

ISyE 4134 CONSTRAINT PROGRAMMING

Concentration Selective Elective for OR and Analytics and Data Sci.

Format, 3 – 0 – 3

Coordinator: Professor Pascal Van Hentenryck, 2023

Prerequisites: ISyE 3133 with concurrency, CS 2316

Texts and other resources

PDFs of the lecture slides will be made available on the course website for you to print out and take to class if you wish. It is recommended that you take notes on and save these copies, as they will be a valuable resource for the project.

The OPL Studio system will be available for your assignments. It contains a sophisticated online documentation that should help design the projects.

Catalog Description

This course is an introduction to constraint programming, from its modeling language to its computational methodology and its applications to scheduling, routing, and resource allocation.

Topics outlines

Topics	Wks
Basic Concepts (Week 1): Getting started, basic concepts I, basic concepts II, OPL primer	1
Elements of Constraint Programming (Week 2): Reified constraints, Optimization, Expressions	1
Theoretical Foundation (Week 3): Computational Model	1
Global Constraints (Week 4): The element constraint, the table constraint, combinatorial Constraints, the pack constraint, the circuit constraint, the lex constraints	1
Modeling in Constraint Programming (Week 5): Symmetry breaking, subexpression elimination, redundant constraints I, redundant constraints II,	1
Search in Constraint Programming (Week 6): Search tree and impact, restart and nogoods	1
Implementation of Constraint Programming (Week 7): Packing, AllDifferent, NoOverlap	1
Scheduling in Constraint Programming (Week 8-12): Interval variables and noOverlap, The sequence constraints, cumulative constraints, the house problem II, the house problem III, the perfect square problem, state constraints, the trolley application, optional activities, standard scheduling problems, calendars	5
Advanced Topics (Week 13): Large neighborhood search, scripting models, routing, CP in Python	1

Topics	Wks
Implementation in MiniCP (Week 14): Semantics of CP, operational model of CP, inference, search, advanced inference, advanced search	1
Total	14

Course Learning Outcomes and Relationship to BSIE Program Outcomes

By the end of this course the students should

1. Understand the modeling methodology and computational paradigms underlying constraint programming.
2. Understand how to use constraint programming to model and solve problems in a variety of engineering and scientific fields.
3. Understand the fundamental properties of good constraint programming models and how they differ from other methodologies.
4. Be able to determine when and how to use constraint programming to solve practical applications.
5. Be able to model and solve practical applications with constraint programming in areas such as scheduling, routing, and resource allocation.
6. Achieve fluency in the modeling language OPL for constraint programming and its derivatives in Python.
7. Recognize when additional features (e.g., new constraints and dedicated search procedures) are necessary to solve a problem and understand what this involves.

The Mapping from the Course Outcomes to ABET Student Learning Outcomes

The table below shows the relationship between course outcomes and ABET student learning outcomes. The table has 8 columns. The first column lists the course learning outcomes listed above. The next 7 columns list the abbreviated ABET Student Learning Outcomes. The entry of H in a row with specific course learning outcome and column with specific ABET Student Learning Outcomes indicate the importance of attaining this outcome is high and will be assessed.

Course outcome \ Program Outcomes	1. identify, formulate solve engg prob by engg, sci & Math	2. produce solutions consider public health, safety, welfare, global, cultural, social, environ &	3 communicate with a range of audience	4 recognize ethical & professional responsibilities, make informed judgement consider resolutions in global, economic, environ and	5. effective on a team provide leadership, collaborative and inclusive environ, plan tasks & meet objectives	6. develop and conduct experiment, analyze and interpret data & use engineering judgement to draw conclusions	7. acquire and apply new knowledge using appropriate learning strategies
1. Understand the modeling methodology and computational paradigms underlying constraint programming.							
2. Understand how to use constraint programming to model and solve problems in a variety of engineering and scientific fields.		M					
3. Evaluate monetary and environmental costs and benefits of technology choices (by exam)						M	
4. Be able to determine when and how to use constraint programming to solve practical applications.							
5. Be able to model and solve practical applications with constraint		M					

Course outcome \ Program Outcomes	1. identify, formulate solve engg prob by engg, sci & Math	2. produce solutions consider public health, safety, welfare, global, cultural, social, environ &	3 communicate with a range of audience	4 recognize ethical & professional responsibilities, make informed judgement consider resolutions in global, economic, environ and	5. effective on a team provide leadership, collaborative and inclusive environ, plan tasks & meet objectives	6. develop and conduct experiment, analyze and interpret data & use engineering judgement to draw conclusions	7. acquire and apply new knowledge using appropriate learning strategies
programming in areas such as scheduling, routing, and resource allocation.							
6. Achieve fluency in the modeling language OPL for constraint programming and its derivatives in Python.							
7. Recognize when additional features (e.g., new constraints and dedicated search procedures) are necessary to solve a problem and understand what this involves.							

Evaluation of the important course outcomes

This elective course will not be used for assessing Student Outcomes.