Agenda

» LP & MIP performance
» Solving problems faster
Shifting paradigm: From Heuristics to MIP
Technologies

» Linear Programming
» Integer Programming
» Heuristics
» Constrained Programming
» Business Rules
Xpress-MP: Modular Optimization Modeling Tools
Fast Optimization Engines

- Solvers
- GUI / studio
- Extensions / NI
- Vertical applications
- Modeling platform

MOSEL
XAD
IVE

Solvers:
- LP
- MIP
- MIQP
- MISLP
- SLP
- CP
- LP
- QP

Extensions / NI:
- Heuristics

Vertical applications:
- CP
- CP

Modeling platform:
- XAD
- IVE
LP Performance across releases

Internal test set of 796 public and customer models
LP Performance across releases

Internal test set of 796 public and customer models
LP Performance across releases

Internal test set of 796 public and customer models
MIP Performance across releases

Internal test set of 320 public and customer models
MIP Performance across releases

Internal test set of 320 public and customer models
MIP Performance across releases

- Branch and Bound
- Cuts Classic problem specific
- Heuristics General and problem specific parallelize

Time

Number Solved

Release

FICO 7.0
Feedback Loop

MIP Performance

Reengineer B&B
Decomposition Algorithms – more flexible
Perform Operations - Node

Release


Number Solved

Total Time (s)


290 270 290 150 170 190 210 230 250 270 290

Number Solved

Total Time
### Xpress 7 parallel speed ups

<table>
<thead>
<tr>
<th></th>
<th>Xpress 7 1 thread</th>
<th>Xpress 7 4 thread</th>
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<tbody>
<tr>
<td>“Internal” deterministic</td>
<td>25,724</td>
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# Xpress 7 parallel speed ups

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- Parallel processors on a Newtwork
- Parallel MIP (same computer) P-MIP
- Deterministic P-MIP
Concurrent LP solver

» Efficient LP method parallelization

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<td>1 thread</td>
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Time(concurrent) \sim \min(\text{Time(dual)}, \text{Time(primal)}, \text{Time(barrier)})

Controls: LPTHREADS and DETERMINISTIC
(concurrent is nondeterministic!)
Concurrent LP solver

» Efficient LP method parallelization

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Time(concurrent) ~ min(Time(dual), Time(primal), Time(barrier))

Controls: LPTHREADS and DETERMINISTIC (concurrent is nondeterministic!)
Customers want multiple alternative solutions
Example: air04

- Set partitioning problem for airline crew scheduling
- Available from MIPLIB 2003

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<thead>
<tr>
<th></th>
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<th>5-Best Solution Solver</th>
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<tbody>
<tr>
<td>1st Solution</td>
<td>56137</td>
<td>56137</td>
</tr>
<tr>
<td>2nd Solution</td>
<td>56166</td>
<td>56137</td>
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<tr>
<td>3rd Solution</td>
<td>56307</td>
<td>56137</td>
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<tr>
<td>4th Solution</td>
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<td>56137</td>
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<tr>
<td>5th Solution</td>
<td>57562</td>
<td>56137</td>
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<tr>
<td>Total B&amp;B Nodes</td>
<td>141</td>
<td>15 981</td>
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<tr>
<td>Total Time</td>
<td>26 sec</td>
<td>29 sec</td>
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