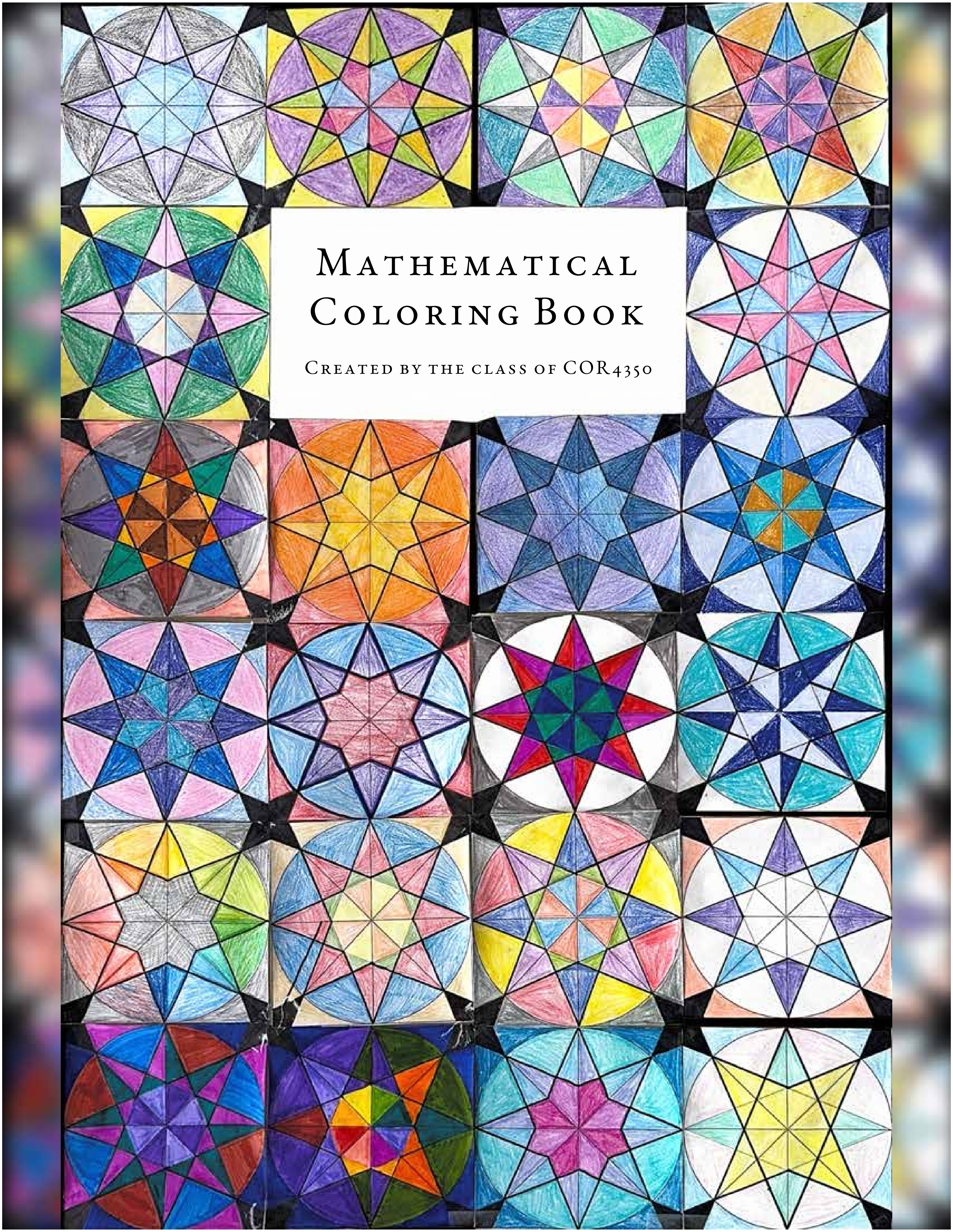
Mathematical Coloring Book

Created by the class of COR4350



Preface

This coloring book is a collaborative effort among the student of Elon University's Winter 2025 class of COR4350, *Art Thru a Mathematical Lens*, taught by Dr. Nancy Scherich. Each student contributed one piece of artwork inspired by the mathematics learned during this three week intersession course. Accompanying each piece is a short essay describing the mathematical content and inspiration for the work. Enjoy their creations!

The cover art is a traditional Islamic tiling. Each tile is hand-drawn and colored by a student in the course.

The Golden Ratio

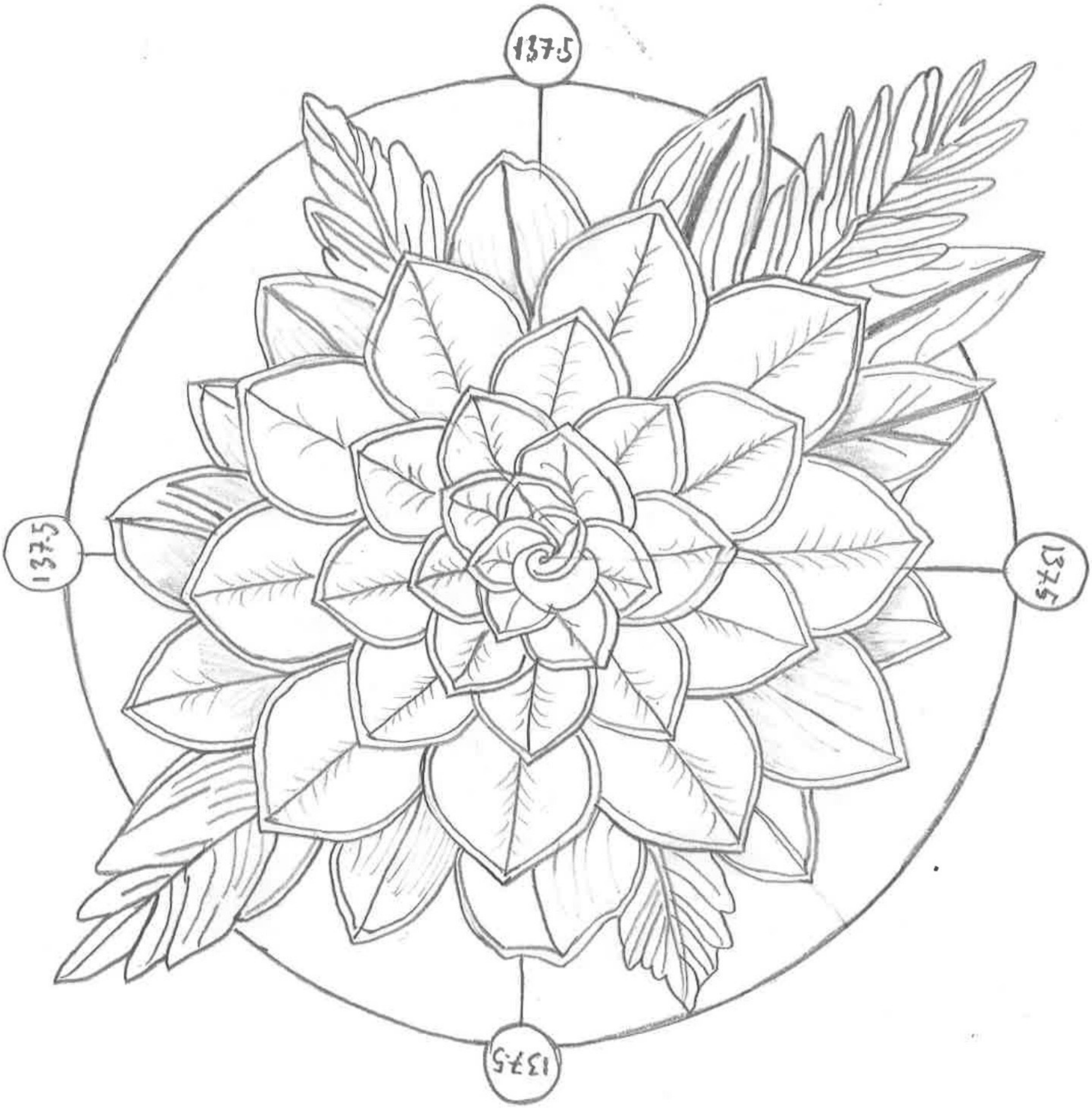
by Mac Msabaha

My drawing is inspired by one of the most beautiful concepts in nature and math, which is the golden angle of 137.5 degrees. This special angle comes from "The golden ratio", this number is approximately 1.618, that shows up in plants, art, and even architecture. The leaves in this design are arranged to follow the golden angle, creating a natural, balanced spiral pattern that feels both organized and beautiful.

The golden angle is important because it helps plants grow in the most efficient way possible. For example, if you look at sunflowers or succulents, you will see that their leaves and seeds are spaced out just enough so they don't overlap but also so they fill up the space perfectly. By using this angle in the drawing, the leaves radiate outward in a way that looks natural and calming. Each leaf is placed at 137.5 degrees from the one before it, creating a spiral pattern that mirrors how things grow in the real world.

The petals in the center of the flower add another layer of symmetry. They're arranged evenly around the middle, giving the design a sense of balance. The circular border around the flower helps highlight this symmetry and makes everything feel complete. It ties the entire drawing together, showing how math can create harmony.

This design is a celebration of how math and nature work together. The golden angle is not just a number, it is a pattern that shows up all around us in beautiful ways. By using it in this drawing, the Golden Ratio Angel shows how math can inspire art, turning numbers into something we can see and enjoy. It is a reminder that math is not just about solving problems but also about finding beauty in nature.



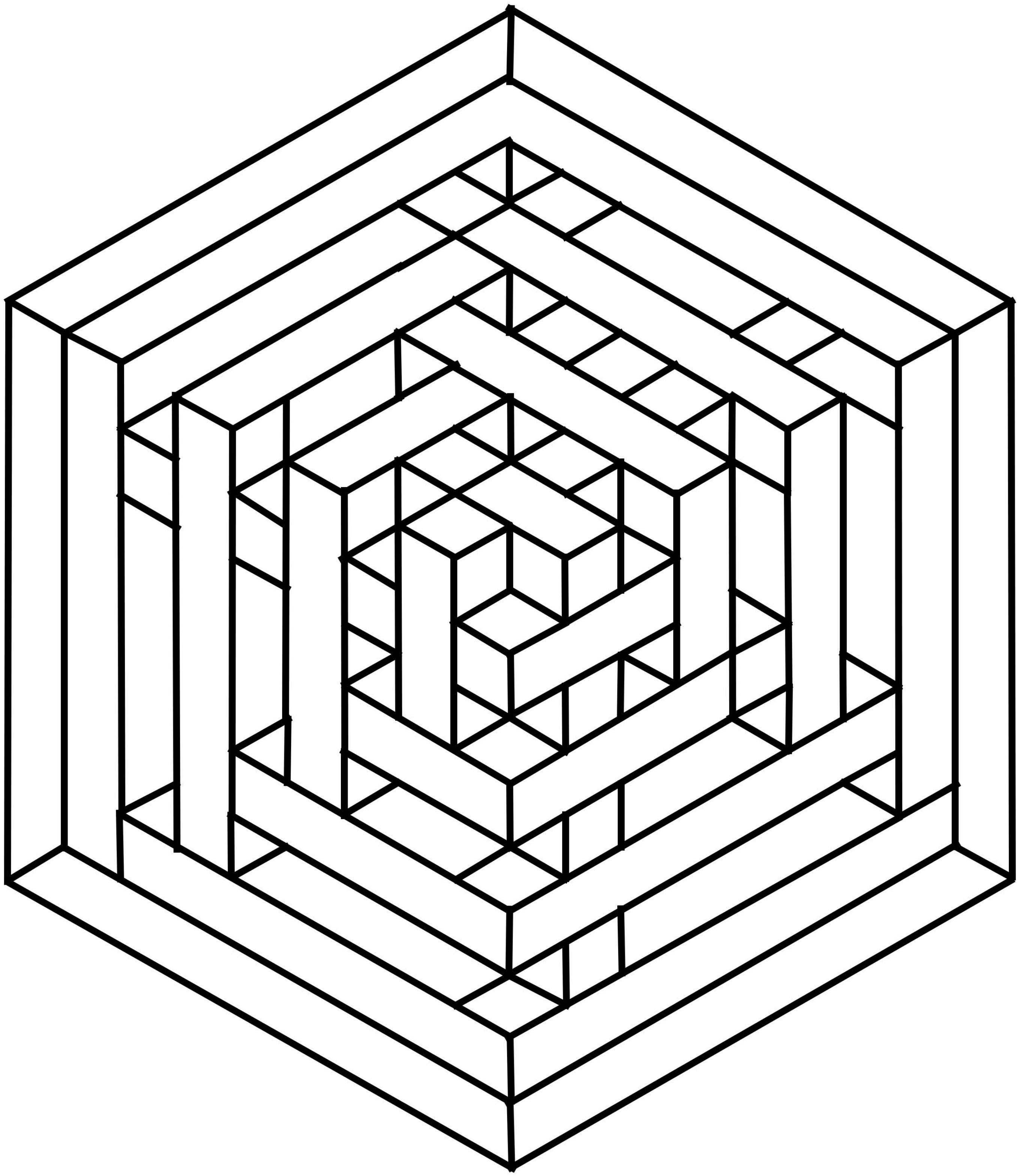
137.5
137.5
137.5
137.5

Infinity Cube

by Tyler McKellar

Throughout this class, the one thing I enjoyed learning about and exploring the most was optical illusions. When we drew them out for class and my group incorporated them into the barn square, I was excited by the opportunity to use them in a creative way that tied art and mathematics together. The excitement of extending the idea of incorporating optical illusions into other projects is the reason why I wanted to use it for the coloring book page. The point of an optical illusion is to trick the brain into perceiving something different from reality, creating intriguing effects that captivate the viewer while challenging their understanding of how they see the world. Optical illusions are fascinating because they rely heavily on mathematical principles to achieve their effects. Through precise calculations and deliberate designs, they create the sensation of objects and shapes that appear larger or smaller, closer or farther, or distorted in ways that seem impossible. By blending geometry, symmetry, and perspective, optical illusions transform simple designs into mesmerizing works that engage both the eyes and the mind.

For my coloring page, the idea is for the optical illusion to suggest that the cube is continuously folding in on itself, shrinking yet leaving traces of its previous forms. This effect is why there are so many additional rows and columns, creating the impression of depth and motion. The mathematical components of this design are deeply rooted in both optical illusions and symmetry, each playing a significant role in the overall structure. When analyzing the lines individually, their symmetry can vary depending on where the center is placed, showing characteristics of either translational or rotational symmetry. However, when considering the shapes as a whole, the page incorporates all three types of symmetry: rotational, translational, and reflectional. For instance, the larger hexagonal pattern can be rotated by 60 degrees and still appear identical, highlighting its rotational symmetry. Similarly, the rules of symmetry can be applied across different levels of the design; whether to individual lines, rows and columns, or the smaller and larger shapes within the composition. These elements work together to create a visually engaging and mathematically intricate coloring page.



Math to Create Art: My Geometric Construction

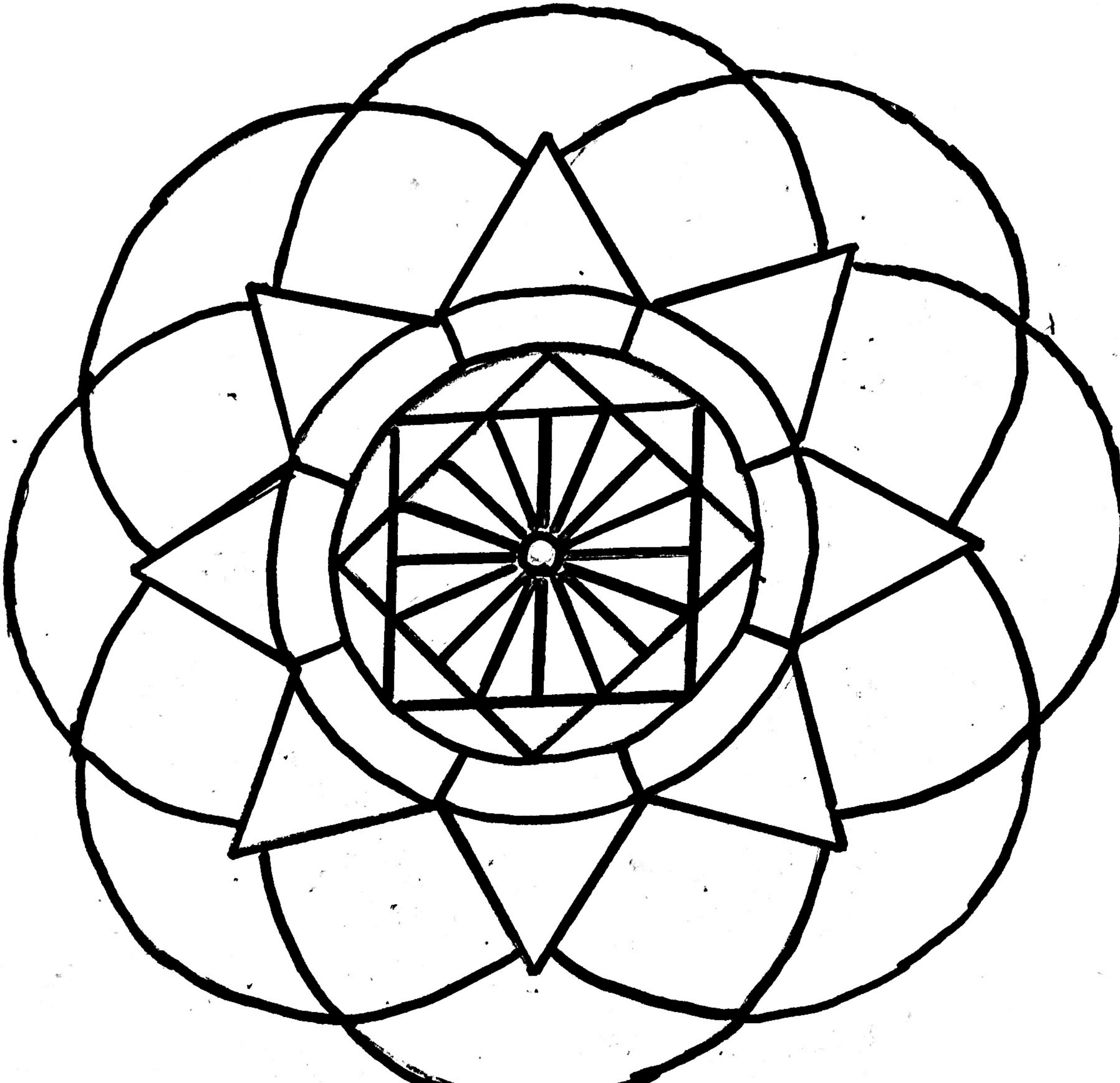
by Carlos Levy

The design I created is a beautiful example of how mathematics can be used to make art. To construct this pattern, I used a compass, protractor, and a ruler to form circles, triangles, an octagon, and squares that all fit together in a very precise way. This geometric drawing is a perfect example of symmetry, geometric constructions, and mathematical beauty.

To start, I drew a circle with a 2.5 cm radius in the center of the page. This was the base for my design. I then added larger circles around it, including one with a 3.5 cm radius and another with a 7 cm radius. The overlapping circles helped create the outer flower-like petal shapes. The symmetry of the overlapping circles comes from their equal size and spacing, which ensures the design looks balanced. This symmetry is known as rotational symmetry because the design looks the same when you rotate it from certain angles. It also has reflectional symmetry, as you can cut it in half and the sides will mirror each other perfectly. The design also includes translation symmetry, which means parts of the pattern can "slide" into another position and still match, as seen by the triangles and squares repeating in a predictable way, making the pattern look harmonious.

Using a protractor, I marked points around the circles at specific angles like 22.5°, 45°, and so on. These equal divisions helped me make sure the design was evenly spaced. From these points, I connected lines to form triangles and squares. For example, I created an octagon in the smallest circle by connecting opposite points, and then I added equally spaced lines from the octagon's vertices toward the center. These shapes were carefully planned to use geometric rules. Some of these rules include equal angles and equal-length lines to ensure the triangles and squares fit perfectly within the circles. By following these rules, the design maintains balance and symmetry.

Overall, with this image, I aim to show the power and beauty of geometric constructions. By using simple tools and basic math concepts like angles, symmetry, and distance, I created a complex and aesthetically pleasing design. This project helped me project a major theme I've learned in this course: that math is not just about numbers, it's also about showing the beauty of balance, symmetry, and patterns. It shows the importance of balance, yet the charm of imbalance. The satisfaction of symmetry, and the grace of chaos. The complexity of math, and the allure of its products.



A Beautiful Flower

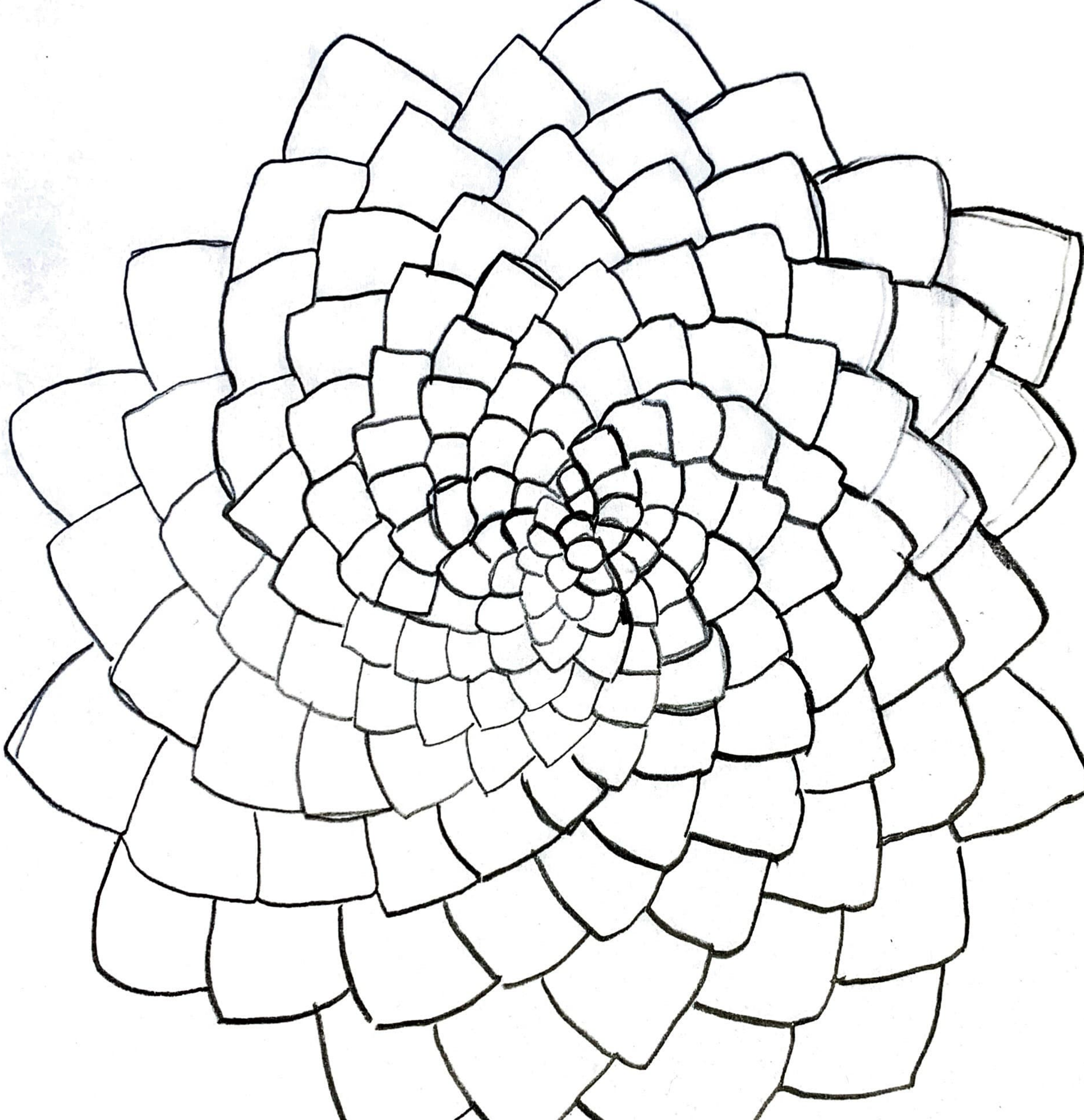
by Sumner Nenninger

The structure of my design was inspired through Fibonacci. You might see his findings pop up in sunflowers, shells, or pinecones. Spirals like this are often connected to the Fibonacci sequence, where each number is the sum of the two before it (1, 1, 2, 3, 5, 8, and so on) as we learned in class. This sequence is closely tied to the golden ratio, about 1.618, which shows up in so many natural and man-made creations. While drawing, I used my protractor to measure and create evenly spaced lines, and as the shapes expanded outward, they naturally formed a spiral-like growth pattern. This proportional expansion gives the drawing a sense of balance and harmony, much like the spirals we see in nature that follow the Fibonacci sequence.

Using my pencil, I carefully connected these lines to create overlapping petals that fit together perfectly. To add, this is an example of a tessellation, where shapes repeat without gaps or overlaps. The protractor helped me maintain precise angles, ensuring that the pattern remained consistent as it spiraled outward. I also noticed how the symmetry of the design made it look complete and satisfying, no matter how I rotated the paper. This rotational symmetry is a key feature of many geometric patterns, adding to the visual appeal of the design.

What surprised me most about this project was how much I learned from such a simple process. In class this process was hard and confusing but counting to try over and over helped me get a lot better. Using a pencil and a protractor might seem basic, but they allowed me to engage directly with concepts like symmetry, proportional growth, and tessellation. Every shape I drew and every angle I measured had a purpose, even if I didn't realize it at the time.

In the end, this piece is more than just a drawing to me—it's a reminder of how math and art are deeply connected. From the Fibonacci-like spiral to the precise tessellation of the petals, this design reflects the beauty of mathematical structures. Creating it with my own hands helped me see how math isn't just something to study—it's something to experience and create.



Manatees lost in the Flowers

by Amalie Keefe

The intersection between math and art can create beautiful, fascinating pieces that amaze the mind. This piece was partially inspired by M.C. Escher, who was famous for his tessellations and optical illusions, among other things. A tessellation is a pattern of repeating shapes that cover a surface without gaps or overlaps. Though my art may not fall into the category of tessellations or tiling, it does take strong inspirations from these methods of creating. Here, manatees could be considered a tile and flowers another tile.

This piece of art has many types of symmetry within it. One type of symmetry shown is rotational symmetry. The manatees can be viewed as spun around several different points, in between the manatees' heads, in between their tails, and the flowers. When looking clockwise around each rotation point, the manatees are rotated 90 degrees clockwise around the spot between their heads and the flowers but are rotated 90 degrees counterclockwise between their tails. Additionally, the flowers have rotational symmetry around the inside of the manatees' heads and inside the manatees' tails.

Another type of symmetry portrayed here is translation symmetry. Looking horizontally, if you pick up the first two rows of manatees, you can put them directly on top of the middle two rows of manatees and they perfectly line up, and again with the last two rows. However, this only holds true for the manatees. The flowers have their own translation symmetry with the first two rows of flowers as well. This can also be done vertically with the manatees and flowers where if you take the first two columns of each, you can move them across the page.

Finally, looking at the border of the pieces, there are braids. These braids are arranged in a periodic function that could be modeled with a sine function. This visually creates a fluid feeling in the art. Additionally, braids are a part of knot theory, the study of knots, and braid theory. Braid theory has recently been found useful in fluid dynamics to study the chaotic mixing of fluid flows, a course I have recently taken as part of my mechanical engineering path. Many complex mathematical concepts are a part of analyzing chaotic mixing including differential equations to determine the change of the Lagrangian trajectory and fractal analysis as the fluids combine. Braids also are a form of knot representation where the strands can be connected to the bottom and top in order to create continuous loops.

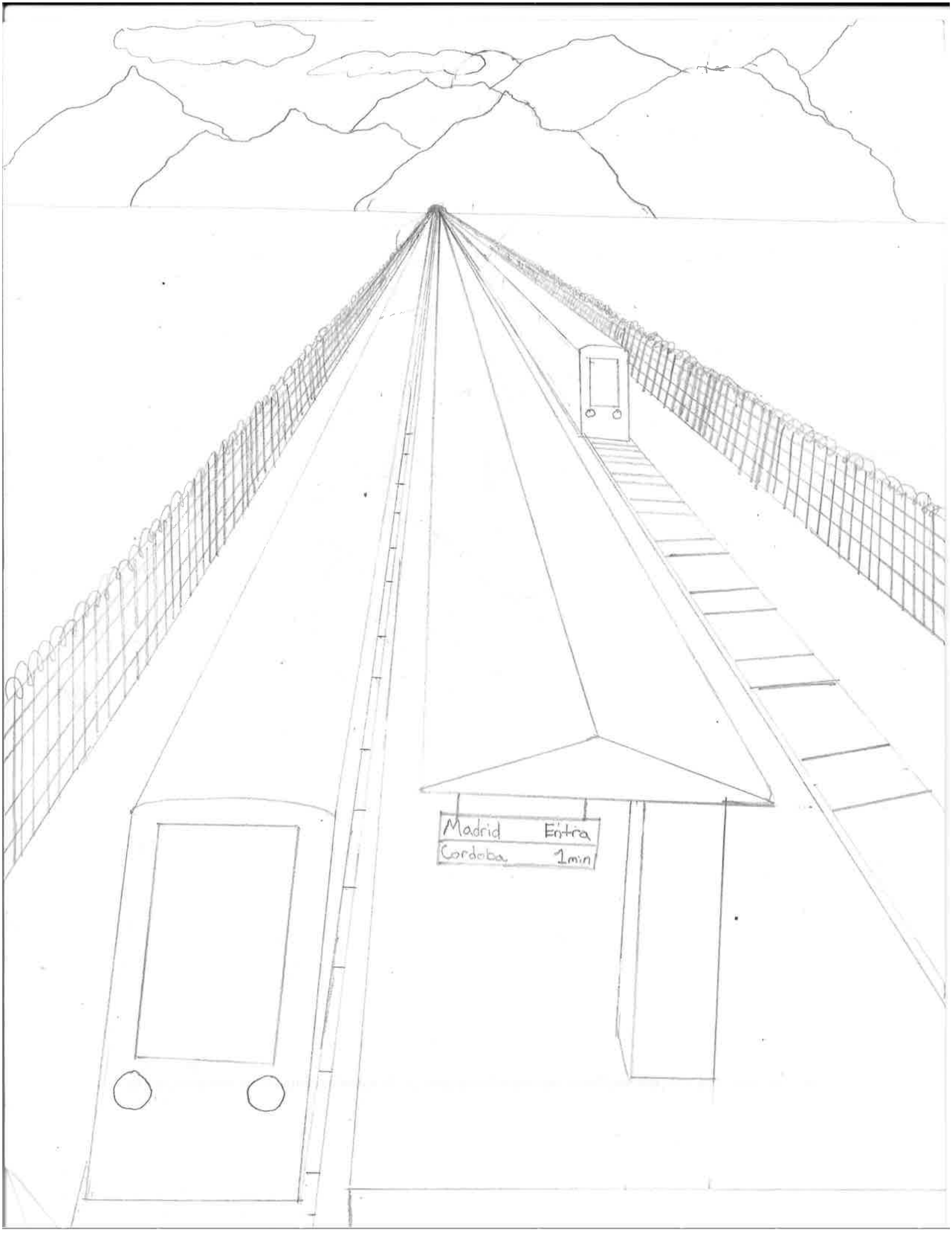
I placed the manatees and flowers in the pattern to demonstrate the variability of movement in water. The manatees can swim in any direction they like, and the flowers will move around with the tides and currents. The braids also resemble currents and the flow of water.

Seville

by Luke Kovensky

For my coloring book I chose to make a picture of a train station, inspired by the station I went to many times in Seville, Spain. For this picture, in order to give the effect of these extremely long bullet trains, I needed to utilize perspective and horizons to make sure that the finished product looked 3D and deep. The main mathematical concepts shown in this work are perception, shapes, and angles to give the illusion of a fading train into the horizon.

In order to make this image I needed to start with choosing a horizon and a vanish point. Once I chose these then I was able to begin creating all of my trains, tracks, fences and the walkway with the roof. By starting off with the rectangle for the trains I could connect the sides of the rectangles to the vanishing point to give the illusion of depth and a vanishing train into the distance. I continued this same process with the walkway, roof, train tracks, and fences on either side to give the effect of vanishing points into the distance. My idea was to make the vanishing point the entrance into a tunnel within the mountains in the far distance which I think came out very well. The whole image seems to be getting sucked into that tunnel. The mountains, clouds and sun in the background have no mathematical concept. They are purely for show and decoration since in the background of this train station in real life there were mountains in the distance and I wanted to mimic that. I did use a compass to ensure a close to perfect circle for the sun in the distance. For the entire train station I only used a pencil and ruler to ensure straight lines that always led to the vanish point to keep everything with an effect of depth.



Madrid Entra
Cordoba 1min

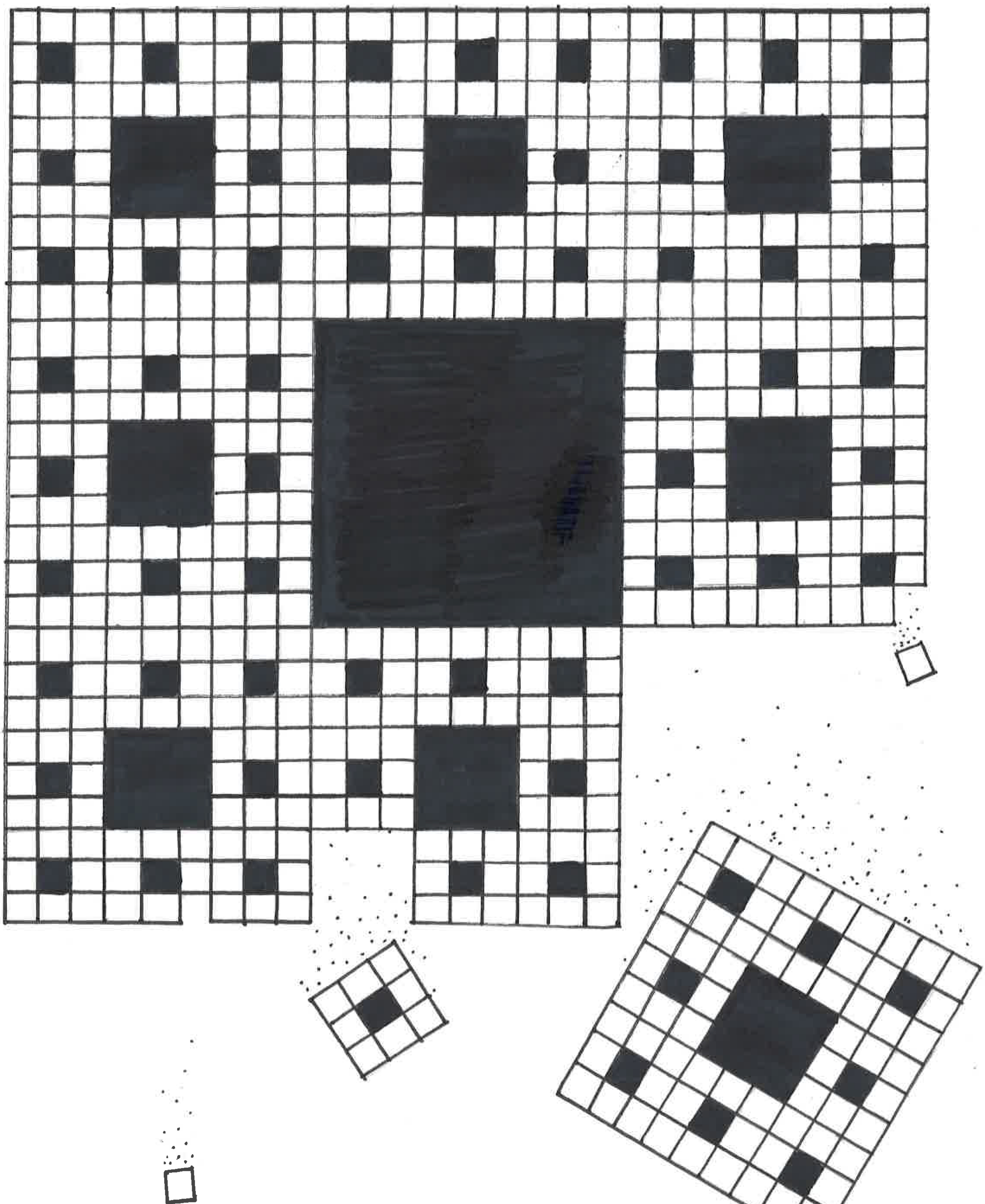
Disappearing Area

by Jillian Thomas

Fractals are one of the many mind-bending mathematical concepts that are quite beautiful to visualize. They are characterized by a fractional dimension and visually they have a high level of self-similarity. One of the most well-known fractals is the Cantor Set, which has a dimension between zero and one. The Cantor Set is constructed by taking a line segment and removing the middle third. Then of the two remaining thirds, we take out the middle third of each of them. This process of removing the middle third is repeated indefinitely until all that's left is what is known as Cantor dust, which has zero length but is an uncountable set. The Cantor Set is often studied in introductory real analysis courses because although it is constructed strangely, it is compact and perfect.

To create a similar set, instead of starting with a one-dimensional line segment, we can also start with a two-dimensional square. We can divide the square into thirds in both directions and then remove the middle ninth of its area. Again, we can repeat this dividing and removing process for the eight remaining squares, and then over and over again until we are left with a fractal with a dimension between one and two. This extension of the Cantor set is known as the Sierpinski carpet and has zero area. The page on the right shows the Sierpinski carpet after three iterations of removing the middle ninth of the squares. The part of the image left to color would eventually converge to have no area over infinite iterations of the construction process.

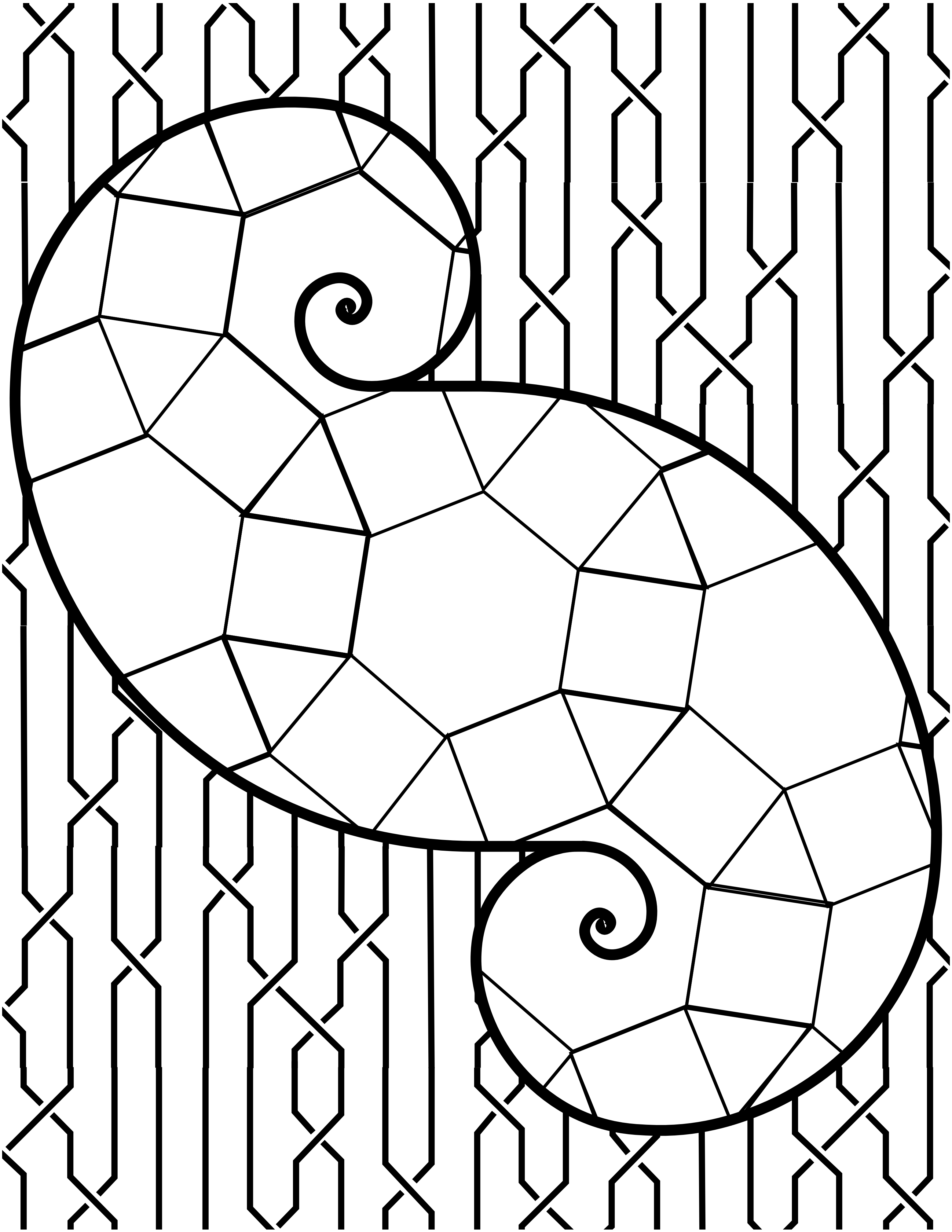
The pieces of the carpet falling off at the bottom are meant to evoke the idea that the area of the figure is disappearing, and although in this image there is plenty of space left to color, the remaining area will eventually converge to nothing. There is even a trail of points left behind each falling square which is meant to allude to the idea of Cantor dust.



Mathematical Mosaic

by Garrett Quinn

For this page, I wanted to create a very complicated, mosaic-like design for viewing and coloring purposes. Thankfully, we've learned about many mind-melting mathematical concept throughout the last month so I had plenty to work with. While I used the more simple concept of the Fibonacci spiral to make the centerpiece of the page, I filled the rest of it with more intricate depictions of numbers. Specifically, the use of irregular tiling and braid diagrams made for some much more complicated and only slightly confusing designs. The first thing I created was the centerpiece. I had wanted to use the Fibonacci spiral after learning about how important it was in design, art, nature, math, and general daily life. It's pretty much hard-coded into the way the universe works, which is a little hard to comprehend but completely factual. I made a Fibonacci spiral and then had the idea to try putting it against another one. I gave it a shot, and the resulting shape was very cool to look at. (Although, I feel like I've seen it on the top of Roman pillars before…) For the backdrop, I wanted to create a complicated design that's almost reminiscent of the matrix. I didn't want to use a matrix, though. What I did use was braids. I found three separate designs of six-strand braids and replicated them. Then I took the braids and lined them up in a row. I then took said row and lined it up with a copy of itself below it. It wasn't exactly below it, it was more so a fifty-fifty split. The three strings on the left would connect to one braid, and the three strings on the left would connect to a different braid. This created a massive interlocking braid system where one line could be taken from one corner of the page to the next, all thanks to the magic of braids. Finally, I wanted to make a less complicated but still complicated design for the inside of the middle shape. I remembered how we learned about irregular tiling and decided to go with that. I couldn't just use a regular tiling of squares or triangles. It would look way too simple for the design I was going for. So I went with a tiling of squares and triangles, as well as hexagons just for good measure. Overall, I'm very happy with how it turned out. If you wanted to try coloring it, you definitely could. It just might take a long while due to the several dozen segments the page is made of. I think the best way to think of the design is that it's a lot like math. Looking at it at first, it probably looks like some very confusing jargon. But when you see the bigger picture and it all comes together, the results are nothing short of beautiful.



Interwoven Paths of Movement

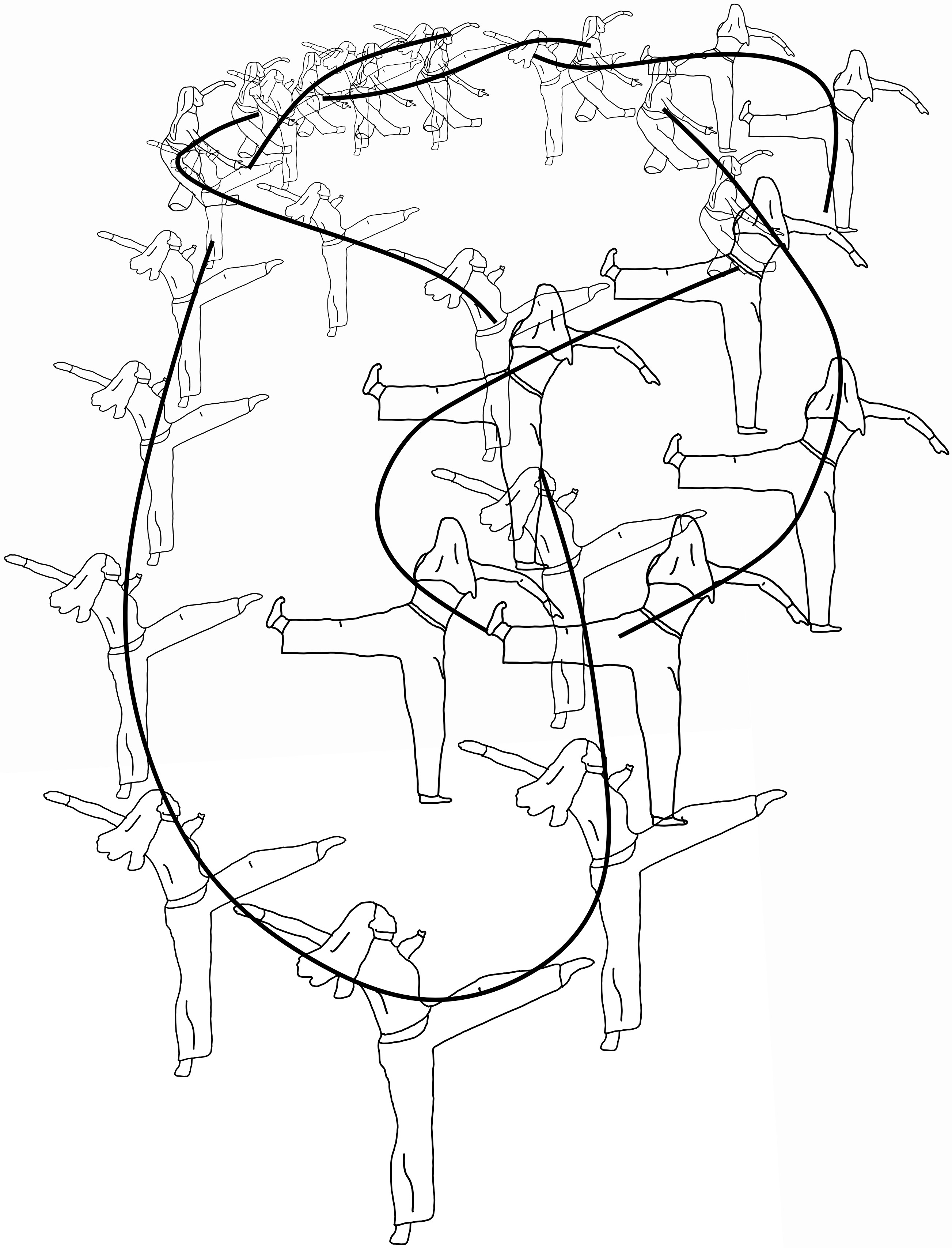
by Lila Snodgrass

The knot illustrated in this coloring page is part of the field of topology called knot theory, which studies the mathematical properties of knots and links in three-dimensional space. Knots are closed curves that can be bent, stretched, and rearranged without self-intersections. Knot theory is actively used in various areas of study, including molecular biology, physical properties of woven fabrics, and even quantum computing. An important aspect of knot theory is classifying knots. The Danceability index is an invariant, which is a common trait that does just that!

The Danceability index, first introduced by Karl Schaffer and later formalized by Sol Addison, Nancy Scherich, and Lila Snodgrass, is an invariant used to determine how many dancers it takes to traverse a knot. The Danceability number represents the minimum number of dancers required to trace the entire diagram of a knot according to specific rules about timing and orientation: 1) We have n dancers at different starting points. 2) Each dancer travels along a pre-chosen orientation of the knot. 3) An under crossing must be crossed before crossing over. In other words, Danceability is how many dancers it takes to dance an entire diagram.

This coloring book page features a knot diagram, 7_2, with Danceability index of three. This means that three dancers are dancing and all three are required to complete the whole diagram. The dancers must move in specific sequences based on timing and orientation in order to ensure that each dancer's trajectory aligns with the others', effectively completing the knot diagram.

The diagram provided for you to color shows the paths taken by each dancer after all three dancers have completed their paths. As you color, you can visually explore the relationships between the dancers and how their movements interconnect, providing a tangible representation of this mathematical concept.



Symmetrical Squares

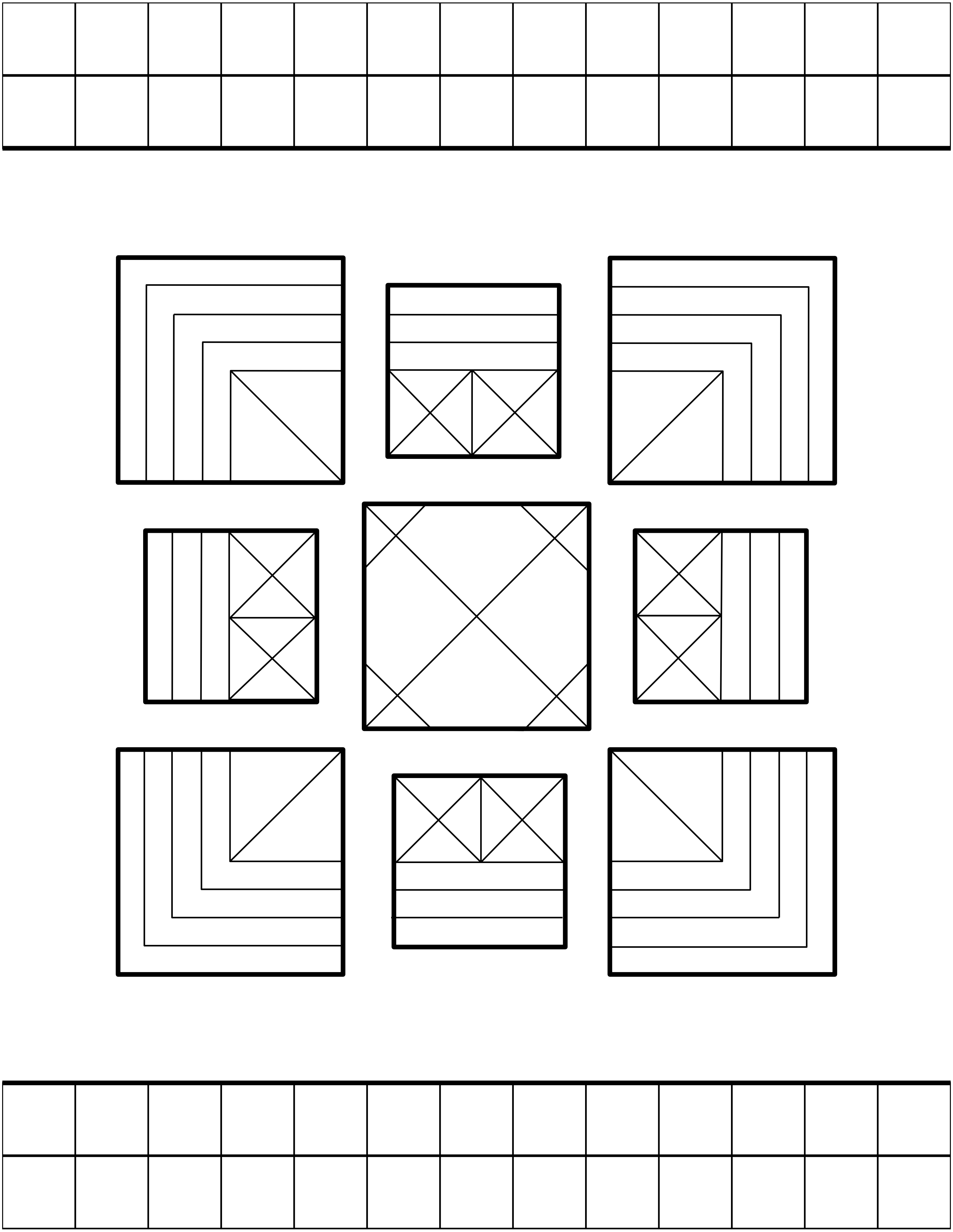
by Erin Martin

My coloring page incorporates various mathematical elements. The overall design is composed of 9 squares, divided into two groups, 5 squares with one diameter and 4 with another. Each square contains horizontal, vertical, and diagonal lines that connect to the larger center design, unifying the individual squares to make one connected design.

Within each smaller square, a single type of reflectional symmetry is present along either the horizontal, vertical, or diagonal midline. In the larger design there is a reflectional symmetry that exists along the horizontal, vertical, and diagonal midlines, creating balance in all directions. Additionally, there is a four-fold rotational symmetry, meaning if you rotate the center design 90 degrees it will remain unchanged. These layered symmetries make the design feel connected as the repetitive patterns reinforce the interconnectedness of the squares.

The center individual square is unique from the other smaller squares. Within the center square there is symmetry along the horizontal, vertical and diagonal midlines as well as having four-fold rotational symmetry. This makes sense since it is the center of my design and the larger design exhibits four-fold rotational symmetry and symmetry along those lines. The center square features an optical illusion effect because it appears to be composed of squares and triangles but is actually formed from irregular polygons and triangles. This distinctive shape connects it with the surrounding squares, enhancing the overall harmony of the composition.

At the top and bottom of the page, I added a border-like design element composed of regular square tiling. I chose to make the rows 12 squares each. The number 12 was selected because it is mathematically versatile, being divisible by 1, 2, 3, 4, and 6. I chose to do square tiling for the bottom and top border because I wanted the page to have a strong foundation that represents sturdiness and solidity. This mathematical choice adds another layer of meaning to the design, demonstrating how numbers can influence patterns and aesthetics.



Circles and Fibs

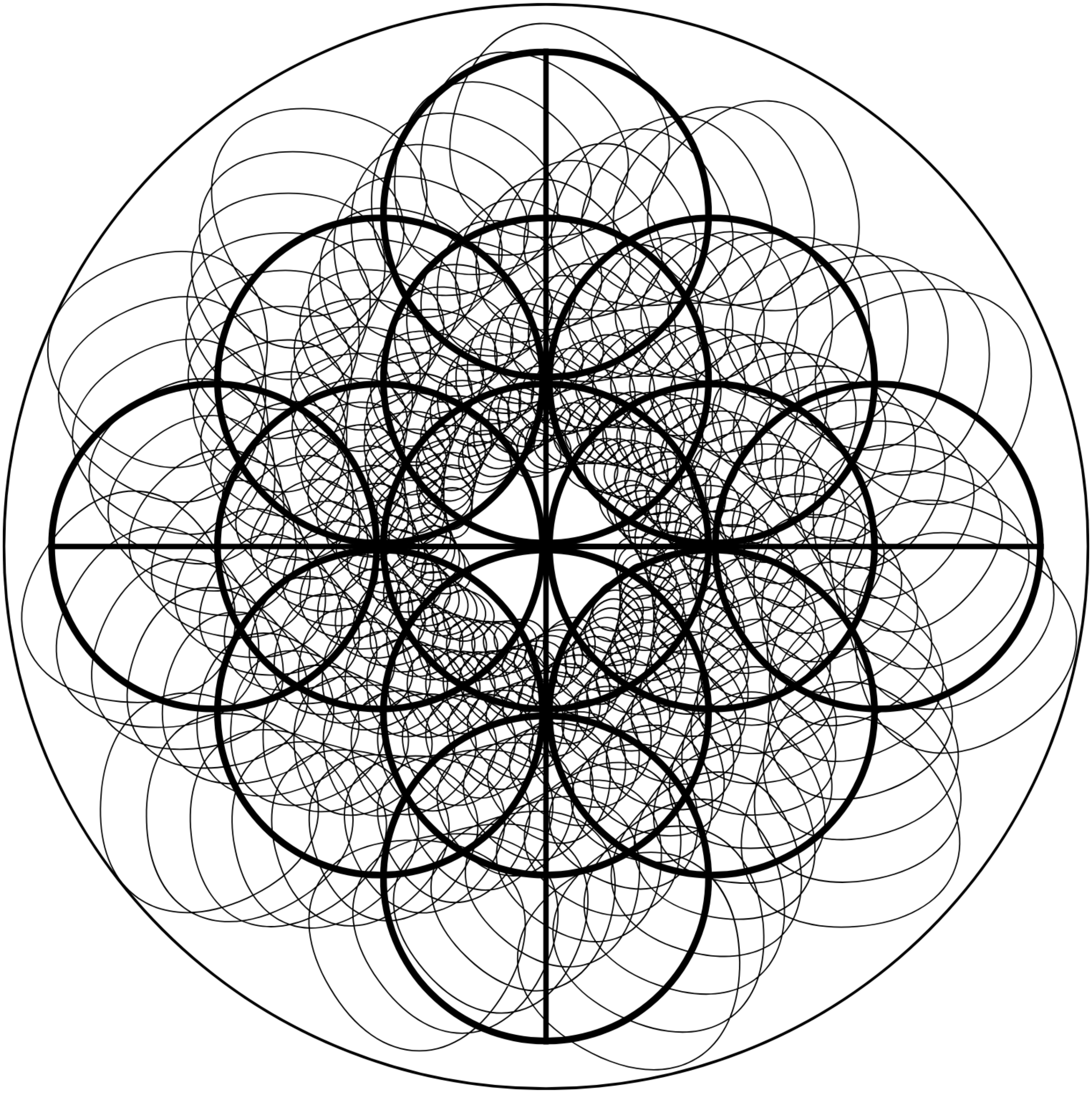
by Shalini Jagannathan

Mathematics encompasses many different genres, including algebra, topology, and geometry. My coloring page exemplifies geometric math all throughout. At the core of the image is a spiral that draws inspiration from the Fibonacci spiral, which is also known as the golden ratio. The Fibonacci sequence is essentially an irrational number that is approximated at 1.618. This is also often known as phi, and is apparent everywhere around us from nature (flowers), to architecture. The spiral is reflected through an arrangement of circles, giving it more depth.

Alongside the Fibonacci spiral, the initial design of 9 circles has two types of symmetry, as they are organized in a radial pattern. The first type of symmetry is reflectional and is also evident through the vertical and horizontal lines. The 13 circles have a rotational symmetry of 4, which creates a balance and harmony to the page. The symmetry is further shown by the placement of the circles alongside the spirals. Since these spirals mimic natural patterns, you can almost see something like a blooming flower. Moreover, the geometric symmetry of the circle provides another layer of mathematical depth. The center circle itself and all of those around it represent infinite symmetry as at any diameter, the circle is perfectly cut in half. In this page, the varying sizes of the circles with the Fibonacci proportions show how math is able to transform these basic shapes into something dynamic. The way in which the circles are scaled helps emphasize the infinite progression of the sequence.

Furthermore, the intersections between the circles are able to form smaller geometric shapes that look almost like lenses. These shapes further emphasize the interconnectedness of the page. Also, the boldness of the lines are able to play into the idea of lights and shadows within the design and are able to symbolize the idea of simplicity and complexity.

Overall, "Circles and Fibs" encapsulates mathematical ideas such as symmetry, geometry, and the Fibonacci sequence. The image explores harmony and has its own connection to the world with the sequence. Through this design, viewers are able to appreciate the patterns within mathematics that have gone through time and are all around us everyday.



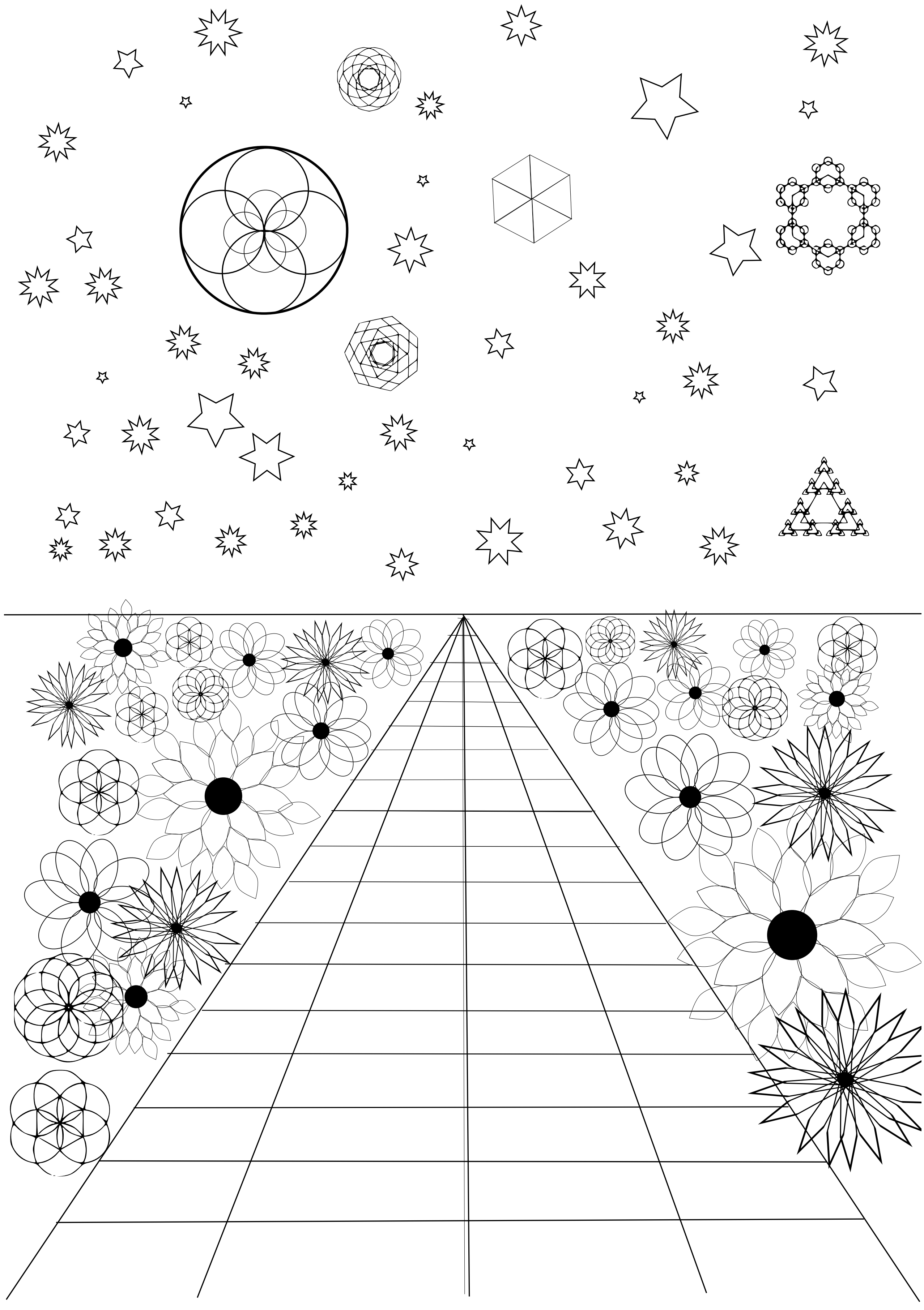
Walking Through a Mathy Wonderland

by Aubrey Spicola

This coloring book page is made to be a blend of art and math, showcasing how geometric constructions, the Fibonacci sequence, and one-point perspective can be combined to create a dreamy scene full of mathematical motifs. At the heart of this is the one-point perspective, a foundational concept in geometry and art, where parallel lines converge at a single vanishing point on the horizon. The lines in this design follow a non-linear progression, calculated as a quadratic, creating the optical illusion of depth as they grow closer together toward the vanishing point. This technique adds realism and emphasizes the infinite nature of perspective.

The flowers lining the path are crafted using the mathematical principle of angular rotation. Each petal is rotated by 137.5 degrees—commonly referred to as the "golden angle"—a key feature in nature's phyllotaxis patterns, observed in sunflowers and pine cones. This rotation ensures optimal spacing, allowing the petals to avoid overlap and form a mesmerizing spiral pattern. As the flowers recede into the distance, their size diminishes, adhering to the rules of perspective and further enhancing the illusion of depth.

The stars above are geometric constructions, ranging from 5 to 10 points. Each star represents different polygonal symmetries, exploring the relationships between angles, vertices, and proportions. Some of the otherworldly "celestial" objects are also geometric constructions, made of triangles, hexagons, and other regular polygons. Fractal patterns, such as the Sierpiński triangle, highlight the concept of infinite self-similarity, a phenomenon often observed in both theoretical mathematics and natural structures like snowflakes and coastlines. These fractals serve as a visual reminder of how patterns can emerge from simplicity, creating complexity through repetition. I designed this page in Inkscape to symbolize a walk through a garden at night, but with geometric constructions and Fibonacci flowers to depict the mathematical patterns that constantly appear around us.



LOTS OF FISH

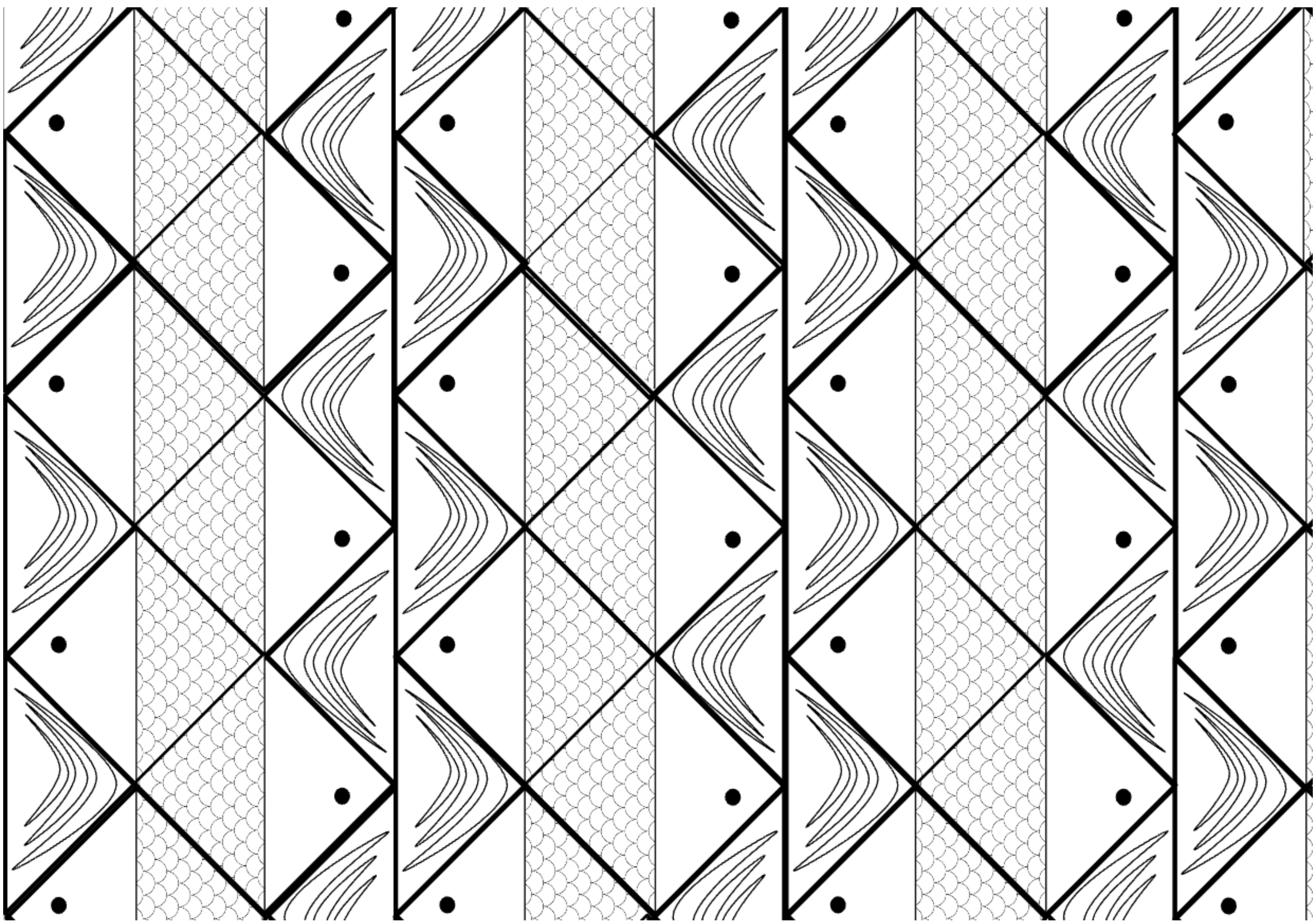
by SOPHIA FERRUOLO

I created Lots of Fish using a tessellation pattern. I wanted to make something that would look very mathematical just from a quick glance. I think Lots of Fish fits this description as it is curated in lots of straight lines and fills out the whole page. Each fish fits into the next, and they flow together perfectly.

Mathematically, Lots of Fish is very symmetrical. It has reflectional symmetry. If you were to fold the page in half horizontally (hotdog way) it would be a mirror image of what it is folding itself upon. There is translational symmetry. If you look at the pattern closely, the same fish are repeating themselves as they move up the page diagonally. There is rotational symmetry. If you were to shift the page 180°, you would be looking at the exact same image. Another interesting form of symmetry included is glide symmetry. I see glide symmetry in the vertical lines created when the tails are flat against each other. They reflect each other upon a vertical axis and are shifted upward each time.

There are a few different shapes in my outline. A little circle for the eye, a diamond for the body of the fish, and a triangle for the tail. I added some more shapes, like the scale pattern and the curves on the tails, to give it an artistic and realistic touch.

I ensured that each fish was an exact mirror image of itself and that they would all fit together by making sure that I was using a perfect square and a triangle that was exactly half of that square. I created one perfect fish and filled in the details before copying and pasting that fish and fitting all of them together like a puzzle. This not only ensured that my tessellation would work out, but also that it would be symmetrically pleasing and perfectly mathematical. Overall, between tessellation, symmetry, and different shapes, Lots of Fish makes for a perfectly mathematical coloring page with multiple mathematical aspects.



Perspective Drawing: A Street View of Miami's South Beach

by Colin Veltri

My perspective drawing of Miami's South Beach was inspired by my trip there during fall break with my family.

In my drawing of Miami South Beach's streetscape, I used the art of perspective drawing. Perspective drawings are deeply rooted in math images that date back to the Renaissance. The math concept used in my picture is linear perspective, which uses a vanishing point (the vertex placed at the center of the paper) to create the illusion of depth on a two-dimensional surface.

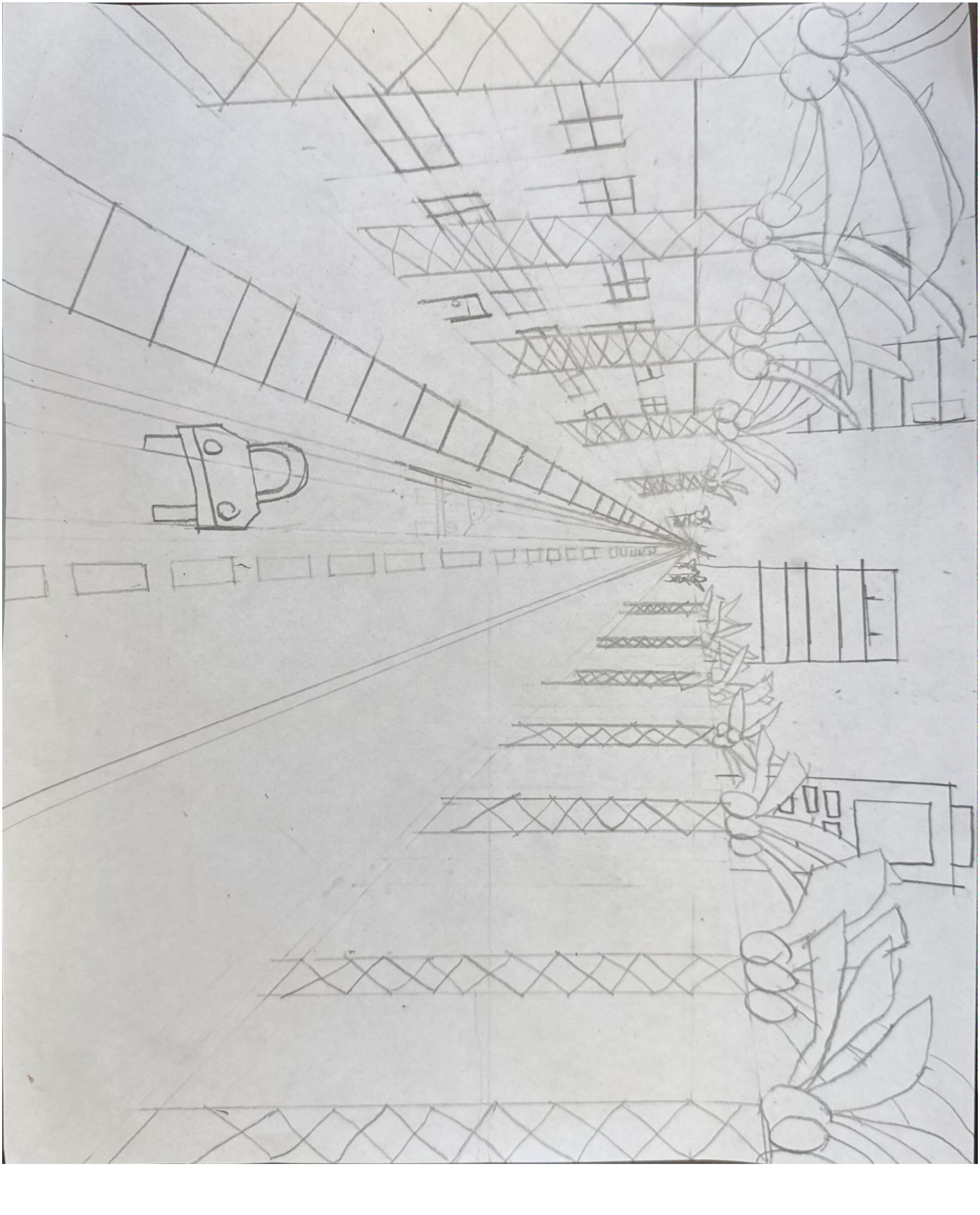
The drawing shows the fundamental use of perspective geometry where parallel lines appear to meet at a single point in the distance. This is shown in how the palm trees, street lines, and buildings all connect to the vanishing point. I used a ruler to make all of the lines straight and connect exactly to the vanishing point to allow an accurate illusion.

The palm trees that are on both sides of the street demonstrate translational symmetry. Translational symmetry is a type of symmetry where the same shape/object is repeated at regular intervals along a line. This creates a pattern that not only adds cool visuals but also adds the perspective effect. The cross pattern on the palm tree trunks adds texture while maintaining geometric consistency throughout.

The buildings in my drawing have vertical parallel lines that remain perpendicular to the horizon. The apartment building on the left and the skyscrapers in the background are rectangular shapes that appear smaller in size as they extend toward the vanishing point, adding to the illusion of what perspective drawing is about.

The road markings in the center of my drawing demonstrates how parallel lines appear to come together as the picture goes into the distance. The lines start farther away in the beginning, and towards the end of the road the lines get closer and closer until they go into the vanishing point.

My drawing combines art creativity and math precision to create an illusion of a three-dimensional space on a two-dimensional surface. This shows how math serves as the foundation for realistic architectural and landscape representation. Pretty cool.



Enhanced Pinstripes

by Daniel Esterman

Okay, let me start by saying that this page is inspired by Marvel and the New York Yankees (as I am a big fan of both)…with a focus on symmetry and geometric design. The images used came from iconic symbols, including Captain America's shield and the logo of S.H.I.E.L.D., as well as the Yankees emblem. To integrate these references into a cohesive design, I emphasized symmetry and geometric relationships, using a mix of circles, triangles, and lines.

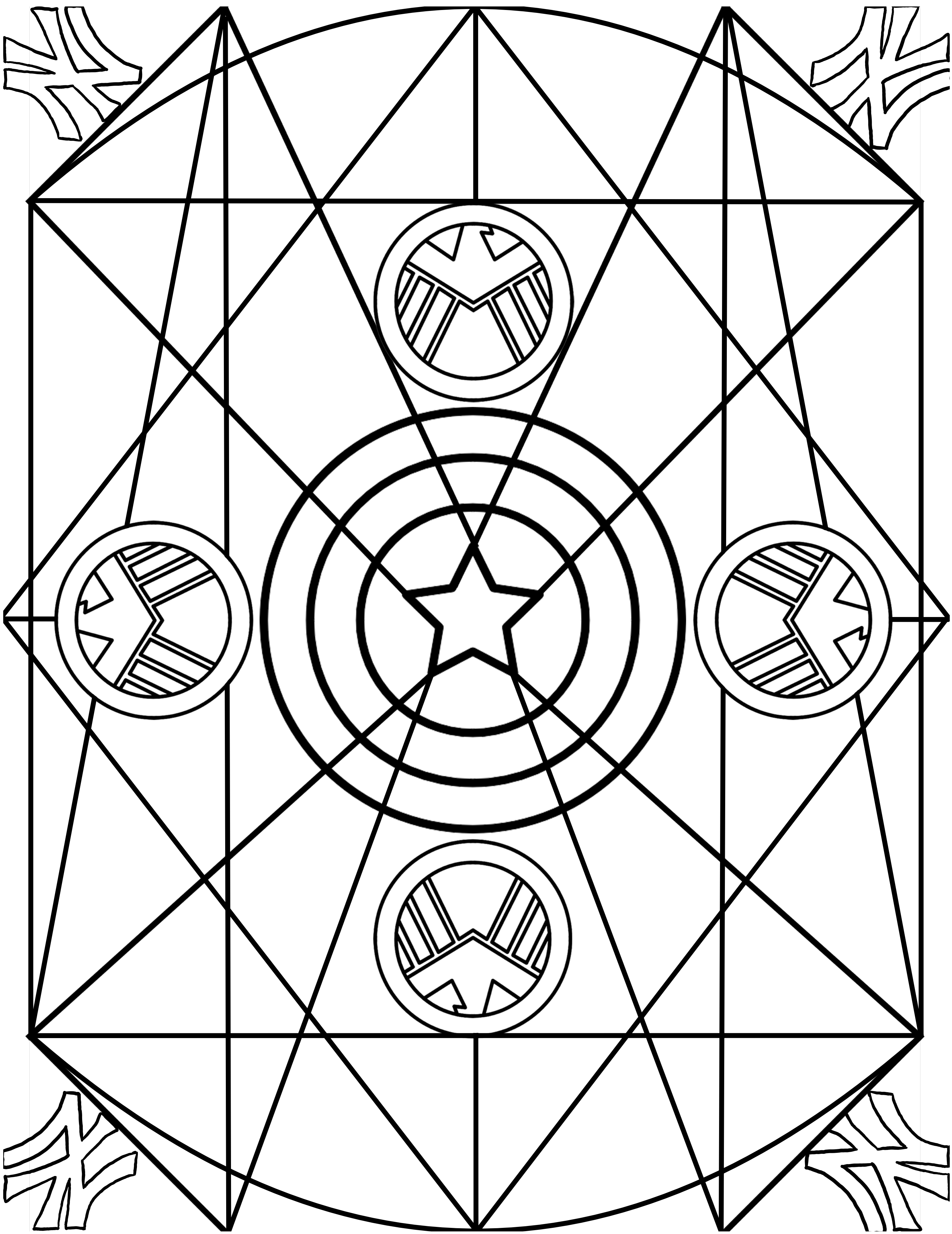
At the heart of the image is an outline of Captain America's shield, a perfect circle containing concentric rings and a central five-pointed star. The star serves as a critical design element, as its points determine the alignment of several intersecting lines, creating a web of symmetrical shapes throughout the design. These lines generate triangles and diamonds that add depth to the overall design while maintaining mathematical integrity. The shield itself has rotational symmetry, as its star and rings maintain uniformity across multiple rotations.

Surrounding the shield are four identical S.H.I.E.L.D. logos, arranged to establish both twofold and fourfold rotational symmetry. These logos further anchor the design, ensuring balance in all directions. However, the S.H.I.E.L.D. logo introduces a slight asymmetry (reflectional) due to the eagle heads within, which face opposite directions. This deviation subtly disrupts the vertical mirror plane, adding a layer of complexity to the otherwise symmetrical layout.

In the corners of the page, I included the Yankees logo. To ensure the logos wouldn't lose quality, as any images I found were pixelated, I hand-traced them, preserving their shape while creating a sense of fourfold rotational symmetry at the edges. This placement ties the corners to the central design while remaining distinct.

The image also features reflectional symmetry, with two primary mirror planes: one vertical and one horizontal. Despite this, there are intentional exceptions. The horizontal mirror plane is disrupted by the lines radiating from the points of the star. While the lines align perfectly with the S.H.I.E.L.D. logo at the top, they diverge slightly at the bottom due to the angles created by the star's inherent lack of horizontal symmetry.

Ultimately, the design has complexities including both the aesthetic appeal of geometric shapes and personal symbolism, creating a detailed and engaging composition for you to color in and enjoy.



Nature's Mandala

by Yi Zhu

The intertwining of the natural and mathematical worlds inspires my designs. The starting point for designing this pattern was the beauty of symmetry in the art of mandalas and nature. In this piece, the layering of mandalas is incorporated into the geometric structure, with each layer having several radioactive designs that encourage the colorist to interact with the pattern through coloring.

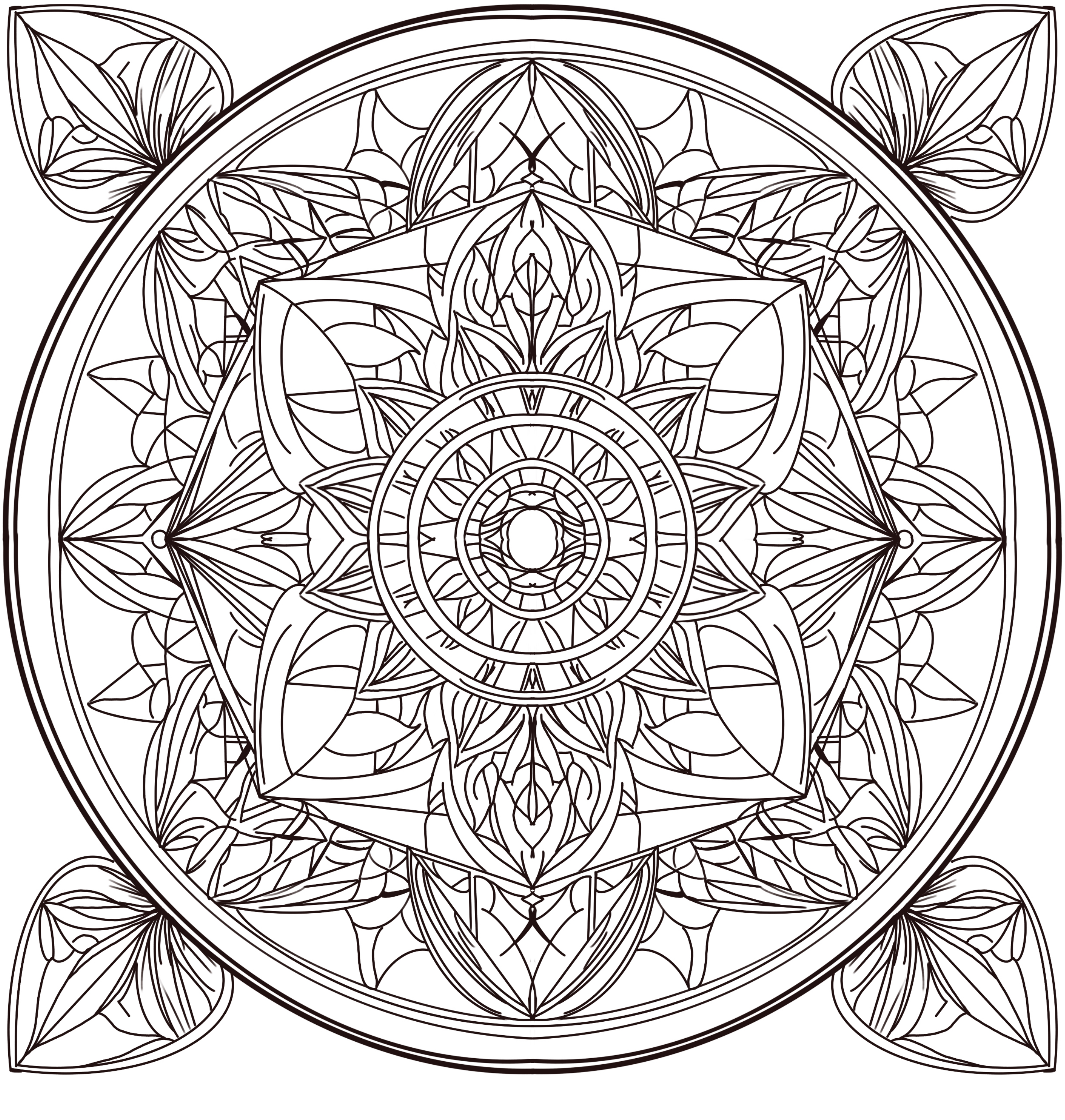
Firstly, the pattern has many leafy elements, which are partly inspired by the arrangement of the leaves and the symmetry of the flowers. I observed that leaves often unfold along a sort of logarithmic spiral. Therefore, in the design, I incorporated the leaves' shape into the pattern's outer layers.

Geometric patterns of different shapes and sizes are intertwined in the figure. For example, the circle shrinks layer by layer, giving a visual effect of gathering towards the center. The outline of the octagon can be seen in the pattern, connecting with the flower's petals in the center, while the triangle is hidden in the petal-like design. There are also semi-circles inside that add a sense of softness to the overall design.

The circle in the pattern's center expands outward, gradually forming geometric shapes such as octagons, triangles, and leaves. This structure is similar to the principle of scaling. I hope to create a visual effect from near to far by progressing layer by layer from the center outwards, trying to create a sense of three-dimensional depth on a two-dimensional plane. This is inspired by the "progressive scale."

The pattern also contains a variety of symmetrical patterns, such as rotational symmetry and mirror symmetry. I designed two symmetrical axes, each dividing the pattern into symmetrical parts. This pattern stays the same whether rotated 90 degrees or flipped in a mirror image. And the circular structure gives the entire pattern a very smooth rotational feel. At the same time, each layer is composed of similar geometric shapes, and this repetitive regularity reflects the "self-similarity" property of fractal geometry.

The pattern also contains variations of lines, both thick and thin, with thick lines framing the main structure and thin lines filling in the details. In addition, the lines of the leaves are denser in the pattern, while the lines of the other large, framed parts are looser. The lines in the middle section are connected behind the circular lines, hoping to give a sense of visual extension that spreads outward. It is also expected that the complexity of the lines will add interest to the drawer. I hope that by designing such a layered pattern, the viewer will feel the beauty of nature and math.



Simple Spirals

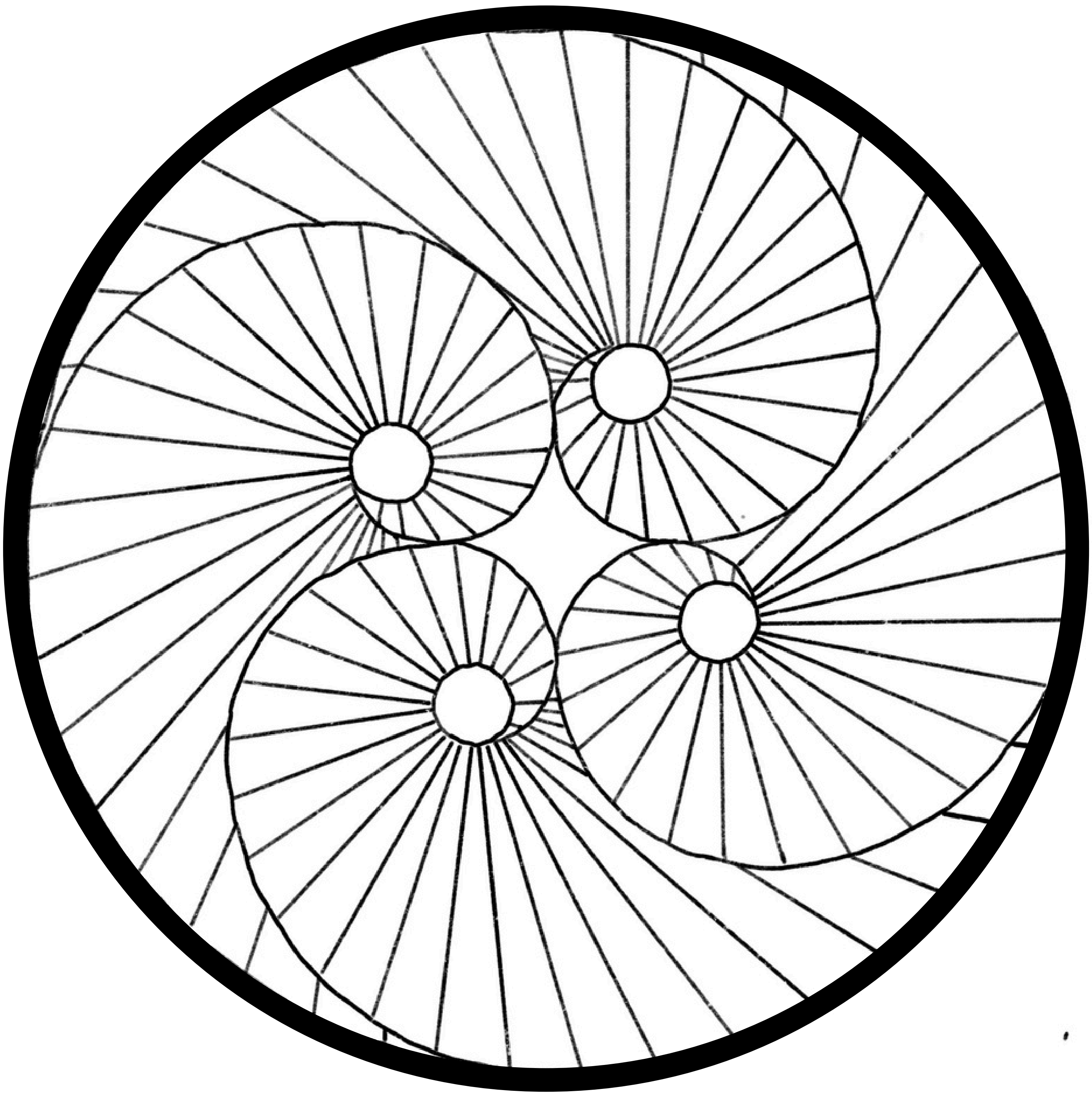
by Drew Fetterolf

The overall design revolves around a large circle with four smaller circles inside, each serving as a focal point for lines radiating outward. These radiating lines create a spiraling effect, giving the image a sense of motion while maintaining its symmetrical structure. The way the lines are arranged can be linked to polar coordinates, where patterns are described using angles and distances from a central point—a widely used concept in mathematical modeling and visualization.

What truly makes this design stand out is its symmetry. The smaller circles are evenly spaced within the larger one, creating rotational symmetry. This means that if the entire image is rotated by 120 degrees, it remains unchanged. Symmetry like this is an essential element of geometry and is often used in art and design to establish a sense of balance and flow. The intersections of the radiating lines form wedge-shaped sections that connect to mathematical concepts like angles, arcs, and sectors, making this design a creative and visual representation of trigonometry in action.

The spiraling effect of the lines also reflects patterns found in nature, such as nautilus shells, galaxies, or the arrangement of sunflower seeds. These spirals are often associated with the Fibonacci sequence or the golden ratio, mathematical principles that frequently appear in nature's designs and growth patterns. This coloring page captures the essence of those natural patterns while using mathematics to recreate them in an artistic and structured way.

The enclosing circle ties the entire design together, creating a unified and complete look. At the same time, the radiating lines bring complexity to the simplicity of the shapes, demonstrating how math can take basic ideas and transform them into something intricate and visually captivating. This coloring page perfectly showcases how math and art intersect to create something that's both logically structured and beautifully creative.



Circular Pyramid

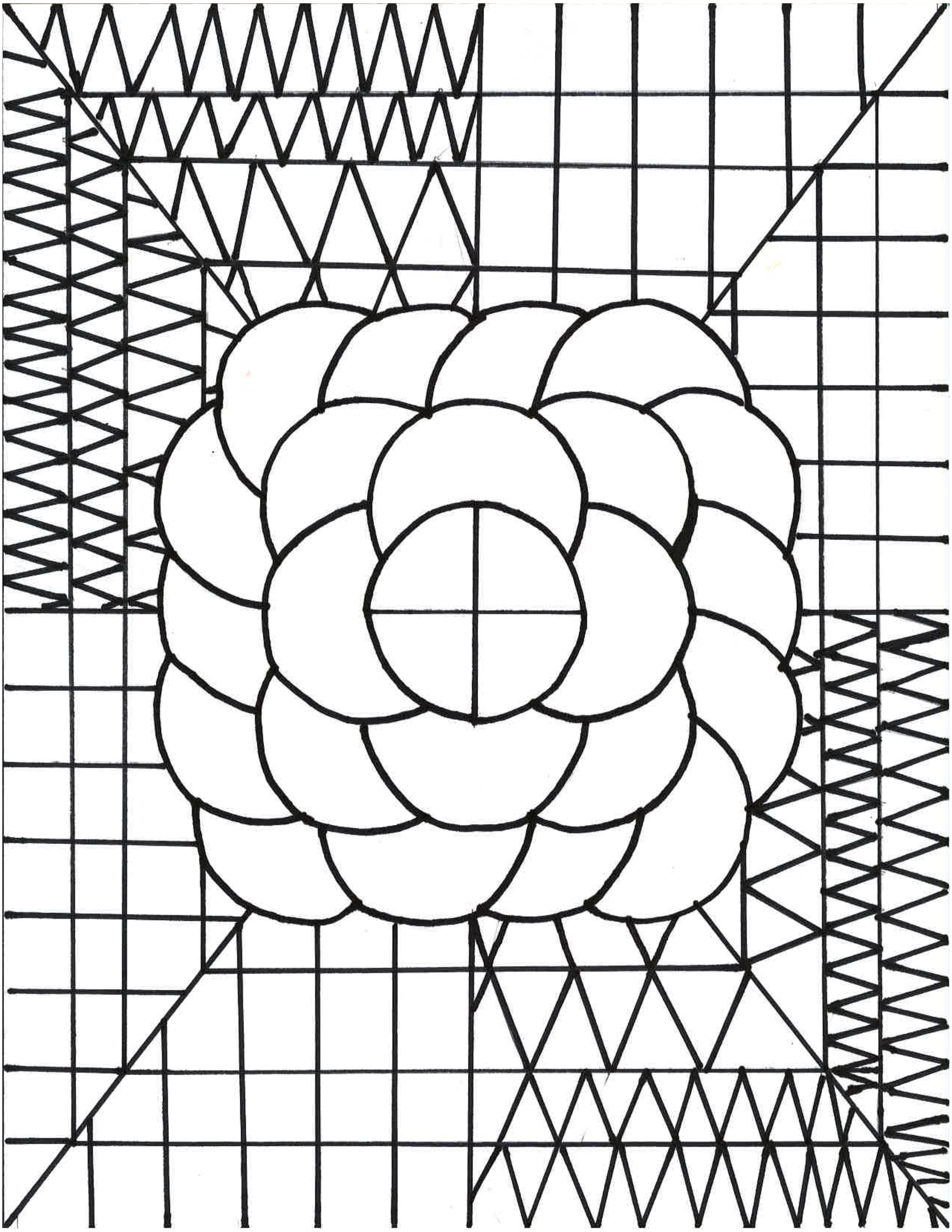
by Ryan Kolaitis

This coloring book page mainly took inspiration from the geometric construction assignment with its central design that incorporates layered circles. Overall design is composed of three shapes: triangles, rectangles, and circles. The use of only a few shapes allows it to keep its very geometrical look to the design. The main focus of the design was to stack circles on one another in the center to give it a look of depth, like a birds eye view of a pyramid.

There are multiple planes and types of symmetry throughout the design which can be seen in the central circular section and also throughout the external border section. The internal circular section of the design contains no forms of reflective or translational symmetry but it does contain a two fold rotational symmetry. This rotational symmetry can be seen if you rotate the central circular section 180 degrees and you will observe that the design implants directly back onto itself.

In terms of the external border section, it contains both rotational and translational symmetry. In both the rectangular and the triangular sections of the border they contain translational symmetry in their respective sections by being able to shift the different layers to the right or left and they are able to fit into the other shapes seamlessly. The external border section also contains a two fold rotational symmetry by being able to rotate the sections 180 degrees so they can fit into the other section of their shape on the other side of the page.

In the external triangular section of the design, it contains multiple layers of triangles which slowly decrease in size as they move towards the edge of the page. The triangles in each layer all have equivalent interior angles which allows them to have translational symmetry. In the rectangular sections of the external border it contains multiple layers of rectangles, each layer having a different area to them.



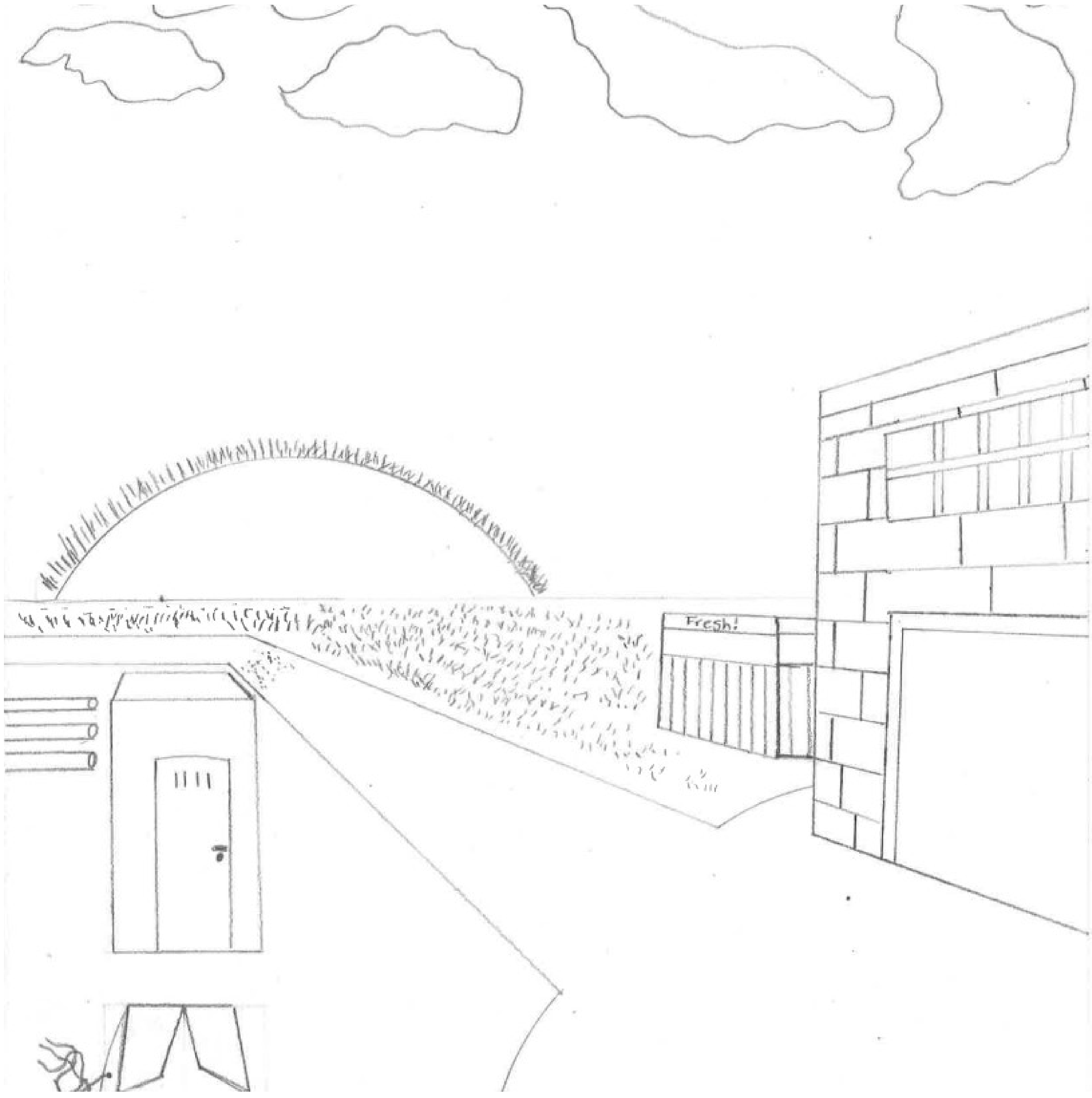
Sunset at my Farm

by Jack Slaven

I used a combination of artistic and mathematical skills to create this landscape drawing as a nostalgic homage to the farm where I grew up. The single-point perspective method that we covered in this class was one of the main strategies I used. I was able to add depth and pull the viewer's eye into the scene by placing a vanishing point on the horizon. Additional details, like the rear of the barn, the nearby farmstand, and a wider perspective of the porta potty and the logs next to it would have been visible if I had decided to add a second vanishing point. This choice gave me the opportunity to hint at the wider surroundings while concentrating on a single viewpoint.

I designed the barn quilt especially for this piece, incorporating a series of knots at the edges to suggest where it would have been attached and highlighting symmetry. The goal of this arrangement of texture and order was to evoke the practical as well as the aesthetic elements of the farm setting.

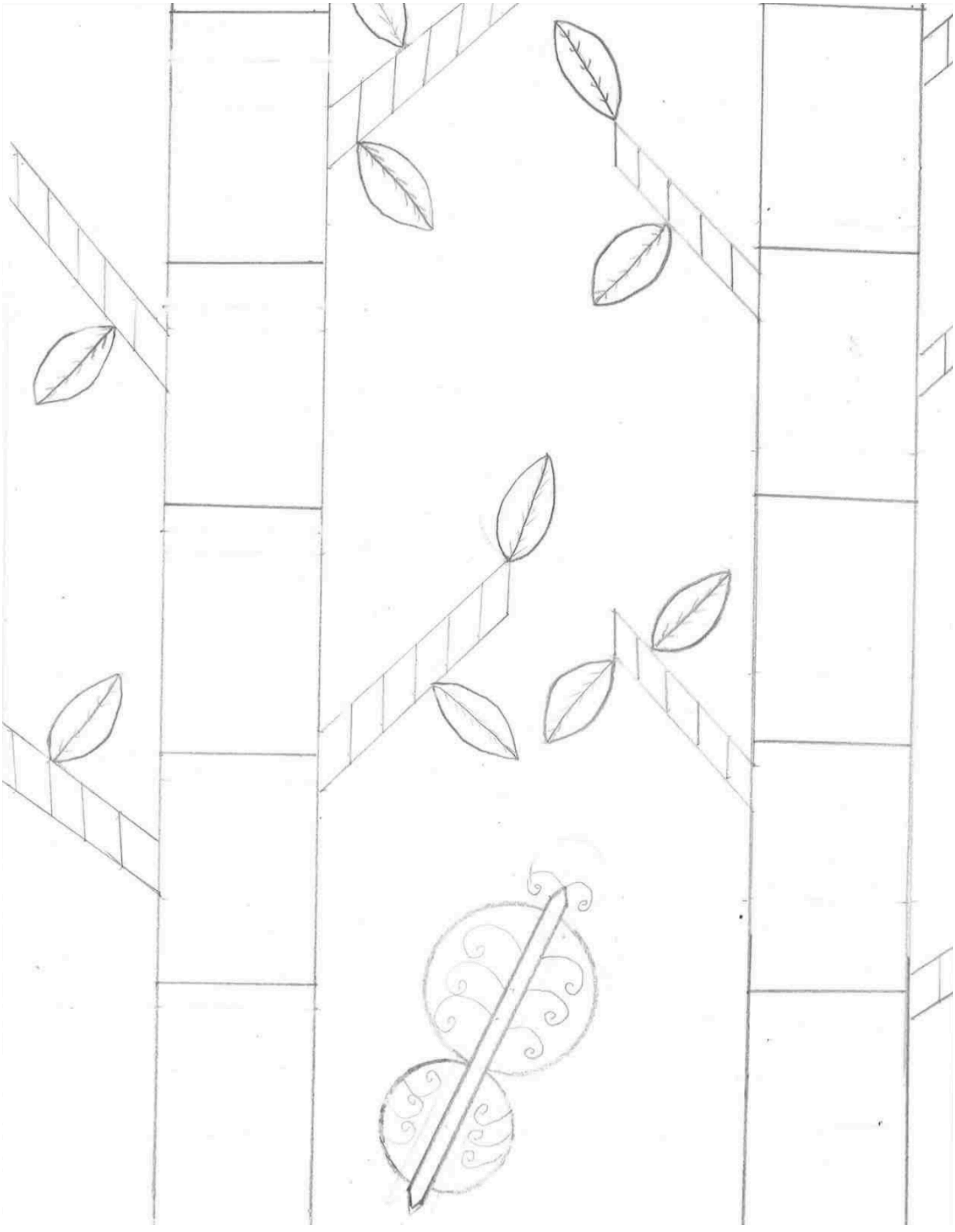
I represented the porta potty we used for staff by adding a three-dimensional rectangular prism beneath the vanishing point in the lower part of the drawing. This component was thoughtfully created to mirror the geometric concepts we studied in class. I placed some logs on the ground behind the porta potty so that they could be used as benches during lunch and break times. In order to provide an extra degree of visual interest and a link to the methods we have been studying, these logs were created to resemble the optical illusion exercise we practiced.


Fresh!

Butterfly Bamboo

by Will McDonald

When creating my final piece for the class coloring book, I knew I wanted to take an approach that used math in the image but to the average person might not appear obvious as a mathematical image. I wanted to do my best to create an image that could be found in any children's coloring book without bringing too much attention to the math while also subtly incorporating many of the elements of math art that we learned throughout this class. In this way, I settled on creating an image based upon nature that incorporates as many mathematical concepts learned in class that I could. My image, two shoots of bamboo framing a butterfly flying in between, was created almost completely using a ruler, compass, and tracing, as to make every aspect as consistent as possible. Beginning with the two main shoots of bamboo, the nodes separating the bamboo shoots into rectangles were all measured out as to make every rectangle of the main bamboo shoots golden rectangles, with a ratio of 3.5 cm to 5.6 cm, coming out to a ratio of 1.6. Furthermore, the two main shoots of bamboo were designed to be symmetrical, with each one mirroring the other. The smaller shoots coming off the bamboo however were designed to not be symmetrical, as to make sure the image did not become too stale. The leaves coming off the smaller bamboo shoots however were all designed by first using a compass to make circles where the leaves would be, all the same size. I then traced through the middle of the circle to make leaf shapes that were as close to perfectly the same as all the other leaves that I could get by hand drawing. While not exactly perfect, the goal was to have each leaf be translationally symmetrical with every other leaf in the image. Finally, the butterfly was created using a compass to make two perfect circles for the wings, one slightly smaller than the other. I then bisected both circles and created the body of the butterfly, and to finish off the image traced the Fibonacci spiral as best as I could for the butterfly's antennas and the design on the wings. In this way, I hoped my image Butterfly Bamboo would incorporate plenty of math concepts without making it outwardly obvious.



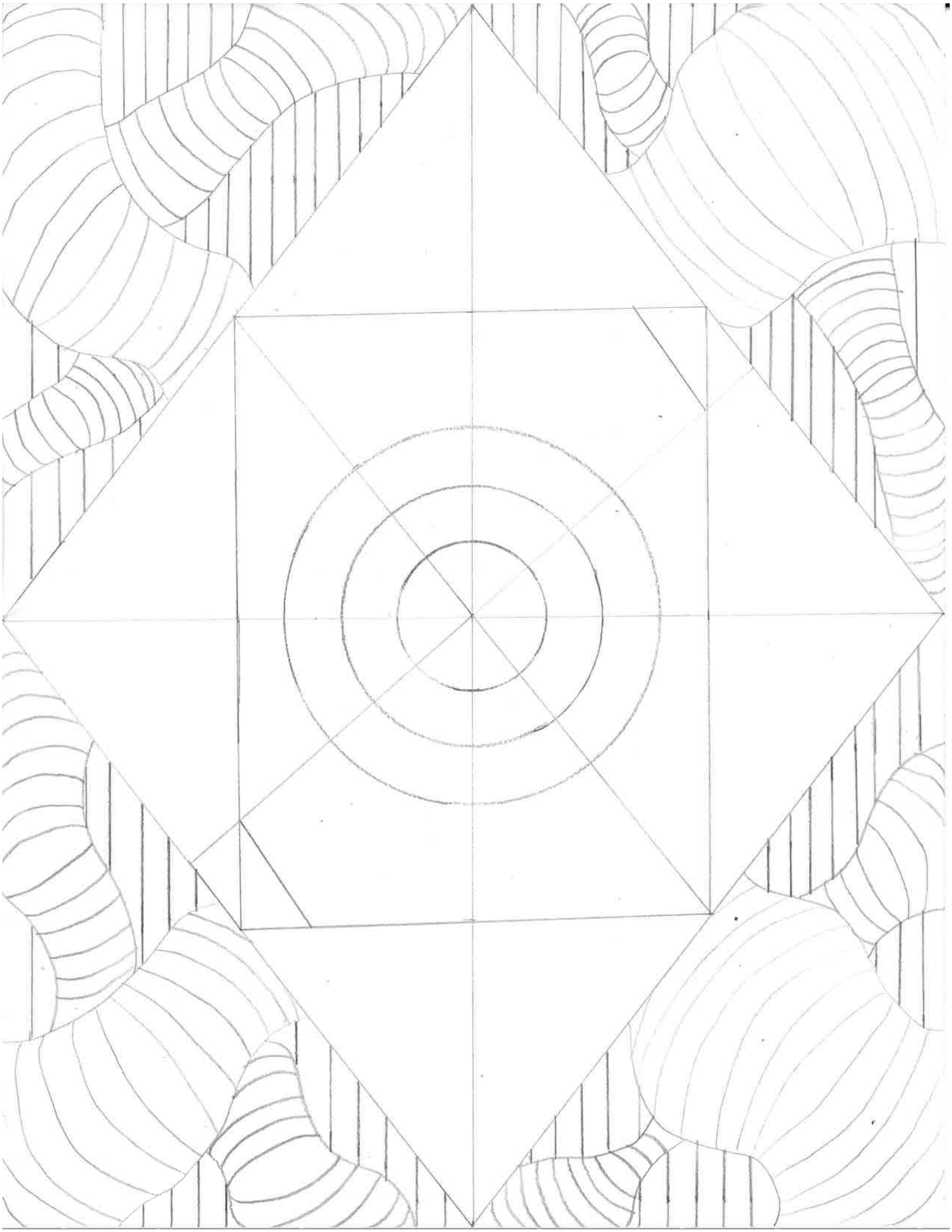
True Illusions

by Olivia Casavant

This coloring book page, titled True Illusions, was inspired by the interplay of tubular illusions and regular polygons, including squares, circles, and diamonds. The design incorporates curving tubes that create the illusion of three-dimensionality, giving the piece a dynamic and immersive feel. The background consists of straight lines spaced a quarter inch apart, contributing to a sense of depth and movement that contrasts with the precise geometric shapes in the focal point.

At the center of the page, a large diamond shape serves as the focal point, with three circles in the center that all share the same vertex. A rectangle is also prominently placed within the design, and its top-left and bottom-right corners bisect the lines of the larger diamond. These intersecting corners, however, are not the same as the corners of the rectangle where small triangles are located which don't bisect the diamond lines. The use of triangles throughout the artwork adds further complexity, inviting the viewer to explore the relationships between the various shapes.

The design features both rotational and reflectional symmetry. The rectangle at the center exhibits 2-fold 180-degree rotational symmetry about the center of the page, which also happens to be the vertex of the three circles. This means the design remains unchanged when rotated 180 degrees around this central point. Additionally, ignoring the small triangles in the rectangle's corners, there is mirror symmetry along both the vertical and horizontal axes within the rectangle, creating a balanced, symmetrical appearance. However, the presence of the triangles disrupts any reflectional symmetry along the diagonal lines of the rectangle, resulting in a break in symmetry along those axes. Overall, the design blends geometric harmony and illusion, creating an engaging and thought-provoking visual experience.

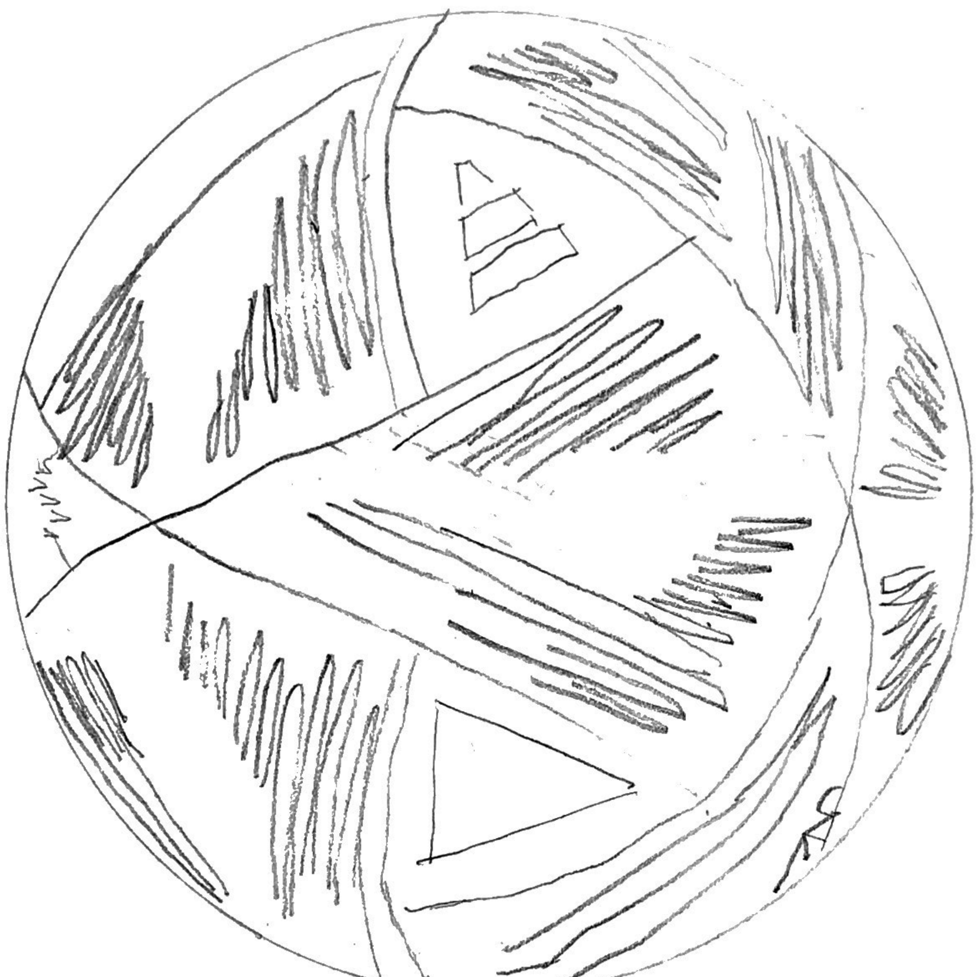


Symmetry in Motion

by Malcolm Migoya

Soccer has always been more than just a sport to me; it's a connection to my dad, his roots, and the incredible legacy of Argentina. My dad was born in Buenos Aires, Argentina, a country where soccer is more than just a sport, it's a religion, a way of life, and a symbol of unity. Growing up, he would tell me stories of the great players who wore the famous light blue and white jersey with pride, and how they won the world cup in a thriller back in 1986. This past World Cup in 2022 they were able to bring it home and I was able to watch it with my dad, a memory I will have with me the rest of my life. This soccer ball, which commemorates the year Argentina won the World Cup, has a special meaning to me. It represents not just a historic victory, but also the heart and determination that define Argentine soccer. My dad always emphasized the importance of mental toughness and hard work, which are key values embodied by the team who brought the trophy home. Through soccer, I've learned to push myself, embrace and overcome both individual and team challenges.

The World Cup - Al Rihla Adidas 2022 ball uses geometry to make it better for players on the field. It's designed with very interesting geometric concepts like shapes that fit perfectly together, balance, and being really round to help it perform well. The ball has 20 tesselating panels that are shaped like triangles and kites. These shapes are put together in a way that leaves no gaps or overlaps. The pattern was designed from a traditional hexagonal soccer ball to make the ball's aerodynamics better. The way the panels are placed also makes the ball last longer and keeps it up to FIFA's high standards. Symmetry is another big part of the ball's design. Within the tessellating triangles and kites, there are narrow shapes that are symmetrical over a vertical line going down the top and bottom of the kite. The panels are arranged evenly, so the ball's weight is spread out equally. This makes the ball act the same no matter how you kick it, giving players consistent control. The surface of the ball has tiny textures and ridges that help it move through the air better. These little details reduce drag, making the ball stable and easy to control. This ball is very interesting because it uses geometry to help real world problems and help create memories of a lifetime.



Petals

by William Borges

Ever since we watched a video in class discussing how to create flower pedals mathematically, I knew I wanted to write about it. I've drawn hundreds of flowers in my life and seen so many examples of Fibonacci's sequence in nature and everyday life, but I had never seen the correlation between the two before now.

At first, it might seem random that flowers could recreate the Fibonacci Sequence since flowers cannot understand the Fibonacci sequence, beauty, and math as humans do. Still, after countless studies and undeniably repetitive conclusions to these studies, it is evident that flowers implement Fibonacci's sequence, the golden ratio, and golden spirals.

First, the center of all flowers, although especially visible on flowers such as sunflowers and daisies, have formations of seeds that follow golden spirals. A golden spiral is a logarithmic spiral where the growth factor is the "golden ratio" (approximately 1.618). That's not all; there's another layer of the Fibonacci sequence all in the seeds of a flower. The seeds arrange themselves in a spiral pattern where the number of spirals in each direction often corresponds to consecutive numbers in the Fibonacci sequence; if there are three golden spirals flowing counterclockwise, there must be either one or five golden spirals flowing clockwise, and vice versa.

Additionally, I'll discuss the petals and their relation as well to the Fibonacci Sequence. The easiest way to see this is by counting petals. Almost every time, the final number will be a Fibonacci number. For example, Lilies have three petals, Daisies have thirteen, and Black-Eyed-Susans have twenty-one petals. However, the most interesting way flowers utilize Fibonacci's Sequence is how they space their petals. When flowers are growing, they need to maximize the sunlight that hits each petal/leaf. To do this, pedals will grow 137.5 degrees apart. This angle is directly related to the golden ratio and allows for the minimum amount of overlap with the addition of each pedal. This was kept in mind when creating this coloring book entry, and every pedal I added was spaced 137.5 degrees from the last to create a realistic drawing of a flower.