Content Recommendation Through Linked Data

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Information Overload

3 million likes, 240 thousand new photos, 3 million posts shared
56 thousand pictures
430 thousand tweets
300 hours of new videos
120 new accounts

http://www.go-globe.com/blog/60-seconds/
Recommender Systems

“Which movie can I watch?”
Linked Data

- Enormous repository of multi-domain knowledge
- Standard access
- Semantic relationships between structured and interlinked data
Goals

Exploitation of Linked Data relationships

User and context representation

Contextual preferences

Effective visualization

Visualization

Recommender System

Linked Data

User Context

User and context representation
Outline

A Linked Data based Recommendation Framework

A Linked Data based Recommendation Algorithm

Ontologies for Context-Aware Recommendations

Visualizing Linked Data based Recommendations

Conclusions and Perspectives
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Linked Data Relationships

Visitor attractions in Turin

Museums in Turin

Egyptian Museum

National Museum of Cinema

Valentino Park

Mole Antonelliana

Turin

Linked Data Relationships:
- Category-Category
- Resource-Category
- Resource-Resource
- skos:broader
- dbo:location
- dbo:location-city
Allied: a Linked Data RS Framework
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## Linked Data-only Recommendations

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Cross-dataset</th>
<th>Cross-domain</th>
<th>Transversal links</th>
<th>Hierarchical links</th>
</tr>
</thead>
<tbody>
<tr>
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</table>
The ReDyAl Algorithm

Start

Transversal generation

Hierarchical generation

Ranking

End
Traversals Generation
Traversals Generation

National Museum of Cinema \(\xrightarrow{\text{dbo:location}}\) Mole Antonelliana

\(\xrightarrow{\text{dbo:location-city}}\) Turin
Hierarchical Generation

National Museum of Cinema
Hierarchical Generation

Museums in Turin

- National Museum of Cinema
- Egyptian Museum
Hierarchical Generation

Visitor attractions in Turin

Museums in Turin

National Museum of Cinema

Egyptian Museum

Valentino Park

Mole Antonelliana
ReDyAl Ranking

Quotient of a weighting function and a distance (maxDistance)

Links between 2 resources (incoming/outgoing, direct/indirect)

\[
HybridSim(ir, r_i) = a \cdot (1 - LDSD(ir, r_i)) + b \cdot hyP(ir, r_i)
\]

Parameters to privilege transversal or hierarchical ranking
Evaluation of ReDyAI
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Context-Aware Recommendations

"Which movie can I watch?"

Which context?

Saturday
Cinema
Partner

Tuesday
Home
Friends
The RSCtx Ontology

- Address contextual data sparsity
- General model of contextual information that could be reused in multiple domains and applications
- Represent context parameters on different levels of granularity
- Reuse existing ontologies
  - Extension of PRISSMA
# Context Ontologies

<table>
<thead>
<tr>
<th>Feature</th>
<th>SOUPA</th>
<th>CoOL</th>
<th>CONON</th>
<th>CoDaMoS</th>
<th>Koripää</th>
<th>Hervás</th>
<th>DCO</th>
<th>PRISSMA</th>
<th>RScx</th>
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<tr>
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<td>Reuse of existing terms</td>
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<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
Time Representation in RSCtx

- prissma:Environment
  - time:Instant
    - Time
      - Hour
        - PartOfDay
      - DayOfWeek
        - WeekDay
        - Weekend
      - season
      - isHoliday
    - CalendarSeason
    - TropicalSeason
Context-Aware Approach with RSCtx

RSCtx

Generalize context

Find preferences

Enough

Run recommendation algorithm
Context Generalization

05-05-2017
14.30
Context Generalization

05-05-2017
14.30

user1_t=weekend
user1_t=weekday
user1_t=weekday_l=Boston
user1_t=weekend

TimeType
LocationType
TimeLocationType

env
Time
PartOfDay
afternoon
DayOfWeek
WeekDay
Weekend

dayOfWeek
isHoliday
false
time
partOfDay
Context Generalization

05-05-2017
14.30
## Evaluation of Our Approach

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>MAE with RSCtx</th>
<th>MAE without RSCtx</th>
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</thead>
<tbody>
<tr>
<td>Random Guess</td>
<td>0.2315</td>
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<tr>
<td>User Average</td>
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<tr>
<td>Item kNN</td>
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<td>SVD++</td>
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<tr>
<td>Time SVD++</td>
<td>NA</td>
<td>0.2693</td>
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</tbody>
</table>
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## Linked Data Visualization Tools

<table>
<thead>
<tr>
<th>Work</th>
<th>Lay users</th>
<th>Mobile</th>
<th>Cross-domain</th>
<th>Cross-dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBpedia mobile</td>
<td>✔️</td>
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<td>✔️</td>
</tr>
</tbody>
</table>
Use cases

- Use cases

  **Browse whole DBpedia**

  - User

  - Developer

  **Browse a specific domain in DBpedia**

  **Build applications**

  - Only movies
  - Only POIs

  - Recommend movies or tourist attractions
Architecture

DBpedia → SPARQL / RDF → End user application → Code generation module
Approach

View categories of a resource

View a resource

Browse a category

SELECT

DESCRIBE

SELECT

DBpedia
The Matrix is a 1999 American science fiction action film written and directed by The Wachowski Brothers, starring Keanu Reeves, Laurence Fishburne, Carrie-Anne Moss, Hugo Weaving, and Joe Pantoliano. It depicts a dystopian future in which reality as perceived by most humans is actually a simulated reality called "the Matrix", created by sentient machines to subdue the human population, while their bodies' heat and electrical activity are used as an energy source.
Awards for best film

Martial arts films

Post-apocalyptic films

Films by American directors

Films set in the future
Post-apocalyptic films

The Matrix (franchise)

V for Vendetta (film)

The Invasion (film)

The Postman (film)
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Recommendation System

Visualization

Linked Data

User Context
Main PhD Thesis Contributions

- A systematic literature review of Linked Data based RS
- A new recommendation algorithm
- Context representation for recommendation algorithms
- Participation in development of a framework to execute Linked Data based recommendation algorithms
- Application of results in several use cases of Telecom Italia
Limitations and Open Issues

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Ontologies for Context-Aware Recommendations

Visualizing Linked Data based Recommendations

- Test in multiple domains
- Test using other datasets
- More resource in input
- Context-awareness

- Test in multiple domains
- Test with other context dimensions

- UI Evaluation
- Test in multiple domains
- Test using other datasets
Perspectives

- Diversity of recommendations
- Mining micro-blogs and user reviews
- Explaining recommendations
- Serendipity
- Exploratory search
Thank You


RSCtx  softeng.polito.it/rsctx
ReDyAl  natasha.polito.it/LDRecommenderWeb
Allied  natasha.polito.it/AllliedWI

http://softeng.polito.it/vagliano/