Research Projects BSc 2013

Natural Computing Group

LIACS

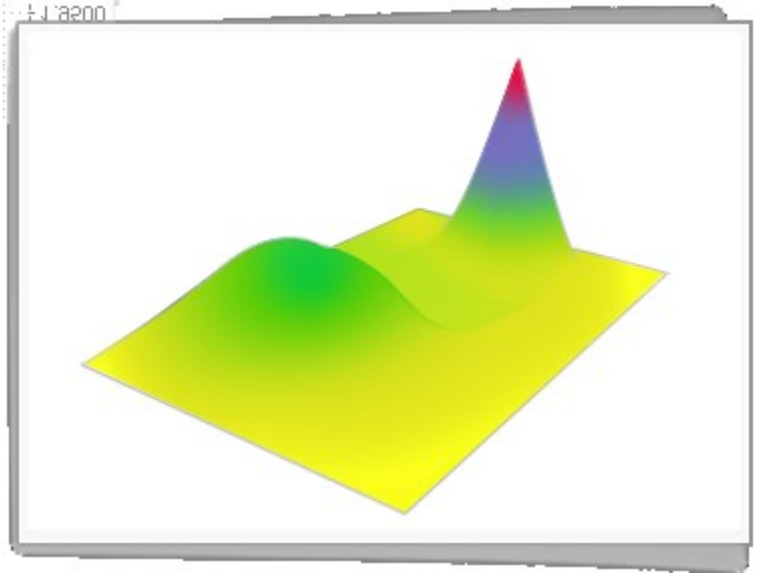
Prof. Thomas Bäck, Dr. Rui Li, Dr. Michael Emmerich

See also:

https://natcomp.liacs.nl

Research Project: Dynamic Updates in Robust Optimization

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Jürgen Branke
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl



Summary: Prerequisites (helpful, not mandatory):

Robust design optimization deals with finding stable optima. Testing the stability of an optimum can be extremely time consuming. Sampes can be recycled and overlap can be exploited in order to reduce complexity. Gibbs samplers can make this process very efficient. Dynamic updates are used in combinatorial optimization but not yet in robust optimization, and a study of this strategy might yield a high impact result.

- Interest and basic knowledge in statistical distributions, algorithm complexity, and calculus
- MATLAB , or C
- evolutionary algorithms

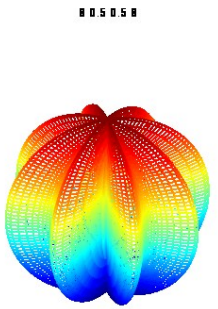
Research Project: Diversity Optimization

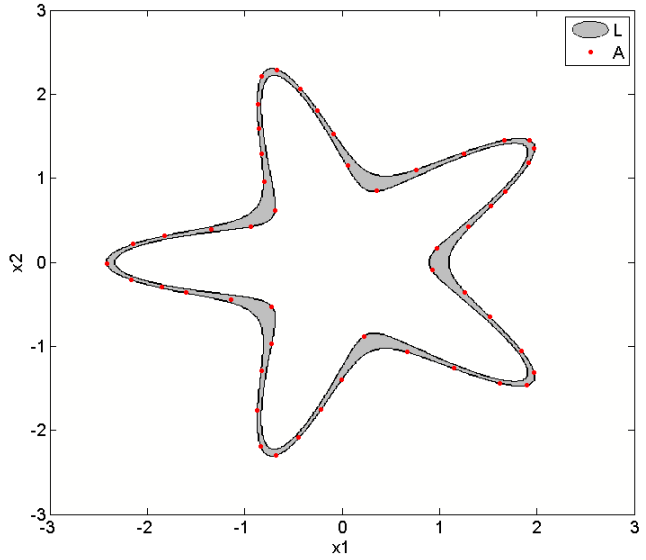
Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Iryna Yevseyeva
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

Summary: Prerequisites (helpful, not mandatory):

Finding a diverse set with prescribed properties can be formulated as an optimization problem. Since long diveresification plays an important role in minimizing risks for portfolios. But there is also a great potential in using diversification in optimization, in particular in constraint optimization and in cases where objectives give rise to alternative solutions that all require inspection. More recently Diversity has been put on a axiomatic basis and this has given rise to systematic algorithm design approaches for diversity optimization. First prototypes of such algorithms have been developed in LIACS and applied for drug-discovery. The assignment is to experimentally investigate these, for instance by approximating natural shapes represented in Gielies superformula.

Prerequisites: - Interest and knowledge in evolutionary algorithms, computer graphics





Research Project: Evolution in four dimensions: Can new insights from biological evolution theory enhance evolutionary algorithms?

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Patsy Haccou (biologist)
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

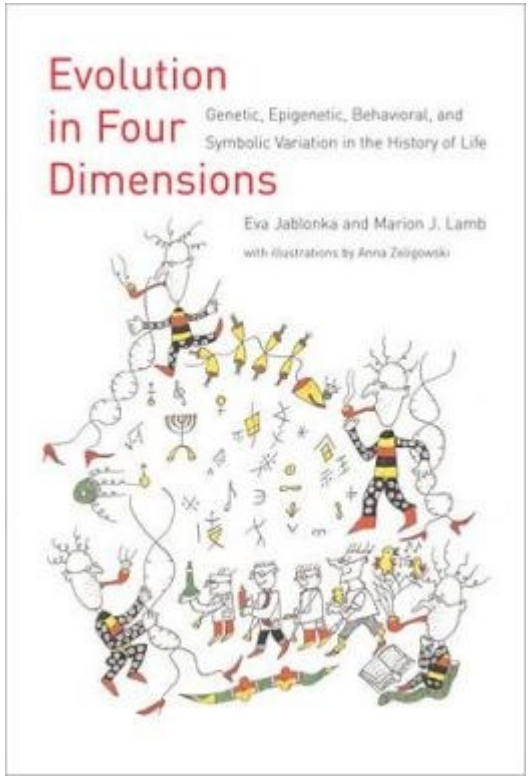
Note:The supervisor is a leading Researcher on this question and has developed HSSP selection for special cases. There are some ideas that can be tried.

Summary:

Whereas in the classical neo-darwinian model of evolution the variation of genes by mutation and recombination was considered the main innovation source in evolution, in a modern view besids genetic variation also epigenetic behavioral and symbolic variation are considered as driving forces of evolution. Moreover, in modern works the competitive advantage of certain traits are evaluated in a multiobjective and co-evolutionary setting. A recent trend in the design of evolutionary algorithms is to adopt some of the insights into the development of nature inspired adaptative algorithms. This research project is to assess recent developments in this direction, and optionally extend this work into the development of a nature inspired algorithm.

Prerequisites (helpful, not mandatory):

Interest in biology and algorithms, exploration of a wider topic



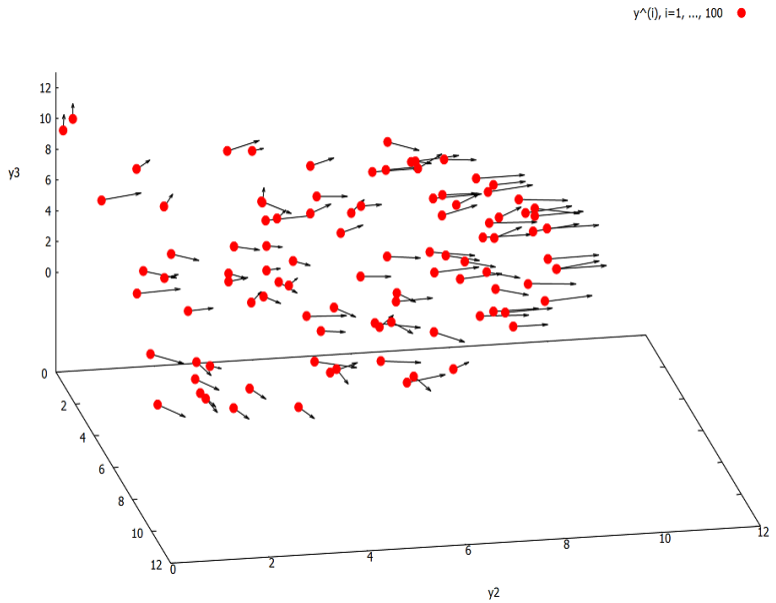
Research Project: Gradients in multiobjective optimization.

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. André Deutz
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

Note:The supervisor is a leading Researcher on this question and has developed HSSP selection for special cases. There are some ideas that can be tried.

Summary:

The hypervolume gradient is a field of vectors that point in the direction of maximal net-improvement of a Pareto front approximation in multiobjective optimization. The structure and computation of it has been described in 2013 by André Deutz and Michael Emmerich from Leiden university. It is expected that using the gradient information will significantly enhance continuous multiobjective optimization methods. The aim of the thesis is to develop gradient based algorithms for multiobjective optimization and test their performance on the state-of-the art set benchmarks, both in 2-D and 3-D.



Prerequisites (helpful, not mandatory):

Interest in optimization algorithms and numerics.

Bachelor Project:

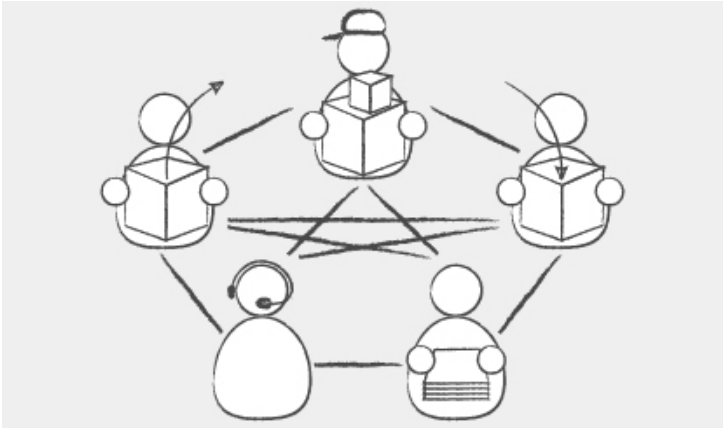
Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Zhiwei Yang
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

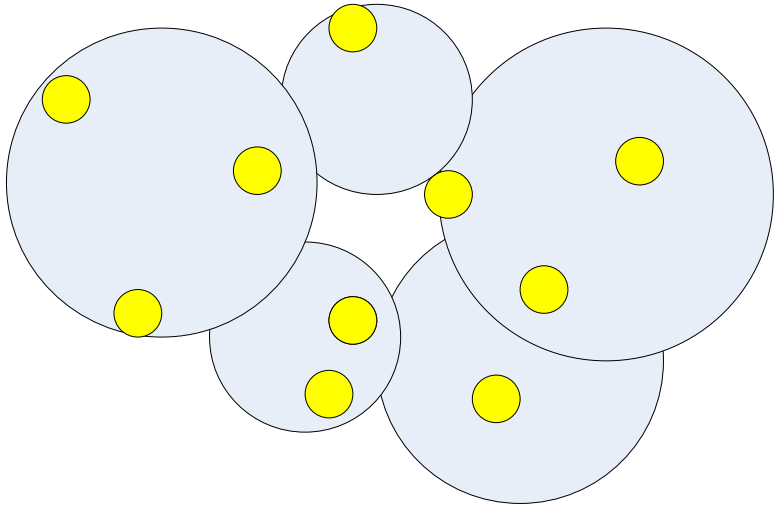
The project willl be a collaboration with DEAL Platforms, Rotterdam

Summary: Instance: n customers with different quantity of demand, and m depots with different capacity of serving customers. Objective: find minimize number of depots that can serve all the customers.

Prerequisites (helpful, not mandatory):

C/C++, Algorithms, Natural Computing





Bachelor Project: Multiple Criteria Bicycle Route Planner

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Zhiwei Yang
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

Summary:

A mutiple-objective optimization algorithm for finding bicycle routes has been recently developed in the open streetmaps environment. It is so far limited to two criteria, distance and highways – and can only plan a route from a single starting point to a single end point. The task is to extend the planner by additional criteria and integrate it with smart mobile technology. The pilot area will be the Groene Hart in South Holland. It is possible to focus on algorithm design or more on graphical user interfaces and geographical information system coupling.

Prerequisites (helpful, not mandatory):

Interest in algorithms, geographical applications, JAVA/C++, XML.

Bachelor Project: Portfolio Selection from Large Molecular Databases

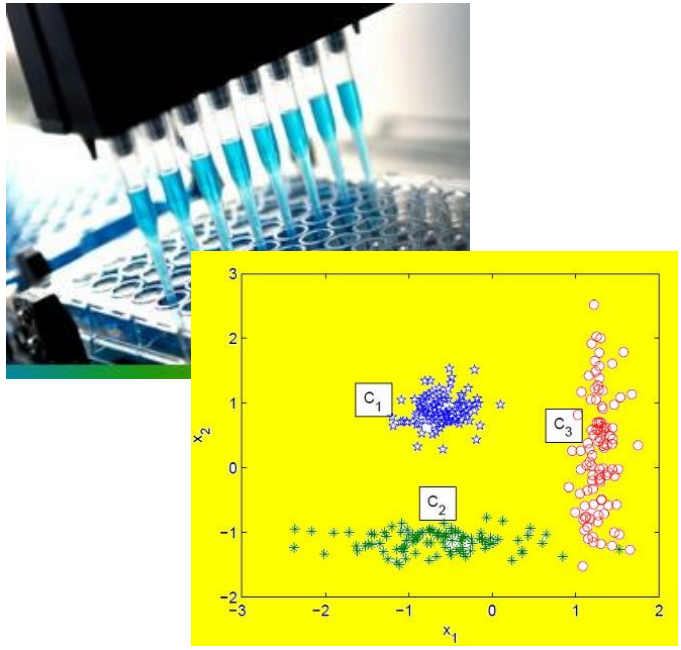
Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Iryna Yevseyeva
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

The research will be in collaboration with the Leiden Academic Center of Drug Research

Summary: In high throughput screening the problem is to select subsets of chemicals from large databases. Portfolio optimization balances risk and return. To find an optimal portfolio a small subset has to be extracted from a large set – an NP hard problem. Instead of quadratic programming, which is too slow for large sets, a fast construction and genetic algorithms will be used and tested on some problem instances.

Prerequisites (helpful, not mandatory):

Interest in Algorithm Design, Statistical Quality Assessment, Interest in Cheminformatics (no specific knowledge in chemistry will be required).



Bachelor Project:

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Zhiwei Yang
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

In collaboration with Trigion

Summary: Dynamical vehicle routing makes it possible to plan a fleet of vehicles over a period of time with new events coming in during the day. A challenge is to predict new events based on past distribution of events. An example is given by a emergency company for which alarms in different nodes of the network will be simulated based on the distribution of past events. The stochastic simulation will be implemented and used in an existing optimization algorithm to improve solutions. Implementing and testing the approach is the goal of the thesis. We will collaborate with a security company (Trigion, NL).

Prerequisites (helpful, not mandatory):

Knowledge in Vehicle Routing or TSP, Programming in JAVA and C++. Programming with threads. Interest in probability and statistics.

Bachelor Project: Buiding Design Optimization in 4-D

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Zhiwei Yang
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

Summary:

The goal is to design buildings based on four objectives -- cost, comfort, energy, and robustness. We have a simulator for buildings that can be used as a black box objective function. The challenge is to find 4-D Pareto fronts and visualize them using transparent plots. Recently there exists a software for transparent plots. The task is to couple this software with a 4-D evolutionary multiobjective optimizer – SMS-EMOA and to test this approach on a real world scenario.

Prerequisites (helpful, not mandatory): Interest in real world optimization problems, OpenGL, basic knowledge evolutionary algorithms

Bachelor Project: An Evolutionary Machine Learning Engine and its application to SPAM filtering

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Rui Li
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

The research is conducted in collaboration with researcjhers from ICCI Portugal and University Vigo.

Summary:

Researchers from LIACS have recently discovered a new algoroithm for learning classifiers based on RoC curve approximation --- it is based on multiobjective evolutionary optimization and called CHEMOA. The algorithm seeks to find RoC curves with minimal area under the RoC. Currently it maximizes the number of correct alarms while minimizing the number of false alarms. The new research will extend the capability towards minimal parsimony – that is the number of rules for machine learning is to be minimized.

Prerequisites (helpful, not mandatory): Interest in data mining, machine learning, and evolutionary algorithms. Source code is available in JAVA and needs to be extended

Bachelor Project: Memetic Algorithms for Making Bit Coins?

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Zhiwei Yang
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

Summary:

The bitcoin is a virtual currency based on cryptographic functions. In the SHA-256 cryptography algorithms preimages of a function needs to be computed. BitCoin uses the SHA-256 hash algorithm to generate verifiably "random" numbers in a way that requires a predictable amount of CPU effort. Generating a SHA-256 hash with a value less than the current target solves a block and wins you some coins. This means that the deviation from a result needs to be minimized. Memetic algorithms – combination of local search and genetic search - are powerful minimization algorithms. The assignment it to represent the problem of finding a preimage of a hash funtion (SHA-256) as a search problem for genetic algorithms and find out how close these algorithms get to preimages. There is a small chance that they are even capable to solve the problem, in which case the bachelor thesis will yield a major result – i.e. an algorithm that creates money.

Prerequisites (helpful, not mandatory):

Interest in genetic algorithms and cryptography. Curiosity. Programming skills in C.

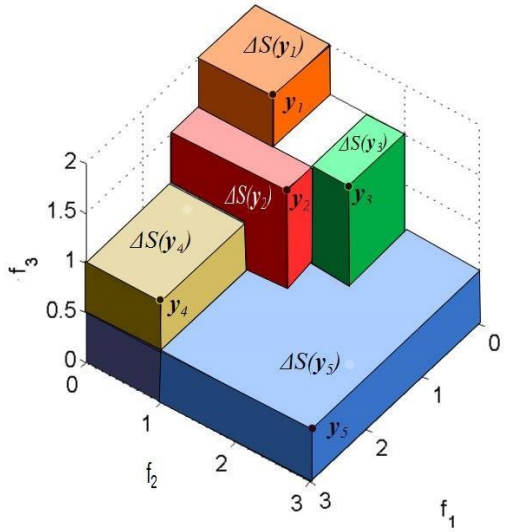
Research Project: Hypervolume Subset Selection – A candidate for an NP hard problem?

Supervisor LIACS:	Prof. dr. Michael Emmerich
In cooperation with:	Dr. Andre Deutz
Start date:	15.9.2013 (immediately)
Contact:	emmerich@liacs.nl

Note:The supervisor is a leading Researcher on this question and has developed HSSP selection for special cases. There are some ideas that can be tried.

Summary: Prerequisites (helpful, not mandatory):

Consider problems where n axis aligned boxes cover a volume and a selection of k< n boxes need to be selected that together (union) covers a maximal volume. In 2D dynamic programming can be used, yielding a cubic time complexity, Can it be done faster? It is conjectured that hypervolume subset selection is NP hard in more than two dimensions. Is that so? The assignment will be to work on this difficult question and look for results in the field of paramererized complexity that might point towards solutions. Any progress towards the solution of this problem is very valuable to the advancement of multiobjective optimization methods.



- Interest in computational geometry and complexity