The use of Genetic Algorithms to solve the allocation problems in the Life Cycle Assessment

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One of the most controversial issues in the development of Life Cycle Assessment (LCA) is the allocation procedure, that consists in the partition and distribution of economic flows and environmental burdens among to each of the products of a multi-output system.

Because of the use of the allocation represents a source of uncertainty in the LCA results, this paper presents a new approach based on Genetic Algorithms (GA) to solve the multi-output systems characterized by a rectangular (and thus non-invertible) coefficients matrix, without using computational expedients such as the allocation procedure.

The GA is a population-based stochastic global search technique inspired from the biological principles of natural selection and genetic recombination. Starting from a codified random set of possible solutions of a problem (population), the GA simulate the evolution of the population through genetic operator (as inheritance, selection, genetic mutation) up to obtain the optimal solution.

The evolution of a component of the population (single solution of the problem), its probability to procreate and to hand down its gene pool depend on its fitness: a solution is assessed as acceptable if it minimizes or maximizes a specific objective function.

The objective function is based on two principles: the respect of the bonds and the analysis of the performance of the solution. The genetic research represents a balance between "*exploitation*" (local research) of the optimal available solution and "*exploration*" (global research) of the space of the research.

The paper applies a GA to a multi-output productive process of essential oils, natural and concentrated juices from oranges and lemons.

The results obtained for the case study taken into consideration showed that the application of GA allows to respect the energy and mass balances for the examined system. Moreover, low differences

between the inventory vectors obtained by using the GA and those obtained with the solutions based upon the traditional computational technique of the allocation have been observed.

Since the real solution of the inventory vector is unknown, the authors are not able to compute a proper performance indicator for the implemented algorithms. However, considering that the differences of the obtained GA solutions from the traditional solution are not overwhelming, this methodology is worthy of further investigations.