

Multimedia Analytics for Business

Stevan Rudinac

Associate Professor // Amsterdam Business School // UvA
Guest Researcher // Informatics Institute // UvA



About the Speaker

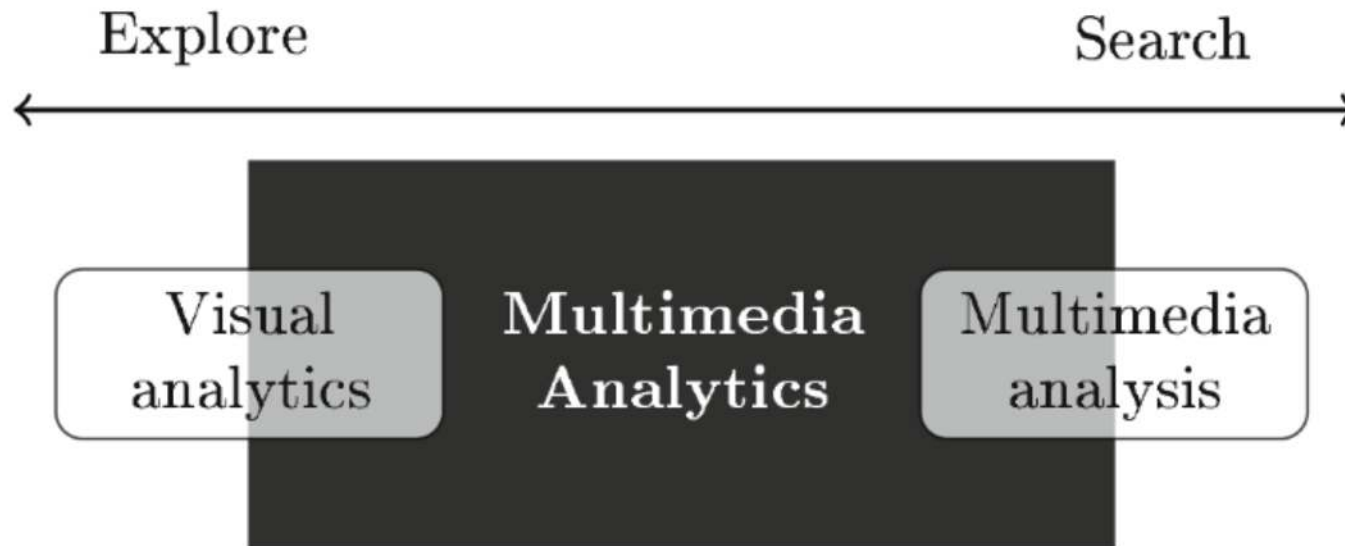


dr. Stevan Rudinac

Associate Professor @ Amsterdam Business School
// FEB // UvA

- Received PhD degree in Computer Science @ TU Delft 2013
- Graduated in Electrical Engineering @ University of Belgrade 2006
- Worked @ Informatics Institute (UvA), NFI, TU Delft, TU/e and University of Belgrade
- Conducting research in multimedia analytics with current focus on urban computing and business applications

Multimedia analytics: what and why

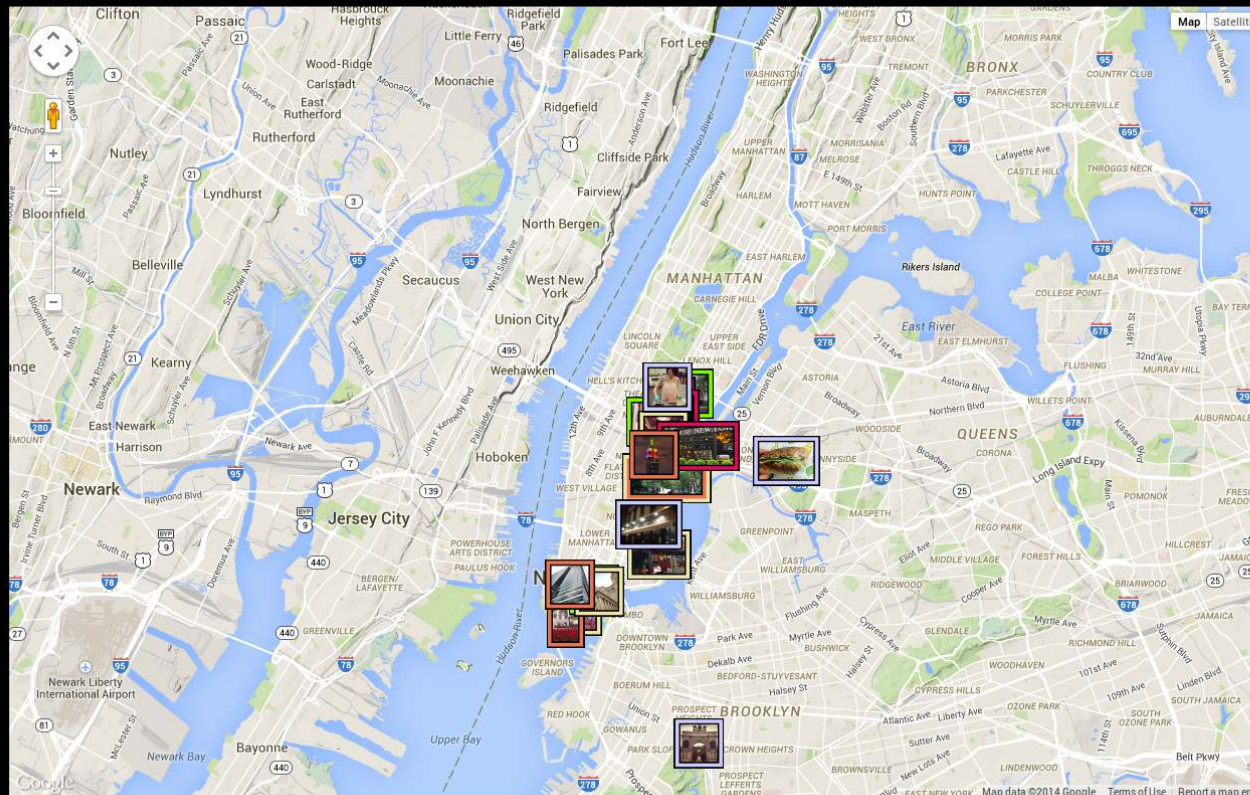


Applications in Urban Computing

City Exploration / Location Recommendation

Interactive city exploration

New Yorker Melange



User	Venues shown	Interesting?
 F. X. G. B. Raspberry	3 / 3	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="button" value="x"/>
 E. B. H. B. Chartreuse	4 / 4	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="button" value="x"/>
 H. B. C. Goldenrod	5 / 8	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="button" value="x"/>
 Q. S. F. B. Periwinkle	4 / 4	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="button" value="x"/>
 H. C. D. B. Burnt-Sienna	5 / 9	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="button" value="x"/>

Show more!



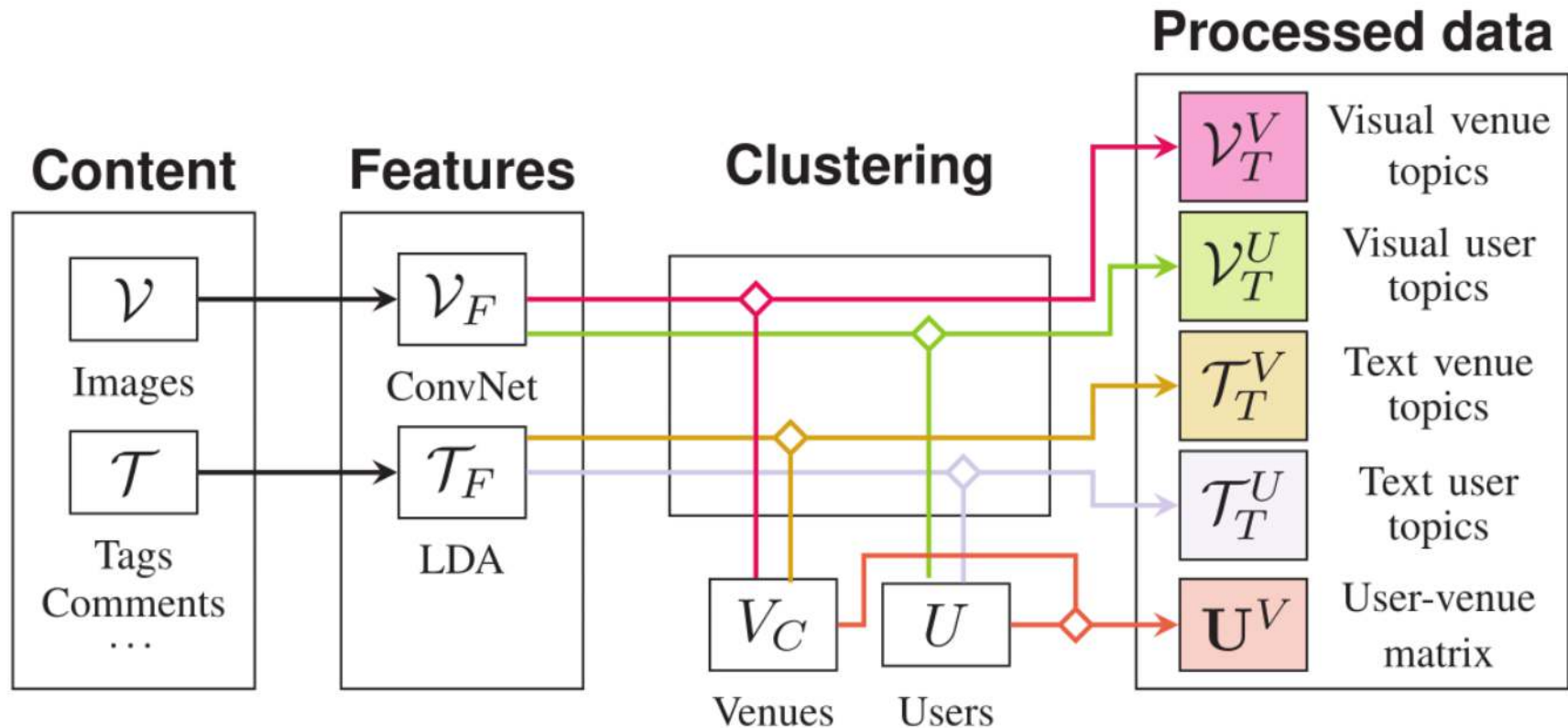
UNIVERSITEIT VAN AMSTERDAM

J. Zahálka, S. Rudinac, and M. Worrington, 2014 ([paper](#))

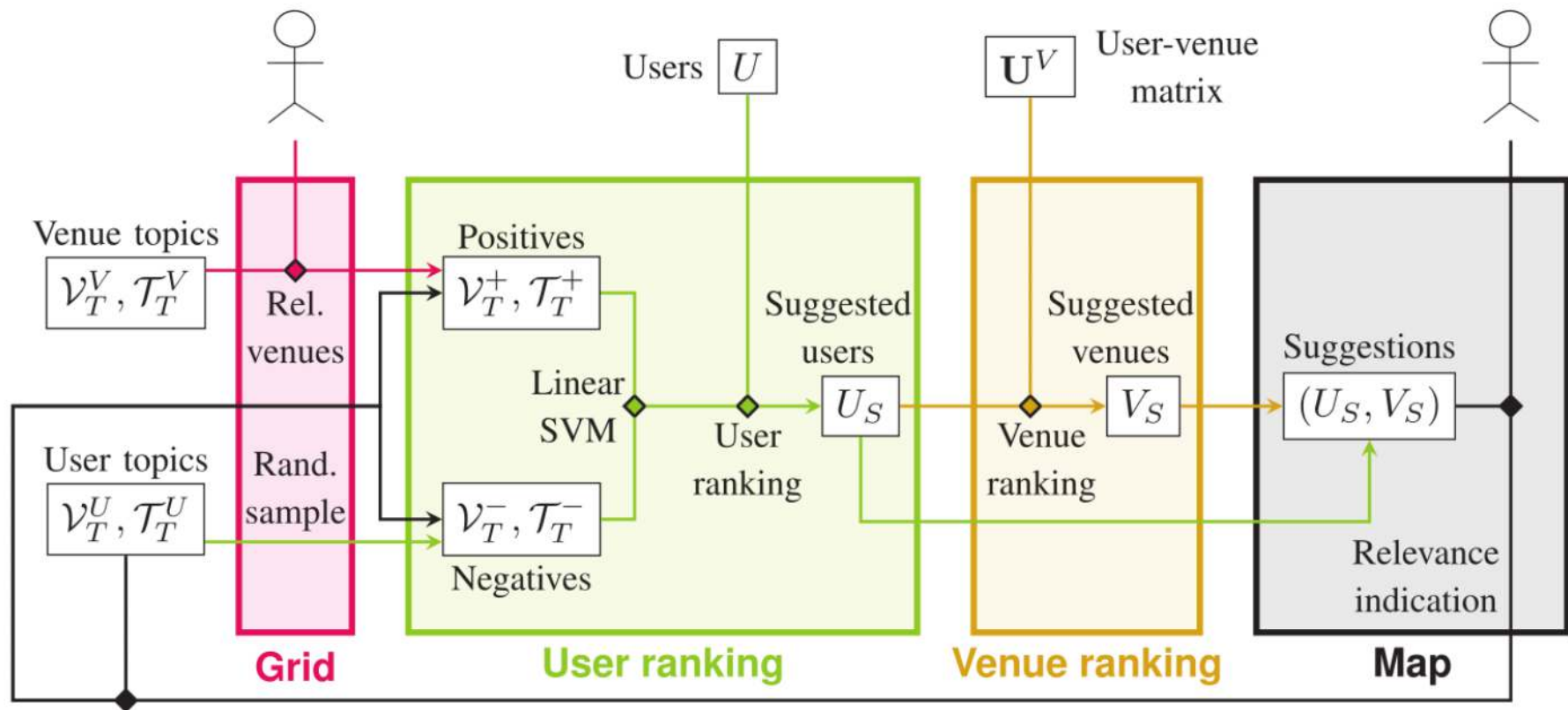
Jan Zahálka, Stevan Rudinac, and Marcel Worrington. 2014. New Yorker Melange: Interactive brew of personalized venue recommendations. Grand Challenge 1st Prize at the ACM Multimedia 2014 conference.

J. Zahálka, S. Rudinac and M. Worrington, "Interactive Multimodal Learning for Venue Recommendation," in IEEE Transactions on Multimedia, vol. 17, no. 12, pp. 2235-2244, Dec. 2015.

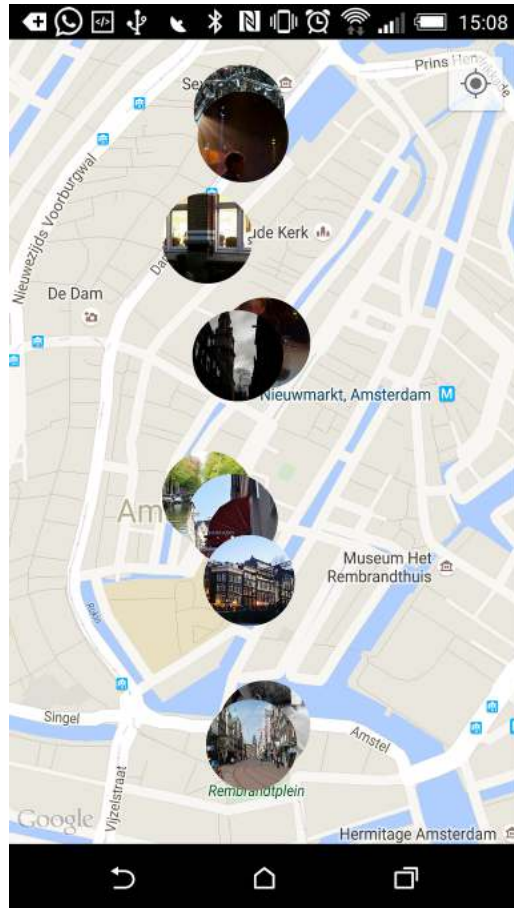
Melange – data processing pipeline



Melange – venue recommendation



Automatic multi-modal summarization of tourist routes

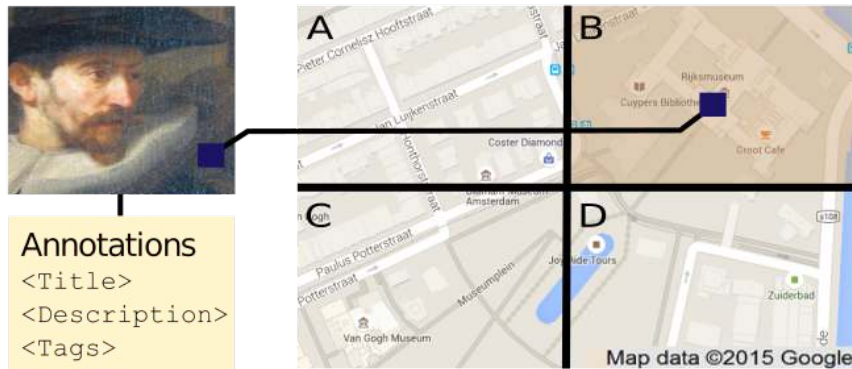


Jorrit van den Berg, Stevan Rudinac, Marcel Worring. 2016. Scenemash: Multimodal Route Summarization for City Exploration. In 38th European Conference on Information Retrieval (ECIR '16)

Scenemash: under the hood

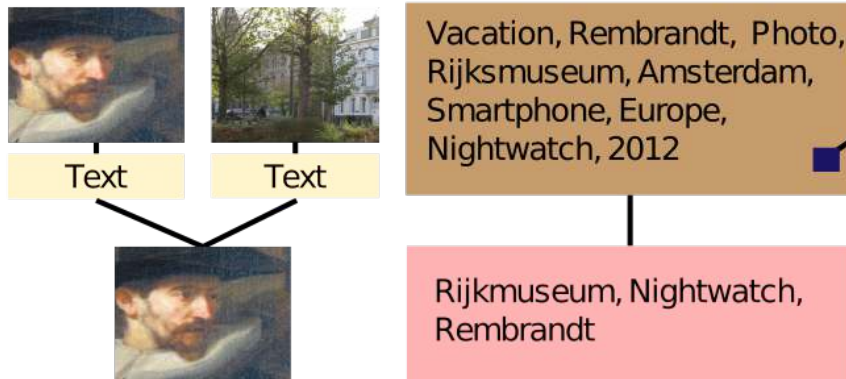
1

Download images and their annotations and group them in cells of a geographical grid



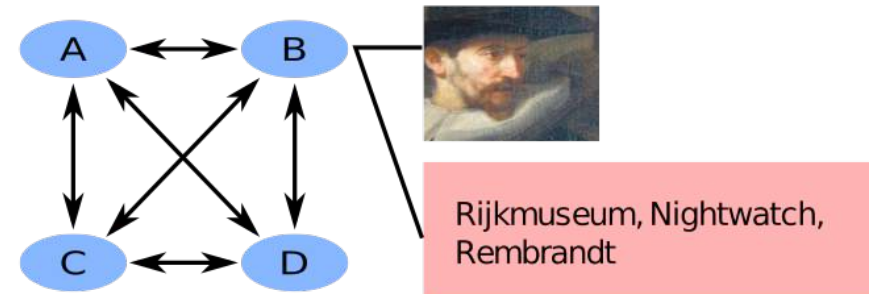
2

Select a representative image and filter descriptive terms from annotations for each cell in the grid



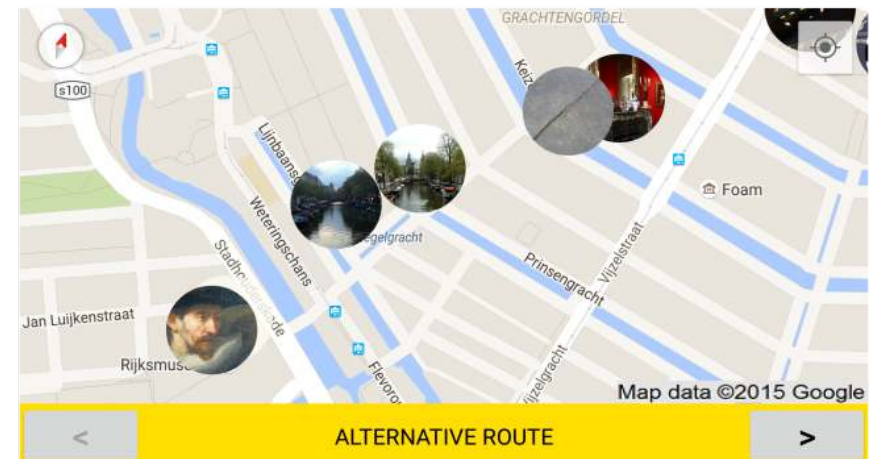
3

Create a graph with the geographical centroids of each cell as nodes to enable routing



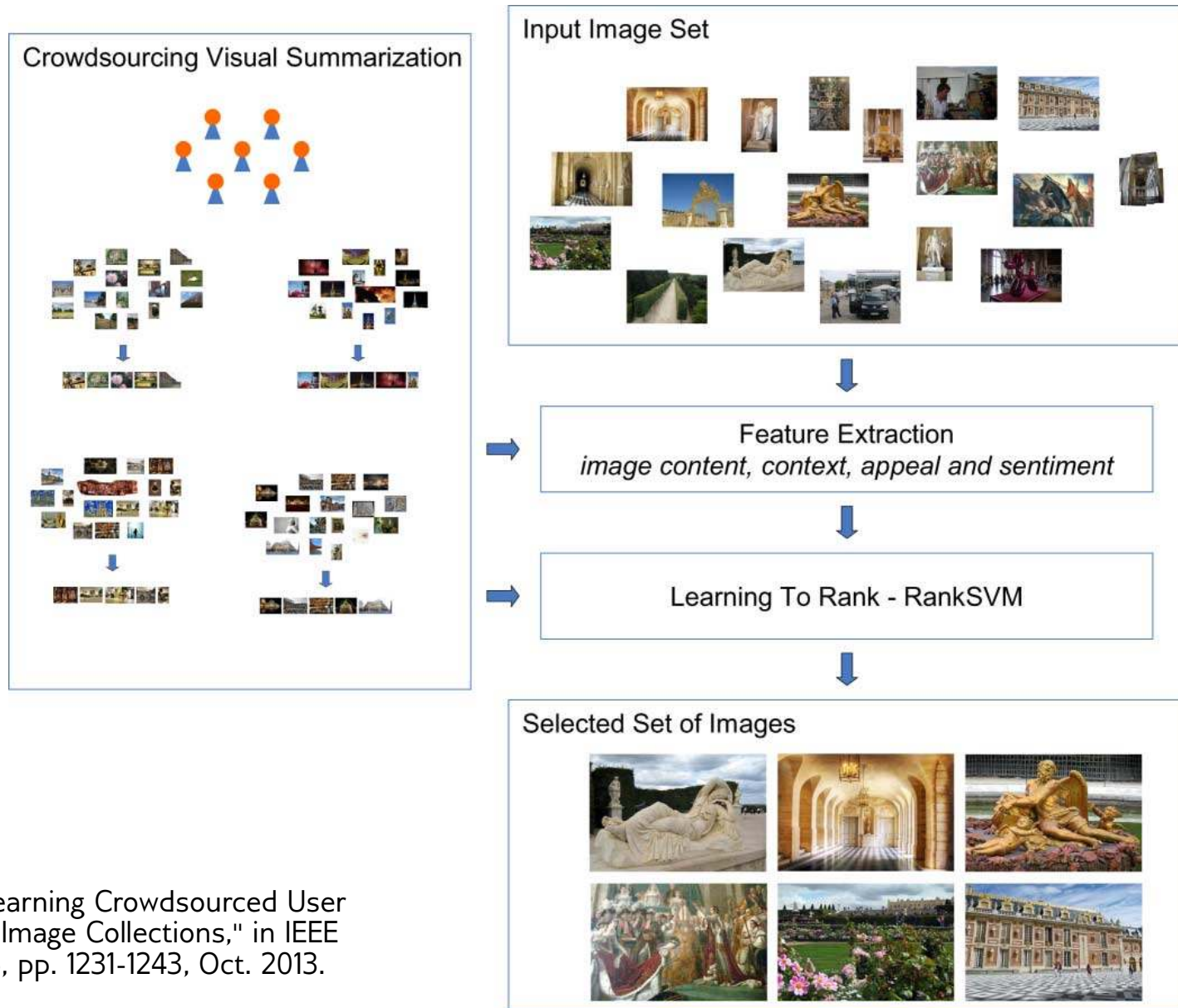
4

Generate routes between two locations and visualise them in a mobile app



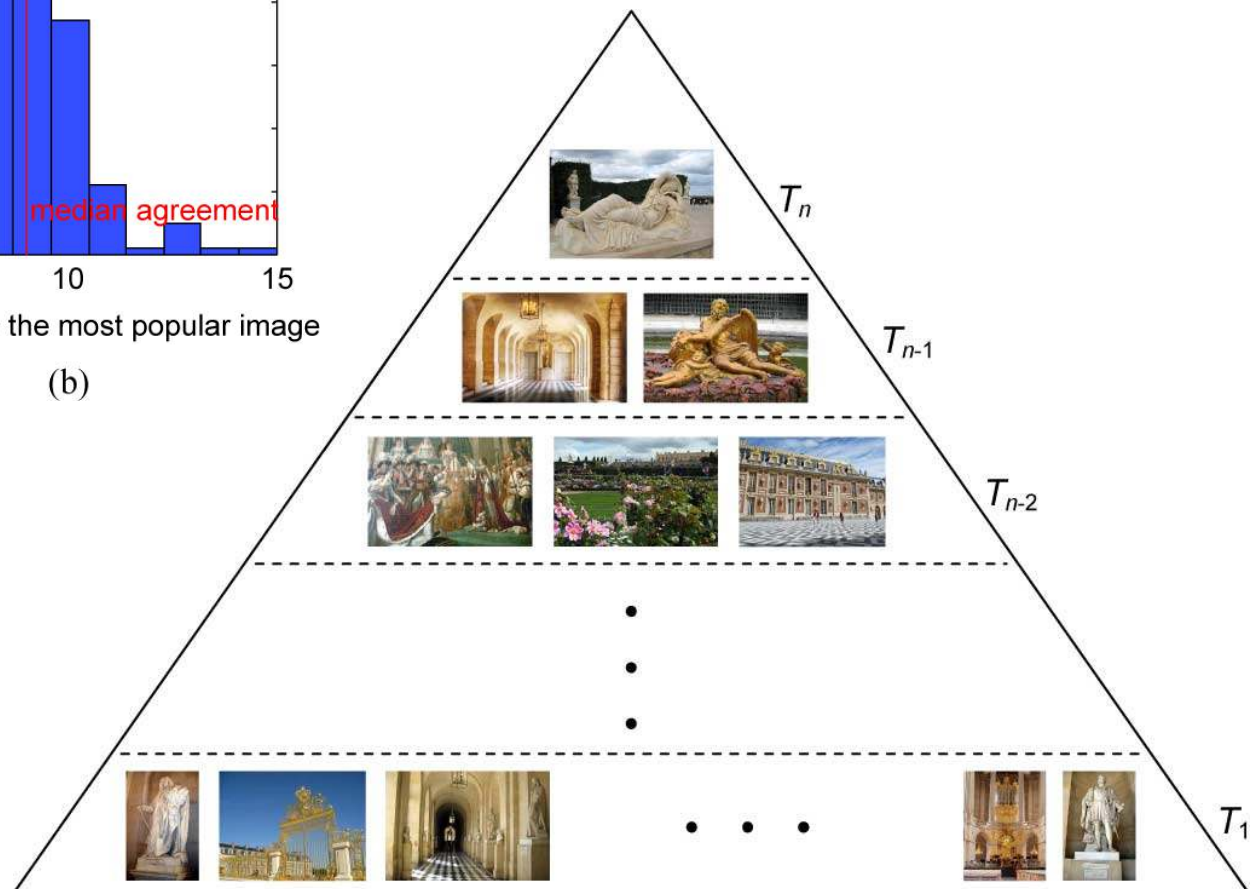
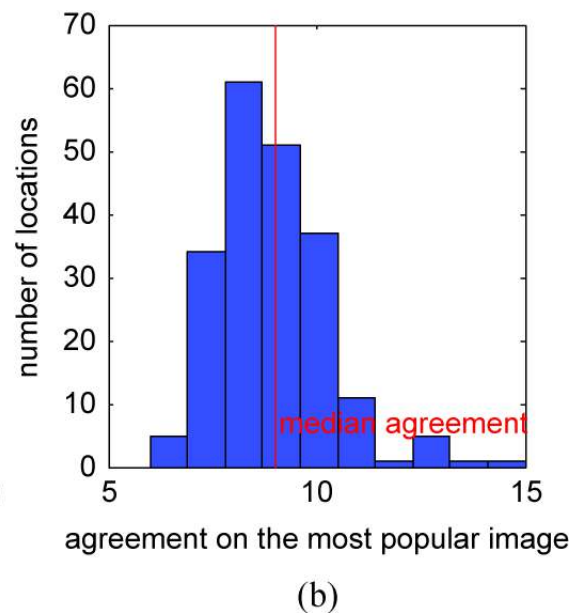
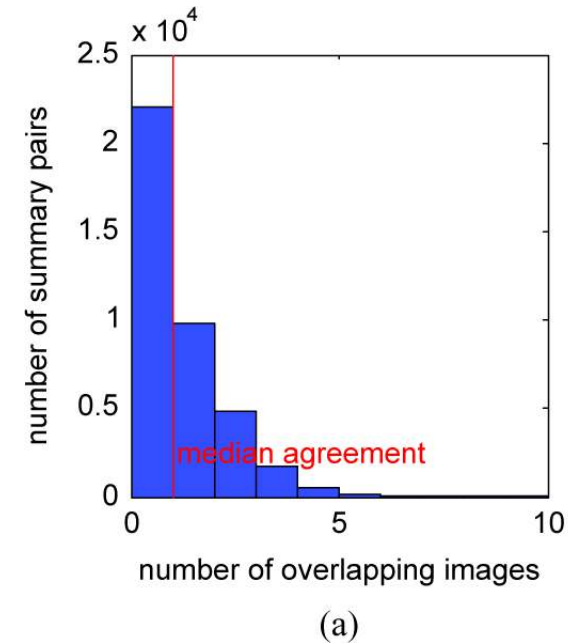
And Naturally, What Makes Multimedia
Content Popular?

Learning to select a set of images the way a human would do



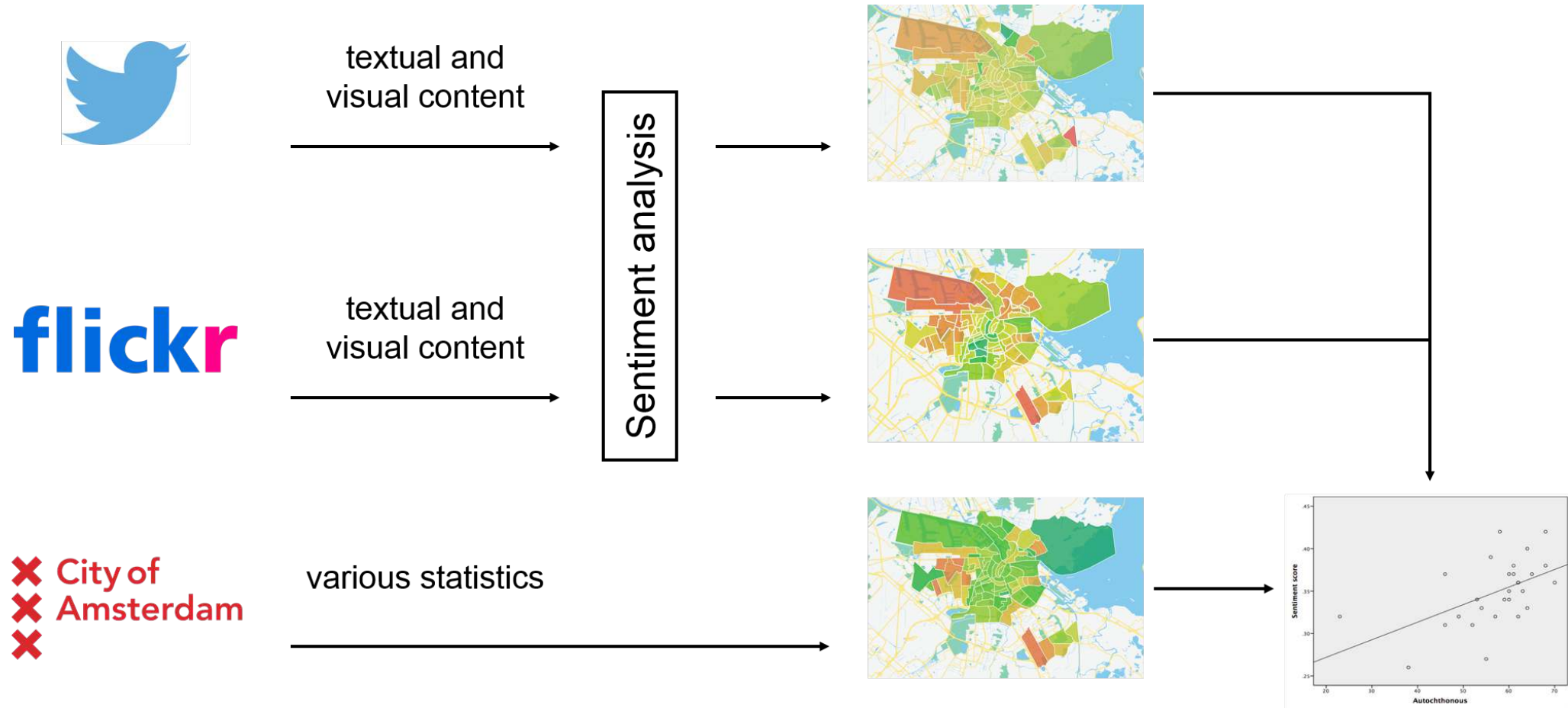
S. Rudinac, M. Larson and A. Hanjalic, "Learning Crowdsourced User Preferences for Visual Summarization of Image Collections," in IEEE Transactions on Multimedia, vol. 15, no. 6, pp. 1231-1243, Oct. 2013.

Learning to select a set of images the way a human would do



Analysing and Improving City Liveability

Mapping sentiment of the city



Joost Boonzajer Flæs, Stevan Rudinac, Marcel Worring. 2016. What Multimedia Sentiment Analysis Says About City Liveability. In 38th European Conference on Information Retrieval (ECIR '16).

Sneak peek into the ingredients: *visual sentiment*



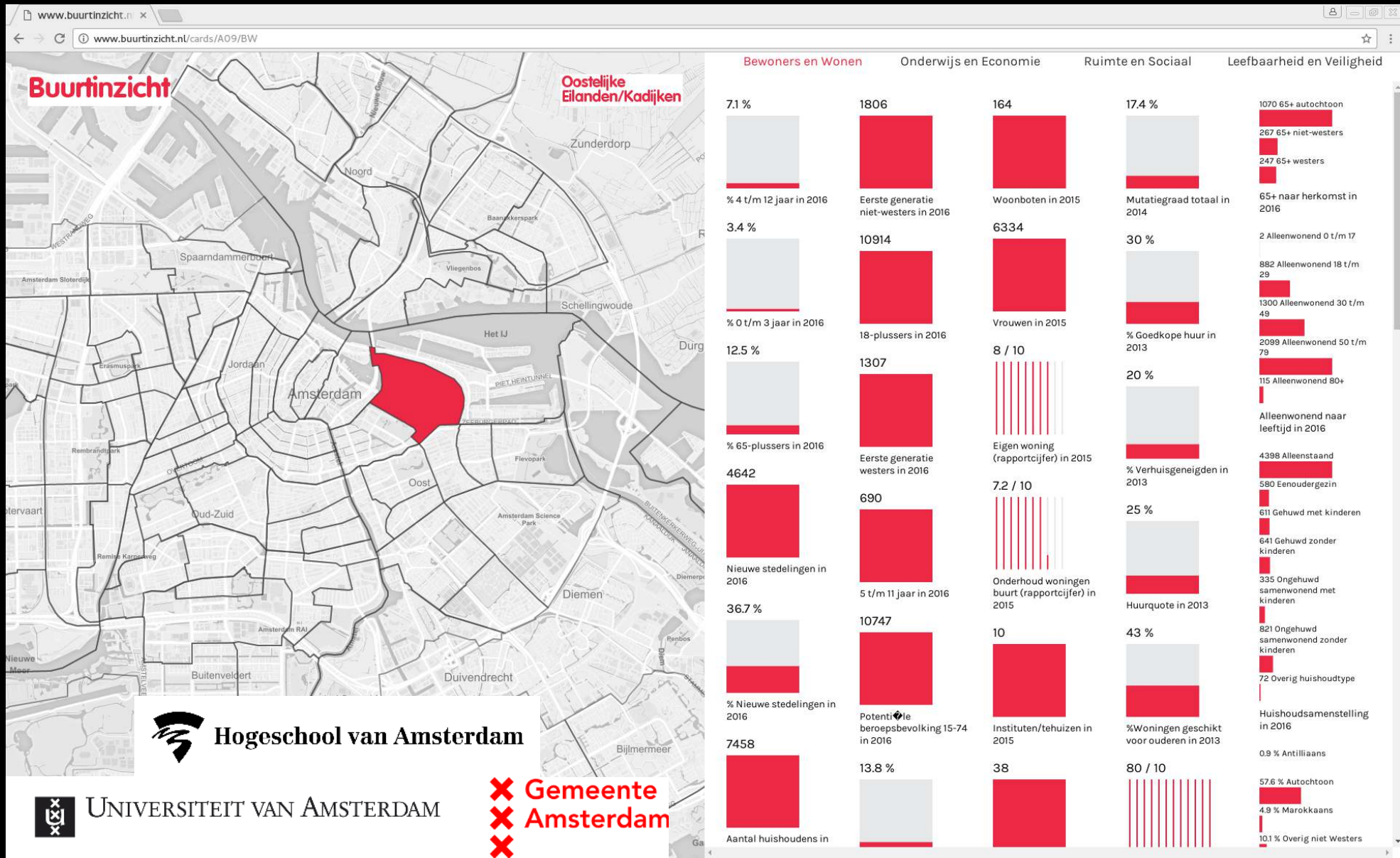
Figure 6: Concepts detected: Lonely road -1.47, Dusty sky -1.83, Misty valley -0.48, Magnificent sunrise +1.78, Wet road -1.47, Weird fog -1.34, Gorgeous morning +1.65, Great sunset +1.71, Misty lake -0.26, Misty road -0.47



Figure 5: Concepts detected: Yummy meat +1.63, Sweet chocolate +2.00, Amazing food +2.00, Yummy food +2.00, Yummy pie +2.00, Awesome food 2.00, Pretty present +2.00, Fancy food +2.00, Delicious chocolate +2.00, Great food +2.00

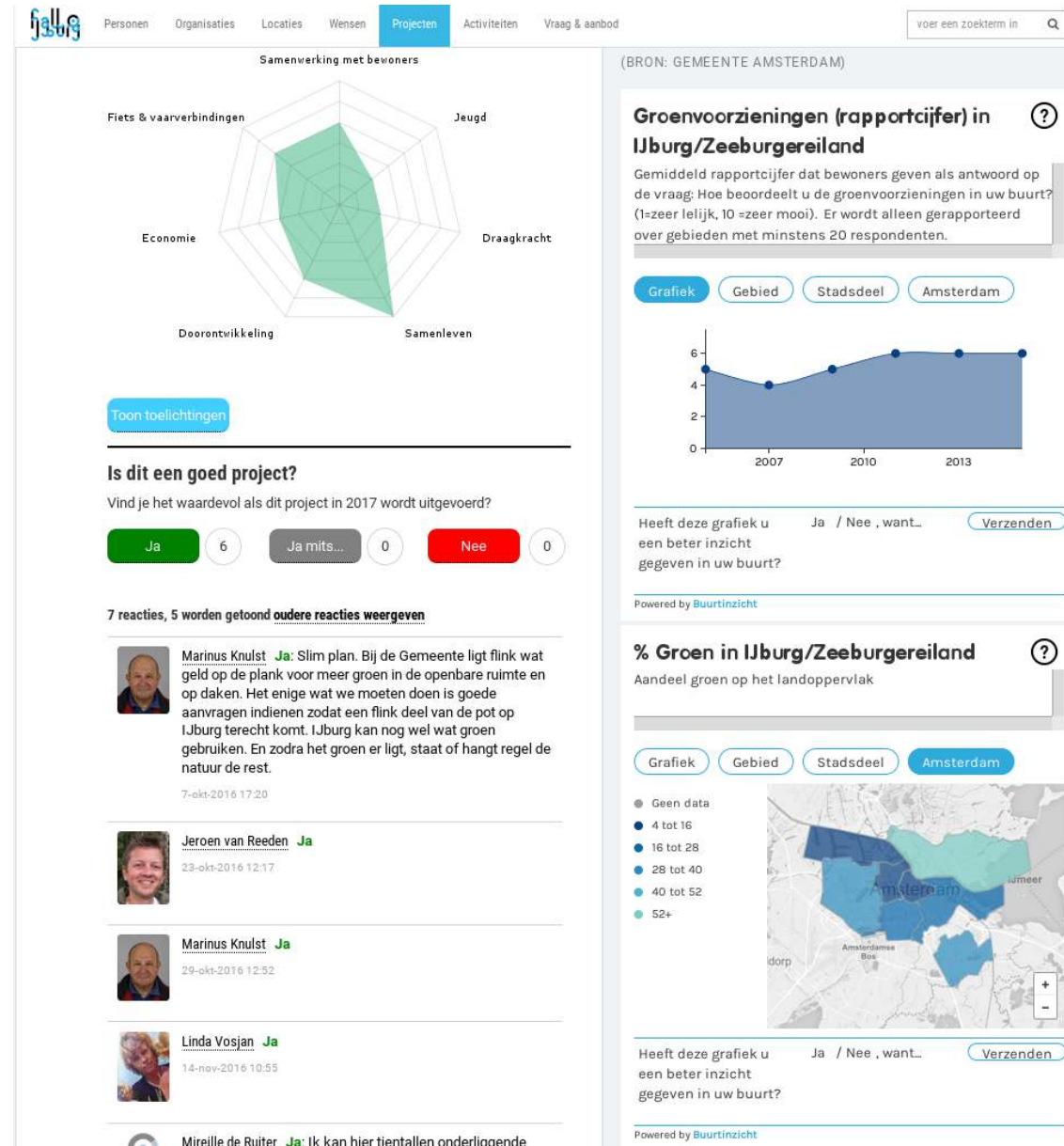


Buurtinzicht: empowering local urban communities



Buurtinzicht: empowering local urban communities

Interactive widgets in the neighborhood platforms



Classification, prioritization and routing of citizen reports



Maarten Sukel

- **WHO:** AI specialist @ City of Amsterdam | PhD researcher @ UvA with Prof. Marcel Worring and dr. Stevan Rudinac
- **WHAT:** Improving liveability of the neighbourhoods in Amsterdam
- **HOW:**
 - Designing an intelligent citizen report system
 - Multi-modal analysis of participatory data, social multimedia and open data.

Nieuwe melding

Beschrijf uw melding

173.940 per year and growing ...

Waar is het?

De Boelelaan 1105, 1081HV Amsterdam



1 *location*

Waar gaat het om?

Beschrijf uw melding

2 *issue description*

Geef het tijdstip aan

☐

Nu

☐

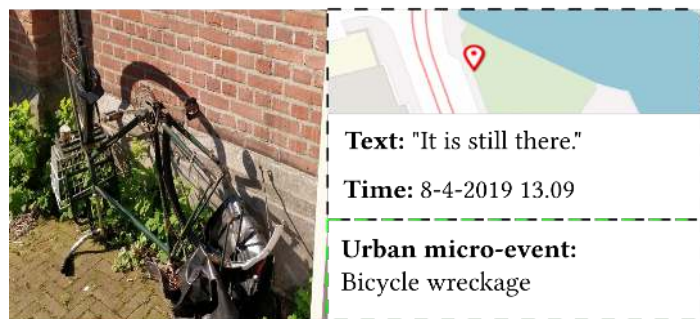
Eerder

3 *timestamps*

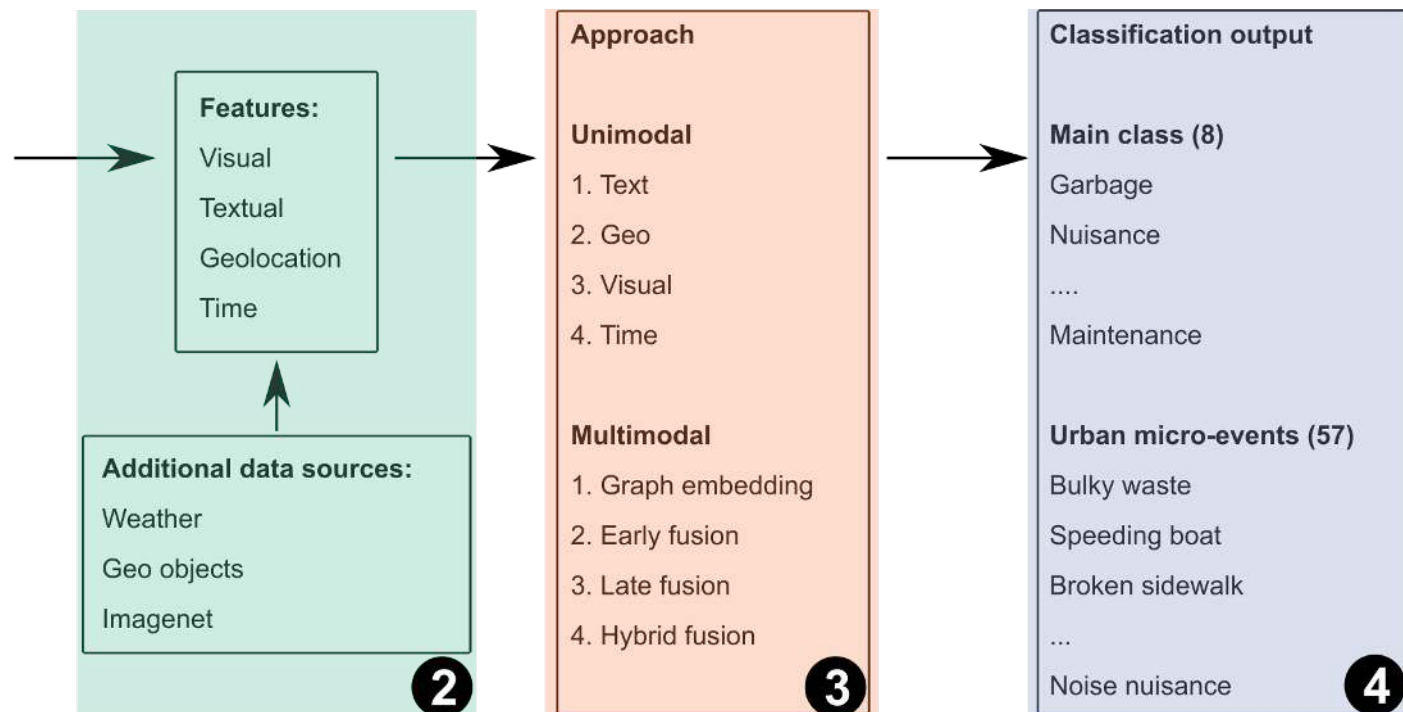
Wilt u een foto meesturen? (niet verplicht)

Foto kiezen

4 *user-provided image*

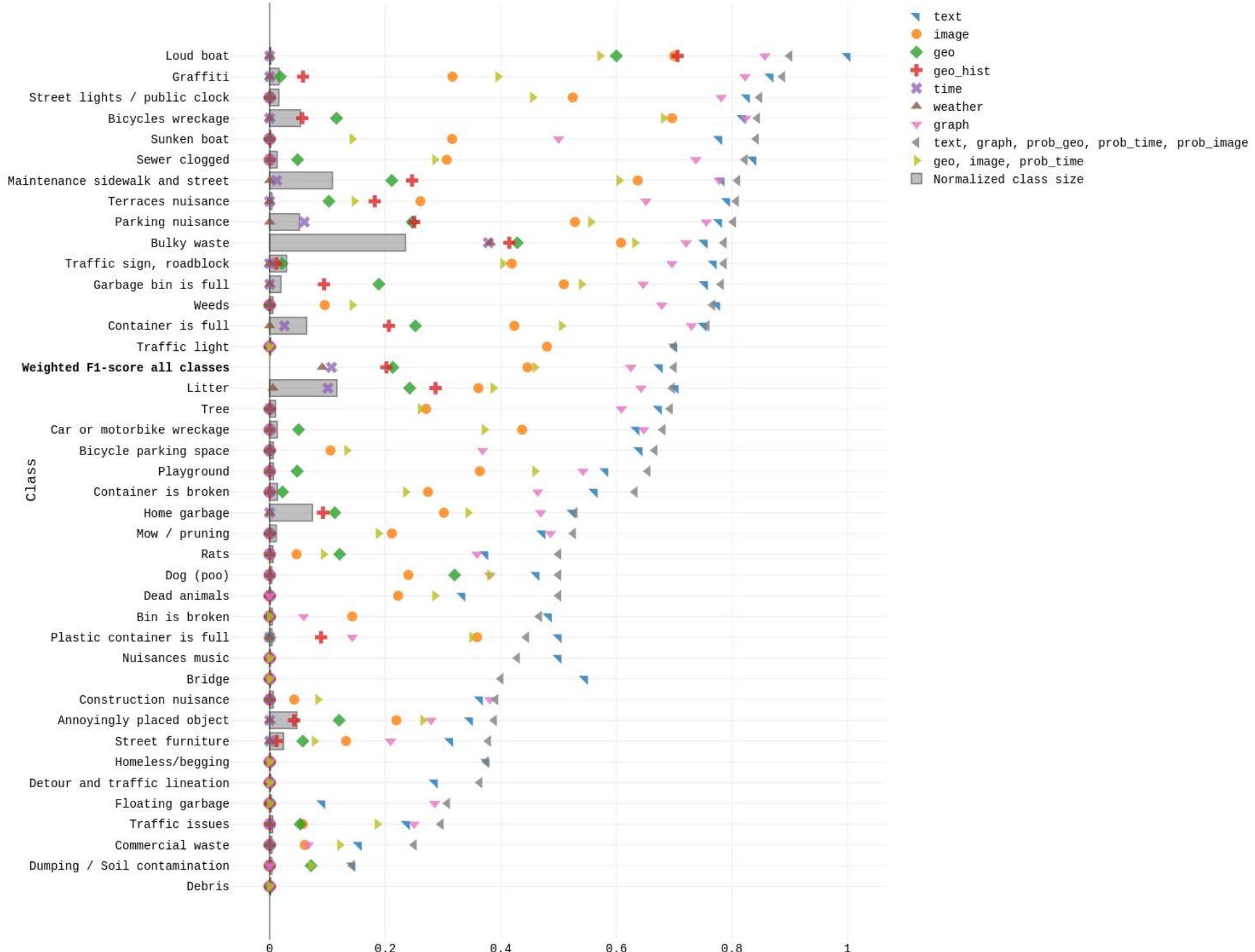


1



Maarten Sukel, Stevan Rudinac, and Marcel Worring. 2019. Multimodal Classification of Urban Micro-Events. In Proceedings of the 27th ACM International Conference on Multimedia (MM '19), Oct. 21–25, 2019, Nice, France, 9 pages. (TO APPEAR)

Class



F1-score and normalized class size

So, what's next?



Halsema wil met camera's en scanauto's overlast aanpakken

17 oktober 2019, 16:48 uur · Aangepast: 17 oktober 2019, 19:10 uur



Scanauto's, cameratoezicht en een pilot met 'effectieve beeldherkenning bij grofafval'. Digitale innovaties moeten de stad schoner en veiliger maken.

Dat staat in het Masterplan Handhaving en Reiniging dat burgemeester Halsema vandaag naar de gemeenteraad stuurde. Het langverwachte plan somt een keur aan maatregelen en onderzoeksrichtingen op die de stad leefbaarder moeten maken.



Dijksma wil scanauto gebruiken in strijd tegen afvalbergen

23 september 2019, 11:12 uur · Aangepast: 23 september 2019, 11:41 uur



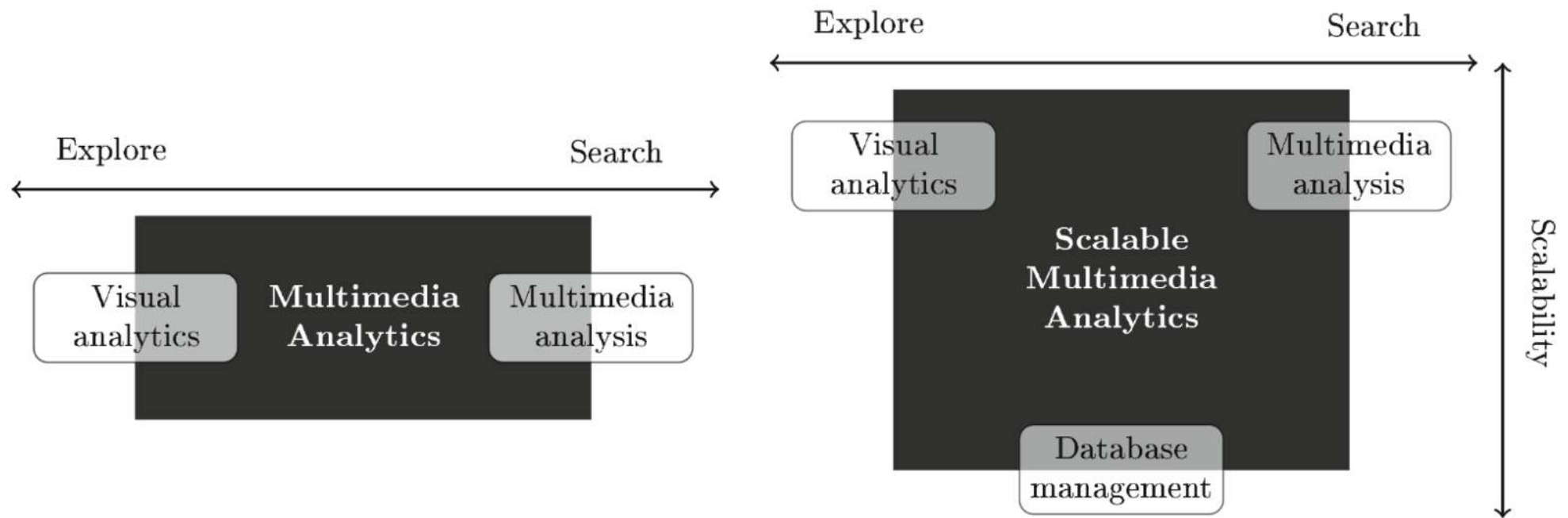
Wethouder Sharon Dijksma wil de scanauto's van Parkeerbeheer ook inzetten voor het herkennen van zwerfvuul in de stad. De gemeente onderzoekt of de scanauto's bergen afval kunnen herkennen.

Dat zegt de wethouder in een interview met [Nieuwsuur](#).

Erder maakte de gemeente bekend de scanauto's naast het inzetten van parkeervolledingen en het

Going (very) big ...

Scalable multimedia analytics



Björn Þór Jónsson, Marcel Worring, Jan Zahálka, Stevan Rudinac, Laurent Amsaleg. 2016. Ten Research Questions for Scalable Multimedia Analytics. MMM 2016: 290-302.

COMMUNICATIONS OF THE ACM

CACM.ACM.ORG

OF THE

02/2016 VOL.59 NO.02

YFCC100M: The New Data in Multimedia Research

The Beckman Report
on Database Research

Lessons from the
Tech Transfer Trenches

Schema.org

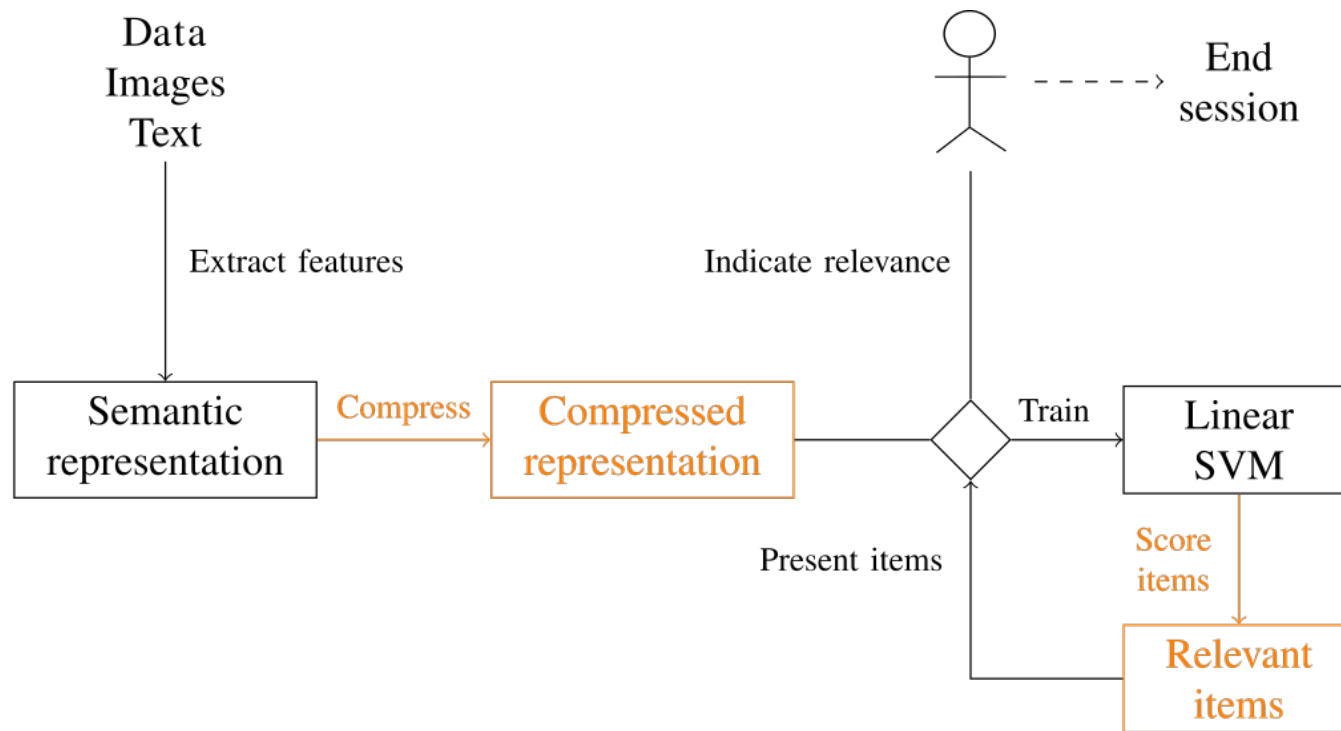
Robot Self-Repair
Techniques



Association for
Computing Machinery



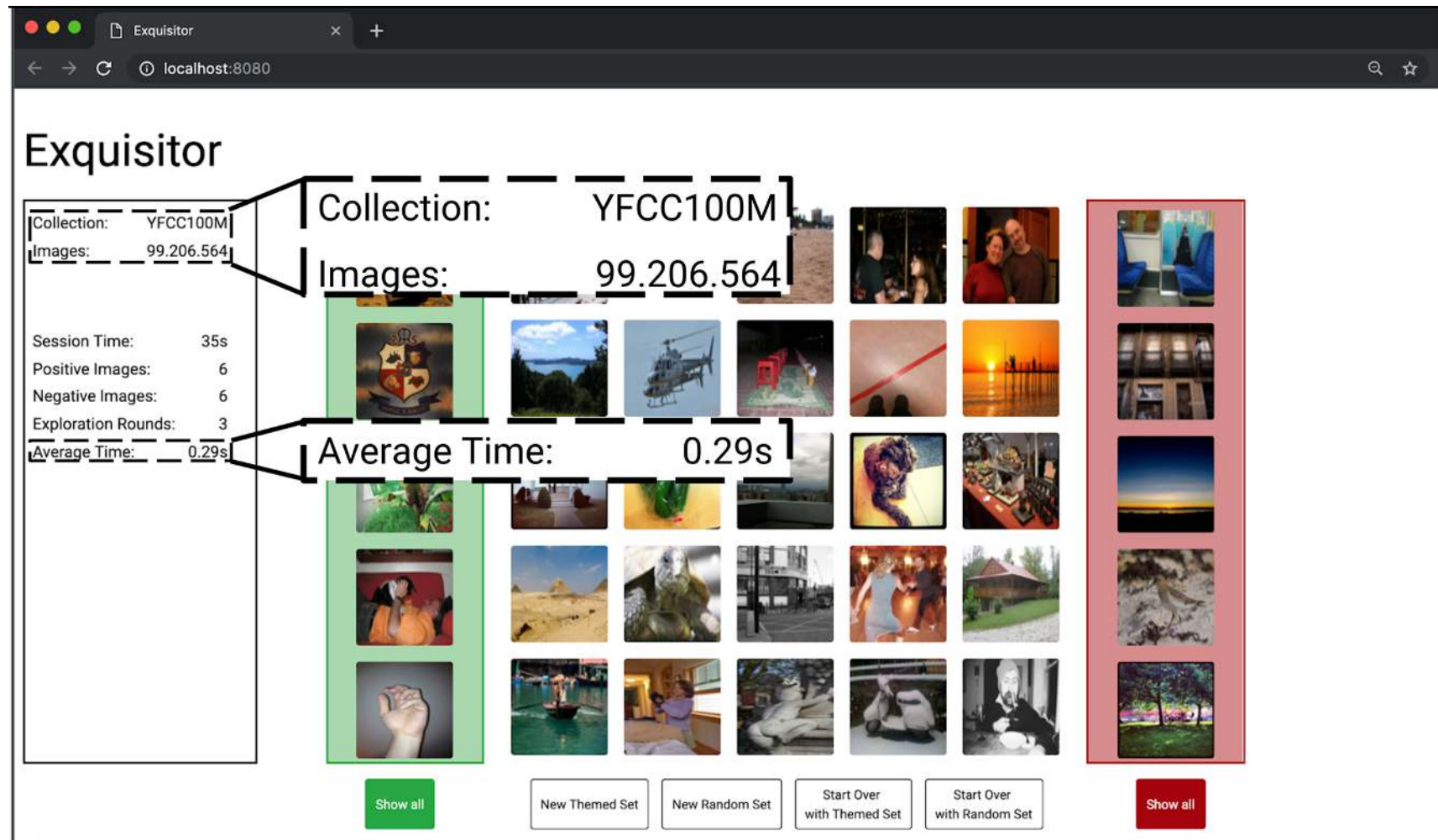
Blackthorn



Jan Zahálka, Stevan Rudinac, Björn Þór Jónsson, Dennis C. Koelma, and Marcel Worring. 2016. Interactive Multimodal Learning on 100 Million Images. In Proceedings of the 2016 ACM on International Conference on Multimedia Retrieval (ICMR '16). ACM, New York, NY, USA, 333-337.

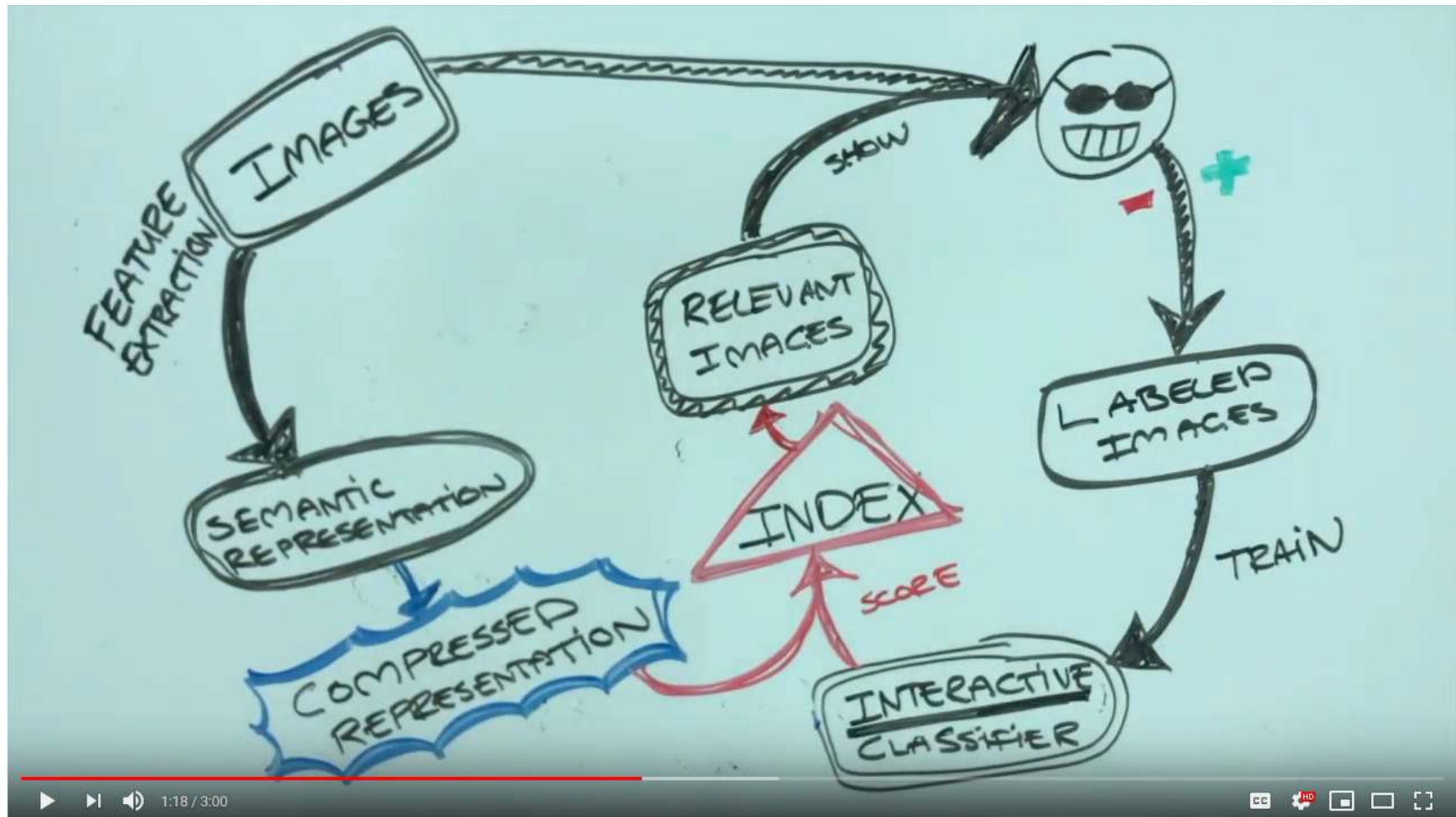
Jan Zahálka, Stevan Rudinac, Björn Þór Jónsson, Dennis C. Koelma, and Marcel Worring, "Blackthorn: Large-Scale Interactive Multimodal Learning," in IEEE Transactions on Multimedia, vol. 20, no. 3, pp. 687-698, March 2018. doi: 10.1109/TMM.2017.2755986

How about laptops or mobiles?



Hanna Ragnarsdóttir, Þórhildur Þorleiksdóttir, Omar Shahbaz Khan, Björn Þór Jónsson, Gylfi Þór Guðmundsson, Jan Zahálka, Stevan Rudinac, Laurent Amsaleg, and Marcel Worring. 2019. Exquisitor: Breaking the Interaction Barrier for Exploration of 100 Million Images. In Proceedings of the 27th ACM International Conference on Multimedia (MM '19), October 21–25, 2019, Nice, France. ACM, New York, NY, USA, 3 pages. (TO APPEAR)

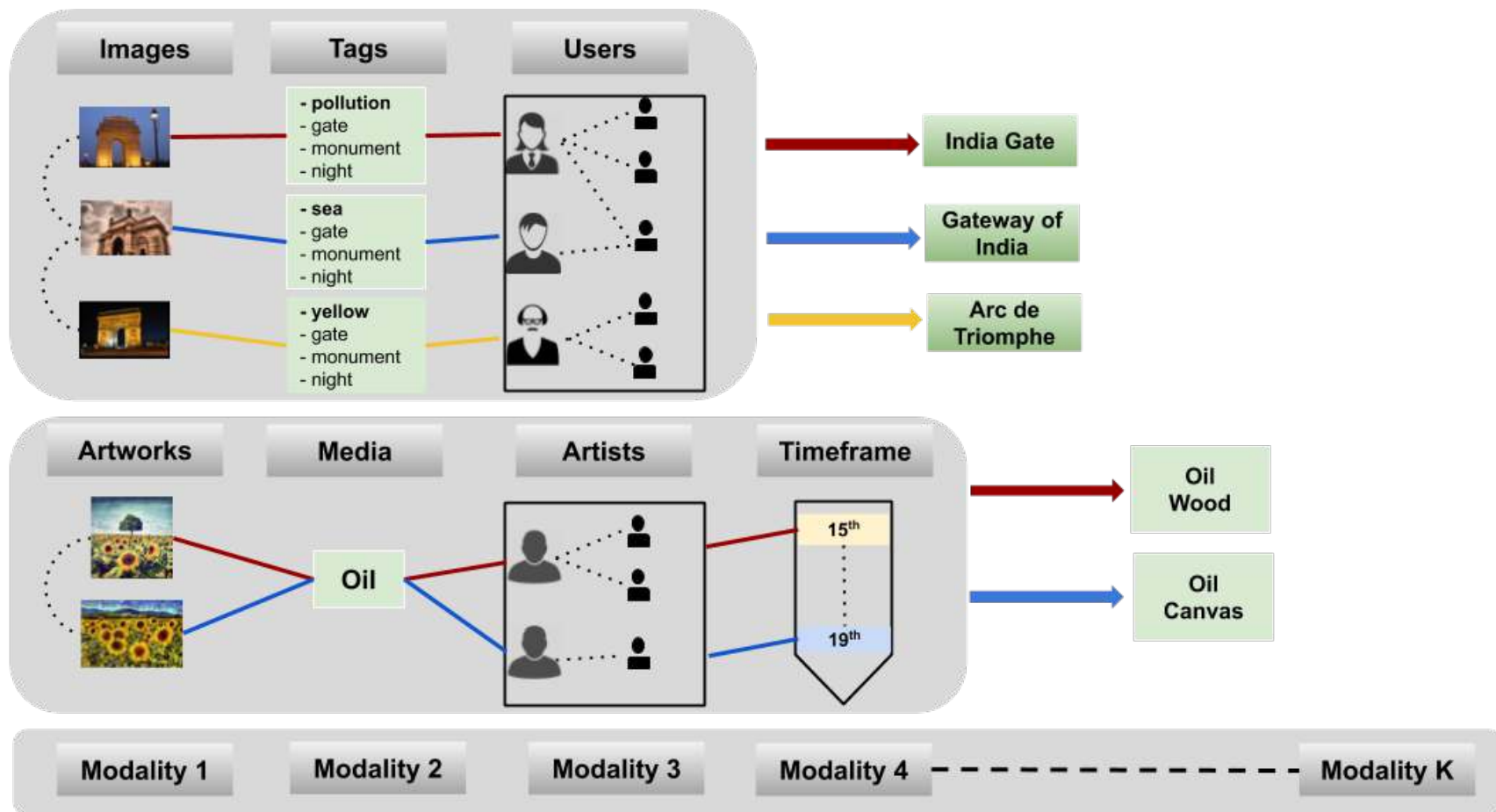
How about laptops or mobiles?



Hanna Ragnarsdóttir, Þórhildur Þorleiksdóttir, Omar Shahbaz Khan, Björn Þór Jónsson, Gylfi Þór Guðmundsson, Jan Zahálka, Stevan Rudinac, Laurent Amsaleg, and Marcel Worring. 2019. Exquisitor: Breaking the Interaction Barrier for Exploration of 100 Million Images. In Proceedings of the 27th ACM International Conference on Multimedia (MM '19), October 21–25, 2019, Nice, France. ACM, New York, NY, USA, 3 pages. (TO APPEAR)

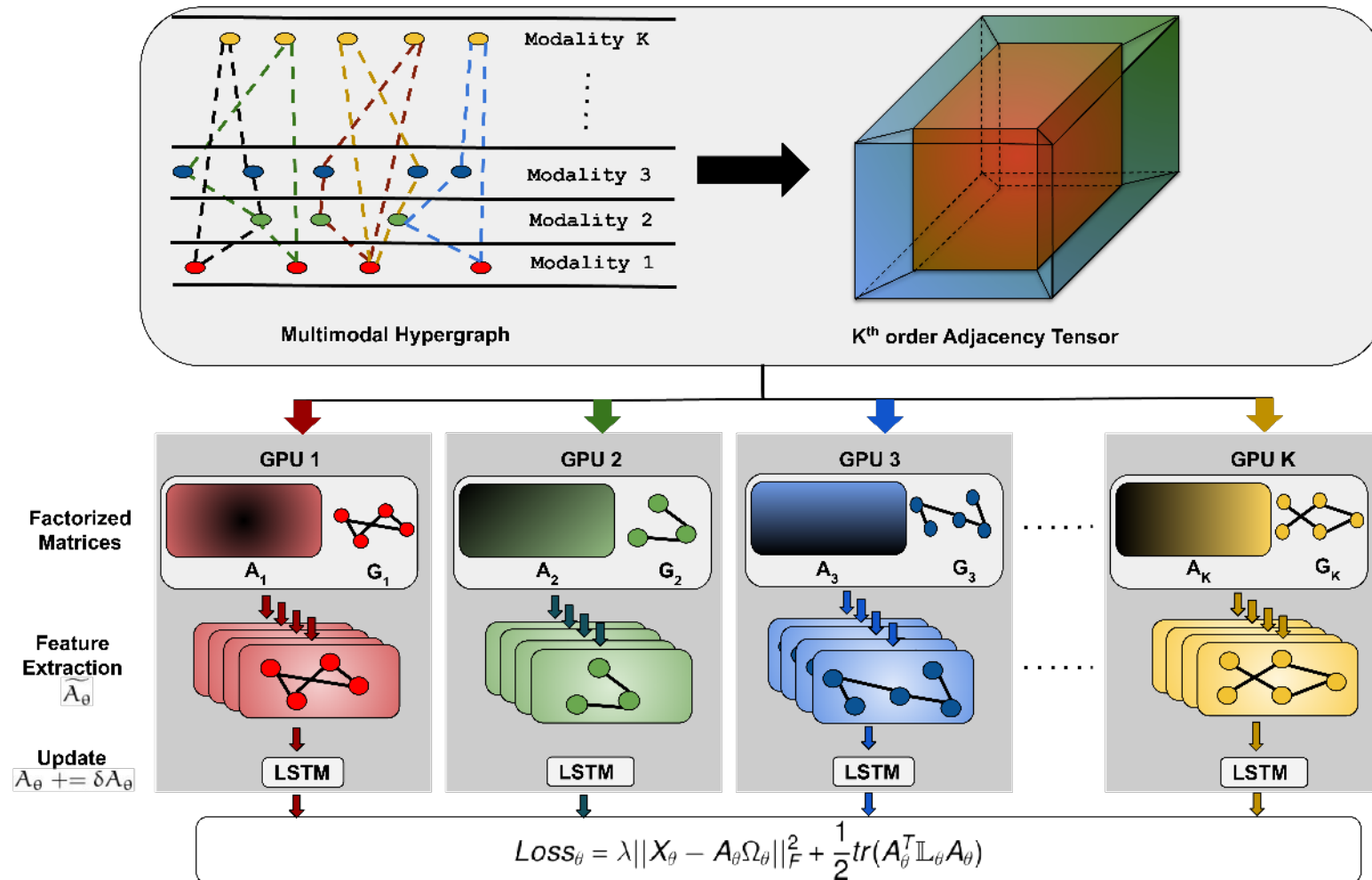
Modeling Higher Order Relations

Example ternary and quaternary relations



Devanshu Arya, Stevan Rudinac, and Marcel Worring. 2019. HyperLearn: A Distributed Approach for Representation Learning in Datasets With Many Modalities. In Proceedings of the 27th ACM International Conference on Multimedia (MM '19), October 21–25, 2019, Nice, France. ACM, New York, NY, USA, 9 pages. (TO APPEAR)

Example ternary and quaternary relations



Devanshu Arya, Stevan Rudinac, and Marcel Worring. 2019. HyperLearn: A Distributed Approach for Representation Learning in Datasets With Many Modalities. In Proceedings of the 27th ACM International Conference on Multimedia (MM '19), October 21–25, 2019, Nice, France. ACM, New York, NY, USA, 9 pages. (TO APPEAR)

(Additional) Work in Progress

How liveable are these neighbourhoods?



From problem to hip neighbourhood in under 10 years



probleemwijken in Amsterdam volgens VROM, maart 2007

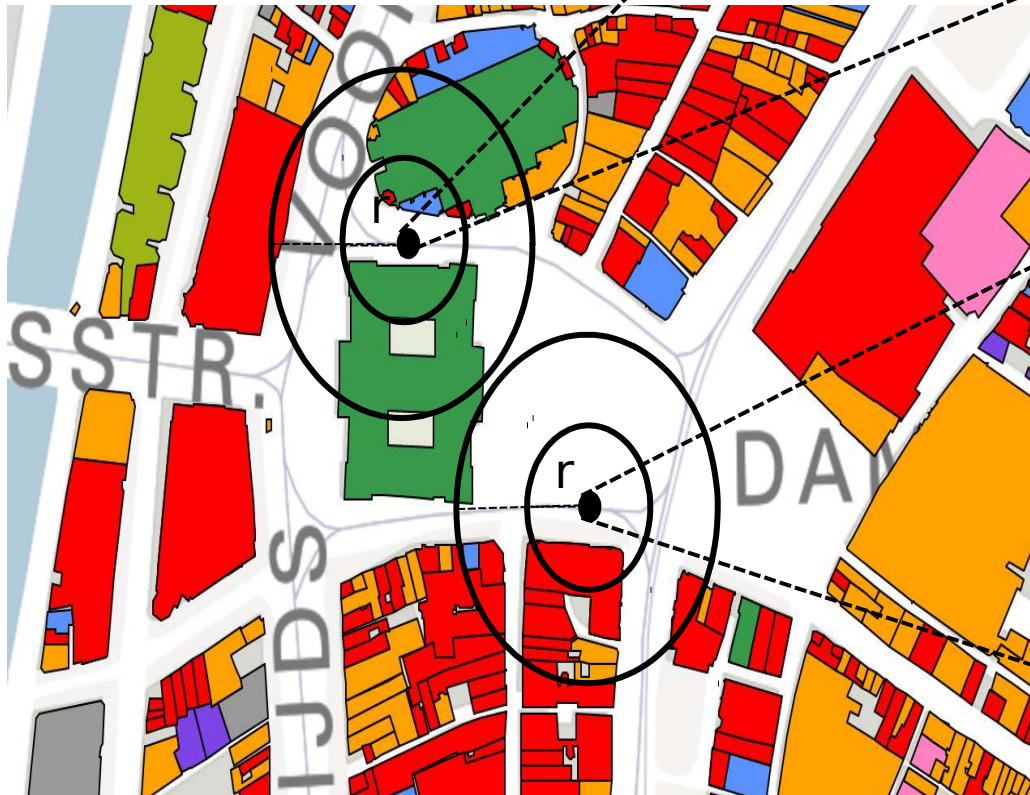
'Tien jaar geleden was er nauwelijks een aantrekkelijke kroeg of koffietent te vinden in de Javastraat. Nu is het de hipste buurt van Amsterdam'

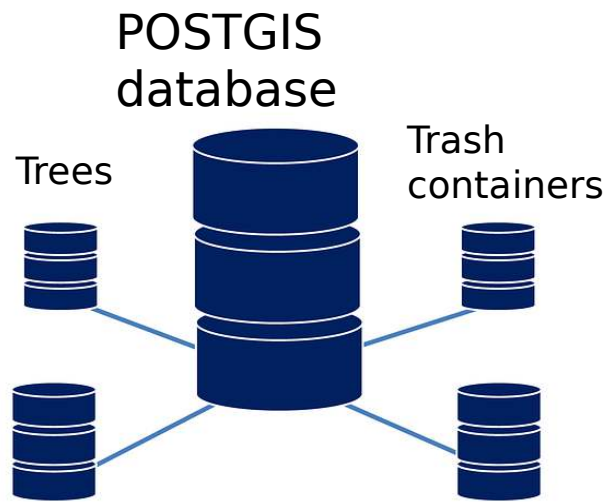


Panoramas and GIS Information



$r = 5$ meter





Generate box
proposals

Human
corrects boxes



Multimedia analytics for urban computing



Inske Groenen

- **WHO:** PhD researcher @ UvA with Prof. Marcel Worring and dr. Stevan Rudinac
- **WHAT:**
 - Developing innovative ways of fusing highly heterogeneous content
 - Going beyond object, action and event detection to understanding complex phenomena such as neighbourhood liveability and urban decay

SCORE Smart Cities and Open data REuse

Programme	NSR
Duration	4 years
Project partners	14
Budget	€5.7M
EC-contribution	€2.8M
Coordinator	City of Amsterdam



Solutions developed in SCORE will be open source and based on Open Data



Water level sensors can inform early flood warning systems



Real-time information about free parking spaces can reduce CO2 emission by decreasing traffic by up to 30%



Public transit frequency can be adjusted based on live user data



Waste collection can be improved by intelligent routing



Streetlight sensors can be used to measure traffic flows and improve traffic management

Background	Aim	Approach	Results	Impact
<p>Cities aim to improve the delivery of public services based on innovative software solutions and data sharing.</p> <p>However, Data has not and will not automatically lead to better public service delivery.</p> <p>To capture that potential, value from data needs to be unlocked by making it interoperable between departments and organisations.</p> <p>The shared challenge is how to generate innovative solutions that address common city needs.</p>	<p>SCORE aims to increase the efficiency and quality of public service delivery of cities in the sectors of Environment, Waste & Water, Parking & Traffic, and Sustainable Mobility by developing innovative open source solutions that use urban data. Contributing to Interreg NSR's objective by stimulating "the public sector to generate innovation demand and innovative solutions for improving public service delivery".</p> <p>The solutions will be free to use by other cities, adhere to EU standards, and replicable.</p>	<p>9 cities from 7 countries in the NSR will be grouped according to their shared challenges. The cities will formulate 6 public service challenges based on their in-depth understanding of the city's operations (business case), the available data (feasibility) and knowledge of their existing programmes and initiatives (funding).</p> <p>Each challenge will form a group that will develop 2 open source solutions using urban data. The solutions will be tested in Urban Living Labs. All cities will collaborate throughout the development process to ensure relevance and compatibility. In fact, solutions will be replicated transnationally at least twice within the SCORE project period.</p>	<p>By implementing the innovative open source solutions, SCORE will:</p> <ul style="list-style-type: none"> Reduce by 10% service provision costs of public authorities in the sectors of urban sustainability using open data and open source solutions. Improve by 20% the quality of public service provision as valued/assessed by citizens. Reduce by 30% the software development time in cities. 	<p>SCORE will solve public service delivery challenges common to partner cities through innovation. This community will contribute to the open-source movement and deliver solutions that are free to use by other NSR cities and beyond.</p> <p>The partnership will create an ecosystem with cities, research institutions and network organizations for smart public service delivery innovation. Organisations learn from each other while building solutions, eg in agile software development, transitioning towards being more data-driven.</p>



Contact: Bert-Jan Daan (b.j.daan@amsterdam.nl), Dr. Sebastiaan van Herk (s.vanherk@foxconn.com)

- Addressing the challenges in the sectors of e.g. Livability, Environment, Waste and Water, Mobility
- Collaboration between 9 cities in the North Sea Region

... and a Slightly Different Use Case



Advies en informatie

Alles wat je wilt weten over een bedrijf starten of overnemen, ZZP, MKB, internationaal ondernemen, financiering, innovatie, fraude, AVG en LEI.





Store placement and design



Ujjwal Sharma

- **WHO:** PhD researcher @ UvA with Stevan Rudinac (CS/AI) and Willemijn van Dolen (Marketing)
- **WHAT:** Automatic prediction of store location, popularity and design
- **HOW:** Joint utilization of
 - Neighborhood-level open data statistics
 - Social multimedia
 - Participatory data

Questions