Mathematical Modeling Educational Activities in Russia (and Thailand)

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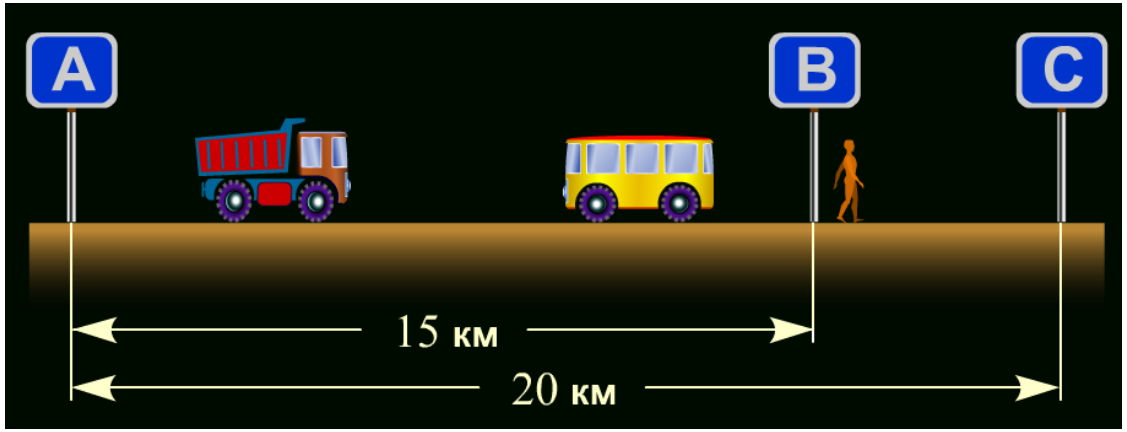
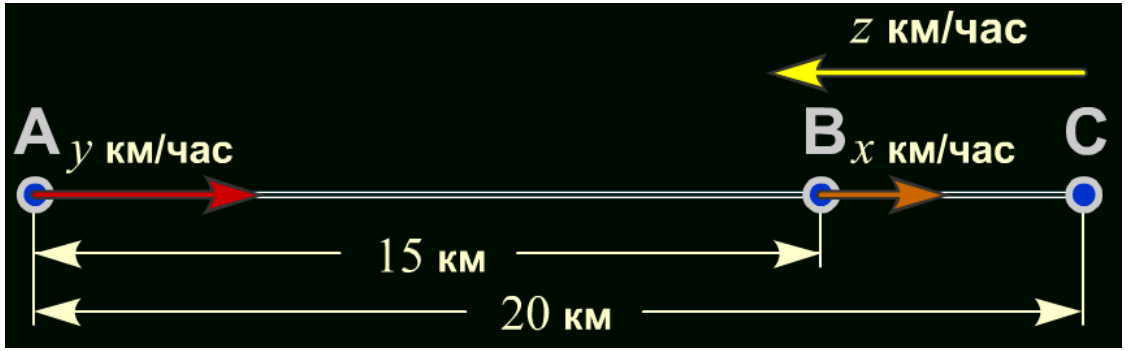
Mathematical modeling in Russian schools

The National Educational Standard requires that students must learn to model real situations using the language of algebra and geometry, explore the models, and interpret the results of their exploration. But by and large, the "real" situations from textbooks are not really real. Most often this "modeling" boils down to making equations in algebraic verbal problems.





$$\begin{cases} \dfrac{15}{y-x} = \dfrac{20}{y+z} + \dfrac{1}{2} \\ 3 \cdot \dfrac{5}{x+z} = \dfrac{20}{y+z} \end{cases}$$

Mathematical modeling in Russian schools

We encounter all the difficulties specific to newbies in math modeling on the school level: no tradition, no textbooks or any guides, very few interested and/or knowledgeable teachers and very few institutions that were doing anything in the area.

IMMC became an attractor of the scattered persons and institutions that tried to do modeling at schools.

To make the next step in promoting mathematical modeling and familiarize our teachers and students with IMMC-type problems, we established
the International Math Modeling Tournament.

International Math Modeling Tournament (MMT)

The Tournament is a one-week event conducted by the Kolmogorov school of Moscow State University since 2018. It is designed so as to make it attractive and accessible for students who, at best, have only the faintest notion of what math modeling is.
To this end, we combine four contests in one event and divide participants into two leagues, senior and junior.

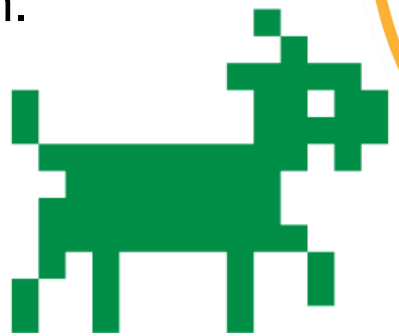
https://internat.msu.ru/turnir-mm-4/ and go to English

The Tournament Structure

IMMC-style
contest, 3 days

Math Around Us
Olympiad, 2 h.

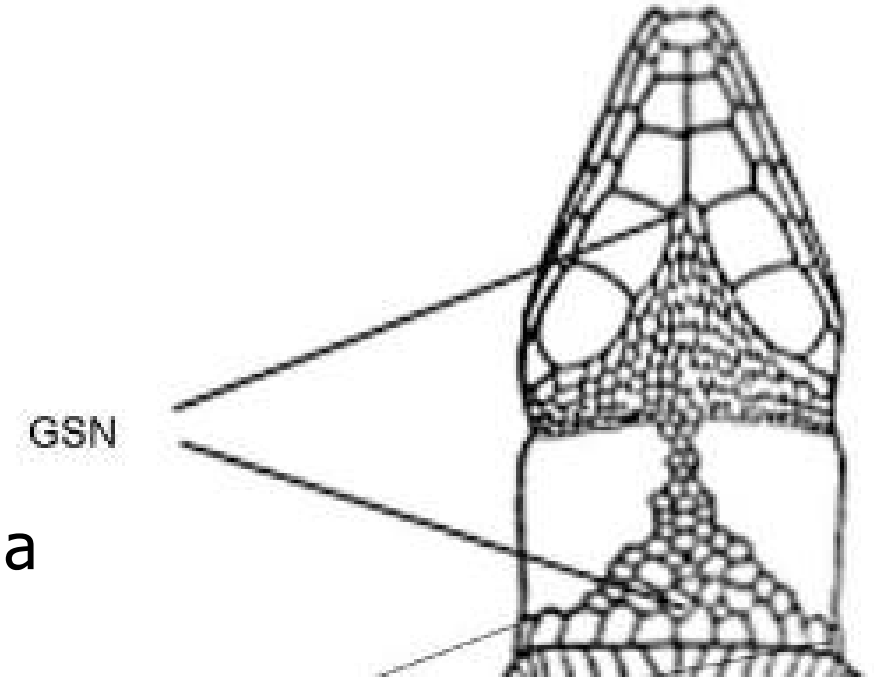
Computer-based
Optimizing, 2 h.



Math Applied to Science
Olympiad, 2 h.

Math Modeling Contest

You are provided with a set of real data containing the measurements of 564 lizards of 8 species belonging to genus *Darevskia*. For each lizard, its number-coded biological species and sex are given.



You have to develop relatively simple and obvious criteria that enable a biologist in field conditions using nothing more than an engineering calculator to predict, on the basis of such measurements, the biological species and sex of a lizard with the best possible accuracy.

Math Applied to Science

The speed limit for vehicles in city M, famous for its traffic jams, is 80 km/h, but an average trip 30 km long takes 45 min. Give an upper estimation for the change of the average trip duration if the speed limit is lowered to 50 km/h while the trip length and the time lost in jams remain the same.
Speeding is strictly forbidden. Give as precise estimation as you can and present the answer in percentage of the initial trip duration.

Answer: $$\boldsymbol{\varepsilon = \frac{L(V_2 - V_1)}{T_1 V_1 V_2} = 0.3 = 30\%}$$

Math Around Us: Purely mathematical problems borrowed from real life

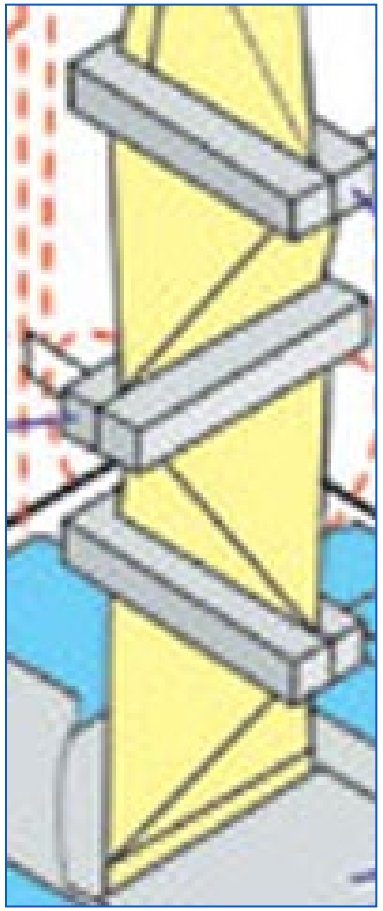


Fig. 1

Fig. 1: this is how "triangular" milk boxes were made years ago;

Fig. 2 and 3: this is how such boxes were packed.

How wide a cardboard band is needed to obtain boxes of volume 0.5 liter?

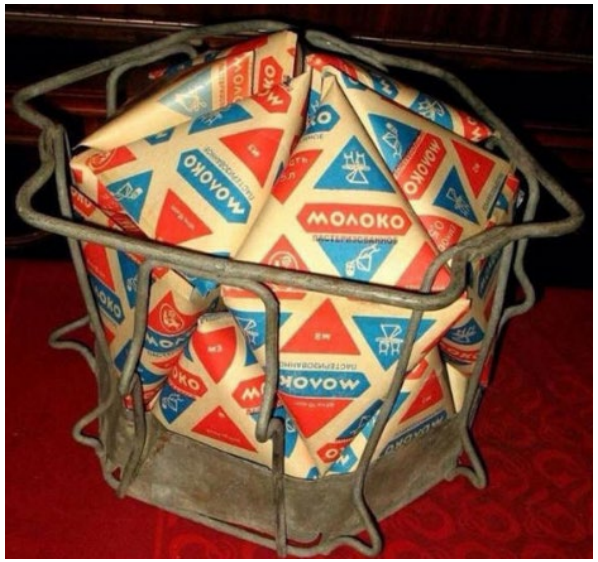
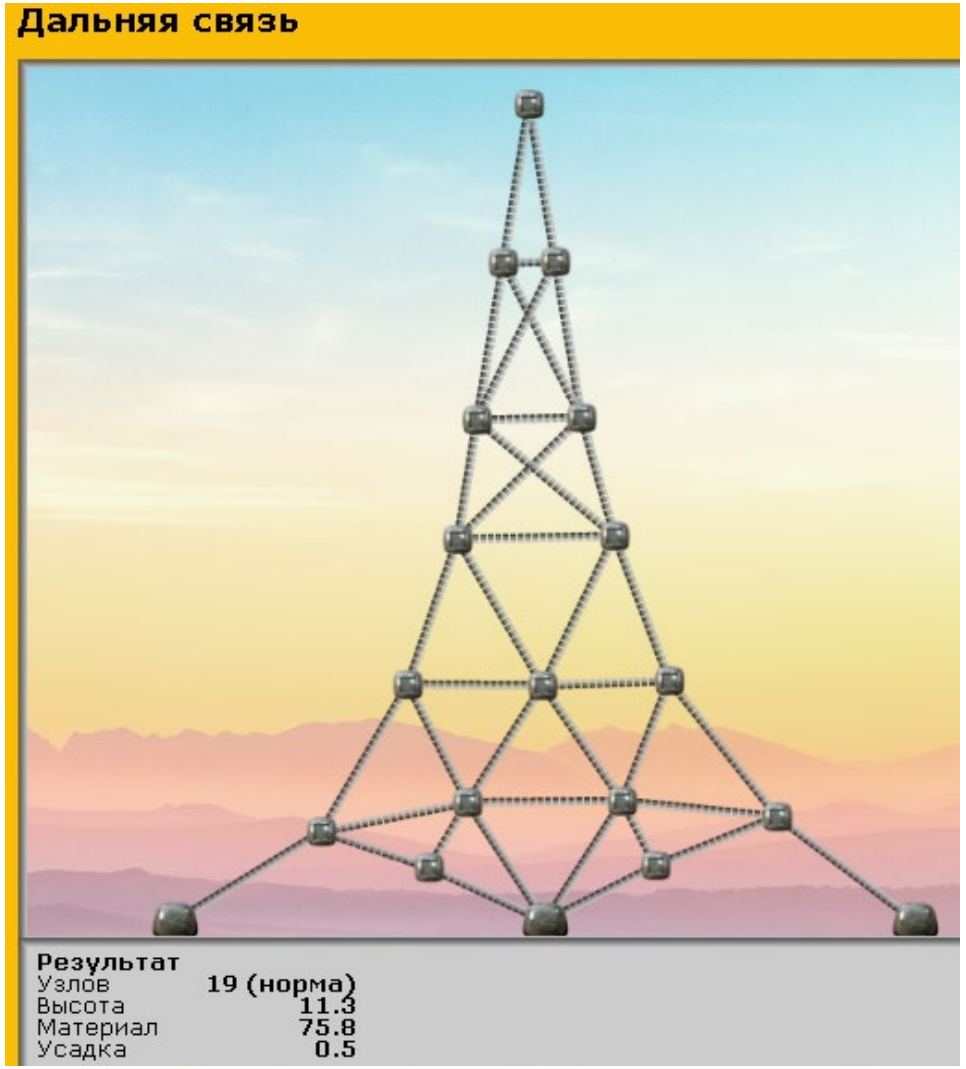


Fig. 2

Fig. 3

Computer Optimization : Long-range Communication



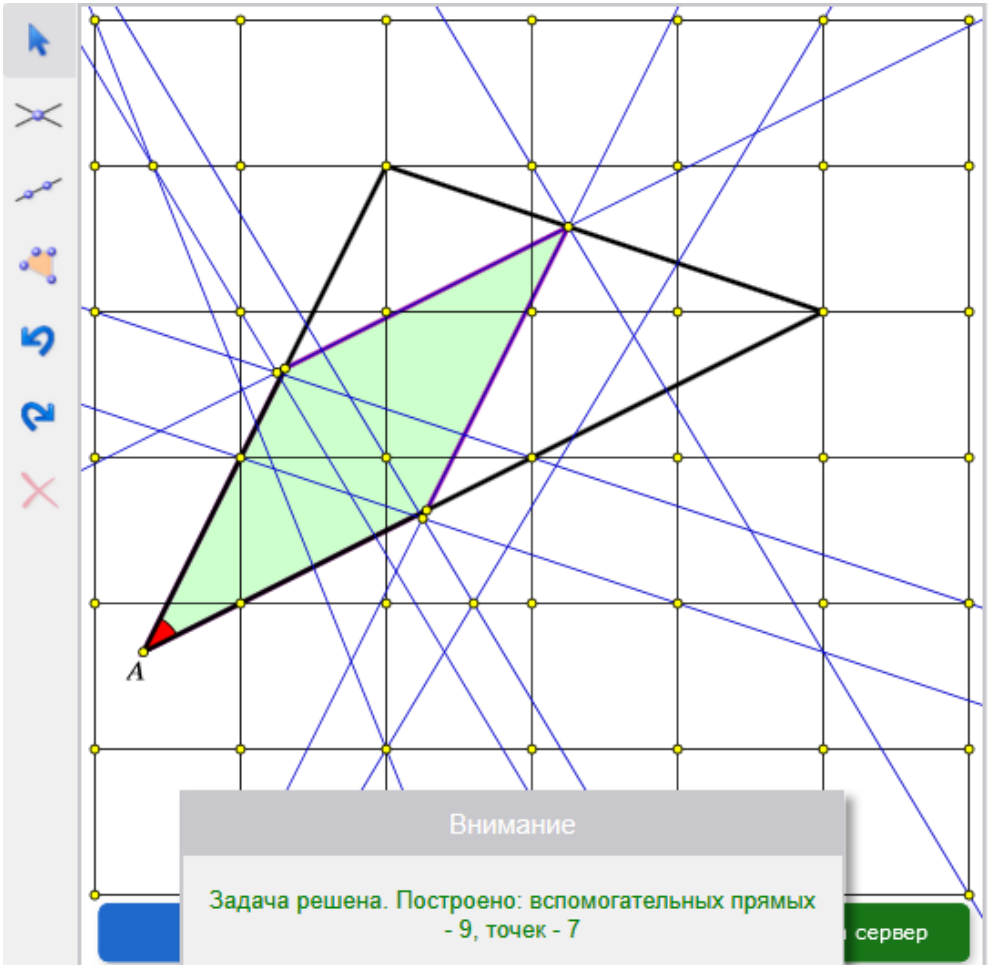
You have to assemble the highest possible mast from elastic bars joined to one another by hinges.

The length of bars and the number of hinges are limited.

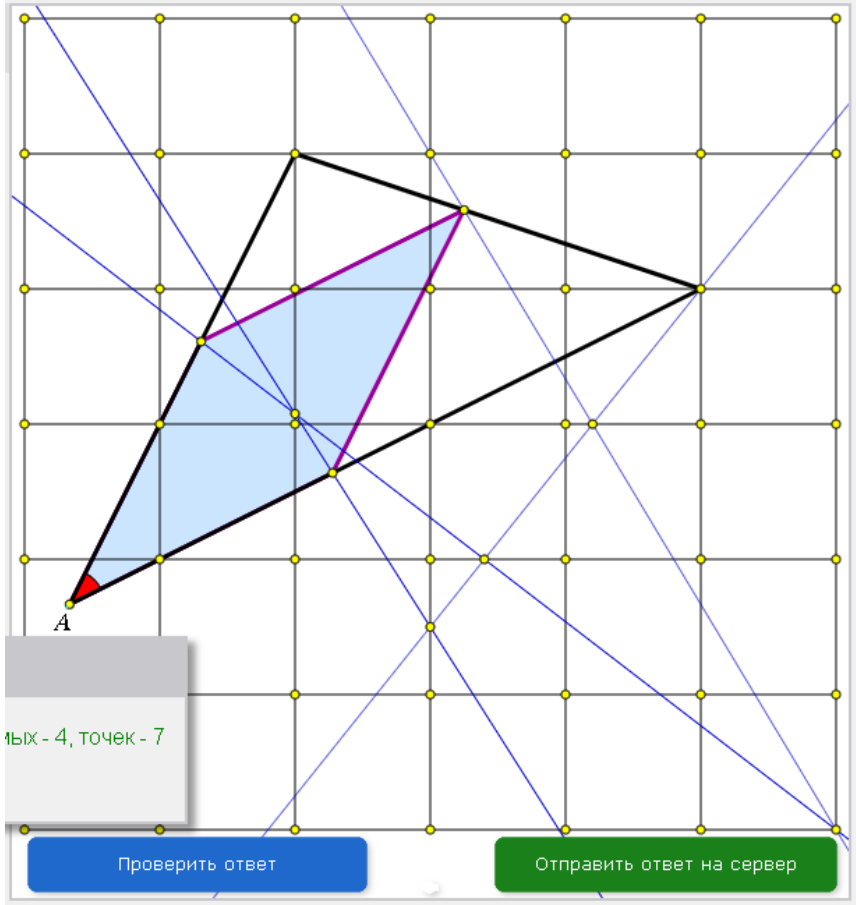
Under load, the bars spring and shrink, so the mast can collapse.

The task is given as a computer app and is solved online.
Usually, such tasks have no “best” solution or it cannot be found in reasonable time.

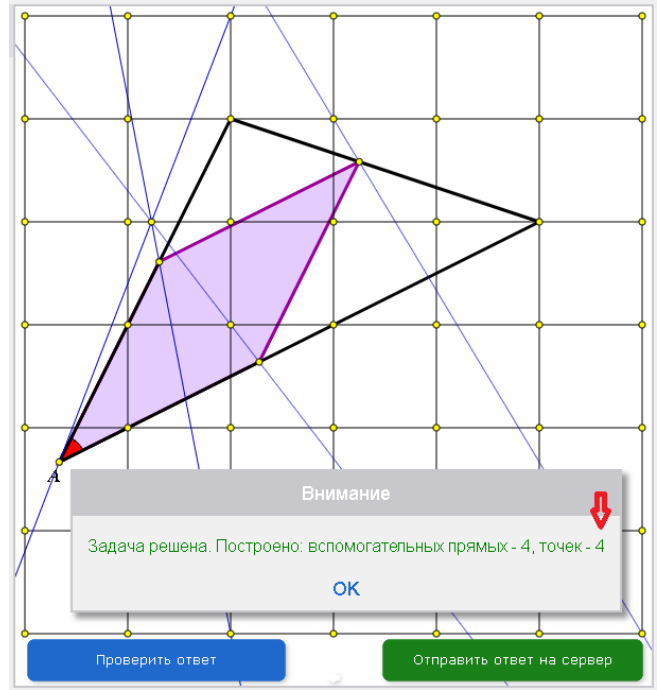
Computer Optimization: Rhombi (inscribe a rhombus in a given figure)



Solution 1: 9 lines, 7 points



Solution 2 (with analysis of fractions): 4 lines, 7 points



Solution 3 (computer search): 4 lines, 4 points

How MMT works

The contests accompanying the main math modeling competition are intended to give the participants a chance to excel in their favorite area:
the "Math Around Us" contest – for those who got used to 'classical' mathematical olympiads, which are extremely popular;
"Math Applied to Science" – for fans of physics;
Optimization contest proved to be the one well suited for all, including juniors.
In addition, during MMT we give lectures and seminars for teachers.

On the average, we have about 30 teams, or 120 participants. Many of them join the national (selection) round of IMMC.
Local centers regularly involved in math modeling activities have been formed in Republic Saha (Yakutia, the heart of Siberia), in the Caucasus and some other places. This year, for the first time, a team from Yakutia qualified for IMMC.

IMMC in Thailand

The Kolmogorov School of MSU has permanent and close ties with two leading Thailand schools, MWIT and KVIS. This is how IMMC was introduced in Thailand.

Both schools take part in MMT; up to 10 teams compete for the national representation at IMMC.

This year a team from KVIS was designated as outstanding!

I asked the advisor of the winning team, math teacher from KVIS, how they prepared to the contest. His answer was somewhat surprising.

IMMC in Thailand

In grade 10 they have two mandatory courses **Scientific Inquiry and Nature of Science** and **Seminar I** in which they learn and practice how to write a research paper in math & science, needed to complete students' graduation research projects.
In Grade 11 they have **Mathematical Modeling** and **Numerical Methods** focused on the modeling.

(MWIT also used to have a similar course.)

But the winning team was in Grade 10, so they have not enrolled in the specialized courses yet. Their success is due only to their enthusiasm for mathematical modeling.

This is something for us to ponder.

Thank you!

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