

Card Sorting Analysis Techniques

706.414 Seminar-Project

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Agenda

- Introduction
- Manual Analysis
 - Preprocessing
 - Category Standardisation
 - Mindset Management
 - Participant, Card, and Category Statistics
- Statistical Analysis:
 - Similarity and Co-Occurrence Matrix
 - Similarity Map
 - Dendrogram
 - Label Suggestions

Introduction

- What is card sorting? What problem does it solve?
- Create information hierarchies.
- Collaborative technique
- Sort and organise cards into meaningful groups.
- Gives good insight into how users think.
- Open card sorting.
- [Closed card sorting.]

Card Sorting

- Give participants unsorted stack of cards.
- Ask participants to sort cards into meaningful groups
- Ask participants to label the groups.
- Ask participants to explain sorting strategy (mindset).



Used with kind permission of Keith Andrews. Information Architecture and Web Usability. Course Notes. Graz University of Technology, Austria, 17 Oct 2023. <u>https://courses.isds.tugraz.at/iaweb/jaweb.pdf</u>

Raw Card Sorting Data

• A typical card sorting result dataset:

Individual sorts of each participant

	#	Card	Sort 1	Sort 2	Sort 3	Sort 4
		1 Sausages	Fleischwaren	Wurst	Fleischiges	Fisch, Fleisch, Geflügel
		2 Beer	Getränke	Getränke Alkohol	Alkohol	alkoholische Getränke
		3 Parsley	Gemüse	Gewürze	Gemüse	Gewürze
	6	4 Mustard	Gewürze	Gewürze	Würzen	Essig, Öl, Saucen
		5 Hand Cream	Toilettartikel	Hygiene	Körperpflege	Pflegeprodukte
		6 Teabags	Grundnahrungsmittel	Getränke alkoholfrei	Tee & Kaffee	nicht alkoholische Geträ
		7 After Shave	Toilettartikel	Hygiene	Körperpflege	Pflegeprodukte
List of all		8 Honey	Süßigkeiten	Gewürze	Frühstück	Frühstück
used cards	7	9 Whipping Cream	Süßigkeiten	Milchprodukte	Kühlregal	Milchprodukte
	1	0 Biscuits	Süßigkeiten	Nascherei	Naschen	Naschen
	1	1 Strawberries	Obst	Obst	Obst	Obst
	1	2 Walnuts	Nüsse	Nüsse u.ä.	Backen	Nüsse
	1	3 Cucumbers	Gemüse	Gemüse	Gemüse	Gemüse
	1	4 Beef	Fleischwaren	Hauptspeisen	Fleischiges	Fisch, Fleisch, Geflügel
	1	5 Kitchen Roll	diverse	Hygiene	Haushalt	Sanitärbedarf
	1	6 Apple Juice	Getränke	Getränke alkoholfrei	Anti-Alkohol	nicht alkoholische Geträ

Screenshot taken from Keith Andrews; *Card Sorting Analysis Spreadsheet: 100 Products*; Information Architecture Course, FH Joanneum Graz, SS 2016. Unpublished.

Category labels

Card Sorting Analysis Goals

- Spot key patterns in your data.
- Derive useful insights for your project.
- Improve your information architecture.
- Understand how your users think.
- People group items in a way that makes sense to them.
- Understand the user's mindset.

Types of Card Sorting Analysis

• Manual analysis:

- Intuitive and creative.
- What groups do people form? (categories)
- Identify the user's mindset (grouping strategy).
- What labels and descriptions were used?
- Card placement which card is placed into which group?
- How accurately participants have grouped the cards?

• Statistical analysis:

- Identify most consistent pattern.
- Compare results from different groups of people.
- Justify a recommendation.
- Use of statistical methods (e.g. hierarchical clustering, k-means).

Manual Analysis

Card Sorting Analysis Process

- Exclude outlier sorts.
- Identify the participants mindset:
 - Participants may have used a different grouping strategy.
 - Split data by mindset (= grouping strategy).
 - Analyse one mindset at a time.
- Category standardisation:
 - Merge similar groups and give them a single meaningful name.
- Standardised matrix for each mindset:
 - Sorts of this mindset with standard category names.

Exclude Outlier Sorts

- Outlier sorts can negatively affect results:
 - e.g. participants, who did not make a serious attempt.
- Hard to spot outlier sorts, some rules of thumb:
 - \circ Number of categories: Too few or too many, compare to average.
 - Vague category labels (e.g. "stuff", "miscellaneous").
 - Duplicate or synonymous category labels.
 - Time taken: Unusually short or long time.

Participant Statistics

Participant	Status	Time taken	Question responses	Cards sorted	Categories created	Categories named	
Participant 1	Completed	23:16	0	100%	17	100%	Exclude from results
Participant 2	Completed	28:13	0	100%	26	100%	Exclude from results
Participant 3	Completed	13:00	0	100%	10	100%	Exclude from results
Participant 4	Completed	14:39	0	100%	17	100%	Exclude from results
Participant 5	Completed	9:43	0	100%	17	100%	Exclude from results

Screenshot taken from Optimal Workshop https://www.optimalworkshop.com/

Card Statistics

Analyse card placement:

- Categories: # categories each card sorted to.
- Frequency: # participants who placed each card in a category.
- Position: Average position (rank) of card in group [optional].

Card 🗘	Sorted into 💲	Categories 💲	Frequency	Position 🗘
After Shave	1 category	Personal hygienie	5	6.2
Almonds	3 categories	Fruits	3	4.0
		Nuts	1	1.0
		Fruits and Vegetables	1	17.0
Apple Juice	2 categories	🗎 Beverages	4	6.3
		🗎 Breakfast	1	5.0
Apples	2 categories	🕒 Fruits	4	8.3
		Fruits and Vegetables	1	18.0
Bananas	3 categories	🕒 Fruits	3	3.7
		Fruits and Vegetables	1	2.0
		🕒 Breakfast	1	7.0

Screenshot taken from Optimal Workshop https://www.optimalworkshop.com/

Mindset Management

#	Cards	Sort 1	Sort 2
1	Muesli	Breakfast	Staple food
2	Yoghurt	Breakfast	Milk products
3	Bananas	Breakfast	Fruits
4	Bread Rolls	Breakfast	Staple food
5	Ham	Breakfast	Meat
6	Kitchen Roll	Cooking	Household items
7	Olive Oil	Cooking	Sauces & Spices
8	Salt	Cooking	Sauces & Spices
9	Pepper	Cooking	Sauces & Spices
10	Vinegar	Cooking	Sauces & Spices
11	Potting Soil	Gardening	Household items
12	Cat Litter	Pet-keeping	Pet supplies
13	Dog Food	Pet-keeping	Pet supplies
14	Cat Food	Pet-keeping	Pet supplies
15	Pencils	Workplace	Office supplies
16	Copier Paper	Workplace	Office supplies
17	Sticky Tape	Workplace	Office supplies
Mindset		Activities	Groceries in a Supermarket

- Identify grouping strategy (mindset) used for each individual sort.
- For example: shelf in supermarket, activity of use, ingredients for recipe, country of origin, ...
- Ask user to explain their mindset:
 - In-person (supervised), or post-study question (unsupervised).

Screenshot taken from Keith Andrews; *Card Sorting Analysis Spreadsheet: 100 Products*; Information Architecture Course, FH Joanneum Graz, SS 2016. Unpublished.

Category Standardisation

- Participants use similar but not identical words to describe things.
- Create a list of all categories created by participants.
- Merge categories with similar names or ideas.

Original Category	Standard Category (DE)	Original Category	Standard Category (DE)	
Körperpflege	Hygieneartikel	Lang haltbare Nahrung	Dosenkonserven	
Pflegeprodukte	Hygieneartikel	Dosenprodukte	Dosenkonserven	
Sanitärbedarf	Hygieneartikel	Non-perishable foods	Dosenkonserven	
Hygieneartikel für den Körper	Hygieneartikel	Dosengemüse	Dosenkonserven	
Hygieneartikel	Hygieneartikel	Konserven	Dosenkonserven	
Artikel-Hygiene	Hygieneartikel	Dosenprodukte	Dosenkonserven	
Hygiene/Waschartikel	Hygieneartikel	Vorratskammer	Dosenkonserven	
Körnernflege	Hygieneartikel	Haltbares (Vorratsschrank)	Dosenkonserven Dosenkonserven	
Körperpflege	Hygieneartikel	stored food		
Hygienenrodukte	Hygieneartikel	stationery	Dosenkonserven	
	Hygieneartikel	Lang-haltbare Lebensmittel	Dosenkonserven	
hygiene	Hygieneartikel	Cans	Dosenkonserven	
Drugstore items	Hygieneartikel	Screenshot taken from Keith Andrews	s: Card Sorting Analysis Spreadsheet:	

100 Products;

Information Architecture Course, FH Joanneum Graz, SS 2016. Unpublished.

Category Standardisation

Standardized category name Animal supplies

Agreement

42%

Cards

card into.

Update your standardized category by including or excluding participant categories.

Categories

Include

Select a category name to show which cards your participant sorted into this category.

Pets
Pet supplies
Pet supplies
Animal-based food
Animal supplies

Unique Cards		Frequency
3	Sausages	1
3	Beef	1
3	Cheese	1
10	Butter	1
3	Milk	1
	Ham	1
	Dog Food	4
	Yoghurt	1
	Eggs	1

Select a card to show which categories your participants sorted this

Attention[.]

- Always check category's content! Ο
- Similar name does not \bigcirc necessarily mean similar idea!

Agreement:

Measure of agreement among 0 participants about which cards should belong to a (standardised) category.

Screenshot taken from Optimal Workshop https://optimalworkshop.com/

Category Standardisation

Standardized category name			Agreement	
Anin	nal supplies		100%	
Update	e your standardized category by including or e	excluding particip	ant categories.	
Catego	pries		Cards	
Select sorted	a category name to show which cards your pa into this category.	articipant	Select a card to show which categories your participants s card into.	sorted this
Include	2	Unique Cards		Frequency
	Pets	3	Dog Food	4
	Pet supplies	3	Cat Food	4
	Pet supplies	3	Cat Litter	4
	Animal-based food	10		
	Animal supplies	3		



Screenshot taken from Optimal Workshop https://www.optimalworkshop.com/

Correlation Count (Standardisation Grid)

• How many participants have sorted a card into a certain category:

Total participants 0 5										
Name	÷ ;	Fruits	h. F	Fruits an 🕴		Gardening 🗍	Househol ‡	Me	at	Å
After Shave										
Almonds		3	1	1						
Apple Juice										
Apples		4	4	1						
Bananas		3		1						
Batteries							4			
Beef										3
Beer										

Standardised Matrix

• Transform raw card sort data into standardised matrix.

#	Card	Sort 1	Sort 2	Sort 3	Sort 4
1	Sausages	Fleischwaren	Wurst	Fleischiges	Fisch, Fleisch, Geflügel
2	Beer	Getränke	Getränke Alkohol	Alkohol	alkoholische Getränke
3	Parsley	Gemüse	Gewürze	Gemüse	Gewürze
4	Mustard	Gewürze	Gewürze	Würzen	Essig, Öl, Saucen
5	Hand Cream	Toilettartikel	Hygiene	Körperpflege	Pflegeprodukte
6	Teabags	Grundnahrungsmittel	Getränke alkoholfrei	Tee & Kaffee	nicht alkoholische Geträ
7	After Shave	Toilettartikel	Hygiene	Körperpflege	Pflegeprodukte
8	Honey	Süßigkeiten	Gewürze	Frühstück	Frühstück
9	Whipping Cream	Süßigkeiten	Milchprodukte	Kühlregal	Milchprodukte
10	Biscuits	Süßigkeiten	Nascherei	Naschen	Naschen

#	Card	Sort 1	Sort 2	Sort 3	Sort 4
1	Sausages	Meat	Meat	Meat	Meat
2	Beer	Drinks	Alcoholic Drinks	Alcoholic Drinks	Alcoholic Drinks
3	Parsley	Vegetables	Sauces & Spices	Vegetables	Sauces & Spices
4	Mustard	Sauces & Spices	Sauces & Spices	Sauces & Spices	Dressings
5	Hand Cream	Hygiene	Hygiene	Hygiene	Hygiene
6	Teabags	Staple Food	Non-Alcoholic Drink	Coffee & Tea	Non-Alcoholic Drinks
7	After Shave	Hygiene	Hygiene	Hygiene	Hygiene
8	Honey	Sweets	Sauces & Spices	Breakfast	Breakfast
9	Whipping Cream	Sweets	Milk Products	Fridge	Milk Products
10	Biscuits	Sweets	Sweets	Sweets	Sweets



Screenshot taken from Keith Andrews; *Card Sorting Analysis Spreadsheet: 100 Products*; Information Architecture Course, FH Joanneum Graz, SS 2016. Unpublished.

Standard Category Statistics

1	Standard Category (EN)	Sorters who used this	Total cards in this category	Unique cards	Agreement
2	Alcoholic Drinks	20	112	7	0.80
3	Baking	7	30	13	0.33
4	Breakfast	18	73	26	0.16
5	Canned Food	7	17	19	0.13
6	Cereals	2	5	7	0.36
7	Coffee & Tea	6	13	3	0.72
8	Convenience Products	7	24	24	0.14
9	Dressings	8	32	12	0.33
10	Drinks	12	106	26	0.34
11	Fresh Food	1	14	27	0.52
12	Fridge	3	18	37	0.16

Screenshot taken from Keith Andrews' spreadsheet

- Agreement = Total cards / (Sorters * Unique cards)
- E.g. 100 % = 12 / (3 * 4)

 $\circ~$ All 3 participants have sorted the same cards into this category.

Demos

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Alconol	7 different cards	Whisky	1	3.0	1 perocipants		
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		White Wine	1	1.0			

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	6 Orange Juice	Getränke	Getränke alkoholfrei	Anti-Alkohol	nicht alkoholische Geträr	Nicht alkoholische Geträr	Mineralwasser & Safte	Getränke
	7 Noodles	Grupdpahnupgsmittel	Beitagen	Kohlehydrathaltiges	Grundnahnungsmittel	Lang halthare Natining	Grundnahnungsmittel Kohlehvdra	te Grundnahnungsr
	8 Energy Drink	Getränke	Getränke alkoholfrei	Anti-Alkohol	nicht alkoholische Geträr	Nicht alkoholische Geträr	Mineralwasser & Safte	Getränke
	9 Champagne	Getränke	Getranke Alkohol	Alkohol	alkoholische Getränke	Alkoholische Getränke	Weine & Spirituosen	Getranke
	In Tomato Ketchun	Gewirze	Gewürze	Wiirzen	Essia Ol Saucen	Gehört ins Essen macht	Dressings & Marinaden	Wirzen
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	4 Toothoaste	Toilettartikel	Huniene	Kömernflene	Pflegenrockukte	Hypieneartikel für den Kö	Hunioneartikel	Artikel-Hyniene
6	Mushrooms	Gemüse	Gemüse	Gemüse	Gemüse	Gemüse	Obst & Gemüse	Gemüse
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Statistical Analysis

Similarity Matrix

• Shows how often two cards are sorted into same category.

	A	В	с	D	E	F	G	Н
1	Cards	Sausages	Beer	Parsley	Mustard	Hand Cream	Teabags	After Shave
2	Sausages	38	1	3	3	0	4	0
3	Beer	1	38	0	0	0	9	0
4	Parsley	3	0	38	16	0	2	0
5	Mustard	3	0	16	38	0	4	0
6	Hand Cream	0	0	0	0	38	2	38
7	Teabags	4	9	2	4	2	38	2
8	After Shave	0	0	0	0	38	2	38

Screenshot taken from Keith Andrews; *Card Sorting Analysis Spreadsheet: 100 Products*; Information Architecture Course, FH Joanneum Graz, SS 2016. Unpublished.

Total number of sorts: 38

Co-Occurrence Matrix

	A	В	С	D	E	F	G	н	I	J	к	L	м	N	0	Р	Q	R	S	т	U	V	W	X	Y	Z	AA	AB
1	38		Sausages	Beer	Parsley	Mustard	Hand Cream	Teabags	After Shave	Honey	Whipping Cream	Biscuits	Strawberries	Walnuts	Cucumbers	Beef	Kitchen Roll	Apple Juice	Red Wine	Frozen Pizza	Body Lotion	Bread Rolls	Strawberry Jam	Ice Cream	Candles	Vinegar	Chocolate Bars	Orange Juice
2																												
3	1	Sausages	Sausag	jes																								
4	2	Beer	3%	Beer																								
5	3	Parsley	8%	0%	Parsley	·																						
6	4	Mustard	8%	0%	42%	Mustard	1																					
7	5	Hand Cream	0%	0%	0%	0%	Hand C	ream																				
8	6	Teabags	11%	24%	5%	11%	5%	Teabag	s																			
9	7	After Shave	0%	0%	0%	0%	100%	5%	After Sh	ave																		
10	8	Honey	8%	0%	24%	34%	0%	26%	0%	Honey																		
11	9	Whipping Cream	16%	0%	11%	8%	0%	5%	0%		Whippi	ng Crea	m															
12	10	Biscuits	5%	0%	3%	3%	0%	11%	0%	34%	16%	Biscuits	s															
13	11	Strawberries	3%	0%	3%	3%	0%	0%	0%	0%	5%	5 0 %	Strawb	erries														
14	12	Walnuts	3%	0%	5%	5%	0%	8%	0%	18%		26%	0%	Walnut	s													
15	13	Cucumbers	5%	0%	61%	8%	0%	3%	0%	3%	5%	6 O%	13%	3%	Cucum	bers												
16	14	Beef	92%	3%	8%	13%	0%		0%	11%	13%	3%	3%	3%	5%	Beef		_										
17	15	Kitchen Roll	0%	0%	0%	0%	32%	5%	32%	0%	0%	6 <mark>0%</mark>	0%	0%	0%	6 0%	Kitcher	Roll										
18	16	Apple Juice	5%	32%	3%	3%	0%		0%	0%	3%	6 0%	3%	0%	3%	6 5%	0%	Apple	Juice									
19	17	Red Wine	3%	100%	0%	0%	0%	24%	0%	0%	0%	0%	0%	0%	0%	6 3%	0%	6 32%	Red Wi	ne								
20	18	Frozen Pizza	16%	0%	11%	8%	0%	8%	0%	5%	11%	3%	3%	3%	5%	6 18%	0%	6 3%	6 0 %	Frozen	Pizza							
21	19	Body Lotion	0%	0%	0%	0%	100%	5%	100%	0%	0%	6 0 %	0%	0%	0%	6 0%	32%	0%	6 <mark>0</mark> %	0%	Body L	otion						
22	20	Bread Rolls	13%	3%	5%	16%	0%		0%	45%	8%	13%	0%	8%	3%	6 16%	0%	6 3%	3%	5%	0%	Bread	Rolls					
23	21	Strawberry Jam	5%	0%	5%	16%	0%	26%	0%	79%	21%	5 39%	3%		3%	6 8%	0%	6 0%	0%	5%	0%	47%	Strawb	erry Jan	1			
24	22	Ice Cream	3%	0%	8%	3%	0%	0%	0%	32%	26%	50%	3%	16%	3%	6 3%	0%	6 3%	6 0%	39%	0%	0%	37%	Ice Cre	am			
25	23	Candles	0%	0%	0%	0%	5%	5%	5%	0%	0%	0%	0%	0%	0%	6 0%	74%	0%	0%	0%	5%	0%	0%	0%	Candle	5		
26	24	Vinegar	5%	0%	37%	82%	0%	8%	0%		5%	3%	0%	5%	3%	6 11%	0%	6 0%	6 <mark>0</mark> %	3%	0%	18%	13%	0%	0%	Vinega	r	
27	25	Chocolate Bars	0%	0%	3%	3%	0%	5%	0%	32%	13%	87%	0%	26%	0%	6 0%	0%	6 0%	0%	0%	0%	3%	37%	50%	0%	3%	Chocol	ate Bars

- % of participants who grouped two cards together.
- = normalised similarity matrix.
- Colour coding: start manual grouping with darker shades of blue.

Screenshot taken from Keith Andrews; *Card Sorting Analysis Spreadsheet: 100 Products*; Information Architecture Course, FH Joanneum Graz, SS 2016. Unpublished.

Co-Occurrence Matrix



- Matrix permutations: most closely related pairings clustered along diagonal.
- Clusters of related cards appear.
- Can be used to visually separate cards into categories.
- Darker color means higher % similarity.

Similarity Map

Similarity Map (t-SNE)



- Similarity between cards shown as 2D proximity.
- Algorithms:
 - Transform similarity matrix into 2D map.
 - Dimension reduction preserving similarity.
 - PCA, FDP, t-SNE, UMAP.
- Each point represents an individual card.
- Cards closer together were more frequently sorted into same category.

Screenshot taken from *Enhanced Card Sorting Analysis in R* Michaela Kargl, Ajdin Mehic, Zoran Prodanovic, and David Seywald 706.057 Information Visualisation SS 2018, Graz University of Technology https://courses.isds.tugraz.at/ivis/projects/ss2018/ivis-ss2018-g5-project-r-card-sort.pdf

Similarity Map

Similarity Map (t-SNE)



• Manually select dense areas to create potential categories.

Screenshot taken from *Enhanced Card Sorting Analysis in R* Michaela Kargl, Ajdin Mehic, Zoran Prodanovic, and David Seywald 706.057 Information Visualisation SS 2018, Graz University of Technology https://courses.isds.tugraz.at/ivis/projects/ss2018/ivis-ss2018-g5-project-r-card-sort.pdf

Similarity Map 3D

3D cluster view 0



- Similarity visualised as 3D spatial relationship.
- Multidimensional Scaling:
 - Translate a table of similarities into a 3D map.
 - Dimension reduction preserving similarity.
- Potential categories are marked as polygons.

Screenshot taken from Optimal Workshop https://www.optimalworkshop.com/

Dendrograms

Screenshot taken from *Enhanced Card Sorting Analysis in R* Michaela Kargl, Ajdin Mehic, Zoran Prodanovic, and David Seywald 706.057 Information Visualisation SS 2018, Graz University of Technology

https://courses.isds.tugraz.at/ivis/projects/ss2018/ivis-ss2018-g5-project-r-card-sort.pdf



- Hierarchical clustering
- Cards grouped into clusters depending on similarity.
- Start with N clusters (each card).
- Recursively merge clusters.
- Choose granularity: # categories.

Label Suggestions

- Show category name suggestions for each resulting cluster.
- Frequency of category:
 - # participants who used a specific category for each item.
 - Show top 3 category labels.

Drinks:68.7%, Alcoholic Drinks:25.2%, Non-Alcoholic Drinks:6.1%
Beer
Apple Juice
Red Wine
Orange Juice
Energy Drink

Spices:35.4%, Food:34.9%, Meat:29.7%	H
Sausages	F
Mustard	A
Teabags	E
Honey	C

Hygiene:97.6%, Household:1.9%, Fruit:0.5%
Hand Cream
After Shave
Body Lotion
Deodorant

Vegetables:47.4%, Fruit:39%, Fruit and Vegetables:13.6%
Parsley
Strawberries
Walnuts

Screenshots taken from *Enhanced Card Sorting Analysis in R* Michaela Kargl, Ajdin Mehic, Zoran Prodanovic, and David Seywald 706.057 Information Visualisation SS 2018, Graz University of Technology https://courses.isds.tugraz.at/ivis/projects/ss2018/ivis-ss2018-g5-project-r-card-sort.pdf

Demos





