Karim Kadry

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Education

Massachusetts Institute of Technology September 2021- June 2026
PhD in Medical Engineering and Medical Physics (Concentration: Computer Science) *Cambridge, MA, USA*

Ecole Polytechnique Fédérale de Lausanne September 2018-March 2021
Master of Science (M.Sc.) in Life Sciences Engineering (Concentration: Biomechanics) *Lausanne, Switzerland*

American University in Cairo September 2013-June 2018
Dual Bachelor of Science (B.Sc.) in Mechanical Engineering and Physics *Cairo, Egypt*

Skills

Deep Learning: Diffusion Models, Autoencoders, Neural Fields, Image Registration, Image Segmentation

Neural Networks: Convolutional Neural Networks, Graph Neural Networks, Transformers

Modelling & Simulation: Computational Geometry, Finite Element Analysis, Continuum Mechanics

Programming: Python, Linux, SLURM, Github, Docker, AWS, SSH

Research Experience

Institute for Medical Engineering and Science, MIT Sep 2021 – Present
PhD Candidate, Edelman Lab *Cambridge, MA*

- **Synthetic Anatomy for Virtual Interventions with Diffusion Models**
  - Developed **latent diffusion model** to generate and edit 3D cardiovascular anatomy.
  - Analyzed anatomic bias inherent to **diffusion-based editing techniques**.
  - Leveraged **computational topology** to enhance viability of synthetic anatomy for numerical simulations.
  - Created diffusion **guidance algorithms** to enforce geometric and structural constraints on generated anatomy.
- **Multi-modal Coregistration of Coronary Artery Imaging**
  - Trained neural network for the **multi-label segmentation** of coronary morphology from intravascular images.
  - Developed a **spatial transform module** to model intravascular catheter motion artifacts.
  - Created **coregistration algorithm** for alignment of intravascular and coronary computed tomography images.

Edelman Lab, MIT Jun 2020 – Sep 2021
Research Assistant, Master Thesis Project *Cambridge, MA*

- Created semi-automatic workflow to **reconstruct coronary digital twins** from intravascular imaging.
- Developed a **stress-adaptive mesh refinement** module for multi-component artery models.
- Conducted **biomechanical simulations** of patient-specific atherosclerotic arteries to examine the effect of atherosclerotic anatomy on arterial wall stress.

Laboratory of Hemodynamics and Cardiovascular Tech., EPFL Sep 2018 – Sep 2020
Research Assistant *Lausanne, Switzerland*

- Created a **lumped parameter model** to simulate the hemodynamics of left ventricular dysfunction.
- Analyzed the effect of **ventricular pathology** on valvular and aortic hemodynamics.
- Replicated the hemodynamic profiles for each stage of **diastolic dysfunction**.

Moore Research Group, Imperial College London Jul 2019 – Sep 2019
Visiting Research Intern *London, United Kingdom*

- Developed a **finite element solver** of diffusion, advection, and binding for chemokines within the lymph node.
- Coupled the chemokine solver to an **agent-based model** of dendritic cell chemotaxis to study cellular dynamics.
- Created a **generative model** of transport networks within the lymph node to study network topology and cellular dynamics.

Bedewy Research Group, University of Pittsburgh Apr 2017 – Sep 2017
Visiting Research Intern *Pittsburgh, PA*

- Developed **age-dependent model** of both geometry and material properties of the multi-layered skull.
- Conducted **biomechanical simulations** of neurosurgical pin penetration to study the interaction between axial penetration depth, transverse force stability, and age.

Industry Experience

General Electric Healthcare May 2024 – August 2024
Research Scientist Intern *San Ramon, CA*

- Developed **patch based latent diffusion model** for 3D MRI images of knee joints.
- Created conditioning mechanism for **in-painting pathological features** to augment segmentation model training.

Novostia January 2020 – July 2020
Engineering Intern *Neuchatel, Switzerland*

- Synthesized R&D documentation for a novel **trileaflet mechanical heart valve**.
- Co-supervised in-vitro/in-silico development activities including **manufacturing, characterization, testing, and simulation**.

Selected Publications and Preprints

Note: Equal contributions indicated by †

P1 **Kadry, K.**, et al. (2024). *A Diffusion Model for Simulation Ready Coronary Anatomy with Morpho-skeletal Control.* **ECCV 2024**

P2 **Kadry, K.**, et al. (2024). *Morphology-based non-rigid registration of coronary computed tomography and intravascular images through virtual catheter path optimization.* **IEEE Transactions in Medical Imaging**

P3 **Kadry, K.**, et al. (2023). *Probing the Limits and Capabilities of Diffusion Models for the Anatomic Editing of Digital Twins.* **arXiv preprint. Under Review**

P4 Straughn, R†, **Kadry, K.**†, et al. (2023). *Fully Automated Construction of Three-dimensional Finite Element Simulations from Optical Coherence Tomography.* **Computers in Biology and Medicine**

P5 **Kadry, K.**, et al. (2021). *A platform for high-fidelity patient-specific structural modelling of atherosclerotic arteries: from intravascular imaging to three-dimensional stress distributions.* **Journal of the Royal Society Interface**

Mentorship Experience

Defined research projects for and mentored the following masters students:

M1 Elias Salameh: Neural Field Representations for Anatomic Diffusion Models

M2 Mert Ertugrul: Graph Neural Networks to Predict Coronary Angioplasty in Coronary Arteries

M3 Mariia Eremina: Keypoint-guided Registration of Coronary Intravascular Images

M4 Naravich Chutisilp: Contrastive Learning with Pre and Post Intervention Coronary Imaging

M5 Shreya Gupta: Deep-learning Assisted Analysis of Coronary Intravascular Lithotripsy

M6 Kehan Pan: Biomechanical Interaction Between Vessel Curvature and Calcium in Coronary Arteries

M7 Sohee Ahn: Multimodal Data Fusion for Applications in Coronary Image Segmentation

M8 Jonas Sogbadji: Impact of lesion preparation-induced calcium fractures in vascular intervention for atherosclerotic disease: in silico assessment

M9 Ross Straughn: Fully Automated Construction of Three-dimensional Finite Element Simulations from Optical Coherence Tomography

Awards

Massachusetts Institute of Technology Cambridge, MA, USA
Carl E. Nielsen, Jr. Family Fund Award *2025*

Massachusetts Institute of Technology Cambridge, MA, USA
Termeer Fellowship of Medical Engineering and Science *2023*

American University in Cairo Cairo, Egypt
Undergraduate Scholarship for Outstanding Academic Achievement *2013-2018*