# Research Behind ALEKS

ALEKS is an artifically intelligent learning and assessment system, which utilizes big data and machine learning. ALEKS applies combinatorics and stochastic processes theory to the modeling and empirical description of particular domains of knowledge (Algebra 1, for example). ALEKS uses Knowledge Space Theory to determine precisely what each individual student knows, and what the student is ready to learn next.

Knowledge Space Theory is the culmination of ground-breaking theoretical research in mathematical cognitive science conducted by Dr. Jean-Claude Falmagne, founder of ALEKS, at New York University and the University of California, Irvine (UCI), and Dr. Jean-Paul Doignon, at Université Libre De Bruxelles. Since then, hundreds of scientific papers and several books have been published on Knowledge Space Theory. A bibliographical database is maintained by **Cord Hockemeyer at the University of Graz in Austria**. A brief list of recent publications by ALEKS research scientists is here: **ALEKS Publications**.

Dr. Falmagne, leading a team of cognitive scientists, mathematicians and software engineers at UCI, developed the first version of ALEKS with major funding from the National Science Foundation.

National Science Foundation
WHERE DISCOVERIES BEGIN

ALEKS is based on Learning Spaces, a type of *Knowledge Space*. A *Knowledge Space* is a representation of a domain of knowledge (such as Algebra 1) as a combinatorial structure that delineates the combinations of elements of knowledge (problem types in Algebra, for example) that comprise all the feasible states of knowledge of individual students. A student's *knowledge state* is the complete set of problems that the individual student is capable of solving in the particular domain of knowledge. For example, Algebra 1 is regarded as a domain of roughly 400-500 core problem types - giving rise to a *knowledge space* of a few trillion empirically feasible states of knowledge. That is, each Algebra 1 student could be in any one of a few trillion feasible knowledge states.

In ALEKS, mathematically rigorous theory facilitates the development of computer algorithms for the construction and mapping of knowledge spaces. This enables ALEKS machine learning software to comprehensively investigate trillions of potential knowledge states to accurately diagnose each individual student's precise knowledge of the subject, and what that individual student is currently ready to learn. Even with such a large number of knowledge states in the knowledge space, the ALEKS adaptive assessment is nevertheless able to rapidly and efficiently assess a particular student's knowledge after the student has answered only 20-30 questions.

The outcome of an ALEKS assessment consists in (i) the precise and comprehensive description of an individual student's competence in a particular subject in the form of a knowledge state that describes the problem types already mastered by that individual student, and (ii) the problem types that the individual is ready to learn next.