Khoa Le Anh Huynh

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Research Interests

My research interests focus on developing statistical methodologies and artificial intelligence algorithms for high-dimensional spatial and methylation data to address significant real-world healthcare challenges. Specifically,

Methods: High-dimensional spatial models, imaging data analysis methods, regression methodology, dimension reduction, multi-modality data integration, hierarchical and longitudinal data analysis, statistical computing, machine learning, and deep learning.

Applications: Spatial transcriptomics/proteomics data, network data, single-cell RNA, genetics and genomics data, histology and multiplexed imaging data, clinical data.

Collaborations: Diagnostic imaging, computer science, epidemiology, computational biology, medicine, oncology, sociology, surgery, hematology.

Education

PhD Biostatistics Class of 2025
Department of Biostatistics, Virginia Commonwealth University, Virginia, USA
Advisor: Dr. Jinze Liu
Thesis: "Advanced algorithms for spatial deconvolution of cellular ecotypes"
Courses: Mathematical Statistics, Biostatistical Methods, Survival Analysis, Longitudinal Data, Advanced Inference, Clinical Trials, Adaptive Clinical Trials, Analysis of Biomedical Data, Biostatistics Computing, Time Series Analysis, Statistical Learning, and Data Mining.

B.S. Mathematics Class of 2020
Department of Mathematics and Statistics, University of Cincinnati, Ohio, USA
Advisor: Dr. Xia Wang
Thesis: "LASSO in Generalized Linear Regression Model"
Courses: Mathematical Statistics, Financial Mathematics, Time Series, Bayesian Analysis, Stochastic Processes, Probability, Advanced Linear Algebra, Differential Equations, Statistics Computing.

Experience

Stratica Biosciences Aug 2024 – Present
- Start-up company in spatial omics dataset.

Research Assistant, AI4health Lab, Virginia Commonwealth University Aug 2022 – Present
Advisor: Dr. Jinze Liu
- Developed TACIT, an unsupervised algorithm for cell annotation in spatial proteomics, analyzing over 5 million cells across 51 cell types, significantly enhancing accuracy and scalability.
- Developed stability methods for spatial neighborhood analysis, integrating clinical outcomes to improve data precision and reliability.
- Analyzed cell-cell interactions in the tumor microenvironment and spatial proteomics to characterize 200 distinct cancer subtypes.
- Developed HE+, a diffusion model that leverages HE images to predict markers in spatial proteomics, advancing the integration of imaging and omics data.

Machine Learning Engineering, Medical Genetics Institute, Vietnam Dec 2021 – Dec 2024
Supervisor: Dr. Hoa Giang
- Utilized methylation and fragmentomic signatures from circulating tumor DNA for early detection of colorectal, breast, gastric, liver, and lung cancers, employing multimodal deep-learning analysis.
- Achieved 72.4% detection sensitivity and 97.0% specificity, with sensitivity increasing from 73.9% at Stage I to 88.3% at Stage IIIA cancers.
- Attained 70% accuracy in identifying tumor origin, demonstrating the assay's diagnostic potential.

- Applied advanced feature engineering techniques, including Hidden Markov Models for chromosomal localization and Geometric Principal Component Analysis to manage feature distributions.
- Collaborated with R&D leadership to present statistical modeling and machine learning strategies, significantly shaping early cancer detection projects during pivotal funding rounds.

Associate, Biostatistics Consulting Laboratory, VCU Aug 2021 – Aug 2024
Supervisor: Dr. Roy Sabo
- Supervised 20+ research projects per semester for Principal Investigators at VCU's School of Medicine.
- Collaborated with PhD students to analyze and revise reports before submission to Principal Investigators.

Research Assistant, Virginia Commonwealth University Aug 2021 – Aug 2022
Advisor: Dr. Jinze Liu
- Conducted multi-group differential expression studies, established data processing pipelines for mRNA, proteomics, and scATAC data analysis, and executed advanced pathway analysis and gene ontology enrichment.

Research Assistant, Virginia Commonwealth University May 2021 – Sept 2021
Advisor: Dr. Mikhail Dozmorov
- Developed algorithms for classifying boundaries of Topologically Associating Domains (TADs) based on chromosome conformation capture techniques such as Hi-C.

Patent pending application

- Analyzing Multiplexed and Multimodal Imaging Data (April 2024)

Grant application

- 2025–2027: Boehringer Ingelheim, Grant proposals re: "Tumor immune archetypes at single cell resolution". "Spatial Deconvolution of Pan-Cancer Immune Archetypes Using AstroSuite". Role: Graduate student. $250,000. (Submitted)
- 2025-2028: Tanoto Foundation Medical Research Fund (MRF): "Delineating the origins of Lung Cancer in Never Smokers (LCINS)". Role: Graduate student. $5,000,000. (Submitted)
- 2025-2028: The Colgate sponsored research grant: "Multiplexed Multiomics of Human Biofluids for Advancing Precision Oral Diagnostics". Role: Graduate student. $565,000. ((**Funded**))
- 2025–2027: VCU Breakthroughs Grant: "The VCU PROSPECTS Initiative: AI-Driven, Scalable Spatial Multiomics for Precision Medicine". Role: Graduate student. $200,000. (Submitted)
- 2025–2029: NIH/NIDCR RM1: "A Team Science Approach to the Co-Development of Oral Mucosa for Therapeutic Purpose". Role: Graduate student. $3,500,000. (Submitted)
- 2025–2026: HuBMAP JumpStart Fellowship: "Coordinating Neighborhood Patterns Across Microinches in the Human Body". Role: PI. $50,000. (Submitted)
- 2025–2026: Brazilian NIH (CNPq): "High-throughput Data Inference in Low-throughput Single-cell Assays: A Generative Adversarial Networks Model". Role: Graduate student. $100,000. (Submitted).
- 2023–2024: Chan Zuckerberg Initiative Single-Cell Biology Data Insights (Cycle 3): "TACIT: Decoding Single Cell and Spatial Phenomics". Role: Graduate student. $200,000. (Not funded).
- 2021-2025: ADA Foundation Volpe Research Scholar Grant: "A Multimodal Atlas of Chronic Oral Inflammation Over the Lifespan". Role: Graduate student. $1,700,000. (**Funded**).
- 2023-2024: Alternative Research and Development Foundation (ARDF) Annual Open Grant: "Precision-cut gingival slices as an animal-free model of oral inflammation". Role: Graduate student. $40,000. (**Funded**).

- 2023-2024: ADA Foundation Grant: "A Single Cell and Spatially-resolved Atlas of the Adult Oral Cavity.". Role: Graduate student. $130,000. (**Funded**).
- 2021: AAID Foundation Large Research Grant: "Single cell Immunophenotyping of the Gingival Barrier in Peri-implantitis.". Role: Graduate student. $25,000. (**Funded**).

Publications

2025

- Nguyen THH, Vu GH, Nguyen TT, Nguyen TA, Tran VU, Vu LT, Nguyen GTH, Nguyen ND, Tran TH, Nguyen VTC, Nguyen TD, Nguyen TH, Vo DH, Van TTV, Do TT, Le MP, **Khoa Huynh, L. A**, et al. (2025). *Combination of Hotspot Mutations With Methylation and Fragmentomic Profiles to Enhance Multi-Cancer Early Detection.* Cancer Med. 2025 Jan;14(1):e70575. DOI

2024

- Thien Nguyen, C. V., Hanh Nguyen, T. H., Vo, D. H., Vi Van, T. T., Huong Nguyen, G. T., Tran, T. H, **Huynh, L. A. K.**, et al. (2024). *Evaluation of a multimodal ctDNA-based assay for detection of aggressive cancers lacking standard screening tests.* Future Oncology, 1-11. DOI
- Nguyen, T. H., Doan, N. N. T., Tran, T. H., **Huynh, L. A. K.**, et al. (2024). *Tissue of origin detection for cancer tumor using low-depth cfDNA samples through combination of tumor-specific methylation atlas and genome-wide methylation density in graph convolutional neural networks.* Journal of Translational Medicine, 22(1), 618. DOI
- Easter, Q. T., Fernandes Matuck, B., Beldorati Stark, G., Worth, C. L., Fremin, B., **Huynh, K.**, et al. (2024). *Single-cell and spatially resolved interactomics of tooth-associated keratinocytes in periodontitis.* Nature Communications, 15(1), 5016. DOI
- Luu, M. N., Imoto, A., Matsuo, Y., Huy, N. T., Qarawi, A., et al. (2024). *Anxiety and its risk factors among non-Japanese residents living in Japan undergoing COVID-19 situation: A cross-sectional survey.* PloS One, 19(3), e0280144. DOI

2023

- Nguyen, V. T. C., Nguyen, T. H., Doan, N. N. T., Pham, T. M. Q., Nguyen, G. T. H., Nguyen, T. D., Tran, T. T. T., Vo, D. L., Phan, T. H., Jasmine, T. X., Nguyen, V. C., Nguyen, H. T., Nguyen, T. V., Nguyen, T. H. H., **Huynh, L. A. K.**, Tran, T. H., Dang, Q. T., Doan, T. N., Tran, A. M., Nguyen, V. H., ... Tran, L. S. (2023). *Multimodal analysis of methylomics and fragmentomics in plasma cell-free DNA for multi-cancer early detection and localization.* eLife, 12, RP89083. DOI
- Nguyen, N. T., Nguyen, T. N., Nguyen, K. M., Tran, H. P. N., **Huynh, K. L. A.**, Hoang, S. V. (2023). *Prevalence and impact of metabolic syndrome on in-hospital outcomes in patients with acute myocardial infarction: A perspective from a developing country.* Medicine, 102(45), e35924. DOI
- Ellis, L. P., Hess, O., **Huynh, K. L. A.**, Bearman, G., Kang, L., Doern, C. D. (2023). *A comparison of severity of illness between the SARS-CoV-2 Omicron variant and Delta variant.* Antimicrobial Stewardship Healthcare Epidemiology, 3(1), e188. DOI
- Pham, T. M. Q., Phan, T. H., Jasmine, T. X., Tran, T. T. T., **Huynh, L. A. K.**, et al. (2023). *Multimodal analysis of genome-wide methylation, copy number aberrations, and end motif signatures enhances detection of early-stage breast cancer.* Frontiers in Oncology, 13, 1127086. DOI
- Nguyen, V. C., Nguyen, T. H., Phan, T. H., Tran, T. T., Pham, T. T., Ho, T. D., Nguyen, H. H. T., Duong, M. L., Nguyen, C. M.,**Huynh, L. A. K.**, et al. (2023). *Fragment length profiles of cancer mutations enhance detection of circulating tumor DNA in patients with early-stage hepatocellular carcinoma.* BMC Cancer, 23(1), 233. DOI

2022

- **Khoa Huynh, L. A.**, Nguyen, H. T., et al. (2022). *Multimodal analysis of ctDNA methylation and fragmentomic profiles enhances detection of nonmetastatic colorectal cancer.* Future Oncology, 18(35), 3895–3912. DOI
- Hoang, S. V., Nguyen, H. P., Huynh, T. M., Vinh, K. T., **Huynh, K.**, Nguyen, K. M. (2022). *Relationship between Asian-BMI classification and radiographic severity index in hospitalized COVID-19 patients.* Microbiology, Pathology, and Research, 7(4). DOI
- Hoang, S., Pham, Q. D. D., Nguyen, K. M., **Huynh, K. L. A.**, et al. (2022). *Association between Lipoprotein(a) Concentration and Adverse Cardiovascular Events in Vietnamese Patients with Acute Myocardial Infarction: An observational cohort study.* Biomedical Research and Therapy, 9(1), 4873-4883. DOI
- Hoang, S. V., Nguyen, K. M., Le, H., Tung, A. T., Huynh, P., Le, T. V., **Huynh, K.**, et al. (2022). *The effects of the COVID-19 lockdown on patients with chronic cardiovascular disease in Vietnam.* Journal of Infection in Developing Countries, 16(2), 268–275. DOI
- Hoang, S. V., Nguyen, K. M., Huynh, T. M., **Huynh, K.**, et al. (2022). *Chest X-ray Severity Score as a Putative Predictor of Clinical Outcome in Hospitalized Patients: An Experience From a Vietnamese COVID-19 Field Hospital.* Cureus, 14(3), e23323. DOI
- Trang, V., **Huynh, K.**, Truong, H. T., Nguyen, H. T., et al. (2022). *Predicting Anxiety and Depression Among Patients With COVID-19 in Concentrated Isolation at Medical Camps in Vietnam.* Frontiers in Psychiatry, 13, 823586. DOI
- Jain, N., Hung, I. C., Kimura, H., Goh, Y. L., Jau, W., **Huynh, K.**, et al. (2022). *The global response: How cities and provinces around the globe tackled Covid-19 outbreaks in 2021.* The Lancet Regional Health Southeast Asia, 4, 100031. DOI

2021

- Van Hoang, S., Minh Nguyen, K., Hoang Nguyen, A., **Khoa Huynh, L. A**, & Phuong Nguyen Tran, H. (2021). *The value of the Global Registry of Acute Coronary Events and Gensini scores in predicting long-term outcomes in Vietnamese patients with non-ST-elevation acute coronary syndrome.* Biomedical Research and Therapy, 8(2), 4233-4241. DOI

Manuscripts in progress

1. Spatial Deconvolution of Cell Types and Cell States at Scale Utilizing TACIT (accepted, Nature Communications)
2. Small Circular mRNA Vaccines (accepted, Nature Biomedical Engineering)
3. GZMK+ CD8+ T cells Target a Specific Acinar Cell Type in Sjögren's Disease (under revision, Cell)
4. The Immunoregulatory Architecture of the Adult Oral Cavity (under revision, Cell)
5. Analytical and Clinical Validation of a Circulating Tumor DNA-based Assay for Multi-Cancer Early Detection (under submission, BMC Cancer)
6. The Single-Cell Landscape of Peripheral and Tumor-infiltrating Immune Cells in HPV-HNSCC (under review, Cancer Immunology Research)

Presentations

Contributed (Poster) Presentations

1. **Salivary Gland and Exocrine Biology, Gordon Conference Seminar** (Jan 2025)
   Title: *Single-Slide Spatial-omics Reveals Tertiary Lymphoid Structures in the Minar Salivary Glands of Chronic GVHD*
   Role: Lead analysis contributor, Speaker (Bruno Matuck, DDS, Ph.D)

2. **Symposium on Data Science and Statistics, American Statistical Association** (June 2024)
   Title: *Spatial Deconvolution of Cell Types and Cell States at Scale Utilizing TACIT*
   Role: Primary contributor, Speaker (**Khoa Huynh**)

3. **Massey Walter Lawrence Research Retreat, Massey Cancer Center** (June 2024)
   Title: *Spatial Deconvolution of Cellular Communication Network*
   Role: Primary contributor, Speaker (**Khoa Huynh**)

4. **American Society of Clinical Oncology** (August 2024)
   Title: *Multimodal analysis of methylation and fragmentomic profiles in plasma cell free DNA for differentiation of benign and malignant breast tumors*
   Role: Analysis contributor, Speaker (Vi Van)

5. **IADR/AADOCR/CADR Hatton Competition** (March 2024)
   Title: Niche-Specific and Spatially-Resolved Cell-Cell Communication Strategies of Adult Oral Tissues
   Role: Lead analysis contributor, Speaker (Bruno Matuck, DDS, Ph.D)

6. **Chan Zuckerberg Initiative Single Cell Biology Annual Meeting** (December 2023)
   Title: *Oral and craniofacial multiomic analysis reveals fibroblast heterogeneity and cellular communication*
   Role: Analysis contributor, Speaker (Diana Pereira)

7. **Massey Walter Lawrence Research Retreat, Massey Cancer Center** (June 2023)
   Title: *TACIT: Threshold-based Assignment of Cell Types from Multiplexed Imaging Data*
   Role: Primary contributor, Speaker (**Khoa Huynh**)

Contributed (Oral) Presentations

1. **Salivary Gland and Exocrine Biology, Gordon Conference Seminar** (January 2025)
   Title: System-level Patterning & Organization in Human Salivary Glands Revealed using Spatial Multiomics
   Role: Lead Analysis contributor, Speaker (Kevin M. Byrd, DDS, Ph.D)

2. **IADR/AADOCR/CADR General Session & Exhibition** (March 2025)
   Title: Cross-Species Multiomics Reveals Oral Mucosa's Scarless Potential compared to Skin
   Role: Analysis contributor, Speaker (TBD)

3. **IADR/AADOCR/CADR General Session & Exhibition** (March 2025)
   Title: Multicellular Interaction Modules Predict Therapeutic Interventions in Chronic Periodontitis
   Role: Analysis contributor, Speaker (TBD)

4. **Spatial Omics Frontiers, Akoya Biosciences Webinar** (December 2024)
   Title: Revealing Functional Tissue Architecture with AI-Driven Multiomics
   Role: Lead analysis contributor, Speaker (Kevin M. Byrd, DDS, Ph.D)

5. **24 Hour "Multiscale Human" Event, Human Reference Atlas** (December 2024)
   Title: Anchoring Oral and Craniofacial Cell Types within Digitized Vasculature Networks
   Role: Analysis contributor, Speaker (Kevin M. Byrd, DDS, Ph.D)

6. **Chan Zuckerberg Initiative Pediatrics Meeting** (November 2024)
   Title: Accelerating Spatial Biology with AI-driven Annotaton
   Role: Lead analysis contributor, Speaker (Bruno F. Matuck, DDS, Ph.D)

7. **HTAN Data Jamboree** (November 2024)
   Title: Spatialytica LLM cancer analysis
   Role: Primary contributor, Speaker (**Khoa Huynh**)

8. **Society for Immunotherapy of Cancer** (November 2024)
   Title: Metacellular Networks and Proteomic Ecotypes Predict Survival Outcomes in HNSCC Treated with Post-operative Radiation Therapy and Durvalumab
   Role: Primary contributor, Speaker (Siddharth Sheth, DO, MPH)

9. **RSGDREAM 2024** (October 2024)
   Title: Spatial Deconvolution of Cell Types and Cell States at Scale Utilizing TACIT
   Role: Primary contributor, Speaker (**Khoa Huynh**)

10. **Biostatistics Student Research Symposium Program, Virginia Commonwealth University** (September 2024)
    Title: Spatial Deconvolution of Cellular Communication Network
    Role: Primary contributor, Speaker (**Khoa Huynh**)

11. **Human Cell Atlas General Meeting** (September 2024)
    Title: Deciphering Tissue Circuits and Cellular Interactomes in Spatially-anchored, 3D Landscapes
    Role: Lead analysis contributor, Speaker (Kevin M. Byrd,DDS, Ph.D)

12. **Xenium 5k Webinar - Multimodal spatial reconstruction of autoimmune diseases with 5,000-gene assays, 10X Genomics** (June 2024)
    Title: Spatial Reconstruction of Sjogren's Disease
    Role: Analysis contributor, Speaker (Blake Warner, DDS, Ph.D)

13. **IADR/AADOCR/CADR Hatton Competition** (March 2024)
    Title: Niche-Specific and Spatially-Resolved Cell-Cell Communication Strategies of Adult Oral Tissues
    Role: Lead analysis contributor, Speaker (Bruno Matuck, DDS, Ph.D)

14. **IADR/AADOCR/CADR General Session & Exhibition** (March 2024)
    Title: A Universal Method for Cryopreserving Biofluids to Scale Cell Analyses
    Role: Analysis contributor, Speaker (Theresa M. Weaver)

15. **IADR/AADOCR/CADR General Session & Exhibition** (March 2024)
    Title: Co-Coordination of Immune Responses by Gingival Keratinocytes and Fibroblasts
    Role: Analysis contributor, Speaker (Quinn T. Easter, Ph.D)

16. **IADR/AADOCR/CADR General Session & Exhibition** (March 2024)
    Title: Highly Multiplexed, Spatial Immunophenotyping of Peri-implantitis and Periodontitis
    Role: Analysis contributor, Speaker (Akira Hasuike, Ph.D)

17. **IADR/AADOCR/CADR General Session & Exhibition** (March 2024)
    Title: Multiomics analyses of polycellular and polymicrobial assemblages within human biofluids
    Role: Analysis contributor, Speaker (Brittany Rupp, Ph.D)

18. **Biostatistics Student Research Symposium Program, Virginia Commonwealth University** (September 2022)
    Title: A comparison of gene co-regulation pattern analysis methods with multi-group RNA-seq data
    Role: Primary contributor, Speaker (**Khoa Huynh**)

19. **Biostatistics Student Research Symposium Program, Virginia Commonwealth University** (September 2021)
    Title: Improving machine learning modeling and predictions of 3D domain boundaries
    Role: Primary contributor, Speaker (**Khoa Huynh**)

20. **The 37th Annual Workshop on Mathematical Problems in Industry, Virtual** (June 2021)
    Title: Utilizing clinical data to predict the severity of presentation of chronic lung diseases
    Role: Analysis contributor, Speaker (**Khoa Huynh**)

21. **The Undergraduate Mathematics Day, University of Dayton** (October 2019)
    Title: LASSO in Generalized Linear Regression Model
    Role: Primary contributor, Speaker (**Khoa Huynh**)

22. **Interdisciplinary Workshop for Undergraduate Students, SAMSI** (May 2019)
    Title: Characterizing and Predicting Alzheimer's Diagnosis
    Role: Primary contributor, Speaker (**Khoa Huynh**)

Teaching Experience

Graduate Assistant, Virginia Commonwealth University Aug 2020 – Dec 2021
- Graded assignments for Biostatistics Research Methods I and II.
- Clarified concepts and answered queries for over 70 students.

Peer Tutor, Learning Commons, University of Cincinnati May 2018 – May 2020
- Provided one-on-one coaching for students in Calculus, Probability, and Statistics.

Supplemental Review Session Leader, University of Cincinnati Jan 2018 – May 2018
- Led a weekly 45-minute review session for 20 students.
- Prepared practice problems and attended weekly mentor-leader meetings.

Awards and Honors

- HTAN Data Jamboree (2024)
- VCU School of Medicine Travel Grant (2024)
- Jacob B. and Veronica Schmitt Scholarship Endowment Fund (2017, 2018, 2019)
- Harry S. Kieval Mathematics Fund (2017, 2018, 2019)
- Undergraduate Research Award (2020, 2018)
- STEM Fellowship (2017)
- Undergraduate Research Workshop Grant (2018)

Technical Skills

Statistical Computing: R, Python, SAS
Technologies: LaTeX, Microsoft Office Suite

Professional Service

I have provided ad-hoc reviews for a variety of journals, including:

- *Plos One* (since 2022)
- *Human Genomics* (since 2022)
- *Hindawi* (since 2022)
- *IEEE Access* (since 2024)