Making the first solution good!

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Constraint-Programming

Many business applications

Configuration | Planning | Scheduling | Packing

Used in production for years by many companies

→ Mature technology

Constraint-Programming

A programming paradigm between AI and OR to model and solve constrained problems in a declarative way.

Constraint Programming represents one of the closest approaches computer science has yet made to the Holy Grail of programming: the user states the problem, the computer solves it. [Eugene Freuder]

Constraint-Programming

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Guess what?

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Constraint-Programming

They lied!

Counter-Example

Traveling Salesman Problem

- Everyone knows it
- Trivial to get a solution
- Very easy to get a good solution

Yet in CP

- Tricky to model the cost
- Cannot scale without “circuit” constraint
- Require specifying search
  - ✧ First solution will be random -> VERY BAD
  - ✧ Enumeration will never reach a descent solution

Constraint-Programming

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CP is complex!

- Modeling
- Global constraints
- Search procedures

➢ The code is not so declarative

CP is a technology for experts

- Experts on challenging problems : OK
- Poor results on simple problems : KO

➢ Too often the case in black-box optimization

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Objective

Constraint-Programming should be

At least as simple
At least as good

As coding a simple heuristic

Improving Black-box solving

~~Filtering~~

Very hard to get generic results

→ Search

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Black-box search

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Existing approaches are *Fail-first*

- MinDomain, DomWDeg, ABS, IBS, etc.
- Designed to escape from unfeasible space
  - ➢ Better not get in!
- Good for very constrained problems
  - ➢ Very rare ! (to avoid "no solution" you often relax it)
- Good for optimality certificates
  - ➢ Once you are already close to optimum
  - ➢ Unrealistic on most applications anyway

➔ *Best-first*

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Best-Impact-Value-Selector

Given a variable X to branch on

- For each value V in its domain
  - Apply X=V
  - Propagate
  - Record objective LB (UB) bound for minimization (max)
  - Backtrack
- Select the value with lowest LB (highest UB)

CP variant of MIP's strong branching

Branching variant of SAC

Best-Impact-Value-Selector

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Given a variable X to branch on

- For each value V in its domain
  - Apply X=V
  - Propagate
  - Record objective LB (UB) bound for minimization (max)
  - Backtrack
- Select the value with lowest LB (highest UB)

➔ 1st solution is good!

➔ 100% generic ☺

➔ May be combined with any variable selector

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Best-Impact-Value-Selector

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Results on 50-cities TSP instance

Search	1st sol time	1st sol cost	Best sol cost (30s)
DEFAULT	0.02	3775	2043

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Best-Impact-Value-Selector

Results on 50-cities TSP instance

Search	1st sol time	1st sol cost	Best sol cost (30s)
DEFAULT	0.02	3775	2043
MIN_COST_SUCC	0.03	629	352

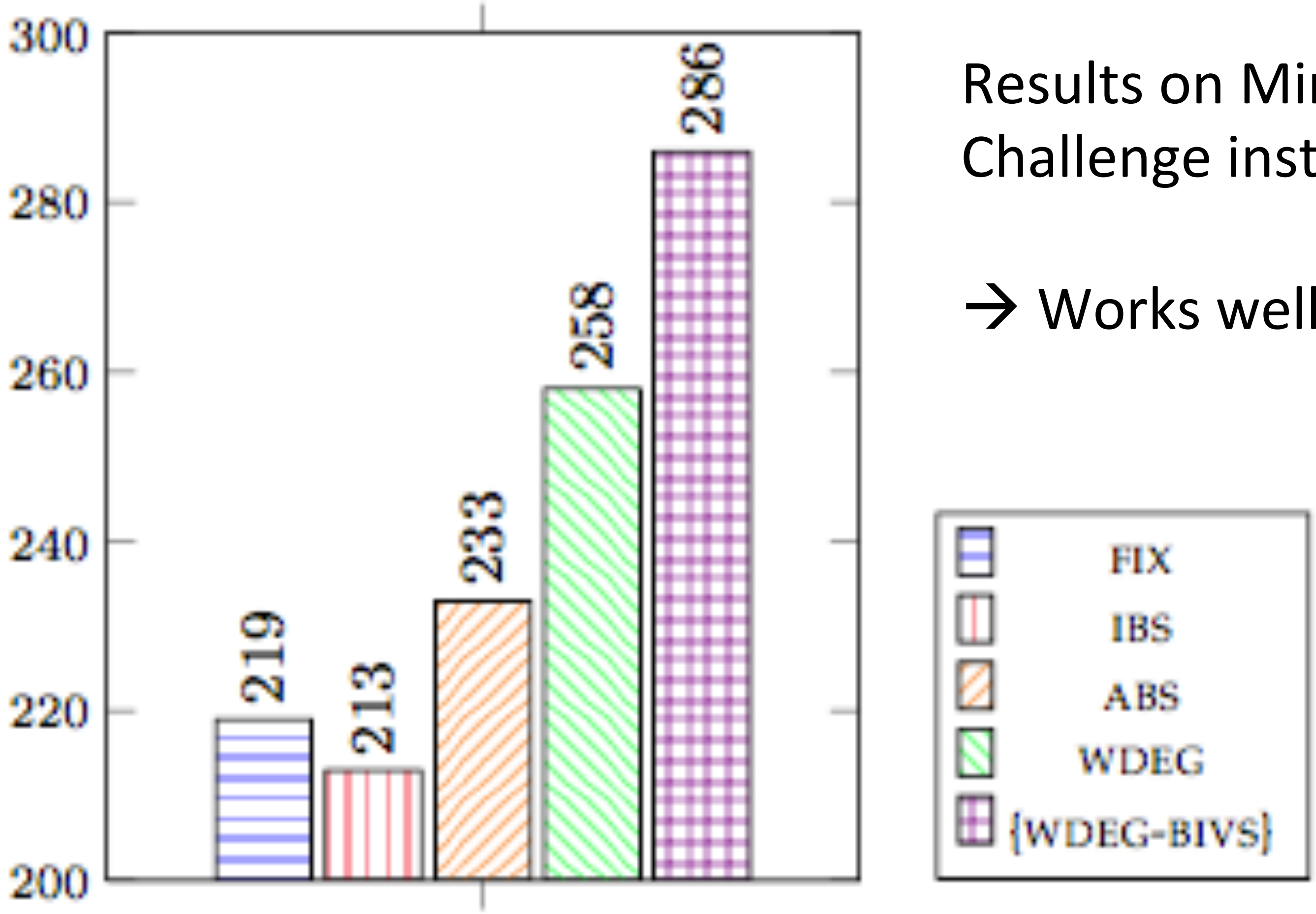
Only 1 min for an expert, but many users would not do it

Best-Impact-Value-Selector

Results on 50-cities TSP instance

Search	1st sol time	1st sol cost	Best sol cost (30s)
DEFAULT	0.02	3775	2043
MIN_COST_SUCC	0.03	629	352
BEST_IMPACT	**0.60**	**455**	**327**

Best-Impact-Value-Selector



Results on MiniZinc Challenge instances

→ Works well on average

Conclusion

Black-box value selector for optimization

- Simple
- Generic
- Efficient

Used in Choco Solver default configuration
→ Helped to win a lot of medals this year! ☺

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Next steps

Next steps: identify (groups of) decision variables

- Different from variable selector
- Does not exist in any solver
- Need to analyze variables & constraints

➢ Great Challenge!

Thank you

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