

Directed tilings of the Euclidean and hyperbolic plane

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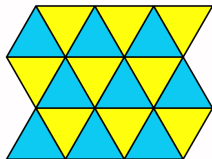
[†]Tufts University, [◇]Clemson University, ^{*}University of Virginia

2024 UVA Topology REU

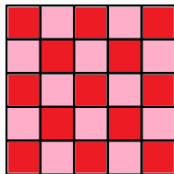
MAA Spring 2025 MD-DC-VA Section

Regular tilings of the plane

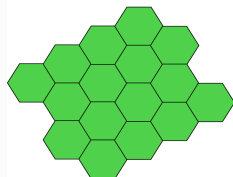
Euclidean tilings:



$\{3,6\}$

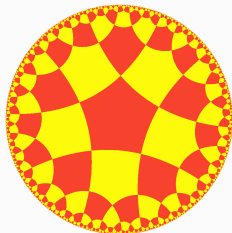


$\{4,4\}$

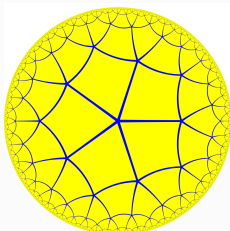


$\{6,3\}$

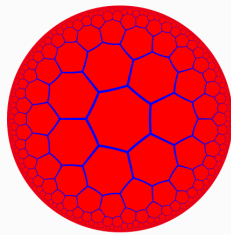
Hyperbolic Tilings:



$\{5,4\}$



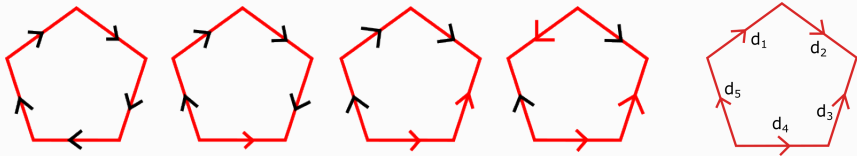
$\{4,5\}$



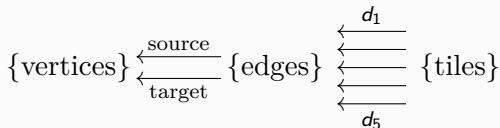
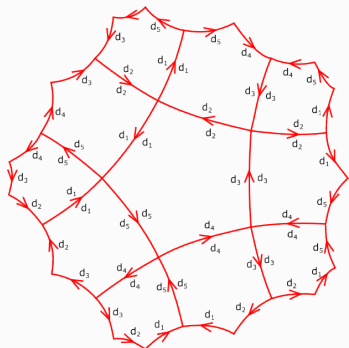
$\{7,3\}$

Directed tiles

Edge direction patterns, up to rotation and reflection:

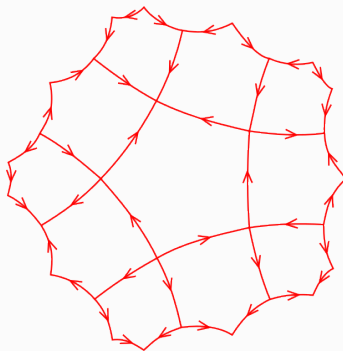
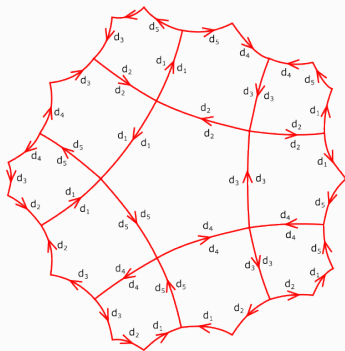
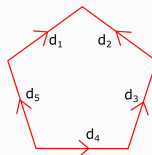
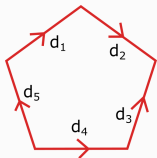


Labeled endpoints & edges facilitate computational models:



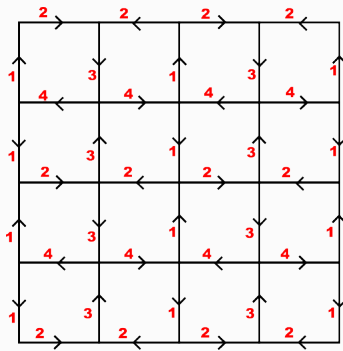
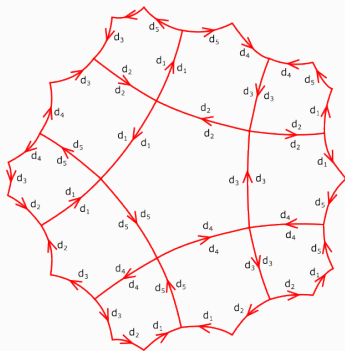
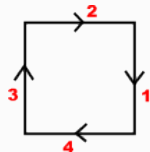
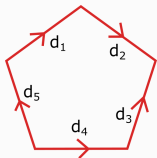
Directed tilings

There are many different directed $\{m, n\}$ tilings:



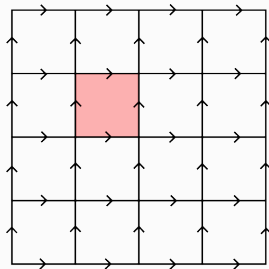
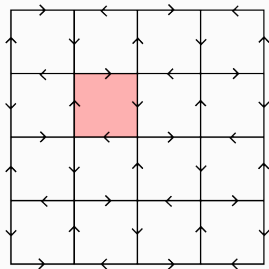
Reflective tilings

Whenever n is even, there is a reflective directed $\{m, n\}$ tiling:

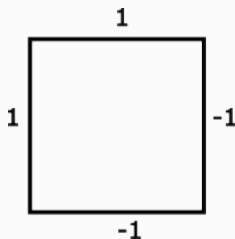


Reflection generated tilings

How to change the directions of a reflective tiling:

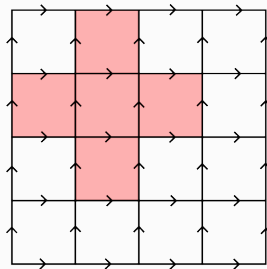
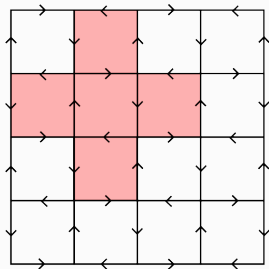


Reverse some edges of one tile:

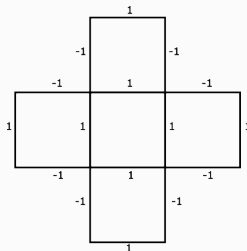


Reflection generated tilings

How to change the directions of a reflective tiling:

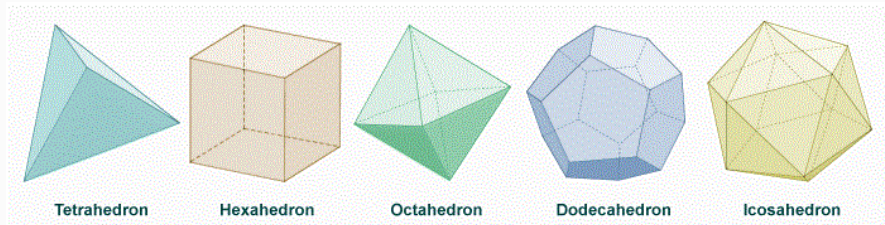


Reflect that tile outward and reverse more edges:



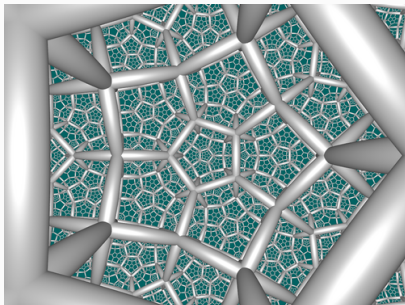
Where next?

- Tilings of the sphere (polyhedra) and other surfaces



Where next?

- Tilings of the sphere (polyhedra) and other surfaces
- 3-Dimensional tilings



Where next?

- Tilings of the sphere (polyhedra) and other surfaces
- 3-Dimensional tilings
- Irregular tilings and subdivisions



“Categorical Tiling Theory” - DiLeo, Sessoms, S., work in progress

Thanks for coming!

https://en.wikipedia.org/wiki/Order-4_pentagonal_tiling

https://en.wikipedia.org/wiki/Order-5_square_tiling

https://en.wikipedia.org/wiki/Heptagonal_tiling

<https://www.technologyuk.net/mathematics/geometry/platonic-solids.shtml>

https://en.wikipedia.org/wiki/Order-4_dodecahedral_honeycomb