**MAT 598 93581 – Introduction to Knot Theory and its applications.**
Instructor: Eleni Panagiotou
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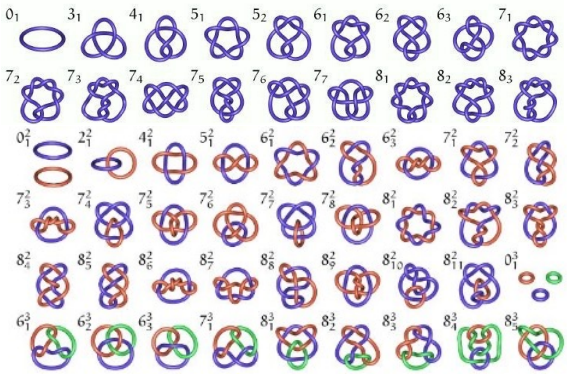
Time and location: Fall 2023 TTh 4:30-5:45pm, Tempe WXLR A302

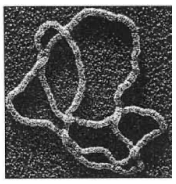
**Course Description**: Knots and links appear in our every day life; from our shoelaces and the textiles that we wear, to unvisible to us, knots in our DNA and proteins. Knot theory, is an area of topology that studies and classifies simple closed curves (knots). In this class we will set the foundation for studying the conformation of open and closed curves in 3-space in general, with traditional methods from knot theory and topology, as well as new methods in knot theory. We will show hand-in-hand how these new mathematics are immediately applied to reveal new aspects of materials and biopolymer function through computation and testing against experimental data. This cutting edge area of research is promising for an unexpected application of mathematics to contributing to answering major pressing problems related to health and disease, as well as manufacturing.
The students of this class will benefit by acquiring the background to think mathematically on problems involving systems of curves in 3-space. This course may be of interest to students interested in topology and/or graph theory and/or mathematical biology.
Topics include: knots, links, Seifert surface, genus, linking number, Kauffman bracket polynomial, Jones polynomial, HOMFLYPT polynomial, Vassiliev invariants, tangles, braids, knotoids, entanglement of open curves in 3-space, entanglement in systems employing Periodic Boundary Conditions, entanglement of random walks, applications to DNA and protein structure, entanglement in polymer melts and solutions.

Knot Theory and Its Applications

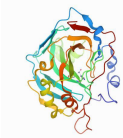
Knots and Links



$$L(l_1, l_2) = \frac{1}{4\pi} \int_{[0,1]} \int_{[0,1]} \frac{(\dot{\gamma}_1(t), \dot{\gamma}_2(s), \gamma_1(t) - \gamma_2(s))}{||\gamma_1(t) - \gamma_2(s)||^3} dtds$$

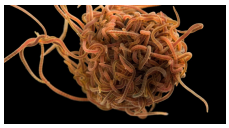


DNA
Cozzarelli et al,
*Science* 229, 171, 1985



Protein folding
Plaxco et al.
*J. Mol. Biol.*, 277:985–994, 1998

Textile weaving
amien et al *J. Eng. Fibers and Fabrics*, 15, 2020



Worm blobs
Patil et al
*Science* 2022
A. Deblais, S. Woutersen, and D. Bonn Phys. Rev. Lett. 124, 188002 (2020)

**Grading**: Students will be expected to give an in-class presentation based on a research project selected from those offered in the class or based on a research paper.

**Textbook**: C. C. Adams. The knot book: an elementary introduction to the mathematical theory of knots. AMS, 2004 and selected surveys.

**Prerequisites**: Background in logic and proof required, or instructor approval. Basic knowledge of a programming language is recommended.