Use of a genetic heritage for solving the assignment problem with two objectives

Xavier GANDIBLEUX
LAMIH- UMR CNRS 8530, Université de Valenciennes
Campus “Le Mont Houy”, F-59313 Valenciennes cedex 9, France
Xavier.Gandibleux@univ-valenciennes.fr

Hiroyuki MORITA
Osaka Prefecture University
1-1 Gakuen-cho, Sakai, Osaka 599-8231, Japan
Morita@eco.osakafu-u.ac.jp

Naoki KATOH
Kyoto University, Yoshidahonmachi,Sakyo ward
Kyoto 606-8501, Japan
Naoki@archi.kyoto-u.ac.jp

Abstract : The paper concerns a multiobjective heuristic to compute approximate efficient solutions for the assignment problem with two objectives. The aim here is to show that the genetic information extracted from supported solutions constitutes a useful genetic heritage to be used by crossover operators to approximate non-supported solutions. Bound sets describe one acceptable limit for applying a local search over an offspring. Results of extensive numerical experiments are reported. All exact efficient solutions are obtained using Cplex in a basic enumerative procedure. A comparison with published results shows the efficiency of this approach.

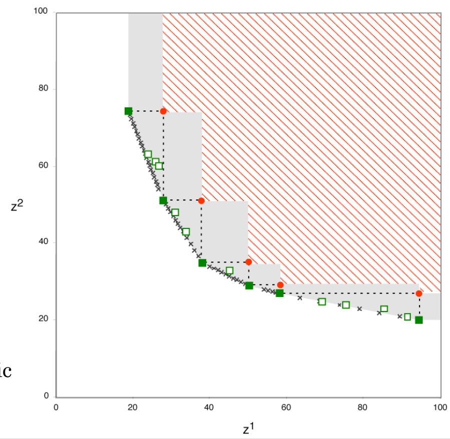
Assigment problems, solutions and bounds

$$\left[\begin{array}{lll} \text{“min”}\, z^q(X) = \sum_{i=1}^{n}\sum_{l=1}^{n} c_{il}^q x_{il} & q=1,2 \\ \sum_{i=1}^{n} x_{il} = 1 & l = 1,\dots,n \\ \sum_{l=1}^{n} x_{il} = 1 & i = 1,\dots,n \\ x_{il} \in \{0,1\} & \end{array}\right]$$

BiAP :
- $E = SE \cup NE$
- LBS : LP
- UBS : «nadirs» points

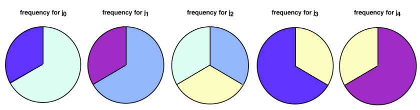
15 Instances
- sizes : 5x5 to 100x100
- range c_{il}^q : [0,20]
- E : CPLEX(01)

Principle
- compute SE : (CPLEX LP)
- approximate NE : EMO | AP heuristic



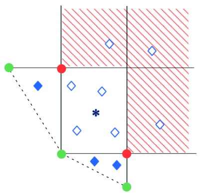
EMO | AP heuristic

SE	x_0	x_1	x_2	x_3	x_4	z^1	z^2
1	3	1	0	4	2	27	56
2	4	0	3	2	1	51	9
3	3	0	2	4	1	31	36



j	=	0	1	2	3	4
$I1$	=	3	1	0	4	2
$I2$	=	3	0	2	4	1
$I3$	=	3	*	*	4	*

1) position j_1 :
   wheel$_{j_1} = \{0,1\}$
   $\Rightarrow$ 1 is selected (for example)
2) position j_2 :
   wheel$_{j_2} = \{0,2,3\}$
   but 3 is not feasible $\rightarrow$ wheel$_{j_2} = \{0,2\}$
   $\Rightarrow$ 2 is selected (for example)
3) position j_4 :
   wheel$_{j_4} = \{1,2\}$
   but 1, 2 are not feasible $\rightarrow$ wheel$_{j_4} = \emptyset$
   $\rightarrow$ feasible list $= \{0\}$
   $\Rightarrow$ 0 selected



$\widehat{E} \leftarrow se \cup \widehat{NE}$ $\quad (\widehat{NE} = \emptyset)$

for a given number of generations **loop**

--| **Selection of individuals**
  Select $I1$ and $I2 \in \widehat{E}$ at random ($I1 \neq I2$)

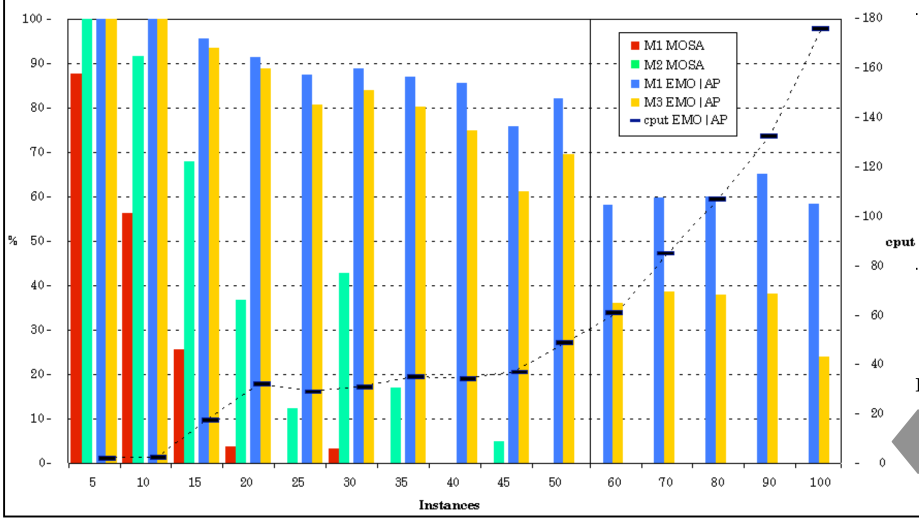
--| **Offsprings of individuals**
  --| $I3$ is built using the genetic information available in $I1$, $I2$ and $\widehat{E}$
  for j **in** $1..n$ **loop**
    --| common genes are copied
    if $I1_j = I2_j$ **then** $I3_j \leftarrow I1_j$ **endIf**
    --| others genes : value is selected using the wheel
    if $I1_j \neq I2_j$ **then** $I3_j \leftarrow$ `useGeneticInformation`(j) **endIf**
  endFor
  if `isNotDominated`$(I3, UBS)$ **then** `TwoLevelsLS`$(I3, \widehat{E})$ **endIf**

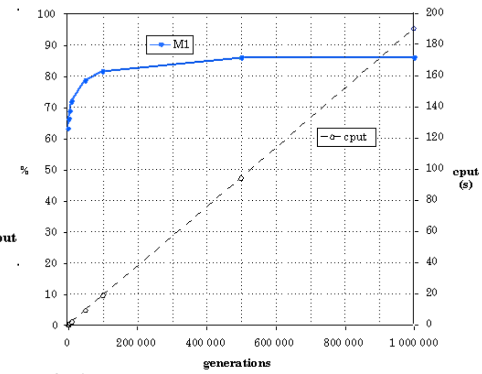
--| **Mutation of individual**
  $I4 \leftarrow$ Mutate $I1$
  if `isNotDominated`$(I4, UBS)$ **then** `TwoLevelsLS`$(I4, \widehat{E})$ **endIf**

--| **Refresh the genetic map**
  Update the genetic information after a determined number of generations.
  Roulette wheels are rebuilt using $\widehat{E}$.

endLoop generationProcess

Numerical experiments





EMO | AP :
Generations : 250 000
Refreshment : each 100 000 generation
Resolution repeated 9 times
Means results for M1 & M3

EMO 2003
Second International Conference on Evolutionary Multi-Criterion Optimization
April 08-11, 2003 - Faro, Portugal