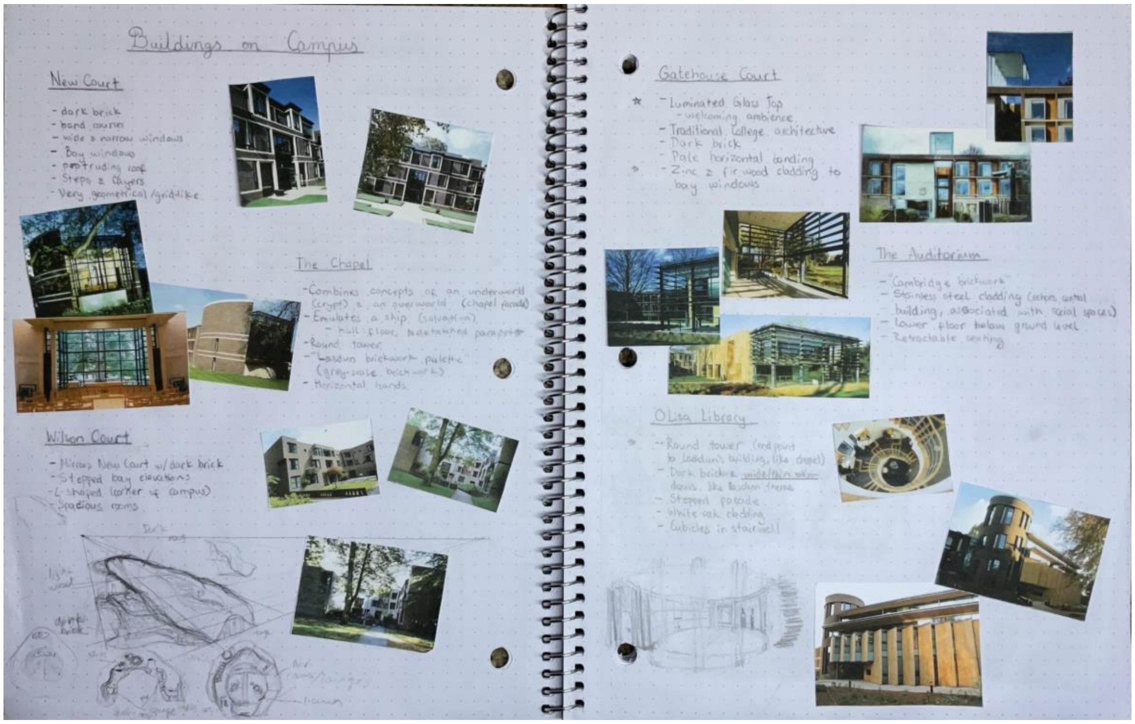
Front Section

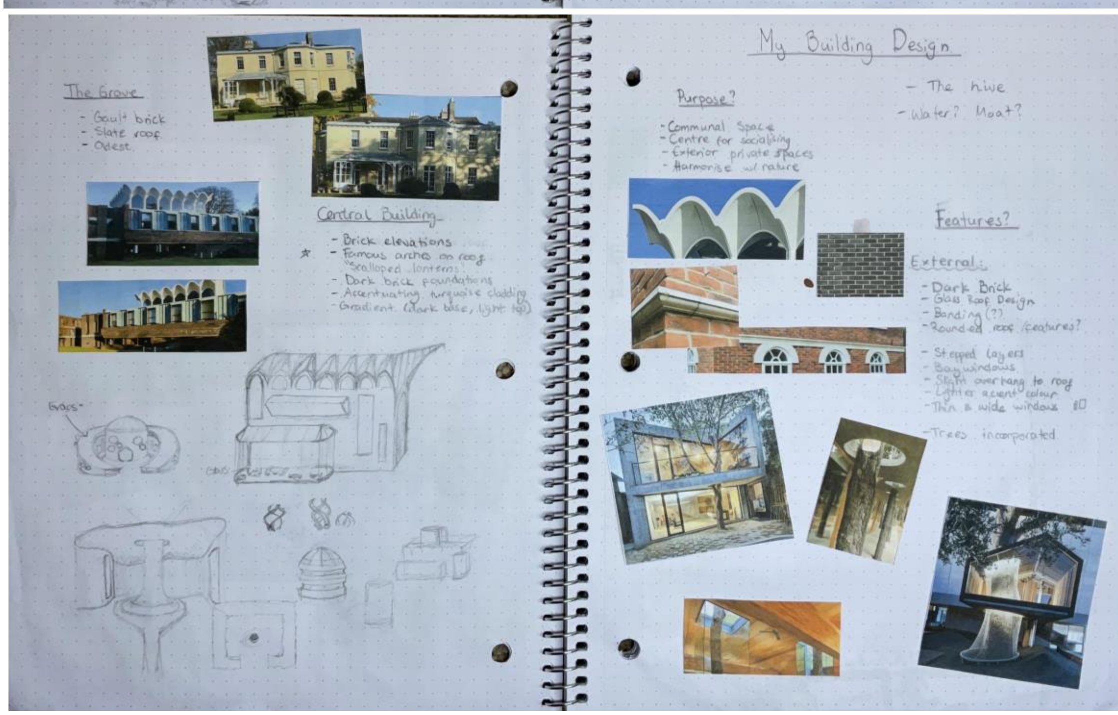



Side Elevation
1m


Gatehouse Court
Wilson Court
Auditorium
New Court
The Nest
The Grove
Chapel

<u>The Process</u>





This Essay is also used for:

Fitzwilliam College Essay (Architecture)

Research on the 'Big Issue'

By Ms Jaami
& her L3 English Language Class

Amelie D. 10/02/23

They exist in the hopes of providing "vital support and specialist services that enable them to rebuild their lives"

- Once people sign up, the organisation sells Big Issue Magazines to vendors at £1.75, and they can then resell them to customers at £4.00, pocketing the difference.
- Vendors can earn a sensible income, whilst gaining relevant social and financial skills.

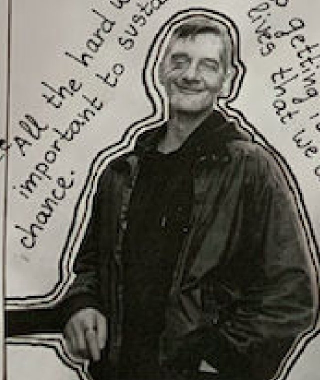
What is The Big Issue?

Europe's 1st street nespaper, and one of UK's leading social enterprises committed to supporting the homeless & disadvantaged in escaping poverty!

- Their work is fully flexible: vendors can sell on their pitches any time of day and are responsible for their own earnings.
- Based on individual circumstances, some personal support plans can be arranged.
- If vendors sell over 100 magazines a week, they can earn £225+ each week.

When and why did it get founded?

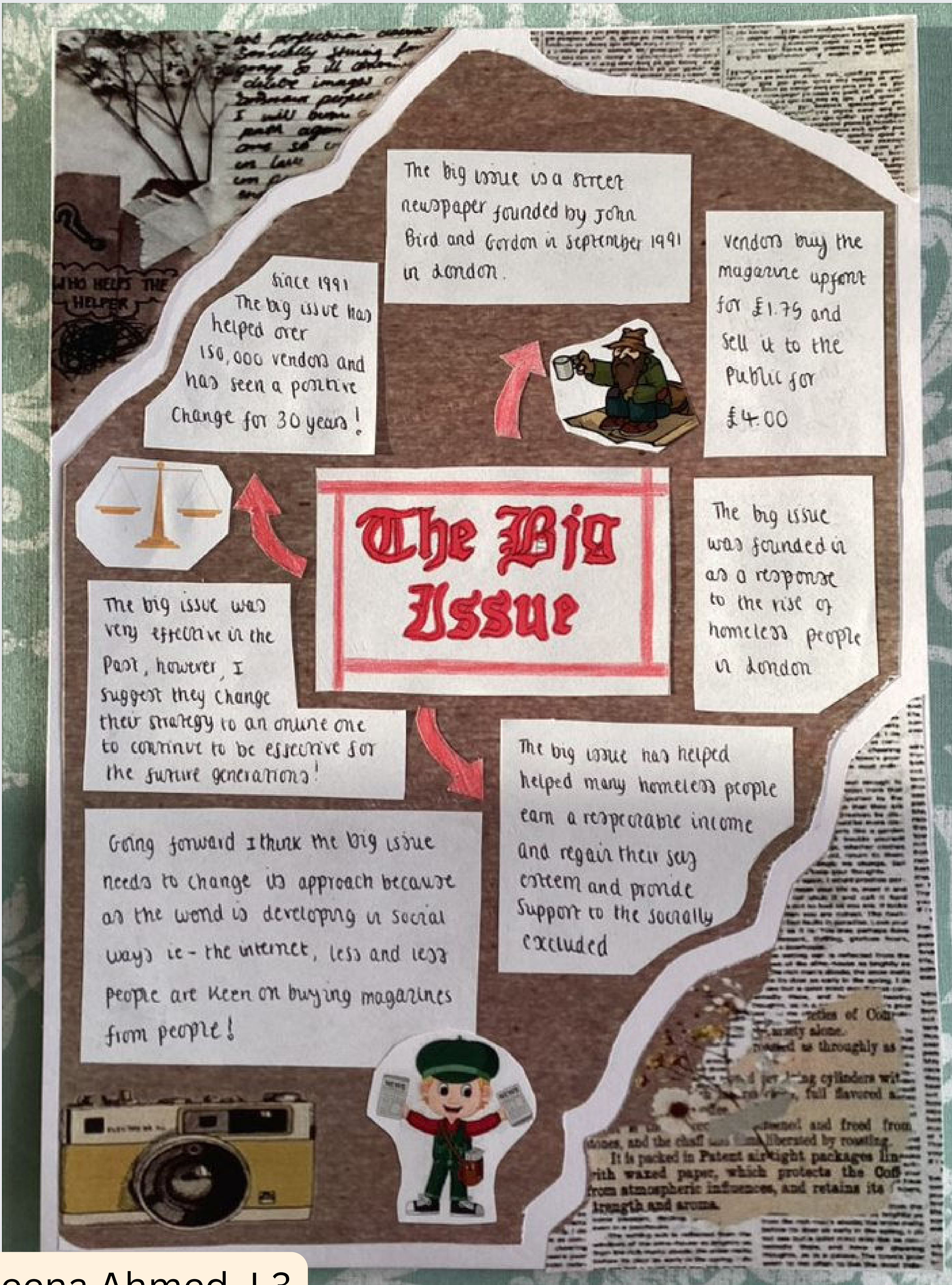
- The 1st issue was published in 1991, when homelessness was at its peak.
  - Between 2000-3000 sleeping on the streets of London alone
  - Gordon Roddick (co-founder) became inspired by 'street news' in NYC, and chose to respond to this crisis by starting a similar magazine
  - He contacted John Bird to be the editor. Thus, their project was born.
- The Big Issue foundation was established in April of 1995; when growing numbers of vendors set up and were linked up to other support services.



"All the hard work you put into getting it right. It's very important to sustain our lives that we are given a chance."

- Jamie's story

Amelie Deroo, L3



Heena Ahmed, L3

Scarlett Essex, L3

Research on the 'Big Issue'

The upcoming pages contain presentation slides on the 'Big Issue' by (in alphabetical order of the authors' name):

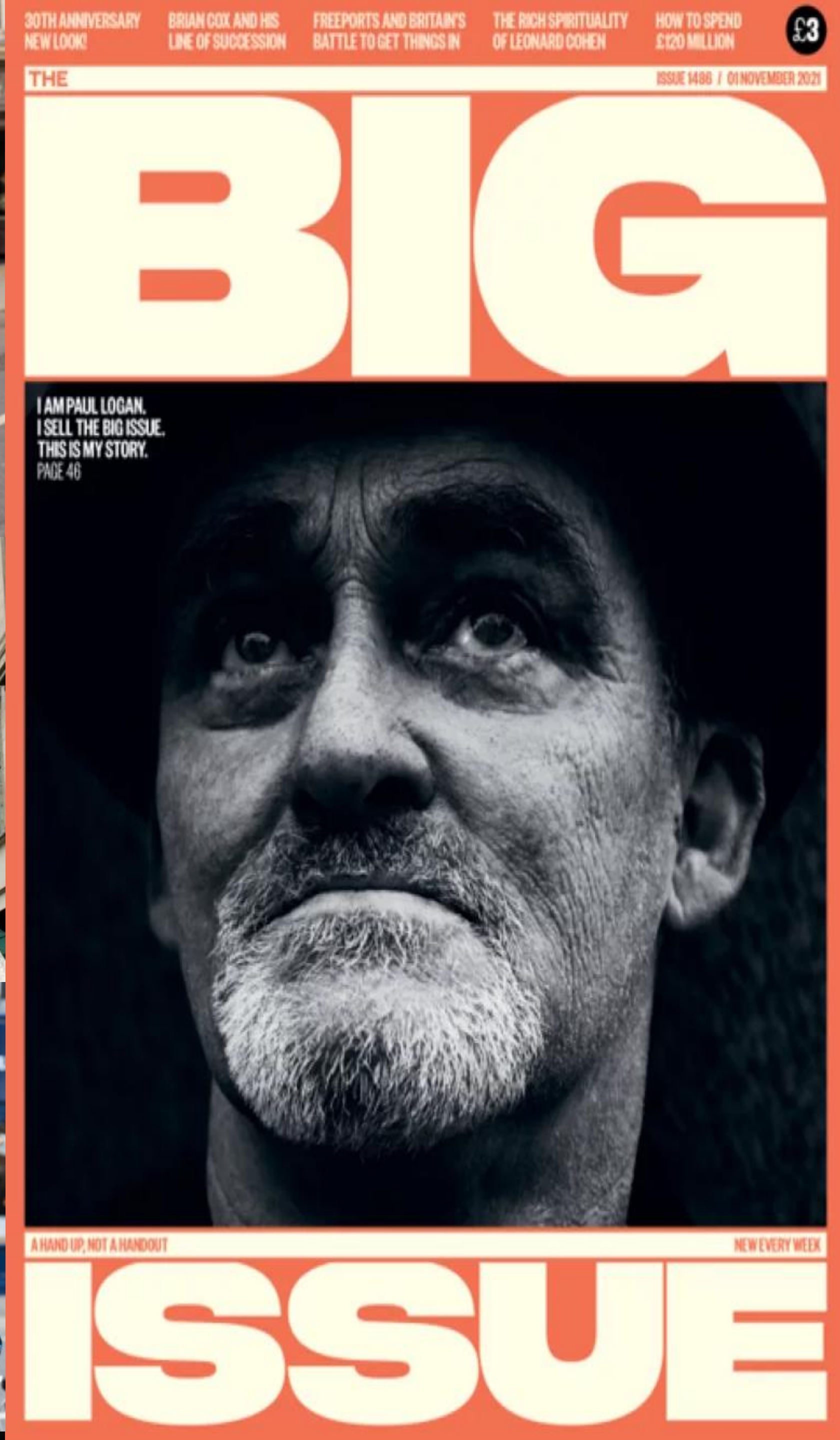
- Anya Ragel Welsted, L3
- Ben Jones, L3
- Conrad Ho, L3
- Deborah Iheanacho, L3
- Izzy Boyden, L3
- Lina Khazragi, L3

The big issue

Anya Ragel Welsted

What is The Big Issue?

The Big Issue is a newspaper founded as a response to the increasing numbers of homeless people in London. This newspaper is sold on the streets by homeless people with the purpose of earning some income and increasing their self-esteem. All of the economic benefits that the newspaper generates are sent to the big issue foundation, which allows the reintegration of people who have been excluded from society. The Big Issue has economically contributed to found other newspapers in Eastern and western Europe, South Africa and Australia.



The Big Issue: the begining

When did The Big Issue get founded?

- The big issue was founded by John Bird and Gordon Roddick in September 1991. The Body Shop provided financial invesment towards The Big Issue. The newspaper was initially published monthly, but in June 1993 The Big Issue was published weekly.

Why did The Big Issue get founded?

- The Big Issue got founded as a response to the increasing numbers of homeless people in London. The Big Issue is one of the largest social Companys in the UK. It exists to offer the opportunity of having a legitimate income to those that are or are about to be homeless, which also helps them be less excluded from society. This newspaper has become international over the years, now helping the homeless in 4 continents and over 30 countries all around the world.

Struggles, archievements and the pandemic

The Big Issue: struggles

From 2007 to 2011 The Big Issue reduced its sales by 20%, at the same time that competition between vendors increased. But then, in January 2012, the newspaper was relaunched with a new focus on campaigning and political journalism.

The Big Issue: archievements

The Big Issue has spent 30 years at the forfront of the personal wellbeing revolution. Since 1991, The Big Issue has sold over 200 million copies through 100,000 people. In 2005, Big Issue invest was started with the aim of extending its purpose by financing the development of social enterprises and charities across the UK.

The Big Issue: pandemic

During the lockdown in 2020, The Big Issue lost 80% of its revenue due to the pandemic. These events made The Big Issue´s leaders to question their future position: "we had to accept the fact that we dont have an income if dont have a street" said John Bird as a response to the pandemic. The Big Issue then decided to work on an online project to win back the revenue lost.

1991 – The Big Issue is founded and publishes monthly.

1993 – The Big Issue starts to publish weekly.

2010-2015 – The Big Issue expands to, Grece, Seattle, Russia, Bergen, Argentina, Mexico, Korea, and Taiwan

Conclusion

- In my opinión, The Big Issue has saved many lives and taught many people about the struggle of the homeless. I believe that because of The Big Issue´s way of selling, homeless people have been much more accepted by society tan they previosly were. Not only has the big issue helped homeless peple have recognition, but it has also helped them economically. This project has saved thousands from hunger on an international scale. Furthermore, due to the events of the pandeic, The Big Issue struggled, but the struggle has lead to The Big Issue going online. By doing this they are keeping up with modern marketing, insuring the magazine has a bigger and better future.

The Big Issue

By Ben

What is ‘The Big Issue’?

The Big Issue is a national magazine that was first published in 1991 to help support individuals who are homeless or are at risk of homelessness.

It has helped over 92,000 homeless people and currently has 1,500 Vendors. The Big Issue is sold across the UK which its head office based in London.

What is 'The Big Issue?' (continued)

Vendors buy magazines for £1.25 with their own money from official distribution points and sell them for £2.50 from a designated pitch.

By doing this, vendors are able to generate financed stability through the magazine sales whilst helping them overcome social disadvantages previously holding them back.

What is ‘The Big Issue?’ (last one I promise)

As well as selling the big issue, vendors receive support and success to help them rebuild their lives e.g. housing, employment.

The Big Issue foundation also generates money through Individual giving and charitable trusts.

How the main principle of The Big Issue has been successful in achieving its objective.

The Big Issue continues to help and support homeless people across the UK and continues to grow each year. More recently with the cost of living crisis, The Big Issue group are calling on people to sell The Big Issue in a way to boost their income. Big Issue vendors can earn over £150 a week, also allowing people to work the hours they can.

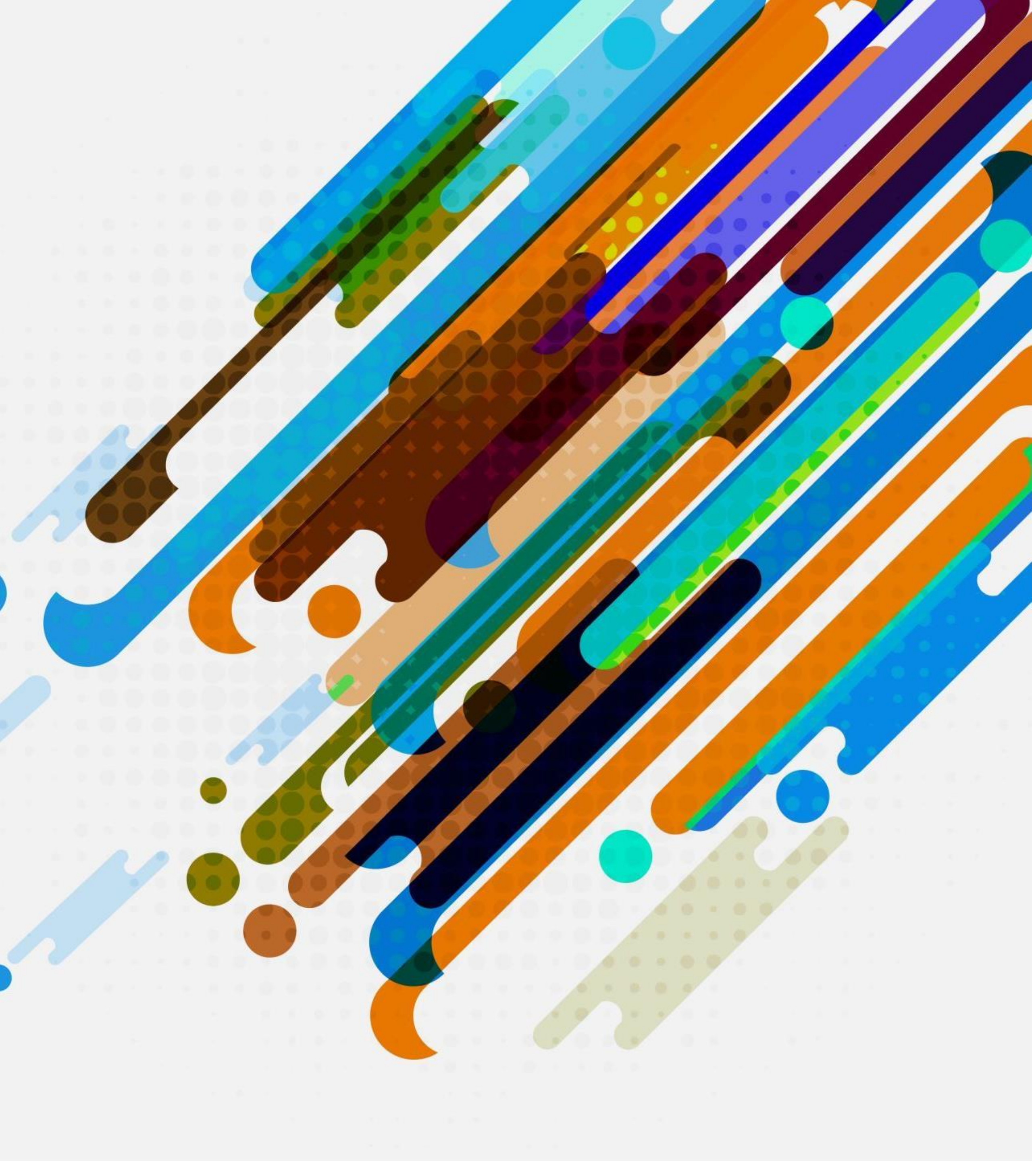
The Big Issue group has supported 100k people over the last 30 years, helping people get back on their feet.

Why was it founded?

Founded by John Bird and took its idea from a newspaper sold by homeless people in New York. Originally set up to tackle homelessness in London.

What can you do?

The Big Issue does not deserve to become unnoticed and abandoned. Whenever you see someone selling The Big Issue just remember why they are doing it and what it stands for. It matters now more than ever.



Big Issue

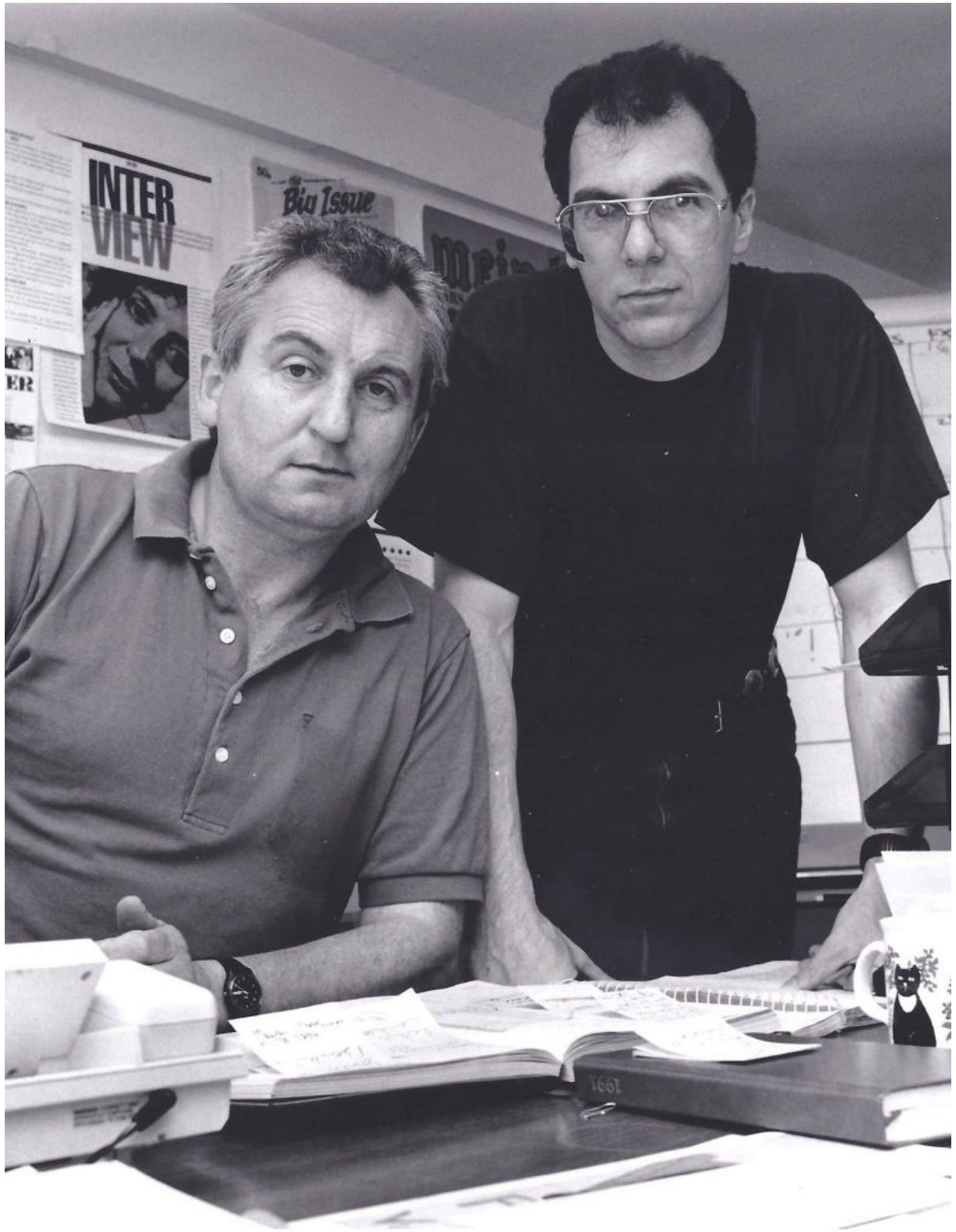
Conrad Ho

What is the Big Issue?

The Big Issue is a social enterprise magazine that is sold by homeless or vulnerably housed individuals in the UK and Australia. It was founded with the aim of providing a means of income for those who are struggling with poverty and homelessness, as well as raising awareness about these issues.

When and why did get founded?

- The Big Issue was founded in 1991 in the UK by John Bird and Gordon Roddick as the founders had a vision to help those who are suffering from poverty and homelessness by providing them with a way of gaining income because they believed that by offering homeless individuals the opportunity to sell The Big Issue, they could provide a source of income and help them work their way out of poverty.



Has the principal of 'The Big Issue' been successful in achieving its objectives?

The Big Issue has been successful in achieving its objectives. Over the past three decades, it has provided homeless individuals with a source of income and has raised awareness about homelessness and poverty and in 2019, The Big Issue UK reported that its vendors earned a total of £5.5 million through selling the magazine, which highlights the positive impact it has had on their lives.

Is 'The Big Issue' a successful, viable venture.

The data and statistics clearly show that 'The Big Issue' has been successful in creating opportunities for those who are struggling with poverty and homelessness. By providing a means of income, 'The Big Issue' has helped many individuals work their way out of poverty and gain a sense of stability in their lives. This is a paramount as when individuals are struggling with poverty, they may feel hopeless and consider suicide. By providing them with this 'job', they have something to rely on and a sense of purpose, which could possibly make a big difference in their lives.

The future of Big Issue

As the technology of the modern society improves, less people are willing to get a free physical copy let alone paying for it. This is a big issue the Big Issues would have to deal with sooner or later. To cope with the raise of technology, they might public their publications online via a subscription-based plan. They could allow the reader to decide the amount they would like to pay for but perhaps with a set prize which is affordable. This obviously would reduce the opportunity to create work positions for the homeless, but it would on the other hand ensure those in need could be supported finically.

The Big Issue

What is the Big Issue???

The Big issue is one of the Uk's leading social businesses and exists to offer homeless people, or individuals at risk of homelessness, the opportunity to earn a legitimate income.

How does the Big Issue work?

- Since The Big Issue was founded in 1991 they have been in constant partnership with there vendors. They buy magazines for £1.25 and sell them for £2.50. They keep the profit from every sale, and can reinvest it buying more magazines.

What does the Big issue stand for?

- The Big issue is a national award-winning magazine and social enterprise started in London in 1991. The publication has helped 92,000 homeless and impoverished people collectively earn £115 million through work rather than begging. Right now, 1.500 vendors sell The Big Issue across the Uk.

Who is the audience for The Big Issues

- The Big Issue audience is affluent and environmentally, socially and ethically aware. 66% agree that they buy products that give something back to society. 77% agree that they are willing to make compromises to benefit the environment.

Why do people buy The Big Issue?

- A subscription to Big Issue magazine means you can support some of the UK's most marginalized people and get people and get a great read every week- for a special one-off price of £6 for the first month.

Where does The Big Issue get their money from?

- The Big Issue in the North has three main income streams, income from selling the magazine to vendors, income from selling advertising space in the magazine and a contract with The Big Issue in the North Trust to provide support to vendors. Staff costs make up to 50% of the costs of The Big Issue in the North.

Is The Big Issue successful?

- Well Vendors act as micro-entrepreneurs, buying the magazine for £1.50 and selling it for £3, and with each 'donation' buyers must take a magazine, so that vendors are working, not begging. In it's 30-year history

How is The Big Issue different to other magazines?

- The Big Issue is not only a publication it also includes the Foundation charity arm, which connects vendors to broader support; Big Issue invest, which invests in other social enterprises and charities, and the BII Trust, which channels donations from the public, foundations and corporates.

Can The Big Issue be more successful

YES

- Yes why? Because The Big Issue can decide to promote the magazine business more by reaching out to social media so more people can view there business and make more money plus it will be more of an outreach to show that homeless people can try to make an honest living. And they can receive donations from different big companies out there ready to donate.

THE BIG ISSUE

By Izzy Boyden

CONTENTS

This PowerPoint aims to answer the questions highlighted below. Answering these questions will give us a good overall picture of The Big Issue and it's aims.

What is the big issue

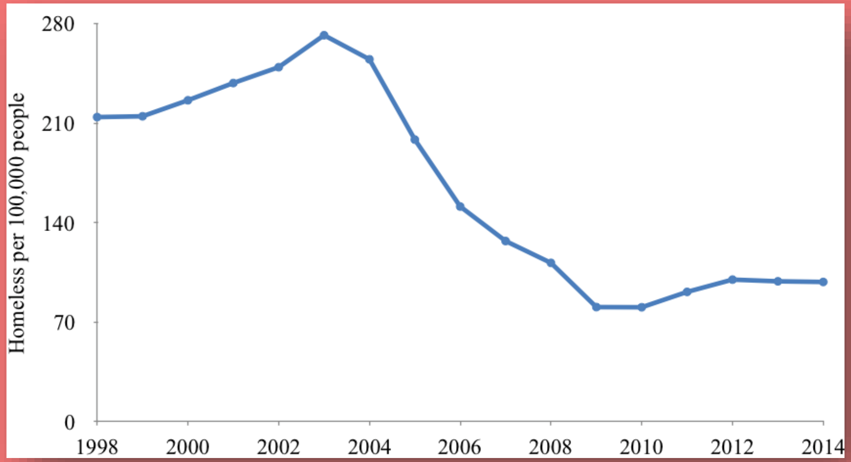
Has it stood the test of time?

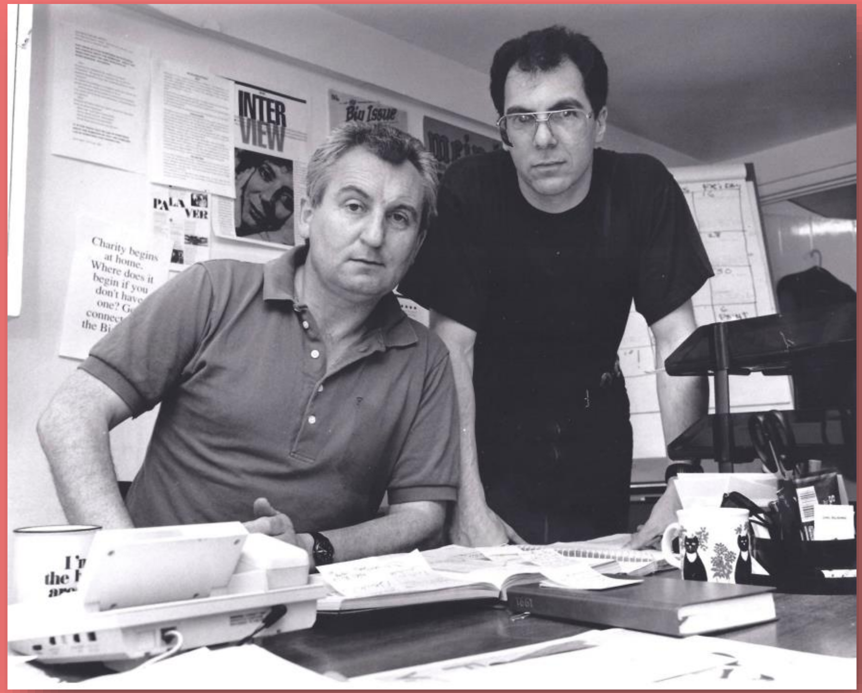
Has the principal of the big issue been successful in achieving its objectives?

My opinion on the big issue

WHAT IS 'THE BIG ISSUE'?

- *The Big Issue* is a national street magazine/newspaper that was founded in London in 1991 by John Bird and Gordon Roddick to reduce the numbers of homeless people in London. In giving people who are homeless and/or in extreme poverty jobs of selling the magazines, they have helped 92,000 people to earn £115,000,000.
- Its articles are written by professional journalists and the magazine has over 400,000 UK readers. The Big Issue is one of the most widely-read street magazines on the planet.



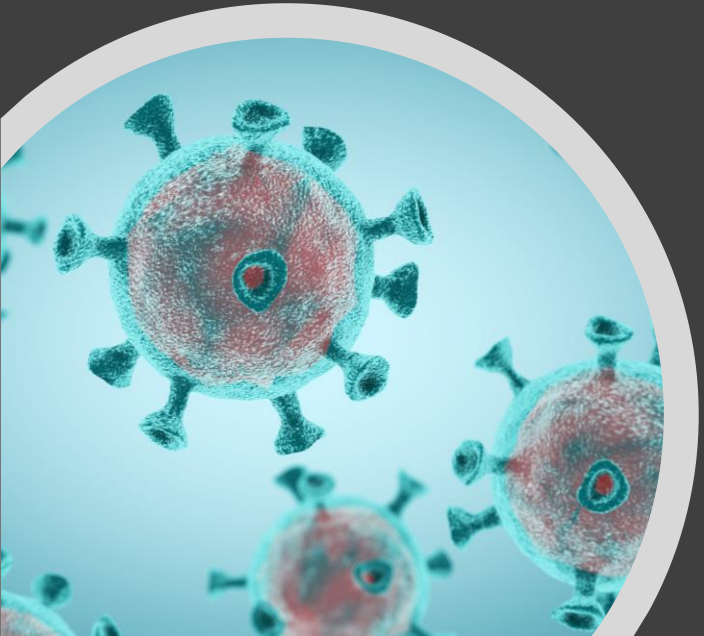


Has the Big Issue stood the test of time?

- The Big Issue has a unique method to sell its papers which ensures that the profits go directly into the vendors' hands. The vendors buy the magazine for £1.50 and sell it to the public for £3.00. However, less and less people are carrying cash, meaning The Big Issue's quantity of sales is significantly decreasing.
- The Big Issue has also adapted to modern expectations in certain areas, for example they have created a Website where readers can purchase a subscription to the magazine and an app where readers have access to the magazine online.

HAS THE PRINCIPAL OF THE BIG ISSUE BEEN SUCCESSFUL IN ACHIEVING ITS OBJECTIVES?

- The Big Issue's mission as a charity for those experiencing financial struggles, is to enable them to rebuild their lives and to achieve pathways to a better future.
- John Bird and Gordon Roddick created one of the UK's leading social businesses which offers homeless people, or struggling individuals the opportunity to earn a valid and self-earned income, eventually helping them to return to mainstream society.
- Starting from 1991, The Big Issue has been successful in tackling poverty and homelessness, aiding vulnerable men and women in the UK with employment opportunities through self-help and perseverance.



MY OPINION ON THE BIG ISSUE:

From my point of view, The Big Issue was a success, until recent changes and subtle modernizations came into play. The combination of the pandemic reducing the number of people visiting shopping centers, and using companies like Amazon more often, and the move from a cash to a cashless society with the rise in contactless payments means The Big Issue is having to re-invent itself to remain current and successful now and for the future.


THANK YOU

BIG
ISSUE

What is the big issue?

- ***The Big Issue*** is a street newspaper founded by Jhon Bird and Gordon Rodrick in September 1991
- They started the business due to the rising number in homelessness in London they were inspired by another newspaper company called street news in New York

Hand up not handout feedback

- The big issue motivates people who are struggling and helps them keep a sustainable income as they pay a small amount for the newspaper and sell it to earn profit many people say that this is much better then just giving a upfront sum and gives the people who want to help make a big difference

The startup of the business and worldwide expansion

The body shop gave the business provided start-up capital to the equivalent value of $50,000.] the magazine was initially published monthly but, in June 1993 *The Big Issue* went weekly. The venture continued to expand with national editions being established in Scotland and Wales, as well as regional editions for Northern England and England's South West Region.

Further editions are also produced in seven locations overseas including United Kingdom, Australia, Ireland, Japan, South Africa ,South Korea, Namibia Kenya ,Taiwan and Malawi.

Decline of business and how it improved

- Between 2007 and 2011, the circulation of *The Big Issue* declined from 167,000 to less than 125,000. Competition between vendors also increased at this time. From July 2011, the different regional editions were merged into a single UK-wide magazine. January 2012, the magazine was relaunched, with an increased focus on campaigning and political journalism. New columnists were added, including the Premier League footballer Joey Barton, Rachel Johnson, Mike Shinoda of Linkin Park and Samira Ahmed. The cover price was increased.
- in 2016, *The Big Issue* celebrated surpassing 200 million magazine sales.] In September 2021, the magazine celebrated its 30th birthday.

Nick Cuthbert

- Nick Cuthbert was homeless and was a struggling alcoholic he claims that the big issue turned his life around and says that selling the big issue gives him motivation in 1995, **The Big Issue Foundation** was founded to offer additional support and advice to vendors around issues such as housing, health, personal finance and addiction.

Will the business survive

- Due to the evolving world I don't think that the business will survive even with many investors and individuals who would like to make a change consumers can resort to cheaper more accessible ways to find out news for example online news outlet which they could start but wouldn’t be as beneficial to the cause of helping the homeless

Newspaper and targeted audience

- The big issue has a broad audience mostly for younger and middle aged people doesn't limit consumers keeps up with latest news


EVERY MONDAY £2.50
VENDOR


ANY CHANGE?
HOMELESSNESS IS BACK
Will de BLASIO'S
Latest PLAN break
the CYCLE?


STREET
SHELTER
FLAKE NEWS
Hinz&Kunzt
THE BIG ISSUE


THE BIG ISSUE
FOUNDATION
INCREDIBLE JOURNEY
THE BIG ISSUE
OFFICIAL VENDOR
BACK ON TRACK


THE BIG ISSUE
CELEBRATE

The end

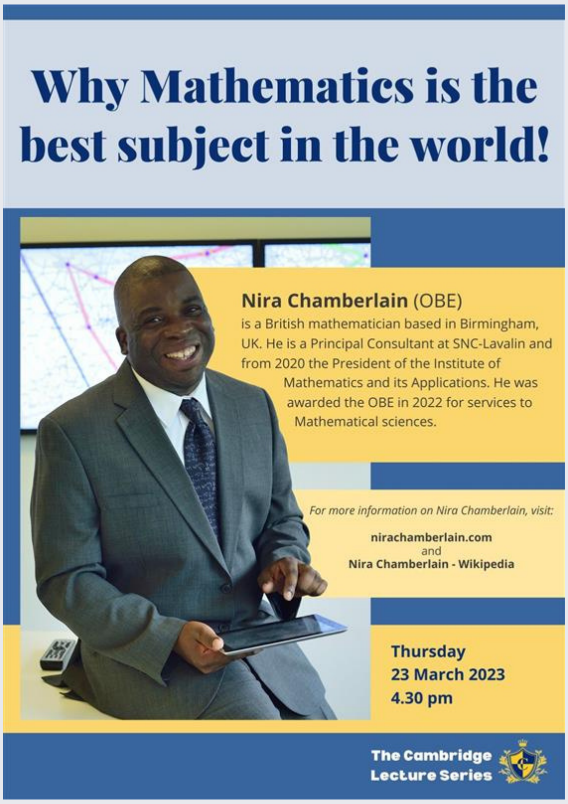

HOUSE OF FRASER
TEMPTATION ON EVERY LEVEL

Q&A with Nira Chamberlain

Q1) What would you say to someone who said 'Maths you learn in school is not useful in the real world'?

The maths that you learned in school is that is definitely laying down the foundations for what you need to do in the future. Everybody needs to be good at good at numeracy, and from Numeracy you move on to, let's say, Algebra and then you're gonna move on to do your Calculus and your Statistics. So, you know, what you do in school is definitely, definitely, definitely important! So, don't underestimate Numeracy, do not underestimate Algebra, do not underestimate Statistics. I will just tell them, "Guess what, Mathematics is indisputably the greatest subject in the world"

This Q&A is based on extracts from the following Lecture:



Q2) What are some advice that you could give to young people interested in publishing works on Mathematics?

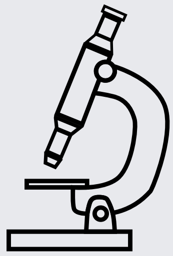
Blog and Journals

Q3) If one day all the knowledge we have on maths would vanish completely from the word. What would be 1 key piece of information that you would you would think we could keep in order to rebuild everything we had?

1 + 1 = 2

Q4) Just like the Black Panther suit that you drew inspiration from, do you think that there are some fictional concepts which are feasible with what we have now?

In Mathematics, you have something called conjecture and you have proof. Sometimes, where you'll find in these films, they come in all these conjectures, but some of them you're thinking. “No, not a chance” but some of them you're thinking “actually that's interesting”. Then you actually go down and you do the start doing the mathematics and engineering from it. The prime example is Star Trek and Star Trek was done in the 1960s and they had like this communication equipment that looked very much like a mobile phone of today.

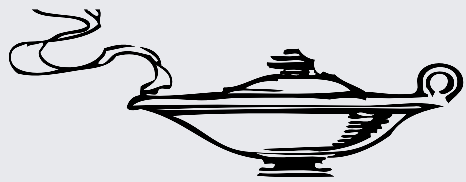


Q5) What is your favourite area of Maths now? Are there any areas that particularly stood out to you when you were learning them as a child?

I liked Probability. I liked Statistics, and then I was moving very much to the Applied (Mathematics) and the simulation but I very much, as a Mathematical modeller, I tend to like all types of Mathematics, everything that's Mathematics, I like.

Q6) What would your life be without Mathematics?

Let me answer your question by telling you this joke:
Once Upon a time there was this person and he came across a genie. The genie said to the person, “I will grant you 3 wishes”
“My first wish is I wish that mathematics didn't exist”
The genie goes “right, done.” and then the person says, “what about my next wish?”.
The Genie says, “Sorry”.



"A Mathematician is not somebody that finds Mathematics easy. A Mathematician is somebody that sees a problem and never quits."

\- Prof. Nira Chamberlain