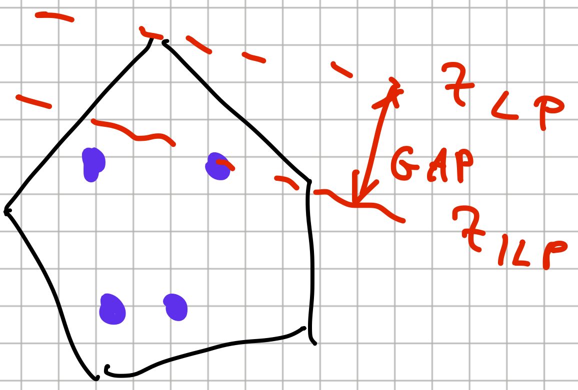
OR1 17-NOV-2021

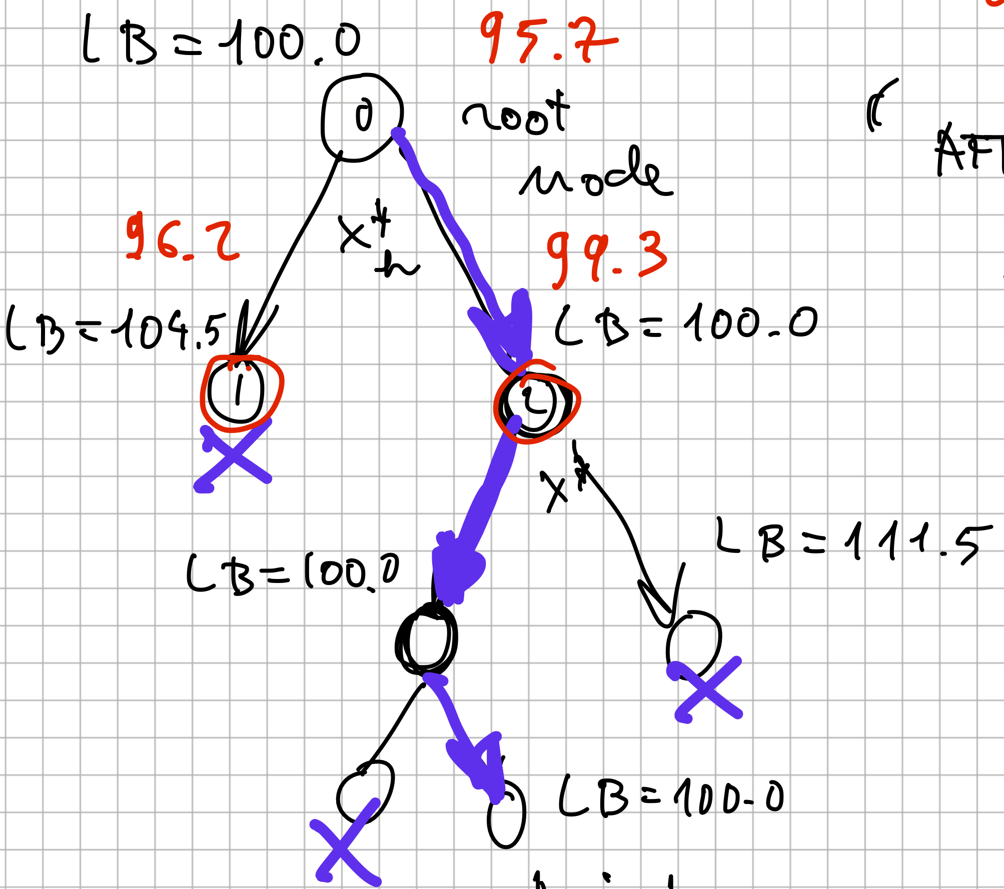
LOWER BOUND IMPORTANCE IN B&BOUND



$z_{LP} \le z_{ILP}$

IDEAL CASE : $z_{LP} = z_{ILP}$

“ 0% GAP”



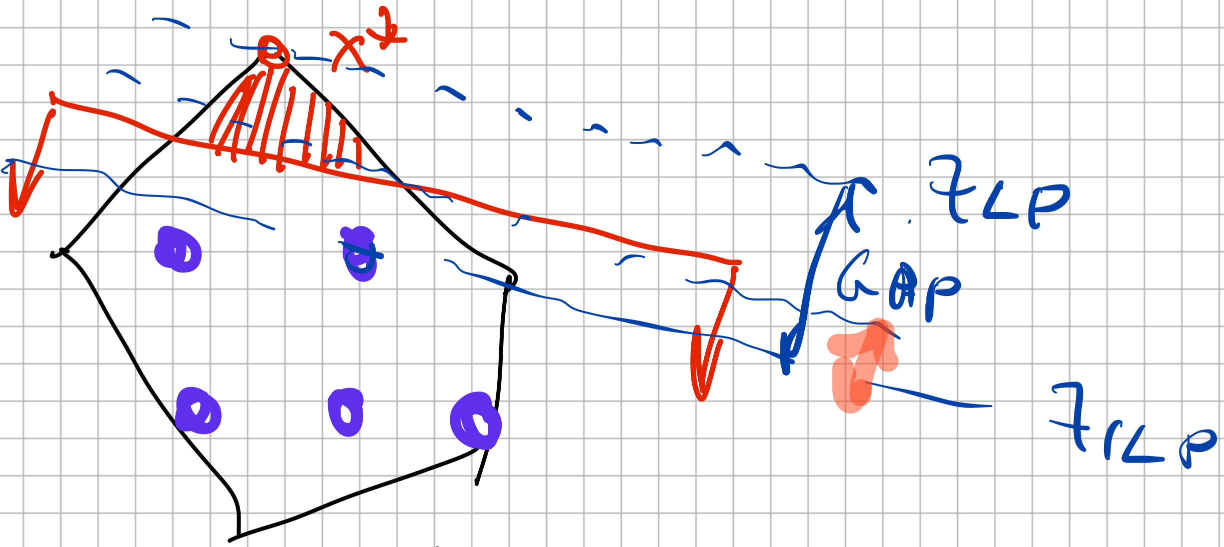
“AFTER, AT MOST, n problems I set to an integer optimal sol.”

x^* integer

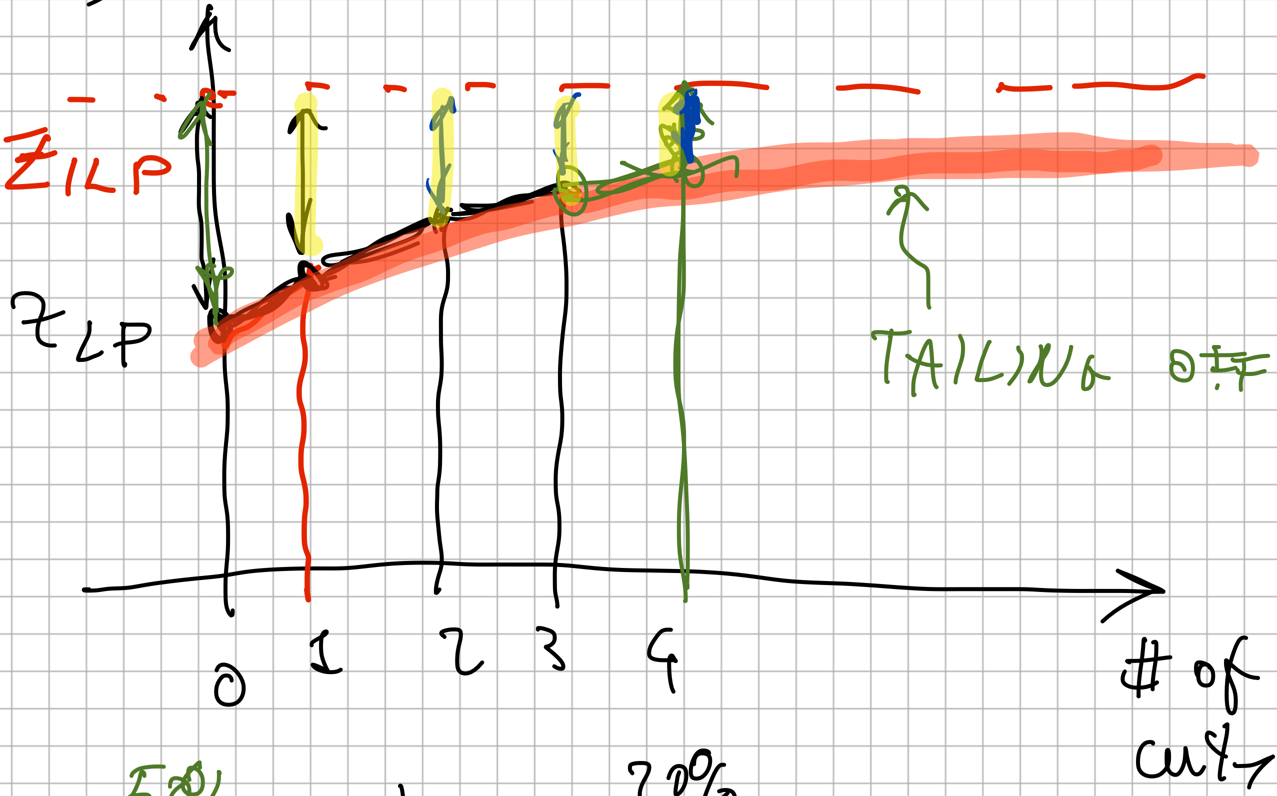
$c^T x^* = 100 \rightarrow z_{OPT} = 100$

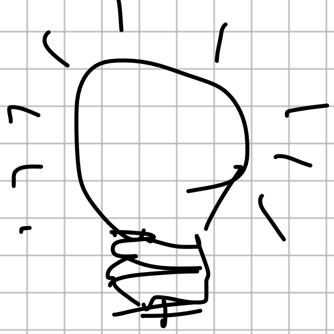
“ GAP > 5% ⇒ B&B HOPELESS”

CUTTING PLANE METHOD



$$LB = c^T x^*$$



⇒  IDEA :

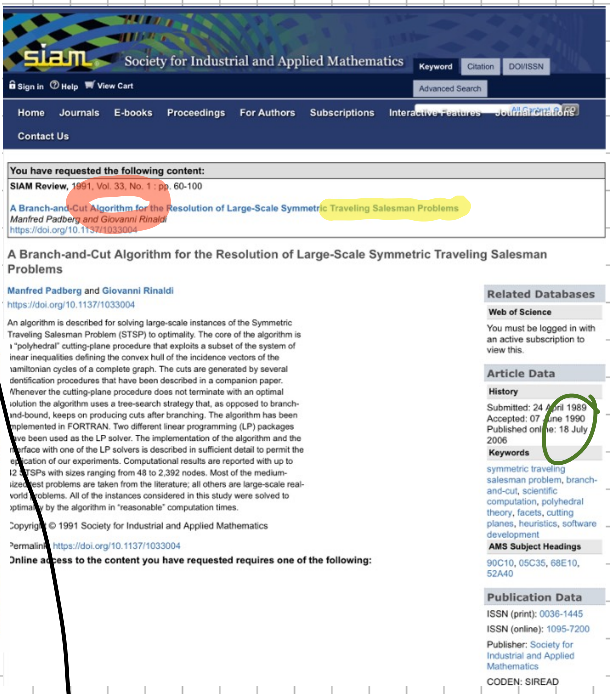
COMBINE CUTTING PLANES

& B & BOUND !!

THE BRANCH-AND-CUT METHOD


New York 1985


Erlangen 2010



You have requested the following content:

SIAM Review, 1991, Vol. 33, No. 1 : pp. 60-100

A Branch-and-Cut Algorithm for the Resolution of Large-Scale Symmetric Traveling Salesman Problems
Manfred Padberg and Giovanni Rinaldi
https://doi.org/10.1137/1033004

A Branch-and-Cut Algorithm for the Resolution of Large-Scale Symmetric Traveling Salesman Problems

Manfred Padberg and Giovanni Rinaldi

https://doi.org/10.1137/1033004

An algorithm is described for solving large-scale instances of the Symmetric Traveling Salesman Problem (STSP) to optimality. The core of the algorithm is "polyhedral" cutting-plane procedure that exploits a subset of the system of inear inequalities defining the convex hull of the incidence vectors of the amiltonian cycles of a complete graph. The cuts are generated by several dentification procedures that have been described in a companion paper. Whenever the cutting-plane procedure does not terminate with an optimal solution the algorithm uses a tree-search strategy that, as opposed to branch-and-bound, keeps on producing cuts after branching. The algorithm has been mplemented in FORTRAN. Two different linear programming (LP) packages ave been used as the LP solver. The implementation of the algorithm and the nterface with one of the LP solvers is described in sufficient detail to permit the eplication of our experiments. Computational results are reported with up to 42 STSPs with sizes ranging from 48 to 2,392 nodes. Most of the medium-sized test problems are taken from the literature; all others are large-scale real-world problems. All of the instances considered in this study were solved to optimality by the algorithm in "reasonable" computation times.

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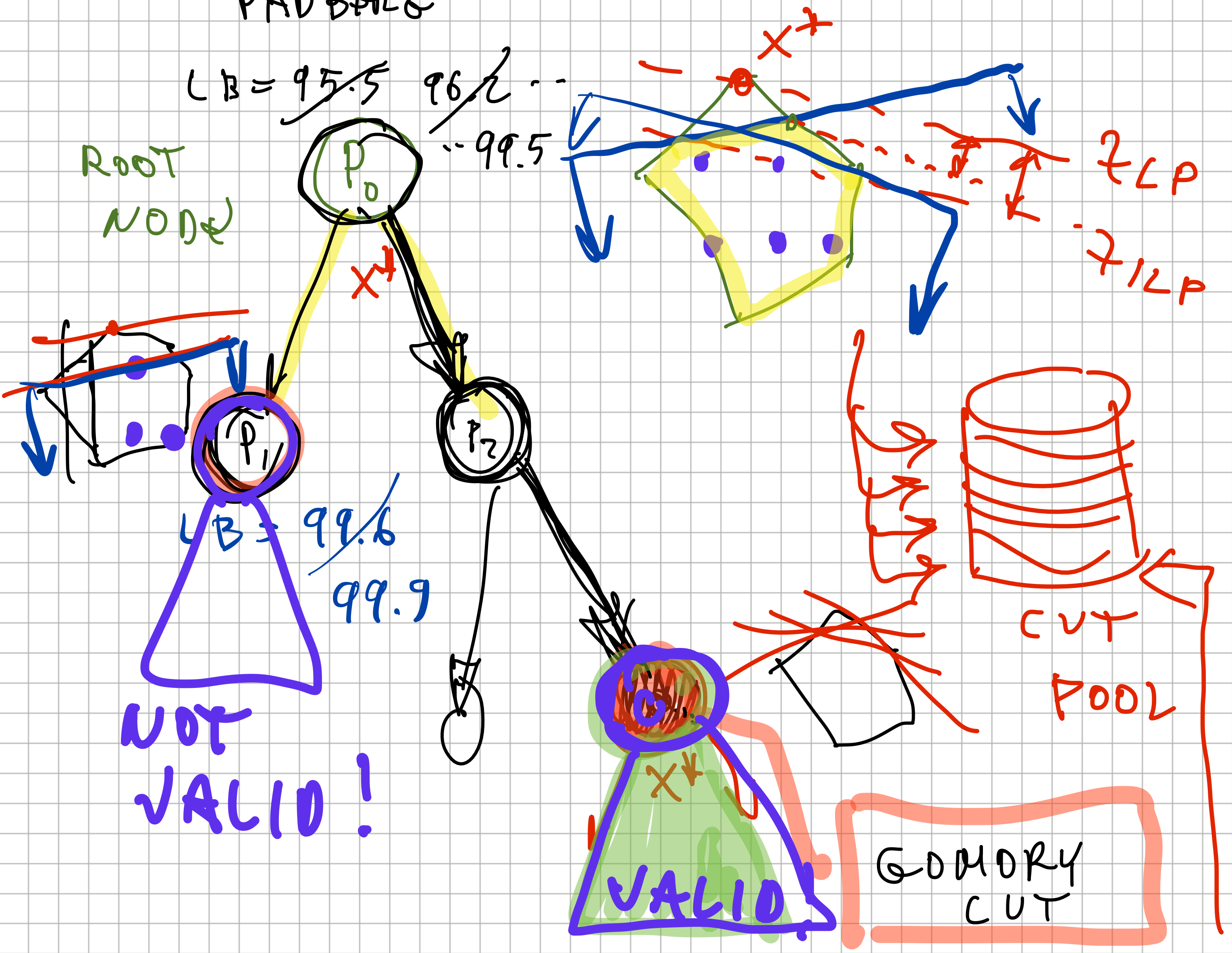
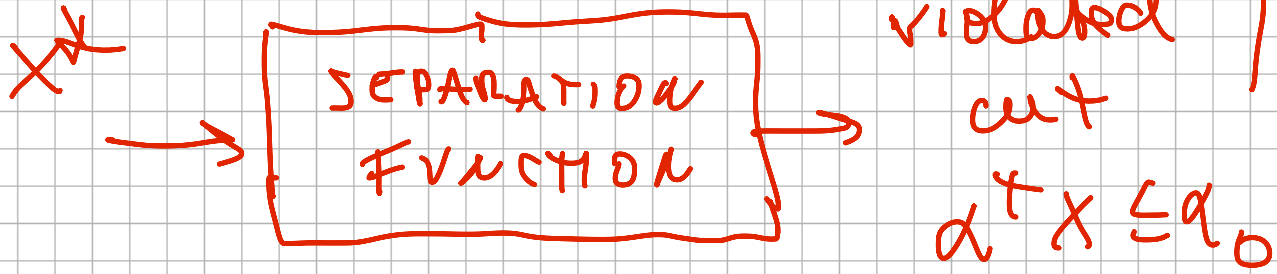
GIOVANNI RINALDI





CUTS

→ GLOBALLY VALID

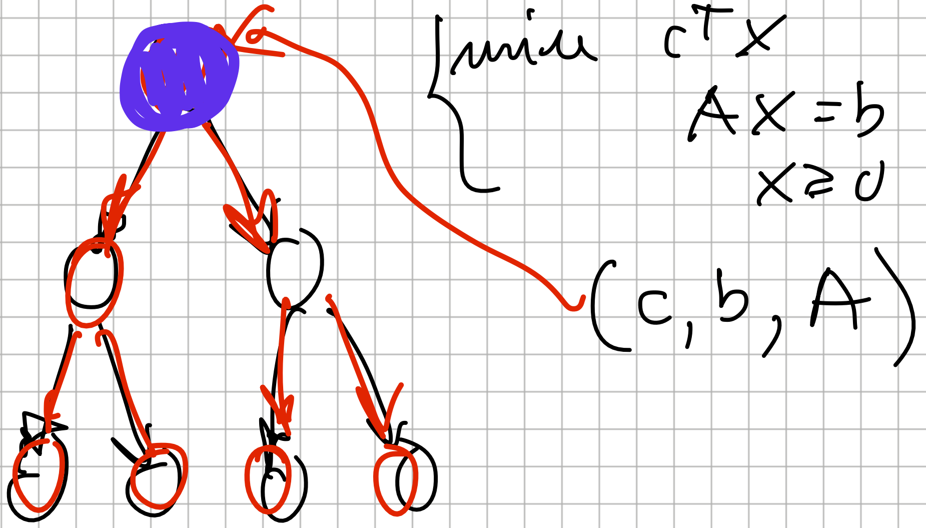
→ LOCALLY VALID

COMMERCIAL ILP SOLVERS

THROUGH CALL BACKS

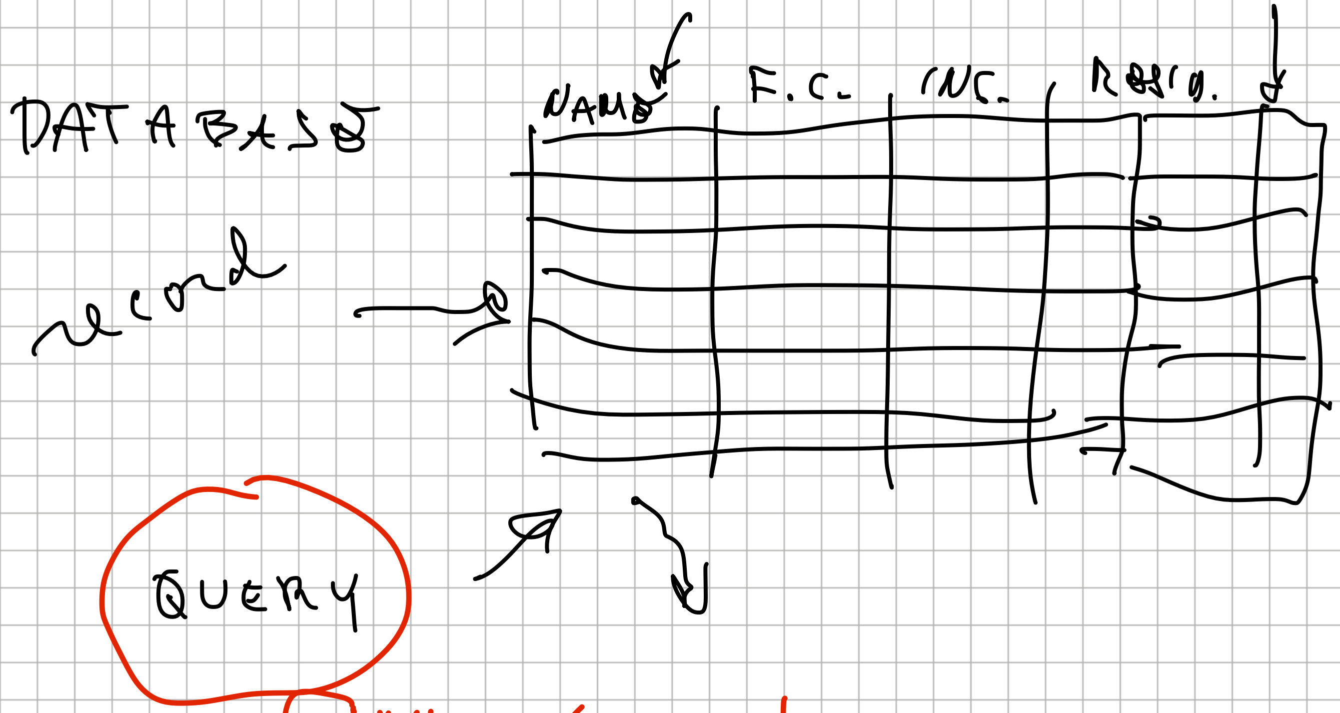
IBM CPLEX / GUROBI / EXPRESS

SCIP / COIN-OR "free"



$$\begin{cases} \min c^T x \\ Ax = b \\ x \geq 0 \text{ integer} \end{cases}$$

INDEX SELECTION PROBLEM



$INDEX_1$ = by age

$INDEX_2$ = by name

= by residence

= - - -

INPUT:

m = n. of queries (~1000)

n = n. of potential indices (~10'000)

(dummy index 0 ⇝ scan all data)

EX:

m = 6 queries

n = 5 potential indices

$$\gamma = \begin{array}{c|cccccc} \text{query} \backslash \text{index} & 0 & 1 & 2 & 3 & 4 & 5 \\ \hline 1 & 6700 & 1300 & 6700 & 6700 & 6700 & 6700 \\ 2 & 7000 & 900 & 700 & 7000 & 7000 & 7000 \\ 3 & 800 & 800 & 800 & 800 & 800 & 800 \\ 4 & 6700 & 6700 & 6700 & 1700 & 6700 & 2700 \\ 5 & 5000 & 5000 & 5000 & 7700 & 1200 & 4200 \\ 6 & 2000 & 2000 & 2000 & 2000 & 2000 & 750 \end{array}$$

$$c = \begin{array}{|c|c|c|c|c|c|} \hline 0 & 200 & 1700 & 400 & 2400 & 250 \\ \hline \end{array}$$

$$d = \begin{array}{|c|c|c|c|c|c|} \hline 0 & 10 & 5 & 10 & 8 & 6 \\ \hline \end{array}$$

total available space for the indices

$$D = 19 \text{ (TB)}$$

Ex

$S = \{1, 5\}$ SOLUTION

FEASIBLE: $d_1 + d_5 = 10 + 6 = 16 \le 19$ ok

COST: $1300 + (900 + 800 + 2700 + 4200 + 750) + (200 + 250)$

$= 11'100$

FEASIBLE SOL.S : 2^n

$$\sim 2^n \equiv \begin{array}{|c|c|c|c|c|c|c|} \multicolumn{1}{c}{1} & \multicolumn{1}{c}{2} & \multicolumn{1}{c}{3} & \multicolumn{3}{c}{\dots} & \multicolumn{1}{c}{n} \\ \hline 1 & 0 & 0 & 1 & 0 & 0 & 1 \\ \hline \end{array} \qquad S = \{1, 3, n\}$$

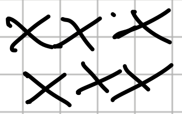
$n = 5 \rightsquigarrow 2^5 = 32$ possible sol.s

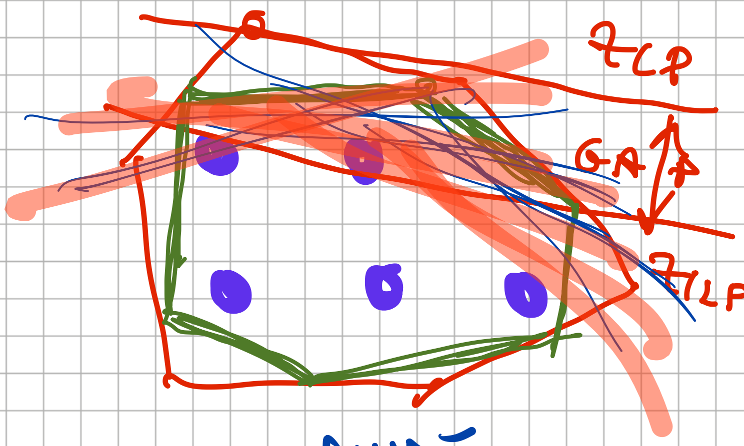
$\;\;= 10 \rightsquigarrow 2^{10}$

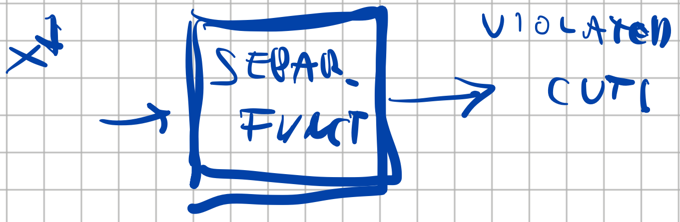
$\;\;\vdots$

$\;\;= 100 \rightarrow 2^{100}$ HUGE!!

ILP model







problem-specific "ad-hoc" cuts