Thinking Fast:
Patterns Of Cognitive Error In Software Engineering Education

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In this paper, the author examines typical mistakes of third year undergraduate Computer Science and Software Engineering students in advanced software engineering courses. In elementary courses, the students learn and apply techniques locally to relatively simple problems. In advanced courses the students are trained to select and integrate a number of techniques to solve several interdependent problems encountered in the development of complex systems. In this context, the work of Daniel Kahneman on System 1 (intuitive) and System 2 (rational) thinking is very relevant to analyze the patterns leading to cognitive errors. This analysis enables inferring conclusions about the software knowledge itself, viz. the abstract conceptual structures of the software engineering design patterns themselves and their inherent cognitive difficulties. We show how System 1 may "prime" to solve the wrong problem or solve the problem incorrectly, as evident from diagrammatic representations (UML and Statecharts) in the students' solutions. Other recurring phenomena include: reversal of reciprocal roles (as in the Visitor pattern), difficulty in superposition of paradoxical roles (e.g., an observable that is also an observer), difficulty in integration of multiple diagrams (e.g., interactions among several statecharts). We propose multi-disciplinary data mining of exam answers to identify desired emphases, and individualize instruction according a student's cognitive profile.

Dr. Reuven Gallant is a vice-chairman of the Computer Science and Engineering at the JCT Lev Academic Center. Prior to his transition to academia he worked in system integration, software/system development methodologies and process improvement at Sikorsky Aircraft and Israel Aerospace Industries. His present research focuses on the cognitive challenges of model-based engineering. He has a B.S. and M.S in Electrical Engineering from M.I.T. and a doctorate in History from Yale University.