



# Lecture 2D Patterns & Ornaments

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## Advanced Topics in Digital Design

67682

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# Pattern

A pattern is a discernible regularity in **the world or in a manmade design**. As such, the elements of a pattern repeat in a predictable manner. A geometric pattern is a kind of pattern formed of geometric shapes and typically repeating...

Any of the senses may directly observe patterns. Conversely, abstract patterns in science, mathematics, or language may be observable only by analysis. Direct observation in practice means seeing visual patterns, which are widespread in nature and in art. Visual patterns in nature are often chaotic, never exactly repeating, and often involve fractals... Patterns have an underlying mathematical structure; indeed, mathematics can be seen as the search for regularities, and the output of any function is a mathematical pattern.

(from Wikipedia)

# Symmetry (geometry)

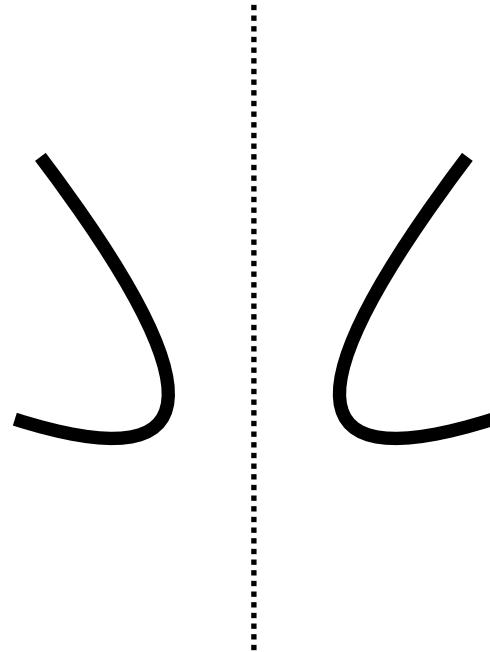
A geometric object has symmetry if there is an "operation" or "transformation" (technically, an isometry or affine map) that maps the object onto itself; i.e., it is said that the object has an invariance under the transform.

The types of symmetries that are possible for a geometric object depend on the set of geometric transforms available, and on what object properties should remain unchanged after a transform. Because the composition of two transforms is also a transform and every transform has an inverse transform that undoes it, the set of transforms under which an object is symmetric form a mathematical group.

(from Wikipedia)

# Types of symmetry

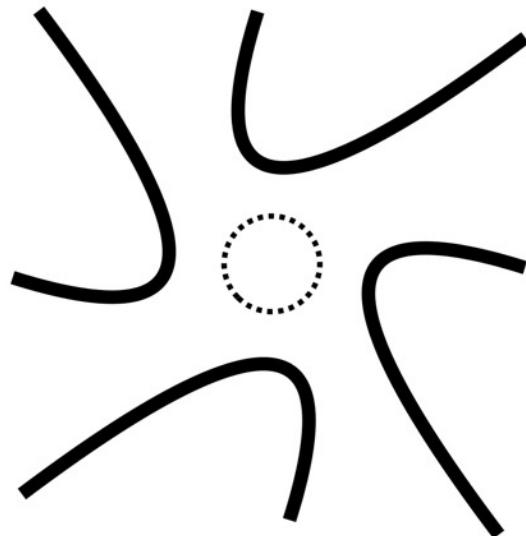
Reflectional symmetry



# Types of symmetry

Reflectional symmetry

Rotational symmetry

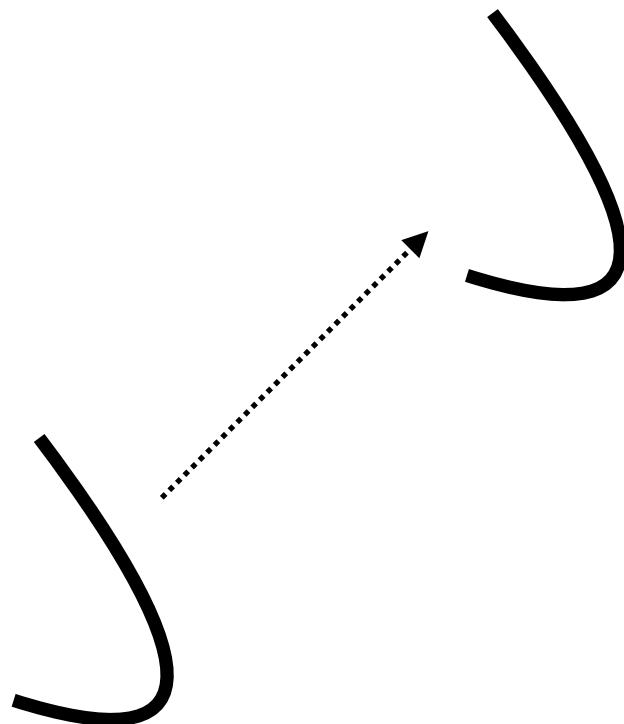


# Types of symmetry

Reflectional symmetry

Rotational symmetry

Translational symmetry



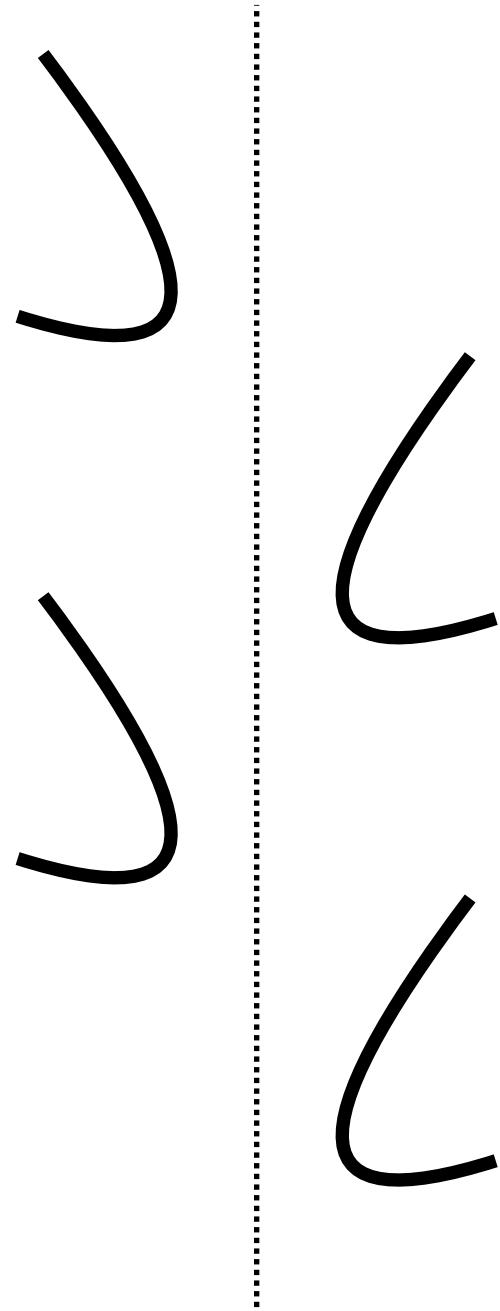
# Types of symmetry

Reflectional symmetry

Rotational symmetry

Translational symmetry

Glide reflection symmetry



# Types of symmetry

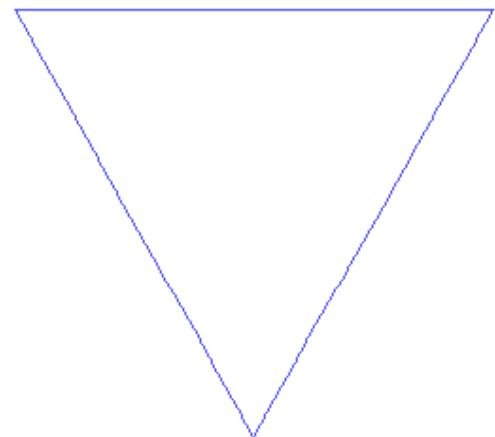
Reflectional symmetry

Rotational symmetry

Translational symmetry

Glide reflection symmetry

Scale symmetry, fractals and self symmetry

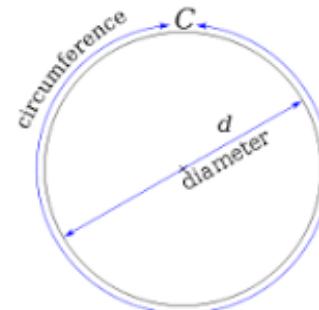


# **Golden Section**

# Numbers

$\pi$

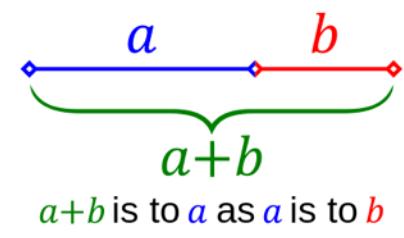
3.1415926535...



$\Phi$

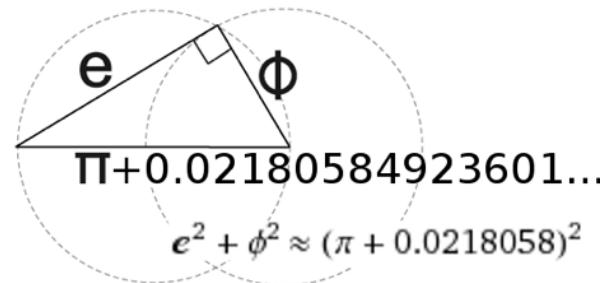
1.6180339887...

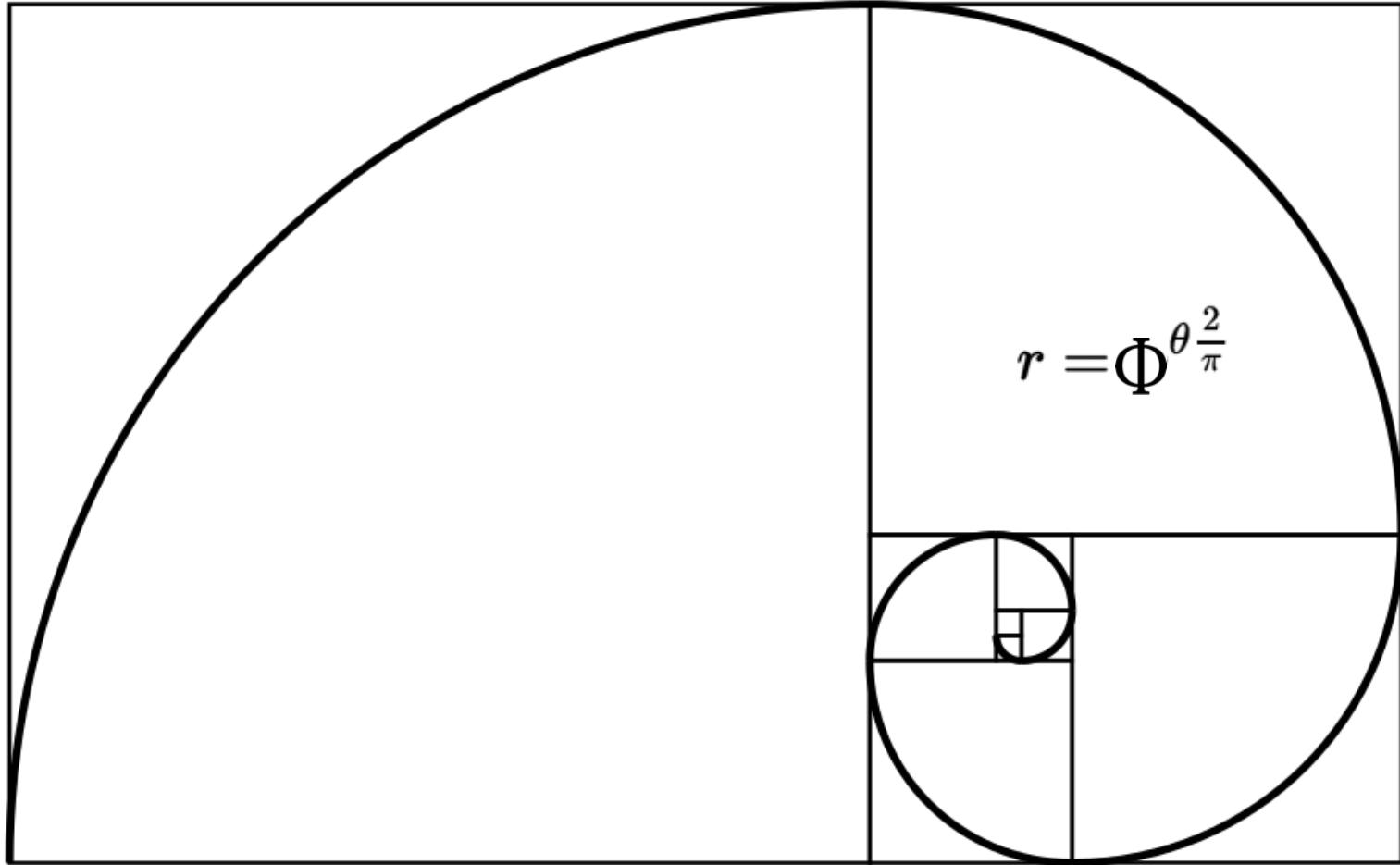
## The Golden Section



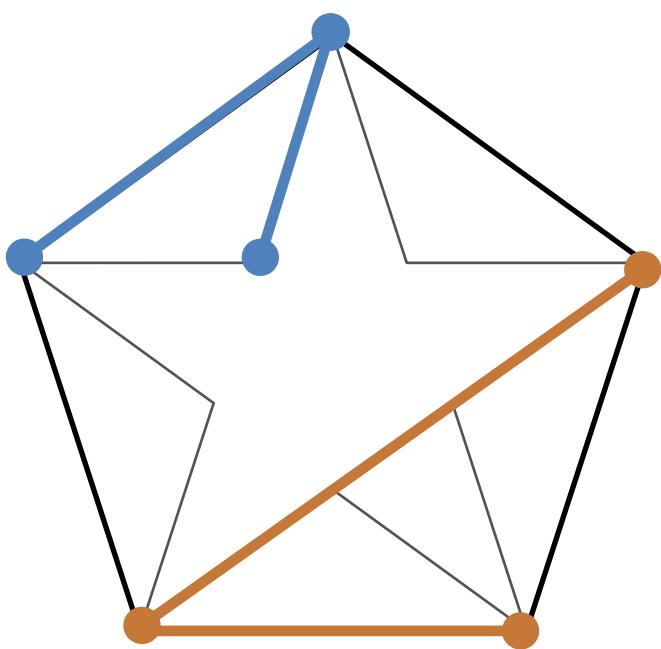
$e$

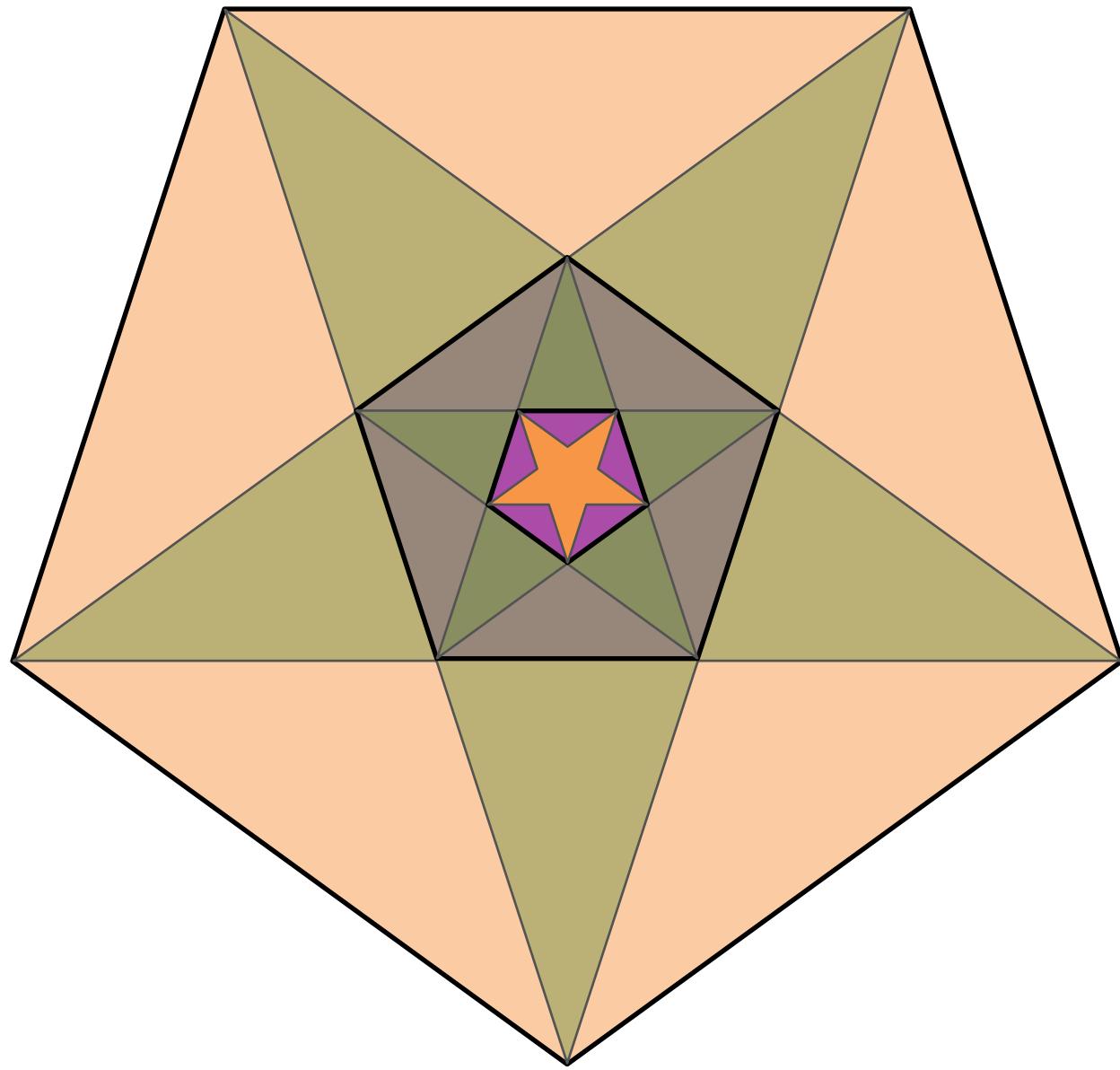
2.7182818284...

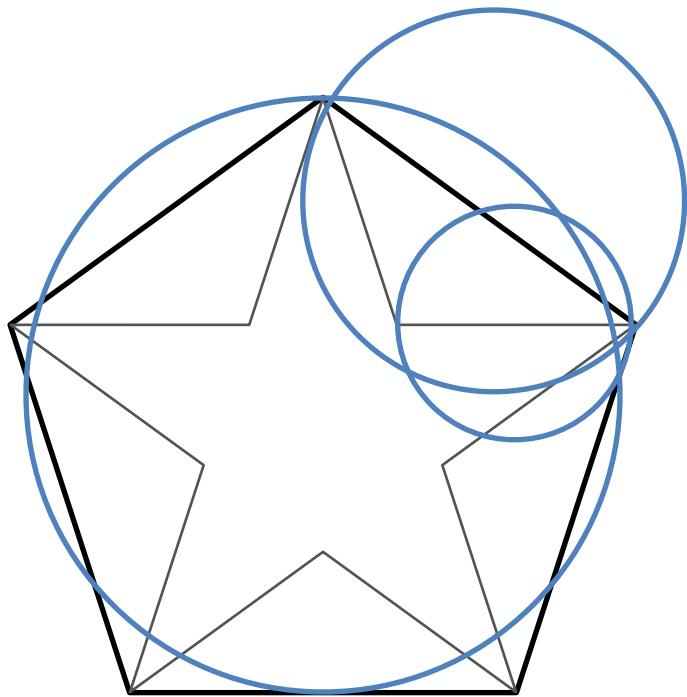


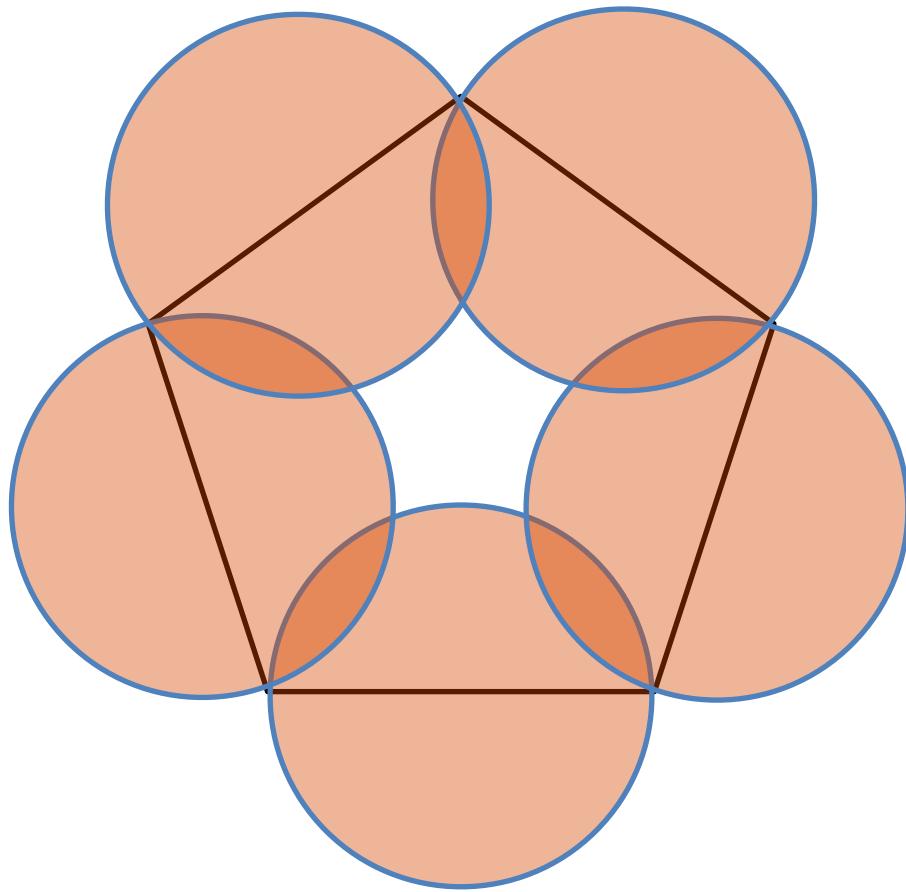


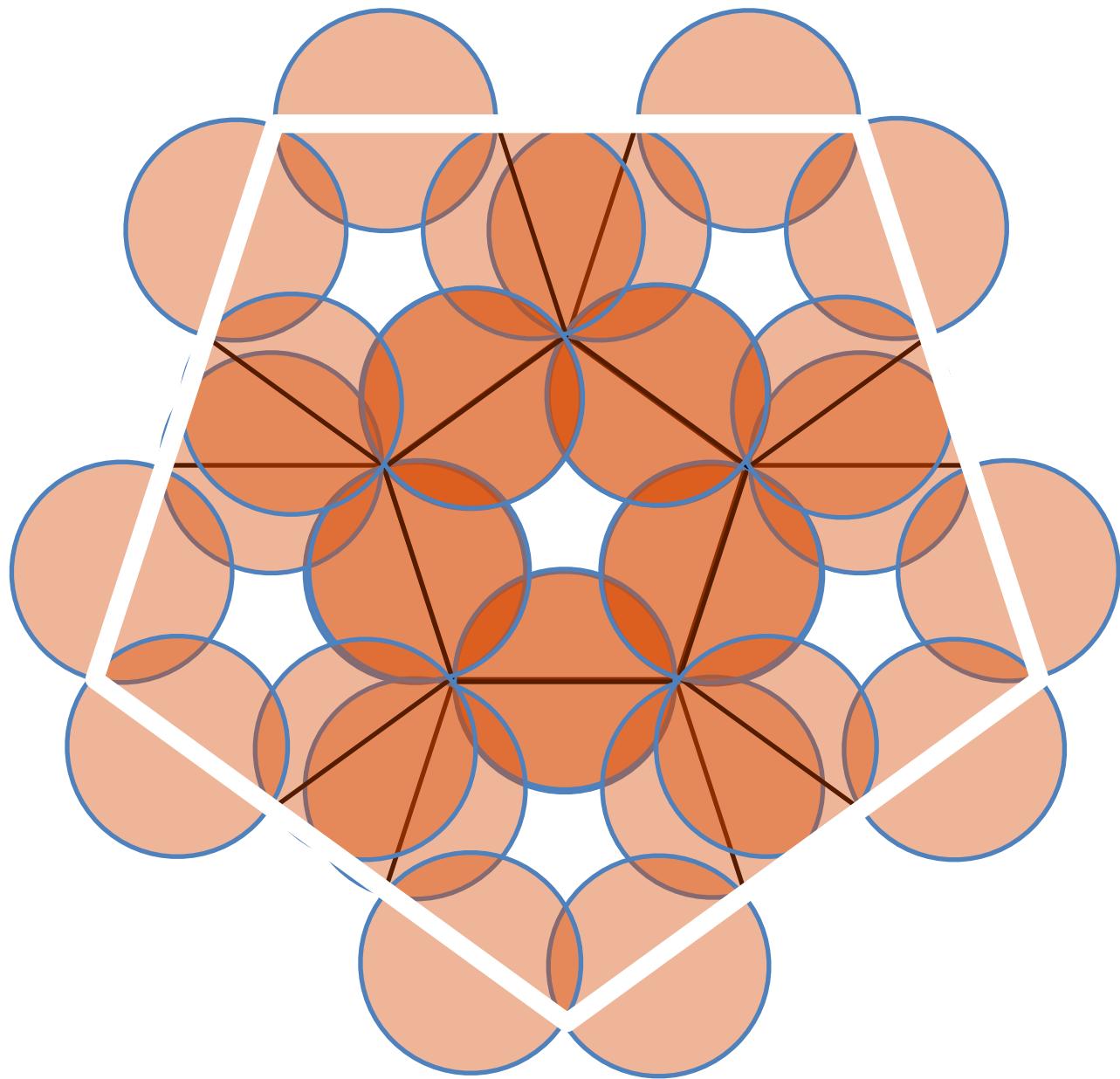
Fibonacci spiral approximates the golden spiral - growth factor is  $\phi$



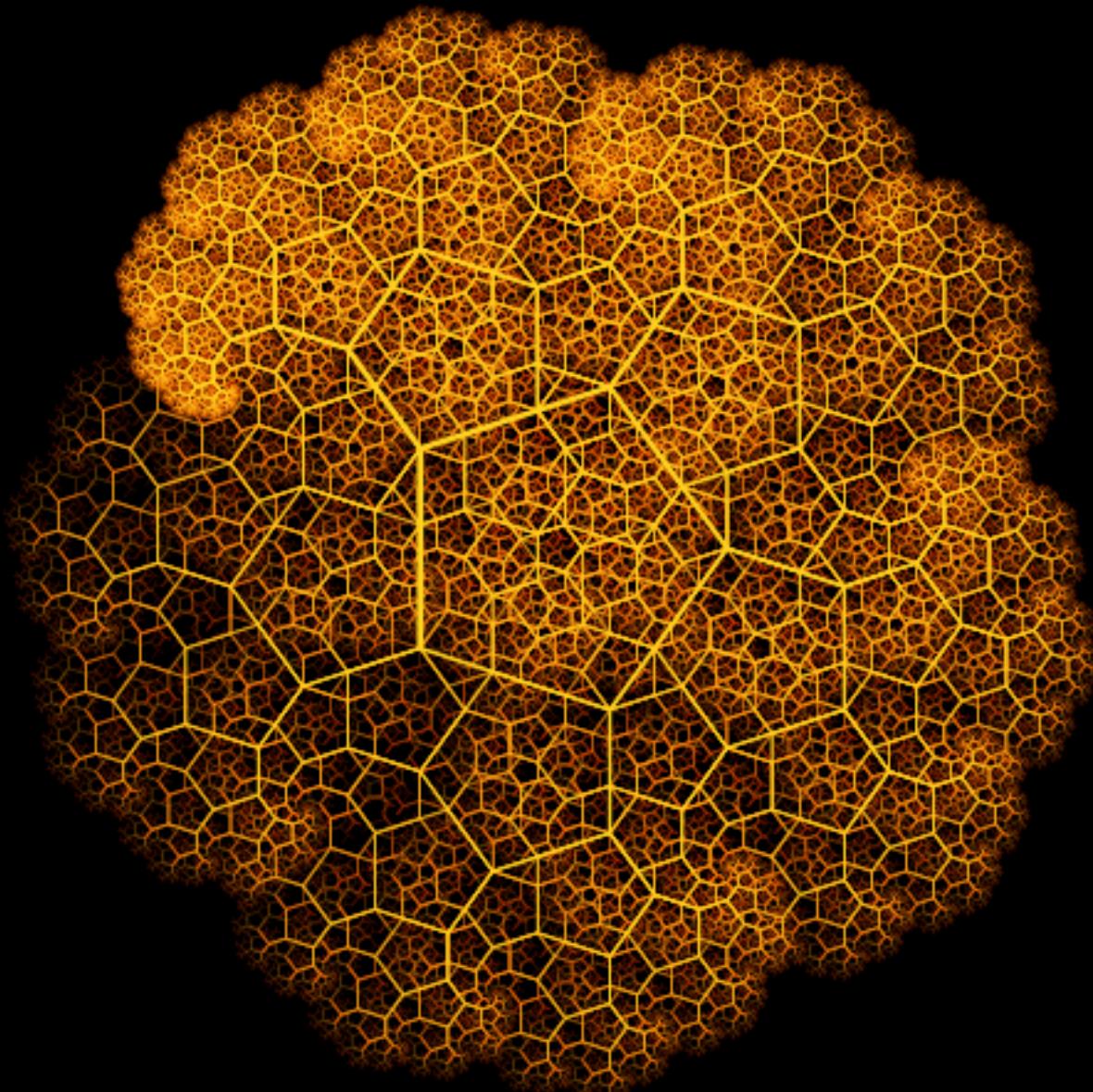








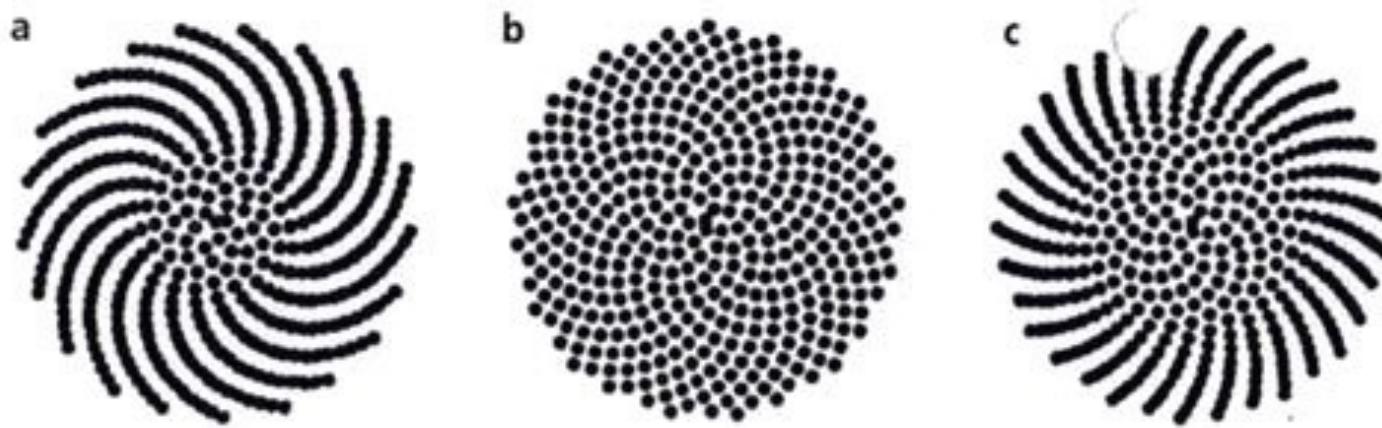
# Golden Ratio Fractal



<http://blog.wolfram.com/2014/05/22/adventures-into-the-mathematical-forest-of-fractal-trees/>

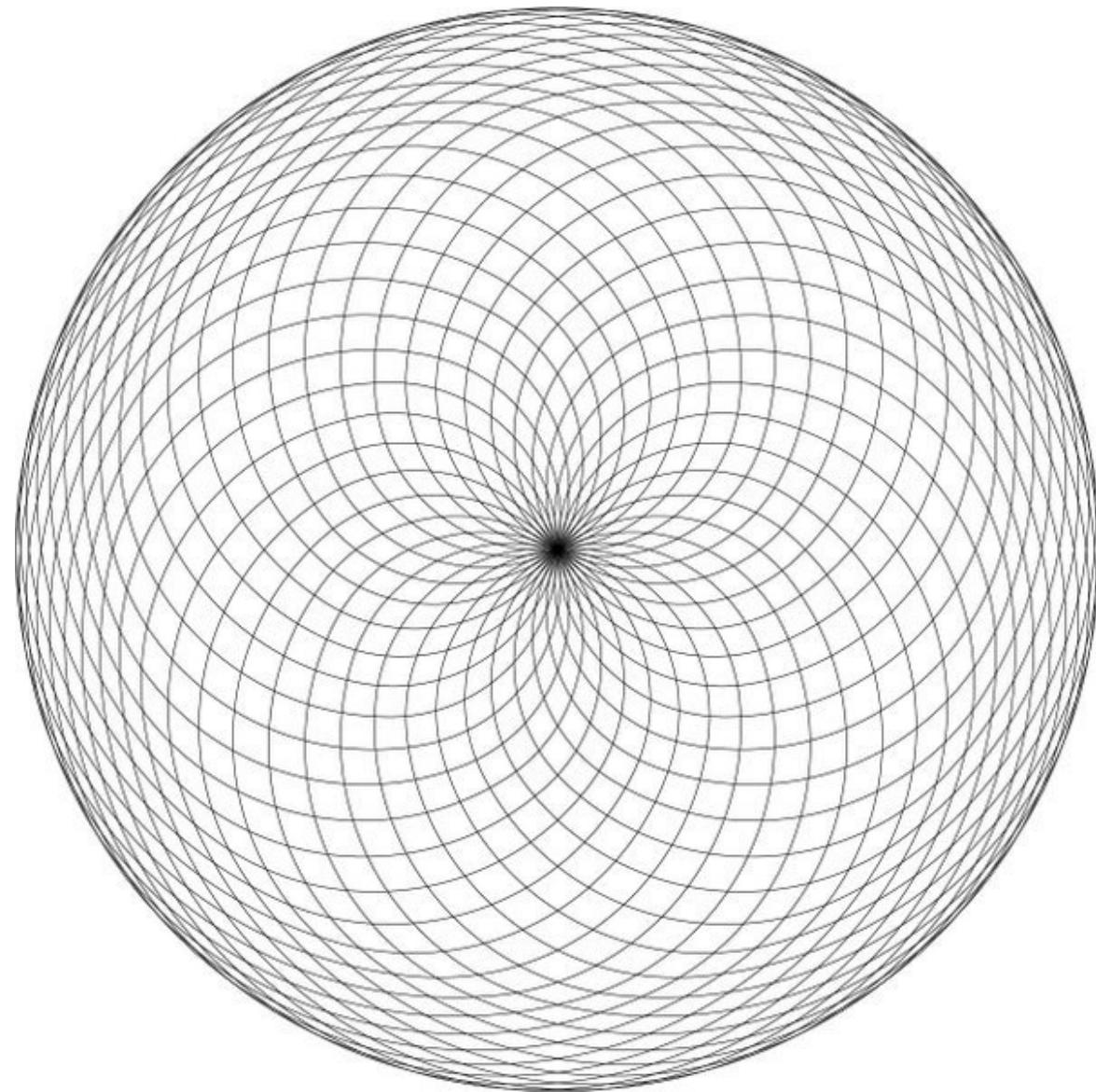
# Golden Angle = 137.5

$$\Phi = 1.6180339887\dots = 360 / 137.5$$

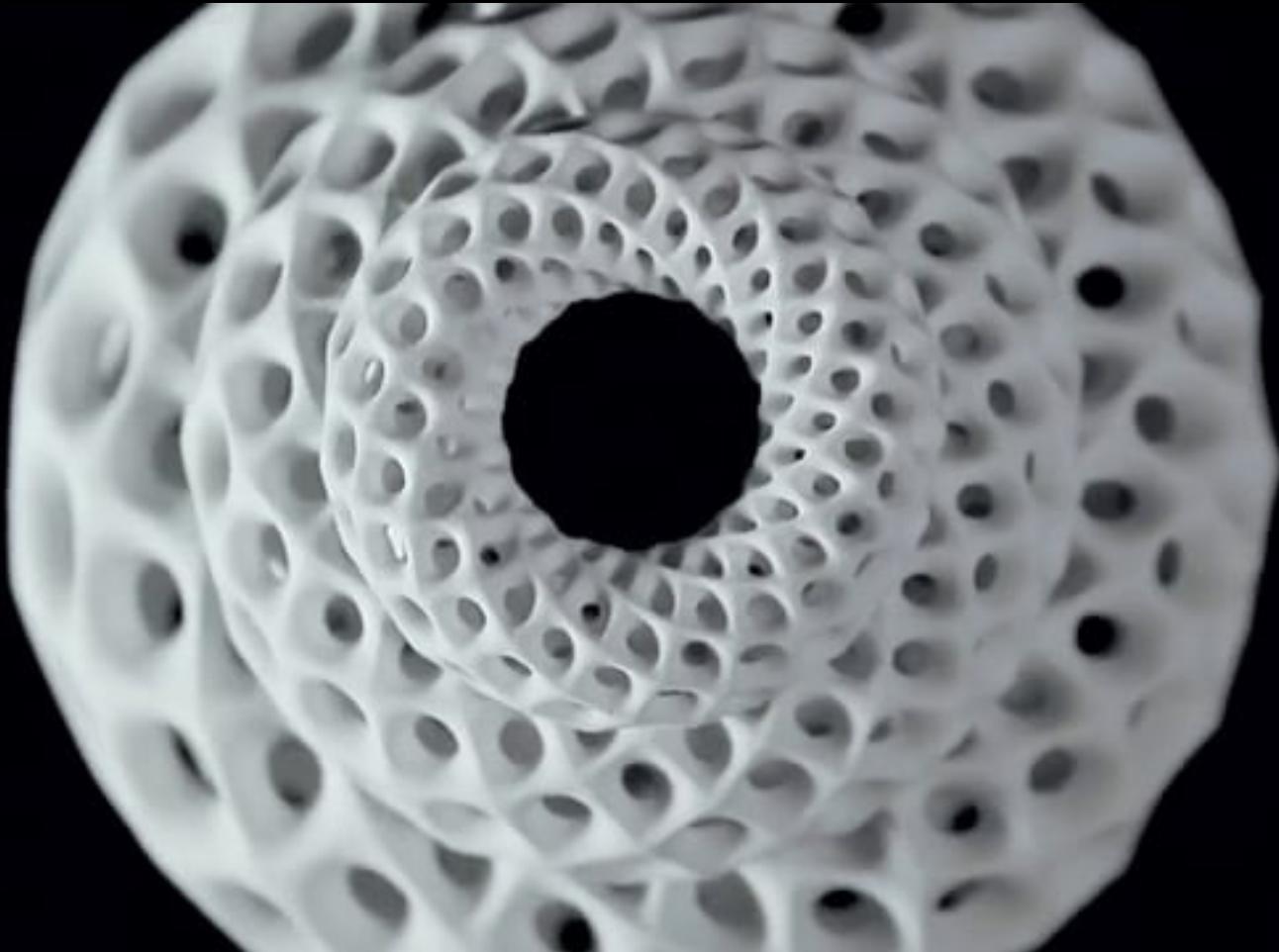


Packings created by divergence angles of (a)  $137.3^\circ$ , (b)  $137.5^\circ$  (golden angle) and (c)  $137.6^\circ$

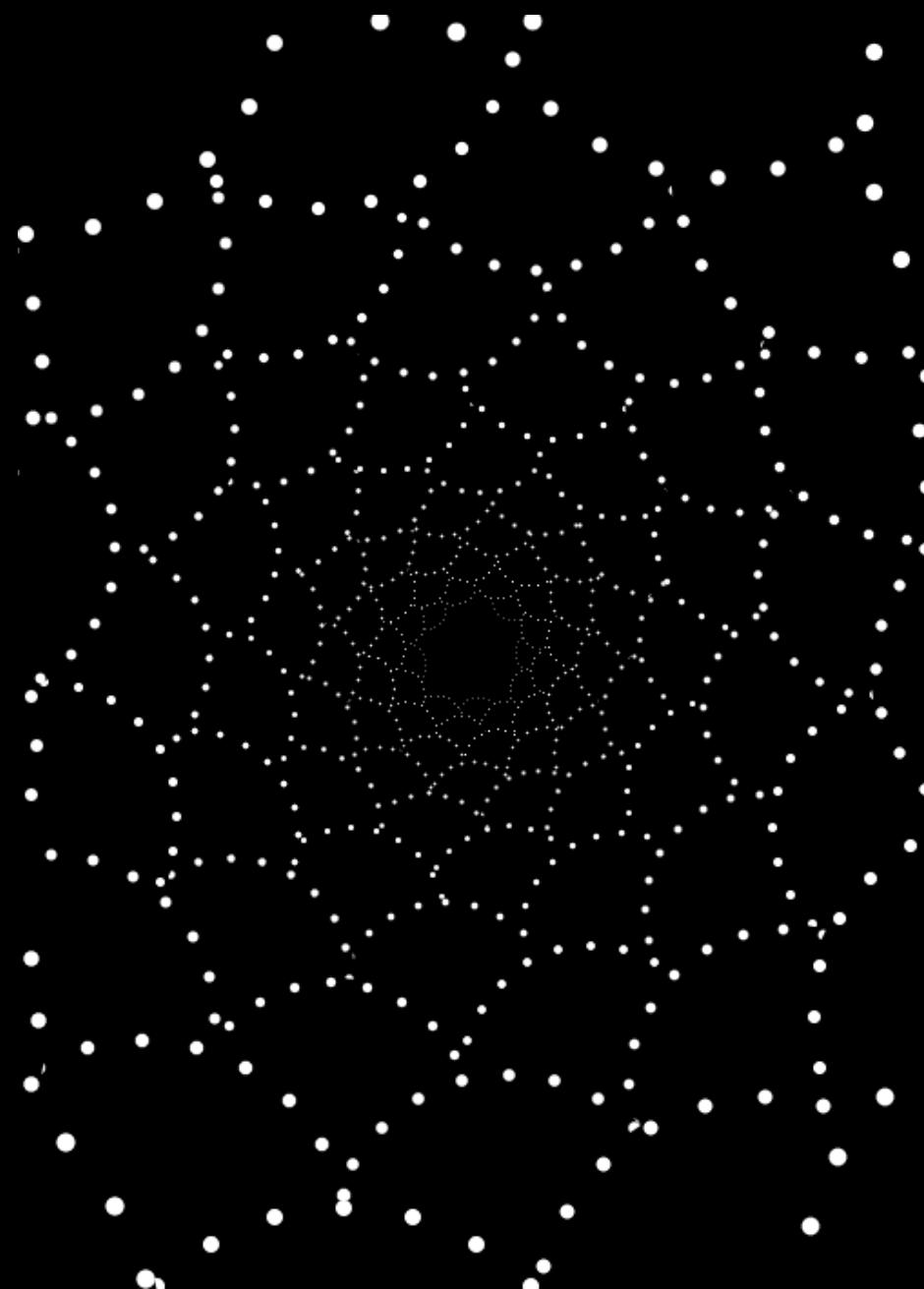
Figure by Dirk Bertels



Fibonacci spiral - sunflower

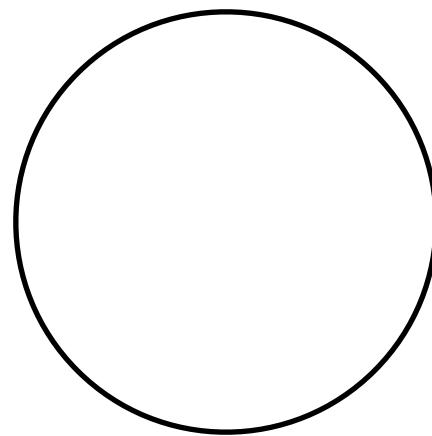


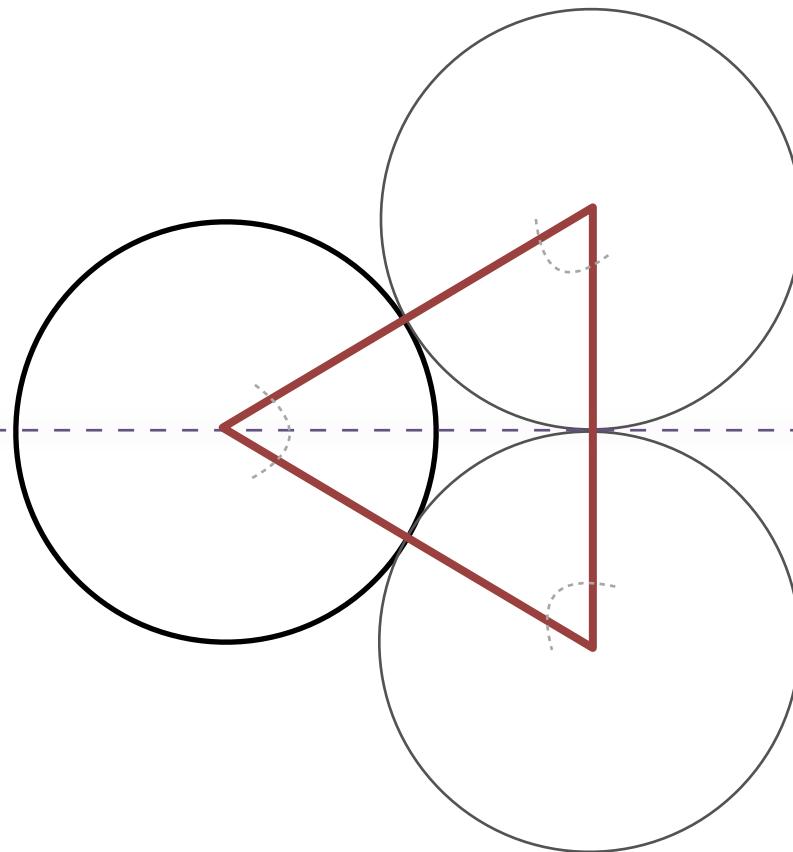
Blooms: Strobe Animated Sculptures Invented by John Edmark

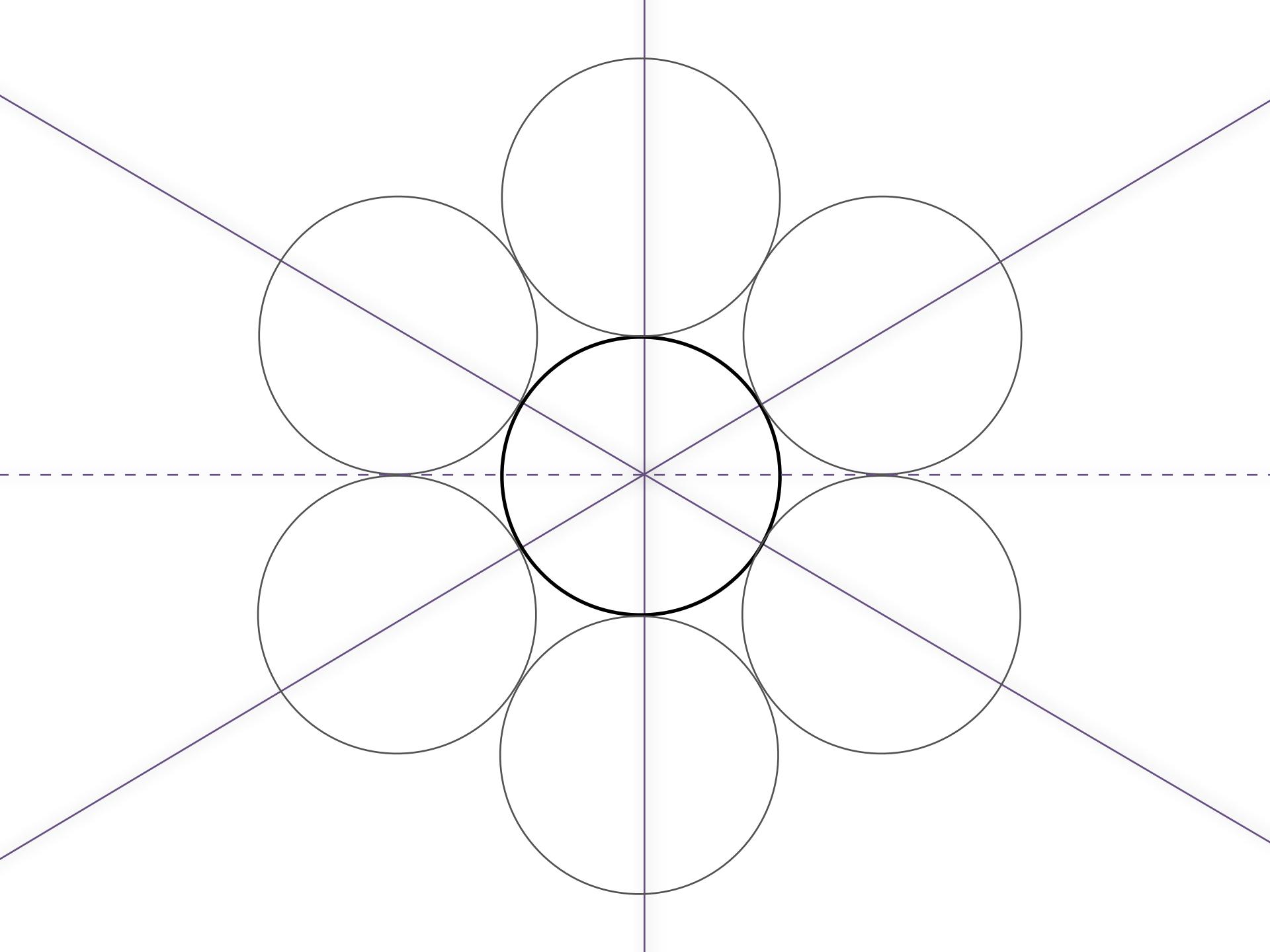


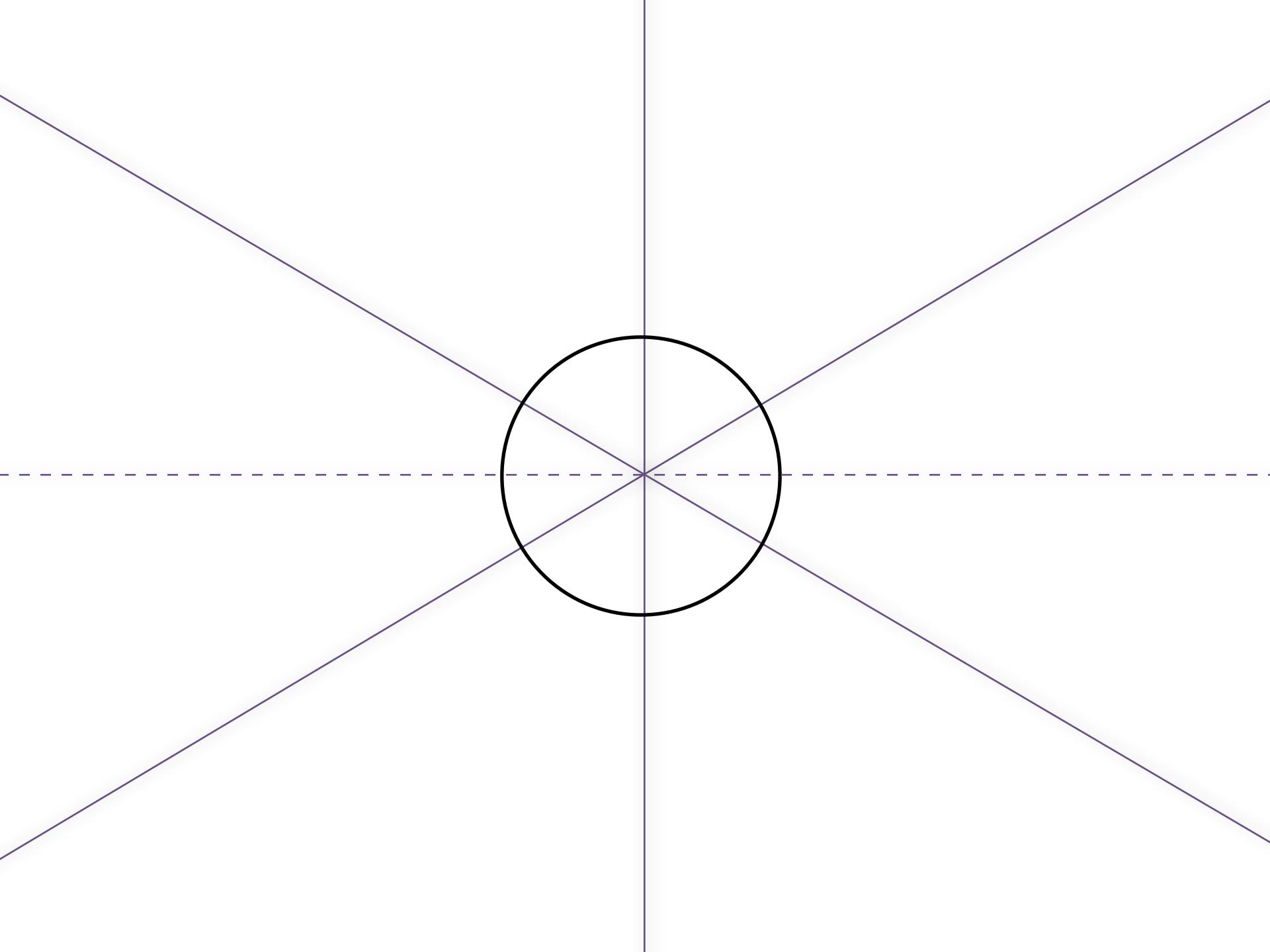


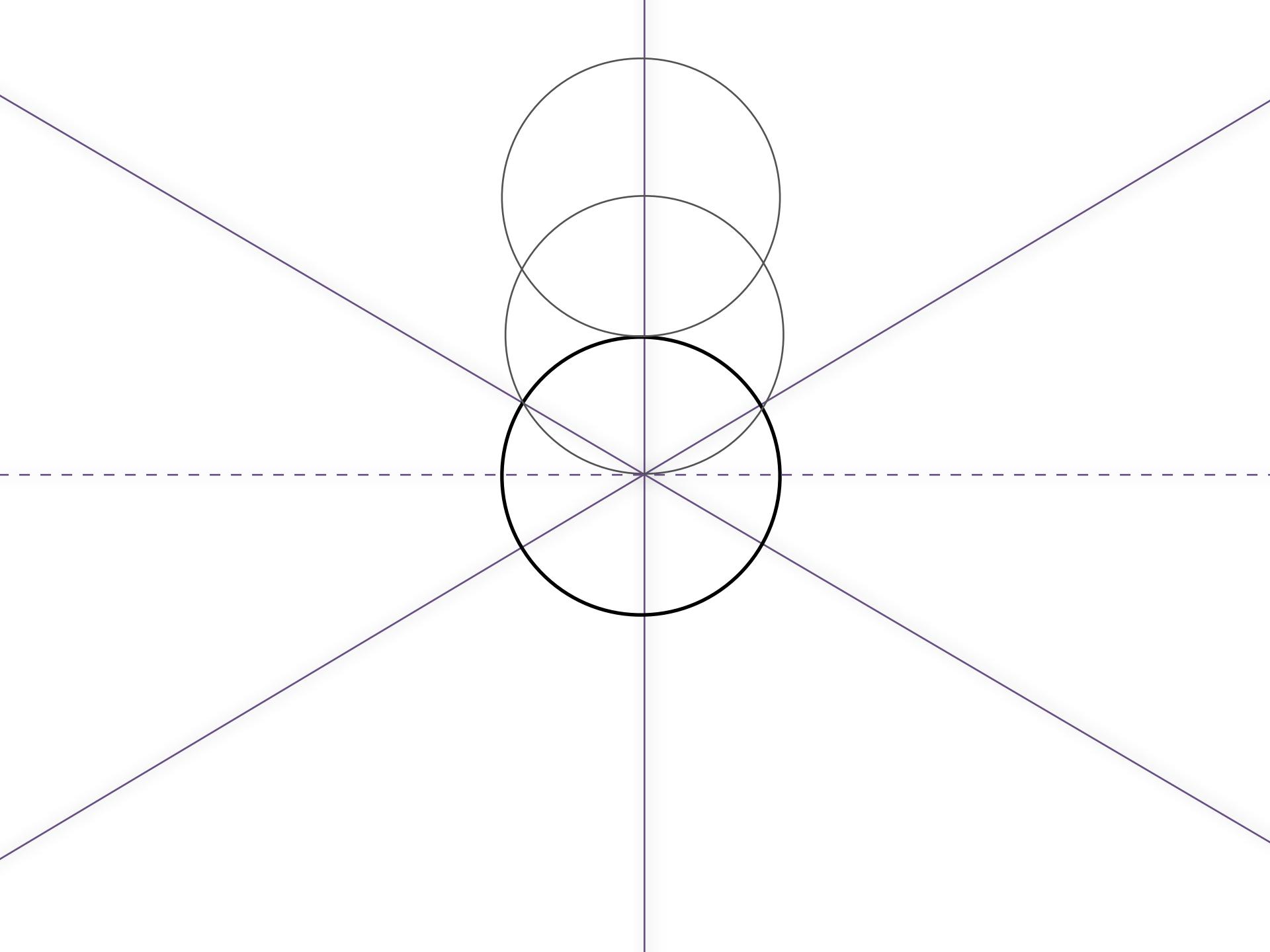
# **Sacred and Islamic Patterns & Tessellations**

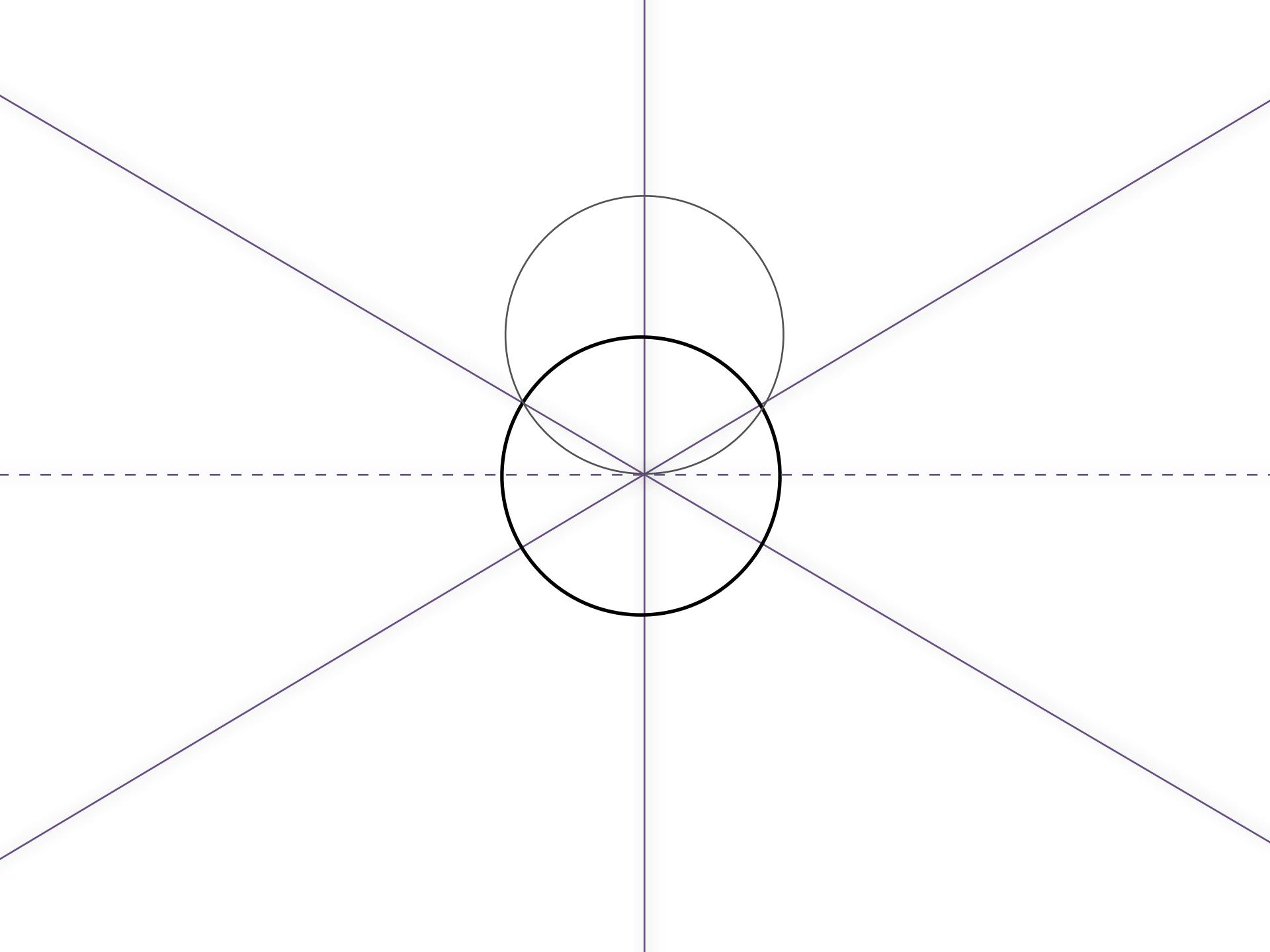


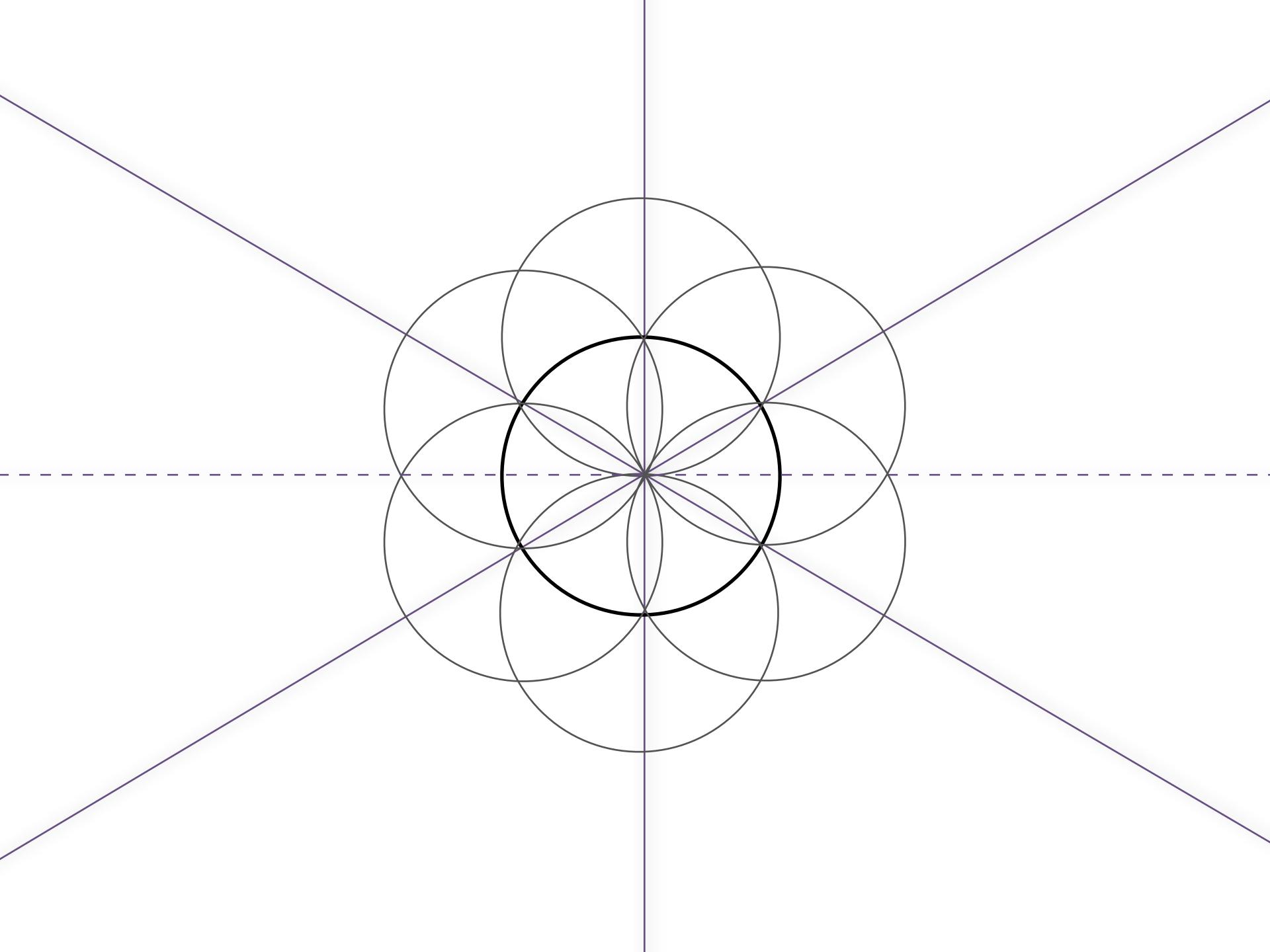


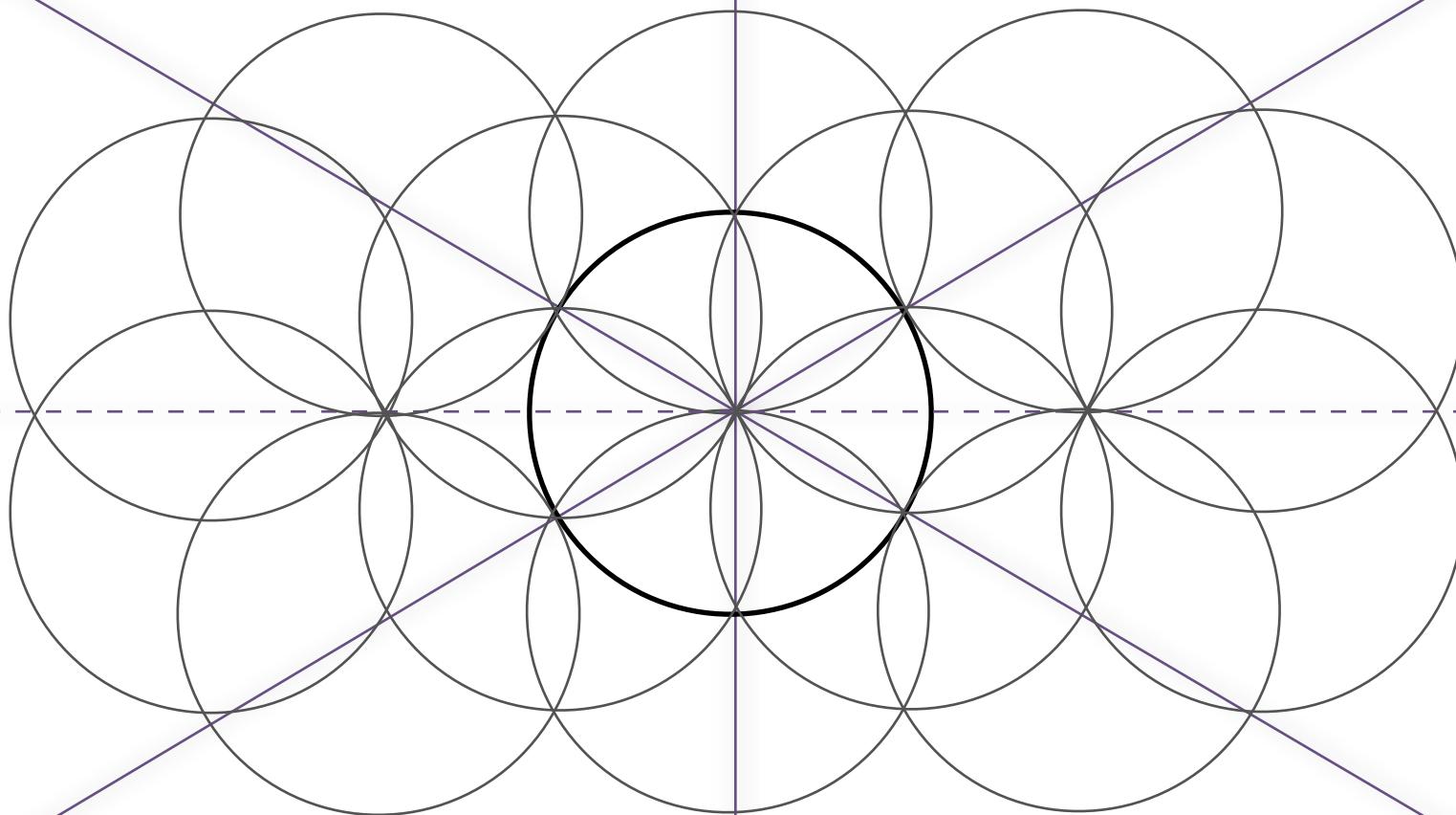


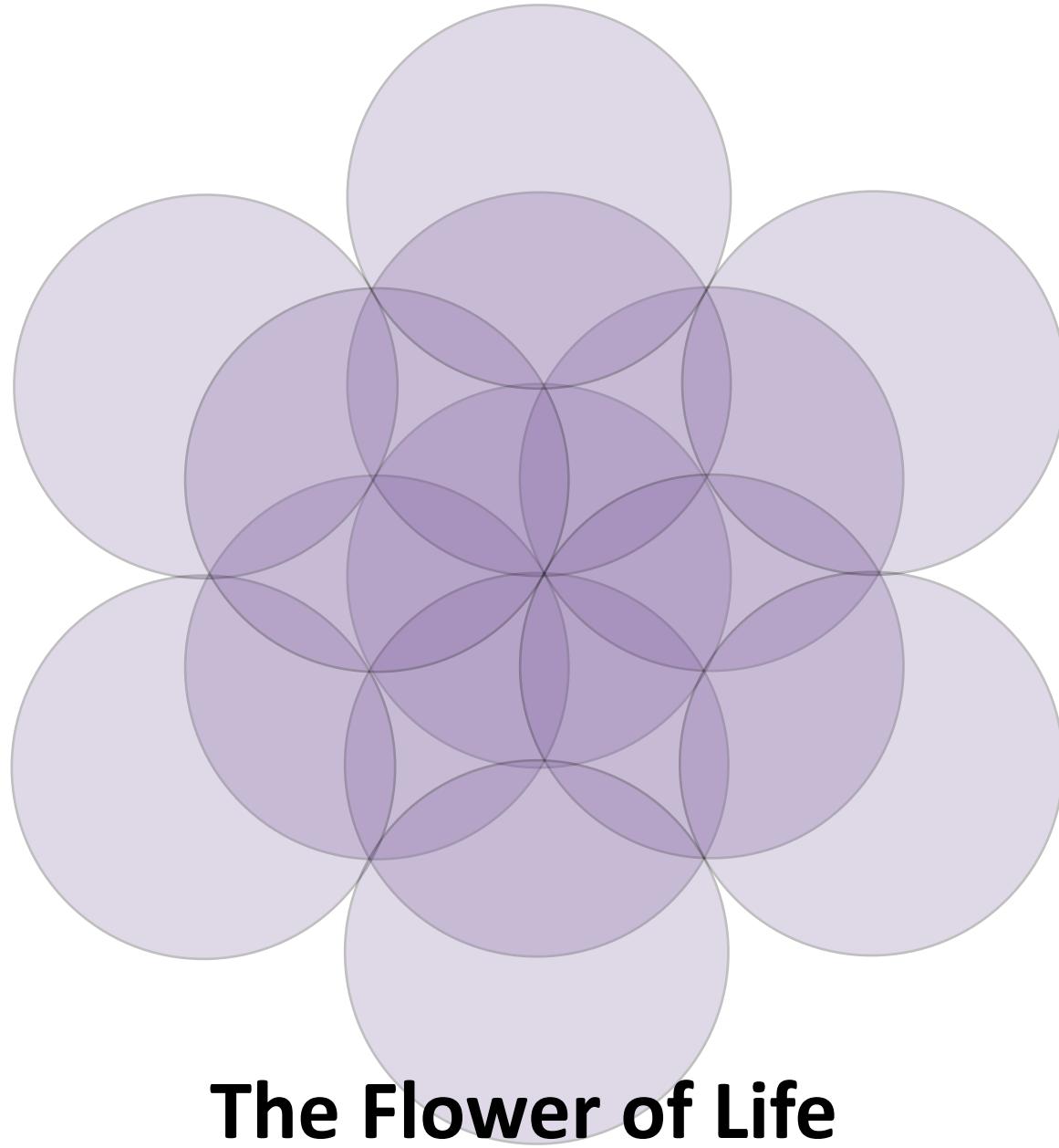




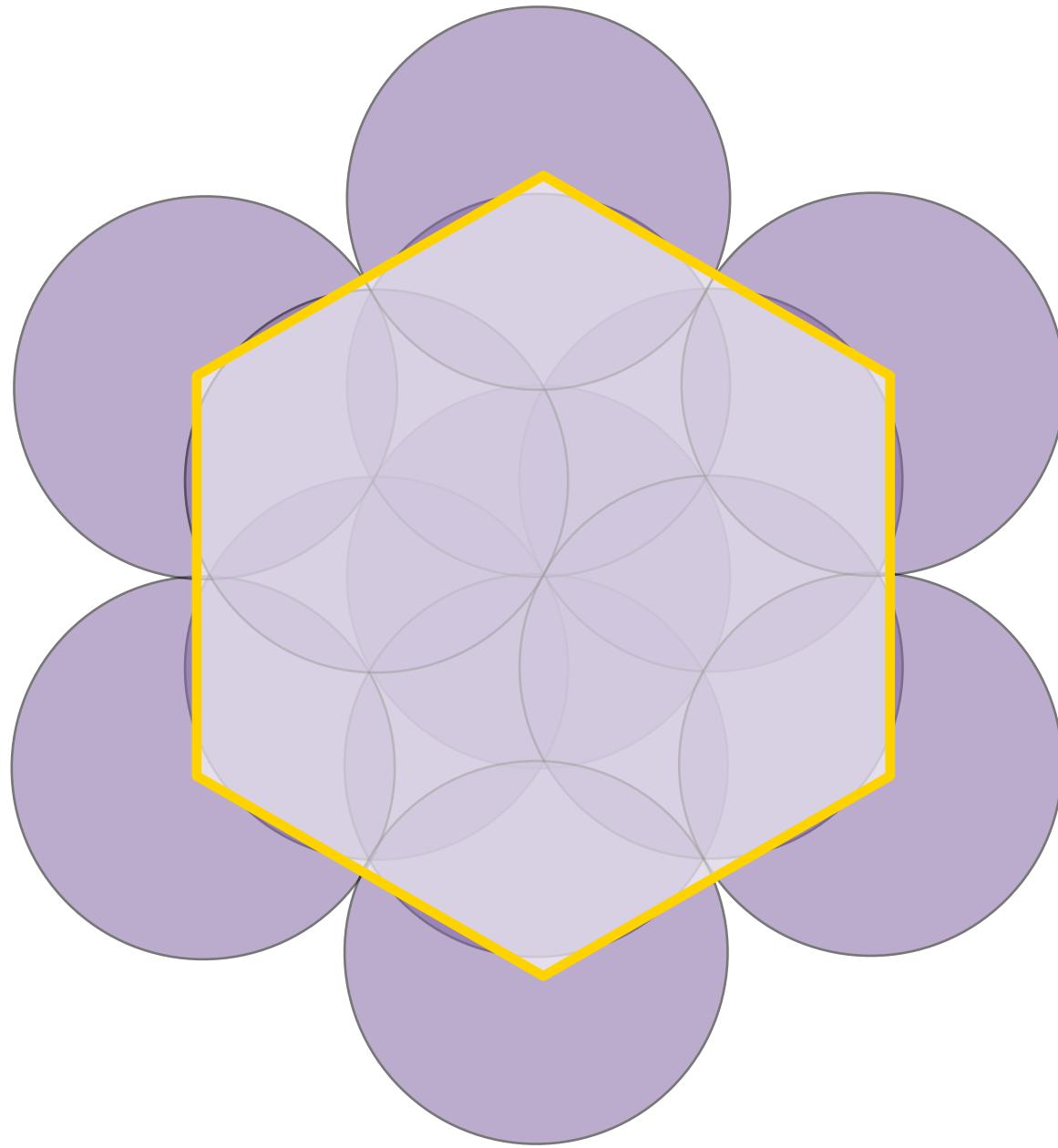


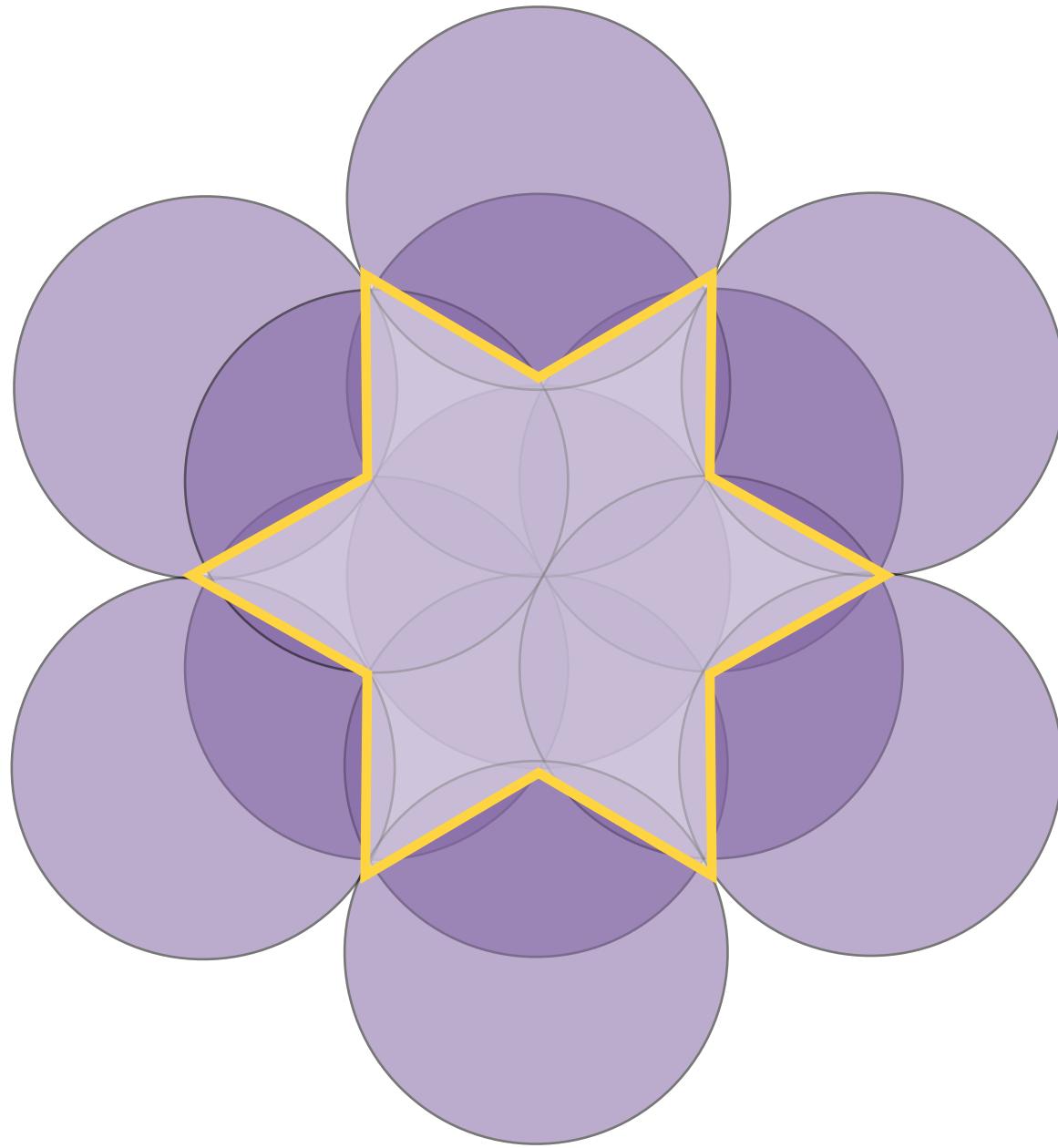


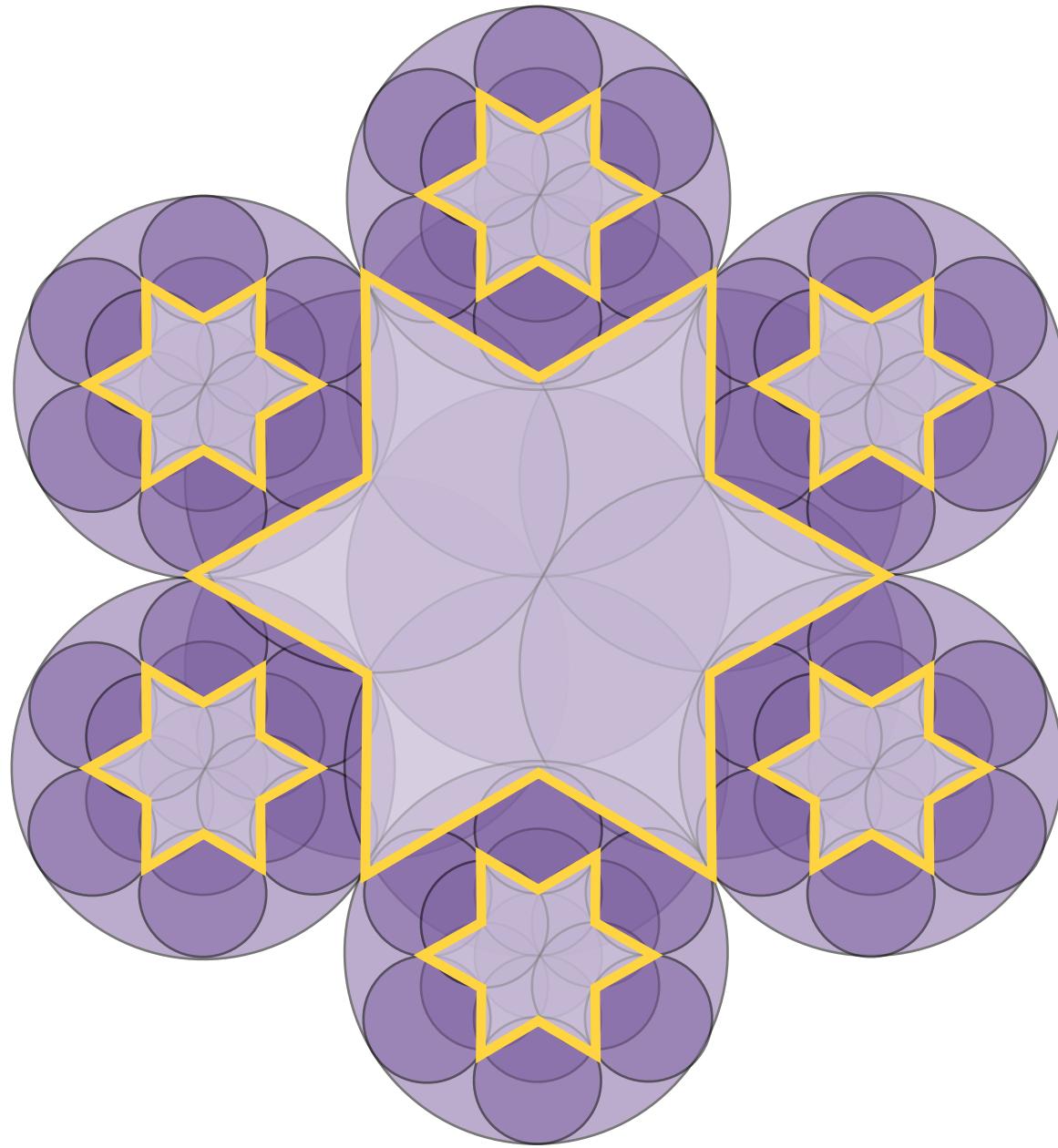


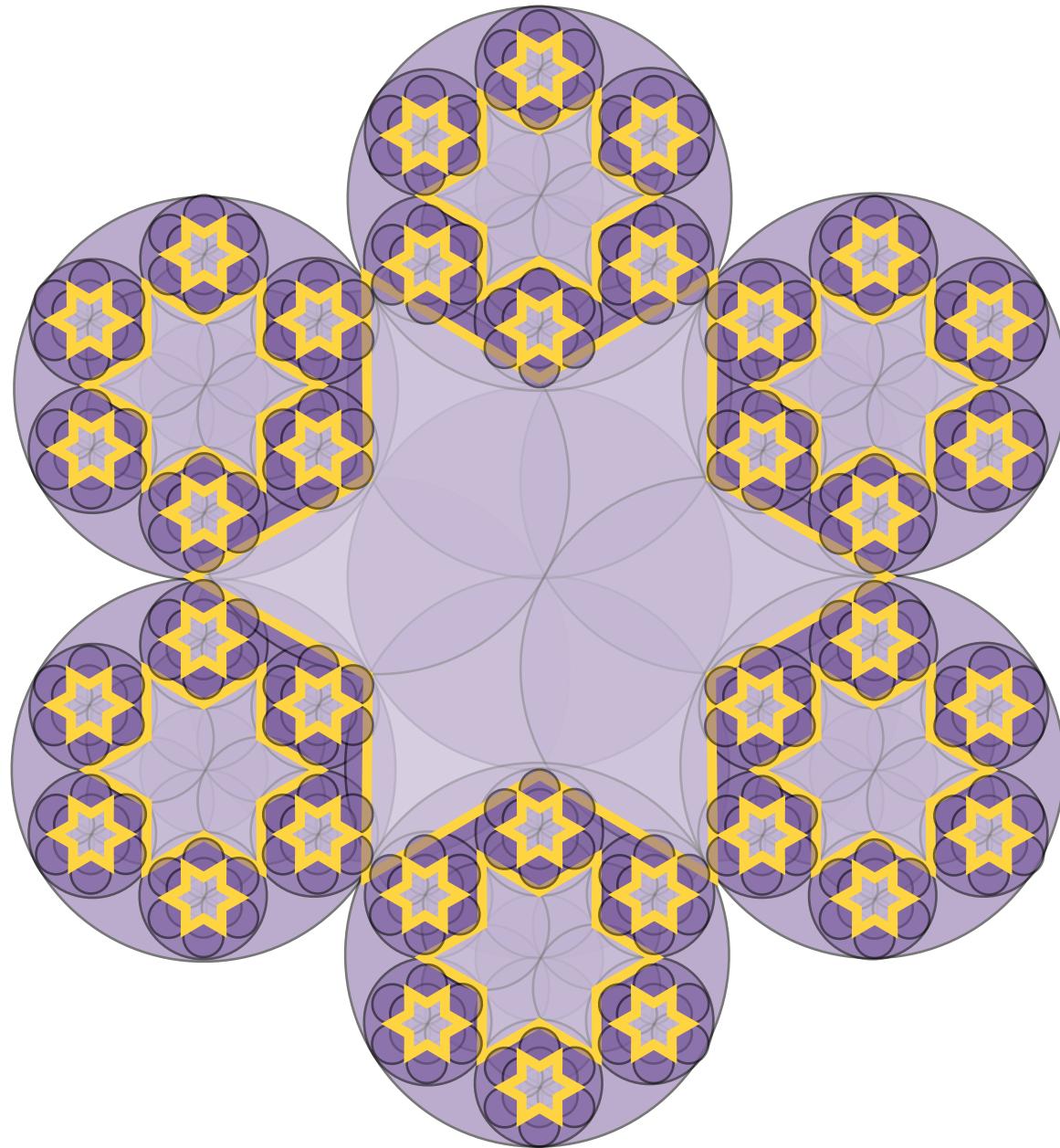


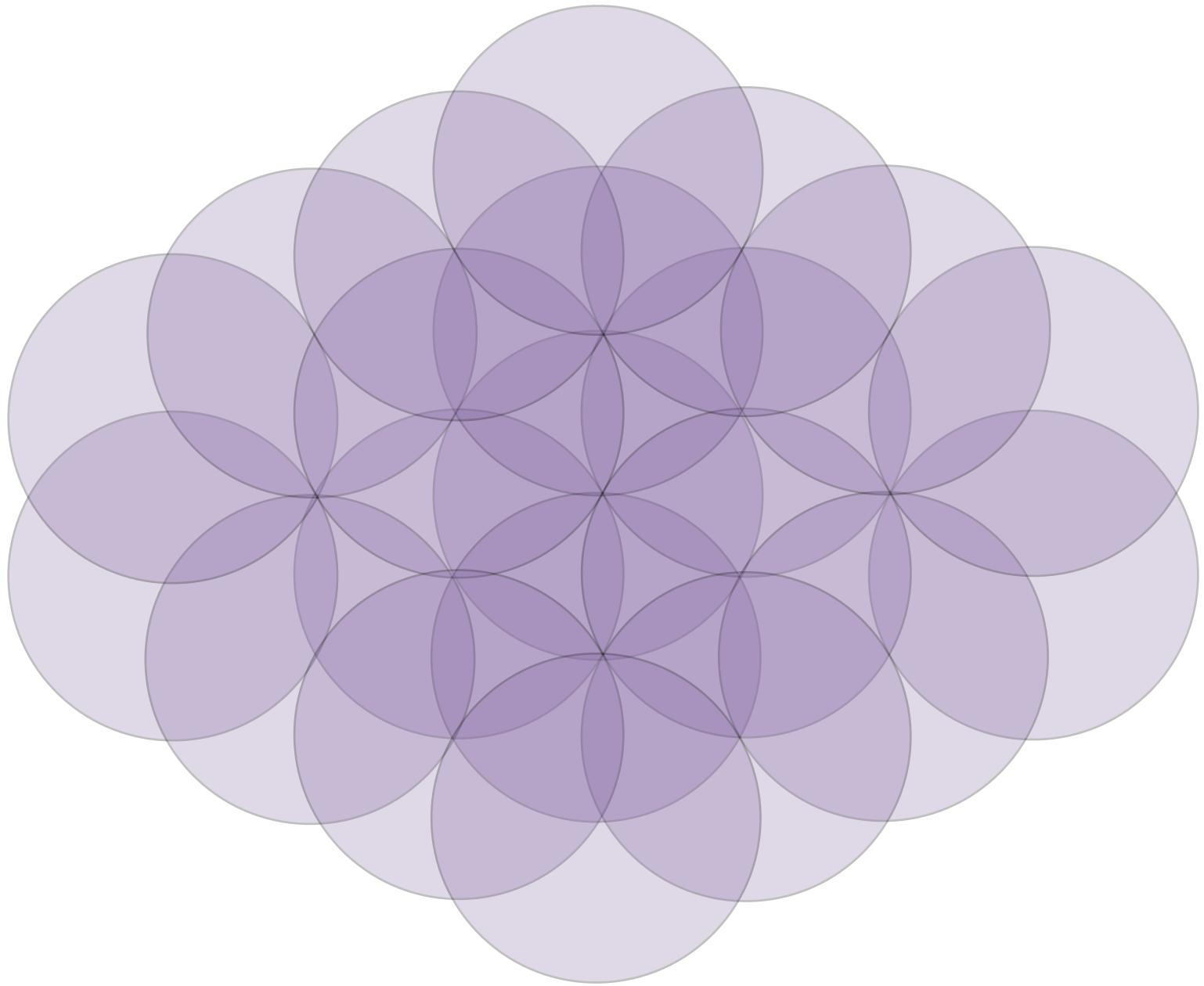
**The Flower of Life**

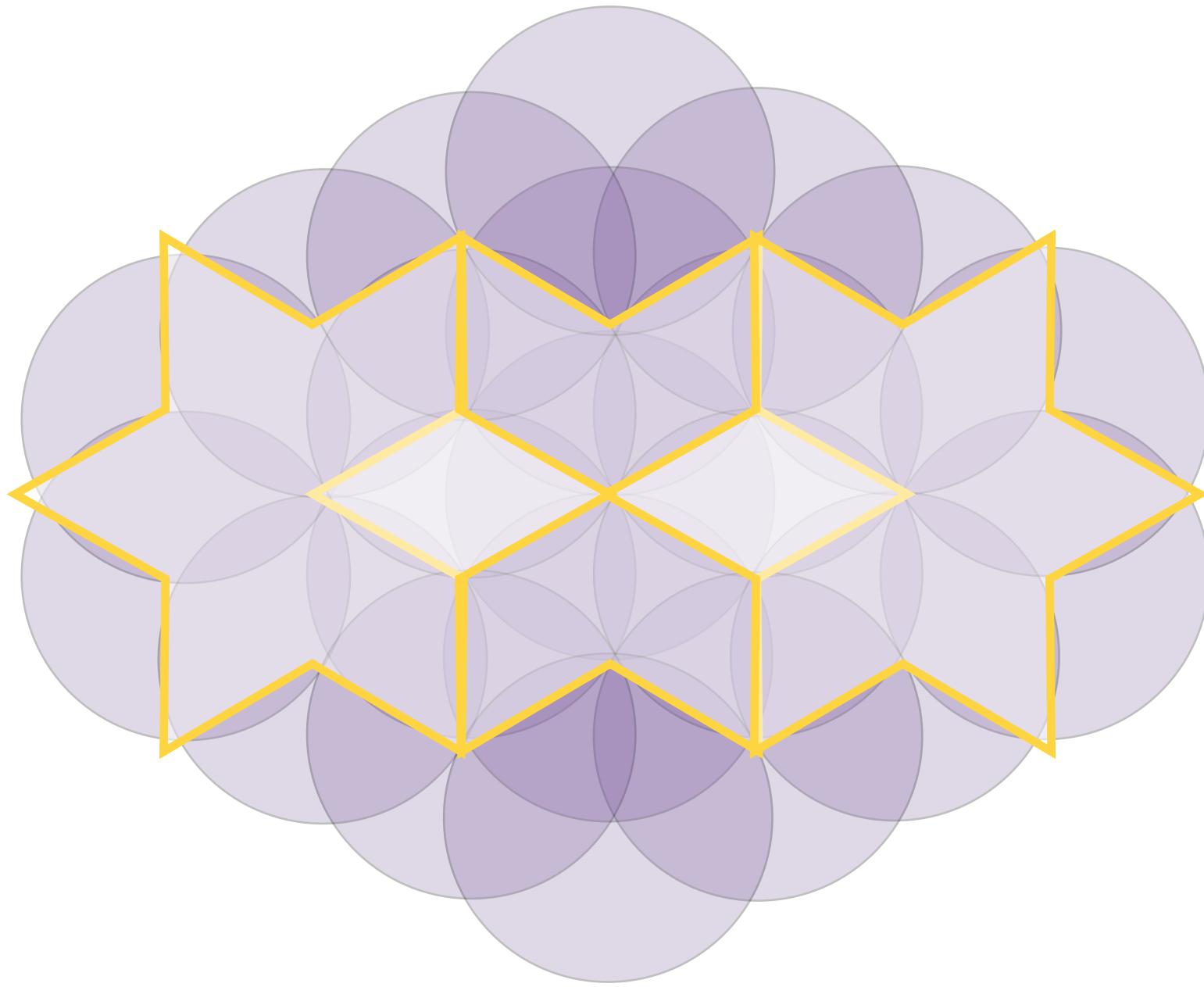


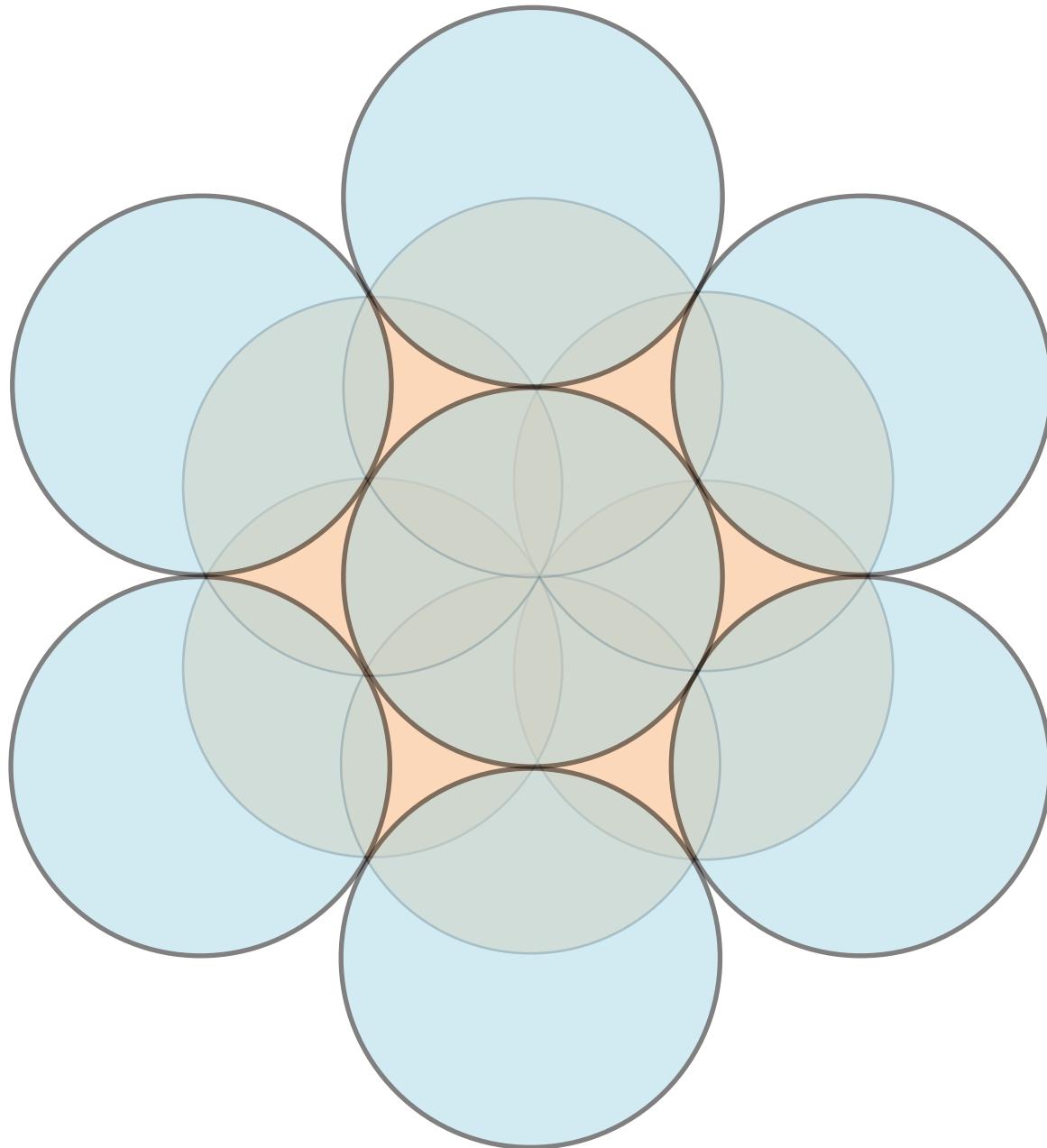


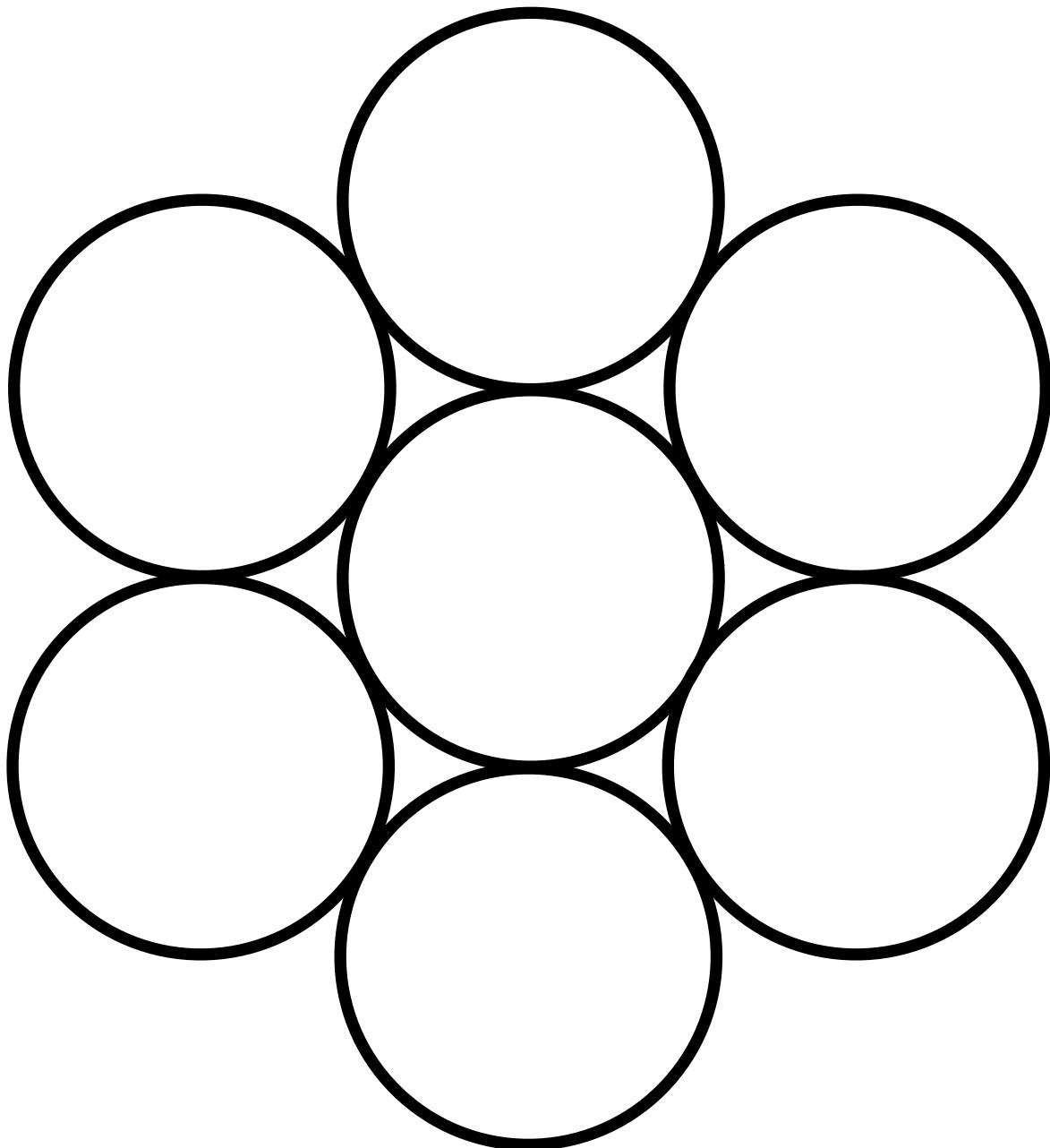


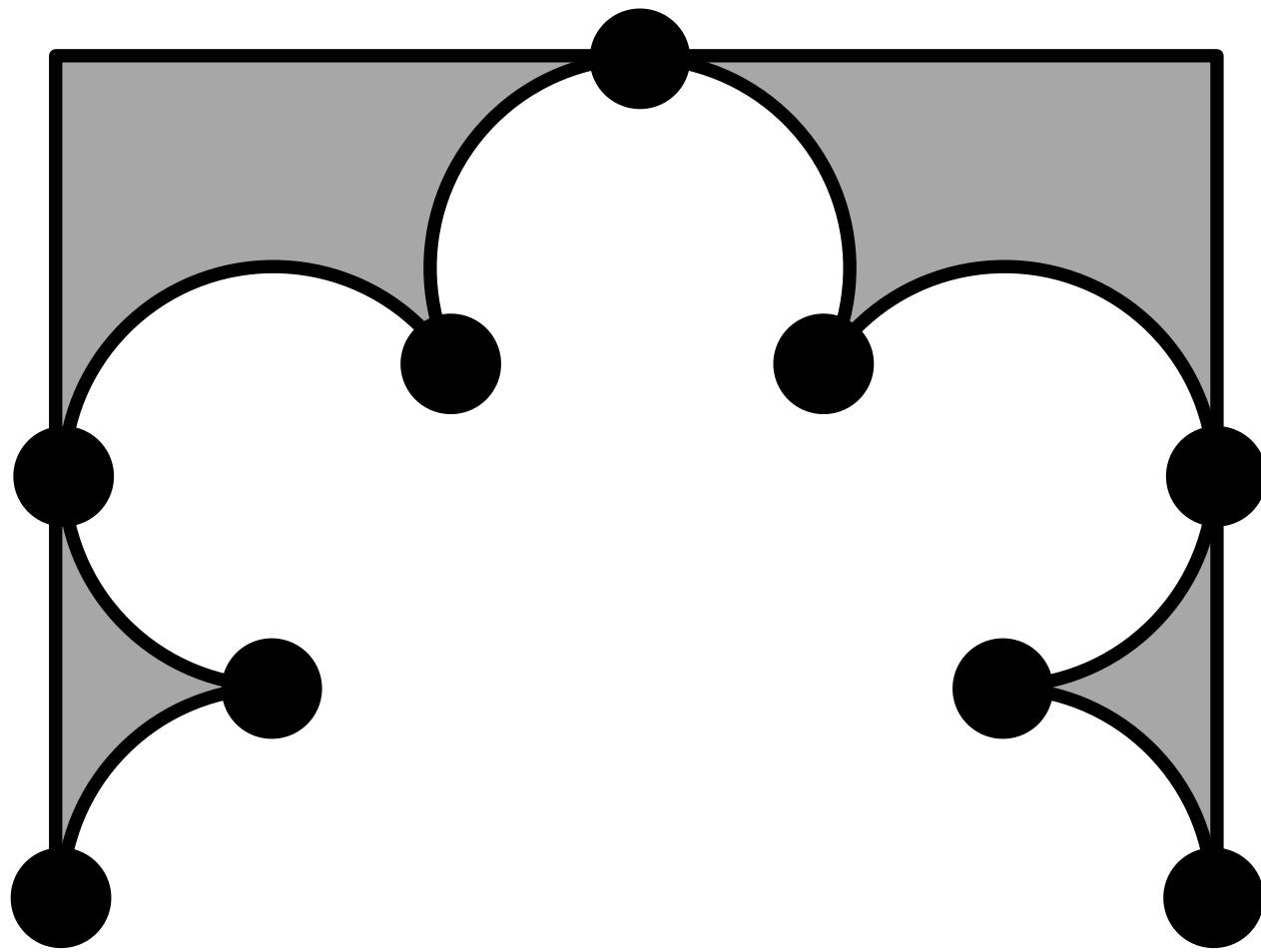




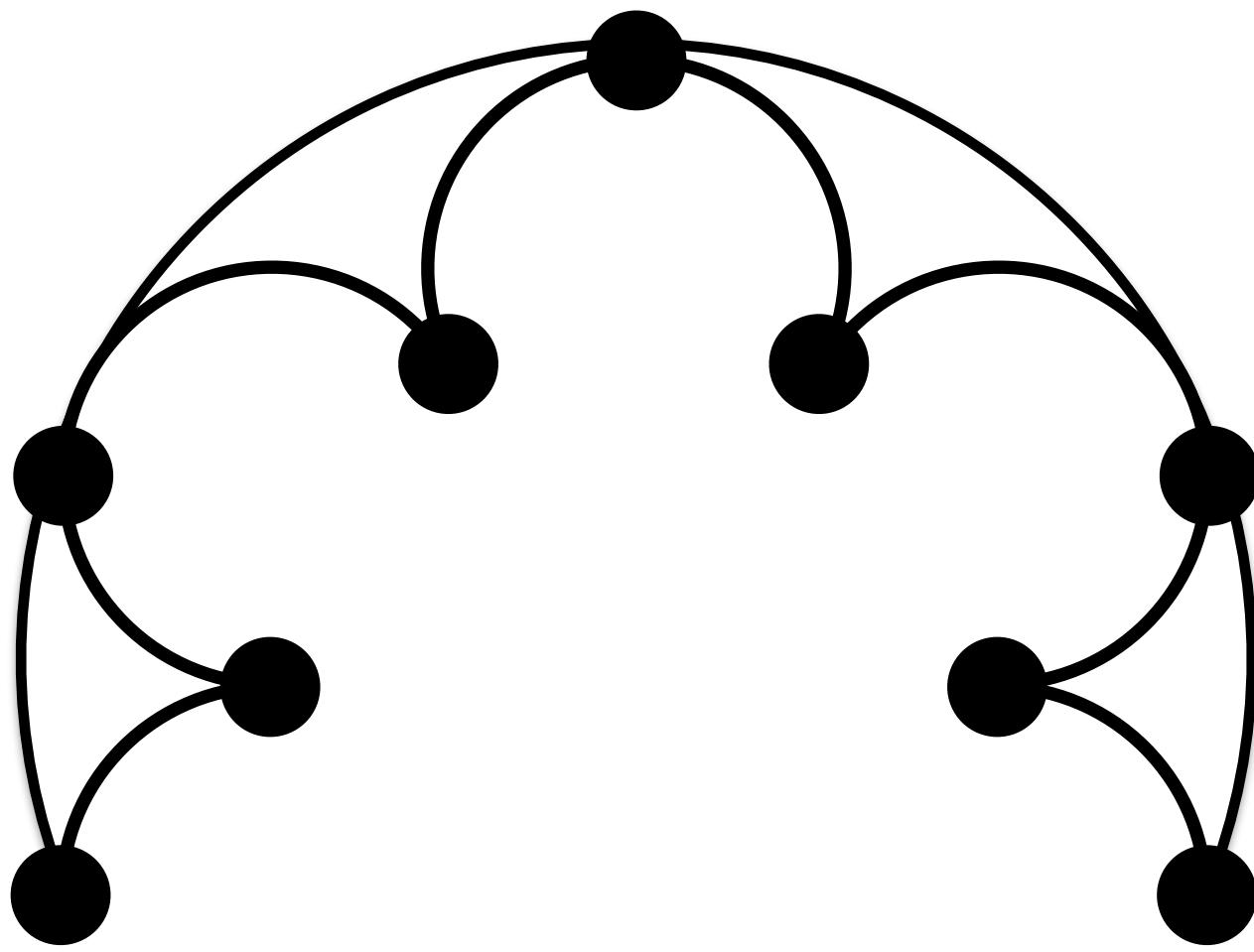




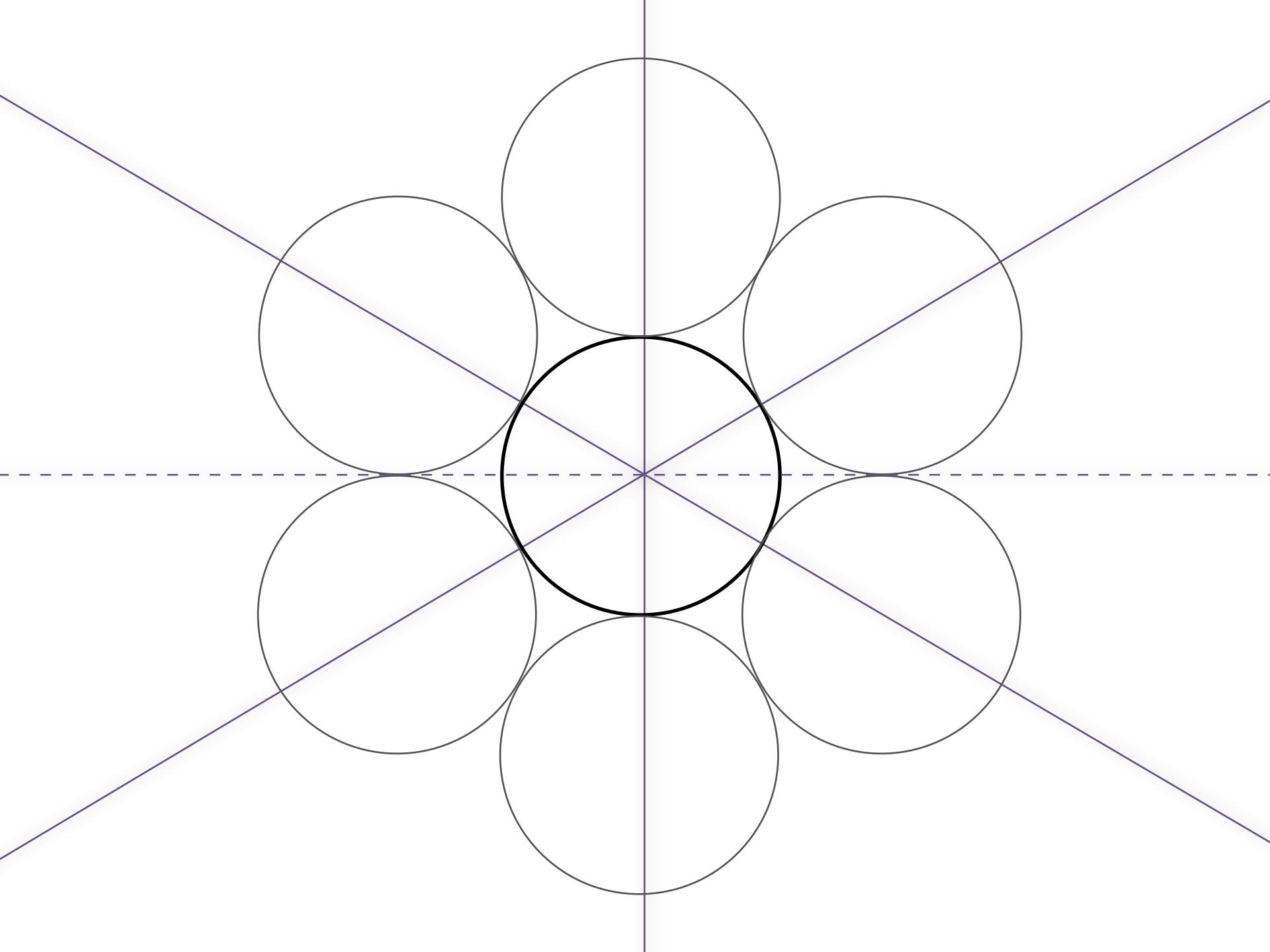


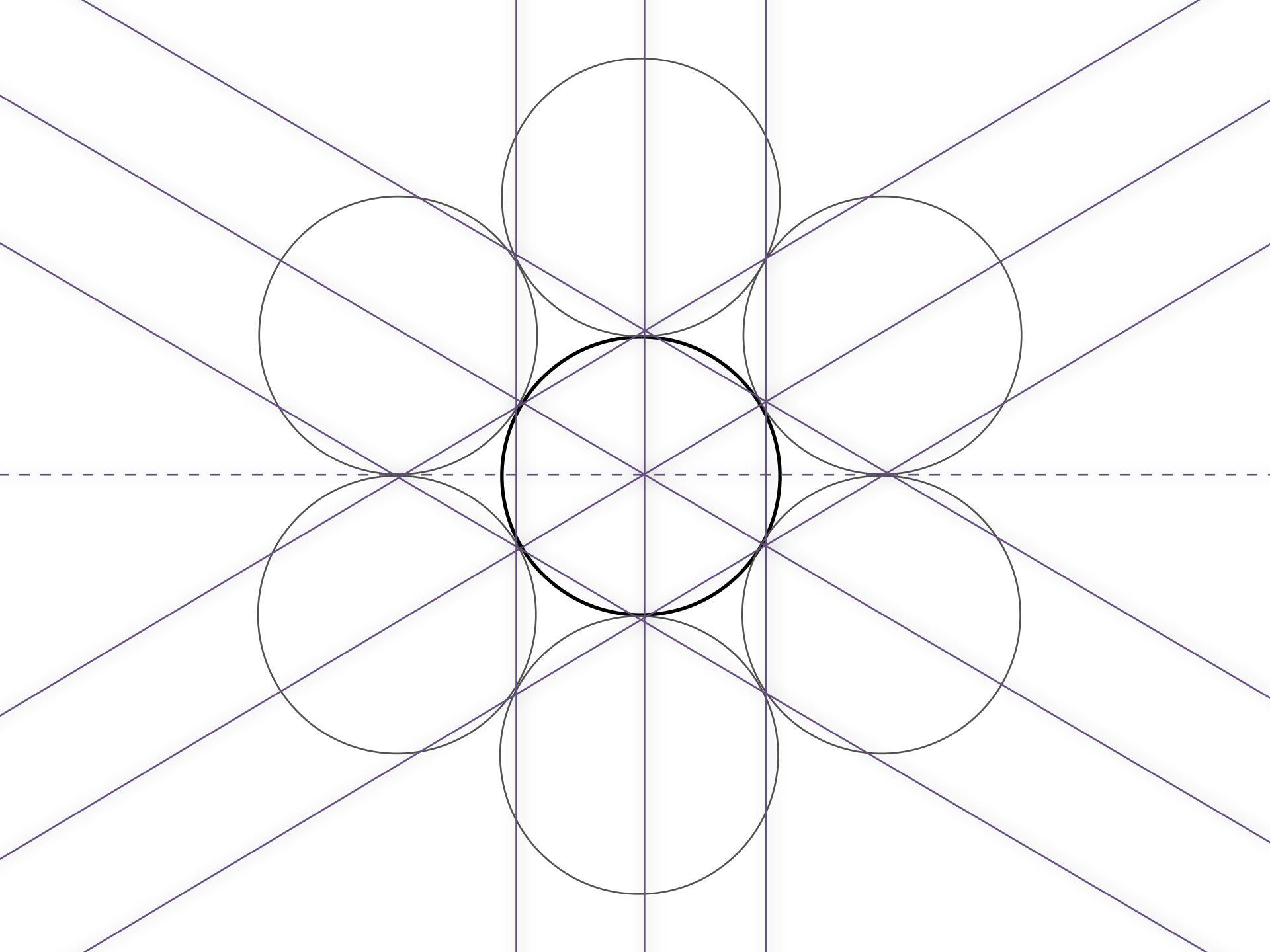


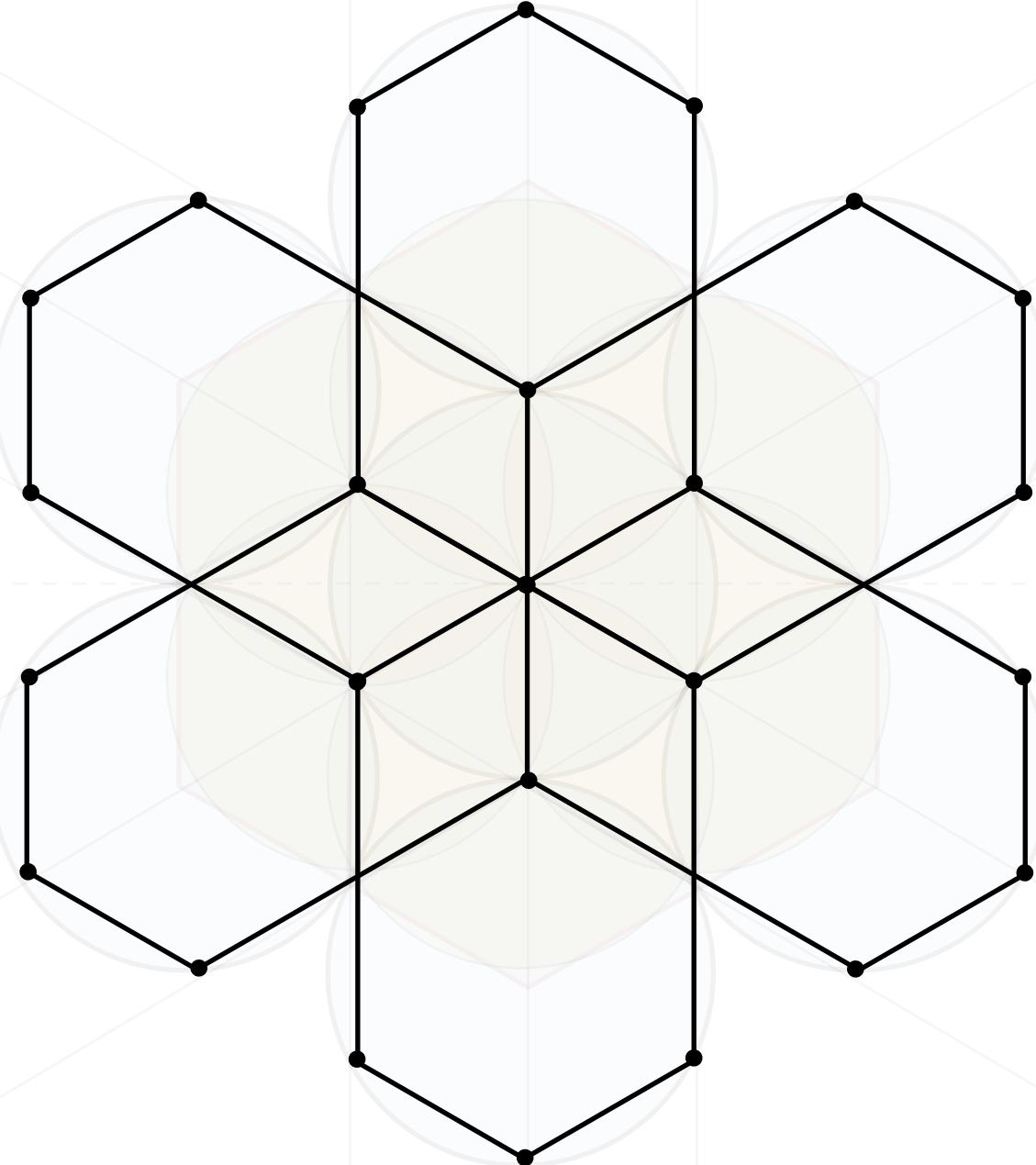
**Church windows / doors**

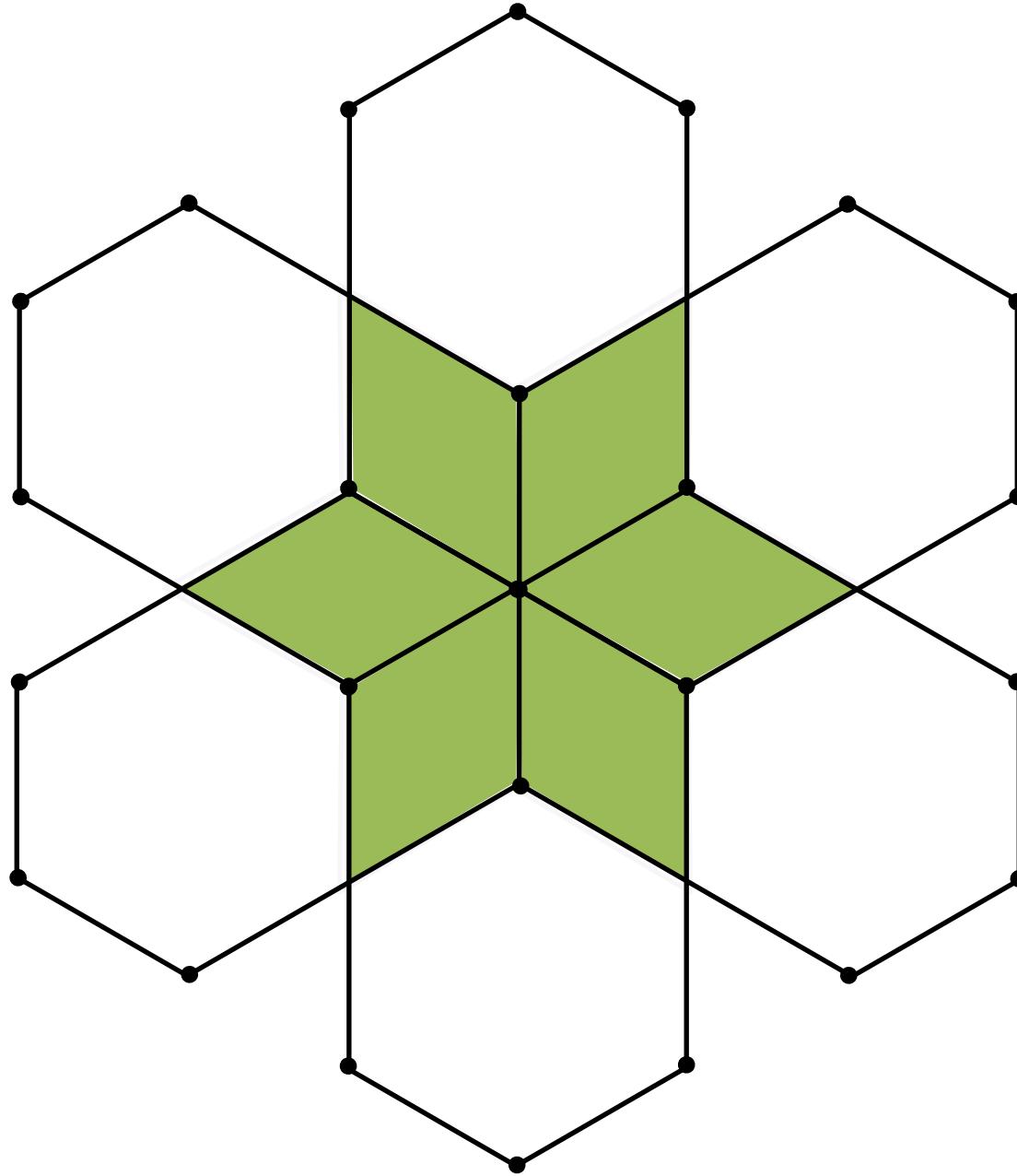


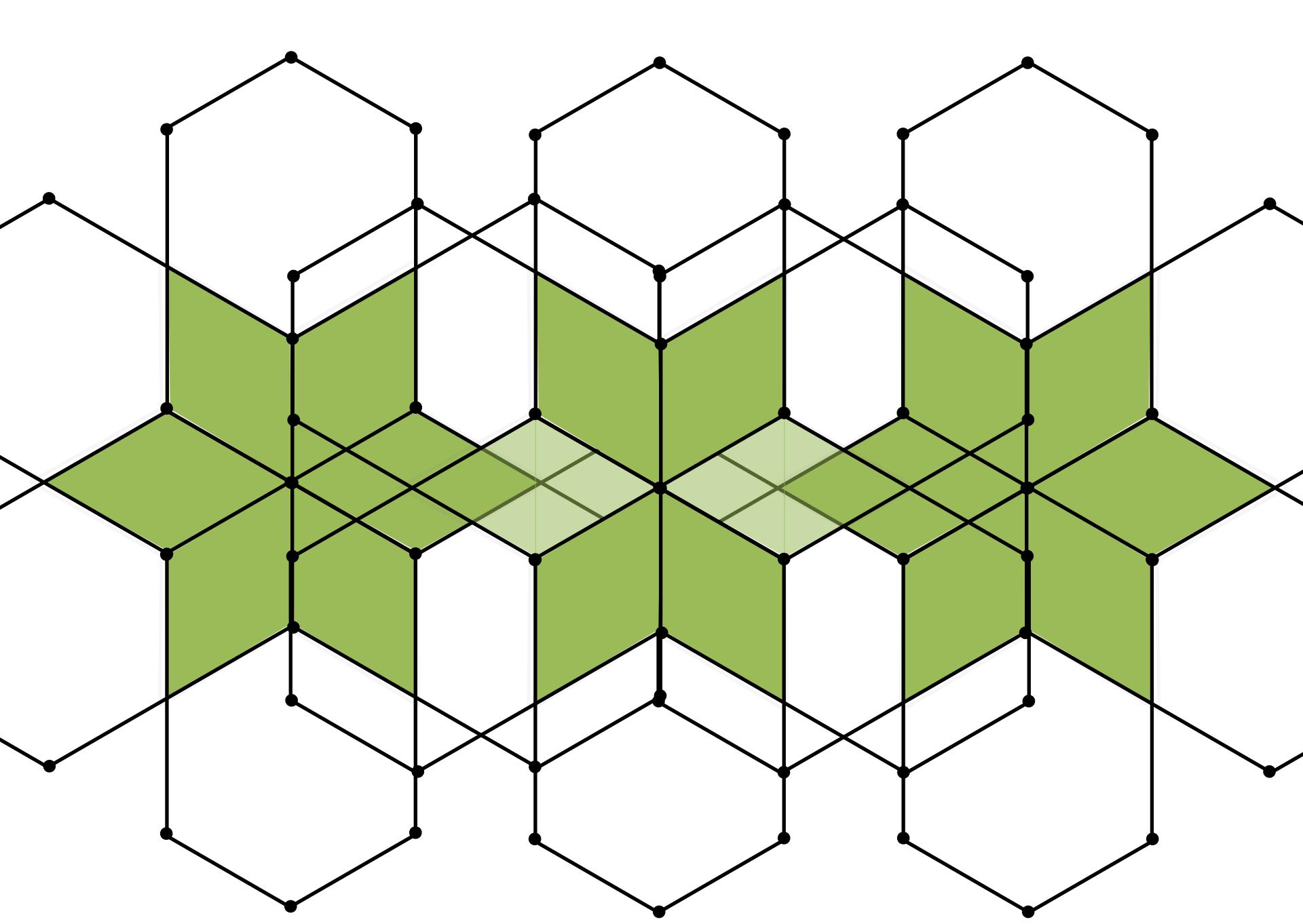
**Church windows / doors**

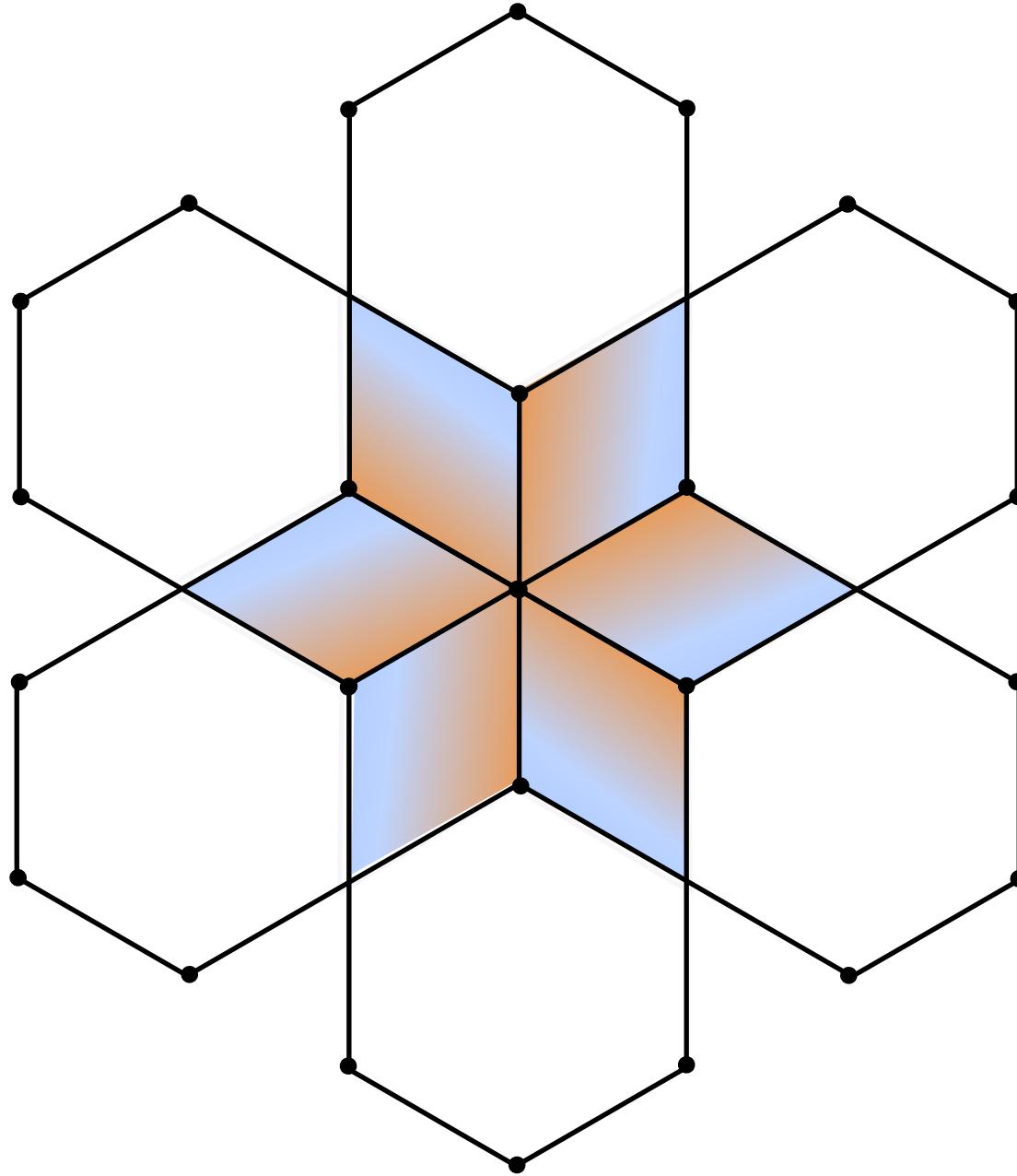


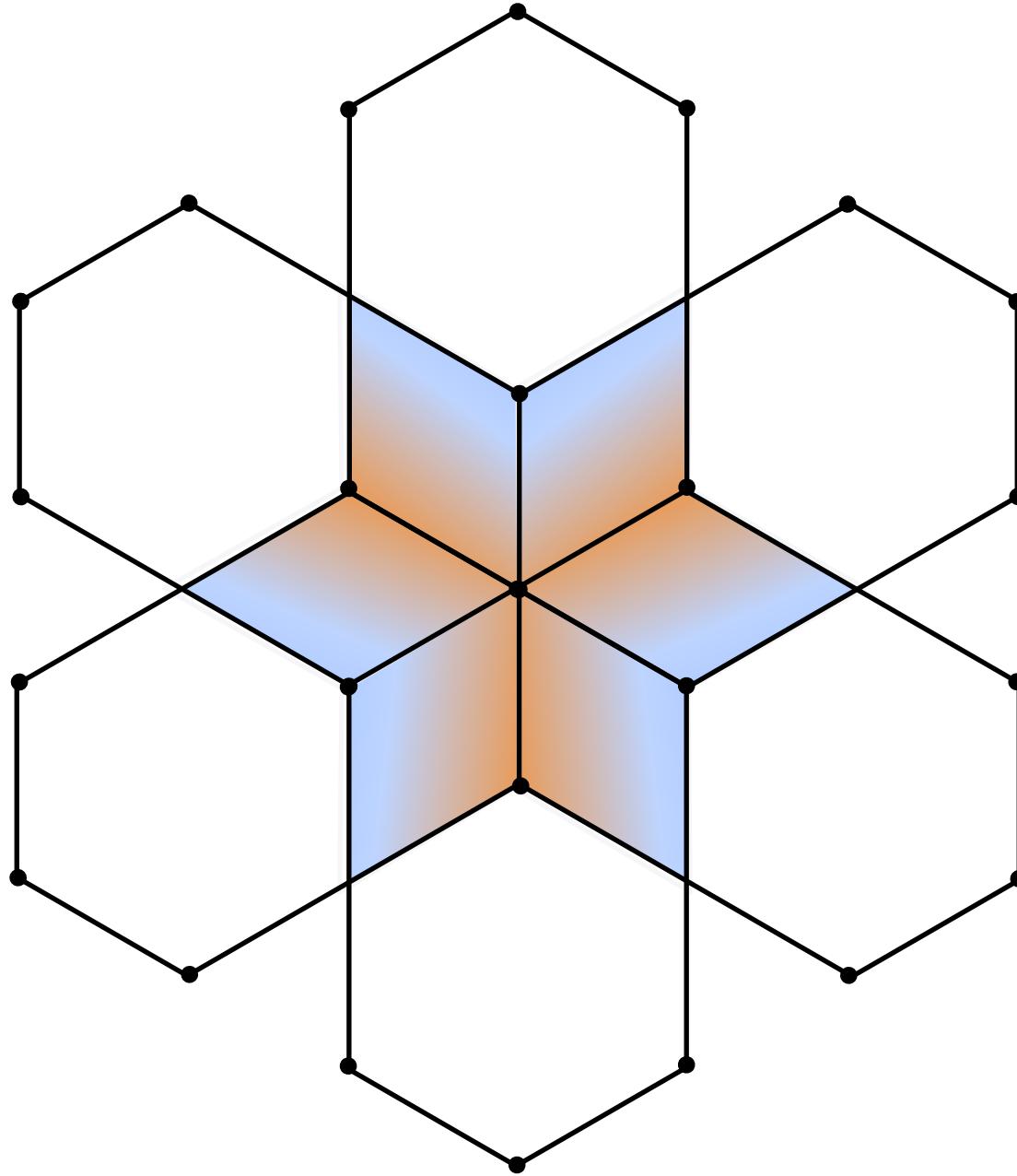


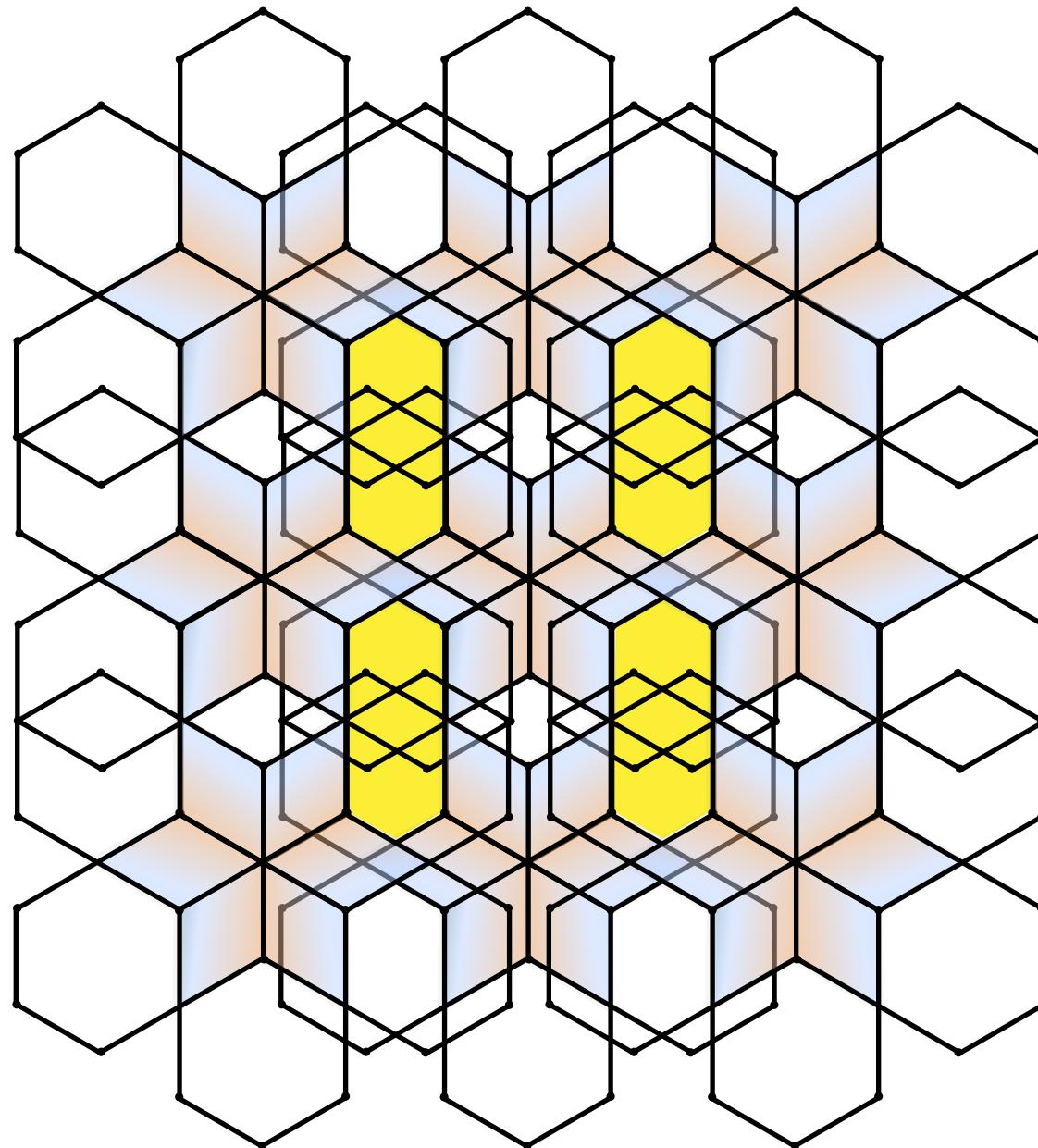


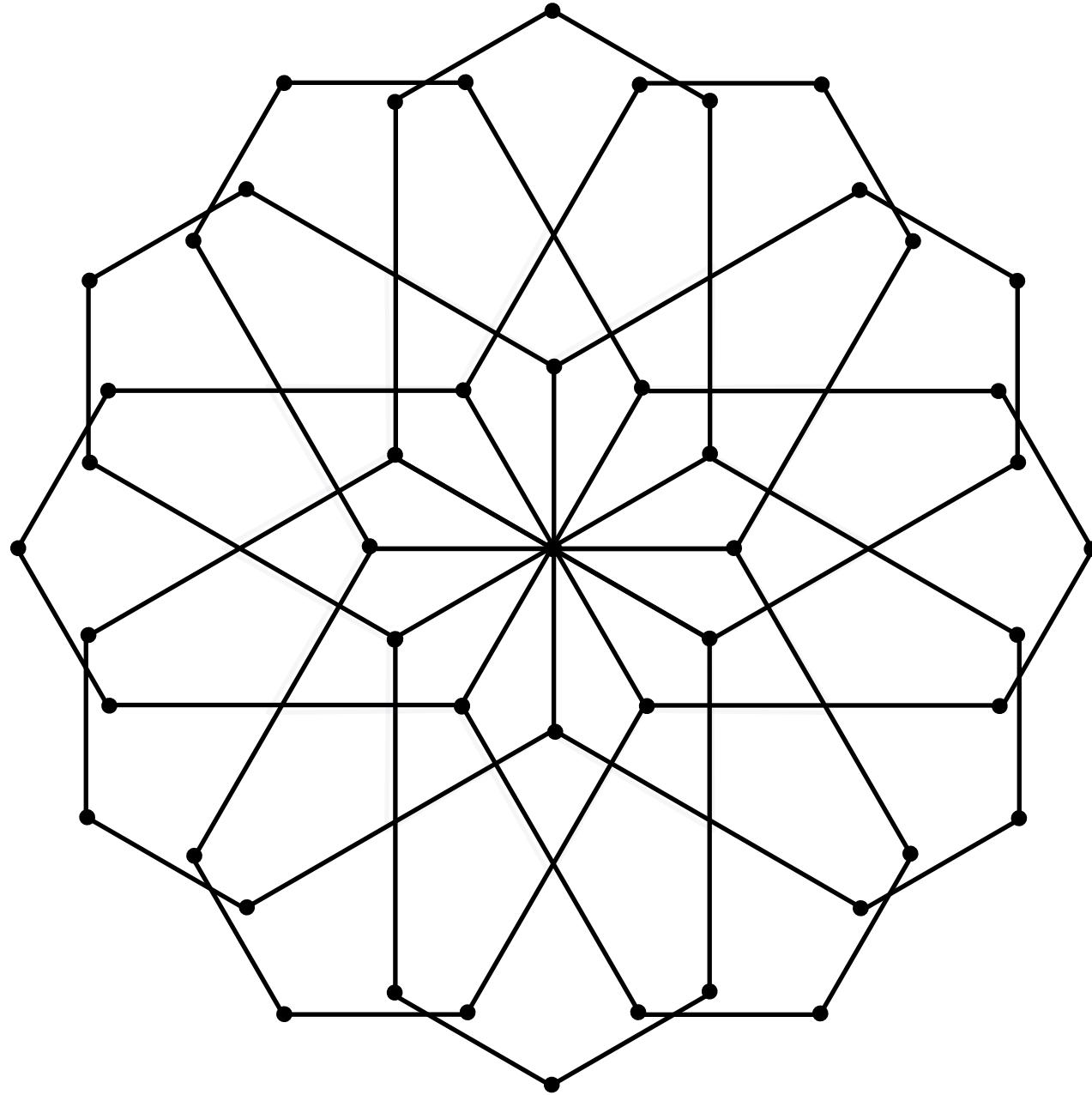


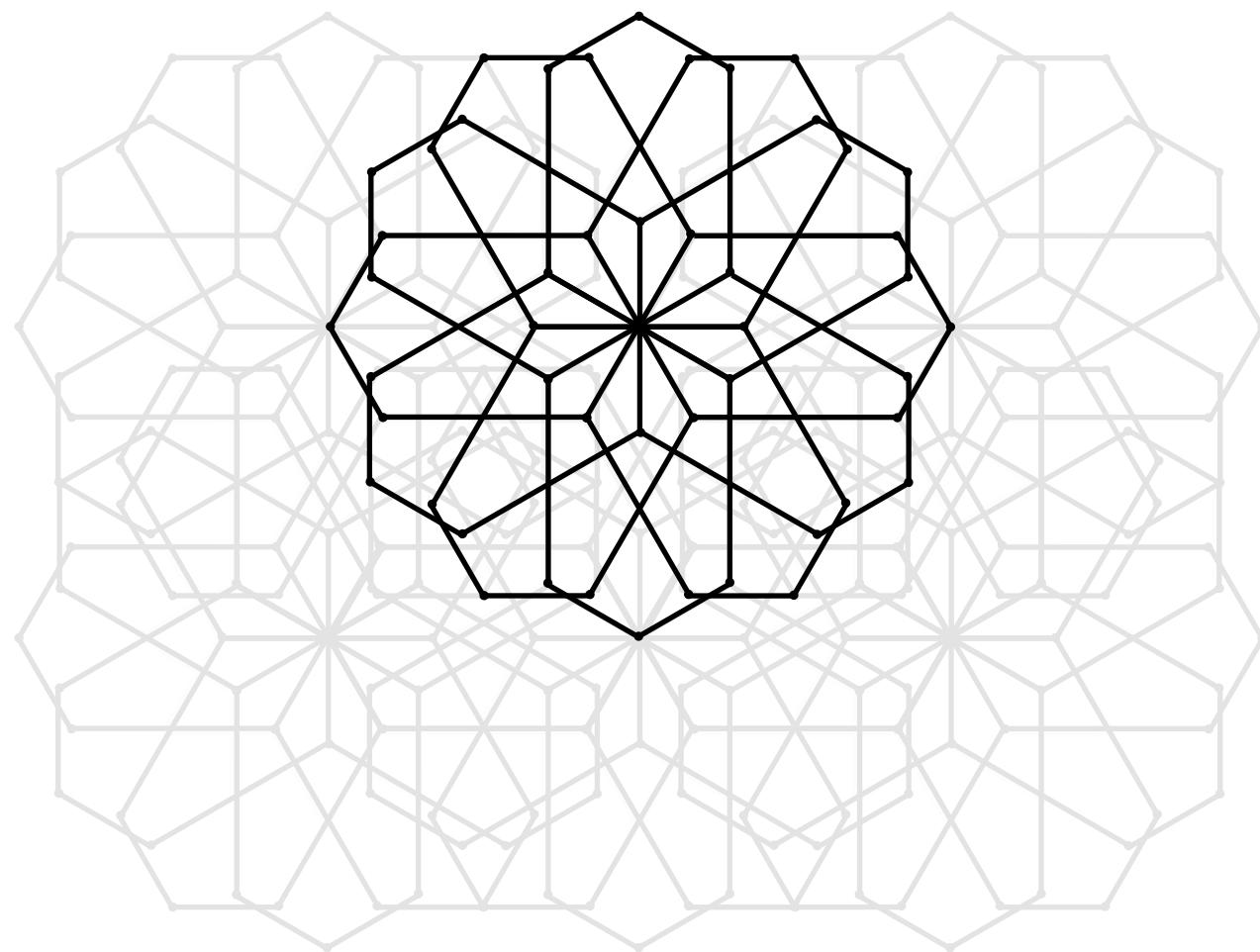


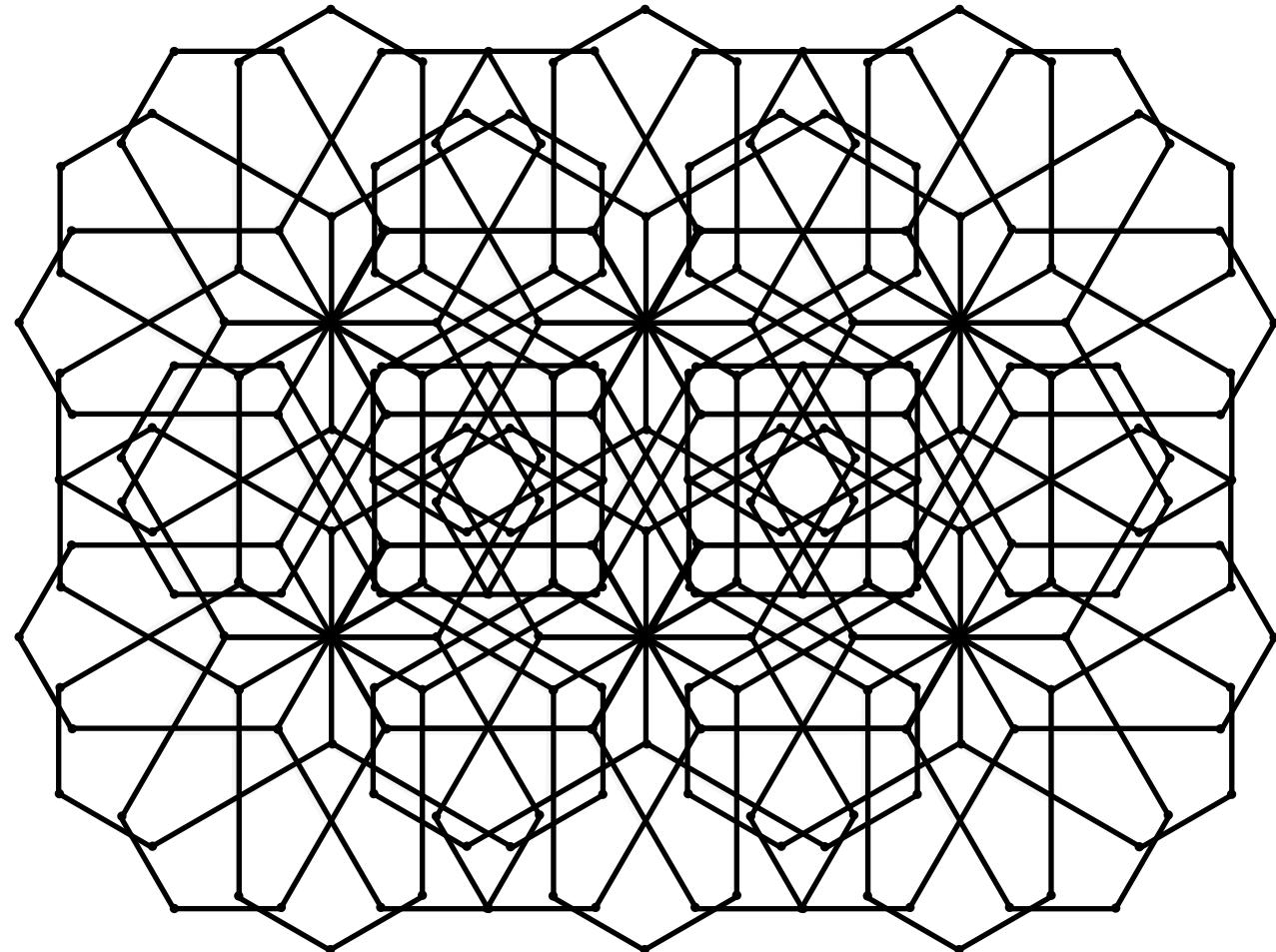




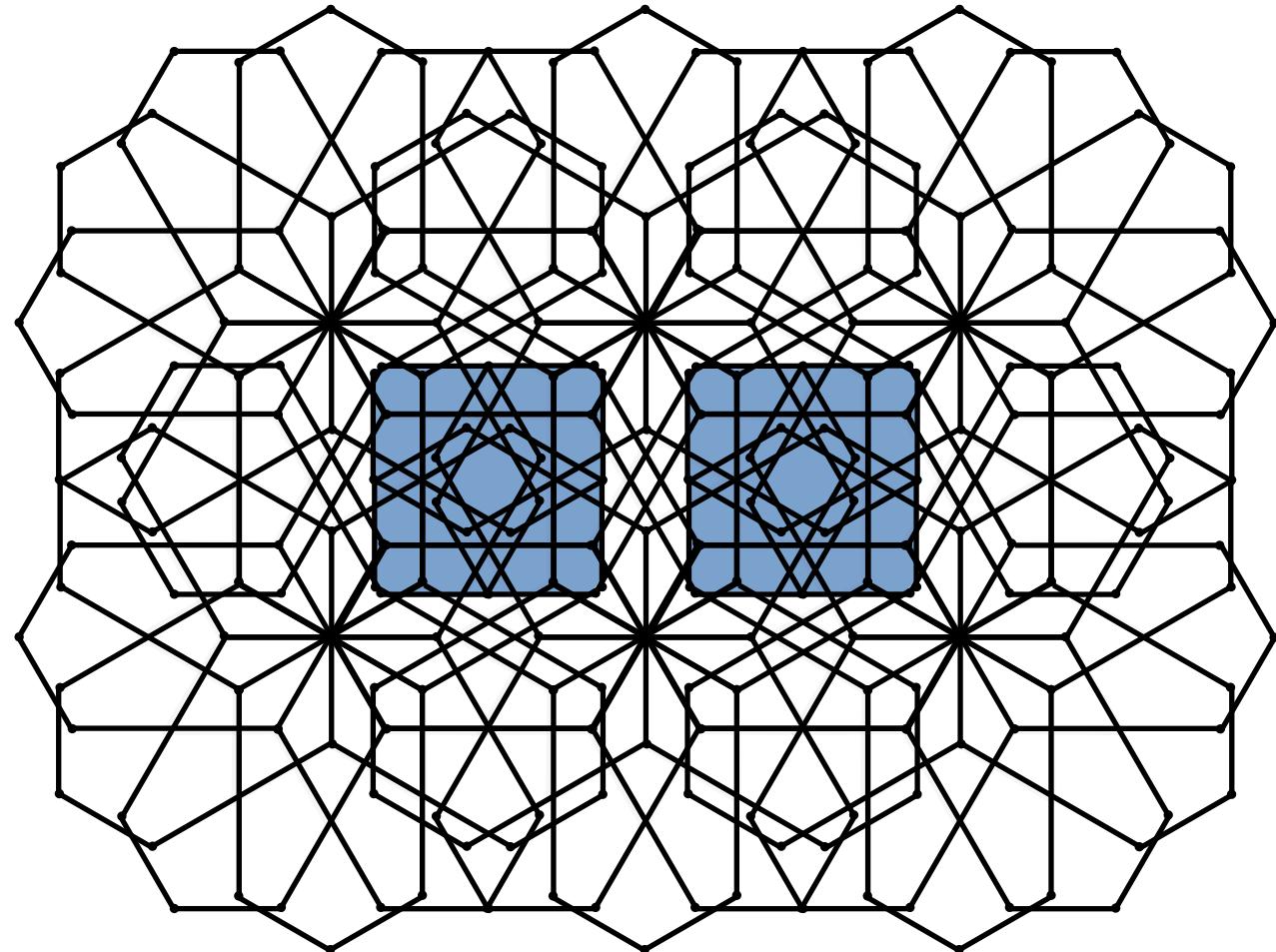




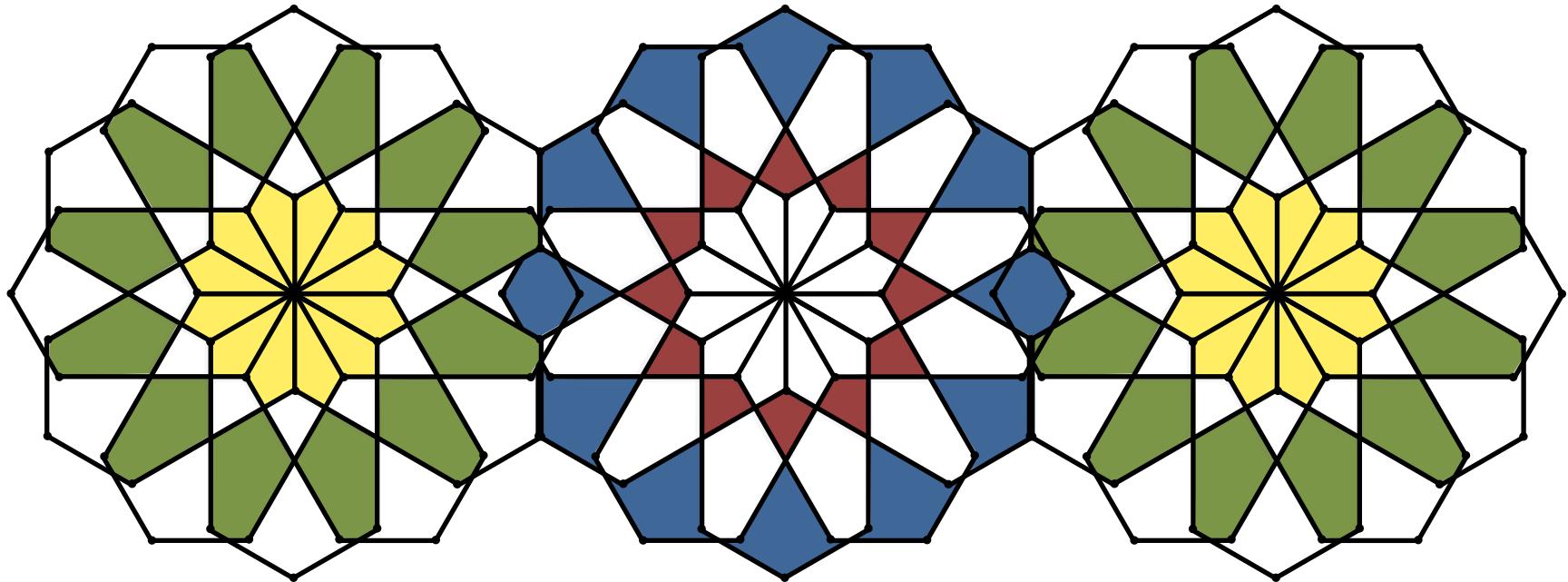




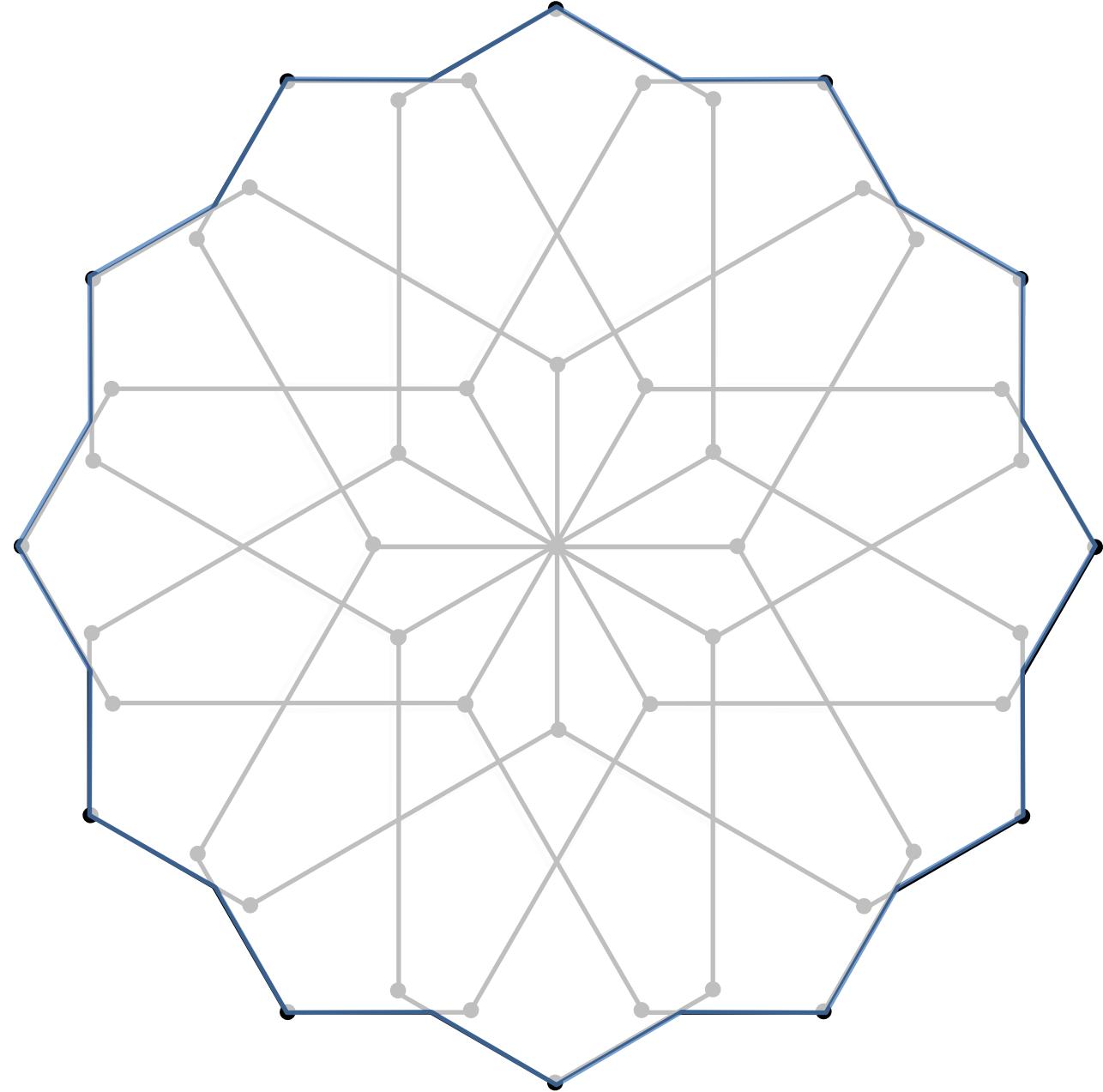
**Islamic patterns**

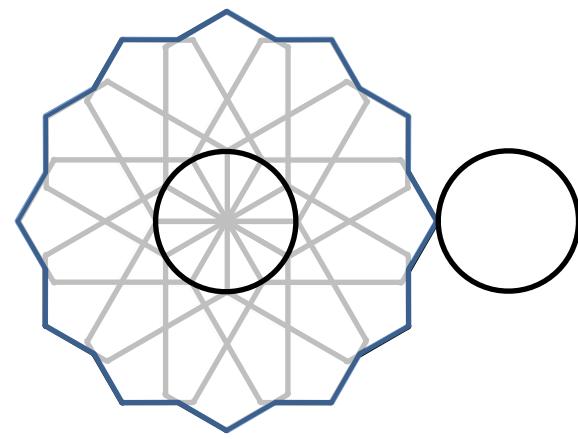


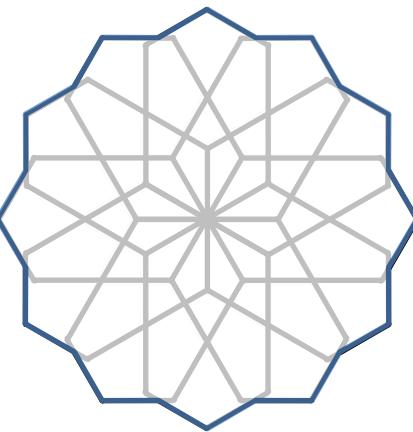
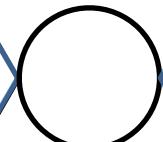
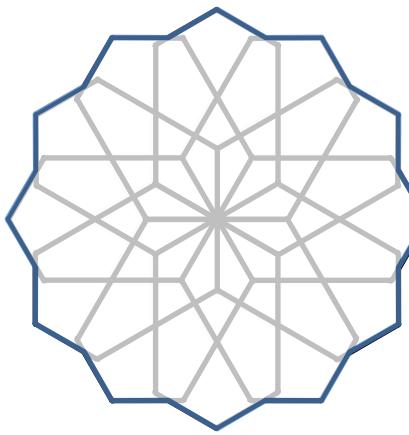
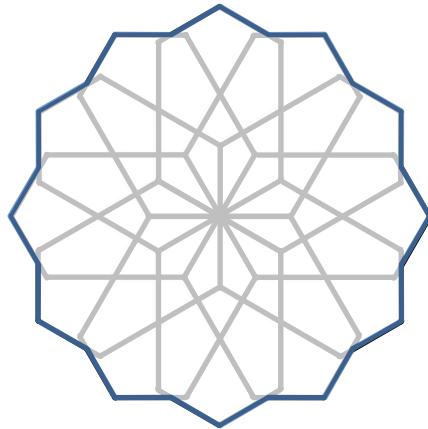
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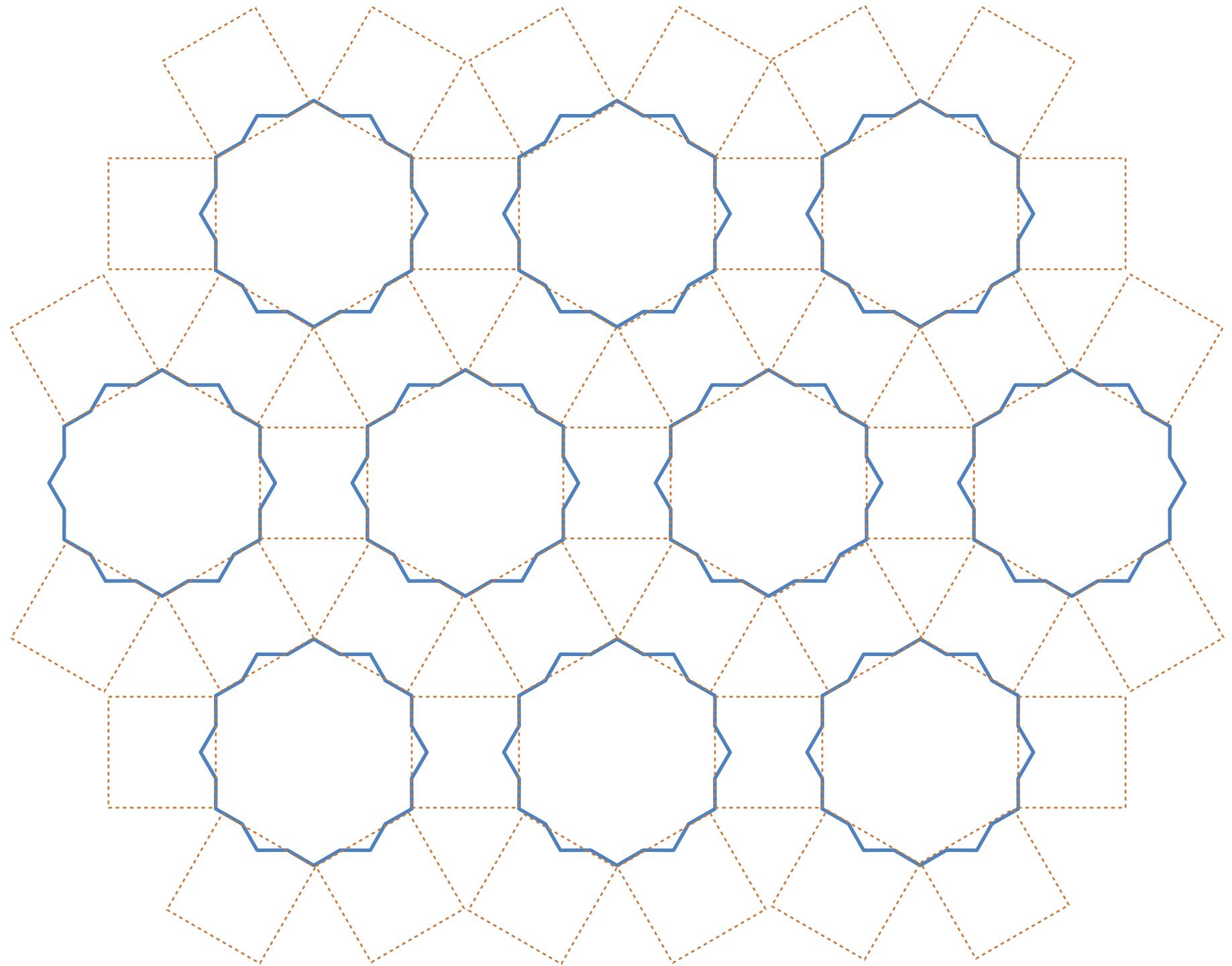


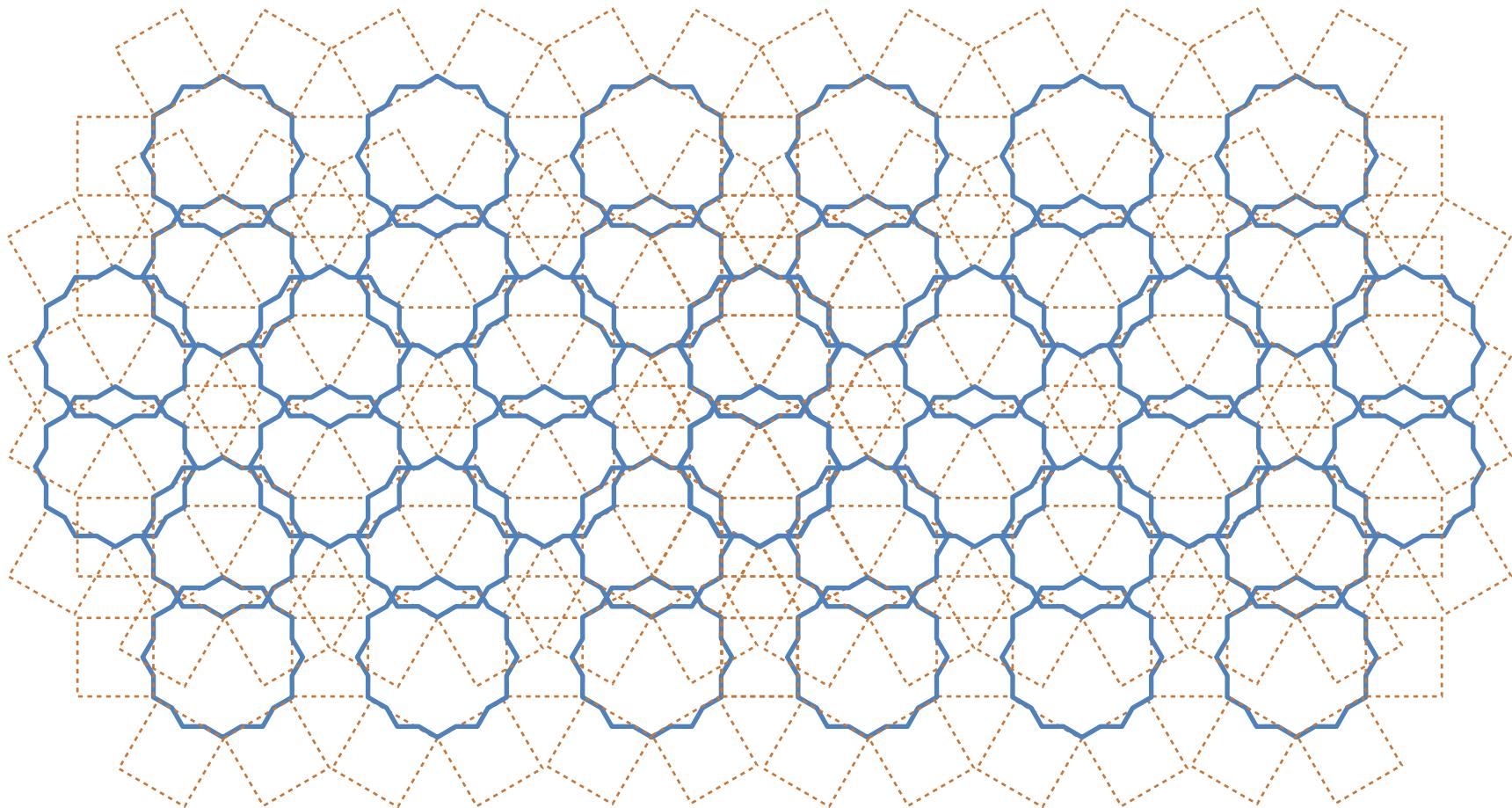
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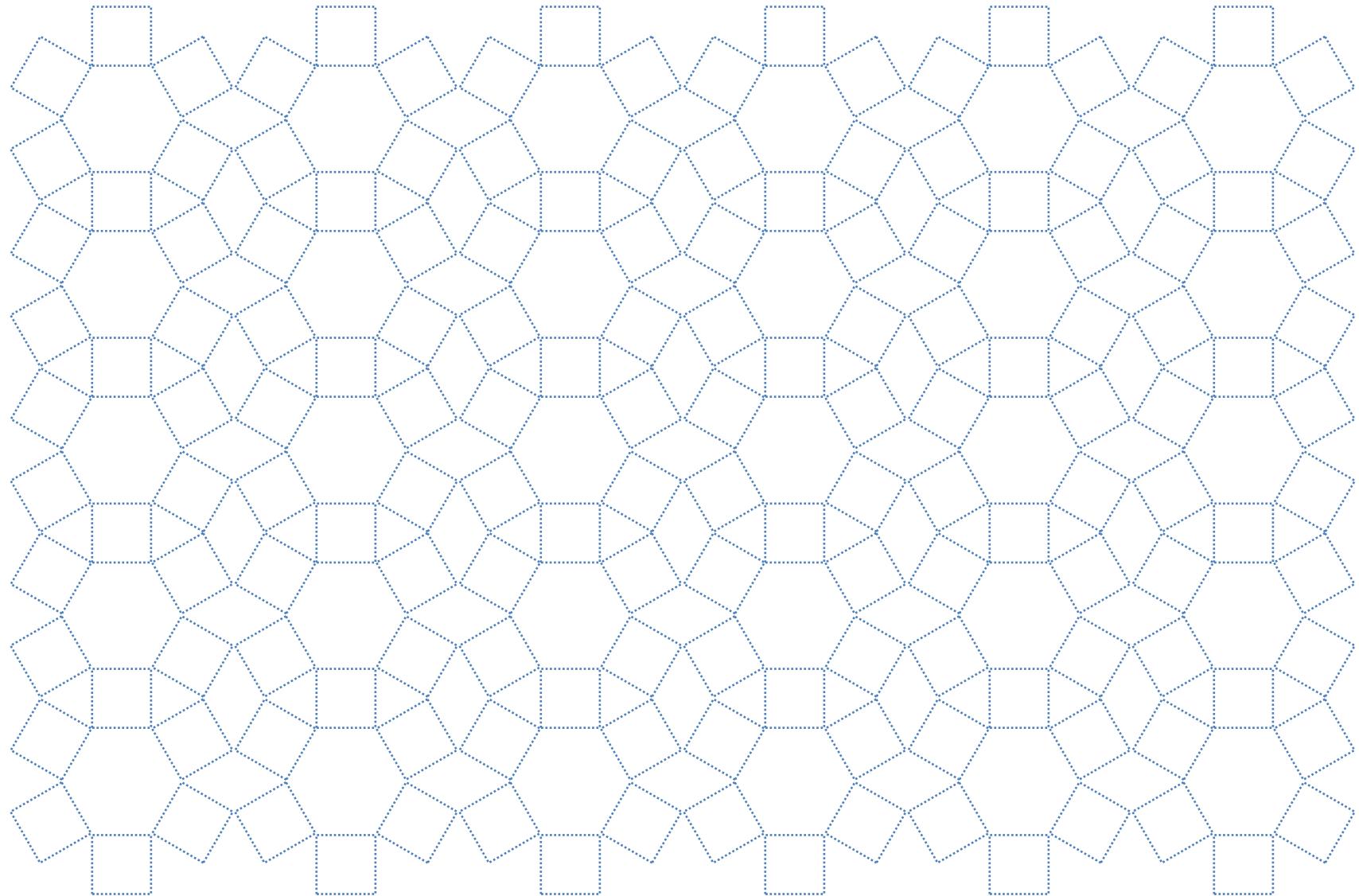


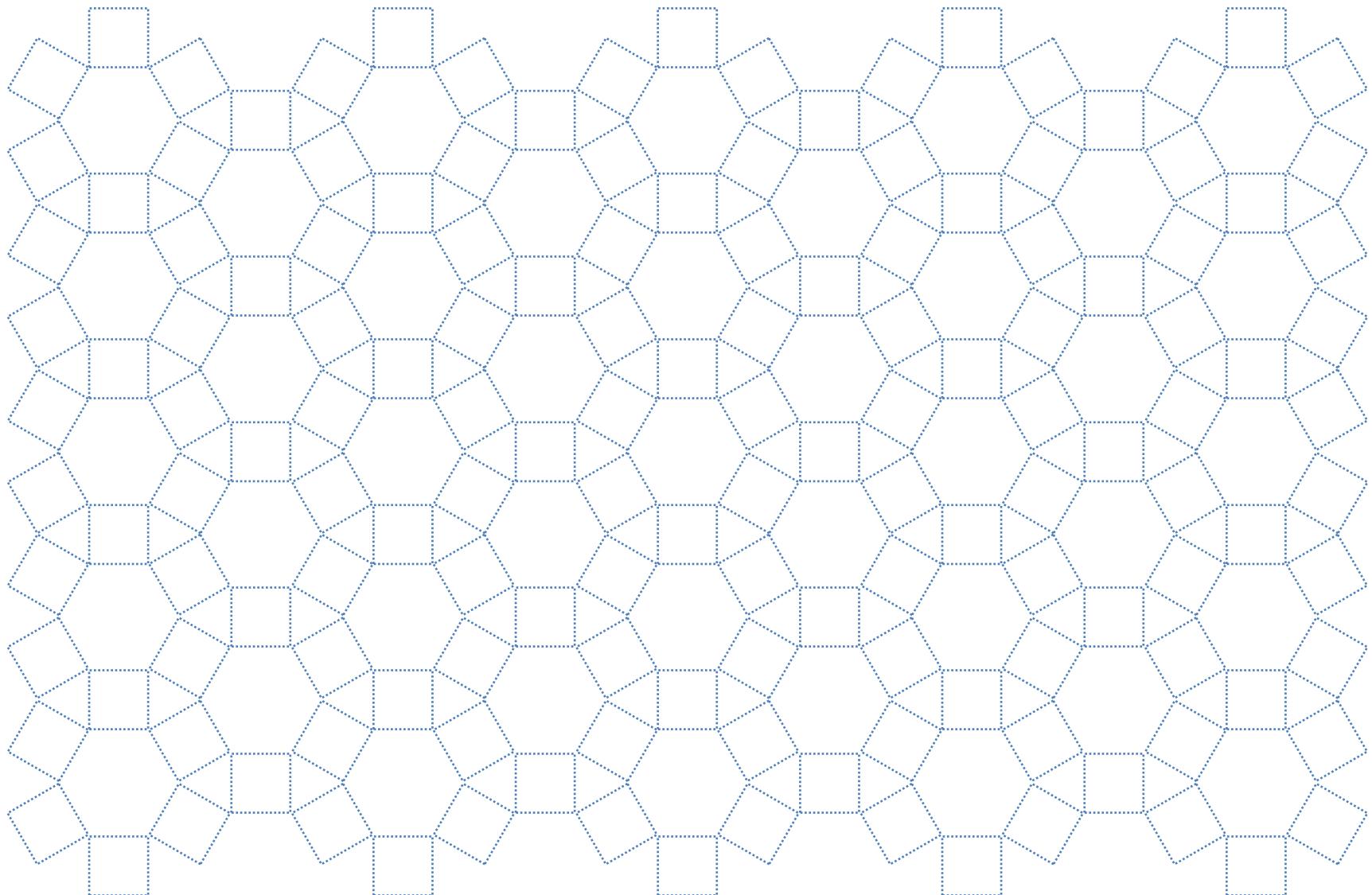


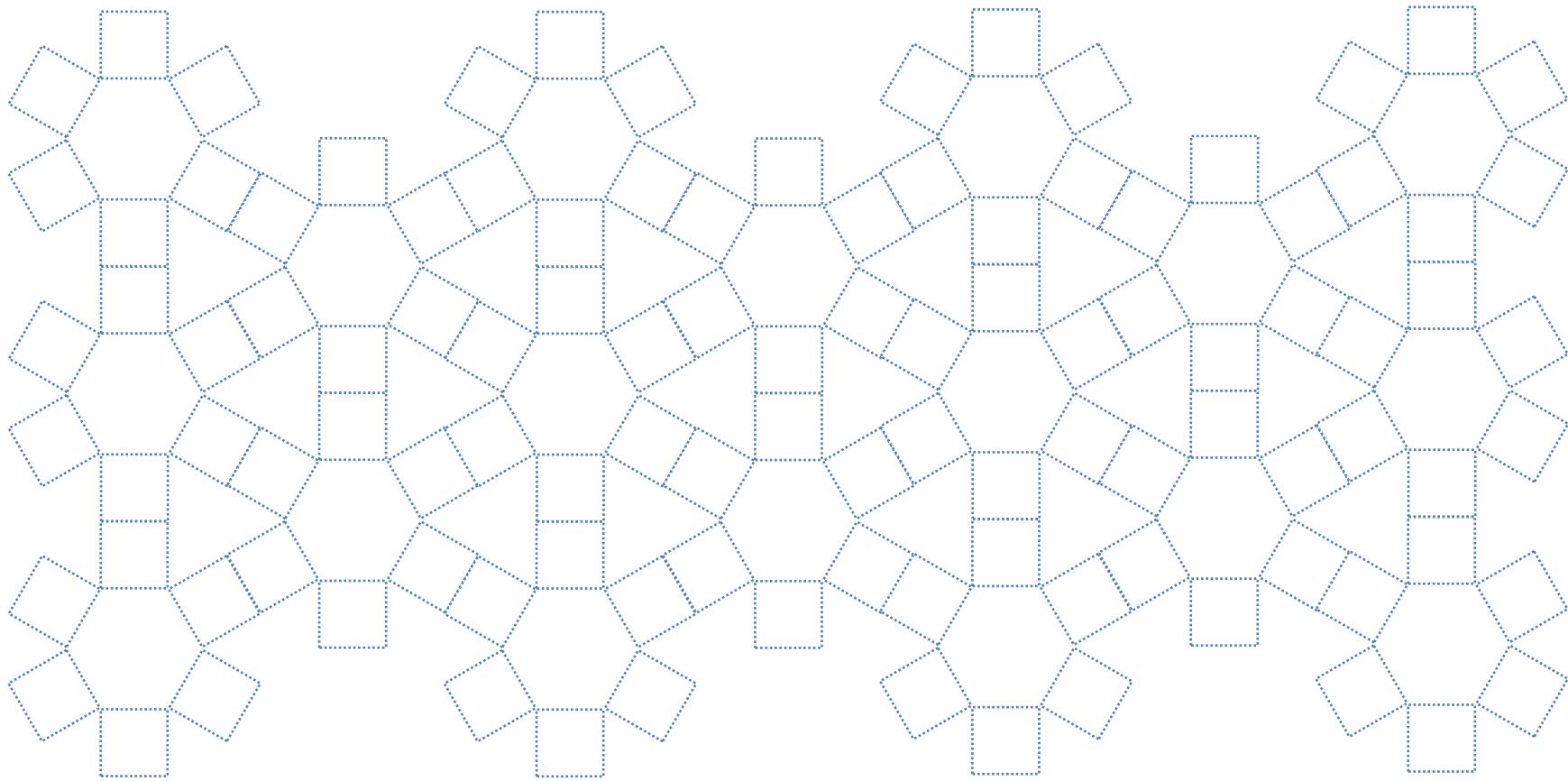


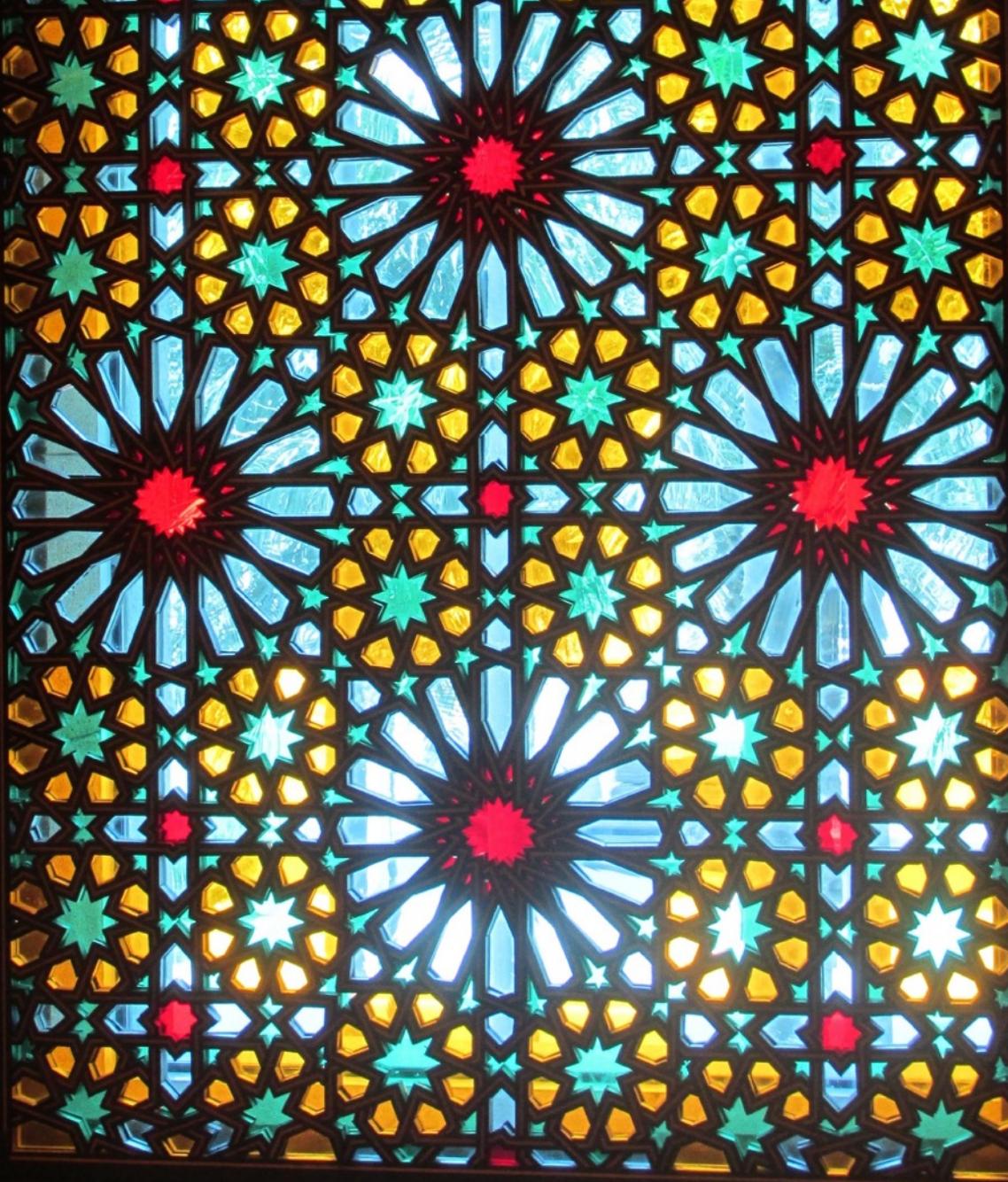




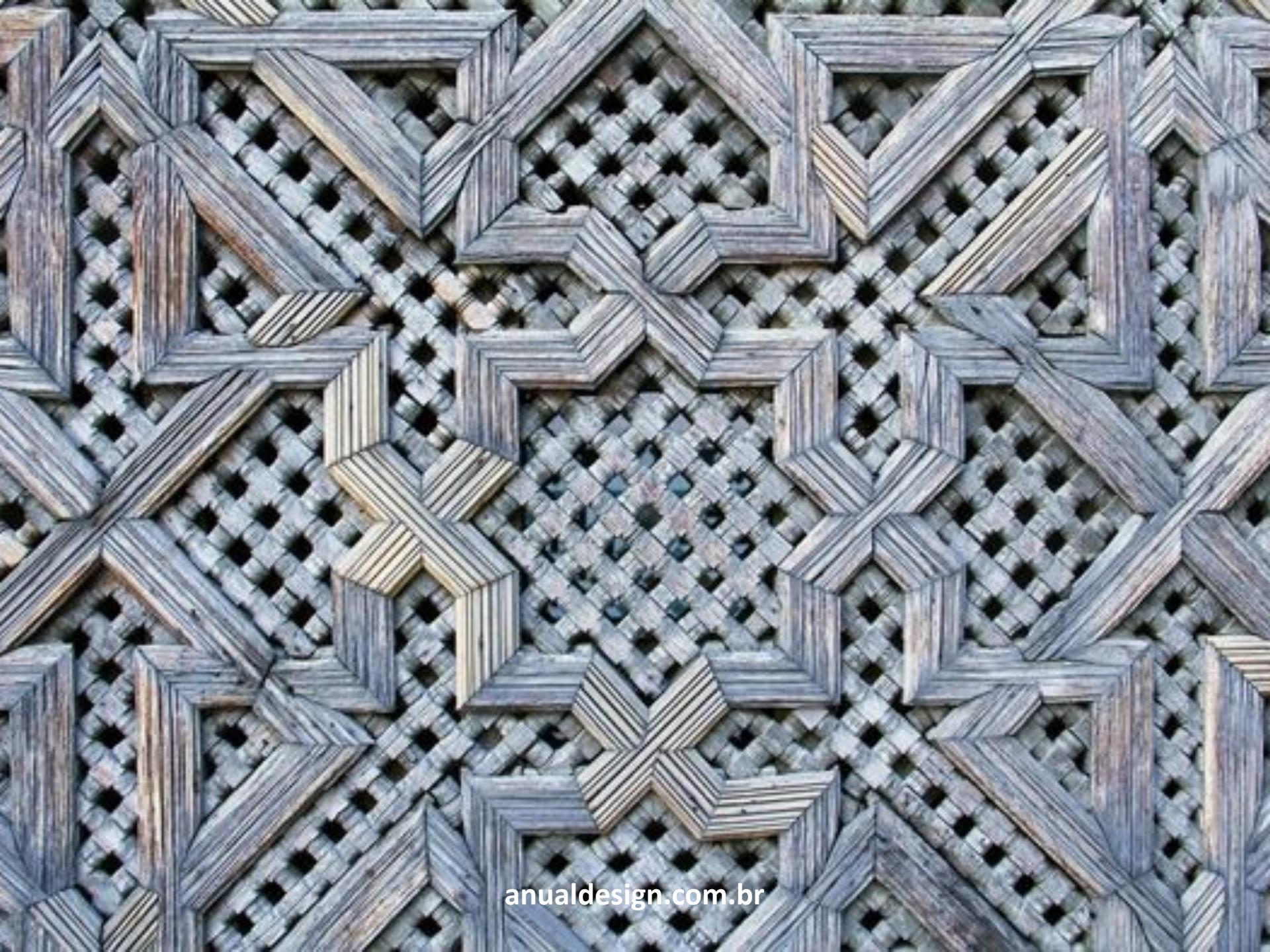








<https://allaboardforadventure.wordpress.com/>

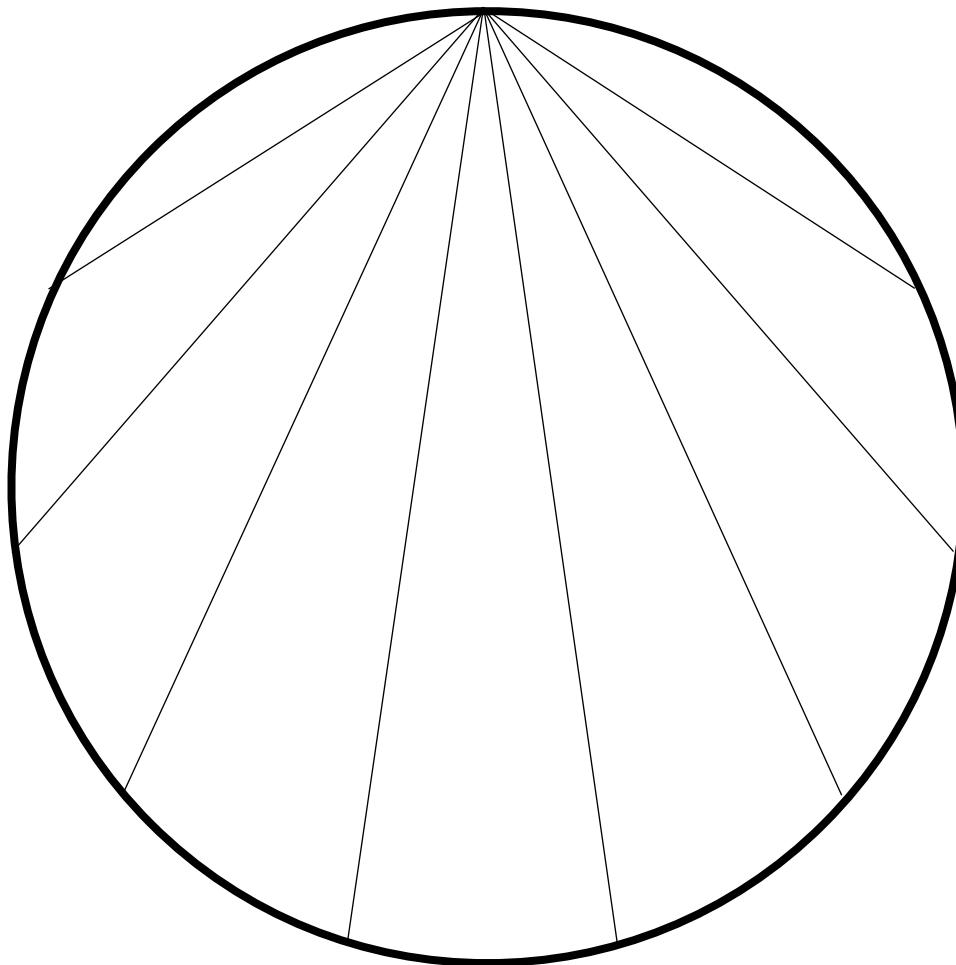


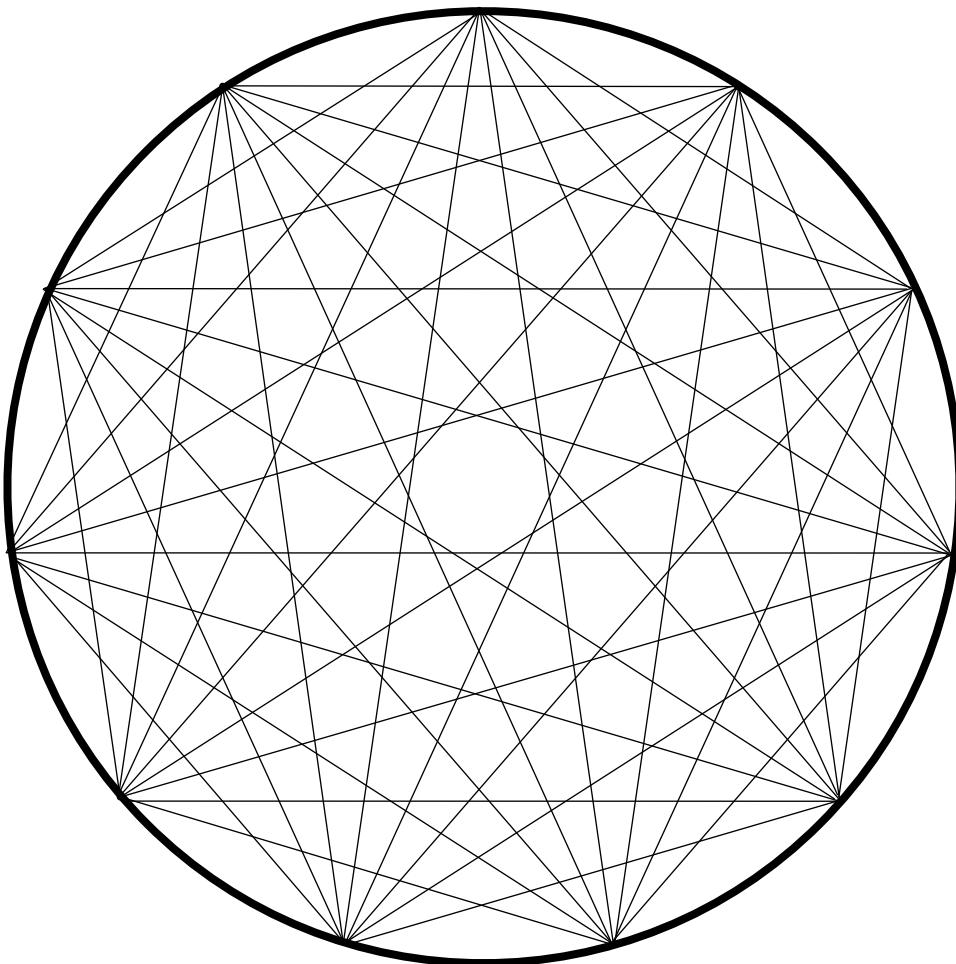
anualdesign.com.br

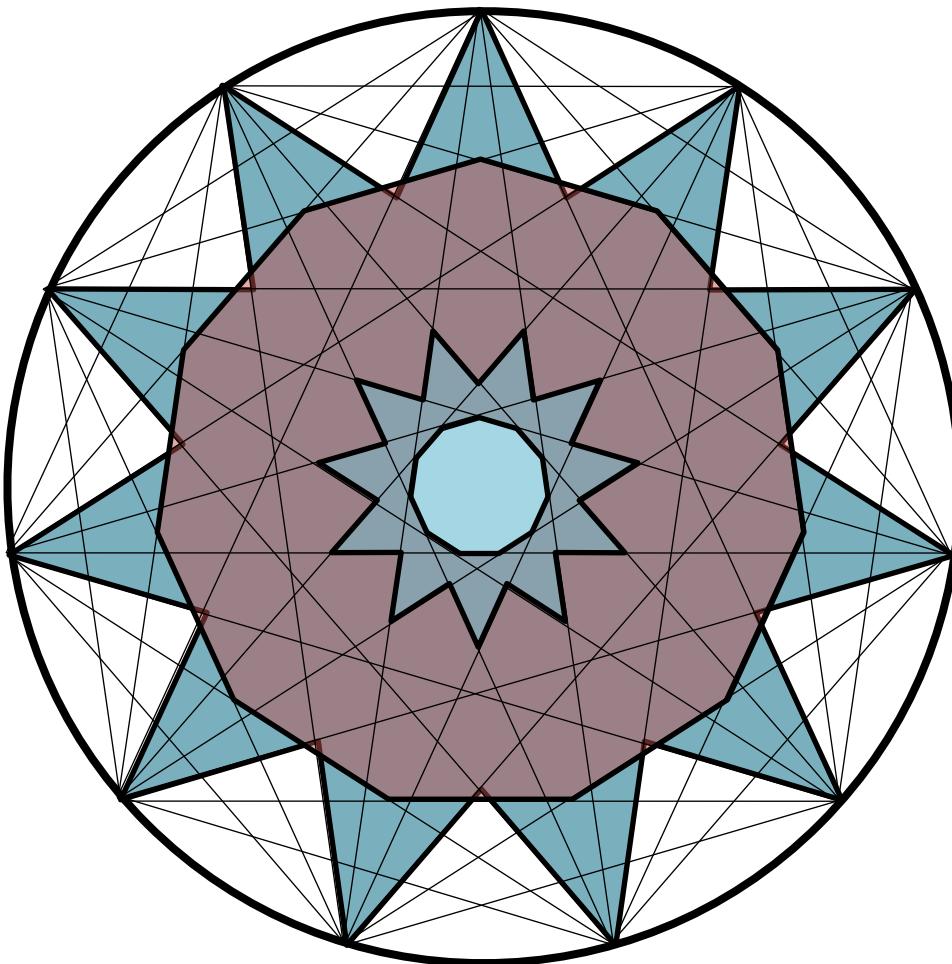
<https://allaboardforadventure.wordpress.com/>

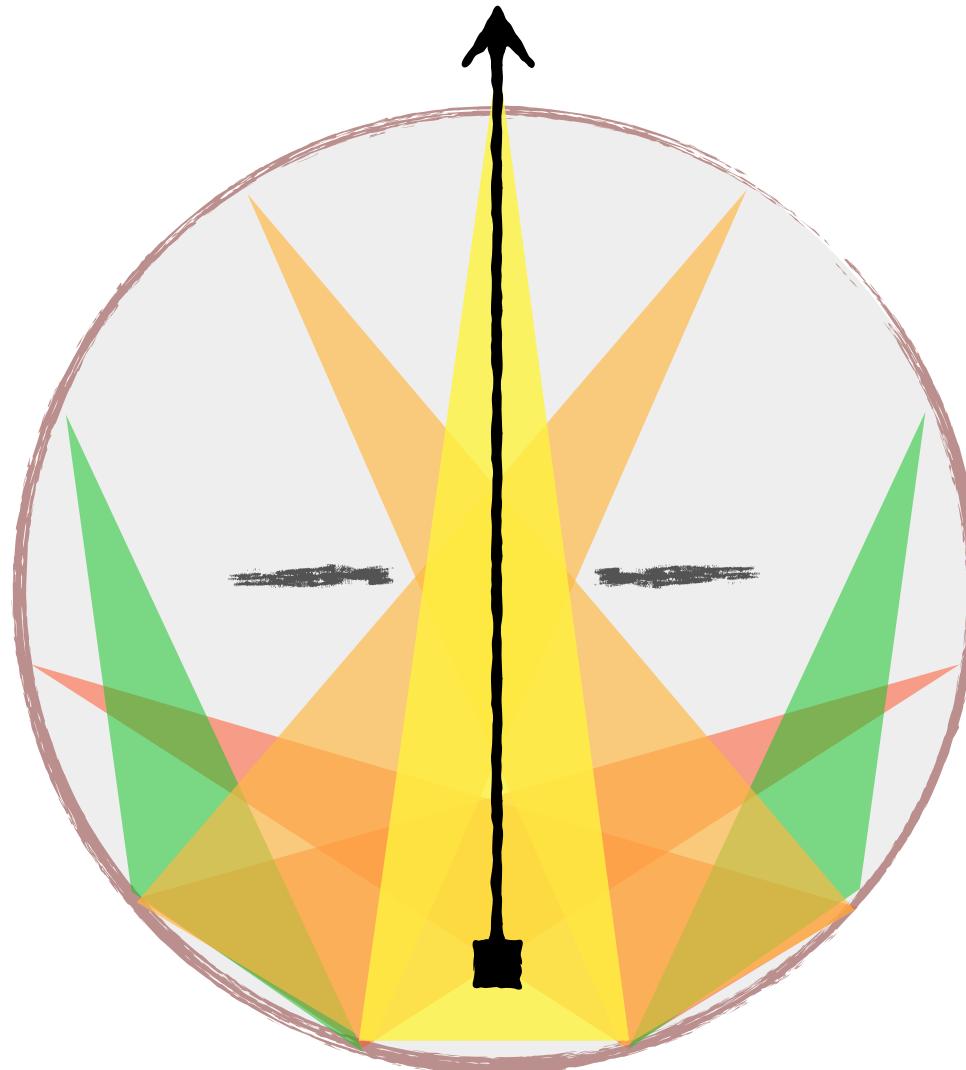


# **String Art**





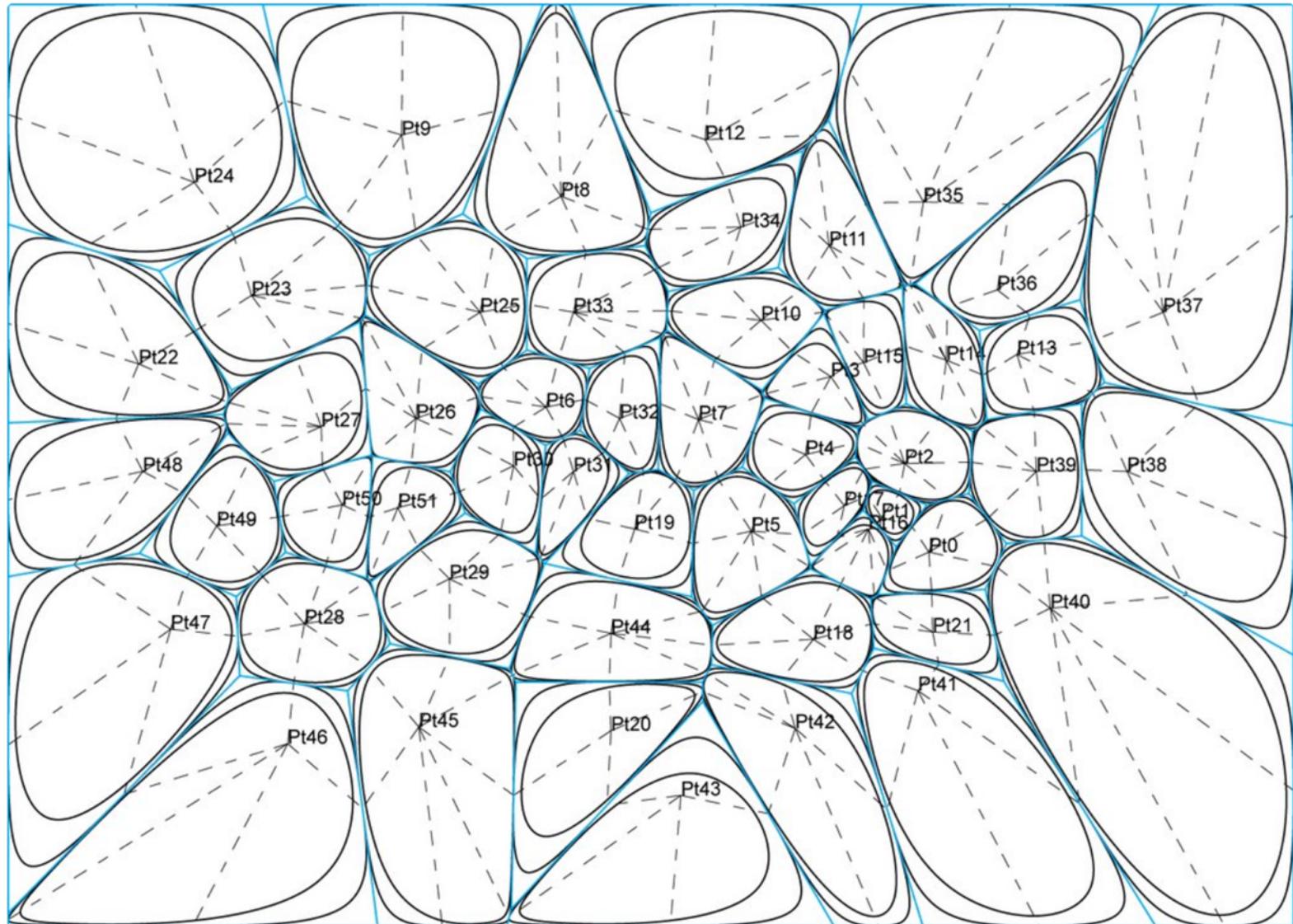




# Else



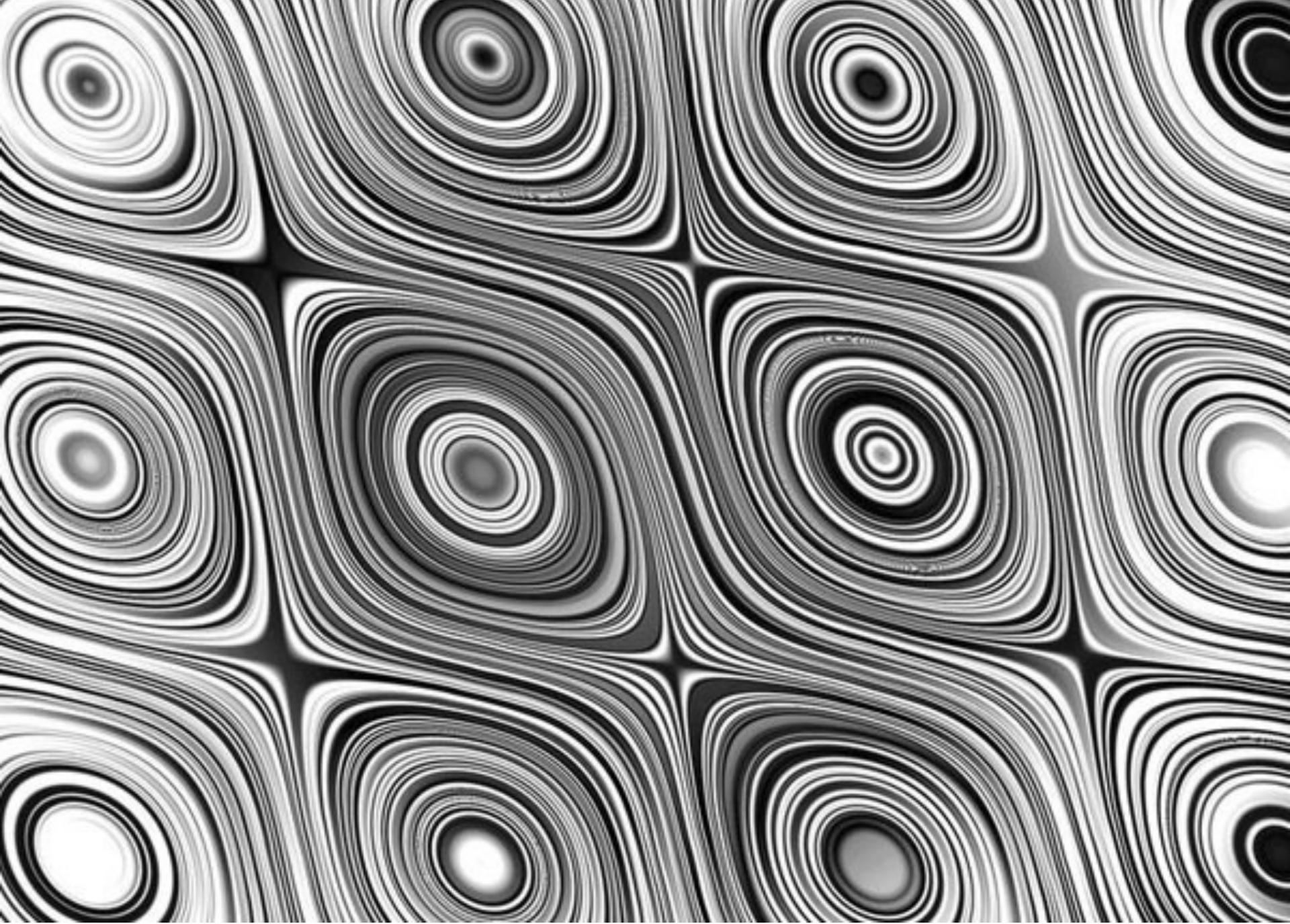
<http://www.zastavki.com/eng/3D-graphics/wallpaper-32080.htm>



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Elspeth McLean

# **Ornament Style**

Ancient Egyptian

Ancient Greek

Arabian

Turkish

Moresque (Alhambra)

Persian

Indian

Chinese

Celtic

Italian



Owen Jones's The Grammar of Ornament Originally published in 1856

Ancient Egyptian

Ancient Greek

Arabian

Turkish

Moresque (Alhambra)

Persian

Indian

Chinese

Celtic

Italian



Ancient Egyptian  
Ancient Greek  
**Arabian**  
Turkish  
Moresque (Alhambra)  
Persian  
Indian  
Chinese  
Celtic  
Italian



Ancient Egyptian

Ancient Greek

Arabian

Turkish

Moresque (Alhambra)

Persian

Indian

Chinese

Celtic

Italian



Ancient Egyptian

Ancient Greek

Arabian

Turkish

**Moresque (Alhambra)**

Persian

Indian

Chinese

Celtic

Italian



# Ancient Egyptian

# Ancient Greek

# Arabian

# Turkish

# Moresque (Alhambra)

# Persian

# Indian

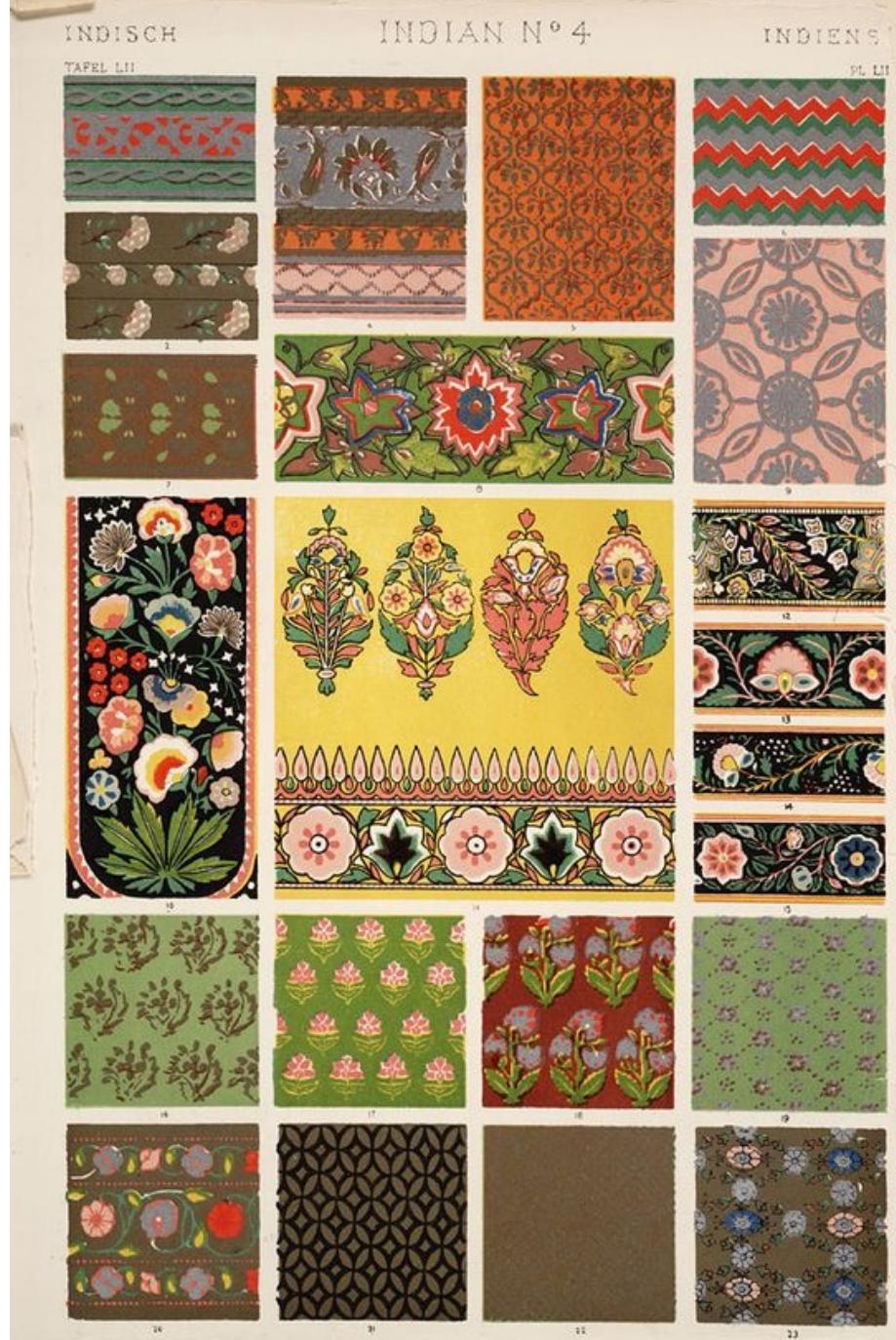
# Chinese

# Celtic

# Italian



Ancient Egyptian  
Ancient Greek  
Arabian  
Turkish  
Moresque (Alhambra)  
Persian  
Indian  
Chinese  
Celtic  
Italian



Ancient Egyptian  
Ancient Greek  
Arabian  
Turkish  
Moresque (Alhambra)  
Persian  
Indian  
**Chinese**  
Celtic  
Italian



Ancient Egyptian  
Ancient Greek  
Arabian  
Turkish  
Moresque (Alhambra)  
Persian  
Indian  
Chinese  
**Celtic**  
Italian



Ancient Egyptian

Ancient Greek

Arabian

Turkish

Moresque (Alhambra)

Persian

Indian

Chinese

Celtic

**Italian**

