Janakiraman (Ram) Balachandran Ph.D

Building AI Solutions for Physical Systems

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ABOUT ME

- *Mechanical engineering + AI:* Ph.D.-trained mechanical engineer with 10+ years building AI for real-world systems across renewable energy, water, oil & gas, and manufacturing.
- *Engineering-first AI:* I use physics intuition to build models and tools that make assets safer, more reliable, and more efficient.
- *Proof through impact:* Recent wins include a $3 million cost savings in water networks by reducing water hammer, computer vision tools that cut sewer inspection cost by 25%, automated valuations for 200,000 properties and an enterprise knowledge search.
- *Business-first partner*: I turn unclear goals into scoped roadmaps, design and deliver AI embedded solutions that generate tangible business impact.

EDUCATION

Ph.D. in Mechanical Engineering.

University of Michigan

2009 – 2014 | MI, USA

Masters in Mechanical Engineering.

National University of Singapore

2008 – 2009 | Singapore

Bachelors in Mechanical Engineering.

Anna University

2002 – 2006 | Chennai, India

WORK EXPERIENCE

SpiralData / Transient Detect

Chief Data Scientist

2023 – Ongoing | Adelaide, Australia

- **Embedding AI into BAU workflows**
  - Built a multi-modal ingestion pipeline (parsers, speech-to-text, embeddings, vector search, NL2SQL) so every response cites governed data.
  - Proved the concept on a RAG use case that surfaces financial health signals from analyst-call transcripts and quarterly reports that can be incorporated into insurance risk modeling.
- **AI pressure-transient detection platform**
  - Stood up an AWS-native stack that ingests > **100 Hz** pressure feeds and serves transient-risk views within ~15 minutes, that was previously not observed by water utilities.
  - Designed detection and clustering algorithms with >97% reliability so utilities can tie invisible water-hammer spikes to preven asset failure and extend asset life by 5–10 years at hot spots.
  - Worked with Greater Western Water to identify and mitigate transient sources, unlocking roughly $3 million in avoided reactive work and underpinning SpiralData's $1.5 million scale-up capital raise.

Complexica

Lead Machine Learning Scientist

2022 – 2023 | Adelaide, Australia

- **Promotional planning and price optimization**
  - Replaced spreadsheet-only trade planning for Endeavour Group with a guided AI workspace that captures objectives, constraints, and deals before they hit retailers.

- Fused POS, pricing, promo calendars, product hierarchies, data to model uplift, elasticity, and cannibalisation models at store–SKU–week depth.
- Built forecasting and optimization layers that recommend mechanics, depth, timing, and price while respecting guardrails such as ticket counts or off-location slots, giving sales and category teams clear levers.

PointData

Data Scientist

2021 – 2022 | Adelaide, Australia

- **Automated residential valuations**
  - Delivered parcel-level valuations with up to 90% accuracy for over 200,000 South Australian properties, shortening lender valuation cycles and helping councils identify subdivision-ready lots.
  - Built pipelines that ingest sales records, cadastral parcels, zoning, GNAF addresses, and auction feeds so the AVM always sees the freshest planning and economic signals.

Hitachi Vantara

Data Science Manager

2019 – 2021 | Bangalore, India

- **AI sewer inspection (Dragonfly)**
  - Founding member of Dragonfly, in collaboration with Jacobs Water, to turn raw CCTV into prioritized maintenance actions and trimming inspection and rehab cost by roughly 25%.
  - Trained deep-learning models on over 300,000 meters of video footage, that had $>$95% PACP coding accuracy even in gritty sewer conditions.

Royal Dutch Shell

Researcher

2017 – 2019 | Bangalore, India

- Lead the development of deep learning models based on graph convolutional neural networks with multi-task learning to predict properties of 48,000 materials which can be further screened for energy conversion and storage applications. (NeurIPS 2018 Workshop).
- Developed machine learning model (BootStrapped Projected Gradient Descent) that are constrained by domain knowledge. This led to the development of a simple, interpretable and transferable model that can be used to design supercapacitor materials from small datasets (Chem. Mater. 2018).
- Developed a python based workflow to extract data from external databases and perform analytics. This project led to identification of new electrocatalysts for hydrogen peroxide production (currently under consideration for patent filing).
- Lead the development of deep learning model that led to the accurate classification of crystal structures of energy materials obtained from electron microscopy (manuscript under preparation).
- Lead the collaborative project to develop better cathode materials for sodium ion batteries (Journal of Power Sources 416 2019).

Oak Ridge National Laboratory

Postdoctoral Research Fellow

2015 – 2017 | Oak Ridge, TN, USA

- Developed *ab initio* material models benchmarked by experiments, that elucidated the influence of disorder, doping and strain on ion transport in various families of oxide materials. This elucidation resulted in identification of design principles to discover new fast-ion transporting materials for fuel cell and energy battery technologies (multiple publications).
- Developed materials informatics framework that integrates automated massively scalable workflows, ab initio modeling and data analytics. The framework enabled the development of one of largest defect datasets in perovskites for fuel-cell application (J. Phys. Chem. C 2017).
- Developed data mining approaches to automatically extract process parameters for material synthesis to develop a material synthesis database (Journal of Applied Physics 2018).

University of Michigan

Doctoral Candidate

2009 – 2014 | Ann Arbor, MI, USA

- Designed and employed state of the art models, benchmarked by experiments, to design nanoscale materials for thermoelectic devices (J. Am. Chem. Soc. 2011 and Appl. Phys. Lett. 2012).
- More importantly, the computational model elucidated the influence of material structure on these properties. This elucidation provides important insights to experimentalist by interpreting various experimental results in a unified framework (J. Phys. Chem. Lett. 2012).
- This mechanism also enabled us to develop efficient computational strategies to calculate the aforementioned properties, which has potential for high-throughput calculations (J. Phys. Chem. Lett. 2013).

TECHNICAL EXPERTISE

Machine Learning

Algorithms: Statistical Learning, Deep Learning, Time Series Analysis, Anomaly Detection,
Specializations: Computer Vision, Optimization, Signal Processing
Frameworks: PyTorch, Scikit-learn, XGBoost, Prophet

Core Engineering

Topics: Nanoscale systems, Multi-scale modeling, thermoelectrics, solid-state battery materials, proton-conducting perovskites, defect chemistry, metal-insulator transitions, electronic-structure modeling (DFT/QMC)

Modern AI & LLMs

LLM Applications: RAG, Fine-tuning, AI Agents, Speech to Text
Platforms: OpenAI GPT-4, Anthropic Claude, Google Gemini, Hugging Face Transformers

MLOps & Production

Deployment: Docker, AWS SageMaker
Monitoring: Grafana
CI/CD: GitHub Actions

Software Engineering

Languages: Python, SQL, R,
Cloud Platforms: AWS, GCP, Azure
APIs: FastAPI, Flask
Test Framework: Pytest, Playwright
Architecture: Microservices, Event-driven, REST APIs

PUBLICATIONS

Journal Articles

- Shivani, RB et al. (2025). “Intercalation of Bi2S3–graphene into MXene nanosheets: a novel strategy for enhanced thermoelectric performance”. In: *Journal of Materials Science: Materials in Electronics* 36.22, p. 1371.
- Baburaj, Abhijit et al. (2020). “Multilayer graphene coated vanadium (V) oxide as electrodes for intercalation based brackish water desalination”. In: *2D Materials* 7.4, p. 045025.
- Shinde, Ganesh Suryakant et al. (2019). “Ultrasonic sonochemical synthesis of Na0. 44MnO2 insertion material for sodium-ion batteries”. In: *Journal of Power Sources* 416, pp. 50–55.

- Unocic, Raymond R et al. (2019). “Multi-modal characterization approach to understand proton transport mechanisms in solid oxide fuel cells”. In: *Microscopy and Microanalysis* 25.S2, pp. 2048–2049.
- Ding, Jilai, Janakiraman Balachandran, Xiahan Sang, Wei Guo, Jonathan S Anchell, et al. (2018). “The influence of local distortions on proton mobility in acceptor doped perovskites”. In: *Chemistry of Materials* 30.15, pp. 4919–4925.
- Ding, Jilai, Janakiraman Balachandran, Xiahan Sang, Wei Guo, Gabriel M Veith, et al. (2018). “Influence of nonstoichiometry on proton conductivity in thin-film yttrium-doped barium zirconate”. In: *ACS applied materials & interfaces* 10.5, pp. 4816–4823.
- Ganesh, Panchapakesan, Janakiraman Balachandran, et al. (2018). “Influence of Strain on VO 2 Stoichiometry and its Metal-Insulator Transition”. In: *Bulletin of the American Physical Society* 63.
- Heinonen, Olle et al. (2018). “Electronic properties of doped and defective NiO–perspectives from quantum Monte Carlo and density functional theory”. In: *Bulletin of the American Physical Society* 63.
- Kumar, Narendra et al. (2018). “Machine learning constrained with dimensional analysis and scaling laws: simple, transferable, and interpretable models of materials from small datasets”. In: *Chemistry of Materials* 31.2, pp. 314–321.
- Kylänpää, Ilkka, Janakiraman Balachandran, Panchapakesan Ganesh, Olle Heinonen, Paul Kent, et al. (2018). “DFT Density Errors in Vanadium Dioxide Analyzed by Quantum Monte Carlo”. In: *Bulletin of the American Physical Society* 63.
- Sharma, Yogesh et al. (2018). “Nanoscale control of oxygen defects and metal–insulator transition in epitaxial vanadium dioxides”. In: *ACS nano* 12.7, pp. 7159–7166.
- Young, Steven R et al. (2018). “Data mining for better material synthesis: The case of pulsed laser deposition of complex oxides”. In: *Journal of Applied Physics* 123.11.
- Balachandran, Janakiraman, Panchapakesan Ganesh, et al. (2017). “Influence of electro-chemo-mechanical coupling on the metal-insulator transition in VO2”. In: *Bulletin of the American Physical Society* 62.
- Balachandran, Janakiraman, Lianshan Lin, Jonathan S Anchell, et al. (2017). “Defect genome of cubic perovskites for fuel cell applications”. In: *The Journal of Physical Chemistry C* 121.48, pp. 26637–26647.
- Benali, Anouar et al. (2017). “Quantum Monte Carlo study of a K-doped NiO Mott insulator”. In: *Bulletin of the American Physical Society* 62.
- Cheng, Yongqiang et al. (2017). “The influence of the local structure on proton transport in a solid oxide proton conductor La 0.8 Ba 1.2 GaO 3.9”. In: *Journal of Materials Chemistry A* 5.30, pp. 15507–15511.
- Dathar, Gopi Krishna Phani et al. (2017). “Li-ion site disorder driven superionic conductivity in solid electrolytes: a first-principles investigation of β-Li 3 PS 4”. In: *Journal of Materials Chemistry A* 5.3, pp. 1153–1159.
- Ganesh, P et al. (2017). “Systematic study of the electronic structure of a doped Mott insulator”. In: *Bulletin of the American Physical Society* 62.
- Krogel, Jaron et al. (2017). “Quantum Monte Carlo study of the oxygen vacancy in vanadium dioxide”. In: *Bulletin of the American Physical Society* 62.
- Kylänpää, Ilkka, Janakiraman Balachandran, Panchapakesan Ganesh, Olle Heinonen, Paul RC Kent, et al. (2017). “Accuracy of ab initio electron correlation and electron densities in vanadium dioxide”. In: *Physical Review Materials* 1.6, p. 065408.
- Shin, Hyeondeok et al. (2017). “Electronic properties of doped and defective NiO: A quantum Monte Carlo study”. In: *Physical Review Materials* 1.7, p. 073603.
- Balachandran, Janakiraman, Lianshan Lin, and Panchapakesan Ganesh (2016). “High throughput ab-intio modeling of proton transport in solid electrolytes”. In: *Bulletin of the American Physical Society* 61.
- Ding, Jilai, Xiahan Sang, et al. (2016). “Atomic Resolution Distortion Analysis of Yttrium-Doped Barium Zirconate”. In: *Microscopy and Microanalysis* 22.S3, pp. 910–911.
- Ganesh, Panchapakesan, Andrew A Lubimtsev, and Janakiraman Balachandran (2016). “Theoretical Investigation of oxides for batteries and fuel cell applications”. In: *Bulletin of the American Physical Society* 61.
- Balachandran, Janakiraman and Donald Siegel (2015a). “Electronic Structure at Electrode/Electrolyte Interfaces in Magnesium based Batteries”. In: *Bulletin of the American Physical Society* 60.
- Balachandran, Janakiraman, Pramod Reddy, Barry Dunietz, et al. (2014). “End-group Influence on the Frontier Molecular Orbital Reorganization in Molecular Junctions—Effect on Thermopower”. In: *Bulletin of the American Physical Society* 59.
- – (2013). “Effect of Stabilization and End Group Induced Charge Transfer on Frontier Molecular Orbital Reorganization-Applications to Molecular Thermoelectrics”. In: *Bulletin of the American Physical Society* 58.
- Balachandran, Janakiraman, Pramod Reddy, Barry D Dunietz, et al. (2013). “End-group influence on frontier molecular orbital reorganization and thermoelectric properties of molecular junctions”. In: *The Journal of Physical Chemistry Letters* 4.22, pp. 3825–3833.
- – (2012). “End-group-induced charge transfer in molecular junctions: effect on electronic-structure and thermopower”. In: *The Journal of Physical Chemistry Letters* 3.15, pp. 1962–1967.
- Tan, Aaron, Janakiraman Balachandran, Barry D Dunietz, et al. (2012). “Length dependence of frontier orbital alignment in aromatic molecular junctions”. In: *Applied Physics Letters* 101.24.
- Tan, Aaron, Janakiraman Balachandran, Seid Sadat, et al. (2011). “Effect of length and contact chemistry on the electronic structure and thermoelectric properties of molecular junctions”. In: *Journal of the American Chemical Society* 133.23, pp. 8838–8841.
- Muthucumaraswamy, R and B Janakiraman (2008). “Mass transfer effects on isothermal vertical oscillating plate in the presence of chemical reaction”. In: *International Journal of Applied Mathematics and Mechanics* 4.1, pp. 66–74.
- – (2007). “Diffusion and thermal radiation effects on isothermal vertical oscillating plate”. In: *International Journal of Applied Mechanics and Engineering* 12.4, pp. 1093–1101.

- Muthucumaraswamy, R and B Janakiraman (2006). “MHD and radiation effects on moving isothermal vertical plate with variable mass diffusion”. In: *Theoretical and Applied Mechanics* 33.1, pp. 17–29.

Conference Proceedings

- Maheshwari, Shantanu et al. (2019). “Molecular Dynamics Simulations of Ion Transport in Poly-Ethylene Oxide”. In: *Electrochemical Society Meeting Abstracts iba2019*. 2. The Electrochemical Society, Inc., pp. 256–256.
- Stephens, Ryan M et al. (2019). “Modeling at Multiple Scales for Development of Future Energy Storage Technologies”. In: *Electrochemical Society Meeting Abstracts 235*. 22. The Electrochemical Society, Inc., pp. 1130–1130.
- Bridges, CA et al. (2017). “On the design and development of ion conducting oxides”. In: *Acta Crystallographica A-Foundation and Advances*. Vol. 73. INT UNION CRYSTALLOGRAPHY 2 ABBEY SQ, CHESTER, CH1 2HU, ENGLAND, A323–A323.
- Jalarvo, Niina et al. (2017). “Neutron scattering studies on atomic-scale proton diffusion processes in a solid oxide electrolyte”. In: *ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY*. vol. 253. AMER CHEMICAL SOC 1155 16TH ST, NW, WASHINGTON, DC 20036 USA.
- Unocic, Raymond et al. (2017). “Multi-modal approach to understand proton transport mechanisms in Y-doped barium zirconate”. In: *ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY*. vol. 254. AMER CHEMICAL SOC 1155 16TH ST, NW, WASHINGTON, DC 20036 USA.
- Balachandran, Janakiraman and Donald Siegel (2015b). “Electronic structure at electrode/electrolyte interfaces in Mg based electrochemical systems”. In: *ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY*. vol. 249. AMER CHEMICAL SOC 1155 16TH ST, NW, WASHINGTON, DC 20036 USA.
- Balachandran, Janakiraman, Barry Dunietz, et al. (2013). “Tailoring the thermopower and nature of transport in aromatic molecule-metal junctions through end-groups”. In: *ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY*. vol. 246. AMER CHEMICAL SOC 1155 16TH ST, NW, WASHINGTON, DC 20036 USA.

Dissertation

- Balachandran, Janakiraman (2014). “Influence of Material Structure on Thermoelectric Properties of Atomic Scale Systems.” PhD thesis.