Sand sculpture in Rio de Janeiro ahead of the 2016 Olympics.

Editorial

Celebrai! Rio de Janeiro is where the parties will be during August and September, as the Summer Olympic and Paralympic Games converge on this beautiful Brazilian city, which paradoxically will be celebrating winter. The statistics are stunning: more than 10,000 elite athletes from 206 nations will compete for 306 sets of Olympic medals in 39 sports, which will offer an amazing variety of challenges for competitors and much excitement for those of us lounging on sofas. These sports include two new events, rugby sevens and golf. Similarly impressive, more than 4,000 athletes from 56 nations will compete for Paralympic medals in 23 sports. These sports also include two new events, canoeing and triathlon: a thrilling prospect indeed.

These quadrennial, international, multi-sport competitions began in 1896 (modern Olympics) and 1960 (Paralympics), and surely contribute significantly towards encouraging comradeship and friendly rivalry, and maintaining world peace. For readers who wish to discover more, [1] presents a fascinating, open-access discussion of past and future Olympic sports, while [2] applies data envelopment analysis to determine overall rankings of countries. The latter paper was written by scholars from Rio de Janeiro and published in the *IMA Journal of Management Mathematics*.

As you might expect, mathematics plays important roles in the planning and conduct of Olympic and Paralympic Games. Just imagine the complex logistics involved in efficiently providing and managing venues, volunteers, equipment, accommodation, transportation, safety, security, scheduling, catering, healthcare, cleaning, maintenance, publicity, ticketing, medals, finance, communications, broadcasting, analysis, reporting, ceremonies and entertainment, to name just a few of the many vital operations. With this giant, intricate network of constrained optimisation problems, it's a wonder that the Games actually occur and generally do so with resounding success.

Mathematical modelling and statistical analysis are also increasingly relevant to competitors and coaches, who wish to determine optimal policies for squad selection, support facilities, training schedules, diet regimes, injury avoidance, competitive strategies and team tactics. Sport poses tricky algebraic and computational problems and has a high level of public appeal, so the IMA and other research groups have been able to organise several successful conferences and public meetings on mathematics in sport over recent years. Even more importantly, at least two mathematicians won gold medals in the London 2012 Games, Anna Watkins MBE (rowing) and Sophie Christiansen OBE (equestrian): another entry for our Maths Careers website perhaps.

For several years, I have been fortunate enough to collaborate occasionally with Australian Hugh Daniel, who advises the International Paralympic Committee on the factor methods that it uses to ensure fair competition among athletes with varying physical, visual and intellectual impairments. Such comparisons are needed as some ability classes contain few competitors, and separate medal allocations for these athletes would detract from the achievements of competitors in larger classes. How, for example, might one compare the performances of swimmers who have different levels of limb functionality? Several methods are employed, including neutralising advantages and adjusting results to reflect individual class abilities.

The first method, neutralising advantages, involves combining similar classes, imposing the use of specialised technology such as eyeshades and wheelchairs, or ensuring that team members collectively satisfy a minimum aggregate handicap requirement. The second method, adjusting results, is performed using short-term historical records from major competitions to determine and update base factors, with regular committee interventions to allow for classification variations, technological advances and new sports. My particular interest is in making such adjustments using only current competition results by means of a generic handicapping system, in order to standardise the process, reduce the need for subjective committee decisions, account for different ability class sizes and allow for current competition-specific conditions.

Sadly, not everything has come up roses in preparations for Rio 2016, with concerns over timely completion of construction and infrastructure projects, political and economic stability, water pollution, crime and security. Furthermore, several athletes were this year stripped of their past Olympic medals for doping and drug testing offences, and language confusion meant that kitesurfing very nearly replaced windsurfing at these Games.

These problems appear to be well under control, though unfortunate outbreaks of the Zika virus and dengue fever also occurred recently in Brazil and elsewhere. These are both vector-borne diseases transmitted by daytime-active mosquitoes, predominantly *Aedes aegypti*. The main concern is that visitors might be bitten and become infected. They could subsequently infect mosquitoes in their home countries, which could then spread the virus among other human populations. The Zika virus can also be spread by blood transfusion, sexual intercourse and childbirth.

Epidemiologists play a huge part in modelling and forecasting the spread of these and similar diseases, and have developed systems of differential and difference equations to enable such predictions. Popular among these are the compartmental SIR (susceptible-infective-recovered) models for human condition, optionally supplemented by SI (susceptible-infective) terms corresponding to mosquito behaviour as originally proposed in [3]. Note that recovered humans become immune and so do not revert to the susceptible state, and that recovery from infection is negligible for mosquitoes as they typically live for less than a month.

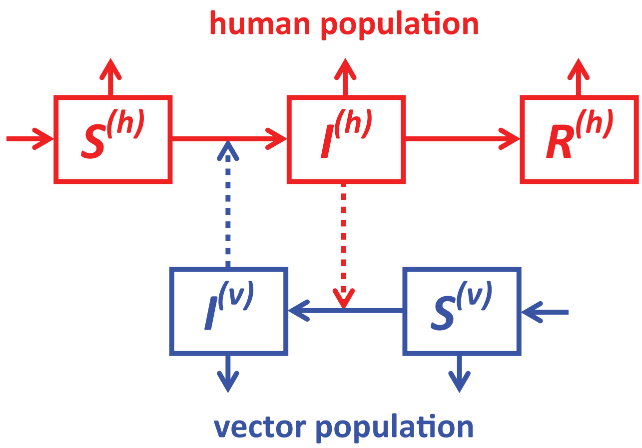

Figure 1: Schematic display of SIR-SI model for dengue fever.

The resulting SIR-SI models are illustrated in Figure 1 and can be further enhanced by stochastic terms that allow for random fluctuations around model expectations. In this diagram, solid arrows represent transitions between states and dotted arrows represent viral transmissions, rates for which are determined by extensive scientific study. Using similar methodology, Ximenes et al. [4] predict for Rio 2016 that the worst-case scenario would lead to a low dengue fever incidence of about 6 symptomatic and 52 asymptomatic cases per 100,000 individuals, and that preliminary calculations on the risk of Zika virus infection for tourists to the Games suggest a very low individual risk. These tentative conclusions are very welcome news, though we hope for the best-case scenario that would lead to no infections of either virus.

August's issue of *Mathematics Today* contains the second part of Edward Stansfield's tutorial paper on Kalman filters, an entertaining article by Colin Wright that presents an introduction to topology and Möbius strips, a valiant attempt to unify matrices, groups, space-time and general relativity by Paul Masham and two papers that consider transportation. One of these is a first Urban Maths offering by recently appointed Editorial Board member Hannah Davies and relates to the infernal problem of traffic queues. The other, by Stuart Berry and Chris Parkes, identifies some paradoxes that arise when planning environmentally friendly transport.

Indeed, road transportation seems to be such a popular topic among contributors that we shall produce a special issue on this theme in October, courtesy of guest editor Kathryn Stewart (Edinburgh Napier University).

Finally, thanks to those of you who participated in our recent readers' survey. We shall discuss the results of the survey at the next editorial meeting and publish our response to the survey in *Mathematics Today* early next year. I am pleased to announce that the lucky winner of an Android tablet is Dr Alfred Ma CMath CSci MIMA.

David F. Percy CMath CSci FIMA

REFERENCES

1 Stefani, R. (2016) Olympic sports of the future, *The Sport Journal*, United States Sports Academy.

2 Soares de Mello, J.C.C.B., Angulo-Meza, L. and Branco da Silva, B.P. (2009) A ranking for the Olympic Games with unitary input DEA models, *IMA Journal of Management Mathematics*, vol. 20, no. 2, pp. 201–211.

3 Esteva, L. and Vargas, C. (1998) Analysis of a dengue disease transmission model, *Mathematical Biosciences*, vol. 150, pp. 131–151.

4 Ximenes, R., Amaku, M., Lopez, L.F., Coutinho, F.A.B., Burattini, M.N., Greenhalgh, D., Wilder-Smith, A., Struchiner, C.J. and Massad, E. (2016) The risk of dengue for non-immune foreign visitors to the 2016 summer olympic games in Rio de Janeiro, Brazil, *BMC Infectious Diseases*, vol. 16, no. 186.