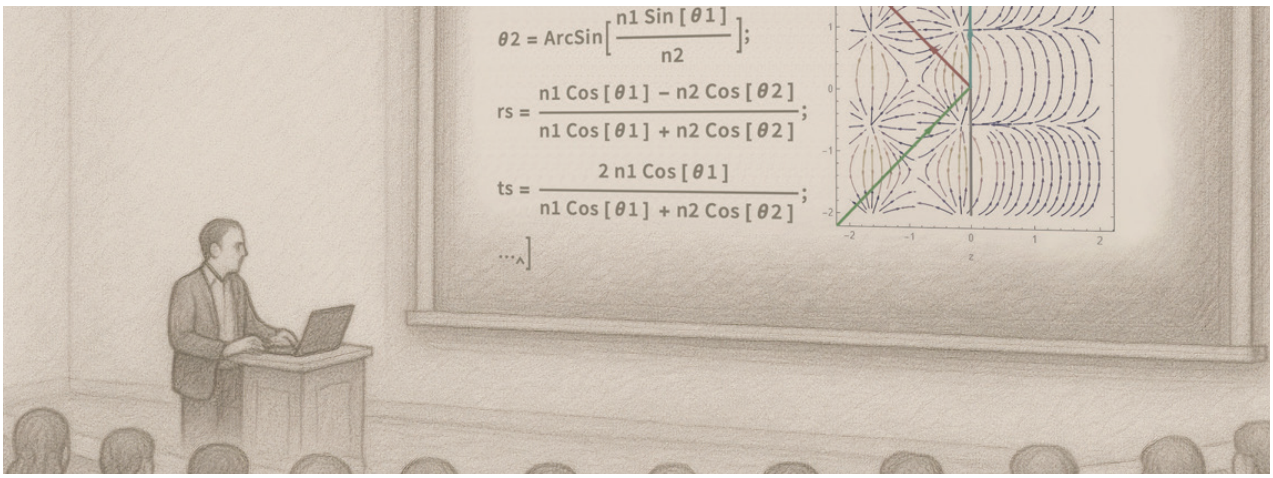
WOLFRAM CONSULTING SERVICES

The Power of Symbolic Computation for Research, Teaching and Development

Industry: Education

Applications: Mathematics, Engineering, Physics



ABOUT

Professor Youngjoo Chung first discovered Wolfram Mathematica in 1990, using Version 1.2 while working at Argonne National Laboratory as a postdoc during his education in the United States. Since then, Mathematica has remained an invaluable tool in his academic life, guiding his studies, research collaborations and investigations into complex mathematical systems.

Nowadays, in addition to his research, Professor Chung uses Wolfram Mathematica to teach electrical engineering at South Korea's Gwangju Institute of Science and Technology (GIST), where he is a proponent of computer-based mathematics, encouraging students to rely on computers for computation so they can focus on understanding the underlying concepts rather than getting bogged down in hand calculations.

To support both research and teaching, Professor Chung developed a comprehensive add-on package built on Wolfram Language, designed to adapt the symbolic computation environment of Wolfram Mathematica for more traditional mathematical input and greater control over how expressions are structured and manipulated.

This combination helps researchers and students to more easily transition from handwritten work to computer-based mathematics. For his work on MathSymbolica, Professor Youngjoo Chung received the Wolfram Innovator Award in 2017.

MATHSYMBOLICA: BUILDING ON A SYMBOLIC FOUNDATION

In 2002, Professor Chung began developing MathSymbolica, a comprehensive add-on package built on top of Mathematica's symbolic engine. Designed to support more structured, didactic workflows and traditional mathematical input, MathSymbolica adapts the flexibility of Wolfram Language to serve both teaching and research needs. The package includes its own interpreter language, full interactive documentation and dedicated palettes, and has been adopted by other educators and researchers seeking a similar approach.

The latest version of MathSymbolica packs in over 1,200 functions in addition to the thousands already available in Wolfram Language. These functions cover a wide range of symbolic mathematics, from basic algebra to more advanced topics such as complex variable transformations and symbolic differentiation.

MathSymbolica is built on a few distinctive design principles:

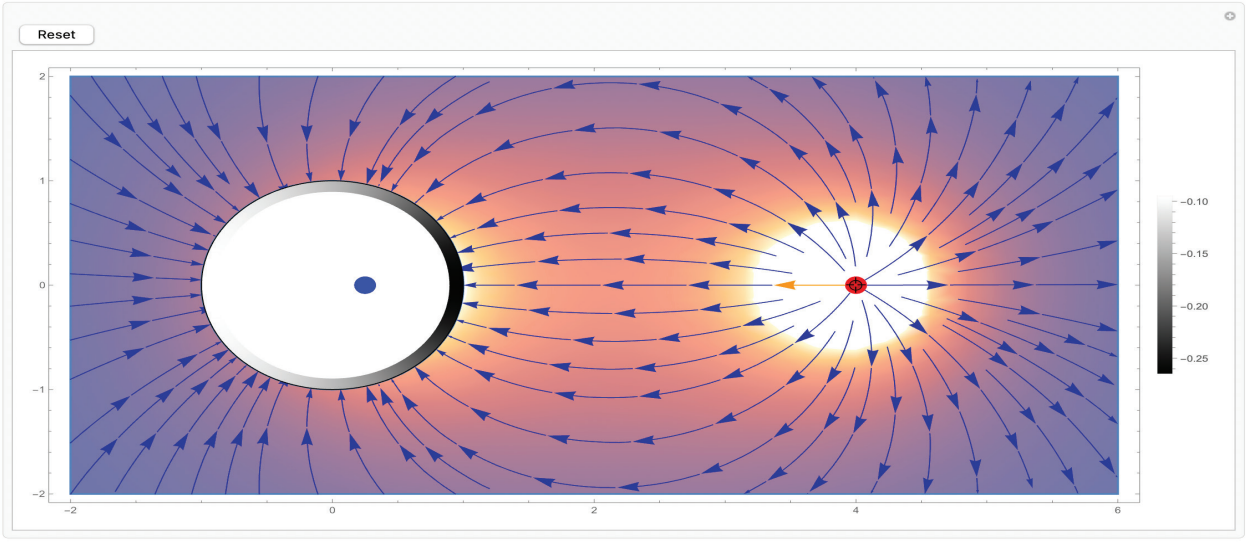
- Deferred evaluation—expressions can be defined symbolically without being evaluated immediately. This separation between representation and execution allows for a focus on the general form of a problem, encouraging a deeper understanding of the underlying mathematics.
- Sequential execution of functions—functions can be applied in a step-by-step manner, allowing instructors to walk through each stage of a solution in a controlled, didactic way.
- Traditional notation—mathematical expressions are input in a form that closely mirrors handwritten math, making computer code more readable and bridging the gap between handwritten notation and computer-based math.

Fundamentally, it is Wolfram Language's symbolic nature and extensibility that provided the optimal foundation for MathSymbolica. The ability to easily extend core functionality combined with the freedom to deviate from Wolfram's design choices where necessary made it possible for Professor Chung to build a tool that is both technically sophisticated and tailored for the classroom.

Today, Professor Chung uses Wolfram technologies across every aspect of his research and teaching—from creating presentations and interactive course materials in Mathematica to guiding students through symbolic modeling of engineering laws and principles. MathSymbolica integrates seamlessly into this environment, extending Mathematica's capabilities to support step-by-step, didactic workflows and giving students a consistent, end-to-end experience in computer-based mathematics.

"When it comes to symbolic computation, there is no other choice considering the foundation and extensibility. It has to be done in Mathematica."

—Professor Youngjoo Chung
Gwangju Institute of Science and Technology



An interactive visualization of electrostatic potential and electric field lines around a grounded conducting cylinder, built entirely with core Wolfram Language and MathSymbolica. In the notebook, users can manipulate the position of the source line charge (red) and observe the resulting changes to the induced image charge (blue), field lines and surface charge distribution.

THE FUTURE OF MATH EDUCATION

While Professor Chung and some of his colleagues at GIST have found great success using Wolfram Mathematica for all course materials and calculations, they recognize that computer-based mathematics is still far from the norm.

"Many students are not trained in computational thinking," Chung explained. "They still prefer doing calculations by hand because it's what they're used to." Despite the maturity and potential of symbolic computation, integrating it into the classroom remains a challenge.

What distinguishes Wolfram Language from other computational platforms is not only its capability to carry out complex computations with accuracy and efficiency but also its flexibility as a development platform. It is the combination of these two strengths that creates meaningful opportunities for advancing mathematics education and research.

"Oftentimes, the difficult part is not mathematics but calculations. Let computers do the calculations!"

—Professor Youngjoo Chung
Gwangju Institute of Science and Technology

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