NZMS Newsletter #91

CENTREFOLD

Rod Downey

Since coming to New Zealand in 1986 Rod Downey's career has flourished. He is now one of New Zealand's most prominent mathematicians and is undoubtedly one of the best two or three computability theorists in the world. Rod rapidly rose through the ranks to a Personal Chair in Mathematics at Victoria University in 1995. He currently has over 170 publications. He has a string of awards including the RSNZ Hamilton Award and an NZMS Research Award. He has had numerous major research grants including being a PI on at least three Marsden Grants as well as an AI on several others. He is a director of the NZIMA and the NZMRI. He is a former president of the NZMS, has had a number of graduate students, has very successfully supervised numerous post docs, is an FRSNZ, and no doubt I've missed a number of other things I should have mentioned.

Having got that out of the way we can proceed to the good stuff; that is, the human interest and the question of what drives Rod's research. Human interest first. Rod grew up in a working class family in Brisbane, Australia. His father was a bookie; a career in which survival required a sharp mind. Given Rod's current interest in Martingales (essentially betting strategies), it seems the wheel has turned full circle. Rod claims that mathematics is one of the few academic areas in which you can achieve even if you do not come from a cultured background and perhaps he is right, but there is no doubt that his parents regarded his interest in mathematics as eccentric at best. After graduating from Queensland University Rod had to decide between doing a PhD at Monash or managing the bottle shop at the local pub. His parents were keen on the pub. From an economic point of view they were probably right.

Rod developed an interest in logic at an early stage. One of the curiosities of the Queensland system at the time was that it was possible to study logic in the final years of high school, but only for students in the bottom class. Rod duly moved down from the top class to study logic. Rod's first year at university was not distinguished, but a threat to take him out of the honours stream brought out a streak that will be familiar to all who know him, and from then on he excelled. I believe that he gained an A^+ in all of his papers in his honours year with the exception of a course in Combinatorics. Of course, this meant that subsequently some of his best research has had strong interactions with combinatorics.

Given his research output it is remarkable that Rod has time for anything else, but the energy and enthusiasm with which he tackles mathematics is also evident in his recreation. Rod has always been a keen sportsman. While a PhD student he represented the state of Victoria in volleyball. Rod tells me he thoroughly enjoyed the black art of being a rugby forward in his youth (why am I not surprised). He played squash to a high standard and is currently a keen tennis player. But amongst sports, it is surfing that is his lifelong passion. I guess that most surfers need a day job and what could be better than being an academic with its generally flexible hours. Rod and Mike Fellows developed the fundamental ideas of paramaterized complexity (now a significant branch of theoretical computer science) while on a surfing trip around New Zealand; something to think about for those who would seek to prescribe how mathematical research ought be undertaken.

Apparently Rod's wife Kristen first encouraged him to take up Scottish Country Dancing. In characteristic style the interest developed rapidly and now he is even a qualified teacher — something achieved only at the end of a lengthy and arcane process. He has also written numerous dances leading to the marvelously named "Cane Toad Collection". Rod's individuality is evident to all who meet him, but a quick proof can be obtained by examining the cardinality of the intersection of the set of mathematicians, surfers and Scottish Country Dancing teachers.

Rod's research is broad ranging and far reaching. While it is impossible here to begin to do justice to it, there are several themes that run through his work. A strong theme is the question of what it means for an object to be more "complex" than another and how does one measure this. This is entwined with the theme of trying to understand the intrinsic difficulty of computation. Rod takes a very broad view of these themes. For example, his view of "complexity" ranges from Turing reducibility to polynomial-time reducibility to parametric reducibility. In addition, his view of a reasonable object to study has no bounds. He has studied objects which only appear in computability theory such as the c.e. sets and degrees, index sets, and Π^0_1-classes to almost any type of graph or algebraic structure.

As a highlight from computability theory consider the array non-recursive sets and degrees. In a permitting argument one likes to construct an object, say B, Turing below some set S and before one adds anything to B one needs permission from S. More or less a set is an anr set if it allows a certain type of permitting argument where multiple and increasing permissions are needed. The idea for these sets first arose in Rod's thesis. At that time the goal was to show that there was a Martin-Pour-El theory of every Turing degree but Rod showed this was impossible. It turned out that the construction of a Martin-Pour-El theory needed a multiple permitting argument and works for every anr degree. Over time Rod with others was able to refine this idea into the anr sets. Since these sets have nice properties in terms of permitting arguments it is not surprising that they have other nice properties. For example, recent work of Downey and others showed that there is an orbit $\mathcal{O}$ of the Π^0_1 classes such that if $P \in M$ then P has anr degree and if a degree has anr degree there is an element of that degree in $\mathcal{O}$; that is the anr degrees are invariant in the Π^0_1 classes. It is open and a great question if the anr degrees are definable within the c.e. degrees. Rod with others was able to use an extension of these permitting arguments to define the low_2 within the c.e. weak Turing degrees.

Rod's work in combinatorial complexity has a somewhat different flavour. A problem with classical complexity theory is what to do when a problem is found to be *NP*-complete. Do we just give up in despair? Rod and Mike Fellows noticed that such problems frequently become tractable when certain parameters are bounded. Moreover many parameters, such as the vertex degree or tree width of a graph frequently are bounded in natural examples. This study flourished and eventually led to the monograph "Parameterized Complexity". The area is now a thriving branch of computer science with regular meetings in Dagstuhl (the computer science equivalent of Oberwolfach). It is typical of Rod that, while the subject has thrived, his interests have largely moved on and currently he is focussing on algorithmic randomness with a book in the area due for completion soon.

To conclude, a personal note. From Rod I've learnt so much about what it means to be a serious research mathematician. In particular, I've learnt that there are no excuses and the only limitiations are the ones you place on yourself. I could not have had a better lesson.

Geoff Whittle (with help from Peter Cholak and Mike Fellows)