



Mapping olfactory cues for wayfinding – A theoretical Approach and an empirical Study

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<https://www.vcp.de/pfadfinden/allgemein/immer-der-nase-nach>

Motivation

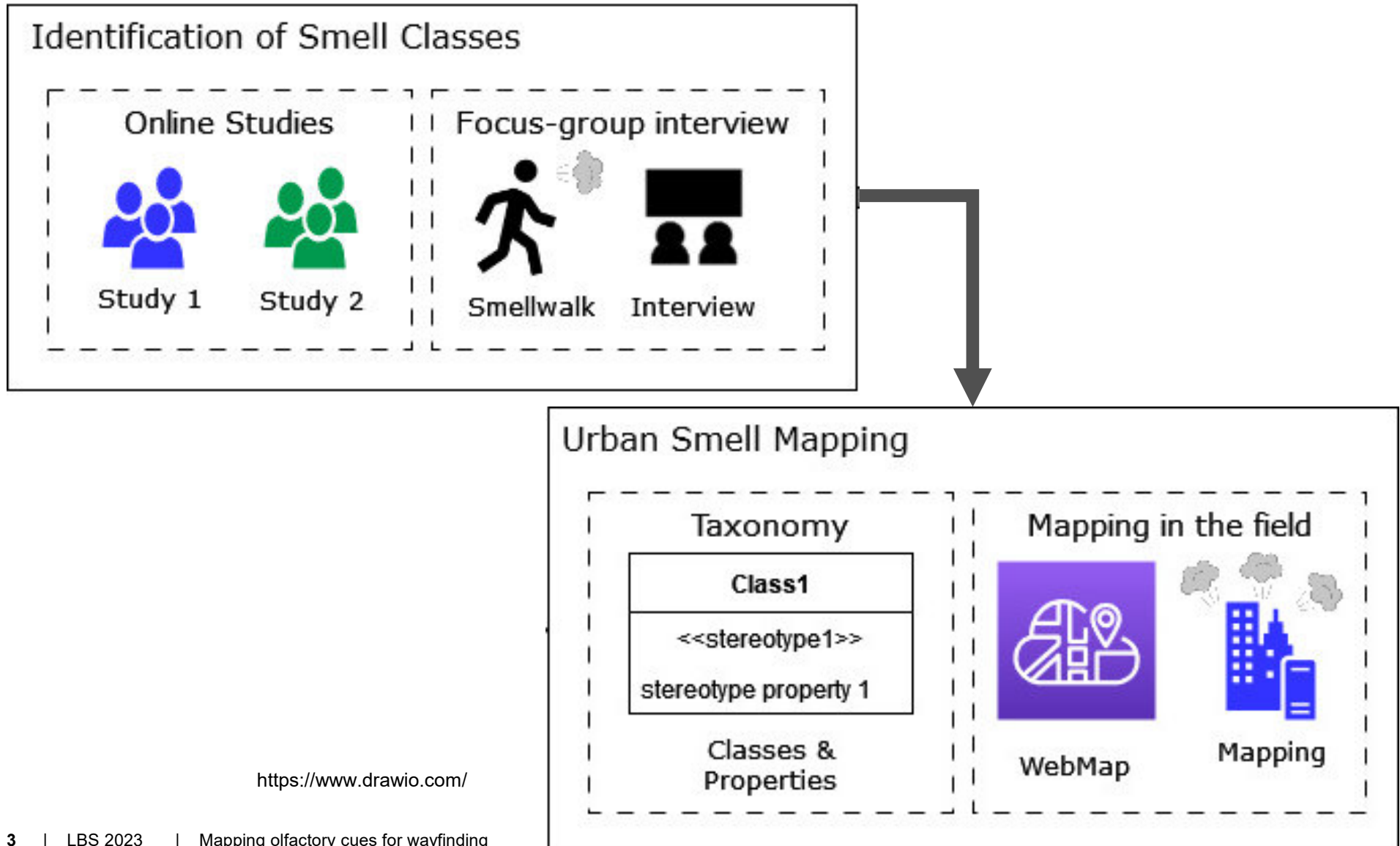
”We see the city, we hear the city, but above all: we smell the city” (Henshaw, 2013)

- Mobile pedestrian navigation systems continue to solely use visual information → Other modalities than vision are still neglected in current navigation systems
- “olfaction,..., provides crucial spatial information that allows many species, including humans, to navigate the environment” (Raithel&Gottfried, 2021)
- Olfactory information can be useful for spatial orientation and should be integrated into mobile pedestrian navigation systems
- We here address the olfactory sensory modality in psychological studies and mapping with GIS
- Investigation which smells are important and how they can be mapped → Implementation/integration into future navigation systems



<https://newsinhealth.nih.gov/2016/08/what-your-nose-knows>

Motivation



<https://www.drawio.com/>



Identification of Smell Classes

Online Studies – Study 1

- Online study conducted at Gießen University
- Studies are based on a study of Koutsoklenis and Papadopoulos (2011) with visually-impaired and sightless people
- Participants: N=28, M=28.89, SD=10.63, 25 females
- Name smells that could possibly serve as valuable (landmark) information for successful orientation
- Result: Categories for further investigation



<https://www.wortwolken.com/>



Identification of Smell Classes

Online Studies – Study 2

- Online study conducted at Gießen University
- Participants: N=29, M=25.75, SD=10.90, 21 females
- Judgement of the (subjective/personal) frequency of use and the usefulness of such landmark-like information for successful orientation
- Result: Frequency of use / Judged usefulness

Smells	Frequency of use	Jugded usefulness
Restaurant and food	3	4
Bakery	3	4
Gasoline	2	4
Exhaust Gases	2	4
Grasslands	4	4
(freshly) mowed grass	3	4
Ocean/Seawater	3	4
Wood/Trees	3	3
Perfume	2	3



Identification of Smell Classes

The results of the two online studies demonstrate that

- sighted people indeed seem to use olfactory information in wayfinding/navigation,
- there is a large overlap with previous studies (which were not in the wayfinding domain; see our paper for comparison), and
- sighted people provide us with a basis of possible odors for further experimentation.

Not sufficient to simply "ask" people possible odor information from their own experience and memory → important to let them smell the environment and also to discuss these smells with them



Identification of Smell Classes

Focus-group interview – Smellwalk

- Students heard a lecture about
 - the terms navigation and wayfinding (Montello, 2005; Golledge, 1999),
 - cognitive aspects of human wayfinding including spatial knowledge acquisition (Siegel and White, 1975),
 - the communication of route directions (Allen, 1997),
 - a definition and characterisations of landmarks (Lynch, 1960; Sorrows and Hirtle, 1999), and
 - several landmark modalities (visual, olfactory, and auditory) (Hamburger and Röser, 2014).
- The students were advised to walk at least 1.5 hours in an urban outdoor environment, to smell and to collect olfactory cues
- Students walked individually through an urban outdoor environment



Identification of Smell Classes

Focus-group interview – Interview

- Qualitative data collection approach, to gather local knowledge and perspectives as a basis for research and planning
- It aims to draw from complex personal experiences, beliefs, perceptions, and attitudes of the participants of a group through a moderated interaction
- The corresponding author facilitated the discussion between the participants
- The participants were asked to start a discussion about the smells they encountered while navigating → documentation on a concept board

Bakery	Flowers	Market stands (Fruits, Fish)	Hairdresser (Hair colour, Shampoo)	Waste water	Transport and their exhausts	Paint, Varnishes
Perfumery	Animal (Zoo, Pigeons, Ducks)	Gastronomy (Pizzeria, Food, Grill)	Grill, Charcoal (Fire place)	Urin, Faeces	Cut gras, Meadow	Trees, Wood
Cemetery (Soil, Flower, Gras)	Waste, Garbage	Musty, wet (for water areas)	Perfume	Sweat	Petrol, Diesel	Cigarette, Waterpipe, Chimney

Class1
<<stereotype1>>
stereotype property 1

Urban Smell Mapping

Taxonomy – Classes and Sub-classes

Class	Sub-classes
Animal	Park, Street, Train station, Zoo, Other
Bakery	Ihle, Wolf, Other
Construction Site	Paints and varnishes, Tar, Other
Sewage	Faeces, Urine, Other
Flower	Flower shop, Garden, Park, Other
Gastronomy	Asian, Butcher shop, Cafe, Chinese, Kebab, Fastfood, ..., Other
Market Stalls	Fish, Flowers, Fruits and vegetables, Meet, Other
Petrol	Parking place, Petrol station, Street, Other
Shop	Perfumery, Pharmacy, Other
Smoke	Chimney, Cigarette, Water pipe, Other
Vegetation	Bush, Tree, Other
Waste	Basket, Container, Household, Other
Water	Channel, River, Other

Class1
<<stereotype1>>
stereotype property 1

Urban Smell Mapping

Taxonomy – Properties of Sub-classes



- **Temporary** – information whether this smell possesses a temporal component (e.g., time of the year (seasons) or time of the day)



- **Intensity** – subjective evaluation of the intensity of a smell



- **Notes** – important for the details not captured in the sub-classes

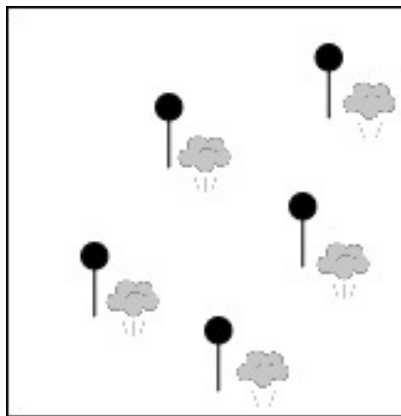
<https://www.drawio.com/>



Urban Smell Mapping

Mapping in the field – From Taxonomy to WebMap

- Editable layer in the GIS for the classes to setup a WebMap
- Field named **type** defining the sub-classes
- Fields for the properties **temporary**, **intensity**, and **notes**
- **Point geometry** → mapping of the smells as a point at the location where it is most smellable or being produced
- Additional layer **others**



<https://www.drawio.com/>





Urban Smell Mapping

Mapping in the field – Mapping

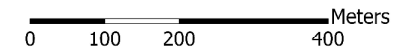
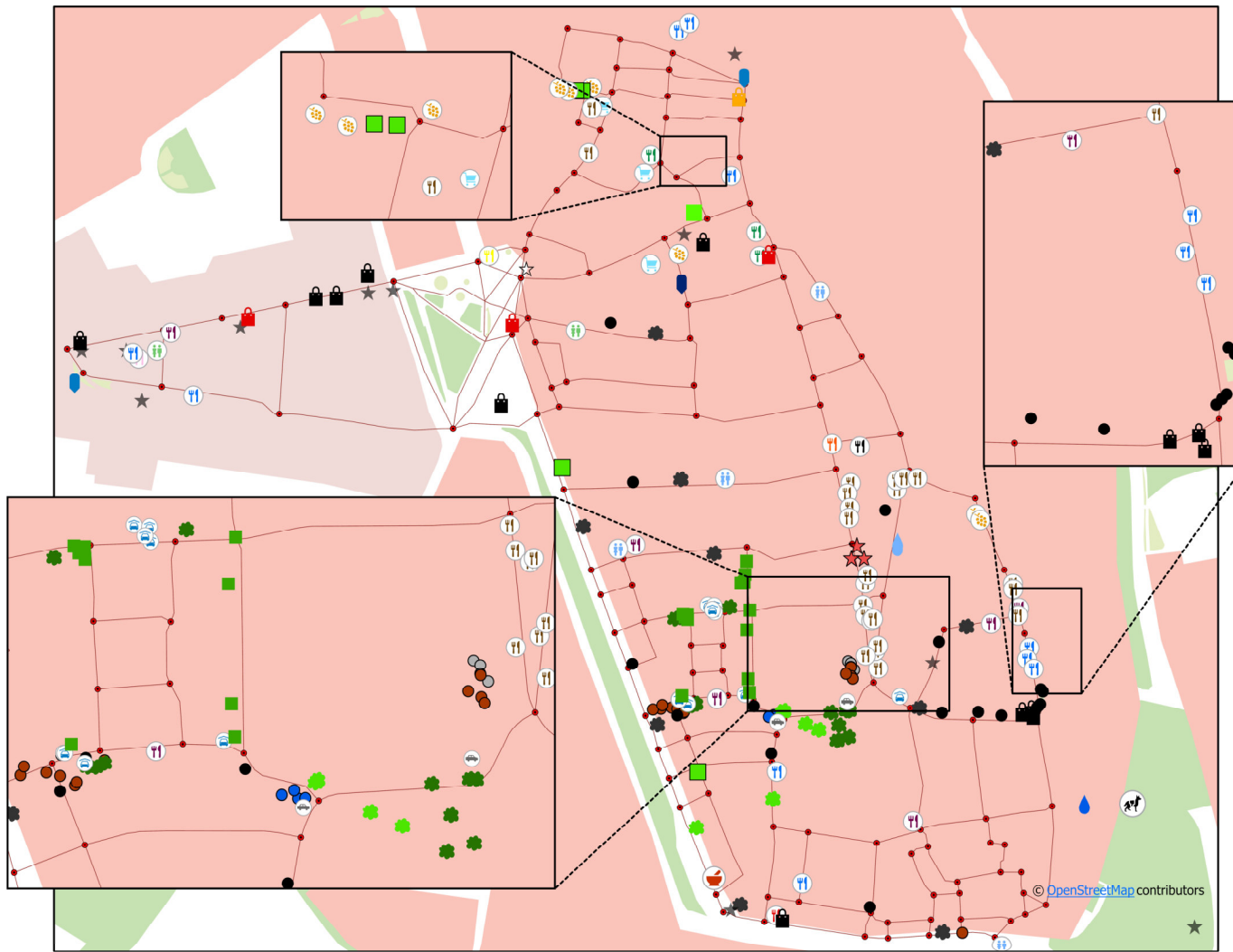
- Smells were collected within a project seminar
- Smell mappers mapped smells in the investigation area
- A part of Augsburg was selected as investigation area → different land uses
- On-site mapping was performed over two weeks in June and July 2022
- Values for the properties temporary, notes, and intensity



- Decision Points
 - Routesegments
- Landuse
- commercial
 - grass
 - park
 - residential



<https://www.vcp.de/pfadfinden/allgemein/immer-der-nase-nach>



Animal



Park

Bakery



Ihle



Wolf



Other



Paints and varnishes



Other

Urin



Other

Flower



Garden



Flower shop

Gastronomy



German



Kebab



Ice cream parlour



Fastfood



Mexican

Pizzeria



Asian



Cafe



Other

Market stall



Fruits and vegetables



Flowers

Petrol



Street



Parking place

Shop

Perfumery

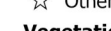


Pharmacy

Smoke



Cigarette



Water pipe



Other

Vegetation



Tree



Bush



Other

Waste

Basekt

Container

Household



Other

Water



River



Other

Decision Points



Decision Points

Routesegments



Routesegments

Landuse



commercial



grass

park

residential

Results

Class	Number smells	Number temporal smells	Intensity		
			Weak	Medium	strong
Animal	1	1	0	0	1
Bakery	14	14	4	7	3
Construction Site	3	3	1	2	0
Sewage	6	5	2	2	2
Flower	16	1	11	2	3
Gastronomy	48	48	25	19	4
Market stalls	11	11	4	5	2
Petrol	12	1	8	4	0
Shop	4	4	2	2	0
Smoke	15	15	5	6	4
Vegetation	26	4	15	10	1
Waste	42	8	26	10	6
Water	3	1	2	1	0
	201	111	105	70	26

Koutsoklenis and Papadopoulos (2011) with visually-impaired and sightless people

1. Restaurants and grills
2. Bakery
3. Garbage can

Results - Temporary

Class	Number smells	Number temporal smells	Intensity		
			Weak	Medium	strong
Animal	1	1	0	0	1
Bakery	14	14	4	7	3
Construction Site	3	3	1	2	0
Sewage	6	5	2	2	2
Flower	16	1	11	2	3
Gastronomy	48	48	25	19	4
Market stalls	11	11	4	5	2
Petrol	12	1	8	4	0
Shop	4	4	2	2	0
Smoke	15	15	5	6	4
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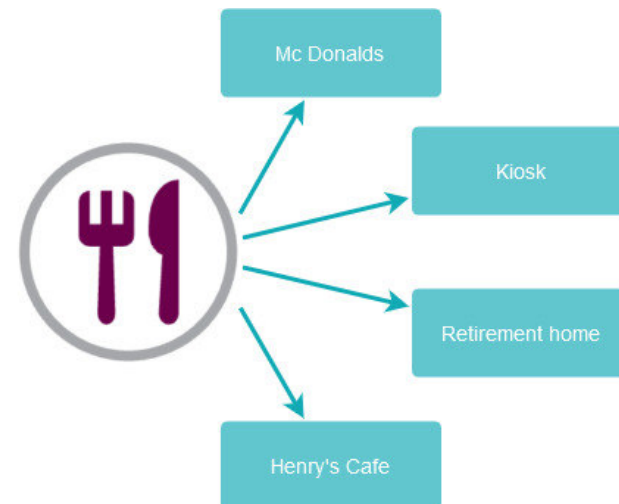
Results - Intensity

Class	Number smells	Number temporal smells	Intensity		
			Weak	Medium	strong
Animal	1	1	0	0	1
Bakery	14	14	4	7	3
Construction Site	3	3	1	2	0
Sewage	6	5	2	2	2
Flower	16	1	11	2	3
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	201	111	105	70	26

Results - Notes

- For smells difficult to assign to the predefined sub-classes (e.g. a kiosk that sells strawberries)
- Further information on the smell (e.g. a bakery additionally sells cake)
- Information on the location (courtyard)
- Arrangement of things (e.g. trees)

Animal Park	Other	Asian	Pharmacy	Other
Bakery Ihle Wolf Other	Flower Garden Flower shop	Cafe Other	Smoke Cigarette Water pipe Other	Water River Other
Construction Site Paints and varnishes Other	Gastronomy German Kebab Ice cream parlour Fastfood Mexican Pizzeria	Market stall Fruits and vegetables Flowers	Vegetation Tree Bush Other	Decision Points Routesegments
Sewage Urin		Petrol Street Parking place	Waste Basket Container Household	Landuse commercial grass park residential



<https://www.drawio.com/>

Discussion / Future Work

- Taxonomy based on the online-studies and the focus-group interview → 13 classes
 - Some of the classes (or sub-classes) could have been created differently (flowers as extra class and flowers in market stalls)
 - Iterative process of taxonomy creation (alternating with field investigations)
- Temporal dependencies
 - Daily dependencies (e.g. bakeries); Seasonal dependencies (flowers); Smell emission only during an event
- Point geometry for the layers to map smells → other ways to represent smell dispersion characteristics
- Investigation whether humans are really able to navigate using smell in a real world environment

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YOUR ATTENTION!