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*

Selected Research Experience

Edelman Lab, MIT Jun 2020 – Present
PhD Candidate (Research Assistant: Jun 2020 - Sep 2021) *Cambridge, MA*

- **Generative Modelling of Synthetic Anatomy for Virtual Interventions**
  - Developed **latent diffusion model** to generate and edit 3D cardiovascular anatomy.
  - Analyzed anatomic bias inherent to **diffusion-based editing methods**.
  - 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 Images**
  - 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.
- **Coronary Digital Twin Reconstruction for Numerical Simulations**
  - 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 Technology, 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.
- Computationally 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

Calico Life Sciences May 2025 – Aug 2025
Machine Learning Intern-Protein Design *San Francisco, CA*

- Developed diffusion guidance methods that enforce **physio-chemical constraints** on protein generative models
- Created diffusion guidance methods that enforce **multi-scale geometric constraints** on protein generative models

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

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

Novostia January 2020 – July 2020
Engineering Intern-Medical Device Design *Neuchâtel, 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**.

Lead-Author Publications

Note: Equal contributions indicated by †

P1 **Kadry, K.**, et al. *CardioComposer: Flexible and Compositional Anatomical Structure Generation with Disentangled Geometric Guidance.* **Arxiv submission**

P2 **Kadry, K.**, et al. *A Diffusion Model for Simulation Ready Coronary Anatomy with Morpho-skeletal Control.* **European Conference on Computer Vision (ECCV)**

P3 **Kadry, K.**, et al. *Probing the Limits and Capabilities of Diffusion Models for the Anatomic Editing of Digital Twins.* **npj Digital Medicine**

P4 **Kadry, K.**, et al. *Morphology-based non-rigid registration of coronary computed tomography and intravascular images through virtual catheter path optimization.* **IEEE Transactions in Medical Imaging**

P5 **Kadry, K.**, et al. *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**

P6 Straughn, R†, **Kadry, K.**†, et al. *Fully Automated Construction of Three-dimensional Finite Element Simulations from Optical Coherence Tomography.* **Computers in Biology and Medicine**

P7 Sogbadji, J†, **Kadry, K.**†, et al. *Impact of lesion preparation-induced calcified plaque defects in vascular intervention for atherosclerotic disease: in silico assessment.* **Biomechanics and Modeling in Mechanobiology**

P8 **Kadry, K.**, et al. *Biomechanics of diastolic dysfunction: a one-dimensional computational modeling approach.* **American Journal of Physiology-Heart and Circulatory Physiology**

Mentorship Experience

Currently mentoring the following students:

1. **Generative Augmentation of Cardiac Simulation Datasets to Train Surrogate Physics Models**: Abdallah Abdelwahed
2. **Differentiable Mechanics Simulators for Estimation of Coronary Artery Material Properties from Interventional Imaging**: Yasmin Tawfik

Mentored the following masters students:

1. **Anatomical Structure Generation through Geometric Guidance**: Mohammed AlKhudhayri
2. **Representing Branched Vascular Anatomy with Neural Fields**: Alexandra Flores
3. **Neural Field Representations for Anatomic Diffusion Models**: Elias Salameh
4. **Graph Neural Networks to Predict Coronary Angioplasty in Coronary Arteries**: Mert Ertugrul
5. **Keypoint-guided Registration of Coronary Intravascular Images**: Mariia Eremina
6. **Contrastive Learning with Pre and Post Intervention Coronary Imaging**: Naravich Chutisilp
7. **Deep-learning Assisted Analysis of Coronary Intravascular Lithotripsy**: Shreya Gupta
8. **Biomechanics of Vessel Curvature and Calcium in Coronary Arteries**: Kehan Pan
9. **Multimodal Data Fusion for Applications in Coronary Image Segmentation**: Sohee Ahn
10. **Impact of lesion preparation-induced calcium fractures in vascular intervention for atherosclerotic disease: in silico assessment**: Jonas Sogbadji
11. **Fully Automated Construction of Three-dimensional Finite Element Simulations from Optical Coherence Tomography**: Ross Straughn

Awards

Carl E. Nielsen, Jr. Family Fund Award, MIT 2025

Termeer Fellowship of Medical Engineering and Science, MIT 2023

Undergraduate Scholarship for Outstanding Academic Achievement, AUC 2013–2018

Skills

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

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

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