

CITRIS



Established in 2001, the Center for Information Technology Research in the Interest of Society (CITRIS) creates information technology solutions for society's most pressing challenges.

CITRIS leverages the research strengths of University of California campuses at Berkeley, Davis, Merced and Santa Cruz, and operates within the greater ecosystem of the University and the innovative and entrepreneurial spirit of Silicon Valley. The institute was created to "shorten the pipeline" between world-class laboratory research and the development of applications, platforms, companies, and even new industries.



Building on existing research strengths and calling out areas of emerging expertise in information technology, we organize our research initiatives into four focus areas:

Connected Communities, Health, People and Robots, and Sustainable Infrastructures.



We recognize several themes that cut across all four, including necessary attention to resilience, opportunities presented by big data analytics, and advances in nanotechnology. We continue to encourage and drive projects with a sharp focus on solving specific, large-scale problems that leverage the unique cross-disciplinary and cross-campus strengths of CITRIS.

In addition to the four main research initiatives, CITRIS fosters a strong entrepreneurial community through facilities and programs in our "invention ecosystem."

Programs include the Berkeley Marvell Nanolab, the CITRIS Foundry startup incubator, the CITRIS Invention Lab, the CITRIS Social Apps Lab, and other testbeds and user facilities.

CITRIS Initiatives



Connected Communities



The Connected Communities Initiative at CITRIS focuses on the affordances of information technology to enhance communities – of learning, of practice, and of governance. The initiative embraces the development of experimental online platforms and novel hardware and software systems that connect peers to each other and to institutions in meaningful and productive ways. Building on leadership expertise in human-computer interaction, user interface design, as well as political, social and economic development, the initiative will support projects in domains including education, collaborative design, philanthropy, journalism, public health, citizen science, and ICT policy. Find out more at connected-communities.citris-uc.org.



Health



The Health Initiative focuses on developing transformative, scalable and sustainable information technology solutions to improve health and wellness. These technology-enabled solutions can improve the quality of care and health outcomes, while reducing health care costs. Focus areas address the primary drivers affecting health, including chronic disease, aging, and formal or informal caregiving. Initiative projects build upon the principal technology solutions of telehealth; sensors; mobile apps and gaming; and data analytics. Examples of projects include innovations in electronic health records and analytics, the Transatlantic Telehealth Research Network, use of in-home sensors and feedback to reduce asthma in children, virtual reality environments for physical rehabilitation, and interactive mapping to assist wayfinding for older adults. Find out more at health.citris-uc.org.



People and Robots



Cloud Robotics, Deep Learning, Human-Centric Automation, and Bio-Inspired Robotics are primary research themes in the new CITRIS People and Robots Initiative. Robotics and automation are advancing rapidly due to innovations in sensors, devices, UAVs, networks, optimization, and machine learning, accelerated by corporate and private investment. These systems have enormous potential to reduce drudgery and improve human experience in healthcare, manufacturing, transportation, safety, and a broad range of other applications in the interests of society. Achieving this will require sensitivity to human issues, rigorous theory evaluated on standard benchmarks, and modular systems built on shared software toolkits. Find out more at robotics.citris-uc.org.



Sustainable Infrastructures



The CITRIS Sustainable Infrastructures Initiative pursues information technology research in energy, water, and transportation as well as cyber-infrastructure as essential components of a sustainable society. Highways, electrical wires, and water channels are just a few examples of the various often-overlooked systems that underpin societal infrastructure in providing basic human needs. Information technology can weave these interrelated systems—transportation, energy, and water—into a sustainable fabric for the next generation, enabling resiliency and addressing climate change. Find out more at sustainable-infrastructures.citris-uc.org.

CITRIS Programs



CITRIS Membership

University of California faculty and students from more than 100 academic disciplines work with industrial and institutional partners to identify major societal challenges, then develop novel technology-based solutions to address them. Through close ties to industry, these innovations are refined, adopted, and commercialized in California and beyond. Find out more at citris-uc.org/membership.



CITRIS Foundry



The CITRIS Foundry helps top entrepreneurs from the University of California build applied tech companies that make a significant impact on the world. The 6-12 month incubator program provides access to design, manufacturing, and business resources within a community of mentors that transforms startup teams into founders. Find out more at CITRISFoundry.org.



CITRIS Invention Lab



The CITRIS Invention Lab supports faculty, student and community innovation by providing the knowledge, tools and support to rapidly design and prototype novel, interactive products, embedded sensing systems and integrated mobile devices. The new facility is a vital piece of the CITRIS "pipeline" running from the innovative minds of researchers, through CITRIS laboratories, and into world. Find out more at InventionLab.org.



CITRIS Social Apps Lab



The CITRIS Social Apps Lab provides interdisciplinary collaboration to create mobile and web applications that encourage citizen participation, urban knowledge, and crowdsourcing solutions for significant social problems. Find out more at citris-uc.org/social-apps-lab.





CITRIS Health Telehealth Innovation Ecosystem: Shortening the Pipeline of Research to Commercialization

MISSION

The mission of CITRIS Health and its Telehealth Innovation Ecosystem leverages the research and commercialization capacity of CITRIS within the University of California. In partnership with industry and government collaborators, CITRIS Health creates solutions that “shorten the pipeline” between world-class health technology and telehealth research and its translation into practice. Ultimately, these efforts can improve healthcare outcomes, quality of care, and the costs of care through scalable and sustainable models.

MULTI-UNIVERSITY, INTERDISCIPLINARY RESEARCH AND COMMERCIALIZATION

CITRIS Health staff, clinicians, and researchers are based at four University of California (UC) campuses across the greater Bay Area: UC Berkeley, UC Davis, UC Merced, and UC Santa Cruz. More than 300 researchers and affiliates discover new challenges and solutions at the intersection of key disciplines such as engineering, clinical health services, computer science, business, informatics, public health, medicine, nursing, and social work.

FOCUS AND IMPACT

CITRIS Health focuses on the priority themes of **Hospital to Home** and **Precision Health** to improve personalized health as well as population health. Through its relationships with collaborating institutions, CITRIS Health serves as a learning laboratory to advance the diffusion of technologies that help individuals with chronic diseases or disabilities lead healthier lives and maintain independence; improve patient and provider engagement; and modernize the healthcare industry as whole. In addition, CITRIS Health collaborates with corporate, federal, state, and civic institutions worldwide to demonstrate effective uses of technology, identify benefits and best practices of technology-enabled care, disseminate outcomes, and inform policymakers.

CITRIS TELEHEALTH INNOVATION ECOSYSTEM

CITRIS Health specializes in transformative **mobile-, cloud-, sensor-, and data-centric solutions to improve telehealth**. Over the past 15 years, the broader CITRIS innovation ecosystem has established a proven track record with more than 60 commercial startups and spin-offs — ranging from semiconductors to medical devices. This rich set of affiliated resources includes:

- CITRIS Foundry (multi-sector startup accelerator)
- CITRIS Health incubator (digital health incubator)
- CITRIS Invention Lab
- CITRIS Social Apps Lab
- Health Care Simulation Lab
- Virtual Health Lab
- Marvel Nanofabrication Lab
- Jacobs Institute for Design Innovation
- 15M-record EHR Platform
- Hospital and Health System
- Primary Health Care System
- Comprehensive Cancer Center
- Memory Support Center
- Health Care Payor
- Health Care Seed Grants
- Hackathons and Design Challenges
- Bay Area and Silicon Valley Incubators, Accelerators & Venture Funds
- International Business Transition Academy



PUBLIC AND PRIVATE PARTNERSHIPS

CITRIS Health, UC Davis Health System, the Center for Health and Technology, and the Center for Technology and Aging have collectively worked with more than seventy Fortune 500 companies, 100 U.S. healthcare agencies and providers, and dozens of international research universities. CITRIS researchers are actively engaged with federal agencies, state policy makers, private healthcare payers, major health systems, and numerous associations and foundations. Collaborators include:

- Centers for Medicare & Medicaid Services (CMS)
- Office of the National Coordinator for Health Information Technology (ONC)
- Centers for Prevention and Disease Control (CDC)
- President's Council of Advisors for Science & Technology
- Center for Connected Health
- Center for Connected Health Policy
- Kaiser Permanente
- Sutter Health
- Dignity Health
- Cleveland Clinic
- Partners HealthCare

CITRIS Health is a strong partner in regional and international innovation, and recently expanded its global corporate outreach in conjunction with the Bay Area Council, which represents the 100 largest companies in Silicon Valley. Additionally, the CITRIS Membership Program offers a suite of benefits for organizations that seek to engage at a deeper level.

Through membership in the International Association of Research Universities and UC Berkeley's ranking as the number one public university in the world, CITRIS Health has established research collaborations with multiple international universities including Aalborg University, Leiden, National University of Singapore, Rotterdam University of Applied Sciences, University College Dublin, University of Copenhagen, Tec de Monterrey, Tsinghua University, and TU Delft.

GLOBAL HEALTH NETWORKS

CITRIS Health is recognized for its leadership in launching multinational networks for digital health and telehealth innovation. Examples of recent initiatives include the Greenland Telehealth Platform, Philippine National Telehealth Pediatric Teleaudiology Assessment Program, Canadian AgeWell Collaborative, and EU Cardiac Intervention Program. Drawing from unique datasets and capabilities across multiple countries, CITRIS Health Networks have been established in Europe, Asia, and North America with active programs and collaborations in Denmark, England, France, Ireland, the Netherlands, China, Japan, the Philippines, Singapore, Canada, and Mexico. Key global collaborators include the Arctic Telehealth Research Network, EIT Digital (EU), Tec de Monterrey (Mexico), Medical Delta and InnovationQuarter (Netherlands), Transatlantic Telehealth Research Network, and World Health Organization.

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CITRIS HEALTH INITIATIVE

The **CITRIS Health initiative** seeks to transform health and healthcare by improving access and reduce disparities and costs through innovative technology solutions. The primary focus areas for CITRIS Health are “Hospital to Home” and “Precision Medicine.”

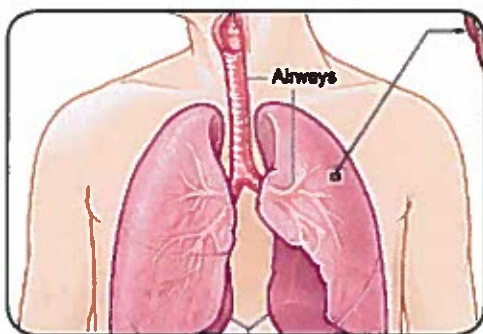
The initiative focuses on developing transformative, scalable and sustainable information technology solutions to improve health and wellness. These technology-enabled solutions can improve the quality of care and health outcomes, while reducing health care costs. Current areas of focus address the primary drivers affecting health, including chronic disease and aging. Initiative projects build upon the principal technology solutions of telehealth; sensors; mHealth; and data analytics. Examples of CITRIS Health Initiative projects include innovations in electronic health records and analytics, the Transatlantic Telehealth Research Network, use of in-home sensors and feedback to reduce asthma in children, virtual reality environments for physical rehabilitation, and interactive mapping to assist wayfinding for older adults.

SAMPLE PROJECTS



Transatlantic Telehealth Research Network (TTRN)

The Transatlantic Telehealth Research Network (TTRN) is dedicated to developing cutting-edge research and innovation within telehealth. The research is interdisciplinary (medicine, engineering, nursing, organizational, economic), and focuses on developing new diagnostic, preventive care and treatment methods/technologies for patients in their own homes utilizing telehealth. Problem-based user driven innovation is a key underpinning for TTRN researchers.



AQUA: Children's Asthma Technology Solution

This project explores home and outdoor pollution and how it affects the health of children with asthma. The study is testing whether an inexpensive home air quality sensor can distinguish between levels of particulate matter in homes of asthmatic children who live with smokers compared to those who do not. This study has the potential to inform future research avenues regarding air quality exposure in pediatric asthma and ultimately lead to possible behavioral modification techniques to improve symptom control.

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KEY AREAS

Data Analytics for Health
Telehealth
Sensors and Services
Mobile Health Apps and Gamification
Precision Medicine
Quantified Self and Wearables

Precision Medicine
Patient Engagement
Chronic Disease
Population Health
Global Health
Connected Health

To learn more, visit: health.citris-uc.org

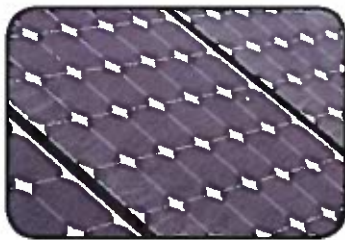




CITRIS SUSTAINABLE INFRASTRUCTURES INITIATIVE

The Sustainable Infrastructures Initiative pursues information technology research in energy, transportation, and water as parts of the cyber-infrastructure of a sustainable society.

ENERGY



Researchers weave IT and Energy together in a number of projects to improve energy performance at the utility grid, building, and sensors levels. The Micro Synchrophasor project (US DOE ARPA-E funded) brings together CIEE, Computer Scientists from UC Berkeley, LBNL, and Power Standards Lab to develop a device to measure phase angle on utility distribution power lines in order to improve reliability. The Deep Energy Efficiency project of the UC Carbon Neutrality Initiative (UCOP funded) identify strategies to fully scale deep energy efficiency for one major end-use (lighting) at four campuses (including two medical centers), analyze related issues and make

recommendations for implementation; UC Berkeley is working with CITRIS partner UC Davis, and UCLA, UCR, and UCSB. The CITRIS headquarters at Sutardja Dai Hall (SDH) showcases several Initiative endeavors, such as acting as a test bed for the Changing the Rules project (CEC funded). The Center for the Built Environment (CBE) and Software Defined Buildings (SDB) research groups at UC Berkeley, CIEE, and Taylor Engineering are developing user-centered building services controls in order to improve comfort and save energy. Another project uses SDH as a test bed to use the inherent temporal flexibility in energy consumption to provide various ancillary services (e.g. frequency regulating, ramping) to the grid in an automated fashion. At the sensor level, along with ChirpMicro, CBE and SDB are developing a low-cost MEMS-based ultrasonic anemometer that will improve building, laboratory, and hospital ventilation performance.

TRANSPORTATION



Led by the Transportation Sustainability Research Center, a newly funded CEC project called Plug-In EV Smart Charging in California brings together faculty and researchers from multiple departments across UC Berkeley including Computer Science and the Energy and Resources Group. The project partners with BMW to integrate electric vehicle charging with other building loads and the electric grid. The Connected Corridors program is a collaborative effort to investigate how corridor components (highways, arterials, buses, and rail) can work together efficiently so they can be managed as an integrated system, to reduce congestion and improve mobility.

Connected Corridors will leverage new technologies: the internet, cellular and mobile devices, GPS technology, and social networking; along with building on the experience from previous PATH projects including Tools for Operational Planning (TOPL) and Mobile Millennium. With the Rossmoor Carsharing project, researchers at TSRC have teamed with Nissan in a four-year research effort to explore methods of improving elderly mobility. In the Smart Bay project, cellular data are securely anonymized and used to generate a virtual population.

WATER



The newly formed UC WATER Security and Sustainability Research Initiative (UCOP funded) focuses on strategic research to build the knowledge base for better water-resources management. UC WATER brings researchers together from multiple University of California campuses—Berkeley, Davis, Merced (lead), Santa Cruz, San Diego—and CITRIS. And the embedded sensor network in the American River basin continues to collect data from 12 wireless sensor clusters distributed across the seasonally snow-covered portion of the basin to provide excellent performance and delivery of real-time data on temperature, snowpack and soil moisture, together with less spatially intense energy-balance data.

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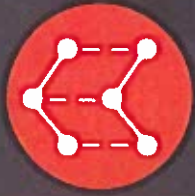
KEY AREAS

Energy Efficiency
Smart Grid
Water Conservation
Snow Water Hydrology

Transportation
Electric Vehicles
Internet of Things
Wireless Sensor Networks

Mobile Apps
Modeling
Participatory Sensing
Software Defined Buildings

To learn more, visit: sustainable-infrastructures.citris-uc.org



CITRIS CONNECTED COMMUNITIES INITIATIVE

The Connected Communities Initiative at CITRIS focuses on the affordances of information technology to enhance communities – of learning, of practice, and of governance.

The new initiative embraces the development of experimental online platforms and novel hardware and software systems that connect peers to each other and to institutions in meaningful and productive ways. Building on leadership expertise in human-computer interaction, user interface design, as well as political, social and economic development, the initiative supports projects in domains including education (in MOOCs, peer-to-peer expertise sharing and “maker” communities), collaborative design, philanthropy, journalism, public health, citizen science, and ICT policy. It contributes to our understanding of crowdsourced learning, decision-making and funding. The Connected Communities Initiative supports ongoing activities in the CITRIS Invention Lab, Social Apps Lab, Mobile App Challenge, as well as events related to open data, privacy and security, governance, and related topics.

The Connected Communities Initiative emerges from a long history of projects to improve communications among community members and the elected officials, policymakers and institutions making decisions on their behalf. The Data and Democracy Initiative, founded in 2011 and a precursor to the present Initiative, showcased and supported such projects regarding political, social and economic issues. Examples include the California Report Card, Vote Your Mind, Stories of Solidarity, Peer-to-PCAST, and others.

SAMPLE PROJECTS



Stories of Solidarity

Stories of Solidarity is a digital labor organizing tool built to connect the experiences of low-income, precarious workers and build connections and solidarity among them. Winning enthusiastic response from gatherings of labor organizers and researchers at UC Davis and UCLA as well as at the 2014 national AFL-CIO convention, Stories of Solidarity has continued to develop technically and enhance its connections and collaborations with labor organizers and academics.



The Collaborative Assessment and Feedback Engine (CAFE)

CAFE is an open source, e-participation platform that provides participants dynamic visual feedback about their position on key social issues, relative to other participants. The platform applies statistical models and collaborative filtering to rapidly discover emerging trends as data is collected. By fostering open-ended dialogue and facilitating a more nuanced assessment of public opinion about complex issues, CAFE enables more informed organizational decisions while increasing participant engagement in decision-making processes.

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KEY AREAS

Participatory Platforms and Social Apps
Interactive Media
Connected Devices
Online Learning Communities
Crowdsourcing

Communitysourcing
Open Data
Privacy and Security
Digital Governance

To learn more, visit: connected-communities.citris-uc.org



CITRIS PEOPLE AND ROBOTS INITIATIVE



Cloud Robotics, Deep Learning, Human-Centric Automation, and Bio-Inspired Robotics

are among the primary research themes of the **CITRIS People and Robots Initiative** that focuses on new theory, benchmarks, software, and approaches that address challenges in the interest of society.

SAMPLE PROJECTS



Deep Learning for Robotics

In this project we aim to develop deep learning techniques that can be deployed on a robot to allow it to learn directly from trial-and-error, where the only information provided by the teacher is the degree to which it is succeeding at the current task. Deep learning is a branch of machine learning that is concerned with learning structure, representations, and underlying patterns in complex "raw" data, such as images and sounds. rll.berkeley.edu/deeplearningrobotics



Human-centered Automation

A key focus of this initiative is human-centered automation, that is, designing automation that works well with people. We are developing a principled design framework that takes the human into account, particularly for systems in which the control authority is shared between the human and the automation. Our framework incorporates machine learning with safety-based control, so that the system can learn properties of human interaction while still providing certificates of safety.



Cloud Robotics and Automation

Rather than viewing robots and automated machines as isolated systems with limited computation and memory, "Cloud Robotics and Automation" provides access to 1) Big Data: access to updated libraries of images, maps, and object/product data, 2) Cloud Computing: access to parallel grid computing on demand for statistical analysis, learning, and motion planning, 3) Collective Learning: robots and systems sharing trajectories, control policies, and outcomes, and 4) Human Computation: use of crowdsourcing to tap human skills for analyzing images and video, classification, learning, and error recovery. Cloud Robotics and Automation raises critical new questions related to network latency, quality of service, privacy, and security.

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Cloud Robotics
Deep Learning
Human-Centric Automation
Bio-Inspired Robotics
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Robustness
Privacy

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