

# Compsci 101

## Recommender Assignment

Susan Rodger  
April 5, 2022

Tandoor	IlForno	McDon	Loop	Panda	Twin
0	3	5	0	-3	5
1	1	0	3	0	-3
-3	3	3	5	1	-1

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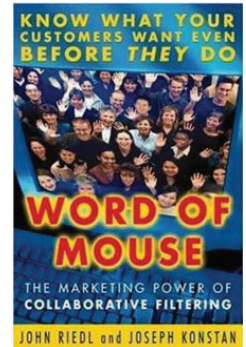
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## John Riedl

- Co-Inventor of Recommender systems
- PhD at Purdue University
- Professor at Univ. of Minnesota
- ACM Software System Award – GroupLens System
- Died of cancer in 2013



- Quote from his son about John:  
“He once looked into how likely people are to follow your book recommendations based on how many books you recommend. We went to his talk at the AH Conference in which he described the answer. It turns out that if you recommend too many books to people, they get overwhelmed and are less likely to follow your suggestions. As he told us in his talk, the optimal number of books to recommend turns out to be about two. Then he proceeded to recommend eight books during the talk.”



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U is for ...



- **URL**
  - <https://duke.edu>
- **Usenet**
  - Original source of FAQ, Flame, Spam, more
- **UI and UX**
  - User is front and center

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## Interested in being a UTA?

- Enjoy Compsci101?
- Would like to help others learn it?
- Consider applying to join the team!
- <https://www.cs.duke.edu/undergrad/uta>
- Apply soon

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## Announcements

- APT-7 due Thursday, April 7
- Assign 6 – Recommender out, due 4/19
- Lab 11 Friday – no Pre-lab
- APT Quiz 2 – April 7-10
- Exam 4 – in one week, April 13

## PFTD

- APT Quiz 2
- Exam 4
- Sorting Review
- Recommender
  - Recommendations big picture
  - Assignment big picture
  - Simple recommendation example
  - Actual recommendation assignment

## APT Quiz 2 April 7-10

- Opens 4/7 11:30am
- Closes at 11pm 4/10 – must finish all by this time
- There are two parts based on APTs 1-7
  - Each part has two APT problems
  - Each part is **2 hours**– more if you get accommodations
  - Each part starts in Sakai under tests and quizzes
  - Sakai is a starting point with countdown timer that sends you to a new apt page just for each part
  - Could do each part on different day or same days
- Put up problems today from an old APT Quiz so you can practice (not for credit) – on APT Page

2 hours  
each part!

## APT Quiz 2

- Is your own work!
  - No collaboration with others!
  - Use your notes, lecture notes, your code, textbook
  - DO NOT search for answers!
  - Do not talk to others about the quiz until grades are posted
- Post private questions on Ed Discussion
  - We are not on between 10pm and 8am!
  - We are not on all the time
  - Will try to answer questions between 8am – 10pm
- See 101 APT page for tips on debugging APTs

## Protect your APT Quiz 2!

- Be defensive in both directions!
- Reduce risk others will see your code
  - Complete it in your dorm room, alone
  - Lock the door!
  - Do not do it in a public space
- Reduce risk you will see/know other's answers
  - Do not ask others about the quiz
  - Do the quiz alone
    - Can't ask for help if there's no one around
- If your code is suspiciously similar to another's, both of you are in trouble

## Exam 4 – in person – Tues, April 12

- Exam is in class on paper – 10:15am
  - Need pen or pencil
  - Closed book, closed notes, no electronics
  - Do not talk to anyone about the exam until it is handed back!
- See materials under 4/12 date
  - Exam 4 Reference sheet - part of exam
- Covers
  - Lectures: through today
  - APTs through APT7
  - Labs through Lab 10
  - Assignments through Assignment 5
  - Sakai Quizzes through 3/31

### Tuesday

**4/12**  
No Reading  
No QZ

### EXAM 4

[Python](#)  
[Reference](#)  
[Sheet for](#)  
[Exam 4](#)  
Only change  
is lambda  
functions

[Specific old](#)  
[tests](#)

[Old Tests](#)

[Reviewer](#)  
[App](#)

## Exam 4 Topics

- Everything from Exam 1 -3
- Sets
- Dictionaries
- Sorting
  - sort() vs sorted()
  - Stable sorting
  - Lambda functions
  - Sorting on multiple criteria
- Problem solving
  - Given a problem, what do you use?

## WOTO-1 Review Sorting

<http://bit.ly/101s22-0405-1>

# Recommendation Systems: Yelp

- Are all users created equal?
- Weighting reviews
- What is a recommendation?

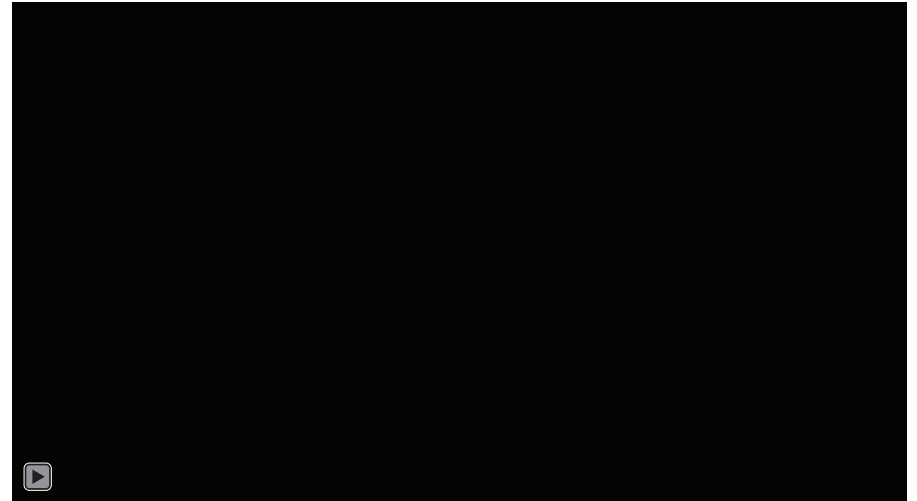


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# Recommendation Systems: Yelp

<https://www.youtube.com/watch?v=PniMEnM89iY>



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# Recommender Systems: Amazon

- How does Amazon create recommendations?

Books you may like



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# Recommendation Systems: Netflix

- Netflix offered a prize in 2009
  - Beat their system? Win a million \$\$
  - <http://nyti.ms/sPvR>



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# Compsci 101 Recommender

- Doesn't work at the scale of these systems, uses publicly accessible data, but ...
  - Movie data, food data, book data
- Make recommendations
  - Based on ratings, how many stars there are
  - Based on weighting ratings by users like you!
- Collaborative Filtering: math, stats, compsci

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# Where to eat? Simple Example

Tandoor	IlForno	McDon	Loop	Panda	Twin
0	3	5	0	-3	5
1	1	0	3	0	-3
-3	3	3	5	1	-1

- Rate restaurants on a scale of (low) -5 to 5 (high)
  - Each row is one user's ratings
  - But a zero/0 means no rating, not ambivalent
- What restaurant should I choose to go to?
  - What do the ratings say? Let's take the average!

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# Calculating Averages

- What is average rating of eateries?

Tandoor	IlForno	McDon	Loop	Panda	Twin
0	3	5	0	-3	5
1	1	0	3	0	-3
-3	3	3	5	1	-1

- Tandoor:

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# Python Specification

- Items: list of strings (header in table shown)

```
items = ["DivinityCafe", "FarmStead", "IlForno", "LoopPizzaGrill",  
         "McDonalds", "PandaExpress", "Tandoor", "TheCommons",  
         "TheSkilllet"]
```

- Values in dictionary are ratings: int list

- `len(ratings[i]) == len(items)`

```
ratings = \n{\n    "Sarah Lee" : [3, 3, 3, 3, 0,-3, 5, 0,-3],\n    "Melanie"   : [5, 0, 3, 0, 1, 3, 3, 3, 1],\n    "J J"       : [0, 1, 0,-1, 1, 1, 3, 0, 1],\n    "Sly one"   : [5, 0, 1, 3, 0, 0, 3, 3, 3],\n    "Sung-Hoon" : [0,-1,-1, 5, 1, 3,-3, 1,-3],\n    "Nana Grace": [5, 0, 3,-5, -1, 0, 1, 3, 0],\n    "Harry"    : [5, 3, 0,-1, -3,-5, 0, 5, 1],\n    "Wei"      : [1, 1, 0, 3, -1, 0, 5, 3, 0]\n}
```

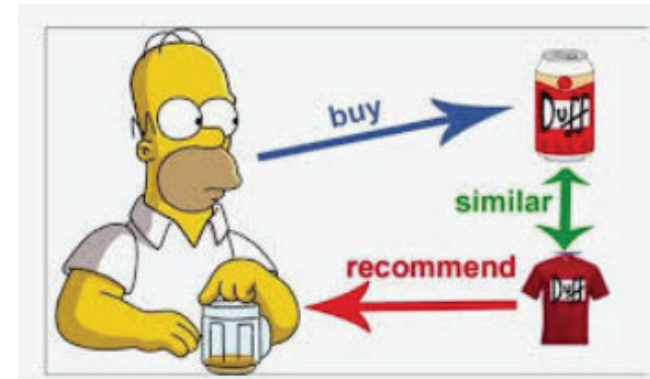
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## Recommender averages

- **def averages(items, ratings) :**
- *Input: items -- list of restaurants/strings*
- *Input: dictionary of rater-name to ratings*
  - ratings: list of ints, [1, 0, -1, ... 1] -- parallel list to list of restaurants
    - $k^{\text{th}}$  rating maps to  $k^{\text{th}}$  restaurant
- *Output: recommendations*
  - List of tuples (name, avg rating) or (str, float)
    - Sort by rating from high to low

## WOTO-2 Averages <http://bit.ly/101s22-0405-2>



## Drawbacks of Averaging, Instead ...

- Are all user's ratings the same to me?
  - Weight/value ratings of people most similar to me
- Collaborative Filtering
  - [https://en.wikipedia.org/wiki/Collaborative\\_filtering](https://en.wikipedia.org/wiki/Collaborative_filtering)
  - How do we determine who is similar to/"near" me?
- Mathematically: treat ratings as vectors in an N-dimensional space,  $N = \#$  of items that are rated
  - a.k.a. weight has higher value  $\rightarrow$  closer to me

## Determining "closeness"

- Calculate a number measuring closeness to me
  - The higher the number, the closer to me
  - I'm also a rater, "me" is parameter to function
- Function:
  - **similarities("rodger", ratings)**



## Determining "closeness"

- Calculate a number measuring closeness to me
  - The higher the number, the closer to me
  - I'm also a rater, "me" is parameter to function
- Function:
  - `similarities("rodger", ratings)`
- Return `[("rater1", #), ("rater2", #), ...]`
  - List of tuples based on closeness to me
  - sorted high-to-low by similarity
  - "rodger" should not be in that list!

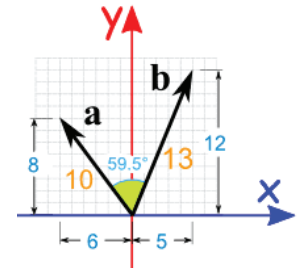
Same as before, dictionary  
of rater to ratings

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## What's close? Dot Product

- [https://en.wikipedia.org/wiki/Dot\\_product](https://en.wikipedia.org/wiki/Dot_product)
  - For  $[3, 4, 2]$  and  $[2, 1, 7]$ 
    - $3*2 + 4*1 + 2*7 = 6+4+14 = 24$
- How close am I to each rater?
- What happens if the ratings are
  - Same sign? Me: 3, -2 Other: 2, -5
  - Different signs? Me: -4 Other: 5
  - One is zero? Me: 0 Other: 4
- What does it mean when # is...
  - Big? Small? Negative?



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## Writing similarities

- Given a name and a dictionary, return list of tuples
  - `def similarities(name, ratings):`
    - `return [('name0', #), ... ('nameN', #)]`
- What is the # here?
  - Dot product of two lists
  - One list is fixed (name)
  - Other list varies (loop)
- Think: How many tuples are returned?

```
1 food.json
2 {"Sarah Lee":
3  [3, 3, 3, 3, 0, -3, 5, 0, -3],
4  "Melanie":
5  [5, 0, 3, 0, 1, 3, 3, 3, 1],
6  "J J":
7  [0, 1, 0, -1, 1, 1, 3, 0, 1],
8  "Sly one":
9  [5, 0, 1, 3, 0, 0, 3, 3, 3],
10 "Sung-Hoon":
11 [0, -1, -1, 5, 1, 3, -3, 1, -3],
12 "Nana Grace":
13 [5, 0, 3, -5, -1, 0, 1, 3, 0],
14 "Harry":
15 [5, 3, 0, -1, -3, -5, 0, 5, 1],
16 "Wei":
17 [1, 1, 0, 3, -1, 0, 5, 3, 0]
```

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## Collaborative Filtering

- Once we know raters "near" me? Weight them!
  - How many raters to consider? 1? 10?
  - Suppose Fran is  $[2, 4, 0, 1, 3, 2]$
- What is Sam's similarity to Fran?

	Tandoor	IlForno	McDon	Loop	Panda	Twin
Sam	0	3	5	0	-3	5
Chris	1	1	0	3	0	-3
Nat	-3	3	3	5	1	-1

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## What is Chris's similarity and weights?

- Suppose Fran is [2, 4, 0, 1, 3, 2]
- Chris's similarity is:

	Tandoor	IlForno	McDon	Loop	Panda	Twin
Sam	0	3	5	0	-3	5
Chris	1	1	0	3	0	-3
Nat	-3	3	3	5	1	-1

## Steps for Recommendations

- Start with you, a rater/user and all the ratings
  - Get similarity "weights" for users: dot product
- Calculate new weighted ratings for all users
  - `[weight * r for r in ratings]`
- Based on these new ratings, find average
  - Don't use zero-ratings
- Check recommendations by ... (not required)
  - Things I like are recommended? If so, look at things I haven't tried!

## Recommendations

- Get new weighted averages for each eatery
  - Then find the best eatery I've never been to

```
def recommendations(name, items, ratings, numUsers):  
    return [('eatery0', #), ... ('eateryN', #)]
```

Fran gets  
a recommendation  
(considering numUsers raters)



```
rc = recommendations("Fran", items, ratings, 3)  
#use this to provide evals to Fran
```

## Similarities Summarized

- How do we get weighted ratings?

	Tandoor	IlForno	McDon	Loop	Panda	Twin
Sam	0	3	5	0	-3	5
Chris	1	1	0	3	0	-3
Nat	-3	3	3	5	1	-1
Fran	2	4	0	1	3	2

```
def similarities(name, ratings):  
    return [('name', #), ... ('name', #)]  
  
weights = similarities("Fran", ratings)
```



# Making Recommendations

- How do we get weighted ratings? Call average?

	Tandoor	IlForno	McDon	Loop	Panda	Twin
Sam	0	3	5	0	-3	5
Chris	1	1	0	3	0	-3
Nat	-3	3	3	5	1	-1
Fran	2	4	0	1	3	2

```
weights = similarities("Fran", ratings)
weights = #slice based on numUsers
weightedRatings = {}. # new dictionary
for person, weight in weights:
    weightedRatings[?] = ?
```

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# Calculating Weighted Average

	Tandoor	IlForno	McDon	Loop	Panda	Twin
Sam	0	39	65	0	-39	65
Chris	3	3	0	9	0	-9
Nat	-36	36	36	60	12	-12
Total	-36	75	101	60	-27	53
Avg	-36	37.5	50.5	60	-13.5	26.5

`recommendations("Fran", items, ratings, 2)`

- Make recommendation for Fran? Best? Worst?
- Fran should eat at Loop! Even though only using Nat's rating
- But? Fran has been to Loop! Gave it a 1, ... McDonalds!!!! ??

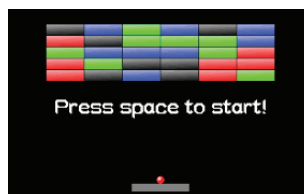
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## WOTO-3 Sims to Recs

<http://bit.ly/101s22-0405-3>

- From Similarities to Recommendations



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# Assignment Modules

## RecommenderEngine

```
1. averages(...)
2. similarities(...)
3. recommendations(...)
```

## MovieReader

```
1. getdata(...)
```

## BookReader

```
1. getdata(...)
```

## RecommenderMaker

```
1. makerecs(...)
```

## TestRecommender

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# Function Call Ordering

- `Some_Reader_Module.getdata(...)`
- `RecommenderMaker.makerecs(...)`
  - `RecommenderEngine.recommendations(...)`
    - `RecommenderEngine.similarities(...)`
    - `RecommenderEngine.averages(...)`