Affective Computing and Bandits: Capturing Context in Cold Start Situations

Sebastian Oehme and Linus W. Dietz
Technical University of Munich

Joint Workshop on Interfaces and Human Decision Making for Recommender Systems
ACM Conference on Recommender Systems 2018
[...] a computer cannot help but be at a loss compared to a human in quickly sizing up a person on the basis of superficial characteristics, if for no other reason than that it can neither see him (to determine his age, type of clothing, or sex) nor hear him […]

**COMPARISION**

**GRUNDY AND NEW TECHNOLOGIES**

Grundy

- can not see or hear to determine:
  - age
  - type clothing
  - gender
  - origine
  - self-assurance

Today

- Powerful chip technology (Moore’s law)
- Computer Vision (YOLO, Inception V4, etc.)
- Vast amount of data (IBM estimates 2.5 quintillion bytes of every day)

→ Technology has evolved!
Contextual recommender systems that incorporate facial classification can outperform traditional systems in cold start situations.
AFFECTIVE RECOMMENDER SYSTEMS

Emotions
Age & Gender
User profile

Recommendation Engine

<table>
<thead>
<tr>
<th>item</th>
<th>score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>0.7</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
BANDIT STRATEGIES

OVERVIEW

- Multi-armed Bandit
- Contextual Bandit
- Full Reinforcement Learning Problem

© Medium / Arthur Juliani
BANDIT STRATEGIES
MULTI-ARMED BANDIT (BASELINE)

Example: \( \varepsilon \)-Greedy strategy

- \( q > \varepsilon \): Exploration
  - Content with max. expected reward
  - Random content

- \( q \leq \varepsilon \): Exploitation

Update reward

Multi-armed Bandit

action

reward
BANDIT STRATEGIES

CONTEXTUAL BANDIT

Contextual Bandit

state ➔ action ➔ reward

Exploitation:
Content with max. expected reward with similar context

Exploration:
Random content

q > \( \varepsilon \)

q ≤ \( \varepsilon \)

\( \varepsilon \) dependent on context

D. Bouneffouf et al. 2012

Update reward
**MODEL**

**COMPUTER VISION-BASED CONTEXTUAL BANDIT**

**Exploitation confidence**

\[ \varepsilon = 1 - \arg\max(sim(U^t, U^c)) \]

**User Similarity**

\[ sim(U^t, U^c) = \alpha \cdot sim(a^t, a^c) + \beta \cdot sim(g^t, g^c) + \gamma \cdot EF \]

**Emotional Feedback**

\[ EF = \frac{\sum_{k} sim_k(f^t_k, f^c_k) \cdot \left(1 + sim_k(e^t_k, e^c_k)\right)}{2i} \]
Comparing two recommendation strategies

Independent variable
- Bandit strategy $\in \{\text{Normal, Contextual}\}$

Dependent variables
- User's ratings (positive or negative)
- Measurement of facial emotions (Microsoft Face)
- Feedback from the questionnaire

Dataset
- 3000 filtered memes
- gathered from 9gag.com

Users
- 21 participants
- Age: 19 years to 31 years
- 10 male and 11 female
- Rated 60 images per strategy
PROTOTYPE
HIGH LEVEL DESIGN

- anger
- contempt
- disgust
- fear
- sadness
- surprise
- **happiness**
- neutral
Experiment

USER INTERFACE

Recommender System

Progress: 1/60

Andrew Scott the Hot

A man broke into Buckingham Palace spending half hour eating chocolate, cheese, and wandering around. He ripped several lamps but they were faulty. He viewed the royal portraits and rested on the throne for a while. He drank half a bottle of wine before becoming bored and leaving.

Yeah OK I did.
RESULTS
LINEAR MODEL POSITIVE RATINGS

Normal

Contextual

Mean Rating [Normal]

Mean Rating [Contextual]
# EXPERIMENTAL EVALUATION

## RESULTS

### EXPERIMENTAL EVALUATION

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>M 1</td>
</tr>
<tr>
<td>26</td>
<td>F 2</td>
</tr>
<tr>
<td>19</td>
<td>M 3</td>
</tr>
<tr>
<td>25</td>
<td>M 4</td>
</tr>
<tr>
<td>23</td>
<td>M 5</td>
</tr>
<tr>
<td>29</td>
<td>M 6</td>
</tr>
<tr>
<td>31</td>
<td>F 7</td>
</tr>
<tr>
<td>26</td>
<td>M 8</td>
</tr>
<tr>
<td>24</td>
<td>M 9</td>
</tr>
<tr>
<td>21</td>
<td>F 10</td>
</tr>
<tr>
<td>25</td>
<td>F 11</td>
</tr>
<tr>
<td>21</td>
<td>F 12</td>
</tr>
<tr>
<td>28</td>
<td>M 13</td>
</tr>
<tr>
<td>24</td>
<td>F 14</td>
</tr>
<tr>
<td>24</td>
<td>F 15</td>
</tr>
<tr>
<td>21</td>
<td>F 16</td>
</tr>
<tr>
<td>21</td>
<td>M 17</td>
</tr>
<tr>
<td>26</td>
<td>F 18</td>
</tr>
<tr>
<td>23</td>
<td>F 19</td>
</tr>
<tr>
<td>25</td>
<td>M 20</td>
</tr>
<tr>
<td>24</td>
<td>M 21</td>
</tr>
</tbody>
</table>

### Color scale for epsilon values:

- **Red**: 0.000 to 0.100
- **Green**: 0.100 to 0.200
- **Yellow**: 0.200 to 0.300
- **Orange**: 0.300 to 0.400
- **Yellow Green**: 0.400 to 0.500
- **Yellow Red**: 0.500 to 0.600
- **Orange Yellow**: 0.600 to 0.700
- **Orange**: 0.700 to 0.800
- **Red Orange**: 0.800 to 0.900
- **Red**: 0.900 to 1.000

### Linear scale

- **Exploration**
- **Exploitation**

---

Linus W. Dietz
RESULTS

OVERFLOWING EMOTIONS

![Graph showing happiness levels over frames for items A, B, and C. The graph includes observed happiness, weighted mean, and mean values.](image-url)
I often show my emotions (e.g., laugh out loud, cry ...) while watching movies.

Table 2: Correlation of Emotions with Rating Feedback

<table>
<thead>
<tr>
<th>Feedback</th>
<th>happiness</th>
<th>neutral</th>
<th>other</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive</td>
<td>25.06%</td>
<td>68.90%</td>
<td>6.04%</td>
<td>680</td>
</tr>
<tr>
<td>negative</td>
<td>7.24%</td>
<td>86.04%</td>
<td>6.72%</td>
<td>580</td>
</tr>
</tbody>
</table>
CONCLUSIONS

SUMMARY AND FUTURE WORK

Summary

- Prototype implementation of an affective computing bandit recommender
- Contextual information from computer vision may be helpful
- Affective Recommender Systems have much potential

Future Work

- Future computer vision algorithms may have a better detection of emotions
- Detect more features, e.g., clothing style, location and weather, etc.
- Add further hybrid-modules to improve
- Analyze long-term convergence
- Investigate privacy concerns

Not significantly better than the baseline algorithm.
THANK YOU

Sebastian Oehme

sebastian.oehme@tum.de

Linus W. Dietz

linus.dietz@tum.de
Paper Download

- Workshop proceedings available on CEUR-WS: http://ceur-ws.org/Vol-2225

PICTURES

- Icons made by Freepik from www.flaticon.com