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Trott, Michael, Wolfram Research, USA
Solving Old and New Problems with Mathematica

The technical computing system Mathematica is an ideal environment for working on many mathematical problems. The integration of symbolic, numeric, and graphic functionality leads to the possibility of many different solution paradigms.

This talk will examine some example problems that can be modelled and solved in Mathematica. They are chosen to give an overview of some of the different solution paradigms. First, it will look at small problems such as the movement of a ruler on a finger, the application of high order WKB perturbation theory, and the approximation of conformal maps, all of these can be solved with elegant implementations of a few lines of code. Second, it will solve some famous classical problems such the cattle problem of Archimedes, only solved by A. H. Bell et al. and A. Amthor at the end of the last century, and the transformation of $\cos(2\pi/65537)$ into nested square roots, solved by J. Hermes in the 90's of the last century. Both of these are non-trivial problems which originally took many years to solve but which can now be solved in hours on a modern computer. Finally we will show how Mathematica can be effective in solving a variety of open problems such as the calculation of a polynomial representation of a trefoil knot tube, the calculation and visualization of Riemann surfaces of general algebraic equations and compositions of elementary functions, like `z^z^z`, and finally the construction of a polynomial Klein bottle which also looks like a Klein bottle.