Online Dating Recommender Systems: The Split-complex Number Approach

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Friend Recommendation

Find friends from different parts of your life
Use the checkboxes below to discover people you know from your hometown, school, employer and more.

Hometown
- [ ] Berlin, Germany
- [ ] Enter another city

Current City
- [ ] Koblenz, Germany
- [ ] Enter another city

High School
- [ ] Französisches Gymnasium
- [ ] Enter another high school

Mutual Friend
- [ ] Steffen Staab
- [ ] Matthew Rowe
- [ ] Gabi Mähias
- [ ] Enter another name

College or University
- [ ] Berlin Institute of Technology

Andreas Mu
- University of Georgia
- Bernhard Szudra and 3 other mutual friends

Nusrat Jahan Ritu

Frank Bohdanowicz
- Anja Hissnauer and 6 other mutual friends

Thombo Hau'i
- Stephan Spiegel and 7 other mutual friends

+1 Add Friend

Friend/Foe Recommendation

Your Relationship with eldavojohn (898314)

Friends of Friends | Foes of Friends

- Friend
- Neutral
- Foe

Change this?

Yup, I'm positive

Friend

Fan

Foe

Freak
Dating Recommendation

DISSIMILAR

LIKE

SIMILAR

DISLIKE
Triangle Closing

Friend \times \text{Friend} = \text{Friend}
"The Enemy of My Enemy"

\[ \text{Friend} = +1 \]
\[ \text{Foe} = -1 \]
\[ +1 \times +1 = +1 \]
\[ -1 \times +1 = -1 \]
\[ -1 \times -1 = +1 \]

(Kunegis et al. 1999)
Dating Recommendation

Like × Like = Similar

Similar × Similar = Similar

Similar × Like = Like
Split-complex Numbers

\[ z = a + bj \]

\[ j \times j = +1 \]

\[ (a + bj) + (c + dj) = (a + c) + (b + d)j \]
\[ (a + bj) \times (c + dj) = (ac + bd) + (ad + bc)j \]

Not a field: \( (1 + j)(1 - j) = 0 \)

Introduced as real tessarines (Cockle 1848)
Online Dating Recommender Systems: The Split-complex Number Approach
Adjacency Matrix

\[
A_{uv} = 1 \text{ when } u \text{ and } v \text{ are connected} \\
A_{uv} = 0 \text{ when } u \text{ and } v \text{ are not connected}
\]
Recommendation Functions

\[ \exp(A) = I + A + \frac{1}{2} A^2 + \frac{1}{6} A^3 + \ldots \]

\[ \begin{array}{c|cccccccc}
   & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\
2 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\
3 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 \\
4 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\
5 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\
6 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\
7 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
\end{array} \]

\[ \begin{array}{cccccccc}
   & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\
1 & 1.66 & 1.72 & 0.93 & 0.98 & 0.28 & 0.06 & 0.01 \\
2 & 1.72 & 3.57 & 2.70 & 2.93 & 1.04 & 0.29 & 0.06 \\
3 & 0.93 & 2.70 & 2.86 & 2.71 & 0.99 & 0.28 & 0.06 \\
4 & 0.98 & 2.93 & 2.71 & 3.63 & 1.95 & 0.76 & 0.22 \\
5 & 0.28 & 1.04 & 0.99 & 1.95 & 2.35 & 1.59 & 0.64 \\
6 & 0.06 & 0.29 & 0.28 & 0.76 & 1.59 & 2.23 & 1.38 \\
7 & 0.01 & 0.06 & 0.06 & 0.22 & 0.64 & 1.38 & 1.59 \\
\end{array} \]
Split-complex Adjacency Matrix

\[ B_{uv} = +j \text{ when } u \text{ likes } v \]
\[ B_{uv} = -j \text{ when } u \text{ dislikes } v \]
\[ B_{uv} = 0 \text{ when } u \text{ and } v \text{ are not connected} \]

\[ B = jA \]
### Split-complex Numbers as 2×2 Matrices

Split-complex numbers can be represented as 2×2 matrices:

\[
a + bj \equiv \begin{pmatrix} a & b \\ b & a \end{pmatrix}
\]

**Addition**

\[
\begin{pmatrix} a & b \\ b & a \end{pmatrix} + \begin{pmatrix} c & d \\ d & c \end{pmatrix} = \begin{pmatrix} a+c & b+d \\ b+d & a+c \end{pmatrix}
\]

**Multiplication**

\[
\begin{pmatrix} a & b \\ b & a \end{pmatrix} \times \begin{pmatrix} c & d \\ d & c \end{pmatrix} = \begin{pmatrix} ac+bd & ad+bc \\ ad+bc & ac+bd \end{pmatrix}
\]
Computation

\[ B = A^T \]

\[ \exp(B) = \begin{bmatrix} \cosh(A) & \sinh(A) \\ \sinh(A) & \cosh(A) \end{bmatrix} \]
Evaluation

(“Do you like me”) – Czech dating site

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<thead>
<tr>
<th>Gender</th>
<th>Count</th>
<th>Unknown</th>
<th>Rating counts</th>
<th>Total</th>
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<tbody>
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<td></td>
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<td>Female</td>
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<td>61,365</td>
<td>2,460,765</td>
<td>7,099,688</td>
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<tr>
<td>All</td>
<td>220,970</td>
<td>3,764,629</td>
<td>8,673,948</td>
<td>4,920,769</td>
</tr>
</tbody>
</table>
Evaluation

![Graph showing evaluation results for different methods compared to real and split-complex numbers. The x-axis represents different methods: Poly, RR, Exp/Sinh, New, and Extr. The y-axis represents average precision ranging from 0.72 to 0.84.]
Thank You

Jérôme Kunegis

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konect.uni-koblenz.de/networks/libimseti
References


