A Revisit to The Identification of Contexts in Recommender Systems

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Atlanta, Georgia, USA
Outline

- Traditional Recommender Systems
- Context-aware Recommender Systems (CARS)
- Current Status of Context Definition & Identification
- Context Identification Framework
- Summary of the Context Identification in CARS
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- Traditional Recommender Systems
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Recommender Systems (RS)
Recommender Systems (RS)

* Sample of Data in RS

<table>
<thead>
<tr>
<th>Movie</th>
<th>Alice (1)</th>
<th>Bob (2)</th>
<th>Carol (3)</th>
<th>Dave (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Love at last</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Romance forever</td>
<td>5</td>
<td>?</td>
<td>?</td>
<td>0</td>
</tr>
<tr>
<td>Cute puppies of love</td>
<td>?</td>
<td>4</td>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>Nonstop car chases</td>
<td>0</td>
<td>0</td>
<td>?</td>
<td>4</td>
</tr>
<tr>
<td>Swords vs. karate</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>?</td>
</tr>
</tbody>
</table>

Usually, it is a 2D rating matrix: User × Item —→ Ratings
Recommender Systems (RS)

* Recommendation Task in RS

1. Rating Predictions for <user, item> pair
2. Top-N Recommendations for a specific user
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Context-aware Recommender Systems (CARS)

- Context-aware Recommender Systems

Pattern: User preferences change from contexts to contexts;
It is necessary to adapt users’ preferences to dynamic situations;
**Sample of Data Set in CARS**

An example in the movie domain:

<table>
<thead>
<tr>
<th>User</th>
<th>Movie</th>
<th>Time</th>
<th>Location</th>
<th>Companion</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>Titanic</td>
<td>Weekend</td>
<td>Home</td>
<td>Girlfriend</td>
<td>4</td>
</tr>
<tr>
<td>U2</td>
<td>Titanic</td>
<td>Weekday</td>
<td>Home</td>
<td>Girlfriend</td>
<td>5</td>
</tr>
<tr>
<td>U3</td>
<td>Titanic</td>
<td>Weekday</td>
<td>Cinema</td>
<td>Sister</td>
<td>4</td>
</tr>
<tr>
<td>U1</td>
<td>Titanic</td>
<td>Weekday</td>
<td>Home</td>
<td>Sister</td>
<td>?</td>
</tr>
</tbody>
</table>

It is a multidimensional rating space:
User × Item × Contexts —> Ratings
Context-aware Recommender Systems (CARS)

- Recommendation Task in CARS

1). Rating Prediction for <user, item, contexts>

2). Top-N recommendation for <user, contexts>
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What is Context?

**Definition**

There are no consistent agreements. But the widely used definition was given by Abowd et al. in 1999:

“Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and application, including the user and application themselves.”
## What is Context?

### Classification of Contexts

<table>
<thead>
<tr>
<th>How Contextual Factors Change</th>
<th>Knowledge of the RS about the Contextual Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fully Observable</td>
</tr>
<tr>
<td>Static</td>
<td>Partially Observable</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Unobservable</td>
</tr>
<tr>
<td>Static</td>
<td>Everything Known about Context</td>
</tr>
<tr>
<td>Partial and Static Context Knowledge</td>
<td>Latent Knowledge of Context</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Context Relevance Is Dynamic</td>
</tr>
<tr>
<td>Partial and Dynamic Context Knowledge</td>
<td>Nothing Is Known about Context</td>
</tr>
</tbody>
</table>
What is Context?

* Context Selection and Identification

Which variables should be considered as contexts?
How to select the most influential contextual variables?

Those problems often happen in the “fully observed” and “static” categories in the classification of contexts.
What is Context?

* Example

User profiles: age, gender, nationality, region, etc
Movie features: genre, actors, year, director, etc
Other variables: time, location, companions, etc

Which variables should be considered as contexts??
What is Context?

* **Current Problems or Conflicts**

Which variables should be considered as contexts??

Some variables from the user profiles or item features are also considered as contexts, which creates confusion between CARS and content-based recommender systems.

Some research simply blend the variables as contexts.
It is necessary to have a context identification framework.

1). For identification or selection of contextual variables;
2). For developing CARS and content-based RS;
3). For interpreting or discovering patterns among variables;
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- **Context Identification Framework**
- Summary of the Context Identification in CARS
Context Identification

* Context Identification Framework

Activity Structure:

1). Subjects: group of users
2). Objects: group of items/users
3). Actions: the interactions within the activities
Context Identification

*Context Identification Framework*

For example: Movie & Music

1). Subject: users
2). Objects: movies or music
3). Actions
   Movie ➔ Seeing movies
   Music ➔ Listening to the music
Context Identification

* Context Identification Framework

For each elements (subject, object, actions), there are attributes:

<table>
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<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Profiles</td>
<td>Age, Gender, Nationality, Mood, etc</td>
</tr>
<tr>
<td>Item Features</td>
<td>Movies (genre, director, language, etc), Music (album, singer, year, etc)</td>
</tr>
<tr>
<td>Action Attributes</td>
<td>Time, Location, Weather, Companions, etc</td>
</tr>
</tbody>
</table>

So, what are the contexts?
Context Identification

**Context Identification Framework**

Rule-1: the attributes of actions are considered as contexts

A 10-year statistics based on the context-aware publications in most popular top academic conferences (e.g., KDD, RecSys, UMAP, WWW, SIGIR, etc)

From Tutorials at UMAP 2013 by Professor Bamshad Mobasher
Context Identification Framework

Rule-2: some dynamic variables from user profiles could be considered as contexts too, where those variables are produced by the users and may change dynamically during the interactional process between the users and the items when the action is performed.

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All user profiles may change, e.g. age; But mood is more dynamical through the interactional process.
**Context Identification Framework**

Rule-3: Most item features cannot be considered as contexts. Usually they are viewed as content profiles in RS. However, social network is an exception, since the objects in social networks are user accounts too!

In this case, partial attributes from the object features (i.e. attributes from user account profiles) could be considered as contexts.

For example: account status, social ties
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- **Summary of the Context Identification in CARS**
Summary

Activity Structure:
1). Subjects: group of users
2). Objects: group of items/users
3). Actions: the interactions within the activities

Three rules for context identification:
1). Action attributes are contexts;
2). Partial subject profiles (dynamic attributes);
3). Partial object features when object is a user;
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Thanks