On the extraction and use of arguments in recommender systems

A case study in the e-participation domain

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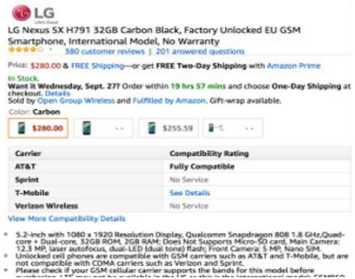
1.1. Context, motivation and goals

- **Review-based recommendations**
  - A textual **review** usually contains detailed information about a user's **opinion** about an item.
  - **Aspects** are attributes or components of an item on which opinions are expressed.



★★★★★ **Honest, unbiased, and straight to the point**
By Michael on December 4, 2016
Color: Quartz | **Verified Purchase**

Makes you satisfied and glad you bought it. It's snappy processor can handle most anything you through at it.

Pros- even with plastic backing it still feels premium, the design leaves you breathless, camera is sub par, and it's stock Android which is a great experience

Cons- lack of as compatibility, no wireless charging, comes with travel charger with an adapter

Overall- definitely a deal and bang for your buck. Highly recommended and after time using it I've fallen in love with no regrets.

1.1. Context, motivation and goals

- **Argument-based recommendations**

  Beyond the benefits of providing recommendations based on opinions, in certain cases, it would be useful to understand and consider the **arguments for given opinions**.

  Hence, there is the need and challenging task of **automatically identifying and using the arguments given in favor of and against the evaluated items and item aspects**.

  Recommendations and their explanations would be based not only on **what** is said, but also on **why** it is said.

- **Research goals**

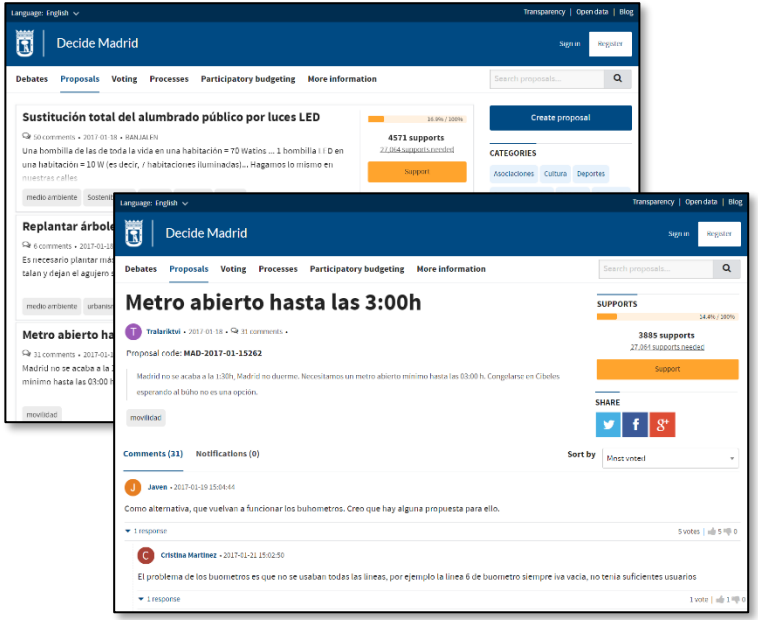
  1. Automatic extraction of arguments from textual content.
  2. Exploitation of interconnected argument structures by recommender systems.

1.1. Context, motivation and goals

- **Traditional domains** where user reviews contain argued user opinions
  - E-commerce
  - Leisure
  - Tourism
- **Other domains**
  - Web applications that are rich in argumentative content
    - Internet forums
    - Online social networks
    - Discussion and debate e-platforms
  - Software tools that handle documents with argumentative information
    - Legal corpora
    - Educational resources
    - Collections of citizen proposals
    - Transcripts of political speeches and parliamentary sessions

1.2. Case study

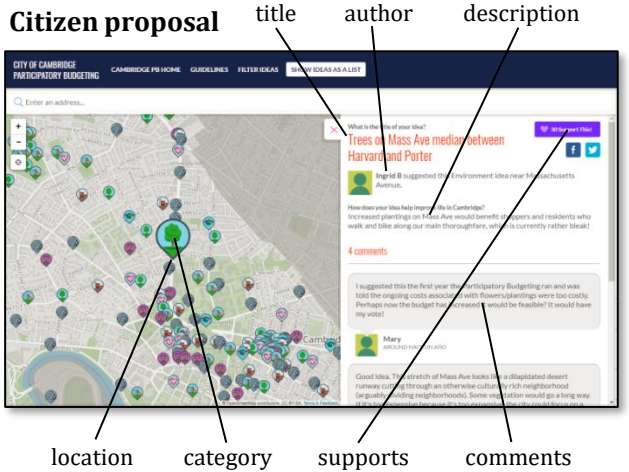
- **The 'Decide Madrid' e-participation platform**
  - A web system designed to allow Madrid residents to make, debate and vote **proposals** for the city
- **Available data for a citizen proposal**
  - Title
  - Author, date
  - Summary, description
  - Freely-chosen tags
  - Number of user votes
  - User comment threads
- Heterogeneous topics and debates
  - Urbanism, transport, environment, health care, education, social rights, education, culture, economy, job, politics, security, housing, family, old age, religion, animals, etc.



1.2. Case study

Topic- and location-based

- **Recommender systems in e-participation**
  - **Cantador, I., Cortés-Cediel, M.E., Fernández, M., Alani, H.** (2018). **What's going on in my city? Recommender systems and electronic participatory budgeting**. 12th ACM Conference on Recommender Systems, pp. 219–223.
  - **Cantador, I., Bellogín, A., Cortés-Cediel, M. E., Gil, O.** (2017). **Personalized recommendations in e-participation: offline experiments for the 'Decide Madrid' platform**. International Workshop on Recommender Systems for Citizens, Art. 5, 1–6.

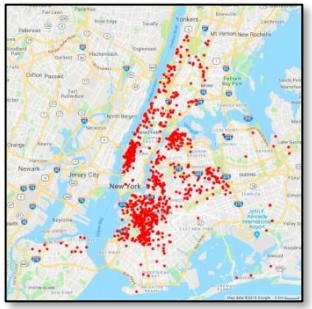


Proposal id: 9 ***Dataset***: Cambridge-2014
User id: 510
Created time: 2014-11-26, 20:19:01
Location: [long:-71.094882, lat: 42.360129]
Title: **Diagonal crosswalks**
Description: Lots of pedestrians here, rather than waiting twice you could cross diagonally.

Supports: [user:16, time:...], [user:923, time:...], ...

Comments: [user:16, text:..., time:...],...

Entities: pedestrian crossing
Topics: pedestrian infrastructure, streets and roads, urban planning
Categories: economy, business and finance > economic sector > transport > traffic



New York City
(approx. scale 1:4x10^5)

2.1. Argument model

- Components of an **argument model** commonly considered in CS literature
  - **Claim**: the conclusion of the argument
  - **Premise**: foundation or basis for the claim
  - **Relation**: support or attack
- In addition to premises and claims, we also consider **major claims** as fundamental argument units
  - Principal, resultant parts of argumentative chains within a discourse
  - Other claims (and premises) relate or depend on major claims
- Instead of narrowing the scope to support and attack relations, we take more fine-grained **relation types** into account
  - e.g., by distinguishing whether an **attack** really represents an *opposition* or, on the contrary, it suggests an *alternative*, a *comparison* or a *concession* for an argument

2.2. Argument relation taxonomy and lexicon

- **Types of argument relations** (compendium from the research literature)
  - **Cause**
    - Links an argument that reflects the *reason* or *condition* for another argument
  - **Clarification**
    - Introduces a *conclusion*, *exemplification*, *restatement* or *summary* of an argument
  - **Consequence**
    - Evidences of an *explanation*, *goal* or *result* of a previous argument
  - **Contrast**
    - Links attacking arguments, distinguishing between several types of attack: giving *alternatives*, doing *comparisons*, making *concessions*, and providing *oppositions*
  - **Elaboration**
    - Introduces an argument that provides details about another one. The details can entail *addition*, *precision* or *similarity* issues about the target argument

2.2. Argument relation taxonomy and lexicon

- **2-level taxonomy**
  - **5 categories**
    - e.g., clarification
  - **16 subcategories**
    - e.g., conclusion, exemplification, restatement, summary
- **Argument connectors**
  - **248 English connectors**
    - e.g., to conclude, for example
  - **364 Spanish connectors**
    - e.g., para concluir, por ejemplo

Category	Subcategory	Primary intent	Num.	English connectors *Examples*	Num.	Spanish connectors *Examples*
Cause	*Condition*	qualifier	34	if [ever/so], in case of/that, on the condition [that], unless	35	si [alguna vez/es así], en caso de/que con/bajo la condición de [que], a no ser que
	Reason	support	14	because [of], due to, since given that, based on, forasmuch as	21	porque, ya que, debido a [que], pues, dado que, basándose en [que], puesto que
			48		**56**	
Clarification	*Conclusion*	support	17	to conclude, in/as conclusion, all in all, all things considered	19	para concluir, en/como conclusión, en definitiva, atendiendo a/con [todo] lo considerado
	Exemplification	support	9	for [example/instance], as an example [of] like, such as, to take/give an example [of]	14	por ejemplo, como ejemplo [de], tales como, por dar/poner un ejemplo [de]
	Restatement	support	6	in other words, that is [to say], put differently, to put it another way	34	en otras palabras, es decir, esto es, mejor dicho, dicho de otro modo
	Summary	support	14	summarizing, summing up, to sum up, in summary/short, in a few words	12	resumiendo, concluyendo, para acabar, por resumir/concluir, en pocas palabras
			46		**79**	
Consequence	*Explanation*	support	6	actually, in [actual] fact, indeed, of course, for that matter	8	realmente, de hecho, en realidad, por supuesto, en efecto, para el caso
	Goal	support	19	for, to, in order to, aimed/aiming to, that/which allows/entails/implies	18	para, por, con el fin de, lo que/cual permite/conlleva/implica
	Result	support	21	therefore, thus, hence, then, so [that] as a result [of], this/that/such reason, accordingly, in/as a consequence	44	por [lo] tanto, por consiguiente/ende como resultado, por esta/esa razón, así que, es por ello que, de este/ese modo
			46		**70**	
Contrast	*Alternative*	support/attack	21	on the other hand, in another case, if not, instead [of], rather than, alternatively [to], otherwise, else	29	por otra parte, por otro lado, en otro caso, si no, en vez/lugar de, en cambio/su defecto, alternativamente [a], de otro modo
	Comparison	support/attack	7	while, whereas, compared [to/with], in comparison to/with, as long as	20	mientras [que], comparado con, en comparación a/con, a la vez de/que
	Concession	support/attack	20	although, [even] though, despite [that], in spite/despite of, regardless [of]	38	aunque, aún/incluso [si/así], a pesar de/del, a pesar de que, pese a [que], pese al
	Opposition	attack	22	but, however, nonetheless, albeit, nevertheless, in contrast [to/with]	46	pero, sin embargo, no obstante, en contraste a/con, en contra [de/del]
			70		**133**	
Elaboration	*Addition*	support	18	also, besides, as well, too, moreover, furthermore, additionally, in addition [to]	22	también, además/aparte [de], [lo que] es más, asímismo, encima de, adicionalmente [a]
	Precision	support	11	in particular, particularly, especially, mainly, [more] specifically/precisely	13	en particular, particularmente, especialmente, principalmente, [más] especificamente/ precisamente
	Similarity	support	9	similarly/analogously [to], like, likewise, in the same way, correspondingly	11	similarmente/analogamente [a], como, al igual que, del mismo modo [que], de la misma manera [que]
			38		**46**	
			248		**384**	

2.3. Argument extraction method

- **Natural language processing (NLP) of sentences**
  - **Part-of-speech tagging** *(grammatical analysis)*: identifying nouns, adjectives, verbs, preposition, etc.
  - **Constituency parsing** *(syntactic analysis)*: extracting the syntactic tree (nested phrases) of a sentence
  - **Named entity recognition** *(semantic analysis)*: people, organizations, locations, etc.
- **Three argument mining tasks**
  - **Argument detection**
    - Syntactic pattern matching

      $[claim\{main\_verb\} + \textbf{\textit{connector}} + premise\{main\_verb\}]$, formed by three grouped phrases

      $[claim\{main\_verb\} + [\textbf{\textit{connector}} + premise\{main\_verb\}]]$, formed by two grouped phrases
  - **Argument component identification**
    - Phrases linked through a **connector**
  - **Argument relation recognition**
    - Categorization via the argument relation **taxonomy**

2.3. Argument extraction method

- **An argument is extracted from a single sentence**
  - **Premise** and **claim**
    - Text
    - Named entities
    - Nouns
  - **Connector**
    - Value
    - Intent (attack, support, qualifier)
    - Category
    - Subcategory
  - **Main verb**
- Major claim
  - Associated to the proposal's title

```
"5717-1": {
    "proposalID": 5717,
    "sentence": "The use of public transport in the city is almost forced but in EMT pets are not allowed",
    "mainVerb": "is forced",
    "connector": {
        "value": "but", "intent": "attack",
        "category": "CONTRAST", "subCategory": "OPPOSITION"
    },
    "premise": {
        "entities": "[EMT]",
        "text": "in EMT pets are not allowed",
        "nouns": "[pets]"
    },
    "claim": {
        "entities": "[]",
        "text": "The use of public transport in the city is almost forced",
        "nouns": "[use, transport, city]"
    },
    "majorClaim": {
        "entities": "[]",
        "text": "Allowing pets on public transport",
        "nouns": "[pets, transport]"
    },
    "pattern": "P1 -> CLAIM + CONNECTOR + PREMISE"
}
```

Structured recommendations

- **Elements**
  - **Proposals** (items)
  - **Topics**, e.g., transport
  - **Aspects**, e.g., subway
  - **Arguments**
- **Arguments**
  - By topic and aspect
  - Components
    - **Claim** and **premise**
    - Relation **category**, e.g., cause
    - Relation **subcategory**, e.g., reason
    - Relation **connector**, e.g., “due to”

```
<recommendations>
    <proposals quantity="5">
        <proposal id="20307" topics="buses" categories="mobility" date="2017-12-10" districts="Tetuán">
            Urban buses connecting San Chinarro and Las Tablas with Cuatro Caminos</proposal>
        <proposal id="1432" topics="environment" categories="mobility" date="2015-09-18" districts="city">
            Public transportation in Madrid Río</proposal>
        <proposal id="5717" topics="pets" categories="mobility" date="2015-11-18" districts="city">
            Allowing pets on public transport</proposal>
        <proposal id="4671" topics="public transport" categories="mobility" date="2015-11-05" districts="city">
            Public transport price</proposal>
        <proposal id="2769" topics="transport pass" categories="mobility" date="2015-10-07" districts="city">
            The Transport Pass should expire in one month</proposal>
    </proposals>
    <topics quantity="1">
        <topic value="transport" aspects="subway,use,price,transports" quantity="4">
            <aspect value="subway" quantity="2">
                <argument id="20307-1">
                    <claim>The PAU of Norte Sanchinarro Las Tablas are poorly served by public transport</claim>
                    <connector category="cause" subcategory="reason" intent="support">due to</connector>
                    <premise>the ineffectiveness of light subway</premise>
                </argument>
                <argument id="1432-1">
                    <claim>The Madrid Rio park was created promising that public transport would reach there</claim>
                    <connector category="contrast" subcategory="opposition" intent="attack">but</connector>
                    <premise>it is false, the Legazpi subway is far away and buses are non-existent</premise>
                </argument>
            </aspect>
```

Conclusions

- We have presented ongoing work on the development of **argument-based recommendation methods** that exploit argumentative information automatically extracted from textual content
  - A proposed **argument mining** and **recommendation** approach has been validated on the **e-participation** domain
- We claim the following **contributions**:
  - A novel **taxonomy of argument relations** that goes beyond the commonly adopted support-attack schema
  - A rich **lexicon of argument connectors** for both *English* and *Spanish*
  - A proposal of **recommendation schema** that includes suggested items together with categorized, structured arguments that complement opinions about the items and related topics and aspects

Future work

- **Further implementation and evaluation**
  - **Argument mining**: considering more features than connectors via machine learning
  - **Recommendation generation**: adapting SoA methods to exploit argumentative information
- **Potential impact on e-participation**
  - **Enrichment of citizen participation**
    - Discovering ideas, proposals and initiatives characterized by high levels of controversy or targeted to minorities
  - **Improvement of decision making**
    - Provision of arguments as a complement of topics and opinions
  - **Increase of transparency**
    - Interactions and explanations for the user
  - **Ethical and legal issues**
    - Biases on the selection and presentation of recommendations: ideological, political, sociocultural, etc.
    - Multiple information needs, comprehension capabilities and exploitation purposes of different stakeholders: citizens, government actors, politicians and businesses

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