Information Operation Across Infospheres: Assured Information Sharing

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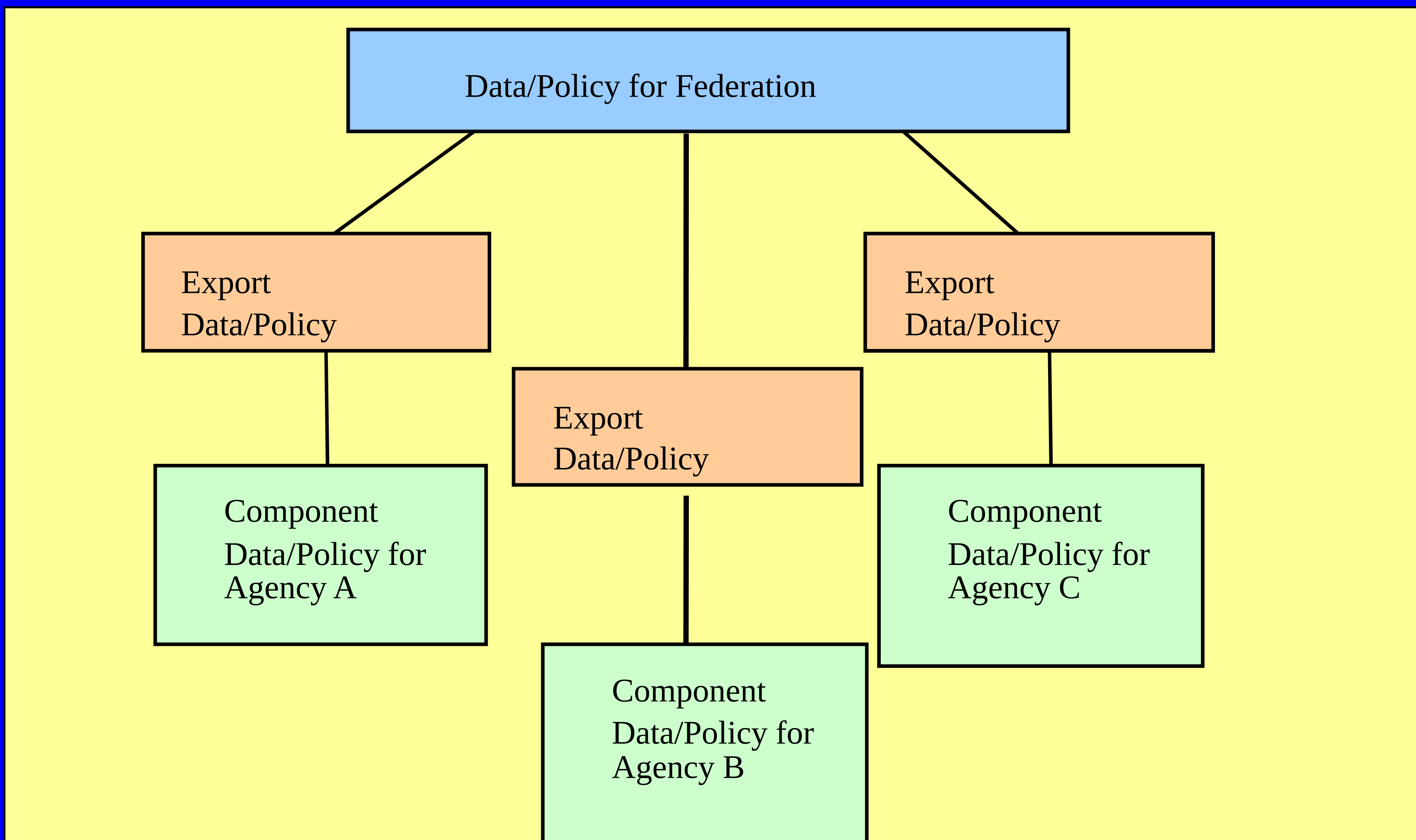
Architecture



Our Approach

- Integrate the Medicaid claims data and mine the data; next enforce policies and determine how much information has been lost by enforcing policies
- Examine RBAC and UCON in a coalition environment
- Apply game theory and probing techniques to extract information from non cooperative partners; conduct information operations and determine the actions of an untrustworthy partner.
- Defensive and offensive operations

Data Sharing, Miner and Analyzer

- Assume N organizations.
  - The organizations don’t want to share what they have.
  - They hide some information.
  - They share the rest.
- Simulates N organizations which
  - Have their own policies
  - Are trusted parties
- Collects data from each organization,
  - Processes it,
  - Mines it,
  - Analyzes the results

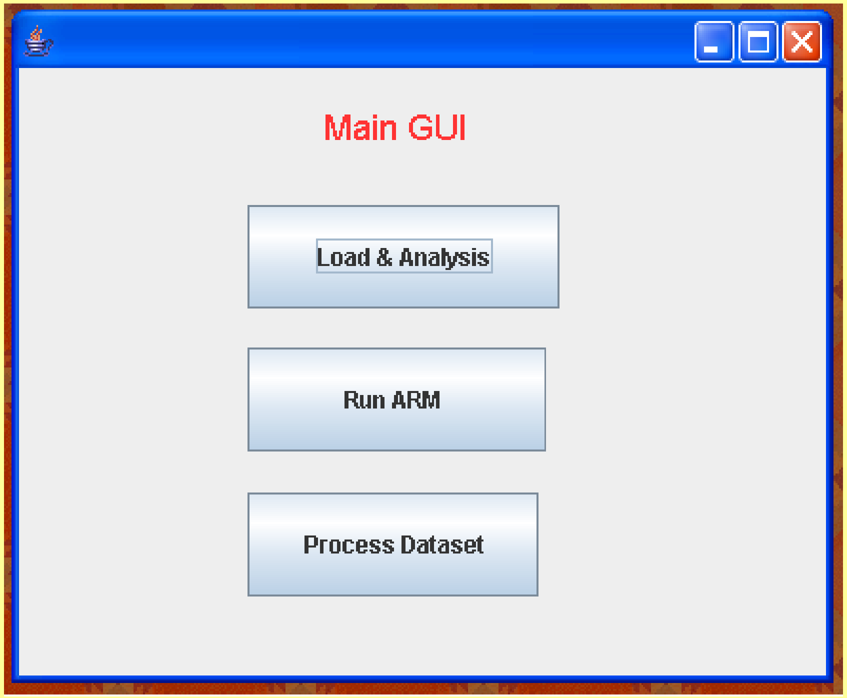
Data Partitioning and Policies

- Partitioning
  - Horizontal: Has all the records about some entities
  - Vertical: Has subset of the fields of all entities
  - Hybrid: Combination of Horizontal and Vertical partitioning
- Policies
  - XML document
  - Informs which attributes can be released
- Release factor:
  - Is the percentage of attributes which are released from the dataset by an organization.
  - A dataset has 40 attributes.
    - “Organization 1” releases 8 attributes
    - RF=8/40=20%

Example Policies

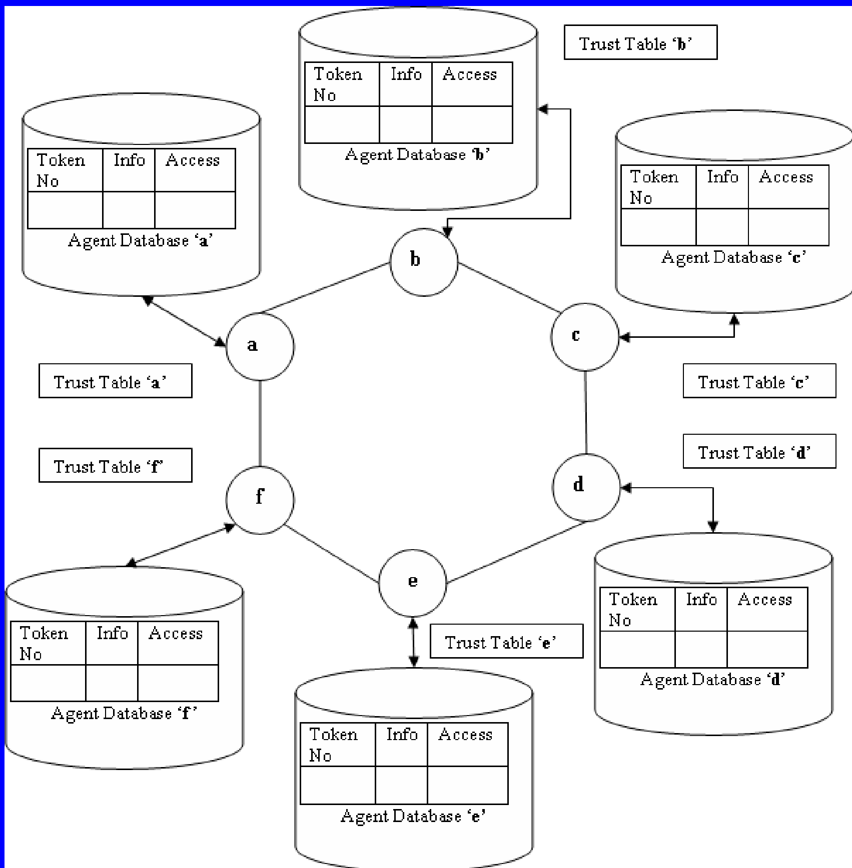
```
<?xml version="1.0"?>
  <TEST_CASE>
    <BASE_POLICY_DIR>/data/policy/</BASE_POLICY_DIR>
    <!-- make sure to have different tc_id for the bundle -->
    <TC_ID>census_income_5</TC_ID>
    <TEST_CASE_DIR>testcases</TEST_CASE_DIR>
    <NUM_ORG>3</NUM_ORG>
    <RELEASE_FACTOR>5</RELEASE_FACTOR>
    <ATTRIB_XML>attributes.xml</ATTRIB_XML>
    <DATASET_BASE>/data/dataset/census_income/</DATASET_BASE>
    <MANDATORY_ATTRIB>income_type</MANDATORY_ATTRIB>
    <POLICY_XML>gen_org.xml</POLICY_XML>
    <ORG_PREFIX>org_</ORG_PREFIX>

     <!-- information about the dataset -->
     <DATASET_FN>census_income/census_income_50k.dat</DATASET_FN>
     <ARFF_PREFIX>census_income</ARFF_PREFIX>

     <!-- for each testcase bundle, used different test_case_id -->
     <TEST_CASE_ID>census_income_test_5</TEST_CASE_ID>
     <DATASET_PROCESSOR>
       <CLASS_NAME>processors.CensusIncomeProcessor</CLASS_NAME>
       <ATTRIB_FN>census_income/attributes.xml</ATTRIB_FN>
     </DATASET_PROCESSOR>
     <POLICY_DIR>census_policy_</POLICY_DIR>
     <DELIM>,</DELIM>
     <TEMPLATE_FN>gen_template.xml</TEMPLATE_FN>
  </TEST_CASE>
```

Processing



- 1. Load and Analysis.
  - loads the generated rules,
  - analyzes them,
  - displays in the charts.
- 2. Run ARM.
  - chooses the arff file
  - Runs the Apriori algorithm,
  - displays the association rules, frequent item sets and their confidences.
- 3. Process DataSet:
  - Processes the dataset using Single Processing or Batch Processing.

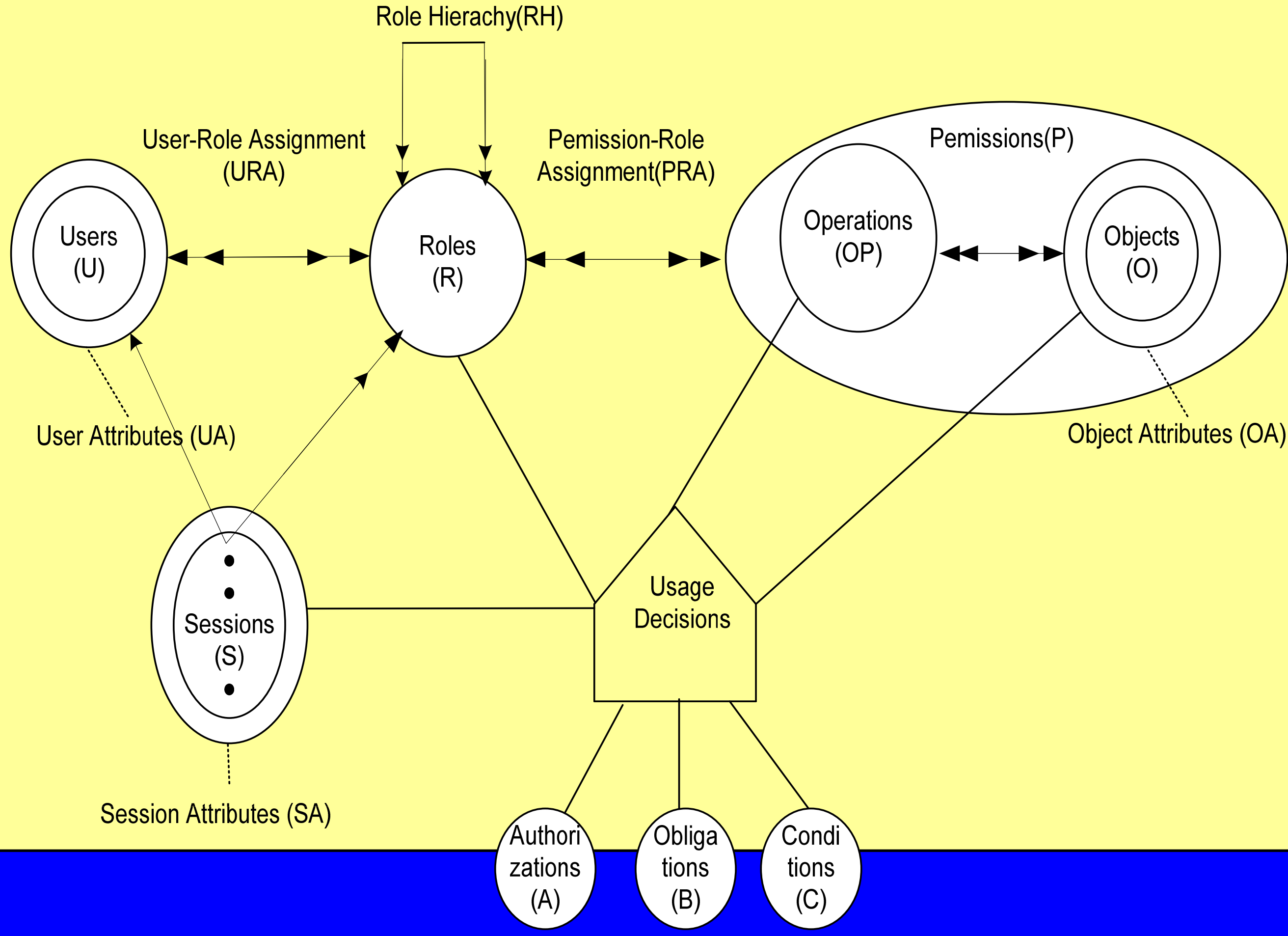
Extension For Trust Management



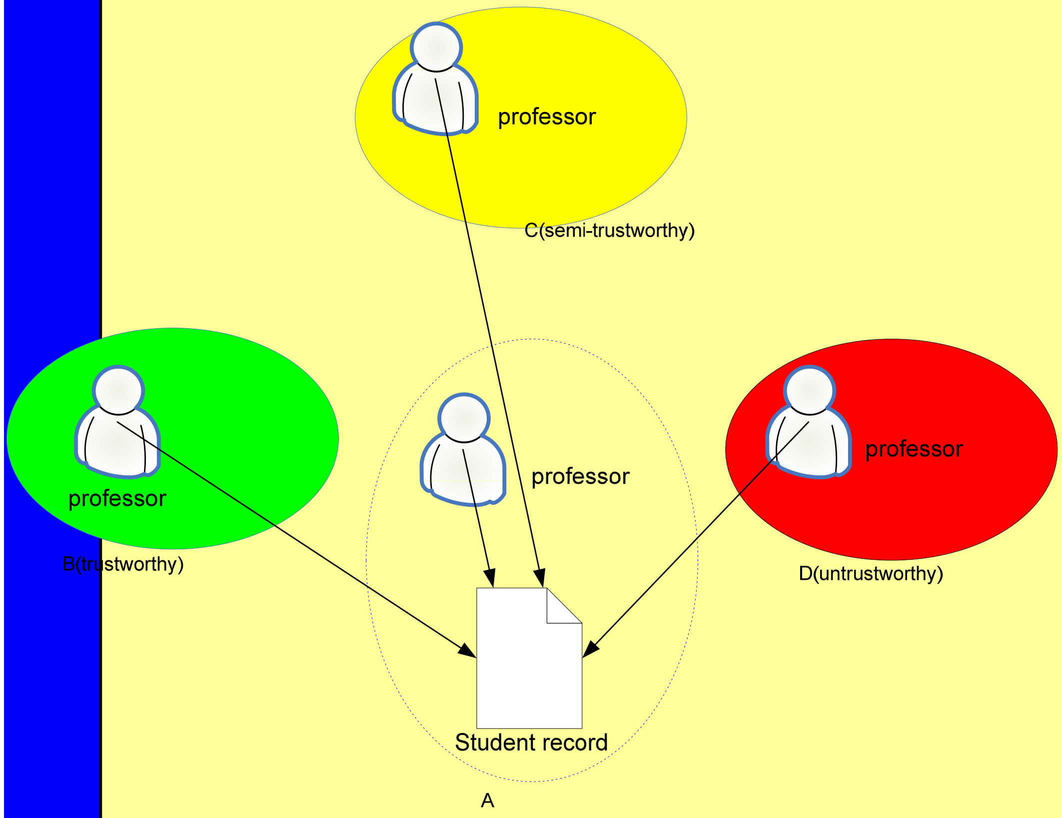
- Each Organization maintains a Trust Table for Other organization.
- The Trust level is managed based on the quality of Information.
- Minimum Threshold- below which no Information will be shared.
- Maximum Threshold - Organization is considered Trusted partner.

Role-based Usage Control (RBUC)

RBAC with UCON extension



RBUC in Coalition Environment



- The coalition partners maybe trustworthy), semi-trustworthy) or untrustworthy), so we can assign different roles on the users (professor) from different infospheres, e.g.
- professor role,
- trustworthy professor role,
- semi-trustworthy professor role,
- untrustworthy professor role.

- We can enforce usage control on data by set up object attributes to different roles during permission-role-assignment,
- e.g. professor role: 4 times a day, trustworthy role: 3 times a day semi-trustworthy professor role: 2 times a day, untrustworthy professor role: 1 time a day

Coalition Game Theory

Players

Expected Benefit from Strategy

Strategy for Player j

Strategy for Player i

P_j / P_i	Tell Truth	Lie
Tell Truth	A ; A	$B - M(p_j^i(\text{verify}))$; $A - L(1 - p_j^i(\text{fake}))$
Lie	$A - L(1 - p_i^j(\text{fake}))$; $B - M(p_i^j(\text{verify}))$	$B - M(p_i^j(\text{verify})) - L(1 - p_j^i(\text{fake}))$; $B - M(p_j^i(\text{verify})) - L(1 - p_i^j(\text{fake}))$

A = Value expected from telling the truth
B = Value expected from lying
M = Loss of value due to discovery of lie
L = Loss of value due to being lied to

$p_j^i(\text{action})$ = Percieved probability by player *i* that player *j* will perform *action*
fake: Choosing to lie
verify: Choosing to verify

Coalition Game Theory

- **Results**
  - **Algorithm proved successful against competing agents**
  - **Performed well alone, benefited from groups of likeminded agents**
  - **Clear benefit of use vs. simpler alternatives**
  - **Worked well against multiple opponents with different strategies**
- **Pending Work**
  - **Analyzing dynamics of data flow and correlate successful patterns**
  - **Setup fiercer competition among agents**
    - **Tit-for-tat Algorithm**
    - **Adaptive Strategy Algorithm (a.k.a. Darwinian Game Theory)**
    - **Randomized Strategic Form**
  - **Consider long-term games**
    - **Data gathered carries into next game**
    - **Consideration of reputation (‘trustworthiness’) necessary**

Detecting Malicious Executables
The New Hybrid Model

- **What are malicious executables?**
  - *Virus, Exploit, Denial of Service (DoS), Flooder, Sniffer, Spoofer, Trojan etc.*
  - Exploits software vulnerability on a victim, May remotely infect other victims
- **Malicious code detection: approaches**
  - **Signature based :** not effective for new attacks
  - **Our approach:** Reverse engineering applied to generate assembly code features, gaining higher accuracy than simple byte code features