Instructors:
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- Lizhi Wang, Associate Professor, Iowa State University
- Reka Howard, Assistant Professor, University of Nebraska Lincoln
- Deniz Akdemir, Michigan State University
- John Cameron, Iowa State University
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Learning objectives:
- Participants will learn how to clearly state objectives and translate these into mathematical objective functions.
- Participants will learn how to discern when to use optimization models, experimental treatment designs, simulation models or combinations of all three.
- Participants will learn how to use available software to find optimal solutions to the objective functions and how to interpret the results.

Keywords:
Genetic Improvement, Genetic Gain, Cultivar Development, Cultivar Placement, Objectives, Optimization Models, Descriptive Models, Simulation Models, Response Surface Methods, Decision Variables, Parameters, Constraints, Feasible Solutions, Optimal Solutions

Pedagogy:
- Case Studies
- Team Based Learning

Venues:
- Online
- On campus
Program:

Sunday May 21

19:00 Informal gathering for dinner. Location TBD

Monday May 22

9:00 Introductions and team assignments
9:30 Plugin, login and network registration
10:00 Session 1. Introduction to Optimization
   - Learning Objectives, Topics and Pedagogy
   - Overview of Operations Research
     - Interesting examples from Operations research
   - Overview of Operations Research for Plant Breeding
     - Demonstration 1: Trade-offs between male and female line development in a CMS Hybrid Crop
     - Demonstration 2: Maximize farm profitability using linear programming
     - Hands-on first case: Optimize seed production from winter nurseries for field trials using linear programming
12:00 Lunch
13:00 Session 2. Response Surface Methods
   - Learning Objectives
   - Overview of Response Surface Methods (RSM)
     - 3 dimensional example
     - Treatment design
     - Steepest ascent method, searching on the response surface
   - Demonstration 2.1: Steepest ascent for four factors using R – Optimization of yield affected by 4 attributes
   - Hands-on Case 2.1: Optimization of profit from yield
17:00 Dismiss
18:00 Dinner
Tuesday May 23

8:00  Plugin, login

8:15  Session 2: Response Surface Models continued.
    •  Case 2.2: Optimization of yield for a qualitative trait

10:00  break
    •  Demonstration 2.2: Response Surface Methodology for comparing methods in Genomic Prediction

10:45
    •  Case 2.3: Treatment design with center points

11:45  Summarize Session 2

12:00  Lunch

13:00  Session 3: Trait Introgression
    3.1 Framework of Cost, Time, Probability of Success
    •  Learning Objectives,
    •  Overview of Single Gene introgression
    •  Demonstration 3.1 Selection for gene only
    •  Demonstration 3.2 Selection for gene and background

15:00  break
    •  Case 3.1: Introduction of the cost, time, and probability of success (CTP) model framework for Single Gene Trait conversion with trade-offs among objectives

16:45  Summarize Case 3.1

17:00  Dismiss

18:00  Dinner
Wednesday May 24

8:00   Plugin, login
8:15   Session 3.2 Multi-gene introgression
       - Learning Objectives,
       - Overview of multi-gene introgression
       - Demonstration 3.3 gene stacking
       - Case 3.2: CTP framework for multi-allele conversion from single and multiple sources using the recently published Predicted Cross Value.

10:00  break
11:45  Summarize Case 3.2
12:00  Lunch
13:00  Session 3.3 Multi-gene introgression with a fixed budget
       - Markov Decision Processes introduction, definitions, components and backwards induction for solving
       - Demonstration 3.4: Simple example for MDP
       - Demonstration 3.5: Simple example for trait introgression with MDP

15:00  Break
       - Demonstration 3.6: Complex example of MDP: fixed budget allocation for multi-allele conversion from single and multiple sources and the recently published Predicted Cross Value.
       - Case 3.3: Use of MATLAB tools to solve a fixed budget allocation for multi-allele stacking.

16:45  Summarize Session 3
17:00  Dismiss
18:00  Dinner
Thursday May 25
8:00    Plugin, login
8:15    Session 4: Maximize genetic gain while minimizing loss of genetic diversity
        4.1: Introductory Concepts
        - Learning Objectives
        - Portfolio Optimization
        - Portfolio selection problem and Markowitz efficient portfolio
        - Quadratic optimization, multi-objective optimization concepts
        - Efficiency frontier
        - Demonstration 4.1 simple example
10:00   break
10:15   4.2 Selection and loss of genetic diversity
        - Genomic selection
        - The optimization problem, solution
        - Demonstration 4.2 simple example
11:45
12:00   Lunch
13:00   4.3 Efficient breeding by genomic mating
        - The optimization problem
        - GenomicMating R package
        - Demonstration 4.3 simple example
        - Demonstration 4.4 more complex example
16:45   Summarize Session 4
17:00   Dismiss
18:00   Dinner
Friday May 26
8:00 Plugin, login
8:30 Participant optimization cases

10:00 break
10:15 Suggested improvements
12:00 Lunch and dismiss