Curriculum Vitae
Hugh Murrell

August 2020

Mbona Private Nature Reserve
Karkloof, KwaZulu-Natal
South Africa

retired Prof of Computer Science
University of KwaZulu-Natal

Personal Details

Address Site H13, Mbona Mountain Estate, Karkloof, South Africa.

Postal Address PO Box 895, Howick, KwaZulu-Natal, SouthAfrica.

e-mail hugh.murrell@gmail.com

url http://hughmurrell.github.io

Phone +2776 6864721 (cell)

Birth Date 17 December 1954.

Birth Place Kasama, Zambia.

Citizenship dual, South African and British

Family wife and 2 grown-up children.

Sport canoeing

Education

Primary

1960-1964: Codrington, Mazabuka.

Secondary

1965-1967: St. George's College, Salisbury.

1968-1968: CBC, Pretoria.

1969-1971: Hyde Park, Johannesburg.

Military

1972: Potchefstroom, surveyor for the artillery.

Tertiary

1973-1975: B.Sc., Natal University, Pietermaritzburg.

Majors: Mathematics, Applied Mathematics.

1981: B.Sc. Hons, Rhodes University, Grahamstown.

Course Work: Classical Mechanics, Quantum Mechanics,

Functional Analysis, Complex Variables,

Differential Equations, Measure Theory.

1982: M.Sc., Rhodes University, Grahamstown.

Thesis: Conductivity Profiles for a Horizontally Uniform Earth.

1995: PhD., Natal University, Durban.

Thesis: Modeling with Mathematica.

Awards Academic Colours from Rhodes.

Experience

1976-1977: Pietermaritzburg,
Assistant Train Driver.

1977-1978: Natal Provincial Administration in Pietermaritzburg,
Scientific Programmer.

1979-1984: Rhodes University, Computing Services,
Scientific Programmer.

- Last position held: Head of Academic Support, responsible for user training, package installation/maintenance and various development projects.

1985-1986: Department of Mathematics, Rhodes University,
Lecturer.

1987-2003: Department of Computer Science, Natal University,
Senior Lecturer and Associate Professor (Durban campus).

2004-2014: School of Computer Science, University of KwaZulu-Natal,
Professor (Pietermaritzburg campus)

- Head of School (Pietermaritzburg and Durban) (2005-2007)
- PI for Bioinformatics grant (2006-2009)
- Deputy Head of School (2009-2010)
- Head of School (2011)

2015-... Contracting:

- contract teaching: Computer Science, UKZN.
- consulting.

Teaching

Mathematics courses taught (1985-1986)

Calculus, Numerical Analysis, Linear Algebra,
Differential Equations, Complex Variables.

Computer Science courses taught (1987-2014)

Discrete Maths, Introduction to Programming, Computer Literacy,
Object Oriented Programming, Data Structures,
Operating Systems, Graphics,
Image Processing, Mathematical Modeling,
Bioinformatics, Data Mining

Contract teaching (2015 - 2018)

honours: Bioinformatics, Data Mining, Deep Learning

third year: Theory of Computation

second year: Object Oriented Programming

Administration Responsibilities

1987-2002:

Lab responsibilities   Before we had a technical team I was responsible for running UNIX servers within Computer Science. These have ranged from an HP 9000 with 3 workstations under HPUX to 2 SGI Indys under Irix and an 8 machine Linux network.

Faculty web site   For about six years I was responsible for Computer Science and Faculty web sites.

2003-2004:

Head of Department   During this period I have acted as Deputy Head of School, Head of Discipline, Programme Director and acting Head of Department in the absence of Prof Sartori-Angus. I was involved with a number of academic appointments, the fulltime appointment of our first technical manager and the re-grading of administation staff.

During 2003 we were forced into a merger with Geology. I played a large part in the operation of our School of Geological and Computing Sciences. I pursued geocomputing projects two of which have resulted in MSc theses under my supervision. My image processing and mathematical modelling experience were found useful to the geologists and I have acted as entertainment officer, seminar series organizer and coffee maker.

During 2004, I accepted a professorship on the Pietermaritzburg campus where I acted as head of discipline for Computer Science. I also played a large part in the planning process for a split from Geology and the formation of a new School of Computer Science that was due to get underway at the beginning of 2005.

2005-2011:

Head of School   At the beginning of 2005 I accepted a three year contract as *Head of School* for the new UKZN School of Computer Science which operated across Pietermaritzburg and Durban. The new School consisted of 19 academics, 4 administrators and 6 technical staff.

I took sabbatical in 2008 and returned in 2009 as deputy head of School. During 2011 I took on the responsibility of one more year as Head of School before our School was again merged, this time with Mathematics and Statistics. During 2012 I took sabbatical and have returned to a teaching position for 2013 and 2014.

Course Development: I have been responsible for the development of a number of courses during my tenure at UND and UKZN.

Java Programming. I played a large part in the move to JAVA based programming and have regularly taught the first year introductory JAVA programming course.

Discrete Mathematics, I was responsible for a large part of the development of our first year course introducing number representation and logic to Computer Science students.

Data Structures, I offer a standard second year Data Structures course which can be delivered using either JAVA or C++.

Numerical Analysis, I developed most of the content for this second year course which has since been taken over by Mathematics.

Graphics and Modeling, I developed this web based third year course using the medium of `VRML` to impart graphics concepts.

Operating Systems, I have been entirely responsible for the development of this course which is now a common course across all delivery sites of Computer Science. This course is popular with students as it is the first time they get experience with Linux and multi-player computer games.

Mathematical Modeling, This honours course, is based on the package, *Mathematica*. I am responsible for the entire content of this course and have since become the University's resident *Mathematica* expert.

Image Processing This honours course is delivered using the Java based image processing shell, ImageJ.

Bioinformatics, After obtaining the NBN grant, I developed a Bioinformatics honours course pitched at Computer Science students who have an interest in genetics. A number of these students have since completed masters in bioinformatics after an introduction via this honours course.

Data Mining, During my 2012 sabbatical I developed a new honours course introducing data mining and machine learning in an R programming environment.

Deep Learning, In the second semester of 2018, for the first time at UKZN, I taught a *deep learning* honours module to Mathematics students. The inspiration for this module came from a 2015 online set of lectures by Nando de Freitas of Oxford university. The course notes have been written up and published online as a free to download textbook. The notes are accompanied by a set of `Jupyter notebooks` that implement the networks described in the text using the `Julia` programming language together with the `Flux` deep learning package. The notes and the notebooks are available from `https://hughmurrell.github.io/DeepLearningNotes`.

Honours Project supervision (in approximate chronological order, 1988 -).

Reconstruction via the Hartley Transform David Carson derived the classic CAT reconstruction algorithm using the Hartley transform as the basic mathematical tool. He coded up his algorithms and obtained equivalent reconstruction results on test projection data.

Voxel based rendering Paul Melamed built a voxel based rendering system for producing 3D pictures from CAT slices.

Ray tracing Laser Beams through Shock Waves Paul Baise built a computer model for generating the path traveled by rays of light through theoretical shock waves.

Ray Tracing for Mathematica Michael Haley built a ray tracing front end for Mathematica.

Speech Recognition and Sound Compression using Wavelets Richard De Oude carried out an investigation into the use of wavelet transforms as a tool for speech recognition and sound compression.

Bird Call Recognition Rowena Mannix used ideas from the speech recognition literature to build a system that attempted to recognize common bird calls.

Flight Plan Production Keith Crompton built a graphical system for light aircraft pilots to use when required to file flight plans for trips over Southern Africa.

Photo Faker Martin Fortmann developed an image processing systems that allowed the user to create fake photographs by inserting small images into larger ones and then smoothing out the joins.

Automated Mapping System Steven Clur built an image processing system that stitched together images taken from a helicopter while flying a predetermined path over an area of interest. The system was installed on the helicopter as a navigational aid to help the pilot stay on track.

Solid Modelling of Geological Phenomena Sheila Van Der Willigen built a solid modeller (similar to noddy) for geological folding, shearing, slipping and weathering.

Web Based Bookings Cuan Brown developed a web-based database for travel agents to advertise tours and take bookings over the web.

3D Julia Sets Mark Lewis built a system for displaying 3D Julia sets based on the convergence of quadratic quaternion generators.

Web Based Car Dealer Database Kamil Reddy built a web based car dealer database using new ideas from JAVA and JDBC.

Cane Simulation Web Service Yevern Govender studied an irrigation simulation package from the SA Sugar Cane Association Experiment Station and rewrote the simulator so that it could deliver irrigation programs to farmers over the web.

Interactive JPEG image compression Gavin Murrison constructed a program for the interactive compression of JPEG images.

Greyscale image enhancement using Pseudo-Colouring Keagan Moodley wrote a colour-map generator for providing pseudo-colour to greyscale images. One of his colour maps is now used by marine geologists to colour images of the sea-bed.

LBW trainer for cricket umpires Sean Patton used OpenGL to build an LBW trainer for cricket umpires. The model includes bowler batsman and wicket keeper. Sean built an algorithm for producing different deliveries that require LBW decisions. These are played at random and the user (the umpire) has his decisions recorded.

Algorithmic music environment Geoffrey Devantier made use of the computer music tool, *Jmusic* , to build an environment for constructing algorithmic music. The main feature of this system was a plugin facility which allows users to write simple algorithmic music generators.

Automatic music scorer Isacc Lundall tried to build a system that used wavelet transforms to convert sound samples to music scores. This was an ambitious project and only musical samples consisting of a sequence of pure notes was tackled.

Delaunay triangulation of the sphere Jacqueline Maw used Mathematica and Java to construct an algorithm for generating Delaunay triangulations of points on the unit sphere. An algorithm for points on the plane already exists but triangulation (spherical) of points on the sphere is much harder (and in some cases impossible). Miss Maw tried to adapt the planar algorithm to the spherical case and deal with spherical nasties as they occur.

Delaunay triangulation of the sphere Chris de Kadt repeated the work done by Miss Maw in 2003. Chris and I investigated a new triangulation algorithm for spherical data. The new algorithm overcame some of the problems that occurred with Miss Maw's algorithm.

Folding proteins on lattice points Kieran O'Neill investigated the protein folding problem. This problem is known as the *holy grail* of bioinformatics. Kieran investigated the application of genetic algorithms to the protein folding problem.

Pitch Recognition Techniques using Fourier and Wavelet transforms John McGuiness rewrote the *Tartini* tool to recognize single pitches in a given melody using both windowed Fourier transforms and Wavelet transforms. This work was much more successful than the note recognition system built by Isacc Lundall in 2002.

Automatic Motif Discovery Stephen Pitchford, wrote and investigated *Mathematica* software for finding motif patterns in a set of nucleotide sequences.

Postgraduate supervision

Hilton Goldstein, MSc thesis, 1990,

Computer Enhanced Skull Surgery,

a graphics system that used CAT data to help surgeons make decisions on which piece of skull to use when reconstructing a forehead for children suffering from dwarf syndromes.

Hilton Goldstein, PhD thesis, 1994,

Space Frequency decomposition of arbitrary signals,

Space/Frequency decomposition of one dimensional signals. using wavelets to construct a *dominant scale algorithm* for which applications in music and speech recognition exist. This PhD resulted in two journal papers and two conference presentations.

Cuan Brown, MSc thesis, *cum laude*, 2000,

A Real Time, Secure, Internet Based, Auctioning System,

A web based auctioneering system. Bidding was controlled by java applets running under client web browsers and communicating with a java controller on the host auction server. The latest cryptographic techniques were employed to protect the bidders and the auctioneer.

Mark Lewis, MSc thesis, 2001,

Spectral Techniques for Roughness Estimation,

Spectral based algorithms for estimating the *roughness* of 1D and 2D signals. Applications in geology and biology were tackled. This project has produced one paper in SACJ.

Theo Naicker, MSc thesis, 2002,

Modelling the two body abrasive wear problem,

A computer model for the two-body abrasive wear problem in response to a request from the DeBeer's mining company. This problem involves the study of how one surface, the tool surface, will degrade another surface, the work surface, when they come into contact while in relative motion.

Keagan Moodley, MSc thesis, *cum laude*, 2002,

Pseudo-Colouring of grayscale images,

an extension of his pseudo colouring honours project to allow for colour maps to be generated from many different colour models with applications such as, sonar images of sea beds and x-ray medical scans. This project produced a paper in SACJ.

Luke Vorster, MSc thesis, 2004,

A UML framework for computer music,

A general framework for computer music based on UML (the Unified Modelling Language).

Kieran O'Neill, MSc thesis, *cum laude*, 2007,
>   *Relieving the Cognitive Load of Constructing Molecular Biological Ontology Based Queries by means of Visual Aids,*
>   Co-Supervisors: Daniel Jacobson and Alexander Garcia-Castro.

Rafael Jimenez, MSc thesis, 2007,
>   *Vector Graphics to improve Blast Graphic Representations,*
>   Co-Supervisors: Daniel Jacobson and Alexander Garcia-Castro.

John McGuiness, MSc thesis, *cum laude*, 2009,
>   *Investigation of techniques for automatic polyphonic music transcription using wavelets,*
>   a bold attempt to produce software that constructs musical scores from sound recordings.

Anisa Ragalo, MSc thesis, *cum laude*, 2011,
>   *An analysis of algorithms to estimate the characteristics of the underlying population in Massively Parallel Pyrosequencing data,* A Mathematica platform for evaluating various Pyrosequencing algorithms.

Devin Pelser, Msc thesis, 2019,
>   *Deep and dense sarcasm detection,* A deep, dense neural network for detecting sarcasm.

Funding

Bioinformatics I spent many hours during 2004 and 2005 preparing a funding application for a Bioinformatics node at UKZN. I was the principal investigator for this fund and in cooperation with staff from our biochemistry department submitted the UKZN application late in 2005. We were awarded close to R1m early in 2006. During 2007 a further R0.5m continuation award was made. This award has been used to set up infrastructure and technical services to support the KwaZulu-Natal Bioinformatics Node and as a source of scholarships for bioinformatics students.

Opensource

CRAN package During my 2012 sabbatical I wrote an R data mining package for discovering non-linear associations between variables in a dataset. Read `https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0151551` for further details.

Covid-19 tracking During the first half of 2020 under lockdown, I constructed a Julia script to compute Rt estimates at scale from global data sets. This script updates nightly and allows users to compare Covid outbreaks from region to region. Results can be viewed here; `https://reproduction.live/`

Consulting

Leather Dyeing Recipes I connected a PC to an electronic scale using a BurrBrown board so as to monitor recipes for a local leather dyeing shop and update workshop inventories.

Noise Monitoring I wrote a vibration monitoring package for Toyota that listens to accelerometers placed at various parts of a car as it is taken through a rev sequence. FFT's were calculated and plotted so as to enable engineers to track major frequencies versus rev count.

Unit Trust Performance I constructed a linux based database containing equity performance predictions from a local stock-exchange research company. I then wrote a front-end that queries the database and produces performance predictions for local unit trust portfolios.

Product Counting I constructed product-counting software for a plastic injection molding company. This software produces daily, monthly and yearly graphs of production figures for each machine operated by the company.

Access Control I act as consultant to Mr. Rob Davey who supplies access control equipment and web-based monitoring devices.

R Consulting

Genetic Drift App During 2015 I constructed a ShinyApp that allows the user to upload a *wildtype* virus sequence to a gene pool and then set *fitness* parameters before initiating an in-silico random genetic drift operation on the gene pool. The app employs third party software to perform RNA folding in parallel in order to implement one of the fitness parameters that the client was interested in. The app maintains a phylogenetic tree for all the sequences surviving in the gene pool and the app allows the user to download genetic variants of the wildtype from the gene pool for later in-vivo construction and testing. I wrote the app under instruction from Prof. Darren Martin of UCT's Faculty Of Health Sciences. He plans to make the code open source eventually.

Retirement Planning App During 2015 and 2016 I constructed another ShinyApp that allows Financial Advisors to load their client's portfolio data and then use the app to simulate performance of the financial instruments into retirement and beyond. I wrote this application for Mr. Peter Strydom of Enhance IFA who intends to market the app to South African financial advisors. The app will be hosted on the shinyapps.io server and only paid up advisors will have access to it.

Publications

1982: *From Cagniard's Method to the method of the Differential Transform*, Comp. & Maths. with Appls., Vol. 8, No. 2, pp.103-118, Co-Author: Abraham Ungar.

1985: *The Differential Transform and its application to an electrostatics Image Problem*, Comp. & Maths. with Appls., Vol. 11, No. 6, pp.565-572, Co-Author: Abraham Ungar.

1986: *Non-Linear runoff routing, a comparison of solution methods*, Journal of Hydrology, 85, pp.339-347, Co-Author: Dennis Hughes.

1989: *A case for Computer Tomography in the Undergraduate Syllabus*, proceedings of the 15th South African symposium on Numerical Mathematics, Umhlanga Rocks, July 1989.

1990: *Image Reconstruction via the Hartley transform*, South African Computer Journal, Number 1, pp36-42, Co-Author: David Carson.

1991: *A model of age-dependent population dynamics providing simple criteria for growth or extinction*, Mathematical Biosciences, 103, pp1-17, Co-Author: John Swart.

1992: *Animation of rotating rigid bodies*, The Mathematica Journal, Vol. 2, No. 1, pp.61-65.

1993: *A mathematical golf swing*, The Mathematica Journal, Vol. 3, No. 4, pp.62-65.

1994: *Planar Phase Plots and Bifurcation Animations*, The Mathematica Journal, Vol 4, No. 3, pp.80-85

1995: *Wavelets and Birdcall Recognition*, Proceedings of the 25th annual SACLA conference, pp.51-62, (copies from Rhodes University).

1996: *Computer Aided Tomography*, The Mathematica Journal, Vol 6, No. 2, pp.60-65

2001: *On Measuring Roughness*, South African Computer Journal, Number 27, pp 49-56, Co-Authors: Mark Lewis, Colin Jermy and Tally Palmer.

2004: *A colour-map plugin for the open source, Java based, image processing package, ImageJ*, Computers & Geosciences, vol 30, pp 609-618. Co-Author: Keagan Moodley.

2007: *An oscillatory model revisited*, Chaos Solitons and Fractals, Vol 32, issue 4, pp 1325-1327. Co-Author: John Swart.

2008: *A generalised Verhulst model of a population subject to seasonal change in both carrying capacity and growth rate*, Chaos Solitons and Fractals, Vol 38, issue 2, pp 516-520. Co-Author: John Swart.

2008: *Gene Spotting with Support Vector Machines*, Proceedings of IMS2008, Maastricht.

2009: *Classification of the maxillary sinus according to area of the medial antral wall: a comparison of two ethnic groups*, J Maxillofac Oral Surg, Vol 8, issue 2, pp 103107 Co-Authors: CL Fernandes and CMC Fernandes.

2011: *Fisher Discrimination with Kernels*, The Mathematica Journal, Vol 13, July 26, Co-Authors: Kazuo Hashimoto and Daichi Takatori.

2012: *Matie, Measuring Association and Testing Independence Efficiently*, a presentation at *The Data-mining Revolution*, a bioinformatics conference in Stellenbosch. Co-Authors: Ben Murrell and Daniel Murrell.

2013: *Synchronisation of fertility with carrying capacity; an investigation using classical and agent based modeling*, South African Computer Journal, Number 50, Co-Author: John Swart.

2014: R^2*-equitability is satisfiable*, Proc Natl Acad Sci USA , early edition, Co-Authors: Ben Murrell and Daniel Murrell.

2016: *Discovering General Multidimensional Associations*, PLoS ONE 11(3): e0151551. doi:10.1371/journal.pone.0151551 Co-Authors: Ben Murrell , Daniel Murrell.

2019: *Deep and dense sarcasm detection*, `https://arxiv.org/abs/1911.07474`, November 2019, Co-Author: Devin Pelser.

2019: *Deep Learning Notes, with Julia and Flux*, Edition 1, `https://HughMurrell.github.io/DeepLearningNotes` Co-Author: Nando de Freitas.

2020: *Estimating Rt from Covid-19 data, using SIR models*, `https://hughmurrell.github.io/CoVmodel/index.html` Co-Author: Daniel Murrell.

Referees

`deshen@cs.uct.ac.za`
 Prof. Deshendran Moodley,
 Computer Science,
 University of Cape Town.
 (ex-colleague)

`anbanp@gmail.com`
 Mr. Anban Pillay,
 Computer Science,
 University of KwaZulu-Natal.
 (colleague)

`rosanne@cs.ukzn.ac.za`
 Mrs. Rosanne Els
 Computer Science,
 University of KwaZulu-Natal.
 (colleague and PhD student)