University of Regina, Department of Computer Science
CS 890BR Constraint Programming, Syllabus for Spring/Summer 2021

Course Information

Instructor: Dr. Sultan Ahmed

Lectures: Lectures will be delivered in asynchronous mode. Lecture videos will be uploaded to UR Courses on a weekly basis.

Office: Tuesday and Thursday from 12:00 pm to 1:00 pm.
Monday and Wednesday from 4:30 pm to 5:30 pm.
ZOOM link will be provided.

Students can email instructor anytime at sultan.ahmed@uregina.ca . Emails will typically be replied on the same day. Please do not send email in the UR Courses email as I do not check UR Courses often.

Marker: TBD

Grading Scheme

4 Assignments X 5.....20%
Final exam (online) 40%
Project 40%
Total 100%

Schedule

Task	Due date/Scheduled date
Assignment 1	May 14, 2021
Assignment 2	May 25, 2021
Assignment 3	June 4, 2021
Assignment 4	June 15, 2021
Final exam	June 25, 2021
Project proposal	July 3, 2021
Project report	August 12, 2021
Project presentation	August 19, 2021

Recommended Textbooks

Krzysztof R. Apt, Principles of Constraint Programming, Cambridge University Press, 2003.

Rina Dechter, Constraint Processing, Morgan Kaufmann, 2003.

Topics

Introduction: Constraint Programming, its characteristics, and applications

CSP Modelling: Basic concepts of CSP, cryptarithmetic problems (SEND+MORE=MONEY), the N-Queens problem, the Zebra puzzle, the Crossword puzzle, Qualitative temporal reasoning, Qualitative spatial reasoning, Constrained Optimization Problems, the Knapsack problem

A Basic Constraint Programming Framework: Projections and Equivalence of CSPs, solved and failed CSPs; a basic framework and its components, preprocess, atomic, split, heuristics, proceed by cases,

backtracking, branch and bound, constraint propagation; Boolean constraints example; Polynomial constraints example

Constraint Solver: A proof theoretic framework, equivalence preserving, domain reduction rules and transformation rules, rule applications, derivation; Alphabet, term equations, substitution, composition, unification problem, most general unifier, Martelli-Montanari algorithm; Linear equations over reals, linear expressions and equations, normal form, pivot form, Gauss-Jordan elimination algorithm, Gaussian elimination algorithm

Local Consistency: Node consistency; arc consistency, hyper arc consistency, directional arc consistency; path consistency, directional path consistency

Search: Search trees, labeling trees, complete labeling trees, reduced labeling trees, Propagation labeling trees; forward checking, partial look ahead, maintaining arc consistency; Backtrack-free search, Backtrack-free search with constraint propagation, Backtrack search, Backtrack search with constraint propagation, branch and bound algorithm, branch and bound algorithm with constraint propagation; Heuristics, variable ordering, value ordering

Constrained Optimization with Qualitative Preferences: representation of preferences using CP-net, semantics, forward sweep procedure, dominance testing, divide and conquer method, Search-CP algorithm; Partial CP-net, Search-Partial-CP algorithm; CPR-net, Search-CPR algorithm; LP-tree, Search-LP algorithm

Project

A project can be any of the following types:

1. Development of some novel theoretical idea, related to constraint programming.
2. Experimental study of some method, covered in class or related to constraint programming.
3. Literature review (or survey) on a topic directly related to constraint programming. Some typical topics would be on arc consistency, path consistency, backtrack search, branch and bound algorithm, constraint propagations, preference-based constrained optimization, multi-objective optimization, constrained CP-net, constrained LP-tree, etc.

Hints. For the type 3 above, papers from the following conferences or journals are preferable (not necessary):

1. International Conference on Principles and Practice of Constraint Programming (CP)
2. International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research
3. Constraints, an International Journal (https://www.springer.com/journal/10601)
4. Papers related to Constraint Programming, from IJCAI, AAAI, ICTAI, or Canadian AI conference.
5. Papers related to Constraint Programming, from Artificial Intelligence journal (https://www.journals.elsevier.com/artificial-intelligence) or Journal of Artificial Intelligence Research (https://www.jair.org/index.php/jair).

A project of any type above will be chosen by the student, and approved by the instructor.

Grading in project:

1. Project proposal (10%): Every student is expected to write one page (single spaced, times new roman font with 11pt) proposal. An additional page may be allowed for references only if needed. The proposal should highlight – a clear title, what to do, why, and how.
2. Report (20%): The student is expected to write a 10 pages (single spaced, times new roman font with 11pt) report. Typically, the report will consist of Abstract, Introduction, Background Knowledge, what the student has accomplished, and Conclusion. Abstract should be a paragraph, in which the summary of the achievement should be outlined. In Introduction, the student starts with General Knowledge, states the problem, and briefly describes accomplishment. Background Knowledge contains the necessary topics which are needed to explain the Accomplishment section. In Accomplishment, the student should explain detail what they have done and achieved. The Conclusion should summarize the report, and should mention some related future works.
3. Presentation (10%): Each student will prepare the slides for a 20 minutes presentation. The student should present remotely, and record. Then, the video should be uploaded to UR Courses or Youtube.

Some additional notes

1. UR Courses should be used for all assignments submission, final exam, and project submission. It is the responsibility of students to make sure that the submitted material has been successfully uploaded to UR Courses before the due date. This can be checked by viewing the uploaded files. Email and Hardcopy submissions are not accepted.

2. Late assignments are not accepted for any reason and will receive a mark of 0.

3. A student can discuss the assignment with other students but MAY NOT read, copy, or exchange other student's assignment. Students are encouraged to read the Section on academic misconduct of the Graduate Calendars.