DRP Presentations Winter 2022

April 1st, 2022

“The Poincaré homology sphere” - Titus Sharman

Abstract: A homology 3-sphere is a manifold with the same homology groups as the 3-sphere. The presence of nontrivial homology spheres indicates that homology does not detect the 3-sphere. The first such example was discovered by Poincaré in 1904. We give a construction of this manifold, the Poincaré homology sphere.

“Elliptic Curves over Finite Fields” - Sidhart Krishnan

Abstract: In this talk, we will answer why people want to study elliptic curves and what are elliptic curves. After introducing elliptic curves and some fundamental properties about them, we specifically consider elliptic curves over finite fields culminating in a discussion of the Hasse-Weil bound on the size of elliptic curve groups over finite fields

“Counting Triangles in Random Graphs” - Jasdeep Sidhu

Abstract: We will first introduce the Erdos - Rényi model. Using this random graph model, we will find a lower and upper bound for the number of triangles. We'll then show that there exists a threshold for the probability of the appearance of a triangle.

“The Probabilistic Method in Combinatorics” - Aoden Teo

The probabilistic method is a powerful tool in combinatorics. We will demonstrate two classic uses of this technique: lower bounds for diagonal Ramsey numbers and lower bounds for sum-free subsets of the integers. Beyond simply proving existence theorems, the probabilistic method can prove more general classes of statements: we will demonstrate this by providing a probabilistic proof of the Kraft inequality.

“Rotation matrices and quaternions: a different perspective on 3D rotations” - Andrew Lee

In this talk, I aim to demystify the relationship between 3D rotations and the unit quaternions. We first define the matrix groups $SU(n)$ and $SO(n)$, or the special unitary and orthogonal groups, respectively. Then, we discuss the correspondence between the unit quaternions, SU(2), and SO(3). This correspondence reduces the problem of composing 3D rotations from the computationally intensive 3×3 matrix multiplication to simply multiplying quaternions. Thus, the correspondence between the unit quaternions and 3D rotations is at the core of modern computer models involving 3D rotations.