PATTERNS: MATH, PHYSICS, AND ART

Orderly structures exist in our minds and our surroundings. From unique hexagonal snowflakes to honeycombs, patterns often emerge in nature in response to the constraints set by physics. But often these constraints are consequences of pure mathematics, with the material world purely acting as a medium. For instance, the packing of spheres (the kissing problem) is a mathematical fact. Other times, patterns are a consequence of human behavior, like mosh pits in concert arenas or grid-like structures of many modern cities. Artists have long found themselves obsessed with patterns (consider Escher, Mondrian), often finding inspiration in patterns mentioned earlier. Poets work to create patterns of words and phonetics that evoke deep emotions. Musicians find themselves lost in the sensation of harmony that exists in mathematical patterns emergent in sounds of various frequencies. Finally, there are patterns in our minds, the symmetries we desire, the order we instill, and the rhymes we seek. It is thus intriguing to explore the origins and lateral connections between such patterns, and how they influence our lives. The course will include dedicated explorations of patterns and symmetries as they emerge in various contexts. Computational, musical, and artistic explorations would be encouraged. The course will cover physics, basic space groups, and geometric constraints necessary to understand the origins of patterns, along with computational analysis of such patterns.

Syllabus

Math and Philosophy of Patterns

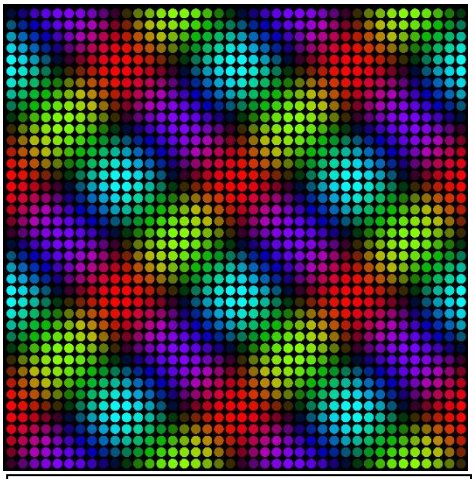
- Excerpts from Kauffman, *The Origins of Order: Self-Organization and Selection in Evolution*
- Tessellations, Honeycombs, Kepler's Conjecture
- Introduction to Space Groups
- Information Entropy and Compression

Order and Disorder in Nature

- Turing, *"The Chemical Basis of Morphogenesis",*
- Prigogine, "Order out of Chaos"
- Crystals and Cycles

Patterns in Art

- Escher, Frank Lloyd Wright, Nick Cave, Andy Warhol
- Stereograms, Dressing
- Music: time signatures, rhymes, harmonies, overtones.



The vibrational modes of a 2D mesh result in beautiful patterns emerging out of the natural constraints of elasticity and inertia.

The Human Patterns

- Cities, Housing
- Calendars and Timekeeping
- Psychological Patterns. Bion: *The Grid*
- Science as a form of pattern recognition (Sethna, Sloppy Models)