RESEARCH.moves

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

DRESDEN

An extrapolation method on European accident data based on weighting and data harmonization

RSS 2022, Athens

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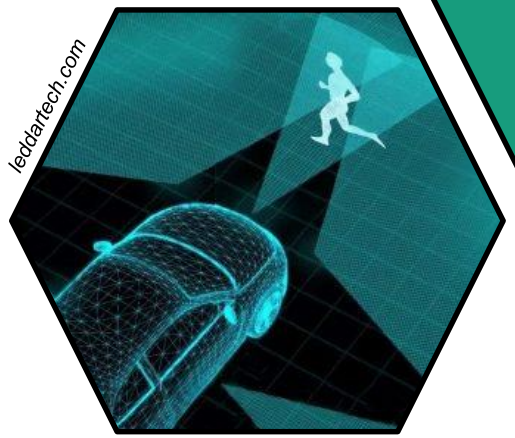
ADAS/AD systems



Handle complex real world situations

Validation of safety performance

Small-scale accident data sources

Introduction on markets

Large-scale markets

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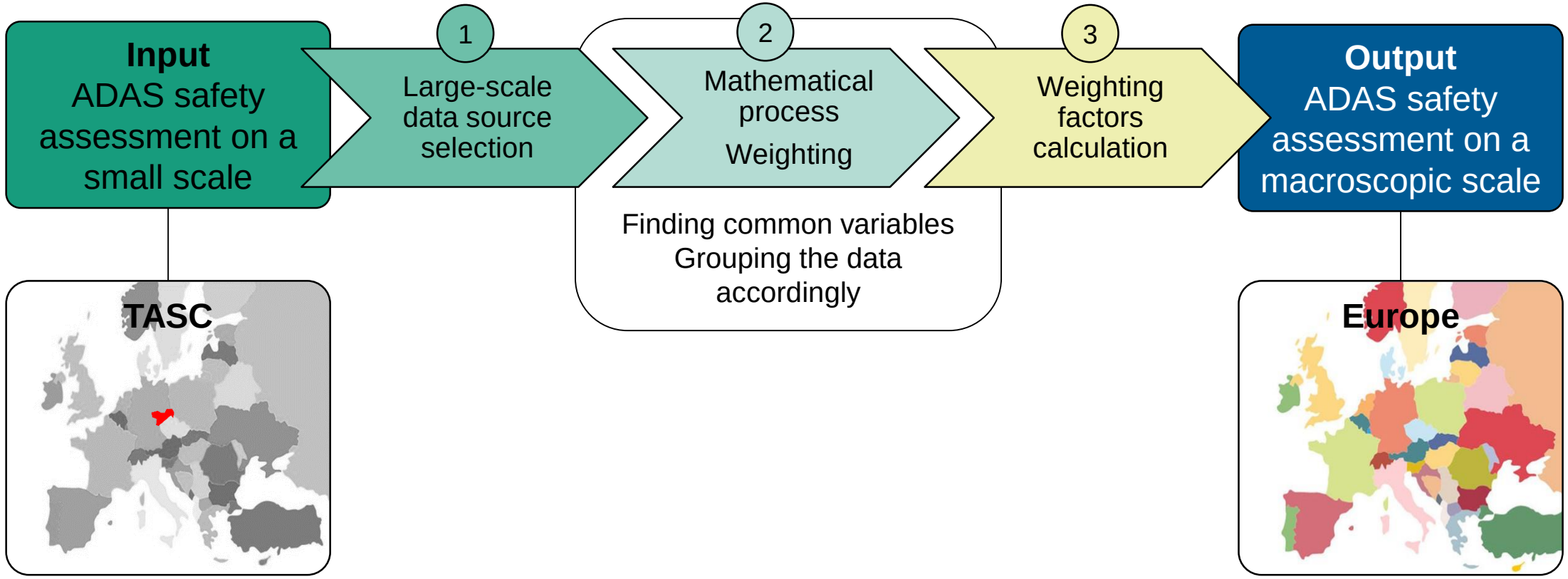
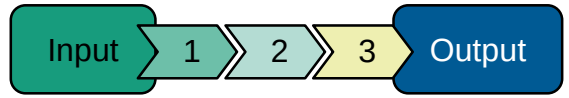
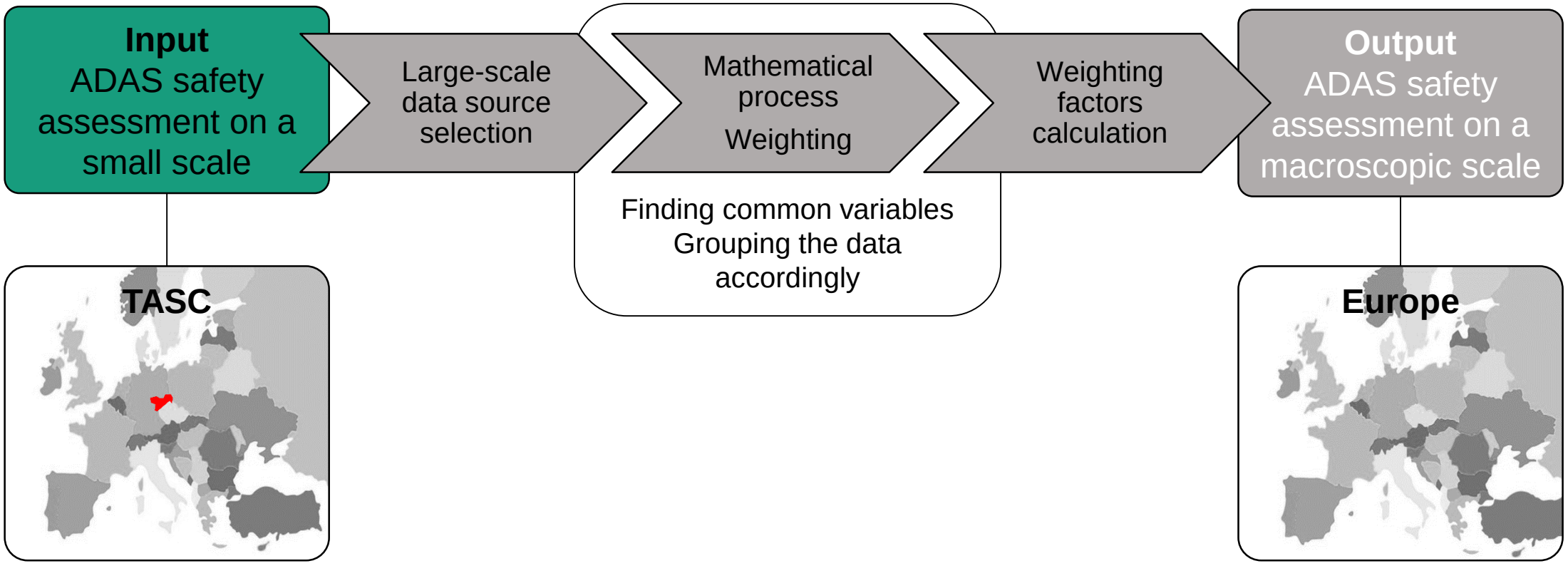
An extrapolation method on European accident data based on weighting and data harmonization



Working steps





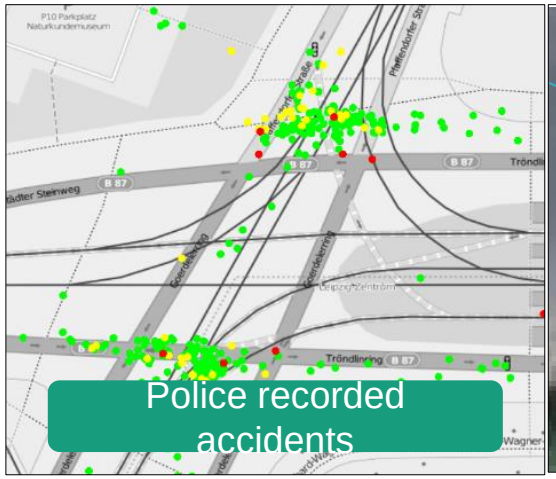
Input data
TASC source

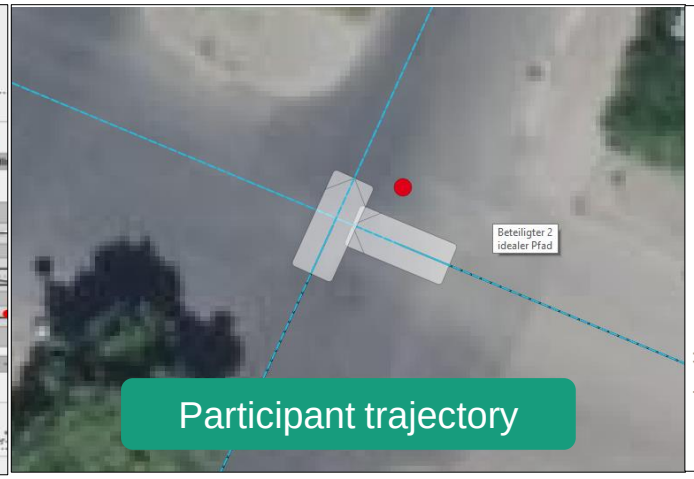
Traffic **A**ccident **S**cenario **C**ommunity* (developed by TME and Fraunhofer)

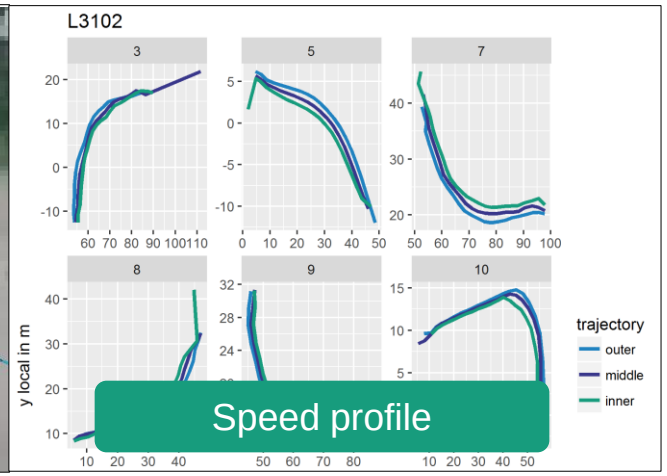
- Police recorded accidents for Saxony, Germany
- Participant's trajectories
- Speed profiles

Can be used for:

- Reconstruction of the accident scene and pre-crash phase
- Assessment of the effectiveness of ADAS system

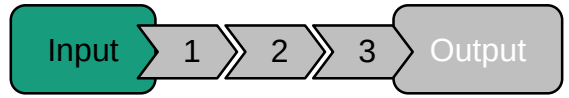






A methodology for building simulation files from police recorded accident data (for ADAS effectiveness assessment), M. Urban et al., Fisita Conference 2020
TASC-Scenarios, C. Erbsmehl, SafetyUpdate Conference, Würzburg 2020

Working steps



Input
ADAS safety assessment on a small scale

Large-scale data source selection

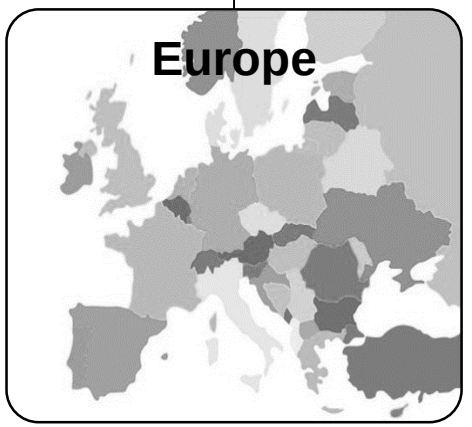
Mathematical process
Weighting

Finding common variables
Grouping the data accordingly

Weighting factors calculation

Output
ADAS safety assessment on a macroscopic scale

Safety system preventing:
All car-to-pedestrian collisions in urban areas



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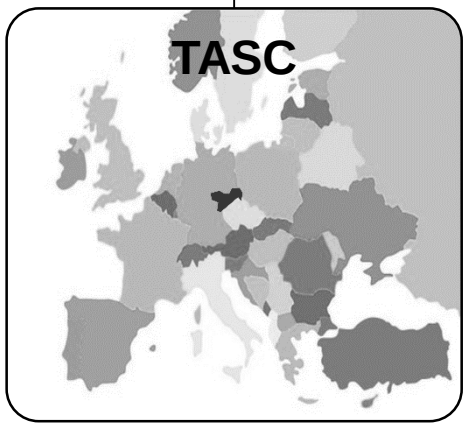
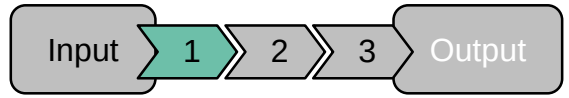


Large-scale data source selection

European crash data



TASC	IRTAD 2001-ongoing	CARE 1993-ongoing
• Accident police data, trajectories, speed estimations • About 4,000 cases in 2018 • Only 2-participants accidents • At least one car • Only accidents with injured persons	• National police data integrated through transformation rules • About 1 M. Accidents per year • Only accidents with injured persons	
	• 33 countries (worldwide) • Aggregated data only (about 30 parameters)	• 29 countries (Europe-wide) • Aggregated data only (about 70 parameters)

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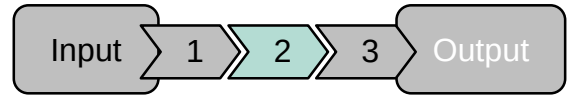
Working steps



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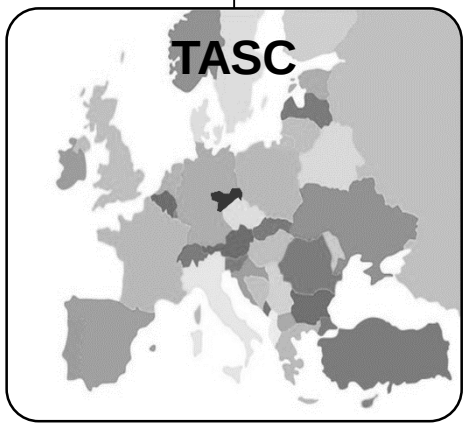
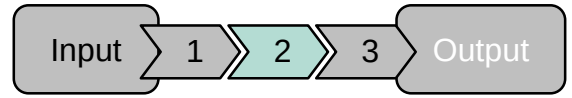


Mathematical process – Weighting
Theory



Extrapolation based weighting factors

- Group both data sources by common parameters
- Calculate weighting factors for each group (e.g. for accidents):

$$wf = \left(\frac{Accidents_{group\_TASC}}{Accidents_{total\_TASC}}\right) \Big/ \left(\frac{Accidents_{group\_CARE}}{Accidents_{total\_CARE}}\right)$$

$Accidents_{group\_CARE}$ *CARE accidents per group (location, injury severity, accident constellation, etc.)*

$Accidents_{group\_CARE\_total}$ *CARE accidents in total*

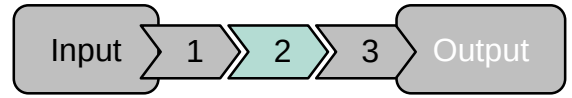
$Accidents_{group\_TASC}$ *TASC accidents per group (location, injury severity, accident constellation, etc.)*

$Accidents_{total\_TASC}$ *TASC accidents in total*

- By multiplication of each accident number in the local source with corresponding weighting factor

Common parameters

Data review – parameter level



	Parameters	TASC	CARE
Accident level	Area, road class, junction information, surface condition	✓	✓
	Road infrastructure		
	Accident description	✓	✓
	Accident type	✓	✗
Participant level	Injury severity	✓	✓
		✓	✓
Vehicle level	Vehicle type, hit object		
	Participant manoeuvre	✓	✓
	Trajectory	✗	✓
	Speed estimations	✓	✗
		✓	✗

- Road safety parameters
- Collision describing parameters
- Vehicle describing parameters

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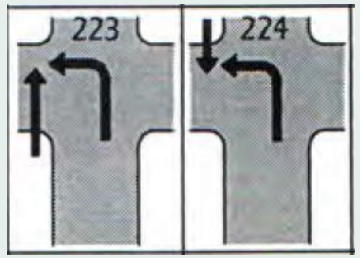
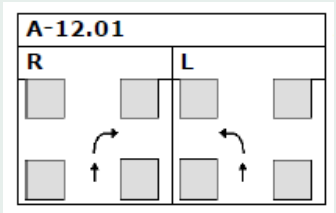
Common parameters

Data review – category level

Parameter	Category
Area	Rural, urban
Road class	Primary road, secondary, locals
Junction	4-arms, 3-arms, roundabout
Injury severity	Time definition
Vehicle type	Car, bus, 2-wheeler, pedestrian, heavy vehicle
Accident type	**TASC** 297 accident types 
	CARE 61 accident types 

- Partial data: 15 countries (accident type) VS 14 countries (participant manoeuvres)
- Only aggregated data form

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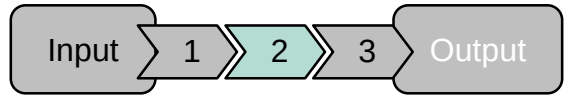
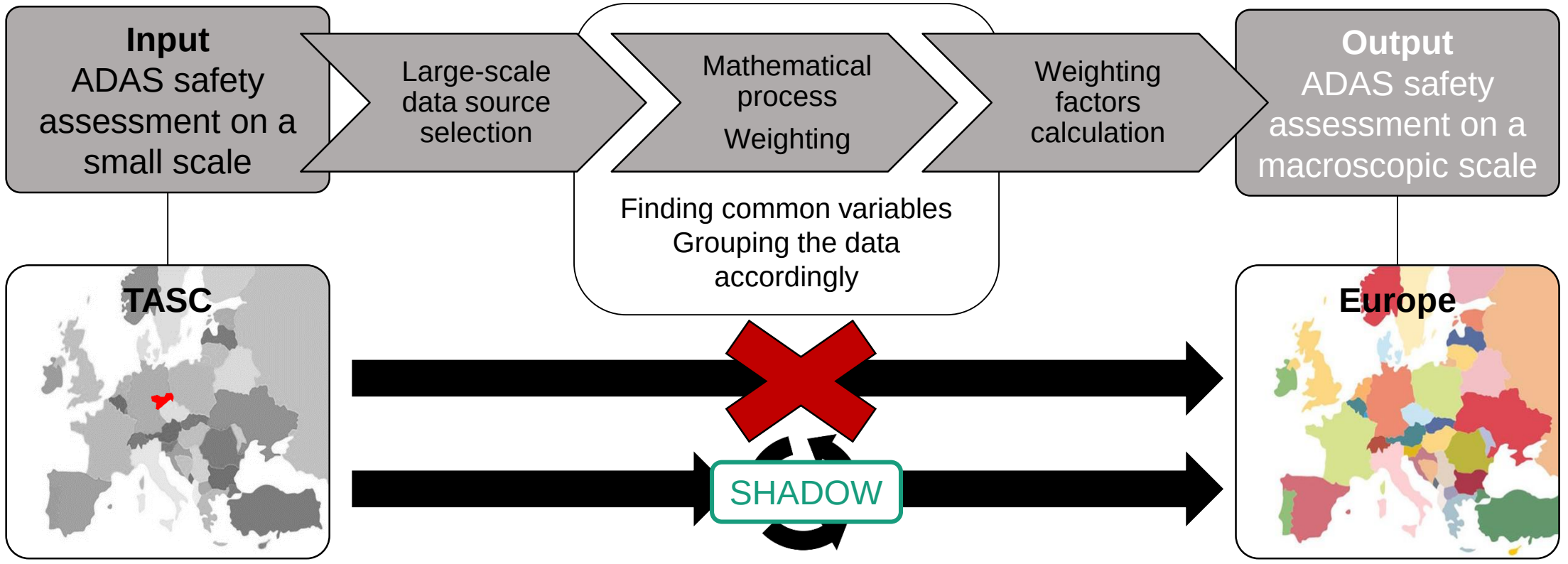
Working steps





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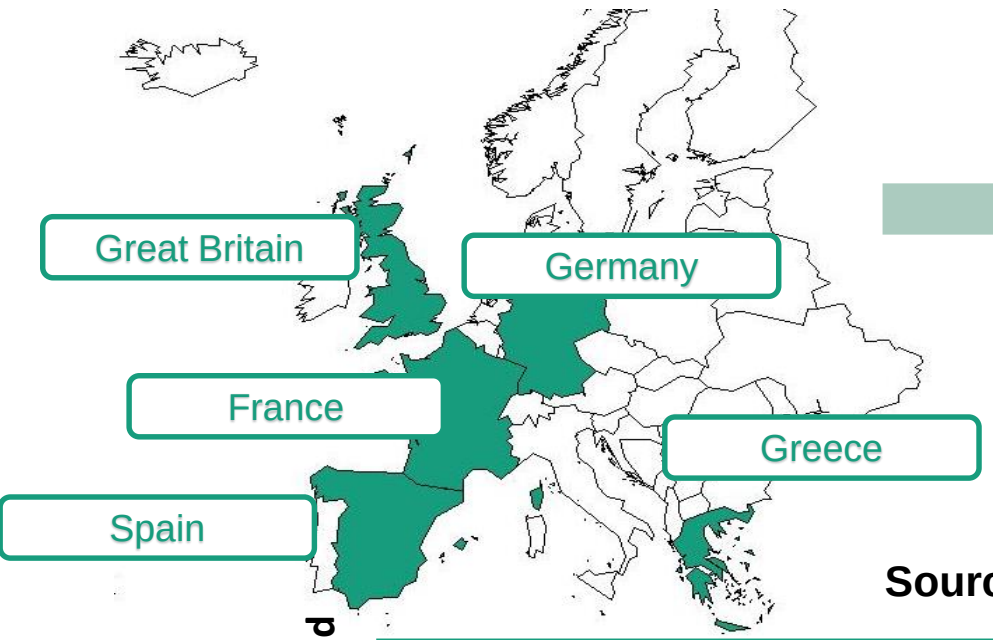
SHADOW data

Content



Data review → Data cluster → Harmonized data

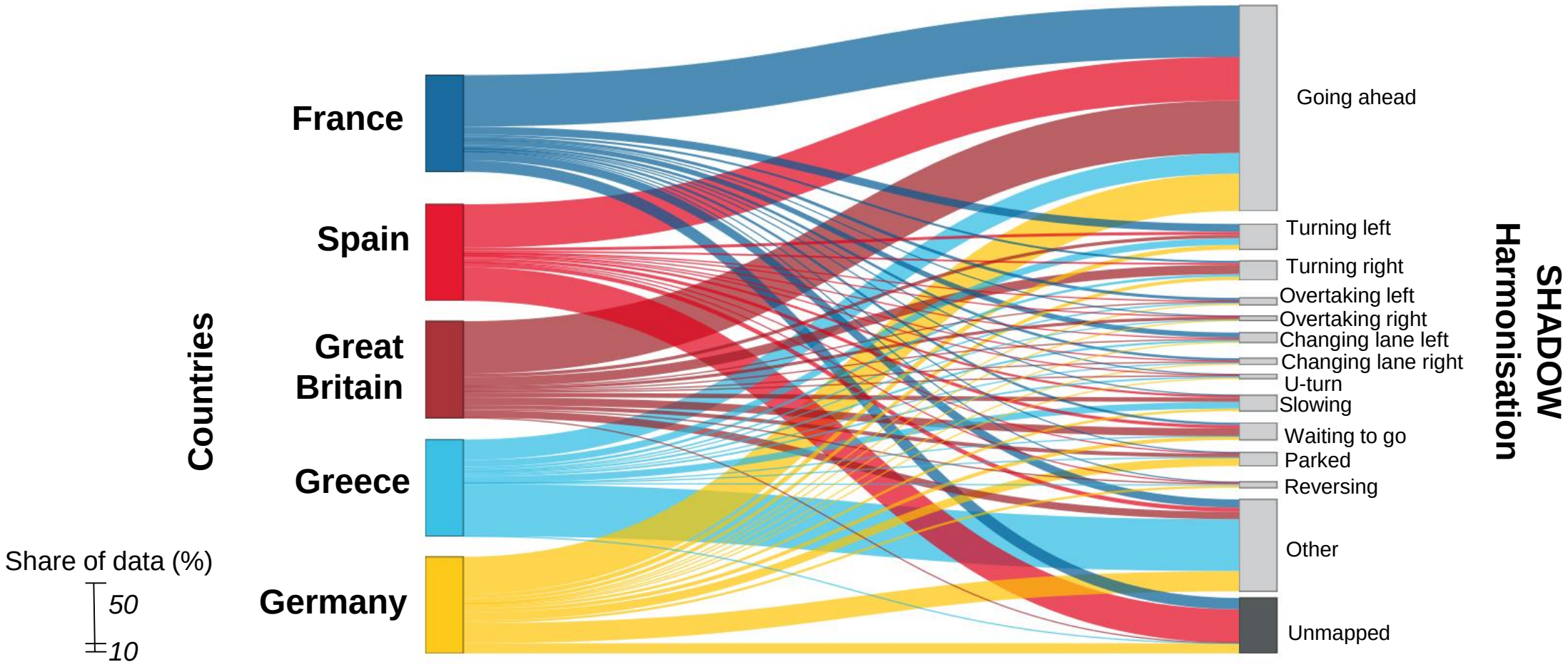
- Area
- Road class
- Junction
- Injury severity
- Participant manoeuvre
- Vehicle type

		Source	Year for study	Number of accidents
Police recorded data	**Germany (Saxony)**	Fraunhofer IVI	2016	13.800
	France	ONISR	2016	59.600
	Great Britain	Department for Transport	2016	136.500
	Spain	General direction of traffic	2017	221
	Greece	Hellenic statistical authority	2016	11.300

SHADOW data

Harmonized manoeuvres

Input 1 2 3 Output



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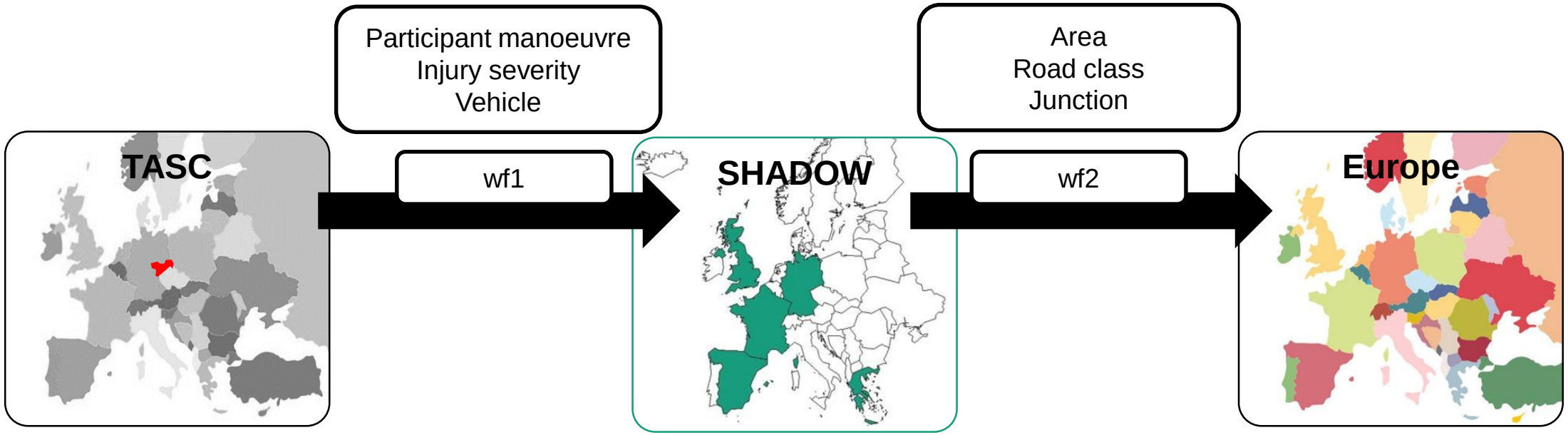
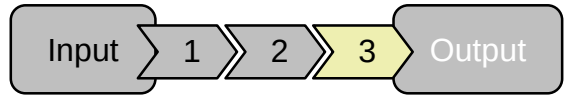
Extrapolation parameters

Two ranges of weighting factors



Working steps



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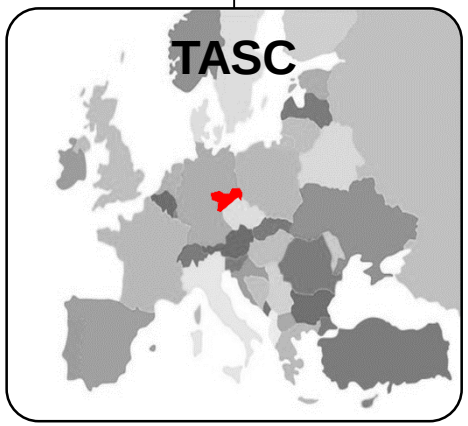


Weighting factors calculation

Input | 1 | 2 | 3 | Output

Filters and grouping

Data filter

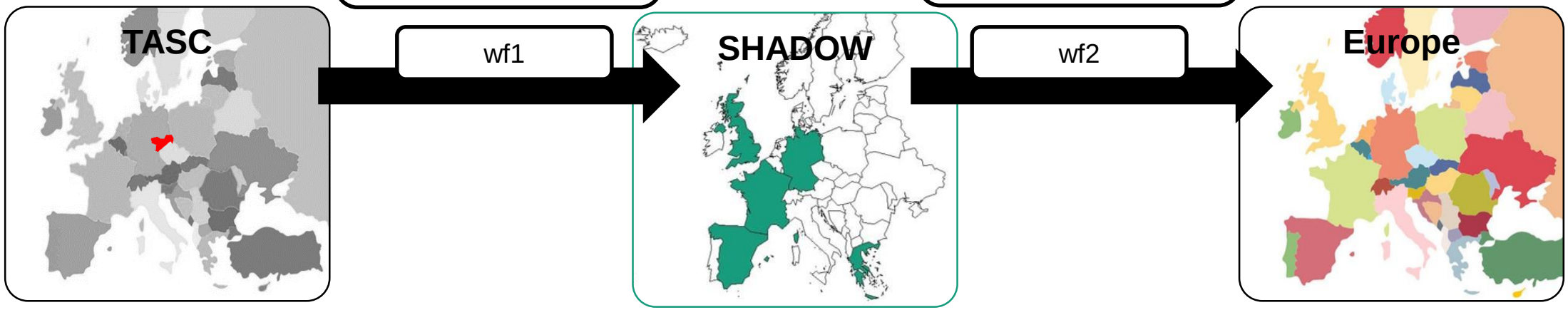
- Only 2-participant accidents
- At least one car
- No single-car accident
- Only with injuries

Data grouping

- TASC / SHADOW
- SHADOW / CARE

Participant manoeuvre
Injury severity
Vehicle

Area
Road class
Junction



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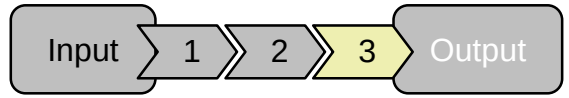
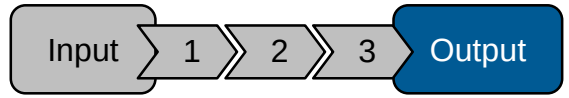
Weighting factors calculation



Extract of the weighting factors

TASC - SHADOW				SHADOW - CARE			
Harmonised manoeuvre	**Vehicles**	**Injury severity**	**Weighting factor 1**	**Area**	**Junction**	**Road class**	**Weighting factor 2**
Going straight	Car	Not injured	5.43	Urban area	On junction	Secondary road	4.26
Going straight	Bicycle	Severely injured					
Going straight	Car	Severely injured	37.54	Rural area	On junction	Secondary road	3.29
Turning left	Truck	Not injured					
…							

Working steps



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Output
ADAS safety assessment on a macroscopic scale

TASC

Safety system preventing:
All car-to-pedestrian collisions in urban areas

400 prevented crashes

Filtering the weighting factors:
Car-to-pedestrian accidents
Urban areas

FORECAS

Europe

$N_{extra} = wf.N_{TASC}$

3,500 prevented crashes

Summary

Extrapolation method

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ADAS safety assessment on a small scale

Large-scale data source selection

Mathematical process
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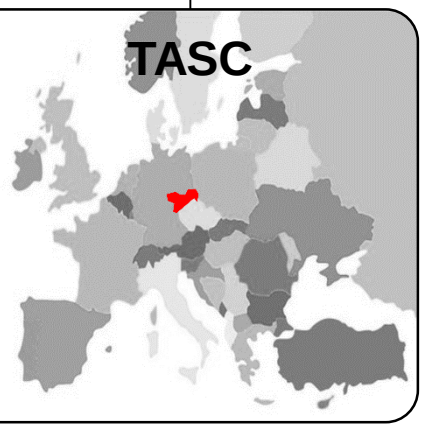
Weighting factors calculation

Output
ADAS safety assessment on a macroscopic scale

TASC



- ✓ Process through **data harmonization** and **weighting factors**
- ✓ **Exportable and reproducible** on other datasets, for other countries as **supporting data differences,** by taking into account meta-data and data
- ✓ **Extend already existing databases** (EU, national)
- ✓ **Enable data projections** on special research questions (ADAS safety assessment)

Europe

Thank you for your attention

DRESDEN

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Contact:

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Annexs

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CARE database

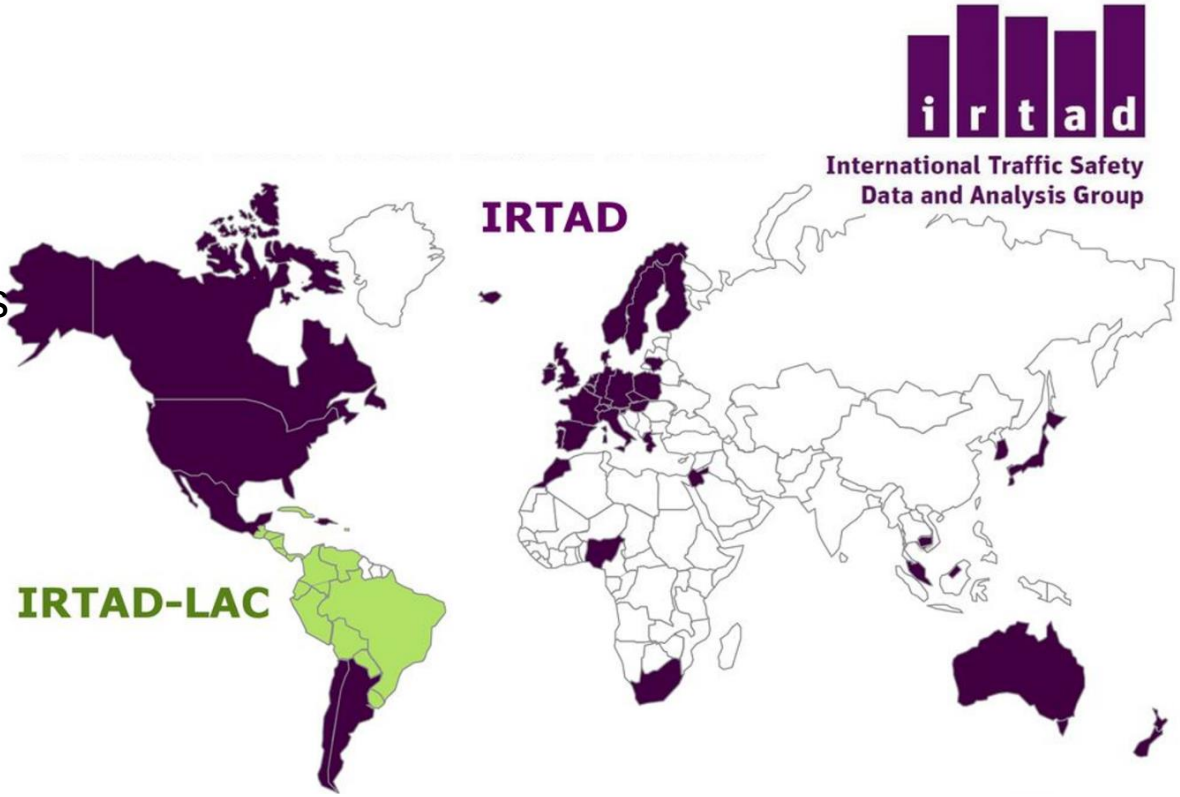
Community Database on Road Accidents (1993-ongoing)

- Based on police recorded traffic accidents with injuries within Europe from government authorities
- Foreign data adapted through transformation rules -> harmonized dataset
- About 70 parameters: information on accident place, participants, vehicles, and road characteristics

IRTAD database

International Traffic Safety Data and Analysis Group (2001-ongoing)

- Based on police recorded traffic accidents with injuries worldwide
- Foreign data adapted through transformation rules -> harmonized dataset
- About 30 parameters: information on accident place, participants, vehicles, and road characteristics
- Not only a database, but a community: more than 80 members from private and public instutions



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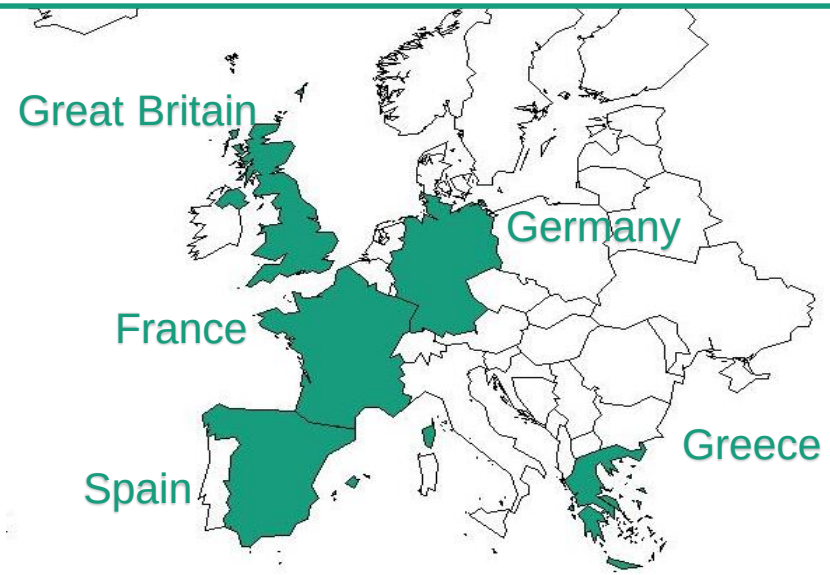
Data review

Country data sources

Data sources



- **Data collection:** police data under a non-aggregated form
- **Data translation**

Data review

- **Common structure level** (accident data, participant data, vehicle data)
- **Different** variable levels
- **Different** sub-variable levels

Data example

Accident constellation:
accident type VS participant manoeuver

Data harmonization
Clustering methods

- Depending on the parameters, two challenges:
  - One-level cluster (one-variable or sub-variable modification, simple adaptation)

    area | road class | junction | injury severity | vehicle type
  - Multiple-level cluster (a more than one-variable or sub-variable modification)

    accident constellation

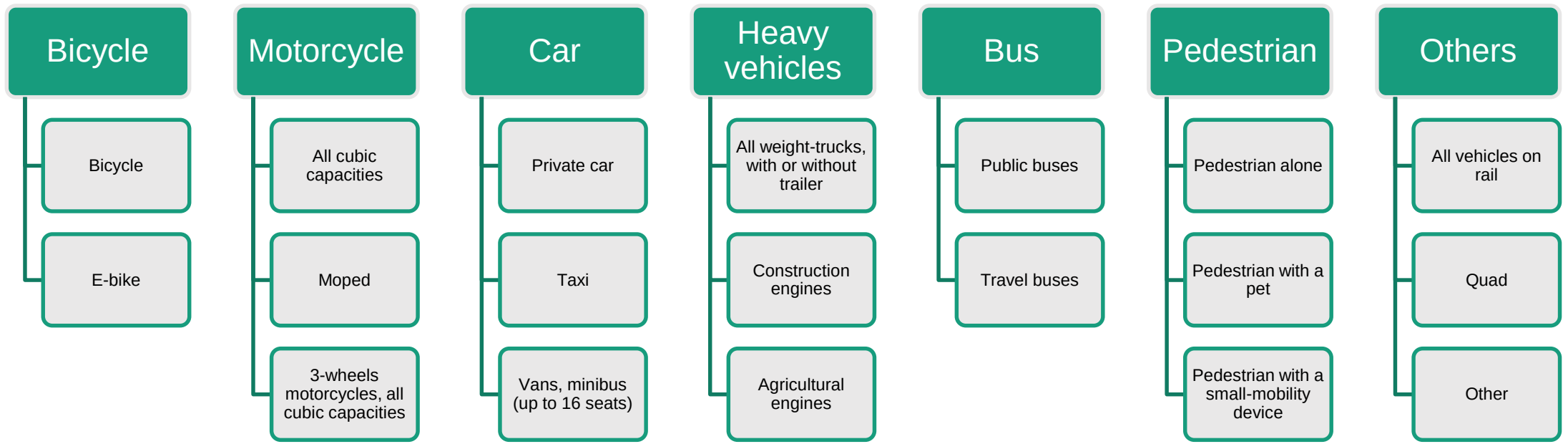
Data harmonisation

One-level cluster: vehicle type

Origine

	France	Germany	Great Britain	Greece	Spain
Number of vehicle types originally	28	39	17	33	27

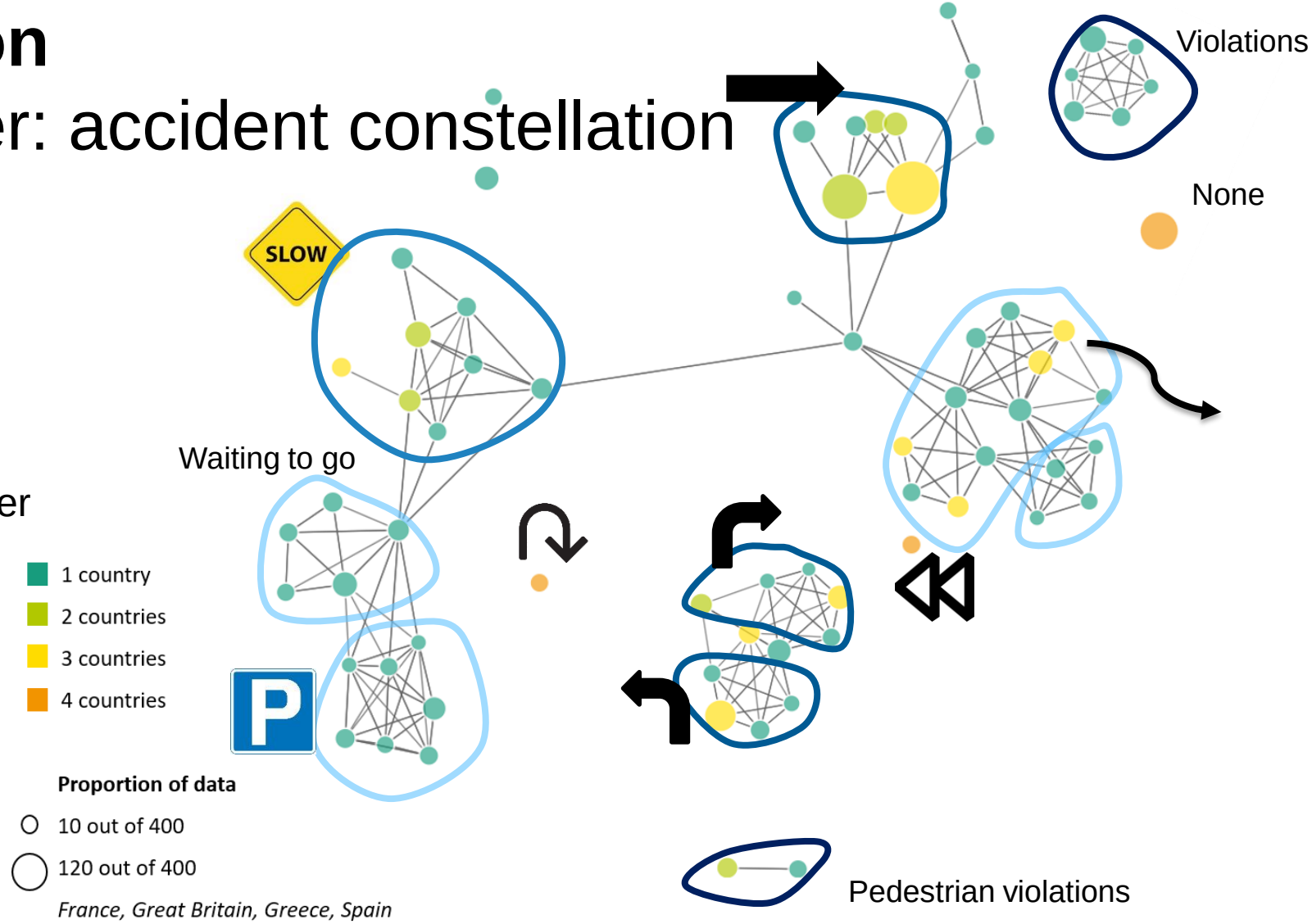
One-level cluster



Data harmonisation

Multiple-level cluster: accident constellation

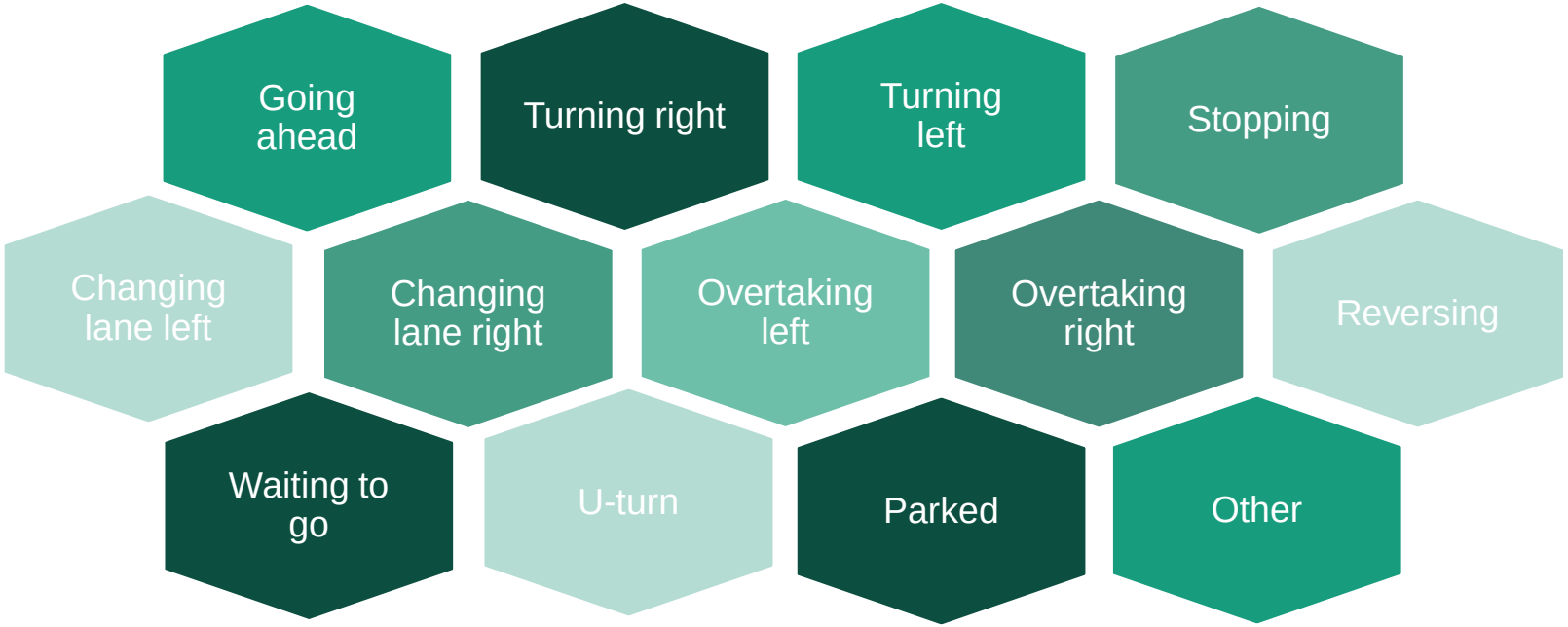
- 5 country accident constellation
  - Germany: accident type
  - France, Great Britain, Spain, Greece: participant manoeuver
- Manoeuver basis only
- Cluster all manoeuvers



Shadow creation

Harmonized accident manoeuver

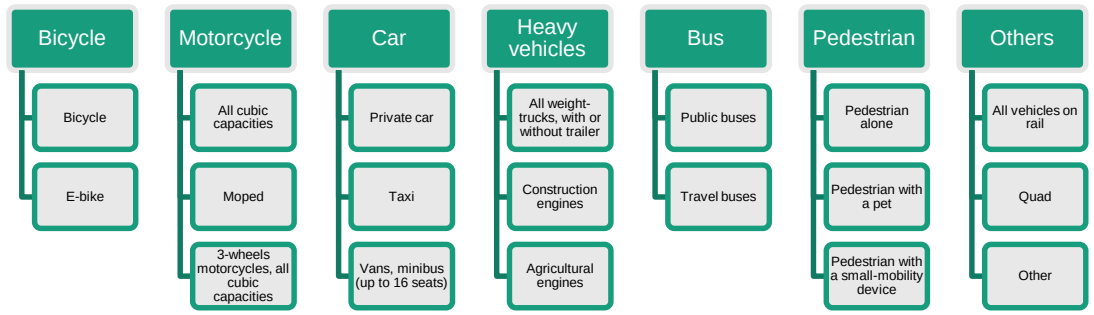
- Based on four countries (France, Great Britain, Spain and Greece) whose database contains a manoeuver classification;
- Based on cluster analysis run on several level (data level, geometry level, word used in label)



Data mapping

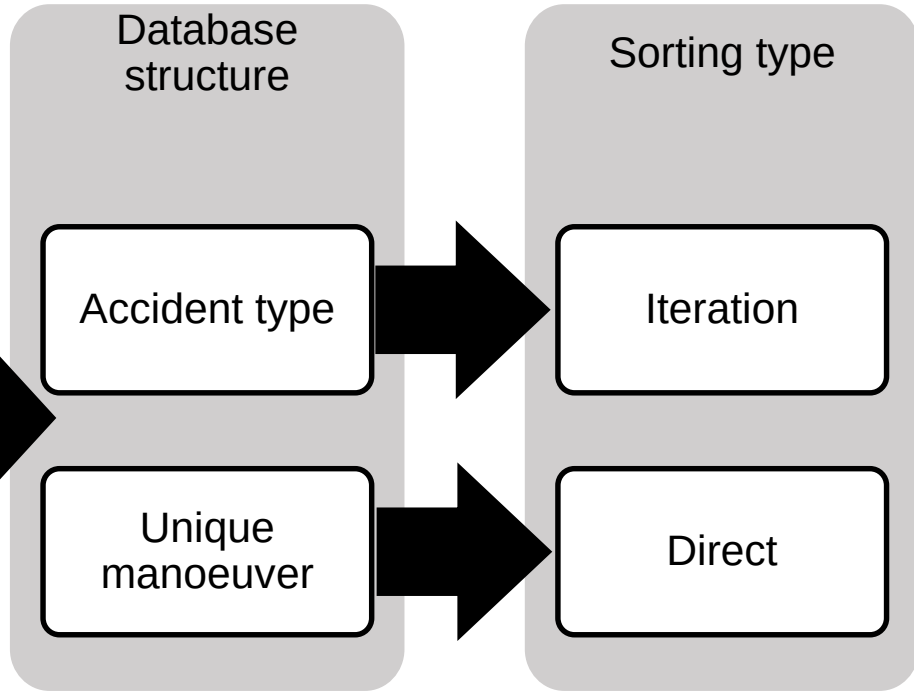
Link the original data to the harmonisation

One-level cluster



Multiple-level cluster

Country	Accident type*	Unique manoeuver
Germany	Yes	n.r.
France	n.r.	Yes
Great Britain	n.r.	Yes
Spain	n.r.	Yes
Greece	n.r.	Yes



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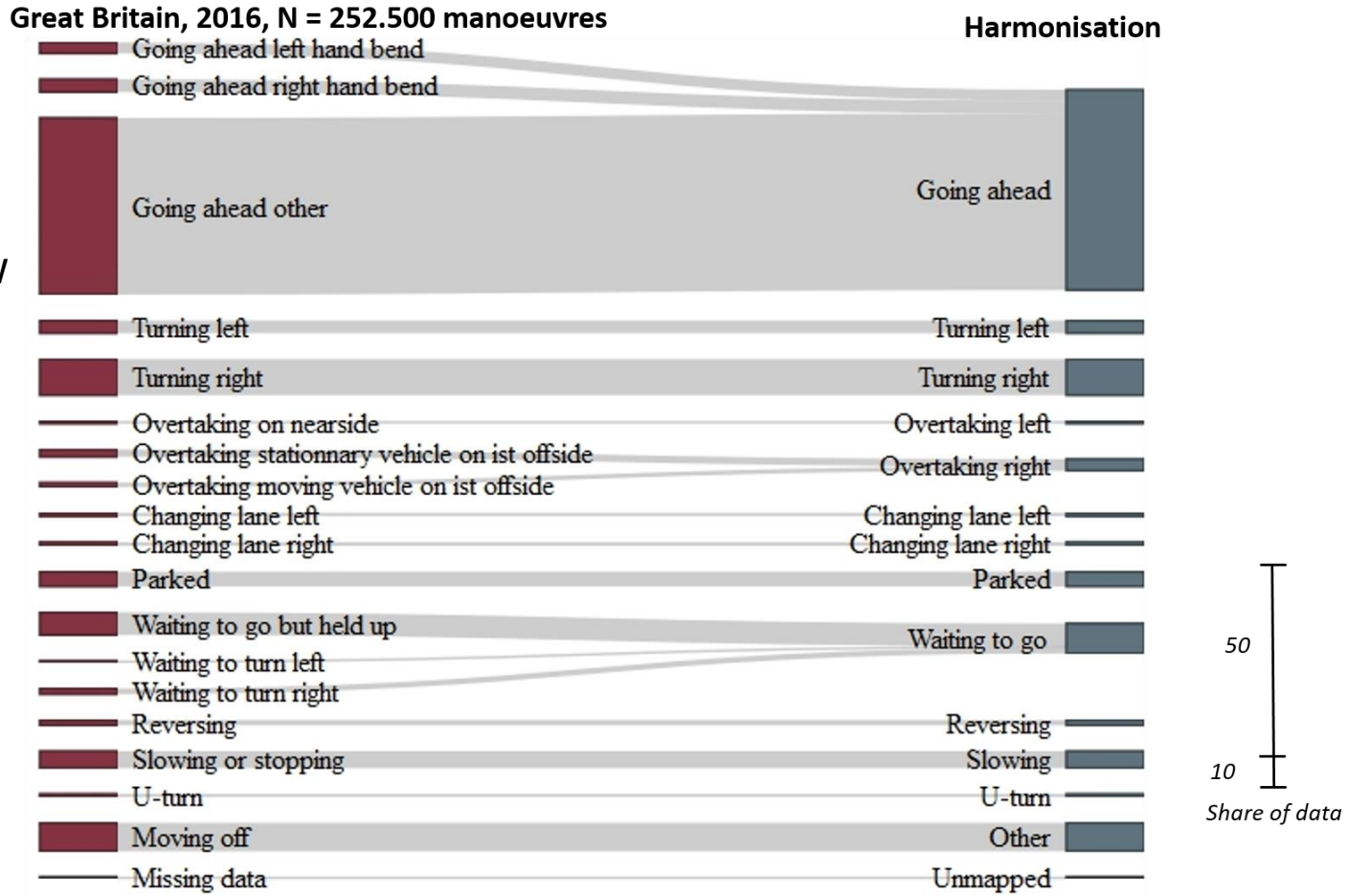
Data mapping
Example for Great Britain

- Links for the British database to the shadow database
- Data for 2016, N= 252.500 vehicles
- Special shares:
  - Other 8%
  - Unmapped <1%

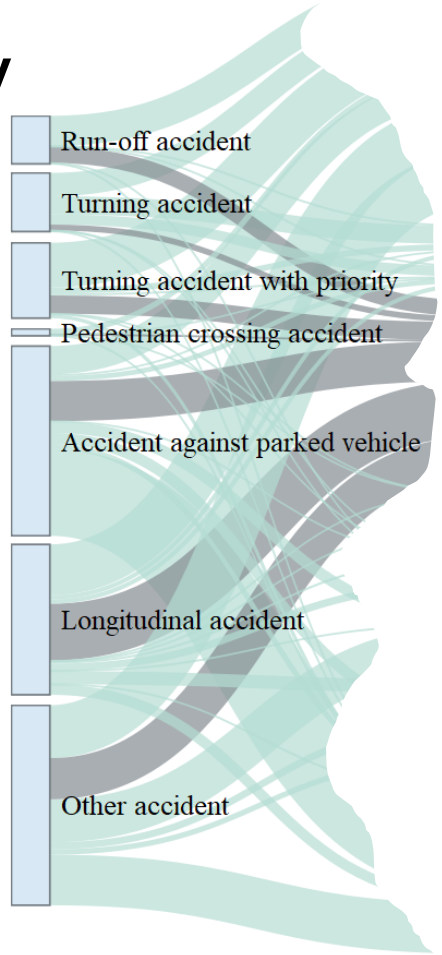
Analog for France, Greece and Spain



Data mapping
Example for Germany

State 0: German main accident types*

Mapped to the harmonization
(based on the number of participants, the serial number, the accident type)



State 0

** German 3-digits accident types*

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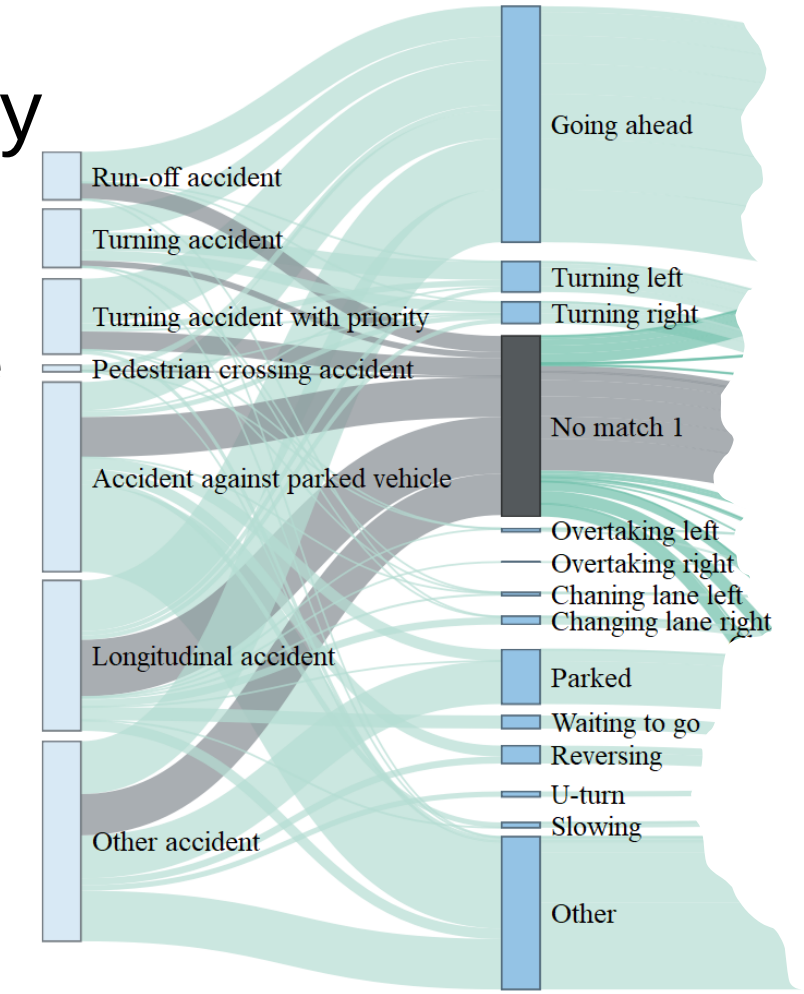
Data mapping
Example for Germany

State 0: German main accident types*

Mapped to the harmonization
(based on the number of participants, the serial number, the accident type)

- **Iteration 1: Ideal cases**
  Unmatched = 25%



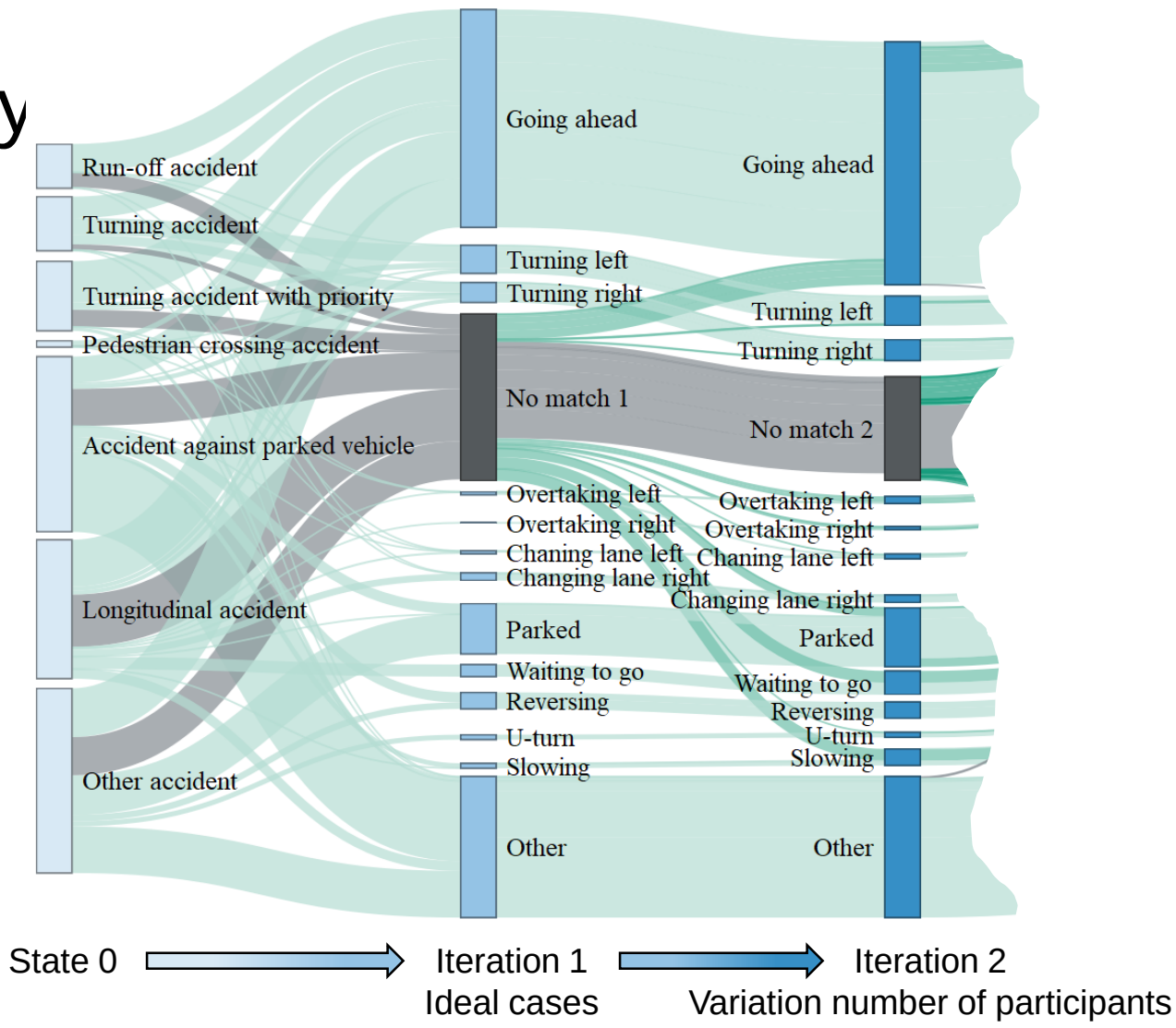
** German 3-digits accident types*

Data mapping
Example for Germany

State 0: German main accident types*

Mapped to the harmonization
(based on the number of participants, the serial number, the accident type)

- **Iteration 1: Ideal cases**
  Unmatched = 25%
- **Iteration 2: Variation number of participants**
  Unmatched= 15%



** German 3-digits accident types*

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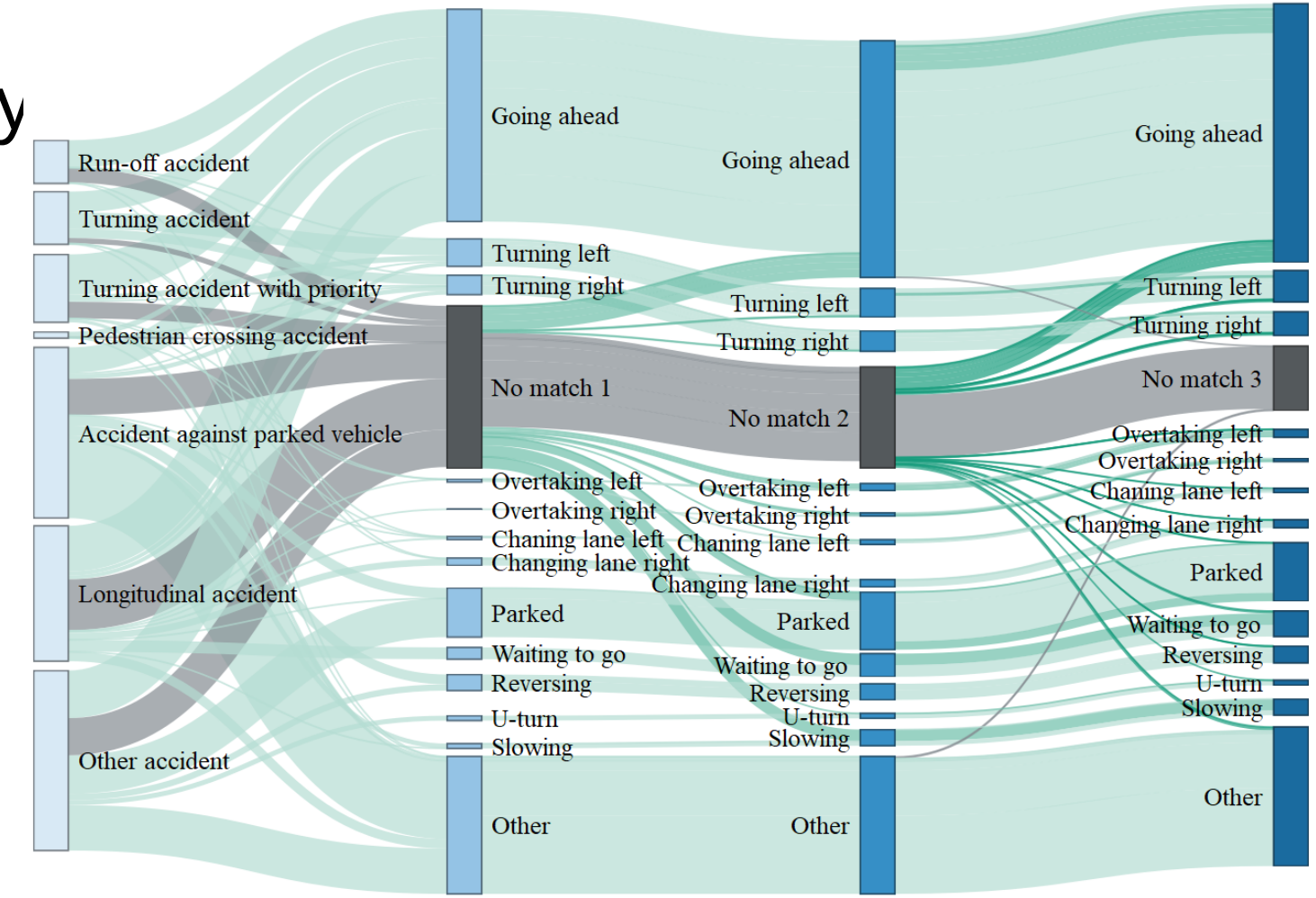
Data mapping
Example for Germany

State 0: German main accident types*

Mapped to the harmonization
(based on the number of participants, the serial number, the accident type)

- **Iteration 1: Ideal cases**
  Unmatched = 25%
- **Iteration 2: Variation number of participants**
  Unmatched= 15%
- **Iteration 3: Probability assignment**
  Unmatched = 10%

Reaching the same value of unmapped data as other countries (e.g. France)



** German 3-digits accident types*

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Results

A harmonized database

ID	Country	Accident area	Vehicle type	Severity	Manoeuvre
1-1	France	Urban	Car	Not injured	Turning right
1-2	France	Urban	Pedestrian	Severely injured	Going straight
…		Rural	Truck	Not injured	
452-1	Spain	Rural	Car	Dead	Going straight
452-2	Spain				Going straight
…					

One-level cluster harmonisation

Multiple-level cluster harmonisation

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Results

Evaluation of the share of manoeuvers per country