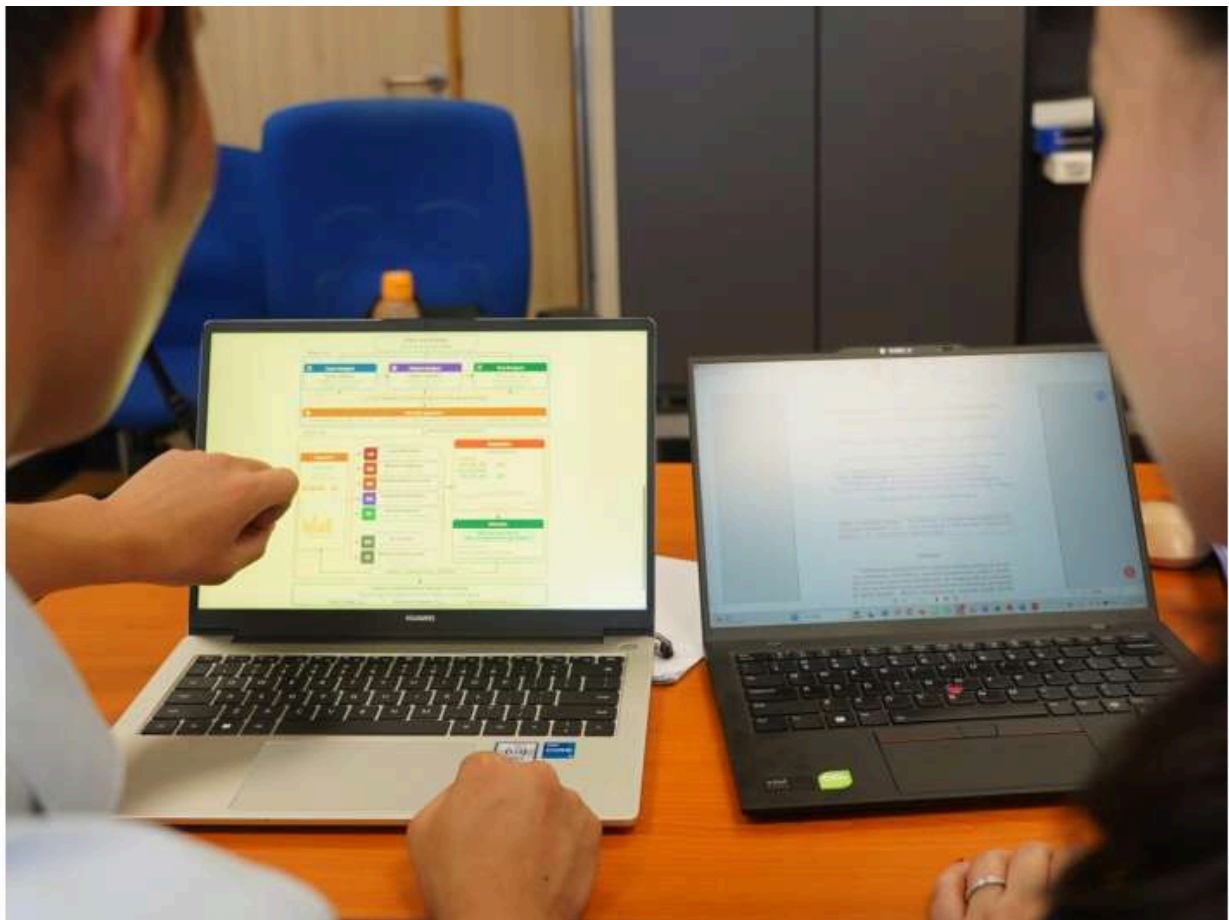


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# AI builds custom decision-making software in about an hour instead of months

by Nanyang Technological University

edited by Swati Mestri, reviewed by Robert Egan



Research Fellow Dr Gong Huatian (L) and Asst Prof Yan Ran highlighting the LACE model they created. Credit: NTU Singapore.

Researchers at Nanyang Technological University, Singapore (NTU Singapore) have developed an artificial intelligence (AI) framework that automates the creation of complex decision-making software, cutting development time from months of specialized engineering to about an hour.

Named Large Language Model (LLM)-driven Algorithm Construction via Complementary Evolution, or LACE, the system allows nonspecialist users to input complex operational problems in plain language. LACE then automatically constructs, evaluates and refines a dedicated "portfolio" of specialized algorithm heuristics tailored to solve the problem efficiently.

LACE was put to the test on four new maritime problems and achieved scores of 97% to 99% of the best result obtained by any method tested. In addition, LACE was able to design a solution in around an hour for about US\$10 (S\$12.70).

The study, published in [Nature Machine Intelligence](#), was led by assistant professor Yan Ran and research fellow Dr. Gong Huatian of NTU's School of Civil and Environmental Engineering (CEE).

## Outperforming existing AI frameworks and solution-finding software programs

Combinatorial optimization (CO) is a subfield of computer science that focuses on finding the optimal solution from a vast set of possible solutions. It underpins critical global operations, including maritime port berth scheduling, hospital operating room allocations, supply chain routing and power grid management.

To solve complex CO problems, systems engineers often rely on modular contracts, or clear rules, to split the problems into smaller pieces. They then use specialist heuristics, or smart shortcuts, to solve each piece of the problem quickly.

Traditionally, tailoring algorithms to new operational constraints required months of painstaking trial and error by domain experts. While LLMs can write computer code, existing AI methods routinely fail when tasked with building complete solvers for novel, real-world logistical problems in a single attempt.

LACE overcomes this bottleneck through a two-stage architecture. First, it breaks down the problem into modular contracts, then iteratively evolves a team of complementary specialist heuristics.

Lead author Yan said, "Designing custom software for real-world operations has historically been a major bottleneck across industries like port management, health care and energy. With LACE, we demonstrate that clever design of an AI framework, rather than just building larger AI models, can bridge this gap.

"By turning months of manual coding into a roughly one-hour automated process, we are making high-performance operational optimization accessible to organizations of all sizes."

## Democratizing high-performance algorithm discoveries

When tested on four entirely new, complex container terminal and tugboat routing problems designed to reflect modern maritime challenges, LACE achieved scores of 97% to 99% of the best result obtained by any method tested. Competing LLM-based AI systems, including Google's FunSearch, failed completely to produce feasible algorithms or software capable of meeting operational constraints.

In fact, LACE completed its execution in about an hour for each problem and at a cost of under US\$10 in computation fees per problem.

Gong said, "Whether rerouting tugboats in a busy port during unexpected congestion or, in future applications, reallocating hospital beds during a surge, operational conditions shift rapidly. LACE allows decision-makers to generate validated, highly effective solution strategies on demand in about an hour. By comparison, traditional software designs can take months and cost hundreds of thousands."

By dramatically reducing both time and computational costs, the NTU research team believes LACE can democratize high-performance algorithm discoveries, enabling smaller research teams, regional logistics hubs, public health care institutions and utility providers that lack multimillion-dollar algorithm engineering budgets to build software solutions.

## Publication details

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