Developing Intelligent Portals by Using WI Technologies

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What Are Web-Based Portals?

- Enabling a company or an organization (community) to create a virtual enterprise (virtual community) on the Web where key production/information steps are outsourced to partners and customers.

- A single gateway to personalized information needed to enable informed interdisciplinary research, services, and/or business activities.

One of the most sophisticated applications in WI.
Categories of Portals

- e-Science portals
- e-Government portals
- e-Business (e-Commerce) portals
- e-Learning portals
- ......

What are the common requirements and specific features of these kinds of portals?
Common Requirements

- A unique website (a single gateway) in which all of the contents related to the virtual organization can be accessed although such organization information is geographically distributed in multi-site, multi-data repositories, and multi-institution.

- Easy access to expensive remote facilities, to computing resources, and share information acquired from different subjects using different techniques and stored in dedicated knowledge-data bases.
Specific Features

- e-Science portals
  computational, data-intensive experiments
- e-Government portals
  on-line services
- e-Business (e-Commerce) portals
  marketing and services
- ....
What Is e-Science?

- **e-Science** is about distributed global collaboration in key areas of (the large scale) science, and enabled by the next generation of infrastructure such as the Wisdom Web and Knowledge Grids.

- It also offers new possibilities for enabling interdisciplinary research through the provision of the new powerful infrastructure.
Our Goals (Zhong-Wu, 01-04)

- Investigating human multi-perception mechanism by cooperatively using cognitive technology and data mining techniques for developing artificial systems which match human ability in specific aspects.

- Building a multi-database mining system on the Wisdom Web and Grid platform for developing an e-Science portal.
Main Questions

- How to design the psychological and physiological experiments for obtaining various data from human multi-perception mechanism?

- How to analyze such data from multiple aspects for discovering new models of human multi-perception?
physiological experiments
(fMRI, EEG/MEG, …)
results (image)
results (wave)
results (discrete)
data modeling and transformation
image data
wave data
discrete data
data mining & knowledge discovery
models of human multi-perception
test of the multi-perception models
application of the models
The future of cognitive science and neuroscience may be affected by the ability to do large-scale mining of fMRI brain activations.

fMRI – functional Magnetic Resonance Imaging
Understanding human multi-perception mechanism by analyzing fMRI images obtained from human visual and auditory psychological experiments.
The results of the **visual** and **auditory** calculation processing in fMRI experiments
Peculiarity Oriented Analysis  
(Zhong et al, 99-04)

- We observe fMRI brain activations from the viewpoint of peculiarity oriented analysis and proposed a way of peculiarity oriented mining (POM) for knowledge discovery in multiple human brain data.

- **Peculiarity** is a kind of interestingness. Peculiarity relationships/rules (with common sense) may be hidden in a relatively small number of data.
A Multi-Step Process

Various tools (e.g. MEDx) can be cooperatively used with POM in a multi-step process for pre-processing (data cleaning, modeling and transformation), mining and post-processing.

Goal: Machine-processing/understanding to replace human-expert centric visualization.
Brain Waves (EEG/MEG)

Sample Brain Waves  Visualization in BI MUTAS

Cooperative use with fMRI images for multi-aspect analysis
Multi-Aspect Analysis

- Using various data mining techniques (peculiarity-oriented, association, classification, etc) for analyzing in one data source.
- Using various data mining techniques for analyzing in multiple data sources (multi-site and multi-owner data repositories).

The perspective of cognitive scientists will be changed from a single type of experimental data towards a holistic view, based on multi-database mining for multi-aspect analysis.
The Wisdom Web for e-Science
(Liu-Zhong-Yao, 02-03)

- To provide
  - not only a medium for information/knowledge exchange/sharing
  - but also a type of man-made resources for sustainable knowledge creation and scientific evolution.

- The Wisdom Web will rely on grid-like agencies:
  - self-organize, learn, and evolve their courses of actions in order to perform service tasks as well as their identities and interrelationships in communities
  - cooperate and compete among themselves in order to optimize their as well as others’ resources and utilities.
Building a Data Mining Grid

- Creating a grid-based, organized society of data (Web) mining agents, called a Data Mining Grid on the grid computing platform (e.g. Globus):
  
  To develop **various data mining agents** for different e-Science tasks.

  To organize the agents into a **grid** with multi-layer under the OGSA as **middleware**, to understand the user’s questions, transform them to DM issues, discover the resources and information, and get a composite answer/solution.

  To manage the grid by a multi-level control authority.
Ontologies Based Multi-Data Source Description and Integration

- Providing a formal, explicit specification for integrated use of multiple data sources in a semantic way.
- Providing conceptual representation about the sorts and properties of data/knowledge and DM agents, as well as relations between data/knowledge and DM agents.
- Providing a vocabulary of terms and relations to model the domain, and specifying how you view the data sources and how to use DM agents.
- Providing a common understanding of multiple data sources that can be communicated between grid-based DM agents.
An Ontology of Data Mining Agents

- Entity
  - D&K
    - Data
      - RawData
      - CleanData
      - SelectedData
    - Knowledge
      - Kdomain
        - Kdiscovered
      - CRule
      - PRule
      - MVF
      - Cluster
  - Agent
    - Preprocess
    - KElicit
    - Post-process
Grid-Based Middleware

Wisdom Web-1
- Browsing/Sampling Data
- KDD Process Planning
- Model Analysis/Refinement
- Visualization

Coordinating Agent
- Cooperative planning
- Distributing KDD tasks
- Combining partial models

Wisdom Web-2
- Browsing/Sampling Data
- KDD Process Planning
- Model Analysis/Refinement
- Visualization

Private Workspace-1
- Local DB
- KDD process plan

Private Workspace-2
- Local DB
- KDD process plan

Shared Workspace
Specific Features

- e-Science portals
  computational, data-intensive experiments
- e-Government portals
  on-line services
- **e-Business (e-Commerce) portals**
  marketing and services
- .......
A Paradigm Shift in e-Business

E-Tailing
Goods
Tangible Products
Advertising
Cost Reduction
Efficiency Focus
Supply Chain
Product Profitability
Brand Equity
Mass Marketing
Commodities
Low Margins

E-Service
Services
Information Products
2-Way Dialogue
Revenue Expansion
Satisfaction Focus
Information Flows
Customer Profitability
Customer Equity
1-to-1 Marketing
Customization
High Margins

CACM-46-6
What Is Targeted Marketing?

- Involves the identification of customers having potential market value by studying the customers’ characteristics and the needs, and selects certain customers to promote.

- Aims at obtaining and maintaining direct relationships between suppliers and buyers within one or more product/market combinations.

Also called **direct marketing**
Targeted marketing (TM) is an important area of applications for DM. Although standard DM may be applied for the purpose of TM, many specific algorithms need to be developed and applied for direct marketers to make decisions effectively.
Given:

- A set $U$ of customers, which is divided into three disjoint subsets $P$, $N$, and $D$.
- The sets $P$, $N$, and $D$ are called positive, negative, and don't know instances, respectively. The set $N$ may be empty.

Goal:

Find valuable customers from $D$, and possibly from $N$, to increase size of $P$. 
An Example of TM Analyses

Examples:

1. **Special interesting clubs**:
   - P denotes current members,
   - N denotes the people who quit the club, and
   - D denotes potential customers the club have some information. The targeted marketing is the membership driven.

2. **Special product (phone, credit cards) plans**:
   - P denotes the customers in the plan,
   - N denotes the people who quit the plan, and
   - D denotes potential customers. The targeted marketing is to extend the plan members.
Features of TM Analyses

- Each customer has a different market value.
- We do not want to send advertisements to everyone in D, due to some practical constraints (costs).
- The targeted marketing problem is different from standard classification problems.
  - The goal is **not** to find rules that define the set P, or differentiate sets P, N, and D, although such rules may be helpful.
- A difficulty with rule-based methods.
  - One may use association between members of P and D to identify valuable customers.
  - Rules may produce either **too many** or **too few** candidates.
A Solution of TM Analyses

Underlying assumption:

**similar type of people tend to make similar decisions and to choose similar services.**

A market value functions (MVF) model:

- A MVF can be used to rank customers in D.
- A cut-off point of the ranked list may be chosen based on various criteria such as financial constraints.
- A MVF can be derived from the underlying assumption.
- A MVF can be obtained from a certain representation of customers and their relationships under the representation.
Market Value Functions (MVF) (Yao-Zhong, 01-04)

The potential usefulness and effectiveness of the proposed MVF model depends on, to a large extent, the estimation of the individual utility functions and the attribute weights, i.e., the coefficients of the linear MVF.

\[ r(x) = \sum_{a \in At} w_a \ u_a(I_a(x)) \]

The estimation of utility functions draws from probabilistic models of IR.

The estimation of attribute weights is based on information-theoretic measures of attribute importance.
E-BI needs Web based targeted marketing, which is integrated with other functions of WI such as Web mining, personalized recommendation, and so on, to set up an e-portal.

Multiple data sources that are obtained from multiple customer touch points, including the Web, wireless, call centers, and brick-and-mortar store data, need to be integrated into a distributed data warehouse that provides a multi-faced view of their customers.
Observations

- To accurately quantify success, portals must examine visitor profiles and online behavior, instead of the number of page views.
- To support business/service goals, companies and organizations need a robust WI model capable of accommodating new strategies and technologies. The cornerstone of WI is the ability to uniquely identify and segment users.
- WI must form the foundation for developing intelligent portals (i-Portal).
WI Technologies for Intelligent Portals

- Ubiquitous Computing
- Multi-modal Interaction
- Web Information Retrieval
- Web Agents
- Web Mining and Farming
- Knowledge Networks and Management
- Social Networks
- Grid Computing

i-Portals
WI for i-Portals

Information overflow

XML? HTML? DTD? WSDL?

Information heterogeneity

High Perform. computing

manageable ...

interoperable ...

on-demand ...

Data Mining

Agent Tech. / Semantic Web

Grid Computing

Web Intelligence

MIDDLEWARE

Protocols

DAML-S
Globus
SOAP/XML
HTTP
TCP/IP
Four Levels of WI Support

Level-1: Internet-level communication, infrastructure, and security protocols

Level-2: Interface-level multi-media presentation standards

Level-3: Knowledge-level information processing and management tools

Level-4: Application-level ubiquitous computing and social intelligence utilities
An Example of e-Business Portals:
Virtual Industry Park (VIP)
Basic System

Enterprise Information

Register, update

Automatic HP generation, modification

Search engine

DBMS

Registered data

VIP Portal
Advanced Questions

- How the customer or prospect enters our VIP portal in order to target products and manage promotions and marketing campaigns?
- To the already demanding requirement to capture transaction data for further analysis, we now also need to use the Web mining techniques to capture the clicks of the mouse that define where the visitor has been on our website.
Advanced Questions (2)

- What pages has he or she visited?
- What is the semantic association between the pages he or she visited?
- Is the visitor familiar with the Web structure? Or is he or she a new user or a random one?
- Is the visitor a Web robot or other users?
- ......
Modeling User Groups (Liu, 04)

- **Recurrent user** is familiar with the Web structure, and can find the useful information right away.
- **Rational user** is new to the website, and knows clearly what he/she wants and selects a direction based on the information of hyperlinks.
- **Random user** has no strong intention to get something, and just wanders among pages.
A **Personalized** description of customer’s shopping behaviors, habits, preferences, and purchasing power, that can be divided into several sub-models:

- the shopping model
- the preference model
- the consumption model

**Representation and learning** by combining Bayesian Networks + Web Mining
Web Farming

- The systematic refining of information resources on the Web for BI.
- Extending Web mining to **Web farming** that is treated more like a large agricultural business including planting and harvest.
- Web farming extends Web mining into an evolving breed of information analysis in a whole process of Web-based information management including seeding, breeding, gathering, harvesting, refining, and so on.
Web Farming vs. Web Mining

Web Farming
- website design and modification
- data modeling and transformation
- user behavior analysis

Web Mining
Advanced VIP

- Register, update
- Automatic HP generation, modification
- User profiles
- Web logs
- Web mining/farming
- Targeted marketing
- Security solution
- Search engine-1
- Search engine-2
- Web agent
  - Email filtering, managing, auto-reply

Enterprise Information

Grid-based middleware

Products data

Customers data

Web farming data

Ontologies
Three Types of Services

VIP Portal

Products Data

Customer Profiles

Online shopping

Registering and login

Shopping data

Web Usage/Logs

Updating based on user behaviors

Updating based on rules

Responses

Enterprise Marketers

Customers/Visitors

Globus

Grid-based Middleware
Various Data Mining Agents

- **POM** for finding peculiar data/rules
- **MVF** for learning targeted marketing values and ranking
- **GDT-RS** for discovering decision rules
- **LOI** for discovering ordering rules/important attributes

The agents can be used to deal with each of data sources, separately.
GDT-RS (Zhong et al., 98-02)

- GDT-RS is a soft hybrid induction system for discovering **classification rules** in data with **uncertainty** and **incompleteness**.
- The **GDT** provides a probabilistic basis for evaluating the strength of a rule and for using **background knowledge**.
- The **rough set (RS)** theory is used to find minimal relative reducts from the set of rules with larger strengths.
An Information Table

Definition: An information table is a quadruple.

\[ T = (U, A, \{V_a \mid a \in A\}, \{I_a \mid a \in A\}) \]

where

- \( U \) is a finite nonempty set of objects
- \( A \) is a finite nonempty set of attributes
- \( V_a \) is a nonempty set of values for \( a \in A \)
- \( I_a: U \rightarrow V_a \) is an information function
What attributes play more important roles in determining the overall ranking?
Analyses of Information Tables

- Horizontal analysis:
  relationships, such as the similarity, association, and dependency between values of different attributes (e.g. GDT-RS).

- Vertical analysis:
  relationships, such as closeness, similarity, and distance between values of the same attribute (e.g. LOI).
An ordered information table is obtained by adding order relation on attribute values

\[ OT = (T, \{ \succ_a \mid a \in A \}) \]

where

- \( T \) is the standard information table and
- \( \succ_a \) is an order relation on attribute \( a \).

Incorporating semantics into IT.
Example:
The Ordered Information Table

<table>
<thead>
<tr>
<th>u</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>p1</td>
<td>middle</td>
<td>3 years</td>
<td>$200</td>
<td>heavy</td>
<td>1</td>
</tr>
<tr>
<td>p2</td>
<td>large</td>
<td>3 years</td>
<td>$300</td>
<td>very heavy</td>
<td>3</td>
</tr>
<tr>
<td>p3</td>
<td>small</td>
<td>3 years</td>
<td>$300</td>
<td>light</td>
<td>3</td>
</tr>
<tr>
<td>p4</td>
<td>small</td>
<td>3 years</td>
<td>$250</td>
<td>very light</td>
<td>2</td>
</tr>
<tr>
<td>p5</td>
<td>small</td>
<td>2 years</td>
<td>$200</td>
<td>very light</td>
<td>3</td>
</tr>
</tbody>
</table>

$\succ_a$: small $\succ$ middle $\succ$ large

$\succ_b$: 3 years $\succ$ 2 years

$\succ_c$: $200$ $\succ$ $240$ $\succ$ $300$

$\succ_d$: very - light $\succ$ light $\succ$ heavy $\succ$ very - heavy

$\succ_o$: 1 $\succ$ 2 $\succ$ 3
Construct a binary information table (BIT) from an ordered information table (OIT):

\[ I_a((x, y)) = \begin{cases} 
1, & x \succeq_{\{a\}} y \\
0, & x \preceq_{\{a\}} y 
\end{cases} \]

The object pairs of the form \((x,x)\) will not be considered.

Statements in an OIT can be translated into equivalent statements in the BIT.
Example: The Binary Information Table

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>o</th>
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<td>small</td>
<td>2 years</td>
<td>$200</td>
<td>Very light</td>
<td>3</td>
</tr>
</tbody>
</table>

\(\succ_a: \text{small} \succ \text{middle} \succ \text{large}\)

\(\succ_b: 3\text{ years} \succ 2\text{ years}\)

\(\succ_c: \$200 \succ \$240 \succ \$300\)

\(\succ_d: \text{very-light} \succ \text{light} \succ \text{heavy} \succ \text{very-heavy}\)

\(\succ_o: 1 \succ 2 \succ 3\)
Using GDT-RS with LOI

- Transforming a problem that deals with ordering of objects into the one of classification.

- Our GDT-RS rule mining system can be applied on the BIT for mining ordering rules.
Example: Mined Ordering Rules

The lower approximations produce an ordering rule:

$$R_1 : (b, \leq) \land (c, \leq) \Rightarrow (o, \leq)$$

accuracy = 1, coverage = 0.615

warranty and price are very important for the products ranking
Examples of possible ordering rules obtained from the upper approximations are:

\[ R_2 : (c, \succ) \Rightarrow (o, \succ), \quad \text{accuracy} = 0.625, \quad \text{coverage} = 0.714 \]
\[ R_3 : (b, \succ) \Rightarrow (o, \succ), \quad \text{accuracy} = 0.5, \quad \text{coverage} = 0.286 \]

Maybe \textbf{price} is more important than \textbf{warranty}.
Using POM for Web Mining (Ohara-Zhong, 03)

- Web logs
- main DB
- session DB
- user session files
- peculiar data
- Rule Mining
- peculiarity rules
- comparing
- association rules
How to Integrate Multi-Data Source for Multi-Aspect Mining?

- In order to integrate multiple data sources together into the advanced VIP system, we must know how to interact with each of these sources.
- Key questions: how to manage, represent, integrate, analyze, and utilize the information coming from multiple, huge data sources?
Challenges

- How to plan, organize, control, and manage the data mining process dynamically for different mining tasks?
- How to get the system to use what it knows by imparting it the knowledge to decide what tools are appropriate for what problems and when they should be employed?
Knowledge-grid

Knowledge-flow

Mining-grid

Data-grid

Knowledge Base

Mining Results

Useful Knowledge

Portal

Customers/Visitors

Enterprises/Marketers

Sales Analysis

Personalized Service

Updating/Modifying

Ordering Rule Mining

Targeted Marketing Mining

Web Mining

Browsing

Web Logs/Profiles

Shopping

Customers

Searching

Products

Knowledge Services

Data to Knowledge

Data-flow

Mining-flow

Knowledge-flow

Grid-based Middleware
A conceptual model (and system) with three-levels of workflow, called data-flow, mining-flow, and knowledge-flow, corresponding to three-layers of Grids called data-grid, mining-grid, and knowledge-grid, is required.
An Agenda

- Semantic Web mining and automatic construction/management of ontologies
- Semantic social networks for intelligent enterprise portals
- PSML and Web inference engine
- Wisdom Web based computing
An Agenda

- Web mining and automatic construction of ontologies
- Social network intelligence
- PSML and Web inference engine
- Wisdom Web based computing
Existing Web Information Structures

- Web information/knowledge could be:
  - either **globally, distributed** throughout the Web (including the Grid),
  - or **locally, centralized** on an intelligent portal providing Web services (i.e. the intelligent service provider) that is joined to its own **cluster** of specialized intelligent applications.
How to Integrate Global and Local Information?

- To develop and use **PSML (Problem Solver Markup Language)**, for
  - collecting **globally** distributed content and knowledge from semantic Web and Grid supported social networks, and
  - incorporating it with **locally** operational knowledge-data bases in an enterprise or community for local centralized, adaptable Web intelligent services or decision-making.
Automatic Transformation content

Local Info-Sources

Social Network Mining

Global Info-Sources

Content Mining

Automatic Transformation

Prolog-like format

Inference engine

PSML

OWL

meta

content

KB

DB
The core of PSML (Problem Solver Markup Language) is distributed inference engines that can perform automatic reasoning on the Web by incorporating contents and meta-knowledge automatically collected and transformed from the Semantic Web with locally operational knowledge-data bases.

A feasible way to implement such PSML is to use existing Prolog-like logic language (such as KAUS) plus dynamic contents, meta-knowledge collection, and transformation agents.
The Semantic Web

- Static, Local Sources
- Dynamic, Global Sources

Decision-making Support

Output

Transformation

OWL/XML

KAUS

Static, Local Sources

coupling
Enable representation of knowledge and data in the first-order logic with data structure in multi-level.

Easily used for inference and reasoning as well as transforming and managing both knowledge and data.
Structure Representation by KAUS

Entity, Concept ➔ Hierarchy

association

generalization

aggregation

PERSON ➔ *PERSON ➔ *2PERSON

EMPLOYEE ➔ *EMPLOYEE ➔ *2EMPLOYEE

!ins_e *person employee;
person:name
person:sex
......

NAME  SEX  BIRTH  AGE  ADDRESS
Transformation Process

Content Info (XML/RDF)

Application-1
XSLT

Ontology for semantic unification of a vocabulary (OWL)

Task/Domain specific ontology (OWL)

Application-2
XSLT

Semantic unified content info (RDF Schema)

KAUS
The development of intelligent portals is based on the paradigm of *Wisdom Web computing* in which *AI* (e.g. knowledge representation, planning, data mining, intelligent agents, and social intelligence) and *advanced IT* (e.g. ubiquitous computing, social networks, wisdom Web and data/knowledge grids) are incorporated to make a reality of intelligent portals.

The *WI technologies* will produce the new tools and infrastructure components necessary to create *intelligent portals* that serves its users *wisely* for e-business activities, interdisciplinary research, and services.
**WIC Introduction**

**Web Intelligence** (WI) has been recognized as a new direction for scientific research and development to explore the fundamental roles as well as practical impacts of Artificial Intelligence (AI) (e.g., knowledge representation, planning, knowledge discovery and data mining, intelligent agents, and social network intelligence) and advanced Information Technology (IT) (e.g., wireless networks, ubiquitous devices, social networks, and data/knowledge grids) on the next generation of Web-empowered products, systems, services, and activities. It is one of the most important as well as promising IT research fields in the era of Web and agent intelligence.

The **Web Intelligence Consortium** (WIC) ([http://wi-consortium.org/](http://wi-consortium.org/)) is an international, non-profit organization dedicated to advancing world-wide scientific research and industrial development in the field of Web Intelligence (WI). It promotes collaborations among world-wide WI research centers and organizational members, technology showcases at WI related conferences and workshops, WIC official book and journal publications, WIC newsletters, and WIC official releases of new industrial solutions and standards.

The major activities of WIC include:

- Organizing international and regional Web and agent intelligence related conferences/workshops.
  - The IEEE/WIC WMAT joint conference series (i.e., The IEEE/WIC International Conference on Web Intelligence and The IEEE/WIC International Conference on Intelligent Agent Technology).
To Learn More about WI

The IEEE/WIC/ACM International Conference on Web Intelligence

IEEE-CS TCCI

wi-consortium.org
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- WIC Technical Committee

- WIC Research Centers in Australia, Beijing, Canada, Hong Kong, India, Japan, Korean, Mexico, Poland, Spain, France, and UK, among others

- Students and Post-doc/Visitors at:
  - Maebashi Institute of Technology
  - Beijing University of Technology
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BIO of Ning Zhong

Ning Zhong received the Ph.D. degree from the University of Tokyo. He is currently head of Knowledge Information Systems Laboratory, and a professor at Maebashi Institute of Technology, Japan. He is also a guest professor of Beijing University of Technology. His research interests include knowledge discovery and data mining, web intelligence (WI), rough sets and granular-soft computing, intelligent agents and databases, knowledge information systems, e-science with more than 120 journal and international conference publications, as well as more than 10 books including We Intelligence (Springer) and Intelligent Technologies for Information Analysis (Springer).

Dr. Zhong is the editor-in-chief of the Web Intelligence and Agent Systems journal (IOS Press), associate editor of IEEE Transactions on Knowledge and Data Engineering, regional editor of the Knowledge and Information Systems journal (Springer), editor-in-chief of the Annual Review of Intelligent Informatics (World Scientific), a member of the editorial board of the LNCS Journal on Advances in Rough Sets (Springer), and the editorial board of Advanced Information and Knowledge Processing (AI&KP) book series (Springer). He has also served as guest editor of special issues for several international journals including IEEE Computer “Web Intelligence” special issue.

Dr. Zhong is the co-founder and co-chair of Web Intelligence Consortium (WIC), vice chair of the executive committee of the IEEE Computer Society Technical Committee on Computational Intelligence (TCCI), an advisory board member of ACM-SIGART, steering committee member of the IEEE International Conference on Data Mining (ICDM), an advisory board member of the International Rough Set Society. He has served or is currently serving on the program committees of more than 80 international conferences and workshops, including program chair of IAT’99, PAKDD’99, RSFDGrC’99, WI-IAT’01, RSCTC’02, ISMIS’03, WI-IAT’04, conference chair of ICDM’02, ICAMT’03, WI-IAT’03, as well as advisory committee member of IJCAI’03.
Thank You !