

Module 4 Assignment — Symmetries of Patterns

Due Midnight, Wednesday, March 26

1 Assignment

1. Create and submit a design that you create with iOrnament. You will export your creation from iOrnament as an image and upload it to Canvas. Scoring:
 - (a) Successful submission: 35 points.
 - (b) Artistic quality/complexity: 5 points.
2. You will take and submit 12 photographs of objects that exhibit various types of symmetry, 3 of each of four types, detailed below. You will also submit a Word file in which you identify the symmetry type of each object (e.g.; Z_3 , D_5 , Spin Hop, pmm). It is ok to consult with your class members, *but you should not take photos of the same objects as others in the class*. Scoring:
 - (a) Submit 3 photos of objects with Z_n -type symmetry. Do not use Z_1 . Each object should have a different value of n . Do not use all the same type of object; e.g., they should not all be hubcabs, they should not be all flowers, etc. 4 points each.
 - (b) Submit 3 photos of objects with D_n -type symmetry. Each object should have a different value of n . Do not use all the same type of object; e.g., they should not all be hubcabs, they should not be all flowers, etc. 4 points each.
 - (c) Submit 3 photos of objects with border pattern symmetry. Each object should have a different type of symmetry. 4 points each.
 - (d) Submit 3 photos of objects with wallpaper pattern symmetry. Each object should have a different type of symmetry. 4 points each.
 - (e) Submit a document (preferably a Word file) listing the 12 photos you have taken, and for each one, describing what it is, where you found it, and correctly specifying the symmetry type (e.g.; Z_3 , D_5 , Spin Hop, pmm). 12 points for submission and correctness.
3. Extra Credit. Create and submit a carefully executed drawing of your name (first or last or both) *of your own design* that exhibits symmetry (e.g.; rotational, reflectional). Scoring:

5 points for submission, 5 points for execution and artistic quality/complexity.

2 Introduction

- If the pattern does not extend indefinitely in any direction, it is a *Finite Pattern*. Go to Section 3.
- If the pattern has translational symmetry along only one direction (e.g., to the right and left), and there is a basic, smallest, translation symmetry that can be repeated to the right and to the left as many times as desired, and there is a basic design or motif that repeats indefinitely along this direction, then the pattern is a *Border Pattern* (also known as a *Strip Pattern* or *Frieze Pattern*). Go to Section 4.
- If the pattern has translational symmetry along two nonparallel directions, and there are two basic, smallest, translation symmetries in two nonparallel directions that can be repeated in various combinations backwards and forwards as many times as desired, and there is a basic design or motif that repeats indefinitely with these translations, then the pattern is a *Wallpaper Pattern*. Go to Section 5.

3 Finite Patterns

Finite Patterns do not extend indefinitely in any direction.

- **Type Z_1 :** *No* symmetry.
- **Type Z_n :** *No* reflectional symmetry, but has rotational symmetry, and the smallest symmetry rotation is the fraction $1/n$ of a full turn.
- **Type D_n :** Reflectional *and* rotational symmetry, and the smallest symmetry rotation is the fraction $1/n$ of a full turn.
- **Type D_∞ :** Reflectional and rotational symmetry, and can be symmetrically rotated by *any* amount.

4 Border Patterns

Border Patterns have translational symmetry along only one direction (e.g., to the right and left), and there is a basic, smallest, translation symmetry that can be repeated to the right and to the left as many times as desired, and there is a basic design or motif that repeats indefinitely along this direction,

In addition to their translational symmetries (T), these patterns (for convenience in this discussion viewed as extending left and right) might also have one or more of the following symmetries: a reflection across the central horizontal line (H), reflections across various vertical lines (V), rotations by 180° about various central points (R), and glide reflections by various amounts across the central horizontal line (G).

Symmetry Type	Translation	Horizontal Reflection	Vertical Reflection	Half-Turn	Glide Reflection
11 (Hop)	Y	-	-	-	-
1m (Jump)	Y	Y	-	-	Y
m1 (Sidle)	Y	-	Y	-	-
12 (Spin Hop)	Y	-	-	Y	-
1g (Step)	Y	-	-	-	Y
mg (Spin Sidle)	Y	-	Y	Y	Y
mm (Spin Hop)	Y	Y	Y	Y	Y

5 Wallpaper Patterns

Wallpaper Patterns have translational symmetry along two nonparallel directions, and there are two basic, smallest, translation symmetries in two nonparallel directions that can be repeated in various combinations backwards and forwards as many times as desired, and there is a basic design or motif that repeats indefinitely with these translations.

In addition to their translational symmetries, these patterns might also have one or more of the following symmetries: reflections, glide reflections, rotations about various points by multiples of 180° (2-fold rotational centers), rotations about various points by multiples of 90° (4-fold rotational centers), and rotations about various points by multiples of 60° (6-fold rotational centers).

Each of these patterns falls into one of 17 types, and can be classified using the flow chart at this location: http://www.dynamicgeometry.com/documents/recentTalks/islamicArt/Symmetry_Group_Flowchart.pdf.