ABED HAMMOUD

Princeton, New Jersey, United States of America
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PROFESSIONAL EXPERIENCE

CIMES Postdoctoral Research Associate Aug 2024-
Princeton University
Project Title: Parametrization of atmosphere-surface exchanges in the marginal ice zone.

EDUCATION

PhD in Mechanical Engineering Jun 2020 - Apr 2024
King Abdullah University of Science and Technology (KAUST)
Dissertation: Artificial Intelligence for Data Assimilation and Downscaling: Application to Uncertain Chaotic Systems
GPA: 4.0/4.0 (High Distinction)

MS in Mechanical Engineering Sep 2018 - May 2020
King Abdullah University of Science and Technology (KAUST)
Thesis: "Moving Source Identification in an Uncertain Marine Flow: Mediterranean Sea Application"
GPA: 4.0/4.0 (High Distinction)

BEng. Mechanical Engineering Aug 2014 - May 2018
American University of Beirut
# of Honors: 8 (All Semesters)
GPA : 4.0/4.0 (High Distinction)

EXPERIENCE

Teaching Assistant: AMCS 206 Numerical Methods Jan 2022 - May 2022
Thuwal, Saudi Arabia

· Help Professor George Turkiyyah correct student's assignments and answer questions regarding the class material.

Teaching Assistant: AMCS 206 Numerical Methods Jan 2020 - May 2020
Thuwal, Saudi Arabia

· Help Professor Omar Knio correct student's assignments and answer questions regarding the class material.

Reseach Assistant at AUB with Professor Issam Lakkis Sep 2017 - Aug 2018
Beirut, Lebanon

· Helped generate an ensemble of ocean current fields for the Mediterranean Sea.
· Develop the in-house Lagrangian particle tracking (LPT) code to accommodate the new ensemble of ocean currents
· Expand the utility of the LPT code for continuous release of particles from fixed and moving sources
· Validate code outputs in comparison to buoy data.

Visiting Research Student at KAUST with Professor Ibrahim Hoteit Jun 2017 - Aug 2017
Thuwal, Saudi Arabia

· Visiting student in Professor Hoteit's assimilation group.
· Learned about data assimilation, Kalman and Ensemble Kalman filtering.
· Worked on coding and running experiments for a Variational Bayes data assimilation algorithm.

Internship at Khater Engineering and Trading SAL (Honeywell Control), Dec 2016 - Jan 2016
El-Metn, Lebanon

· Engineering student internship to help better understand control and building management systems.

- I worked on computing the energy requirements of an HVAC system for a client's villa.
- Learned the ASHRAE guidelines and requirements for HVAC systems

Internship at Bassoul-Heneine (BMW, Renault) Jul 2016 - Aug 2016
Beirut, Lebanon

- Mechanical engineering student internship to help better understand the interworks of automotives by shadowing technicians and engineers.
- I shadowed one technician and one engineer, where I was able to help disassemble and reassembele an engine.

TALKS AND WORKSHOPS

AMS BLT 2025 June 2025
Turin, Italy (Virtual)

- Present a talk on recent developments in data-driven atmospheric boundary layer flux parameterization.

Princeton Fluids Group May 2025
Princeton NJ, USA

- Invited to give a 30 minutes talk for the fluids group at Princeton University.
- Present a talk on data-driven atmospheric boundary layer flux parameterization.

AUB CAMS Seminar June 2024
Beirut, Lebanon

- Invited to give a 60 minutes talk for the Center For Advanced Mathematical Sciences at the American University of Beirut.
- Present a talk on continuous and discrete data assimilation in the presence of uncertainties, and the potential use of artificial intelligence to advance downscaling strategies.

Stochastic Numerics and Statistical Learning Conference May 2024
Thuwal, Saudi Arabia

- Invited to give a 60 minutes talk in the KAUST SNSL conference
- Present a talk on gradient-enhanced surrogate models in which we showcase our work on derivative-informed surrogate models (polynomial chaos and neural networks) for interpolation, orthogonal projection and optimization-based regularized regression.

ISDA Online Mar 2024
Virtual

- Invited to give a 15 minutes talk to the International Symposium on Data Assimilation's (ISDA) monthly seminar
- Present a talk on deep reinforcement learning for data assimilation

SIAM UQ Feb 2024
Trieste, Italy

- Attended a 1-week conference on uncertainty quantification.
- Gave a talk on deep reinforcement learning for data assimilation of chaotic systems
- Presented two posters describing Bayesian neural networks ocean colour models for surface chlorophyll-a estimation, and statistical downscaling in an uncertain framework using a physics-informed deep neural network.

Summer School: 200 Years of Navier Stokes and Turbulences Aug 2023
Chamonix, France

- Attended a 1-month summer school on turbulence.
- Present a poster describing the performance of CDAnet when lifting coarse-scale information in the presence of observational and model noises.

· Attend inspiring talks on established and rising ideas in turbulence research.

Ocean Colloquium 2023 May 2023
Liege, Belgium

· Attended a 1-week conference on artificial intelligence for ocean sciences.
· Give a talk on CDAnet, my PhD project involving a physics informed neural network that serves as a surrogate of a lifting function between coarse-scale solution trajectories and their fine-scale counterpart.
· Present two posters, the first describes my project on backward in time predictions using a physics informed deep neural network. The second outlines a semantic segmentation approach for mesoscale eddy detection, where we argue that recent advances in this field are under-utilizing available remotely sensed data, and offer means to improve the accuracy of detecting eddies in the ocean.

ISDA 2022 Jun 2022
Boulder, Co, USA

· Attended a 1-week conference on data assimilation.
· Give a talk on my first PhD project involving continuous and discrete data assimilation with observational uncertainties.
· Present a poster describing our efforts with physics-informed deep learning for downscaling that was named CDAnet; a project that later become a publication in AGU JAMES.

DCSE Fall School on Reduced-Order Modeling and Uncertainty Quantification Nov 2019
Delft, Netherlands

· Attended a 1-week winter school on reduced-order modeling and uncertainty quantification.
· Benefit from the various ideas presented on stochastic partial differential equations, reduced order models, Bayesian inference and sensitivity analysis.
· Learned about the current developments and research areas within the larger field of uncertainty quantification.

Short Course on Uncertainty Quantification Apr 2018
Beirut, Lebanon

· Attended a 1-week short course on uncertainty quantification presented by Habib Najm and Professor Omar Knio.
· Dr. Najm covered a wide range of topics on statistics, polynomial chaos expansions and sensitivity analysis.
· Dr. Knio presented a lecture on Bayesian inference and their utility in uncertainty quantification applications.

PUBLICATIONS

Published:

· **Hammoud, M. A. E. R.**, Papagiannopoulos, N., Krokos, G., Brewin, R., Raitsos, D., Knio, O., Hoteit, I. (2025) On the potential of Bayesian neural networks for estimating chlorophyll-a concentration from satellite data. MDPI Remote Sensing.

· **Hammoud, M. A. E. R.**, Titi, E. S., Hoteit, I., Knio, O. (2025) Downscaling Using CDAnet Under Observational and Model Noises: The Rayleigh-Bénard Convection Paradigm. Computational Geosciences.

· Lakkis, I., Rustom, A., **Hammoud, M. A. E. R.**, Issa, L., Knio, O., Hoteit, I. (2025) Identification of Moving Sources in Stochastic Fields: A Bayesian Inferential Approach with Application to Marine Traffic in the Mediterranean Sea. Computational Geosciences

· **Hammoud, M. A. E. R.**, Raboudi, N., Titi, E. S., Knio, O., Hoteit, I. (2024) A Novel Deep Reinforcement Learning Based Data Assimilation Framework: Application To Lorenz'63. AGU Journal of Advances in Modeling Earth Systems (JAMES).

· Mittal, HVR., **Hammoud, M. A. E. R.**, Kenia Carassco, A., Hoteit, I., Knio, O. (2024) Oil spill risk analysis for the NEOM shoreline, Nature Scientific Reports.

· ElAwaar, E., **Hammoud, M. A. E. R.**, Hoteit, I. (2024) Efficient Bayesian Source Identification of Atmospheric Pollutants Using Deep Embeddings, Atmospheric Environment.

· **Hammoud, M. A. E. R.**, Mittal, HVR., Le Maitre, O., Hoteit, I., Knio, O. (2023) Global Sensitivity Analysis of an Oil Spill Model: a Regularized Regression Approach, Frontiers in Marine Science: Marine Pollution.

· **Hammoud, M. A. E. R.**, Zhan, P., Hakla, O., Knio, O, Hoteit, I. (2023) Semantic Segmentation of Mesoscale Eddies in the Arabian Sea: A Deep Learning Approach, MDPI Remote Sensing.

· **Hammoud, M. A. E. R.**, AlWassel, H., Ghanem, B. S., Knio, O., Hoteit, I. (2023). A Physics-Informed Deep Neural Network for Backward in Time Prediction: Application to Rayleigh-Bénard Convection. American Meteorological Society, Artificial Intelligence for the Earth Systems.

· **Hammoud, M. A. E. R.**, Titi, E. S., Hoteit, I., Knio, O. (2022). CDAnet: A Physics-Informed Deep Neural Network for Downscaling Fluid Flows. AGU Journal of Advances in Modeling Earth Systems (JAMES).

· **Hammoud, M. A. E. R.**, Le Maitre, O., Titi, E. S., Hoteit, I., Knio, O. (2022). Continuous and Discrete Data Assimilation with Noisy Observations for the Rayleigh-Bénard Convection: A Computational Study, Computational Geosciences.

· Hoteit, I., Abualnaja, Y., Afzal, S., Ait-El-Fquih, B., Akylas, T., Antony, C., Dawson, C., Asfahani, K., Brewin, R. J., Cavaleri, L., Cerovecki, I., Cornuelle, B., Desamsetti, S., Attada, R., Dasari, H., Sanchez-Garrido, J., Genevier, L., El Gharamti, M., Gittings, J. A., Gokul, E., Gopalakrishnan, G., Guo, D., Hadri, B., Hadwiger, M., **Hammoud, M. A. E. R.**, Hendershott, M., Hittawe, M., Karumuri, A., Knio, O., Köhl, A., Kortas, S., Krokos, G., Kunchala, R., Issa, L., Lakkis, I., Langodan, S., Lermusiaux, P., Luong, T., Ma, J., Le Maitre, O., Mazloff, M., El Mohtar, S., Papadopoulos, V. P., Platt, T., Pratt, L., Raboudi, N., Racault, M., Raitsos, D. E., Razak, S., Sanikommu, S., Sathyendranath, S., Sofianos, S., Subramanian, A., Sun, R., Titi, E., Toye, H., Triantafyllou, G., Tsiaras, K., Vasou, P., Viswanadhapalli, Y., Wang, Y., Yao, F., Zhan, P., & Zodiatis, G. (2021). Towards an End-to-End Analysis and Prediction System for Weather, Climate, and Marine Applications in the Red Sea, Bulletin of the American Meteorological Society.

· **Hammoud, M. A. E. R.**, Lakkis, I., Knio, O., Hoteit, I. (2021). Moving source identification in an uncertain marine flow: Mediterranean Sea Application. Ocean Engineering, 220, 108435.

INTERESTS

- Computational Fluid Dynamics
- Deep Learning
- Oceanography
- Remote Sensing
- Uncertainty Quantification
- Reinforcement Learning
- Data Assimilation
- Inverse Problems
- Boundary Layer Meteorlogy
- Data Science
- Bayesian Statistics
- Urban Climate

TECHNICAL SKILLS

· **Programming Languages:** Python, Matlab, C++, Fortran
· **Programming Packages/Software:** openFOAM, pyTorch, UQTk, ANSYS (Fluent), AutoCAD
· **OS:** Linux and Windows
· **Developer Tools:** Atom, VS Code

AWARDS & ACCOMPLISHMENTS

· KAUST Physical Science and Engineering Dean's Award, Mechanical Engineering (2024) - First in KAUST to achieve the maximum number of awards possible
· KAUST Physical Science and Engineering Dean's Award, Mechanical Engineering (2023)

- KAUST Physical Science and Engineering Inaugural Dean's Award, Mechanical Engineering (2022)
- Faculty of Engineering and Architecture Dean's honor list award for all semesters, American University of Beirut (2014-2018)
- 3^{rd} place in Mobarat alOloum (National Association for Science and Research, science fair), 2011
- 3^{rd} place in the Lebanese Scientific Excellence Exams, 2014
- Academic excellence award for having the highest average over all sections over the last 3 years of high school, 2014

PROFESSIONAL MEMBERSHIPS

- SIAM Student Member — January 2023 -
- ASME KAUST Chapter (member) — August 2022 -
- ASME AUB Chapter (member) — September 2014 - May 2018

REFERENCES

- Prof. Omar Knio: omar.knio@kaust.edu.sa
- Prof. Edriss S. Titi: est42@cam.ac.uk,
- Prof. Elie Bou-Zeid: ebouzeid@princeton.edu
- Prof. Issam Lakkis: il01@aub.edu.lb