

# Matthew B. Applegate

## Curriculum Vitae

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NCBI Bibliography

### Current Work

- I am currently working as an Experiential AI Fellow at Northeastern University with Jennifer Dy. My work sits at the intersection of biomedical imaging and machine learning. I seek to use new machine learning algorithms to reduce the size, increase the speed, and lower the cost of reflectance confocal microscopy (RCM) imaging devices. RCM is currently used to diagnose skin cancer and monitor suspicious lesions in specialized cancer centers. Low-cost RCM powered by AI has the potential to expand access to cutting-edge skin cancer imaging tools to clinics around the world.

### Education

- 2016 **PhD, Biomedical Engineering**, *Tufts University*.  
Thesis title: Sculpting with light: light/matter interaction in biocompatible polymers
- 2009 **BS, Electrical Engineering**, *Cornell University*.  
Concentration in Signal Processing

### Publications in preparation

- **Applegate MB**, Kivanc Kose, Sandesh Ghimire, Milind Rajadhyaksha, Jennifer Dy. "Self-supervised denoising of volumetric biomedical images." Under Review at: IEEE Transactions on Medical Imaging
- "Frequency Domain Diffuse Optical Spectroscopy (FD-DOS) for evaluation of the sternocleidomastoid muscle during isometric flexation" with Raef Istfan

### Peer-reviewed Publications (J numbers are links)

2021

- J29 **Applegate MB**, Robert Amelard, Gómez CA, Roblyer D. "Real-time handheld probe tracking and image formation using digital frequency-domain diffuse optical spectroscopy". IEEE Transactions on Biomedical Engineering. 68(11): 3399, 2021

- J28 **Applegate MB**, Gómez CA, Roblyer D. "Modulation frequency selection and efficient look-up table inversion for Frequency Domain Diffuse Optical Spectroscopy." *Journal of Biomedical Optics* 26(3) 036007, 2021
- J27 **Applegate MB**, Spink SS, Roblyer D, "Dual-DMD hyperspectral spatial frequency domain imaging (SFDI) using dispersed broadband illumination with a demonstration of blood stain spectral monitoring," *Biomedical Optics Express* 12(1): 676, 2021
- 2020
- J26 **Applegate MB**, Istfan RE, Spink S, Tank A, Roblyer D, "Recent advances in high speed diffuse optical imaging in biomedicine," *APL Photonics* 5(4): 040802, 2020
- J25 **Applegate MB**, Karrobi K, Angelo JP, Austin W, Tabassum SM, Aguénonon E, Tilbury K, Saager RB, Gioux S, Roblyer D, "OpenSFDI: an open-source guide for constructing a spatial frequency domain imaging system," *J. Biomed. Opt.* 25(1): 016002, 2020
- 2019
- J24 Hariri LP, Adams DC, **Applegate MB**, Miller AJ, Roop BW, Villiger M, Bouma BE, Suter MJ, "Distinguishing Tumor from Associated Fibrosis to Increase Diagnostic Biopsy Yield with Polarization-Sensitive Optical Coherence Tomography" *Clinical Cancer Research* 25(17): 5242, 2019
- J23 Adams DC, Miller AJ, **Applegate MB**, Cho JL, Hamilos DL, Chee A, Holz JA, Szabari MV, Hariri LP, Harris RS, Griffith JW, Luster AD, Medoff BD, Suter MJ, "Quantitative assessment of airway remodelling and response to allergen in asthma," *Respirology* 24: 1073, 2019
- 2018
- J22 **Applegate MB**, Zhao Y, Istfan R, Roblyer D, "Quantitative real-time pulse oximetry with ultrafast frequency-domain diffuse optics and deep neural network processing" *Biomedical Optics Express*. 9(12): 5997, 2018
- J21 **Applegate MB**, Roblyer D, "Multi-distance diffuse optical spectroscopy with a single optode via hypotrochoidal scanning" *Optics Letters*. 43(4): 747-50, 2018
- 2017
- J20 **Applegate MB**, Roblyer D. "High-speed spatial frequency domain imaging with temporally modulated light" *Journal of Biomedical Optics*. 22(7): 076019, 2017
- J19 Franklin AM, **Applegate MB**, Lewis SM, Omenetto FG. "Stomatopods detect and assess achromatic cues in contests" *Behavioral Ecology*. 28(5): 1329-36, 2017

- J18 Tseng P, Napier B, Zhao S, Mitropoulos AN, **Applegate MB**, Marelli B, Kaplan DL, Omenetto FG. "Directed assembly of bio-inspired hierarchical materials with controlled nanofibrillar architectures" *Nature Nanotechnology*. 12(5): 474-80, 2017
- J17 Tseng P, Zhao S, Golding AS, **Applegate MB**, Mitropoulos AN, Kaplan DL, Omenetto FG. "Evaluation of Silk Inverse Opals for 'Smart' Tissue Culture" *ACS Omega*. 2(2): 470-7, 2017
- J16 Landry MJ, **Applegate MB**, Bushuyev OS, Omenetto FG, Kaplan DL, Cronin-Golomb M, Barrett CJ. "Photo-induced structural modification of silk gels containing azobenzene side groups" *Soft Matter*. 13(16): 2903-6, 2017
- 2016
- J15 Partlow BP, **Applegate MB**, Omenetto FG, Kaplan DL. "Dityrosine Cross-Linking in Designing Biomaterials" *ACS Biomaterials Science & Engineering*. 2(12): 2108-21, 2016
- J14 **Applegate MB**, Alonzo C, Georgakoudi I, Kaplan DL, Omenetto FG. "A simple computational model of multiphoton micromachining in silk hydrogels" *Applied Physics Letters*. 108(24): 241903, 2016
- J13 **Applegate MB**, Partlow BP, Coburn J, Marelli B, Pirie C, Pineda R, Kaplan DL, Omenetto FG. "Photocrosslinking of silk fibroin using riboflavin for ocular prostheses." *Advanced Materials*. 28(12): 2417-20, 2016
- J12 Zhao S, Chen Y, Partlow BP, Golding AS, Tseng P, Coburn J, **Applegate MB**, Moreau JE, Omenetto FG, Kaplan DF. "Bio-functionalized silk hydrogel microfluidic systems." *Biomaterials*. 93: 60-70, 2016
- J11 Brenckle MA, Partlow BP, Tao H, **Applegate MB**, Reeves A, Paquette M, Marelli B, Kaplan DL, Omenetto FG. "Methods and applications of multilayer silk fibroin laminates based on spatially controlled welding in protein films." *Advanced Functional Materials*. 26(1): 44-50, 2016
- 2015
- J10 **Applegate MB**, Coburn J, Partlow BP, Moreau JE, Mondia J, Marelli B, Kaplan DL, Omenetto FG. "Laser-based 3-dimensional multiscale micropatterning of biocompatible hydrogels for customized tissue engineering scaffolds." *Proceedings of the National Academy of Sciences*. 112(39): 12052-7, 2015
- J9 **Applegate MB**, Perotto G., Kaplan DL, Omenetto FG. "Biocompatible silk step-index optical waveguides." *Biomedical Optics Express*. 6(11): 4221-7, 2015

- J8 Mitropoulos A, Marelli B, Ghezzi CE, **Applegate MB**, Partlow BP, Kaplan DL, Omenetto FG. "Transparent, nanostructured silk fibroin hydrogels with tunable mechanical properties." *ACS Biomaterials Science & Engineering*. 1(10): 964-70, 2015

## 2014

- J7 Partlow BP, Hannah CW, Rnjak-Kovacina J, Moreau JE, **Applegate MB**, Burke KA, Marelli B, Mitropoulos AN, Omenetto FG, Kaplan DL. "Highly tunable elastomeric silk biomaterials." *Advanced Functional Materials*. 24(29): 4615-24, 2014

## 2013

- J6 **Applegate MB**, Marelli B, Kaplan DL, Omenetto FG. "Determination of multi-photon absorption of silk fibroin using the Z-scan technique." *Optics Express*, 21, 29637-42, 2013
- J5 Hariri LP, **Applegate MB**, Mino-Kenudson M, Mark EJ, Medoff BD, Luster AD, Bouma BE, Tearney GJ, Suter MJ, "Volumetric optical frequency domain imaging of pulmonary pathology with precise correlation to histopathology." *Chest Journal*, 143(1): 64-74, 2013.
- J4 Hariri LP, Mino-Kenudson M, **Applegate MB**, Eugene MJ, Tearney GJ, Lanuti M, Channick CL, Chee A, Suter MJ. "Towards the guidance of transbronchial biopsy: Identifying pulmonary nodules with optical coherence tomography." *Chest Journal*, 144(4): 1261-8, 2013.
- J3 Hariri LP, Villager M, **Applegate MB**, Mino-Kenudson M, Mark EJ, Bouma BE, Suter MJ. "Seeing beyond the Bronchoscope to Increase the Diagnostic Yield of Bronchoscopic Biopsy." *American Journal of Respiratory and Critical Care Medicine*, 187(2): 125-9, 2013.

## 2012

- J2 Hariri LP, **Applegate MB**, Mino-Kenudson M, Mark EJ, Bouma BE, Tearney GJ, Suter MJ. "Optical Frequency Domain Imaging of Ex vivo Pulmonary Resection Specimens: Obtaining One to One Image to Histopathology Correlation." *Journal of Visualized Experiments: JoVE*, 71, 2012.
- J1 Tan KM, Shishkov M, Chee A, **Applegate MB**, Bouma BE, Suter MJ. "Flexible transbronchial optical frequency domain imaging smart needle for biopsy guidance." *Biomedical Optics Express*, 3(8): 1947-54, 2012.

## Other Publications

- O2 **Applegate MB**, Brenckle MA, Marelli BM, Tao H, Kaplan DL, Omenetto FG. "Silk: A different kind of 'fiber optics'," *Optics and Photonics News*. June 2014. (cover)
- O1 **Applegate MB**, Hariri LP, Beagle J, Tan KM, Chee C, Hales CA, Suter MJ. "Assessment of smoke inhalation injury using volumetric optical frequency domain imaging in sheep models," *Proc. of the SPIE* 8207, 2012.

## Honors & Awards

- 2019 **Awardee**, *NIH F32 Ruth L. Kirschstein National Research Service Award (NRSA) Individual Postdoctoral Fellowship*.  
National 2-year fellowship
- 2017 **3<sup>rd</sup> place**, *Poster competition*.  
ECI Advances in Optics for Biotechnology XV Conference
- 2015 **Recipient**, *Incubic Milton Chang Student Travel Grant*.  
International
- 2014 **Awardee**, *National Defense Science and Engineering Graduate Fellowship*.  
National 3-year fellowship
- 2014 **Winner**, *Tufts University Graduate Student Research Competition*.  
University-wide
- 2013 **Honorable Mention**, *National Science Foundation Graduate Research Fellowship*.  
National
- 2012 **Recipient**, *Stern Fellowship, Tufts University*.  
College of Engineering 2-year fellowship

## Invited Talks

- 2016 **"Photostructuring silk biomaterials"**, *Institute for Theoretical Atomic, Molecular, and Optical Physics (ITAMP) seminar*.  
Harvard University
- 2016 **"'Subtractive' 3D printing via multiphoton absorption in silk hydrogels"**, *SelectBio Conference*.  
Boston, MA

## Presentations

- 2021 **Frequency-Domain Diffuse Optical Spectroscopy with Real-time Data Visualization for Monitoring of Breast Neoplasms**, *Photonics West*, Held virtually due to COVID.  
Oral presentation
- 2021 **Frequency Selection in Frequency Domain Diffuse Optical Spectroscopy**, *Photonics West*, Held virtually due to COVID.  
Oral presentation
- 2020 **High-speed Frequency Domain Diffuse Optical Spectroscopy for Rapid Assessment of Breast Neoplasms**, *OSA Biophotonics Congress: Biomedical Optics*, Held virtually due to COVID.  
Oral presentation
- 2018 **Hyperspectral spatial frequency domain imaging (HS-SFDI) for monitoring rapid changes in tumor oxygenation**, *SPIE Photonics West*, San Francisco, CA.  
Podium Presentation
- 2018 **Real-time diffuse optical B-mode Imaging (DOBI) for cancer monitoring**, *SPIE Photonics West*, San Francisco, CA.  
Podium Presentation
- 2017 **High-speed spatial frequency domain imaging with temporally modulated light**, *ECI Advances in Optics for Biotechnology XV*, Snowmass, CO.  
Poster Presentation
- 2015 **Biocompatible silk fibroin optical waveguides**, *Advanced Photonics Congress*, Boston, MA.  
Podium Presentation
- 2015 **3D laser ablation of silk fibroin hydrogels for biomedical applications**, *Conference on Lasers and Electro-Optics (CLEO)*, San Jose, CA.  
Podium Presentation
- 2013 **Direct Laser Writing of Three Dimensional Microscale Features in Silk Fibroin Hydrogels**, *Biomedical Engineering Society (BMES) Annual Meeting*, Seattle, WA.  
Podium Presentation
- 2009 **A novel method of electrothermal weed control**, *Cornell University Undergraduate Research Symposium*, Ithaca, NY.  
Poster Presentation

## Teaching Experience

- 2014 **Teaching Assistant**, *Tufts University*.  
Design of Medical Instrumentation
- 2013 **Teaching Assistant**, *Tufts University*.  
Systems Biology
- 2011 **Volunteer Math Tutor**.
- 2009 **Volunteer Math Tutor**, *Tompkins Learning Partners*.

## Service

- 2018–2020 **Instructor**, *Artemis Project Summer Program*, Boston University.
- 2017 **Reviewer**, *Journal of Biomedical Optics*.
- 2016 **Reviewer**, *Applied Physics Letters: Photonics*.
- 2014–2015 **Reviewer**, *Graduate Student Research Competition*, Tufts University.
- 2015 **Vice President**, *Optical Society of America Student Chapter*, Tufts University.
- 2015 **Optics Outreach**, *O-mazing Optics*, Discovery Museum, Acton, MA.
- 2014 **Optics Outreach**, *Community Day*, Tufts University.

## Research Experience

- 2021–present **Machine Learning, Artificial Neural Networks, Image Denoising, Reflectance Confocal Microscopy for Skin Cancer Monitoring**.  
Northeastern University
- 2017–2020 **Diffuse optical spectroscopic imaging (DOSI), spatial frequency domain imaging (SFDI)**.  
Boston University
- 2012–2016 **Nonlinear Optics, Microscopy, Multiphoton Micromachining, Biopolymers, Photopolymerization, Tissue Engineering Scaffolds**.  
Tufts University
- 2010–2012 **Optical Coherence Tomography (OCT), Lung Biology**, *Suter Lab*.  
Massachusetts General Hospital
- 2009 **Organic Cropping Systems**.  
Cornell University

## Relevant skills

### Electronics

- Firmware design
- DSP in FPGA

- PCB Design

## Optics

- FD diffuse optics
- Beam alignment
- Reflectance Confocal Microscopy
- Micromachining

## Programming

- C++
- Python/PyTorch
- LabView
- ImageJ
- OpenCV

## Biomaterials

- Mechanical testing
- 3D printing

- PCB Layout

- Spatial frequency domain imaging
- Optical coherence tomography
- Microscopy
- Interferometry

- VHDL
- Matlab
- R
- $\text{\LaTeX}$

- SEM
- Biopolymer processing