Blessed Madukoma

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Research Interests

Which changes to AI-powered data systems make their answers complete and up to date, or clear about what they lack, and at what cost. Current focus: telling an AI agent when hidden rows change its answer.

Education

- **Carnegie Mellon University** *Aug 2024 – May 2026*
  MSc Information Technology (Software Engineering, Big Data and Applied ML). GPA: 3.93/4.00 Kigali, Rwanda
  - **Thesis:** Performance anomaly detection in sports using ML models and statistical methods, with a systems engineering application. *Advisor: Prof. Prasenjit Mitra.*

- **Babcock University** *Aug 2018 – Jun 2022*
  BSc Software Engineering, First Class Honours. GPA: 4.55/5.00 Ogun, Nigeria

Research Experience

- **Carnegie Mellon University Africa** Kigali, Rwanda
  Graduate Research Associate, Spatial and Language Technologies (SaLT) Lab *Jun 2026 – Sep 2026*

  Project: Harness effects and data-reference errors in LLM data agents (code, DOI). *Advisor: Prof. Prasenjit Mitra.*

  - Traced 37% of DataAgentBench's recorded agent failures (16,293 of 44,277) to its harness, not its six LLMs (including GPT-5.2 and Gemini 3 Pro); removing them reorders the models by failed steps. Analysed 283,435 agent steps across six benchmarks.
  - Built a static guardrail in Python (`ast`) that blocks agent code naming missing files, columns or keys before it runs, with zero false blocks on 8,517 working steps from three unseen benchmarks; on DABstep, a standard linter (pyflakes) flags only 6% of the errors it stops.
  - Built a sandboxed agent harness (no network, read-only data) and ran 36,990 pre-registered runs: for gpt-oss-120b, the guardrail cut errors that ran from 3,316 to 2 and raised accuracy by 1.44 points; no detectable gain for gemma4-31b or over a cheaper error message listing valid names.

  Project: Sports analytics for Rwanda's Ministry of Sports.

  - Wrote two policy documents for the Ministry, including a feasibility study of sports prediction systems.

  Graduate Research Assistant, Spatial and Language Technologies (SaLT) Lab *Sep 2025 – May 2026*

  Project: Performance anomaly detection in athletics. MSc thesis; paper [C1]. *Advisor: Prof. Prasenjit Mitra.*

  - Narrowed 31,604 athletes to about 163 for investigator review (99.5% fewer) by combining 8 statistical, ML and Bayesian detectors over 1.6M performances, checked against Athletics Integrity Unit sanctions.
  - Replaced a Kafka-based, four-container pipeline with one FastAPI service on PostgreSQL, DuckDB and Redis: a full analysis fell from 129 s to 33 s, and testing a method change from 20+ min to about 30 s (live platform).

- **Pre-registered study: do LLM data agents say when rows are hidden? (report)** Sep 2026
  - On five BIRD databases under PostgreSQL row-level security, three cheaper models presented partial answers as complete in 70–95% of affected cases; a stronger model doubted 8 of 16 complete answers.

Publications

C = conference, W = workshop

[C1] **B. Madukoma** and P. Mitra, "Performance Anomaly Detection in Athletics: A Benchmarking System with Visual Analytics," in *IEEE Swiss Conference on Data Science and AI (SDS)*, Zurich, Switzerland, 2026. Poster presentation. **Honorable Mention – Best Paper Award**. arXiv:2604.21953.

[W1] S. Wafula and **B. Madukoma**, "Unmasking COVID-19 Vulnerability in Nigeria: Mapping Risks Beyond Urban Hotspots," in *Women in Machine Learning (WiML) Workshop at NeurIPS*, 2025. OpenReview. arXiv:2509.05398.

Honours and Awards

- **Honorable Mention – Best Paper Award**, IEEE SDS 2026, Zurich, for paper [C1].

Industry Experience

- **Sedge** [sedge.app]
  Co-founder
  - Built the Go backend of a data platform that answers questions over company databases with LLM-written SQL (text-to-SQL).
  - Wrote its query guardrail, now in code review: one read-only SELECT with allow-listed functions, a 15-second timeout and a 10,000-row cap; it blocks all 61 attack queries written to test it.

- **SLS Energy** — Kigali, Rwanda
  Backend Software Engineer (Contract) — *Jun 2026 – Aug 2026*
  - Cut invoicing from over a month after month-end to two days by replacing a manual spreadsheet with a metered billing engine that now invoices 9 client organisations; days without meter readings are flagged, never estimated.

- **Ministry of Infrastructure (MININFRA)** — Kigali, Rwanda
  Data Engineering and Analytics Engineer (Contract) — *May 2025 – Sep 2025*
  - Architected Rwanda's infrastructure intelligence platform, built to attract foreign investment: pipelines that join construction-permit and land-use records, and a Grafana dashboard of 12+ indicators such as permit throughput and capital-allocation trends.

- **Huza HR** — Kigali, Rwanda
  Software Engineer — *Jun 2025 – Sep 2025*
  - Built the email-notification system (candidate, recruiter and internal templates with delivery tracking) behind the company's first fully digital applicant-tracking workflow, in Next.js and Node.js.

- **The UPANZI Network** — Kigali, Rwanda
  Software Engineer — *Sep 2024 – Dec 2024*
  - Cut page load times by 40% on an African dataset-hosting platform by keeping fetched data in Redux state, which cut repeated database queries; cut the CSS bundle by 30% with Tailwind CSS.

- **Platnova** — Remote
  Golang Backend Engineer — *Mar 2024 – Aug 2024*
  - Cut payment processing time by 20% by automating vault settlement in Go with scheduled jobs, and support enquiries by 15% by redesigning transaction receipts.

- **21st Century Technologies** — Lagos, Nigeria
  Software Architect (National Youth Service) — *Dec 2022 – Nov 2023*
  - Cut release time by 40% by automating deployments (CI/CD with Docker and GitHub webhooks), and co-led an internal reporting system that employees used to give feedback on deployed projects.
  - Coordinated DNS service restoration and implemented failover protocols across Tier III/IV data centres; uptime held at 99.99%.

Selected Graduate Coursework

- **Machine Learning in Production** (Christian Kästner); **Engineering Data-Intensive Scalable Systems** (Paulo Merson): microservices, Kafka messaging, sagas, CQRS, event sourcing, circuit breakers and observability.

Leadership and Service

- **Chairman**, Academic Innovation Sub-Committee, Research Committee, CMU Africa, 2024–2026.
- **Executive President**, Computer Club, Babcock University, 2022.
- **Participant**, Digital Humanism Summer School, CMU Africa, 2025. **Volunteer**, Google DevFest Kigali, Dec 2024.

Technical Skills

- **Languages:** Python, Go, SQL, TypeScript, JavaScript
- **LLM & ML:** LLM Agents, Agent Evaluation, Guardrails, Text-to-SQL, Static Analysis, Scikit-learn, Statistical Modelling
- **Backend & Data:** FastAPI, PostgreSQL, DuckDB, MySQL, Redis, Kafka, Node.js, ETL Pipelines
- **Infrastructure & Quality:** Docker, GitHub Actions (CI/CD), pytest, mypy, Git
- **Frontend:** Next.js, Vue.js, Nuxt, Tailwind CSS

References

- **Prof. Prasenjit Mitra**, Bob Dykes Chair Professor in Advanced Artificial Intelligence, Victoria University of Wellington, New Zealand. Formerly Research Professor, Carnegie Mellon University Africa; my MSc thesis and research advisor, 2025–2026.
- **Prof. Edwin Mugume**, Assistant Teaching Professor, Carnegie Mellon University Africa; my course instructor.
- **Prof. Sunday Idowu**, Babcock University; Dean, School of Computing and Engineering Sciences, during my BSc.