Social vote recommendation: Building party models using the probability to vote feedback of VAA users

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Outline

• What is a VAA?
• Social Vote Recommendation (SVR)
• Methodology for implementing SVR
• Compared models
  • Mahalanobis Classifier
  • Weighted Mahalanobis Classifier
  • Function approximation
• Experimental Results
• Conclusion
What is a VAA? (1)

**Voting Advice Application:**
- A system that allows citizens to define their own subjective, political preferences and to match these with the stated (or academically coded) preferences of candidates or political parties

**How it works:**
- **Step 1: Identifying the party policy positions**
  - Prior to an election, candidates and/or parties fill in a questionnaire containing an extensive set of policy statements related to salient political issues (typically around 30 policy statements are included in most VAAs).
- **Step 2: Recording user political profile**
  - A user fills in the same policy questionnaire. His / her answers form his / her political profile (a vector space model)
- **Step 3: Matching the profiles of a user and parties**
  - A proper metric (Euclidean distance, City block distance, empirically defined variants of the previous)
- **Step 4: Showing matching results (indirect vote recommendation)**
  - Presentation of matching scores

What is a VAA? (2)

**Steps 1 & 2: Identifying party's and user's policy positions**

**Initial Screen:**

EUvox will now be launched. Please indicate your views on the policy statements that follow. The more questions you answer, the better we will be able to position you on the political landscape.
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What is a VAA? (3)

- Steps 1 & 2: Identifying party’s and user’s policy positions
- Example of a policy statement:

```
EU

There should be a common EU foreign policy even if this limits the capacity of Greece to act independently
```

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What is a VAA? (3)

- Steps 3 & 4: Computing similarity and presenting the results
- Introductory page:

```
 EUvox 2014

Thank you for completing the questionnaire!

On the next page you will be able to analyse your results. The results will allow you to compare your stated ideological preferences with the parties on the policy questions selected by the research team and should not be considered as a recommendation to vote for a party.
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What is a VAA? (3)

Steps 3 & 4: Computing similarity and presenting the results

Similarity matching (indirect recommendation):

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Social Vote Recommendation (SVR)

What is SVR?
- The similarity of a user with a party/candidate is computed based on the similarity between the profiles of the user and other users that declared voting intention for that party.

How it works?
- Need to get voting intention from VAA users.
- Build models (through a supervised learning procedure) for each one of the parties.
- This paper deals with the building party models for SVR and it compares several approaches getting also some insights of the clustering of voters within a "party space".

Gathering voting intention from a user
- As a categorical variable:

You can help our research by taking a moment to answer these questions. If you prefer not to answer simply click on the continue arrow.

Which party do you feel closest to?
- CDU/CSU
- SPD
- The ideas of the party are close
- CDU/CSU
- I am undecided

In the European elections, which party or bloc do you intend to vote for?
- CDU/CSU
- SPD
- The ideas of the party are close
- CDU/CSU
- I am undecided

What is the main reason for voting for your party/bloc of choice?
- CDU/CSU
- SPD
- The ideas of the party are close
- CDU/CSU
- I am undecided

In the last national election that took place in 2013, which party did you vote for?
- CDU/CSU
- SPD
- The ideas of the party are close
- CDU/CSU
- I am undecided

If there were a national election tomorrow, which party/bloc would you vote for?
- CDU/CSU
- SPD
- The ideas of the party are close
- CDU/CSU
- I am undecided
Gathering voting intention from a user

As an ordinal variable:

How probable is it that you will ever vote for the following parties? Please state your views on the drop down scale where 0 means 'not at all probable' and 10 means 'very probable'

presentation of SVR results:

Social vote recommendation (SVR)

Presentation of SVR results:
Methodology (1)

- **Research Questions:**
  - Which of the various compared methods for party/candidate modeling (linear and non-linear ones) is the best in terms of F-measure and MAP (Mean Average Precision)?
  - Is there any benefit in training party models using the ordinal variables (likelihood to vote - $l_j$) instead of the categorical one (vote intention - $v_j$) as desired output?

- **Mathematical formulation:**
  - Vector space representation of $j$-th VAA user (U=30, number of political statements) upon which the users defines his/her policy position:
    $$\mathbf{x}_j = \{x_{j,1}, x_{j,2}, \ldots, x_{j,k}, \ldots, x_{j,U}\}$$
  - $x_{j,k} = j$-th user answer to k-th political statement ($x_{j,k}$ takes values in {-2 (strongly disagree), -1 (disagree), 0 (neither agree or disagree), 1 (agree), 2 (strongly agree)})

- **Aim:**
  - Train party / candidate models $M_i$ ($i=1, \ldots, \text{number of parties / candidates}$) using either $(\mathbf{x}_j, v_j)$ or $(\mathbf{x}_j, l_j)$ pairs
  - Estimate the likelihood a VAA user to vote for party $i$ based on his / her profile, $L(j, i | \mathbf{x}_j) = \hat{p}_j$, $\hat{l}_j = M(\mathbf{x}_j)$

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Methodology (2)

- **Mathematical formulation (cont.):**
  - $p_j = \text{likelihood the } j\text{-th user to vote for } i\text{-th party /candidate (this value is recorded in the probability to vote question)}$
  - $l_j = \{p_1, p_2, \ldots\}$ a vector representing the likelihood user $j$ to vote for each one of the competing parties / candidates
  - $v_j = \text{voting intention of the } j\text{-th user (recorded in the corresponding supplementary question)}$

- **Aim:**
  - Train party / candidate models $M_i$ ($i=1, \ldots, \text{number of parties / candidates}$) using either $(\mathbf{x}_j, v_j)$ or $(\mathbf{x}_j, l_j)$ pairs
  - Estimate the likelihood a VAA user to vote for party $i$ based on his / her profile, $L(j, i | \mathbf{x}_j) = \hat{p}_j$, $\hat{l}_j = M(\mathbf{x}_j)$
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Compared Methods

- **Mahalanobis Classifier (MC):**

\[ L(j, i \mid \vec{x}_j) = e^{-\frac{1}{2}(\vec{x}_j - \vec{m}_i)^T \cdot C_i^{-1} \cdot (\vec{x}_j - \vec{m}_i)} \]

where the model for the \( i \)-th party is obtained with the aid of the average user profile \( \vec{m}_i \) and the covariance matrix \( C_i \) (both computed by using only the users that expressed voting intention for party \( i \)):

\[
\vec{m}_i = \frac{1}{N_i} \sum_{j: v_j = p_i} \vec{x}_j
\]

\[
C_i = \frac{1}{N_i} \sum_{j: v_j = p_i} (\vec{m}_i - \vec{x}_j)(\vec{m}_i - \vec{x}_j)^T
\]

- **Weighted Mahalanobis Classifier (WMC):**

  WMC is similar to MC with the difference that the party models are built with the aid of \( \vec{f}_j \) instead of the voting intention \( v_j \). Thus, the average user profile \( \vec{m}_i \) and the covariance matrix \( C_i \) are computed using all user profiles weighted by the corresponding likelihood of each user to vote party \( i \):

\[
L(i, i \mid \vec{x}_i) = e^{-\frac{1}{2}(\vec{x}_i - \vec{m}_i)^T \cdot C_i^{-1} \cdot (\vec{x}_i - \vec{m}_i)}
\]

\[
\vec{m}_i = \sum_{j=1}^{N_i} w_j \vec{x}_j
\]

\[
C_i = \frac{1}{N_i} \sum_{j=1}^{N_i} (w_j^2 (\vec{m}_i^j - \vec{x}_j)(\vec{m}_i^j - \vec{x}_j)^T
\]

where \( N_i \) is the number of users in the training set.

\[
w_j = \frac{f_j}{\sum_{j=1}^{N_i} f_j}
\]
Compared Methods (3)

- Neural Networks for classification (NNC):
  - Train a neural network using \((\vec{x}_j, \vec{u}_j)\) pairs \((\vec{u}_j = [0 \ldots 0 \ 1 \ldots 0]^T)\) s a D-dimensional vector of zero values a unity in the \(i\)-th position indicating that the \(j\)-th user expressed voting intention for the \(i\)-th party) to approximate a multiple input-multiple output function \(\mathbf{M}^c\) to estimate voting intention vector:

\[
\vec{u}_j = M^c(\vec{x}_j)
\]

where \(\hat{u}_j^i\) is the \(i\)-th element of vector \(\vec{u}_j\).

Compared Methods (4)

- Neural Networks for Function Approximation (NNFA):
  - Train a neural network using \((\vec{x}_j, \vec{l}_j)\) pairs to approximate a multiple input-multiple output function \(\mathbf{M}\) to estimate the likelihood to vote vector:

\[
L(j, i \mid \vec{x}_j) = \hat{l}_j^i, \quad \vec{l}_j = \mathbf{M}(\vec{x}_j)
\]

- As seen above the likelihood a user \(j\) to vote for party \(i\) is the \(i\)-th element of the likelihood to vote vector.
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**Evaluation framework:**

- **Metrics:**
  - Variations of Precision, Recall and F-measure
  - MAP (Mean Average Precision)

- **Dataset** (taken from the VAA for the German parliamentary elections in 2013)

<table>
<thead>
<tr>
<th># samples (Questionnaires)</th>
<th># samples in the training set</th>
<th># samples in the test set</th>
<th># parties modeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>50839</td>
<td>33800</td>
<td>17039</td>
<td>6</td>
</tr>
</tbody>
</table>

**Data:**

- **Dataset:** Yahoo!Movies data (movies.yahoo.com)
- **Criteria:** acting, story, direction, visuals, as well as overall rating
- **Scale:** F(worst), A+(best) => {1,2,...,13}
- **Subset referring to users who rated more than 30 movies (see below)**
- **50% of movies for training, 20% for validation set, 30% for testing**
- **Experiments conducted using Matlab in a typical PC**

<table>
<thead>
<tr>
<th>#users</th>
<th>#movies</th>
<th>#ratings</th>
<th>#ratings per movie (average)</th>
<th>sparsity</th>
</tr>
</thead>
<tbody>
<tr>
<td>239</td>
<td>976</td>
<td>13286</td>
<td>14</td>
<td>0.9430</td>
</tr>
</tbody>
</table>
Experimental Results

\[
L(j, i \mid \vec{x}_j) \text{ computed via: } 
\begin{array}{c|c|c|c|c}
 & \text{Recall} & \text{Precision} & \text{F-measure} & \text{MAP} \\
\hline
\text{basic MC (eq. 8)} & 0.435 & 0.474 & 0.454 & 0.642 \\
\text{WMC (eq. 12)} & 0.458 & 0.471 & 0.464 & 0.662 \\
\text{function } M \text{ (eq. 15)} & 0.492 & 0.513 & 0.502 & 0.689 \\
\text{function } M^c \text{ (eq. 16)} & 0.498 & 0.493 & 0.496 & 0.692 \\
\end{array}
\]

Conclusion

- Non-linear party modeling techniques (neural network based) clearly outperform the linear methods (Mahalanobis based).
  - => unimodal distribution, although sufficient, does not perfectly cover the variance of users' political stances within a particular party
- the use of ordinal variables (likelihood to vote) in party modeling enhances the social vote recommendation performance in a linear party modeling setting (WMC vs MC)
  - this is not true, however, in non-linear party modeling (NNFA vs NNC)
- The MC and WMC party modeling methods can be easily adapted to operate in a sequential manner. This is an important parameter for real VAAs where the social vote recommendation (SVR) module must be activated as soon as a few hundred of users answer the probability to vote and vote intention supplementary questions
Thank you for your attention

Questions?