CPLEX Optimization Studio 12.10
Performance improvements
CPO Performance
CPO – Scheduling Performance

- **Iterative Diving**
  - Fast dives using limited propagation at nodes
  - Used in defaults with >3 threads
  - 1.5 x speedup over testset of 2690 problem instances
CPO – Optimizer Performance

- Strategy selection via reinforced learning
  - CPO comprises a portfolio of search and propagation strategies
  - Automatically and dynamically pick the “best” one to use on a particular problem instance via reinforced learning
  - 1.5x overall performance improvement
  - More for feasibility problems (no objective):

Feasibility Problems

- CPO 12.8.0
- CPO 12.10.0

<table>
<thead>
<tr>
<th>Time Range</th>
<th>CPO 12.8.0</th>
<th>CPO 12.10.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1s</td>
<td>0.35</td>
<td>0.23</td>
</tr>
<tr>
<td>&gt;10s</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>&gt;100s</td>
<td>1.00</td>
<td>0.17</td>
</tr>
<tr>
<td>251 models</td>
<td>2.87x</td>
<td>5.73x</td>
</tr>
<tr>
<td>174 models</td>
<td>4.37x</td>
<td></td>
</tr>
<tr>
<td>113 models</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LP Performance Improvements
CPLEX 12.9.0 vs. 12.10.0: LP performance improvement

- **Improved code generation**
  - Switched to icc 19.0.4.243
  - Compiler pragmas to better exploit SIMD instructions
    Helped by some code reorganization

- **Algorithmic improvements**
  - Better handling of superbasics in crossover
  - Better handling of presolve in concurrent optimizer

**Date:** January 2, 2020  
**Testset:** LP: 2203 models  
**Machine:** Intel(R) Xeon(R) CPU E5-2667 v4 @ 3.20GHz, 64 GB RAM, 12 threads, deterministic  
**Timelimit:** 10,000 sec

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MILP Performance Improvements
CPLEX MILP performance evolution

- Red line: > 10.0 sec. 1671 models
- Green line: > 100.0 sec. 1112 models
- Blue line: > 1000.0 sec. 674 models

Date: January 2, 2020
Testset: MILP: 5118 models
Machine: Intel(R) Xeon(R) CPU E5-2667 v4 @ 3.20GHz, 64 GB RAM, 12 threads, deterministic
Timelimit: 10,000 sec
CPLEX 12.9.0 vs. 12.10.0: MILP performance improvement

- MILP improvements summary
  - Dynamic search: Improved restarts: 12% on 7% affected models
  - Improved handling of indicator variables: 20% on 0.01% affected models
  - Heuristics: 1-2% overall
  - Cuts:
    - improvements of zero-half cut separator for models with relatively dense binary constraints: 10% (on 5% affected models)
    - Farkas Cuts from infeasible node LPs: 2% overall

Date: January 2, 2020
Testset: MILP: 5118 models
Machine: Intel(R) Xeon(R) CPU E5-2667 v4 @ 3.20GHz, 64 GB RAM, 12 threads, deterministic
Timelimit: 10,000 sec

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MIQP Performance Improvements
**CPLEX 12.9.0 vs. 12.10.0: MIQP performance improvement**

![Bar chart showing performance improvement](chart.png)

- Automatic decision whether Q should be linearized or kept as is
  - Use Machine Learning to learn a classifier
    - [Bonami, Lodi, Zapperlon, 2018](#)

- Problem instances from training set excluded

**Date:** January 2, 2020  
**Testset:** MIQP: 1465 models  
**Machine:** Intel(R) Xeon(R) CPU E5-2667 v4 @ 3.20GHz, 64 GB RAM, 12 threads, deterministic  
**Timelimit:** 10,000 sec
Benders Performance Improvements
**CPLEX 12.9.0 vs.12.10.0: Benders B&C improvements**

- **Benders improvements summary**
  - Benders specific presolve: 2%
  - Improved purging of Benders cuts: 2-3%
  - Exploitation of General Bound Constraints: 5%
    - 66x speedup on Partial Set Covering Location Problems

**Benders MILP branch-and-cut (12 threads)**

- Time limits: 9 / 3
  - 280 models
  - 241 models
  - 160 models

**Graph Data**

- CPLEX 12.9.0: 1.93x
- CPLEX 12.10.0: 2.04x
- CPLEX 12.10.0: 2.78x

**Testset Details**
- Date: January 2, 2020
- Testset: Benders MILP: 374 models
- Machine: Intel(R) Xeon(R) CPU E5-2667 v4 @ 3.20GHz, 64 GB RAM, 12 threads, deterministic
- Timelimit: 10,000 sec
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