⏩ CPTEST: A framework for the automatic fault detection, localization and correction of constraint programs

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CPTEST tool

- A testing framework for OPL constraint programs (detection, localization and correction):
  - A complete OPL parser,
  - detection, localization and correction algorithms implementation
  - Based-on IBM ILOG CP Optimizer 2.1 solver
  - Java implementation – 25K LOC

- CPTEST available on www.irisa.fr/celtique/lazaar/CPTEST

Background

N. Lazaar, A. Gotlieb, and Y. Lebbah. On testing constraint programs. CP'10.

$M \equiv C_1 \wedge C_2 ... \wedge C_n$ $\quad$ $P \equiv C'_1 \wedge C'_2 ... \wedge C'_m$

$sol(M) : \ set\ of\ solution\ of\ M$ $\quad$ $sol(P) : \ set\ of\ solution\ of\ P$

Conformity relations:

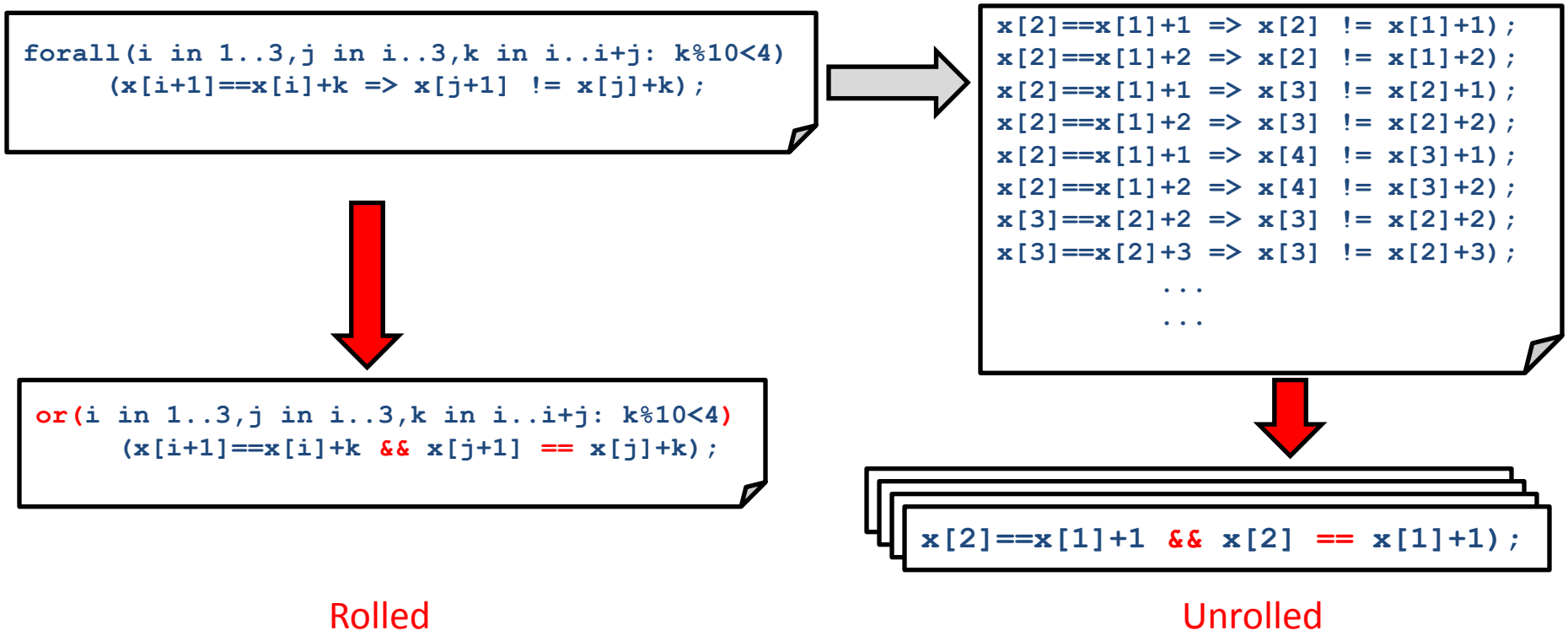
$$P\ conf_{one}\ M \Leftrightarrow sol(P) \neq \emptyset \wedge sol(P) \subseteq sol(M)$$

$$P\ conf_{all}\ M \Leftrightarrow sol(P) = sol(M)$$

$$P\ conf_{best}\ M \Leftrightarrow bounds_{lw,up}(P) \neq \emptyset \wedge bounds_{lw,up}(P) \subseteq bounds_{lw,up}(M)$$

Background: Constraint Negation

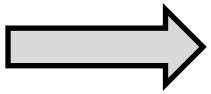
- Elementary constraints (e.g. == turns out in !=, …)
- “forall” aggregator



Background: Constraint Negation

- Elementary constraints (e.g. == turns out in !=, …)
- “forall” aggregator
- Global constraints

```
inverse(all[R](i in R) g[i],
        all[S](j in S) f[j]);
```



```
forall(i in S)
  g[f[i]]==i;

forall(j in R)
  f[g[j]]==j;
```

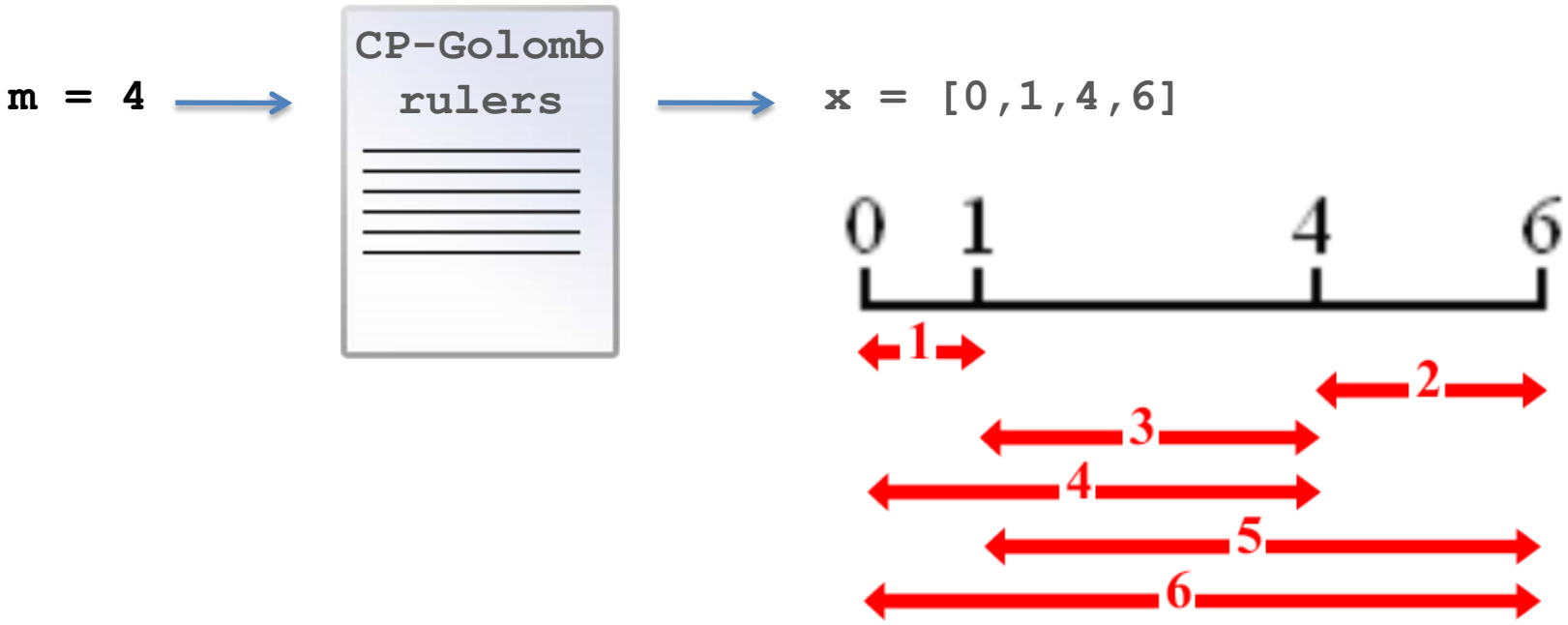
```
or(i in S)
  g[f[i]]!=i;

or(j in R)
  f[g[j]]!=j;
```

```
allMinDistance,
allDifferent,
forbiddenAssignments,
allowedAssignments,
...
```

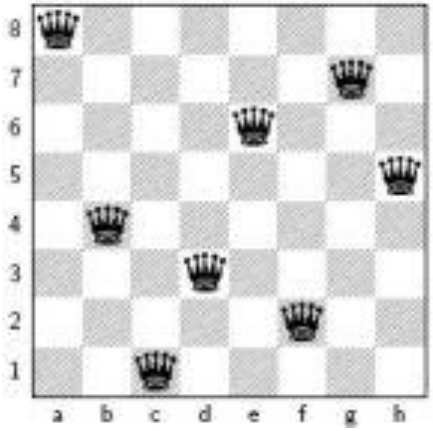
Golomb Rulers Problem

- a **Golomb ruler** is a set of **m** marks at integer positions along an imaginary ruler such that no two pairs of marks are the same distance apart,
- and the largest distance between two of its marks is its **length**.
- The goal is to find an **optimal Golomb ruler** where no shorter Golomb ruler of the same order exists.



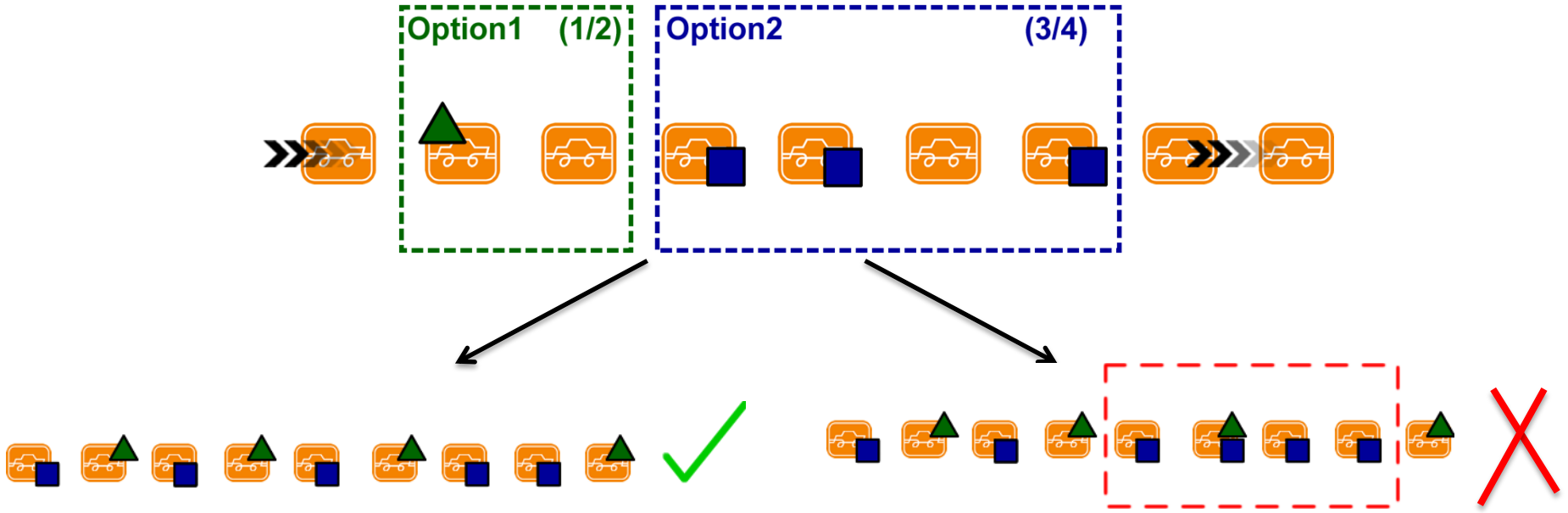
N-queens Problem

- The N-queens problem requires to place **N** queens on an **N** x **N** chessboard were all queens are placed on distinct column and two queens cannot be placed on the same upper or lower-diagonal.



Car Sequencing Problem

- Car sequencing is a real-world CP problem that amounts to find an assignment of **cars** to the **slots** of a car-production company, where **cars** are grouped by **classes**.
- Each **class** represents **cars** with some specific **options**.
- The assembly line must satisfy some option capacity constraints.



References

- Testing Process:

N. Lazaar, A. Gotlieb, and Y. Lebbah. On testing constraint programs. CP'10.

- Localization Process:

N. Lazaar, A. Gotlieb, and Y. Lebbah. Fault Localization in Constraint Programs. ICTAI'10.

- Correction Process:

N. Lazaar, A. Gotlieb, and Y. Lebbah. A Framework for the Automatic Correction of Constraint Programs. ICST'11.

- CPTEST documentation:

http://www.irisa.fr/celtique/lazaar/CPTEST/