Experimental Mathematics with Computers

Credits: 5 ECTS
Course period: November 2021 – February 2022
Teacher: Klara Stokes, klara.stokes@umu.se

Prerequisites: A course in basic programming. Courses in mathematics at undergraduate level.

Description:
Computers are useful in most areas of mathematics. In experimental mathematics computational tools are used to make new conjectures and to get better acquainted with the mathematical objects under study. Computers can also prove results in mathematics by providing examples and counterexamples, or by counting the number of mathematical objects with a certain property (including proving there is no such object). For example, a computer was used in the proof that there is no projective plane of order 10. Proofs made by computers are however not uncontroversial.

The topic of this course is the use of computers in mathematics, both methodology and practice. The student will learn how to use the symbolic programming language SageMath in experimental mathematics. Sagemath (available from www.sagemath.org) is an umbrella software for a large number of computational libraries designed by and for mathematicians in different fields. The interface is Python-based, and there is wide range of packages, such as for example Maxima, Singular (algebra), R (statistics), Pari/GP (number theory), Nauty and NetworkX (graph theory), GAP (computational discrete mathematics), GLPK (linear programming), etc. Additionally, SageMath has a lot of native functionalities.

For a complete list of packages included in SageMath see:
https://doc.sagemath.org/html/en/reference/spkg/

The area of mathematics to focus on can be adapted according to the interests of the students. For students without specified interests a general syllabus will be according to the main interests of the department and/or the teacher. (Examples of the teacher's interest: computational group theory, finite geometry, Groebner bases, embeddings of discrete structures on surfaces.)

Course structure and examination:
Lectures, seminars, and projects. Examination consists of projects that will be presented both in written and oral form. The students will present their projects to the course participants in a seminar, receive feedback and then finalize the written projects in short conference article form taking into account the feedback.