CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: **Improving elementary education with custom online environmental science lectures**
Sponsor information*: Dr. Chris Doughty Assistant Professor SICCS, Northern Arizona University* Chris.Doughty@nau.edu

The Problem

People are motivated to learn when they can personally relate tothe topic and content of the material. For some historical event, for instance, an account from the a local observer that the reader can specifically relate to will be much more memorable and motivating than a generic description. Nowhere is this more true than at the elementary school (K-6) educational levels, where it is particularly important to use a hands on and experiential approach. Inventing new tools and approaches that use "smart" information technologies to tailor information be specific about what information you are talking about to each reader's specific locale and background could be game-changers in this specific education context.

This project focuses on creating a technological tool to present information on several important environmental topics by automatically tailoring and presenting to students in a regionally specific fashion. Learning about such topics from a specific regional perspective will not only engage students by seeing information relevant to their particular locale, but also provides the opportunity to present information relevant to specific local challenges or issues that students could be motivated to address. The main current obstacles to this approach are information and effort involved: first, teachers relying on generic textbooks often lack the specific knowledge of local or regional environmental factors and issues to create such lectures; and even if that information were available, teachers often lack the skills and time to create custom lessons.

The Solution

We envision creating a powerful web app for teaching about a wide range of environmental topics. Teachers will be able to access the app to create an account and set up a custom "class" that they populate with *lessons*, that their students can visit as part of their studies. The experience is not aimed at online learning; that is, we envision that teachers will use this tool in-class, to present the special environmental lessons on-screen, and use them to support their own teaching/discussions. The key feature is the lessons: these will be custom-tailored by automatically pulling regionally-specific data on local animal species, species threat level, extinct species, land use change, and future climate predictions from a geo-tagged database to build custom lessons. Thus, the same lesson inserted into classes being held in Los Angeles will have different (localized) content than the same lesson added to a class in Boston. This geo-localized data will be combined with static videos explaining key concepts about biodiversity loss, climate change and land use change. The hypothesis is that students will learn the concepts more easily when they environmental information relevant to and with custom examples from regions where they live.

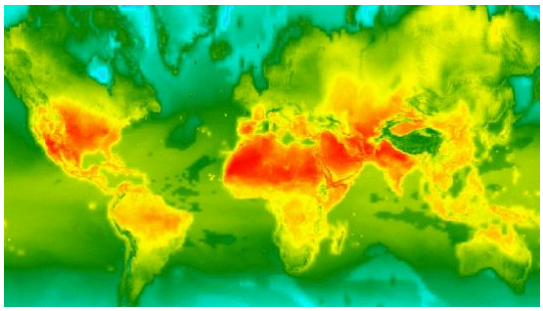
All this regionally-specific data is available but is difficult for people to access without coding skills and/or extensive training in environmental science. Our web app is aimed at largely automating the whole process. We propose that the lessons output by the process should simply be Google slides, i.e., the app should use the Google Slides API to build presentations. This leverages this powerful existing technology, allows results to be stored in teachers' Google Drive, and makes it easy for teachers to download and share the results.

As soon as a first prototype is developed, we plan to test our lectures at several local elementary schools; based on feedback from the schools we will make adjustments to the product and content. We imagine this concept will be of interest to schools worldwide. There is also much potential for growth into other types of regionally-specific lectures, e.g., history, economics, etc. Looking forward, there is a viable business model for funding improvements in this tool over time: charging the schools just a few dollars a lecture could result in significant revenue when multiplied over hundreds or thousands of schools.

Project Details

Overall, the specific goal for this proof-of-project-concept is to use the ideas outlined above to create three regionally specific 20 minute environmental science lessons. The teacher will chose one of the topics, the software product will rapidly assemble a regionally-customized lesson (Google Slide deck), and then a link will be provided to the educator**.** The three initial topics will be as follows:

1. **Land Use Change** - The first lesson will explore how people have changed the landscape and why this is important. We will link Google Slides API to Google Earth Engine API to use existing code to generate a 30 year time series of landsat satellite data to show how your community has changed.
2. ***Biodiversity loss* –** This lesson will explore what animals are currently in your ecosystem, which are threatened, which are extinct. It will talk about ecosystem services of these animals and what will happen if threatened animals go extinct. For example, after inputting location, a link to the automatically generated video would start with pictures of animals specific to the region and a voiceover – "*you may recognize some of these animals. But many other mammals originally overlapped with the first human inhabitants in this area"*. Then it will show some of the animals that had gone extinct with a short description of each animal class (ie herbivores vs carnivores).
3. ***Climate change* –** The last lesson will be on how your community will be affected by climate change using existing climate simulations of future temperature and precipitation predictions. There are now maps of future climate predictions in google earth engine API. We will again link this existing code to google slides API to generate regionally specific predictions on future temperature and precipitation for your city. The static lecture will teach about the causes of climate change and what can be done to stop it. For instance, the map given here is a sample temperature prediction pulled from google earth engine.



We expect detailed requirements to be developed by the time during requirements acquisition. However, some specific features for the desired software product might be prioritized as follows:

Phase 0: Minimum viable product

- Web app provides GUI to allow basic system admin, i.e., allowing updating of contained data and templates via secure web portal or other means.
- Highly usable GUI for allowing end-users (teachers) to create accounts and put together lessons (e.g. selecting from various topics/lesson templates), and retrieve the presentations produced.
- System can create a Google Slides presentation using the Google slides API linked to the google earth engine API or Animap. For instance, for the climate change and land use change lectures, it might go to Google slides API script.google.com/create and use a template that we will develop. Then link to google earth engine API https://developers.google.com/earth-engine/ to pull information on the users coordinates and use the above code to create a time lapse video of where they are, future climate simulations for that place, etc.
- Can create geo-customized lessons that will display detailed information on each animal species, including a picture and other key information. Might be automatically extracted in real-time from Wikipedia; or could be pre-extracted, formatted and stored in the database.
- Creates geo-customized lessons that provide some visualization of local ecosystem services (e.g. a color map with a legend, etc.) to allow user to view ecosystem services at specified location.
- Web App and supporting database will be provided as web service installed on a cloud server, accessible using any modern browser.
- Basic administrative interface for central database,

Phase 1: A truly usable result

A truly usable product would also allow:

- Users can upload content that they have created to the website. For instance, a local teacher with local knowledge could create a lecture on, for example, a local endangered frog. Likewise, a leading expert could create a small video on the topic that they know best. The teacher then could chose which content to include in the final lesson produced, and also share new content with other teachers.
- These videos could be rated by the broader community so that educators know the good ones from the bad ones. The educator can choose local vs expert videos or both
- Lessons could be tailored by age demographic. For instance, if the teacher chooses 3rd grade a different supply of materials and templates will create the lecture versus for the 8th grade.

Phase 2: Really cool advanced features (stretch goals

- Support for an interactive quiz that will be automatically generated based on the material in the lecture.
- Quizzes can also be rated by the students, so we know which are the best made.
- Students can have their own accounts so that the quizzes can be tailored based on the prior success of the student. Therefore, a struggling student will not be overwhelmed and a good student will be challenged.

Knowledge, skills, and expertise required for this project:

- Experience/Interest in Google Slides API and Google Earth Engine API.
- Modern Web2.0 web application frameworks and techniques.
- Design and deployment of cloud-based servers, databases and other resources.
- Fundamentals of user-friendly website design

Equipment and Data Requirements:

- Ordinary development platform and software/tools freely available online.
- Client will provide access to appropriate mobile device(s) for product testing, if needed.

Required **Software and other Deliverables:**

- Web app, as outlined above, installed on a virtual machine (e.g. AWS) recommended by team and provided by sponsor.
- A systems admin manual written for non-technical (ecologist) users, covering installation, configuration, and updating of the cloud-based elements.
- A complete user manual (preferably online and integrated into the web app itself) detailing for teacher/users how to use the app to generate and download geo-specific lessons.
- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- Complete professionally-documented codebase, delivered both as a repository in GitHub, BitBucket, or some other version control repository; and as a physical archive on a USB drive.