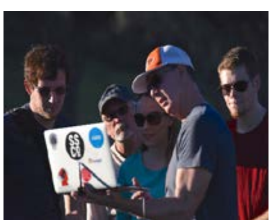
Use Case 7: Multi-Sourced Data Analytics to Improve Food Production

K. McCurdy (Sedgwick Reserve, University of California, Santa Barbara Natural Reserve System) with B. Roberts, B. Sethuramasamyraja (California State University, Fresno), B. Liu (California State Polytechnic University, San Luis Obispo), D. Zoldoske (California Water Institute)

Motivation: World food production depends critically on the ability to manage increasingly limited natural resources (e.g., arable land and water) with new techniques that both enhance environmental stewardship and increase productivity. Food security and food safety are critical societal functions but without significant technological advances, they will be difficult or impossible to ensure in a way that is economically sustainable. The ubiquitous availability of low-power, low-cost, highly durable consumer electronics with data gathering capabilities has begun to motivate new models of environmental and agricultural science. Scientists have begun to take advantage of these technologies to improve the quality and quantity of new ecological results with increasingly lower costs [1]. For example, it is possible to obtain thermal imaging capability with a commodity cell phone for $250; the previous offering cost $2,000.

This confluence of new scientific development is emerging from university operated “science reserves” like those operated by the University of California [2]. Ecological laboratories administered by the university host an amalgamation of experimental science projects, community education and outreach efforts, and citizen science endeavors. Critical environmental questions such as the effect of climate change on indigenous flora can be studied in conjunction with localized commercial agricultural activities in a controlled setting. Citizen volunteers work closely with scientific researchers and guest farmers to gather and analyze data for specific ecological research projects. For example, The Sedgwick Reserve (administered by UCSB) brings together scientists studying the effect of climate change on S. California oak trees [3,4], with guest farmers who cultivate land on the property to introduce agricultural effects. Volunteer docents guide public access and serve as stewards for the data gathering activities.



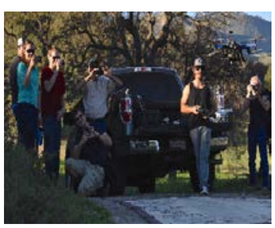


Figure 3.3: UCSB graduate students work with the CEO of VineRangers to collect thermal and NVDI image data from the Sedgwick Reserve along an aging water line that Sedgwick farming concerns believe has a leak (left image). Students, citizen volunteers, and the local growing community take pictures of the drone overflight while a VineRangers pilot collects the aerial images (right image).

Leveraging this nexus of scientific endeavor, food security and ecological concerns by the citizenry, and consumer technology trends requires a new type of campus federated data infrastructure. Scientists gathering sensor data and scientific imagery wish to combine this data with images taken by others in analytics calculations that attempt to optimize food productivity.

Activity: To analyze the totality of the images gathered requires a data infrastructure that combines both campus clouds and public cloud services (where personal images are archived). The data, while gathered for the purpose of water leak detection, is also useful in other analysis contexts. In another project, Sedgwick researchers are exploring the use of human face and identity recognition technology to identify animal movements on the property. Local ranching interests raise livestock

#1541215

in "free-graze" areas bordering the reserve while indigenous predators (e.g. black bears and mountain lions) and recovering endangered species (Lynx) live on the reserve. When livestock cross reserve boundaries, locating and identifying them, and identifying the specific population of predators that may be straying into neighboring ranch areas, is labor intensive and difficult. The project will combine "camera trap" data (motion activated cameras scattered on the property) with scientific imagery and digital photographs taken by local farmers and citizens, using human image recognition software in conjunction with existing animal recognition and tracking techniques [5-8] to develop an on-going wildlife census. In this work, we will study the feasibility of enabling multi-data set science projects that bring together trained domain scientists, computer scientists, and citizen scientists/volunteers using federated campus clouds. We will work with Sedgwick as a prototype of a regional nexus for action that can bring together such constituencies interested in a common scientific problem based on geographic location. We envision this prototype will serve as a model for campuses nationwide that are able to exploit both their research stewardship of "reserves" to which they have been entrusted and their respective educational, student, and community relationships.

References

[1] Liu. B., Koc. A. (2014). Mobile Phone Sensing in Scientific Research, Encyclopedia of Mobile Phone Behavior (In Press).
[2] Natural Reserve System, University of California. Retrieved from: http://nrs.ucop.edu.
[3] Ortego, J., Gugger, P, Riordan, E. & Sork, V. (2014). Influence of climate niche suitability and geographical overlap on hybridization patterns in southern Californian oaks. *Journal of Biogeography*, 41,1895-1908. Retrieved from: http://onlinelibrary.wiley.com/doi/10.1111/jbi.12334/abstract.
[4] Sork, V., et al. (2002). Pollen movement in declining populations of California Valley oak, Quercus lobata: where have all the fathers gone? *Molecular Ecology*, 11(9), 1657-1668. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/12207717.
[5] Wawerla, J. et al. (2009). BearCam: automated wildlife monitoring at the arctic circle. *Machine Vision and Applications*, 20(5), 303-317. Retrieved from: http://link.springer.com/article/10.1007%2Fs00138-008-0128-0.
[6] Ernst, A., Kublbeck, C. (2011). Fast face detection and species classification of African great apes. *Advanced Video and Signal-Based Surveillance (AVSS)*, 2011 8th IEEE International Conference. 279-284. Retrieved from: http://dl.acm.org/citation.cfm?id=2190886.
[7] Valsby-Koch, D. Interactive computer vision system: recognizing animals on the Savannah in Aalborg Zoo. Retrieved from: http://projekter.aau.dk/projekter/files/198542802/MTPaper.pdf.
[8] Loos, A. & Andreas, E. (2013). An automated chimpanzee identification system using face detection and recognition. *EURASIP Journal on Image and Video Processing*, 1-17. Retrieved from: http://jivp.eurasipjournals.com/content/2013/1/49.

#1541215