Motivation: Constraint processing has been introduced three decades ago and has been used to represent a wide range of problems, from scheduling and timetabling problems to VLSI layout design. All of these problems share a common representation which is very general - Constraint Satisfaction Problems (CSPs) and Constraints Optimization Problems (COPs). Another field of growing interest is that of Distributed CSPs & COPs. Here the variables are owned by a set of constrained agents, each holding some variables, and the search for a solution becomes a distributed algorithm. Agents exchange messages and follow a distributed protocol in order to find cooperatively a satisfiable complete assignment or an optimal one.

General: The course will introduce the field of Constraint Programming in short and will focus on Intelligent Search Algorithms for solving constraints satisfaction and optimization problems (also called constraint processing). All of the main search algorithms for CSPs and COPs will be discussed and a selected few will be implemented by the students. The last third of the course is dedicated to distributed constraints processing (or distributed constraints reasoning – DCR). The DCSP & DCOP chapter will form the basis for the final project. The course includes programming assignments, a Final Paper, and a Bohan but no final exam.
1. Introducing Constraints Satisfaction Problems:
   1. Assignment problems and constraint networks
   2. Arc & Path consistency; Famous properties - solvability (E. Tsang CSP book ch. 1-3)
   3. Preprocessing algorithms: arc consistency (E. Tsang ch. 4)

2. Constraints Programming
   1. Bounds consistency; Constraint Logic Programming (intro. from Mariott + ECLP)”
   2. Optimization - simple and full cases of the Branch & Bound algorithm

3. Intelligent backtracking of the search space (Prosser ’93)
   1. BackJumping; Forward Checking; Conflict-based BackJumping; Hybrids
   2. Variables and Value ordering heuristics
   3. Comparing algorithms (Kondrak Thesis)
   4. Dynamic Backtracking (Ginzburg’93)

4. Introduction to Constraints Optimization Problems – COPs
   1. Branch & Bound for MaxCSPs
   2. Lookahead for COPs

5. Experimental behavior of algorithms and problems (2 papers)

6. Local search for assignment problems:
   1. Hill climbing; Simulated annealing; TABU search (2 review papers)
   2. non-local stochastic search - Genetic Algorithms

7. Distributed Constraints Networks
   1. What are DCSPs - a synchronous search algorithm
   2. Asynchronous search algorithms
   3. Distributed constraints optimization problems (DCOPs) and search algorithms
   4. Comparing algorithm behaviors – distributed performance measures
The marking of the course will be the combined mark of the programming assignments, Bohan, and final paper listed below. The Final Papers assignments will not be identical among all students. A requirement of the course is a passing mark in the Bohan.

a. First assignment – Implementing a simple search algorithm (10%)
   Week 6 -

b. Second assignment - Implementing and comparing COP algorithms (10%)
   Week 8 -

c. Bohan - Week 10 (30%)
   Chapters 1-5

d. Third assignment - Implementing and comparing an advanced search algorithm (10%)
   Week 11 -
   Comment: If only 2 programming assignments are given, the marks are 15% + 15%

e. Final paper (40%)