Customizing Cyberspace:
Methods for User Representation and Prediction

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Outline

1. Context
   • The domain – Cyberspace
   • The project – ElComAg
   • The research field – Web Intelligence

2. Research Questions
   • Main research Question
   • Specific Research Questions with Answers

3. Evaluation
   • Self-evaluation
   • Research Impact

4. Conclusions and Future Work
The Domain - Cyberspace

Methods & Technologies
- Grid Computing
- Information Retrieval
- Semantic Web
- Web Intelligence
- Web Services
...

Applications & Services
- E-Commerce
- E-Mail
- M-Commerce
- Online Games
- Search Engines
- World Wide Web
...

Victor Nguyen, Rainer Broda, Oliver Bujalski
The Project - ElComAg

- Electronic Commercial Agents (ElComAg)

- Research Topics
  1. Conceptual Modeling of Knowledge and Trading Process
  2. The design of sale-sites (electronic marketplaces)
  3. The design of agents for serving the trade process
  4. Information system architecture for knowledge trade

- Key issue: improving the usability of commercial cyberspace services with software agent and related technologies
The Methods – Web Intelligence
Cyberspace Service Complexity

- Bandwidth
- Network
- CPU/GRAM
- Hardware
- Energy
- Latency
- CPU
- Graphics

M-Commerce
Rest of Cyberspace
Online Games

Service Complexity
Customizing Cyberspace

Data, Methods & Technologies
- Agents
- Clickstreams
- Prediction
- User Profiles
- Web Mining
- ...

Customization Types
- Acceleration
- Advertising
- Automation
- Language & Culture
- Personalization
- ...

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Research Opportunities?

- **World Wide Web** – relatively well studied:
  - Search Engines [Brin and Page, 1998]
  - Adaptive Web Sites [Perkowitz and Etzioni, 1999]
  - Web Mining [Cooley et.al, 1997]

- **M-Commerce**
  - Mainly studied from a telecom perspective

- **Massively Multiplayer Online Games**
  - Almost unstudied from a customization perspective
Main Research Question

• How can we provide scalable and flexible user representation and prediction methods for increased automatic customization of cyberspace services?

Overview - Specific Research Questions:

RQ1: Customization of M-Commerce
RQ2: Extension of RQ1 for MMOGs
RQ3: Classification for MMOG and M-Commerce
Research Question 1 (RQ1)

• How can mobile customers be supported by software agents?
  – Resource constraints – wired software agent
  – Customer profile/data – stored in software agent
  – Service Types Supported – flexible
  – E-Commerce support – yes, wired software agents

Answered in Paper A and B
RQ1 – P2P-Coll. Filtering
Research Question 2 (RQ2)

• How to test the proposed solution to RQ1, and extending it toward supporting Massively Multiplayer Online Games?
  – MMOGs relevant case – upper bound cyberspace
  – Player Usage Data – logging avatar/person
  – Standards for MMOG usage logging ~ apache
  – Patterns of boredom/logoff, balancing

Answered in paper C, D and E
## RQ2 – Game Taxonomy

<table>
<thead>
<tr>
<th></th>
<th>Singleplayer (SPG)</th>
<th>Multiplayer (MPG)</th>
<th>Massive Multiplayer (MMPG)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discrete Gamestate</strong></td>
<td>Solitaire, Tetris</td>
<td>Go, Backgammon, Chinese Checkers</td>
<td>?</td>
</tr>
<tr>
<td><strong>Non-Discrete Gamestate</strong></td>
<td>Zelda, The Longest Journey</td>
<td>Quake, MUD/MOO</td>
<td>Everquest, Lineage</td>
</tr>
</tbody>
</table>
RQ2 – MMOG Server Pattern
RQ2 – Zereal MMOG Simulator
RQ2 – Zereal Agent Behavior

- Scan Gameworld for Players, NPCs and Items
- Select action based on Sensing and
  1. Markov-matrix OR
  2. Hierarchical Plan
- (Try) Selected Action:
  - Fight
  - Move (A*)
  - Chat
  - Pick up/Use items
Research Question 3 (RQ3)

• How can classification algorithms be used for customization of cyberspace services, e.g. mobile commerce and massively multiplayer online games?
  – Classification appropriate – e.g. predict next action
  – Scaling up – parallel, incremental (online)
  – Concept drift – decremental (unlearn)
  – Evaluation – empirically (cross-validation)

⇒ Answered in paper F, G, H and I
RQ3 – Scale in #examples
RQ3 - Scale in \#classes

![Graph showing the comparison between Naive and Lazy methods for scaling with number of classes. The graph displays the time taken in seconds as the number of classes increases. The Naive method shows a steep increase in time, while the Lazy method remains relatively flat.](image-url)
RQ3 - Concept Drift Accuracy

Number of examples=20000

![Graph showing classification accuracy over increment number.]
RQ3 – Parallel Speedup

Increment size = 10

Increment size = 10000

LEAF-READ
ALL-READ

#CPUs

SPEEDUP
RQ3 – UCI Datasets
RQ3 – Zereal Player Classification
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   • Contributions
   • Research Impact?

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Contribution 1

A conceptual architecture for personal software assistant agents in m-commerce (paper A), focusing on subscription-based services

 ➔ Contribution to the mobile commerce research society (paper A cited 3 times)

 ➔ Influence on state-of-the-art:
Believed to probably be the first published interface-agent platform (Sep. 2001) supporting mobile users in accessing subscription and valued customer membership services.
Contribution 2

Conceptual peer-to-peer algorithmic extension of the previously mentioned platform in order to do distributed collaborative filtering for mobile product and service recommendations (paper B)

➡ Contribution to the recommender system and mobile commerce research societies (paper B cited 17 times)

➡ Influence on state-of-the-art:
Believed to probably be the first published work (July 2001) proposing a peer-to-peer recommender algorithm (the bibliographies of papers citing paper B seems to support that)
Contribution 3

Scalable platform (Zereal) for simulating customers (players) in Massively Multiplayer Online Games (paper C and D)

Contribution to the computer game research society (paper C cited 3 times), and as a technical contribution to the agent/individual-based simulation societies. Platform is currently in use at Ritsumeikan University in Japan.

Influence on state-of-the-art:
Believed to probably be the only current simulation platform geared towards experiments towards improved player personalization based on game usage mining
Contribution 4

Investigation and proposal of requirements for doing customer personalization in Massively Multiplayer Online Games (MMOGs), including proposing a new data mining subfield – ”Game Mining” that covers data mining in a MMOG context (paper E)

⇒ Contribution to the computer game (paper E cited 1 time) and data mining research societies.

⇒ Influence on state-of-the-art:
Quote from Ho and Thawonmas [2004]:
"That leads to a new research field called Game Mining, proposed originally by Tveit et al. at NTNU"
Contribution 5

Investigation and proposal of classification algorithms with characteristics suitable for cyberspace services, i.e. Scale with a large number of classes (Paper F), utilizes parallelization (paper H), and handles changes in classification over time (paper G)

 CONTRIBUTION TO THE DATA MINING AND MACHINE LEARNING SOCIETIES (PAPER H HAS BEEN CITED 2 TIMES).

INFLUENCE ON STATE-OF-THE-ART:
Believed to provide novel algorithmic approaches for efficient computation of regularized least-squares classifiers (proximal support vector classifiers).
Research Impact?

Curriculum or Rec.reading:
1. University of Leipzig, Germany
2. University of Köln, Germany
3. University of Carleton, Canada
4. University of Savoie, France
5. University of Alabama, USA
6. University of Texas (Dallas), USA
7. University of Wasa, Finland
8. University of Utah, USA
9. Royal Institute of Tech., Sweden
10. NTNU, Norway
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4. Finale
   • The Big Picture?
   • Lessons Learned
   • Conclusions
   • Further Work
The (Big)Picture

3 ”Things”

• Agents for M-Commerce
• Agents for MMOG
• Classification Algorithms

➔ Prediction of boredom patterns (logoff symptom)
Lessons Learned

Publishing and Research Events
- Reviewing process
- People

Multi-disciplinary Research
- Hard to get overview
- More places to publish

Research path towards thesis
- Surprisingly hard and nonlinear
Conclusions ➔ Papers
Conclusions ➔ Contributions

5 main contributions

1. Mobile Commerce Agent Architecture
2. P2P-based collaborative filtering of 1
3. Scalable Simulation Platform of MMOGs
4. Requirements for MMOG Data Mining
5. Incremental, Decremental and Parallel Classifier Algorithms

➔ All in order to increase cyberspace customization
Opportunities for Further Work

- Industrially test and deploy m-commerce architecture
- Further work on distributed/p2p coll. filtering
- Deploy game usage mining ideas for industrial MMOGs
- Add incremental balancing mechanisms to the classifiers
- Transformations symm.positive def. matrix => toeplitz