



DATA ANALYTICS

Unit 4: Knowledge-Based Recommender System

Jyothi R.

Department of Computer Science and
Engineering

"Core" Recommendation Techniques

Technique	Background	Input	Process
Collaborative	Ratings from U of items in I	Ratings from U of items in I	Identify users in U similar to u, and extrapolate from their ratings of i
Content-based	Features of items in I	U's ratings of items in I	Generate a classifier that fits U's rating behavior and use it on I
Demographic	Demographic information about U and their ratings of items in I	Demographic information about U	Identify users that are demographically similar to U, ad extrapolate from their ratings of i
Utility-based	Features of items in I	A Utility function over items in I that describes U's preferences.	Apply the function to the items and determine I's rank
Knowledge-based	Features of items in I. Knowledge of how these items meet a user's needs.	A description of U's needs or interests.	Infer a match between I and U's need.

Knowledge-based recommender systems

knowledge-based recommender systems are appropriate in the following situations:

1. Customers want to explicitly specify their requirements. Therefore, interactivity is a crucial component of such systems. Note that collaborative and content-based systems do not allow this type of detailed feedback.
2. It is difficult to obtain ratings for a specific type of item because of the greater complexity of the product domain in terms of the types of items and options available.
3. In some domains, such as computers, the ratings may be time-sensitive. The ratings on an old car or computer are not very useful for recommendations because they evolve with changing product availability and corresponding user requirements.

Knowledge-based recommender systems types

- Knowledge-based recommender systems can be categorized on the basis of user interactive methodology and the corresponding knowledge bases used to facilitate the interaction.
- There are two primary types of knowledge-based recommender systems:
 1. Constraint-based recommender systems: In constraint-based systems users typically specify requirements or constraints (e.g., lower or upper limits) on the item attributes. Furthermore, domain-specific rules are used to match the user requirements or attributes to item attributes. These rules represent the domain-specific knowledge used by the system.

Knowledge-based recommender systems types

- Knowledge-based recommender systems can be categorized on the basis of user interactive methodology and the corresponding knowledge bases used to facilitate the interaction.
- There are two primary types of knowledge-based recommender systems:
 2. Case-based recommender systems: In case-based recommender systems, specific cases are specified by the user as targets or anchor points. Similarity metrics are defined on the item attributes to retrieve similar items to these targets. The similarity metrics are often carefully defined in a domain-specific way.

Knowledge-based recommender systems

The Conceptual goals of various recommender systems

Approach	Conceptual Goal	Input
Collaborative	Gives us recommendations based on a collaborative approach that leverages the ratings and actions of our peers/myself	User ratings + Community ratings
Content-based	Gives us recommendations based on the content (attributes) we have favored in our past ratings and actions.	User ratings + item attributes + domain knowledge
Knowledge-based	Gives us recommendations based on our explicit specification of the kind of content (attributes) we want	User specification + Item attributes + domain knowledge

Knowledge-Based Recommender Systems

- The Interaction between user and recommender may take the following forms.
 1. **Conversational Systems:** The user preferences are determined in the context of a feedback loop. The item domain is complex, and the user preferences can be determined only in the context of an iterative conversational system.
 2. **Search-based systems:** User preferences are elicited by using a preset sequence of questions such as the following; "Do you prefer a house in a suburban area or within the city?".

Knowledge-Based Recommender Systems

- The Interaction between user and recommender may take the following forms.
- 3. **Navigation-based recommendation:** The user specifies a number of change requests to item being currently recommended. Through an iterative set of change requests, it is possible to arrive at a desirable item.

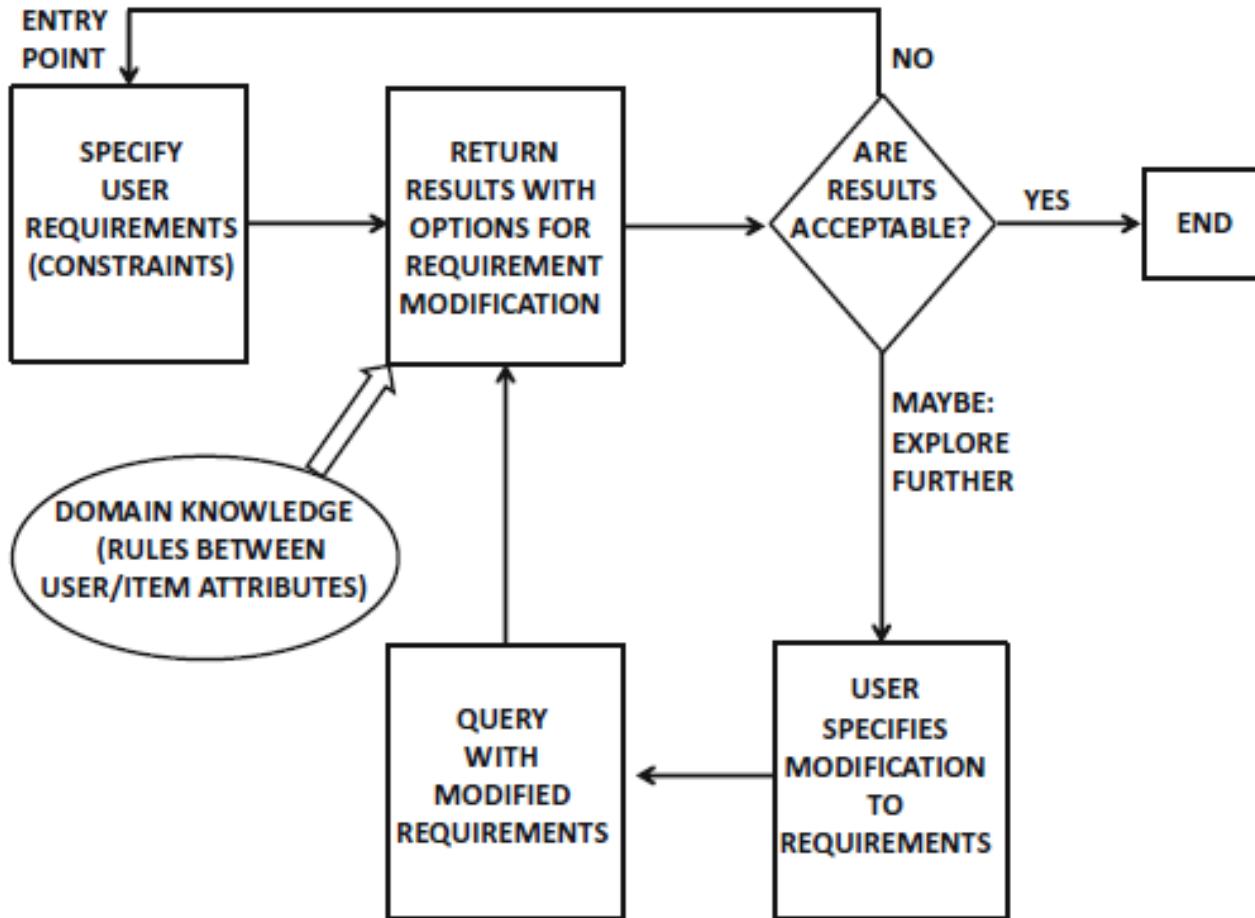
Eg. “I would like a similar house about 5 miles west of the currently recommended house.” Such recommender systems are also referred to as critiquing recommender systems.

Knowledge-Based Recommender Systems

- Critiquing recommender systems are naturally designed for case-based recommender systems, because one critiques a specific case in order to arrive at the desired outcome.
- A search-based system can be used to set up user requirements for constraint-based recommenders.

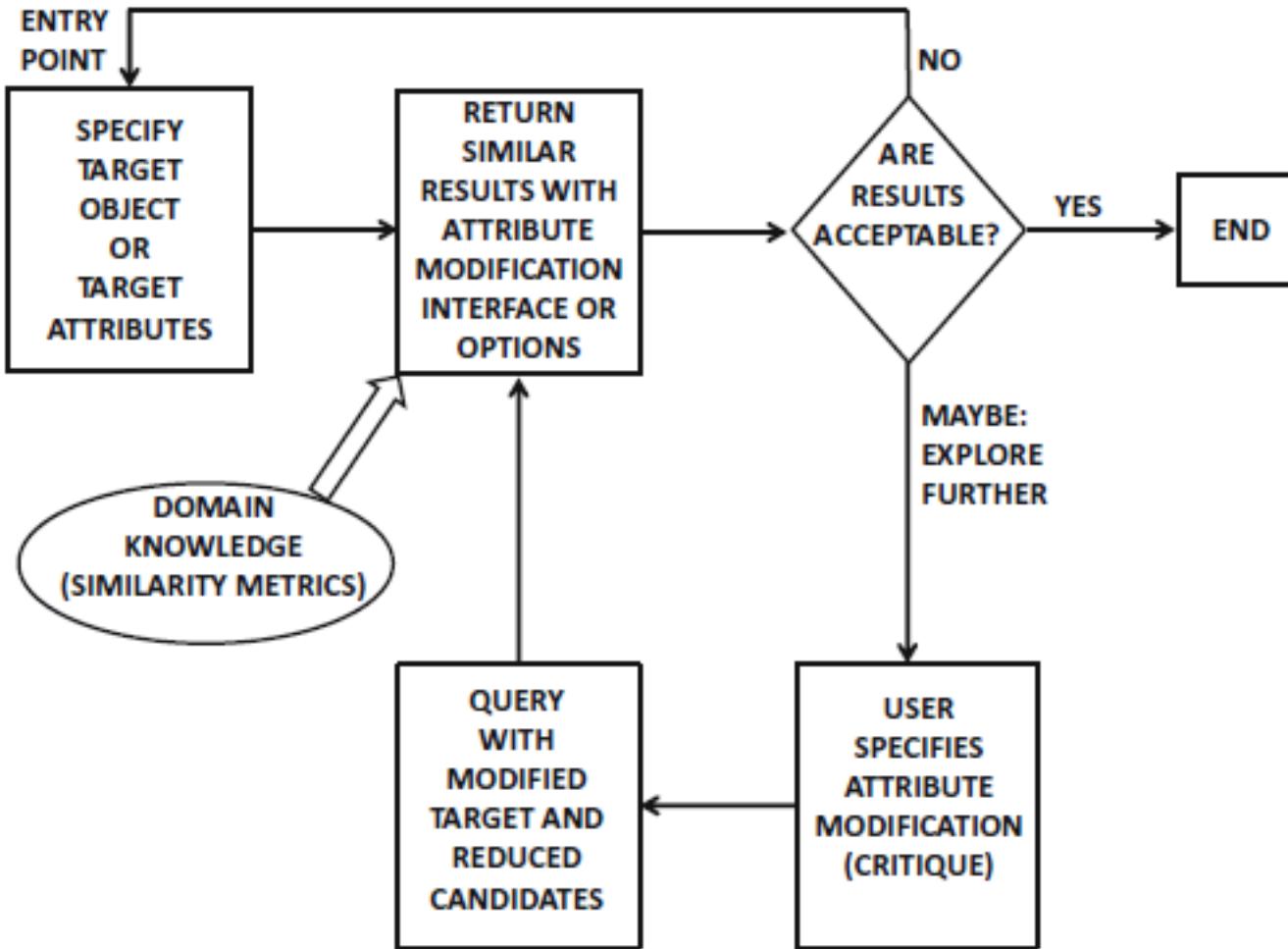
Knowledge-based Recommendation system

Constraint-based Recommender systems.



Knowledge-based Recommendation system

Case-based Recommender systems.



Knowledge-based Recommendation system

Difference between Constraint-based and Case-based Recommender systems.

- In constraint-based systems, specific requirements or constraints are specified by the user.
- The Original query is modified by addition, deletion, modification, or relaxation of the original set of user requirements.
- Users are not in apposition to exactly state their requirements up front in a complex product domain, this problem is partially addressed through a knowledge-base of rules, which map user requirements to product attributes.
- In case-based systems, specific targets or cases are specified.
- Either the target is modified through user interaction, or the search results are pruned through the use of directional critiques.
- This problem is addressed through a conversational style of critiquing.

Knowledge-based recommender systems types

Examples of attributes in a recommendation application for buying homes.

Item-Id	Beds.	Baths.	Locality	Type	Floor Area	Price
1	3	2	BTM	Town House	1600	220,000
2	5	2.5	JP	Split-level	3600	973,000
3	4	2	RT	Ranch	2600	630,000
4	2	1.5	MAJESTIC	Condo	1500	220,000
5	4	2	Dollars	Colonial	2700	430,000

Knowledge-Based Recommender Systems

- Suggests products based on **inferences** about a user's needs and preferences
- **Functional knowledge:** about how a particular item meets a particular user need
- The **user model** can be any knowledge structure that supports this inference
- A query, i.e., the set of preferred features for a product
- A case (in a case-based reasoning system)
- An adapted similarity metric (for matching)
- A part of an ontology
- **There is a large use of domain knowledge encoded in a knowledge representation language/approach.**

Knowledge-Based Recommender Systems

digital camera product advisor

Find by: Product Use | [Product Features](#)

I need photo quality high enough for... [More Info](#)

- 5" x 7" prints (2 megapixels)
- 8" x 10" prints (4 megapixels)
- 11" x 14" prints (6 megapixels)
- No preference

My camera should fit inside a... [More Info](#)

- Shirt pocket
- Backpack
- Waist pack
- No preference

I prefer cameras that have an Epinions.com rating of at least [--select--](#)

--select--

[GET RESULTS](#)

I want to spend... [More Info](#)

From \$ up to \$

I want to zoom in on subjects across a... [More Info](#)

- Small room (8 ft. away)
- Living room (15 ft. away)
- Backyard (35 ft. away)
- No preference

My preferred brands... [More Info](#)

select all that apply

<input type="checkbox"/> Canon	<input type="checkbox"/> Fujifilm	<input type="checkbox"/> Kodak
<input type="checkbox"/> Nikon	<input type="checkbox"/> Olympus	<input type="checkbox"/> Sony

[more brands...](#)

[MORE GUIDANCE](#)

[GET RESULTS](#)

camcorder product advisor

Find by: Product Use | [Product Features](#)

I need a camcorder for... [More Info](#)

- Occasional & casual recordings
- Home and vacation movies
- Business productions
- No preference

I want to zoom in on subjects across a... [More Info](#)

- Playground (40 ft. away)
- Tennis court (60 ft. away)
- Park (80 ft. away)
- No preference

I prefer camcorders that have an Epinions.com rating of

at least [--select--](#)

[GET RESULTS](#)

I want to spend... [More Info](#)

From \$ up to \$

My camcorder should fit inside a... [More Info](#)

- Shirt pocket
- Backpack
- Waist pack
- No preference

My preferred brands... [More Info](#)

check all -- clear all

<input type="checkbox"/> Canon	<input type="checkbox"/> JVC	<input type="checkbox"/> Panasonic
<input type="checkbox"/> Samsung	<input type="checkbox"/> Sony	

[more brands...](#)

[MORE GUIDANCE](#)

[GET RESULTS](#)

mp3 player product advisor

Find by: Product Use | [Product Features](#)

My MP3 player (Digital Music Player) needs to be compatible with a... [More Info](#)

select all that apply

<input type="checkbox"/> Windows operating system	<input type="checkbox"/> Mac operating system
---	---

I want my MP3 player to hold...

- A handful of songs (less than 128 MB)
- A few dozen songs (128 MB - 512 MB)
- Hundreds of songs (512 MB - 5 GB)
- Thousands of songs (5 GB or more)
- No preference

I prefer MP3 players that have an Epinions.com rating of

at least [--select--](#)

[GET RESULTS](#)

I want to spend... [More Info](#)

From \$ up to \$

My preferred brands... [More Info](#)

check all -- clear all

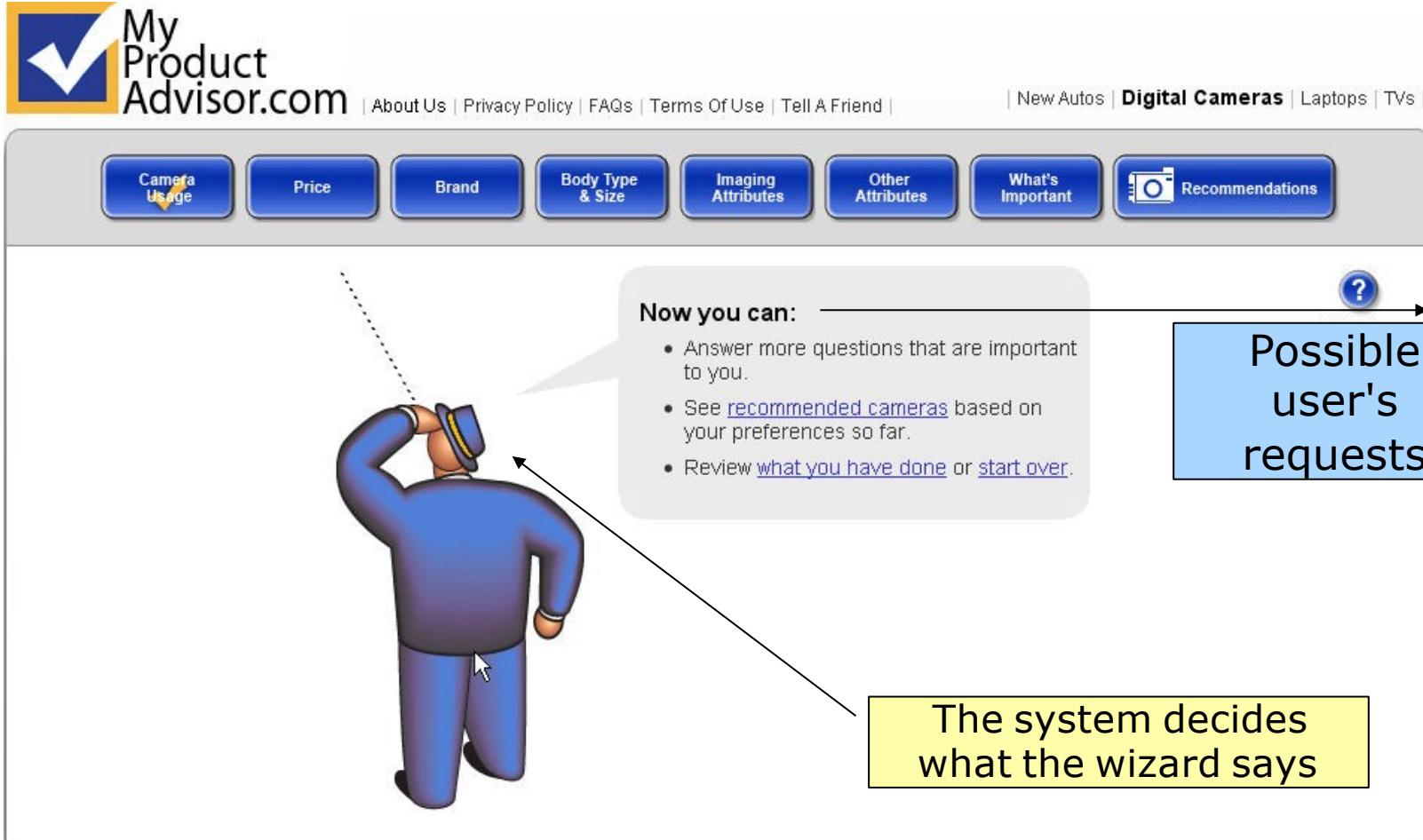
<input type="checkbox"/> Apple/iPod	<input type="checkbox"/> Creative Labs	<input type="checkbox"/> iRiver
<input type="checkbox"/> Lexar	<input type="checkbox"/> RCA	<input type="checkbox"/> Rio

[more brands...](#)

[MORE GUIDANCE](#)

[GET RESULTS](#)

Knowledge-Based Recommender Systems



Knowledge-Based Recommender Systems

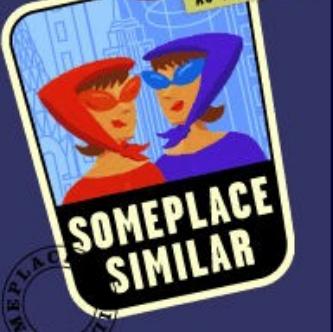
Welcome to VACATIONCOACH.COM - TRAVEL PLANNING AS UNIQUE AS YOU - Mi... [Minimize] [Close]

File Modifica Visualizza Preferiti Strumenti ?

Indietro ▾ ➡ 🔍 Cerca 🌐 Preferiti 🕒 Cronologia ⌂ ⌂ ⌂ ⌂ ⌂

Indirizzo Vai Collegamenti

BE A MEMBER! : WHY JOIN? : HOW DOES THIS WORK? : ABOUT VACATIONCOACH : FAQs : MEMBERS LOG-IN : HOME

Someplace Similar.

Now you can easily find a place that's like a destination you've enjoyed before!

Q1. In which region is the destination you liked?

Europe

Q2. Choose the destination you liked, and we'll find a similar spot.

Paris and Vicinity

let's go!

© VacationCoach Inc., 2000, 2001. All rights reserved.

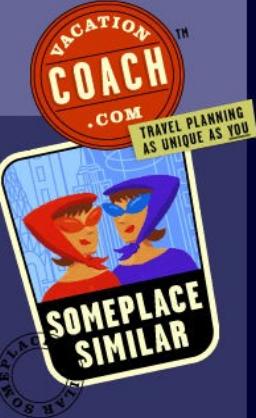
Operazione completata Internet

Knowledge-Based Recommender Systems

Welcome to VACATIONCOACH.COM - TRAVEL PLANNING AS UNIQUE AS YOU - Microsoft Internet Explorer

File Modifica Visualizza Preferiti Strumenti ?
Indietro ▾ Avanti ▾ Home ▾ Cerca ▾ Preferiti ▾ Cronologia ▾ ▾ ▾ ▾ ▾ ▾
Indirizzo http://www.vacationcoach.com ▾ Vai ▾ Collegamenti

BE A MEMBER! ▾ WHY JOIN? ▾ HOW DOES THIS WORK? ▾ ABOUT VACATIONCOACH ▾ FAQs ▾ MEMBERS LOG-IN ▾ HOME

Someplace Similar.

Now pick a personality type that best describes YOU -- this will help us find similar spots based on things you like.

 CULTURE CREATURE Loves everything cultural - theater, shows, museums... local & historical culture too!	 BEACH BUM Somebody has to lay around on the beach with little umbrellas pitched in their drinks.	 TRAIL TREKKER If it's outdoors - you're there. Hiking, walking... parks, forests, mountains.	 SIGHT SEEKER Always looking for that landmark, event, or attraction.
 CITY SLICKER An urban creature who goes where the action is. Clubs, people... love the pulse of the city.	 AVID ATHLETE Always on the court or the course... always in the game... whatever game it is.	 SHOPPING SHARK Stopped looking for a cure for your shopaholism?	 WINTER WARRIOR Will work for lift ticket. Can become quite abominable if there's no snow on the ground.

{pick one and click!}

Operazione completata Internet

Knowledge-Based Recommender Systems

Welcome to VACATIONCOACH.COM - TRAVEL PLANNING AS UNIQUE AS YOU - Mic... [Minimize] [Close]

File Modifica Visualizza Preferiti Strumenti ?

Indietro → Cerca Preferiti Cronologia [Search] [Back] [Forward] [Home] [History] [Print] [Help]

Indirizzo <http://www.vacationcoach.com> Vai Collegamenti

BE A MEMBER! WHY JOIN? HOW DOES THIS WORK? ABOUT VACATIONCOACH FAQS MEMBERS LOG-IN HOME

If you liked Paris and Vicinity, you'll probably like these destinations as well:

MATCH	DESTINATION	FIND OUT MORE
88%	New York City, NY	more ➤
87%	Berlin	more ➤
87%	London	more ➤
85%	Greater Montreal, QC	more ➤
85%	Beijing	more ➤
83%	Washington D.C.	more ➤
83%	Philadelphia and Lehigh Valley, PA	more ➤
83%	Chicagoland Region, IL	more ➤
83%	Hesse (Frankfurt and Vicinity)	more ➤
82%	Greater Boston, MA	more ➤

*BACK TO TOP

Want to try Someplace Similar with a different destination? [Click here](#).

© VacationCoach Inc., 2000, 2001. All rights reserved.

Operazione completata Internet

Knowledge-Based Recommender Systems

Welcome to VACATIONCOACH.COM - TRAVEL PLANNING AS UNIQUE AS YOU - Micro... x

File Modifica Visualizza Preferiti Strumenti ?
Indietro → Cerca Preferiti Cronologia Vai Collegamenti

Indirizzo http://www.vacationcoach.com

BE A MEMBER! WHY JOIN? HOW DOES THIS WORK? ABOUT VACATIONCOACH FAQs MEMBERS LOG-IN HOME

SOMEPLACE SIMILAR | **1 FIND ME A PLACE LIKE...** | **2 ABOUT THIS DESTINATION**

About New York City, NY

Recommended for: Culture Creature
Cost: (per person/per day \$364-793 -- meals and lodging)

Overall Score: 99%
why? Find out why we recommended this place for you.
[Go back to Find Me a Place Like...](#)

Overview
Where to, Mack? Central Park? You got it. First time to the Big Apple? Well, that's the Manhattan skyline over there -- \$24 in glass beads. The deal of the last millennium, I call it. Then, of course, we have Queens, da Bronx, Staten Island, and Brooklyn, where yours truly was born. In these five boroughs you'll find more landmarks, history, museums, restaurants, shopping, and people than I got problems. Can I name one of each? With my eyes closed. Relax, Mack! It's just a figure of speech. The Empire State Building, The American Museum of Natural History, the Metropolitan Museum of Art, the Carnegie Deli, Bergdorf's, and Sy Glickman. He lives on 86th and Amsterdam. I see you like to be entertained. Well, for you we got theater, nightlife (and I mean all night, Mack), music, and sports. Where? You don't get out much, huh? Ever hear of Broadway, Times Square, Lincoln Center, and the Bronx Bombers? The Yankees. Riight -- I see your meds are kickin' in. We also got the NFL, NHL, NBA, bocci ball in Little Italy, and ping-pong in Chinatown. Say what? You like multiculturalism? You mean who lives here, right? EV-ER-Y-BOD-Y Name a country and you have a little piece of New York. OK, my friend, we're here. That'll be 80 bucks. It seems expensive? Welcome to New York, sweetheart!

Principal Cities
New York City

 **BOOK LODGING**

 **BOOK AIRFARE**

http://www.vacationcoach.com/visitor/request/recommend/aboutdest.jhtml?tc Internet

Knowledge-Based Recommender Systems

Trip.com - Vacation and Travel Destinations - Microsoft Internet Explorer

trip.com

Hurry, the London for FREE sale ends January 16th! ►► book now! BRITISH AIRWAYS

Welcome! Tell us what you think about our new site.

Travel Resources

- > Trip Coach
- > FlightTracker
- > Driving Directions
- > Street Maps
- > Destination Guides
- > Airport Maps
- > Airport Delays
- > Weather
- > Travel Tips
- > Int'l Calling Codes
- > Wireless

Trip Coach

People are as different as the trips they take. That's why Trip Coach finds destinations for you based on your travel interests. Select a personality or create your own, and we'll find destinations that are great for you.

Select the personality below that best describes you.

<input type="radio"/>  WINTER WARRIOR	<input type="radio"/>  SPORTS ENTHUSIAST
All you need on your trip is snow. Skiing, snow boarding, and hanging out at the lodge mark your final destination.	Whether spectator or participant, your ideal trip involves anything sports-related □ golf, tennis, baseball, football, and everything in between.
<input type="radio"/>  SIGHT SEEKER	<input type="radio"/>  SEASONED SHOPPER
You revel in trips that keep you busy searching for the next tour, attraction, or landmark.	Your motto is "shop 'til you drop." For you, traveling is all about finding the best shops and bargains in town.
<input type="radio"/>  OUTDOOR ADVENTURER	<input type="radio"/>  FAMILY TRAVELER
The great outdoors and all that goes with it - hiking, biking, kayaking, canoeing, skiing, exploring - is your idea of a perfect getaway.	From amusement parks to festivals to outdoor fun, you love to travel with your children, or you're just a kid at heart. Either way, your trip is usually playful and carefree.
<input type="radio"/>  CULTURE CONNOISSEUR	<input type="radio"/>  BEACH BUM
Your perfect destination offers an abundance of art, architecture, galleries, and theaters.	Your ideal trip revolves around enjoying the latest water sports, sipping tropical drinks, and working on your tan.

If you did not find a personality that fits you,
 Build your own travel personality.

CONTINUE

Trip.com

DATA ANALYTICS

Knowledge-Based Recommender Systems



Trip.com

TripleHop Technologies - TripMatcher - Microsoft Internet Explorer

File Modifica Visualizza Preferiti Strumenti ?

Indietro Cerca Preferiti Cronologia Vai Collegamenti

Indirizzo http://www.triplehop.com>Showcase/TripMatcher/searchPa Vai Collegamenti

TECHNOLOGIES

Home Company Solutions Product Demos Clients Partners Press Room Contact Us

Overview
Technology
Knowledge Management
Recommendation Engines

Wednesday, September 26, 2001

TripMatcher™

Welcome to TripMatcher™, the Web's first vacation advisor. We have researched all the major resorts for you. Answer a few simple questions, and we'll suggest the ski resort that best matches your preferences.

No time to answer? Click here ...

 Search by Destination <ul style="list-style-type: none"> Knowledge Management Management Consulting Financial Services Media Legal Other Industries 	<p>Activities</p> <p>What do you enjoy?</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Adventure Sports <input checked="" type="checkbox"/> Relaxing <input type="checkbox"/> Dining Out <input type="checkbox"/> Leisure Activities <input type="checkbox"/> Nightlife <input type="checkbox"/> Shopping <input type="checkbox"/> Sights & Culture <input type="checkbox"/> Theme Parks & Zoos <input type="checkbox"/> Water Sports <input type="checkbox"/> Winter Sports 	<p>Optional Criteria</p> <p>You may refine your search.</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Avoid Crowded Destinations <input type="checkbox"/> Avoid Jet Lag <input type="checkbox"/> Choose Weather Conditions <input type="checkbox"/> Good Safety Conditions <input type="checkbox"/> Improve A Foreign Language <input type="checkbox"/> Select A Specific Environment <input type="checkbox"/> Set A Budget <input type="checkbox"/> Specify A Region <input type="checkbox"/> Traveler Support <input type="checkbox"/> Traveling With Companions
	<p>Timing</p> <p>When are you leaving?</p> <p>Late November</p> <p>How long will you be gone?</p> <p>One Week</p>	<p>Departure City</p> <p>Please choose your gateway.</p> <p>Washington Dc</p>

Operazione completata Internet

Knowledge-Based Recommender Systems



TripleHop Technologies - TripMatcher - Microsoft Internet Explorer

File Modifica Visualizza Preferiti Strumenti ?

Indietro ▶ ➡ Cerca Preferiti Cronologia Vai Collegamenti

Indirizzo Vai

TRIPLEHOP TECHNOLOGIES

Home Company Solutions Product Demos Clients Partners Press Room Contact Us

Wednesday, September 26, 2001

Tell us more !

Give us a better idea about what you like. Feel free to skip any question, but the more you tell us, the better our recommendation will be.

Knowledge Management Management Consulting Financial Services Media Legal Other Industries	Adventure Sports Any favorite adventure sports? <input type="checkbox"/> Children'S Adventure Sports <input checked="" type="checkbox"/> Hiking <input type="checkbox"/> Mountain Biking <input type="checkbox"/> Paragliding <input type="checkbox"/> Rock Climbing <input type="checkbox"/> Whitewater Rafting	Relaxing Which of these do you enjoy? <input type="checkbox"/> Enjoying Spa Treatments <input type="checkbox"/> Lying On A Beach <input checked="" type="checkbox"/> Sitting In Cafes <input type="checkbox"/> Strolling In Parks <input type="checkbox"/> Watching Sports
--	--	---

Save Your Preferences

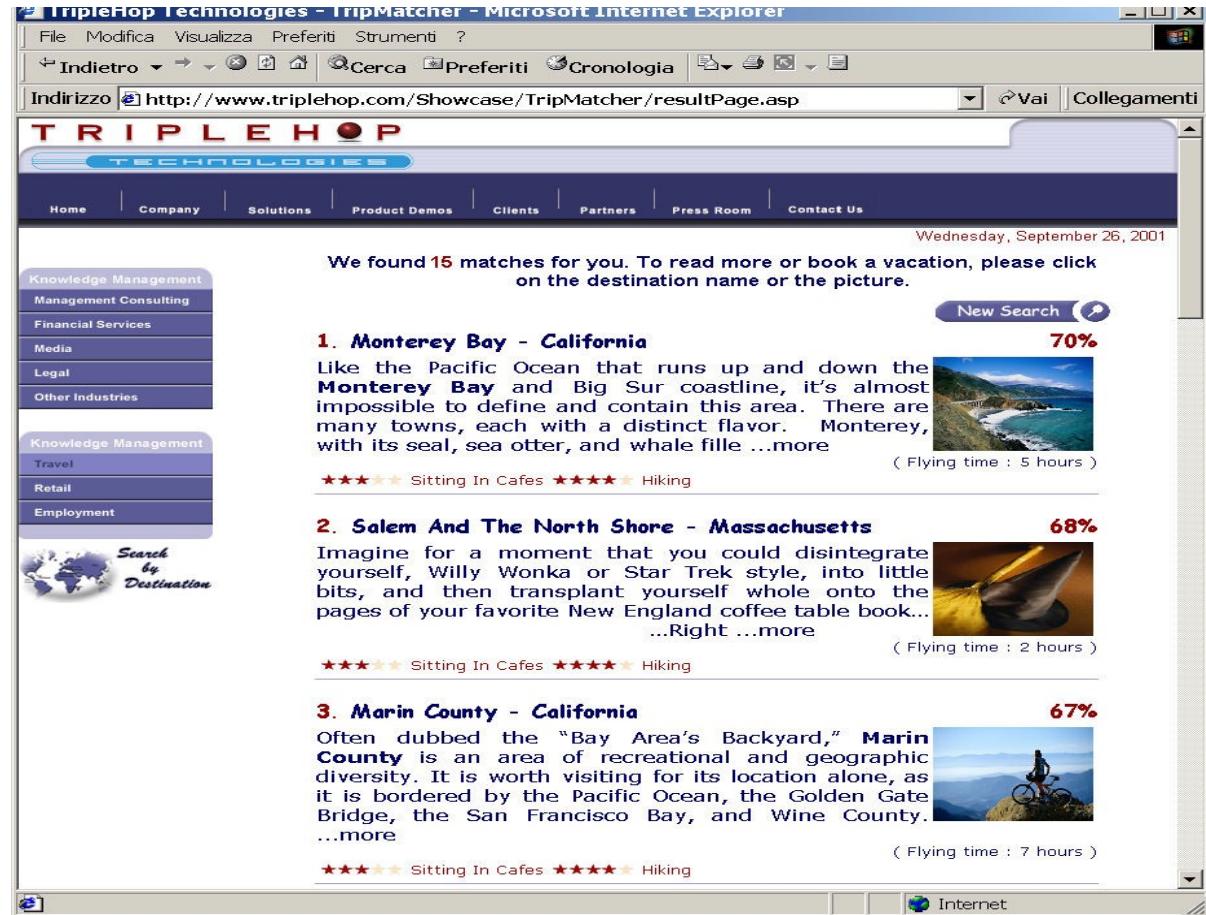
Email Address :

Search 

Trip.com

Knowledge-Based Recommender Systems

Trip.com

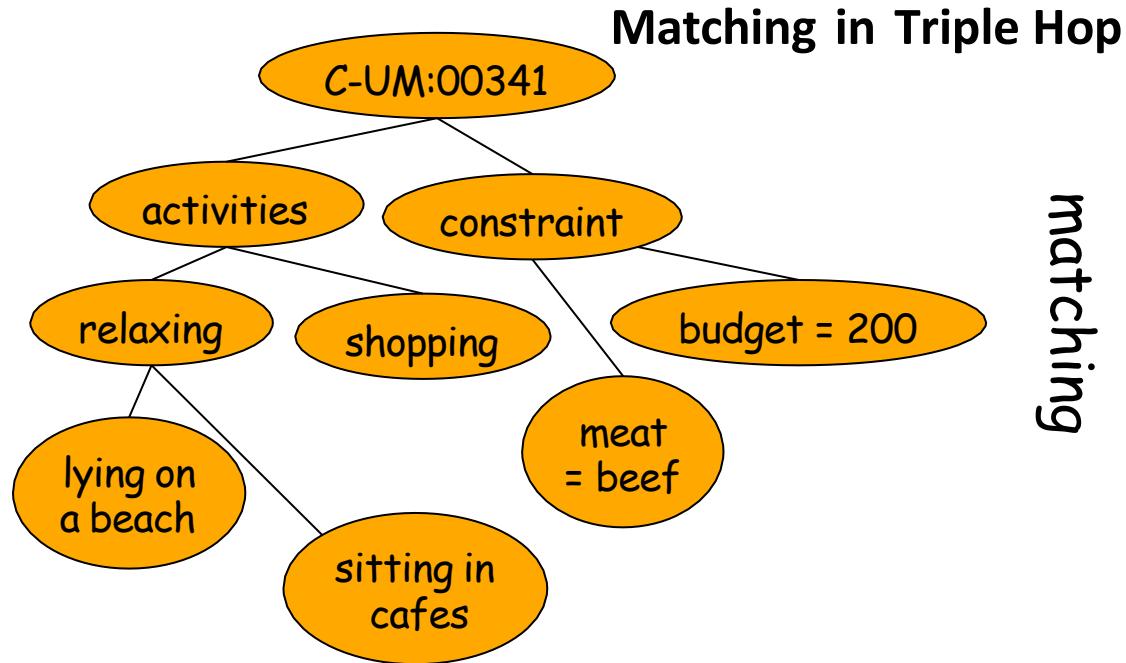


The screenshot shows a Microsoft Internet Explorer window displaying a web page from TripleHop Technologies. The page is titled "TripMatcher" and shows search results for travel destinations. The left sidebar has sections for "Knowledge Management" (Management Consulting, Financial Services, Media, Legal, Other Industries) and "Travel" (Travel, Retail, Employment). A "Search by Destination" button is also present. The main content area shows three destination matches:

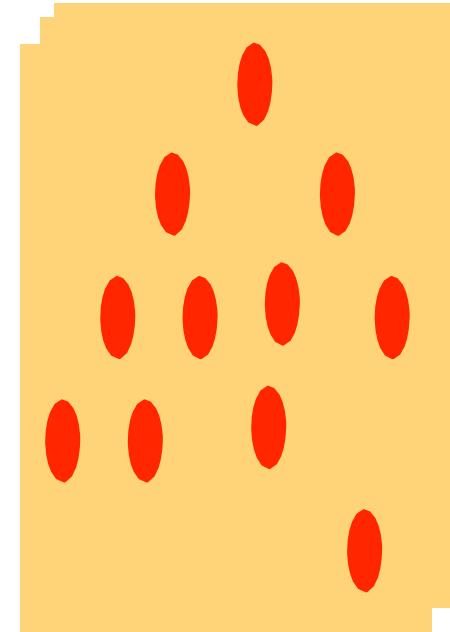
- 1. Monterey Bay - California**: 70% match. Description: Like the Pacific Ocean that runs up and down the **Monterey Bay** and Big Sur coastline, it's almost impossible to define and contain this area. There are many towns, each with a distinct flavor. Monterey, with its seal, sea otter, and whale fille ...more. Image: A scenic view of a coastal road. Rating: ★★★★☆ Sitting In Cafes, ★★★★☆ Hiking. Flying time: 5 hours.
- 2. Salem And The North Shore - Massachusetts**: 68% match. Description: Imagine for a moment that you could disintegrate yourself, Willy Wonka or Star Trek style, into little bits, and then transplant yourself whole onto the pages of your favorite New England coffee table book... Right ...more. Image: A close-up of a coffee cup. Rating: ★★★★☆ Sitting In Cafes, ★★★★☆ Hiking. Flying time: 2 hours.
- 3. Marin County - California**: 67% match. Description: Often dubbed the "Bay Area's Backyard," **Marin County** is an area of recreational and geographic diversity. It is worth visiting for its location alone, as it is bordered by the Pacific Ocean, the Golden Gate Bridge, the San Francisco Bay, and Wine County. ...more. Image: A person riding a bicycle on a trail. Rating: ★★★★☆ Sitting In Cafes, ★★★★☆ Hiking. Flying time: 7 hours.

Knowledge-Based Recommender Systems

Example: TripleHop



Catalogue of Destinations



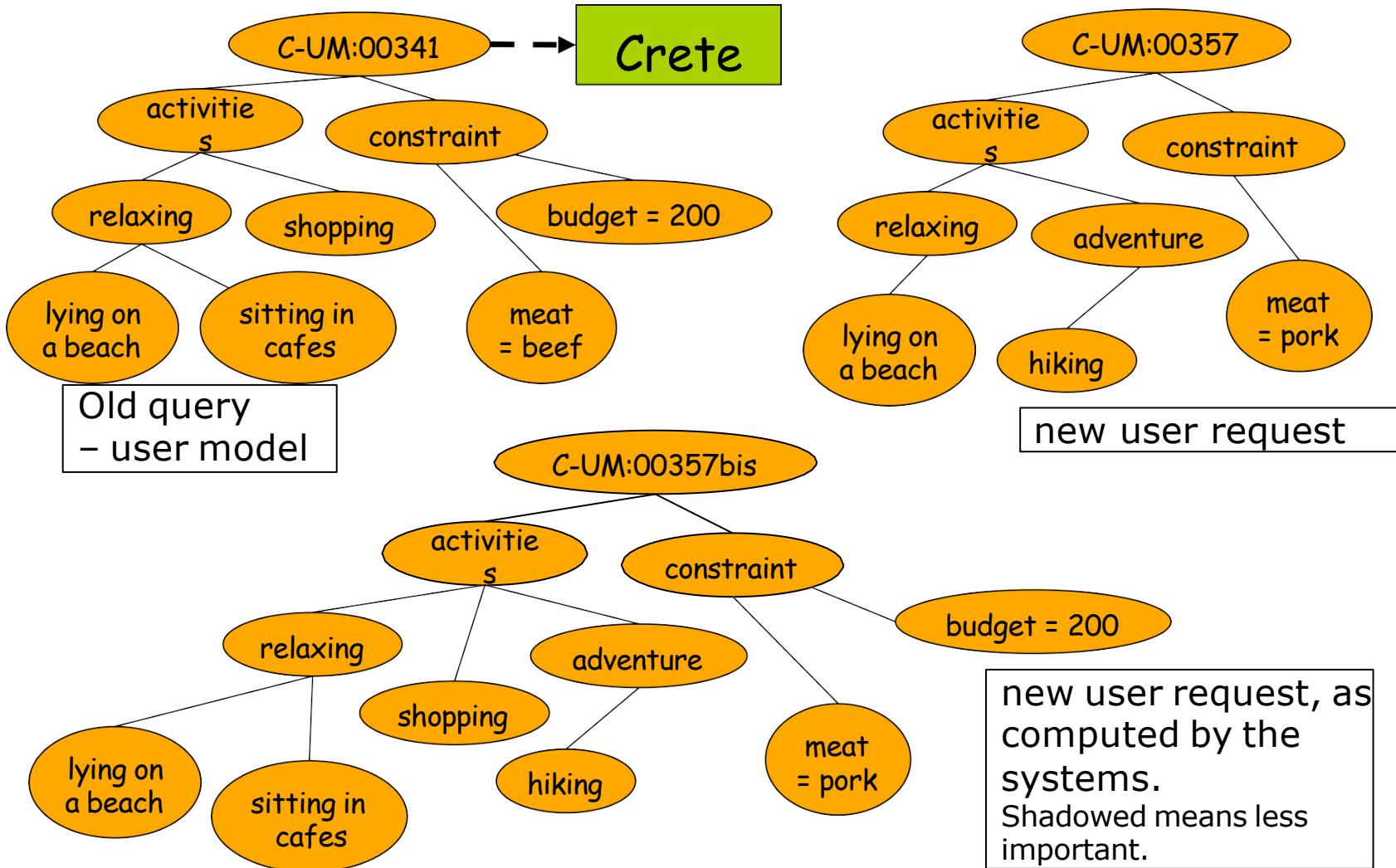
matching

Knowledge-Based Recommender Systems

TripleHop and Content-Based RS

- The content (destination description) is exploited in the recommendation process
- A classical Content-Based method would have used a “simpler” content model ,e.g., keywords or TF-IDF
- Here a more complex **knowledge structure** – a tree of concepts – is used to model the product (and the query)
- The query is the user model and it is acquired every time the user asks for a new recommendation - (not exactly, more details later)
- Stress on ephemeral needs rather than building a persistent user model
- Typical in Knowledge-Based RS, they are more focused on ephemeral users – because Collaborative Filtering and Content-Based methods cannot cope with that users.

Knowledge-Based Recommender Systems



Learning User Profile: Query mining

Knowledge-Based Recommender Systems

Query Augmentation

- Personalization in search is not only “information **filtering**”
- **Query augmentation:** when a query is entered it can be compared against contextual and individual information to refine the query
- Ex1: If the user is searching for a restaurant and enter a keyword “Thai” then the query can be augmented to “Thai food”
- Ex2: If the query “Thai food” does not retrieve any restaurant the query can be refined to “Asian food”
- Ex3: If the query “Asian food” retrieves too many restaurant, and the user searched in the past for “Chinese” food the query can be refined to “Chinese food”.

Knowledge-Based Recommender Systems

Query Augmentation in TripleHop

1. The current query is **compared** with **previous queries** of the **same user**
2. Preferences expressed in past (similar) queries are identified
3. A new query is built by **combining the short term preferences** contained in the query with the "**inferred**" preferences extracted from the persistent user model (past queries)
4. When the query is matched against an item (destination) if two destinations have the **same degree of matching for the explicit preferences** then the "**inferred**" preferences are used to break the tie
 - This is another example of the **cascade** approach
 - the two combined RS are based on the same knowledge but with two definitions of the user model.

Knowledge-Based Recommender Systems

Query Augmentation in TripleHop

4. When the query is matched against an item (destination) if two destinations have the same degree of matching for the explicit preferences then the “inferred” preferences are used to break the tie.
 - This is another example of the cascade approach
 - the two combined RS are based on the same knowledge but with two definitions of the user model.

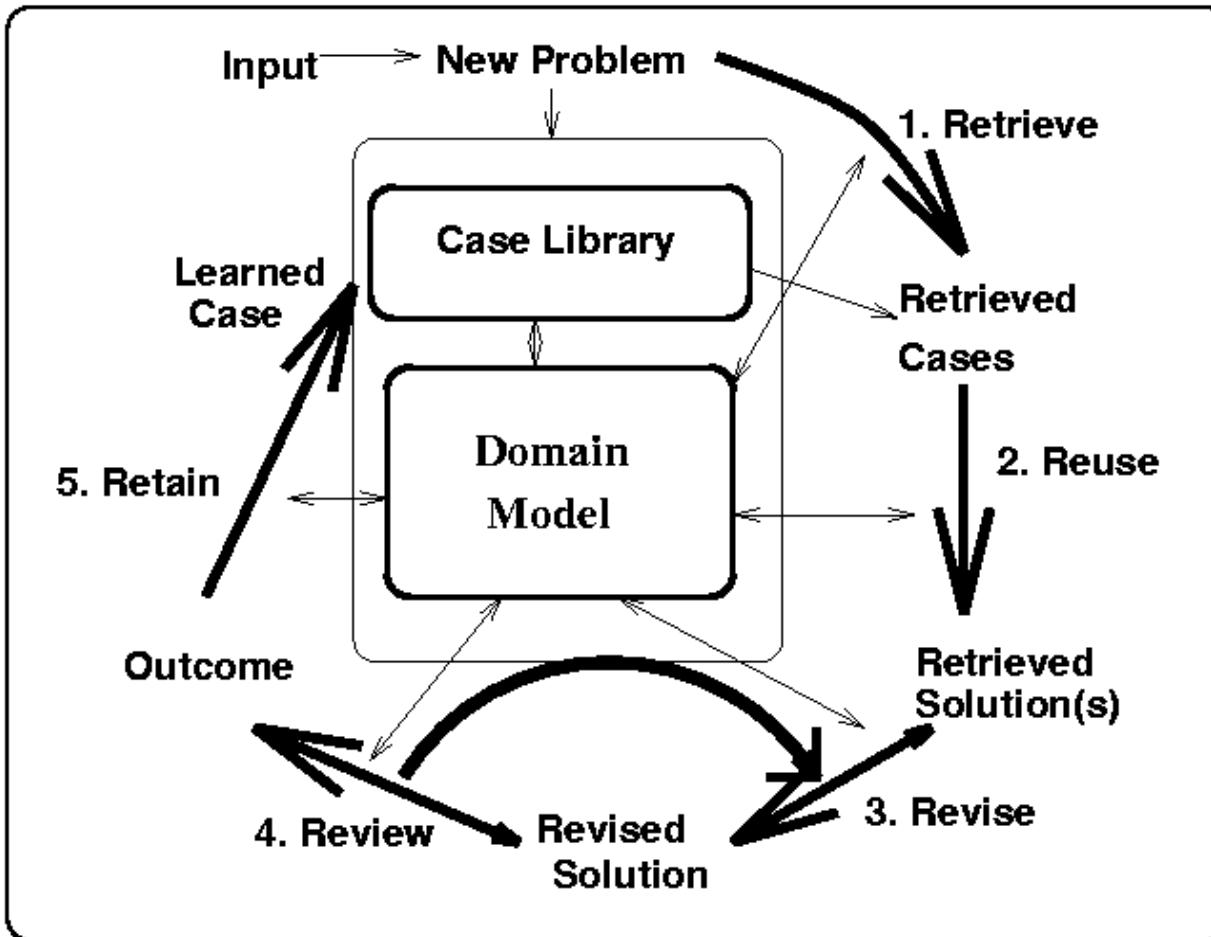
Knowledge-Based Recommender Systems

What is Case Based Reasoning ?

- **A case-based reasoner solves new problems by adapting solutions that were used to solve old problems** (Riesbeck & Shank 1989)
- CBR problem solving process:
- store previous experiences (cases) in memory to solve new problems
- Retrieve from the memory similar experience about similar situations
- Reuse the experience in the context of the new situation: complete or partial reuse, or adapt according to differences
- Store new experience in memory (learning)

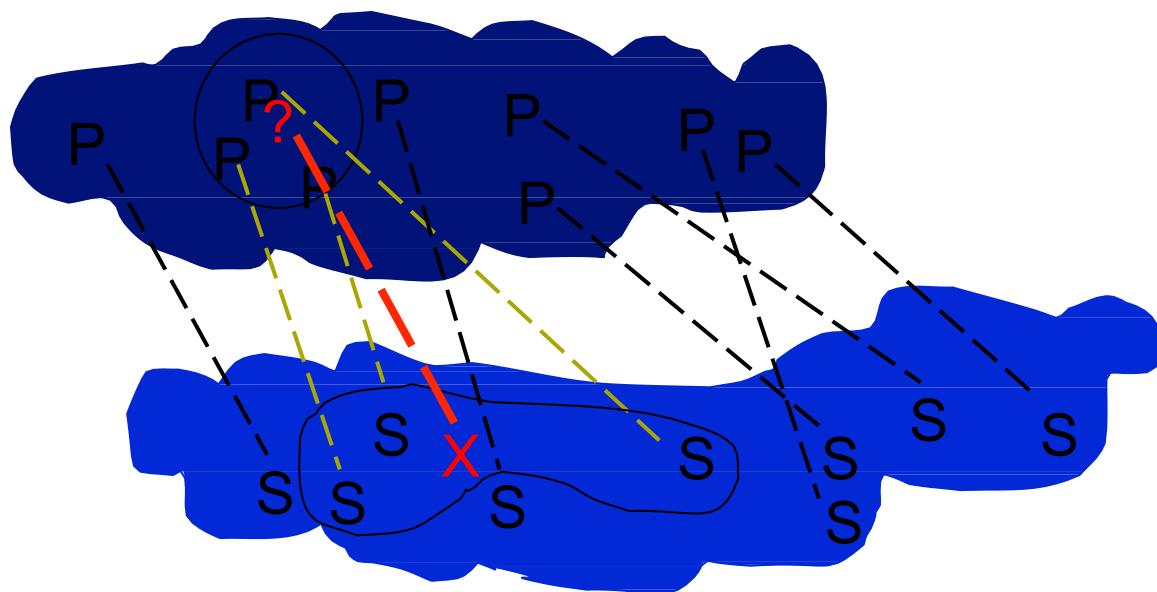
Knowledge-Based Recommender Systems

Case-Based Reasoning



Knowledge-Based Recommender Systems

CBR Assumption



- New problem can be solved by
 - retrieving similar problems
 - adapting retrieved solutions
- Similar problems have similar solutions

Knowledge-Based Recommender Systems

Examples of CBR

- Classification: “The patient’s ear problems are like this prototypical case of otitis media”
- Compiling solutions: “Patient N’s heart symptoms can be explained in the same way as previous patient D’s”
- Assessing values: My house is like the one that sold down the street for \$250,000 but has a better view
- Justifying with precedents: “This Missouri case should be decided just like Roe v. Wade where the court held that a state’s limitations on abortion are illegal”
- Evaluating options: “If we attack Cuban/Russian missile installations, it would be just like Pearl Harbor”

How to find similar problems : K Nearest Neighbours

K nearest neighbors is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure (e.g., distance functions).

KNN has been used in statistical estimation and pattern recognition already in the beginning of 1970's as a non-parametric technique.

Knowledge-Based Recommender Systems

Algorithm

A case is classified by a majority vote of its neighbors, with the case being assigned to the class most common amongst its K nearest neighbors measured by a distance function. If K = 1, then the case is simply assigned to the class of its nearest neighbor.

Distance functions

Euclidean

$$\sqrt{\sum_{i=1}^k (x_i - y_i)^2}$$

Manhattan

$$\sum_{i=1}^k |x_i - y_i|$$

Minkowski

$$\left(\sum_{i=1}^k (|x_i - y_i|)^q \right)^{1/q}$$

How to find similar problems : K Nearest Neighbours

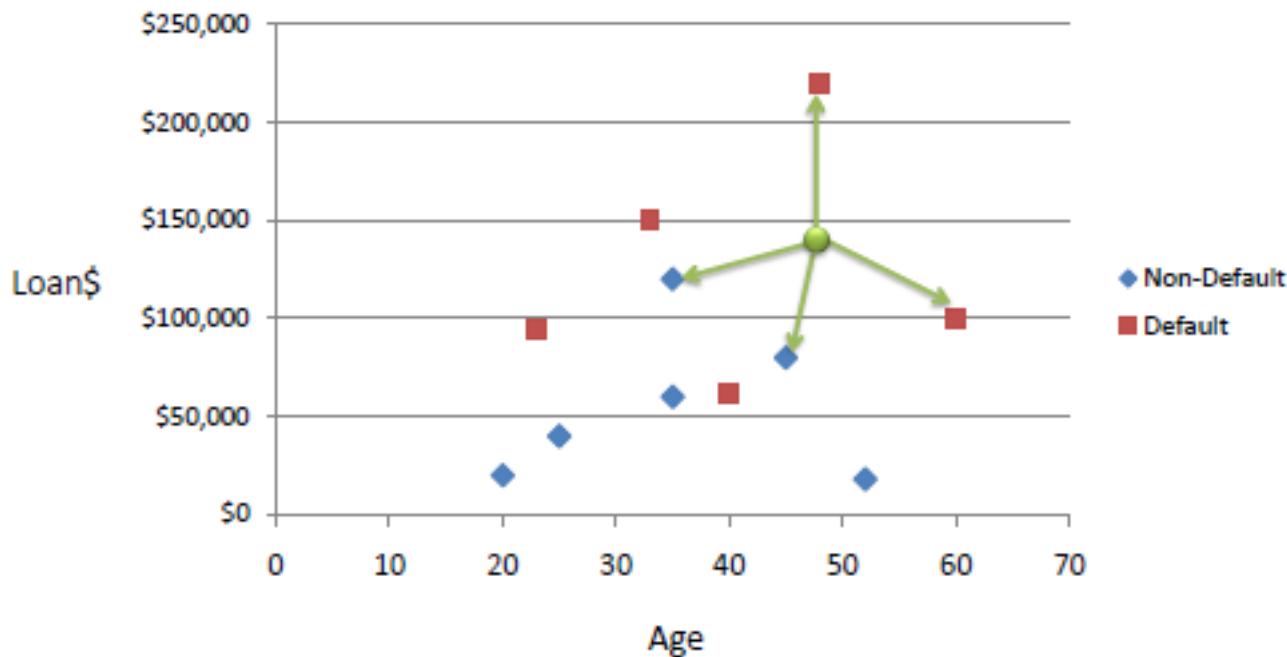
The distance between examples

- We need a **measure of distance** (or similarity) in order to know who are the neighbors
- Assume that we have T attributes for the learning problem. Then one example point x has elements x_t , $t=1,\dots,T$
- The distance between two points x and y is often defined as the **Euclidean distance**:

$$d(x, y) = \sqrt{\sum_{t=1}^T [x_t - y_t]^2}$$

KNN –Example 1

Consider the following data concerning credit default. Age and Loan are two numerical variables (predictors) and Default is the target.



We can now use the training set to classify an unknown case (Age=48 and Loan=\$142,000) using Euclidean distance.

If K=1 then the nearest neighbor is the last case in the training set with Default=Y.

$$D = \text{Sqrt}[(48-33)^2 + (142000-150000)^2] = 8000.01 \gg \text{Default}=Y$$

Age	Loan	Default	Distance
25	\$40,000	N	102000
35	\$60,000	N	82000
45	\$80,000	N	62000
20	\$20,000	N	122000
35	\$120,000	N	22000
52	\$18,000	N	124000
23	\$95,000	Y	47000
40	\$62,000	Y	80000
60	\$100,000	Y	42000
48	\$220,000	Y	78000
33	\$150,000	Y	8000
48	\$142,000	?	

Euclidean Distance

$$D = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}$$

2
3
1

With K=3, there are two Default=Y and one Default=N out of three closest neighbors. The prediction for the unknown case is again Default=Y.

Standardized Distance

One major drawback in calculating distance measures directly from the training set is in the case where variables have different measurement scales or there is a mixture of numerical and categorical variables. For example, if one variable is based on annual income in dollars, and the other is based on age in years then income will have a much higher influence on the distance calculated. One solution is to standardize the training set as shown below.

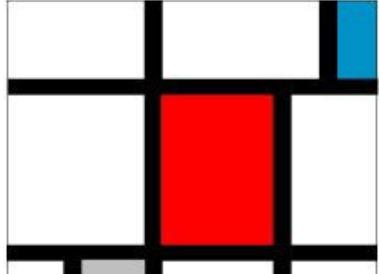
Age	Loan	Default	Distance
0.125	0.11	N	0.7652
0.375	0.21	N	0.5200
0.625	0.31	N	0.3160
0	0.01	N	0.9245
0.375	0.50	N	0.3428
0.8	0.00	N	0.6220
0.075	0.38	Y	0.6669
0.5	0.22	Y	0.4437
1	0.41	Y	0.3650
0.7	1.00	Y	0.3861
0.325	0.65	Y	0.3771
0.7	0.61	?	

Standardized Variable

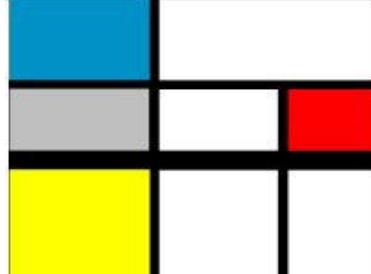
$$X_s = \frac{X - \text{Min}}{\text{Max} - \text{Min}}$$

Using the standardized distance on the same training set, the unknown case returned a different neighbor which is not a good sign of robustness.

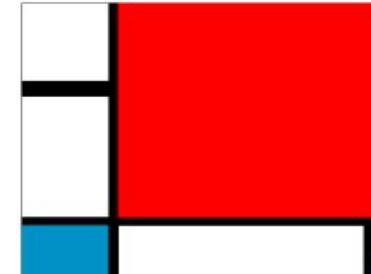
KNN : example 2



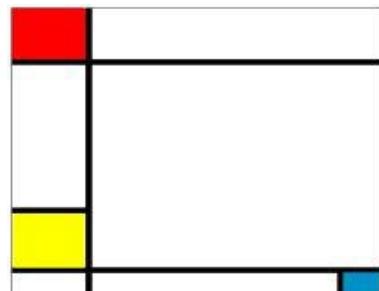
no



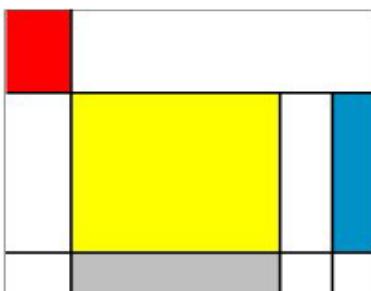
no



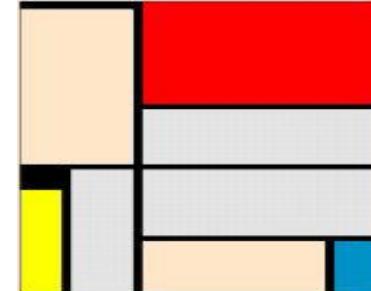
yes



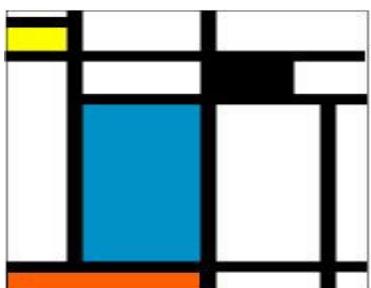
yes



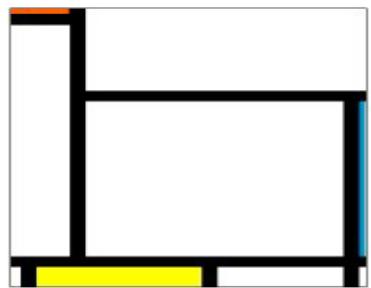
no



yes



no



?

Knowledge-Based Recommender Systems

Training data

Number	Lines	Line types	Rectangles	Colours	Mondrian?
1	6	1	10	4	No
2	4	2	8	5	No
3	5	2	7	4	Yes
4	5	1	8	4	Yes
5	5	1	10	5	No
6	6	1	8	6	Yes
7	7	1	14	5	No

Test instance

Number	Lines	Line types	Rectangles	Colours	Mondrian?
8	7	2	9	4	

Knowledge-Based Recommender Systems

	Lines	LinesT	Rect	Colors	Class	Distance to test
Train1	4	2	8	5	no	3,32
Train2	5	2	7	4	yes	2,83
Train3	5	1	8	4	yes	2,45
Train4	5	1	10	5	no	2,65
Train5	6	1	8	6	yes	2,65
Train6	7	1	14	5	no	5,20
test	7	2	9	4		
Train1	-0,32	0,32	-0,11	0,06	no	0,80
Train2	-0,08	0,32	-0,21	-0,28	yes	0,52
Train3	-0,08	-0,16	-0,11	-0,28	yes	0,69
Train4	-0,08	-0,16	0,08	0,06	no	0,77
Train5	0,16	-0,16	-0,11	0,39	yes	0,86
Train6	0,40	-0,16	0,47	0,06	no	0,76
test	0,40	0,32	-0,02	-0,28		

Feature values are not normalized

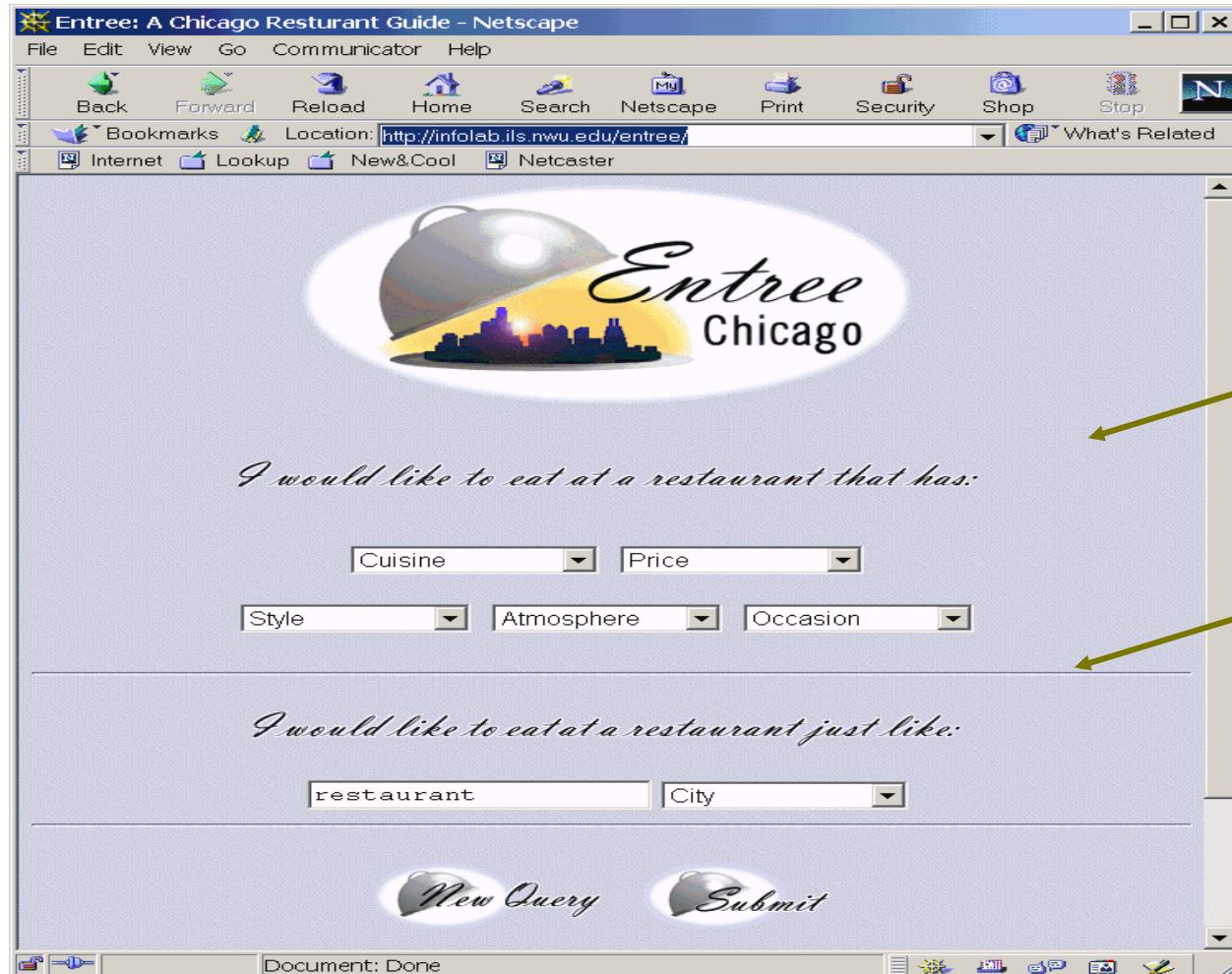
Feature values are normalized

What is the difference between this feature value normalization and vector Normalization in IR?

$$x' = (x - \text{avg}(X)) / 4 * \text{stdev}(X), \text{ where } x \text{ is a feature value of the feature } X$$

Knowledge-Based Recommender Systems

Example of CBR Recommender System



Entree is a restaurant recommender system – it finds restaurants:

1. matching some user goals (case features)
2. or similar to restaurants the user knows and likes

Knowledge-Based Recommender Systems

The Product is the Case

- In Entrée a case is a restaurant – **the case is the product**
- The **problem** component is the description of the restaurant given by the user
- The user will input a partial description of it – this is the only difficulty
- The **solution** part of the case is the restaurant itself – i.e. the name of the restaurant
- The assumption is that the needs of the user can be modeled as the features of the product description

Knowledge-Based Recommender Systems

Partial Match

The screenshot shows a Netscape browser window with the title "Entree: A Chicago Restaurant Guide - Netscape". The URL in the address bar is <http://infolab.lis.nwu.edu/cgi-bin/entree/query.pl>. The main content area displays "Entree Results" with a logo. Below it, a section titled "We recommend:" lists "Dave's Italian Kitchen" with a map link. The restaurant's address is 906 Church St. (bet. Ridge & Sherman Aves.), Evanston, 708-864-6000. It is categorized as "Italian" and "below \$15". Descriptions include "Fair Decor, Excellent Service, Excellent Food, No Reservations, Weekend Brunch, Carry in Wine and Beer, Wheelchair Access, Long Drive". Below this, there are two rows of circular buttons with text: "less \$\$", "nicer", "cuisine", "traditional", "creative", "livelier", and "quieter". At the bottom, a section titled "For other suggestions, select:" lists several restaurants with their names in blue: Dave's Italian Kitchen, Dancing Noodles Cafe, Anna Maria Pasteria, Gusto Italiano, La Sorella di Francesca, Mia Francesca, Carlucci, Village, Rosebud, Spavone's Seven Hills, and Salvatore's.

In general, only a subset of the preferences will be matched in the recommended restaurant.

Knowledge-Based Recommender Systems

Nearest Neighbor

Entree: A Chicago Restaurant Guide - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: http://infolab.ils.nwu.edu/cgi-bin/entree/query.pl What's Related

Internet Lookup New&Cool Netcaster

 *Entree Results*

The Washington DC restaurant you chose is:

Parioli
4800 Elm St. (Wisconsin Ave.), Bethesda, MD, 301-951-8600
Italian \$15-\$30
Excellent Decor, Excellent Service, Extraordinary Food, Authentic, Catering for Special Events, Takeout Available, Delivery Available, Health Conscious Menus, Dining Outdoors, Parking/Valet, Private Rooms Available, Private Parties, No Smoking Allowed, Weekend Dining, Wheelchair Access

We recommend:

Stefani's ([map](#))
1418 W. Fullerton Ave. (Southport Ave.), Chicago, 312-348-0111 601 Skokie Blvd. (bet. Dundee & Lake Cook Rds.), Northbrook, 708-564-3950
Pizza, Italian \$15-\$30
Excellent Decor, Excellent Service, Excellent Food, Dining Outdoors, Private Rooms Available, Private Parties, Weekend Brunch, Parking/Valet

Document: Done

Knowledge-Based Recommender Systems

Recommendation in Entree

- The system first selects from the database the set of all restaurants that satisfy the largest number of logical constraints generated by considering the input features type and value
- If necessary, implicitly relaxes the lowest important constraints until some restaurants could be retrieved
 - Typically the relaxation of constraints will produce many restaurants in the result set
- Sorts the retrieved cases using a similarity metric
 - this takes into account all the input features.

Knowledge-Based Recommender Systems

Similarity in Entree

- This similarity metric assumes that the user goals, corresponding to the input features (or the features of the source case), could be **sorted** to reflect the importance of such goals from the user point of view
- Hence the **global similarity metric** (algorithm) sorts the products **first** with respect the **most important goal** and then iteratively with respect to the remaining goals (multi-level sort)
- *Attention: it does not work as a maximization of a Utility-Similarity defined as the sum of local utilities.*

Knowledge-Based Recommender Systems

File Edit View Go Bookmarks Tools Help

 Powered by Trip@dvice

[Home](#) [Travel Plan](#) [My Travels](#) [My profile](#) [FAQs](#)

[Are you already registered? Click here.](#)

Please tell us what you'd like to do on this trip. Your answers will help the system to make the best possible recommendations. (The answers you give apply only to this trip. [Why?](#))

Tip: If you'd like to save your travel plans, please [register](#) now.

TRAVEL COMPANIONS
Who will you travel with?

TRANSPORT
How will you travel?

ACCOMMODATION
What kind of accommodations do you want?

What's your daily budget (for accomodation)?

DEPARTURE
Where are you from?

PERIOD
When do you want to travel?

How long do you want to stay?

PREVIOUS VISITS
Have you ever visited Trentino?

ACTIVITIES
What would you like to do on this trip?
 Sports
 Adventure
 Relaxing
 Art & Culture
 Wine and Food
 Environment and Landscape
 Fitness and Wellness

[NEXT](#)

© 2003 - eCommerce & Tourism Research Lab - ITC - ist - All rights reserved
[Webmaster](#)

Done

DATA ANALYTICS

Knowledge-Based Recommender Systems



File Edit View Go Bookmarks Tools Help



NutKing



Home **Travel Plan** **My Travels** **My profile** **FAQs**

Locations **Accommodation** **Sporting activities** **Events** **Culture** **Maps**

[Are you already registered? Click here.](#)

Search
[Search by location](#)

Altitude (min-max)
 m m

Activities:



Area
[\[List of Areas\]](#)

3 Locations found.

The elements found meet all research criteria. The number of green trees  indicates how suitable it is for your request (for more information [>>>](#)). To include a location in your travel plan, click on **Add** 

ARCO [Search on the web](#) [Why this recommendation for you?](#) 

Alto Garda, Valle di Ledro, Valle dei Laghi



Arco is situated on the northern fringe of Lake Garda. It is a historical and cultural centre of great interest with a well documented tradition of hospitality and tourism. The town of Arco, as well as the whole area surrounding it, enjoys the natural benefits of a mild climate and the florid ... [more >](#)

Altitude: 91 **Activities:** 

[How to get to](#)  [Where is it?](#)  [Add](#) 

[Other User's feedback](#) [Give us your feedback](#)

TRENTO [Search on the web](#) [Why this recommendation for you?](#) 

Valle dell'Adige, Trento e Monte Bondone



Trento is a city that hides itself from the hasty traveller. Shaped by the old course of the river Adige, it withdraws behind the splendid walls of painted edifices portraying illustrious visitors of long ago: mythological figures of ancient times, German emperors on their way to Roma, bishops and ... [more >](#)

[javascript:popUp\('why.do?travelasset=TRAVELASSET-473&myTaName=ARCO&score=52&type=LOCATION&iicodep=50','6...'\)](#)

Knowledge-Based Recommender Systems

Query Tightening



The screenshot shows the NutKing travel planning website interface. At the top, there are two cartoon squirrel icons, a tree icon, and the NutKing logo. The page is powered by Trip@dvice. The navigation menu includes Home, Travel Plan, Accommodation, My Travels, Sporting activities, My profile, Events, Culture, FAQs, and Maps. Below the menu, the breadcrumb navigation shows: Home > Travel Plan > Accommodation. A registration link "Are you already registered? Click here." is also present.

Search
-> [Suggestions...](#)

Area
Valle dell'Adige, Trento e

Location
[List of Locations]

Accommodation type
[Select a type]

Category
3 ★ 3 ★

Cost day / person
min. [] € max. [] €

Number of beds
2

Icons for various amenities: swimming pool, sauna, search, lift, car park, TV, children, disabled access, and a camera.

24 results

I found 24 results that matched your request. Below we suggest ways to modify your request and receive more refined results.

- ↳ Add "**Cost**" to your query.
- ↳ Add "**Car park**"  to your query.
- ↳ Add "**TV**"  to your query.

Skip the refinement  [Get all results](#)

Search Reset

Knowledge-Based Recommender Systems

File Edit View Go Bookmarks Tools Help

  **NutKing**  Powered by **Trip@device**

Home Travel Plan My Travels My profile FAQs

Locations Accommodation Sporting activities Events Culture Maps

 > Travel Plan > Accommodation Welcome fmr59 - ([sign-out](#))

Current travel plan **TRAVEL_18-08-2004**

Search 

> [Suggestions...](#)

Area

Location

Accommodation type

Category  

Cost day / person
min. € max. €

Number of beds

[Legenda](#)

[Search](#) [Reset](#)

Sorry. We don't have anything to satisfy your requirements.
You can change your request by:

Trying to remove "**Location**" from the research and you obtain **15** results. Click on [Remove and Get results](#) 

Trying to modify "**Cost**" from the research and you obtain **2** results. Click on [Modify and Get results](#) 

Trying to remove "**Outdoor swimming pool**" from the research and you obtain **1** result. Click on [Remove and Get results](#) 

Trying to remove "**Solarium**" from the research and you obtain **6** results. Click on [Remove and Get results](#) 

© 2003 - eCommerce & Tourism Research Lab - ITC - ist - All rights reserved
[Webmaster](#)

Done

Knowledge-Based Recommender Systems

 **NutKing** Powered by Trip@dvice

Home | Travel Plan | My Travels | My profile | FAQs | Locations | Accommodation | Sporting activities | Events | Culture | [Maps](#)

[Home](#) > [Travel Plan](#) > Suggested Travels Are you already registered? [Click here.](#)

> [New Travel Plan](#)

We recommend

 These are the travel plans we recommend.
We have examined travel plans of users with similar preferences to yourself.
Click on the name for details.

Garda Lake in July	
Description: From 2002-07-01 To 2002-07-13	
Locations: RIVA DEL GARDA	
Accommodation: RESIDENCE SPIAGGIA	
Sporting activities: Malga Grassi ; Fraglia Vela Riva	

Vacanza in montagna 2002	
Description: Con la famiglia nel Primiero	
From: 2002-09-06 To: 2002-09-15	
Locations: IMER	
Accommodation: AL BIVIO	
Sporting activities: Passeggiata Passo Rolle e Baita Segantini ; Passo Brocon -Col del Boia e rit.	
Culture: Palazzo del Dazio o delle Miniere ; Sentiero Etnografico nell' Ecomuseo del Vanoi ; Castel Pietra ; Museo della Grande Guerra sul Lagorai	

TRAVEL_09-12-2002	
Description: val di fassa	
From: 2002-07-01 To: 2002-07-01	
Accommodation: RESIDENCE DOLOMIA	
Sporting activities: Pozza-Buffaure-Sela Brunech-Rif. Passo S. Nicolò	
Culture: Torre di Pozza ; Molin de Pezol - mulino ad acqua	

Knowledge-Based Recommender Systems

[New Travel Plan](#)

[Suggested Travels](#)

Suggested Travel Plan

Here's a trip we recommend. If you like you can [save this as your trip](#).

Garda Lake in July

General information			
Name:	Garda Lake in July		
Description:			
Start date:	2002-07-01		
End date:	2002-07-13		
Travel plan preferences			
Travel companions:	with family	Activities:	Sports
Accommodation:	apartment / between 20 and 40 €	Relaxing	Wine and Food
Transport:	car	Environment and	Landscape
Period:	July		
Length of stay:	two weeks		

The travel plan includes:

Locations: RIVA DEL GARDA

Description



In Riva, Lake Garda is particularly charming. The colour blue of the water is more intense, the sunlight more vivid and the air is oxygenated by the mountains and purified by the Lake Garda breeze which blows and fills the coloured sails of the windsurfs. The beaches, surrounded by vegetation or...[more](#)

Services

 Museums	 Mountain bike	 Mountaineering
 Hiking	 Places of historic interest	 Swimming
 Windsurfing	 Eno-gastronomic events	 Canoeing
 Classical music	 Sailing	
 Pop music	 Jazz	

[Give us your feedback](#)

Accommodation: RESIDENCE SPIAGGIA

Details



Address:
Telephone:
Fax:
Web: www.rivadelgarda.com/spiaggia
E-mail:
Max Cost: 25 €

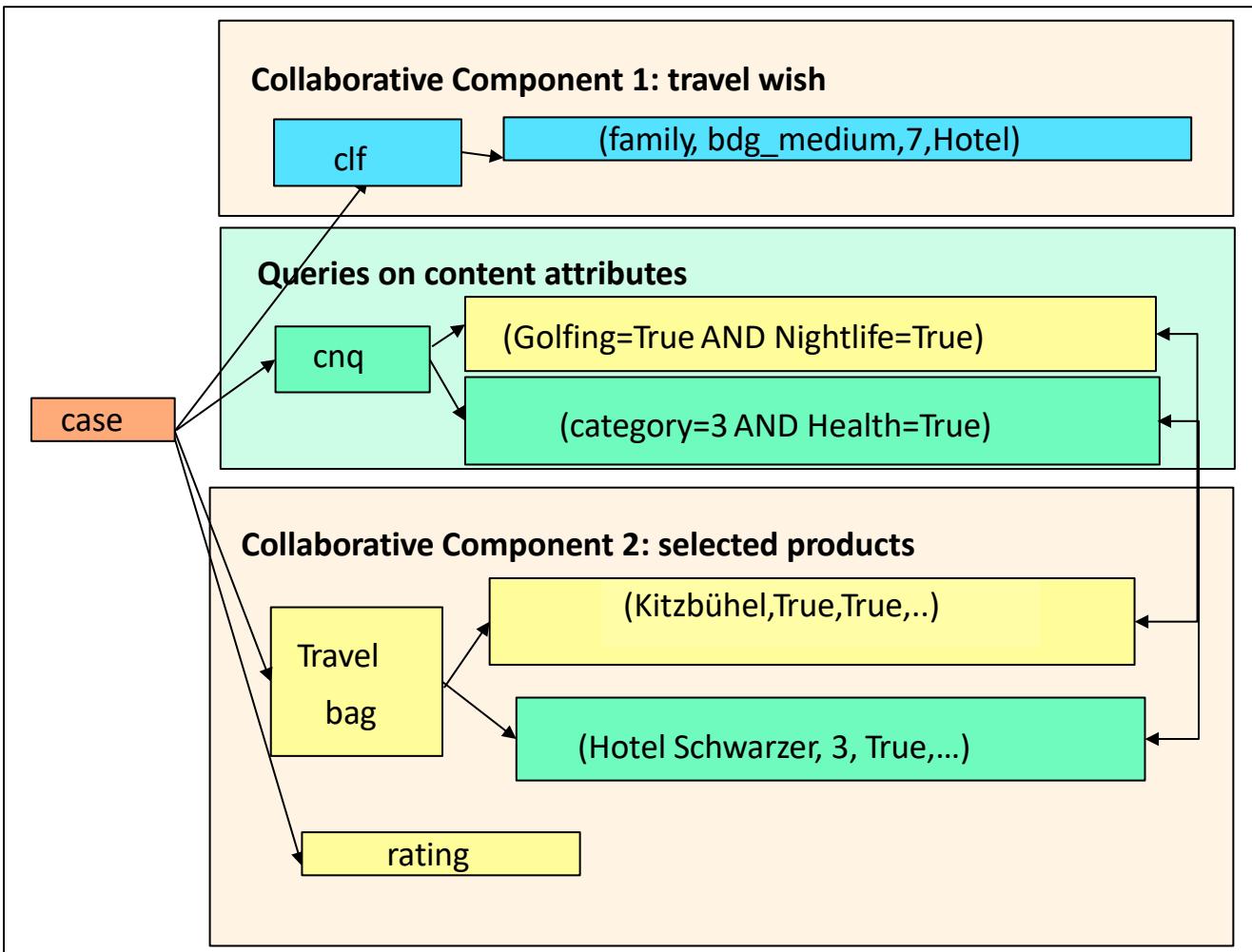
Knowledge-Based Recommender Systems

NutKing as a CBR System, NutKing is a hybrid case-based recommender system

- **Problem** = recommend a set of tourism related products and build a travel plan
- **Cases** = All the recommended travel plans that users have built using the system (how they were built and what they contain)
- **Retrieval** = search in the memory travel plans built during “similar” recommendation sessions
- **Reuse**
 1. extract from previous travel plans elementary components (items) and use them to build a new plan
 2. rank items found in the catalogues

Knowledge-Based Recommender Systems

Travel Plan Model and Interaction Session



Knowledge-Based Recommender Systems

July in Fiemme Valley

 NutKing

Thanks for planning your trip with us. Remember that you can review details of your trip by clicking on My Travels. Bon Voyage! Come back to NutKing soon.

Locations: TESERO

Description

 Situated on terraces facing the Lagorai mountain range, Tesero is called the citadel of the Fiemme craftsmanship. This is expressed in various fields, from artistic to productive, and is constantly growing; renowned the musical instruments (organs and pianos), the furniture, doors, sport articles and textiles. Tesero has always been the artistic and cultural centre of Fiemme as evidenced by its very rich history and tradition: churches, shrines, sundials, the frescoes on the old houses. Worth mentioning the important Alpe di Pampeago ski area which is part of the Ski Center Latemar and the Cross Country Ski Centre in Lago di Tesero, the place of the 1991 World Championships and those planned for 2003.

Services

 Downhill skiing	 Cross country skiing	 Snowboarding
 Cycle paths	 Alpine skiing	 Mountaineering
 Mountain bike	 Horse riding	 Folklore

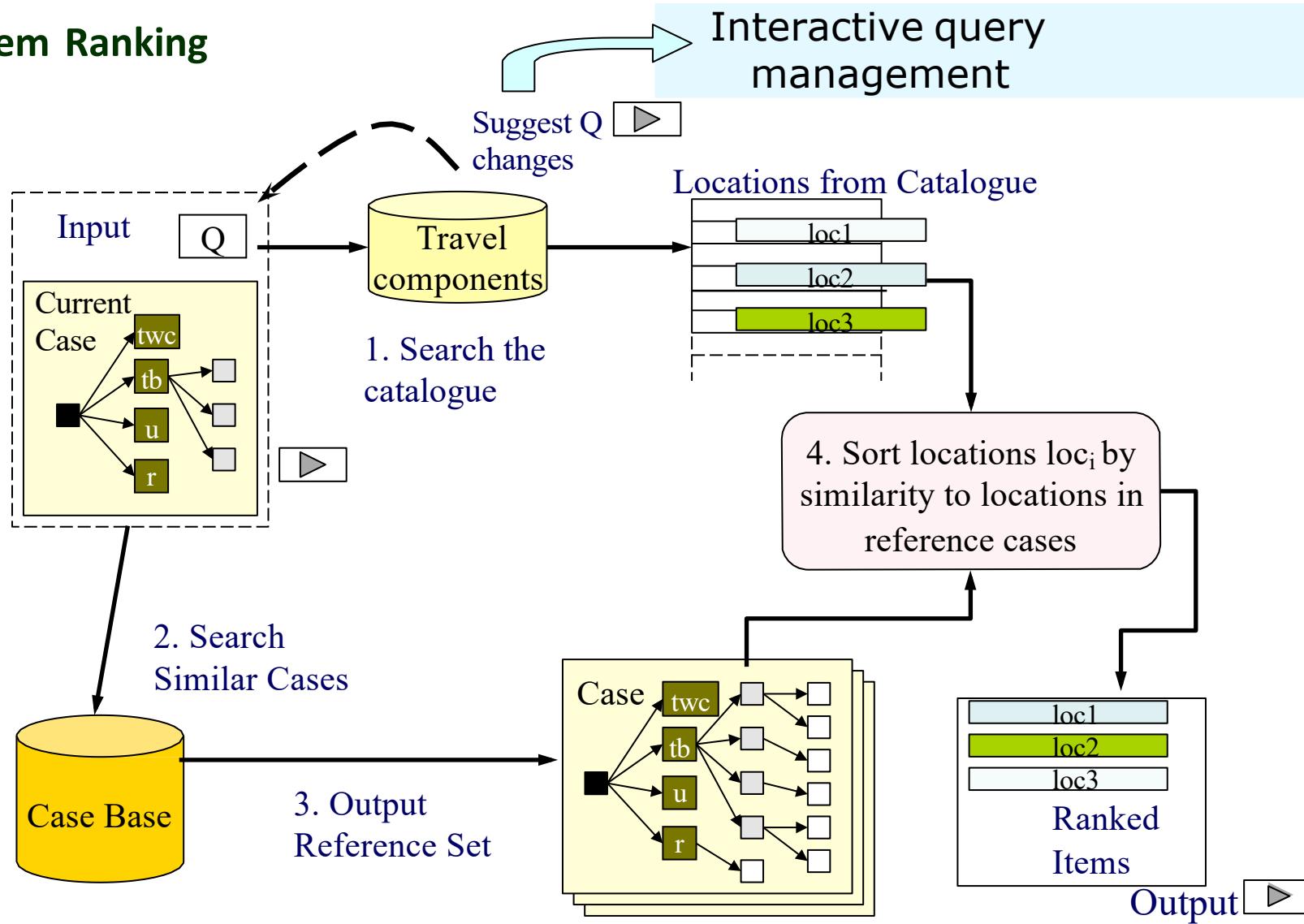
Accommodation: POZZOLE

Details

 **Address:** VIA POZZOLE, 8 38038 STAVA
Telephone: 0462813788
Fax: 0462813788
Web:
E-mail:
Max Cost: 32 €

Knowledge-Based Recommender Systems

Item Ranking



Knowledge-Based Recommender Systems

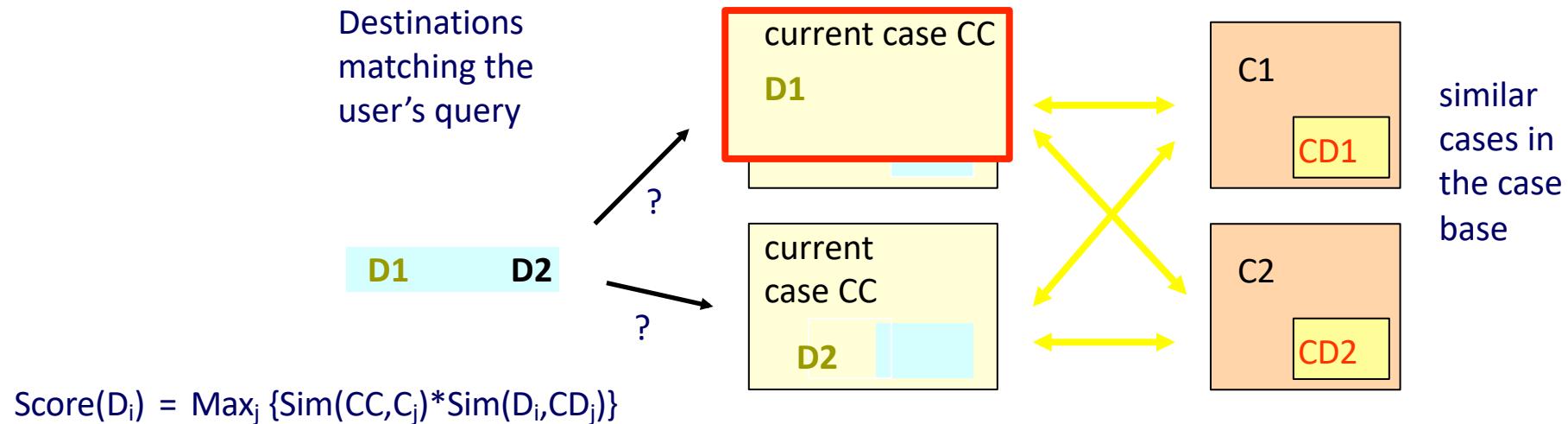
Rank using Two-Fold Similarity

Given the current session case c and a set of retrieved products R (using the interactive query management facility - IQM)

1. retrieve 10 cases (c_1, \dots, c_{10}) from the repository of stored cases (recommendation sessions managed by the system) that are most **similar** to c with respect to the collaborative features
2. extract products (p_1, \dots, p_{10}) from cases (c_1, \dots, c_{10}) of the same type as those in R
3. For each product r in R compute the $\text{Score}(r)$ as the maximum of the product of a) the similarity of r with p_i , the similarity of the current case c and the retrieved case c_i containing p_i
4. sort and display products in R according to the $\text{Score}(r)$.

Knowledge-Based Recommender Systems

Example: Scoring Two Destinations



Sim(CC,C1)	0.2
Sim(CC,C2)	0.6

Sim(D1, CD1)	0.4
Sim(D1, CD2)	0.7
Sim(D2, CD1)	0.5
Sim(D2, CD2)	0.3

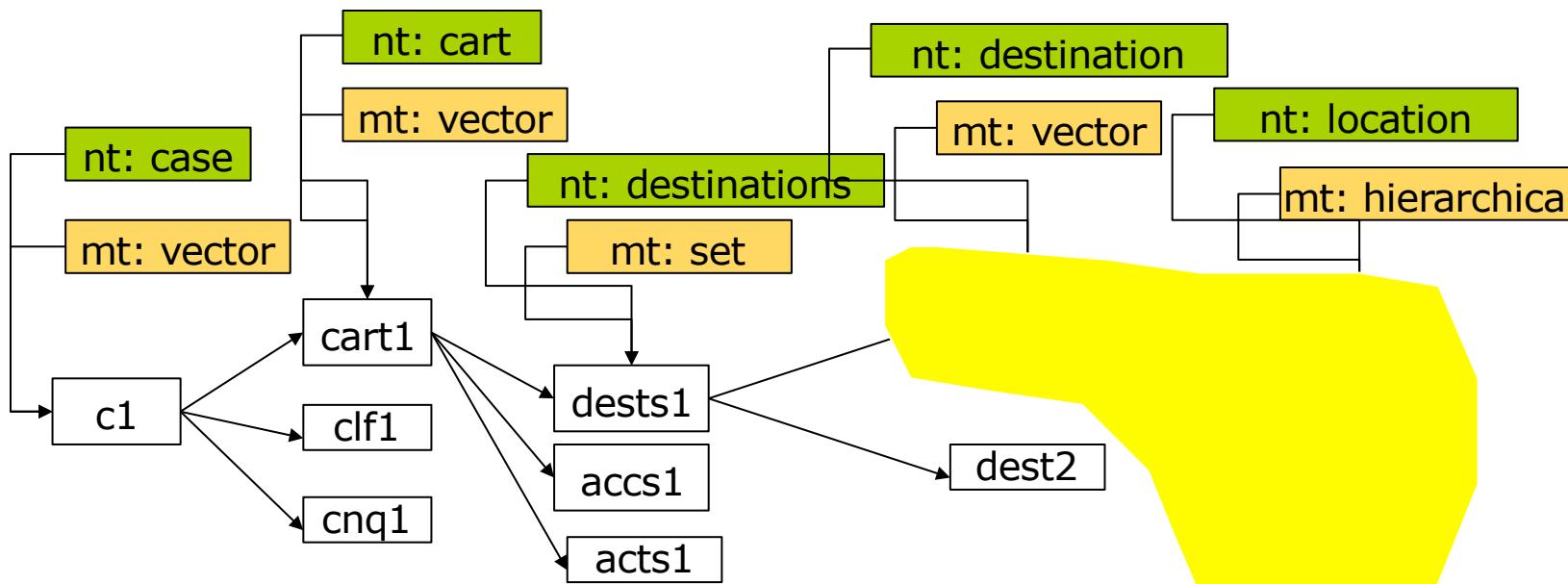
Knowledge-Based Recommender Systems

Tree-based Case Representation

- A case is a rooted tree and each node has a:

node-type: similarity between two nodes in two cases is defined only for nodes with the same node-type

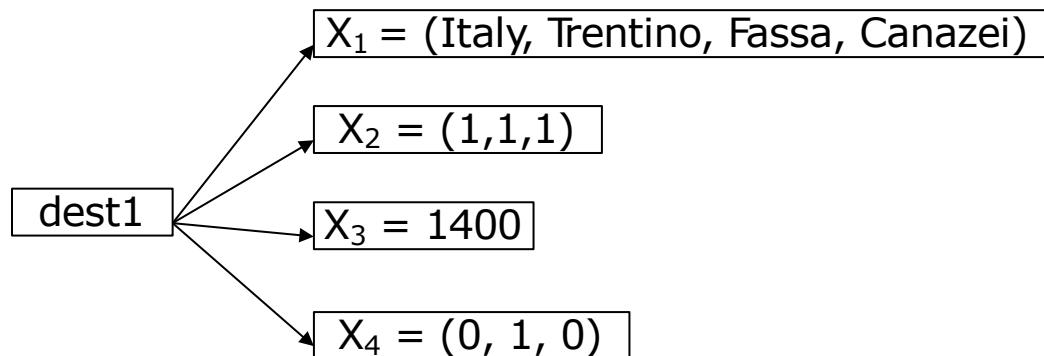
- Metric type:** node content structure - how to measure the node similarity with another node in a second case



Knowledge-Based Recommender Systems

Item Representation

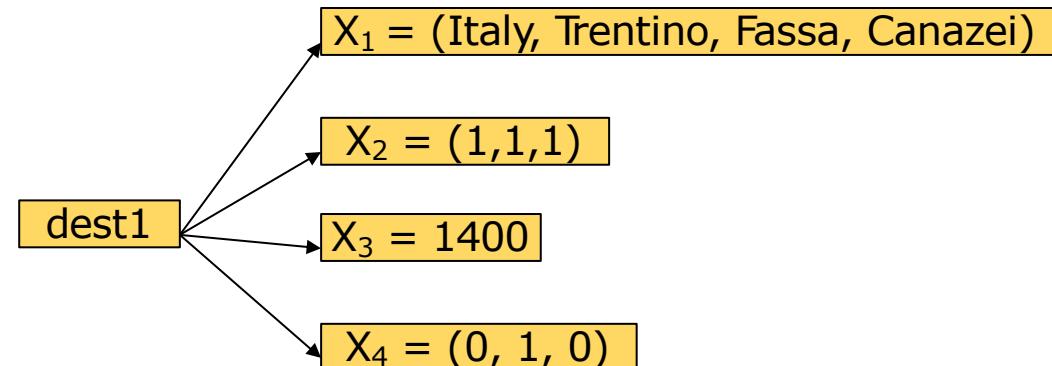
	Node Type	Metric Type	Example: Canazei
X ₁	LOCATION	Set of hierarchical related symbols	Country=ITALY, Region=TRENTINO, TouristArea=FASSA, Village=CANAZEI
X ₂	INTERESTS	Array of Booleans	Hiking=1, Trekking=1, Biking=1
X ₃	ALTITUDE	Numeric	1400
X ₄	LOCTYPE	Array of Booleans	Urban=0, Mountain=1, Rivereside=0



Knowledge-Based Recommender Systems

Item Query Language

- For querying purposes items x are represented as simple vector features $x=(x_1, \dots, x_n)$



$(\text{Italy}, \text{Trentino}, \text{Fassa}, \text{Canazei}, 1, 1, 1, 1400, 0, 1, 0)$

- A query is a conjunction of constraints over features:

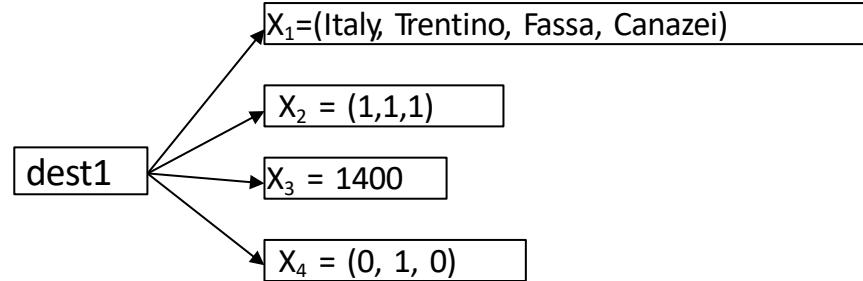
$$q = c_1 \wedge c_2 \wedge \dots \wedge c_m \quad \text{where } m \leq n \text{ and}$$

$$c_k = \begin{cases} x_{i_k} = \text{true} & \text{if } x_{i_k} \text{ is boolean} \\ x_{i_k} = v & \text{if } x_{i_k} \text{ is nominal} \\ x_{i_k} \in [l, u] & \text{if } x_{i_k} \text{ is numerical} \end{cases}$$

Knowledge-Based Recommender Systems

Item Similarity

If X and Y are two items with same node-type



$$d(X, Y) = \left(\frac{1}{\sum_i w_i} \sum_i w_i d_i(X_i, Y_i)^2 \right)^{1/2} \text{ where } 0 \leq w_i \leq 1,$$

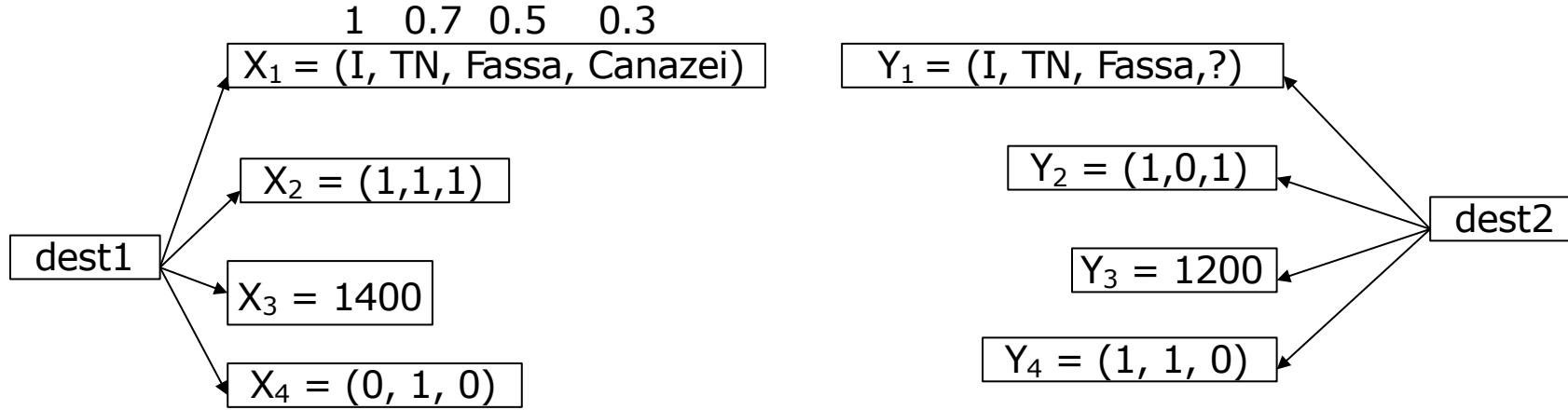
and $i=1..n$ (number of features).

$$d_i(X_i, Y_i) = \begin{cases} 1 & \text{if } X_i \text{ or } Y_i \text{ are unknown if } X_i \text{ is symbolic} \\ \text{overlap}(X_i, Y_i) & \text{if } X_i \text{ is finite integer or real if } X_i \text{ is an array of Boolean if } X_i \text{ is a hierarchy} \\ |X_i - Y_i|/\text{range}_i & \text{if } X_i \text{ is a circular feature (month) if } X_i \text{ is a date} \\ \text{Jaccard}(X_i, Y_i) & \\ \text{Hierarchical}(X_i, Y_i) & \\ \text{Modulo}(X_i, Y_i) & \\ (X_i, Y_i) & \end{cases}$$

$$\text{Sim}(X, Y) = 1 - d(X, Y) \quad \text{or} \quad \text{Sim}(X, Y) = \exp(-d(X, Y))$$

Knowledge-Based Recommender Systems

Item Similarity Example

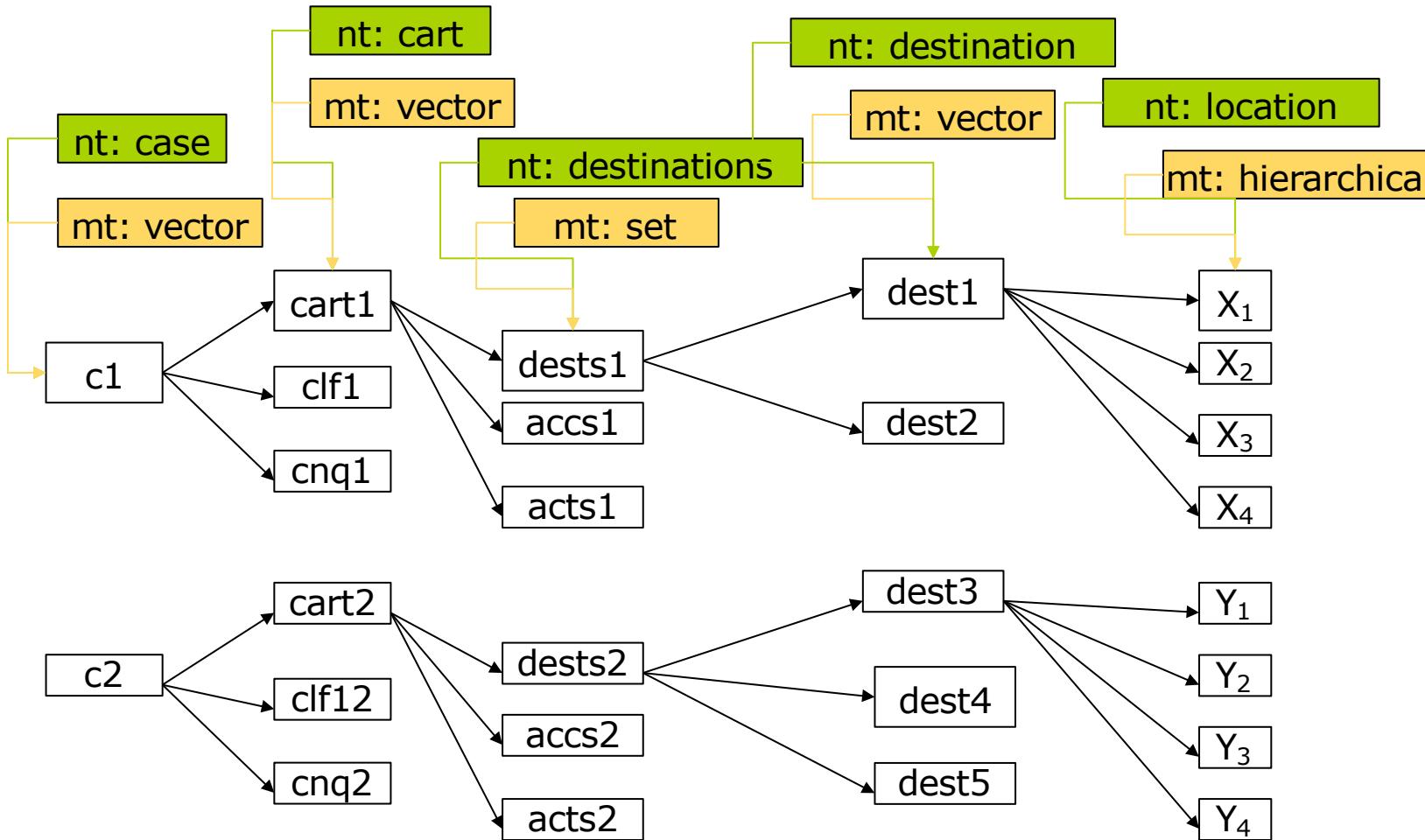


$$\begin{aligned}
 Sim(dest_1, dest_2) &= \exp\left(-\frac{1}{\sqrt{4}}\sqrt{d(X, Y)^2 + \dots + d(X, Y)}\right) \\
 &= \exp\left(-\frac{1}{\sqrt{4}}\sqrt{(0.3)^2 + (1 - 2/3)^2 + ((1400 - 1200)/2000)^2 + (1 - 1/2)^2}\right) \\
 &= \exp\left(-\frac{1}{\sqrt{4}}\sqrt{0.461}\right) = \exp(-0.339) = 0.712
 \end{aligned}$$

3 in the union

2 in the union

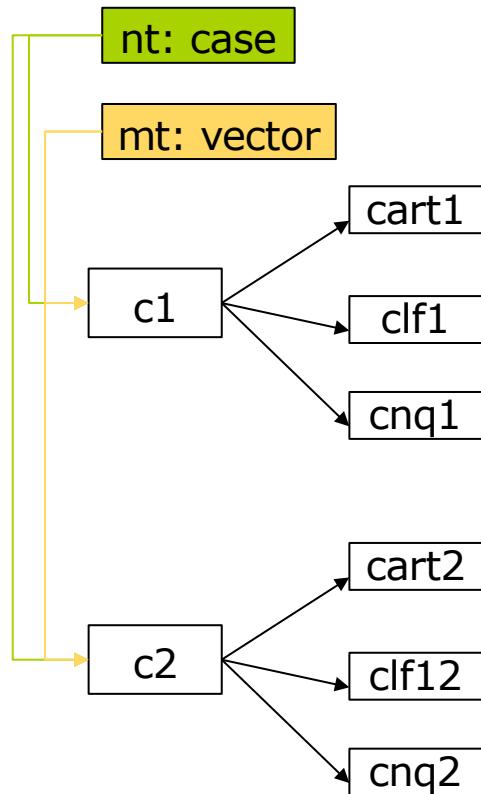
Case Distance



Knowledge-Based Recommender Systems

Case Distance

$$d(c_1, c_2) = \frac{1}{\sqrt{\sum_{i=1}^3 W_i}} \sqrt{W_1 d(cart_1, cart_2)^2 + W_2 d(clf_1, clf_2)^2 + W_3 d(cnq_1, cnq_2)^2}$$



Knowledge-Based Recommender Systems

CBR Knowledge Containers

- CBR is a knowledge-based approach to problem solving
- The knowledge is “contained” into four **containers**
 1. **Cases:** the instances belonging to our case base
 2. **Case representation language:** the representation language that we decided to use to represent cases
 3. **Retrieval knowledge:** the knowledge encoded in the similarity metric and in the retrieval algorithm
 4. **Adaptation knowledge:** how to reuse a retrieved solution to solve the current problem.

Knowledge-Based Recommender Systems

Conclusions

- Knowledge-based systems exploits knowledge to map a user to the products she likes
- KB systems uses a variety of techniques
- Knowledge-based systems requires a big effort in term of knowledge extraction, representation and system design
- Many KB recommender systems are rooted in Case-Based Reasoning
- Similarity of complex data objects is required often required in KB RSs.
- NutKing is a hybrid case-based recommender system
- The case is the recommendation session.

References

Text Book:

“Business Analytics, The Science of Data-Driven Making”, U. Dinesh Kumar, Wiley 2017

“Recommender Systems, The text book, Charu C. Aggarwal, Springer 2016
Section 5

DATA ANALYTICS

Image Courtesy

https://www.ics.uci.edu/~welling/teaching/CS77Bwinter12/presentations/course_Ricci/15-KnowledgeBased.pdf

https://www.researchgate.net/publication/331829548_Knowledge_based_Recommendation_System_in_Semantic_Web-A_Survey

<http://www.visitfinland.com/web/guest/travel-planner/home>

https://www.ics.uci.edu/~welling/teaching/CS77Bwinter12/presentations/course_Ricci/15-KnowledgeBased.pdf

https://www.saedsayad.com/k_nearest_neighbors.htm



THANK YOU

Jyothi R.

Assistant Professor,
Department of Computer Science

jyothir@pes.edu

