

# OR 604: Practical Optimization

## George Mason University

Department of Systems Engineering and Operations Research

Spring 2015

**Time:** Tuesdays 7:20 PM to 10:00 PM

**Classroom:** Room 1110, Nguyen Engineering Building

**Professor:** Dr. Steven Charbonneau

**Phone:** (202) 418-4016 (work) from 08:30 AM to 5:30 PM

(703) 550-5006 (home) from 6:30 PM to 9:00 PM

**Email:** scharbo2@gmu.edu

**Office hours:** By appointment

**Text:** *Optimization in Operations Research, Rardin, R.L., Prentice Hall, 1998.*

**Software:** You will need to download and configure software for this course. Before downloading and installing all of the software listed in this syllabus, scan the [Gurobi Quick Start Guide](#) to figure out the order and sequence of software to be loaded.

Gurobi – We will use Gurobi as our optimization library. I recommend you use the latest version of Gurobi (currently 6.0). If you already have 5.6 loaded, it will be well worth it to upgrade your license to 6.0. There is no reason not to upgrade since it is free for academic users (you are an academic user if you are taking this course). You will need to register on the Gurobi website to download the software. Go to [www.gurobi.com](http://www.gurobi.com) to register and download your academic license. HEADS UP: You will need to be on campus to activate your software. Please have your version of Gurobi loaded and activated before class starts.

Python – You can use either 2.7 or 3.X for the course. Be aware the professor is using 2.7. If you are new to Python specifically (or programming in general) it is recommended that you use 2.7 so you can receive help. If you chose to use 3.X, be advised it is NOT backwards compatible with 2.7 – YOU WILL BE RESPONSIBLE FOR MODIFYING YOUR CODE TO MAKE IT COMPATIBLE WITH 2.7 SO THE PROFESSOR CAN GRADE YOUR WORK. Download your preferred version of the software from <https://www.python.org/downloads/>.

PyScripter IDE – An integrated Development Environment (IDE) is optional but highly encouraged. PyScripter is the IDE supported by Gurobi and the one your professor uses. If you use a different IDE, it is likely Gurobi will work, but not guaranteed. Download PyScripter from the following location: <http://code.google.com/p/pyscripter/>. Follow directions from the

[Gurobi Quick-Start Guide](#) on how to install PyScripeter, Python, and Gurobi to ensure all three packages work together (start reading on page 98).

**SQLite Studio** – This is an optional piece of software. Those of you who are inexperienced with or not well versed in Structured Query Language (SQL) may find this a useful tool. It is a graphical user interface and database management tool for SQLite (the database library that ships with Python). By using this software you will be able to test your SQL commands and statements before you run them in your Python routines. To download a copy of SQLite Studio go to <http://sqlitestudio.pl>

**Course Description:** This course builds on the techniques learned in Analytics and Decision Analysis (OR 531). As data of huge sizes becomes ubiquitous, analysts must learn to set up, formulate, solve, and interpret prescriptive models of unprecedented size. This course describes optimization techniques and codes capable of working in the Big Data setting. The course will use state-of-the-art optimization packages coupled with programming languages and databases suitable for big data analysis. The course covers model formulation, convexity, linear programming, integer programming, and heuristic methods. *Computer programming skills are not required to take this course. Be advised, however, that you will be writing and running your own code for each homework assignment. If you do not know how to write code, you will be provided the resources and opportunity to learn. This means you will have to allocate more time to this course in the beginning of the semester than your peers. I have taught similar courses to many people with no prior programming skills and have been successful. If you have concerns, contact the professor before the course starts so you may discuss your concerns with him.*

**Course Objectives:** This course focuses on developing student skills in the formulation and implementation of large-scale optimization models. At the end of this course, students will be able to:

- Formulate large-scale optimization models by taking advantage of the regular structure of families of constraints
- Solve large-scale optimization models by employing advanced techniques and heuristics that allow generally intractable problems to solve
- Take advantage of the advanced features of optimization engines
- Set up, read from, and write to databases using SQL statements run from a programming language
- Create and run routines in Python that can be used to formulate and solve optimization problems.

**Course Schedule:** The course schedule is subject to change as the course progresses. Modifications will be posted on blackboard.

Lecture	Date	Topic	Prep Work
Lesson 01	20 January, 2015	Course Overview and Mathematical Modeling Review	Read: Chapters 1 and 2 Prepare: <ul style="list-style-type: none"> <li>Download and test all required software</li> <li>Review Skill Builder 1 if you are very new to Programming in an IDE</li> <li>Complete the <a href="#">Python Basic Tutorial</a> section “Basic Syntax” through “Loops”</li> </ul>
Lesson 02	27 January, 2015	Linear Programming – Part I	Read: Chapter 4 Prepare: <ul style="list-style-type: none"> <li>Complete the <a href="#">Python Basic Tutorial</a> section “Numbers” through “Dictionary”</li> <li>Complete Skill Builder 2: Using sqlite</li> <li>Familiarize yourself with the <a href="#">sqlite tutorial website</a>.</li> </ul>
Lesson 03	3 February, 2015	Linear Programming – Part II	Read: Chapter 4 (again)
Lesson 04	10 February, 2015	Integer Programming – Part I	Read: Section 5.1 through Section 5.7
Lesson 05	17 February, 2015	Integer Programming – Part II	Read: Section 5.1 through 5.7 (again)
Lesson 06	24 February, 2015	Multi-Objective Optimization	Read: Chapter 8
Lesson 07	3 March, 2015	Duality and Sensitivity Analysis	Read: Chapter 7
<b>Spring Break</b>			
Lesson 08	17 March, 2015	Discrete Optimization Methods	Read: Chapter 11
Lesson 09	24 March, 2015	Finding Initial Feasible Solutions	Read: Chapter 12
Lesson 10	31 March, 2015	<b>No Class</b>	
Lesson 11	7 April, 2015	Improving Model Performance Through Heuristics	Read: TBD

Lesson 12	14 April, 2015	Bender's Decomposition – Part I	Read: TBD
Lesson 13	21 April, 2015	Bender's Decomposition – Part II	Read: TBD
Lesson 14	28 April, 2015	Distributed Computing and Meta-heuristics	Read: TBD

**Grading Scheme:**

Homework: 90%

Class participation: 10%

**Coursework & Grading:** Unless otherwise indicated, you are expected to work individually on homework assignments. You must submit homework directly to me via email at [scharbo2@gmu.edu](mailto:scharbo2@gmu.edu).

**Academic Integrity:** GMU is an honor code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task on your own. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit, in writing, as a cover document to your homework submission. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

**GMU Email Accounts:** Students must use their Mason email accounts to receive important University information, including messages related to this class. See <http://masonlive.gmu.edu> for more information.

**Additional Notes:** I will make every effort to use Blackboard to post homework, assignments, lecture notes, and grades. I will send out email notices each time I have uploaded new information to blackboard. Failure to turn in homework on the due date will result in a 0% for that submission. Best way to contact the professor is by email.

The following is a great source for getting started on Python and SQL: The GMU library has an academic subscription to Safari Books Online; a repository of technical books on programming, big data, math, and all sorts of IT subjects. These are books (from publishers like Wrox, Sams, and O'Reilly) you generally would spend between \$50 and \$150 if you wanted to buy your own

copy. As an academic license, it is limited in its features (cannot bookmark or highlight pages) but it is an excellent resource. Get to it from the following URL and use your GMU credentials to log on:

<https://login.gmu.edu/login?service=https%3a%2f%2flogin.mutex.gmu.edu%2flogin%3furl%3dezp.2aHR0cDovL3Byb3F1ZXN0LnNhZmFyaWJvb2tzb25saW5lLnNvbS8.dWljY2RlPjZpdmE->