# **University of Minnesota**

Personalization, Socialization, and Recommendations in Location-based Services 2.0

### Mohamed F. Mokbel

Department of Computer Science and Engineering University of Minnesota www.cs.umn.edu/~mokbel mokbel@cs.umn.edu

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### **Location-based Services**



#### Many people like to use these advanced technologies and devices

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## **Location-based Services**

- Range Query: Give me all gas stations within one mile
- K-Nearest-Neighbor Queries: Where is my nearest restaurant
- Shortest Path Queries: What is the fastest/ shortest route from here to the airport



**RNN** Queries, Group NN Queries, Trip Planning Queries, etc.



- Aggregate Queries
- **Continuous (Monitoring) Queries**
- Moving Queries

### Do not we feel old fashion with these queries..!!!

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# Web 2.0





HOW TO USE WEB 2.0 IN THE ENTERPRISE



PART 1: COMMUNICATE WITH YOUR EMPLOYEES



# Web 2.0

- The Web is no longer a collection of static pages that describe something in the world.
- Crowdsourcing and usergenerated contents, i.e., a large group of people can create a collective work whose value far exceeds that provided by any of the individual participants.



- Gets better when more users are involved
- The main concept is that "You are not alone...."



# The World of 2.0



### Travel 2.0

From expedia, travelocity, Kayak, to a more interactive websites and contests with photo sharing, comments, and personal experience.

### Library 2.0

- Feedback, review, and discussion about books and services
- Government 2.0, Classroom 2.0, Movies 2.0, etc

### **Revolution 2.0**





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# When LBS meets Web 2.0



- Instead of asking about restaurants in a certain area or closest to me, I can:
  - Ask what are the K-best restaurants according to my profile and context (*Personalization*)
  - Ask for comments/suggestions from my friends (*Socialization*)
  - Ask a recommender system to suggest few restaurants for me, i.e., predict what I could like (*Recommendations*)



### Is it going to be a romantic meeting..!!

# Three Pillars of LBS 2.0



#### Personalization

Query answer should be personalized to the user profile and context

#### Socialization

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- The location aspect deserves to be more than an attribute
- Location-based social networks

#### Recommendations

- Recommender systems are among the most successful applications in Web 2.0
- However, they completely ignore the "locations"





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# **Socialization in LBS 2.0**



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# **Social Networking Services**



#### Have become one of the most important Web services!!!

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# "Locations" in Social Networks

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#### Foursquare

7:30 PM

foursquare

Verizon Center, Washington Capitals Bench

Unrestricted Free Agency (July 2010) Location unknown/Retirement/???

Verizon Center Press Box, Level 400
American Hockey League (minors)

**Nearby Favorites** 

Hershey, PA (Hershey Bears)

**Back-up Goalie** 

**Healthy Scratch** 

**Badges** 

AT&T E

#### **Facebook Places**



#### **Twitter Nearby**



- Strictly built for mobile devices
- Only cares about whereabouts of user friends (check-in functionality)
- Isolated from the main social networking functionality

STAYCLASSY.NET

#### Location is dealt with as just an additional attribute

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### What would be a "Location-based" Social Network



- Instead of redefining a new term, we can just start from existing social networks and make them "location-aware"
  - Location-based Facebook
  - Location-based Twitter
- This should be different from adding Check-in procedure, or just tracking the whereabouts of your friends
- "Location" should be ubiquitous in every functionality of social networks rather than just an additional attribute

## Social Networks: The News Feed Functionality



- Display a set of message/news from user friends / subscribed news aggregators.
  - Examples
    - □ Social networking system, i.e., Facebook, Twitter
    - News Aggregators, i.e., My Yahoo!, iGoogle



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US: Only single bin Laden d	efender shot at SEALs (AP) - Yahoo! News: Most Viewed - 13 hours ago
Pakistan threatens U.S. on c	cooperation if more raids (Reuters) - Yahoo! News: Politics News - 15 hours ag
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Family: Seve Ballesteros su	ffering deterioration (AP) - Yahoo! News: Sports News - 4 hours ago
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### The Need for "Location-based" News Feed



### **Traditional News Feed**

- Organized by either message issuing time, e.g., Twitter, or some diversity requirements, e.g., Facebook
- □ Spatial relevance is overlooked, users get the *same news feed* from different log on locations

### Motivating Scenarios

- Travelling user is more interested in the news/messages that are close to her *current location* to explore the new place
- Stationary users may not be interested in the news/messages that are issued very far from their locations

If the news feed functionality is aware of the inherent locations of users and messages, more relevant news feed will be delivered

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## **GeoFeed:**

## A location-Aware News Feed System



### **Location-based Messages**

■ Each posted message has a spatial extent that indicates the relevance range of the message, i.e., only users located in this spatial extent may be interested of this message

#### System users

- Have a friend list
- Can post *location-based* messages to their friends
- Receive those messages that are:
  - a) posted from their friends, and
  - b) overlap with either their current locations or a specified area of interest

# For a user *U* with *N* friends, the news feed functionality is abstracted to a set of *N* location-based queries, such that:

- 1 The N queries are fired upon U logging on to the system
- 2 Each query retrieves the set of relevant messages from one friend



# The Spatial Pull Approach in GeoFeed



### Spatial Pull approach

- Do nothing when the user offline
- Once the user logs on, compute al the queries for the user



- *Advantages*: No extra overhead during offline period
  - *Disadvantages*: High user response time, not efficient for the user with short offline time

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# The Spatial Push Approach in GeoFeed



### Spatial Push approach

- Maintain materialized view for each query
- Once the user logs on, the answer is ready



*Advantages*: Users are very happy with very low response time

*Disadvantages*: System is overwhelmed with maintaining large number of views that may no be necessary

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# The Shard Push Approach in GeoFeed



### Shared Push approach

- Share some views among queries for the same producer
- Once the user logs on, the answer is ready



- *Advantages*: Users are still very happy with very low response time, and system overhead could be significantly lower
- *Disadvantages*: Need to continuously check if views can be shared

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- GeoFeed employs a decision model that decides upon the best approach to evaluate each query such that:
  - 1 The system computational overhead is minimized; hence scalability is increased
  - 2 Each use U will get the required news feed in  $T_U$  time units; set based on the user priority

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# **Recommendations in LBS 2.0**



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### The Functionality of Recommender Systems



Analyze user behavior to recommend personalized and interesting things to do/read/see



Collaborative filtering process is the most commonly used one in Recommender Systems

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# "Locations" and "Recommendations"

# Recommender systems rely on the input triple *(user, item, rating)*

- Recommender systems completely ignore the spatial aspects of both users and items
- The locations of users and/or items have significant impact on the result of recommendations

### All heavy work in Recommender Systems is done offline.

- This is acceptable when the model changes slowly, i.e., movies, music, clothes, books, etc.
- Considering the "location" aspect call for online changes in the model

## **Location Matters: Netflix Rental Patterns**



#### Movie preferences differ based on the user location (zip code)

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									9. The Wrestler
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#### Most rented in 55418

- 1. Milk
- 2. The Curious Case of Benjamin Bu

NETFLIX

- 3. Burn After Reading
- 4. The Wrestler
- 5. Slumdog Millionaire
- 6. Gran Torino
- 7. Doubt
- 8. Changeling
- 9. Rachel Getting Married
- 10. Twilight

16. I Love You, Man

#### Most rented in 55455

- 1. I Love You, Man
- 2. Slumdog Millionaire
- 3. Adventureland
- 4. My Best Friend's Girl
- 5. Nick and Norah's Infinite Play
- 6. Sunshine Cleaning
- 7. Forgetting Sarah Marshall
- 8. Away We Go
- 9. Role Models
- 10. Confessions of a Shopaholic

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Button

in Button



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### Location-based Ratings in LARS (Location-Aware Recommender System)



- We need to go beyond the traditional rating triple *(user, item, rating)* to include the following taxonomy:
  - **1** Spatial Rating for Non-spatial Items
    - □ (user\_location, user, item, rating)
    - *Example:* A user with a certain location is rating a movie
    - **Recommendation:** Recommend me a movie that users within the same vicinity have liked
  - **2** Non-spatial Rating for Spatial Items
    - □ (user, item\_location, item, rating)
    - *Example:* A user with unknown location is rating a restaurant
    - *Recommendation:* Recommend a restaurant within a close vicinity
  - **3** Spatial Rating for Spatial Items
    - (user\_location, location, item\_location, item, rating)
    - **Example:** A user with a certain location is rating a restuarant

### **Dealing with Spatial Ratings in LARS**



- A collaborative filtering model is built for each grid cell
- Allows querying user to select *influence level*
- Query is evaluated using grid at given level



# **Dealing with Spatial Items in LARS**



- Penalize each item, with a *travel penalty*, based on its distance from the user.
- Use a ranking function that combines the recommendation score and travel penalty
- Incrementally, retrieve items based on travel penalty, and calculate the ranking score on an ad-hoc basis
- Employ an early stopping condition to minimize the list of accessed items to get the *K* recommended items



# Offline Proces: Things have changed...



### We live in an increasingly social and "real-time" world

Number of things to recommend is growing exponentially

#### **Facebook Posts**

Microsoft Research Eric Horvitz of Microsoft Research discusses Artificial Intelligence and when talking, thinking machines might become commonplace. http://bit.ly/agbAr7 Artificial Intelligence – how smart are our machines? 189.3 KPCC bit.ly 89.3 KPCC | Southern California Public Radio's home page with news, podcasts, radio broadcast schedules, aptimits to its productions including AirTalk with host Larry Mantle, Pattmorrison, Off-Ramp, Marketplace, All Things Considered, Day to Day, Fresh Air, This American Life, Morning Edition, and...

# 11 people like this. Manoj Jain wow..!!! really amazing... July 15 at 12:05pm · Like · Flag Write a comment...

#### **Blog/News Items**

Fraternity of the Wired Works in the Wee Hours <sup>By JENNA WORTHAM</sup> Published: July 25, 2010 NY Times "Recommend" button

NEW YORK — After college, most people do their best to avoid having to pull any more all-nighters. But for some, even after graduation, the wee hours of the morning are the most productive.



That is what led Amber Lambke and Allan Grinshtein to start a group called the New York Nightowls, a sort of study hall for entrepreneurs, freelancers and software developers who gather at 10 every Tuesday night

f	FACEBOOK
B	TWITTER
✓	RECOMMEND
⊠	SIGN IN TO E- MAIL
Ð	PRINT
ē	REPRINTS
28	SHARE

- Users expressing opinions faster than ever
- Recommendations change second-to-second

### "Offline" step can <u>no longer</u> be tolerated



## **Recommender Systems in DBMS ?**



- Incoming stream of rating data: (user, item, rating)
- Ratings are used to build a recommendation model as:
  - 1 Item-based collaborative filtering: (*item*, *item*, *similarity*)
  - 2 User-based collaborative filtering: (user, user, similarity)

#### **Recommendation query:**

- ① Item-based collaborative filtering:
  - Given a user u, find the top-k items that are most similar to the items that u has liked before
- ② User-based collaborative filtering:
  - Given a user u, find the top-k items that the users who are similar to u have liked

"Online" recommendation environments have all the pieces of a data management problem

# GoeScoialDB



### GeoScoialDB is a social networking system that injects the *location-awareness* into the core functionally of social networks. Each decision in GeoSocialDB is taken while consulting the *locations* of both users and messages



### **Architecture of GeoSocialDB**





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### **GeoSocialDB System Prototype**







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# **Summary**



### When LBS Meets Web 2.0

### **Personalization in LBS 2.0**

- □ The CareDB/FlexPref Project
- A unified framework for supporting the location attribute within preference functions

### Socialization in LBS 2.0

- Location-based Social Networks
- □ The GeoFeed Project as a Location-Aware News Feed System

### **Recommendations in LBS 2.0**

- A taxonomy of spatial ratings
- □ The LARS project as a Location-Aware Recommender System

### The GeoSocialDB Project as an LBS 2.0 System

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# Conclusion





### ... And, they lived happily ever after

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# Thanks



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