David Angwenyi Nyachae

Curriculum Vitae

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"With malice toward none, with charity for all, with firmness in the right." — *Abraham Lincoln*

Personal Information

Date of Birth: 21st December, 1986
Nationality: Kenyan
Gender: Male
Languages: English, Swahili, Kisii, Kalenjin, German
Marital State: Married

Research Interests

Data Assimilation: Simultaneous state and parameter estimation, inverse problems, filtering using optimal transport ideas, machine learning where a filter is applied in initialising neural network model.

Numerical Analysis: Numerical analysis of SPDEs. Numerical solution of SPDEs and SODEs on extruded domains using finite element and finite volume methods.

Modeling: Disease modeling, statistical models for geospatial phenomena, economic models, modelling traffic flows, movement of pollutants and fluid flows.

Teaching & Work Experience

06.11.2023– present — **Senior Lecturer of Applied Mathematics**, *Masinde Muliro University of Science and Technology*, Kakamega, Kenya
Teaching, assessment and curriculum development of postgraduate and undergraduate Applied Mathematics courses.
Detailed achievements:
○ Teaching undergraduate, masters and doctoral students in Applied Mathematics.
○ Preparing course content, set examination and graded exams in Applied Mathematics courses.
○ Supervising postgraduate students in their research work in numerical analysis.
○ Writing research proposals for funding and conducting research in the area of numerical analysis.
○ Developing and reviewing of PhD courses.

29.02.2020– 05.11.2023 — **Lecturer of Applied Mathematics**, *Masinde Muliro University of Science and Technology*, Kakamega, Kenya
Teaching, assessment and curriculum development of graduate and undergraduate Applied Mathematics courses.
Detailed achievements:
○ Taught undergraduate, masters and doctoral students in Applied Mathematics.
○ Prepared course content, set examination and graded exams in Applied Mathematics courses.
○ Supervised postgraduate students (4 to completion and 3 ongoing) in their research work in numerical analysis.
○ Wrote research proposals for funding and conducted research in the area of numerical analysis.
○ Developed a new Data Assimilation PhD course.

15.10.2017–04.02.2018	**Tutor**, *Institute of Mathematics, University of Potsdam*, Potsdam, Germany Held seminars on Markov Chain Monte Carlo Methods. Held lectures on Feedback Particle Filters.
01.10.2013–27.02.2020	**Assistant Lecturer**, *Masinde Muliro University of Science and Technology*, Kakamega, Kenya Taught and evaluated undergraduate courses in Applied Mathematics Coordinated bridging in Mathematics programme Coordinated examinations in Mathematics department
30.04.2010–29.08.2010	**Teacher**, *Starehe Boys' Centre and School*, Nairobi, Kenya Taching practice in Mathematics and Physics (with a score of A (plain) in both.)

Academic History

01.10.2015–02.09.2019	**Doctor of Natural Sciences (Mathematics)**, *University of Potsdam*, Potsdam, Germany, Research Field: Numerical Analysis
23.08.2017 –19.12.2017	**Doctoral Course on Sequential Monte Carlo Methods**, *Uppsala Universitet*, Uppsala, Sweden, *6.0 Credit Points* Super-intensive course on Sequential Monte Carlo Methods, computer experiments, exercises and workshop on Sequential Monte Carlo Methods and take-away assignments on Sequential Monte Carlo Methods.
26.09.2011 –23.08.2014	**Master of Science in Applied Mathematics**, *University of Nairobi*, Nairobi, Kenya, *Distinction* Courses involved: Partial Differential Equations, Ordinary Differential Equations, Numerical Analysis, Functional Analysis, Applied Complex Analysis, Fluid Mechanics, and Methods in Applied Mathematics
14.10.2007 –08.09.2011	**Bachelor of Education (Science)**, *University of Nairobi*, Nairobi, Kenya, *First Class Honours* Courses involved: Calculus, Real Analysis, Complex Analysis, Dynamics, Probability and Statistics, Measure Theory, Operations Research, Numerical Analysis, Vector Analysis, Linear Algebra, Ordinary Differential Equations, Geometry, Algebra, Electricity and Magnetism, Waves and Optics, Mechanics, Atomic Physics, Nuclear Physics, Solid State Physics, Mathematical Physics, History of Education, Philosophy of Education, Psychology of Education, Sociology of Education, Elements of economics, Comparative and contemporary issues in education, HIV and AIDs Instructions, Communication skills, Guidance and Counselling, Educational Measurement and Evaluation, Psychology teaching and learning, Teacher education, Educational planning, Instructional technology and media practical, Teaching methods in Mathematics and Physics, Teaching practice in Mathematics and Physics, Physics practicals.
04.02.2001 –17.11.2005	**Kenya Certificate of Secondary Education (KCSE)**, *Mochenwa Secondary School*, Keroka, Kenya, *Grade A- (77 Points)* Subjects involved: English, Kiswahili, Mathematics, Physics, Biology, Chemistry, Geography, and Accounting
05.01.1993 –16.11.2000	**Kenya Certificate of Primary Education (KCPE)**, *Cheptuech Primary School*, Kuresoi, Kenya, *417 Marks* Subjects involved: English, Kiswahili, Mathematics, Geography, History and Civics, Science and Agriculture, Christian Religious Education, Art, Craft and Music.

Doctoral Thesis

Title	*Time-Continuous State and Parameter Estimation with Application to Hyperbolic SPDEs*
DOI	https://doi.org/10.25932/publishup-43654
Supervisors	Prof. Dr. Sebastian Reich and Prof. Dr. Claudia Stolle

Description The goal of this thesis is to:— i) Review the derivation of Kushner-Stratonovich equation from first principles and its extant numerical approximation methods, ii) Study the feedback particle filters as a way of avoiding resampling in particle filters, iii) Study joint state and parameter estimation in time-continuous settings, iv) Apply the notions studied to linear hyperbolic stochastic differential equations. The interconnection between Ito integrals and stochastic partial differential equations and those of Stratonovich is introduced in anticipation of feedback particle filters. With these ideas and motivated by the variants of ensemble Kalman-Bucy filters founded on the structure of the innovation process, a feedback particle filter with randomly perturbed innovation is proposed. Moreover, feedback particle filters based on coupling of prediction and analysis measures are proposed. They register a better performance than the bootstrap particle filter at lower ensemble sizes. We study joint state and parameter estimation, both by means of extended state spaces and by use of dual filters. Feedback particle filters seem to perform well in both cases. Finally, we apply joint state and parameter estimation in the advection and wave equation, whose velocity is spatially varying. Two methods are employed: Metropolis Hastings with filter likelihood and a dual filter comprising of Kalman-Bucy filter and ensemble Kalman-Bucy filter. The former performs better than the latter.

Masters Thesis

Title *An Investigation of Numerical Solution to Partial Differential Equations in Numerical Weather Prediction*

Supervisor Dr. Charles Nyandwi

Description In this study, we begin by presenting an overview of the Numerical Weather Prediction process as used in the Unified Model of the Met Office in UK The primitive equations are the continuity equation, the momentum equations, equations for representation of moisture, the expression for the first law of thermodynamics and the equation of state. Discretisation of these equations is done using the two-time-level, off-centred, Semi-Implicit, Semi-Lagrangian time discretisation scheme. This is preferred to the Eulerian decomposition in which advection terms abound, rendering it computationally inefficient. Consistency and stability of this scheme is analysed; the latter using the matrix method of stability analysis. Convergence of the SISL scheme is inferred by using Lax Equivalence Theorem. The coupling of the discretised governing equations results in the Helmholtz equation whose solution yields the increment in pressure field, n'. To analyse the condition for stability of the Helmholtz equation we have used the Von Neumann approach, which shows that the spatial-steps chosen and the wave number are factors that affect stability. In the final analysis, the recurrence relation for a 2 - D Helmholtz equation is solved using Jacobi, Gauss-seidel, Successive-Over-Relaxation, Conjugate Gradient, Bi-Conjugate Gradient, Bi-Conjugate Gradient Stabilized, Quasi-Minimal Residual and Gradient Minimal Residual methods. Respective iteration time is also shown. We show that Bi-CGSTAB method is most efficient, followed by GMRES method. Finally, a visual aid for the solution of 2-dimensional Helmholtz equation is shown.

List of Publications

[12] **David Angwenyi**, (2023) *Estimation of Spatially Varying Parameters with Application to Hyperbolic SPDES.* Journal of Applied Mathematics. DOI:https://doi.org/10.1155/2023/7909668

[11] Sheila Kiprotich, **David Angwenyi**, & Titus Rotich, (2022) *Particle Tracking Model of Contaminant in a Flow Through a Porous Medium to Determine Concentration and Decay.* Journal of Applied Physical Science International, Volume 14, Issue 2, Page 1-17, DOI: 10.56557/japsi/2022/v14i27972

[10] Harrison Onyango, Patrick Odhiambo, **David Angwenyi**, and Patrick Okoth., (2022) *In Silico Identification of New Anti-SARS-CoV-2 Main Protease (Mpro) Molecules with Pharmacokinetic Properties from Natural Sources Using Molecular Dynamics (MD) Simulations and Hierarchical Virtual Screening.* Journal of Tropical Medicine.DOI: https://doi.org/10.1155/2022/3697498

[9] Robert O., **Angwenyi D.**, Achiles N., & Ong'ala J. , (2022). *Initialization and Estimation of Weights and Bias using Bayesian Technique.* Asian Journal of Probability and Statistics, 17(2), 61-85. https://doi.org/10.9734/ajpas/2022/v17i230420

[8] **D. Angwenyi** (2021), *Feedback particle filter with stochastically perturbed innovation and its application to dual estimation,* arXiv, https://arxiv.org/abs/2107.08381

[7] **D. Angwenyi** (2021), *Estimation of spatially varying parameters with application to hyperbolic SPDEs*, arXiv, https://arxiv.org/abs/2107.07246

[6] R. Oryiema, **D. Angwenyi,** and K. Midenyo (2021), *Extended Ensemble Filter for High-dimensional Nonlinear State-Space Models*, Journal of Advances in Mathematics and Computer Science, Volume 36.

[5] Ronald Mwesigwa, Godwin Kakuba and **David Angwenyi** (2020), *The Fundamental Solution of the One– Dimensional Elliptic Operator and its Application to Solving the Advection–Diffusion Equation*, Journal of Applied and Computational Mathematics, Volume 9:1, 2020, DOI: 10.37421/jacm.2020.9.458.

[4] **Angwenyi David** (2019), Time-Continuous State and Parameter Estimation with Application to Hyperbolic SPDEs, Doctoral thesis, Universität Potsdam, DOI: http://doi.org/10.25932/publishup-43654

[3] Rachel A. Nyang'inja, **David N. Angwenyi,** Cecilia M. Musyoka and Titus O. Orwa (2018), *Mathematical Modelling of the Effects of Public Health Education on Tungiasis—a Neglected Disease with many Challenges in Endemic Communities,* Advances in Differential Equations, https://doi.org/10.1186/ s13662-018-1875-5

[2] **Angwenyi D**., de Wiljes, J. and Reich, S. (2017), *Interacting Particle Filters for Simultaneous State and Parameter Estimation,* arXiv: 1709.09199v1

[1] **Angwenyi D.**, Lawi, G., Ojiema, M. and Owino, M. (2014) *On the Computationally Efficient Numerical Solution to the Helmholtz Equation,* International Mathematics Forum, Vol. 9, no. 6, 259 − 266 HIKARI Ltd, www.m-hikari.com http://dx.doi.org/10.12988/imf.2014.311224

Research Supervision, Mentoring & Training

2019–present **Mentoring postgraduate students in their research**

Completed

○ PhD Thesis of Robert Oryema on *Initialization And Estimation of Weights and Bias in Artificial Neural Network Using Bayesian Technique*, who graduated in December 2022.

○ PhD Thesis of Ronald Mwesigwa on *Analysis of the Payne–Whitham Traffic Flow Model using the Finite and Boundary Element Methods*, who graduated in April 2023.

○ PhD Thesis of Sheila Kiprotich on *Contaminant Tracking Mathematical Model in a Flow Through Porous Medium to Underground Water Bodies*, who graduated in December 2023.

○ PhD Thesis of Michael Musyoki on *Modified Vector Autoregressive Model Incorporating New Information Using Bayesian Approach*, who graduated in December 2023.

Ongoing

○ PhD Thesis of Cavin Oyugi on *Second Order Extended Ensemble Kalman Filter For Initialization of Artificial Neural Weights*, which is ongoing.

- ○ MSc. Thesis of Kevin Midenyo on *Extended Ensemble Kalman Filter for Nonlinear Filtering*, which is ongoing.
- ○ MSc. Thesis of Owen Mulinya on *Mathematical Modelling of Dam-break Problem in 3-D*, which is ongoing.
- ○ MSc. Thesis of Ndarawit K. Wilberforce on *In-silico Search for α-Glucosidase and α-Amylase Inhibitors for Management of Postprandial Hyperglycemia*, which is ongoing.

2019–present **Mentoring undergraduate students in their research**

Completed

- ○ Undergraduate final year project on *Numerical Solution to The Shallow Water Equation*, to completion.
- ○ Undergraduate final year project on *Numerical Solution to Black-Scholes Model for Option Pricing*, to completion.
- ○ Undergraduate final year project on *Modelling and Prediction of Kenya's GDP Using ARIMA model*, to completion.
- ○ Trained Geospatial Information Science students on *numerical solution of Ordinary Differential Equations using MATLAB*
- ○ Trained Geospatial Information Science students on *Spatial Statistics using R*
- ○ Undergraduate final year project on *Stock Price Prediction Using Geometric Brownian Motion*, to completion.
- ○ Undergraduate final year project on *Mathematical Modelling for Responsible Fish Harvesting*, to completion.

Conferences, Workshops, Seminars and Summer-schools

06/2023 Helped organize and participated in the 1st African STACK Conference for Undergraduate Mathematics - MMUST held at Masinde Muliro University of Science and Technology.

08/2021 Facilitated in the Data Science seminar during the Carnegie African Diaspora Fellowship Program held at Masinde Muliro University of Science and Technology.

06/2021 Participated in School of Natural Sciences (SONAS) Workshop with the theme: Embracing Multidisciplinary Research and Innovation in the Intervention of Societal Problems: STEM in focus. Organised by Masinde Muliro University of Science and Technology (MMUST)

12/2020 – Took part in the Online Grant Writing and Research Dissemination Seminar conducted
04/2021 by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

08/2019 Data Science and Computational Intelligence session of the 5th Strathmore International Mathematics Conference held in Strathmore University from 12th to 16th August 2019. I presented on *Simultaneous State and Parameter Estimation.*

07/2019 Maseno University fortnight mathematics seminars, 2nd July, 2019. I presented on *Time-Continuous Filtering and Parameter Estimation.*

08/2017 Sequential Monte Carlo PhD course and workshop, 24th August - 1st September, 2017, Uppsala University, Sweden.

08/2017 Kliakhandler Conference on Statistics and Statistical Genetics, 16th - 20th August, 2017, Michigan Technological University, Houghton, Michigan, USA. I gave a talk titled *Parameter Estimation: Application of Ensemble-based Kalman Filter.*

10/2016 Mathematical and Algorithmic Aspects of Data Assimilation in the Geosciences Conference, 2nd - 8th October, 2016, Mathematisches Forschungsinstitut Oberwolfach, Germany.

05/2016 Higher-Order DG Methods and Finite Element Software on Modern Architectures, 31st May - 2nd June, 2016, University of Bath, UK.

02/2016	Focus Retreat on Stochastic Tools in Mathematics, 29th February - 4th March, 2016, Ellmau, Austria.
06/2014	Hands-on Research in Complex Systems, 29th June-11th July, 2014, The Abdul Salam International Centre for Theoretical Physics, Italy.
08/2013	The 2nd Strathmore International Mathematics Conference and Research Methods Pre-Conference School, 12th-16th August, 2013, Strathmore University, Nairobi, Kenya.
07/2013	East African School on Applicable Algebraic Geometry, 8th -26th July, 2013, Bandari College, Mombasa, Kenya.
06/2013	First Kenyatta University Workshop on Mathematical Modelling, 17th -21st June, 2013, Kenyatta University, Nairobi, Kenya.
08/2012	The EAUMP Summer School on Combinatorial Commutative Algebra, 13th -21st August, 2012, The Nelson Mandela African Institute of Science and Technology, Arusha, Tanzania.
07/2012	International Mathematics Research Meeting and Workshop on Pure Mathematics, 23rd -27th July, 2012, Strathmore University, Nairobi, Kenya.
04/2006	SMASSE PROJECT: In-Service Training for Secondary Mathematics And Science Teachers, April 2006 and April 2007, Nyansiongo Boys' High School, Nyamira District, Kenya.

Other Work-related Appointments

Sep. 2022 – present	Member of School of Natural Science Research Committee representing Mathematics department.
Sep. 2021 – present	Representative of Western Kenya in the executive committee of Kenya Mathematical Society.
Sep. 2021 – present	Patron of Masinde Muliro University of Science and Technology Seventh-day Adventist (MMUSDA) Church.
Feb. 2019 – present	Examination coordinator in the department of Mathematics.
Sep. 2014 – Apr. 2015	Patron of Masinde Muliro University of Science and Technology Seventh-day Adventist (MMUSDA) Church.
Jan. 2014 – Apr. 2015	Examination coordinator in the department of Mathematics.

Membership in Professional Bodies

Sep. 2021 – present	Executive Committee Member of Kenya Mathematical Society representing Western Kenya Region.

Community Service

Jan. 2023 – present	Communication Secretary and member of the board of Seventh-day Adventist Church Harmony.
Jan. 2022 – Dec. 2022	Elder in charge of Adventist Men Ministry, Youth Ministries, Communication Department, Prayer Department and Education Department and member of the board in Seventh-day Adventist Church Harmony.
Jan. 2021 – Dec. 2021	Deputy Chairman of Adventist Men Ministries, Communication Secretary and member of the board of Seventh-day Adventist Church Harmony.

Research Grants Won

2020	Center for International Migration and Development research grant worth **10,000 Euros** for research in Data Assimilation.

2015	German Academic Exchange Service (DAAD) scholarship to pursue three-year doctoral studies in Numerical Analysis at University of Potsdam, Germany, and a six-months preparatory language course at Goethe Institute in Nairobi, Kenya, and Dresden, Germany.
2011	Masinde Muliro University of Science and Technology staff development scholarship to pursue a two-year Master of Science degree in Applied Mathematics at the university of Nairobi.

Honours & Awards

2013	Certificate of merit for an astounding project titled *On the Cayley-Hamilton Theorem* at the East African School on Applicable Algebraic Geometry, 8th—26th July, Bandari College, Mombasa.
2006	Kitutu Masaba Way Forward Award for outstanding academic achievement in KCSE 2005.

Languages

Kisii	fluent	**English**	fluent
Kalenjin	fluent	**German**	Independent user
Kiswahili	fluent		

Skill matrix

- ■□□□□ basic knowledge
- ■■□□□ intermediate knowledge with some project experience
- ■■■□□ extensive project experience
- ■■■■□ deepened expert knowledge
- ■■■■■ expert / specialist

	Level	Skill	Years	Comment
Language:	■■■■■	Python	5	*I have an online certificate in Python and have been doing statistical analyses in Python.*
	■■■■■	R	5	*I have been doing statistical analyses in R. Taught undergraduate spatial statistics using R.*
	■■■■■	MATLAB	10	*I am proficient in MATLAB, and I have taught solving PDEs and ODEs using MATLAB.*
	■■■■■	LaTeX	14	*I use LaTeX to make exams, resumes, journal articles, flyers, minutes and letters.*
OS:	■■■■■	iOS	7	*I mostly use iOS at work and at home.*
Data Analysis	■■■■■	Statistical Analysis	5	*Done a number of analyses*

Referees

1. **Dr. Ongaro Jared**
   School of Mathematics
   University of Nairobi
   P. O. Box 30197 - 00100, Nairobi, Kenya
   Tel: +254 (0)733 270 231
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2. **Prof. George Owuor Lawi**
Associate Professor, Biomathematics
Masinde Muliro University of Science and Technology (MMUST)
P. O. Box 190-50100, Kakamega, Kenya
Tel: +254 (0)722 292 635
Email: glawi@mmust.ac.ke

3. **Prof. Dr. Sebastian Reich**
Institute für Mathematik
Universität Potsdam
Campus Golm, Haus 9
Karl-Liebknecht-Str. 24-25
D-14476 Potsdam OT Golm, Germany
Tel: +49 331 977-1859
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Certification

I, the undersigned, certify that the information provided correctly describe my qualifications, my experience, and my person.

Signed ....D. A. N........................   **Date: February 6, 2024**
Dr. Angwenyi Nyachae David, PhD