



*AT THE FOREFRONT OF ANALYTICS IN AFRICA*



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Bernie Lindner



Brian van Vuuren

Karibu (welcome in Swahili) and merry Christmas to all our members.

This newsletter focusses on Operations Research within Africa. Hans Ittmann wrote a great and valuable article on page 2 regarding the history and current state of African OR societies and related activities. Winnie Pelser and I were fortunate and blessed to attend the Pan African Operations Research Society Summit that took place in Nairobi in November, see more on page. Winnie and I also travelled a bit around Nairobi after the summit and you may find our diaries on page 9 and 10 respectively.

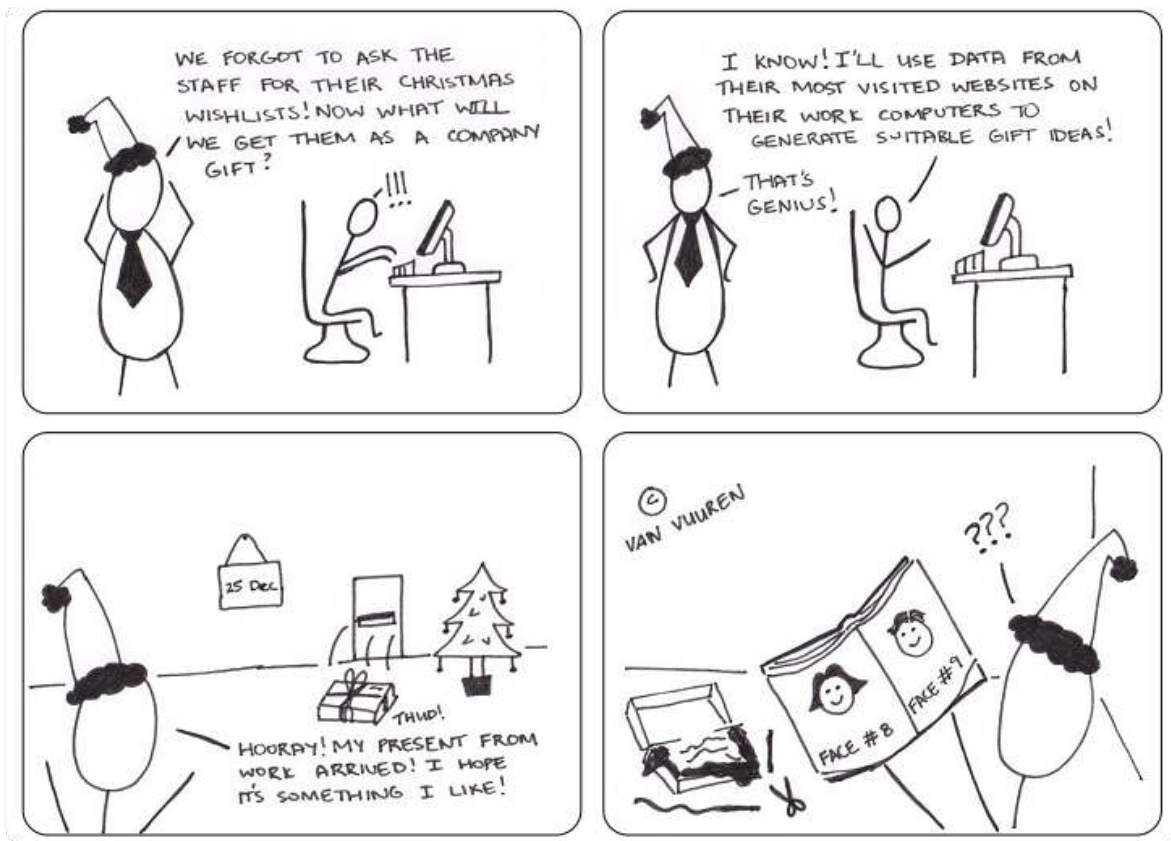
This is my sign off as Newsletter editor and I would like to say thank you to ORSSA for the amazing opportunity. Also thank you to Prof van Vuuren and Danie Lötter for offering me this amazing opportunity and helping me immensely along the way. I will still be involved, as the Newsletter's Business manager, I wish the very capable and creative Brian van Vuuren all the best as newsletter

editor from March 2017.

Futhermore I have been nominated on this new African OR Federation's executive committee as the secretary. I look forward to any input from you the reader. I have a passion for OR and Africa, both of which seem to be taking note of each other in the last few months especially and highlighted in this edition.

Salamu and Kwaheri  
 Bernie Lindner

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## FROM THE PRESIDENT'S DESK

By WINNIE PELSER ([wpelser@csir.com](mailto:wpelser@csir.com))

### ORSSA PRESIDENT



Winnie Pelsler

When you read this final newsletter of 2016, we are at the brink of the holiday season. The past year was once again a busy year for our society.

Most of the chapters of ORSSA were very active during the year. The KwaZulu Natal Chapter is the only exception.

Frequent meetings and meetup groups continued to be productive and interesting.

The Lancerac hotel in the beautiful Cape wine region in Stellenbosch was a superb location for a very successful conference. The large number and variety of papers presented at the conference is proof of the wellbeing of OR in South Africa. It is always a great opportunity to reward recipients for outstanding achievements with the Tom Rozwadowski, Theodor Stewart and Gerhard Geldenhuys medals. A number of recognition awards and a fellowship were also awarded to members. Congratulations to these very worthy recipients. The social side of the conference was as usual a wonderful opportunity to rekindle old friendships and to build new relationships!

I want to thank each and every member of the Society for their contributions, hard work and participation. The members are an essential part of our Society and the healthy membership number is a testimony to the health of our profession.

A few members are leaving the national Executive Committee at the end of the year. They are Dave Evans (as

Webmaster), Mark Einhorn (Marketing Manager) Angela Rademeyer and Robert Benetto (Johannesburg Chapter Chair). Your hard work is greatly appreciated. To all serving members, I want to convey a big thank you to each of you. Newly elected members of the Executive Committee are Gemma Wilson (Webmaster), Denzil Kennon (Marketing Manager), Hennie Kruger (Additional Member), Ian Cambell (Additional Member) and David Clark (Johannesburg Chapter Chair). Welcome to incoming executive committee members. We are looking forward to dynamic activities in 2017. The next newsletter will have more detail.

Hennie Kruger has completed his four years cycle as president of ORSSA. He was the president in 2013 and 2014 and vice president in 2013 and 2016. Hennie, I want to thank you very much for your service to ORSSA. In particular, your assistance and support to me was extremely valuable. Your calm and effective manner was and is exceptional. Thank you very much for doing such a sterling job as president and vice president over the last four years. It is good news that Hennie is remaining on the Executive Committee as an additional member in 2017.

The Society is committed to outreach in Africa. In line with this, ORSSA sponsored and participated in an initiative to get an African Operations Research Society of the ground. It is still early days, but we are positive that it will be the start of a good initiative. More on this will follow later in the newsletter.

Last but not least, I want to wish each and every member a peaceful and joyful festive season. May you all be blessed with a well-deserved rest and time with family and friends. Drive safely and all of the best for 2017.

## AFRICAN OR SOCIETIES AND THEIR ACTIVITIES

by Hans Itmann, HWI Consulting ([hitmann@gmail.com](mailto:hitmann@gmail.com))



Hans Itmann

### 1. Introduction

*The International Federation of Operations Research Societies (IFORS)* has over many years encouraged, invested funds through sponsorships and provided assistance in developing *Operations Research (OR)* in African countries (Merchant, 2016). One of the aims has been to encourage recognized

groups of OR experts in African countries where there are no formal OR societies to establish societies within their respective countries. Over the last few years a number of new OR societies have been established in Africa. Recently representatives of some of these societies, as well as other interested Operations Researchers from different African countries, met in Kenya with the objective of establishing

an *African Federation of Operations research Societies (AFROS)*.

In addition to the efforts of IFORS there was a period during which the Association of European Operational Research Societies (EURO) also actively focused efforts on promoting OR in African countries. Funding was provided as sponsorships for organising conferences, etc. This was an action by EURO that lasted around five years, driven especially by Alexis Tsoukias (Rand and Tsoukias 2002) during his term of office as secretary and President of EURO.

Given the recent developments it is interesting to try to give an overview of OR activities over the past twenty, thirty years in African countries. This is, however, not such

an easy task since information is limited. Most of what is presented in this article has been obtained from what is available in the literature, from presentations, short reports in a variety of OR newsletters, from the Internet and the personal involvement of the author in some of these initiatives and events. It is by no means claimed that this is a complete and comprehensive overview, there may be omissions and also factual errors although we trust these are limited.

The outline of the article is to give brief descriptions of established OR societies and then of groupings, networks and other African related OR activities.

## 2. Established OR societies

### 2.1. Israel: ORSIS

It is not clear whether Israel forms part of Africa or not; some sources indicate it is while others exclude Israel. Reference to this society is included here for completeness. The *Operations Research Society of Israel* (ORSIS) is a non-profit organization, established in 1966 with the goal of promoting and enhancing the research and practice of OR in Israel. The society has around 150 members and one of its activities is to organise an annual conference. ORSIS is a member of EURO and joined IFORS in 1969. This is clearly a well-functioning society with active members (<http://orsis.net.technion.ac.il/>).

### 2.2. South Africa: ORSSA

ORSSA was established in 1969 (Geldenhuys and Rudolph 1997). ORSSA is very active and its activities include a number of regional chapters that meet regularly, a quarterly newsletter, a journal, ORiON, that has been published bi-annually since 1985 while ORSSA also has an annual conference (Ittmann and Yadavalli 2010). Over the years other activities of ORSSA have included arranging the 18<sup>th</sup> IFORS international conference in 2008 in Sandton, two other international conferences in the early 80's and a very successful MCDM conference in January 1997 in Cape Town. During the 90's ORSSA initiated a project "OR into Africa" which endeavoured to establish a community of OR workers in the development arena within South Africa. A further outflow of this initiative of reaching out to Africa was arranging the 4<sup>th</sup> *International Conference on OR for Development* (ICORD) held in the Kruger National Park in May 2001. Although a small conference, with 64 delegates from 14 countries, it was by all accounts a successful one. The ICORD conference established a number of future objectives and this led to ORSSA being involved in assisting the East African OR fraternity in the formation and establishment of their own society and in organising its first OR conference. Furthermore, as part of the African outreach, two annual conferences of ORSSA were held outside the country. In 1996, the 26<sup>th</sup> annual ORSSA conference was held in Mbabane, Swaziland. This was held from 9-10 Oc-



tober 1996 jointly with the Southern African Mathematical Science Association (SAMSA). In addition, the 40<sup>th</sup> Annual ORSSA conference was held at the Elephant Hills Hotel at Victoria Falls in Zimbabwe. The conference took place from 18-21 September 2011 and was co-hosted by the *National University of Science and Technology* (NUST) in Zimbabwe (Evans et al. 2011). Then the 37<sup>th</sup> annual conference of ORSSA incorporated the 2<sup>nd</sup> Conference on Operational Research Practice in Africa (ORPA) as well as an ORPA/INFORMS workshop on OR education. Within the country the University of Limpopo, a previously disadvantaged university, was responsible for organizing the very successful 39<sup>th</sup> annual ORSSA conference in Magoebas kloof in 2010 (<http://www.orssa.org.za/>).

### 2.3. East African countries: ORSEA

After the ICORD conference in 2001 held in South Africa a process was initiated by operations researchers from Kenya, Tanzania and Uganda to establish the *Operations Research Society of East Africa* (ORSEA). This was also based on a resolution taken at the establishment of the *African Operations Research Network* (AORN) in 2003. There was talk of involving people from Rwanda and Burundi, but that does not seem to have materialized. The main people involved in this initiative were Prof Isaac Mbeche from Kenya and Joe Kakeneno together with Prof Erasmus Kaijage both from Tanzania. It took a number of years to get the society formally registered, but ORSEA nevertheless started initiating its activities. The 1<sup>st</sup> International Conference in the *Eastern Africa Region on Operations Research and Development for Africa* (ORDA-1) was held in Nairobi, Kenya over the period 17-19 September 2003. ORDA-2 was held in Dar es Salaam, Tanzania on 17-19 November 2004. Both these conferences were later considered to be the 1<sup>st</sup> and 2<sup>nd</sup> ORSEA conferences and subsequently these became annual conferences, the venues rotating between the three countries Kenya, Tanzania and Uganda. There might have been one year where there was no conference. ORSEA has its own website, which is unfortunately not well maintained. On the website there is reference to a newsletter as well as a journal. In the latter case the link to the journal shows a limited number of titles of papers only. From the first two conferences an overall observation was that these countries don't have access to the latest OR journals and books. Most of the work presented by the local OR professionals lacked inclusion of what was happening at this stage in OR. Hope-



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fully this situation has improved since then. Nevertheless, there were many enthusiastic delegates and participants in the initial conferences. The fact that there are now annual conferences is evidence of a vibrant society (<http://orsea.uonbi.ac.ke/>).

#### 2.4. Tunisia: TORS

The *Tunisian Operational Research Society* (TORS) was officially recognized in Tunisia in May 2013. TORS aims to share and exchange knowledge, and to promote theoretical developments and applications in OR within Tunisia. The society became a member of IFORS in November 2014 (Haouari and M'hallah 2005; Masmoudi 2015). TORS is also a member society of EURO. The 1<sup>st</sup> TORS annual conference was held in Sousse, Tunisia from 12-14 June 2015 (Teghem and Abdelaziz 2015) while the 2<sup>nd</sup> conference will be held at the same venue from 16-18 December 2016. The developments in Tunisia around OR over the last number of years are very encouraging (<http://www.tors-tn.org>).



(It seems as if TORS was a member of IFORS previously having been admitted as a member in 2005. The membership might have lapsed for some reason.)

#### 2.5. Nigeria

Twenty years after OR was introduced in Nigeria, most executives in public and private industries are still unaware of the profession and much less use it (Salawu 2014). Undergraduates and graduates of OR, especially those doing their internship, are frequently asked, "What is Operations Research?" The University of Benin, Nigeria established the first postgraduate programme in Industrial Mathematics which directly included OR as a field of study in 1980. In 1986, Professor Eytayo Lambo, a former minister for health in Nigeria, started a PhD programme in OR at the University of Ilorin. Contributors to the development of OR as a discipline in Nigeria include Professors B. Onimode, Joseph Funsho Akingbade, A.A. Agbadudu, Eytayo Lambo, Soyibo and Adamu Idama (who introduced the discipline as an undergraduate programme at *Modibbo Adama University of Technology Yola* (Mautech)). Today Mautech is the only University in Nigeria that offers pure OR at undergraduate and postgraduate levels. On 1 September 1998 the department of Statistics and Operations Research was established in the School of Pure and Applied Sciences at this university and the department now offers courses leading to M.Tech and PhD degrees in OR. The Statistics and Operations Research department at Mautech

is also home to a *National Society of Operations Research Students* (NSORS). In 1980, the OR club was formed at the University of Lagos by Prof Akingbade. In late 2004, the *Institute for Operations Research of Nigeria* (INFORN) was established under the leadership of Abdulfatai Oyeyemi Lawal. It was formally recognised under the laws of the Federal Republic of Nigeria as from 4<sup>th</sup> July 2006. The Institute provides a venue for professionals in OR within Nigeria to interact, develop the profession, and advance its practice, methods and application for improved systems performance in Nigeria. It also offers courses leading to a Certificate and a Diploma in OR. In 2015, INFORN joined IFORS (Merchant 2016). The current president of INFORN is Obasohan Phillips Edomwonyi. INFORN also started journal publication (*Nigerian Journal of Operations Research* (NIJOR)), where reports of their research works could be published. The maiden publication came out in October, 2010. Given the long history of OR involvement and activities in Nigeria it is a great development that Nigeria has now joined the IFORS fraternity. Much of the above was taken from <http://inforng.org/index.php/index.php/index.php/about-us>.

There is also another Operations Research Society in Nigeria, called the *Institute of Operational Research and Management Science of Nigeria* (IORMS) which, according to their website (<http://iorms.com/>), started deliberations on establishment in March, 2011 and eventually, in June 2014, the certificate of incorporation of IORMS was issued by Nigerian *Corporate Affairs Commissions* (CAC) under the CAMAL Act of 1990 of Nigerian constitution.

#### 2.6. Egypt: ORSE

The *Operations Research Society of Egypt* (ORSE) joined IFORS in 1976 but its membership has lapsed and there is no indication whether this society is still in existence. IFORS, as well as EURO, has lost contact with ORSE as well as members within this society. In 1989, an Egyptian group was one of the finalists in the then ORSA Franz Edelman award competition for work done for the Egyptian Cabinet (El Sherif, 1990). It is unfortunate that there is no contact with OR groups in Egypt and it is thus not entirely correct to list them under established societies. The fact remains there must still be ongoing OR activities in this politically unstable country.

### 3. Countries with known or some OR activities

#### 3.1. Zimbabwe

OR in Zimbabwe started in the 1970s with elective courses offered under Engineering and Statistics degrees at the then University of Rhodesia (Evans 2011). Although it was not called OR during those years, courses such as Systems Engineering, Optimisation, Decision Theory, and Mathematical Programming were found in several

relevant degree programmes. During the early 1980s, after the country attained independence, the secondary school mathematics syllabus was reviewed and courses that included linear programming were introduced and are still being offered. In 1995, Professor Santosh Kumar introduced Linear Programming, OR, Queuing Theory, Decision Theory and Stochastic Processes at NUST. These courses were offered under the Applied Mathematics Honours degree programme.

An MSc degree in OR was introduced in 1998. The following year a Special Honours Degree in OR was introduced, catering mainly for candidates who had general degrees in Mathematics/Applied Mathematics, Computer Science and other relevant qualifications. In 2005, a four-year bachelor of OR honours degree was introduced in the department after recommendations from industry and commerce. That same year, lecturers in OR and Statistics established a *Statistics and Operations Research Group* which started marketing OR across the country, including exhibiting at the Zimbabwe International Trade Fair for four consecutive years (Evans 2005).

In 2010, a strong contingent of Zimbabwean delegates attended the 39<sup>th</sup> annual ORSSA conference in Limpopo while the NUST of Zimbabwe co-hosted the 40<sup>th</sup> ORSSA conference the next year. For many years OR has survived the political instability in the country where the education system still remained at a high level. NUST's Operations Research and Statistics department is passionate about OR and some are ORSSA members, they are keen to start a Zimbabwe Operations Society soon. There is already a *Zimbabwe Operations Research/Management Science Society* (ZORMS) Facebook page (<https://www.facebook.com/Zimbabwe-Operations-ResearchManagement-Science-Society-ZORMS-469805089815081/>), though its last post is from 2014. There is also a relatively inactive website at <https://zormss.wordpress.com/>.

Bernie Lindner recently had a meeting with the OR and Statistics department at NUST (see page 9 for more) and it has been proposed that there should be a Zimbabwe Chapter under ORSSA (like Johannesburg, Western Cape, etc.) with Philimon Nyamugure from NUST (pnyamugure@gmail.com) recommended as the first chapter chair. The chapter will be mainly based at NUST in Bulawayo, but has contacts and plans for other related OR work in the country. This chapter will help foster ORSSA relations with OR in Zimbabwe until Zimbabwe's OR community is strong enough to start their own national society.

### 3.2. Swaziland

After the 26<sup>th</sup> ORSSA conference that was held in Swaziland there has been minimal further contact with relevant Swazi people. Seemingly there is little OR activity in Swaziland.

### 3.3. Eritrea

Very little is known about OR in this country. However, as part of an exchange programme by the Eritrean Department of Human Resource Development with Stellenbosch University, a number of students from Eritrea completed post-graduate degrees in OR over a number of years (Habte et al. 2003). A number of these students attended the 32<sup>nd</sup> ORSSA annual conference in 2002. Unfortunately nothing more is known about OR in Eritrea.

### 3.4. Senegal

Senegal is one of the Francophone countries with strong French ties. Many students have continued their post-graduate studies in OR at a French university. Not much is known about OR historically in Senegal. In 2013, however, the ORPA 2013/ORTRANS workshop was held from 19-20 November in Dakar, Senegal. The theme was "Freight Transport Planning and Modelling – its application within a rail environment". This workshop was the initiative of Prof Serigne Gueye, who originates from Senegal, but at that stage hailed from the University of Avignon, France. Locally he was ably assisted by the co-organiser, Prof Babacar Ndiayne of the local *Université Cheikh Anta Diop* (UCAD). The conference was held in the Auditorium of the *l'Agence universitaire de la Francophonie* (AUF) located on the UCAD campus. The workshop was attended by some 30 attendees, mainly from UCAD and Senegal. In total there were 14 presentations on a variety of topics, mainly by PhD students. The high standard of the work, and the presentations, were very noticeable (Ittmann 2013). This workshop demonstrated that OR is actively pursued at graduate and post-graduate levels in Senegalian universities and these students do find their way into the public and private sectors.

### 3.5. Morocco

Morocco does not have a formal OR society but there are a number of very active operations researchers in the country. For example, the 4<sup>th</sup> International *Conference of Operational Research* (CIRO) was held in Marrakech (Morocco), during the period 23-26 May 2005 (see <https://www.euro-online.org/africanOR/EnglishFrame.htm>). Papers from CIRO'05 were published in the journal, *RAIRO – Operations Research* (see [https://www.cambridge.org/core/journals/rairo-operations-research/issue/Vol 42 \(2\), April 2008](https://www.cambridge.org/core/journals/rairo-operations-research/issue/Vol%2042%20(2),%20April%202008)). There must have been similar CIRO conferences held previously and possibly subsequently. Later, the 1<sup>st</sup> *International Symposium on Operational Research and Applications* (ISORAP) was held in Marrakesh, Morocco, on 8-10 May 2013 (Menou et al. 2013). The conference had parallel sessions with almost 50 percent foreign country delegates. Many papers were presented by masters or PhD students, but in quite a number of cases the OR content of the work was not clearly visible. For this conference Dr Abdellah Menou was the general chairman, with an

organizing committee comprising members from various universities in Morocco. In 2015, another ISORAP conference took place over the period 21-23 May 2015. There can be no reason why the OR community in Morocco cannot establish a local society.

### 3.6. Algeria

The 6<sup>th</sup> *Operational Research Practice in Africa* (ORPA) Conference was held at the *University of Science and Technology Houari Boumedienne* (USTHB) in Algiers, Algeria, on April 20-22, 2015 (Sihal 2015). For this conference IFORS sponsored two plenary speakers, both from South Africa. More than 70 participants from Algeria, France, Tunisia, Mali, Senegal, Oman and Jordan attended the conference. More than 50 presentations were presented covering a wide range of topic. Though French was the most widely spoken language at the conference, many presentations were in English, and the universal language of mathematics helped to overcome language barriers. A Doctoral School programme held in conjunction with the conference covered topics on graph theory, combinatorial optimization, transportation and logistics. Serigne Gueye, from Senegal, currently with the University of Avignon, France; and Mohamed El-Amine Chergui of USTHB Algiers, along with the organizing and programme committees ensured a well-organized conference. Noticeable was the enthusiastic and highly skilled students who showed a keen interest in OR and confidence in presenting their work in English. A number of the students were keen to pursue the formation of a local OR society. As in many other African countries, establishing a society can be a laborious and frustrating process. This is possibly one of the main reasons that there is not an Algerian OR society as yet.

### 3.7. Other West and Central African countries

The *African Operations Research Network* (AORN) was established as part of the "Africa Project" initiative of EURO, a project aimed at promoting OR in Africa (see Rand *et al.* 2003 and <https://www.euro-online.org/africanOR/EnglishFrame.htm>). It was under this initiative that an *African Conference on Operational Research* (ACOR1) was organised during 5-7 January 2003 in Ouagadougou, Burkina Faso (West Africa). This conference was hosted by the University of Ouagadougou, Burkina Faso and the RAMAD (Reseau Africain Math'ematiques du D'veloppement, <http://www.chez.com/ramad>) sponsored by EURO and IFORS and with the active support of ICTP and the Facult'e Polytechnique de Mons (Belgique). The chairman of the Organising Committee was Professor Blaise Some, University of Ouagadougou, while the Programme Committee was chaired by Jacques Teghem (Facult'e Polytechnique de Mons, Belgium). The conference was a great success with a number of papers presented and delegates from Algeria, Burkina Faso, Belgium, Benin, Cameroun,

Congo, France, Italy, Mali, Morocco, Niger, Nigeria, Senegal, Chad, Tanzania, Tunisia, UK and the USA (see <https://www.euro-online.org/africanOR/EnglishFrame.htm> and Rand *et al.* 2003). At ACOR1 a number of important decisions were taken:

- The creation of the West and Central African Operational Research Society, to bring together OR researchers and practitioners from western and central African countries;
- An Africa-wide teaching scheme to encourage the exchange of OR students and researchers, both within and outside Africa;
- The development of the Operations Research Society of East Africa, which would bring together OR specialists from East Africa and the region of the Great Lakes; and
- The development of the AORN website together with a mailing list in order to facilitate communication between all OR practitioners and researchers working in Africa.

The 1<sup>st</sup> International Conference on Operational Research was organised by the West and Central African Network of OR in Niamey (Niger), during 26-28 January 2004. There is a chairman of the conference report available, but it is in French! Over 100 delegates attended from a number of countries with the majority from Niger. It is not clear whether this conference led to the formation of a society or network called the *West and Central African Network of Operational Research* (ROCARO). There does not seem to be any further activities from this network since the first conference. Little is known of what the situation is in most of the West and Central African countries regarding OR. Although a number of decisions were taken at ACOR1, very little seem to have been achieved since that conference, illustrating the lack of continuity and sustainability.

### 3.8. Cameroon

The 3<sup>rd</sup> Buea International Conference on Mathematical Sciences held from April 30 to May 3, 2013 featured a new colloquium on OR, made possible with the sponsorship of IFORS. The objective of the activity was to generate enthusiasm for the study and application of OR in the region. This objective was addressed through a series of workshops and conference-wide plenaries to participants who were primarily mathematics faculty members and students from West Africa (Khumbah and Cochran 2013). Here is a further indication of students getting exposure to OR in another West African country.

## 4. AORN, ORPA and ICORD

These three initiatives are focused on Africa specifically and on developing countries in Africa:



AORN had some 62 members at the time it was established in 2003. The memberships ranged from Nigeria (18), Zambia (3), Kenya (10), Mozambique (3), Zimbabwe (6), Ghana (2), Algeria (5), Tanzania (2), Tunisia (4), Namibia (2), Morocco (3) and 1 each from Lesotho, Uganda, Botswana and Congo. Dr Eric Soubeiga was one of the founding members and was also responsible for the AORN website. It seems as if this initiative has become dormant.

ORPA has emerged as an initiative aimed at promoting the use of OR approaches to decision-making processes in Africa. This implies actions on the continent to promote OR use and research to share experiences, taking good practices wherever they are located with the idea of concrete applications on the continent. The 1<sup>st</sup> ORPA conference in Ouagadougou, Burkina Faso in 2005 was supported financially by IFORS and EURO. Subsequent ORPAs have since been held in London, Cape Town, Washington, Dakar and Algiers. From what is presented above this is an initiative that is seemingly very successful been used in promoting OR across Africa (see <http://www.orpagroup.net/documents.html>).

IFORS has an initiative aimed at developing countries in general and not focused solely on Africa. This was an initiative that originated from the IFORS conference in 1987 held in Buenos Aires, Argentina. This led to the establishment of the ICORD “instrument” of IFORS. The 1<sup>st</sup> ICORD conference was held at the Indian Institute of Management in Ahmedabad, India in December 1992. The aim was to provide a forum for intensive discussion and exchange of experiences of various researchers dealing with OR in developing countries and OR for development; and for effective interaction and discussion among a critical mass of participants from the developing countries. A resolution known as “The Ahmedabad Declaration” was adopted unanimously by the conference. The focus was to support OR in developing countries through various ways and mechanisms. A total of 11 ICORD conferences have been held in India (1992), Brazil (1996), the Philippines (1997), South Africa (2001), India (2005), Brazil (2007), Tunisia (2012), Italy (2013), Spain (2014), Sri Lanka (2015) and Mexico (2016), and the next one will be held in Quebec City, Canada prior to the IFORS 2017 conference (see <http://ifors.org/icord-history/>).

## 5. Conclusion

OR activities in Africa are diverse across the continent. It has taken years to get to a point where a number of countries and individuals are now taking the first steps of establishing an entity that will represent OR interest across Africa. There are many countries where there are known and sufficient interests and activities around OR that would justify the formation of more societies. These countries

should be encouraged to take the necessary steps towards more formal structures. It is about time OR in Africa has a mechanism not just to promote the discipline across Africa, but also to focus on ways and means of assisting in addressing African-specific problems.

## References

1. El Sherif, H, 1990, *Managing Institutionalization of Strategic Decision Support for the Egyptian Cabinet*, Interfaces: February 1, 1990, pp 97 – 114 (El Sherif was at The Management Department, The American University in Cairo, 113 Kasr El Aini Street, Cairo, Egypt and Information and Decision Support Center, Cabinet of Egypt).
2. Rand, G. K. and Tsoukias, A., 2002, *Developing OR in Africa: initiatives of IFORS and EURO*, Presentation at the IFORS 2002 Conference, Edinburgh, Scotland.
3. Geldenhuys, G, Rudolph, G. 1997, *A Brief History of the Beginnings of Operations Research in South Africa*. [www.orssa.org.za](http://www.orssa.org.za)
4. Ittmann, H.W. and Yadavalli, V.S.S., 2010, *The Operations Research Society of South Africa*, book chapter in Wiley Encyclopaedia of Operations Research and Management Science, John Wiley & Sons, 2010, 1 - 4.
5. Evans, D., Lesoana, M., Nyamugure, P. and Sigauke, C., 2011, *Operations Research Comes to Zimbabwe in a Big Way – The ORSSA 2011 Conference at Victoria Falls*, OR/MS Today, 1 June 2011.
6. Evans, D., 2011, *Operations Research in Zimbabwe*, IFORS newsletter March 2011.
7. Salawu, I., 2014, *Operations Research Practice in Nigeria*, IFORS newsletter March 2014.
8. Habte, A.G., Yohannes, A.M., Kassa, D.F., Negash, E.O. and Manna Z.G., *Eritrean Students: Their Views and Impressions of OR and ORSSA*, IFORS Newsletter for Developing Countries, 11(2), June 2003.
9. Masmoudi, Y., 2015, *Tunisian Operational Research Society: A Look Into Our Newest Member*, IFORS Newsletter March 2015.
10. Haouari, M. and M'hallah, R., 2005, *Operations Research In Tunisia*, IFORS Newsletter for Developing Countries, 13(2), June 2005.
11. Teghem, J. and Abdelaziz, F.B., 2015, *A Historic First OR Annual Conference in Tunisia*, IFORS Newsletter, December 2015.
12. Rand, G.K, Smith, D.K. and Soubeiga, E., 2003, *OR take-off in West Africa?*, *OR Newsletter*, 2003, <https://www.euro-online.org/africanOR/ORNewsletter2003a>
13. Caulkins, J.P., Eelman, E., Ratnatunga, M. and Schaarsmith, D., 2005, *O.R. Africa Recent Programs, Future Potential*, OR/MS Today, October 2005, <http://www.orms-today.org/orms-10-05/africa.html>
14. Ittmann, H.W., 2013, *IFORS Supports Urban Transport Planning Conference in Senegal*, IFORS Newsletter, December 2013.
15. Silal, S., 2015, *IFORS Supports ORPA Conference in Algeria*, IFORS Newsletter, June 2015.
16. Khumbah, N. and Cochran, J.J., 2013, *IFORS Brings Operations Research To Cameroon*, IFORS Newsletter, June 2013.
17. Merchant, S., 2016, *Report of the IFORS VP at large and Chair*, Developing Countries Committee, IFORS Newsletter, June 2016.
18. Menou, A., 2013, *Editorial Chairman's Preface*, International Symposium Operations and Applications (ISORAP 2013), 8-10 May 2013, Marrakech, Morocco.

# PAN AFRICAN OPERATIONS RESEARCH SOCIETY SUMMIT

## (NAIROBI 2016)

by *Bernie Lindner (berndtlindner@gmail.com)*



The Pan African Operations Research Society 2016 summit was held at the Lukenya getaway hotel just outside Nairobi, Kenya from the 3-4 November 2016. This initiative was brought about by the efforts of Abdulfatai Lawal (Nigeria) and Charles Malack Oloo (Kenya), enthusiastic OR people from several

different countries, and a little help from Michael Trick (IFORS President) and Sue Merchant (Chair of the IFORS Developing Countries Committee).

The agenda of the summit was to propose the concept and inauguration of an African OR regional society. This included deliberations on a name, logo, constitution, membership requirements, etc.

Many OR delegates from across Africa were invited, but only 11 prominent delegates were able to attend (see Table 1), including: the president of IFORS (Michael Trick), who was the keynote speaker, the president of INFORN (Obasohan Phillips Edomwonyi), and the president of ORSSA (Winnie Pelser). I had the great privilege of being able to attend along with the big weights.

Table 1: List of delegates who attended the Summit

Name	Country	OR Society	Other affiliation(s)	Email
Abdulfatai Lawal	Nigeria	INFORN		metcorms@gmail.com
Charles Oloo	Kenya	ORSEA	UK OR Society	olooocm@gmail.com
Michael Trick	USA	IFORS		trick@cmu.edu
Serigne Gueye	Senegal	ORPA		serigne.gueye@univ-avignon.fr
Winnie Pelser	South Africa	ORSSA		WPelser@csir.co.za
Florence Kimathi	Kenya		(Human) waste management	kikikim2004@gmail.com
Phillips Obasohan	Nigeria	INFORN		philiobas@yahoo.com
Opaleke Olesgun Taiwo	Nigeria	INFORN		oopaleke@yahoo.co.uk
Berndt Lindner	South Africa	ORSSA		berndtlindner@gmail.com

Name	Country	OR Society	Other affiliation(s)	Email
Nicholas Mwaura	Kenya		International Procurement & Logistics (IPL)	nickmwama@gmail.com
Hatem Masri	Tunisia			hatem.masri@gmail.com

The concept of an African regional OR society was well received by the delegates who could attend and other stakeholders not present (via email/skype). The name adopted for the new African regional body was *African Federation of Operations Research Societies* (AFROS) and the first elected President is Charles Malack Oloo of Kenya. Other committee members are proposed from South Africa, Tunisia, ORSEA and ORPA. Post holders will serve a two-year term.

A constitution is still being drafted but the following was deliberated and decided upon at the summit:

The proposed vision of AFROS is to promote Operations Research for African development.

The proposed mission of AFROS is:

- to mobilise the formation of African OR societies,
- to bring together all existing African OR societies.

The proposed objectives of AFROS are:

- organising and supporting OR-related events, such as conferences, workshops, training, exchange programs, within Africa,
- disseminate information regarding OR related work in Africa, and beyond.

From deliberations and reports by each society member the following constituted the pioneer executive members of AFROS:

- President – Kenya (ORSEA) – Charles Malack Oloo
- Vice President - Nigeria (INFORN) – Olusegun Taiwo Opaleke
- Secretary – South Africa (ORSSA) – Bernie Lindner
- Treasurer – Tunisia – Hatem Masri
- Database Manager/Webmaster – ORPA – Serigne Gueye
- Public Relations Manager – Kenya (ORSEA Secretary General) – Gituro Wainaina
- Ex-officio (Presidents of African OR societies) –

- Nigeria (INFORN) – Phillips Obasohan
- South Africa (ORSSA) – Winnie Pelsler
- Tunisia – Fouad Ben Abdelaziz
- (ORPA) – Eric Soubeiga
- Kenya (ORSEA) – Prof Isaac Mbeche

AFROS will be an umbrella body which will cover and nurture current national and regional Operations Research societies in countries of Africa. This includes some countries who already have national societies, like Nigeria (INFORN), South Africa (ORSSA) and Tunisia (TORS), but importantly house other regional OR bodies such as ORPA and ORSEA for example house members who do not yet have regional national societies (Ghana, Senegal, Kenya, etc.)

Initially AFROS will work out how best to establish itself and reach out to all stakeholders in Africa. It is also the time that more support is required from all our partners especially from IFORS and other regional bodies. OR people in Algeria, Benin, Botswana, Burkina Faso, Ghana, Senegal and Tanzania have expressed an interest in the new federation although they were unable to attend the initial meeting, and AFROS executive committee members would be delighted to hear from others who would like to contribute to the discussion. Further discussions with stakeholders who could not attend the conference are also taking place, with positive feedback and comments.

AFROS plans to have a website, facebook page, etc. up hopefully early next year, where you may find more information and further developments.

I furthermore visited the *University of Nairobi* (UoN) as



Figure 1: 9 delegates at the AFROS summit. From left to right: Phillips Obasohan (President INFORN, Nigeria), Charles Malack Oloo (Kenya), Abdulfatai Lawal (INFORN), Opaleke Olesegun Taiwo (INFORN), Florence Kimathi (Kenya), Serigne Gueye (ORPA, Senegal), Winnie Pelsler (President ORSSA, South Africa), Bernie Lindner (ORSSA), Nicholas Mwaura (Kenya). Hatem Masri from Tunisia also participated for some of the meeting via Skype. Michael Trick (IFORS) is the only other delegate not present.

part of promoting exchange programs with Stellenbosch University. I also made contact and visited the Department of Management Sciences. I met amongst others, Prof Isaac Mbeche, who is the Deputy Vice-Chancellor, Student Affairs at the UoN and a Professor in Management Sciences and with Kate Litondo, who is the Head of the Department of Management Science at UoN. I also met with ORSEA's Secretary General, Gituro Wainaina, at one of

the many prestigious and member exclusive country clubs in and around Nairobi. ORSEA is strongly run from the UoN Department of Management Science.

If you have any questions or comments, please let me know via email. I would like to thank ORSSA for the funding to attend this promising initiative.

See more at

Facebook - <https://www.facebook.com/ORSocietySA/>

Twitter - #AFROS #AfricaORSummit @\_ORSSA @berndtlindner

## THE NAIROBI DIARIES

by Winnie Pelsler ([wpelsler@csir.com](mailto:wpelsler@csir.com))



ORSSA put trust in me and Bernie to attend the founding meeting of an Operations Research Society for Africa. Bernie will give the formal feedback of the Africa Summit. This contribution is an informal commentary of the few days we spent in Kenya.

**Winnie Pelsler** We arrived at Jomo Kenyatta International airport on 2 November 2016, after a four-hour flight. From the runway we could see zebra next to the fence. What a good welcome!

The trip from the airport to Lukenya Getaway was interest-

ing. In my mind I saw this route via open plains with game. The reality was lots of traffic on this road to Mombasa. But we did see giraffes, and zebra grazing peacefully next to the road. They were not in fenced areas. It seems as if wild animals are streetwise in Kenya. We arrived at the Lukenya Getaway late the afternoon. The hotel was a great venue. The mosquito nets in the rooms were very welcome!

The Lukenya Getaway is situated in the Lukenya hills with large grounds nestled in the rich, cultured Athi plains region. The 30 km from the airport took about 45 minutes due to traffic. We met Michael Trick the evening for supper. It was really good to see him.

The meals at Lukenya Getaway were really good. We ate a few interesting dishes. Items such as arrow root, ugali (maize meal porridge or pap), irio (mashed peas and potato mix), chapatti (flat bread), githeri (beans) and sukuma wiki (kale). Kenya is a major producer of tea and coffee. Within Kenya coffee is mostly drunk instant. But the brewed coffee is more to my taste and really the good stuff. Pre-mixed tea with milk and sugar is very nice and well-liked. Bernie was used to similar tea in Zimbabwe. A very popular and well-balanced local lager is Tusker, named after a famous elephant.



Mike Trick (President of IFORS), Bernie and Winnie

We met the rest of the team and all were very friendly and enthusiastic to get the most of the few days we had together.

A highlight of the Summit was a special dinner that was sponsored by Michael Trick. It was good to meet the team in an informal manner.

Charles Oloo from Kenya was a very kind host and escorted Serigne Gueye, Bernie and me to Nairobi some 40 km away. We visited the Nairobi animal orphanage that is located within the Nairobi National park. The Nairobi National Park only 8 km from the city centre and is Kenya's oldest national park. Charles took us to Carnivore, an open air restaurant in the Langata suburb of Nairobi. They serve a variety of meat and are famous for their game. Barbequed meat is known as Nyamachoma. The meat was really excellent. After the meal Charles took us to the Maasai market in Nairobi. He was kind enough to bargain on our behalf!

The next day we went to the Karen Blixen Museum which was once the centre piece of a farm at the foot of the hills of the Ngong Hills. It is located 10 km from the city centre. The farm house gained international fame after the movie *Out of Africa*, an Oscar winning film based on Karen's autobiography with the same name. It was great to see the museum and the surroundings. We stumbled upon the old coffee mill in the grounds.

## **KENYA DIARIES: THE LION, MY CRUTCH & MAASIA'S WARDROBE**

by *Bernie Lindner (berndtlindner@gmail.com)*



Bernie Lindner

Kenya is a very special country with exceptionally nice people. In true Swahili I greet you, *Kwaheri*.

Kenya is popularly epitomised in the West as "Africa". For example, Disney's the *Lion King* borrows its native language, Swahili, for terms such as *Simba* (meaning Lion) and the setting and animals in the movie. The book and movie "Out of Africa" is based in Nairobi, Kenya. Winnie and I, in fact, visited Karen Blixen's (the heroine and biographer of *Out of Africa*) farmstead, which has been turned into a National museum.

During my stay in Nairobi following the Africa OR summit, I stayed in the Kenya comfort hotel, right across the road from the University of Nairobi. Which I would highly recommend for a student or young working adult. Winnie stayed just down the road at the After 40 hotel, which was a bit more expensive, but had more luxurious rooms. The Kenya comfort hotel nevertheless had a very nice restaurant and bar, as Winnie and I can testify. Both these hotels are situated in the city. Buzzing supermarkets, craft markets, popular fast food stores (debonairs, steers), international

banks and ATMs within walking distance.

The local Kenyans I found to be very friendly, always offering to help and interested to know where I was from. Almost every Kenyan I met was very surprised that I was from South Africa, most assumed I was from USA or Australia.

Kenya has a wide variety and flair for food. This includes a number of salads, more finely chopped and artistically decorated than I am used to in South Africa. The Kenyans enjoy their meat, much like South Africans. Kenya's unofficial national dish is called *Nyama choma*, which means barbequed meat in Swahili. Winnie and I, in fact, went to a famous restaurant called Carnivore in Nairobi, which is sort of a buffet restaurant where all different kinds of meat are served, from the normal lamb, beef and pork, to more exotic meats like ostrich, camel, goat, turkey and crocodile. I enjoyed all of these but I must admit after four days of a more than usual amount and variety of meat my stomach wasn't too impressed and I had to switch to being more of a herbivore for a couple of days.

*Uber* is quite cheap in Nairobi and I used it predominantly for travelling. I was unfortunately on crutches in Kenya due



Bernie enjoying some local cuisine

to a soccer injury sustained to my knee, but I was able to get around safe and sound. Kenya did have some political and safety concerns a while ago, but it seems to be very safe to travel around. I would highly recommend Kenya and Nairobi to anyone.



Nyama choma

**Quick facts on Kenya:**

- Swahili is predominant in Tanzania, Kenya, Uganda, Rwanda, Burundi, Mozambique and the Democratic Republic of the Congo.
- The country is named after Mount Kenya, the largest mountain in Kenya with a height of 5199 m.
- Kibera, sitting about 5km outside of Nairobi, is the the largest urban slum in Africa
- The impressive Nairobi National park, housing much wildlife, is situated right next to the city.

A FEW SWAHILI (“KISWAHILI”) TERMS	
<i>Simba</i>	Lion
<i>Rafiki</i>	Friend
<i>Nyama choma</i>	Barbequed meat
<i>Karibu</i>	Welcome



One of the local Kenyan markets

**BULAWAYO MEET-UP & NEW CHAPTER ESTABLISHMENT**

by *Bernie Lindner (berndtlindner@gmail.com)*



Bernie Lindner

The idea for this meeting started with me asking Dave Evans to have all the Zimbabwean ORSSA members’ details so that I could check in with them during my visit to Bulawayo, Zimbabwe late November. My mom lives about 40km outside Bulawayo, near a place called Esigodini. She lives on a small plot where she grows vegetables

and flowers in her own greenhouses. I thought it might be nice to visit the handful of ORSSA members based in Bulawayo, most of whom are based at the *National University of Science and Technology* (NUST) in Bulawayo. Instead of the small gathering of ORSSA members, Philemon Nyamugure, a lecturer at NUST, rather surprised me on the day, having scheduled an hour lecture on OR to all the students and staff at the Department of Statistics and Operations Research at NUST. Luckily I had a few slides on OR in general, ORSSA, and my PhD work on my Dropbox account which I could quickly scrounge. Marc Hatton (a friend and also an ORSSA member)

also accompanied me on my holiday and also spoke to the students and staff, specifically on working within OR. He gave a 15-20 minute presentation, thanks Marc. The OR community at NUST is thriving and there were many eager and passionate students and lecturers. So much so that a proposal was brought forth to establish a Zimbabwe Chapter under ORSSA, with the obvious choice of Philemon as the first chair. Zimbabwe plans to create a national society in the near



The presentation panel for the meeting



Meeting attendees

future. There are already talks of a *Zimbabwe Operations Research Society (ZORS)*. Please see page 4 for more information on the state of OR in Zimbabwe. NUST and Philemon plans also to get other Universities and practioners of OR involved. The students at NUST are quite keen to do some internships (part of their studies) at South African-based institutions doing OR-related work. If you or your company are interested please contact Philimon (pnyamugure@gmail.com) and/or me.



## BOOK REVIEW: DECISION SUPPORT FOR FOREST MANAGEMENT

by Hans W. Ittmann, University of Johannesburg (hittmann01@gmail.com)



Hans Ittmann

The generally-accepted definition of democracy highlights the principle of representative government. However, that was not always the case. Over a number of millennia, democracy as a concept evolved and it certainly did not follow a straight path. From the Athenian period, where the selection of officials by lot was a characteristic distinction of democracy (Aristotle 340BC), the gist of the concept has altered totally. In 2004 the United Nations declared that essential elements of democracy include: "the right to take part in the conduct of public affairs, directly or through freely chosen representatives, to vote and to be elected at genuine periodic free elections by universal and equal suffrage." The *Mathematical Theory of Democracy* deals with the selection of representatives who make decisions on behalf of the

citizens of a country. While presenting an in-depth history of democracy, the book delves into the mathematical principles underlying democratic theory (i.e. the mathematical theories of voting and election rules) in a systematic and comprehensive manner.

The book consists of three parts: history, theory and applications with an appendix containing computational formulas and statistical tables. The first part outlines "Athenian democracy," giving a historical perspective on the establishment of democracy which culminated in Aristotle's mathematical model of government types. The republican period in "Ancient Rome" is then described with strong emphasis on the writings of Pliny the Younger as he was seen as the pioneer of strategic thinking in voting institutions. Through his analysis, he foresaw the emergence of the mathematics of multi-alternative choice and

strategic voting. During the early middle ages, there was a sort of revival of democracy in the Venetian and Florentine Italian medieval city-republics. It was during this period that Llull, considered to be the first, started to consider an election from a mathematical perspective.

Chapter 4 in the history part covers the Age of Enlightenment, with ideas around democracy of Montesquieu and Rousseau being outlined. Rousseau still associated selection by lot with democratic rule. The ideas of these two influenced the thinking around mathematics in elections by redirecting selection by lot to election voting. Borda, Condorcet and Laplace were some of the main authors. Borda developed “a method for election,” fairly simple although some of his thinking and methodology is still used today. Laplace justified the Borda method while Condorcet developed a social choice theory. A number of theorems, with proofs, are included as well as one dealing with the convergence of the Borda and Condorcet methods.

The final chapter on history, following the American and French revolutions during which the concept of representative government was pushed strongly, discusses some of the limitations of representative democracies. This is done both in a mathematical sense with results such as Arrow’s Impossibility Theorem, and in a more general sense using recent examples of wars that compromised the democratic idea.

Part two is devoted to the development of theory aimed at improving the performance of representative democracy by re-considering the election principles and the use of voting. The focus is on representative bodies and how well they reflect popular views on a range of issues. Three indices are defined and applied, namely, representativeness, popularity and universality. For an issue (or question), *representativeness* is defined as the size of the group represented by the representative. The *popularity* of the representative, in turn, is the average (over a number of issues) size of the group whose opinion is represented, where the importance of issues could be weighted. Finally, *universality* is the frequency with which the representative’s view on issues (or questions) coincides with that of a majority. Ultimately, an election method not based on voting but on indexing of candidates with respect to the electorate’s political profile is proposed. Clearly, this reflects how well public decision making echoes the opinions of the electorate.

In Chapter 8, using an example, it is shown how the indices of representation can be applied empirically to the case of the 2009 German Bundestag election. The position taken

by 5 parties over 30 policy issues are compared with the results of opinion polls. This is analysed for all issues and the view of the voters are compared using the popularity and universality indices as determined from the positions taken by the parties. Findings show that: voters tended to vote inconsistently in elections with respect to their own opinion profiles; party manifestos played almost no role in how they voted; and voters appeared to be influenced by traditions and candidate charisma. A number of additional methods are developed towards “truly democratic elections.” As John F Kennedy said, “Democracy is never a final achievement. It is a call to an untiring effort.”

The third part of the book, comprising four chapters, is devoted to further applications. These range from applications such as planning public opinion polls with no cyclic majorities, collective multi-criteria decisions where travel alternatives for an outing needs to be considered for one and several travel alternatives, to stock exchange prediction applications and traffic control problems. The range of

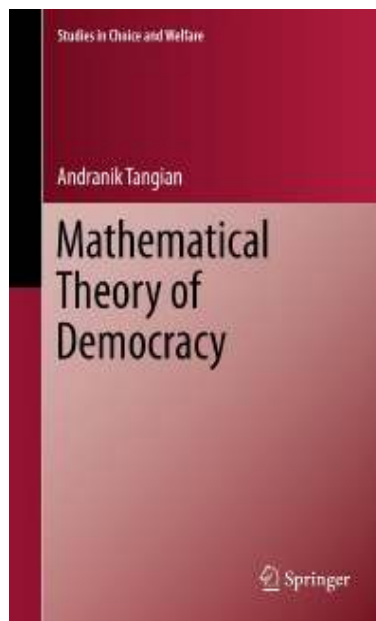
applications demonstrates the versatility of the methodology that is developed by the author. The book has several appendices, mostly covering technical material such as Chebyshev’s Inequality, the Beta Distribution, Multinomial Sums, Probability Tables, and statistical significance.

This is an impressive book covering a wide range of fields around the concept of democracy. It covers in great depth the history, limitations, and strengths from the mathematical, historical and philosophical perspectives. The author is able to unfold how various societies, over several millennia, handled the issue of electing and selecting their representatives in different forums – starting with

basic and simplistic philosophical approaches to quantifying real-life situations through mathematical models – with the ultimate objective of ensuring fair and equitable representation for as many different groupings, or factions of a population as possible.

Elections affect every citizen of a country. The *International Foundation for Electoral Systems* (IFES) monitors elections held worldwide. Recently, Wales, Scotland and Northern Ireland held their elections on May 5<sup>th</sup>, 2016 while the Philippines had theirs four days later. All countries have electoral systems with some kind of strong quantitative foundation. Many of these can be traced back to what is covered in the *Mathematical Theory of Democracy*.

*This book review appeared in the IFORS newsletter of June 2016.*

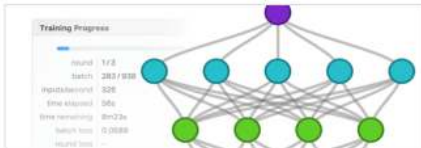


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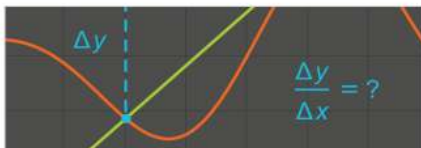


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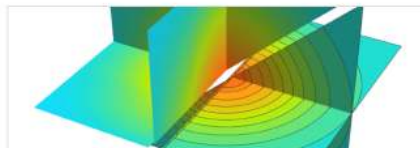
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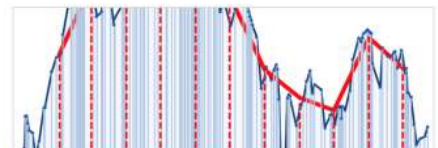
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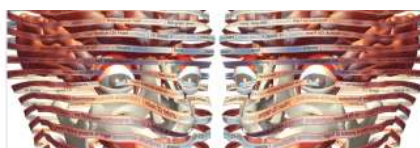
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