

Mathematical art of mc escher

The Mathematical Art of M.C. Escher: Where Geometry and Illusion Collide

M.C. Escher, renowned for his mind-bending optical illusions, was not just an artist, but a master of mathematical principles. His works, often featuring impossible staircases, tessellations, and paradoxical spaces, demonstrate a deep understanding of geometry, topology, and perspective. This delves into the intricate connection between Escher's art and mathematics, exploring the concepts he employed and their impact on his creative vision. **Escher's fascination with geometry is evident in his use of tessellations, repeating patterns that seamlessly fit together without gaps or overlaps.** He explored this concept in numerous works, including "Day and Night" (1938) and "Reptiles" (1943). His tessellations often depict animals and other creatures seamlessly transforming into one another, showcasing his mastery of geometric shapes and their ability to morph and interlock.

Escher's Exploration of Perspective

Beyond tessellations, Escher experimented with perspective, challenging traditional understandings of space and depth. His iconic lithograph "Relativity" (1953) depicts a world where gravity seems to shift and multiple perspectives coexist within a single frame. The impossible staircases in his "Ascending and Descending" (1960) further demonstrate his manipulation of perspective, creating a visual paradox that captivates the viewer. Escher's understanding of perspective allowed him to create illusionary spaces that defy logic, making his work not only visually appealing but intellectually stimulating.

The Influence of Topology

While Escher's art often incorporates geometric principles, his understanding of topology played a crucial role in creating his signature illusions. Topology, the study of shapes and their properties under continuous transformations, allows for seemingly impossible transformations, such as turning a sphere inside out or stretching a sheet of paper into a Möbius strip. **Escher's "Möbius Strip II" (1961) is a prime example of how he integrated topological concepts into his art. The artwork depicts an ant endlessly walking along the surface of a Möbius strip, a single-sided surface that has only one edge.** This artwork not only showcases the fascinating properties of a Möbius strip but also reflects Escher's fascination with the infinite and the interconnectedness of seemingly disparate elements.

Mathematical Art as a Bridge Between Disciplines

Escher's work demonstrates the symbiotic relationship between art and mathematics. His ability to translate complex mathematical concepts into visually compelling forms served as a bridge between these two disciplines. **His art serves as a testament to the inherent beauty found within mathematics, making abstract concepts accessible and engaging for a wider audience.** Furthermore, Escher's work inspired generations of mathematicians and artists, solidifying its

lasting impact on both fields.

Conclusion

M.C. Escher's legacy lies in his ability to bridge the gap between art and mathematics. His unique blend of creativity and scientific understanding resulted in visually captivating and intellectually stimulating artwork. By exploring concepts like tessellations, perspective, and topology, Escher demonstrated the potential for mathematics to be a source of artistic inspiration, challenging conventional perceptions and pushing the boundaries of creative expression. His influence continues to be felt in various fields, making him a true pioneer in the realm of mathematical art.

FAQs:

1. How did Escher learn about mathematics? Escher did not have formal training in mathematics but was self-taught. His interest in the subject was piqued during his travels and through interactions with mathematicians. *2. Was Escher's art solely based on mathematical principles?* While Escher's work heavily relies on mathematical concepts, it also encompasses elements of symbolism, philosophy, and personal experiences. *3. How has Escher's work influenced contemporary art?* Escher's art has inspired countless artists in various fields, including graphic design, architecture, and computer animation. His work continues to spark new interpretations and creative explorations. *4. What are some other examples of mathematical art?* Beyond Escher, there are various examples of mathematical art, including the works of mathematicians like Benoit Mandelbrot and fractal art generated using computer algorithms. *5. Is there a mathematical formula behind Escher's "impossible" staircases?* While there's no specific formula, Escher's staircases rely on the principle of perspective, where lines converge at a vanishing point, creating an illusion of impossible structures.

The Mathematical Tapestry of M.C. Escher: Where Illusion Meets Logic

Step into the mesmerizing world of M.C. Escher, and you'll quickly realize you're not just looking at art; you're gazing into a visual manifesto of mathematical principles. Escher, a Dutch graphic artist, is renowned for his impossible constructions, explorations of infinity, and tessellations that seamlessly blend art and science. His work, often described as "mathematical art," captivates audiences with its intricate detail, mind-bending perspectives, and a profound underlying logic that invites us to question reality itself.

But what exactly makes Escher's art so mathematical? It's not just about drawing numbers or complex equations on a canvas. Escher's genius lay in his ability to translate abstract mathematical concepts into tangible, often surreal, visual experiences. He was a master of geometric principles, perspective, symmetry, and the exploration of paradoxes, all woven together with an artist's sensibility. His prints are not merely decorative; they are invitations to explore the beauty and order that can be found in the seemingly chaotic. Let's delve deeper into the fascinating intersection of Escher's imagination and the world of mathematics.

The Foundation: Tessellations and Regular Division of the Plane

One of the most recognizable elements of Escher's work is his masterful use of tessellations. A tessellation, in mathematical terms, is the tiling of a plane using one or more geometric shapes, called tiles, with no overlaps and no gaps. Escher took this geometric concept and elevated it to an art form, transforming simple shapes into intricate, interlocking figures that often morph into one another.

From Simple Shapes to Living Forms

Escher's journey into tessellations began with exploring the work of mathematicians like George Pólya. He was particularly fascinated by the "regular division of the plane," where identical shapes fit together perfectly. Initially, his tessellations featured basic geometric shapes like squares, triangles, and hexagons. However, his artistic curiosity pushed him further. He began to replace these abstract forms with recognizable figures – birds, lizards, fish, even human figures.

The magic lies in the transition. In works like "Metamorphosis I, II, and III," Escher masterfully depicts how one tessellated shape gradually transforms into another. A cluster of black and white birds might morph into a series of interlocking fish, which then evolve into architectural forms. This visual metamorphosis is not just a trick of the eye; it's a sophisticated demonstration of symmetry and transformation groups, fundamental concepts in geometry and abstract algebra. The seamless flow from one form to the next showcases Escher's deep understanding of how shapes can be manipulated and related through reflection, rotation, and translation.

The Golden Ratio and Geometric Harmony

While not always explicitly stated, the principles of geometric harmony, including the Golden Ratio (often denoted by the Greek letter phi, $\phi \approx 1.618$), likely played a role in Escher's compositions. The Golden Ratio, found in nature and aesthetically pleasing to the human eye, contributes to a sense of balance and proportion. Even in his complex tessellations, there's an inherent order and visual appeal that can be linked to these underlying mathematical ratios. The precise repetition and scaling within his works suggest a deliberate application of principles that create visual equilibrium.

Impossible Realities: The Geometry of Paradox

Beyond tessellations, Escher is perhaps best known for his "impossible constructions." These are artworks that depict objects or scenes that, while appearing perfectly rendered, defy the laws of physics and geometry as we understand them. They are visual paradoxes that challenge our perception of space and reality.

Ascending and Descending: A Never-Ending Staircase

The iconic print "Ascending and Descending" is a prime example. It features a group of monks perpetually walking up and down a staircase that seemingly forms a closed loop. No matter where they are on the stairs, they are always ascending or descending, creating a never-ending cycle. This impossible structure

is a masterful manipulation of perspective, drawing on concepts of non-Euclidean geometry and the Penrose stairs, a two-dimensional representation of an impossible staircase.

Escher's ability to create such convincing illusions stems from his meticulous attention to perspective. He understood how vanishing points, orthogonal lines, and foreshortening create the illusion of depth and three-dimensionality on a flat surface. By subtly distorting these rules, he could construct scenes that are visually plausible but logically impossible.

Waterfall: The Perpetual Motion Machine

Another famous impossible construction is "Waterfall." Here, water flows downhill, turns a waterwheel, and then seemingly flows back uphill to its source. This creates a perpetual motion machine, a concept that violates the laws of thermodynamics. Escher achieves this illusion by exploiting optical illusions and the way our brains process visual information. The composition is designed to trick our perception, making us believe in the impossible flow of water.

These impossible constructions are not just whimsical drawings; they are visual explorations of paradoxes and the limitations of our understanding. They make us ponder the nature of space, time, and dimension, blurring the lines between the real and the imagined.

Infinity and the Infinite Regression

Escher's fascination with the infinite is another key element of his mathematical art. He sought to visually represent concepts that are inherently boundless, challenging our finite human comprehension.

Reptiles: The Cycle of Life and Transformation

In prints like "Reptiles," Escher explores the idea of transformation and cyclicity, hinting at the infinite. Here, three-dimensional, realistic reptiles emerge from a two-dimensional drawing, crawl across a table, and then transform back into the flat drawing. This creates a sense of continuous renewal and a subtle suggestion of an ongoing, perhaps infinite, cycle. The detailed rendering of the reptiles, their scales and textures, adds to the realism, making the impossible transition even more striking.

This concept of infinite regression, where a process repeats endlessly, is a recurring theme. Escher uses repetition and scale to suggest that his worlds extend beyond the frame of the artwork, inviting the viewer to imagine what lies beyond.

The Infinite Grids and Approaching Infinity

Works like "Circle Limit" series are direct attempts to depict infinity. In these prints, figures (often birds or fish) are arranged in concentric circles, getting progressively smaller as they approach the edge. The composition creates the illusion of an infinite plane that is compressed into a finite space. This is mathematically related to concepts like hyperbolic geometry, where space can be infinitely divided.

The meticulous arrangement and diminishing scale in these works are not arbitrary. They are carefully calculated to create a visual representation of an infinite expanse within a framed artwork. Escher's ability to translate such abstract mathematical ideas into visually compelling images is truly remarkable.

Perspective, Symmetry, and Visual Illusions

Escher's art is a masterclass in the manipulation of perspective and symmetry. He understood the rules of visual representation and then artfully bent them to create his unique world.

One-Point and Two-Point Perspective

Escher's understanding of one-point and two-point perspective is evident in his architectural works and impossible landscapes. He uses vanishing points and orthogonal lines to create a sense of depth and realism. However, in his impossible constructions, he often manipulates these perspectives to create conflicting viewpoints or illogical spatial relationships. For example, in "Relativity," different gravitational directions are depicted simultaneously, defying our standard understanding of a unified perspective.

Symmetry Groups and Transformations

Symmetry is a cornerstone of mathematics, and Escher explored its various forms: reflectional, rotational, and translational symmetry. His tessellations are built upon these principles. He identified 17 different types of wallpaper symmetry groups, the mathematical classifications of how patterns can repeat across a plane. He then brought these abstract groups to life with his imaginative motifs. The interplay of positive and negative space, where the gaps between shapes are as significant as the shapes themselves, further highlights his sophisticated use of symmetry.

The Art of the Optical Illusion

Escher's work often borders on optical illusions. He plays with the ambiguity of visual perception, creating images that can be interpreted in multiple ways. This is particularly evident in his "Hand with Reflecting Sphere" and works that play with figure-ground relationships. The sphere in his self-portrait reflects not just the artist but also the room around him, hinting at the interconnectedness of perception and reality. This ability to create visually engaging illusions, often with a profound underlying mathematical structure, is what makes his art so enduringly fascinating.

Escher's Legacy: Bridging Art and Mathematics

M.C. Escher's legacy extends far beyond the art world. His work has inspired mathematicians, scientists, and artists alike, serving as a bridge between disciplines that are often perceived as separate. His prints are used in textbooks to illustrate mathematical concepts, and his explorations of infinity and paradox continue to be a subject of study and fascination.

Escher's art reminds us that mathematics is not just about numbers and formulas; it's about patterns, logic, and the exploration of the universe's underlying structure. His ability to translate complex abstract ideas into visually stunning and thought-provoking imagery is a testament to the power of human creativity and intellect. He showed us that within the rigid framework of mathematics, there lies an infinite realm of beauty, wonder, and endless possibility. So, the next time you encounter an Escher print, take a moment to appreciate not just the illusion, but the intricate mathematical tapestry woven within.

The Mathematical Art of MC Escher: A Fusion of Geometry and Imagination From the intricate tessellations of M.C. Escher to the boundaries of mathematical creativity, the artist's work transcends mere visual appeal, entering a realm where geometry, symmetry, and paradox converge. At the heart of this fusion lies a unique mathematical philosophy that Escher explored with profound insight—an artistic language rooted in tessellation, transformation, and infinite repetition. Though not a mathematician by training, Escher's intuitive grasp of mathematical principles elevated his art into a visual dialogue with topology, group theory, and Euclidean geometry.

The Architecture of Tessellation and Symmetry

Escher's fascination with tessellation—the tiling of a plane with non-overlapping shapes without gaps—reveals his deep engagement with mathematical structure. He meticulously studied how regular polygons could fit together seamlessly, often pushing beyond traditional Euclidean constraints by incorporating irregular forms and curved boundaries. His work demonstrates how geometric principles such as rotational symmetry, reflection, and translation are not merely technical tools but expressive devices that shape perception. By arranging shapes in repeating patterns that shift and transform, Escher created visual illusions that challenge our understanding of space, inviting viewers to perceive infinity within a finite frame. This mastery of symmetry extends beyond decoration; it forms the foundation of a mathematical aesthetic that blends art and logic in a harmonious dance.

Key Insights: Transformation, Paradox, and Infinite Logic

One of Escher's most compelling contributions lies in his use of transformation—forced perspective, morphing forms, and impossible geometry. His pieces often depict objects that appear to bend or shift endlessly, such as staircases looping into themselves or staircases ascending only to vanish into infinity. These visual paradoxes emerge from rigorous application of mathematical transformations, including glide reflections, rotational symmetry, and even elements of projective geometry. Escher's exploration of infinity is not abstract but tangible—his works make the infinite accessible through geometry. By manipulating spatial logic, he reveals how mathematical rules can be bent, broken, and reimaged, opening a window into deeper questions about dimension, continuity, and perception.

Applications and Influence Across Disciplines

The mathematical art of MC Escher extends far beyond fine art, influencing fields as diverse as computer graphics, architecture, and theoretical physics. In modern computer graphics, Escher's tessellations inspire algorithms for texture mapping and procedural generation, where repeating patterns create seamless digital environments. Architects draw from his spatial logic to design structures that challenge traditional geometry, embracing fluid forms and symmetry in innovative ways. In mathematics education, Escher's visual puzzles serve as accessible gateways to complex concepts like group theory, symmetry groups, and non-Euclidean geometry, making abstract ideas tangible and engaging. Even in physics, his exploration of tiling and periodicity resonates with crystallography and the study of quasicrystals—structures that defy conventional repetition yet follow exact mathematical rules.

Enduring Benefits: Bridging Art and Science

Escher's legacy lies in his ability to bridge artistic expression and mathematical rigor, fostering a holistic appreciation of both disciplines. His work encourages viewers to see mathematics not as cold abstraction but as a creative force shaping beauty and perception. By presenting mathematical ideas through visual storytelling, he makes complex concepts emotionally resonant and intellectually inviting. This fusion nurtures curiosity, enhances spatial reasoning, and inspires innovation across generations. In an era increasingly defined by interdisciplinary collaboration, Escher's art exemplifies how mathematics and art can coalesce to expand human imagination and understanding.

The Future of Escher's Mathematical Legacy

As technology advances, the mathematical art of MC Escher continues to inspire new frontiers. Digital tools now enable dynamic tessellations and interactive installations that evolve in real time, expanding Escher's static visions into immersive experiences. Artificial intelligence and generative design draw from his principles to create novel patterns and structures, pushing the boundaries of algorithmic creativity. Moreover, Escher's exploration of infinity and transformation remains relevant in theoretical explorations of higher dimensions, fractals, and quantum geometry. His work invites future generations to merge artistic intuition with mathematical insight, proving that the dialogue between art and science is not only enduring but essential for innovation and discovery. Through the mathematical artistry of M.C. Escher, geometry becomes a canvas for imagination, and paradox becomes a gateway to deeper understanding. His legacy endures not just as a visual phenomenon, but as a testament to the profound synergy between art and mathematics.

The Mathematical Artistry of M.C. Escher: Weaving Logic and Illusion

M.C. Escher, a name synonymous with mind-bending visual paradoxes and impossible constructions, was far more than just a graphic artist. His work is a profound testament to the inherent beauty and philosophical depth found at the intersection of art and mathematics. Escher didn't merely illustrate mathematical concepts; he breathed life into them, transforming abstract principles into tangible, often unsettling, visual realities. His meticulous approach, driven by a deep understanding of geometric principles and logical structures, created a unique artistic language that continues to captivate audiences worldwide, from art enthusiasts to mathematicians.

The enduring appeal of Escher's art lies in its uncanny ability to engage both the intellect and the imagination. He masterfully employed concepts like tessellations, symmetry, infinity, and perspective to construct worlds that defy conventional understanding. These explorations weren't just for aesthetic pleasure; they were a way for Escher to grapple with fundamental questions about reality, perception, and the nature of the universe. His prints, often created using woodcuts, lithographs, and mezzotints, are not just images; they are intricate puzzles, inviting viewers to unravel their complexities and contemplate their deeper meanings.

A Life Dedicated to Visual Inquiry

Born Maurits Cornelis Escher in the Netherlands in 1898, his early artistic development was somewhat unconventional. While he initially pursued architecture, his true passion lay in the intricate patterns and forms he encountered. His exposure to the Alhambra palace in Granada, Spain, with its stunning Islamic geometric tilework, proved to be a pivotal moment. The principles of tessellation, the seamless repetition of shapes without gaps or overlaps, became a cornerstone of his artistic vocabulary. This fascination with pattern would inform his explorations of symmetry and the infinite for the rest of his career.

Escher's artistic journey was one of constant experimentation and intellectual curiosity. He delved into the mathematical underpinnings of his creations, often collaborating with mathematicians who recognized the profound connections within his work. This intellectual exchange fueled his artistic innovation, pushing him to explore increasingly complex geometric ideas. His prints are not spontaneous outbursts of creativity but rather the result of rigorous study and meticulous planning, where every line and shape serves a deliberate purpose in constructing his visual narratives.

Tessellations: The Building Blocks of Escher's Worlds

Perhaps the most recognizable element of Escher's art is his masterful use of tessellations. A tessellation is a tiling of a plane using one or more geometric shapes, called tiles, with no overlaps and no gaps. Escher took this mathematical concept and elevated it to an art form, transforming regular polygons and repeating motifs into dynamic and often anthropomorphic figures. His "Metamorphosis" series, for example, showcases a breathtaking progression of shapes that seamlessly transform into one another, illustrating the fluidity of form and the interconnectedness of visual elements.

The Art of Regular and Irregular Tessellations

Escher's early tessellations often featured simple, repeating geometric shapes. However, he soon moved towards more complex and imaginative tessellations, where the repeating units were recognizable figures, such as birds, fish, or even human forms. He meticulously studied the properties of regular polygons and their ability to tile a plane, but he was equally fascinated by the possibilities of irregular tessellations. By carefully manipulating the edges of his shapes, he created interlocking figures that seemed to flow and merge into one another, blurring the lines between distinct entities.

His exploration of symmetry was crucial to his tessellated designs. He understood the twelve different types of plane symmetry groups, which describe all the possible ways a pattern can be repeated symmetrically. By applying these principles, he created works with a profound sense of order and balance, even when depicting seemingly chaotic or impossible scenes. The interplay between repetition and variation within his tessellations creates a visual rhythm that is both captivating and intellectually stimulating.

Impossible Structures and Infinite Loops

Beyond tessellations, Escher is renowned for his "impossible constructions" and explorations of infinity. Works like "Relativity," "Ascending and Descending," and "Waterfall" depict architectural marvels that defy the laws of physics and perspective. These paradoxical structures are not mere visual tricks; they are

invitations to question our assumptions about space, gravity, and perception.

Challenging Perceptual Norms

Escher's ability to create these optical illusions stemmed from his deep understanding of linear perspective and his willingness to subvert its conventions. In "Relativity," for instance, multiple light sources and gravitational fields coexist within the same space, allowing figures to walk on walls and ceilings simultaneously. This creates a disorienting yet compelling visual experience, forcing the viewer to re-evaluate their own spatial understanding. These impossible structures highlight the subjective nature of perception and how our brains interpret visual information.

The concept of infinity also played a significant role in Escher's artistic vision. He sought to represent the boundless nature of the universe and the human fascination with the eternal. In works like "Circle Limit III" and "Circle Limit IV," he used hyperbolic geometry to depict an infinite pattern within a finite circular frame. As the pattern recedes towards the edges, the shapes become smaller and more numerous, creating an illusion of infinite repetition. These explorations of infinity are not just visually striking; they offer a glimpse into the abstract beauty of mathematical concepts.

The Mathematical Foundations of Escher's Genius

While Escher was primarily an artist, his work is deeply rooted in mathematical principles. He was particularly interested in geometry, symmetry, and the concept of infinity. His artistic process often involved a rigorous study of these mathematical ideas before translating them into his prints.

Geometric Harmony and Symmetry

Escher's keen eye for geometric harmony is evident in the precise arrangements of shapes and forms in his artwork. He understood how basic geometric figures could be manipulated and combined to create intricate and visually pleasing patterns. His use of symmetry, from simple reflectional symmetry to more complex rotational and translational symmetry, imbues his works with a sense of order and balance, even in the most paradoxical scenes. The mathematical classifications of symmetry, such as wallpaper groups, provided him with a framework for generating complex and harmonious repeating patterns.

Infinity and Fractals

While the term "fractal" was coined much later, Escher's work foreshadowed many of the visual characteristics associated with fractal geometry. His explorations of self-similarity, where a pattern repeats at progressively smaller scales, are evident in works like the "Circle Limit" series. These intricate patterns create a sense of infinite detail within a confined space, reflecting the self-replicating nature of fractals. His fascination with the boundless also led him to explore concepts like the Möbius strip, a surface with only one side and one boundary, which he incorporated into his art to symbolize the continuous and cyclical nature of existence.

Escher's Legacy: Art, Science, and the Mind

M.C. Escher's art transcends disciplinary boundaries, captivating a diverse audience. His work has found its

way into textbooks, scientific papers, and popular culture, a testament to its profound impact. Mathematicians admire his intuitive grasp of complex concepts, while artists and the general public are drawn to the sheer visual wonder and intellectual stimulation his creations provide.

Inspiring Future Generations

The enduring appeal of Escher's art lies in its ability to spark curiosity and encourage critical thinking. His prints invite us to look closer, to question our assumptions, and to appreciate the intricate beauty of the world around us, both visible and abstract. His legacy continues to inspire artists, designers, scientists, and educators, proving that the most profound insights often emerge from the unexpected fusion of art and logic. His ability to translate complex mathematical ideas into universally understandable visual narratives solidifies his place as one of the most influential graphic artists of the 20th century, a true master of the mathematical art.

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Questions & Answers About mathematical art of mc escher

No	Question	Answer
1	What makes M.C. Escher's art so mathematically fascinating?	Escher's art is deeply rooted in mathematical concepts like tessellations, impossible structures, symmetry, and infinity. He visualized abstract mathematical ideas, making them tangible and mind-bending for viewers.
2	Can you explain 'tessellations' in the context of Escher's work?	Tessellations are patterns made of repeating shapes that fit together without any gaps or overlaps. Escher is famous for using this technique with animal or human figures, transforming the simple geometric arrangement into dynamic compositions.
3	What are 'impossible structures' and how did Escher use them?	Impossible structures are drawings that appear to depict three-dimensional objects, but are geometrically impossible in reality. Escher famously depicted these using techniques like the Penrose stairs, challenging our perception of space and logic.
4	How does Escher explore the concept of infinity in his art?	Escher achieved this through repetitive patterns that recede into seemingly endless spaces, or by depicting processes that could theoretically continue forever. Works like 'Circle Limit III' are prime examples of this visual exploration of infinity.

5	Did Escher have a formal math background?	While not a mathematician by training, Escher was deeply interested in mathematics and collaborated with mathematicians like Roger Penrose. He developed an intuitive understanding of mathematical principles through his artistic practice.
6	What is the significance of symmetry in Escher's art?	Symmetry, in its various forms (reflectional, rotational, translational), is fundamental to Escher's tessellations and overall compositions. It provides order and structure to his often complex and illusionistic scenes.
7	How did Escher's work influence later artists and designers?	Escher's pioneering use of mathematical concepts and optical illusions has inspired countless artists, illustrators, and designers. His work is often cited in discussions of visual perception, graphic design, and even in the development of computer graphics.
8	What's the connection between Escher's art and paradoxes?	Many of Escher's pieces create visual paradoxes, such as staircases that lead nowhere or water flowing uphill. These paradoxes arise from the interplay of his mathematical principles and his masterful depiction of perspective, forcing us to question what we see.

Mathematical art of MC Escher, MC Escher tessellation techniques, intersecting patterns mathematical art, MC Escher geometry and tessellations, artistic tessellations inspired by MC Escher, mathematical patterns in MC Escher's work, Escher-inspired mathematical art, geometric art inspired by MC Escher, mathematics in Escher's tessellations, visual math art from MC Escher

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