

# User Modeling and Personalization

## 9: Evaluation of Adaptive Systems

### Accuracy Measures Exercise

Eelco Herder

L3S Research Center / Leibniz University of Hanover  
Hannover, Germany

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## Accuracy Metrics

Calculate the accuracy of the output of recommender algorithms A and B with the following measures:

- precision, recall, F-measure, P@2, S@2 and MRR.

The algorithms provide recommendations for the following users, who specified their following interests:

Bob: Cars, videos, tools, beer, and schnitzel

Alice: Cars, flowers, wine, and books

The two recommender algorithms produced the following ranked lists for both of the users:

Recommender A: Shoes, games, flowers, cars, and beer

Recommender B: Books, french fries, shoes, and computer

## Precision

$$\begin{aligned}
 \text{Precision}(\text{RecA}, \text{Bob}) &= \frac{|D_{\text{rel}} \cap D_{\text{sel}}|}{|D_{\text{sel}}|} \\
 &= \frac{|\{\text{cars}, \text{videos}, \text{tools}, \text{beer}, \text{schnitt.}\} \cap \{\text{sh.}, \text{ga.}, \text{fl.}, \text{ca.}, \text{be.}\}|}{|\{\text{shoes}, \text{games}, \text{flowers}, \text{cars}, \text{beer}\}|} \\
 &= \frac{|\{\text{cars}, \text{beer}\}|}{|\{\text{shoes}, \text{games}, \text{flowers}, \text{cars}, \text{beer}\}|} \\
 &= \frac{2}{5} = 0.4 \\
 \text{Precision}(\text{RecA}, \text{Alice}) &= 0.4(\text{flowers}, \text{cars}) \\
 \text{Precision}(\text{RecA}) &= \frac{\sum_{\text{User}} \text{Precision}(\text{RecommenderA}, \text{User})}{|\text{User}|} \\
 &= \frac{0.4 + 0.4}{2} \\
 &= 0.4
 \end{aligned}$$

# Precision

$$\textit{Precision}(\textit{RecB}, \textit{Bob}) = 0$$

$$\textit{Precision}(\textit{RecB}, \textit{Alice}) = \frac{|\{\textit{cars}, \textit{flowers}, \textit{wine}, \textit{books}\} \cap \{\textit{books}, \textit{fries}, \textit{shoes}, \textit{computer}\}|}{|\{\textit{books}, \textit{frenchfries}, \textit{shoes}, \textit{computer}\}|}$$

$$= \frac{1}{4} = 0.25$$

$$\textit{Precision}(\textit{RecommenderB}) = 0.125$$

## Recall

$$\begin{aligned}
 \text{Recall}(\text{RecA}, \text{Bob}) &= \frac{|D_{\text{rel}} \cap D_{\text{sel}}|}{|D_{\text{rel}}|} \\
 &= \frac{|\{\text{cars}, \text{videos}, \text{tools}, \text{beer}, \text{schnit.}\} \cap \{\text{sh.}, \text{ga.}, \text{fl.}, \text{ca.}, \text{be.}\}|}{|\{\text{cars}, \text{videos}, \text{tools}, \text{beer}, \text{schnitzel}\}|} \\
 &= \frac{|\{\text{cars}, \text{beer}\}|}{|\{\text{cars}, \text{videos}, \text{tools}, \text{beer}, \text{schnitzel}\}|} \\
 &= \frac{2}{5} = 0.4
 \end{aligned}$$

$$\begin{aligned}
 \text{Recall}(\text{RecA}, \text{Alice}) &= \frac{|\{\text{cars}, \text{flowers}, \text{wine}, \text{books}\} \cap \{\text{shoes}, \text{games}, \text{flowers}, \text{cars}, \text{beer}\}|}{|\{\text{cars}, \text{flowers}, \text{wine}, \text{books}\}|} \\
 &= \frac{2}{4} = 0.5
 \end{aligned}$$

$$\begin{aligned}
 \text{Recall}(\text{RecA}) &= \frac{\sum_{\text{User}} \text{Precision}(\text{RecommenderA}, \text{User})}{|\text{User}|} \\
 &= \frac{0.4 + 0.5}{2} \\
 &= 0.45
 \end{aligned}$$

# Recall

$$\begin{aligned} \text{Recall}(\text{RecB}, \text{Bob}) &= 0 \\ \text{Recall}(\text{RecB}, \text{Alice}) &= \frac{|\{\text{cars}, \text{flowers}, \text{wine}, \text{books}\} \cap \{\text{books}, \text{frenchfries}, \text{shoes}, \text{computer}\}|}{|\{\text{cars}, \text{flowers}, \text{wine}, \text{books}\}|} \\ &= \frac{1}{4} = 0.25 \\ \text{Recall}(\text{RecB}) &= 0.125 \end{aligned}$$

## F-Measure

$$\begin{aligned} F(RecA) &= 2 * \frac{Precision(RecommenderA) * Recall(RecommenderA)}{Precision(RecommenderA) + Recall(RecommenderA)} \\ &= 2 * \frac{0.4 * 0.45}{0.4 + 0.45} \\ &= \frac{0.18}{0.85} \\ &\approx 0.42 \\ F(RecB) &= 2 * \frac{0.125 * 0.125}{0.125 + 0.125} \\ &\approx 0.12 \end{aligned}$$

P@2

$$\begin{aligned}
 P@2(RecA, Bob) &= \frac{|D_{rel} \cap D_{sel@2}|}{|D_{sel@2}|} \\
 &= \frac{|\{cars, videos, tools, beer, schnitzel\} \cap \{shoes, games\}|}{|\{shoes, games\}|} \\
 &= \frac{|\{\}|}{|\{Shoes, games, flowers\}|} \\
 &= 0 \\
 P@2(RecA, Alice) &= \frac{|\{cars, flowers, wine, books\} \cap \{shoes, games\}|}{|\{shoes, games\}|} \\
 &= 0 \\
 P@2(RecA) &= \frac{\sum_{User} Precision(RecommenderA, User)}{|User|} \\
 &= \frac{0 + 0}{2} \\
 &= 0
 \end{aligned}$$



## P@2

$$P@2(RecB, Bob) = \frac{|\{cars, videos, tools, beer, schnitzel\} \cap \{books, frenchfries\}|}{|\{books, frenchfries\}|}$$

$$= 0$$

$$P@2(RecB, Alice) = \frac{|\{cars, flowers, wine, books\} \cap \{books, frenchfries\}|}{|\{books, frenchfries\}|}$$

$$= 0.5$$

$$P@2(RecB) = 0.25$$

S@2

$$S@2(RecA) = \frac{|\{User : P@2 > 0\}|}{|User|} = \frac{0}{2} = 0$$

$$S@2(RecB) = \frac{1}{2} = 0.5$$

# MRR

$$\begin{aligned} MRR(RecA) &= \frac{1}{N} \sum_{n \in N} \frac{1}{rank_n} \\ &= \frac{1}{2} * \left( \frac{1}{rank_{Bob}} + \frac{1}{rank_{Alice}} \right) \\ &= \frac{1}{2} * \left( \frac{1}{4} + \frac{1}{3} \right) \\ &\approx 0.29 \\ MRR(RecB) &= \frac{1}{2} * \left( \frac{1}{6} + \frac{1}{1} \right) \\ &\approx 0.58 \end{aligned}$$