Misha Rubanov

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Molecular, software, and robotics programmer interested in building novel tools to enable scaled, robust, and modelable experiments. I enjoy being on the interface between science and engineering, be it via experimental/SOP design, building custom UIs for other scientists, or improving developer interfaces for custom SDKs. My experience in molecular programming has given me a unique lens in which to apply a programming mindset towards problems in a wide variety of fields.

RESEARCH AND PROJECT EXPERIENCE

Senior Systems Engineer, Digital Biology

- Led a multidisciplinary computational team for developing computer vision-guided closed-loop microscopy for spatial transcriptomics using photochemistry (light-seg)
 - o Architected a software package for ML + human in the loop segmentation and photoillumination of biological tissue, scaling biological workflows by 4 orders of magnitude with respect to processing and analysis of tissues, unlocking scaled single-cell spatial transcriptomics.
 - o Replaced a commercial software package which was prone to crashing, with an in-house tool with 100% success rate.
 - o Developed a mono-repo SDK that is fully cross-platform with strict data hygiene that allowed for full traceability of all performed steps after an experiment.
 - Parallelized the microscopy platform across different microscopes, leading to a simpler developer interface for adding custom microscopes or other hardware
 - Interfaced with contractors and vendors to scale spatial transcriptomic experimentation (i.e., 0 photoillumination) and liquid handling
 - o Designed, built, and integrated a unified Python API within a single Bazel ecosystem for scientist control of automated microscopes, Hamilton liquid handlers, and Inheco thermocyclers.
- Developed data infrastructure (SQL databases) for combining image and NGS sequencing data for • analysis pipelines
- Integrated LIMS (Benchling) schemas to automate kick-off of image-analysis and NGS
- Designed and built image analysis GUIs in Napari for rapid iteration by scientists

Scientist/Automation Engineer, Digital Biology

- Built a custom python-based microscopy platform for spatial illumination of tissues using custom workflows built in real-time during experiment runs
 - o Developed and built a custom on-microscope Python-controlled liquid handler for automated liquid exchanges working in-tandem with scientists, contractors, and interns
- Designed experiments to optimize and understand underlying molecular mechanisms for light-seg
- Debugged both hardware and software problems related to the microscopes and Hamilton liquid handler both during and after experiments with scientists and research assistants
 - o Led effort to develop and integrate Python-based SDKs onto a Hamilton STARIet liquid handler for sample processing workflows related to light-seg
- Optimized in-lab protocols using in-house built consumables (PDMS) for custom workflows

PhD Researcher, Johns Hopkins University, Schulman Lab

- January 2019 February 2023 Led a series of applied research projects within a biomolecular engineering lab known for research in DNA nanotechnology, intelligent soft materials, and genetic regulatory networks
 - o Developed machine learning algorithms (convolutional neural networks) for designing new chemical reaction networks within DNA-functionalized hydrogels
 - Constructed an automated digital photolithography-based printer with a Python interface for fabricating multi-domain DNA-functionalized hydrogels (MAPDH)
 - o Developed and characterized new modeling techniques for RNA concentration field formation

May 2023 - June 2024

June 2024 – November 2024

- Designed DNA and enzymatic reaction networks for a variety of applications, including dissipative self-assembly, nucleic acid amplification, bistable switches, and RNA gradient generation
- Filed disclosure for a novel RNA concentration field printing method
- Developed an optimization algorithm for the discovery of new chemical reaction networks using the Maryland Advanced Research Computing Center (MARCC)
- Mentored 4 PhD students, 2 Master's students and 1 undergraduate student over 4 years on experimental and modeling research

Intern, Applied Physics Laboratory (APL)

- Investigated the feasibility of building DNA-driven magnetic microbots funded with a Combustion Grant
- Collaborated on designing a microfluidic platform for salt separation and sample preparation for future astrobiology missions
- Utilized aerosol jet printing (AJP) for flexible electronics and silicon photonics applications

EDUCATION

Johns Hopkins University

Doctor of Philosophy

• Chemical and Biomolecular Engineering

Johns Hopkins University

Master of Science and Engineering

Chemical and Biomolecular Engineering

University of Texas at Dallas (UTDallas)

Bachelor of Science, Cum Laude

• Biomedical Engineering with a minor in Chemistry

SPECIALIZED SKILLS

- **Software:** Software engineering (L3/L4), mechanistic and ML modeling, and UX design.
 - o Software Engineering: Proficient with Git, Github, Bazel, CI/CD, Linux, WSL, SQL
 - o **UX design:** Proficient in design of scientist-facing APIs
 - Python: Tensorflow, Keras, PyMOO (multi-objective optimization), packages for microscopy hardware integration (Pycro-manager), modeling DNA/RNA/enzymatic reaction networks as ordinary (PDE/ODEs), Napari, PyQT
 - COMSOL: Partial differential equation modeling of DNA/RNA reaction networks
 PK/PD-type models
- Wet lab: qPCR, PCR, microfluidic device design and fabrication, running well-mixed DNA and cell-free reaction networks, digital photolithography, soft lithography
- Automation: custom-built microfluidic flow controller, Tecan Fluent, Biotek plate readers, fluorescence microscopy, Hamilton STAR, Inheco ODTC, custom on-microscope liquid handling, LIMS integration (Benchling)
- Engineering Design: PCB design, microcontroller programming, breadboarding
- Languages: Fluent in Spanish, Russian

GRANTS AND AWARDS

Carver Mead New Adventures Fund

 Awarded for the proposal for building matrix chemical reaction networks for advanced control of hydrogel soft robots

Defense Advanced Research Projects Agency (DARPA) Grant

• Awarded for the proposal for the directed assembly of DNA-coated microparticles using programmable RNA gradient-generating hydrogel posts

Mightex Annual Research Excellence Award

 Awarded for the use of the Mightex Polygon 400 digital micromirror device for fabricating multi-domain DNA-functionalized hydrogels for sequential activation

Army Research Office (ARO) Grant

Richardson, Texas Graduated 2016

Baltimore, Maryland

Baltimore, Maryland Graduated 2019

Graduated 2023

May 2019 - August 2020

June 2020

May 2023

January 2022

November 2021

- Awarded for the proposal of a novel 3D microfabrication method to create autonomous, DNA controlled hydrogels for combinatorial shape change and responsivity
- Combustion Grant: Applied Physics Lab at Johns Hopkins University (JHUAPL) October 2019
 - Internal Grant at APL awarded for an innovative idea to create DNA controlled, magneto-responsive micro-robots

PEER-REVIEWED PUBLICATIONS

- Rubanov, M., Moerman, P., Schulman, R., Programmable RNA Gradient Formation using Photopatterned Hydrogel Generators. In preparation.
- Chen, K.-L. et al. Hydrogels with Tethered Transcription Circuit Elements for Chemical Communication and Collective Computation. Preprint at https://doi.org/10.26434/chemrxiv-2024-1fk8r (2024).
- Rubanov, M. et al. Multi-domain automated patterning of DNA-functionalized hydrogels. PLOS ONE 19, e0295923 (2024).
- Rubanov, M., Dorsey, P. J., Scalise, D. & Schulman, R. Sequential Activation of Spatially Localized Oligonucleotides. ACS Materials Lett. 1807–1814 (2022).
- Scalise, D., Rubanov, M., Miller, K., Potters, L., Noble, M., Schulman, R. Programming the Sequential Release of DNA. *ACS Synth*. Biol. 9, 749-755 (2020).
- Dorsey, P. J., Rubanov, M., Wang, W. & Schulman, R. Digital Maskless Photolithographic Patterning of DNA- Functionalized Poly(ethylene glycol) Diacrylate Hydrogels with Visible Light Enabling Photodirected Release of Oligonucleotides. ACS Macro Lett. 8, 1133-1140 (2019).

PATENTS

• Filed disclosure titled "Systems and Methods for RNA Gradient Pattern Generation" December 2022

CONFERENCE PRESENTATIONS

SynCell 2022

• Oral Presentation titled An automated DNA-functionalized hydrogel photopatterning system for RNA gradient generation using localized transcription

Synthetic Biology: Engineering, Evolution & Design (SEED) 2022

• Poster Presentation titled Constructing a Tunable RNA Gradient Generator using Photopatterned Hydrogels

Gordon Research Seminar: Complex Active and Adaptive Material Systems Ja

Oral Presentation titled Spatiotemporal Release of Oligonucleotides for Soft Material Programming

Material Research Society 2019

• Oral Presentation titled Spatiotemporal Release of Oligonucleotides for Soft Material Programming

TEACHING EXPERIENCE

Johns Hopkins MATLAB Bootcamp	January 2019 - Present
Course Teacher and Curriculum Designer	Baltimore, Maryland
Develop a coding curriculum in MATLAB that captivates students' interests through exciting	
programming applications (through the week-by-week development of a cellular automata simulator)	

- Teach the online course every semester for 8+ semesters
- Incorporate student and supervisor feedback for iterative program improvement

UT Dallas Student Success Center

Super Leader

- Held semester observations to give feedback to the tutors based on student reviews
- Led weekly one-on-one and group tutoring sessions in biochemistry and organic chemistry

January 2019

May 2022

May 2022

April 2019

January 2016 - May 2016

Richardson, Texas