

**AREC 615: Optimization Methods for Applied Economics**  
**Colorado State University**  
**Clark A206**  
**Tuesday and Thursday, 9:30 am-10:45 am**  
**Fall, 2020**

**Course Syllabus**

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OH: Tuesday, 1pm-2pm, Thursday, 1pm-2pm, and by appointment—I will hold a Teams Meeting during these times; in-person meetings can be requested

Final Exam: Monday, 12/14/2020, 9:40-11:40am (if it's take-home, due by 5pm 12/14)

Midterm Exam: 10/15/2020 in class (or other 1 hour, 15 min block on that day)

TA: Siddharth Kishore

siddharth.kishore@colostate.edu

OH: Mondays and Wednesdays, 12:30-1:30pm and by appointment, using Teams

You should all have access to a Team group called AREC 615, which is a subgroup of CAS DARE Online Instruction.

### **Course Description**

This course is for graduate students interested in applied economics. I assume you have some background in economic theory. Content will provide an overview of optimization methods used in economics, with an emphasis on numerical techniques such as coding basics, linear and nonlinear programming, and dynamic optimization. We will become familiar with these numerical techniques in applied settings while emphasizing appropriate interpretation of results. Generally, examples used in class will be relevant to students interested in environmental, resource, and agricultural economics, though methods are more widely applicable.

### **Course Objectives**

This course has 3 objectives. First, you should become familiar with numerical optimization methods available for solving economic problems. This includes setting up, solving, and interpreting model output. Next, you should become comfortable using a computer software. I will use the program R in class, but you are free to use your preferred program (e.g., Matlab, Python, GAMS). Finally, students should be able to develop a mathematical programming model of behavior in a range of applied settings. Students will write a short paper that develops and solves a programming model in a context of their choosing. Even if your dissertation/thesis does not contain a programming model, the work in this class should inform the development of hypothesis tests and interpretation of reduced form econometric modeling.

## COVID-Specific Course Information

This class is available in-person as long as the university allows it. Students also have the option to take the course online, with synchronous participation *highly encouraged*. This allows for real-time interactions and questions that benefit individual students but also the class as a whole. Lectures will be broadcast live using Teams (or other technology). In addition, the in-person lectures will be recorded and posted on Canvas for later viewing.

If you are participating online, please monitor Canvas for announcements and informal assignments that may arise (e.g., introductions). Lectures will be posted here as well. You will be held accountable for the same material as the in-class participants.

Each student will present to the class twice after the Thanksgiving break. We will find these times early in the semester so you can plan accordingly (or make other accommodations). If you cannot participate in your classmates' presentations, you can provide written comments (details coming soon).

If the class moves online, I will continue to hold class synchronously through Teams (or other software), with recordings posted afterwards.

**Important information for Students: All students should fill out a student-specific symptom checker each day before coming to class** (<https://covidrecovery.colostate.edu/daily-symptom-checker/>). In addition, please utilize the symptom checker to report symptoms, if you have a positive test, or if you have been exposed to a known COVID contact. If you know or believe you have been exposed or are symptomatic, it is important for the health of yourself and others that you report it through this checker. You will not be in trouble or penalized in any way for reporting. If you report symptoms or a positive test, you will receive immediate instructions on what to do and CSU's Public Health Office will be notified. Once notified, that office will contact you and most likely conduct contact tracing, initiate any necessary public health requirements and/or recommendations and notify you if you need to take any steps. For the latest information about the University's response, please visit the CSU COVID-19 site (<https://covidrecovery.colostate.edu/>).

## Prerequisites

According to the DARE website, AREC 506 (Applied Micro Theory) is the prerequisite for this class. In practice, this means that I assume you have seen the basics of producer, consumer, and general equilibrium theory and have solved analytical constrained and unconstrained optimization problems. I do not, however, assume that you have developed an optimization model on your own or used numerical methods to solve these problems.

## Textbooks

I will use one book for linear programming methods but will draw from several when discussing other numerical methods such as nonlinear programming and dynamic optimization. I may also ask you to read other articles but will make those available on Canvas. Finally, each of you will choose an article to present to the class after the Thanksgiving break.

The linear programming book is *Applied Mathematical Programming Using Algebraic Systems*. It is self-published by Bruce McCarl and Thomas Spreen and is available online at <http://agecon2.tamu.edu/people/faculty/mccarl-bruce/books.htm> . It is also on Canvas.

Other textbooks I will use include:

Kaiser, Harry and Kent Messer. *Mathematical Programming for Agricultural, Environmental, and Resource Economics*

Judd, Kenneth. *Numerical Methods in Economics*.

Miranda, Mario and Paul Fackler. *Applied Computational Economics and Finance*, 2002.

### **Grading**

Grades will come from a **mid-term** (15%), a **final** (20%), a **paper review and presentation** (10%), about 6 **homework assignments** (25%), a **modeling paper\*** (25%), and **participation** (5%). The midterm will be 'in class' but the final will likely be a take-home exam. I will hand out a homework assignment about every 2-3 weeks and specify a due date (you will have approximately 2 weeks per homework). You can collaborate on homework and turn in one problem set per 2 people, but exams must be done entirely independently. I encourage you to participate in office hours if additional help is needed. Homework answer keys will be available for most problem sets and should help in preparing for the midterm and final.

I will give grades based on a percentage score but use a curve to ensure that the average grade is approximately a B+.

\*More details to follow but this assignment will likely have several parts, including a proposal, and final draft.

*If you are a student who will need accommodations in this class due to a disability or chronic health condition, please make an appointment with me to discuss your individual needs. Any accommodation must be discussed in a timely manner prior to implementation. A verifying accommodation letter from Resources for Disabled Students is required before any accommodation is provided. Student Disability Center <https://disabilitycenter.colostate.edu/> located in TILT, room 121 or via phone 970-491-6385.*

## Main Course Topics (Tentative—based on last year)

1. Modeling basics/intro
  - a. Uses
  - b. Problem setup and components
  - c. R intro
2. Linear programming
  - a. Solution methods
  - b. Interpretation
  - c. Duality
  - d. Input-output models
3. Nonlinear programming
  - a. Positive mathematical programming (PMP)
  - b. Solution methods
  - c. Computable general equilibrium (CGE) models

Midterm, 10/15, likely in class

- d. Stochasticity/Risk
4. Dynamic optimization
  - a. Intro to dynamics
  - b. Dynamic programming
  - c. Optimal control
5. Other methods (if time and interest)
  - a. Rootfinding
  - b. Function approximation
  - c. Integer programming
  - d. Numerical integration/differentiation
6. Student presentations
  - a. Paper review
  - b. Modeling project

# Principles of Community

The Principles of Community support the Colorado State University mission and vision of access, research, teaching, service and engagement. A collaborative, and vibrant community is a foundation for learning, critical inquiry, and discovery. Therefore, each member of the CSU community has a responsibility to uphold these principles when engaging with one another and acting on behalf of the University

## Inclusion:

We create and nurture inclusive environments and welcome, value and affirm all members of our community, including their various identities, skills, ideas, talents, and contributions.

## Integrity:

We are accountable for our actions and will act ethically and honestly in all our interactions.

## Respect:

We honor the inherent dignity of all people within an environment where we are committed to freedom of expression, critical discourse, and the advancement of knowledge.

## Service:

We are responsible, individually and collectively, to give of our time, talents, and resources to promote the well-being of each other and the development of our local, regional, and global communities.

## Social Justice:

We have the right to be treated and the responsibility to treat others with fairness and equity, the duty to challenge prejudice, and to uphold the laws, policies and procedures that promote justice in all respects.

## **Mental Health statement**

### Need Help?

CSU is a community that cares for you. If you are struggling with drugs or alcohol and/or experiencing depression, anxiety, overwhelming stress or thoughts of hurting yourself or others please know there is help available. Counseling Services has trained professionals who can help. Contact 970.491.6053 or go to <http://health.colostate.edu>. If you are concerned about a friend or peer, tell someone at by calling 970.491.1350 to discuss your concerns with a professional who can discreetly connect the distressed individual with the proper resources (<http://supportandsafety.colostate.edu/tellsomeone>). Rams take care of Rams. Reach out and ask for help if you or someone you know is having a difficult time.

### Sexual Assault and Violence Elimination

CSU's Student Sexual Harassment and Violence policy, following national guidance from the Office of Civil Rights, requires that professors follow CSU policy as a "mandatory reporter" of any personal disclosure of sexual harassment, abuse, and/or violence related experiences or incidents shared with the professor in person, via email, and/or in classroom papers or homework exercises. These disclosures include but are not limited to reports of personal relational abuse, relational/domestic violence, and stalking. While professors are often able to help students locate appropriate channels of assistance on campus (e.g., see the CSU Health Network link below), disclosure by the student to the professor requires that the professor inform appropriate CSU channels to help ensure that the student's safety and welfare is being addressed, even if the student requests that the disclosure not be shared.

For counseling support and assistance, please see The CSU HEALTH NETWORK, which includes a variety of counseling services that can be accessed at: <http://www.health.colostate.edu/>. And, The Sexual Assault Victim Assistance Team is a confidential resource for students that does not have a reporting requirement and that can be of great help to students who have experienced sexual assault. The web address is <http://www.wgac.colostate.edu/need-help-support> .