Mark Moussa

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WORK EXPERIENCE

NASA Goddard Space Flight Center **July 2019 – Present**
AI/ML Research Engineer *Greenbelt, MD*

- **Architected and fully developed end-to-end a multimodal Earth-observation AI/ML model** for predicting forest canopy height change. Fuses 426-band hyperspectral cubes, LiDAR CHM/DTM/DSM, vegetation indices, climate time series, and soil parameters; delivered **over 30% lower MAE and over 10% better accuracy** for both 1m and 10m resolution vs. published baselines.
- **Built end-to-end a real-time 2-stage wildfire detection and analysis AI/ML model pipeline** (MobileNet v3 classification → UNet segmentation) that runs **30 ms/frame** on NVIDIA Jetson; quantized model size **over 80% and inference latency by 4x**, with no loss in accuracy, enabling on-board wildfire detection + analysis for airborne and spaceborne use cases. Integrated as part of next-generation wildfire detection sensor instrument.
- **Architected and built AI/ML model for quantitative biosignature flux for intelligent detection of life on exoplanets.** Developed custom Bayesian CNN-based model architecture, built exoplanet atmospheric parameters and spectra dataset from scratch. **Achieved state-of-the-art** accuracy and decreased time to biosignature flux retrieval from months to milliseconds. Model will be utilized to intelligently inform project scientists on exoplanet candidates for $11 billion Habitable Worlds Observatory (HWO). (Principal Investigator & AI/ML Lead Research Engineer).
- **Pioneered a reinforcement-learning based multi-agent autonomous high-level decision maker** that coordinated methane-plume localization during an Alaska field campaign and informed a next-generation SmallSat constellation concept (AI/ML Lead).
- **Lead working group team to develop $11 billion flagship NASA mission Habitable Worlds Observatory (HWO) AI/ML** requirements, design, white papers, to serve the new mission from the ground up. Developed use cases and proof of concepts for finding habitable worlds, exoplanet characterization, biosignature detection, autonomous mission operations (e.g., data prioritization, downlinking, anomaly detection, autonomous decision making).
- **Secured over $5 million in competitive funding** as PI/Co-I for research & development.
- **Developed comprehensive Mixed-Reality Engineering Toolkit** using Unity 3D for AR/VR development of NASA mission hardware, speeding up mission design iterative cycle by **over 60%** (new flagship Roman Space Telescope heavily utilized this for mission design)
- **Built full-stack model-running web service** for the Community Coordinated Modeling Center (CCMC), which sees over 20,000 users, 27,000 simulation runs, 8,000 interactive visualizations, and users from over 170 countries per month.

Mosaic Voice **Oct. 2023 – Present**
Founder/CEO *Remote*

- Launched first-of-its-kind multi-modal LLM-powered Augmentative Alternative Communication (AAC) platform that turns symbol taps into fluent first-person sentences; **1,000 users** report smoother daily conversations with caregivers and peers.
- Fine-tuned Gemma, Llama, Mistral, Qwen, etc., models with QLoRA, using Supervised Fine Tuning and Reinforcement Learning on a bespoke AAC corpus, beating leading models on function-specific benchmarks.
- Invented novel dynamic multi-LoRA adapter-swapping so each user carries a personal LoRA that updates in real-time, enabling individualized language prediction per user without full model retrain.
- Engineered a hybrid inference stack (serving using vLLM on serverless and AWS SageMaker, and on-device) that serves **ultra-low latency** cloud responses
- Loaded models on-device using quantized Executorch/TFLite models for offline use on capable devices, saving **over 20% in cloud costs**.
- Architected and built full-stack production code (React Native/Expo, FastAPI backend, NoSQL DB, AWS S3/SageMaker/EC2) across iOS & Android.
- Conducted 100+ user feedback interviews, 30+ stakeholder interviews, 10+ investor pitches, iterated UI/UX and grew daily active minutes **38%** over three releases.

EDUCATION

University of South Florida **December, 2018**
B.S., Computer Science & B.S. Biomedical Sciences *Tampa, FL*

- **GPA: 3.84/4.0** Honors; Minor in Biomedical Physics

SELECTED PUBLICATIONS (full list available at: https://scholar.google.com/citations?user=GJmp7w4AAAAJ&hl=en&authuser=1)

A Novel Framework for Multi-Path Data Fusion in Earth Observation and New Observing Strategies: Applications to Predicting Forest Canopy Height
Mark Moussa, James MacKinnon, David Harding, Matthew Brandt
10.5281/zenodo.13885555
SPAICE, 2024

Multimodal Earth Observation Workflow for Machine Learning: A Case Study in Canopy Height Change Prediction
Mark Moussa, James MacKinnon, David Harding, Matthew Brandt
https://agu.confex.com/agu/agu24/meetingapp.cgi/Paper/1682021
AGU, 2024

Using Artificial Intelligence and Machine Learning to Enhance Mission Design and Operations of the Habitable Worlds Observatory (HWO)
Victoria Da Poian, **Mark M. Moussa** (Presenting author), Umaa Rebbapragada, John Wu, Emilio Salazar-Donate, Ehsan Gharib-Nezhad, Vicki Toy-Edens, Hamsa Venkataram, Mark Giuliano, Steve Chien, Aquib Moin, Gautier Bardi de Fourtou, Connor Basich, Eric Lyness, Bruce Dean, Megan Ansdell
https://agu.confex.com/agu/agu24/meetingapp.cgi/Paper/1706755
AGU, 2024

An Autonomous Agent Framework for Constellation Missions: A Use Case for Predicting Atmospheric CO2
Mark Moussa, Matt Brandt, Daniel Rogers, Bethany P. Theiling, Shannon Bull, James MacKinnon, Timothy Chase, Ethan Haengel
https://digitalcommons.usu.edu/smallsat/2023/all2023/139
SmallSat, 2023

Human Adaptations to Multiday Saturation on NASA NEEMO
Andrew P. Koutnik, Michelle E. Favre, Karina Noboa, Marcos A. Sanchez-Gonzalez, Sara E. Moss, Bishoy Goubran, Csilla Ari, Angela M. Poff, Chris Q. Rogers, Janine M. DeBlasi, Bishoy Samy, **Mark Moussa**, Jorge M. Serrador, Dominic P. D'Agostino
10.3389/fphys.2020.610000
Frontiers in Physiology, 2021

SKILLS & INTERESTS

- **Technologies:** Python, PyTorch, TensorFlow, JAX, Keras, Hugging Face Libraries, Numpy, Sklearn, Pandas, MLflow, FastAPI, React Native, Expo, AWS, NodeJS, ReactJS, Angular, Docker, CUDA, Executorch, TFLite
- **Skills:**
  - **Technical:** Deep Learning, MLPs, CNNs, LSTMs, Transformers, etc., Multimodal AI/ML, Bayesian Methods, Model Quantization, Edge Deployment, Real-Time Inference
  - **Research**: Principal Investigator, Proposal Writing (PI-led funded NASA research), Technical Writing (first-author papers, conference abstracts, posters)
  - **Mentorship & Collaboration**: Mentored interns, junior, and senior researchers and engineers; led cross-functional teams across science and engineering
  - **Communication**: Presentations (e.g., Conferences, Stakeholder), interdisciplinary collaboration
- **Interests:** Scuba Diving (training to be a Divemaster), Running (training for a marathon), Language Learning, Farming, Piano, Music Production