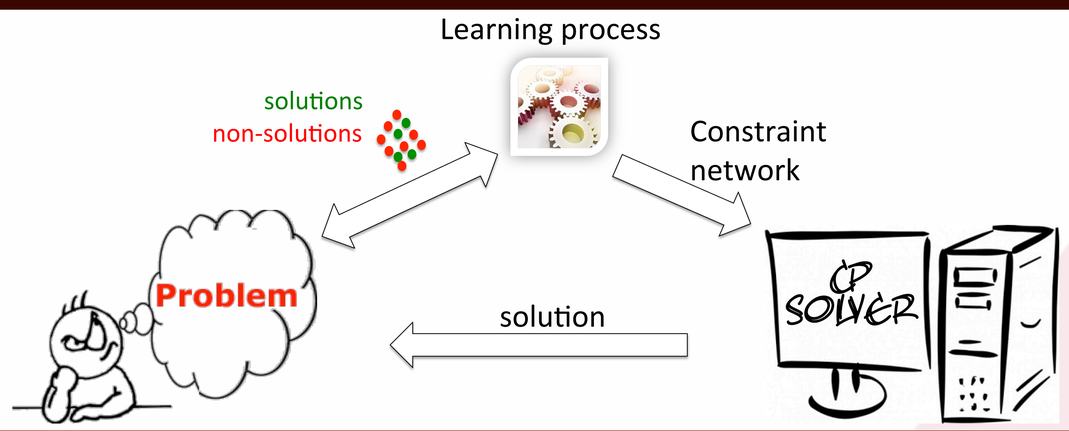
# Constraint Acquisition via Partial Queries*

C. Bessiere[1] R. Coletta[1] E. Hebrard[2] G. Katsirelos[3]
N. Lazaar[1] N. Narodytska[4] C-G. Quimper[5] T. Walsh[4]

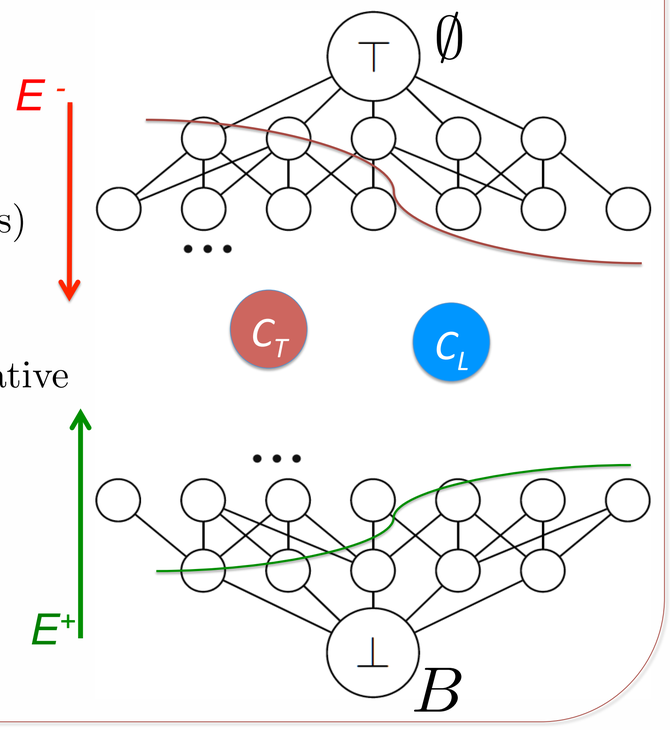
## Abstract

We learn constraint networks by asking the user partial queries.
That is, we ask the user to classify assignments to subsets of the variables as positive or negative. We provide an algorithm that, given a negative example, focuses onto a constraint of the target network in a number of queries logarithmic in the size of the example. We give information theoretic lower bounds for learning some simple classes of constraint networks and show that our generic algorithm is optimal in some cases.

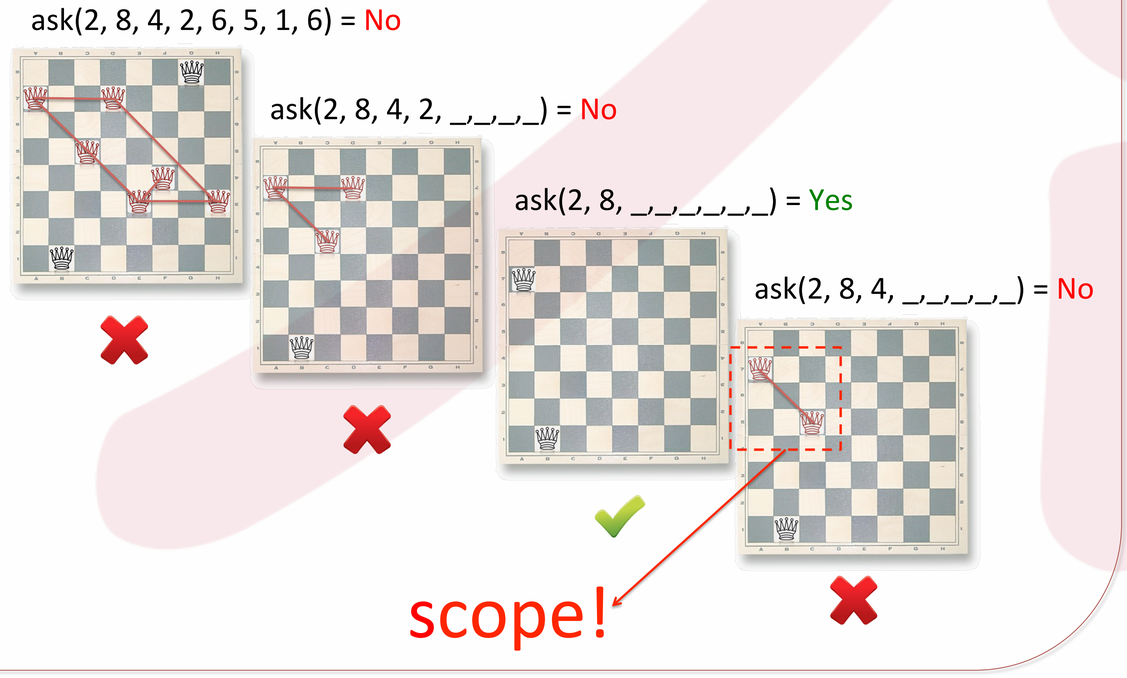



## Constraint Acquisition Problem

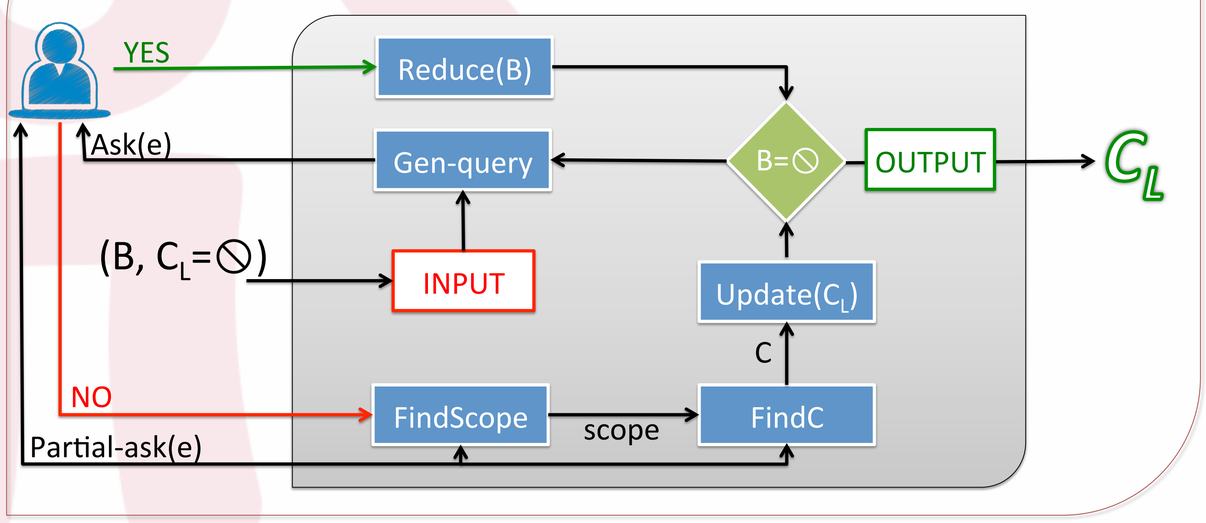
- Inputs:
  - $(X, D)$ : Vocabulary
  - $\Gamma$ : Constraint language
  - $B$ : Bias (possible constraints)
  - $C_T$ : Target network
  - $(E^+, E^-)$ : positive and negative examples
- Output:
  - $C_L$: Learnt network s.t.,
    - $C_L \subset B : C_L \equiv C_T$




## Partial Queries (Example)




## Quick Acquisition (QUACQ)

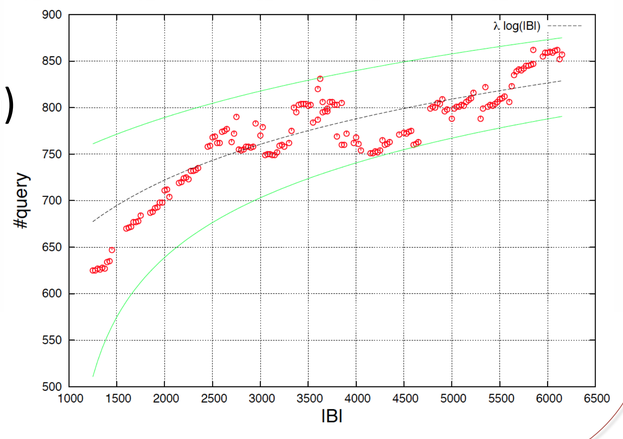


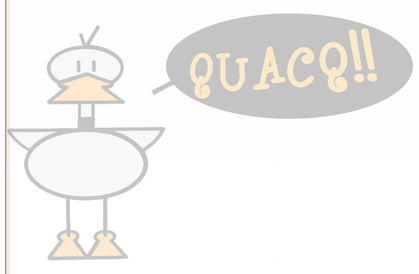

## QUACQ results

- Learning until convergence

| | $\lvert C_L\rvert$ | $\#q$ | $\#q_c$ | $\bar{q}$ | time |
|---|---|---|---|---|---|
| **rand_50_10_12** | 12 | 196 | 34 | 24.04 | 0.23 |
| **rand_50_10_122** | 86 | 1074 | 94 | 13.90 | 0.14 |
| **Golomb-8** | 91 | 488 | 101 | 5.12 | 0.32 |
| **Zebra** | 60 | 638 | 64 | 8.22 | 0.15 |
| **Sudoku** $9 \times 9$ | 810 | 8645 | 821 | 20.58 | 0.16 |

- Log scale on size of B (Zebra problem)




Intel Xeon E5462 @ 2.80GHz with 16 Gb of RAM

## QUACQ in log

$$O(|C_L| \cdot (log|X| + |\Gamma|))$$

Top-down / Bottom-up

$$O(|B|)$$

## QUACQ more?

QUACQ:
- new constraint acquisition approach based on partial queries
- Active learning approach
- Learning a constraint in a log #queries
- Queries are often much shorter than membership ones
- Can learn a constraint network only with negative examples

MORE:
- Asking more than yes/no questions
- Learn & Solve: Elicitation-based solver
- Combination with ModelSeeker

1 {bessiere,coletta, lazaar}@lirmm.fr
2 hebrard@laas.fr
3 gkatsi@gmail.com
4 Toby.walsh@nicta.com.au ninan@cse.unsw.edu.au
5 Claude-Guy.Quimper@ift.ulaval.ca

CNRS, U.Montpellier, France | LAAS-CNRS Toulouse, France |INRA Toulouse, France | NICTA, UNSW,Sydney, Australia |U.Laval, Quebec City, Canada

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