Algorithm Configuration Landscapes: More Benign than Expected?

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Motivation

Algorithm configuration:
• Automatically finds high quality parameter settings
• Improves performance by several orders of magnitude

Existing configurators:
• Use powerful meta-heuristics
• Assume landscapes are challenging to optimize

Our hypothesis:
• Landscapes are more benign than expected
• Parameter responses are perhaps uni-modal/convex

Intuition

Numerical parameters:  
**too little** or **too much**

Tests

• Uni-modal?
• Convex?
• Interesting? ( ✓ or ✗)

Methods

1. Time
   - Parameter 1 vs Parameter 2
   - 95% Confidence Interval
   - Median of Bootstrap Samples
   - Uni-modal Test

2. Time
   - Run 1 vs Run 2
   - Run 3 vs Run 4
   - Bootstrap Sampling

3. Time
   - Parameter 1
   - Median of PAR10 (CPU Sec)
   - 95% Confidence Interval

Conclusions

<table>
<thead>
<tr>
<th>Instance Sets</th>
<th>Individual Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uni-modal</td>
<td>✓</td>
</tr>
<tr>
<td>Convex</td>
<td>✓</td>
</tr>
</tbody>
</table>

Instance set responses:
• Nearly all uni-modal
• Nearly all convex
• Relatively “smooth”

Individual instance responses:
• Mostly uni-modal
• Mostly convex
• More “noisy”

Future Work

• Exploit!
• Interactions? ( 🔍 + ☢️)
• Categoricals? ( ⚔️ or ▪️)

Results

<table>
<thead>
<tr>
<th></th>
<th>Instance Sets</th>
<th>Individual Instances</th>
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<tbody>
<tr>
<td>% uni % cvx</td>
<td>% uni % cvx</td>
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<tr>
<td>All</td>
<td>99.5 99.5</td>
<td>95.3 92.6</td>
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<tr>
<td></td>
<td>94.4 94.4</td>
<td>76.1 66.1</td>
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</tbody>
</table>

Experimental Setup

Domains: SAT, TSP, MIP
Algorithms: Cadical, Cryptominisat, Lingeling, EAX, LKH, CPLEX
Instance Sets: CF, BMC, RUE, CLS, R

Parameter Value

95% Confidence Interval
Median of PAR10

<table>
<thead>
<tr>
<th>Parameter Value</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>🔍</td>
<td>▪️</td>
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