KUK JIN JANG

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Philadelphia, PA, USA

EDUCATION

UNIVERSITY OF PENNSYLVANIA, SEAS, **Ph.D** in Electrical and Systems Engineering   Dec 2021

UNIVERSITY OF PENNSYLVANIA, Wharton School, **AM** in Statistics   Dec 2021

PRINCETON UNIVERSITY, **M.Eng** in Electrical Engineering   Jan 2011

BROWN UNIVERSITY, **Sc.B** in Computer Engineering (Signal Processing Specialty)   May 2009

SUMMARY

Skilled machine learning researcher with 30+ publications and awards with applications of LLMs in various fields. Proven leader of interdisciplinary teams, skilled in robust algorithms, uncertainty quantification, and multimodal learning.

WORK EXPERIENCE

Postdoctoral Research Scientist, Advised by Insup Lee, James Weimer, and Kevin B. Johnson, UPENN   Jan 2022 – Present
Uncertainty Quantification and Robustness for Machine Learning in Medicine and Robotics (2.5+ years)
- **Improved F1 score by 3.13%** in robust ECG classification by developing a memory-based deep learning architecture
- **Improved motion prediction coverage by 13.08%** in F1/10 racing using Imprecise Bayesian Neural Networks
- Led distribution shift recovery with reinforcement learning project and **improved classification accuracy by 14.2%**
- Designed state representations and learning-based methods for distribution shift recovery using reinforcement learning
- Lead developer for a novel credal deep evidential classification approach with aleatoric and epistemic uncertainty
- Developing uncertainty quantification to discover model weaknesses and improve the robustness of ECG classification

Artificial Intelligence for Ophthalmology and Oculomics (1.5+ years)
- Developing a **multimodal generative diffusion model** for predicting vision fields in glaucoma patients
- Pretraining and finetuning Llama 3-8B to establish an **ophthalmology-specific LLM** chatbot application
- **Curating mixed-modality datasets** and developing a **mixed-modality foundation model** for ophthalmology
- Developed a neural network model providing PAC safety guarantees in fundus image-based visual acuity assessment
- Developing novel image biomarkers for mobile monitoring of Grave's disease and large-scale glaucoma screening
- Leading group research efforts in four projects and coordinating research directions in collaboration with clinicians
- Participated and contributed to 4 project proposals for departmental, NSF, and NIH funding opportunities

Multi-modal and Large Language Models for Patient-Provider Interaction Analysis (w. Prof. Kevin Johnson) (1.5+ years)
- Developed modality-importance score to assess modality bias in video question-answering datasets and **generative AI**
- Designing **LLM** and **VLM-based applications** for automated clinical interaction analysis
- Using **natural language processing** and **speech processing** for real-time sentiment analysis in clinical conversation
- Designed method and obtained IRB approval for patient-clinician interaction **dataset curation** with crowdsourcing
- Developing interpretable and extensible artificial intelligence approach for **robust video question-answering**
- Participated and contributed to 3 project proposals for departmental and NIH funding opportunities

Researcher, Medical IT Research Center, Korea Electronics Technology Institute, South Korea   Sep 2011 – June 2014
- Created an image processing algorithm for immunoassay measurement quantification
- Developed embedded system for data acquisition and control of hardware interfaces for bio-MEMs sensors

ADDITIONAL RESEARCH EXPERIENCE

Ph.D Student, Advised by Rahul Mangharam, Electrical and Systems Engineering, UPENN   Sep 2014 – Dec 2021
Computer Aided Clinical Trials for Implantable Cardiac Devices
- Collaborated with a team of clinicians and biophysicists to develop a virtual heart model and evaluation methodology
- Modeled cardiac signals using timed-automata and data-driven methods for generation of synthetic cohorts
- Developed a statistical framework for evaluation of cardiac devices using virtual cohorts in computer aided clinical trials
- Demonstrated **reduction of cohort size by 68.8%** for comparable power with computer-aided clinical trials for ICDs

Data-driven Methods for Electroanatomic Mapping in Cardiac Ablation Treatment of Atrial Fibrillation
- Analyzed electroanatomic data collected from patients undergoing catheter ablation for atrial fibrillation (AF)
- **Improved sensitivity by 7.88%** with Gaussian processes when identifying low voltage (scar) regions

Reinforcement Learning for Unmanned Aircraft System Collision Avoidance
- Designed and obtained a collision avoidance policy using reinforcement learning with curriculum learning
- Implemented a PPO-based controller and custom OpenAI Gym environment in Python using Tensorflow and RLLIB
- Executed experiments on CrazyFlie platform in Vicon environment with ROS
- Achieved a **99.1%-100% collision avoidance rate** with **1000X improvement** in computation time relative to baseline

Content-coupled Activity Surface Development
- Designed activity surface with embedded sensors and control of electroluminescent panels for interactive yoga
- Developed C++ firmware for sensing and actuation layer and implemented backend server-side service with NodeJS

Master's Student, Research Assistant for Professor Naveen Verma, Princeton University   Jan 2009 – Sep 2011
- Researched active-learning based machine learning algorithms for patient-specific atrial fibrillation (AF) detection
- Improved AF detection specificity and demonstrated scalability to patient-specific approaches based on active learning

SKILLS

- **Programming:** (Fluent) Python, Matlab (Proficient) Java, C/C++
- **Machine Learning/Statistical Frameworks**: PyTorch, Tensorflow, RLLIB, Ax, BoTorch
- **Embedded Platform Development:** ROS, MBed, Other standard microcontrollers (MSP430, ATMEGA328, ARM)

AWARDS/FUNDING

- ASSET/IBI Trustworthy AI for Medicine Grant (2024): Interpretable and Extensible Patient-Provider Clinical Interaction Analysis for Frailty Detection with Compositional Reasoning and Vision-Language Models (Contributor)
- ASSET/IBI Trustworthy AI for Medicine Grant (2024): Trustworthy AI for Continuous Monitoring of Grave's Disease with Mobile Devices (Contributor)
- Top Reviewer for AISTATS 2023
- Best Paper of Session, 39th Digital Avionics Systems Conference, 2020
- Best PhD Colloquium Presentation Award, Department of Electrical and Systems Engineering, UPENN, 2017
- Third Prize, CIS520 Machine Learning Course Competition, UPENN, 2016
- First Prize (International Section), 12th Annual World Embedded Software Contest, Seoul, Korea, 2014

PUBLICATIONS

- Sooyong Jang, Kuk Jin Jang, Hyonyoung Choi, Yong-seop Han, Seongjin Lee, Jin-hyun Kim, Insup Lee, "Fundus Image-based Visual Acuity Assessment with PAC-Guarantees," 2024, Accepted to Machine Learning for Health Symposium 2024

- Michele Caprio, Souradeep Dutta, **Kuk Jin Jang**, Radoslav Ivanor, Vivian Lin, Oleg Sokolsky, Insup Lee, "Credal Bayesian Deep Learning," 2024, (Accepted) Transactions of Machine Learning Research, 2024-09-12 https://arxiv.org/abs/2302.09656.

- Joshua Ong *, **Kuk Jin Jang***, Seung Ju Baek, Dongyin Hu, Vivian Lin, Sooyong Jang, Alexandra Thaler, Nouran Sabbagh, Almiqdad Saeed, Minwook Kwon, Jin Hyun Kim, Seongjin Lee, Yong Seop Han, Mingmin Zhao, Oleg Sokolsky, Insup Lee, Lama A Al-Aswad, "Development of Oculomics Artificial Intelligence for Cardiovascular Risk Factors: A Case Study in Fundus Oculomics for HbA1c Assessment and Clinically Relevant Considerations for Clinicians," 2024, Accepted to Asia-Pacific Journal of Ophthalmology, Date: 2024-08-22. *: Co-first Authorship

- Jean Park, **Kuk Jin Jang**, Basam Alasaly, Sriharsha Mopidevi, Andrew Zolensky, Eric Eaton, Insup Lee, Kevin B. Johnson, "Assessing Modality Bias in Video Question Answering Benchmarks with Multimodal Large Language Models," 2024, , https://arxiv.org/abs/2408.12763, (Under review).

- Souradeep Dutta, Michele Caprio, Vivian Lin, Matthew Cleveland, **Kuk Jin Jang**, Ivan Ruchkin, Oleg Sokolsky, Insup Lee, "Distributionally Robust Statistical Verification with Imprecise Neural Networks," https://arxiv.org/pdf/2308.14815.pdf (Under review)

- Jean Park**, Kuk Jin Jang**, Sydney Pugh, Basam Alasaly, Eric Eaton, Insup Lee, Kevin Johnson, "Investigating Vision-Language Models for Clinical Interaction Analysis," 2024 (In preparation)

- Vivian Lin, **Kuk Jin Jang**, Souradeep Dutta, Michele Caprio, Oleg Sokolsky, Insup Lee, "DC4L: Distribution Shift Recovery via Data-Driven Control for Deep Learning Models," Accepted to 2024 Learning for Dynamics and Control Conference (L4DC), 2024, https://arxiv.org/abs/2302.10341

- **Kuk Jin Jang**, Souradeep Dutta, Jean Park, James Weimer, Insup Lee, "Memory Classifiers for Robust ECG Classification against Physiological Noise," 45th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2023, 2023:1-5. doi:10.1109/EMBC40787.2023.10339980.

- Jean Park, **Kuk Jin Jang**, Souradeep Dutta, James Weimer, Insup Lee, "Robust ECG Classification with Hierarchical Domain Knowledge," 2023, 45th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)

- Yahan Yang, Souradeep Dutta, **Kuk Jin Jang**, Oleg Sokolsky, Insup Lee, "Incremental Learning with Memory Regressors for Motion Prediction in Autonomous Racing," 2023. In Proceedings of the ACM/IEEE 14th International Conference on Cyber-Physical Systems (with CPS-IoT Week 2023) (ICCPS '23). Association for Computing Machinery, New York, NY, USA, 264–265. https://doi.org/10.1145/3576841.3589627

- Michele Caprio, Souradeep Dutta, **Kuk Jin Jang**, Radoslav Ivanor, Vivian Lin, Oleg Sokolsky, Insup Lee, "Imprecise Bayesian Neural Networks," 2023, https://arxiv.org/abs/2302.09656

- Alena Rodionova, Yash Vardhan Pan, Connor Kurtz, **Kuk Jin Jang**, Houssam Abbas, Rahul Mangharam, "Learning-'N-Flying: A Learning-based, Decentralized, Mission Aware UAS Collision Avoidance Scheme," 2021, ACM Transactions of Cyber Physical Systems (TCPS) 5 (4), 1-26, Article 35 (October 2021), 26 pages. https://doi.org/10.1145/3447624

- **Kuk Jin Jang**, Yash Vardhan Pant, Alena Rodionova, and Rahul Mangharam, "Learning to Fly RL: Reinforcement Learning-based Collision Avoidance for Scalable Urban Air Mobility," 2020 AIAA/IEEE 39th Digital Avionics Systems Conference (DASC), pp. 1-10, doi:10.1109/DASC50938.2020.9256710. **(Best Paper of Session Award)**

- Alena Rodionova, Yash Vardhan Pant, **Kuk Jin Jang**, Houssam Abbas, Rahul Mangharam, "Learning-to-Fly: Learning-based Collision Avoidance for Scalable Urban Air Mobility," 2020. In 2020 IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC). IEEE Press, 1–8. https://doi.org/10.1109/ITSC45102.2020.9294425

- Samuel Huang, Madeline Diep, **Kuk Jin Jang**, Elizabeth M. Cherry, Flavio H. Fenton, Rance Cleaveland, Mikael Lindvall, Rahul Mangharam, Adam Porter, "Towards Automated Comprehension and Alignment of Cardiac Models at the System Invariant Level," 2020, CSBio '20: Proceedings of the Eleventh International Conference on Computational Systems-Biology and Bioinformatics (CSBio2020). Association for Computing Machinery, New York, NY, USA 18–28. https://doi.org/10.1145/3429210.3429225

- **Kuk Jin Jang**, Yash Vardhan Pant, Bo Zhang, James Weimer, Rahul Mangharam, "Robustness Evaluation of Computer-aided Clinical Trials for Medical Devices," 2019, Proceedings of the 10th ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS '19). Association for Computing Machinery, New York, NY, USA, 163–173. https://doi.org/10.1145/3302509.3311058

- Jiyue He*, **Kuk Jin Jang***, Katie Walsh, Jackson Liang, Sanjay Dixit, Rahul Mangharam, "Electroanatomic Mapping to Determine Scar Regions in Patients with Atrial Fibrillation," 2019, 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2019:5941-5944. doi: 10.1109/EMBC.2019.8856704. (*: equal contribution)

- **Kuk Jin Jang**, James Weimer, Houssam Abbas, Zhihao Jiang, Jackson Liang, Sanjay Dixit, Rahul Mangharam, "Computer Aided Clinical Trials for Implantable Cardiac Devices," 2018, 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2018:1-4. doi: 10.1109/EMBC.2018.8513284.

- Houssam Abbas, Zhihao Jiang, **Kuk Jin Jang**, Marco Beccani, Jackson Liang, Rahul Mangharam, "High-level modeling for computer-aided clinical trials of medical devices," 2016 IEEE International High Level Design Validation and Test Workshop (HLDVT), Santa Cruz, CA, USA, 2016, pp. 85-92, doi: 10.1109/HLDVT.2016.7748260.

- Houssam Abbas, **Kuk Jin Jang**, Jackson Liang, Sanjay Dixit, Rahul Mangharam, "A novel ICD morphology discriminator to improve discrimination between Ventricular and Supraventricular tachycardias," Heart Rhythm Society Scientific Sessions, Chicago, May 2016

- Zhihao Jiang, Houssam Abbas**, Kuk Jin Jang**, Marco Beccani and Rahul Mangharam
  "In-silico Pre-clinical Trials for Implantable Cardiac Devices", 2016, 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2016:169-172. doi: 10.1109/EMBC.2016.7590667.

- Houssam Abbas, **Kuk Jin Jang**, Z. Jiang and Rahul Mangharam, "Towards Model Checking of Implantable Cardioverter Defibrillators", 2016, In Proceedings of the 19th International Conference on Hybrid Systems: Computation and Control (HSCC '16), Association for Computing Machinery, New York, NY, USA, 87–92. https://doi.org/10.1145/2883817.2883841

- Houssam Abbas, **Kuk Jin Jang,** Rahul Mangharam, "Benchmark: Nonlinear Hybrid Automata of Excitable Cardiac Tissue", 2016, 3rd International Workshop on Applied Verification for Continuous and Hybrid Systems (ARCH16), vol 43, pages 1-8, doi: 10.29007/5zfk

- Zhihao Jiang, Houssam Abbas, **Kuk Jin Jang**, Rahul Mangharam , "The Challenges of High-Confidence Medical Device Software", 2016. Computer 49, 1 (Jan. 2016), 34–42. https://doi.org/10.1109/MC.2016.20

- **Kuk Jin Jang**, Jungmin Ryoo, Orkan Telhan, Rahul Mangaharam, "Cloud Mat: Context-Aware Personalization of Fitness Content", 2015, (Invited Paper) 2015, IEEE International Conference on Services Computing, New York, NY, USA, 2015, pp. 301-308, doi: https://doi.org/10.1109/SCC.2015.49.

- Yeong-Tai Seo, Kook-Nyung Lee, Kuk Jin Jang, Min-Ho Lee, HyungSu Lee, WooKyeong Seong, Yong-Kweon Kim, "Negative ions detection in air using nano field-effect-transistors (nanoFET)", 2014, Micro and Nano Systems Letters, Volume 2, Issue 1, article id.7, 6, doi: 10.1186/s40486-014-0007-6

- Hye Youn Kim, **Kuk Jin Jang**, Murugan Veerapandian, Hyung Chul Kim, Yeong Tai Seo, Kook Nyung Lee, Min-Ho Lee, "Reusable urine glucose sensor based on functionalized graphene oxide conjugated AU electrode with protective layers," 2014, Biotechnology reports, Vol.3, pp.49-53, doi: 10.1016/j.btre.2014.06.003. PMID: 28626648.

- Seung-Chul Lee, **Kuk-Jin Jang**, Ki-Man Jeon, Dong-Sun Kim, Young-Hwan Kim
  "Implementation of the ECG Monitoring System for Wearable Healthcare Using Quadratic Variation, " Proceedings of the Institute of Electronics Engineering of Korea, Vol. 7, 1214-1217, 2013

- Chae-young Lim, **Kuk Jin Jang**, Hyun-woo Kim, Young Hwan Kim, "A Wearable Healthcare System for Cardiac Signal Monitoring Using Conductive Textile Electrodes", 2013, Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2013:7500-3. doi: 10.1109/EMBC.2013.6611293.

- Young Hwan Kim, **Kuk-Jin Jang**, Seung-chul Lee, Chang Won Park, Hee Yong Youn
  "A Robust Wearable Health Monitoring System based on WSN," 2013, IEEE 10th Consumer Communications and Networking Conference (CCNC), Las Vegas, NV, 2013, pp. 288-293, doi: 10.1109/CCNC.2013.6488460.

- Naveen Verma, Kyong Ho Lee, **Kuk Jin Jang**, Ali Shoeb,"Enabling System-level Platform Resilience Through Embedded Data-driven Inference Capabilities in Electronic Devices", 2012, IEEE Int. Conf. on Acoustics, Speech and Signal Processing (ICASSP), March 2012, pp. 5285-5288, doi: 10.1109/ICASSP.2012.6289113.

- **Kuk Jin Jang**, Guha Balakrishnan, Zeeshan Syed, Naveen Verma, "Scalable Customization of Atrial Fibrillation Detection in Cardiac Monitoring Devices: Increasing Detection Accuracy through Personalized Monitoring in Large Patient Populations." 2011, Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2011:2184-7, doi: 10.1109/IEMBS.2011.6090411.

- Kyong Ho Lee, **Kuk Jin Jang**, Ali Shoeb, Naveen Verma, "A Data-driven Modeling Approach to Stochastic Computation for Low-energy Biomedical Devices." 2011, 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2011:826-9. doi: 10.1109/IEMBS.2011.6090189.

PATENTS

Methods, systems and computer readable media involving a content-coupled physical activity surface
- Inventors: Rahul Mangharam, Orkan Telhan, Kuk Jin Jang, Matthew Edward O'Kelly
- US Patent US10642360B2, Filed: December 2015, Granted: May 2020

INVITED TALKS

Sungkyunkwan University, Dep. of Intelligent Robotics & Mechanical Engineering   Apr 18, 2024
- Title: "Learning Policies for Safe Planning and Robust Perception in Autonomous Systems."

First Annual F1Tenth Korea Championship, KSMTE 2022   Dec 12, 2022
- Title: "Towards Bridging the Sim-to-Real Gap -F1Tenth Gym Environment for Learning-based Control Policies in Autonomous Racing."

TEACHING EXPERIENCE

Topics in Internet of Medical Things (CIS7000), *UPENN*   Jan 2024 – May 2024
CO-INSTRUCTOR
- Presented lecture "Large Language Models in Internet of Medical Things and Transformers"
- Advised and evaluated students in class assignments and final project

Embedded Software for Life-Critical IoT/CPS Applications (CIS441/541), *UPENN*   Aug 2023 – Dec 2023
CO-INSTRUCTOR
- Presented lecture on pacemaker algorithm modeling and verification required for final class project
- Discussed and developed an updated version of class assignments and final project

Digital Twins – Model-based Embedded Systems (ESE680), *UPENN*   Aug 2017 – Dec 2017
TEACHING ASSISTANT
- Assisted with the planning of assignments in module related to cardiac modeling and pacemaker verification
- Conducted oral examinations and grading of all assignments
- Held office hours and recitation lectures regarding assignments and projects in course to assist students

Principles of Embedded Computation (CIS540), *UPENN*   Jan 2016 – May 2016
TEACHING ASSISTANT
- Assisted Prof. Rajeev Alur for the planning of assignments and projects in principles of embedded computation.
- Managed course projects and graded assignments
- Held office hours and recitation lectures regarding assignments and projects in course to assist students

Digital Electronics Systems Design (ENGN 1630), *Brown University*   Sep 2008 – Dec 2008
UNDERGRADUATE TEACHING ASSISTANT
- Assisted students with the implementation of electronic circuits in the laboratory part of the course

PROFESSIONAL AFFILIATIONS AND SERVICE

- Web and Social Media Co-Chair for ICCPS 2024
- Program Committee Member for ECML-PKDD 2024
- Reviewer for AAAI 2024 Spring Symposium Clinical Foundation Models
- IEEE: IEEE Member, IEEE Young Professionals, IEEE Engineering in Medicine and Biology Society Member
- ACM: ACM Member, ACM SIGBED
- Reviewer for AISTATS, L4DC, ICCPS, EMBC, SAFECOMP, ECML-PKDD, ACM Health