PeopleViews: Human Computation for Constraint-Based Recommendation

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Constraint-based Recommendation

- Specific type of knowledge based recommendation
- Relies on a predefined set of constraints
- Rankings determined by utility function
- Why constraint-based recommendation?
  - Suitable for complex item domains
  - Possible to „explain“ recommendations
  - Diagnoses for too strict requirements
Motivation

Knowledge acquisition bottleneck

- Only a few Knowledge Engineers
- Possibly a lot of users with item knowledge
- Idea: enable users to contribute to knowledge bases
- Are users willing to contribute to knowledge bases?
Motivation

How willing are end users to contribute?

N=161, 111 would be willing to contribute

[Felfernig et al., CrowdRec 2014]
PeopleViews

Short-term tasks (*Micro-tasks*)

- Domain experts perform short-term knowledge engineering tasks they are much better in compared to knowledge engineers.

Potential advantages

- Less effort related to recommendation knowledge base development and maintenance
- Fewer erroneous constraints
- Significantly higher degree of scalability
PeopleViews - Knowledge base

- Product attributes
  - „Facts“ about items, e.g. sensor size of a camera
  - Defined when item is added to knowledge base

- User attributes
  - Perceived differently by users, e.g. a camera's field of application
  - Defined by users in micro tasks

- Support
  - Support of item for specific \{user, product\} attribute value
PeopleViews

PeopleViews - Features

Users are able to:

- Define new knowledge bases
  - Create new recommendation domain
  - Add items to existing domains
  - Evaluate existing items
  - „Answer“ micro tasks
- Use existing knowledge bases to get recommendations
**PeopleViews**

**Definition of knowledge bases**

**Product attributes**

<table>
<thead>
<tr>
<th>attribute</th>
<th>question to user</th>
<th>domain</th>
<th>similarity metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>sensorsize</td>
<td>Preferred sensor size?</td>
<td>{fullframe, APS-C, MFT, 1“, 2/3“}</td>
<td>EIB</td>
</tr>
<tr>
<td>max-shutterspeed</td>
<td>Required max. shutter speed?</td>
<td>{1/4000, 1/6000, 1/8000, 1/16000}</td>
<td>LIB</td>
</tr>
<tr>
<td>maxISO</td>
<td>Required max. ISO sensitivity?</td>
<td>{6400, 12800, 25600}</td>
<td>MIB</td>
</tr>
<tr>
<td>price</td>
<td>Max. price?</td>
<td>integer</td>
<td>LIB</td>
</tr>
</tbody>
</table>

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Definition of knowledge bases

Product attributes
- sensorsize
- Preferred sensor size?
- Usable as recommendation filter

Possible answers
- fullframe
- APS-C
- MFT
- 1"
- 2/3"

Price
- Number
- Less is better
- Usable as recommendation filter

Max. Price?
Definition of knowledge bases

User attributes

<table>
<thead>
<tr>
<th>attribute</th>
<th>choice type</th>
<th>question to user</th>
<th>domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>usertype</td>
<td>multiple</td>
<td>Suited for whom?</td>
<td>{ beginner, amateur, expert }</td>
</tr>
<tr>
<td>application</td>
<td>single</td>
<td>Preferred application?</td>
<td>{ sport, architecture, macro, landscape, portrait }</td>
</tr>
<tr>
<td>usability</td>
<td>single</td>
<td>Minimum accepted usability?</td>
<td>{ average, high, very high }</td>
</tr>
</tbody>
</table>
Definition of knowledge bases

Attribute name: usertype

Question to user: Suited for whom?

Possible answers:
- beginner
- amateur
- expert

+ Add answer

Allow multiple answers
Micro-tasks

Canon DSLR

How would you evaluate the attribute »usertype« for the item »Canon EOS 550D«?

- beginner
  - ?
  - 0%
  - 100%

- amateur
  - ?
  - 0%
  - 100%

- expert
  - ?
  - 0%
  - 100%

choice type: multiple
Micro-tasks

Item «Canon EOS 7D»: Which answer fits the attribute «application» best?

- sport
- macro
- portrait
- architecture
- landscape

How well?

? 0% 100%

choice type: single
PeopleViews

Micro-tasks

Which item fits the answer «sport» of the attribute «application» better?

- Canon EOS 7D
- Canon EOS 5D Mark III

Choose item, single attribute

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Recommendation view

"Canon DSLR"

- Canon EOS 550D
  The Canon EOS 550D is an 18.0 megapixel digital single-lens reflex camera, announced by Canon on 8 February 2010.

Refine by
- Preferred Application?
  - Suited for whom?
    - beginner
    - amateur
    - expert
  - Minimum accepted usability?
    - Preferred sensor size?
      - fullframe
      - APS-C
      - MFT
      - 1"
      - 2/3"
Recommendation view - Item details

Refine by
- Preferred Application?
  - Suited for whom?
    - beginner
    - amateur
    - expert

- Minimum accepted usability?
- Preferred sensor size?
  - Fullframe
  - APS-C
  - OMFT
  - 0.1"
  - 0.2/3"

"Canon DSLR"

Canon EOS 550D

Suited for whom?
- beginner 64.5%
- amateur 48%
- expert 14%

Preferred sensor size?
- APS-C
Recommendation approach

Recommendation approach in PeopleViews

User attributes

\[ \text{support}(\Phi, u, v) = \frac{\sum s(\Phi, u, v)}{|s(\Phi, u, v)|} \cdot \frac{|s(\Phi, u, v)|}{|s(\Phi, u)|} \]

<table>
<thead>
<tr>
<th>symbol</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Phi)</td>
<td>item</td>
</tr>
<tr>
<td>(u)</td>
<td>user attribute (u \in U)</td>
</tr>
<tr>
<td>(p)</td>
<td>product attribute</td>
</tr>
<tr>
<td>(v)</td>
<td>{user, product} attribute value</td>
</tr>
<tr>
<td>(s(\Phi, u, v))</td>
<td>support specified by user</td>
</tr>
</tbody>
</table>
Recommendation approach in PeopleViews

Product attributes

\[
\text{support}(\Phi, p, v) = \begin{cases} 
1 & \text{if } v = \text{val}(\Phi, p), \ 0 \text{ otherwise} \\
1 - \frac{|v - \text{val}(\Phi, p)|}{\max(\Phi, p) - \min(\Phi, p)} & \text{EIB} \\
\frac{\text{val}(\Phi, p) - \text{min}(\Phi, p)}{\max(\Phi, p) - \min(\Phi, p)} & \text{NIB} \\
\frac{\text{max}(\Phi, p) - \text{val}(\Phi, p)}{\max(\Phi, p) - \min(\Phi, p)} & \text{MIB} \\
\frac{\text{max}(\Phi, p) - \text{val}(\Phi, p)}{\max(\Phi, p) - \min(\Phi, p)} & \text{LIB} 
\end{cases}
\]

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Recommendation approach in PeopleViews

Selection of recommendation-relevant items

\[
f(\Phi) = \bigwedge_{u \in U} u \in \text{values}(\Phi, u) \cup \{\text{noval}\} \rightarrow \text{include}(\Phi)
\]

Ranking items by their utility

\[
\text{utility}(\Phi, \text{REQ}) = \sum_{a=v \in \text{REQ}} \text{support}(\Phi, a, v) \cdot w(a)
\]
Evaluation of recommender algorithms

- Collect data using WeeVis (http://www.weevis.org)
- Canon DSLR recommender
  - 16 items, 7 attributes (27 possible „answers“)
- Users defined their requirements and selected best matching camera
- 356 unique sessions
- 1 out of N „training and evaluation“
- Is desired item in top n recommended items?
Evaluation

Comparison to other approaches

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Ongoing and future work

- Recommendation approaches
  - Implementation and evaluation of further approaches; diagnoses and repair
- Micro-task scheduling
  - Automatically assign micro-tasks to users, using a content-based approach
- Quality assurance
  - Improve dataset quality and prevent manipulation
Thank you!