Adam P. Generale

Contact Information

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Education

Georgia Institute of Technology, Atlanta, GA, USA — 2024

Ph.D. Mechanical Engineering, George W. Woodruff School of Mechanical Engineering

- Thesis: "Neural Inverse Microstructure Design with Bayesian Scale-Bridging"
- Advisor: Surya R. Kalidindi

University of Manchester, Manchester, UK — 2014

M.S. Mechanical Engineering, School of Engineering

- Thesis: "Generalized Deformation in Heterogeneous Materials in Mode I Fracture"
- Advisor: Andrey Jivkov

Rensselaer Polytechnic Institute, Troy, NY, USA — 2011

B.S. Mechanical Engineering, School of Mechanical, Aerospace, and Nuclear Engineering

Research Experience

Georgia Institute of Technology, Atlanta, GA, USA — Sep 2019 - Jan 2024

Graduate Research Assistant

- Focus on flow-based generative models (e.g., continuous normalizing flows, flow matching), Bayesian statistics, and Gaussian processes applied towards enabling data-driven materials exploration, learning latent process dynamics, and statistical model calibration.
- Developed a microstructural design framework, with Bayesian statistical and probabilistic deep learning underpinnings, capable of designing 3D structures two orders of magnitude larger than previously possible.
- Extended this framework to the design of manufacturing pathways for the targeted design of microstructures, the first complete framework to accomplish this longstanding goal.
- Constructed the first framework capable of producing large-scale, statistically diverse microstructural datasets – culminating in the largest open-source benchmark microstructure dataset MICRO2D, containing 90,000 unique microstructures and 42 associated properties.
- Established a probabilistic methodology for jointly inferring internal microstructure representations and localized material behavior across lengthscales, providing capability to resolve complex constituent behavior with macroscale experimental data.

Air Force Research Laboratory, Dayton, OH, USA — Jun 2020 - Oct 2020

Research Assistant

- Developed a framework fusing sparse multimodal longitudinal experimental data in the Bayesian calibration of a multimode constitutive damage model.

Professional Experience

Pratt & Whitney, East Hartford, CT, USA — July 2024 - Present

Senior Principal Engineer

- Addressed several multiphysics high-dimensional inverse problems leveraging flow-based generative machine learning architectures (e.g., diffusion models, continuous normalizing flows) in the calibration of complex physics-based models.
- Performed variational inference of thermo-mechanical fracture model for coating spallation in challenging environments against field distress maps, enabling informed decision-making of service intervals and module design improvements.
- Embedded multimodal data (multivariate environmental particulate and engine controller time series, images of coating and fatigue distress, and destructive measurements) into a shared, physically meaningful latent space, enabling downstream model creation to inform product performance, design, and field deployment strategies.
- Leveraged this embedding to construct a multimodal probabilistic model, capable of predicting global unexpected engine removal times with a mean absolute error of 1.6%.

Multiscale Technologies, Atlanta, GA, USA — Jan 2023 - July 2024

Senior Machine Learning Engineer

- Developed Neural ODE/SDE architectures for efficiently learning dynamical systems from unaligned marginal data and identifying families of inverse solutions (e.g., materials and process synthesis design) through conditional transport maps.
- Implemented information-theoretic strategies for the construction of optimal experimental designs through active learning for identifying novel materials.
- Established a conditional extension to the flow matching algorithm capable of disentangling conditional dynamics, resulting in a 3x improvement in Wasserstein-2 error over prior approaches.
- Developed a Bayesian optimization based-methodology for improving coarse grained molecular dynamics simulations with a 22% improvement in all-atom property discrepancy over prior methods.

Awards

IMECE Travel Award, American Society of Mechanical Engineers	2023
CMS3 Fellowship, Texas A&M University	2023
Sloan Foundation Fellowship, Alfred P. Sloan Foundation	2020
President's Fellowship, Georgia Institute of Technology	2020
Team of the Quarter, Pratt & Whitney	Q2 2016, Q4 2017
Best Dissertation, University of Manchester	2014
Best Overall Performance, University of Manchester	2014
Rensselaer Leadership Award, Rensselaer Polytechnic Institute	2007

Technical Knowledge

Statistical Modeling, Bayesian Statistics, Machine Learning, Signal Processing, Data Analysis, Numerical Methods, Finite Element Analysis, Continuum Mechanics, High-Performance Computing

Software: ABAQUS, ANSYS, Fluent, Star-CCM+

Languages: Proficient: Python (*PyTorch, GPyTorch, Pyro, Jax*), MATLAB

Publications

Generale, A.P., Robertson, A.E., Kalidindi, S.R. (2024). Conditional Variable Flow Matching: Transforming Conditional Densities with Amortized Conditional Optimal Transport. *arXiv*. arXiv:2411.08314

Buzzy, M.O., Montes de Oca Zapain, D., **Generale, A.P.**, Kalidindi, S.R., Lim, H. (2025). Active learning for the design of polycrystalline textures using conditional normalizing flows. *Acta Materialia*. doi: 10.1016/j.actamat.2024.120537

Generale, A.P., Robertson, A.E., Kelly, C., Kalidindi, S.R. (2024). Inverse Stochastic Microstructure Design. *Acta Materialia*. doi: 10.1016/j.actamat.2024.119877

Marshall, A., **Generale, A.P.**, Kalidindi, S.R., Radhakrishnan, B., Belak, J. (2024). A Gaussian process autoregressive model capturing microstructure evolution paths in a Ni–Mo–Nb alloy. *J. Mater. Sci.*. doi: 10.1007/s10853-024-09345-6

Robertson, A.E., **Generale, A.P.**, Kelly, C., Buzzy, M.O., Kalidindi, S.R. (2024). MICRO2D: A Large, Statistically Diverse, Heterogeneous Microstructure Dataset. *Integrating Materials and Manufacturing Innovation*. doi: 10.1007/s40192-023-00340-4

Generale, A.P., Kelly, C., Harrington, G.R., Robertson, A.E., Buzzy, M., Kalidindi, S.R. (2023). A Bayesian Approach to Designing Microstructures and Processing Pathways for Tailored Material Properties. *NeurIPS Workshop - AI for Accelerated Materials Design*.

Generale, A.P., Kalidindi, S.R. (2023). Uncertainty quantification and propagation in the microstructure-sensitive prediction of stress-strain response of woven ceramic matrix composites. *Computers & Structures*, 286, 107110. doi: 10.1016/j.compstruc.2023.107110.

Wang, S., **Generale, A.P.**, Kalidindi, S.R., Joseph, V.R. (2023). Sequential Designs for Filling Output Spaces. *Technometrics* , 0, 1-12. doi: 10.1080/00401706.2023.2231042

Generale, A.P., Hall, R.B., Brockman, R.A., Joseph, V.R., Jefferson, G., Zawada, L., Pierce, J., Kalidindi, S.R. (2022). Bayesian calibration of continuum damage model parameters for an oxide-oxide ceramic matrix composite using inhomogeneous experimental data. *Mechanics of Materials*, 175, 104487. doi: 10.1016/j.mechmat.2022.104487.

Hall, R.B., Brockman, R.A., **Generale, A.P.**, Joseph, V.R., Kalidindi, S.R. (2022). A Viscous Damage Theory for Ceramic Matrix Composites in Multi-Axial Loading. *Proceedings of the 12th International Conference on the Mechanics of Time Dependent Materials*.

Generale, A.P., Kalidindi, S.R. (2021). Reduced-order Models for Microstructure-Sensitive Effective thermal Conductivity of Woven Ceramic Matrix Composites with Residual Porosity. *Compos. Structures*, 274, 114399. doi: 10.1016/j.compstruct.2021.114399

PATENTS

Jackson, R.W., **Generale, A.P.**, Liu, X., Zelesky, M.F., 2023. Airfoil having environmental barrier topcoats that vary in composition by location. US11608749B2.

Quach, S., **Generale, A.P.**, Surace, R., Dvorozniak, L., 2022. Engine with cooling passage circuit for air prior to ceramic component. US11492914B2.

Generale, A.P., Dvorozniak, L., Quach, S., 2022. Ceramic airfoil with cooling air turn. US11473444B2.

Generale, A.P., Dvorozniak, L., Quach, S., 2022. Baffle with impingement holes. US11415002B2.

Generale, A.P., Mongillo, D.J., 2022. Components for gas turbine engines. US11371360B2.

Quach, S., Dube, B.P., Propheter-Hinckley, T.A., Arisi, A.N., **Generale, A.P.**, Dvorozniak, L., Liles, H.J., 2022. Cooling arrangement including overlapping diffusers. US11339667B2.

Generale, A.P., Dvorozniak, L., Quach, S., Dube, B.P., 2022. Baffle with tail. US11280201B2.

Generale, A.P., Mongillo, D.J., 2022. Components for gas turbine engines. US11261749B2.

Generale, A.P., Mongillo, D.J., 2022. Trailing edge insert for airfoil vane. US11242758B2.

Generale, A.P., Propheter-Hinckley, T.A., 2021. Airfoil assembly with ceramic airfoil pieces and seal. US11162368B2.

Spangler, B.W., **Generale, A.P.**, Vu, K.H., 2021. Gas turbine engine cooling component. US11131212B2.

Generale, A.P., Liles, H.J., 2021. Airfoil with metallic shield. US11092015B2.

Generale, A.P., Dube, B.P., 2021. Thermal gradient reducing device for gas turbine engine component. US11078844B2.

Generale, A.P., Dube, B.P., 2021. CMC airfoil with cooling holes. EP3808940A1.

Spangler, B.W., **Generale, A.P.**, 2021. Shell and spar airfoil. US10934857B2.

Vu, K.H., **Generale, A.P.**, 2020. Vane platform leading edge recessed pocket with cover. US10822962B2.

Devore, M.A., **Generale, A.P.**, Propheter-Hinckley, T.A., 2020. Airfoil with geometrically segmented coating section. US10711624B2.

Spangler, B.W., **Generale, A.P.**, 2020. Axial flow cooling scheme with castable structural rib for a gas turbine engine. US10822963B2.

Mongillo, D.J., **Generale, A.P.**, 2020. Platform flow turning elements for gas turbine engine components. US10655496B2.

Spangler, B.W., **Generale, A.P.**, 2020. Gas turbine engine cooling component. US10648351B2.

Generale, A.P., Howard, B.L., 2020. Vane air inlet with fillet. US10619492B2.

Clum, C., **Generale, A.P.**, 2019. Adjustable flow split platform cooling for gas turbine engine. US1051 3947B2.

Thornton, L.M., **Generale, A.P.**, 2019. Vane including internal radiant heat shield. EP3567220B8.

PRESENTATIONS

Inverse Stochastic Microstructure Design, presented in the Minisymposium on AI/Data Informatics: Computational Model Development, Verification, Validation, and Uncertainty Quantification at TMS, Orlando, FL. May, 2024.

Unveiling Microstructural Behavior Beyond the Experimental Horizon for Enabling Probabilistic Microstructure Design, invited seminar at Pratt & Whitney and the Raytheon Research Center, East Hartford, CT. November, 2023.

Inverse Stochastic Microstructure Design, presented in the Minisymposium on Integrated Computational Materials Engineering at IMECE, New Orleans, LA. October, 2023.

Stochastic Scale-Bridging, presented at the Artificial Intelligence for Materials Science (AIMS) Workshop, National Institute of Standards and Technology (NIST). July, 2023.