Rules-Based Interaction Processes

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Presentation Outline

- Dynamic Interaction Processes: 4 Scenarios
- Rules-based Interaction Library
  - Dialog Construction Rules
  - Dialog Execution Rules
  - Integration
- Live Demo: Dynamic Loan Approval

Dynamic Interaction Processes

- In complex decision making environments such as loan origination, tax compliance, portfolio balancing, insurance underwriting, or airport security the *interaction logic is dynamic* by its nature and cannot be predefined in advance

- Below are several examples (scenarios) from real-world business environments that illustrate the problem

Scenario 1: Loan Approval

#	Events and Facts	Peter Johnson's Loan Application Decision	Comments
1.	Peter Johnson applied for $50K loan	**Rejected**	Insufficient Income. **But** a bank manager found that their valuable client with the same address can be a guarantor
2.	Joe & Dawn Johnson agreed to be Peter's guarantors. They have a Housing Loan with Available Equity = $300K and Remaining Debt = $150K	**Accepted**	$100K surplus is a sound proposition. **But** Conducting more detailed analysis, the manager notices a joint borrowing on Mr Johnson file which is not with his wife
3.	Joe Johnson and his partner Bill Smith (50/50) have a Business Loan for $200K with Available Equity $52K	**Accepted**	The remaining $26K surplus still meets requirements. **But** Bill and Susan Smith have other facilities outstanding against their property as well as the business loan
4.	Bill & Susan Smith have a Housing Loan with Available Equity = $240K and Remaining Debt = $150K	**Accepted**	Still a surplus. **But** a lending clerk at the lending operations center while preparing the collateral documentation, noticed a secured personal loan in the name of Tommy Smith for $50K secured by his parents
5.	Their son Tommy Smith has $50K loan secured by his parents	**Rejected**	Available Equity $42K < $50K.The business debt would be $8,000 short on cover

Scenario 1: Raised Questions

- To solve a business problem like this one, humans and machines should make an approve/decline decision based on the *joint performance* of tasks
- While new facts about the loan related securities can come from *different sources*, an effective interactive system should be able to request new information:
  - Based on the information entered for a particular case and
  - Based on related existing knowledge about the customer.
- What does "related knowledge" mean? Where is it defined and how can it be brought to the picture?

Scenario 2: Tax Return Compliance for Partnerships

- Tax compliance becomes extremely complicated when it has to consider a possible revenue and distribution of expenses among multiple related corporations (partnerships including foreign ones)
- The main problem here is how to generate the proper data requests, receive the *related* data, and then validate the accumulated information to be compliant with the current regulations
- Again, we deal with a question of how to define and maintain the "related data", which is dynamic in nature and can not be saved in a database

Scenario 3: Maintenance of User Profiles for Portfolio Balancing

- A customer may define preferences related to his/her investment strategy (conservative or moderate risk level, industry sectors, security type distributions, etc.). However, the dynamic nature of the constantly changing financial market requires permanent automatic and interactive adjustments to each customer's profile

- For example, a system should be able to generate questions like: *"Your positions are overly concentrated in a single security. Are you willing to relax position constraints?"* and make an automatic decision in each case based on a customer's preferences and the company's current strategy

Scenario 4: Identifying Suspicious Groups of Airplane Passengers

- A system validates a list of all passengers when they book tickets for air travel. Along with simple criteria such as:
    - age range, gender, country of origin, legal status, etc.

  the system may include *dynamic* characteristics such as:
    - acquired certain chemical products in certain quantities,
    - took certain classes at a certain educational institutions in a certain time period,
    - visited certain countries during the last 2 years, etc.

- Dynamic attributes need to be validated not just for one passenger but also for *all possible combinations of currently known passengers*. The very fact that a passenger satisfies a certain criterion, may initiate a new request about other passengers, that can in turn initiate additional new requests or reconsider already known facts

The Common Thread

- What do all these scenarios have in common?
- They all deal with the joint performance of tasks by humans and machines:
  - with the *dynamic* structure of these communications
  - when the interaction logic can not be predefined and depends on the *interaction history* and the *related information* about involved objects
  - with the necessity to support multiple data information requests, algorithms and programming interfaces
- We have to deal with situations when not all concepts/relationships are known in advance and new concepts/ relationships could be added as we go

A Systematic Approach

- The identified problem is very broad. Its solution requires a systematic long-term research and development activity that will probably combine several technologies including:
    - Ontology/RDF/Semantic Web
    - Rules-based techniques (BRE)
    - Constraint satisfaction techniques
- Many standardization bodies already started to consolidate domain-specific knowledge repositories (e.g. Basel II, ACORD, MISMO). Thus, methods and tools to work with the consolidated information will be required

A BRE Approach

- We tried to limit the scope of the problem to provide *practical* solutions in today real-world environment, and, of course, BRE was our first choice

- In the remaining part of the presentation, we will:

  - describe a practical approach to dynamic interaction using BRE technology

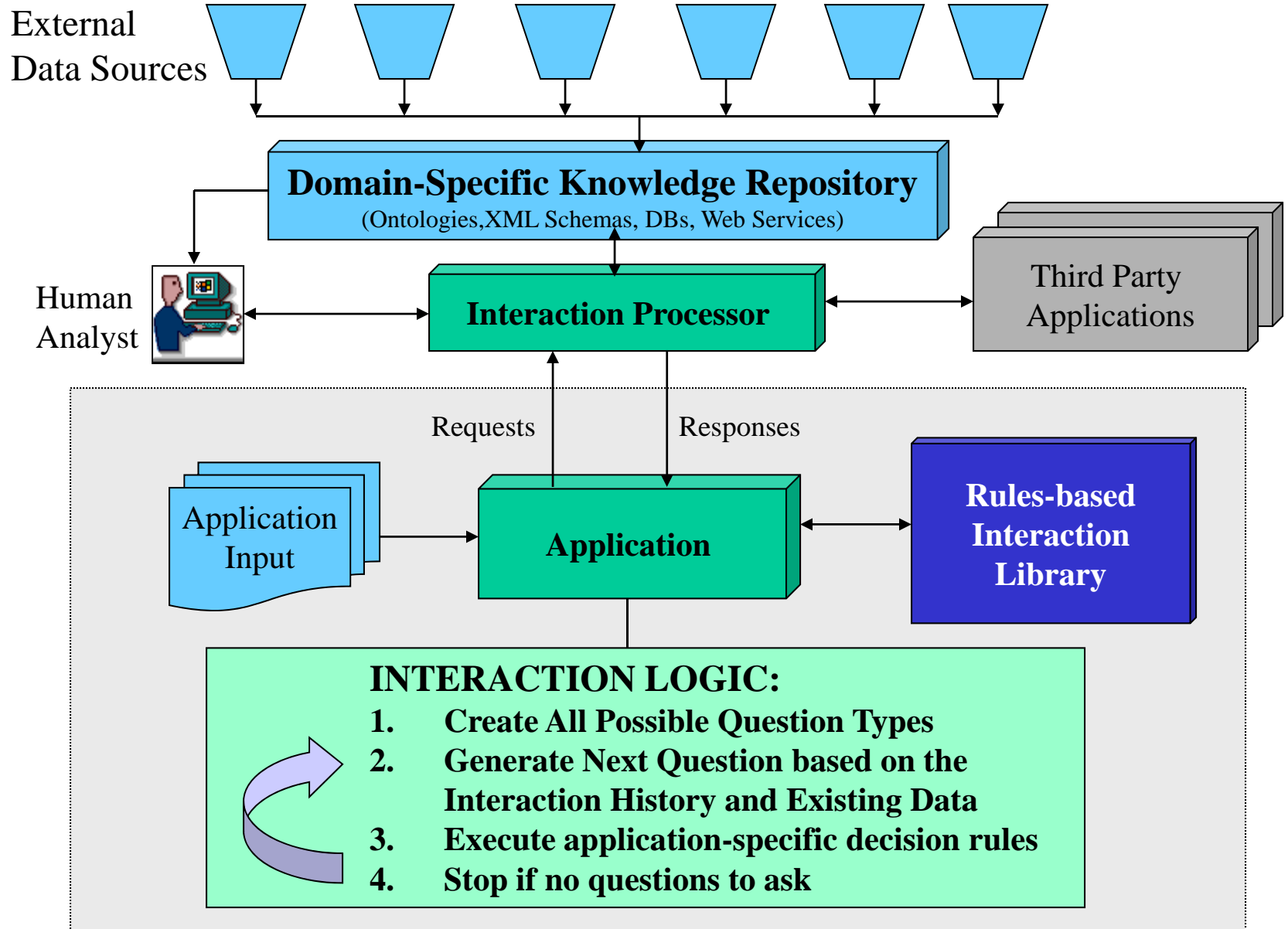 - demonstrate the approach using the Loan Approval scenario

BRE & Dynamic Interacting

- While business rules technology has already proven its effectiveness for many practical applications with complex business logic, it cannot be directly applied as a solution to problems that require *dynamic* interacting

- We have to address the following problems:

  1) Can a rules-based system construct an interaction process "on the fly" based on the interaction history and information already available in a particular business context?

  2) How to apply business rules to define multiple customizable dialogs with a variable content and complex inter-question relationships?

  3) How to achieve it and not to be lost in the complexity of the supporting business rules?

Required Functionality

- Ability to ask the next question based on the previous answers and a problem specific data
- Questions should be generated in a form that is understandable *either* by a human *or* by a computer
- Support for typical interaction constructions like multi-choice questions, auto-responses, inter-question relationships
- Integration with different business contexts (information sources)
- Integration with different portal environments

High-Level Architecture

External Data Sources

Domain-Specific Knowledge Repository
(Ontologies, XML Schemas, DBs, Web Services)

Human Analyst

Interaction Processor

Third Party Applications

Requests

Responses

Application Input

Application

Rules-based Interaction Library

INTERACTION LOGIC:
1. **Create All Possible Question Types**
2. **Generate Next Question based on the Interaction History and Existing Data**
3. **Execute application-specific decision rules**
4. **Stop if no questions to ask**

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Rules-based Interaction Library

- An extensible Interaction Library was created to address the above problems using just business rules technology and a GUI-based interaction processor

- The Interaction Library consists of two parts:
  1. A Java package to support generic interaction concepts and constructions
  2. Set of templates that predefine *semantics* of the rules for different dialog construction like multi-choice questions, questions with answers from a certain domain, events, messages, and auto-responses

Interaction BOM

- The Interaction Library is based on a generic business object model (BOM) to support different rules-based interaction processes
- The BOM is implemented in Java and covers such concepts as:
  - **Interaction Session** for a multi-user environment
  - **Interaction History** to keep track of all asked questions and provided answers
  - **Interaction Dispatcher** to execute the interaction logic
  - **Interaction Processor** to "ask" questions and receive answers from GUIs, DBs, or other sources
  - **Question**s and **Answer**s

Interaction Java Package

- Java API to an Interaction Rule Project
- An application just creates an Interaction Session that uses two predefined rule engines:
    - Rule Engine "**Create Dialog**"
        - creates interaction dialogs with all possible pages, sections, and questions defined by application specific rules
    - Rule Engine "**Execute Dialog**"
        - called constantly during the interaction cycle to resolve inter-question dependencies with respect to the interaction history and to define the next question to ask.
- There could be also PreProcessing and PostProcessing rule engines that contain application specific business rules

Dialog Construction Rules

- The Interaction Library includes generic rules common for any interaction processes

- The predefined rules are used to:
    - Construct Dialog Pages
    - Construct Sections on the Pages
    - Construct Questions inside Sections:
        - Multi-Choice Questions
        - Questions with Answers of different controllable types
    - Modify Questions based on the Interaction History
    - Provide Auto-Responses:
        - Respond to {question} using {string}
        - Respond to {question} using {formula}, etc.

Question Construction Rules
(OpenRules implementation)

DT void createPagesRules(DialogStructure dialog)

	Action 1			Action 2
Page Code	Page Name	Initial	Terminal	Trace
LoanApplication	Loan Application	TRUE	FALSE	LoanApplication
GuarantorRequest	Guarantor Request	FALSE	FALSE	GuarantorRequest
RelatedSecurities	Related Securities	FALSE	FALSE	RelatedSecurities
ResultingPage	Resulting Page	FALSE	TRUE	ResultingPage

DT void createSectionsRules(DialogStructure dialog)

			Action		
Page Code	Section Code	Section Name	Order#	ReadOnly	Trace
LoanApplication	BorrowerData	BorrowerData	1	FALSE	X
LoanApplication	LoanRequest	LoanRequest	2	FALSE	X
GuarantorRequest	GuarantorDeclineExplanations	GuarantorDeclin	1	FALSE	X
GuarantorRequest	GuarantorRequest	GuarantorRequ	2	FALSE	X
RelatedSecurities	AlreadyConsideredSecurities	AlreadyConside	1	FALSE	X
RelatedSecurities	NewSecurityInformation	NewSecurityInf	2	FALSE	X
ResultingPage	Results	Results	1	FALSE	X
ResultingPage	Comments	Comments	2	FALSE	X

DT void createQuestionsRules(DialogStructure dialog)

	Action "Create Question"					Action "Presentation Attribute"	
Question Type	Section Code	Question Code	Question Text	Order#	ReadOnly	Attribute Name	Attribute Value
QuestionWithTextAnsv	BorrowerData	BorrowerFirstN	First Name	1	FALSE	layout	horizontal
QuestionWithTextAnsv	BorrowerData	BorrowerMiddle	Middle Initial	2	FALSE		
QuestionWithTextAnsv	BorrowerData	BorrowerLastN	Last Name	3	FALSE	layout	horizontal
QuestionWithDoubleAr	BorrowerData	BorrowerTotalM	Total Monthly Income	4	FALSE	layout	horizontal
QuestionWithDoubleAr	BorrowerData	BorrowerTotalM	Total Monthly Debt	5	FALSE	layout	horizontal
QuestionWithIntegerAr	LoanRequest	LoanAmount	Loan Amount	1	FALSE	layout	horizontal
MultiChoiceQuestion	LoanRequest	LoanPurpose	Loan Purpose	2	FALSE	layout	horizontal
QuestionWithIntegerAr	LoanRequest	LoanTerm	Loan Term	3	FALSE	layout	horizontal
QuestionWithTextAnsv	GuarantorDeclineExplanations	StatusForGuara	Loan Application Status f	1	FALSE		
QuestionWithTextAnsv	GuarantorDeclineExplanations	ReasonForGuar	Reason	2	FALSE		
MultiChoiceQuestion	GuarantorRequest	GuarantorYesN	Does the applicant has a	1	FALSE	type	dropdownlist

CreateDialog \ **CreatePages** / CreateSections / CreateQuestions / detailQuestionProperties / ExecuteDialo

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How to Define Question Types

- Using a very simple XML file like this one: or   an Excel spreadsheet like this one:

```
<object>
        <key>BorrowerFirstName</key>
        <name>First Name</name>
</object>
<object>
        <key>BorrowerMiddleInitial</key>
        <name>Middle Initial</name>
</object>
<object>
        <key>BorrowerLastName</key>
        <name>Last Name</name>
</object>
<object>
        <key>BorrowerTotalMonthlyIncome</key>
        <name>Total Monthly Income</name>
</object>
<object>
        <key>BorrowerTotalMonthlyDebt</key>
        <name>Total Monthly Debt</name>
</object>
```

29	Question
30	First Name
31	Middle Initial
32	Last Name
33	Total Monthly Income
34	Total Monthly Debt
35	Loan Amount
36	Loan Purpose
37	Loan Term
38	Loan Application Status for Guarantor
39	Reason
40	Does the applicant has a guaranting security
41	Loan Application Status
42	Rejection Reason
43	Loan Application Comments
44	Security ID

- Or using another application specific way

Rules for Inter-Question Relationships

- These business rules define the processing logic based on answers to already asked questions in conjunction with information available from application specific contexts:

  if answer to question <Q1> is <A1> and loan was <declined> then ask question <Q2>

- We use decision tables for the interaction logic to support complex inter-question relationships

- Decision tables allow us to combine both:

  - Predefined interaction rules like:

    "If answer to question <Q1> is <A1>" and

  - Application specific rules like:

    "If loan was <declined>"

Navigation Decision Table (OpenRules example)

C10	C20	C30		A10
Current Page is	**Application Status is**	**Answer to Question**	**is**	**Go to Page**
LoanApplication	Approved			ResultingPage
LoanApplication	Declined			GuarantorRequest
GuarantorRequest		GuarantorYesNo	No	ResultingPage
GuarantorRequest		GuarantorYesNo	Yes	RelatedSecurities
RelatedSecurities		AddModifySecurities	Yes	RelatedSecurities
RelatedSecurities		AddModifySecurities	No	ResultingPage
ResultingPage				ResultingPage

Rules-based Interaction Library

Live Demonstration

1) Web-based Loan Approval Interaction
   - how does it look (a user view)

2) Underlying Rule Project
   - how was it done (an admin view)

Demo Scenario: Loan Approval

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A Web-based Front End:
Loan Application

Rejected. Requests a Guarantor

ABC BANK   ESR: Loan Origination Demo

New

Start Dialog

Log out

Guarantor Request

Guarantor Decline Explanations

Loan Application Status for Guarantor `Declined`

Reason `Insufficient Income`

Guarantor Request

Does the applicant has a guaranting security `Yes ▾`

Cancel   Back Next

Rules-based Interaction

Done   Local intranet

Guarantying Security (Joe&Dawn Johnson)

ABC BANK   ESR: Loan Origination Demo

- New
- Start Dialog
- Log out

Related Securities Requests

Already Considered Securities

Already Entered Securities	None
Total Available Equity	0.0
Total Remaining Debt	0.0
Add or Modify Securities	Yes

New Security Information

Security ID	Joe&Dawn
Security Type	h
Secured By	Property
Available Equity	300000.0
Remaining Debt	150000.0

Cancel   Back   Next

Rules-based Interaction

Done   Local intranet

Related Security
(Joe Johnson &Bill Smith)

ABC BANK   ESR: Loan Origination Demo

- ▶ New
- ▶ Start Dialog
- ▶ Log out

Related Securities Requests

Already Considered Securities

Already Entered Securities	Joe&Dawn;
Total Available Equity	300000.0
Total Remaining Debt	150000.0
Add or Modify Securities	Yes ▾

New Security Information

Security ID	Joe&Bill
Security Type	Business Loan
Secured By	Property,Guarantees
Available Equity	52000.0
Remaining Debt	200000.0

Cancel   Back   Next

Rules-based Interaction

Done   Local intranet

Related Security
(Bill&Susan Smith)

ABC BANK   ESR: Loan Origination Demo

- ▶ New
- ▶ Start Dialog
- ▶ Log out

Related Securities Requests

Already Considered Securities

Already Entered Securities	Joe&Dawn; Joe&Bill;
Total Available Equity	352000.0
Total Remaining Debt	350000.0
Add or Modify Securities	Yes ▾

New Security Information

Security ID	Bill&Susan
Security Type	Housing Loan
Secured By	Property
Available Equity	240000.0
Remaining Debt	150000.0

Cancel   Back   Next

Rules-based Interaction

🔲 Done   🔳 Local intranet

Related Security (Tommy Smith)

ABC BANK   ESR: Loan Origination Demo

- ▶ New
- ▶ Start Dialog
- ▶ Log out

Related Securities Requests

Already Considered Securities

Already Entered Securities	Joe&Dawn; Joe&Bill; Bill&Susan;
Total Available Equity	592000.0
Total Remaining Debt	500000.0
Add or Modify Securities	Yes ▾

New Security Information

Security ID	Tommy Smith
Security Type	Personal Loan
Secured By	Guarantee Bill&Susan
Available Equity	0.0
Remaining Debt	50000.0

Cancel   Back   Next

Rules-based Interaction

No Related Securities Anymore

ABC BANK   ESR: Loan Origination Demo

- ▶ New
- ▶ Start Dialog
- ▶ Log out

Related Securities Requests

Already Considered Securities

Already Entered Securities	Joe&Dawn; Joe&Bill; Bill&Susan; Tommy
Total Available Equity	592000.0
Total Remaining Debt	550000.0
Add or Modify Securities	No

New Security Information

Security ID	
Security Type	
Secured By	
Available Equity	0.0
Remaining Debt	0.0

Cancel   Back   Next

Rules-based Interaction

Peter Johnson' Loan Application Declined ($8K less)

ABC BANK — ESR: Loan Origination Demo

New

Start Dialog

Log out

Loan Origination Results

Loan Application Status

Loan Application Status | Declined

Rejection Reason | Insufficient Equity

Comments

Thank you for doing business with ABC

Cancel   Back   Next

Rules-based Interaction

Done   Local intranet

Demo Implementation

- Each time when a user answers to the generated questions and moves to the next page, the decision-making rule engine is called

- Each engine's run recalculates the total equity and total remaining debt using ALL related securities known so far, and then it makes an Accept/Decline decision

Rule Administration Tool: Loan Approval Rule Project

Integration with Business Contexts

- Our approach moves the interaction logic into an application specific rule project, so it becomes a BRE problem
- To get access to an external business context, the underlying rule language should be able to deal directly with objects like Driver, LoanApplication, or TaxReturn described "somewhere" outside rule project
- The current implementation of our Interaction Library works directly with:
  - Java-based business objects
  - XML Structures (without creating intermediate Java objects)
- We believe that a good rule language should be able to deal with objects (Driver, Loan, etc.) in the same way whether they come from Java, Database, XML schema, WSDL or RDF
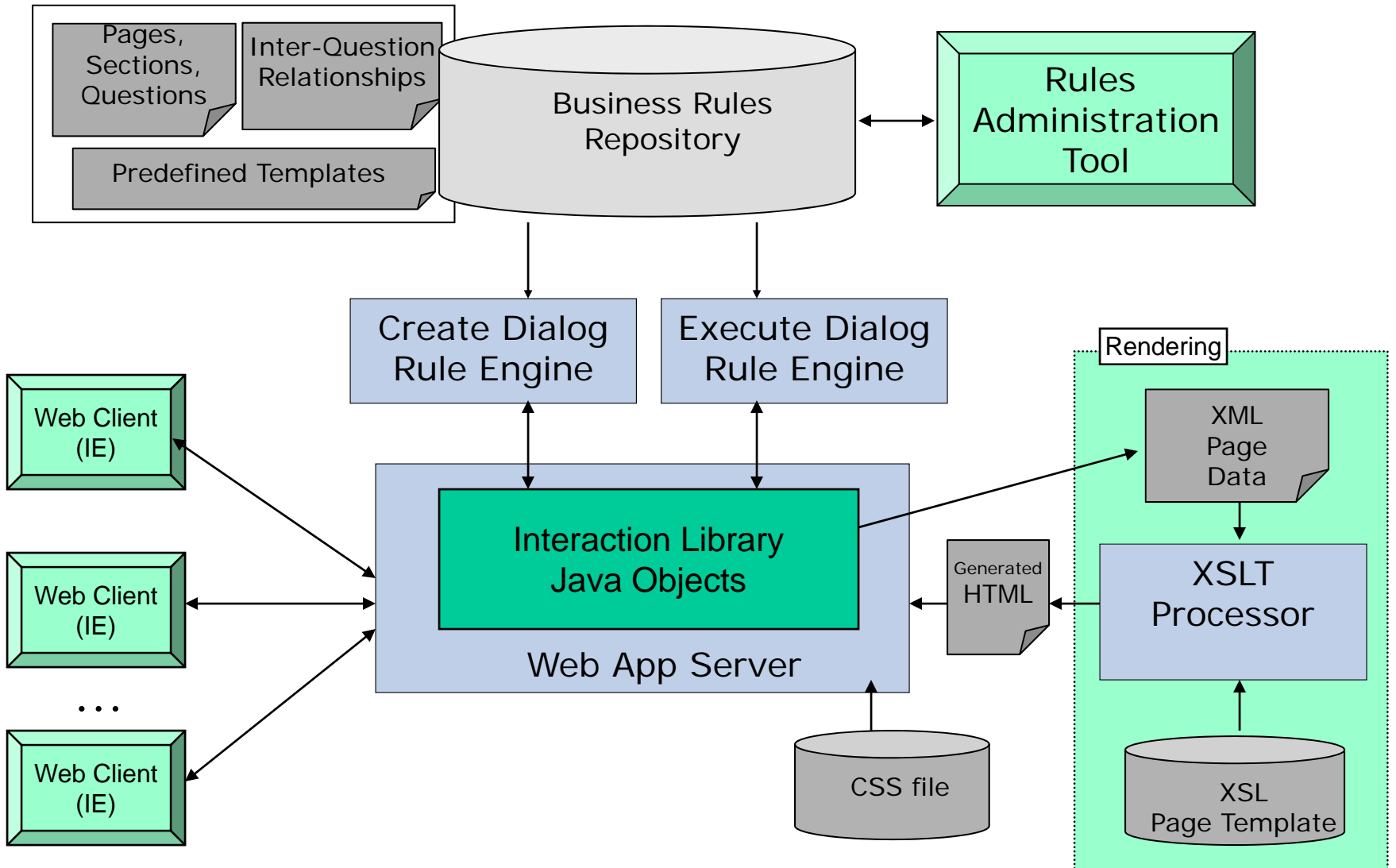
Integration with Portals

- While the presentation logic is usually outside of business rules reach, the Interaction Library not only defines the dialog pages, sections, and questions, but can also set their presentation attributes like:

  Layout=horizontal

  Type=textarea

- A customizable build-in graphical interface allows a developer to easily plug-in the interaction rule project into different Web-based portals

Portal Integration Schema

Important Observations

- An important point: <u>rules generate requests</u>
- A concrete Interaction Processor's implementation converts these requests to queries or to GUI questions (as we did in this demo)
- Ultimately, there could be no human interaction at all, while knowledge "what and when to ask" still can be kept in the same rules
- A Web dialog of this demo is only one of many possible interaction forms

Used BREs

- The rules-based Interaction Library is BRE *vendor-independent*. However, only rule engines with a powerful decision table rules templatization mechanism can be used

- There are two current implementations:
  1. Exigen Rules (www.exigengroup.com)
  2. A new free Open Source full-scale BRE product "**OpenRules**" (http://openrules.com)

Note. Other popular BREs can be added upon a request

Summary

- The proposed rules-based Interaction Library provides a practical solution to real-world business problems with complex interaction logic

- Along with an ability to build powerful interaction servers, it provides a customizable Web-based front end for dynamic dialogs

Questions & Answers

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