TECHNISCHE UNIVERSITÄT
CHEMNITZ

Faculty of Mathematics
Technische Universität Chemnitz

Title

Your Name
yourname@s2017.tu-chemnitz.de

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Content

- Given an item(clothing) in the shopping cart the problem statement is to suggest items complementary to it which may contain garments or accessories which makes a complete set as per current fashion.

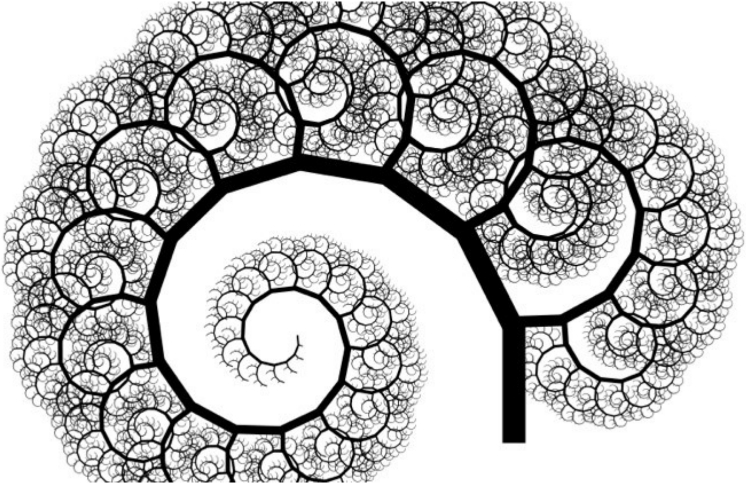

Figure: Existing Recommendation Systems

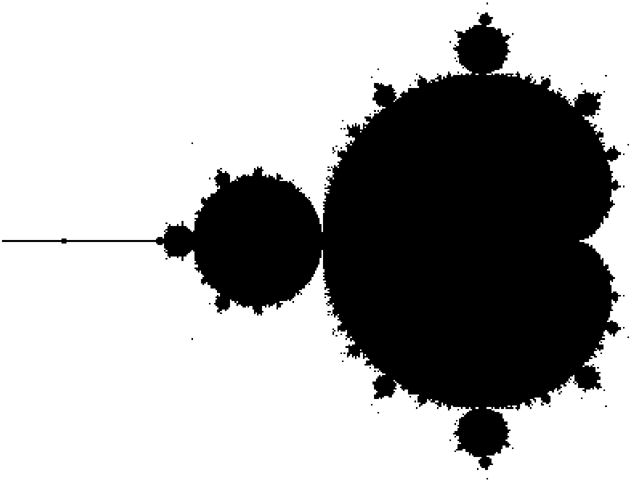

Figure: Visualization of the problem statement

Mathematical Formulation
Simplified Formulation

Given an image *i* containing '*k*' part–features, we describe the image P_i as $P_i^T := [p_{i1}, p_{i2}, ..., p_{ik}]$ where each p_{ij} are textual part–features, which are 2–tuples.

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We learn a model from our dataset of fashion images, say **P**, where **P** $:= [P_1, P_2, ...P_n]^T$.

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The task of our recommendation system is, given one or more apparel, and corresponding part features *p*'s as input query, recommend garments which can be worn with it/them as a set.

Approach
Flow Diagram

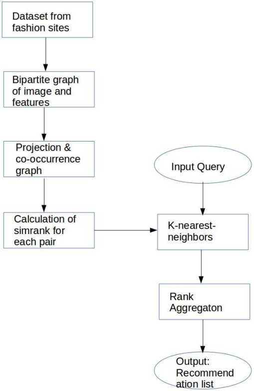

Figure: Flow Diagram of Proposed Approach

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Fashion Websites & Ground Truth

Scraping Fashion Websites

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- Created a vocabulary of part features. Manually normalize the tags associated with each image.
- Ended up with a codebook of total of *48* unique categories including garments like tops, jeans, etc. and accessories like watches, bracelets, etc. and *632* unique items i.e. category-description pair.

Bipartite Network and Co–occurrence Graph

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- The projected graph so obtained is a weighted co–occurrence graph of the part features. Construction of this graph gives us the relation between different garments and accessories which can be used together and are complementary to each other.
- This step helps us learn a correlation and inter-dependence between various part features from the dataset.

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- Convert the co–occurrence graph into a directed graph where each edge between part features p_a and p_b in the original graph is replaced by two directed edges $p_a \rightarrow p_b$ and $p_b \rightarrow p_a$ both with weights equal to the weight of original edge.

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- Compute *Simrank* between each pair of nodes.

- Given a part–feature *p* as query we locate the node corresponding to that part feature in the co–occurrence graph.

Similarity Measure & Nearest Neighbor
Nearest Neighbor Consensus

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- The rationale behind this step is that since the graph had edges between part features that were used together by fashionistas and as the simrank values decrease with increase in node distances, the *k*–nearest–neighbors will be those part features which were frequently used with the selected item and are contemporary to it.

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- We get a list of k part features $p_1, p_2, ...p_k$ which are structurally close to the input feature and thus they can be recommended for the given query part feature.

- Say we have j part features $p_1, p_2, ...p_j$ as input query, we find out individual k–nearest–neighbors for each part feature.

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- Assigns a score corresponding to position in which a part feature appears within each ranked list. In our case, for each list i, ${p_a}^i$ is assigned a weight ${B_{p_a}}^i = k$ * fraction of part features in the list appearing below p_a.

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- The *Broda* score of each element B_{p_a} is the the sum of *Broda* scores for that part feature in all the lists.
- We can recomment the top k elements from this ranked list to the user.

- We took 20 images as test set from our dataset. Since each image is user tagged, we have labelled ground truth for computing the required metrics.

Experimental Results
Evaluation Methodology

- We took 20 images as test set from our dataset. Since each image is user tagged, we have labelled ground truth for computing the required metrics.
- For each image we took, we used all its part features individually as one feature input. We also used various permutations of 2 part features and 3 part features as input to the recommender and compared the recommended part features with the ground truth.

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Formula

$$precision = \frac{no\ of\ matched\ recommendations}{no\ of\ recommendations}$$

$$recall = \frac{no\ of\ matched\ recommendation}{no\ of\ items\ in\ actual\ image}$$

Out of the 158 recommendation sets that we tested, 53 were 1 part feature input, 54 were 2 part feature input and 51 as 3 part feature input. For each generated recommendations we calculated the precision and recall.

Table: Precision

No. of inputs	Max Precision	Avg Precision
1	1	0.31
2	0.75	0.31
3	0.6	0.28

Table: Recall

No. of inputs	Max Recall	Avg Recall
1	0.8	0.23
2	1	0.44
3	1	0.48

Table: f1 score

No. of inputs	Max f1	Min f1
1	0.89	0.13
2	0.71	0.1
3	0.67	0.1

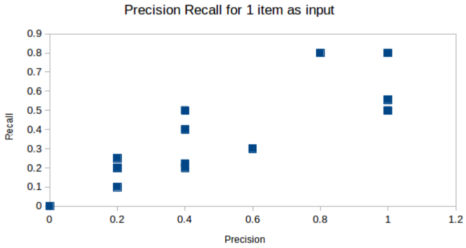
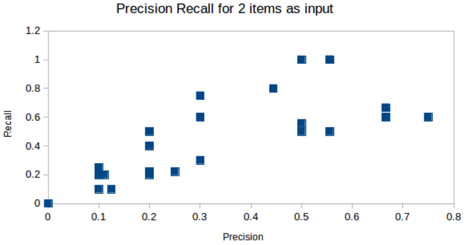
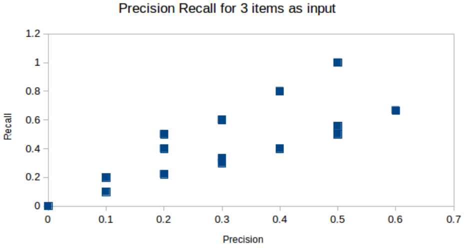


Figure: Precision-Recall for 1 item input


Precision Recall for 2 items as input
Recall
Precision
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8


Precision Recall for 3 items as input
Recall
Precision
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

Experimental Results
Manual Evaluation Results

Table: User rating for recommendation

Rate(out of 10)	Frequency	Cumulative Freq.
10	1	1
9	2	3
8	9	12
7	9	21
6	5	26
5	11	37
4	11	48
3	6	54
2	4	58
1	2	60

Future Work

- Features for representation of parts are to be improved by incorporating visual features. Inclusion of visual features will also include the analysis of features like color, texture, etc. which is expected to improve the quality of evaluation.
- A feedback system can be added to the system as to increase edge weights to the features which are shopped together by users. This will be a self learning system and incorporate the changes in trending fashion all by itself.

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Thank you! Questions?