Mathematics and Computational Thinking

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Symbolic, Numeric and Algebraic Computation
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Computational Thinking in (pure) Mathematics

- While computers are used as a tool for mathematical discovery, their use remains specialized and small-scale.

$\Rightarrow$ This situation represents an opportunity for computational thinking.

- Computer-aided proof is still not accepted.

$\Rightarrow$ Better tools and better education can aid a change in culture.

Micro-Example

Computational thinking in Algebraic Geometry is typically through the theoretical framework of Gröbner bases.

The future of computation in algebraic geometry is not symbolic (nasty complexity, and apparently not parallelizable), but in *verifiable* numerical algebraic geometry, which is embarrassingly parallelizable and scales well. Solving systems with 10^4 solutions is routine.

These numerical techniques will give insight far beyond what is possible from other methods, analogous to the current impact of theoretical physics on algebraic geometry.

Another: Experimentation

High-energy physics uses large-scale experimentation to study the fundamental constituents of matter.

In mathematics, experimentation too often means single (but challenging) computations, or any use of computers.

Why not adapt the paradigm of experimentation in the sciences to discovery in mathematics? (Or use computation in this way in other scientific domains?)

What about organizing our work (scientific and developmental) with students, postdocs, and staff scientists along the lines of a research lab?