



# Generating Muqarnas Plans

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# Initial Goals and Intentions

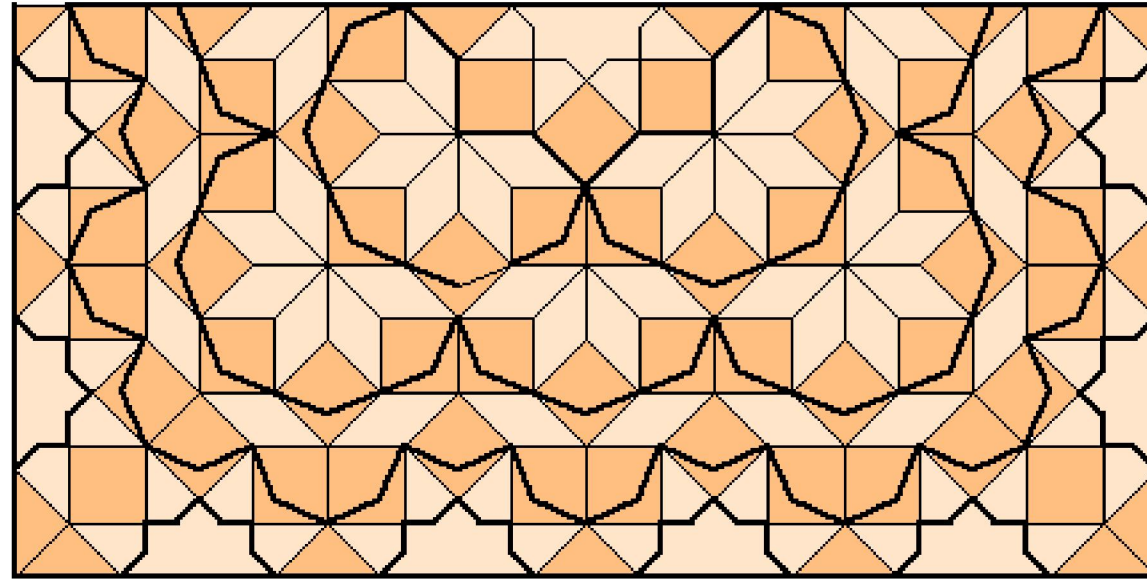
- Investigate the Islamic architectural ornamentation, *muqarnas*, to understand their creation and properties
- Create a series of shape grammars to generate both historical patterns and new design variations



What is *muqarnas*?





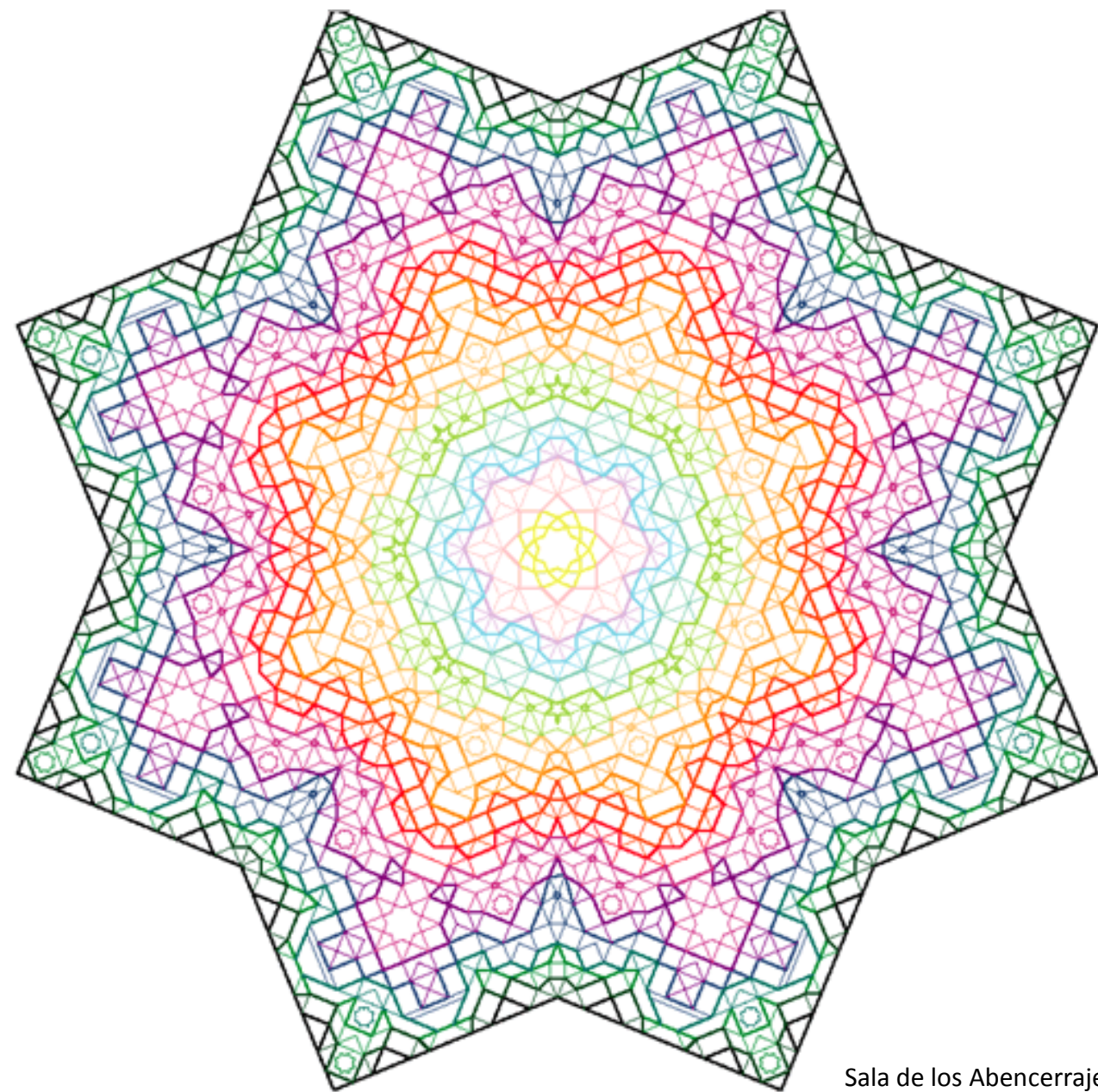


Samarqand, Uzbekistan  
(Shiro Takahashi)









Sala de los Abencerrajes, Alhambra, Granada  
(Shiro Takahashi)

# Glossary of 2D Terms

## *Primitive:*

The geometric shapes that make up muqarnas plan.

## *Seed and Origin:*

The highest point in a muqarnas. The seed refers to the first tier radiating from the origin, due to its unique nature.

## *Tiers:*

The rows in the muqarnas with each tier from the origin being one cell height lower. Thick lines or color in the plans represent the tier differences.

## *Crevice:*

The space between two primitives, in relation to the origin.

# Exploration

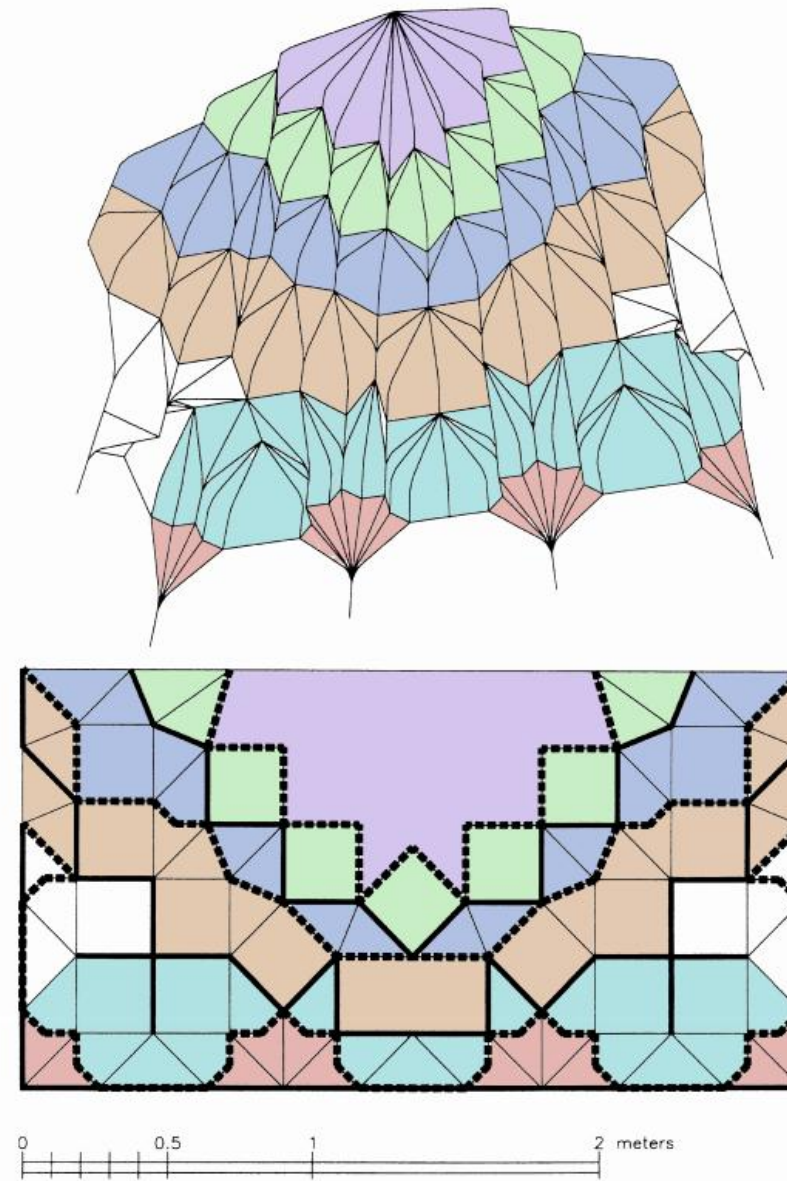
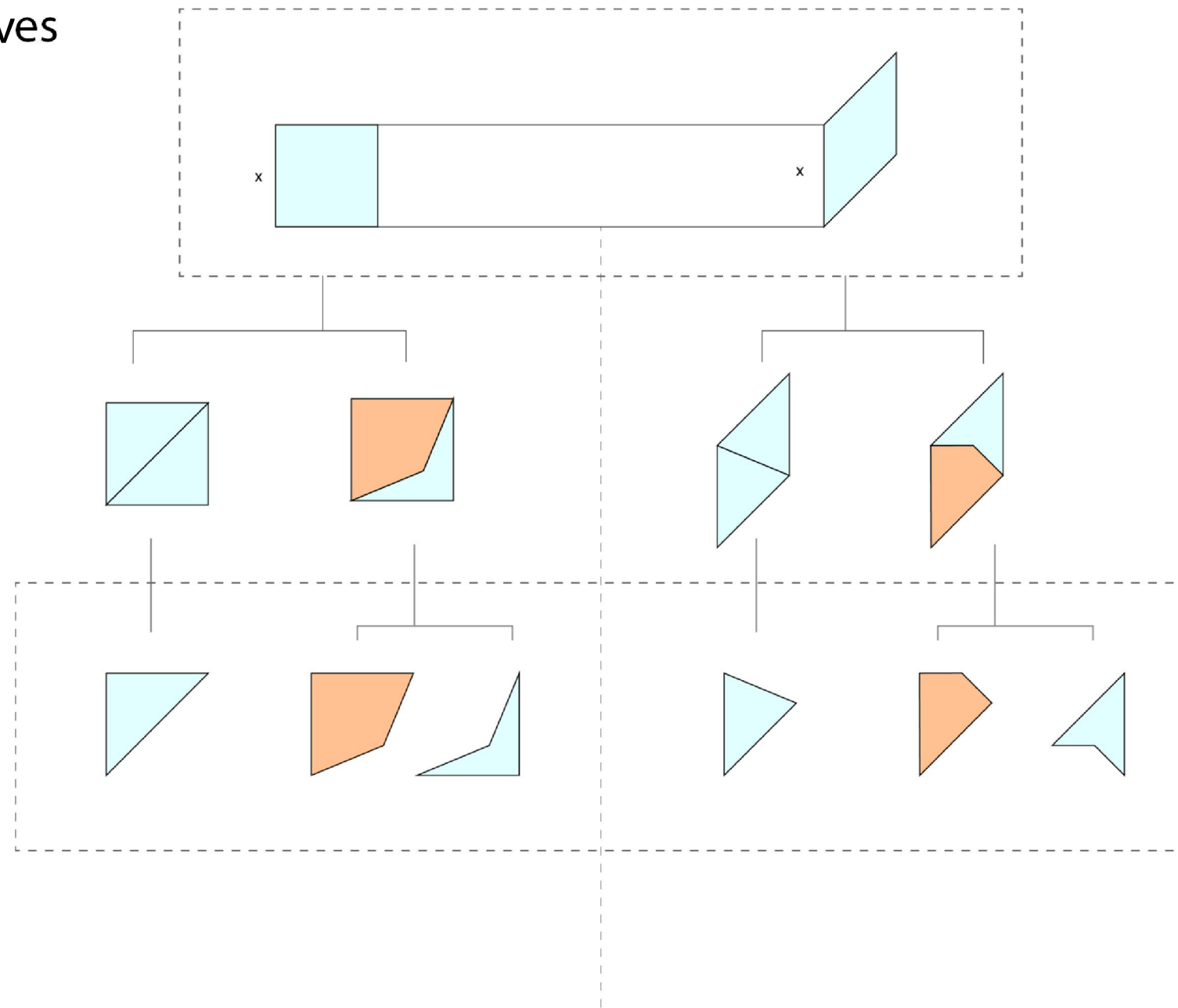


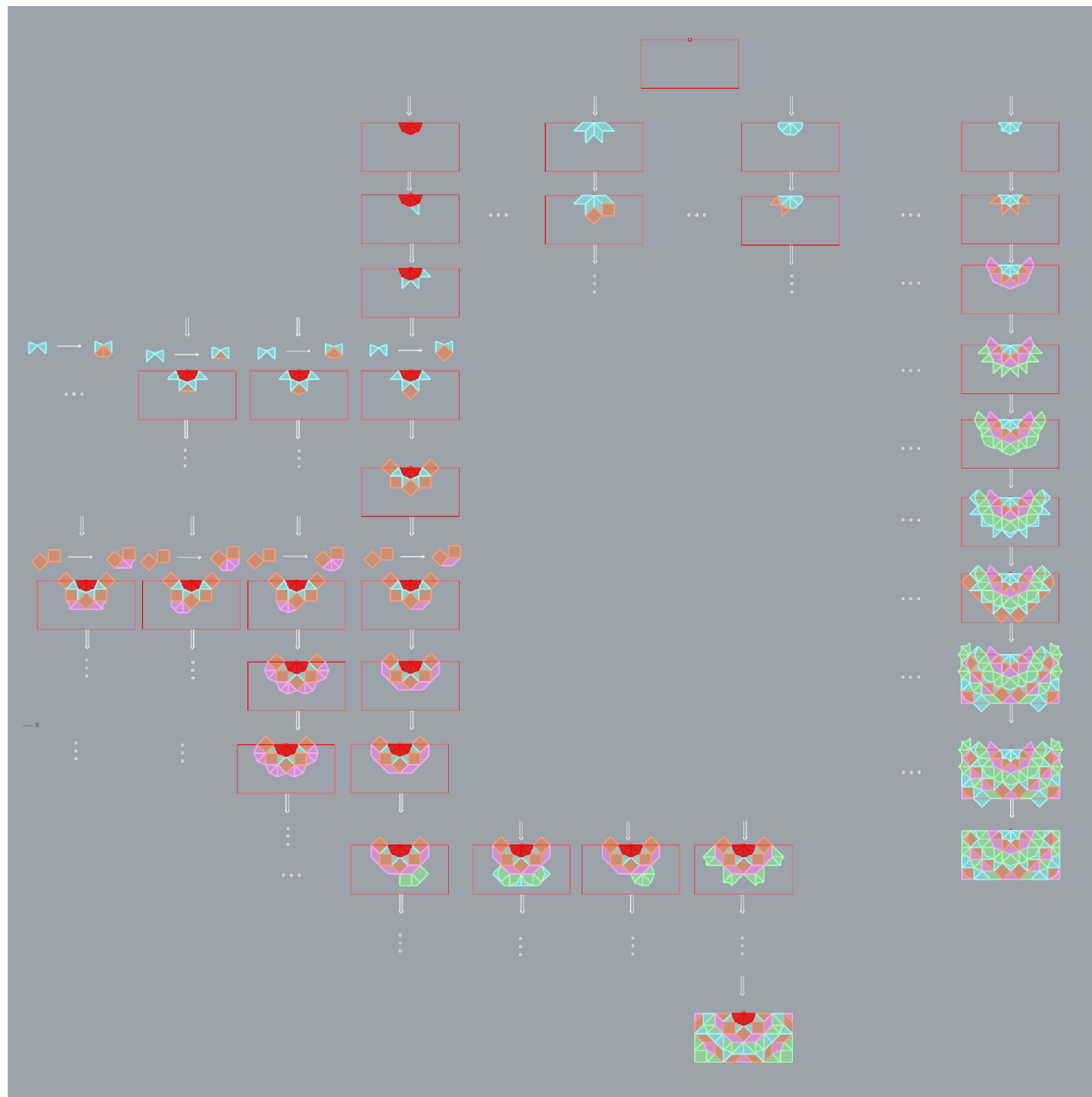
Fig. 9. Plan and 3D view of the muqarnas of a niche in the Friday mosque at Natanz; notice the 3D form of the half-star.



## Primitives



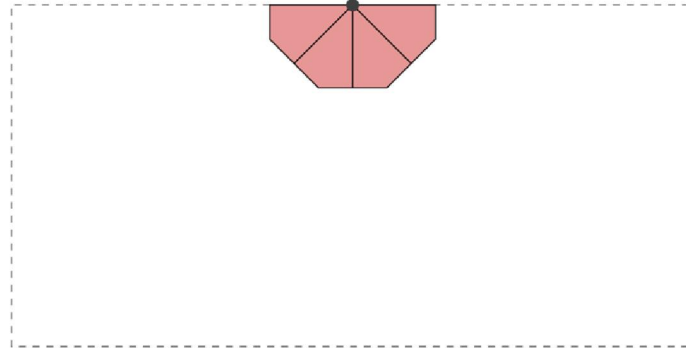
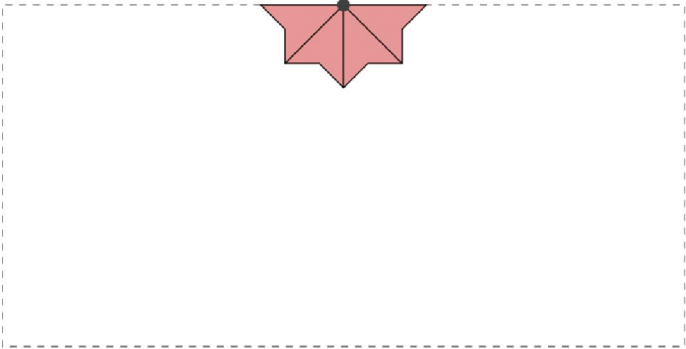
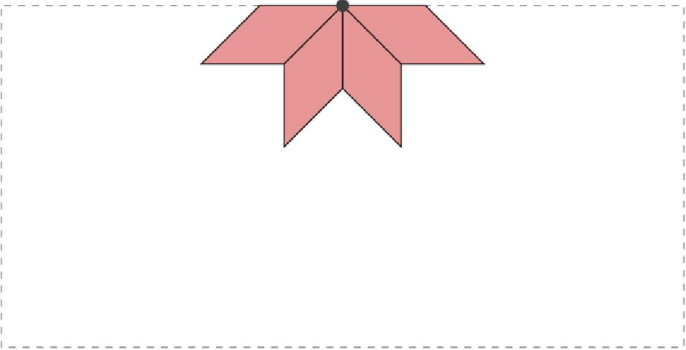
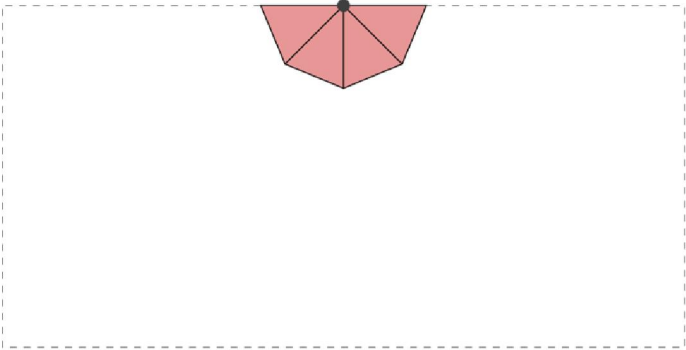
# Plan Generation



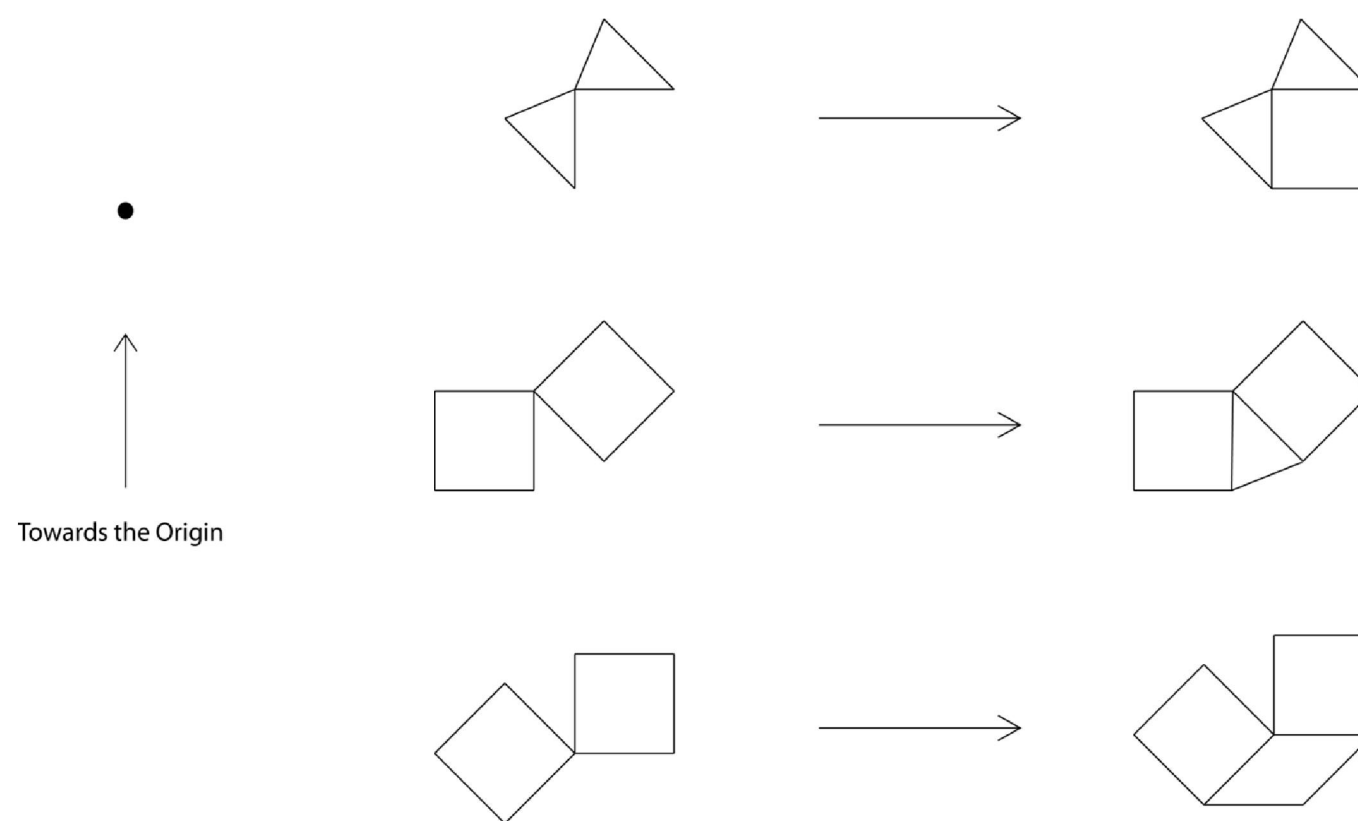


# Grammars: Seeding Possibilities

Origin

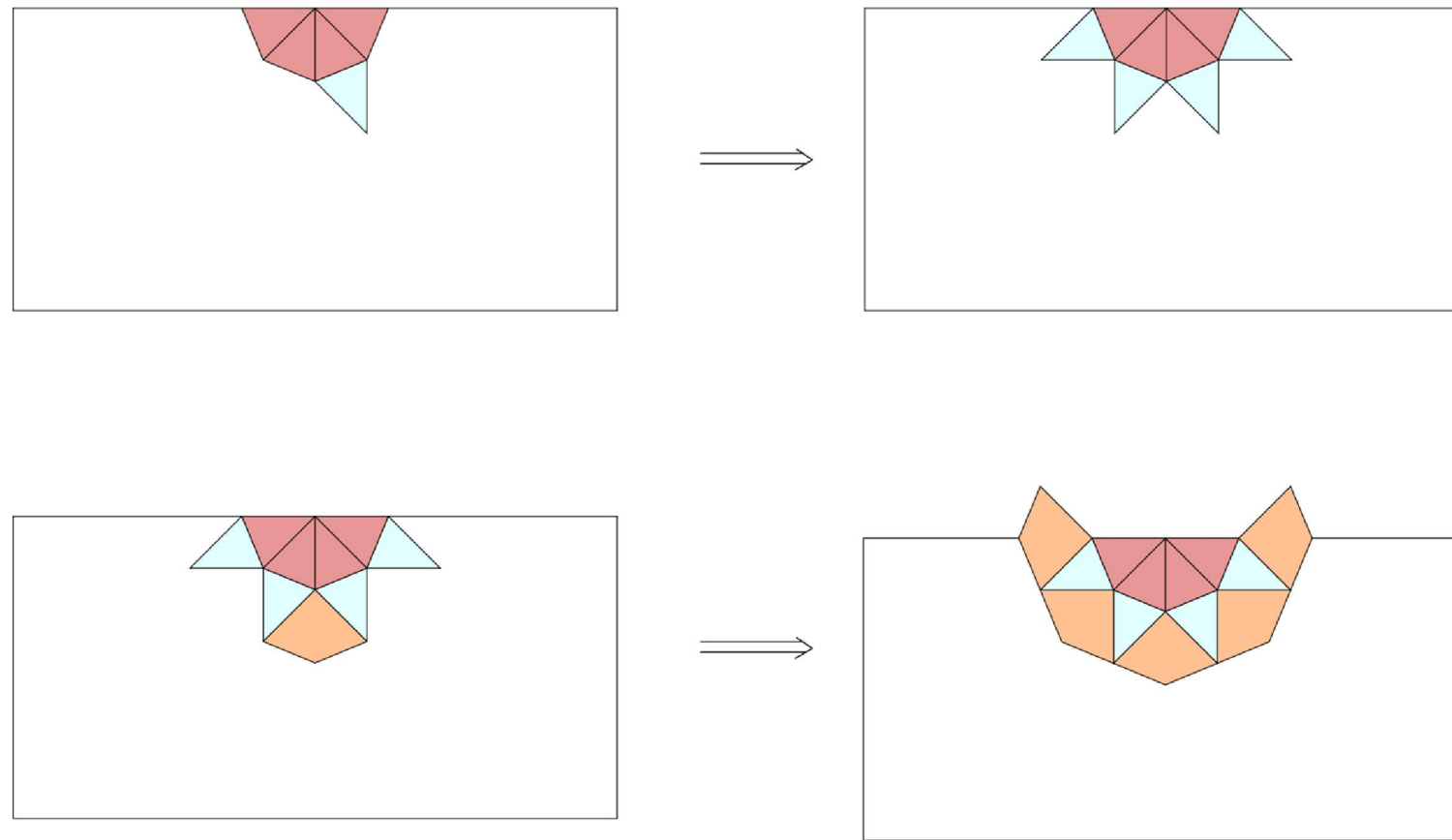


# Grammars: Filling Rules

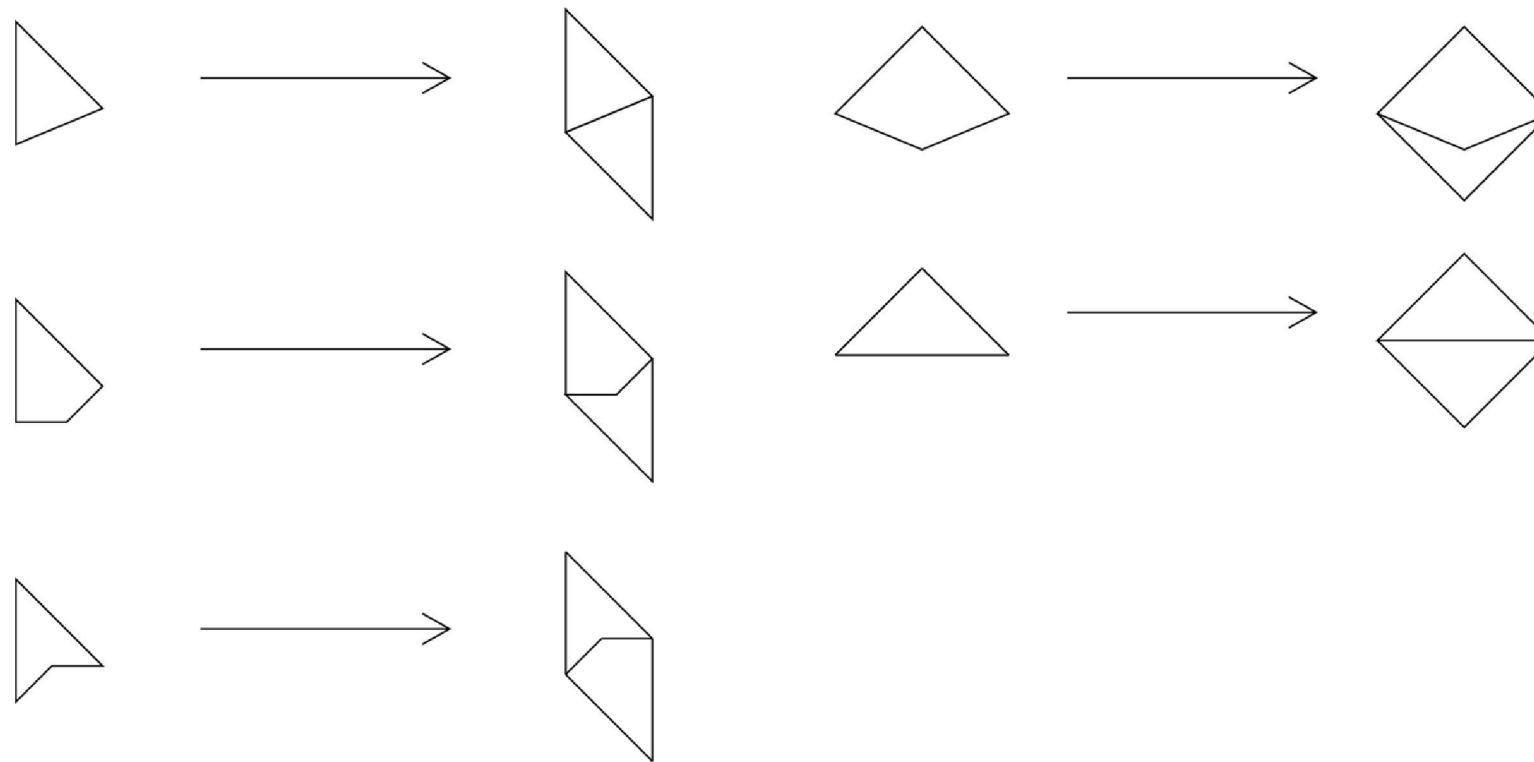




# Grammars: Rotational Filling Rules

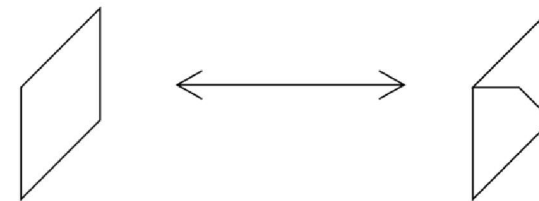
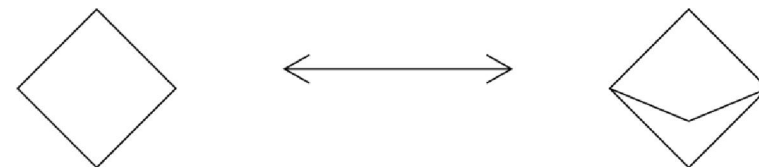
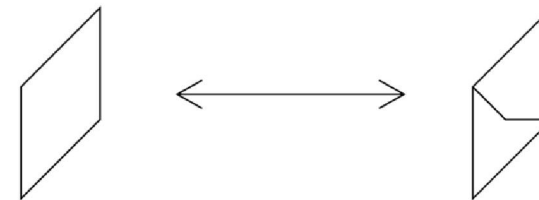
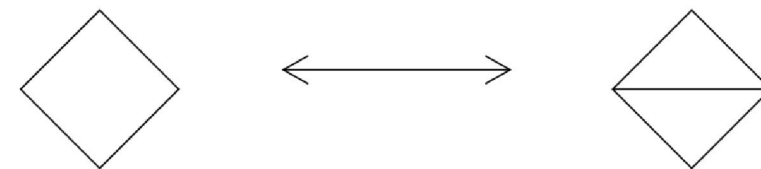
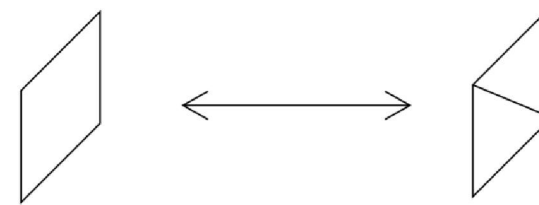


## Grammars: Completion Rules

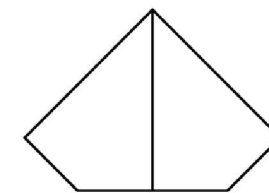
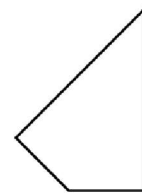
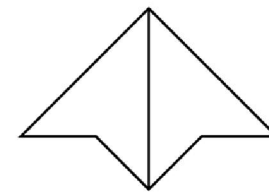
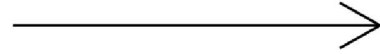
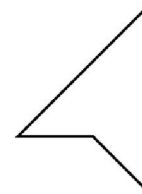
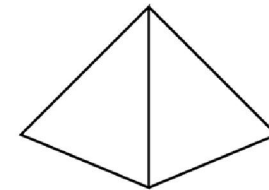
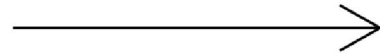
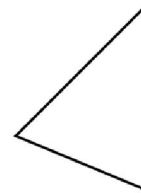




## Grammars: Sub(stitution + division) Rules

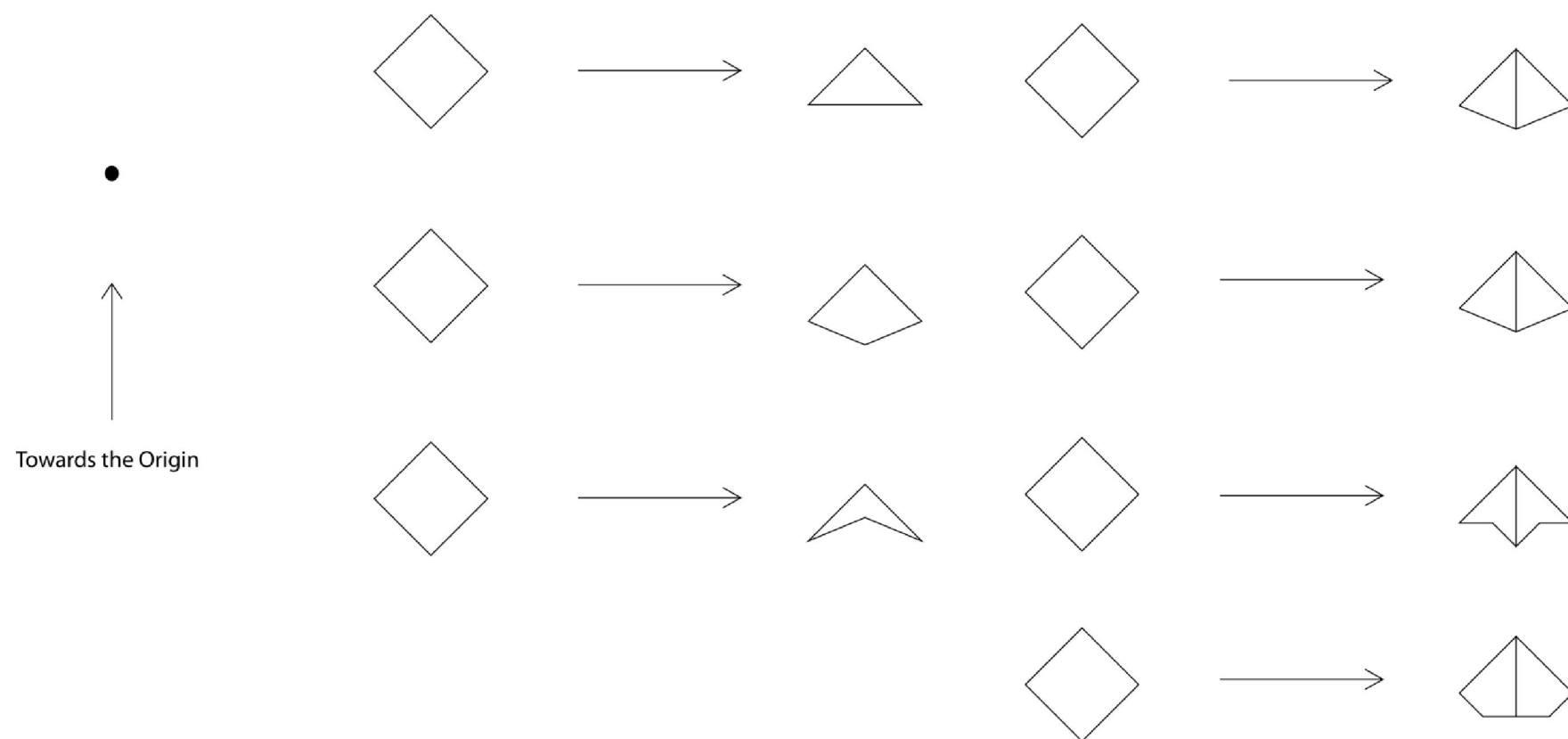


## Grammars: Compositional Rules





## Grammars: Angle Substitution Rules, $90^\circ$



## Grammars: Angle Substitution Rules, $135^\circ$