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On the Mathematics of Social Distancing

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Synopsis

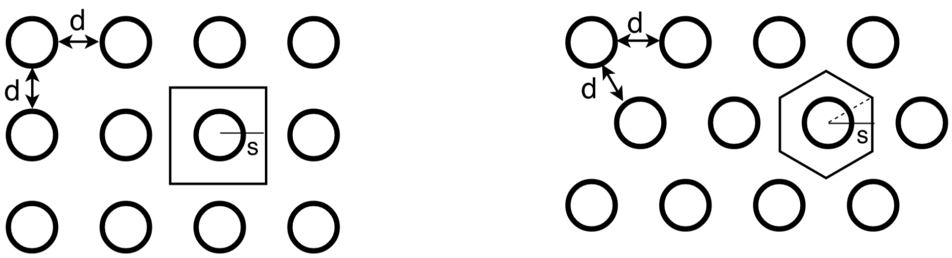
Early in the COVID-19 pandemic, when spring began to make itself felt, photos showed New Yorkers enjoying the outdoors, while properly socially distanced, by sitting on the grass in a square lattice of circles. But the planners should have consulted a mathematician for the design, because significantly more people (over 15% more) could enjoy the same area safely if the circles were closer packed into a hexagonal lattice.

Keywords: *COVID-19, social distancing, square lattice, hexagonal lattice.*

Photos show New Yorkers enjoying the spring of 2020 outdoors, while still rigorously observing social distancing, by sitting in an array of circles (Figure 1). But the planners should have consulted a mathematician first, because a better design would let significantly more people enjoy the same area.

Figure 1: Social distancing circles in New York City in the spring of 2020 [1]. Photo by Aaron Asis, used with the permission of Aaron Asis.

If families in circles of radius r must be separated by a social distance of at least d, the problem reduces to how best to pack a plane area with disjoint circles of radius $s = r + \frac{d}{2}$. The New Yorkers placed their circles in a square lattice (Figure 2A), thus taking up an area of $4s^2$ per family. Interleaving the rows of circles instead into a hexagonal lattice like a honeycomb (Figure 2B) would not compromise the social distancing, yet would take up an area of only $\frac{6s^2}{\sqrt{3}}$ per family, more efficient by a ratio of $\frac{4\sqrt{3}}{6} = 1.1547$: over 15% more people could safely enjoy the same area.



A. Square lattice **B. Hexagonal lattice**

Figure 2: Social distancing with a square lattice (A) and a hexagonal lattice (B).

References

[1] Michelle Young, "Photos of the Social Distancing Circles at Domino Park, Brooklyn", *untapped new york*, May 18, 2020, available at `https://untappedcities.com/2020/05/18/photos-of-the-social-distancing-circles-at-domino-park-brooklyn/`, last accessed on January 20, 2022.

Author bio:

Robert Haas began in mathematics (Ph.D. under Peter Hilton), detoured through a short career in protein biochemistry, and since his early retirement has been both working on new mathematical ideas (see "Intersection Cographs and Aesthetics" in this issue), and enjoying wider aspects of math as reflected in art ("Raphael's School of Athens: A Theorem in a Painting?", JHM **2**(2)), music ("Cello Tangents of Quartic Polynomials", JHM **8**(1)), and literature ("Mortal Taste", JHM **4**(1);"JHM Contents Word Puzzle", JHM **4**(2); "On Mathematicians' Eccentricity,", JHM **5**(2); "John Cheever's Story 'The Geometry of Love'", JHM **10**(1)).
