

The use of Self-Organizing Maps in the analysis of crime data: mainland Portugal (2016)

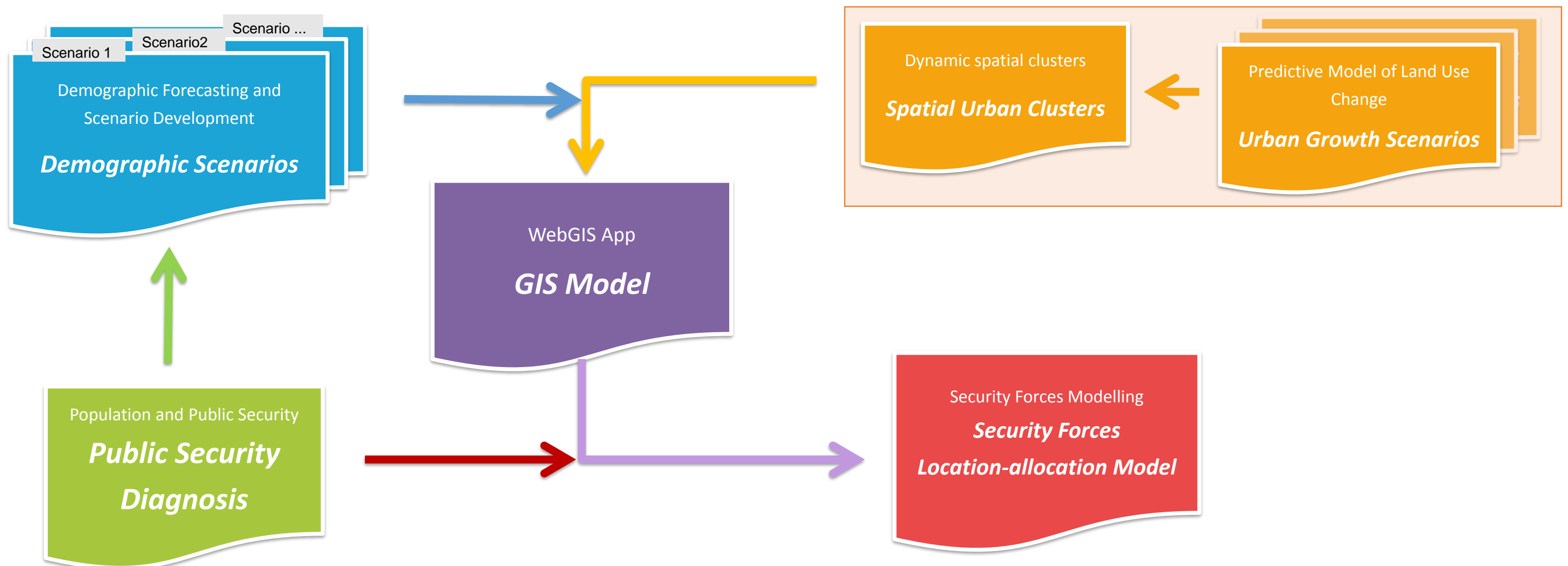
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2nd AGILE Workshop Open Data for Open Cities - OD4OC:
The reuse of open data through spatial analysis

Lund, June 12th, 2018

SIM4SECURITY aims at creating a technological solution to support the decision making process for the optimization of the distribution of security forces in mainland Portugal.

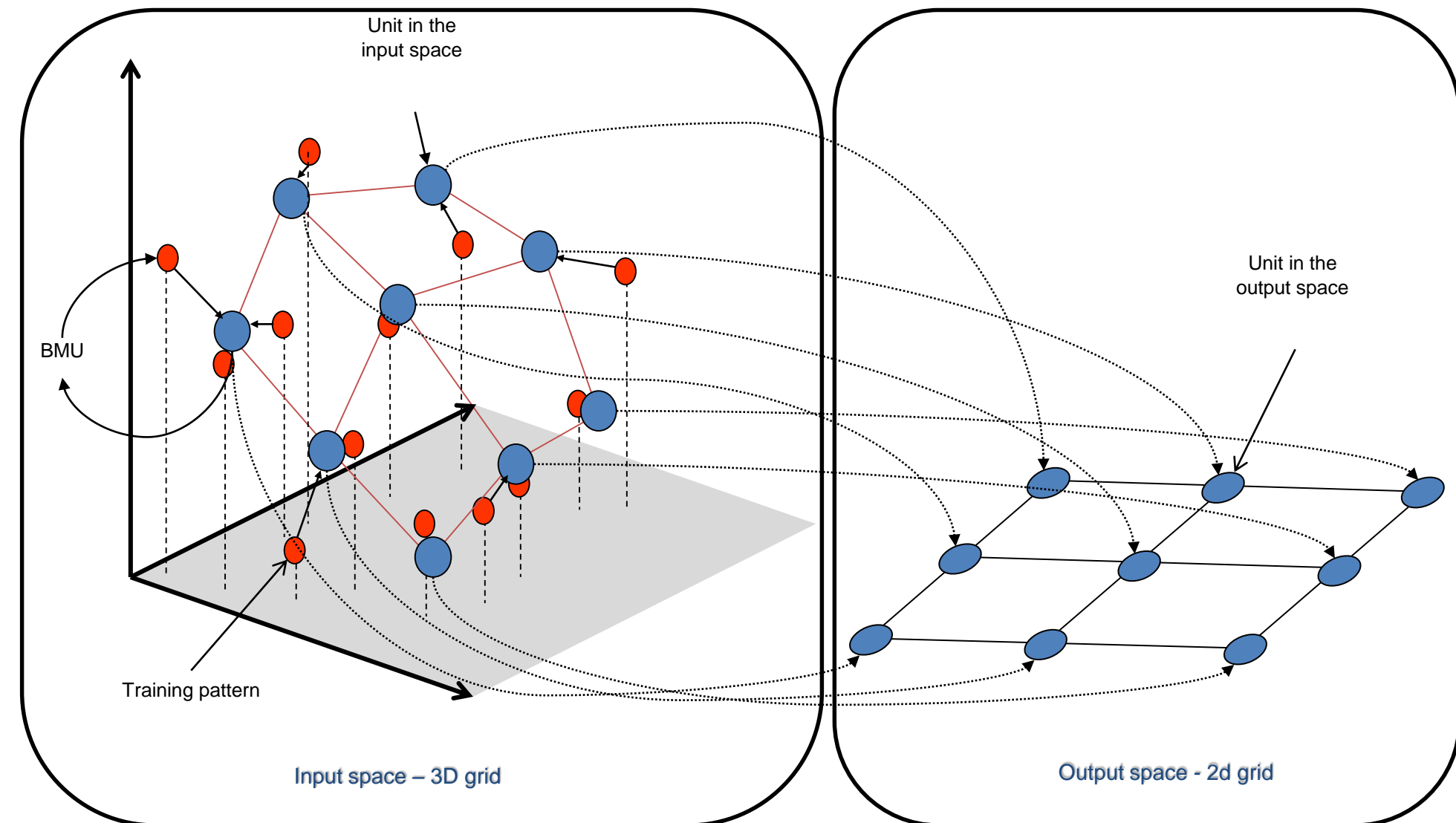


OBJETIVES

- To define areas with different levels of vulnerability to certain criminogenic phenomena where police action can be customized and to contribute to the a suitable, effective and proportional distribution of security forces.
- Crime analysis concerning:
 - Quantification and spatial distribution;
 - Definition of areas with homogeneous characteristics (*clusters*), by the number of crimes and seriousness, so that the distribution of security forces in these areas is adequate, effective and proportionate;
 - Crime analysis undertaken using Self-Organizing Maps (SOM).

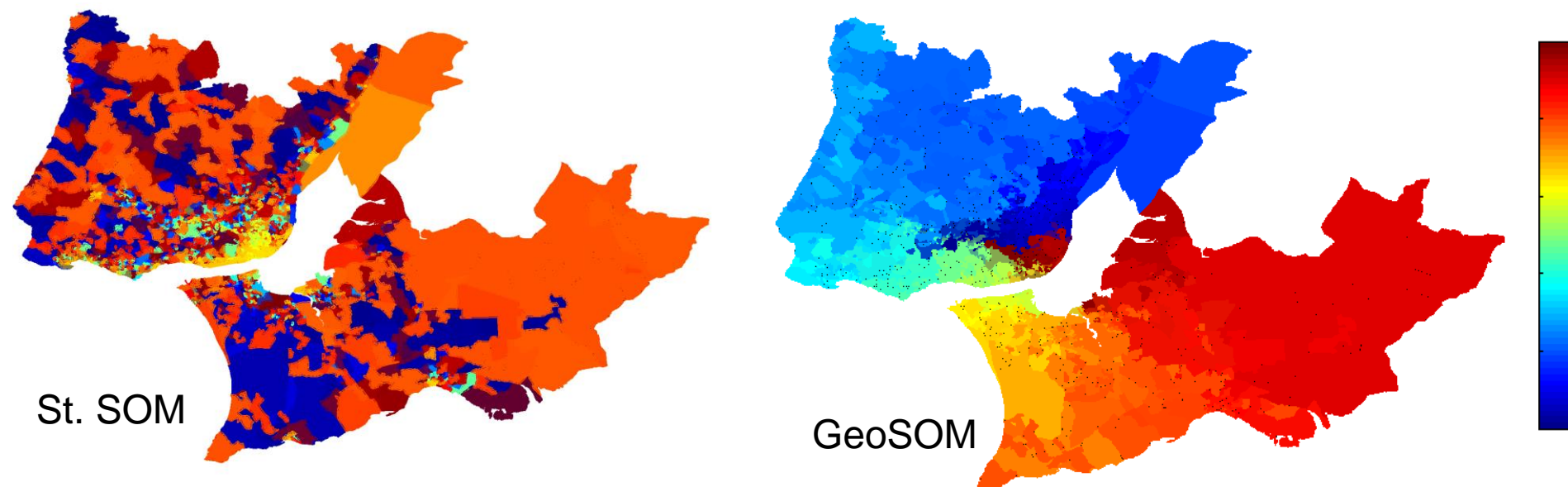
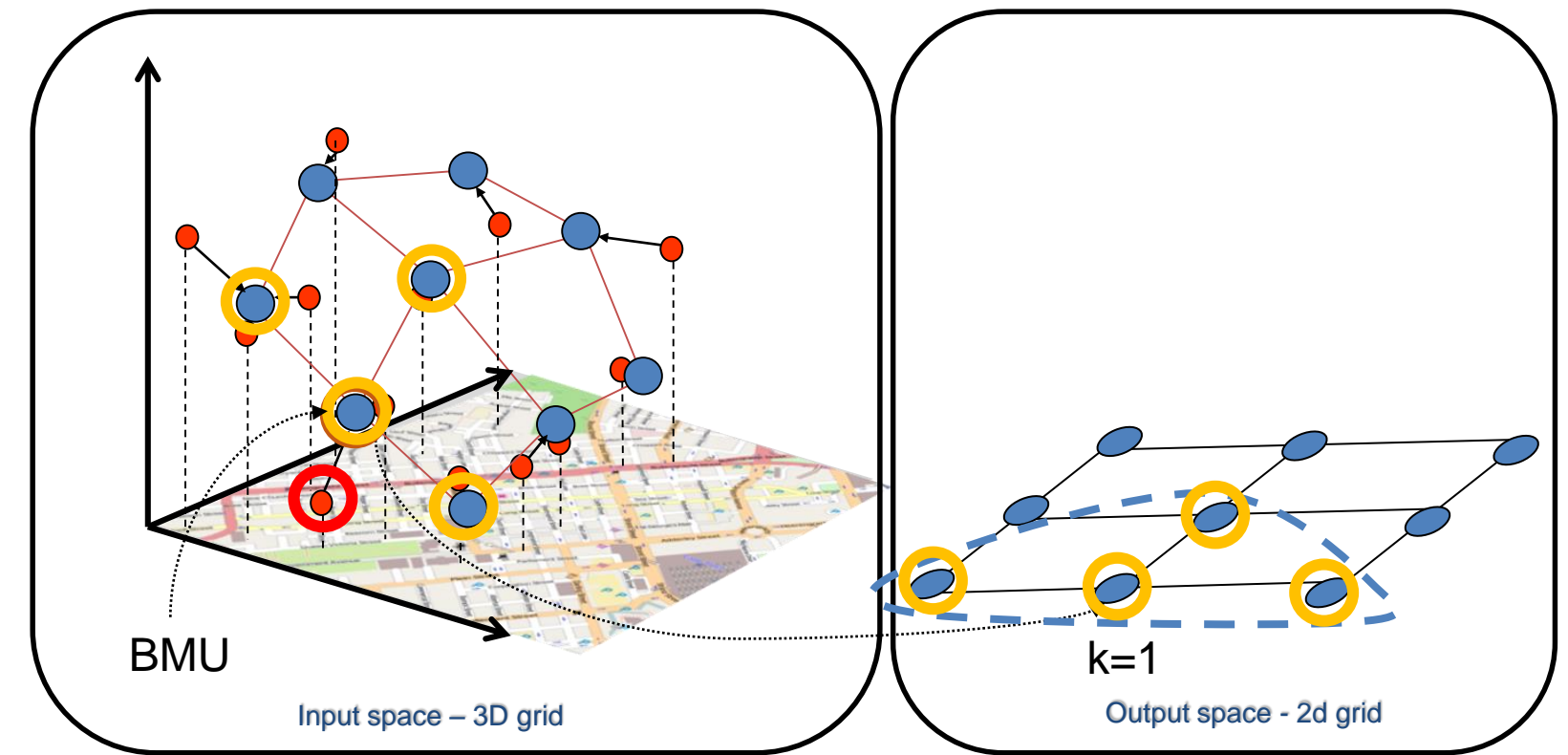
SELF-ORGANIZING MAPS (SOM)

- Initially proposed by Kohonen, 1982;
- Unsupervised artificial neural network, applied in the definition of clusters and its visualization;
- Used to reduce data dimensionality (number of variables) to 1 or 2 dimensions;
- Neurons or units have the characteristics of adapting to the input data during the training phase.



GEO SELF ORGANIZING MAPS (GEOSOM)

- Associates the spatial component of data to the analysis;
- The adaptation of the neural network takes into account the data georeferencing, through *georadius* parameter k ;
- The defined clusters tend to be spatially contiguous.



GEOSOM PARAMETERS

- Size: 5 x 1 or 8 x 1 (5 or 8 clusters)
- Topology: Hexagon
- Shape: Sheet
- Initialization: random
- Number of iterations (rough/finetune): 10000/20000
- Learning rate: 0.3/0.1
- Neighbourhood decay function: gaussian
- Neighbourhood radius: 4/2
- Geo-radius: 1.

The screenshot shows the 'GeoSOM.11-Jan-2018 properties' dialog box. It contains several sections for configuring the GeoSOM model:

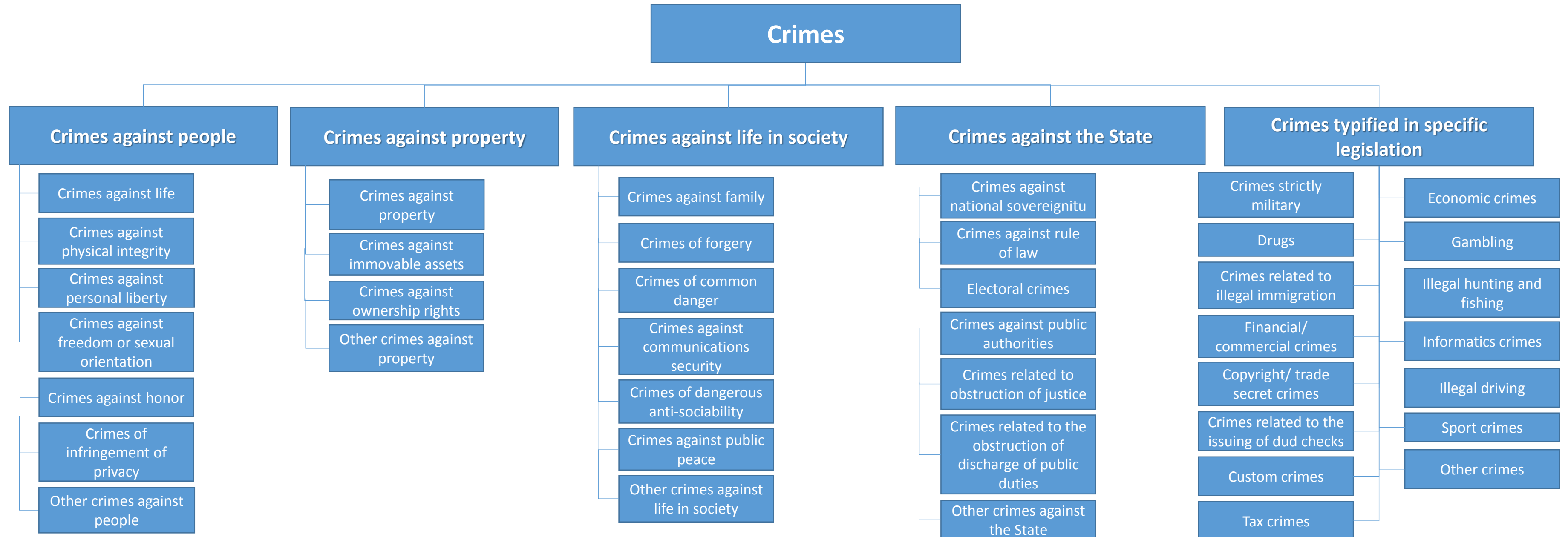
- GeoSOM training parameters**
 - Map Initialization**
 - X: 8, Y: 1
 - Lattice: hexa, Shape: sheet, Type: randinit
 - Geo components**
 - tg1_2016, tg2_2016, tg5_2016, tg6_2016, tg8_2016, tg9_2016, tg11_2016, tg12_2016
 - X, Y
 - Normalize data: range
- Map Train**
 - Batch train (unselected), Sequential train (selected)
 - Neigh: gaus..., Iter.: , Order: , Length: inv
- Rough**
 - Iterations 1: 10000
 - Radio 1: 4
 - Alpha 1: 0.3
- Finetune**
 - Iterations 2: 20000
 - Radio 2: 2
 - Alpha 2: 0.1
- GeoSOM specific parameters**
 - Geo radius(k): 1
 - Update(f): all

An OK button is located at the bottom right.

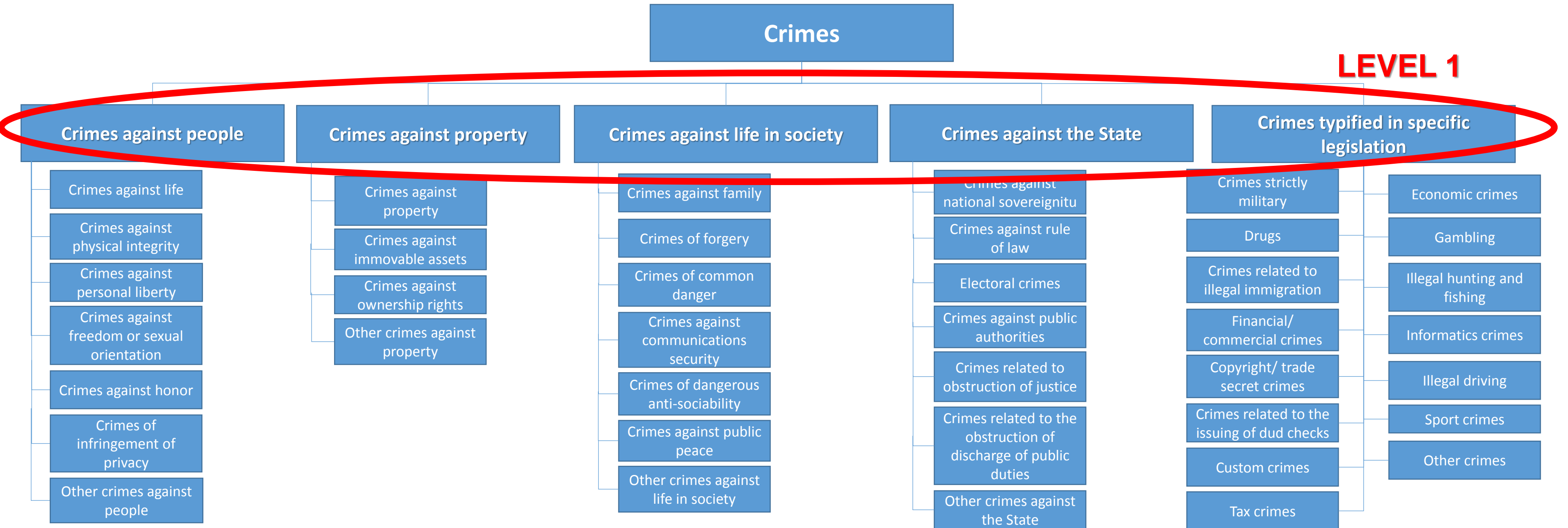
- Portuguese crime data is publicly available at Direção Geral da Política de Justiça (DGPJ, *Directorate-General for Justice Policy*);
- DGJP is the body, within the Ministry of Justice, responsible for the collection, use, treatment and analysis of the justice statistical data and its dissemination within the national statistical framework;

Crimes (Level 1)	Total in 2016
Crimes against people	74631
Crimes against property	164650
Crimes against cultural identity and individual integrity	33
Crimes against life in society	40667
Crimes against the State	5457
Crimes against pet animals	1513
Crimes typified in specific legislation	25875
Total	312826

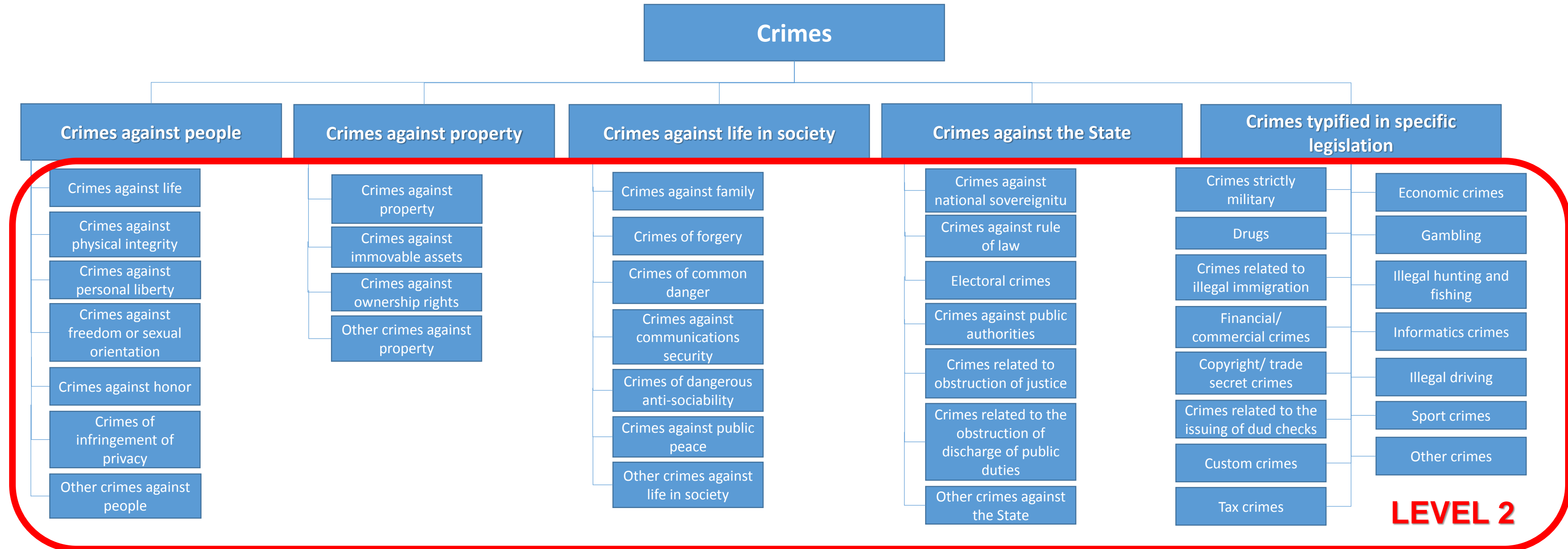
PORTUGAL: CRIMES CLASSIFICATION



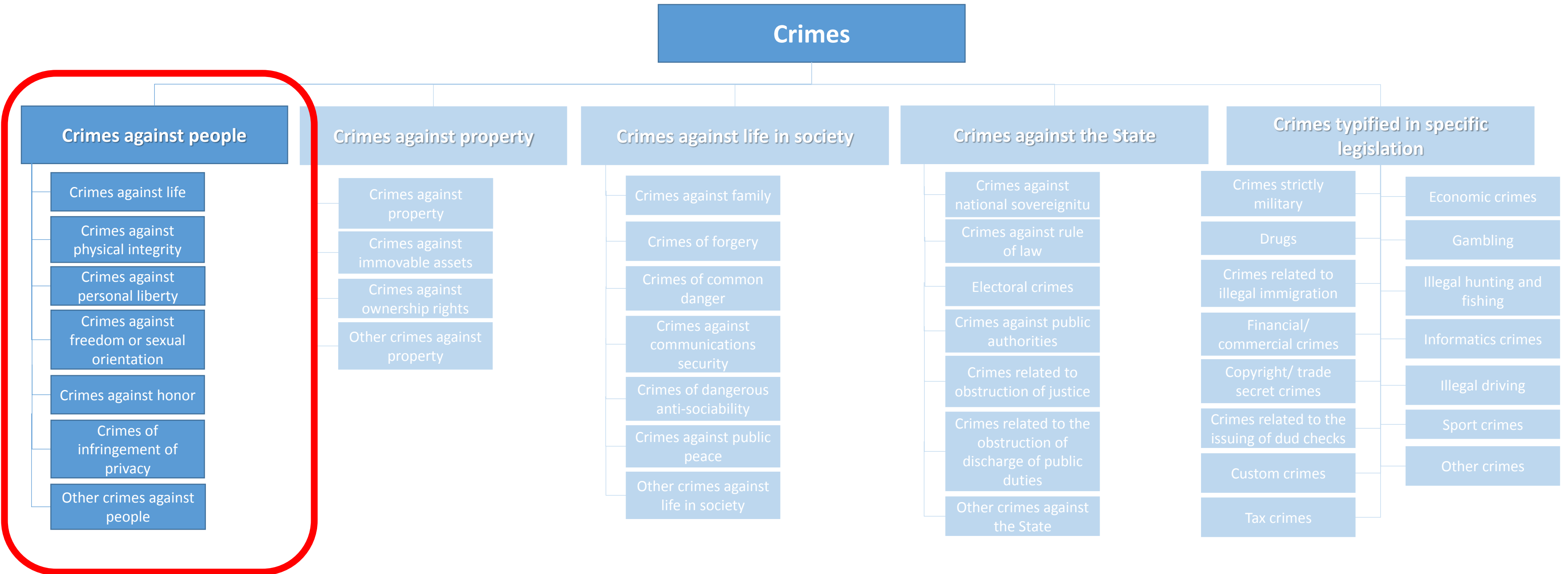
PORTUGAL: CRIMES CLASSIFICATION



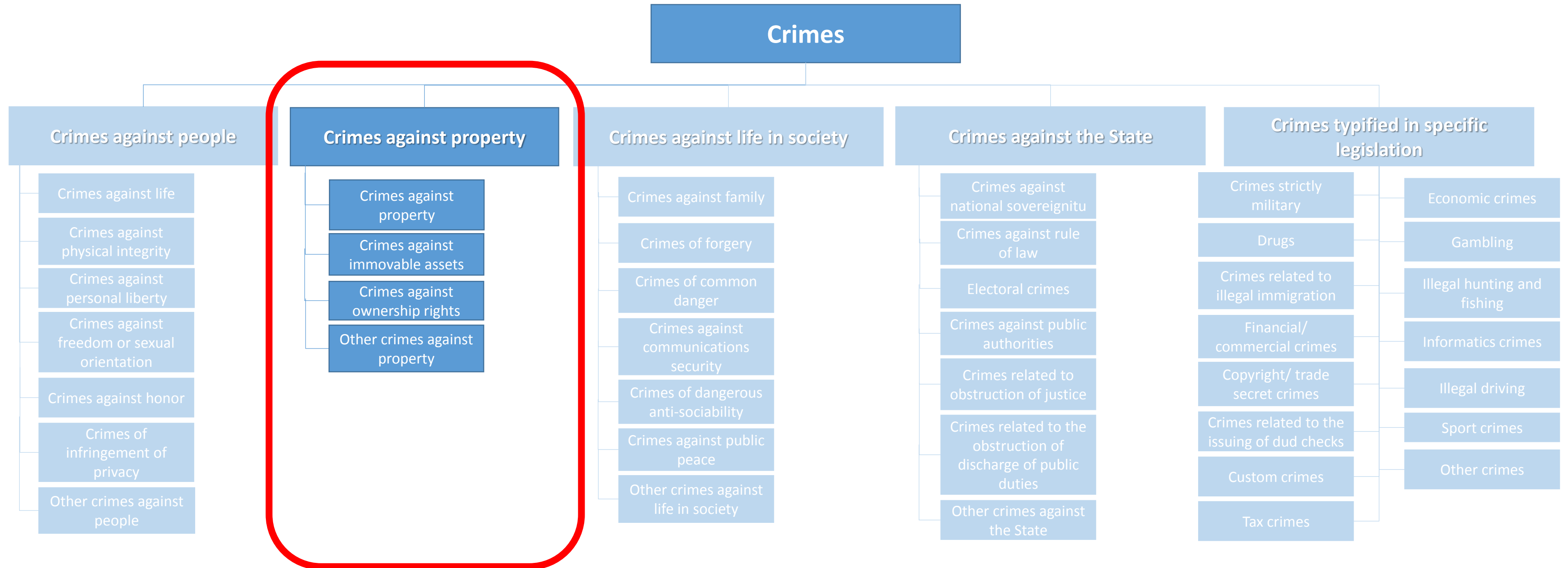
PORTUGAL: CRIMES CLASSIFICATION



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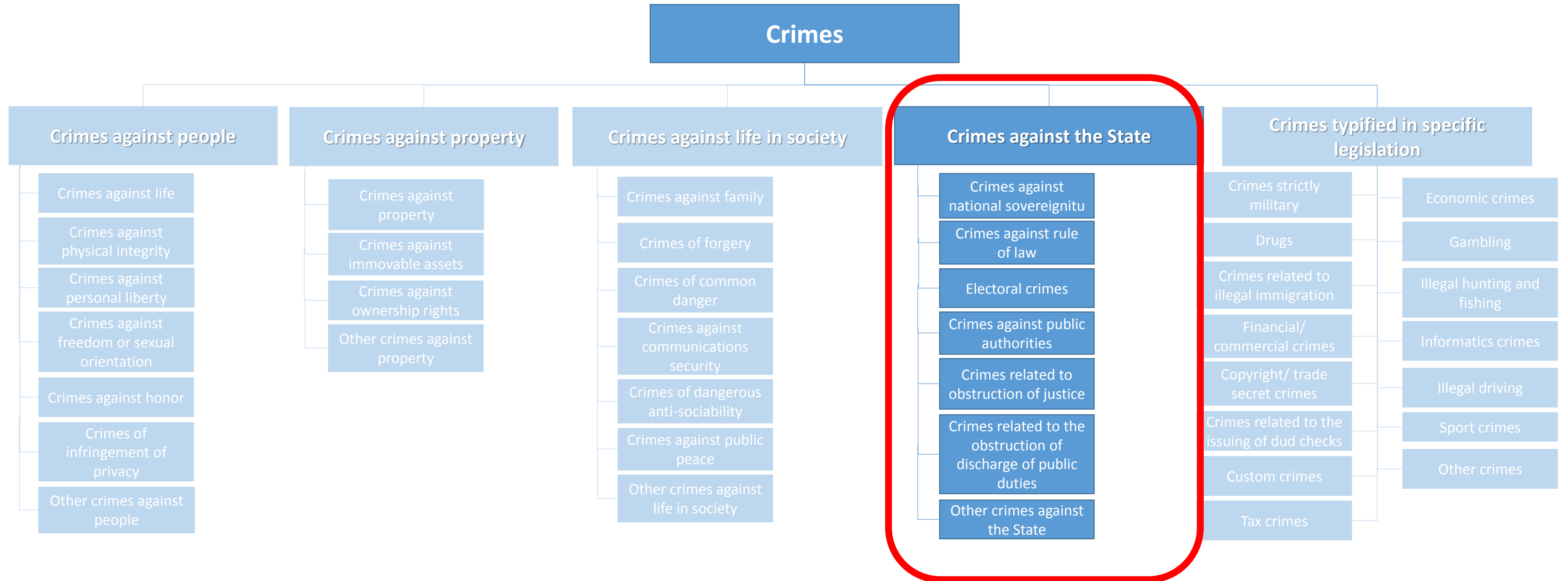
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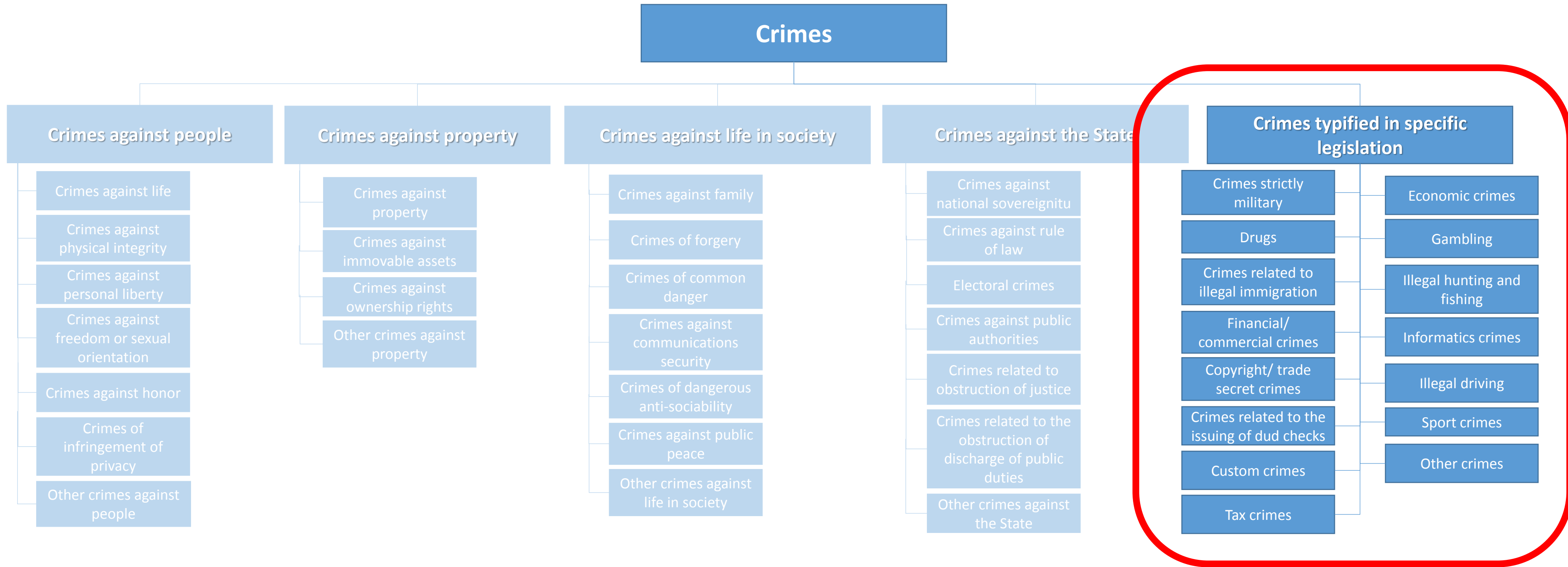
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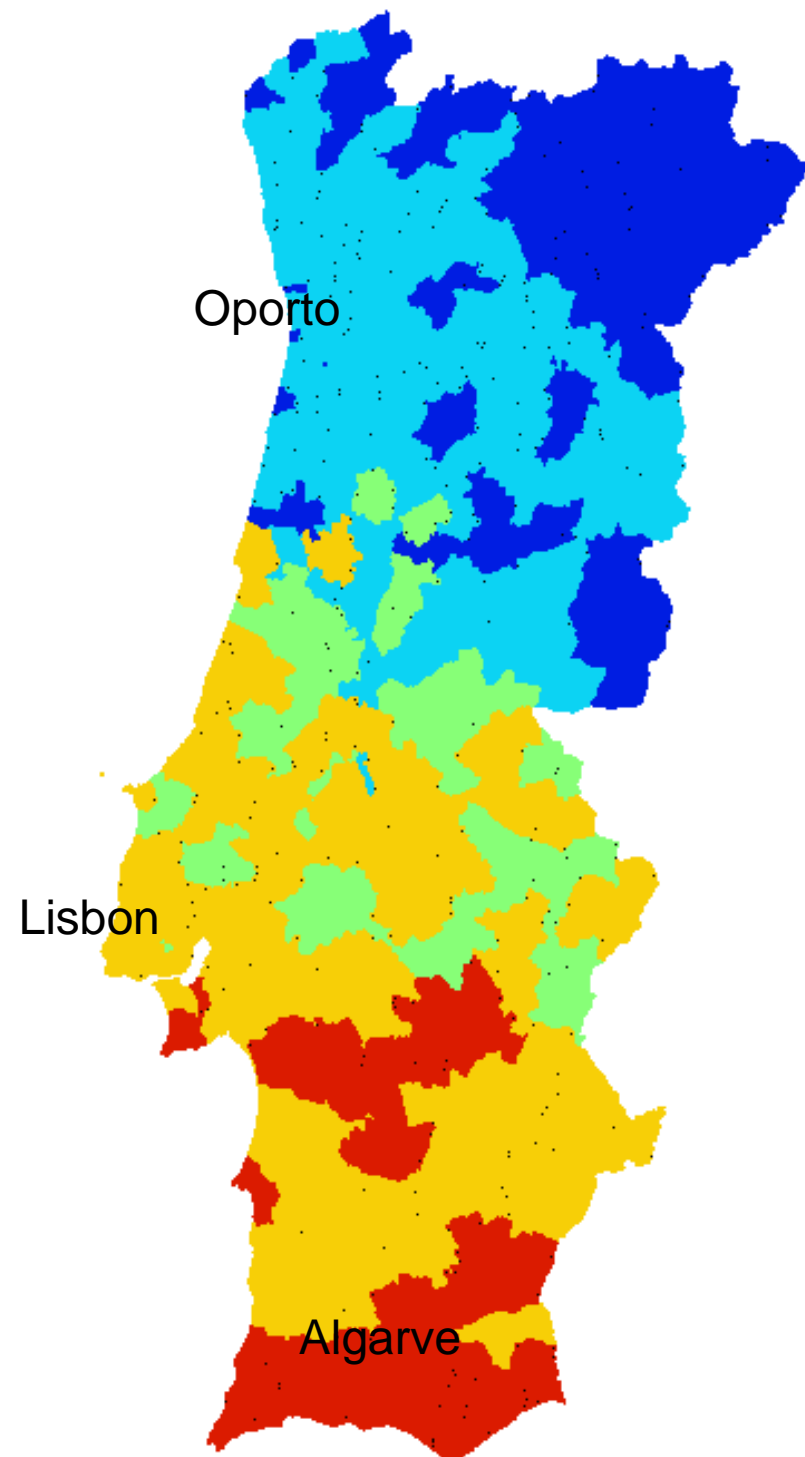


PORTUGAL: CRIMES CLASSIFICATION



- GEOSOM analysis of 2016 level 2 crime rates (number of crimes x 1000 / inhabitants), by municipality (Source: DGPJ):
 - Crimes against people;
 - Crimes against property;
 - Crimes against life in society;
 - Crimes against the State;
 - Crimes typified in specific legislation;
 - All 2016 level 2 crime rates.
- Lisbon and Oporto Metropolitan Areas: All 2016 level 2 crime rates

RESULTS: CRIMES AGAINST PEOPLE



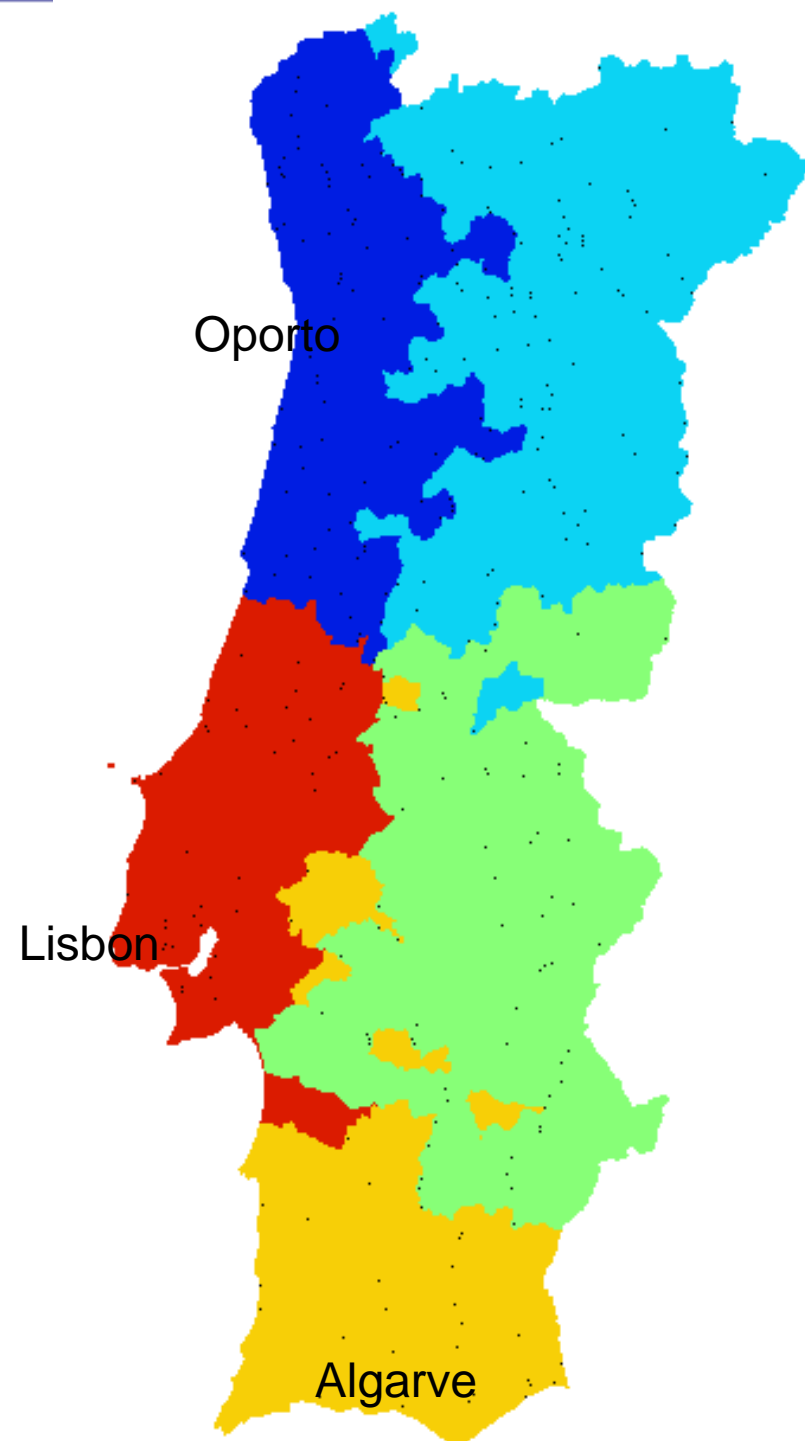
- Level 2 analysed crimes:
 - Crimes against life,
 - Crimes against physical integrity,
 - Crimes against personal liberty,
 - Crimes against freedom or sexual orientation,
 - Crimes against honour,
 - Crimes related to the infringement of privacy, and
 - Other crimes against people.
- Southern part of the country as a (red) cluster with the highest crime rates;
- Northern part of the country (dark blue) with the second highest crime rates - this area generally has the highest value of crimes against honour;
- The cluster characterized by low values (light green) includes some of the municipalities of the central rural area of the country.

RESULTS: CRIMES AGAINST PROPERTY



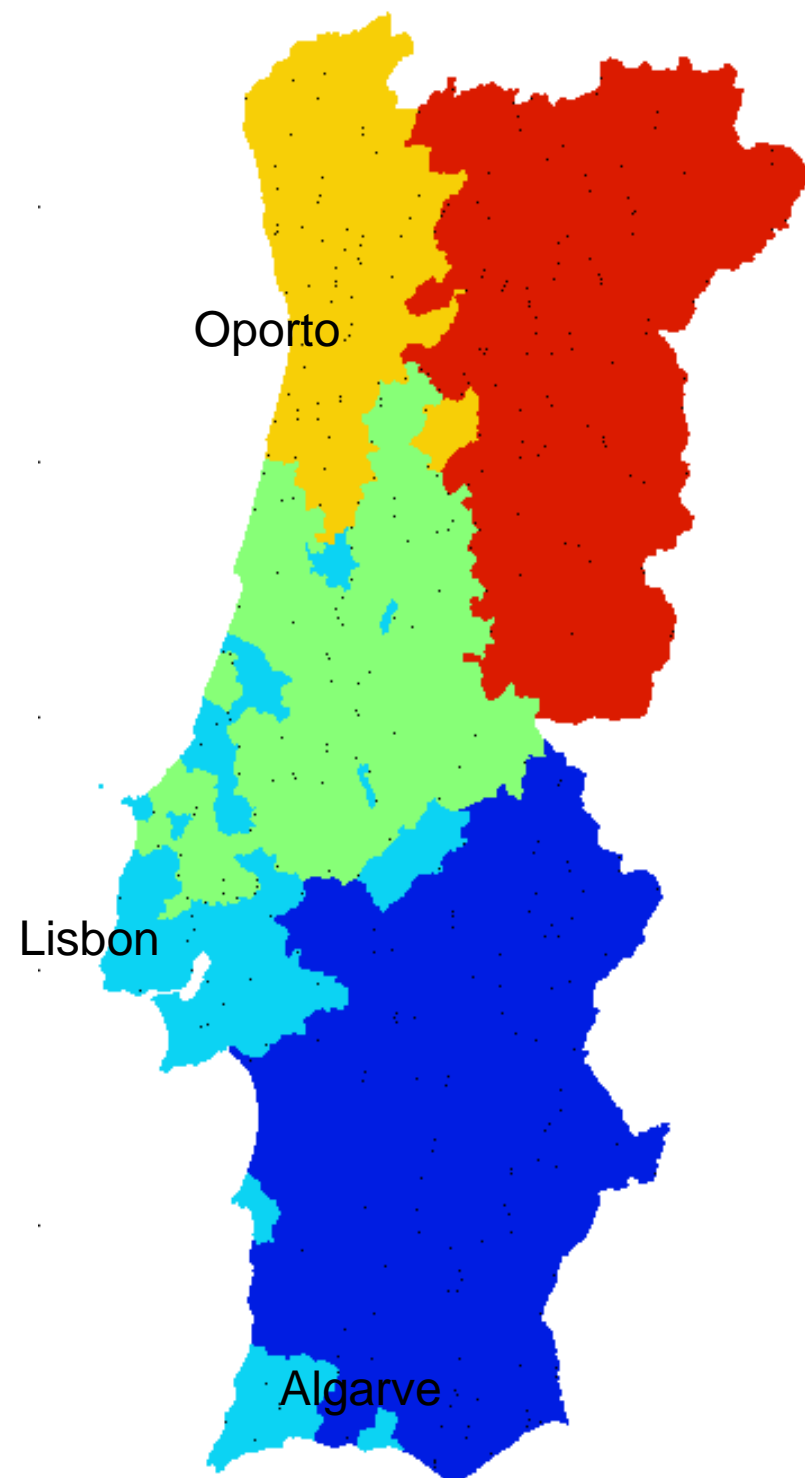
- Level 2 analysed crimes:
 - Crimes against property,
 - Crimes against immovable assets,
 - Crimes against ownership rights, and
 - Other crimes against property.
- Different criminogenic characteristics between the coastal and the country side areas;
- Yellow cluster with the highest crime rates is in the south of Portugal;
- Both light blue and green clusters have the same average crime characteristics, so they can be considered as one;
- The area with the second highest crime rates is represented in the red cluster, followed by the dark blue cluster (in the North Coast).

RESULTS: CRIMES AGAINST LIFE IN SOCIETY



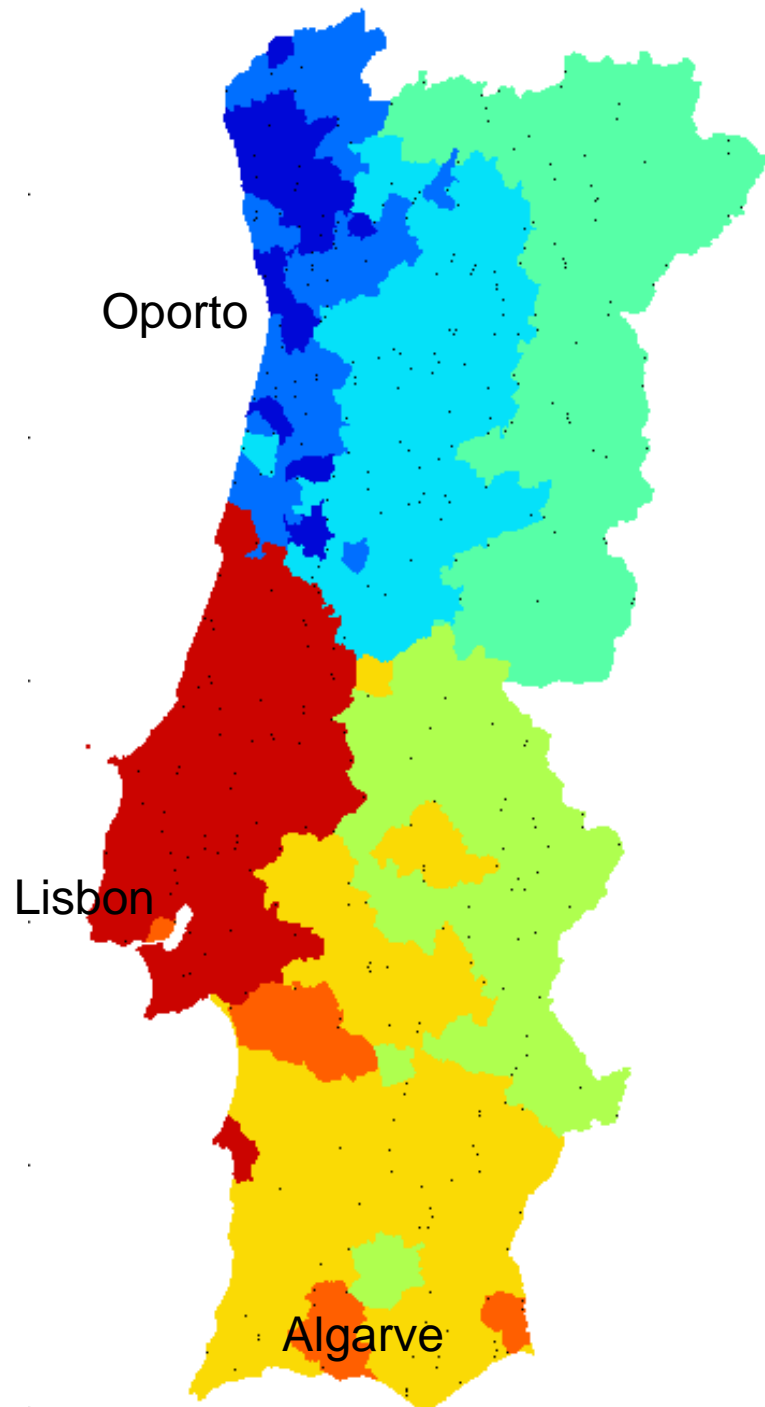
- Level 2 analysed crimes:
 - Crimes against family,
 - Crimes of forgery,
 - Crimes of common danger,
 - Crimes against communications security,
 - Crimes of dangerous anti-sociability,
 - Crimes against public peace, and
 - Other crimes against life in society.
- Level 2 rates of crimes against life in society vary between clusters;
- The cluster with the highest crime rates of common danger (light blue area) is in the northern country side. This level 2 crimes include pollution, damage of nature and arson. However, this cluster generally has low crime rates for other crimes of this type;
- The red cluster is characterized by high rate of crimes of forgery;
- The south of the country (yellow cluster) represents an area with the highest crime rate against communications security.

RESULTS: CRIMES AGAINST THE STATE



- Level 2 analysed crimes:
 - Crimes against national sovereignty,
 - Crimes against rule of law,
 - Electoral crimes,
 - Crimes against public authorities,
 - Crimes related to the obstruction of justice,
 - Crimes related to the obstruction of discharge of public duties, and
 - Other crimes against the State.
- The cluster with the highest crime rate against public authority belongs to Lisbon region (light blue). This cluster also has, in general, the highest rate of electoral crime and other crimes against the State;
- The northern country side as well as the coast central region include the lowest crime rates in this category (red and green).

RESULTS: CRIMES TYPIFIED IN SPECIFIC LEGISLATION (8 CLUSTERS)

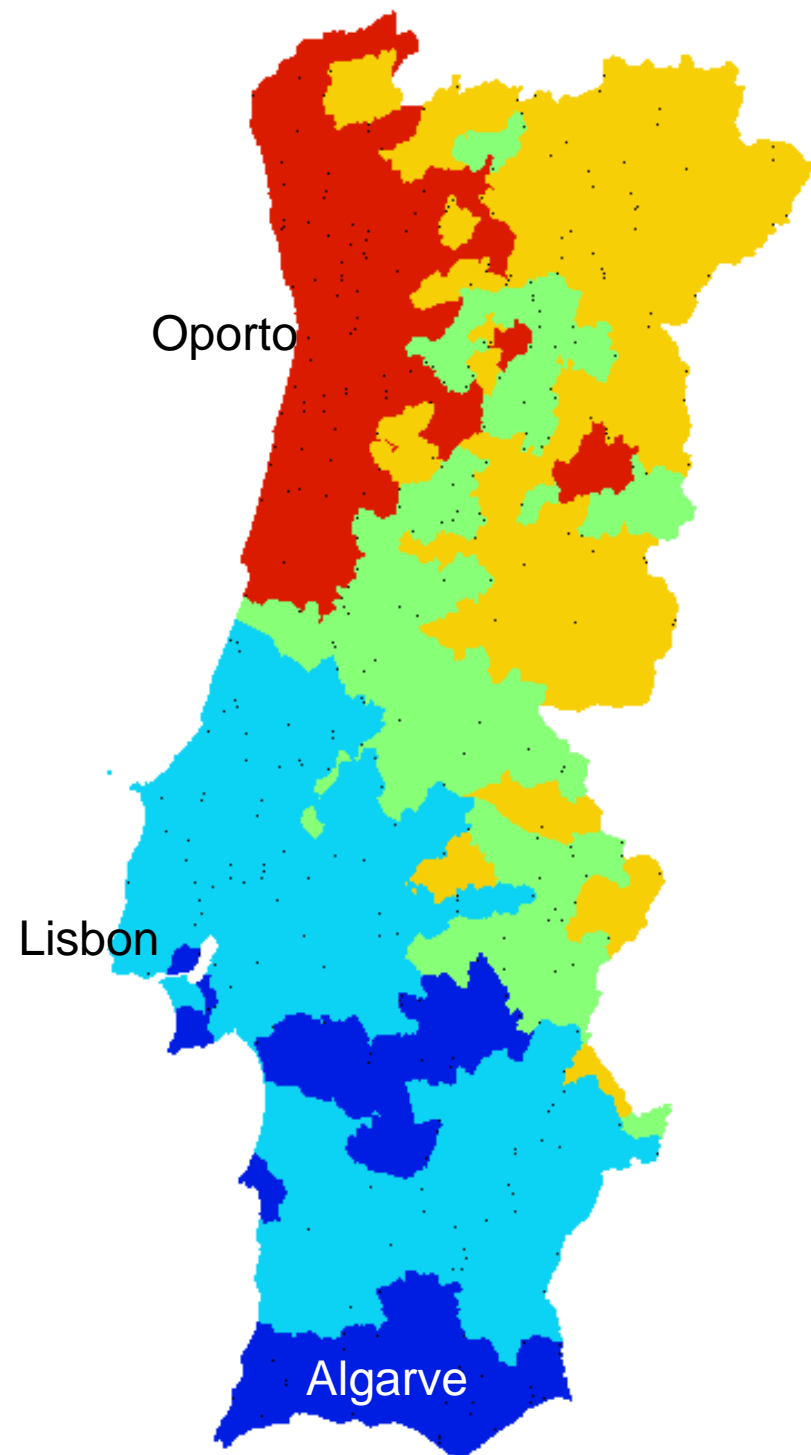


- Level 2 analysed crimes:

- Crimes strictly military,
- Drugs,
- Illegal immigration,
- Financial/ commercial crimes,
- Copyright/ trade secret crimes,
- Crimes related with the issuing of dud checks,
- Custom crimes,
- Tax crimes,
- Economic crimes,
- Gambling,
- Illegal hunting and fishing,
- Informatics crimes,
- Illegal driving,
- Sport crimes, and
- Other crime

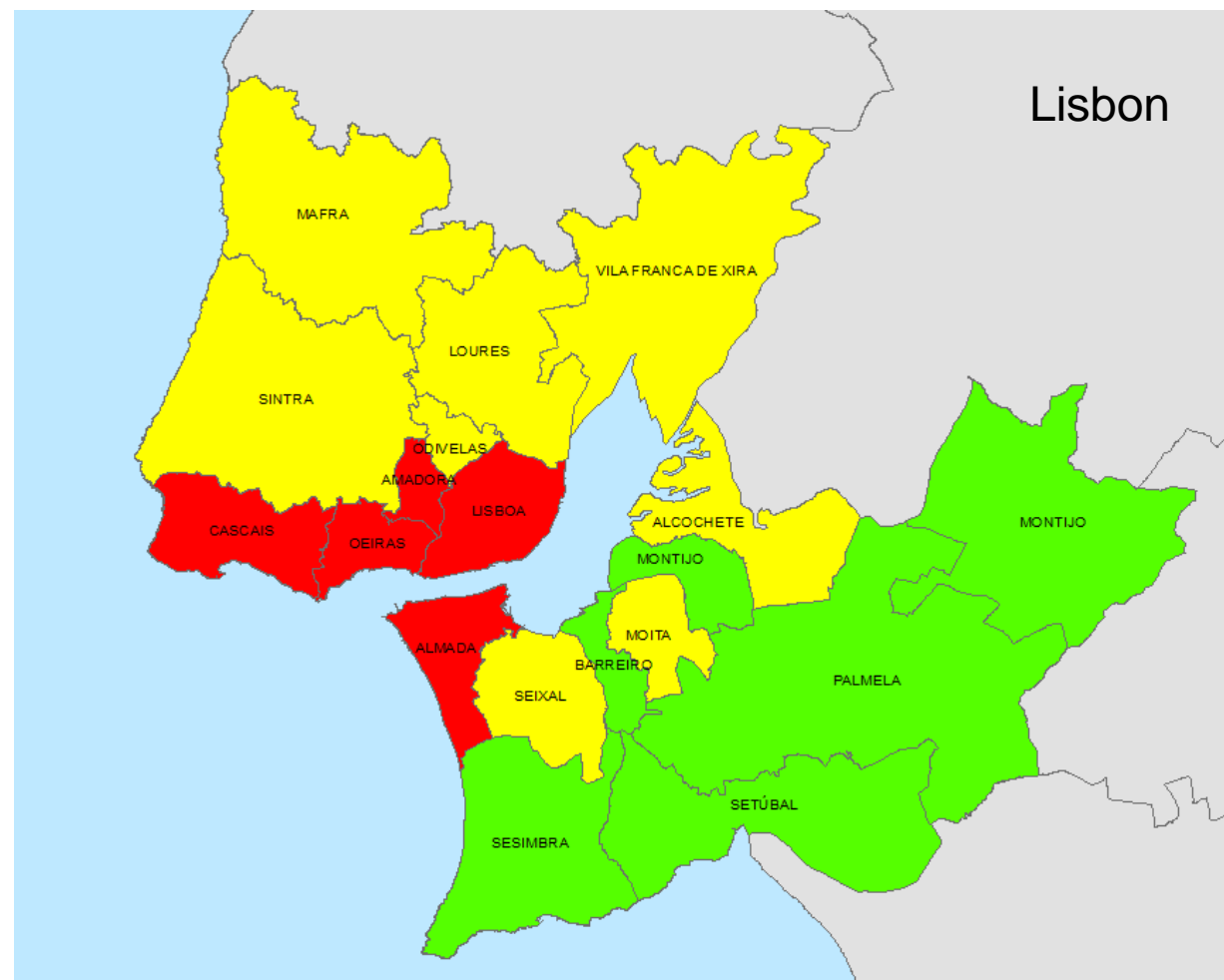
- The analysis of 2016 reveals different patterns in the crime rates typified in specific legislation;
- The municipalities included in the orange cluster have higher crime rates of illegal immigration, issue of dud checks, economic crimes and illegal driving;
- The northern coastal area (light and dark blue) possesses a high concentration of customs, computer and sport crime rates;
- The south of the country (yellow) has the highest rate of tax-related and gambling crimes and high rates of illegal driving and drugs.

RESULTS: ALL LEVEL 2 CRIMES



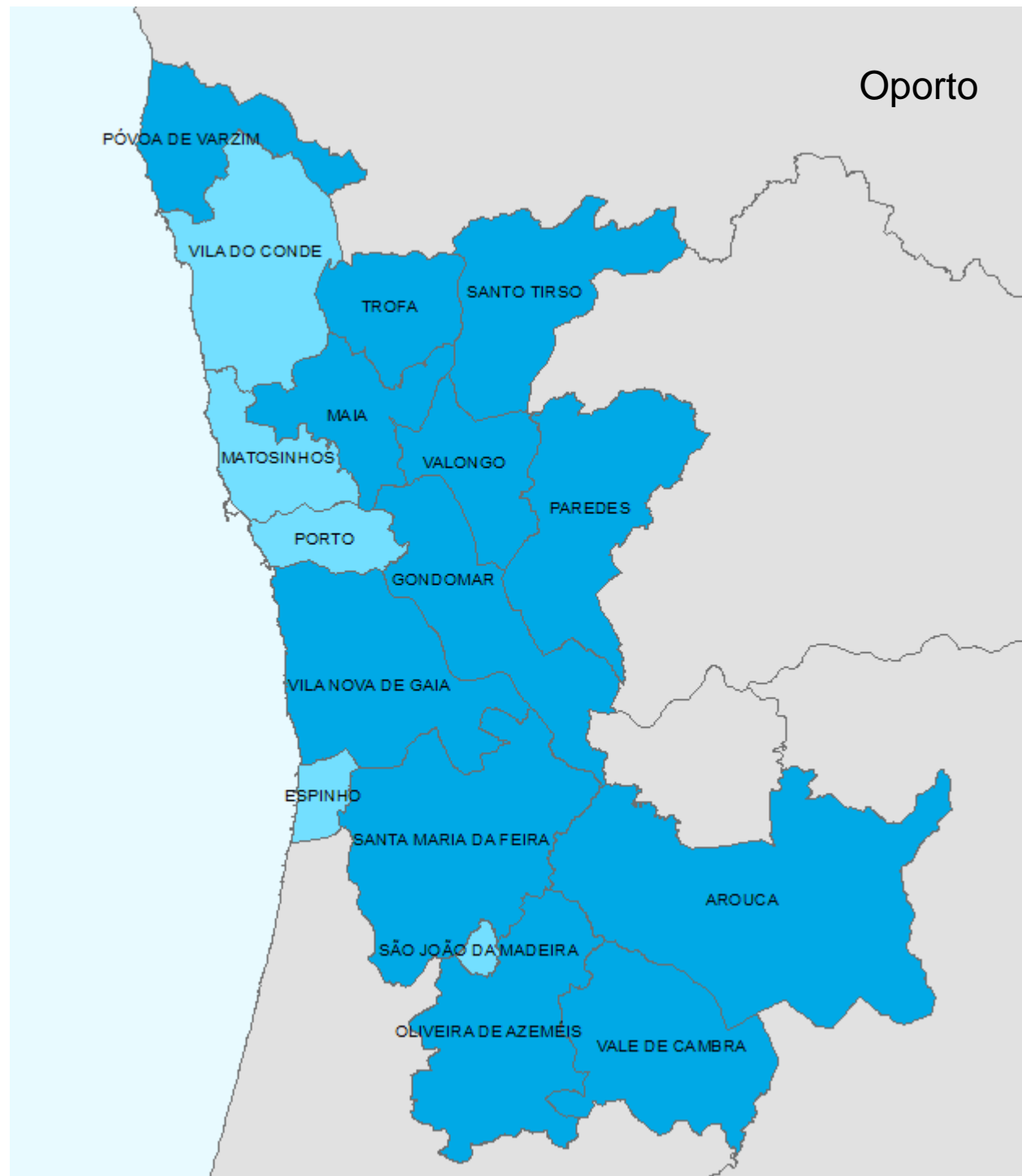
- In general, the area of the country gathering the highest crime rates (dark blue cluster) is situated in the south, followed by the area represented by the light blue cluster.
- The northern coastal part of the country (red) congregates the highest crime rates of copyright/ trade secret, informatics, dangerous anti-sociability and sport crimes.
- The North interior of the country (yellow) is characterized by the highest crime rates for crimes against honor, personal liberty, and crimes of common danger.

RESULTS: LISBON & OPORTO METROPOLITAN AREAS



- Red cluster - Very densely populated urban area of Lisbon
 - Highest rates of crimes against freedom or sexual orientation, against property, against immovable assets, against ownership rights, crimes of forgery, against public peace, electoral crimes, crimes related to obstruction of justice, crimes related to the obstruction of discharge of public duties, drugs, illegal immigration, Financial/commercial crimes, issuing dud checks and economic crimes.
- Yellow cluster - North (less densed) Lisbon
 - Lowest rates of crimes against honor, copyright/ trade secret crimes;
 - Highest rate of crimes against family (together with the green cluster); second highest for issuing dud checks.
- Green cluster: South Lisbon
 - Highest rates of illegal driving crimes, against public authorities, crimes of common danger, against personal liberty and other crimes against people;
 - Lowest rates of crimes against public peace, informatic and sport crimes.

RESULTS: LISBON & OPORTO METROPOLITAN AREAS



- Light blue cluster:

- Highest rates of crimes against physical integrity, against honor, other crimes against property, against the security of communications, copyright/ trade secret crimes, custom, gambling, informatic and sport crimes.

- Dark blue cluster:

- Lowest rates of crimes against life, against freedom or sexual orientation, infringement of privacy, crimes against property, against immovable assets, other crimes against property, against family. crimes of forgery, against public authorities, drugs, illegal immigration and illegal driving crimes.

CONCLUDING REMARKS

- In general, the results show the southern part of the country as the area with highest crime rates. Some exceptions can be made:
 - The northern interior area is highlighted for the highest rates of crimes against honour (crimes against people) and crimes of common danger (crimes against life in society, pollution, damage of nature and arson);
 - The concentration of informatics, copyright/trade secret and sport crimes in the north coast of the country;
 - Lisbon area is characterized by high crime rate in electoral, forgery and illegal immigration crimes;
- The definition of areas provided should be considered in the planning of the future distribution of security forces, especially in the detachment of special security forces to address specific crime types, such as the crimes of common danger, where the presence of the special teams in the prevention or in the first intervention is essential.



Forecast and Spatial Analysis Model
for Public Security

Thank you!



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Regarding the SIM4SECURITY project, please visit <http://sim4security.novaims.unl.pt/>.