An Automated Recommendation Approach to Selection in Personnel Recruitment

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Agenda

- HRM and personnel selection
- IS in HRM - some empirical data
- Framework
  - personnel selection as matching problem
  - personal attributes
  - recommending candidates

http://www.opal-tool.net/
Personnel recruitment and selection

• Sourcing of labor as one factor of production is a core function in human resources management

• HRM process: \( \Rightarrow \text{attract} \rightarrow \text{recruit} \rightarrow \text{develop} \rightarrow \text{retain} \)

• recruitment function
  – \textit{Attraction phase:}
    • employer branding: long-term, indirect attraction of candidates
    • attraction of direct applications: short-term, for concrete vacancies
  – \textit{Selection phase:}
    • pre-selection of profiles: screening of resumes, references, certificates
    • final selection of candidates: based on additional assessments

\Rightarrow \text{selection of candidates is a decision process}

\Rightarrow \text{very limited IS support for decision process} (\Rightarrow \text{emp. study})

Current use of IS

Traditional HRMS

• Often limited to payroll management, reporting tools etc.
• niche vendors with some applicant tracking functionality

E-recruitment

• Capabilities of e-recruitment mainly used to increase coverage of personnel marketing
• \textit{Personnel selection software} so far focuses on marketing functionality (e.g. multichannel posting of job ads)
• Potential to decrease process/administration cost, improve matching quality not yet exploited (mainly due to lack of functionality and of system integration)

Computer-based testing

• Often traditional paper-based tests are simply transferred, not exploiting the advantages of computer-based testing
IS support in recruiting: empirical results

Survey with the German Top 1,000 companies on E-Recruitment practices, response rate = 19.6%

Person-job matching

- Personnel selection can be understood as the matching of persons to jobs in order to accomplish a certain task requiring a specific skill set
  - importance of social as well as task-related aspects
  - personal attributes can be readily detectable or underlying

- decision process based on job-specific criteria and personal attributes

- Boolean search methods currently applied in e-recruitment do not support this process adequately
  - no combination into a single query
  - ontological problem
  - data availability

→ survey: low use of active search, recentralization of profile databases
### Personal attributes as basis for determining job aptitude

**Determination of matching criteria**

- Task-related factors
  - abilities
  - expertise
  -...

- Social factors
  - personality
  - motivation
  -...

**Assessment of personal attributes**

- Readily detectable attributes
  - school grades
  - age
  -...

- Underlying attributes
  - personality traits
  - general intelligence
  -...

**Prediction of aptitude**

- Clinical combination of input data (e.g., expert evaluation)
- Mechanical combination of input data (e.g., rule-based)

Both can be aptitude prediction by...

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### Classification of personal attributes

<table>
<thead>
<tr>
<th></th>
<th>Independent</th>
<th>Continuum</th>
<th>Situation dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual (unary)</strong></td>
<td>Value is independent of situation (→ classical personality theory)</td>
<td>Personality traits according to classical theory</td>
<td>Suitability for a certain job</td>
</tr>
<tr>
<td><strong>Relational (binary)</strong></td>
<td>Links in personal network</td>
<td>Degree of trust when accomplishing a certain task</td>
<td></td>
</tr>
</tbody>
</table>

- ternary and n-ary attributes are neglected → further research
- influence of relational aspects on job performance → further research
A framework for describing personal attributes

From assessment theory, we borrow 4 elements of a personal attribute:

- **Construct**: What?
- **Assessment method**: How?
- **Assessor**: Who?
- **Attribute value**: Who?

Personal attributes are used as input data for recommending candidates.

### Constitution of personal attributes

**Construct**

**Value**

**Assessment method**

**Assessor**

### Personal attributes – Examples

<table>
<thead>
<tr>
<th>Construct</th>
<th>Example 1</th>
<th>Example 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is measured?</td>
<td>Mathematical skills</td>
<td>Suitability for job XY</td>
</tr>
<tr>
<td>How is measured?</td>
<td>GCSE</td>
<td>Evaluation of resume</td>
</tr>
<tr>
<td>Who measures?</td>
<td>School / State</td>
<td>Recruiter</td>
</tr>
<tr>
<td>Evaluation</td>
<td>A-</td>
<td>“Selected for interviews”</td>
</tr>
</tbody>
</table>
IS support for personnel selection

Similarly to recommender systems employed in webshops such as amazon.com, we build a recommender system that recommends applicant profiles.

Basic idea:
- systems suggests profiles based on profiles the same and other users previously liked
- based on hybrid approach, latent aspect model

Application domains include preselection phase (faster process) and later – to some extent - also selection phase (better candidates)

General approaches to automated recommendation

- Collaborative Filtering: recommendations are based on the similarity of profiles of different users
- Content-based Filtering: recommendations are based on the similarity between profile and object characteristics
- Hybrid approaches: combining collaborative and content-based filtering

Problem: data sparsity

In order to better support the selection process through IS, we chose an approach based on recommender systems that automatically learns user preferences, i.e. matching criteria, and suggests candidate profiles.

As we chose a hybrid approach to recommendation, we need to capture the 'content' of persons that is based on a set of personal and interpersonal attributes.
Latent aspect model to recommend candidates

Latent Aspect Model

- \( x \): Job profile (assessor's pref.)
- \( z \): Latent aspect (acad. skills, work experience)
- \( v \): Evaluated aptitude (true/false)
- \( a \): Input attributes (school/dipl. grade)

\[ P(z | x) \]
\[ P(v | z, a) \]

- The latent aspect model is a probabilistic approach to automated recommendation
- The latent aspects \( z \) represent the factors that determine a candidate's aptitude \( v \); they are dependent on the job profile's \( x \) matching criteria

\[ p(v) \text{ dep. on } z, a \]
\[ z \text{ smaller dimension than } x \]
\[ \text{some } x \text{ "share" latent aspects ("collaborative")} \]
\[ a: \text{quadruple consisting of attribute name, assessment method, assessed attribute value and assessor} \]
\[ \text{e.g. } a=\text{("mathematical skills", "diploma grade", "1.0", "University of Frankfurt")} \]

- Latent aspect approach to recommendations is based on work by Hofmann/Puzicha.

Parameter estimation and test design

Input: Candidate profiles with ratings

Determination of profile attributes

Compilation of original rating matrix

Supplementing original rating matrix

Estimation of model

Prediction of ratings for test data

Calculation of ratings for test data based on the model; comparison with original ratings
First results from test runs

- Assessor $x_i$ assesses the suitability of profiles 1-70 for a certain job.
- Model is trained with profiles 1-60, with each profile being evaluated by a single assessor.
- Evaluation for profiles 61-70 are predicted for every assessor with the estimated model parameters.

### Training data

<table>
<thead>
<tr>
<th>Profiles</th>
<th>$x_1$</th>
<th>$x_2$</th>
<th>$x_3$</th>
<th>$x_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-15</td>
<td>1</td>
<td>16</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>16-30</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>31-45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46-60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Automated Recommendations on profiles 61-70 (ranking)

<table>
<thead>
<tr>
<th>Profiles</th>
<th>$x_1$</th>
<th>$x_2$</th>
<th>$x_3$</th>
<th>$x_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>61-70</td>
<td>63(+)</td>
<td>63(+)</td>
<td>63(+)</td>
<td>63(+)</td>
</tr>
<tr>
<td>71-80</td>
<td>68(+)</td>
<td>70(–)</td>
<td>62(+)</td>
<td></td>
</tr>
<tr>
<td>81-90</td>
<td>62(–)</td>
<td>61(–)</td>
<td>66(–)</td>
<td>67(–)</td>
</tr>
<tr>
<td>91-100</td>
<td>64(–)</td>
<td>68(–)</td>
<td>66(–)</td>
<td>64(–)</td>
</tr>
<tr>
<td>101-110</td>
<td>67(–)</td>
<td>64(–)</td>
<td>62(–)</td>
<td>70(–)</td>
</tr>
<tr>
<td>111-120</td>
<td>66(–)</td>
<td>65(–)</td>
<td>69(–)</td>
<td>69(–)</td>
</tr>
<tr>
<td>121-130</td>
<td>69(–)</td>
<td>69(–)</td>
<td>69(–)</td>
<td>66(–)</td>
</tr>
<tr>
<td>131-140</td>
<td>69(–)</td>
<td>67(–)</td>
<td>67(–)</td>
<td>61(–)</td>
</tr>
<tr>
<td>141-150</td>
<td>65(–)</td>
<td>65(–)</td>
<td>64(–)</td>
<td>65(–)</td>
</tr>
</tbody>
</table>

+$+$ Profile assessed as qualified
$-$ Profile assessed as not qualified

Conclusion

- **IS change HR practices and decision process of personnel selection**
  - so far, e-recruitment primarily reduced personnel marketing costs (influenced attraction phase of personnel recruitment), no influence on matching quality
  - large companies begin to use internal and external candidate profile databases to optimize their pre-selection phase

- **new methods required to support complex matching persons ↔ jobs**
  - existing IS support for matching candidates with jobs not adequate considering the complex relationship between job aptitude and personal profiles
  - automated recommendation can improve matching functionality of candidate databases and, therefore, streamlining the pre-selection phase
  - leveraging situational and relational aspects of personal attributes as well as relationships between assessors are further potential extensions of the approach
### next steps

- further model development
  - esp. addressing sparsity problem (e.g. assess assessors)
  - ternary and n-ary attributes (social environment)
  - influence of relational aspects on job performance

- tests with „real“ data

- implement prototype in OPAL project: [http://www.opal-tool.net/](http://www.opal-tool.net/)