

# Modeling Online Reviews with Multi-grain Topic Models


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# Online User Reviews

**Cafe D'Alsace**  
 ★★★★★ 89 reviews  
 1695 2nd Ave  
 New York, NY 10128  
 (212) 722-5133  
[uppereast.com](http://uppereast.com)



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**Your review**

★★★★★ **Good restaurant on UES** - Ryan - Jul 25, 2007  
 Cafe D'Alsace is one of the best restaurants I have found on the upper east side. The food is very good, even the simple things like a hangar steak and fries is cooked well and tasty. The cheese appetizer is excellent, though I wish they would occasionally change some of the options. Great beer and wine selection, beers mostly from bottle. Though they say you should make reservations, if there is just two of you, they will almost certainly squeeze you in without too much of a wait. Anymore and I would definitely make sure you reserve.  
[Edit](#) - [Delete](#)

**All reviews**

★★★★★ **Cafe d'Alsace** - May 24, 2006  
 Will Upper East Siders get their fill of choucroute garni and baeckoffe in the neighborhood formerly home to a bevy of German restaurants? Strasbourg meets Schaller und Weber? ...  
 Was this review helpful? [Yes](#) - [No](#)  
[More from NewYorkCity.com »](#)

★★★★★ **Café D'Alsace Restaurant New York New...**  
 Upper East Siders, starved for well-prepared food in a sleek setting, had often migrated downtown when their stomachs rumbled. But **Café D'Alsace** gives locals one less reason to ...  
 Was this review helpful? [Yes](#) - [No](#)  
[More from Gayot.com »](#)

**Luxury and Performance**  
 Date Posted: 08/15/2007  
 By: Luxury Feel **RATING: 8.9**

**DETAILED RATINGS:**

<b>Performance:</b> 9	<b>Fun-to-Drive:</b> 10	<b>Build Quality:</b> 9
<b>Comfort:</b> 9	<b>Interior Design:</b> 9	<b>Reliability:</b> 9
<b>Fuel Economy:</b> 7	<b>Exterior Design:</b> 9	

**Vehicle**  
 2005 Mazda MAZDA3 s 4dr Sedan (2.3L 4cyl 5M)

**Review**  
 I've recently bought a used Mazda3s w/most of the options (leather, sunroof, abs w/side, spoiler, and 6 CD changer). For the price that I paid for it, I feel like driving a luxury vehicle. It handles great and has an appealing look. The leather feels so comfortable. I actually slept in my the car, learned it was more comfy than my previous cars. I average 26 city and 32 HW. I'm sure you can achieve similar results if you cruise as much as possible on highways but everything else are lot better

**"Great little hotel"**

**Favorite Features**  
 Leather, sunroof, and steering v

**Suggested Improvements**  
 Mazda should have a trunk rele

7 out of 7 people found this review helpful  
 Was this review helpful?  Yes  No  
[Report inappropriate post](#)

**I found THE car!!**  
 Date Posted: 07/26/2007

**DETAILED RATINGS:**

<b>Performance:</b> 10	<b>Fun-to-Drive:</b> 10
<b>Comfort:</b> 10	<b>Interior De:</b> 10
<b>Fuel Economy:</b> 8	<b>Exterior De:</b> 8

**Vehicle**  
 2005 Mazda MAZDA3 s 4dr W

**Review**  
 When I test drove this car I knew that I would love it. For me, ever miles or more). Gas mileage co help if I would keep my foot out

**"Perfectly located clean, small hotel with great stuff."**

Jan 18, 2008  
**3/3 found this review helpful**

The hotel is in a quiet side street in an area with several Japanese restaurants. The location is excellent if you want to visit the Louvre, Opera or Place de Concorde. The rooms are very small but have every thing you need and are very reasonable for a hotel in this location. The staff were extremely freindly. I would not... [more](#)

**"Perfectly located clean, small hotel with great stuff."**

Jan 8, 2008  
**3/3 found this review helpful**

This small hotel is perfectly situated on a quiet side street at the halfway point between Opera and Louvre, there are a few Japanese restaurants within two blocks of the hotel, and the hotel is close to the metro and to the OpenTour bus stop. Also the supermarket is a 2 min walk. We have been walking to the Louvre... [more](#)

11/04/04 02:53 PM

11/02/04 10:16 PM

10/29/04 12:47 PM

**Lou Lumenick**  
 New York Post  
 ★ Top Critic

It is in Ray's many music sequences that Hackford's direction is most confident.

[Full Review | Comment](#)

**Jack Mathews**  
 New York Daily News  
 ★ Top Critic

What can Ray tell us about such a familiar

9.8

# Sentiment Classification

- Sentiment and Opinion Classification (Wiebe, 00), (Pang et al, 02), (Turney, 02)
  - However, sentiment is often provided by the user
    - Isn't this just a contrived task?
- Not always:
  - Train sentiment classifiers on reviews use it 4 blogs
  - Train review ratings, apply on phrases or sentences
  - Train on one blog, apply to unannotated blogs

# Sentiment Summarization

- Take a set of reviews for an entity and summarize them
- **Aspect-based summarization** (Hu & Liu 2004)
  - Summarize along key aspects

## **Nikos' Fine Dining**

Food	4/5	“Best fish in the city”, “Excellent appetizers”
Decor	3/5	“Cozy with an old world feel”, “Too dark”
Service	1/5	“Our waitress was rude”, “Awful service”
Value	5/5	“Good Greek food for the \$”, “Great price!”

- Many real world manual examples, e.g., Zagat.com

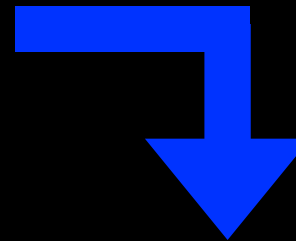
# Text Segmentation

- Focus on models for segmenting text

The chicken was great. On top of that our service was excellent and the price was right. Can't wait to go back!

We went there for our anniversary. My soup was cold and expensive plus it felt like they hadn't painted since 1980.

The food is only mediocre, but well worth the cost. Wait staff was friendly. Lot's of fun decorations.



<b>Food</b>	"The chicken was great", "My soup was cold", "The food is only mediocre"
<b>Decor</b>	"it felt like they hadn't painted since 1980", "Lots of fun decorations"
<b>Service</b>	"service was excellent", "Wait staff was friendly"
<b>Value</b>	"the price was right", "My soup was cold and expensive", "well worth the cost"

# Previous Work

- Hu and Liu '04
  - Aspect-based summarization
  - String-based aspects + lexicon sentiment
- Popescu and Etzioni '05: Opine system
- Gamon et al. '05
  - Aspect clusters: use most frequent word label
- Carenini '06
  - String-based + ontologies
- Mei et al. '07
  - Generative topic-sentiment models (at document level)

# Three Tasks

- Identify Aspects
  - Often we know this (pros-cons, tech specs, ontologies)
- Extract Mentions
  - We always have to do this
- Aggregate Sentiment
  - Again, we often know this (star ratings, eg, TripAdvisor)

## **Nikos' Fine Dining**

Food	4/5	“Best fish in the city”, “Excellent appetizers”
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# Aspect Identification and Extraction

## Nikos' Fine Dining

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- Common method: **String-based extraction**
  - Find frequently occurring nouns that are modified by opinion words
  - Take top K as relevant aspects
  - Extract all sentences / phrases that match
  - **Problem:** Get a long list of aspects w/ no clustering



# Aspect Identification and Extraction

- String-based example: restaurants
- Is list really summarization?
- How far down to get “cozy”, “fish”, “\$”, “waitress”, “dark”?
- We really want to cluster these

General

Food

Ambiance

Service

Value

food  
place  
pizza  
service  
restaurant  
atmosphere  
time  
wine  
meal  
prices  
value  
sauce  
hour  
price  
dim  
selection  
experience  
crust  
dining  
ingredients

## Nikos' Fine Dining

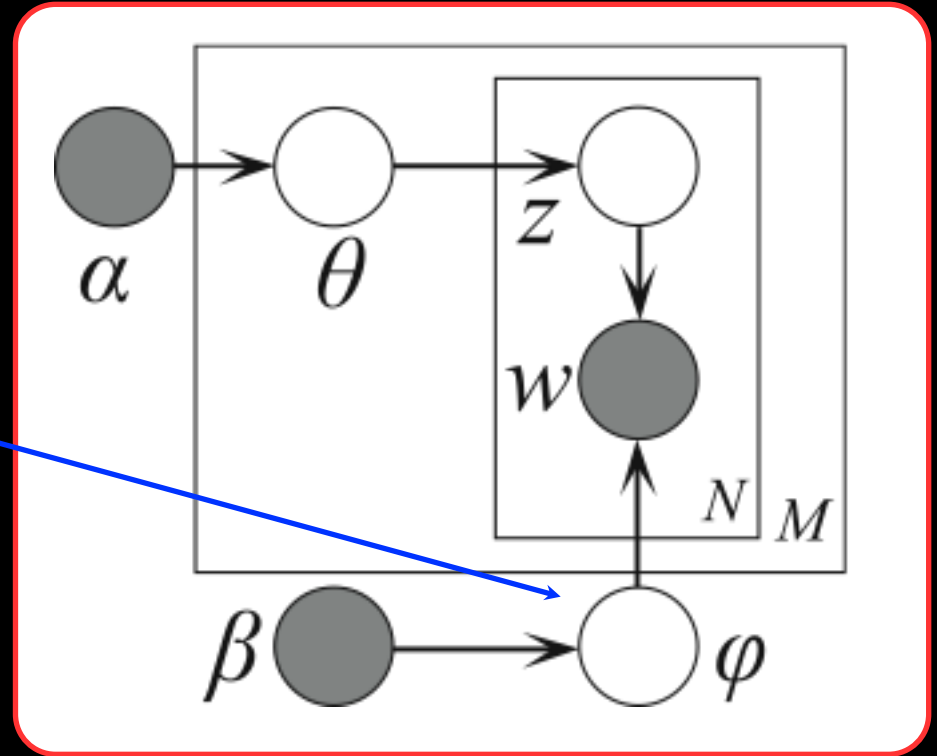
Food	4/5	“Best fish in the city”, “Excellent appetizers”
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# Topic Models

- Studied in ML and Data Mining
  - LSA, PLSA, LDA, Pachinko Allocation, ...
- Build semantic “topics” of data collections
  - e.g., newsgroups into “religion”, “politics”, “science”, ...
- **Simple hypothesis**
  - Topics in reviews correspond to clustered aspects
- We will focus on LDA type models (Blei et al. '03)
  - Others produce similar observations

# LDA

- Generative model of text
- Sample multinomial word distributions for each topic
- The for each document  $d$ :



- choose distribution of topics  $\theta_d \sim Dir(\alpha)$
- for each word  $i$  in document  $d$ 
  - choose topic  $z_{d,i} \sim \theta_d$ ,
  - choose word  $w_{d,i} \sim \varphi_{z_{d,i}}$ .

# Side Note: Inference

- All methods use collapsed Gibbs (Griffiths & Steyvers '04)
- A sample from the chain used to approx:
  - Distribution of words in topics
  - Distribution of topics in text fragments
- We tried variational techniques, but they didn't work for our models
- More details in the paper

# LDA

- Problem with LDA (and most other topic models)
  - Co-occurrences modeled at document level
  - Topics are about instances not aspects
    - e.g., iPod versus Creative Labs
  - Often clusters are meaningless

(Service??) Topic 0: product player did support bought work unit problem \$  
(Creative Labs) Topic 1: gigabeat deleted waiting jukebox creative playback  
(iPod) Topic 11: ipod apple mac firewire dock itunes x display aac

Most topics are incoherent. Only 4 out of first 40 can be viewed as aspects.

# LDA

- Simple solutions: LDA over sentences
  - Co-occurrence counts too sparse
  - Can use sliding window, but results look like LDA
  - Still can't distinguish aspect topics from the rest
- Another solution: **Multi-grain topic models**
  - Model **local topics** (aspects) and **global topics** (types)
  - Creates a **bottleneck** for local topics
  - Words generated from sliding windows

# Varying Granularity

“... public *transport* in *London* is straightforward, the *tube station* is about an 8 *minute walk* ... or you can get a *bus* for £ 1.50 ....

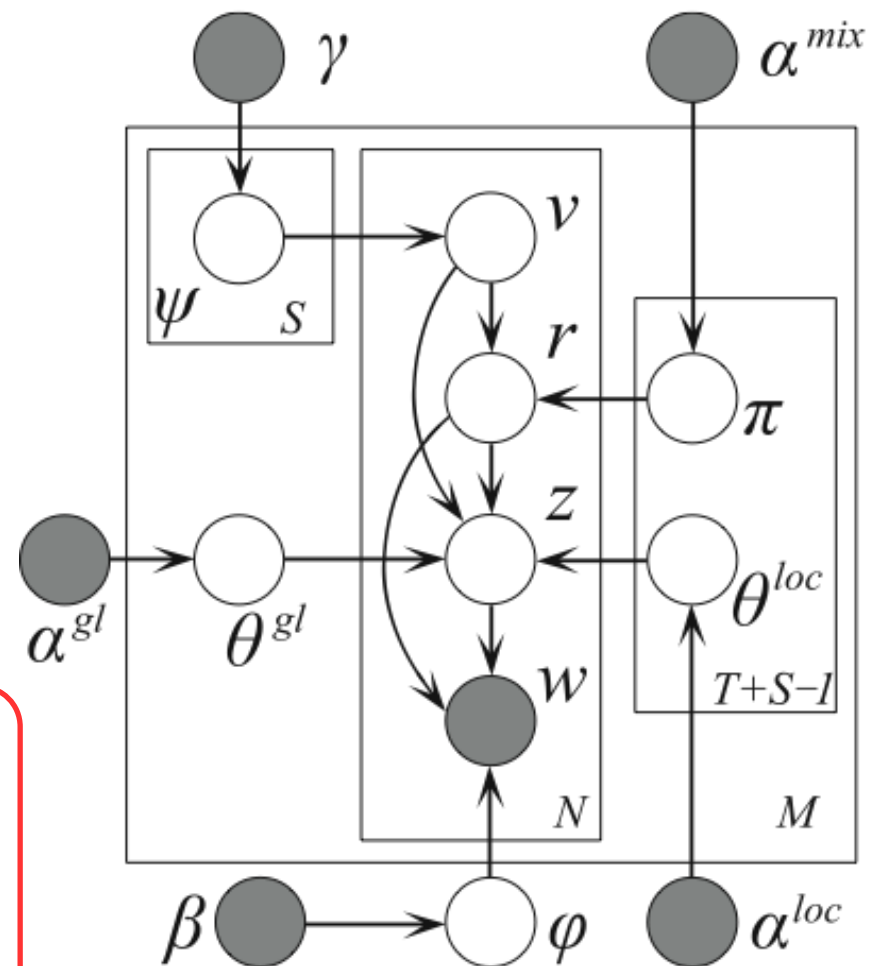
We had a stunning *view* (from the floor to ceiling *window*) of the *Tower* and the *Thames*.”

- Global topic *London*: *London, tube, £, Tower, Thames*
  - Global topic dist is assigned to the document
- Local topics:
  - *Location: transport, station, walk, bus, minute*
  - *View: view, window*
  - Local topic dist is assigned to current sliding window

# MG-LDA

- Draw global topic word dist.
- Draw local topic word dist.
- For each document  $d$ :

- Choose a distribution of global topics  $\theta_d^{gl} \sim Dir(\alpha^{gl})$ .
- For each sentence  $s$  choose a distribution  $\psi_{d,s}(v) \sim Dir(\gamma)$ .
- For each sliding window  $v$ 
  - choose  $\theta_{d,v}^{loc} \sim Dir(\alpha^{loc})$ ,
  - choose  $\pi_{d,v} \sim Beta(\alpha^{mix})$ .
- For each word  $i$  in sentence  $s$  of document  $d$ 
  - choose window  $v_{d,i} \sim \psi_{d,s}$ ,
  - choose  $r_{d,i} \sim \pi_{d,v_{d,i}}$ ,
  - if  $r_{d,i} = gl$  choose global topic  $z_{d,i} \sim \theta_d^{gl}$ ,
  - if  $r_{d,i} = loc$  choose local topic  $z_{d,i} \sim \theta_{d,v_{d,i}}^{loc}$ ,
  - choose word  $w_{d,i}$  from the word distribution  $\varphi_{z_{d,i}}^{r_{d,i}}$ .





# Multi-Grain models

- For **local** topics instead of sliding windows we could use **topical ngrams** (Wang and McCallum 05, Wallach 06)
- But topical ngrams are computationally expensive
- **Efficiency** of MG-LDA is comparable with that of LDA
- Crucial property is that the **topic distributions are associated with different scopes in a text**

# Evaluation

- **Qualitative** comparison of LDA and MG-LDA topics
- **Quantitative** comparison: improving multi-aspect ranking by using information about topic distribution

# Qualitative Evaluation

- Data: 3,872 reviews of **MP3 players**, 32,861 reviews of **hotels** and 32,563 reviews of **restaurants** (from Google Product and Local Search)
- Stop words and punctuation are removed

# MG-LDA Topics (Mp3)

## First 8 Local Topics!!

Sound Quality	Features	PC Connection	Tech Problems	Looks	Controls	Battery	Accessories
sound	games	usb	reset	case	button	battery	usb
quality	features	pc	noise	pocket	play	hours	cable
headphones	clock	windows	backlight	silver	track	life	headphones
volume	contacts	port	slow	screen	menu	batteries	adapter
bass	calendar	transfer	freeze	plastic	song	charge	remote
earphones	alarm	computer	turn	clip	buttons	aaa	plug
ear	notes	mac	remove	easily	volume	rechargeable	power
rock	game	software	playing	small	album	time	charger
settings	quiz	cable	hot	blue	tracks	power	included

## First 4 Global Topics

iPod	Creative Zen	Sony Walkman	Video Players
ipod	zen	sony	video
music	creative Zen	walkman	screen
apple	micro	memory	videos
songs	touch	stick	device
use	xtra	sonicstage	photos
mini	pad	players	tv
very	nomad	atrac3	archos
just	waiting	mb	pictures
itunes	labs	atrac	camera

## LDA

- 40 topics
- Only 4 aspect topics
- A couple other coherent topics
- Good topics in no order
- Mostly junk topics

# MG-LDA: first 8 Local Topics!! MG-LDA vs. LDA (Hotels)

Amenities	Food/Drink	Noise/AC	Bathroom	Breakfast	Spa	Parking	Staff
coffee	food	air	shower	breakfast	pool	parking	staff
microwave	restaurant	noise	water	coffee	area	car	friendly
fridge	bar	door	bathroom	continental	hot	park	helpful
tv	good	room	hot	morning	tub	lot	very
ice	dinner	hear	towels	fruit	indoor	valet	desk
room	service	open	toilet	fresh	nice	garage	extremely
refrigerator	breakfast	night	tub	buffet	swimming	free	help
machine	ate	conditioning	bath	included	outdoor	street	directions
kitchen	eat	loud	sink	free	fitness	parked	courteous

LDA: examples of LDA topics (out of 45), only 9 aspect topics

Beach resorts	Las Vegas	?	Smells/stains?	Getting there	Breakfast	Front desk	Opinion
beach	vegas	motel	room	airport	breakfast	room	hotel
great	strip	rooms	did	hotel	coffee	hotel	best
pool	great	nice	smoking	shuttle	fruit	told	stay
very	casino	hotel	bed	bus	room	desk	hotels
place	\$	like	night	very	juice	did	stayed
ocean	good	place	went	minutes	fresh	manager	reviews
stay	hotel	stay	like	flight	eggs	asked	service
view	food	parking	desk	hour	continental	said	great
just	las	price	smoke	free	very	service	time

# Local LDA

- LDA applied on individual sentences ('Local' LDA) on MP3 reviews:
  - Infers a number of valid aspects
  - Still many are related to brands of MP3 players
    - 20 top words for a half of topics contained brand names ('ipod', 'sony', 'yepp',...)
- Simultaneous modeling of both local and global topics is important for discovery of coherent aspects


# Restaurant Reviews

- Restaurant reviews are challenging, only the following aspects are inferred:
  - MG-LDA : *service*, *location*, *atmosphere* and *decor*
  - LDA: *waiting time* and *location*
- Challenge: majority of aspects are specific for a type of restaurants: *pizza* and *pasta* for a Italian rest., *sushi* and *noodles* for Japanese
- Good results with MG-LDA when applied to a specific restaurant type (9 aspects are inferred for Italian).
- Hierarchical topic modeling could address this problem

# Quantitative Evaluation

- We wish to evaluate **how well the learned topics correspond to aspects that users typically rate**
- Multi-aspect opinion rating (Snyder and Barzilay,07):
  - predicting a rating for multiple aspects of an object
- Data: 27,564 reviews labeled reviews from TripAdvisor

"1 star at best"  
**Hotel Maxim**  
Sep 23, 2007



**CHe1975**  
Canada

Location was great but room left alot to be desired. I'm not sure if it was because we arrived at 8 o'clock and it was the last room available (even thought we pre-paid in May) but it was not what we expected. The room was very dark and the bathroom was an obvious converted closet with a folding door. The first morning our make -shift shower backed up and there was water covering the entire bathroom floor. There was no other rooms available so we were stuck with that room for the next 3 nights. The owner of the hotel fixed the shower problem but after that first morning it left a bad taste in our mouth. The free internet was nice and the breakfast was good but i dont think our room was worthy of 2 stars.  
Will not return

●●●●● Value  
●●●●● Rooms  
●●●●● Location  
●●●●● Cleanliness  
●●●●● Check In / Front Desk  
●●●●● Service  
●●●●● Business Service



# Using a topic model

- Information about a topic of a sentence should help a classifier:
  - “*The X was great*”,
    - X – is “*duck*”, “*steak*”, “*soup*” - **food** rating is high
    - X – is “*music*”, “*light*” – **atmosphere** rating is high
- We extended standard ngram features of text x by adding top topics and their bucketed probabilities:
  - *x contains “great” & topic = 3 & bucket = 0.4-0.5*

# Results

- Ranking loss:  $\sum_n \frac{|\text{actual\_rating}_n - \text{predicted\_rating}_n|}{N}$   
(lower – better)
- PRank (Crammer and Singer, 02) – perceptron for ranking

*Unigram features only*

Model	Overall	Check-in	Service	Value	Location	Rooms	Cleanliness
Baseline	1.118	1.126	1.208	1.272	0.742	1.356	1.002
PRank	0.774	0.831	0.799	0.793	0.707	0.798	0.715
PRank + LDA	0.735	0.786	0.762	0.749	0.677	0.746	0.690
PRank + MG-LDA	<b>0.706</b>	<b>0.748</b>	<b>0.731</b>	<b>0.725</b>	<b>0.635</b>	<b>0.719</b>	<b>0.676</b>

*Unigram, bigram and trigram features*

Model	Overall	Check-in	Service	Value	Location	Rooms	Cleanliness
PRank	0.689	0.735	0.725	0.710	0.627	0.700	0.637
PRank + LDA	0.682	0.728	0.717	0.705	0.620	0.684	0.637
PRank + MG-LDA	<b>0.669</b>	<b>0.717</b>	<b>0.700</b>	<b>0.696</b>	<b>0.607</b>	<b>0.672</b>	0.636

# Summary

- We demonstrated that:
  - **topic models are appropriate** for discovery of aspects in user reviews
  - **simultaneous modeling of both local and global topics** is important for discovery of coherent ratable aspects

# Future/Recent work

- **Integrating user annotation** for topic discovery:
  - (Titov and McDonald, ACL 2008)
- **Hierarchical topic modeling**
  - E.g, infer a hierarchy representing cuisines and with each cuisine extract cuisine specific aspects
- **Combining aspect extraction with sentiment classification:**
  - Examining joint models of topics and sentiment (Mei et al, 07)