

Helping non-experts create mathematical models through natural selection

March 4 2020, by Valentina Bonito



Dhruv Khandelwal, PhD candidate. Credit: Eindhoven University of Technology

Science and engineering applications such as control of high-precision motion systems or electrochemical processes are often built on mathematical models of dynamic systems. Ph.D. candidate Dhruv

Khandelwal developed a framework that allows people without experience in data-driven modeling to fairly easily develop high-quality, optimized mathematical models of these dynamic systems. This is a vital tool that can help researchers of any stripe navigate the complex maze of modeling technologies and systems dynamics, and support data-driven research output and valorization. For instance, electrical engineers managing the health of the electricity grid or researchers studying the growth of cancer cells. Khandelwal defends his Ph.D. thesis on March 4.

Generating a model that is optimized for your criteria

The difficult parts of creating mathematical models is selecting the right model structure and optimizing the model for your specific goals and performance metrics. Khandelwal's algorithm accounts for both.

To help users generate correct models, Khandelwal developed a "grammar" for dynamic models using Tree Adjoining Grammar (TAG), which can explore modeling options in a variety of systems, structures and complexities. To come to an optimal model for the user, Khandelwal designed an [evolutionary approach](#), based on Darwin's definition of [natural selection](#) in biology: "[The] principle by which each slight variation, if useful, is preserved." The fitness landscape the models compete in is determined by the user-specified performance criteria, and the evolutionary algorithm "evolves" models that do best in this environment.

As good as models created by experts

The automated modeling methodology was evaluated on a number of academic, real-world and benchmark applications. This evaluation shows that the framework successfully generates models with minimal user interaction. In cases where the modeled application was fully

understood, the automatically generated models matched the nature of the true system. In multiple [case studies](#), the model proposed by the framework was as good as models obtained state-of-the-art techniques employed by expert users.

More information: Automating data-driven modelling of dynamical systems: an evolutionary computation approach:

[research.tue.nl/en/publication ... -systems-an-evolutio](https://research.tue.nl/en/publication/...-systems-an-evolutio)

Provided by Eindhoven University of Technology

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