Workflow, Rule, and Optimization Engines: Working Together, Jacob Feldman, PhD

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Modern document-intensive business processes require the integration of multiple technologies in a single practical solution. In particular:

- **Workflow Engine**
  - to define and execute a business process

- **Rule Engine**
  - to define and execute business logic

- **Optimization Engine**
  - to find an optimal solution for the business problem
• Claims processing, loan origination, service configuration, insurance policy management are typical examples of the complex document-intensive business processes
• Workflow engines are used to design and execute such processes
• They provide necessary tools to capture, process, route, and archive documents and associated information needed to successfully complete document management
• However, a pure workflow technology itself is missing automatic decision support capabilities
• Business rules management frameworks have already proved their efficiency for rules representation, maintenance, and execution.
• At the same time, business rules are always attached to a business process.
• So, it is natural for business rules to be used to create decision support workflow nodes. Such nodes can control the workflow logic, generate and redirect workflow items.
What Is a Workflow framework?

• A typical workflow engine allows customers to:
  – Make sense of the flood of unstructured information that enters the enterprise
  – Provide the right information, to the right person, at the right time, to get the job done -- right

• Example: Exigen Workflow Framework
  – Provides a consistent Workflow methodology for both knowledge-based and administrative jobs regardless of:
    • Location
    • Customer interaction channel
    • Task
    • Role
A Workflow Framework usually includes

- Scanning
- Inbound Fax
- Outbound Fax
- Document Formats
- Imaging
- OCR/ICR
- Bar Code
- COLD
- Non-Structured Data Archives
- Repository database
• Design work processes using visual tools – Workflow Designers
• Create complex routing rules using “drag & drop”
• Route work items to user groups or automated processors
• Manage data flow through legacy (core business systems) environments
• Monitor and report on business processes; escalate and alarm business bottlenecks
• Centralize into one location or distribute work to branch organizations
• **Skills-based Routing**
  – Knowledge worker abilities matched to item requirement
  – Approval and QA automation

• **Context-based Routing**
  – Customer segmentation
  – Item difficulty
  – Location of customer or issue

• **Workload-based Routing**
  – Named User, Push, and/or Pull Metaphors

• **Audit log and tracking**
Example of a Workflow Designer with Routing Rules

For each work item, the workflow node editor defines the node type, routing rules, escalation and monitoring processes. Routing rules change the flow of work depending on the content of each work item.
Workflow Events

- Events

[Diagram showing workflow process with nodes labeled High Volume Index, Accounting Department, Marketing Department, and an Assign Event window with options like Send e-mail notification, Set Defaults to Folder Fields, etc., and a description field set to "Sends e-mail notification when parcel arrives to user"]
Workflow Solutions

- **Insurance**
  - Underwriting
  - Claims processing
  - Agency automation (B2B Sell Side automation)

- **Finance**
  - Loan origination
  - Credit Card Issuance and processing of payments
  - Broker automation
  - Front Office automation
    - Signature Card Authorization
  - Account management

- **General business**
  - AR/AP
  - HR
  - Document Enabling SAP
  - Doc Archival/Retention

- **Government**
  - Records Management
  - Web-based Constituent access
  - License Renewals
  - Accident Reporting
  - State Insurance Dept
  - Law Enforcement
  - Court Case Management
  - Public Access to Board Agenda
  - Tax Records
A powerful framework for the rapid creation, deployment, and maintenance of business rule management systems

Externalizes business rules from application code

Allows business people to create/modify/deploy business rules

Provides customers with a methodology and tools for building industry specific rule templates which in turn are used to create, test and maintain a diverse hierarchy of inter-related rules.
Typical Pitfalls with Rules Processing

- Creation of thousands of semantically equal rules, instead of hundreds of templates (!)
- No consideration of the lifecycle of rules
- Absence of the rules consistency validation tools (!)
- Attempts to cover ALL possible business situations with rules instead of applying optimization technology(!)
- Do not invent: reuse LOB-specific template libraries built on top of LOB-specific standards (ACORD,MISMO,..)
Rule Templatization Technique

• Template-based Rules Repository:
  – During rules harvesting classify *semantically similar rules* into templates
  – Real-life example: using the template technology, a Wall Street institution combined more than 3000 portfolio management rules into less than 300 templates
  – Define complex relationships between template parameters

• Simplified Maintenance:
  – Rules semantics kept only in a library of hundred templates supported by specialists, while thousands rules are supported by business users themselves.
  – Administrative roles accessing template and rule sets.
Rules-based Application with Three Engines: Functional Scheme

- Parameterized Business Rules (Templates)
  - Rules Representation and Semantics

- Template Editor
  - Technical User

- Rule Editor
  - Non-Technical User
  - Create, Modify, Delete, Activate, Validate

- Rules Instances
  - Client/Problem specific Rules with template parameters

- Business Object Model

- Business Application

- Workflow Engine
  - Representing Business Processes

- Rule Engine(s)
  - Executing Rules

- Constraint Engine(s)
  - Solving Optimization Problems

- Enterprise Data
### Rule Project from an Administrative Perspective

#### Rule Status & Name

<table>
<thead>
<tr>
<th>Rule Status &amp; Name</th>
<th>Rule Presentation</th>
<th>Template Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set Prime Rate</strong></td>
<td>Set current Prime Rate to 7.00%</td>
<td>Prime Rate</td>
</tr>
<tr>
<td><strong>Margin for 110% HELOC, 90% HELOAN</strong></td>
<td>For products 110% HELOC, 90% HELOAN with loan terms 12, 24, 48, 60, 84, 120 set Margin to 1.00%</td>
<td></td>
</tr>
<tr>
<td><strong>Margin for 100% HELOC</strong></td>
<td>For products 100% HELOC with loan terms 12, 24, 48, 60, 84, 120 set Margin to 1.50%</td>
<td></td>
</tr>
<tr>
<td><strong>Margin for 80% HELOC</strong></td>
<td>For products 80% HELOC with loan terms 120 set Margin to 2.00%</td>
<td></td>
</tr>
<tr>
<td><strong>LoanRange 20-250 for terms 1</strong></td>
<td>For products 110% HELOC, 90% HELOC, 100% HELOC with loan terms 12, 24, 48, 60, 84, 120 set Loan Limits from $20,000.00 to $100,000.00</td>
<td></td>
</tr>
<tr>
<td><strong>LoanRange 20-100 for terms 1</strong></td>
<td>For products 80% HELOC with loan terms 120 set Loan Limits from $20,000.00 to $100,000.00</td>
<td></td>
</tr>
<tr>
<td><strong>Eligible Property Types</strong></td>
<td>For products 110% HELOC, 80% HELOC set eligible Property Types to Single Family Detached,</td>
<td></td>
</tr>
<tr>
<td><strong>Eligible Property Types</strong></td>
<td>For products 90% HELOC, 100% HELOC set eligible Property Types to Single Family Detached</td>
<td></td>
</tr>
<tr>
<td><strong>Minimal FICO of 110% HELOC</strong></td>
<td>For products 110% HELOC set minimal FICO to 700</td>
<td></td>
</tr>
<tr>
<td><strong>Minimal FICO of 90% HELOC</strong></td>
<td>For products 90% HELOC set minimal FICO to 600</td>
<td></td>
</tr>
<tr>
<td><strong>Minimal FICO of 100% HELOC</strong></td>
<td>For products 100% HELOC set minimal FICO to 560</td>
<td></td>
</tr>
<tr>
<td><strong>Minimal FICO of 80% HELOC</strong></td>
<td>For products 80% HELOC set minimal FICO to 560</td>
<td></td>
</tr>
<tr>
<td><strong>DTI of 90% HELOC</strong></td>
<td>For products 90% HELOC set Maximum</td>
<td></td>
</tr>
</tbody>
</table>
• Right rules organization, application of only necessary rules and rule engines
• Embracing different Inference engines:
  – Rete-based engines like JESS™ or ILOG™
  – Highly efficient inference engine based on new algorithms from parallel rules languages
• Multiple inter-dependent engines:
  – light-weight
  – re-entrant
  – scalable
• Configurable Run and Test components
• Ability to define and solve constraint satisfaction problems. Automatic formulation of optimization problems in rules and solving them with a built-in constraint engine

• Hard and Soft Rules

• Minimization of the total rule violations

• Rules Consistency and Coherence validation
  – Diagnose rules overlapping and under-covering
  – This feature is particularly important for complex classification rule tables that go far beyond simple if-then statements
Adding Optimization Components

• Rules themselves cannot describe ALL possible business situations and recommend the best solution
• Apply Optimization engine each time there are multiple alternatives and looking not for a solution, but for the best solution
• Integrate Rule Engine with different Optimization Engines (constraint-based, linear, other)
• Add sophisticated decision-support capabilities by applying the optimization engine against different optimization objectives defined in rules
Constraint Satisfaction Engine

- Integer, boolean, and floating point constrained variables
- All basic constraints and constrained expressions
- Generic reversible environment with highly efficient event notification and constraint propagation mechanisms
- Interpreter of symbolic constrained expressions
- Powerful pre-defined search algorithms (goals)
- Ability to write problem-specific constraints and search algorithms
- Built-In integration with rules frameworks
- Implementations in C++ and Java
• Ability to represent rules as constraints
• Use of both rules and constraint programming techniques inside the same framework to solve complex business problems that usually out of reach of regular rule engines
• Real-world examples
• Financial Portfolio Management
  – Use rules like “Technology Stocks should be within 20% and 35%” to define the target portfolio
  – Objective: keep all actual portfolios as close as possible to the target portfolio

• Integrated Engines:
  – Rule Engine warns about possible rule violations during sell/buy
  – Constraint Engine recommends the best combination of trade orders to minimize the total rules violation
• Loan Origination
  – Applying for a loan, a customer usually provides a desired loan amount, term, and a list of included borrowers with different credit scores
  – Objective: to avoid rejection or lengthy “what-iffing”, a bank allows to “a little bit violate” the requested parameters to find a loan with the minimal interest rate

• Integrated Engines:
  – Rule Engine defines all eligible loan products
  – Constraint Engine recommends the best combination of the loan amount, term, and borrowers to select the most suitable loan product
• Telecom Service Configuration
  – Personalized configuration of available calling plans and other wireless, local, long distance and Internet services
  – Rules-based marketing campaigns

• Integrated Engines:
  – Rule Engine determines cross/up selling opportunities
  – Rule Engine warns about possible rule violations
  – Optimization Engine recommends the best set of services that fit a customers’ preferences and actual calling pattern
  – Rule and Optimization Engines work together with customer data to determine and deliver the best account management advice to the CSR desktop
Rules and Constraints Working Together: Insurance Example

- **Insurance Pricing Discount Calculation**
  - According to the specified business rules, the customer is eligible to N different discounts
  - There is a rule/constraint that states that the total discount cannot be more than x%.
  - Objective: find a combination of the discounts that satisfies the “x%” constraint while maximizing/minimizing the premium

- **Integrated Engines:**
  - Rule engine figures out all eligible discounts
  - Optimization engine finds the best alternative for customer and company
• Hybrid use of rules and constraint technologies:
  
  Rule Engine + Constraint Engine =
  
  Online Decision Support

• Use Rules
  – to define and modify the business problem

• Use Constraints
  – to solve the optimization problem
• Workflow, Rules, and Optimization are powerful by themselves
• Integration in couples “Rules+Optimization” or “Workflow+Rules” produces valuable results
• Real efficiency when all three are combined
• The following are excerpts from a Business Process Library for insurance policy servicing for private passenger auto:
  – Incoming Requests
  – Inquiries
  – Endorsements
    • Change Vehicle
    • Add Driver
    • Add Vehicle
  – Rate Policy
  – Renewal
  – Follow-up
Sample business process “Change Vehicle”

• **Policy:**
  – Mr. S drives a 1999 Lexus, Mrs. S drives a 1997 Acura, and their 17 year old son occasionally drives his mother’s Acura

• **Customer Request:**
  – Mrs. S trades in her Acura for a new Mercedes

• **Possible Consequences:**
  – The son used to be assigned to the Lexus as the riskiest driver for a car with the highest exposure
  – Now the Rule Engine gives the Mercedes the highest exposure
  – The Rule Engine assigns the son to the Mercedes
  – Their overall premium goes up to $XXX and the appropriate rule requires a copy of the registration for the Mercedes. The Workflow Engine generates a new workitem to request the registration. The workitem will be escalated if the registration is not received within 4 days
  – If all of this occurred on December 27th, and new rating rules are scheduled for January 1st, this process may be repeated
• Previous process is an example of how Workflow engine works together with Rule and Constraint engines

• There are several logically connected processes:
  – Receive Customer Request (workflow service)
  – Receive Existing Insurance Policy (workflow service)
  – Recalculate Vehicle Exposures (rule service)
  – Reassign Drivers to Vehicles (rule service)
  – Recalculate Premium (rule and optimization services)
  – Generate and Fax Back Confirmation (workflow service)
  – Escalate (workflow service)
  – Follow-Up (workflow service)
Example: An extract from a Loan Origination Workflow with a Built-in Rule Engine

This event is associated with a Rule Engine “LoanRuleEng” that decides to accept or to reject a loan application. The rule engine also produces rejection reasons or additional loan requirements.

This node routes the loan application together with the rule engine generated information to the proper workflow nodes using routing rules.
Practical Recommendations

- Associate Rule/Constraint Engines with workflow nodes to receive/produce/modify workflow items
- Use Rules/Constraints to define status and other variables of the workflow items
- Rule Engine can initiate workflow actions (e.g., send fax or email, put on hold, escalate), but should not execute them directly
- Use workflow Routing rules (not business rules!) to route the workflow items
- Treat Rules and/or Optimization Engines as Workflow Services
• The Exigen Framework automates document-intensive business processes through the use of three integrated intelligent engines:
  – **A Workflow Engine** to define and execute a business process
  – **A Rule Engine** to define, maintain and execute business rules
  – **An Optimization Engine** to find optimal solutions to business problems
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