Craig Kaplan: Computer Generated Islamic Star Patterns

More than a thousand years ago, Islamic artisans began to adorn architectural surfaces with geometric patterns. As the centuries passed, this practice developed into a rich system of intricate ornamentation that followed the spread of Islamic culture into Africa, Europe, and Asia. The ornaments often took the form of a division of the plane into star-shaped regions, which we will simply call "Islamic star patterns." To this day, architectural landmarks in places like Granada, Spain and Isfahan, Iran demonstrate the artistic mastery achieved by these ancient artisans.

Lurking in these geometric wonders is a long-standing historical puzzle. The original designers of these figures kept their techniques a closely guarded secret. Other than the finished works themselves, little information survives about the thought process behind their star patterns.

Many attempts have been made to reinvent the design process for star patterns, resulting in a variety of successful analyses and constructions. University of Waterloo professor Craig Kaplan presents a process for creating computer-generated Islamic Star Patterns, acknowledging a technique described by Hankin [10], based on his experiences seeing partially-finished installations of Islamic art. Kaplan also incorporates the work of Lee [11], who provides simple constructions for the common features of Islamic patterns.

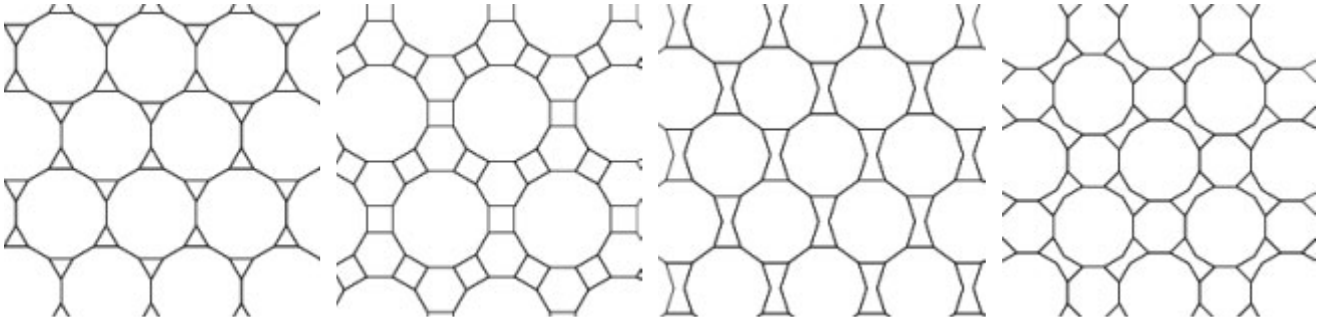
Given a tiling of the plane containing regular polygons and irregular regions, Kaplan fills the polygons with Lee's stars and rosettes, and infers geometry for the remaining regions. Kaplan has implemented this technique as the Java applet Taprats, (http://www.cgl.uwaterloo.ca/~csk/washington/taprats/) available on the web for experimentation. Taprats was used to produce the examples below. You may link to it to construct your own Islamic Star Patterns.

Figures 1 and 2 below present a selection of finished computer-generated drawings. The first group, Figure 1, is made up of reproductions of well-known Islamic star patterns which can be found in Bourgoin [3] or Abas and Salman [2]. Figure 2 contains designs that do not appear in either of those sources.

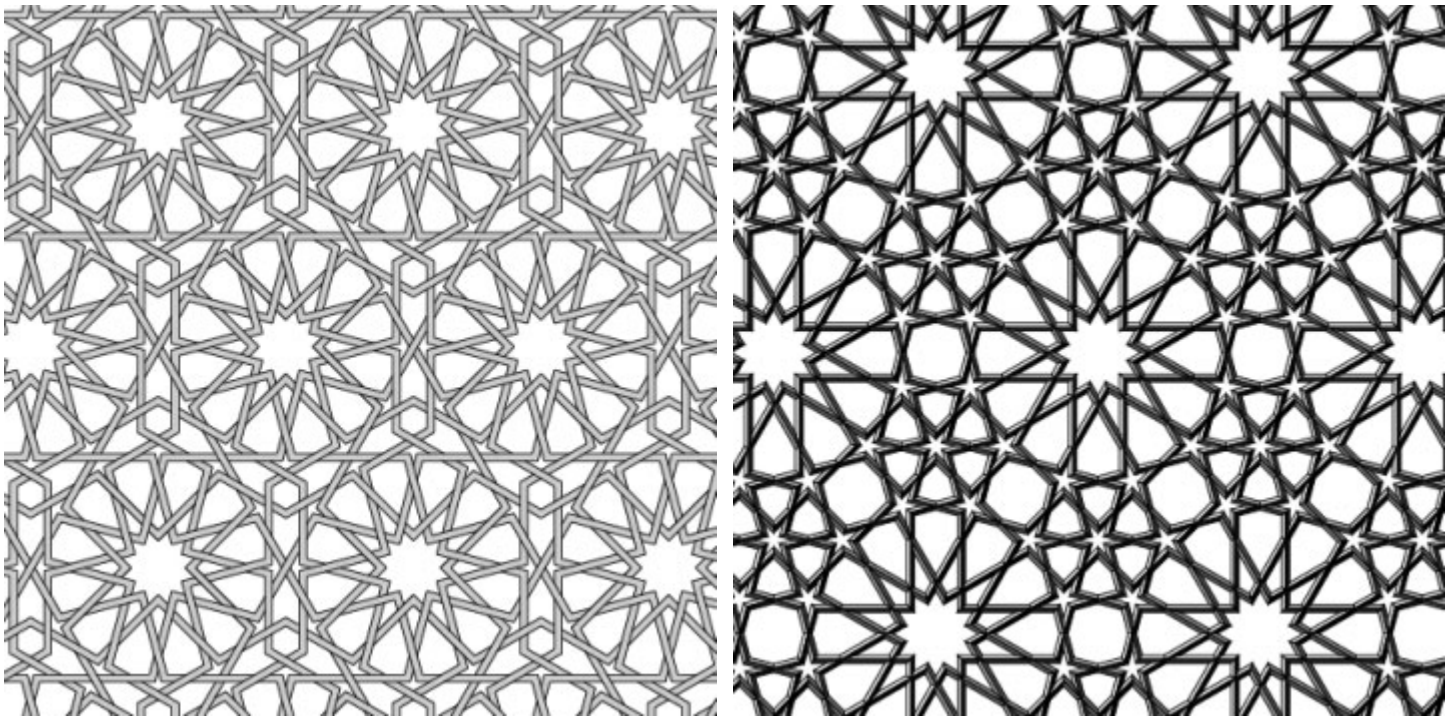
Three of these new patterns are based on polygonal tilings that do not seem to be used by any known designs. These last three are moderately successful, though they seem to lack the harmonious balance of the well-known designs. Still, in an artform with a thousand-year tradition, any sort of novel design is certainly of interest.

A report on this project may be found at Computer Generated Islamic Star Patterns (http://www.mi.sanu.ac.yu/vismath/kaplan/index.html), a web page describing the

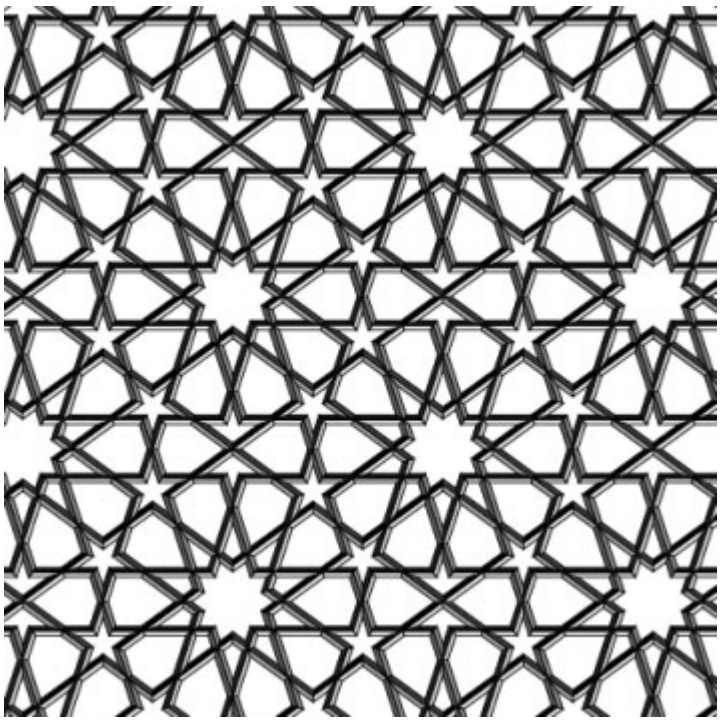
mathematical assumptions and procedures. Also, Professor Kaplan has been pursuing other ideas for generating Islamic Star Patterns, based in non-Euclidean geometry. Stunning photographs of this work and its applications can be seen at Islamic Star Patterns (http://www.cgl.uwaterloo.ca/~csk/projects/starpatterns/).

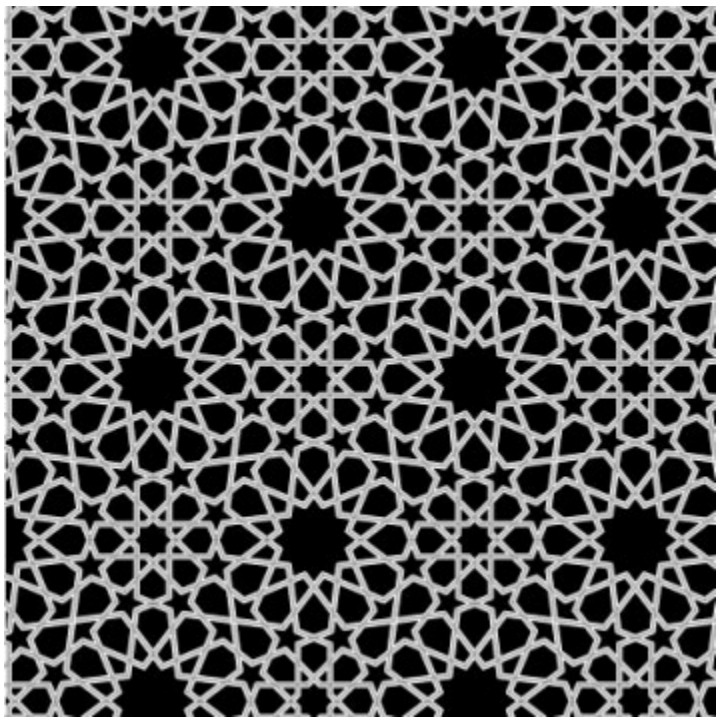


(a) (b) (c) (d)



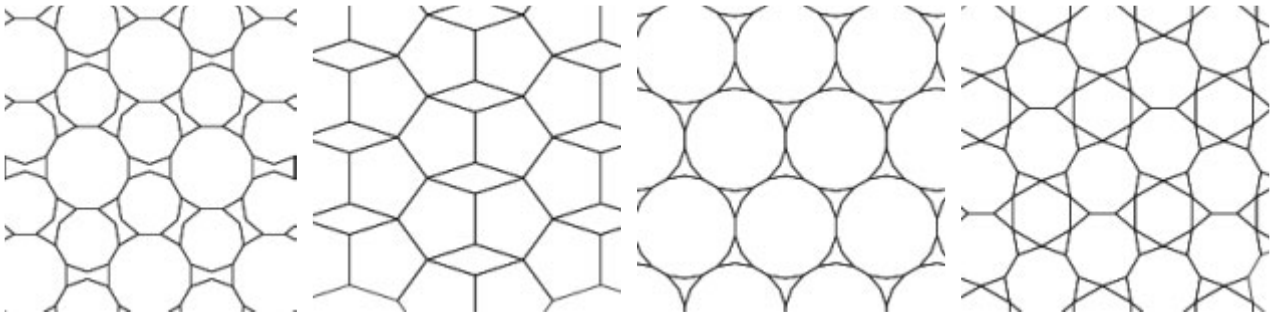
(a) (b)



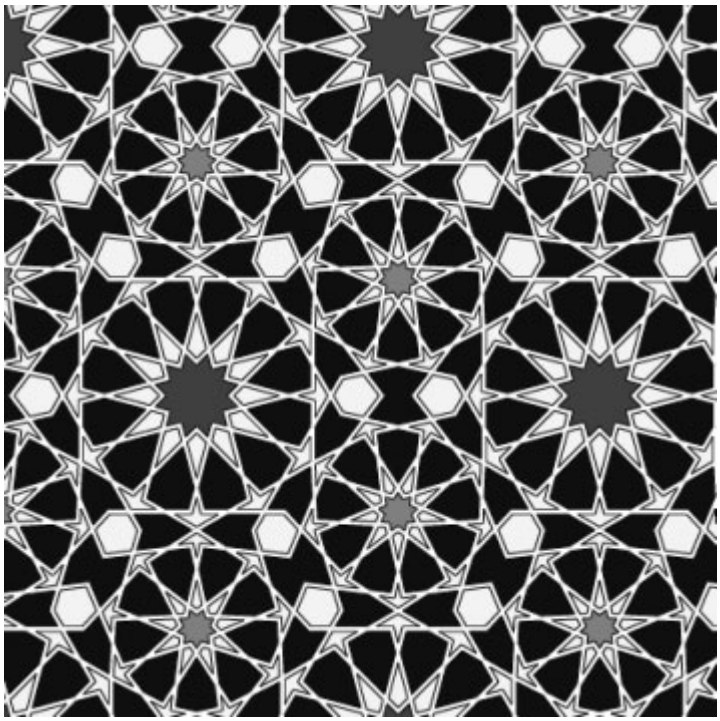


(c) (d)

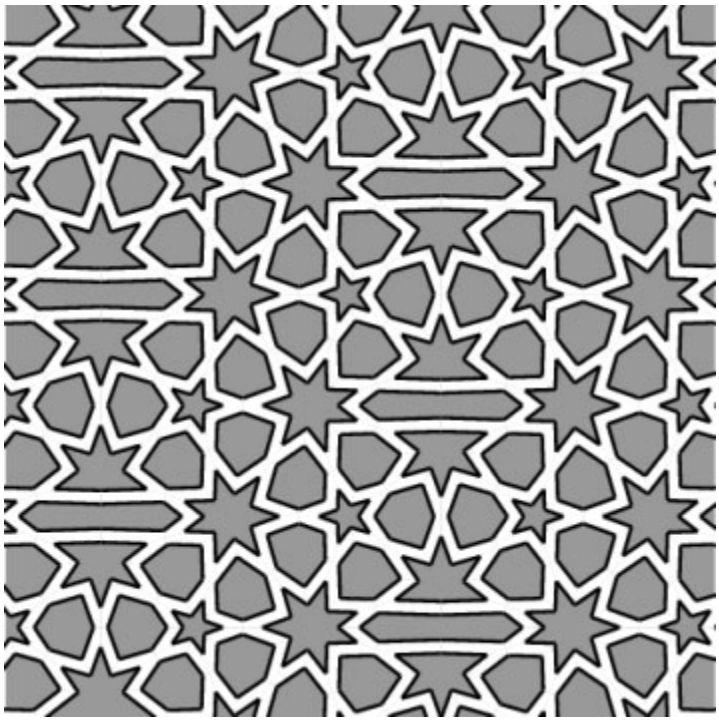
Figure 1: Some sample results based on well-known tilings from Islamic ornament. Each final design is based on the corresponding tiling in the top row.



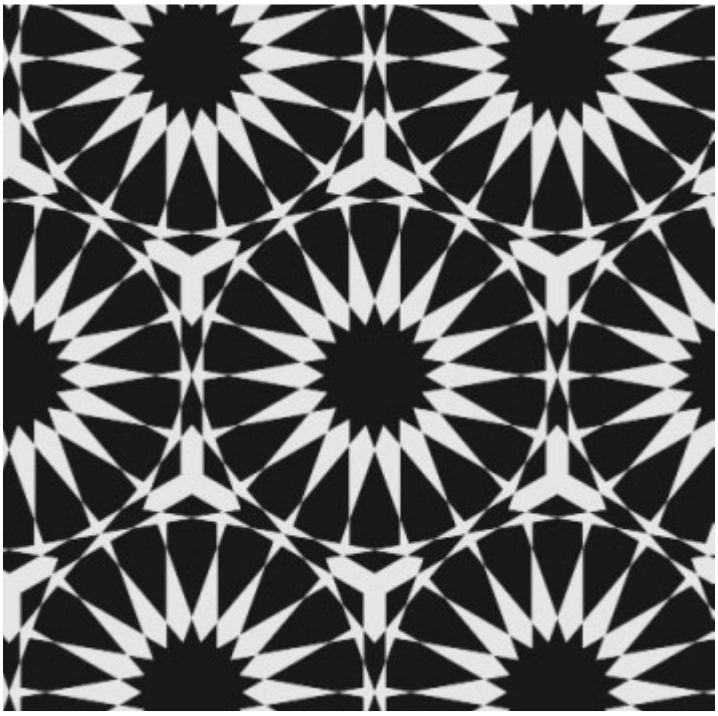
(a) (b) (c) (d)



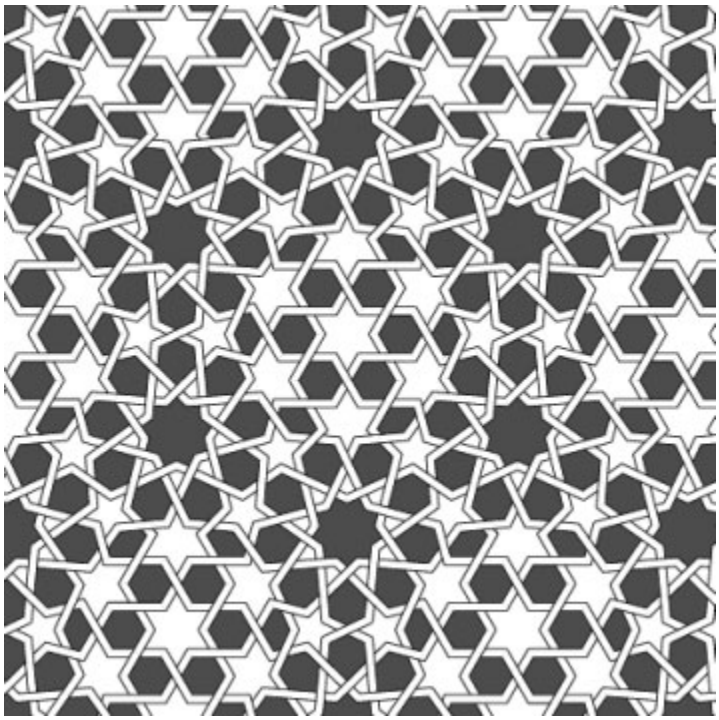
(a)



(b)



(c)



(d)

Figure 2: Sample results not found in the literature. The pattern in (a) is similar to one found in Abas and Salman [2, p. 93], using extended rosettes instead of ordinary rosettes. The other three patterns are based on previously unused tilings.

Craig Kaplan 2000-08-16

Bibliography

1

Syed Jan Abas and Amer Shaker Salman.
Geometric and group-theoretic methods for computer graphics studies of Islamic symmetric patterns.
Computer Graphics Forum, 11(1):43-53, 1992.

2

Syed Jan Abas and Amer Shaker Salman.
Symmetries of Islamic Geometrical Patterns.
World Scientific, 1995.

3

J. Bourgoin.
Arabic Geometrical Pattern and Design.
Dover Publications, 1973.

4

Jean-Marc Castera.
Zellijs, muqarnas and quasicrystals.
In Nathaniel Friedman and Javiar Barrallo, editors, *ISAMA 99 Proceedings*, pages 99-104, 1999.

5

A.K. Dewdney.
The Tinkertoy Computer and Other Machinations, pages 222-230.
W. H. Freeman, 1993.

6

Douglas Dunham.
Artistic patterns in hyperbolic geometry.
In Reza Sarhangi, editor, *Bridges 1999 Proceedings*, pages 139-149, 1999.

7

Jean-Marc Castera et al.
Arabesques: Decorative Art in Morocco.
ACR Edition, 1999.

8

Branko Grünbaum and G. C. Shephard.
Tilings and Patterns.
W. H. Freeman, 1987.

9

Branko Grünbaum and G. C. Shephard.
Interlace patterns in Islamic and moorish art.
Leonardo, 25:331-339, 1992.

10
E.H. Hankin.
Memoirs of the Archaeological Society of India, volume 15.
Government of India, 1925.
11
A.J. Lee.
Islamic star patterns.
Muqarnas, 4:182-197, 1995.

Links

1
Syed Jan Abas.
Islamic Art for the 21st Century.
2
Islamic Arts and Architecture Association.
3
Craig S. Kaplan.
Taprats: Computer-Generated Islamic Star Patterns.
4
Los Angeles County Museum of Art.
Islamic Art.
5
T.C. Rochford.
Welcome to Isfahan!
6
Mamoun Sakkal.
Sakkal Design.

Craig S. Kaplan:

Computer Generated Islamic Star Patterns
http://www.mi.sanu.ac.yu/vismath/kaplan/index.html

Islamic Star Patterns
http://www.cgl.uwaterloo.ca/~csk/projects/starpatterns/

Taprats
http://www.cgl.uwaterloo.ca/~csk/washington/taprats/