PAPERS LIST

In this document, we provide a list of papers to be presented at the Seminar in Combinatorial Optimization 2016A (comop161). The papers will be presented in the specified order, grosso modo.

Papers by weeks:

1. **Focus**: Introduction, Frameworks and Competitions
   a. **Report**: ParadisEO-MO: From Fitness Landscape Analysis to Efficient Local Search Algorithms
   b. **Report**: MaxSat Evaluations: Survey & Recent Results

2. **Focus**: Heuristics
   a. **Paper**: A Multilevel Tabu Search for the Maximum Satisfiability Problem
   b. **Paper**: CCLS: An Efficient Local Search Algorithm for Weighted Maximum Satisfiability
   c. **Section**: Simulated Annealing; Section 2.4 in “Metaheuristics: from design to implementation”
   d. **Lecture note**: Derandomization: MOCE and MOPE; Lecture 16 in UBC CPSC 536N “Randomized Algorithms”

3. **Focus**: Walsh Analysis and Summary Statistics
   b. **Paper**: Polynomial Time Summary Statistics for a Generalization of MAXSAT
   c. **Paper**: A Polynomial Time Computation of the Exact Correlation Structure of k-Satisfiability Landscapes

4. **Focus**: Landscape Analysis
   a. **Paper**: Fitness landscapes and memetic algorithm design
   b. **Paper**: Problem Understanding through Landscape Theory
   c. **Paper**: Maximum Satisfiability: Anatomy of the Fitness Landscape for a Hard Combinatorial Optimization Problem

ParadisEO-MO: From Fitness Landscape Analysis to Efficient Local Search Algorithms

Abstract

This document presents a general-purpose software framework dedicated to the design, the analysis and the implementation of local search algorithms: ParadisEO-MO. A substantial number of single-solution based local search metaheuristics has been proposed so far, and an attempt of unifying existing approaches is here presented. Based on a fine-grained decomposition, a conceptual model is proposed and is validated by regarding a number of state-of-the-art methodologies as simple variants of the same structure. This model is
then incorporated into the ParadisEO-MO software framework. This framework has proven its efficiency and high flexibility by enabling the resolution of many academic and real-world optimization problems from science and industry.

Reference

Miscellaneous
TBD

MaxSat Evaluations: Survey & Recent Results

Abstract
The Tenth Evaluation of Max-SAT Solvers (Max-SAT-2015) is organized as an affiliated event of the 18th International Conference on Theory and Applications of Satisfiability Testing (SAT-2015). The objective of the evaluation is assessing the state of the art in the field of Max-SAT solvers, as well as creating a collection of publicly available Max-SAT benchmark instances. The evaluation allows the submission of incomplete solvers in a Special Track, with the same three categories than for complete solvers, but with a reduced number of instances.

Reference
Josep Argelich et al. MaxSat Evaluations. Website.

Miscellaneous
1. عبر על אתר התחרות לשנת 2015. הצג את התחרות בפנים שציינו שימו כל אחד התחרות incomplete solvers.  
2. عبر על מטא מטא התחרות לשנת 2015. הצג את המר痣 על뢰 כל אחד המ有用 והרבות.  

A Multilevel Tabu Search for the Maximum Satisfiability Problem

Abstract
The maximum satisfiability problem (MAX-SAT) refers to the task of finding a variable assignment that satisfies the maximum number of clauses (or the sum of weight of satisfied clauses) in a Boolean Formula. Most local search algorithms including tabu search rely on the 1-flip neighbourhood structure. In this work, we introduce a tabu search algorithm that makes use of the multilevel paradigm for solving MAX-SAT problems. The multilevel paradigm refers to the process of dividing large and difficult problems into smaller ones, which are
hopefully much easier to solve, and then work backward towards the solution of the original problem, using a solution from a previous level as a starting solution at the next level. This process aims at looking at the search as a multilevel process operating in a coarse-to-fine strategy evolving from k-flip neighbourhood to 1-flip neighbourhood-based structure. Experimental results comparing the multilevel tabu search against its single level variant are presented.

Reference

Miscellaneous
1. קרא את המאמר והמר כריע על פרדיגמת ה multilevel tabu search במאמר MLV-TS. התוצאות שהופעלו במאמר שלב שני, לעומת שלב שלב.
2. עד כמה הופעלו במאמר tabu search ב התורה של multilevel tabu search במאמר שלפוף?
3. האם ח🗄ו ה التواصل בין המגזר הממוצע מקסימום?
4. האם מביעת את תרומת הפרדיגמט של multilevel tabu search במאמר שלפוף?
5. במידה והזזות מאפרוף, קרא את המאמר והמר כריע על סמך 2 מאמרים שמוים בציריפ אחר (איסנר 28)

CCLS: An Efficient Local Search Algorithm for Weighted Maximum Satisfiability

Abstract
The maximum satisfiability (MAX-SAT) problem, especially the weighted version, has extensive applications. Weighted MAX-SAT instances encoded from real-world applications may be very large, which calls for efficient approximate methods, mainly stochastic local search (SLS) ones. However, few works exist on SLS algorithms for weighted MAX-SAT. In this paper, we propose a new heuristic called CCM for weighted MAX-SAT. The CCM heuristic prefers to select a CCMP variable. By combining CCM with random walk, we design a simple SLS algorithm dubbed CCLS for weighted MAX-SAT. The CCLS algorithm is evaluated against a state-of-the-art SLS solver IRoTS and two state-of-the-art complete solvers namely akmaxsat_Is and New WPM2, on a broad range of weighted MAX-SAT instances. Experimental results illustrate that the quality of solution found by CCLS is much better than that found by IRoTS, akmaxsat_Is and New WPM2 on most industrial, crafted and random instances, indicating the efficiency and the robustness of the CCLS algorithm. Furthermore, CCLS is evaluated in the weighted and unweighted MAX-SAT tracks of incomplete solvers in the Eighth Max-SAT Evaluation (Max-SAT 2013), and wins four tracks in this evaluation, illustrating that the performance of CCLS exceeds the current state-of-the-art performance of SLS algorithms on solving MAX-SAT instances.
Abstract
Simulated annealing applied to optimization problems emerges from the work of S. Kirkpatrick et al. and V. Cerny. In these pioneering works, SA has been applied to graph partitioning and VLSI design. In the 1980s, SA had a major impact on the field of heuristic search for its simplicity and efficiency in solving combinatorial optimization problems. Then, it has been extended to deal with continuous optimization problems.

SA is based on the principles of statistical mechanics whereby the annealing process requires heating and then slowly cooling a substance to obtain a strong crystalline structure. The strength of the structure depends on the rate of cooling metals. If the initial temperature is not sufficiently high or a fast cooling is applied, imperfections (metastable states) are obtained. In this case, the cooling solid will not attain thermal equilibrium at each temperature. Strong crystals are grown from careful and slow cooling. The SA algorithm simulates the energy changes in a system subjected to a cooling process until it converges to an equilibrium state (steady frozen state). This scheme was developed in 1953 by Metropolis.

Reference

Miscellaneous
TBD
Derandomization: MOCE and MOPE; Lecture 16 in UBC CPSC 536N “Randomized Algorithms”

Abstract
In this lecture we discuss the topic of derandomization — converting a randomized algorithm into a deterministic one. One of the simplest methods for derandomizing an algorithm is the “method of conditional expectations”. In some contexts this is also called the “method of conditional probabilities”. Another method is the “method of pessimistic estimators”. In this lecture we describe these methods, and illustrate them with examples.

Reference

Miscellaneous
TBD

Genetic Algorithms and Walsh Functions: Part I, A Gentle Introduction

Abstract
This paper investigates the application of Walsh functions to the analysis of genetic algorithms operating on different coding function combinations. Although these analysis tools have been in existence for some time, they have not been widely used. To promote their understanding and use, this paper introduces Bethke's Walsh-schema transform through the Walsh polynomials. This form of the method provides an intuitive basis for visualizing the nonlinearities being considered, thereby permitting the consideration of a number of useful extensions to the theory in Part II.

Reference

Miscellaneous
TBD
Polynomial Time Summary Statistics for a Generalization of MAXSAT

Abstract
MAXSAT problems are notoriously difficult for genetic algorithms to solve. NK-landscapes are often used as test problems of scalable difficulty for genetic algorithms. In this paper we exploit the similar structure of the two problems to create an encompassing class of problems called embedded landscapes. Then we use Walsh analysis to explore the nonlinear bit interactions of these important test functions. We show that by applying Walsh analysis to embedded landscapes, several important summary statistics can be generated in polynomial time. We then use these techniques to discuss the statistical "shape" of both MAXSAT and NK-landscapes.

Reference

Miscellaneous
TBD

A Polynomial Time Computation of the Exact Correlation Structure of k-Satisfiability Landscapes

Abstract
The autocorrelation function and related correlation length are statistical quantities that capture the ruggedness of the fitness landscape: a measure that is directly related to the hardness of a problem for certain heuristic search algorithms. Typically, these quantities are estimated empirically by sampling along a random walk. In this paper, we show that a polynomial-time Walsh decomposition of the k-satisfiability evaluation function allows us to compute the exact autocorrelation function and correlation length for any given k-satisfiability instance. We also use the decomposition to compute a theoretical expectation for the autocorrelation function and correlation length over the ensemble of instances generated uniformly at random. We find that this expectation is invariant to the constrainedness of the problem as measured by the ratio of clauses to variables. However, we show that filtered problems, which are typically used in local search studies, have a bias that causes a significant deviation from the expected correlation structure of unfiltered, uniformly generated problems.

Reference
Miscellaneous
TBD

Fitness landscapes and memetic algorithm design

Abstract
The notion of fitness landscapes has been introduced to describe the dynamics of evolutionary adaptation in nature and has become a powerful concept in evolutionary theory. Fitness landscapes are equally well suited to describe the behavior of heuristic search methods in optimization, since the process of evolution can be thought of as searching a collection of genotypes in order to find the genotype of an organism with highest fitness and thus highest chance of survival.

Thinking of a heuristic search method as a strategy to navigate in the fitness landscape of a given optimization problem may help in predicting the performance of a heuristic search algorithm if the structure of the landscape is known in advance. Furthermore, the analysis of fitness landscapes may help in designing highly effective search algorithms. In the following we show how the analysis of fitness landscapes of combinatorial optimization problems can aid in designing the components of memetic algorithms. However, some of the presented concepts can also be utilized for the development of other search algorithms, including genetic algorithms and neighborhood search algorithms (e.g. simulated annealing and tabu search).

Reference

Miscellaneous
TBD

Problem Understanding through Landscape Theory

Abstract
In order to understand the structure of a problem we need to measure some features of the problem. Some examples of measures suggested in the past are autocorrelation and fitness-distance correlation. Landscape theory, developed in the last years in the field of combinatorial optimization, provides mathematical expressions to efficiently compute statistics on optimization problems. In this paper we discuss how can we use landscape theory in the context of problem understanding and present two software tools that can be used to efficiently compute the mentioned measures.

Reference
Miscellaneous
TBD

Maximum Satisfiability: Anatomy of the Fitness Landscape for a Hard Combinatorial Optimization Problem

Abstract
The fitness landscape of MAX-3-SAT is investigated for random instances above the satisfiability phase transition. This paper includes a scaling analysis of the time to reach a local optimum, the number of local optima, the expected probability of reaching a local optimum as a function of its fitness, the expected fitness found by local search and the best fitness, the probability of reaching a global optimum, the size and relative positions of the global optima, the mean distance between the local and global optima, the expected fitness as a function of the Hamming distance from an optimum and their basins of attraction. These analyses show why the problem becomes hard for local search algorithms as the system size increases. The paper also shows how a recently proposed algorithm can exploit long-range correlations in the fitness landscape to improve on the state-of-the-art heuristic algorithms.

Reference

Miscellaneous
TBD