COMPUTING THAT MATTERS:
Sample Project Domain Scenarios
&
Suggested Prototype Final Projects

COS 120 Introduction to Programming (section requiring instructor permission)

All members of the class will pursue common course modules on programming with Scratch and Python during the first half of the course. After that, each student will pursue a third module of their choice from among a selection of five. The third module should best match your personal interests but also with a vision towards working with others to pursue a final team prototyping project.

I. **Scratch Programming Module**
II. **Python Programming Module**
III. **Self-Selected Third Course Module (select one)**
   A. Programming Robots
   B. Sensor Programming and Data Analysis
   C. Programming Drones and Image Processing
   D. GIS Database Development
   E. Virtual Reality Visualizations
IV. **Final Team Prototyping Project**

To emulate realistic employer expectations and to help build teamwork skills, you will be assigned to a new two-person team for each two-week mini-project. For the prototype challenge final project you will choose your own team of 2 or 3 students.

Upon arriving at the last few weeks of the course, team members should have sufficient background among themselves gained through their earlier two-week project assignments to be successful in developing any number of the listed prototype projects in the lists that follow. Each final team of 2 or 3 students needs to choose only one project. If desired, final teams may choose to propose an alternative final project to those suggested below assuming that the team receives approval by appropriate faculty advisors.

NOTE: Instructors and CLAs will determine early in the Spring Semester whether the envisioned prototype challenge final projects under each of the three scenarios that follow are realistic to complete for students taking their first course in programming. If not, explicit revisions of the descriptions will be provided by the instructors/CLAs.

Sustainability Computing Examples

I. Computing in Support of Marine Science (Global Warming and Climate Change Science Challenge)

A. ***Marine Science Challenges (Client Needs)***

From recent observation of official tidal gauge station data, marine scientists note that tides along the Maine coast on average are higher than predicted in official government tide tables. They hypothesize that sea level may be rising faster than that predicted through current models. Yet the distribution and density of current sea level observation stations, while sufficient for many applications, are insufficient for this and many similar scientific inquiries. Further, accurate predictions in regard to global warming and climate change depend critically on accurate sea temperature measurements. While satellite imagery is providing a wealth of surface sea temperature data on a global basis, little detailed data is available on temperatures and other conditions (acidification, turbidity, etc.) throughout the vertical water column at particular locations and times. These observations are critically needed for better modeling of current and changing ocean conditions and for improving climate change models overall.

B. Challenges for Student Teams

Overall Challenge

Develop and build low-cost prototype technologies and a communication infrastructure that could accomplish detailed monitoring of a hypothetical ocean bay in Maine and communicate the observed environmental data to the web and through visualizations of the data.

Potential Prototype Projects

Among low-cost prototype devices of potential high value to marine scientists that student teams might choose to develop during the last few weeks of the course include:

Possible Prototype Challenge Final Projects	**Recommended Modules** (completed by at least some team members to prepare the team to develop this prototype)
(a) Develop a **robot to gather water conditions** (e.g. temperature) along a vertical water column under a boat and transmit wirelessly to the web the data collected and the test site location	
(b) Develop an inexpensive miniaturized **weather station** with the ability to regularly report temperature, pressure, and humidity wirelessly to the web from a stationary land location on the edge of a bay (e.g. every ten minutes)	
(c) Develop an inexpensive miniaturized **tide gauge station** to be placed on a dock with the ability to regularly transmit surface water elevation,	
(d) Develop a wireless **monitoring infrastructure** that is able to to gather data from deployed sensors and deliver it to the web	
(e) Develop a **map** of a bay represented in a GIS whereby data received from multiple sensors may be automatically and regularly drawn from a web database, sensor site locations may be displayed on the map and data collected over time and space may be displayed in tables and graphs	
(f) Program and fly a **drone** to collect detailed imagery surrounding and over a bay and process it for use in a GIS	
(g) Develop 3D **virtual reality** visualizations of changes in the natural bay environment based on data gathered from sensors deployed in the environment	

II. Computing in Support of Elder Independent Living (Sustainable Local Communities Challenge)

A. ***Aging Population Challenges (Client Needs)***

As the baby boomer generation in the U.S. ages, the percentage of the population over the age of 65 will increase dramatically over the next two decades. As health issues and diminished mental capacity arise, most elder citizens would prefer to stay in their homes rather than move into care facilities. If assisted living at home is achievable, many want to maintain their independence. This approach for care of the elderly is also much less expensive for society and for the involved individuals.

B. Challenges for Student Teams

Overall Challenge

Develop and build low-cost prototype technologies and communication capabilities to aid independent living of elders

Potential Prototype Projects

Prototype devices of potential value to the aging population that student teams might choose from among to develop during the last few weeks of the course include:

Possible Prototype Challenge Final Projects	**Recommended Modules** (completed by some team members to prepare for prototype development)
(a) Create a **smart seven-day pill box** with four compartments per day. Assume the pill compartments (7am, noon, 5pm and 10pm) are filled with a complex series of multiple pills by a caregiver at the beginning of each week. If a compartment is not opened within an hour of the allotted time for the compartment, the elder receives an automated reminder phone call every ten minutes until the chamber is opened. After two reminders, the caregiver receives an automated call to intervene.	
(b) Create an **outside direction finder** capability that will allow an elder with low-vision and diminished mental capacity to walk to any of four caregiver-defined locations (e.g. home, store, coffee shop, Betty's House). When the elder speaks the destination into their smart phone, they receive oral instructions (i.) every twenty feet as they travel (keep going straight), (ii.) whenever the route changes (go left, go right, you are at the coffee shop) or (iii.) when the elder departs from the route (go left to get back on your path, go right to get back on your path).	
(c) Create an inside **location tracker** capability that transmits the room location of an elder every 30 minutes to a web database.	
(d) Create a **motion tracker** capability that transmits lack of motion of a device attached to an elder (e.g. wristband, part of a necklace, in a shoe) to the web whenever the device is stationary for more than 30 minutes.	
(e) Create a personalized **elder situation awareness database** from which a phone call is activated to a caregiver if certain conditions are met (e.g. elder has not taken pills on time or taken them too early, elder departs too far from path of a walk being attempted, elder is in a single room for more then ten hours, elder has not moved in two hours).	
(f) Create an **elder travel map** represented in a GIS whereby data received from multiple trackers may be automatically drawn from a web database, locations for the elder over time may be displayed, and data collected over time and space from each tracker may be displayed in tables and graphs.	

III. Computing in Support of Small Farm Practice and Produce Tracking (Sustainable Farming Challenge)

A. ***Small Farmers Challenge (Client Needs)***
Increasing markets exist for produce that is locally grown and organic using verifiable sustainable farming methods. Small farmers would like technology that helps build confidence in consumers by providing transparency in their operations and verifying for consumers that each vegetable they buy at the local farmers market is organic, fresh, locally grown and has been produced using sustainable farming methods.

B. Challenges for Student Teams
Overall Challenge
Develop and build low-cost prototype technologies and communication capabilities to aid small farmers in making their operations transparent and which tracks vegetables from planting to sale at their farmers market sales stand.
Potential Prototype Projects
Prototype devices of potential value to local organic farmers that student teams might choose from among to develop during the last few weeks of the course include:

Possible Prototype Challenge Final Projects	**Recommended Modules** (completed by some team members to prepare for prototype development)
(a) Create a **farm observation system** able to incorporate video camera feeds from greenhouses, farm fields, animal pens, and production areas whereby any customer may readily view on the web any and all farm locations at any time and date during the last twelve months.	
(b) Develop a miniaturized **field soil condition station** with the ability to regularly report wirelessly to the web every 30 minutes soil moisture and any objectionable herbicide and insecticide detections.	
(c) Program a **pest detection robot** to run between crop rows using image processing to detect the presence of pest insects on plants and send detection times and locations automatically and wirelessly to the web for farmer investigation and use of organic pest control methods.	
(d) Create a **vegetable tracking system** whereby a passive rfid tag is stuck on each vegetable as picked with the exact time, date and GPS location when each item is picked recorded in a database.	
(e) Develop a **map** of a farm represented in a GIS whereby data received from multiple sensors may be automatically and regularly drawn from a web database, sensor site locations may be displayed on the map and data collected over time and space may be displayed in tables and graphs	
(f) Program and fly a **drone** to collect detailed imagery of a farm and process it for use in a GIS.	
(g) Develop a **food chain tracking system** whereby a consumer using an rfid reader on a vegetable tag at the farmers market is able to identify the time, date and location of when the item was picked, name of the farm, any pest insect events and any herbicides and insecticide detection events to which the item might have been exposed, and whether treatment methods used to address such events are accepted as organic. Consumer is also able to see on the web a time lapse map of the location	
(h) Develop 3D **virtual reality** visualizations of changes on the farm from data gathered from sensors deployed in the environment.	