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From Obtuse Triangles to DNA Models and Synthetic Polymers: The Geometry of Random Polygons

In 1884 Lewis Carroll posed the following problem, purportedly solved in bed during a sleepless night: "Three Points are taken at random on an Infinite Plane. Find the chance of their being the vertices of an obtuse-angled Triangle." At least 10 different answers have been proposed over the last 130 years, due to various interpretations of the phrase "at random." I would suggest that Carroll's question is really about random triangles, not random points in the plane, and that the more basic question is: what does it mean to choose a triangle "at random"? And, really, why stop at triangles: what does it mean to choose an n-gon at random? I will give a very concrete answer to this question which has the virtue of being highly symmetric, meaning that it is relatively easy to compute probabilities and averages (which is to say, to integrate), including the probability that a triangle is obtuse. Moreover, the construction generalizes not just to n-gons in the plane, but also to n-gons in 3-dimensional space that are used to model so-called ring polymers, which are polymers like bacterial DNA forming closed loops. In fact, some of the same ideas which give an answer to Lewis Carroll's question have been used in chemistry labs to create synthetic polymers with novel topologies.

Bio: Clayton Shonkwiler is an Assistant Professor of Mathematics at Colorado State University. He received his Ph.D. in 2009 from the University of Pennsylvania, and then was a postdoc at the University of Georgia and a visiting researcher at the Isaac Newton Institute before coming to Colorado State in 2014. Dr. Shonkwiler is an expert on random knots and their applications to polymer models.

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