Online Proceedings

SESSION 1L

MATHEMATICAL MODELING IN THE SCIENCES

Session Moderator: Elizabeth Thompson, Statistics
MGH 271
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Mathematical Studies of Data Storage in CD-ROM and DNA
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Taylour Mills, Sophomore, Aeronautical Engineering, Lake Wash Tech Coll
Mentor: Narayani Choudhury, School of Science, Technology and Math, Lake Washington Institute of Technology, Kirkland

Current data storage elements have reached their threshold capabilities due to extensive data and limiting size requirements. Digital storage in DNA has aroused considerable interest as the next generation miniaturized high capacity storage device. Deoxyribonucleic acid (DNA) forms the genetic blueprint of life and is the primary carrier of genetic information in living cells and organisms. Data storage in DNA involves encoding of digital binary data into synthesized DNA strands. Here, we employ calculus-based methods to provide a comparative study of data storage capacities of conventional CD ROM and DNA. We use parametric equations to model the spiral structure in CD ROM and double helix of DNA and employ calculus-based methods to study the arc length, curvature and topological properties of DNA. The data storage densities for binary, base 3 and base 4 in DNA are estimated. The calculated data storage densities are found to be in good agreement with reported estimates. Recent studies demonstrate that magnetic nano-knots can be used for data storage. The topological properties of DNA including twists, links and knots thus provide additional attributes which may in future be used for data storage.

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Network Topology of Knots and Borromean Rings
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The use of magnetic nano-knots and Brunnian links for data storage and communications, makes understanding the geometric and network topology of knots and links very important. Recent reports suggest that DNA and other halogen networks self-assemble into exotic Borromean ring molecular topologies. Borromean rings form a Brunnian link with three rings linked in such a way that no two alone are connected. Only when all the three rings come together does the linkage occur. Borromean links form the current logo of the International Mathematical Union and they display strength in unity. Understanding knots, links and their networking is central to our understanding of DNA, protein folding, polymers and other soft materials. We have used a 3D printer to print and design a Borromean Math puzzle. The puzzle falls apart when a link is pulled out and is an excellent learning tool for studying Borromean link topologies. We use mathematical methods using parametric equations to study Borromean rings and trefoil knots. We wrote computer visualization code using SAGE to display trefoil knots and complex Borromean links for distorted circular, elliptical and other geometries. The SIEFERT surface of Borromean links are sketched using SeifertView and provide an aesthetic 3D view of the rings which can be oriented on a plane. The Seifert surface of a knot is a knot invariant; it is the characteristic of the knot with the knot as a boundary. The adjacency matrix and topologi-

cal connectivity of the links are studied using vector directed graph models. A computer program is written to unravel the complex linking and intriguing connectivity properties of the trefoil knot and Borromean networks.