Tackling the big unanswered problems

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(PhysOrg.com) -- Scientific research is known to happen slowly but the timeframes pale into insignificance compared to the years spent on some of the great unsolved Maths problems.

One of these problems is the subject of a Marsden funded project for which Victoria University mathematician Dillon Mayhew is principal investigator. Dr. Mayhew estimates that, despite working with a team of five collaborators, the central problem of the project may not be cracked until 2020, if at all.

One of those team members is Professor Geoff Whittle who is also part of a separate collaborative research effort that has already spent 12 years working to prove Rota's Conjecture. That was put forward by Italian mathematician Gian-Carlo Rota in the early 1970s and is one of the central problems in matroid geometry. Professor Whittle's team is close to achieving its goal although close in the world of mathematics means at least a few more years.

Dr. Mayhew's research is also in the field of matroid theory which is a more modern form of geometry than the Euclidian geometry most of us studied at secondary school.

Rather than focusing on distance and angles, matroid theory concentrates on a finite number of points which don't change under projection – three points, for example, are always on a line no matter how you project the line.

Matroids live under the surface of ‘a tonne of different mathematical objects, explains Dr Mayhew but are often bound together by a matrix or array of numbers. But the matrices he is studying aren’t part of the rational number system that we use every day.

Instead they come from one of an infinite number of less well known systems. These include Galois Fields, or finite fields, which contain a finite number of elements, sometimes as few as two.

"For each number system you get a different family of matroids,” says Dr. Mayhew. “Mathematicians have spent decades on the huge task of characterising each family of matroids for each number system."

One discovery that has made the task easier is that obstacles exist which mean certain matroids will never arise in a particular number system. In 1958, researchers proved that the two number system has one obstacle and, 21 years later, proof came that there are four obstacles in the three number system. In 2000, the four number system was found to have seven obstacles.

"The length of time between the results was not because we were being lazy, it just takes that long to figure it out," says Dr. Mayhew.

And here Rota’s Conjecture comes in. His yet to be proven theory is that there are a finite number of obstacles for every finite number system.

While work continues on that question, Dr Mayhew’s team is tackling the five number system and trying to work out how many obstacles it contains.

Using computers, they have worked out that it is at least 564. “Matroids are stubborn little creatures and they tend to grow explosively,” says Dr. Mayhew.

"This one is much more difficult to figure out than the earlier ones. We know that 564 is the lowest number but we have no idea of the upper bound. If it turns out to be billions, even the most advanced computer won't be able to find them all."

And that's why the team can't be sure it will succeed in its goal although Dr. Mayhew says they're unlikely to even consider giving up before doing another decade's research.

As to how mathematicians solve these thorny problems, Dr. Mayhew says they brainstorm just as many other groups do.

"We sit around and think hard, stare at a whiteboard, draws things, argue, write results and get them published, and meet regularly with the other 30 or 40 mathematicians around the world working full time in matroid research."

Dr. Mayhew, who is also an accomplished French Horn player, says the most satisfying part of his work is bringing the unknown into the known.

"We are pushing ourselves and the technology we use as far as we can go to discover new and beautiful things."

Provided by Victoria University

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