Introduction

• We explore classification and prediction of women's clothing outfits.

• Key questions:
  - o What kinds of outfit clusters can unsupervised learning techniques find?
  - o Given a new piece of clothing, can we recommend other items to complete the outfit?

• A previously unexplored problem: how to deal with outfits of clothing rather than individual clothing pieces.

• Practical applications:
  - o Online retailers promote similar clothing next to a desired piece of clothing to encourage consumer purchases (*e.g.*, Google Shopper)

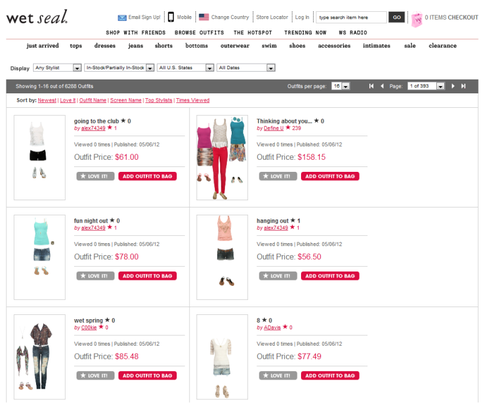
• Previous work:
  - o Google Shopper recommends similar-looking dresses for a given searched dress. We predicts not similar pieces, but *matching* pieces.
  - o Web interface by Princeton undergrads, which recommends accessories for a given outfit based on the color. We predict *all* clothing, not just accessories.

Data Set

• Previously unexplored data set: online teen clothing retailer

• Users combine different clothes (*e.g.*, a t-shirt, jeans, shoes, and some accessories) to create an outfit

• Website was developed as a social shopping feature, but it is a trove of data for machine learning



• We collected information on 1126 outfits with 1585 items

• Each item contains:
  - • Image
  - • Text description
  - • Price

• 8 categories of items
  - • Top
  - • Dress
  - • Bottom
  - • Layer
  - • Under
  - • Swim
  - • Shoe
  - • Accessory

Problem Statement

Unsupervised learning

Input: training outfits
Output: outfit clusters
Evaluation: Perplexity of various cluster sizes
Perplexity comparison with randomly generated training outfits

Supervised learning

Input: a single item
Output: a complete outfit
Evaluation: User study

Random Prediction

• From training data, randomly choose an item from each category

Associative Prediction

• **Input**: which items are in which outfits

• Consider the item type as a categorical variable

• Construct a joint probability distribution over all types

$$P(\text{top}=t,\text{dress}=d,\text{bottom}=b,\text{layer}=l,\text{under}=s,\text{shoe}=sh,\text{accessory}=a)$$
$$=\frac{\sum\text{outfits in which }(\text{top}=t,\text{dress}=d,\text{bottom}=b,\text{layer}=l,\text{under}=s,\text{shoe}=sh,\text{accessory}=a)}{\text{total number of outfits}}$$

• **Prediction:** using conditional probability

$$P(\text{layer}=l,\text{shoe}=sh,\text{accessory}=a\mid\text{dress}=d)$$
$$=\frac{P(\text{layer}=l,\text{shoe}=sh,\text{accessory}=a,\text{dress}=d)}{P(\text{dress}=d)}$$

• Intuition: items which appeared often with the input item in training outfits are likely good matches

• Disadvantage: the input item must appear in training outfits

• Future work: classify an unknown input item as a convex combination of known items, then construct a new conditional probability distribution

EM Clustering & Prediction

• **Input:** bag of words for each outfit in the dataset.

• For 10 clusters, top 5 words:

1	2	3	4	5
neck all rhinestone necklace chain	neck short rhinestone back all	skirt neck knit button front	neck band trend all the	pocket neck trend button solid
6	**7**	**8**	**9**	**10**
pocket button skin skinny jean	strap sand sandal all button	neck pocket all wall wallet	earring bangle neck dress rhineston	all skirt dress measure measures

• Perplexity with 5-fold cross validation :

k	Perplexity
2	386.5815
5	370.6765
10	369.2121
20	378.574
30	387.5336

• **Prediction:** for a given single input item

- Calculate conditional probability:

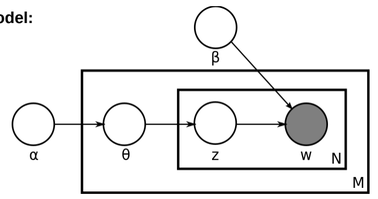
$$\log p(z=k\mid w_{1:N},\Theta)=\log p(z=k\mid\Theta)+\sum_{n=1}^{N}\log p(w\mid z=k,\Theta)$$
$$-\log\sum_{i=1}^{K}p(z=i,w_{1:N}\mid\Theta)$$

- Pick the cluster which has the maximum posterior probability.
- Select random items from the selected cluster (Because of randomness in the prediction part, k is selected 20 instead of 10 which has the minimum perplexity number).

LDA Clustering & Prediction

• **Input:** bag of words for each outfit in the dataset.

• **Model:**



- α : the prior on the per-document topic distributions, β : the per-topic word distribution. θ : the topic distribution, z : the topic for each word in each document, w : observed data.

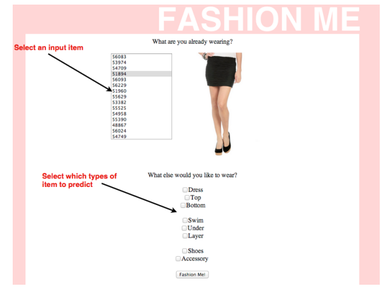
• For 10 topics, top 5 words:

1	2	3	4	5
bangle set platform turq necklace	sand sandal sunglass sunglasses strap	wallet stud wall pocket bangle	boot feather braided leather slouch	blazer not collar sand notch
6	**7**	**8**	**9**	**10**
love heart necklace short reads	flop flip sunglass plastic dress	jean destroyed skinny pocket five	skirt con measure vary measures	bangle set band necklace gold

• **Prediction:** same as EM

User Study Evaluation

• **Web interface:**



• **Predictions:**

- For a given input, recommend items to complete outfit
- For each prediction algorithm, record ratings from users

• **Comparison:** user study with same prediction algorithms, but randomly generated training outfits

Conclusions & Future Work

• Outfit clustering algorithms are somewhat successful, *e.g.* find swimwear

• Evaluate results of user study to determine advantages and disadvantages of each prediction method

• Refine prediction algorithms based on results of user study

• Image-based item clustering and outfit prediction

• Budget constraints on recommended items

References

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• "Princeton Beats Out 13 Schools to Win Facebook's College Hackathon" <http://techcrunch.com/2011/12/04/college-hackathon/>

FASHION ME

Sema Berkiten & Jiasi Chen
http://edge-server-01.princeton.edu/FashionMe/