Mathematicians report way to facilitate problem solving in queueing theory

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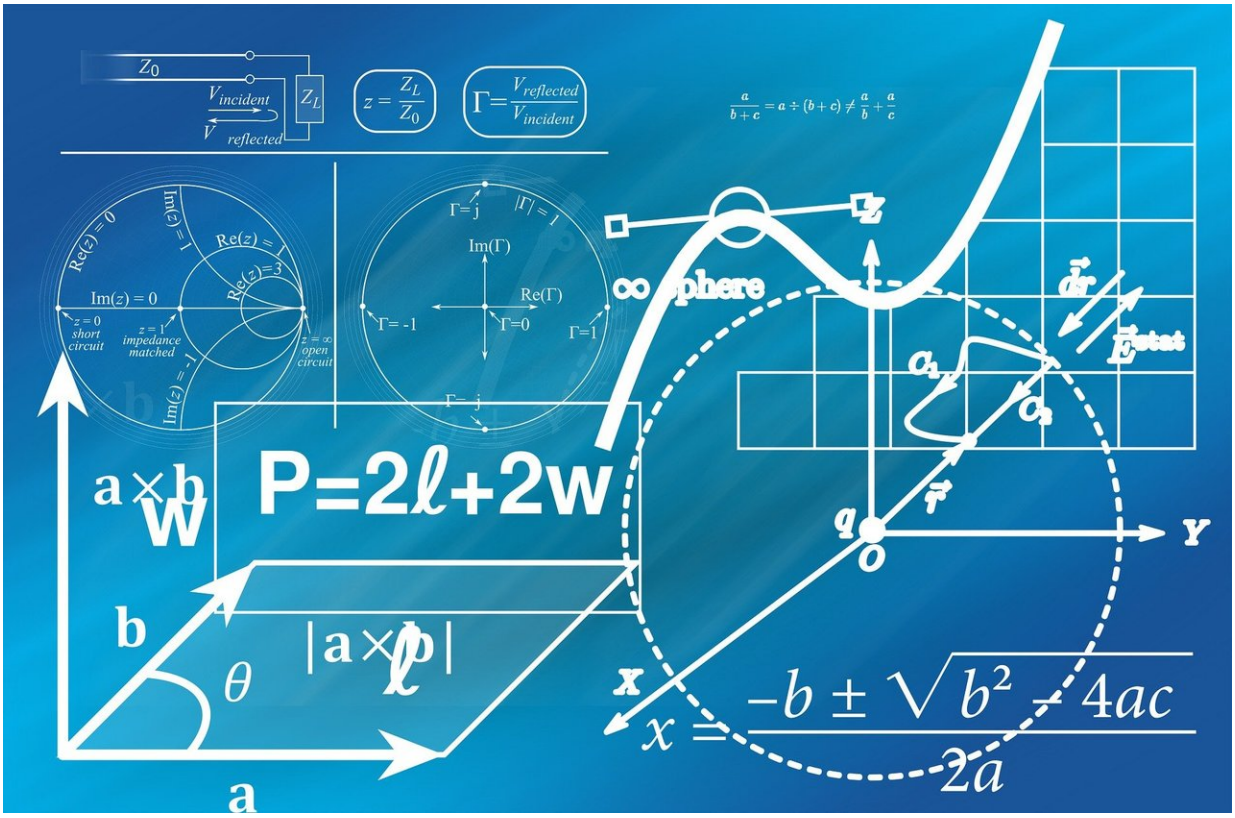

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RUDN University mathematicians proved a theorem that will facilitate the solution of problems in queueing theory—a branch of mathematics that describes query chains, for example, in the service sector. These

results can be applied in industry, information technology, and neural networks theory. The study is published in *Engineering and Informational Sciences.*

Queueing theory models usually consist of two parts. The first one is a conditional store with various resources, for example, products. The second one is the amount of product resources that are purchased at a given time. Traditionally, the second part of the model is called the queue, which gives the theory its name.

The queue is described by a random process, and the behavior of the entire model is determined by a system of probability equations. It is complicated to find a "head-on" solution for such systems, so modeling more often considers systems where solutions can be found in some special form, which is called multiplicative.

RUDN University mathematician Konstantin Samuylov, professor, director of the Institute of Applied Mathematics and Telecommunications of RUDN University, considered the most general version of the model, where queue values can take both positive and negative values. In this case, the amount of resources in the store does not decrease, but increases.

Professor Samuylov managed to find the conditions under which the solutions of the model are multiplicative. These conditions were mentioned in literature before, but only as additional requirements for the model, which were introduced in the calculations along with the multiplicativity requirement. Now, it is possible to prove that these requirements are a necessary consequence of multiplicativity.

Each solution of probabilistic equations in queueing theory is associated with a function of several variables, which is called stationary distribution density. The solution is multiplicative if this function is

represented as a product of functions, each of which depends on one variable. For example, the function f(x, y) = xy is multiplicative since it is represented as the product of the functions x and y.

The new theorem outlines a class of problems where such solutions exist. Restrictive theorems are extremely useful: They contribute to understanding the scope of various models and motivate mathematicians to search for new models.

The results will be useful for industry and modeling tasks in the service sector. They can also be used for calculating highly loaded networks.

More information: Valeriy Naumov et al. Product-Form Markovian Queueing Systems With Multiple Resources, *Probability in the Engineering and Informational Sciences* (2019). DOI: 10.1017/S026996481900024X

Provided by RUDN University

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