

AG2PI Seed Grants Cover Page

Title:

Seeding Public-Private Partnerships for AG2P Training

Lead PI:

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Co-PI:

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Senior Personnel:

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Initial Collaborators:

Corteva Agriscience

Syngenta

Project summary/abstract:

The main goal of this project is to form public-private partnerships to expand meaningful interactions between industry and the public sector. Outcomes will include: 1) enhancing graduate student training through the use of current real-life AG2P project scenarios and datasets; 2) generating public educational resources including datasets and code for use by other scientific communities for AG2P training; and 3) serving as a model and test bed for PPP engagement and seeding meaningful ongoing collaborations in interdisciplinary groups.

Keywords:

Education; Public-Private Partnership; Industry; Graduate training; Interdisciplinary research

1. Project description

a) Objectives/aims with preliminary results and plans for achieving each objective/aim

Problem statement

Training in data analytics in the field of agricultural genomics/phenomics frequently lags behind current, cutting-edge problems, and/or is structured in a way that is not realistic or relevant to future career success. Correspondingly, private industry encounters difficulty finding experts in this field that are not only qualified and skilled in their own area of expertise but also able to work and communicate in interdisciplinary teams.

Objectives

- 1) Establish and maintain industry contacts, including both agricultural and data sciences.
- 2) Facilitate industry career discussions, including current and former NSF Research Training graduate students as well as Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS) graduate students.
- 3) Implement Agricultural Genome-to-Phenome (AG2P) course modules for CSS 844, Frontiers in Computational and Plant Sciences in collaboration with public and private experts.
- 4) Develop and adapt established course modules, including both inputs (data) and outputs (code), as public educational resources for use by other scientific communities.
- 5) Write a publication describing the novel educational approach as well as the resources generated to serve as a model for implementation in other scientific communities and institutions.

Background, preliminary results, and plans

The Integrated training Model in Plant And Compu-Tational Sciences (IMPACTS) NSF Research Training program at Michigan State University trains graduate students in the intersection of computational and plant sciences. Graduate students come from a wide range of programs, including basic and applied plant sciences as well as computer science, engineering, and mathematics. To support this program, a certificate program and three new courses have been established.

The first course in the series, Foundations in Computational and Plant Sciences, is an introductory course covering the basics of both plants and coding. Drs. Dan Chitwood and Robert VanBuren have created this course and its corresponding materials and have created “Plants and Python” as a public educational resource (Chitwood 2020a-b). This course also resulted in a class publication from the students’ work in its first year (Bryson et al. 2020), and will again in year two (currently in preparation).

The second course in the series, Frontiers in Computational and Plant Sciences, is designed to be entirely hands-on small group projects, with 3 modules. These modules typically encompass three broad areas:

Module 1: Genomics, genetics, bioinformatics, gene expression analysis

Module 2: Image analysis, high throughput phenotyping, phenomics, sensor data analysis

Module 3: Genotype-to-phenotype inferences, complex data structures, modeling and algorithms to combine data types

The specific projects rotate each year, and the course is taught every spring. From the course catalog description: “Interdisciplinary research topics interfacing computational and plant sciences. The topics include molecular systems biology, phenomics, and understanding the mechanisms underlying the connection between genotype and phenotype.”

The lead instructor is Dr. Addie Thompson. The co-instructor, Dr. Shin-Han Shiu, co-taught the first iteration of the course (Spring 2020) but is currently on sabbatical (Spring 2021); this was in fact the inspiration for this innovation. In Spring 2021, the course was re-structured to partner with individuals or groups with problem topics in these areas as the end "users" for each module, as well as with experts in data analytics to introduce the students to possible approaches.

As one example, the current module (Module 2, mid-semester Spring 2021) is with a Syngenta sweet corn breeder, on the topic of image analysis on ear traits. The first day of the module, experts from Syngenta came and described their dataset, as well as detailed all the questions they were hoping to address and the eventual applications/outcomes. The second day, Dr. Dirk Colbry, an image analysis expert from MSU, went through some basic concepts and examples of image analysis pipelines. The student groups then developed their plans and timelines and pitched their ideas and focus questions. After having some class periods to work, they will present a mid-project progress update, then a final presentation at the end to the breeders.

After the success of this initial trial run, this idea could be extended to other public and private partnerships. Once new modules are created, they could be adapted and made available to provide public educational modules and training datasets. Funding through this seed grant would cover a small percentage of a postdoctoral research associate to serve as a facilitator for the course that would work on creating the public versions of the modules and putting together code developed by students, as well as paying for computational resources to support the activities. This would also enable multiple ongoing interactions between students and industry partners through career workshops and internship opportunities.

Initial interactions with potential industry partners have been *overwhelmingly positive* and have helped shape some of the directions of this proposal. Enthusiasm has been felt from all sides – private partners, students in the course, IMPACTS trainers, professors in computational and/or plant sciences that area eager to participate (4 expert guests will be joining for Module 3 later this semester!), and PIs at other institutions interested to implement this approach – once fully established – at other institutions. This work could be highly impactful outside of MSU for multiple levels of scientific training, but the additional time and effort required to establish public resources from these modules would not be possible without seed funding.

b) Describe how the project will further the aims of the AG2PI and the basis for evaluating the success of the project

Some of the important relevant goals and challenges identified by AG2PI include: “the integration of multiple sources and types of data” and “the need to train junior researchers and stakeholders for the benefit of US agriculture and society.” (from the AG2PI website)

This project seeks to build on the initial success of a pilot innovation in AG2P training and create resources that are available to the public.

Survey-based metrics for perceived success, usefulness, and applicability of the new modules from student, instructor, and guest instructor (both “users” and “experts”) perspectives. Specifically, gauging student progress toward established course objectives, including students’ ability to:

- initiate, manage, and complete interdisciplinary group projects in computational plant biology.
- learn and apply cutting-edge methods of big data analysis to address grand challenge problems interfacing computational and plants sciences using computational/quantitative thinking.
- improve skills in project management, and particularly verbal and written communication across disciplines.

Success of the project will also be measured based on the achievement of the objectives (see above) and production of the tangible deliverables (see below).

c) Expected outcomes and deliverables

This is a win-win-win opportunity in that it provides:

- Cutting-edge training in Agricultural G2P data analytics for graduate students
- Public educational resources for scientific communities
- Solutions and open-source code for current cutting-edge AG2P science questions
- Access to big datasets for others to develop and test their own approaches
- Direct connections between industry and interested students and researchers doing AG2P work, among other potential benefits.

As for educational outcomes of the course, graduate students will be able to:

Gain project management, collaboration, and leadership skills by working in interdisciplinary teams; effectively communicate across disciplines through frequent interactions with team members; gain practical experiences for addressing challenging problems interfacing computational and plant sciences by working on example projects that require significant infusion of both computational and biological thinking; and gain practical experiences for handling, analyzing, and relating biological big data from genomic, phenomic, and other sources.

Tangible deliverables will include:

- Established relationships with at least 3 private industry partners, including career workshops
- At least 3 course modules – complete with datasets, introductions, and code – successfully developed, implemented, and made publicly available via GitHub
- At least one publication, describing the established innovations in education and training

d) Qualifications of the project team

Addie Thompson is an assistant professor in the Plant, Soil & Microbial Sciences department and Plant Resilience Institute. She is the lead instructor for CSS 844 Frontiers in Computational and Plant Sciences and a trainer for the IMPACTS program, in addition to teaching other graduate courses at MSU. She is also the lead PI for a funded interdisciplinary initiative at MSU focused on plant phenomics (MSU Strategic Partnership Grant “Enabling Innovations in Plant Phenomic Data Acquisition and Analysis”) that brings together more than 20 experts in

computational and plant sciences across 13 different departments. She is passionate about AG2P education/training and outreach at all levels, as well as diversity-equity-inclusion initiatives. The Thompson Lab frequently interacts with middle/high school student groups, undergraduate clubs and organizations, student researchers at all levels, graduate student groups, farmer groups, and the public. Success in the proposed initiative would impact all of these groups.

Postdoctoral research associate (TBD) is currently in the interview phase of the hiring process. All candidates have considerable experience in AG2P fields, including genomics and cutting-edge phenomic data analytics and coding, and strong interest in gaining professional experience in teaching and curriculum development.

Co-PI Tammy Long (see letter of collaboration) is an associate professor and Director of Undergraduate Studies in Plant Biology, as well as the current program Co-Director, and curriculum committee member for the NSF Research Training IMPACTS program. She conducts research in biological and transdisciplinary teaching and learning (see recent examples: Emery et al. 2019, Pelaez et al. 2018, and Trujillo et al. 2018) and has extensive experience in meaningful evaluation of innovative educational approaches. Her expertise will be critical to this project.

Senior Personnel Jyothi Kumar currently serves as an internal evaluator (with Co-PI Long) for NRT-IMPACTS and has worked with professional evaluators to develop instruments and methods (e.g., surveys, focus group and interview protocols, etc.) for obtaining programmatic feedback and data about project outcomes and progress. With IMPACTS, Kumar and Long have worked with project personnel at all levels to not only communicate evaluative feedback, but to strategize and enact programmatic and curricular changes based on findings.

Industry partners (see letters of collaboration) are the primary points of contact for their respective companies that will work in partnership with Thompson and Postdoc to identify experts and datasets for proposed activities.

e) Proposal timeline

Summer 2021 – Establish and maintain industry contacts, including both agricultural and data sciences. Begin to recruit speakers and schedule career discussions. Start module development by identifying topics, industry partners, datasets, and public sector experts, and generate tentative schedule for Fall 2021 and Spring 2022.

Fall 2021 – Finalize and facilitate industry career workshops (at least 3) for computational and plant science students. Invite current and former trainees as well as MANRRS students. Consider extending invitations to graduate students external to MSU, e.g. 2-3 other plant NRT programs across the US, if allowed by industry partners (case by case basis). Continue module development and finalize datasets and schedules in preparation for Spring 2022.

Spring 2022 – Implement course modules for CSS 844, Frontiers in Computational and Plant Sciences in collaboration with public and private experts. Develop established course modules – both inputs (data) and outputs (code) – as public educational resources for use by other scientific communities. Write up publication describing the novel educational approach as well as the resources generated.

f) Description of how the project will engage the AG2P scientific communities and underrepresented groups

Trainers and trainees in the programs benefited by this project will be presenting their work at scientific conferences in both computational/data sciences as well as plant/agricultural sciences. The resultant publication(s) and resources, including datasets and code, will be publicly available and promoted throughout AG2P scientific communities. Participants and leadership on this project would be eager and willing to establish partnerships and interactions with other successful AG2P educational seed projects (e.g., projects to establish catalogs of resources, or to hold training workshops). In addition, PI Thompson will *enthusiastically* speak about this project to any AG2P participants or affiliated groups at relevant events or conferences.

The IMPACTS program intentionally seeks diverse participants, both funded and unfunded, and successfully maintains diversity in gender, race/ethnicity, expertise/training, and other aspects. This will ensure that the initial benefactors of this project will be a cross-cutting sample of trainees. As we branch out beyond IMPACTS students – which we hope to do almost immediately! – our initial point of partnerships for our career panel workshops in Fall 2021 will be with Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS). Thompson has prior experience working with MANRRS, particularly with former MS student Eli Huggis who worked to help establish a new Junior MANRRS program for Detroit area high school students.

Larger grant proposals are currently underway (Thompson as a co-PI with lead PI Chitwood) through the NSF that include training partnerships of IMPACTS with multiple universities in Mexico that would add international trainees to the program. This is outside the scope of seed funding for this proposal, but if both grants are successful, having the module resources and industry partnerships in place (via this proposal) would enable direct interaction and transfer/extension between the two courses. Additionally, outreach and mentoring partnerships with mid/high school and undergraduate programs geared at minority and underrepresented students such as AIMS-B (ANR Institute for Multicultural Students – Bilingual) and MAP (Multicultural Apprenticeship Program) are included in this larger proposal. Thompson Lab has conducted student workshops and hosted summer student researchers from these groups in previous years.

2. Bibliography/References cited

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<https://www.youtube.com/playlist?list=PLm24WzvMepbelAyiwL1zsnwSHUCMxP9Uc>

Chitwood 2020b Plants and Python github repository:
<https://github.com/DanChitwood/PlantsAndPython>

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MSU chapter of Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS):
https://www.canr.msu.edu/academics/undergraduate/student_organizations/minorities-in-agriculture-natural-resources-and-related-sciences

ANR Institute for Multicultural Students – Bilingual (AIMS-B):
https://www.canr.msu.edu/academics/pre_college/anr_institute_for_multicultural_students-bilingual_aims-b/index

Multicultural Apprenticeship Program (MAP):
https://www.canr.msu.edu/academics/pre_college/multicultural_apprenticeship_program_map/index