DeepTech for Social Good

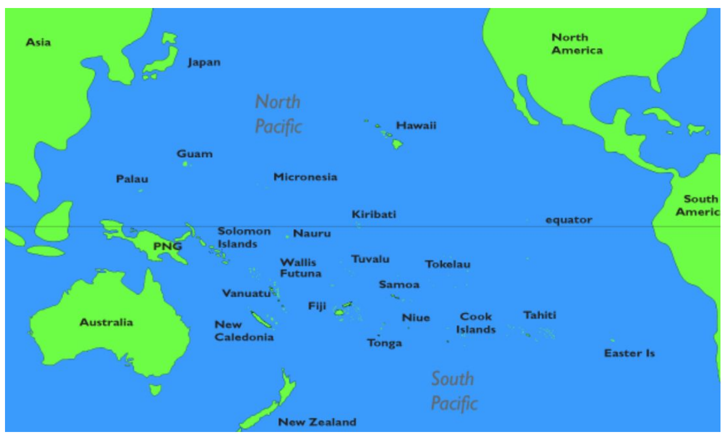
Social Good is something that benefits the largest number of people in the biggest possible way and makes a positive impact on both individuals and society.

DeepTech projects combine scientific discoveries and engineering innovations to make a profound impact on humanity. Social Good projects benefit the largest number of people in the biggest possible way and make a positive impact on both individuals and society. If you combine DeepTech and Social Good you get the AI Precision Health Institute at the University of Hawaiʻi Cancer Center. Scientists at the AI-PHI are using advanced technologies including AI, machine learning and deep learning to improve the diagnosis and treatment of cancer. They are collaborating with doctors in underserved communities, enrolling underrepresented populations in clinical studies, and making contributions to science that will benefit our generation and future generations. The AI-PHI is a prime example of DeepTech for Social Good.

A State of the Art Cancer Research Center

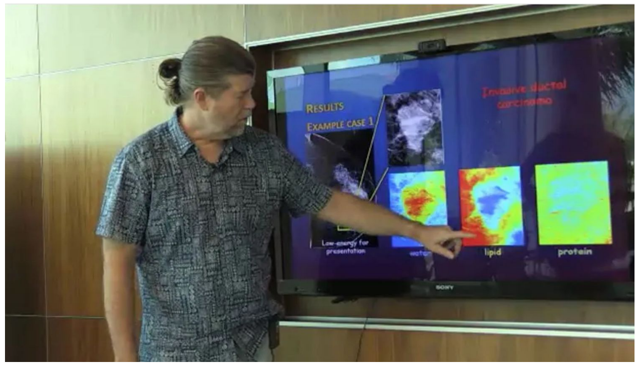
The University of Hawai‘i Cancer Center is one of only 69 NCI designated cancer centers in the US and the only one in all of the Pacific Region. The NCI designation signifies the depth and quality of the research they are doing. Their research is unique because they research how cancer affects people with different ethnic, cultural and environmental characteristics. UH researchers conduct population based and laboratory based cancer research. Since Hawai‘i has one of the most diverse populations in the world, it's an ideal place to study why some ethnic populations are more susceptible to certain cancers and how genetic susceptibility interacts with environmental factors to influence cancer risk. Since gene-environment interaction is a force in cancer development, the UH has developed state of the art laboratory facilities to measure genetic and molecular factors associated with cancer risk and tumor progression and the effects of behavioral and lifestyle interventions for cancer prevention.

Using the most advanced technologies to bridge the technology gap between developing regions and state of the art medical centers.

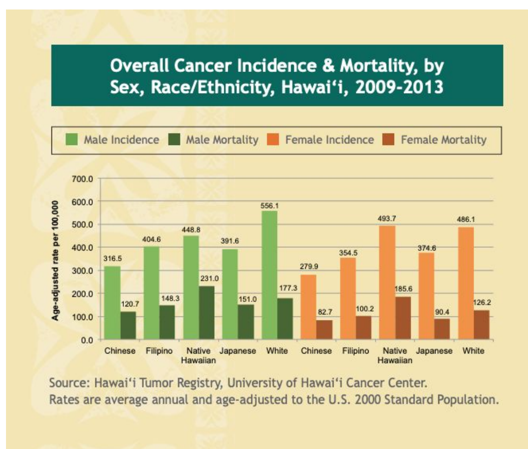


Although Honolulu is one of the most geographically remote cities in the world (2,393 miles from San Francisco and 3,854 miles from Tokyo) it is the closest US city to thousands of islands in the Pacific. The ocean is something that connects these islands rather than something that separates them. Having a top tier cancer center situated in this location presents opportunities to connect with hundreds of thousands of people in island communities that have never participated in cancer research and clinical studies.

UH scientists are actively engaging in collaborations with medical centers in Guam, Micronesia and throughout the Pacific to bridge the technology gap between developing regions and state of the art medical centers. Micronesia encompasses five independent countries and three US territories with 535,022 people spread out over 2100 islands. Cancer is the fourth leading cause of death in Micronesia where over 90% of cancer cases are diagnosed in late stages. Collaboration with UH will improve early detection, diagnosis, and treatment.



On Guam, a US territory 3,950 miles west of the Hawaiian Islands, 81% of the population are Native Hawaiian, Pacific Islanders and Asian. Senior investigators from UH are collaborating with doctors on Guam and working with new populations including Chamorros, Chuukese and Marshallese. This is the first time that doctors on these islands have collaborated with a NCI-designated cancer center and the first time that people in these communities have had access to this level of care. Native Hawaiians, Pacific Islanders and Asians represent a very small fraction of patients enrolled in NCI-sponsored cancer clinical trials in the US, so data from these groups will add diversity to datasets and robustness to cancer research findings. Cultural practices and diet in Hawaiʻi and the Pacific are distinct and contain aspects of Hawaiian, Polynesian, Japanese, and Filipino lifestyles. The distinctive data collected and analyzed by the AI-PHI will be valuable to cancer researchers all over the world and will contribute to the global body of knowledge about cancer that will be used to develop new treatments and therapies.



Cancers with higher incidence in some groups

Hawaiʻi has the highest proportion of people of mixed-race in the US. The five largest ethnic groups in Hawaiʻi' are Native Hawaiian, Caucasian, Japanese, Filipino, and Chinese. Cancer incidence and mortality varies substantially across these ethnic groups. UH researchers are conducting population research to understand the reasons why cancer incidences and mortality vary substantially across different racial and ethnic populations, and are studying intervention strategies to help prevent cancer and to improve the survival of cancer patients. The data collected from ethnic groups across the Pacific provides valuable insight that informs cancer prevention and research efforts worldwide. This racially-diverse population resource has been invaluable in demonstrating ethnic variations in cancer incidence and survival. This data is used by cancer control partners, hospitals, researchers, and physicians around the world.

The Most Beautiful Cancer Center in the World

To draw together the earth, sea, and sky, the interior
of each of the six levels of the building is painted a
different color starting with earth tones on the first floor
with subtle iterations on each floor so that when you
reach the sixth floor the walls are blue like the sky.

The six story 160,000 square foot University of Hawaiʻi Cancer Center is located a few feet from the ocean with panoramic views all the way to Diamond Head and with visibility seven miles out to the horizon. This stunning architectural gem designed by Jeff Nakamura of Shimokawa + Nakamura Architects is a homage to Hawaiian culture. Every design detail and material used in the construction of the building was thoughtfully considered. The stone, the plants, the colors, and even subtle design elements were chosen with reverence to Hawaiian culture and tradition.

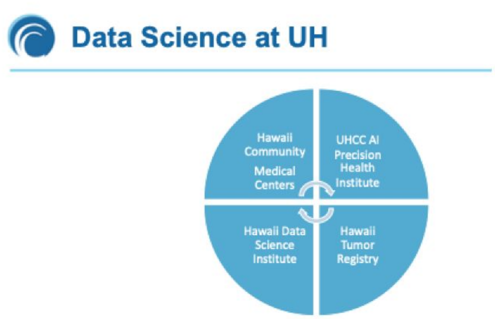
The gardens are filled with beautiful native Hawaiian plants, trees, and pohaku. Pohaku are sacred and healing in Hawaiian culture and mortar and pestles carved from special pohaku have been used for centuries to prepare herbal medicine. There are two landscaped pohaku gardens, one on the mauka (mountain) side and one on the makai (ocean) side.

The Makawalu Vortex sculpture at the entrance was carved by local artist Jerry Vasconcellos from pohaku quarried from Ko'olau, the same source that produced the lava that formed Honolulu. The sculpture symbolizes the core mission of the UHCC - to ease suffering, to comfort, to heal, and to discover. The Native Hawaiian concept of *Makawalu*, meaning "eight eyes" refers to thinking using multiple perspectives and drawing information from many sources. The two large pohaku from Kailua placed on both sides of the path symbolize drawing energy from the surroundings and radiating it outward.

The UHCC has established resources for population-based research. The Hawaiʻi Tumor Registry plays a vital role in cancer research and cancer control activities in Hawaiʻi and across the US. The registry is particularly notable for its contribution to addressing the burden of cancer in Asian and Pacific Island ethnic groups that are underrepresented in the US. The Registry collects detailed information on the more than 7,000 new cases of cancer diagnosed in Hawaiʻi residents annually, as well as follow-up and survival data. Since 1973, the Hawaiʻi Tumor Registry's surveillance has covered over 200,000 cases. The Registry's database contains more cancer cases of Native Hawaiians than any other registry worldwide. It also contains a large amount of data from Chinese, Filipino, Japanese, and Pacific Islanders.

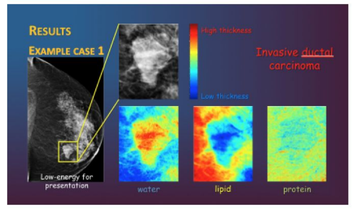
The World's First AI Precision Health Institute

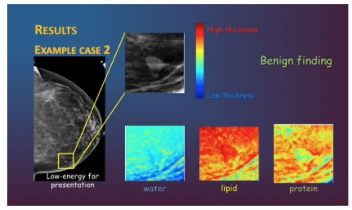
The AI Precision Health Institute was founded by John Shepherd, PhD. Dr. Shepherd is known worldwide for his expertise in quantitative X-ray imaging using AI, machine learning, and deep learning to extract more cancer risk information from various forms of medical imaging including dual-energy X-ray absorptiometry, digital mammography, tomosynthesis, and 3D optical images. He has over 200 peer reviewed papers and has been cited in other publications over 10,000 times. Dr. Shepherd was one of the first to show that volumetric breast density measures are a stronger risk predictor for breast cancer than areal density measures. The AI-PHI is using advanced technology including AI, machine learning and deep learning to analyze medical images and to develop novel biomarkers. These are some of the current projects.



1. HIPI Mammogram Registry

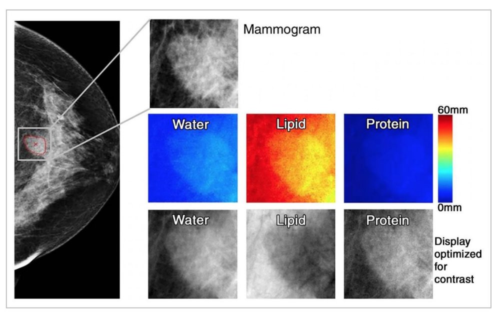
Dr. Shepherd and his colleagues have created the first Hawai‘i and Pacific Islands Mammography Registry. The HIPIMR is a forming collaboration between the Tumor Registry, the AI-PHI, the UH Data Science Institute, and medical centers throughout Hawai‘i. It’s mission is to provide accurate risk of breast cancer assessment for women in Hawai‘i using all available breast health information including clinical risk factors, omic markers, and radiomic biomarkers. The mammography registry's goal is to amass approximately 80% of the screening mammograms, tomosynthesis, and breast MRI images acquired throughout Hawaii to develop the radiomic biomarkers specific to Hawaiian resident women.





2. Three Compartment Breast Lesion Detection (3CB Study)

Dr. Shepherd has accumulated 600 dual-energy full-field digital mammography studies from 600 patients across the US. Each study has an associated biopsy result to confirm or deny malignancy. The studies contain radiologist annotated lesions (freeform ROI following the boundary of the lesion) classified into 4 sub-categories; Invasive, DCIS, Fibroadenoma, Benign. Arterys has developed an FDA approved cloud based AI platform and a mammography lesion detection model is being developed for release. 3CB has applied for funding to extend the study to evaluate tomosynthesis images on women in Hawaii (under review with the NIH/NCI.) If successful, the study will improve the specificity of mammography and reduce the rate of unnecessary biopsies. Currently, 4 in 5 biopsies are negative.



3. Interval and Screening Breast Cancer Risk

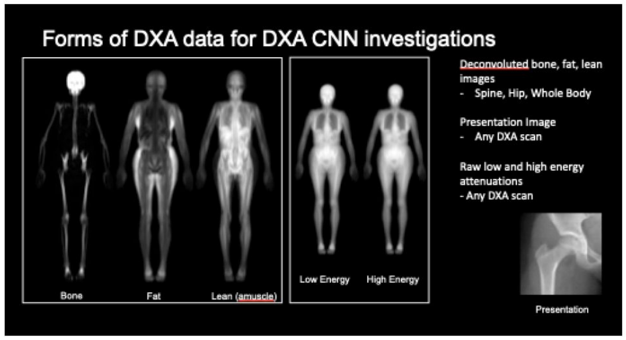
This study is leveraging an ongoing collaboration with UCSF and The Mayo Clinic. The study data consist of women who had participated in screening mammography and went on to develop either screening-detected breast cancer, breast cancer discovered between screening mammogram visits (interval cancer), or no cancer. DL methods are underway to predict these classifications. The data consist of the 4-view screening mammograms on over 5000 women, with divisions for training, validation, and testing. Women at high risk of cancer (screen or interval) may seek counsel with oncologists on risk reduction strategies. Women with elevated risk of screening detected cancer may be counseled to have more frequent mammograms. Women at high risk of interval cancers may be counseled to supplement their mammography with other imaging methods such as MRI or ultrasound. Women with low risk of breast cancer may benefit by decreased frequency of screening visit to reduce their accumulated radiation dose.

4. Hip Fracture Risk

In the *Healthy Aging and Body Composition Study* 3000 men and women were followed for over 10 years for how body composition is related to health including osteoporotic fractures. Dr. Shepherd is using DL methods to study how AI can better predict hip fracture from DXA scans. Over 250 men and women in the study experienced a hip fracture. One unique aspect of this analysis is that Dr. Shepherd has deconvoluted the bone from the overlaying fat and muscle to create three images (bone, fat, muscle) that can take advantage of standard DL architectures that are designed to train on RGB images.

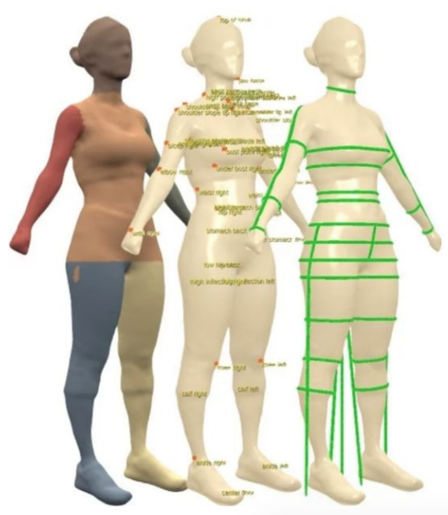
5. Bone age in children from clinical DXA scans

In this study, 8000 hip and 8000 spine DXA scans on approximately 2000 children from the Bone Mineral Density in Children Study will be evaluated to estimate bone age. Bone age is a measure of maturation from birth to 18 years when the bones fuse measured from dedicated hand films. However, hand radiographs are not used to diagnose bone health in children. Spine (and more recently) hip DXA scans are used to evaluate pediatric bone health. Recently the Radiological Society of North America hosted Pediatric Bone Age Machine Learning Challenge using hand radiography. Dr. Shepherd's study tries to accomplish both bone age and density measures from the DXA images alone with a bone age resolution of less than 5 months.



6. Muscle, Fat, and Bone Segmentation on whole body pediatric MRI scans

Most information on pediatric bone, muscle and fat distributions are known from DXA scans. However, MRI scans offer the ability to extract much more information including the volumes of ectopic fats, specific muscle volumes, and even bone mass using ultra fast protocols. We are interested in the onset of obesity in children since obesity is strongly associated with adult cancer risk. Using scans from the Shape Up! Kids Study(720 children from 5 to 17 year), we will be developing DL segmentation algorithms to estimate specific fat regions including visceral, liver, pancreatic, and subcutaneous fat. Currently, approximately 200 children have been recruited.



7. Body Shape Analysis

Body shape is the product of all omic processes. However, it is not known how much can be learned about each omic system from body shape. We are studying how body shape information is related to health markers like strength, body composition, and blood biomarkers. Body shape is measured using 3D optical whole body scanners and advanced statistical modeling. There are about 1500 scans of individuals from 5 to 85 years planned with about 500 acquired to date. We would like to determine the best way to use DL approaches to train on a variety of body composition, blood marker, and other health indicators.

This article was written by Margaretta Colangelo and Dmitry Kaminskiy. John Shepherd collaborated with us on this article. All photos in this article were taken by Margaretta Colangelo at the AI-PHI in February 2019.

Margaretta Colangelo, Managing Partner at Deep Knowledge Ventures, is based in San Francisco. Margaretta serves on the Advisory Board of the AI Precision Health Institute.

Dmitry Kaminskiy, General Partner at Deep Knowledge Ventures, is based in London. Dmitry is Managing Trustee of the Biogerontology Research Foundation.

John Shepherd, PhD is Founder and Director of the AI Precision Health Institute. Dr. Shepherd is known worldwide for his expertise in quantitative X-ray imaging using AI. He has over 200 peer reviewed papers and has been cited in other publications over 10,000 times. He is based in Hawai'i.

Deep Knowledge Ventures is an investment fund focused on DeepTech. Investment sectors include AI, Precision Medicine, Advanced Biomedicine, Longevity, and Neurotech. @DeepTech_VC

Additional Articles about the AI-PHI

The World's First AI Precision Health Institute

Where AI May Make the Biggest Impact

Why Hawaii is an Important Spot for Cancer Research