Multi-Omic Integration for AI Genomic Prediction Breeding Under Different Approaches: Past, Present and Future

PROGRAM & OUTLINES

July 10-14, 2023 | Gainesville, FL

conference.ifas.ufl.edu/moiai

UF|IFAS
UNIVERSITY of FLORIDA

AGRONOMY
DEPARTMENT

Multi-Omic Integration for AI Genomic Prediction Breeding Under Different Approaches: Past, Present and Future

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WI-FI INFORMATION

Network: ufguest

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Name Badge

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UF|IFAS
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WELCOME ATTENDEES!

Thank you for joining us for the Multi-Omic Integration for AI Genomic Prediction Breeding Under Different Approaches: Past, Present and Future Short Course!

On behalf of the University of Florida, the Institute of Food and Agricultural Sciences, and the Agronomy Department, welcome to the first - Multi-Omic Integration for AI Genomic Prediction Breeding Under Different Approaches: Past, Present and Future - short course. This short course brings together experts, researchers, students, and other stakeholders to learn more about the implementation of genomic data and other data types for improving applied prediction breeding.

This course is intended for research scientists from the private sector and public institutions interested in learning the foundations of different prediction frameworks considering the integration of multiple omics of information (or layers) with applications in plant and animal breeding. The course will demonstrate the development and utilization of prediction models in plant breeding programs and how to implement these at different stages of the breeding pipeline. The focus of the course is to facilitate to attendees the foundations of the different paradigms (parametric, non-parametric AI) in which these implementations are based. Participants will learn the basis for modeling trait performance of genotypes assisted by the integration of multiple data types 'omics' considering different approaches (parametric, non-parametric/Artificial Intelligence (AI), AI crop growth models, etc.)

We are proud of the lineup of instructors who are experts in the field working in specialized topics/crop species/developments/etc. This is a great opportunity for not only learning from the experts, but also for the exchange of ideas and networking. We look forward to a successful week of connection and learning!

Sincerely,

Diego Jarquin
Course Coordinator

AGRONOMY DEPARTMENT

COURSE INSTRUCTORS

Dr. Diego Jarquin
Assistant Professor
UF/IFAS Agronomy

Integration and Application of AI and Omics in Plant Breeding

One of the biggest challenge of the humanity is to ensure the current and future food supply chain of a growing population in a world that is facing more often and extreme environmental variations. The contributions of Dr. Jarquin research program are relevant to the society because these are helping to the development of improved (more productive, resistant to biotic and abiotic stress, etc.) genotypes by the integrating artificial intelligence (AI) methods and multi-omics analyses in plant breeding. Dr. Jarquin's program is focused on the development of interpretable AI methods and related disciplines (biostatistics, quantitative genetics, and modeling) that can be applied to large multi-omics data sets for providing solutions to complex plant breeding and plant systems biology questions. More specifically, these developments are oriented to find new ways of driving genetic improvement and biological insights designing and optimizing methods for plant breeding, leveraging information from multiple facets of plant biology—physiology, agronomy, and biochemistry to quantitative genetics and multi-omics (genomics, transcriptomics, proteomics, metabolomics and high throughput phenotyping), and provide novel solutions to unravel the biological basis of complex traits for plant breeding programs.

Dr. Charlie Messina
Professor
UF/IFAS Horticulture Sciences

Predictive Breeding

Charlie Messina is Professor in the Department of Horticultural Sciences at the University of Florida. His teaching and research program focuses on how to harmonize crop improvement and AI efforts for agricultural systems to regenerate the environment while providing nutrition security, improve human health and adapt to climate change. His team evaluates and applies novel prediction methods and systems within operational breeding programs. During his tenure at Corteva Agriscience he contributed to the development of drought tolerant maize in the U.S. and Brazil, which is now grown in >10MM acres.

Dr. Esteban Rios
Assistant Professor
UF/IFAS Agronomy

Forage Breeding and Genetics

Dr. Rios research program meets a critical need for society as the demand for animal-based products is exponentially growing, particularly in subtropical and tropical regions where population growth is more pronounced. The U.S. is the world's largest beef producer and cattle production accounts for more than $78 billion in sales annually. However, feed represents the highest cost component of beef production and accounts for 40-60% of production costs. The interest in utilizing improved forages in pastures, versus grain-fed approaches, is driven by economic factors, followed by environmental and social consciousness. Improved forages contribute to↩

reducing greenhouse gas emissions from the livestock sector, in addition to sequestering carbon in soil to mitigate climate change. My specialization in plant breeding and genetics, quantitative genetics, and forage production are the foundation of my research questions to improve yield, nutritive value, abiotic and biotic stress tolerance in forage species. I have two major goals in my program: 1) contribute to the livestock and agricultural industries by creating and releasing cultivars with higher yield and quality, and greater resilience to abiotic and biotic stresses, and 2) conduct theoretical and applied research in quantitative genetics and genomics to make the plant breeding process more efficient.

Dr. Jeremy Brawner
Assistant Professor
UF/IFAS Plant Pathology

Forest Health Genetic Resources, Quantitative Genetics and Genomics of Disease Resistance

Dr. Brawner's research program is focused on developing disease tolerant tree crops and his extension program delivers these varieties to a range of stakeholders. He works with forest and tree crop managers in Florida, the U.S., and abroad to develop more efficient disease screening and breeding programs. The goal of his research program is to develop disease screening systems and breeding programs that facilitate resistance gene selection into breeding programs. Many projects represent multi-disciplinary collaborations developed to have industrial and development outcomes, both domestically and abroad.

Dr. Claudio Fernandes
Postdoctoral Associate
UF/IFAS Agronomy

Forage Breeding and Genetics

Dr. Claudio Fernandes is a post-doctoral research scientist at the UF/IFAS Agronomy Department, specializing in plant breeding and genetics. He holds a Ph.D. in Plant Breeding and Genetics from the Universidade Federal de Lavras, where he worked on developing genotype by environment models for longitudinal datasets and incorporating enviromic data into genomic selection models for highly accurate results. His current research involves performing quantitative genetic analysis in bermudagrass to make decisions on cultivar releases and develop a panel of molecular markers. Additionally, he studies population structure and perform GWAS in the United States Department of Agriculture (USDA) collection. Along with this, he mentors graduate students and serve as a teacher assistant for data analysis and visualization using R language.

Dr. Felipe Ferrão
Research Assistant Scientist
UF/IFAS Horticultural Sciences

Blueberry Breeding, Statistical, Quantitative Genetics, Genomics

Dr. Ferrão is a quantitative geneticist for UF/IFAS Horticultural Sciences. His research is interested in incorporating statistics, genomics, metabolomics, and bioinformatics with the goal of understanding the genetic architecture of complex traits. In particular, he has focused his research on linkage and QTL mapping studies, genetic association, genomic prediction, and quantitative genetics applied to polyploid species. Most of his activities involve perennial outcrossing crops, in special, coffee and blueberry.

Dr. Luis Osorio

Biological Scientist IV
UF/IFAS Horticulture Sciences in GREC

Strawberry Breeding

Dr. Osorio is a research member of Dr. Whitaker's lab and has been working at the UF strawberry breeding program for 13 years. As a team member his main goal is to contribute to the selection and release of new and better strawberry varieties for the Florida industry and around the world. He participates in different stages of field selection as well as in the implementation of different models and methods of genomic selection in the strawberry breeding program. Dr. Osorio's research interests are on quantitative genetics including experimental design, estimation of genetic parameters, selection indices, genomic prediction and development of breeding strategies.

Dr. Marco Antonio Peixoto

Postdoctoral Researcher
UF/IFAS Horticulture Sciences

Sweet Corn Breeding and Genomics

Dr. Marco Peixoto is a quantitative geneticist who specializes in bridging statistical and genetic methods to enhance plant breeding programs. He is dedicated to developing algorithms and using advanced techniques to optimize quantitative traits and improve breeding programs. More specifically, Dr. Peixoto is applying genomic methods to sweet corn hybrid prediction, as well as using simulations tools and real data to harness long-term genetic gains while circumventing the decrease of variance by controlling inbreeding rates via cross usefulness prediction and mating plan optimization.

Dr. Marcio Resende

Assistant Professor
UF/IFAS Horticulture Sciences

Sweet Corn Breeding and Genomics

Dr. Resende has two active breeding programs working on the development of sweet corn inbreds and potato varieties that are aimed at addressing the concerns of the Florida growers. He is also interested in statistical genomics and quantitative genetic research that can increase genetic gains, increase efficiency and/or accelerate the breeding program. His lab has a strong research and training component in different 'omics' with an applied goal. Current projects include the use of metabolomics to predict food sensory panels, the development of genomic selection models to improve breeding and the analysis of transcriptome information for the detection of eQTLs.

Dr. Caio Canella Vieira

Assistant Professor
University of Arkansas

Soybean Breeder

Dr. Caio Canella Vieira is an Assistant Professor of soybean breeding at the University of Arkansas, currently leading the University's soybean breeding program. Before joining the University of Arkansas, Dr. Canella Vieira obtained his master's and Ph.D. in Plant Breeding, Genetics, and Genomics at the University of Missouri. He was involved in the development and release of over 20 soybean cultivars in Missouri and led the modernization of the soybean breeding program by prioritizing the use of data analytics and prediction models. His program in Arkansas targets the development and release of high-yielding conventional and herbicide-tolerant soybean cultivars with broad biotic and abiotic stressors tolerance, as well as improved seed composition. The program puts efforts into identifying and incorporating economic-important traits from genetically diverse accessions into modern, high-yielding genetic backgrounds. Substantial efforts are also made on maximizing the efficiency of the soybean breeding program through the implementation of genomic prediction and high-throughput phenotyping strategies throughout all stages of the pipeline.

Dr. Vance Whitaker

Professor
UF/IFAS Horticulture Sciences in GCREC

Strawberry Breeding

Dr. Whitaker develops strawberry varieties for Florida. His breeding program is enhanced through genetic research and through collaborations with the GCREC faculty team and Florida industry. Dr. Whitaker works closely with Florida Foundation Seed Producers, the Florida Strawberry Growers Association and Ekland Marketing Company to license and market UF/IFAS varieties in Florida and around the world. Dr. Whitaker conducts an applied research program in breeding and genetics, using both field and lab techniques. His research program is primarily aimed at the genetic characterization of important traits in strawberries and informing methods and strategies for developing newer and better cultivars. Few traits in cultivated strawberry are controlled by single genes, due to the complex genetics of this species. Therefore, the approaches of quantitative genetics are important for determining the types of genetic variance that contribute to economically important traits and how selecting one trait influences another trait. However, for some traits that are controlled by one or few genes, breeding is being enhanced through DNA marker technology.

DETAILED AGENDA

Monday, July 10, 2023 (Emerson Alumni Hall)	
1938 W University Ave, Gainesville, FL 32603	
7:30am–8:30am	Registration
8:20am–8:40am	Welcome and Introductions – Robert Gilbert, UF/IFAS Dean for Research - and - Dr. Gopal Kakani, Chair of the UF/IFAS Agronomy Department
8:40am–9:50am	Field Plot Designs I – Drs. Rios and Fernandez
9:50am–10:10am	AM Break
10:10am–11:30am	Field Plot Designs II – Drs. Rios and Fernandez
11:30am–12:30pm	Group Lunch
12:30pm–1:50pm	Intro to Genomic Selection (GS)- and Genomic Prediction (GP) Models (Bayesian Alphabet) – Drs. Resende and Jarquin
1:50pm–2:10pm	PM Break
2:10pm–3:30pm	GS I in a Clonally Propagated Fruit Crop (Strawberry) – Drs. Whitaker and Osorio
Tuesday, July 11, 2023 (Emerson Alumni Hall)	
1938 W University Ave, Gainesville, FL 32603	
8:30am–9:50am	Frequentist and Bayesian Additive Main and Multiplicative Interaction (AMMI) Models for Studying GxE – Dr. Jarquin
9:50am–10:10am	AM Break
10:10am–11:30am	Bayesian Factor Analytic and Other Covariance Structures – Drs. Peixioto and Jarquin
11:30am–12:30pm	Group Lunch
12:30pm–1:50pm	GxE Prediction Models Using Weather Data – Dr. Jarquin
1:50pm–2:10pm	PM Break
2:10pm–3:30pm	GS II in Forages (Alfalfa) – Dr. Rios
Wednesday, July 12, 2023 (Emerson Alumni Hall)	
1938 W University Ave, Gainesville, FL 32603	
8:30am–9:50am	Multi-Trait and Multi-Environment Strategies for GS – Drs. Resende, Peixoto and Jarquin
9:50am–10:10am	AM Break
10:10am–11:30am	Prediction of Time Related Traits/ Sparse Testing Designs – Dr. Jarquin
11:30am–12:30pm	Group Lunch
12:30pm–1:50pm	GS III in Autopolyploids (Blueberries) – Dr. Ferrão
1:50pm–2:10pm	PM Break
2:10pm–3:30pm	GS IV in Major Crops 1 (Maize) – Dr. Resende

Thursday, July 13, 2023 (Emerson Alumni Hall)	
1938 W University Ave, Gainesville, FL 32603	
8:30am–9:50am	Multi-Omic Integration for Continuous and Categorical Data – *Dr. Jarquin*
9:50am–10:10am	AM Break
10:10am–11:30am	Genomic Prediction Models for Predicting Hybrid Performance Using Genomic Information from Inbreds (GCA and SCA) – *Dr. Jarquin*
11:30am–12:30pm	Group Lunch
12:30pm–1:50pm	AI Methods for Genomic Prediction I – *Dr. Jarquin*
1:50pm–2:10pm	PM Break
2:10pm–3:30pm	GS V in Major Crops 2 (Soybean) – *Dr. Vieira*
Friday, July 14, 2023 (Emerson Alumni Hall)	
1938 W University Ave, Gainesville, FL 32603	
8:30am–9:50am	AI Methods for Genomic Prediction II – *Dr. Jarquin*
9:50am–10:10am	AM Break
10:10am–11:30am	Predicting Resistance, Virulence and Host by Pathogen Interactions – *Dr. Brawner*
11:30am–12:30pm	Group Lunch
12:30pm–3:30pm	DSSAT/ Crop Growth Models and AI – *Dr. Messina*
1:50pm–2:10pm	PM Break
3:30pm	Summer Short Course Concludes

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PRESENTATION OUTLINES

Outlines are listed in chronological order.

Field Plot Designs I & II

Monday, July 10, 2023 | 8:40am–9:50am | 10:10am–11:30am

Dr. Esteban Rios   Dr. Claudio Fernandes

OUTLINE

i. Introduction

ii. Principles of Experimental Design in Plant Breeding

    A. RCBD and Fundamentals of Experimental Design

    B. Making use of RCBD

iii. Designs

    A. Incomplete Block Designs

        1. Lattice Designs – *Hands on demo*

        2. α-Designs

    B. Blocking in Two Dimensions

        1. Row-Column Incomplete Block Design – *Hands on demo*

    C. Spatial Design and Analysis

        1. The use of Spatial Analysis in Plant Breeding

        2. Designing for Spatial Analysis – *Hands on demo*

    D. Partially Replicated Designs

        1. Control Plot Designs

        2. Augmented Designs – *Hands on demo*

iv. Discussion and Conclusions

Class Notes

Intro to Genomic Selection (GS) and Genomic Prediction (GP) Models (Bayesian Alphabet)

Monday, July 10, 2023 | 12:30pm–1:50pm

Dr. Marcio Resende   Dr. Diego Jarquin

OUTLINE

i.   Introduction to Genomic Selection (GS)/Genomic Prediction (GP)
ii. Factors Affecting GS Performance
iii. Prediction Accuracy and Cross-validation Scenarios
iv. Methods in GS: Bayesian Alphabet
v.   Practical Exercises

Class Notes

GS I in a Clonally Propagated Fruit Crop (Strawberry)

Monday, July 10, 2023 | 2:10pm–3:30pm

Dr. Vance Whitaker   Dr. Luis Osorio

OUTLINE

i. **Field Genetic Trials**
   A. Annual Genetic Trials
   B. Stage 1 – Seedling Population
   C. Stage 2 – Advanced Clonal Trials
   D. Stage 3 – Priority Selections

ii. **Genomic Selection (GS) Process**
   A. Breeding Cycle
   B. Genomic Selection
   C. Independent Validation of GS
   D. Effect of Relatedness on Predictive Ability
   E. Independent Validation Conclusions

iii. **Application of GS**
   A. Strawberry Breeding Applications
   B. Parental Selection
   C. GS of Resistance to Diseases
   D. GS of Biomass Indirect Traits
   E. Complex Genomic Prediction Scenarios
   F. Advantages of GS

iv. **Gs in Practice**
   A. Subjectively Evaluated Traits
   B. Deployment of Cultivars
   C. Rapid Cycle Breeding
   D. GS Timeline
   E. Perspectives on Parent Selection
   F. Acknowledgements

Class Notes

Frequentist and Bayesian Addictive Main and Multiplicative Interaction (AMMI) Models for Studying GxE

Tuesday, July 11, 2023 | 8:30am–9:50am

Dr. Diego Jarquin

OUTLINE

i. **Introduction**
   A. Use of Two-way Tables
   B. Revisiting the AMMI Model
   C. Iterative Least Squares
   D. Biplots
   E. Disadvantages

ii. **Bayesian AMMI Model**
   A. Likelihood and Prior Distributions
   B. Posterior Distributions
   C. Conclusions
   D. Hands on Exercise

iii. **Adding Prior Information**
   A. Matrix Formulation
   B. Posterior Distributions
   C. Hands on Exercise

iv. **Hierarchical Models**
   A. Inference on Super-population Parameters
   B. Posterior Distributions
   C. Hands on Exercise

Class Notes

Bayesian Factor Analytic and Other Covariance Structures

Tuesday, July 11, 2023 | 10:10am–11:30am

Dr. Marco Antonio Peixoto   Dr. Diego Jarquin

OUTLINE

i. **Use of Covariance Structures in Modelling**
ii. **Bayesian Factor Analytic Model**
iv. **Practical Exercises**

Class Notes

GxE Prediction Models Using Weather Data

Tuesday, July 11, 2023 | 12:30pm–1:50pm

Dr. Diego Jarquin

— OUTLINE —

i. **Introduction**
   A. Prediction of Complex Traits
   B. Conventional Approaches

ii. **Statistical Methods**
   A. G-BLUP Using SNPs
   B. GBLUP + Weather Data
   C. Adding SNPs × Weather Covariates Interactions
   D. Imperfect Data and Model Miss-specification

iii. **Data & Data Analysis**
   A. Data Description
   B. Models
   C. Empirical Assessment
   D. Results

iv. **Hands On Exercises**
   A. Covariance Structures
   B. Model Fitting
   C. Cross-validation
   D. Results

Class Notes

GS II in Forages (Alfalfa)

Tuesday, July 11, 2023 | 2:10pm–3:30pm

Dr. Esteban Rios

OUTLINE

i.   **Introduction to Forage Breeding**
ii. **Genomic Prediction in Family Bulks**
iii. **Incorporating Enviromics to Predict Complex Traits**
iv. **Genomic vs. Phenomic Prediction Models**
v.   **Discussion and Conclusions**

Class Notes

Multi-Trait and Multi-Environment Strategies for GS

Wednesday, July 12, 2023 | 8:30am–9:50am

Dr. Marcio Resende   Dr. Marco Antonio Peixoto   Dr. Diego Jarquin

OUTLINE

i. **Genomic Best Linear Unbiased Prediction (GBLUP): Models with Multivariate and Multi-environment Information (MTME)**

ii. **Factors Enhancing Prediction Accuracy in MTME Implementation**

iii. **Practical Exercises**

Class Notes

Prediction of Time Related Traits/ Sparse Testing Designs

Wednesday, July 12, 2023 | 10:10am–11:30am

Dr. Diego Jarquin

OUTLINE

i. **Correcting Bias and Resource Allocation**

ii. **Prediction of Time Related Traits**
   - A. Precision vs. accuracy
   - B. Bias
   - C. Model development
   - D. Results
   - E. Hands on exercise

iii. **Sparse Testing Designs**
   - A. Resource Allocation
   - B. Training Set Composition
   - C. Training Set Size
   - D. Data Analyses (Several Crops)
   - E. Hands on Exercise

Class Notes

GS III in Autopolyploids (Blueberries)

Wednesday, July 12, 2023 | 12:30pm–1:50pm

Dr. Felipe Ferrão

OUTLINE

i. **Introduction**

ii. **Polyploid**
- A. What is a Polyploid?
- B. Estimating Allele Dosages
- C. Quantitative Genetics: Diploid vs. Polyploid

iii. **Genomic Selection 1.0: Present and Past in Blueberry**
- A. Blueberry Breeding
- B. Is GS Better than Pedigree Analyses?
- C. How to Implement GS in Polyploid?
- D. What are the Best Predictive Models?
- E. Unifying GS and Biological Discovery

iv. **Genomic Selection 2.0: Present and Future**
- A. Optimization: How low can we go?
- B. GS for Non-gaussian Traits
- C. Multi-omic Prediction
- D. AI for Blueberry

v. **Conclusion**
- A. Main Lessons

Class Notes

GS IV in Major Crops 1 (Maize)

Wednesday, July 12, 2023 | 2:10pm–3:30pm

Dr. Marcio Resende

OUTLINE

i. **Models and Strategies for Genomic Selection in Maize Breeding**

ii. **Use of Simulations to Optimize Genomic Selection in Maize Breeding**

Class Notes

Multi-Omic Integration for Continous and Categorical Data

Thursday, July 13, 2023 | 8:30am–9:50am

Dr. Diego Jarquin

OUTLINE

i. **Multi-omic Integration - Prediction**

ii. **Multi-omic Integration for Continous Data**

    A. Issues Combining Different Data Types

    B. Dimensionality

    C. Covariance Structures

    D. Interactions Between Data Types

    E. Model Assessment

    F. Hands on Exercise

iii. **Multi-omic Integration for Categorical Data**

    A. Binary Responses

    B. Integration of Different Data Types

    C. Proposed Model

    D. Data Analyses and Results

    E. Hands on Excersice

Class Notes

Genomic Prediction Models for Predicting Hybrid Performance Using Genomic Information from Inbreds (GCA and SCA)

Thursday, July 13, 2023 | 10:10am–11:30am

Dr. Diego Jarquin

OUTLINE

i. **Using Genomic Data from Inbreds**

ii. **Model Terms**
   A. General Combining Ability (GCA)
   B. Specific Combining Ability (SCA)
   C. GCA in Interaction with Environmental Factors
   D. SCA in Interaction with Environmental Factors
   E. Models

iii. **Data Analyses**
   A. Results
   B. Conclusions

iv. **Hands on Exercise**
   A. Computing GCA Matrices
   B. Computing SCA Matrices
   C. Interactions
   D. Linear Predictors
   E. Fitting Models

Class Notes

AI Methods for Genomic Prediction I

Thursday, July 13, 2023 | 12:30pm–1:50pm

Dr. Diego Jarquin

OUTLINE

i. **Reproducing Kernel Hilbert Spaces**
   A. Distances
   B. Kernel Trick
   C. Smoothing
   D. Hands on Exercise

ii. **Intro to Artificial Neural Networks and DL**
   A. Inspiration of the Neural Network Approach
   B. Elements of the Neural Networks
   C. Activation Functions
   D. Simple Example

Class Notes

GS V in Major Crops 2 (Soybean)

Thursday, July 13, 2023 | 2:10pm–3:30pm

Dr. Caio Canella Vieira

OUTLINE

i. **Public Soybean Breeding Pipeline**

    A. Overview of Breeding Goals

    B. Early in the Pipeline

    C. Progeny Rows

    D. Multi-environment Yield Trials

    E. Regional Trials

ii. **Genomics Applied to Breeding Research**

    A. Soybean Resistance to Root-knot Nematode

    B. Machine Learning-based GWAS

    C. Soybean Tolerance to Off-target Dicamba

    D. Implementing G×E in GWAS

    E. Impact of Model Overfitting

iii. **Genomics Applied to Cultivar Development**

    A. Opportunities to Implement Genomics

    B. Progeny Rows Yield Prediction

    C. Soil-derived Covariates Enhance Predictions

    D. Maximize Resource Allocation in Yield Trials

    E. Sparse Testing

Class Notes

AI Methods for Genomic Prediction II

Friday, July 14, 2023 | 8:30am–9:50am

Dr. Diego Jarquin

OUTLINE

i. **Artificial Neural Networks (ANN) and Deep Learning (DL) for Genomic Prediction**
   A. Optimization of a Single Parameter
   B. The Chain Rule
   C. Optimizing All Parameter
   D. Example of DL for Genomic Prediction

ii. **Random Forest**
   A. Introduction
   B. Decision and Classification Trees
   C. Regression Trees
   D. Building and Evaluating Random Forests
   E. Hands on Exercise

Class Notes

Predicting Resistance, Virulence and Host by Pathogen Interactions

Friday, July 14, 2023 | 10:10am–11:30am

Dr. Jeremy Brawner

OUTLINE

i. **Introduction & Background**

ii. **Developing Durable Disease Resistance**
   - A. Qualitative Resistance
   - B. Gene for Gene Interactions
   - C. Model 1
   - D. Model 2
   - E. Resistance Breakdown

iii. **Experimental Design and Prediction Models**
   - A. Experimental Connectivity
   - B. Genomic Connectivity Host Population
   - C. Genomic Connectivity Pathogen Population
   - D. Host by Pathogen Interactions
   - E. Stability of Resistance and Virulence

iv. **Worked Example**
   - A. Phenotype and Genotype Summary
   - B. Relatedness Within Populations
   - C. Reaction Norm Predictions
   - D. Factor Analytic Covariances
   - E. Developing Durable Disease Resistance

Class Notes

DSSAT/ Crop Growth Models and AI

Friday, July 14, 2023 | 12:30pm–3:30pm

Dr. Charlie Messina

OUTLINE

i. Crop Modeling for Breeding Applications
   A. Why Crop Models in Breeding?
   B. Crop Modeling Foundations
   C. Emergent GxE
   D. ABC of Crop Model Genomic Selection

Class Notes

ADDITIONAL INFORMATION

Internet Access

To access Internet in the meeting space, follow these instructions on your device:

1. Connect to the network "ufguest"
2. You will be directed to the UF Guest Network Acceptable Use Policy.
3. Click on "Accept AUP and Connect"

Name Badge

Your name badge serves as your admission to all functions while attending the short course.

Morning Coffee, Breaks & Lunches

Networking functions will be held in the break room. Early morning coffee will be available from 7:30am-8:30am. Mid-morning and afternoon breaks provide complimentary beverages and light snacks. A full, 60-minute lunchtime on Monday through Friday provides allows ample time for attendees to network and connect with colleagues.

Cell Phones, Mobile Devices, Tablet Devices

Please mute your cell phones, laptops, tablets, and mobile devices while in the meeting room. Please respect the instructors' wishes not to share certain sensitive data on social media. Please do not photograph or share on social media.

Lost & Found

If you lose or find an article, check with the onsite registration staff.

Covid Safety

Our aim is to promote a safe and inclusive meeting, and we ask all attendees to help keep our community, and those in our lives outside of the short course healthy and well. While masking and social distancing is voluntary, we do expect all attendees to honor and respect the choices of others during the meeting.

Code of Conduct

All meeting participants must agree to follow our Code of Conduct when they register. We welcome you to join, sustain, foster, and help grow our inclusive and supportive environment. The full code of conduct can be found on our website, **conference.ifas.ufl.edu/code-conduct.php**

Medical Emergency and Safety Information:

In the event you experience any type of emergency, please dial 911 to summon medical assistance or to contact authorities.

NOTES

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Logistics for this short course are organized and managed
by the **UF/IFAS Office of Conferences & Institutes**.