Varun Viswanath

website | google scholar | vkviswan@ucsd.edu

I develop **novel machine learning techniques** to study **longitudinal time-series** in **real-world health contexts**. Currently, I am using a dataset of 60,000 real-world wearable device users to explore methods discovering longitudinal structures when detecting anomalies in wearable time series. I have broad experience in across ubiquitous computing, bioengineering, deep learning, human-computer interaction, and computer science. In the future, I hope to further explore how wearable and ubiquitous technology can be better adapted for real-world contexts to improve peoples' health and lifestyle.

Education

2019 - Now   **University of California, San Diego**   La Jolla, CA
Ph.C. in Electrical and Computer Engineering, Machine Learning and Data Science   Anticipated Grad in 06/25
Thesis: Temporal Representations in Anomaly Detection Algorithms for Wearable Health
Advisors: Edward Wang (Design Lab, ECE), Benjamin Smarr (Halıcıoğlu Data Science Institute, Bioengineering)

2015 - 2019   **University of Washington**   Seattle, WA
B.S. in Computer Science and Engineering, Paul G. Allen School of Computer Science and Engineering
Senior Research Thesis: Using Confidence in Smartphone Spirometry
Advisor: Shwetak Patel (Ubicomp Lab, Allen School of CSE)

Publications

Jun 2024   **Five Million Nights: Temporal Dynamics in Human Sleep Phenotypes** [PDF]
Varun K. Viswanath, Wendy Hartogenesis, Stephan Dilchert, Leena Pandya, Frederick M. Hecht, Ashley E. Mason, Edward J. Wang, Benjamin L. Smarr
Nature Publishing Journals (npj) Digital Medicine

Jul 2024   **A cross-study analysis of wearable datasets and the generalizability of acute illness monitoring models** [PDF]
Patrick Kasl, Severine Soltani, Lauryn Keeler Bruce, *Varun K. Viswanath*, Wendy Hartogenesis, Amarnath Gupta, Ilkay Altintas, Stephan Dilchert, Frederick M. Hecht, Ashley E. Mason, Benjamin L. Smarr
Conference on Health, Information, and Learning (CHIL) 2024 – Best Paper Award

Jul 2024   **Augmenting Tele-Postpartum Care with Vision-Based Detection of Breastfeeding-related Conditions: Algorithm Development and Validation** [PDF]
Jessica De Souza, *Varun K. Viswanath*, Jessica Maria Echterhoff, Kristina Chamberlain, Edward J. Wang
Journal of Medical Internet Research (JMIR) AI

Nov 2023   **Variability of temperature measurements recorded by a wearable device by biological sex**
Lauryn Keeler Bruce, Patrick Kasl, Severine Soltani, *Varun K. Viswanath*, …, Ashley E. Mason*, Benjamin L. Smarr*
Biology of Sex Differences

Aug 2023   **SpecTracle: Wearable Facial Motion Tracking from Unobtrusive Peripheral Cameras** [PDF]
Yinan Xuan, *Varun Viswanath*, Sunny Chu, Owen Bartolf, Jessica Echterhoff, Edward Wang
ArXiv

Apr 2023   **Detecting Periodic Biases in Wearable-Based Illness Detection Models** [PDF]
Amit Klein*, *Varun Viswanath**, Benjamin Smarr, Edward Wang
ICLR 2023, Time-Series Representation Learning for Health (TSRL4H) – Selected for Oral Presentation

Sep 2022   **Smartphone Camera Oximetry in an Induced Hypoxemia Study**
*Varun Viswanath**, Jason S. Hoffman*, …, Eric C. Larson, Shwetak N. Patel, Edward Wang
Nature Publishing Journals (npj) Digital Medicine

Mar 2022   **Detection of COVID-19 using multimodal data from a wearable device: results from the first TemPredict Study**
Ashley Mason, Frederick L. Hecht…, *Varun Viswanath*…, Benjamin L. Smarr (80+ Authors)
Scientific Reports

Mar 2022   **Stepping into the Next Decade of Ubiquitous and Pervasive Computing: Ubicomp & ISWC 2021**
Rahul Majethia*, Shreya Ghosh, Hanna Nolasco, Farhana Shahid, *Varun Viswanath*, Ibrahim Shehi Shehu, Yiran Zhao
IEEE Pervasive Computing

Dec 2021   **Dynamical clustering of U.S. states reveals four distinct infection patterns that predict SARS-CoV-2 pandemic behavior** [PDF]
Joseph Lane Natale, Ph.D.., *Varun Viswanath*…, Benjamin L. Smarr
ArXiv

Dec 2021   **TemPredict: A Big Data Analytical Platform for Scalable Exploration and Monitoring of Personalized Multimodal Data for COVID-19** [PDF]
Shweta Purawat, Subhasis Dasgupta…, *Varun Viswanath*…, Benjamin Smarr, Amarnath Gupta, and Ilkay Altintas.
IEEE BigData 2021

Jul 2018	SpiroConfidence: Determining the Validity of Smartphone Spirometry using Machine Learning [PDF]

Varun Viswanath, Jake Garrison, Shwetak Patel
EMBC 2018

Honors, Accolades, Services

Sep 2023	**Organizing Committee, Student Volunteer Chair, Ubicomp 2023**	Cancun, Mexico
	Worked 48 Volunteers, organized a 5-day conference with nearly 600 attendees.	
Mar 2023	**Network Award Winner, Center for Circadian Biology Symposium 2023**	La Jolla, CA
Sep 2021	**Student Volunteer, Ubicomp 2021,** Supported Sessions in Health, Sensing, and HCI	Online: Gather.town
Sep 2020	**Student Volunteer, Ubicomp 2020,** Accessibility and Conference Summary Visualization	Online: Gather.town
Jul 2018	**Session Chair,** Session: Deep Learning Imaging II**,** EMBC '18	Honolulu, HI

Internship Experience

Mar - Sep 2024	**Samsung Research America, Digital Health Team**	Mountain View, CA
	Research Intern, Mentor: Viswam Nathan	
	Designed a novel real-time sleep staging algorithm using smartwatch PPG and Acc. gaining 8% balanced accuracy.	
Jun - Sep 2018	**Uber, Uber Elevate (previously UberAir or Flying Cars Team)**	San Francisco, CA
	Data Science and Engineering Intern, Manager: Jon Peterson	
	Developed a flight routing algorithm for eVTOL vehicles serving mid-range Uber rides. Deployed as UberCopter.	

Mentorship

Shreenithi Navaneethan – Undergraduate Student

Co-first authored publication exploring non-invasive detection of diabetes using a smart ring device (Feasibility of Non-CGM Wearables for Detecting Diabetes Mellitus) currently in review at npj Digital Medicine. Graduate Student at Columbia, Dept. of Biomedical Engineering.

Amit Klein – Undergraduate Student

Co-first authored short paper assessing methods for detecting periodic biases in wearable time series data which was accepted at the ICLR workshop, Time-Series Representation Learning for Health and selected for an oral presentation (Detecting Periodic Biases in Wearable-Based Illness Detection Models). Ph.D. Student at UC San Diego, Dept. of Bioengineering.

Jake Ryan – Undergraduate Student

Studied applying computer vision DL algorithms to visual representations of wavelet transforms on wearable time series data to detect fevers (0.74 AUROC). Further explored pretraining on 30K+ individuals (scaled up from 500 fever individuals). Ph.D. Student at UC San Diego, Dept. of Bioengineering.

Israa Aljarb – Master's Student

Developed a novel machine learning and signal processing pipeline to detect adult vs. motherese speech or sound production across several languages (English, Arabic, Spanish). Data Engineer at Accenture.

ENLACE Summer Research Program Team

ENLACE is a summer research program where researchers from UC San Diego closely mentor undergraduate and research students from school across Mexico and Brazil in various research projects. Our five high school and undergraduate students (**Oscar Trujillo Acevedo, Sophia Pérez Giottonini, Sandy Ihuiyan Romero Hernández, Diana G. Cruz Millán, A. Montserrat Palacios-**Puga) studied 8+ months of COVID-19 infection, mask use, vaccination data and then identified four clusters of states based on their trajectory of infection patterns (Work is available on ArXiv).

Core Research

Jun 2023 – Now	**Feasibility of Non-CGM Wearables for Detecting Diabetes Mellitus**

Diabetes Mellitus (DM) is a common, chronic metabolic disorder that affects the cardiovascular system, autonomic nervous system, and sleep quality. These effects may manifest as differences in physiological data streams (e.g. heart rate, heart rate variability, body temperature), suggesting it might be possible to non-invasively identify persons with a high probability of having diabetes from wearable devices not specifically designed for continuous glucose monitoring (CGM). We tested the hypothesis that diabetes-like physiology can be identified using machine learning algorithms and non-CGM wearable data. We show that a passive screening algorithm that extracts key heart rate, HRV, and circadian features can achieve AUC=0.88, AUPRC 0.80 in binary detection of DM. This work is in review.

2022 - 2024	**Five Million Nights: Temporal Dynamics of Human Sleep Phenotypes**

An increasing number of people are using wearable devices to monitor their sleep. However, algorithms that use wearable sleep data struggle because of how human sleep differs between people and within people over time. We develop a novel representation that uses a topological data analysis pipeline and temporal dynamics graph to better

captures these differences. We characterize the temporal sleep dynamics of a population of 33,152 individuals monitored over 3-6 months and test whether temporal dynamics give us more information about individuals who have chronic or acute illnesses. We show how our model represents several key patterns in how an individual's sleep changes longitudinally and find that these changes in sleep give 2-10 times as much information about the presence of sleep apnea, diabetes, flu, fever, and COVID-19. We are submitting this manuscript to top tier journals in digital health and medicine. We published this work in Nature Publishing Journals Digital Medicine.

2020 - 2022   **TemPredict: Predicting COVID-19 from Continuous Physiological Data**

Continuously measured heart rate, respiratory rate, and skin temperature provide a rich view of our internal state from illness onset to recovery. Through the TemPredict project, we collected data from 63,153 participants and developed a Gradient Boosting-based algorithm using data colleßcted by a consumer wearable (Oura Ring) that predicts the onset of COVID-19 an average of 2.75 days before participants sought diagnostic testing with receiving operating characteristic (ROC) **area under the curve (AUC) of 0.819** (95%CI [0.809, 0.830]). We published this work in the Scientific Reports Journal.

2020 - 2021   **SpO2: Tracking Blood Oxygen Levels with a Mobile Phone**

Respiratory illnesses like Covid-19 often attack our lung's ability to bring oxygen into our blood stream. People can appear unaffected until their blood oxygen reaches dangerous levels (<84%) where they can suddenly faint or lose consciousness. Tracking blood oxygen with a readily available smartphone device can bring safety and peace of mind for those with such respiratory conditions. We collect a novel dataset and develop a novel deep learning algorithm which tracks blood oxygen concentrations ranging from 70-100% within 5% mean absolute error. We published our Patented model alongside further analysis of viability of this approach in Nature Publishing Journals Digital Medicine.

2016 - 2019   **SpiroSmart: Using a Smartphone Microphone to Measure Lung Function**

Access to spirometry, a noninvasive test for lung function fundamental in the diagnosis of most respiratory illnesses, is limited in rural areas where clinics are less equipped or accessible. We develop a deep learning algorithm to perform spirometry using audio clips from smartphone microphone, leveraging machine learning to clean ~40,000 spirometry audio clips and novel techniques for incorporating user metadata in the architecture. Our model regresses a Flow vs. Volume curve and achieves 98% precision and 88% recall in severity classification of the FEV1 score. This research is published in my mentor's master's thesis and the data cleaning machine learning model I developed is published at the IEEE EMBS conference.

Skills

Java | Python | Swift | JavaScript | C/C++ | SQL | R | Keras | PyTorch | FastAI | Arduino | Bash | Vim | Git | Raspberry Pi | Google Cloud Platform

Poster Presentations

Feb 2023   **Center for Circadian Biology Symposium, Poster Session,** RhyPredict: Detecting Periodic Biases in Wearable Time-Series   La Jolla, CA
Discovered a correlation of 0.9 between weekend heart rate perturbations and heightened model predictions.

Nov 2021   **UCSD Design Innovation Building Grand Opening,** Tempredict DL: Using Deep Learning to Analyze Longitudinal High Granularity Signals   La Jolla, CA
Illustrated 12% difference in performance of CNN model on high- versus low- variance physiological data.

Oct 2018   **UW Industry Affiliates Poster Session,** SpiroConfidence   Seattle, WA
Achieved 98% precision and 88% recall on binary classification of spirometry audio using a Gated-CRNN.

Dec 2018   **CSE 590g1 Intro to Deep Learning,** Pneumonia Classifier Using Darknet Architecture   Seattle, WA
Achieved 83% accuracy on Stanford dataset of chest X-rays of normal and pneumonia patients using Darknet model.

Dec 2018   **CSE 455 Computer Vision,** Puppy.CV: Classifying Puppy Breed   Seattle, WA
Achieved 85% accuracy on 6 classes of Stanford Dog Dataset using 5-layer CNN.

Relevant Coursework

UCSD   Unsupervised Learning, GPU Programming, Deep Generative Models, Statistical Learning 1, Probability and Statistics, Neural Networks/Pattern Recognition, Mobile Health Sensing

UW   Deep Learning, Natural Language Processing, Artificial Intelligence, Computer Vision, Machine Learning

Software Development Side Projects

Sep 2021 - Now   **Larry Smarr Gut-Biome Research Dashboard**   UCSD
Developing interactive dashboard of gut microbiome organisms over 20 years to facilitate gut-biome research.

March - April 2020   **COVID Dashboard**   Earth 2.0, UCSD
Helped to design and build a ReactJS + NodeJS citizen science webservice to deliver and collect useful COVID data

Jan - March 2020	**Facial Tracking Glasses**	Ubiquitous Data Computing Lab, UCSD

Constructed device that uses quad-cam Raspberry Pi setup to record wearer's facial expressions through daily living.

Jun - Aug 2017	**FreshAir**	UbiComp Lab, UW

Built Swift iOS app, asynchronous server with Tornado, and Docker system for a server and database, as well as a prediction algorithm that performs real time SpiroSmart tests, both for use in a 2-year international clinical study.

Jun - Sep 2017	**SpiroSound**	UbiComp Lab, UW

Ran study and analyzed data to identify polynomial relationship between audio and human breath air flow.
Built visual feedback for study participant. Built data pipeline and data processing functions in python.

Aug 2017	**PupilScreen**	UbiComp Lab, UW

Built prototype app in Swift and tornado server for collecting and uploading video data.

Extra-Curricular

2015 - 2019	**UW Chess Club,** President

Organized weekly meetings and 4 tournaments with Amazon, Microsoft, and Allen Institute of Artificial Intelligence. Grew club size from just 1 member to 60-70 members. Built website and social media platforms. [[Link]]

2016 - 2018	**CodeDay Seattle Mentorship Team,** Hackathon Mentor for iOS and Web programming

2015 - 2017	**Human Powered Submarine,** Embedded Systems Architect, Web Developer

Hackathons

Oct 2018	DubHacks, University of Washington	Seattle, WA
Oct 2017	DubHacks, University of Washington	Seattle, WA
Apr 2017	DefHacks, Microsoft	Redmond, WA
Feb 2016	ZooHackathon, Woodland Park Zoo	Seattle, WA
Oct 2016	DubHacks, University of Washington	Seattle, WA
Oct 2016	FishHackathon, Impact Hub	Seattle, WA
Oct 2015	DubHacks, University of Washington	Seattle, WA
May 2015	LAHacks, University of California, Los Angeles	Los Angeles, CA