Extending the power and scalability of MATLAB computations within optimization solutions

Horia Tipi
Director, Product Management
FICO
► Introduction
► Connecting MATLAB to Xpress
► MATLAB in the FICO Analytic Cloud
► Discussion
# We Work with the Most Successful Businesses

<table>
<thead>
<tr>
<th>Industry</th>
<th>Clients Include</th>
<th>Client Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banking</td>
<td>More than half of the top 100 banks</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>Two-thirds of the top US P&amp;C insurers</td>
<td></td>
</tr>
<tr>
<td>Retail/Consumer Goods</td>
<td>One-third of the top US retailers</td>
<td></td>
</tr>
<tr>
<td>Health Care/Pharma</td>
<td>7 of the top 10 pharma companies</td>
<td></td>
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<tr>
<td>Government</td>
<td>100+ government agencies</td>
<td></td>
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</tbody>
</table>
### FICO® Optimization Modeler *powered by Xpress*

#### Modeling

**Mosel**
- Flexible, modular, easy-to-learn and use
- Development IDE
- Distributed modeling and cloud enablement
- Data connections (file, excel, databases, web services)
- Precompiled for efficiency and IP protection
- Robust and Nonlinear modeling

#### Optimization

**Optimizer NonLinear Kalis**
- High-performance, scalable and robust LP (Simplex|Barrier), MIP, QP, MIQP, QCQP, MIQCQP, SOCP, MISOCP, NLP, MINLP, and CP engines
- Great out-of-the-box performance — advanced users have full control over solution process
- Utilizes multi-core/CPU machines, automatic tuning
- N-best solutions capabilities and advanced infeasibility handling

#### Applications Services

**Optimization Modeler**
- Adapt data and parameters to create and compare scenarios
- Understand trade-offs and sensitivities
- Visualize data and results for analysis
- Collaborate in a multi-user environment
- Works in a rich client and a web browser — on premise and in the cloud
- Fully featured APIs including web

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Xpress-IVE: Mosel and Optimizer

- Editor
- Debugger
- Profiler
- Progress graphs
- Visualization
- Wizards
- Mosel extensions
- Deployment
One solution example
Solution example: Deal Optimizer

Benefits
- Capture more market share while maintaining profitability
- Provide a faster and better originations customer experience
- Avoid losing customers you could profitably originate
- Re-use existing investments in analytics and infrastructure
- Respond quickly to changes in business environment
Solution example: Deal Optimizer

_features

- Integrates with existing originations systems
- **Integrates analytic services**
- Provides an optimally diverse set of deal alternatives to increase uptake probability
- Enables full management, control, and auditability of originations business logic to ensure both agility and compliance
- Empowers agents (human and virtual) to create a better deal without resorting to credit exceptions
- Flexibly captures your exact business requirements
- Not a black box!
Xpress-MATLAB Interface

► Optimizer interface - already part of Xpress since 2010
  ► Toolkit-like interface for the Xpress-Optimizer
  ► Provides functions for solving the mathematical programming problems supported by the Optimizer
  ► No modeling aid, the user must pass the constraint matrix to the optimizer

► New MATLAB interface for Mosel
  ► The Optimizer interface cannot be used with Mosel models
  ► Some customers do data prep and post processing in MATLAB
  ► Currently they would need to export data into some intermediate file and import back results
MATLAB Interface

► Functionalities
  ► Toolkit function for the Mosel compile-load-run API
  ► Stream redirection from stdin/stdout to the MATLAB console
  ► IO driver for accessing MATLAB data as binary streams
  ► IO driver for reading/writing structured MATLAB objects into/from Mosel objects

► Examples
Enhanced MATLAB – Xpress Interface
A Mosel model can be read from a stream that uses the MATLAB driver. So it is possible to embed the Mosel program in a MATLAB string.
MATLAB Interface

MATLAB variables can be read/set in Mosel “initialization from/to” blocks

```plaintext
model "Portfolio optimization with LP"
  ...
  initializations from "matlab:"
  RISK NA RET
  end-initializations
  ...

initializations to "matlab:"
  evaluation of getobjval as "objval"
  evaluation of array(s in SHARES) frac(s).sol as "frac"
end-initializations
exit(getprobstat)
```

```
foliolp_org.mos

model "Portfolio optimization with LP"
  ...
  initializations from "matlab:"
  RISK NA RET
  end-initializations
  ...

initializations to "matlab:"
  evaluation of getobjval as "objval"
  evaluation of array(s in SHARES) frac(s).sol as "frac"
end-initializations
exit(getprobstat)
```
MATLAB Interface

► Any MATLAB expression can be used as input for initializations
  ► For example, if
    ► `shares.isRisky` is a vector of flags indicating which are the risky shares
    ► `shares.roi` is a matrix with many different return estimates, one per row

```matlab
... initialization from "matlab:"
  RISK as "find(shares.isRisky)"
  RET as "mean(shares.roi)"
  DEV as "std(shares.roi)"
  ...
```

► The driver currently supports
  ► MATLAB scalars, dense and sparse matrices, n-dim array and cell arrays of any basic class
  ► Mosel scalars, sets, lists, arrays of any basic type
  ► Mosel arrays must be integer-indexed (as in MATLAB)
MATLAB Interface

- More advanced usage supported via the Mosel Java API
  - Mosel Compiler and Mosel Run Time APIs
  - Java object creation and manipulation via MATLAB (dynamic) language, even interactively
  - Still possible to use the same MATLAB IO driver for easy access to MATLAB variables

```
>> mosel=com.dashoptimization.XRPM;
>> mosel.compile('burglar2.mcs');
>> mod = mosel.loadModel('burglar2.bim');
>> mod.run
Solution:
Objective: 280
  take(brick): 0
  take(camera): 1
  take(chest): 0
  take(necklace): 1
  take(picture): 1
  take(tv): 0
  take(vase): 1
  take(video): 1
```
MATLAB on FICO Analytic Cloud
Decision Management Platform Components and Services

Components
- Decisions
- Modeling
- Optimization
- Data Orchestrator
- Text Analytics
- Link Analysis
- Social Networks
- PMML
- Adaptive Control
- CEP
- Variable Library
- MATLAB

Core Services
- Analytic Datamart
- Component Lifecycle Management
- Elastic Search
- Access Control
A Network of Intelligence
Accelerating the Development of Ideas

CONSUME
- Researchers
- Businesses
- Governments

CONTRIBUTE
- Entrepreneurs
- ISVs
- Systems Integrators/Consultants

COLLABORATE
- Academics
- Corporate Developers
Thank You

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# FICO Snapshot

| Profile | The leader in predictive analytics for decision management  
|         | Founded: 1956  
|         | NYSE: FICO  
|         | Revenues: $676 million (fiscal 2012) |
| Products and Services | Scores and related analytic models  
|                       | Analytic applications for risk management, fraud, marketing, mobility  
|                       | Tools for decision management |
| Clients and Markets | 5,000+ clients in 80 countries  
|                     | Industry focus: Banking, insurance, retail, health care |
| Recent Rankings | #1 in services operations analytics (IDC)  
|                  | #6 in worldwide analytics analytics software (IDC)  
|                  | #7 in Business Intelligence, CPM and Analytic Applications (Gartner)  
|                  | #26 in the FinTech 100 (American Banker) |
| Offices | 20+ offices worldwide, HQ in San Jose, California, USA  
|         | 2,400 employees  
|         | Regional Hubs: San Rafael (CA); San Diego (CA); New York; Roseville, MN; London; Birmingham (UK); Istanbul; Madrid; Munich; Sao Paulo; Bangalore; Beijing; and Singapore. |
# FICO Product Portfolio

For Specific Decision Processes

<table>
<thead>
<tr>
<th>Applications</th>
<th>Marketing</th>
<th>Origination</th>
<th>Customer Management</th>
<th>Collections and Recovery</th>
<th>Fraud Management</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeting Models</td>
<td>FICO® Customer Dialogue Manager</td>
<td>FICO® Origination Manager</td>
<td>FICO® TRIAD® Customer Manager</td>
<td>FICO® Debt Manager™</td>
<td>FICO® Falcon® Fraud Manager</td>
<td>FICO® Adeptra® Fraud Resolution</td>
</tr>
<tr>
<td>Time-to-Event</td>
<td>FICO® Analytic Offer Manager</td>
<td></td>
<td></td>
<td>FICO® Recovery Management System™</td>
<td>FICO® Insurance Fraud Manager</td>
<td>FICO® Adeptra® Risk Intervention Manager</td>
</tr>
<tr>
<td>Analytics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FICO® Claims Fraud Manager</td>
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</tr>
</tbody>
</table>

For Any Decision Process

<table>
<thead>
<tr>
<th>Scores</th>
<th>B2B: FICO® Score • FICO® Credit Capacity Index™ • FICO® Insurance Risk Scores myFICO®</th>
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<tbody>
<tr>
<td>Tools</td>
<td>FICO® Blaze Advisor® • FICO® Model Builder • FICO® Model Central • FICO® Optimization Modeler • FICO® Xpress • FICO® Decision Optimizer</td>
</tr>
<tr>
<td>Professional Services</td>
<td>Custom Analytics • Operational Best Practices • Strategy Design and Optimization</td>
</tr>
</tbody>
</table>
New ways of contracting
Air Products and Chemicals using robust optimization

► Production planning at a liquid oxygen/nitrogen plant, a very energy-intensive operation
  ► Interruptible Load Contract (ILC): power company can suspend supply in periods of high demand (summer)
  ► At most k interruptions each month (8 hours each)
  ► Cost per kWh is lower than with uninterrupted contract
► The power supplier won’t tell us when the interruptions will be.
  ► treat interruptions as uncertain
  ► RC: plan production so that even with the most evil-placed k interruptions we satisfy customer demand
► Production of critical gases for hospitals => a robust (always feasible) solution is needed
FICO® Xpress Solver Performance
Based on Public Benchmark Results

- FICO has the most complete optimization offering and all solvers are very competitive
- Robust / (MI)SOCP solver dominates the competition
- FICO has the leading nonlinear offering with applications in particular in finance, insurance, and power/gas/oil industries

Results as of March 30, geometric means of time to optimality, LP/QP geometric mean computed by FICO, MIP 12 threads, nonlinear numbers directly computed from the logs and computed by FICO