Self-Adaptive and Self-Learning Computational Methods for Engineering, Mathematics, and Scientific Discovery, and for the Automated Development of Student Assignments

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For decades, mathematical modeling and computational mechanics have advanced through adaptive algorithms such as adaptive finite element methods, which dynamically refine meshes, and shape optimization techniques that iteratively improve structural designs. Subsequent research has extended these principles toward meta-optimization—the automated discovery of the most effective algorithms for a given class of problems—and toward automated code generation that translates mathematical formulations directly into executable implementations. These developments emphasize the importance of dynamic, evolving computational structures capable of adapting their logic, models, and code.

This presentation introduces ongoing research on self-adaptive and self-learning computational methods that can autonomously refine not only numerical procedures but also higher-level mathematical reasoning. Such systems are designed to generate, test, and improve both the methods and the results of computation across disciplines—including engineering analysis, abstract mathematics, theoretical computer science, and general scientific modeling.

As a particular application, the same framework can be used for the autonomous development of educational assignments in mathematics, computer science, and engineering, providing dynamically generated problems tailored to specific learning objectives. These efforts mark a step toward a new generation of autonomous computational systems capable of evolving knowledge and methods across both scientific and educational domains.