Recommender Systems

A Lecture in the Freshman Seminar Series: Puzzling Problems in Science and Technology
About This Presentation

This presentation belongs to the lecture series entitled “Puzzling Problems in Science and Technology,” devised for a ten-week, one-unit, freshman seminar course by Behrooz Parhami, Professor of Computer Engineering at University of California, Santa Barbara. The material can be used freely in teaching and other educational settings. Unauthorized uses, including any use for financial gain, are prohibited. © Behrooz Parhami

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<th>Edition</th>
<th>Released</th>
<th>Revised</th>
<th>Revised</th>
<th>Revised</th>
<th>Revised</th>
</tr>
</thead>
</table>
Find Seven Differences between These Images
How Are These Two Images Different?
Identify All the Differences in these Two Images

Image from an Android app
Which Term Isn’t Like the Others?

<table>
<thead>
<tr>
<th>A</th>
<th>H</th>
<th>I</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>V</th>
<th>W</th>
<th>X</th>
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<tbody>
<tr>
<td>0</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td></td>
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<td>13</td>
<td>20</td>
<td>33</td>
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<td>86</td>
<td>139</td>
</tr>
</tbody>
</table>

Big Fast Green Warm

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Which Image Should Come Next?
Which Image Should Come Next? (Part 2)

Answer figures:

1. [Image of red square with plus signs]
2. [Image of red square with equal signs]
3. [Image of red square with plus signs]
4. [Image of red square with plus signs]
5. [Image of red square with plus signs]

Which image should come next? (Part 2)

Options:

A. [Image of domino with dots]
B. [Image of domino with dots]
C. [Image of domino with dots]
D. [Image of domino with dots]
What do the following sets of words have in common?

assess; banana; dresser; grammar; potato; revive; uneven
(besides all having at least two repeating letters)

bulb; orange; angel; silver; month; revive; uneven

baobab; youngberry; hopscotch; yieldability; dachshund;
dumbfounded

aquamarine; beloved; discrepancy; frangipani; freedom;
gallipot; overflowing; pagoda; scrounger
Classifying by Color, Shape, or Other Features

Very young kids are taught about classification by features
(2-minute video: http://www.youtube.com/watch?v=5bip0bcFlgo)

Possible features in the shapes shown in the video:
Color: Blue, Green, Orange, Yellow
Geometric shape: Square, Rectangle, Triangle, Circle, …
Curvature: Straight sides only, at least one curved side
Size: Large, Small (area)
Number of sides: 2, 3, 4
Triangleness: Yes, No
Thickness?
Material?
Weight?
Floats on water?
Example: Recognizing Five Letters

A, B, C, D, E

Example features:

- $x$: Number of curved segments
- $y$: Number of straight segments

Where would “F” fall?

Suggest an additional feature
Pattern Classification

Extracting features from given inputs allows us to separate and classify the inputs according to desired categories.
Which Book/Movie/Song Should Come Next?

<table>
<thead>
<tr>
<th>More Items to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>You viewed</strong></td>
</tr>
<tr>
<td><strong>Customers who viewed this also viewed</strong></td>
</tr>
<tr>
<td>![Image]</td>
</tr>
<tr>
<td><strong>The Appeal</strong></td>
</tr>
<tr>
<td>John Grisham</td>
</tr>
<tr>
<td>Paperback</td>
</tr>
<tr>
<td>$14.00 $11.20</td>
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</table>

| **Top 10 for Michael** |
Fingerprint Classification and Matching

Needed for criminal investigations and biometric identification

Does a fingerprint match any of the prints in a criminal database?
Does the fingerprint match one recorded for an authorized user?

Human fingerprints tend to be unique

Even identical twins have different prints
The Basics of Comparing Fingerprints

(6-minute video: http://www.youtube.com/watch?v=IrpTqKkgygA)
Image Search

By keywords (when stored images have been indexed previously)
By photographer, location, etc. (image metadata)
By providing an image as key (not quite possible yet)

https://images.google.com/

Example searches:

Sunset
UCSB
Soccer
INT 94TN
Searching the Worldwide Web

Google has indexed the entire contents of the Web

Find all occurrences of the pattern “abcbab”
Google’s “Pagerank” Algorithm

Algorithm to rank the hits so that the most useful ones come first

Google also takes your profile, interests, and previous searches into account.
Neural-Network Pattern Recognition

Train the system using known patterns, then use it on others
(4-minute video: http://www.youtube.com/watch?v=kGv-1it8Sac)
Facial Recognition Technology

Train the system using known patterns, then use it on others
(1-minute video: http://www.youtube.com/watch?v=tZzIH4Qf5Y8)
Gender Classification by Neural Networks

Train the system using known faces, then use it on others
(2-minute video: http://www.youtube.com/watch?v=3jAqlu7HtnI)
Overview of Recommender Systems

Track activity, interactions, and ratings, combine with other data
(17-minute video: http://www.youtube.com/watch?v=1JRrCEgiyHM)

Formal Model

- $C = \text{set of Customers}$
- $S = \text{set of Items}$
- Utility function $u: C \times S \rightarrow R$
  - $R = \text{set of ratings}$
  - $R$ is a totally ordered set
  - e.g., 0-5 stars, real number in $[0, 1]$