Building a 4D Ray Tracing Package for use in General Relativity
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I worked with Leo Brewin last summer on visualisations of black holes using a ray tracing package called POVRay. We got some great pictures and movies, but as POVRay is a large, complicated package we were not sure that the mathematics we had inserted into the program was doing its job everywhere that it should.

A ray tracer is a piece of software that takes a mathematical description of a world and produces a 2D image that is essentially a viewing window into that world. It works by tracing rays from the eye point into the world and determining pixel colours by calculating which object the ray intersects with and the colour of the object at that point.

The project I undertook had several aims, the first of which was to build a working ray tracer that was extremely simple and well documented so as to enable easy manipulation and insertion of any mathematics deemed applicable. I then intended to replicate the results that Leo and I obtained last year, by inserting the General Relativity mathematics we had used with POVRay into my ray tracer and eventually to produce a ray tracer with inherently 4D intersection collisions.

I am continuing on with the project and hope to get some interesting GR (and other) visualisations very soon. I currently have a working ray tracer that produces movie files from a 4D description of a world, however, the intersection calculations are still 3D at this point.

This was a great opportunity to work with some great people, and I hope that my results will be helpful to others in future mathematical visualisation endeavours.