

# Recomendación Basada en Contexto

**IIC 3633 - Sistemas Recomendadores - PUC Chile**

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# Memo del Semestre

- Sitio web fue actualizado.
- Presentaciones de estudiantes serán anunciadas esta noche
- Mañana se enviará detalles y entregas del proyecto final

# Contexto

Un factor importante a considerar al realizar recomendaciones



# Definiciones I

- Primeras definiciones basadas más bien en ejemplos.
- En uno de los estudios más tempranos sobre contexto, Shilit et al. (1994) identifica como contexto:
  - Dónde estás (where you are),
  - Con quién estás (who you are with), y
  - Qué recursos hay alrededor (what resources are nearby.)



# Definiciones I

- Dey (2001) intenta formalizar la definición de contexto para volverla más fácilmente operable como:

**Context is any information that can be used to characterise the situation of an entity.**

**An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves**

ref: Anind K. Dey. 2001. Understanding and Using Context. Personal Ubiquitous Comput. 5, 1 (January 2001), 4-7. DOI=<http://dx.doi.org.ezproxy.puc.cl/10.1007/s007790170019>

# Definiciones III

- En un trabajo más reciente, Ranganathan & Campbell (2003) identificaron: "...context denotes additional information to what is traditionally represented in a user model, such as:"
  - demographics or interests, and refers to "physical contexts (e.g., location, time),
  - environmental contexts (weather, light and sound levels),
  - informational contexts (stock quotes, sports scores),
  - personal contexts (health, mood, schedule, activity),
  - social contexts (group activity, social activity, whom one is in a room with),
  - application contexts (emails, websites visited) and
  - system contexts (network traffic, status of printers)"

# Definiciones IV

- Como es de esperarse, un contexto considerado "relevante" varía bastante según el área:
  - Marketing: Contexto es definido como las etapas de vida que caracterizan al cliente ya que pueden determinar un cambio importante en sus preferencias, estado y valor para las compañías:
    - nuevo trabajo,
    - nacimiento de un hijo,
    - casamiento, divorcio, jubilación.
- Personalización en e-commerce
  - Intento de compra, Palmisano et al. (2008), construir distintos perfiles de usuario dependiendo del contexto.
  - Sistemas context-aware móviles y ubicuos: ubicación, fecha, estación (Brown et al. 1997, 2005 ) temperatura y estado emocional.

# Cómo obtener información contextual

- **Explícitamente:** Encuestas
- **Implícitamente:** Información de dispositivos (hora, ubicación, temperatura, etc)
- **Infiriendo:** e.g. distintos usuarios que está viendo películas con la misma cuenta de movie city (Naïve Bayes o redes Bayesianas, Palmisano et al. 2008)

# Contexto en Sistemas de Recomendación

- Observable / Parcialmente / No Observable
- Estático / Dinámico

| How Contextual Factors Change | Knowledge of the RS about the Contextual Factors |                                       |                                |
|-------------------------------|--|---------------------------------------|--------------------------------|
|                               | Fully Observable                                 | Partially Observable                  | Unobservable                   |
| Static                        | Everything Known about Context                   | Partial and Static Context Knowledge  | Latent Knowledge of Context    |
| Dynamic                       | Context Relevance Is Dynamic                     | Partial and Dynamic Context Knowledge | Nothing Is Known about Context |

Figure 1. Contextual Information Dimensions.

ref: Adomavicius, G., Mobasher, B., Ricci, F., & Tuzhilin, A. (2008) Context-Aware Recommender Systems. AAAI Magazine.

# Paradigmas para Incorporar Contexto

Pre-Filtrado / Post-Filtrado / Modelado Contextual

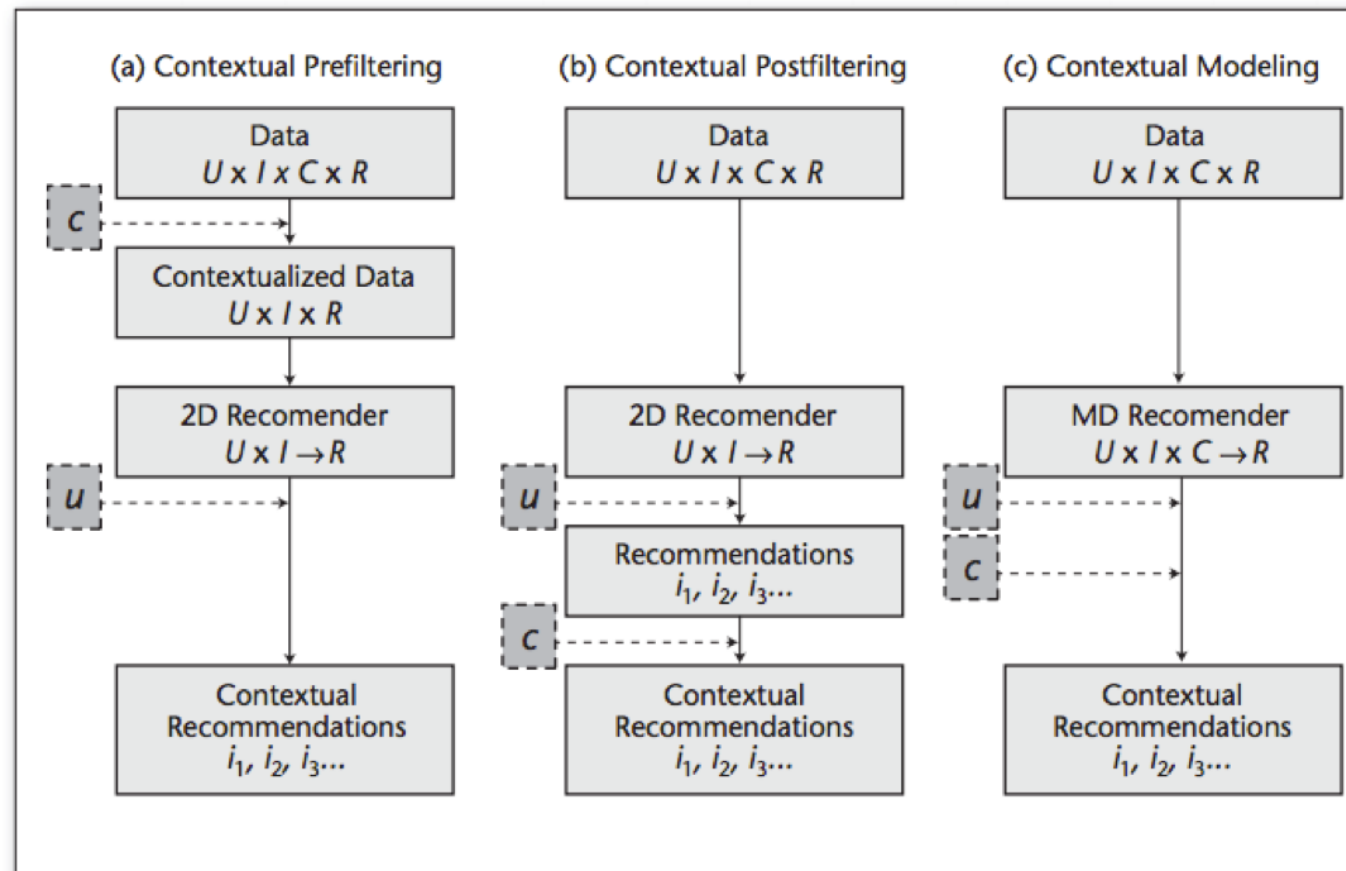


Figure 2. Paradigms for Incorporating Context in Recommender Systems.

# Caso de Pre-filtrado

- Baltrunas, L., & Amatriain, X. (2009, October). Towards time-dependant recommendation based on implicit feedback. In Workshop on context-aware recommender systems (CARS'09)

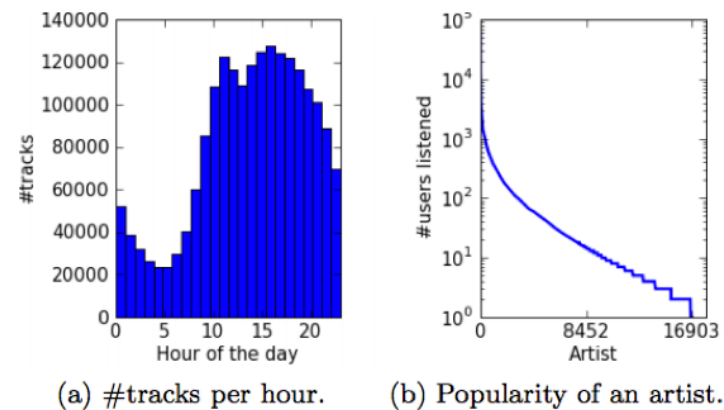


Figure 1: Last.fm data information

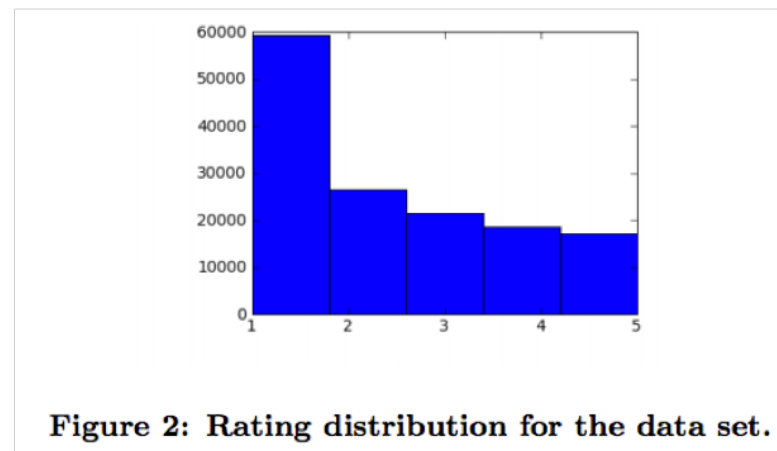


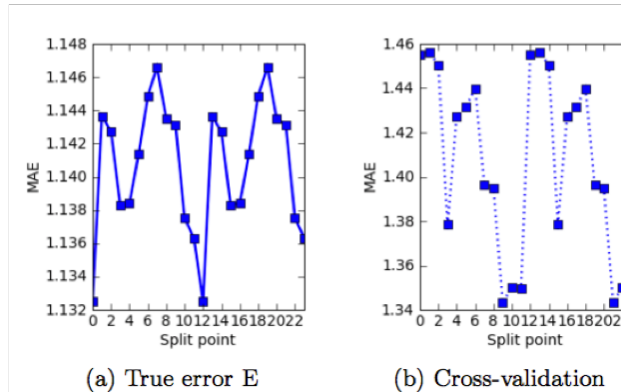
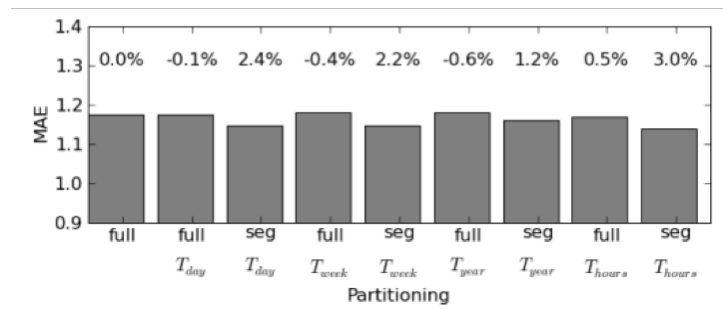
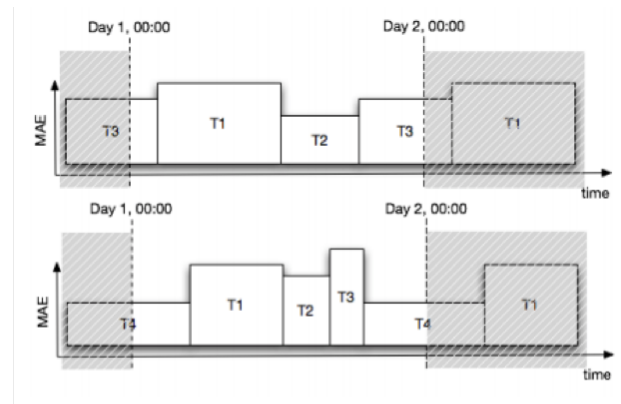
Figure 2: Rating distribution for the data set.

# Caso de Pre-filtrado: Evaluación

- Baltrunas, L., & Amatriain, X. (2009, October). Towards time-dependant recommendation based on implicit feedback. In Workshop on context-aware recommender systems (CARS'09)

|   |         |
|---|---------|
| #users  | 338     |
| #tracks   | 322871  |
| #artists  | 16904   |
| #entries  | 1970029 |
| #ratings (after normalization)                  | 143091  |
| average mean repetition of a track for a user   | 3.09    |
| average mean repetition of an artist for a user | 19.87   |

**Table 1: Summary of the data set**





# Caso de Post-Filtrado: Sharing the Square

- Sharing the Square (2005)

## Sharing the square: Collaborative Leisure in the City Streets

Barry Brown<sup>1</sup>, Matthew Chalmers<sup>1</sup>, Marek Bell<sup>1</sup>, Malcolm Hall<sup>1</sup>, Ian MacColl<sup>2</sup>, Paul Rudman<sup>1</sup>

<sup>1</sup>Department of Computing Science, University of Glasgow, Glasgow, UK <sup>2</sup>School of IT and Engineering, University of Queensland, Brisbane, Australia

**Abstract.** Sharing events with others is an important part of many enjoyable experiences. While most existing co-presence systems focus on work tasks, in this paper we describe a lightweight mobile system designed for sharing leisure. This system allows city visitors to share their experiences with others both far and near, through tablet computers that share photographs, voice and location. A collaborative filtering algorithm uses historical data of previous visits to recommend photos, web pages and places to visitors, bringing together online media with the city's streets. In an extensive user trial we explored how these resources were used to collaborate around physical places. The trial demonstrates the value of technological support for *sociability* - enjoyable shared social interaction. Lastly, the paper discusses support for collaborative photography, and the role history can play to integrate online media with physical places.

# Caso de Post-Filtrado: Sharing the Square

- Sharing the Square (2005): Interfaz e Interacción

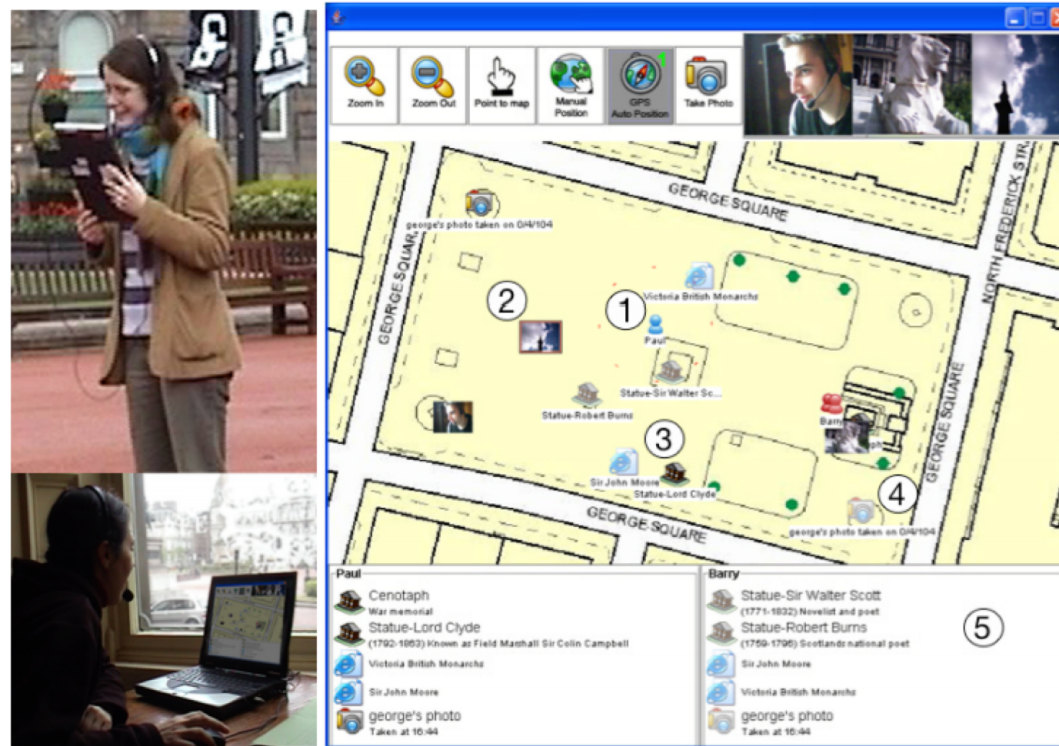


Figure 1. Example usage of the system and screenshot showing a map that displays each user's location (1), thumbnail photos (2), recommended locations, web pages (3) and photos (4), and each user's recommendation list (5).

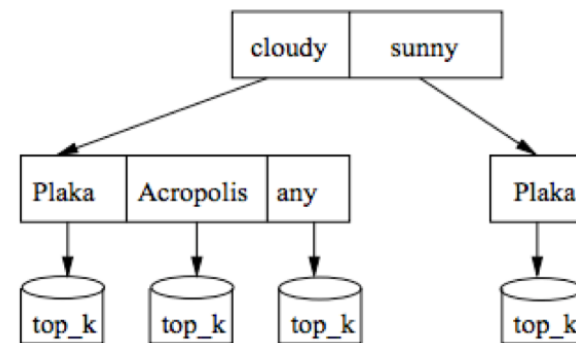
# Caso de Post-Filtrado: Sharing the Square

- Databases: Adaptar resultados de las bases de datos dependiendo del contexto: Stephanidis (2007), Agrawal (2006), and Mokbel's CareDB (2009)

**Query 2** Look for Mary's most preferable restaurants (in the current context).

The execution of *Query 2* leads to the execution of the following subqueries (we suppose that  $CS(c) = \{Acropolis, sunny\}$ ):

- ```
SELECT R.name, FL.score
FROM Users U, Restaurants R, Fact_Location L
WHERE U.name = 'Mary' AND U.uid = FL.uid
AND R.rid = FL.rid AND L.lid = F.current_location = 'Acropolis';
and
```
- ```
SELECT R.name, FW.score
FROM Users U, Restaurants R, Fact_Weather FW
WHERE U.name = 'Mary' AND U.uid = FW.uid AND
R.rid = FW.rid AND current_weather = 'sunny';
```



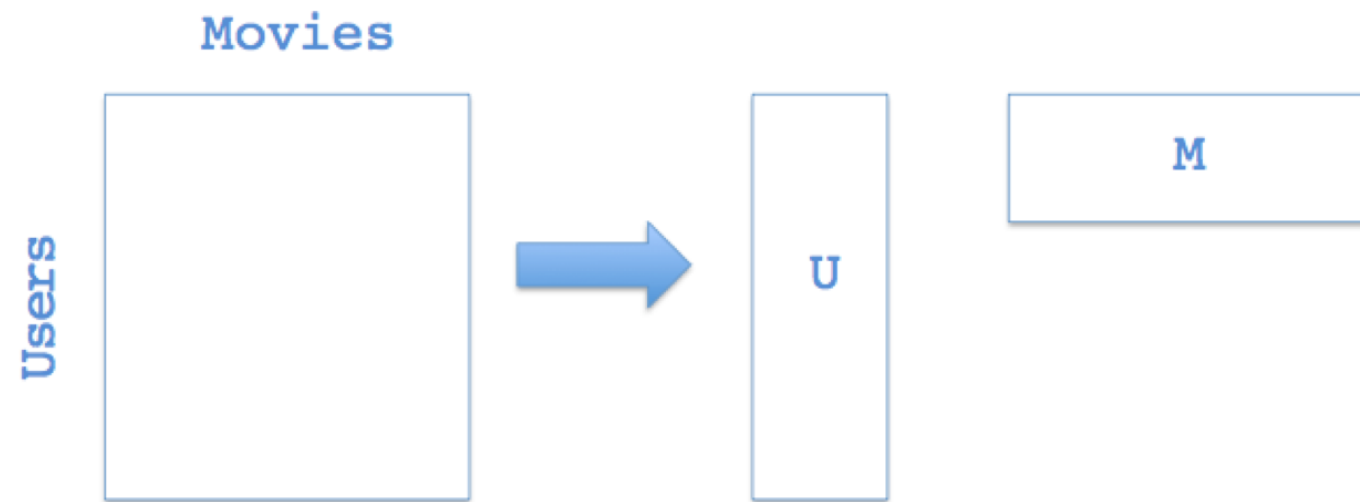
# Sistema donde Contexto es parte del Modelo

- Karatzoglou, A., Amatriain, X., Baltrunas, L., & Oliver, N. (2010, September). **Multiverse recommendation: n-dimensional tensor factorization for context-aware collaborative filtering**. In Proceedings of the fourth ACM conference on Recommender systems (pp. 79-86). ACM.

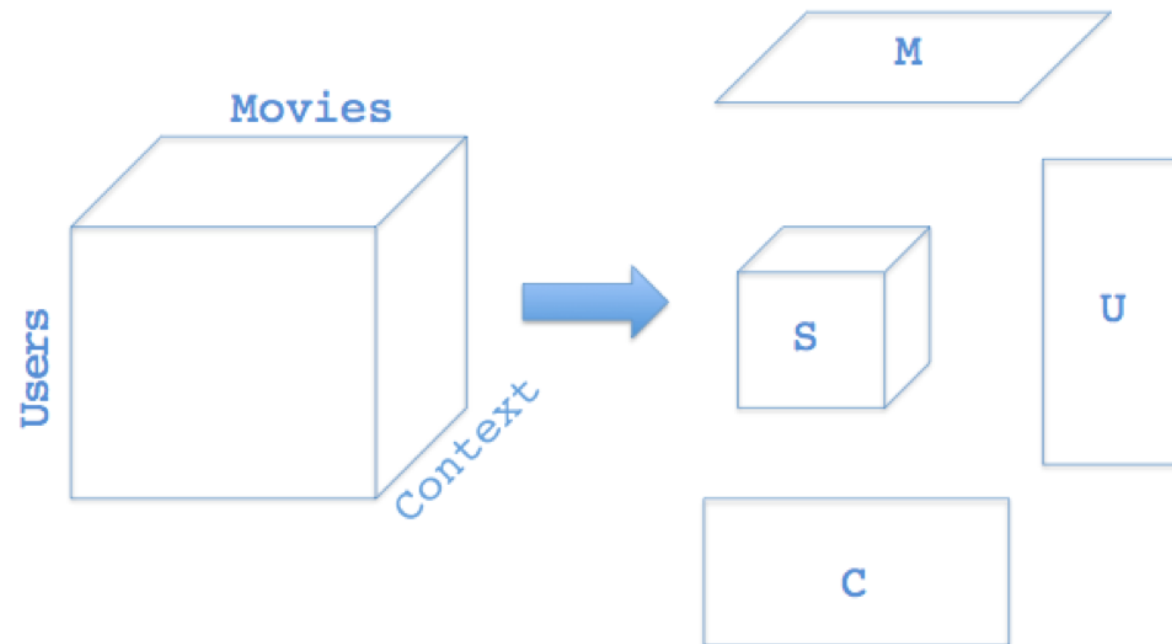
# FM Tradicional

Find  $U \in R^{n \times d}$  and  $M \in R^{d \times m}$  so that  $F = UM$

minimize $_{U,M} L(F, Y) + \lambda \Omega(U, M)$



# Matriz -> Tensor



$$F_{ijk} = S \times_U U_{i*} \times_M M_{j*} \times_C C_{k*}$$

$$R[U, M, C, S] := L(F, Y) + \Omega[U, M, C] + \Omega[S]$$

$$\Omega[F] = \lambda_M \|M\|_F^2 + \lambda_U \|U\|_F^2 + \lambda_C \|C\|_F^2$$

$$\Omega[S] := \lambda_S \|S\|_F^2$$

# Función de Pérdida

- Opción 1: Cuadrado del Error

$$l(f, y) = \frac{1}{2}(f - y)^2$$

$$L(F, Y) = \sum_i^n \sum_j^m l(f_{ij}, y_{ij})$$

- Opción 2: Error Absoluto

$$l(f, y) = |f - y|$$

$$L(F, Y) = \sum_i^n \sum_j^m l(f_{ij}, y_{ij})$$

# Datasets / Evaluación

$$MAE = \frac{1}{K} \sum_{ijk}^{n,m,c} D_{ijk} |Y_{ijk} - F_{ijk}|$$

---

| Data set | Users | Movies | Context Dim. | Ratings | Scale |
|----------|-------|--------|--------------|---------|-------|
| Yahoo!   | 7642  | 11915  | 2            | 221K    | 1-5   |
| Adom.    | 84    | 192    | 5            | 1464    | 1-13  |
| Food     | 212   | 20     | 2            | 6360    | 1-5   |

Table: Data set statistics

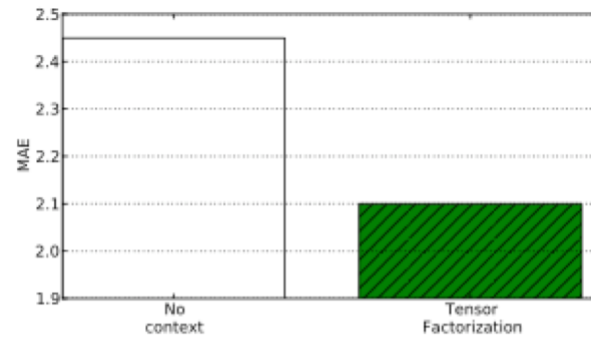


# Comparación con Otros Métodos

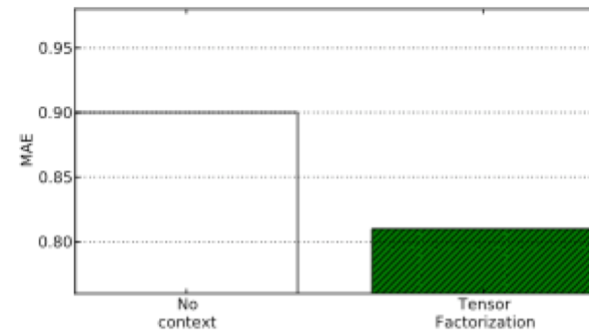
Pre-filtering based approach, (*G. Adomavicius et.al*), computes recommendations using *only* the ratings made in the same context as the target one

Item splitting method (*L. Baltrunas, F. Ricci*) which identifies items which have significant differences in their rating under different context situations.

# Con/Sin Contexto



(a)



(b)

**Figure:** Comparison of matrix (no context) and tensor (context) factorization on the Adom and Food data.

# Con/Sin Contexto II

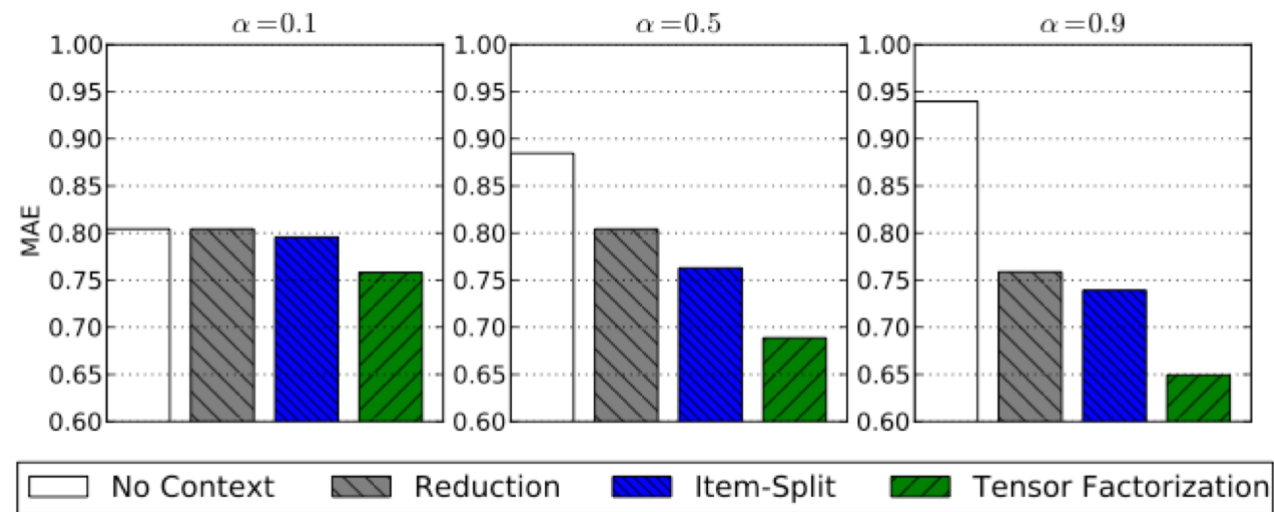
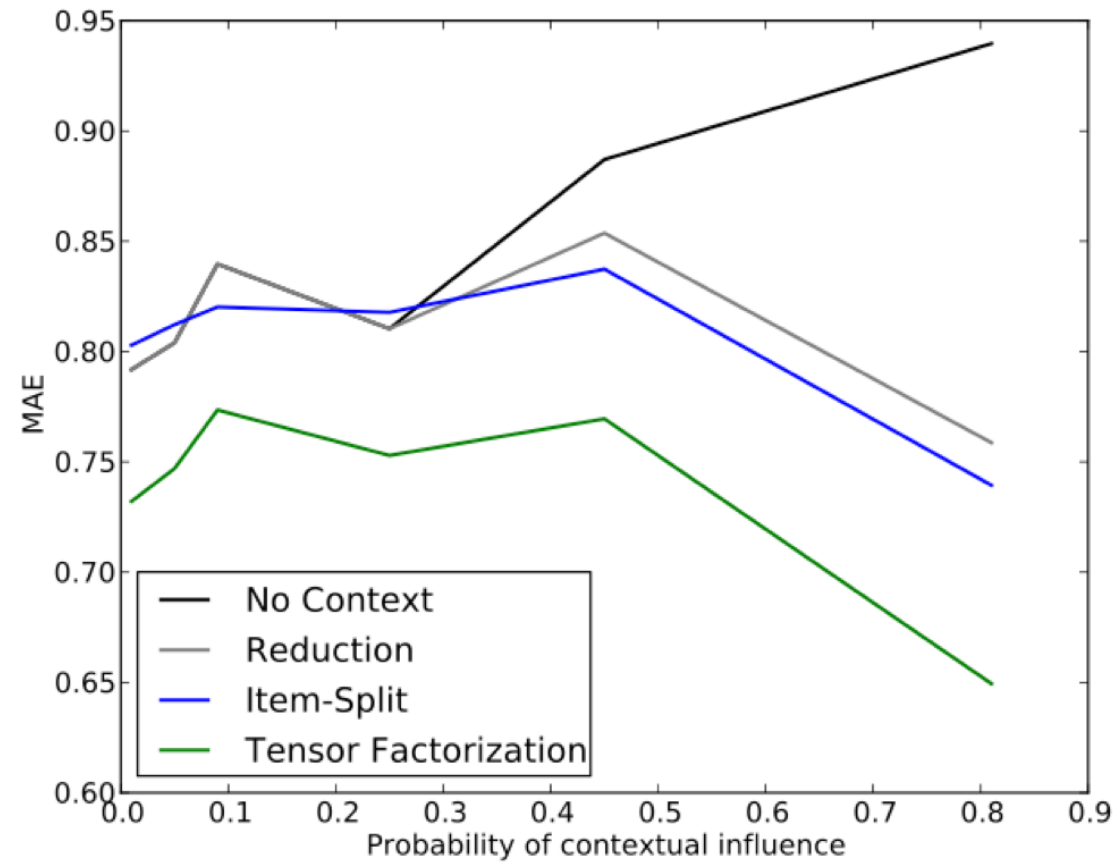


Figure: Comparison of context-aware methods on the Yahoo! artificial data

# Influencia de Información Contextual



# Efecto en Otros Datasets

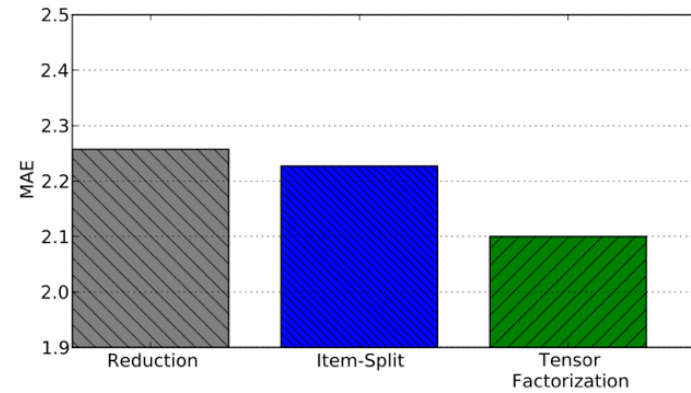


Figure: Comparison of context-aware methods on the Adom data.

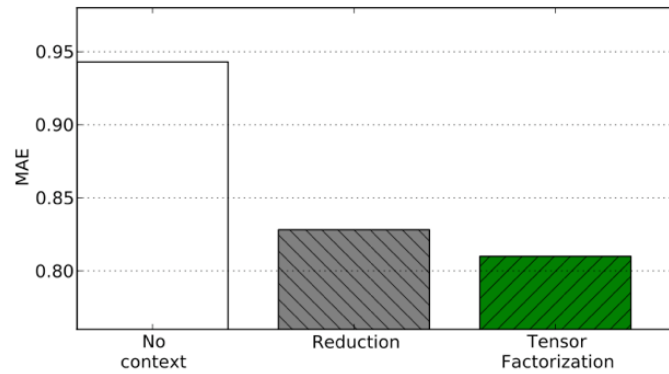



Figure: Comparison of context-aware methods on the Food data.

# Caso de Estudio Modelado Contextual II



Linas Baltrunas, Bernd Ludwig, Stefan Peer, and Francesco Ricci. 2012. **Context relevance assessment and exploitation in mobile recommender systems.** Personal Ubiquitous Comput. 16, 5 (June 2012), 507-526.  
DOI=10.1007/s00779-011-0417-x

# Rescate de Preferencias del Usuario

[\(user:ciccio\)logout](#)



Imagine that you are in Bolzano and you are making a plan for today. You are considering **to relax in a spa**. Please mark the conditions that would positively or negatively influence the decision to do that, or would have no effect.


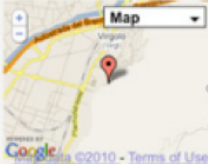
|  |  |                                  |  |
|--|--|----------------------------------|--|
|  |  | No effect                        |  |
| Imagine that you are on a wellness trip: | <input type="radio"/>  | <input type="radio"/>            | <input checked="" type="radio"/>   |
| Imagine that it is a cold day:           | <input type="radio"/>  | <input checked="" type="radio"/> | <input type="radio"/>  |
| Imagine that it is raining:              | <input type="radio"/>  | <input type="radio"/>            | <input checked="" type="radio"/>   |

[next...](#)

Situation 1 of 5

### Rating in Context

Castel Flavon - Haselburg

**Category:** castle

**Introduction:** Castel Flavon Haselburg nestles on a wooded hill slightly above Haslach, a quarter of the city of Bolzano. Built in late 12th century, still today it boasts some valuable frescoes.

**Description:** Castel Flavon Haselburg nestles on a wooded hill slightly above Haslach, a quarter of the city of Bolzano. Built in late 12th century, still today it boasts some valuable frescoes. It was recently renovated and the restaurant is open again. Address: Via Castel Flavon 48 Phone:0471 402130 Email: info@haselburg.it www: www.haselburg.it Opening hours: Tuesday-Saturday 11am-12pm, Sunday 11am-5pm, Monday closed.

**Imagine you are in Bolzano and you are making plan for today**

How likely is that you will visit Castel Flavon - Haselburg ★ ★ ★ ★ ☆

**We want to know which circumstances influence your decision**

Imagine that you are sad. How likely is that you will visit Castel Flavon - Haselburg: ★ ★ ☆ ☆ ☆

Imagine that you feel comfortable and happy. How likely is that you will visit Castel Flavon - Haselburg: ★ ★ ★ ★ ☆

Imagine that you can only use public transport. How likely is that you will visit Castel Flavon - Haselburg: ★ ★ ★ ☆ ☆

[Next](#)

# Contextos Usados


**Table 1** Context factors used in the web survey

| Context factor       | Conditions          | Context factor      | Conditions          | Context factor | Conditions              | Context factor | Conditions          |
|----------------------|---------------------|---------------------|---------------------|----------------|-------------------------|----------------|---------------------|
| Budget               | Budget traveler     | Crowdedness         | Not crowded         | Companion      | With girl/<br>boyfriend | Season         | Spring              |
|                      | High spender        |                     | Crowded             |                | With family             |                | Summer              |
| Time of the day      | Price for quality   | Travel goal         | Empty               | Weather        | With children           | Transport      | Autumn              |
|                      | Morning time        |                     | Health care         |                | Alone                   |                | Winter              |
|                      | Afternoon           |                     | Cultural experience |                | With friends            |                | Public transport    |
|                      | Night time          |                     | Scenic/landscape    |                | Snowing                 |                | No means of transp. |
| Day of the week      | Weekend             | Working day         | Education           | Mood           | Clear sky               | Temperature    | Bicycle             |
|                      | Working day         |                     | Hedonistic/fun      |                | Sunny                   |                | Car                 |
| Distance to POI      | Near by             | Far away            | Social event        | Religion       | Rainy                   | Time available | Warm                |
|                      | Far away            |                     | Religion            |                | Cloudy                  |                | Cold                |
| Knowledge About area | New to city         | Citizen of the city | Activity/sport      | Business       | Happy                   | Time available | Hot                 |
|                      | Citizen of the city |                     | Visiting friends    |                | Active                  |                | Half day            |
|                      | Returning visitor   |                     | Business            |                | Sad                     |                | More than a day     |
|                      |                     |                     |                     |                |                         |                | One day             |



# Opciones de la interfaz I

|                 |  |  |
|-----------------|--|--|
| Distance to POI | <input type="checkbox"/> OFF             | Alone                                      |
| Temperature     | <input checked="" type="checkbox"/> ON   | Friends/Colleagues                         |
| Weather         | <input checked="" type="checkbox"/> ON   | Family <input checked="" type="checkbox"/> |
| Season          | <input type="checkbox"/> OFF             | Girlfriend/Boyfriend                       |
| Weekday         | <input type="checkbox"/> OFF             | Children                                   |
| Time day        | <input type="checkbox"/> OFF             |  |
| Crowdedness     | <input type="checkbox"/> OFF >           |  |
| Companion       | <input checked="" type="checkbox"/> ON > |  |



# Opciones de la interfaz II



Fig. 9 Details for a suggestion

# Opciones de la interfaz III

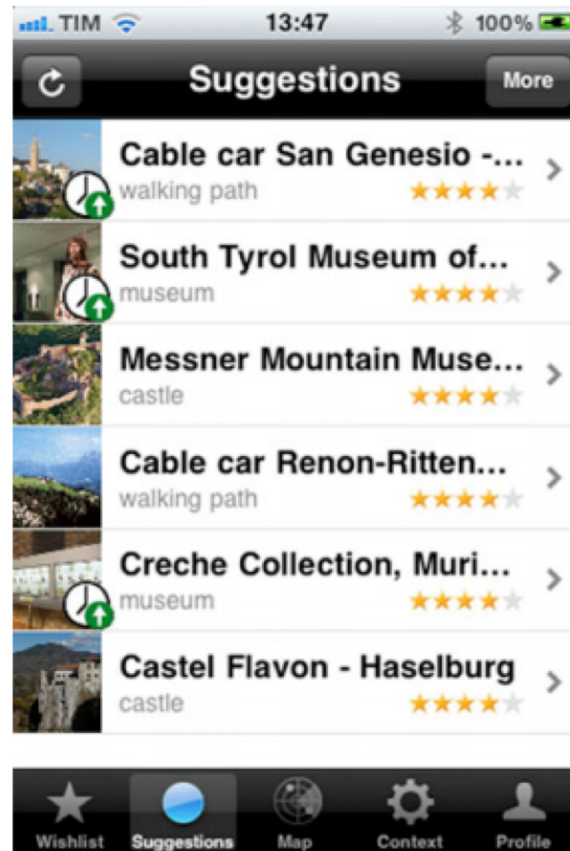
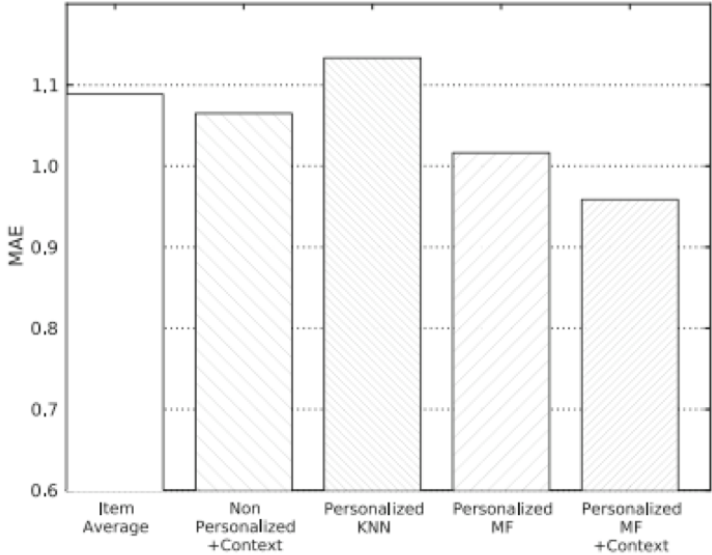
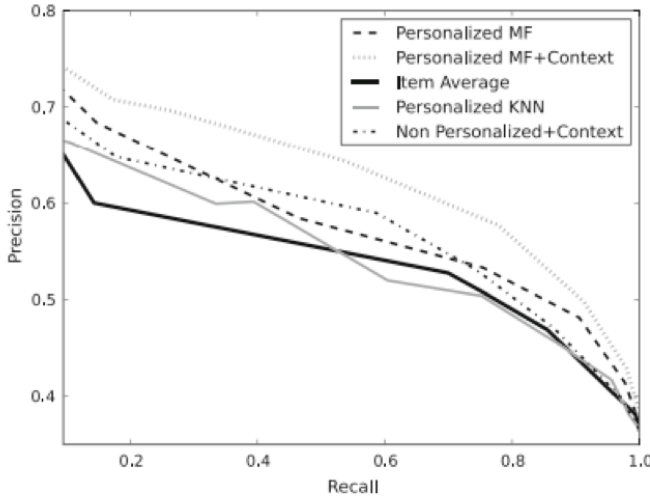


Fig. 8 Suggestions GUI

# Resultados



(a) MAE of different models



(b) Precision and Recall of different methods

Fig. 6 Performance of different methods

## Otro casos interesantes:

- Best paper ACM RecSys 2015: Augusto Q. Macedo, Leandro B. Marinho, and Rodrygo L.T. Santos. 2015. **Context-Aware Event Recommendation in Event-based Social Networks**. In Proceedings of the 9th ACM Conference on Recommender Systems (RecSys '15). ACM, New York, NY, USA, 123-130. DOI=<http://dx.doi.org/10.1145/2792838.2800187>
  - Slides: <http://www.slideshare.net/leandrobaby/recsys15-presentation>
- Paper a presentar en RecSys 2016: Christoph Trattner, Alexander Oberegger, Lukas Eberhard, Denis Parra and Leandro Balby Marinho. 2016. **Understanding the Impact of Weather for POI Recommendations**. ACM RecSys Workshop on Recommenders in Tourism.
  - [Slides](#)
- ¿Preguntas?

# Referencias

- Anind K. Dey. 2001. Understanding and Using Context. Personal Ubiquitous Comput. 5, 1 (January 2001), 4-7. DOI=<http://dx.doi.org.ezproxy.puc.cl/10.1007/s007790170019>
- Adomavicius, G., Mobasher, B., Ricci, F. , & Tuzhilin, A. (2008) Context-Aware Recommender Systems. AAI Magazine.
- Augusto Q. Macedo, Leandro B. Marinho, and Rodrygo L.T. Santos. 2015. **Context-Aware Event Recommendation in Event-based Social Networks**. In Proceedings of the 9th ACM Conference on Recommender Systems (RecSys '15). ACM, New York, NY, USA, 123-130. DOI=<http://dx.doi.org/10.1145/2792838.2800187>
- Christoph Trattner, Alexander Oberegger, Lukas Eberhard, Denis Parra and Leandro Balby Marinho. 2016. **Understanding the Impact of Weather for POI Recommendations**. ACM RecSys Workshop on Recommenders in Tourism