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| **Department** | Decision Sciences | | |
| **Discipline** | Operations Research and/or Quantitative Management | | |
| **Research Focus Area** | Computability, Complexity and Randomness in Decision Science (CCRDS) | | |
| **Total Capacity for 2025** | 14 (7 Masters and 7 PhDs) | | |
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| **Supervision Team details** | **Academic profile** | | **Capacity** |
| Under normal circumstances and at the time of writing the following staff members are available and have the expertise to supervise topics in this focus area. | | | |
| **Professor Petrus H Potgieter**  [[1]](#footnote-1)**(Contact person for this focus area)**  Email: [Potgiph@unisa.ac.za](mailto:Potgiph@unisa.ac.za) | **Highest qualification**: PhD in Mathematics (University of Pretoria).  **Research interests**: Unconventional computation. | Master’s: Up to 1  Doctorates: Up to 1 | |
| **Professor Willem Fouché**  Email: [Fouchwl@unisa.ac.za](mailto:Fouchwl@unisa.ac.za)  Google Scholar: <https://scholar.google.com/citations?user=gP_yY4MAAAAJ&hl=en> | **Highest qualification:** PhD in Mathematics (Stellenbosch University),  **Research interests:** Algorithmic randomness, Fourier analysis and Ramsey theory.  **NRF-rated researcher (B1).** | Master’s: Up to 1  Doctorates: Up to 1 | |
| **Professor Safari Mukeru**  Email: [Mukers@unisa.ac.za](mailto:Mukers@unisa.ac.za) | **Highest qualification**: PhD in Operations Research (Unisa).  **Research interests:** Stochastic Processes and Applications in Financial Modelling, Fourier Analysis, Fractal geometry and Mathematical Logic.  Research in Probability and Statistical modelling in the presence of interdependent random variables. Research in Random polynomials, random matrices and applications.  **NRF-rated researcher (C3).** | Master’s: Up to 3  Doctorates: Up to 3 | |
| **Professor George Davie**  Email: [Davieg@unisa.ac.za](mailto:Davieg@unisa.ac.za) | **Highest qualification**: PhD in Mathematics (University of Pretoria), **Research interests:**  Kolmogorov complexity, effective Brownian motion, effective ergodic theory | Master’s: Up to 1  Doctorates: Up to 1 | |
| **Model of Supervision** | Candidates will be allocated to a supervisor, but will be required to work independently within the requirements of higher degree studies. | | |
| **Selection Criteria:**  **MSc, MCom and PhD** | Refer to the qualification website for selection criteria. | | |
| **Selection Procedure** | Refer to the qualification website for selection procedure. | | |
| **Documents to Support Application** | One-page abbreviated CV, including:   * Academic qualifications * Work experience * Contact details * Expression of interest (see selection criteria) | | |
| **Research Scope** | In Decision Sciences the focus at Master's and PhD level is the application of existing advanced mathematical techniques to a new and demanding problem or the further development of such techniques, algorithms or mathematical theory relevant to the practice of Operations Research and/or Quantitative Management. | | |
| **Reading:**  **Subject Field** | 1. Peter Mörters and Yuval Peres: Brownian Motion. Cambridge University Press, Cambridge Series in Statistical and Probabilistic Mathematics, Cambridge 2010, xii + 403 pp., ISBN 978-0-521-76018-8. 2. P. Billingsley, Probability and Measure (Wiley, 1st Edition 1976, 2nd Edition 1986, 3rd Edition, 1995, Anniversary Edition 2012 ). 3. A. Shen and N. K. Vereshchagin, Computable Functions, American Math. Soc., 2003. 4. H. Dym and H.P. McKean, Fourier Series and Integrals, Academic Press, 1974. | | |
| **Reading:**  **Research Methodology** | * Departmental Honours project study material. | | |
| **Resources: Scholar Community** | N/A | | |
| **Potential M&D Research Focus** | | | |
| **Unit of Analysis** | **Research Focus** | | |
|  | We are working on the linking of the fractal geometry of Brownian motion with algorithmic randomness. New links with Fourier analysis are being studied. Results on the interplay between algorithmic randomness and symmetry in dynamical systems are being explored. The identification of Ramsey properties of Fraïsse first order structures in terms of the Gelfand theory of the symmetry group of the structure is under investigation.  We looked at Ito integration with respect to Brownian motion in an effective setting. We are now preparing a paper on constructing local time of effective Brownian motion in a layerwise computable manner by exploiting recent developments (Hoyrup, Rojas) in computable measure theory and some of our own results on the Fourier properties of the zero sets of Brownian motion. Results (with Arno Pauly, Cambridge) on the effective geometry of Brownian motion in the context Weihrauch degrees were established and in the process of further development.  More generally, we are interested in the broad theme of using Kolmogorov complexity and Algorithmic randomness to find effective versions of probabilistic phenomena. We also study the relations between computability and Kolmogorov complexity.  We also work on the conceptual issues in quantum computation and quantum information theory.  **Some recent papers:**  1. George Davie, Decidable lim sup and Borel–Cantelli-like lemmas for random sequences. Statist. Probab. Lett. 83 (2013), no. 1, 278–285  2. George Davie, Constraints placed on random sequences by their compressibility. Statist. Probab. Lett.82 (2012), no. 7, 1474–1478  3. Willem Fouché, Johannes Heidema, Glyn Jones,Petrus H. Potgieter, Universality and programmability of quantum computers, Theoretical Computer Science 403 (2008) 121–129.  4. Willem L Fouché, Diophantine properties of Brownian motion: recursive aspects. Logic, Computation, Hierarchies (Festschrift in honour of Victor L. Selivanov) (V. Brattka, H. Diener, D. Spreen, eds.), DeGruyter, Berlin, (2014) 139-156. arXiv:1409.1752  5. Willem L Fouché, Safari Mukeru and George Davie, Fourier Spectra of measures associated with algorithmically random Brownian motion. Logical Methods in Computer Science, (Festschrift in honour of Dieter Spreen), 10 (3:20) (2014), 1-24, doi:10.2168/LMCS(3:20)2014.  6. Safari Mukeru, The descriptive complexity of stochastic integration. Journal of Complexity, Volume 31, Issue 1, February 2015, Pages 57-74  7. Paul Potgieter, Arithmetic Progressions in Salem-Type Subsets of the Integers, J Fourier Anal Appl (2011) 17:1138-1151.  8. Petrus H Potgieter, Computable counter-examples to the Brouwer fixed-point theorem, arXiv:0804.3199 (2008) | | |

1. Please note that consulting the research focus area leader is no assurance that your application will be approved. If, however, your application is approved, it is also not a guarantee that he/she will be allocated as your supervisor. [↑](#footnote-ref-1)