

OR 2 13-may-2022

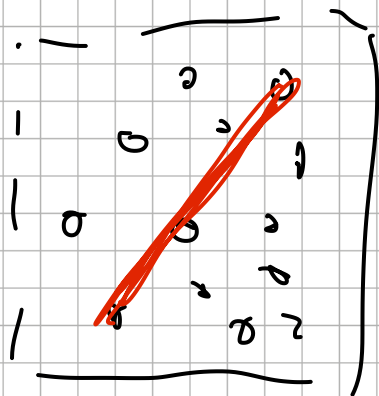
# EXACT HP solver (with CPLEX)

- ① n. of vars / cols  $\rightarrow n(n-1)/2$   
 $n \leq 1000 \rightarrow \leq 0.5M$   
 $n \approx 10000 \rightarrow \text{HUGE!}$

Idea: avoid handling ALL vars

$\rightarrow$  many are fixed to 0 internally by CPLEX

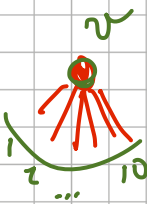
(reduced-cost fixing)



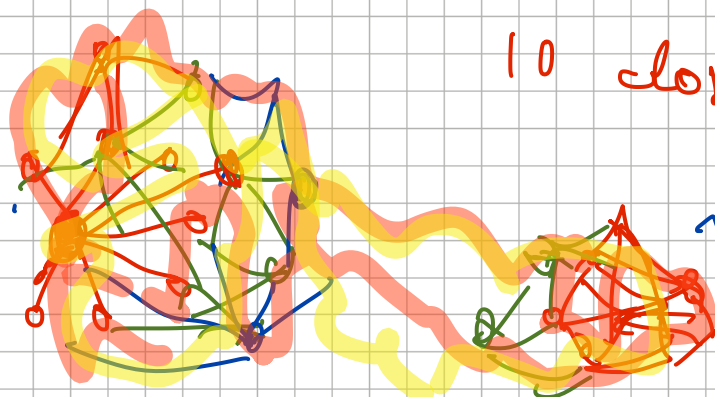
$$x_{ij} = 0$$

$\rightarrow$  heuristic fixing  $x_{ij} = 0$

10 closest points



SPARSE GRAPH!!

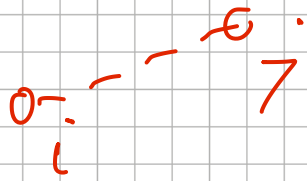


$\sim 10n$

+ the edges in 1D HEUR. JOCS

$x_{pos}(i, j, inst)$

→ to be modified using, e.g. HASH functions

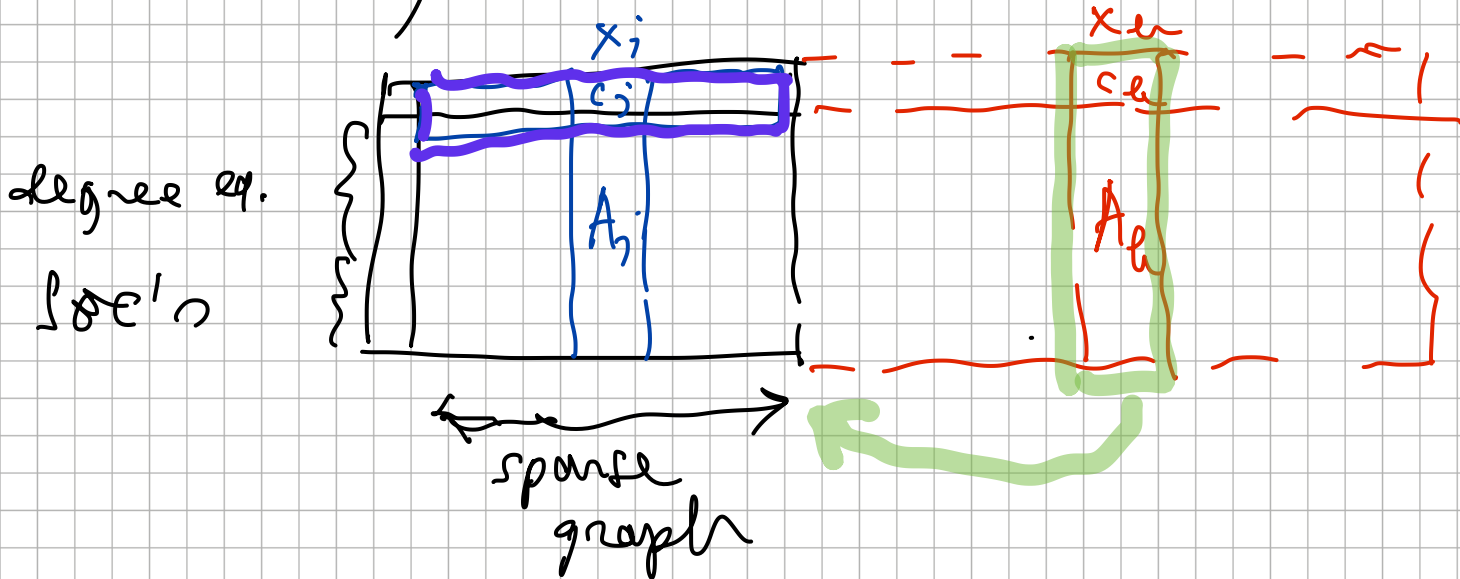


→ ON THE FLY (at each B & C node) → add missing var. s

"COLUMN GENERATED"

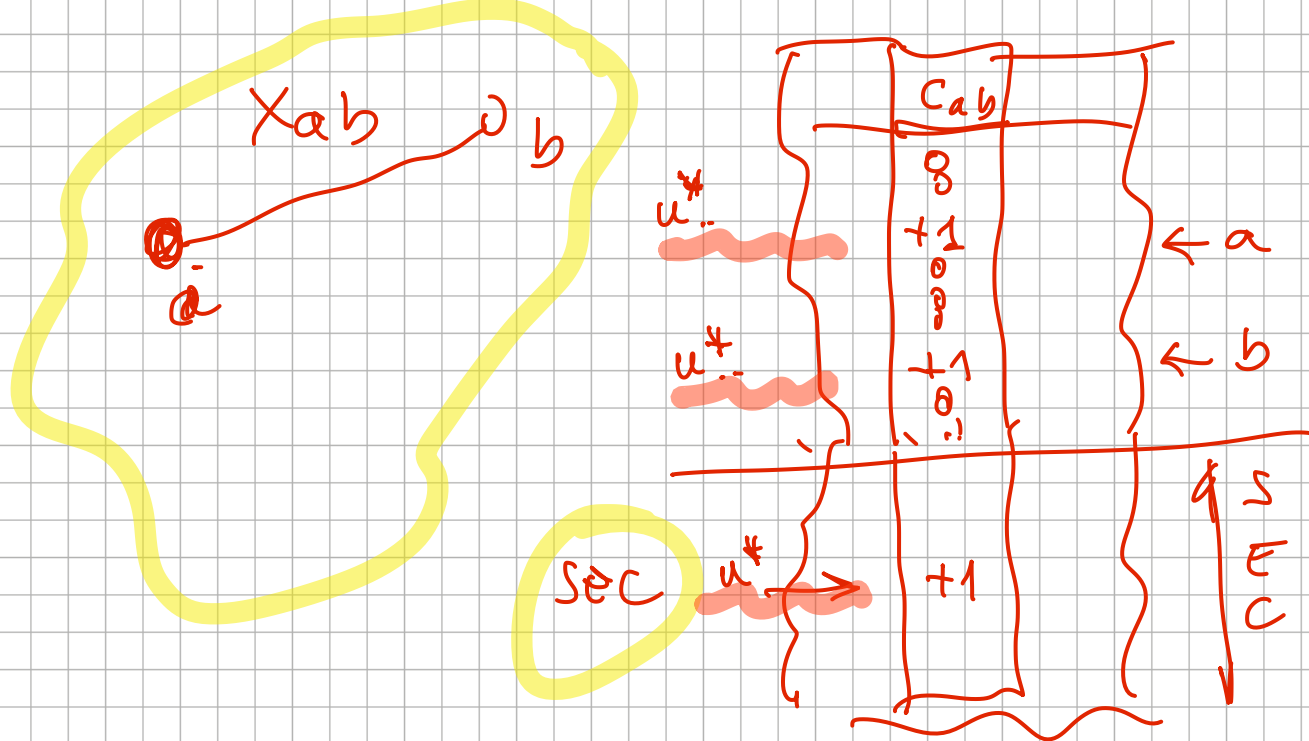
REVISED SIMPLEX

At every node: solve LP



Optimal dual sol.  $a^*$

$$\rightarrow \bar{c}_j = c_j - a^{*T} A_j$$



$$\bar{C}_{ab} = C_{ab} - \dots < 0 ?$$

"VARIABLE PRICING"

COMPUTING THE  $\alpha$

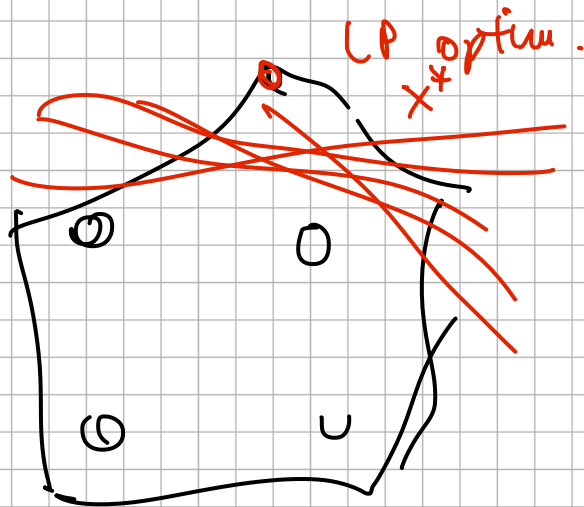
n. of BRANCHING NODES

⇒ IMPROVE THE LOWER BOUND BY GENERATING NEW FAMILIES OF CUTS!

# NEW FAMILIES OF TSP cuts

① SOL

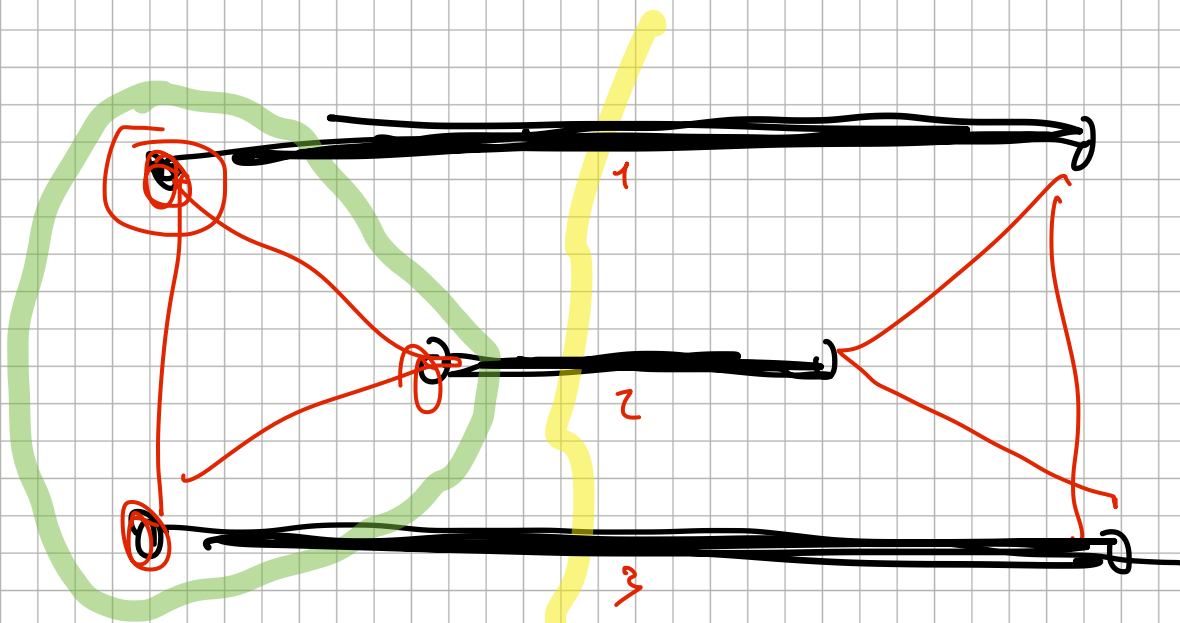
② FRACTIONAL SOL, S



→ IMPROVED LOWER BOUND

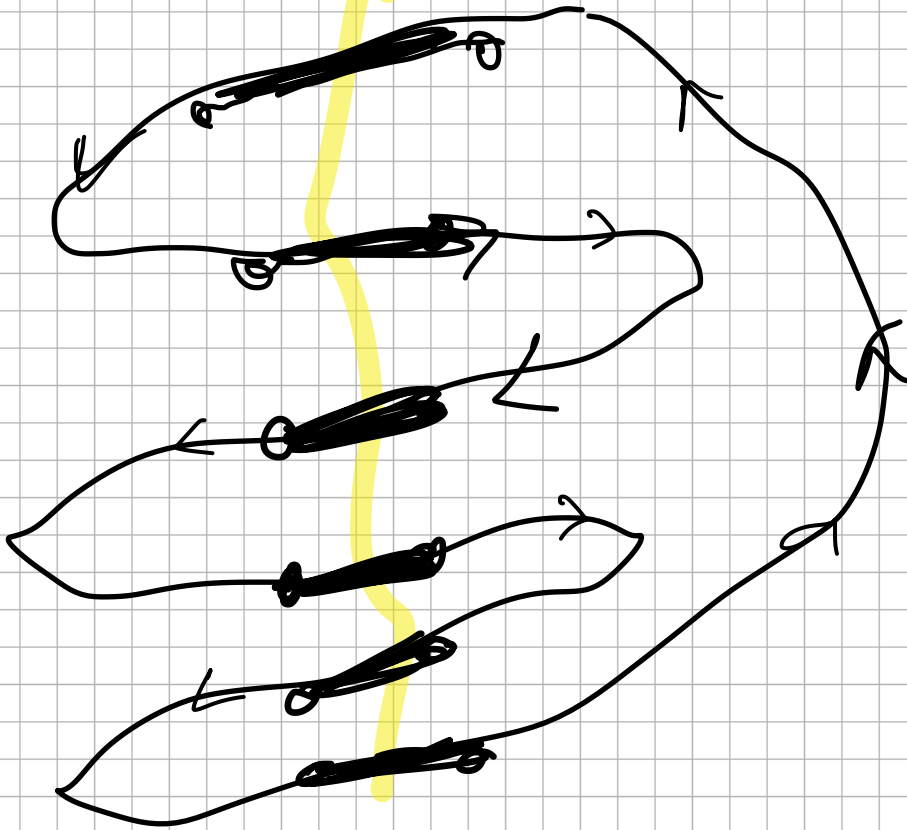
E.g.

$x^* = 1$   
  $x^* = 0.5$

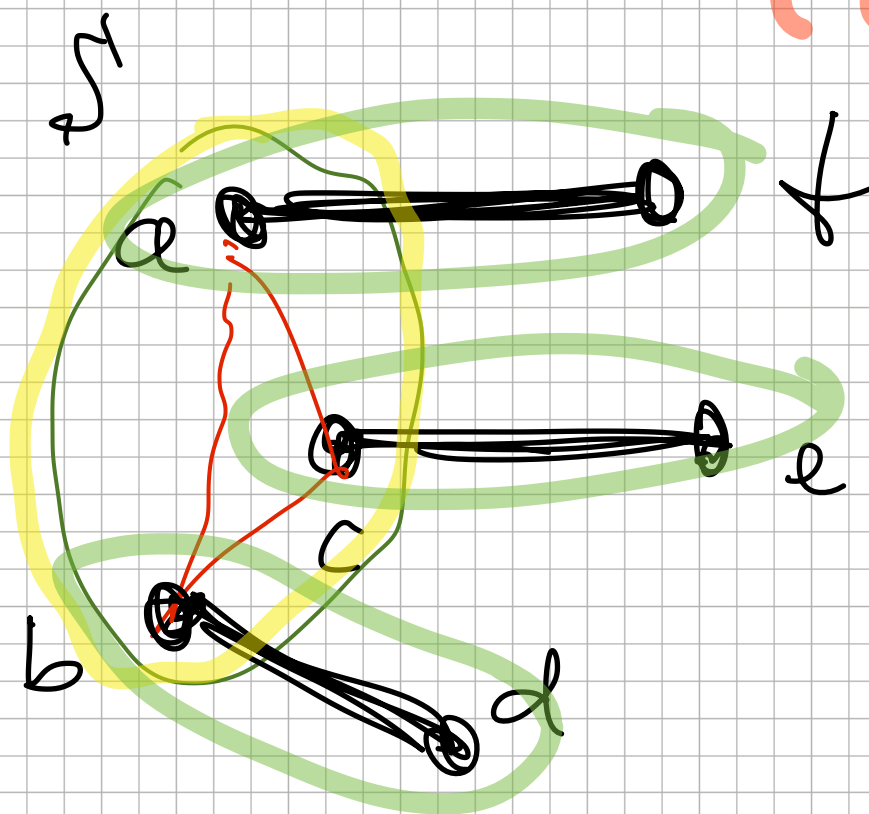


$\geq 3 =$  odd n. of crossing edges?

But, for every TSP solution:



the n. of crossings must be EVEN!



COOR-  
lineq.

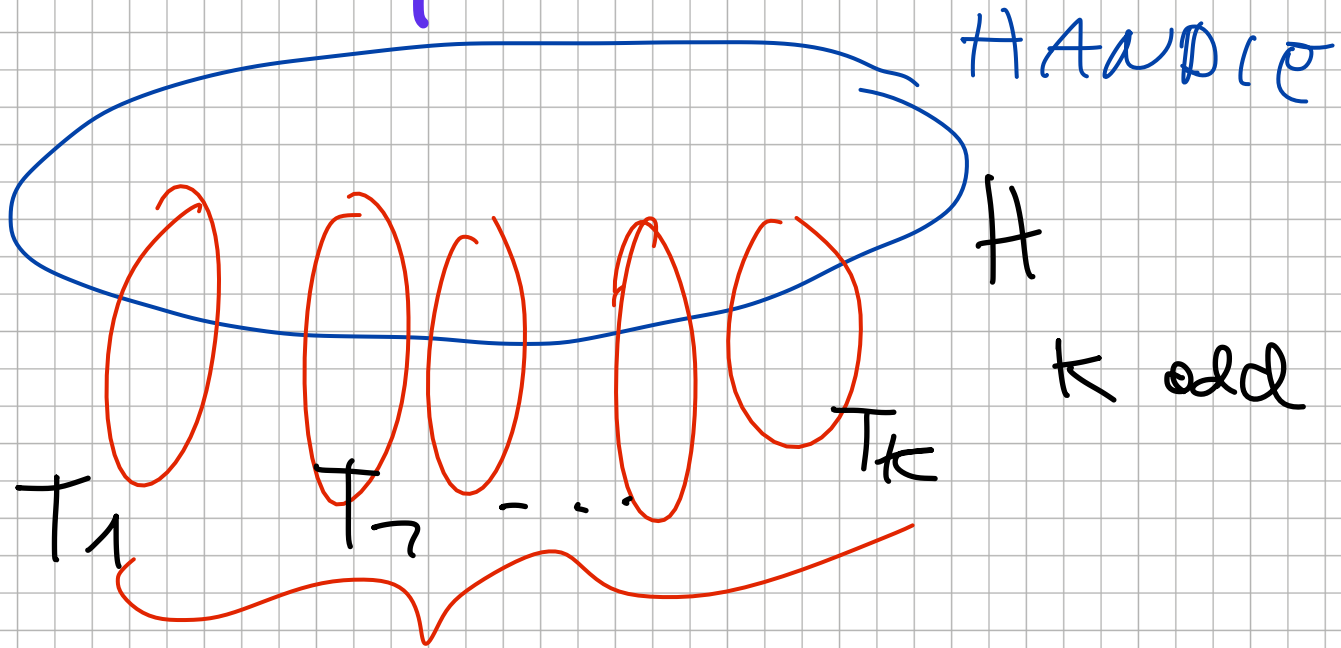
$$X_{ab} + X_{ac} + X_{bc}$$

$$X_{af} + X_{ce} + X_{bd}$$

$\cap \cup$

$\cup \neq \cup$  !

COMB ineq.  $\circ$



odd n. of TEETH

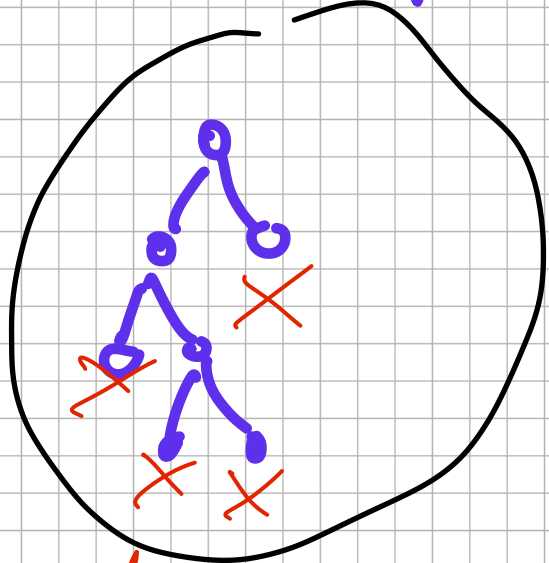
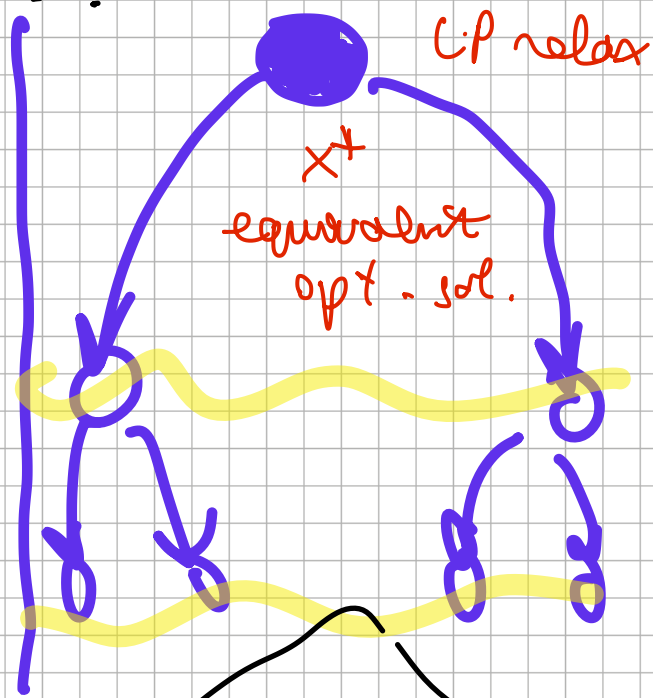
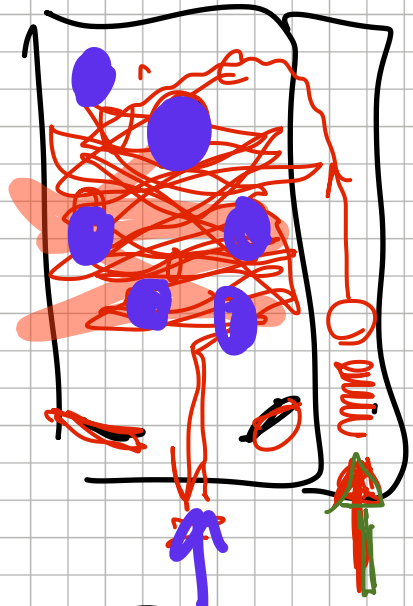
# PERFORMANCE VARIABILITY

B & B  $\approx$  CHAOTIC SYST.

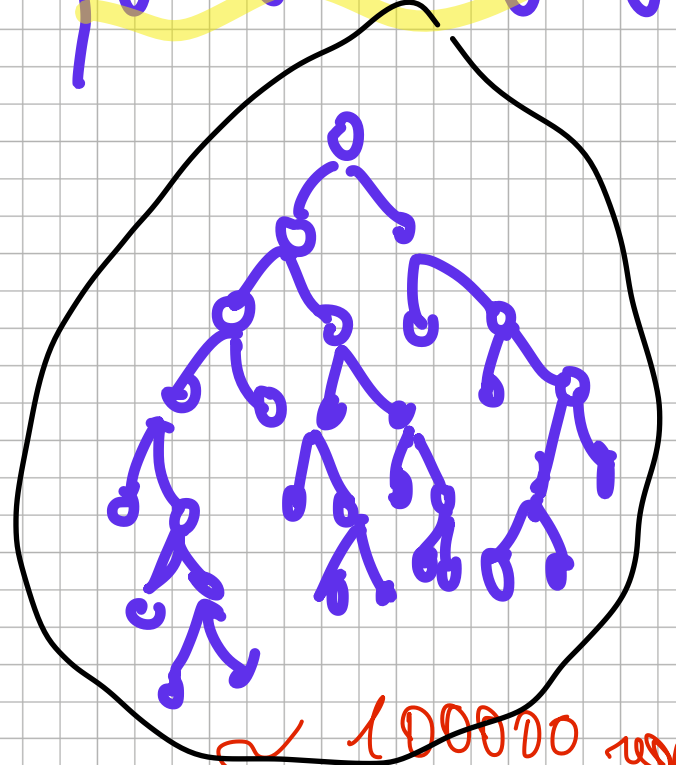
CHAOS

deterministic  
initial cond.

PINBALL



few nodes  
 $\approx 10$  nodes



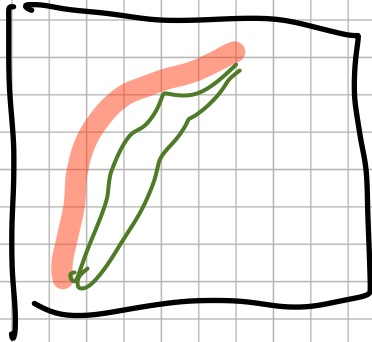
$\approx 100000$  nodes

CHANGE INTERNAL

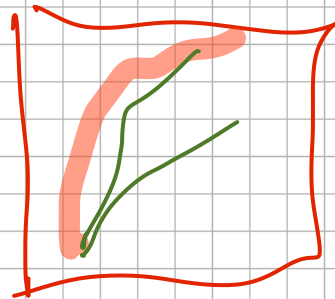
RANDOM

seed of CPLEX

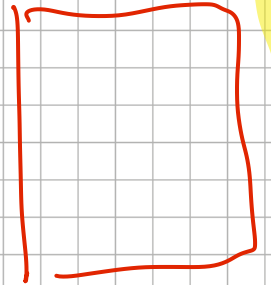
PEAF,  $\nu_{\text{not}}$



seed #0



seed #1



seed #4

⇒ the outcome of the PERFORMANCE PROFILE plots is **STATISTICALLY RELEVANT** only if it is confirmed across (almost) all seeds!