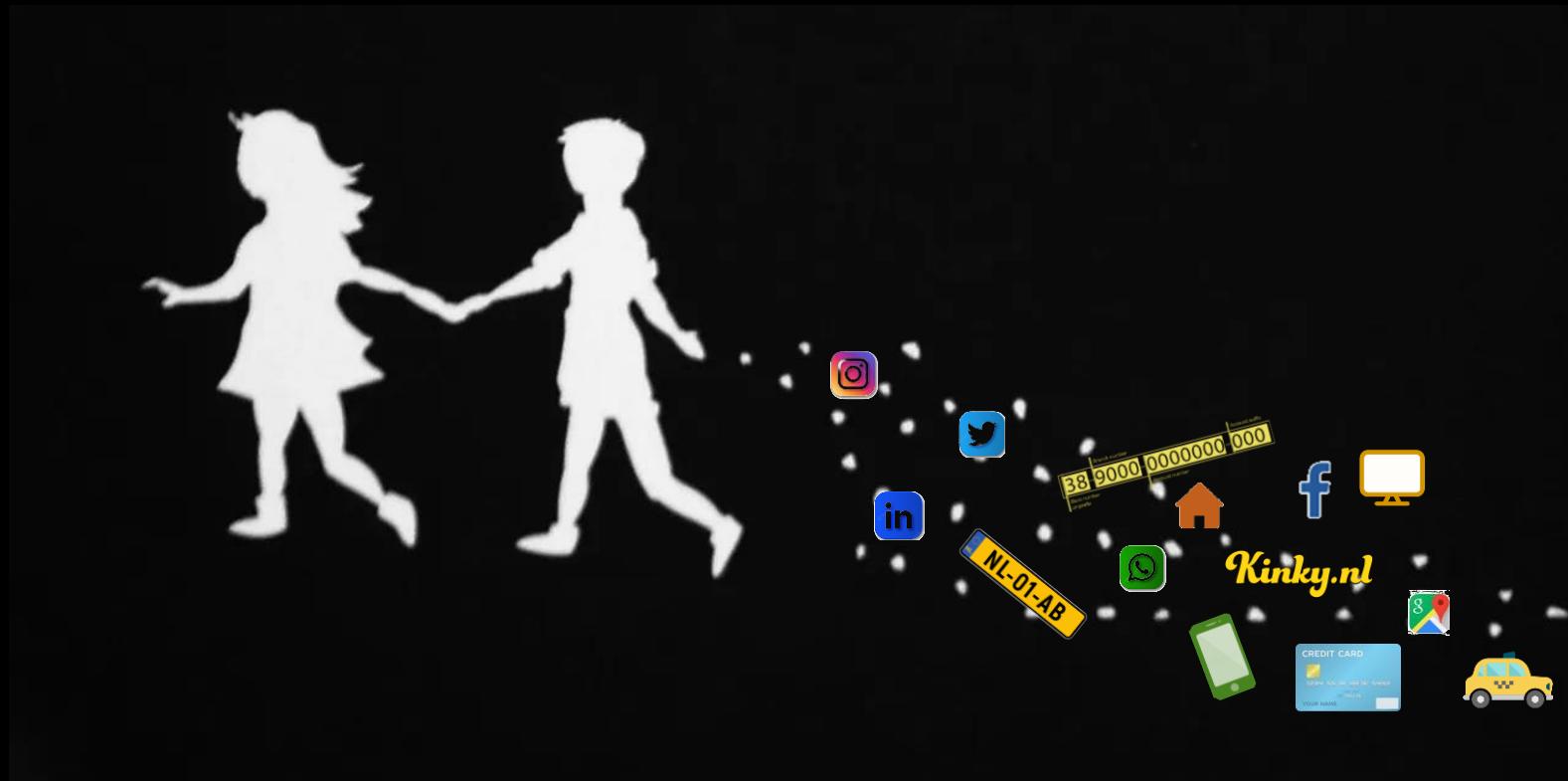


# The Hansel & Gretel Effect

The Hidden Trail of Digital Breadcrumbs  
In Human Trafficking



We balance our team by combining business and trafficking expertise to redefine and focus our vision in fusing processes and technology to combat human trafficking

Advisory Board



**Mary Adams**  
Director

After 25 years of working in management consulting, one charitable event opened my eyes and acted as a catalyst for a career change.

*I am passionate about helping organizations disrupt the human trafficking business model using my business knowledge, ingenuity and determination to build sustainable resilience.*



**Paul Fockens**  
Technical Innovator

All my life my passion has been to use technology for the improvement of business results. Now I am focused on using technology to eradicate Human Trafficking from our planet.

*I am committed to make the invisible crime of Human Trafficking visible using all Human Intelligence available.*



**Jerrol Marten**  
Human Trafficking Expert

As a past manager in various commercial positions focused on social work and probation services; I collaborate with colleagues and work with chain partners to tackle human trafficking in vulnerable groups in Dutch society.

*I want to support organizations who help human trafficking victims and make it difficult for traffickers to exploit people for their own profit.*



Corinne Dettmeijer-Vermeulen

As National Rapporteur on Trafficking in Human Beings and Sexual Violence against Children I reported on the nature and extent of human trafficking and sexual violence against children in the Netherlands, and on the effects of the government policies pursued. During my eleven years term I issued more than 200 recommendations, of which 80% were adopted.

Cleveringa Chair, Leiden University  
Advisory Board member HEUNI  
Chair Social Advisory Council Immigration and Naturalisation Service  
Expert Advisory Council, Global Fund to End Modern Slavery  
Vice-Chair Supervisory Board, Child Helpline International

Elected member of CEDAW for the term 2021-2024



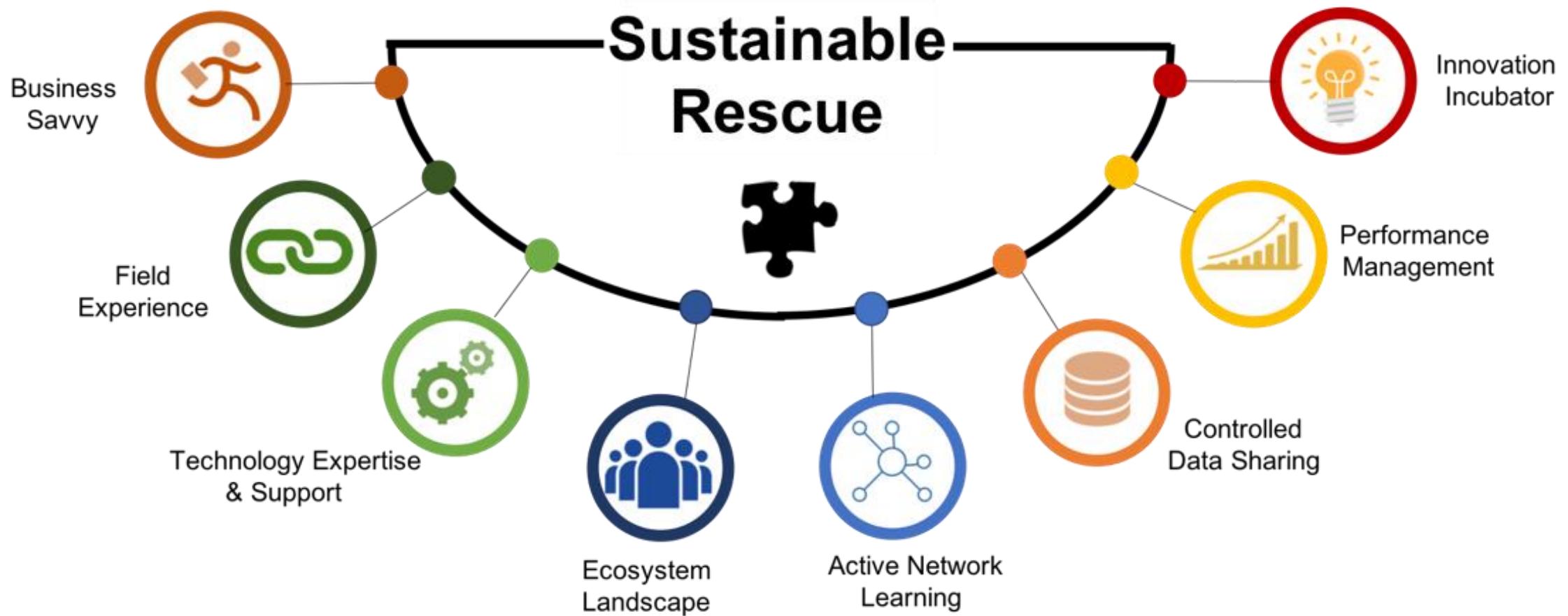
Douwe Lycklama

As experienced initiator of data sharing ecosystems I want to practically contribute to better data sharing in order to help fight human trafficking and sexual violence. If we selectively make the right data available, then law enforcers can more easily connect the dots.

Owner and Founder of Innopay  
iSHARE Lead  
Author, "Alles Transactie," Management Book of the Year (2019)  
Advisor, Data Sharing Coalition



Disrupting the Human Trafficking Business Model means  
Cultivating & Integrating Diverse Existing Solutions



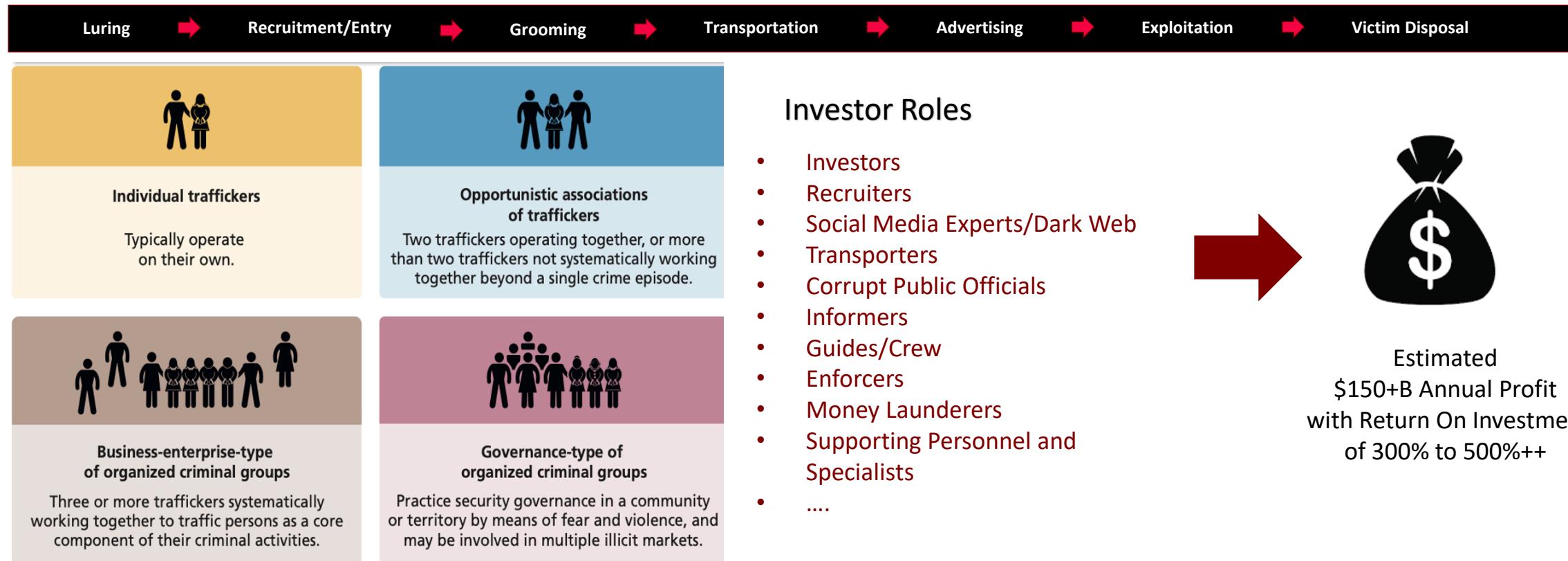
Palermo Protocol defines Trafficking in Human Beings as: '*the recruitment, transportation, transfer, harbouring or receipt of persons, by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments and benefits to achieve the consent of a person, having control over another person, for the purpose of exploitation*'.



- Child Marriages
- Forced Marriages
- Child Soldiers
- Forced Begging
- Forced Criminal Acts
- Domestic Servitude

# Human Trafficking is now the Fastest Growing Criminal Industry in the World

Human trafficking is a market in which people are treated like commodities and are bought, sold, traded and used. Traffickers look at market forces and rapidly adapt their methodologies according to their environments. They calculate opportunities, profit, risk and costs to make investment decisions.\*



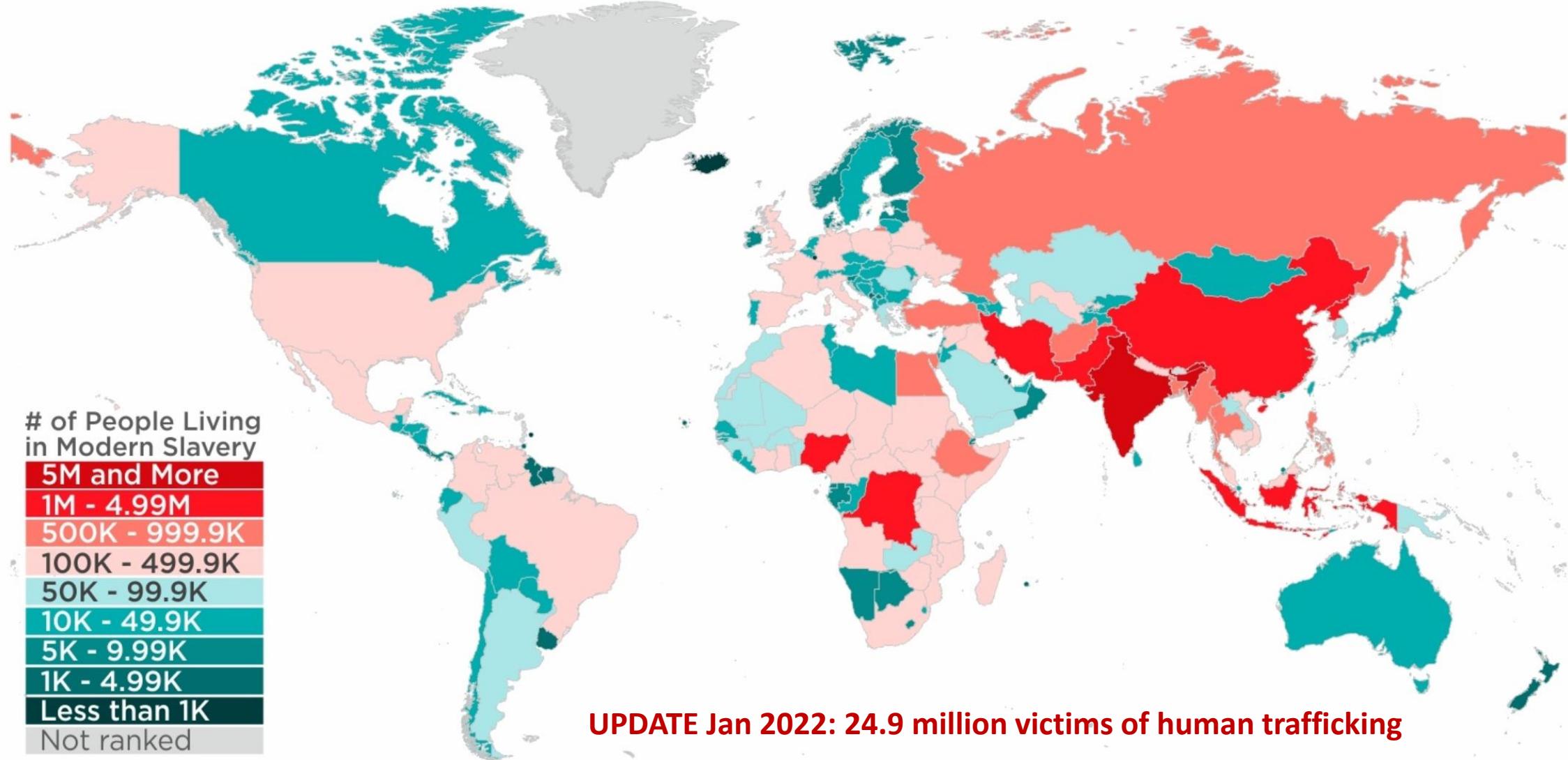
Source: GLOTIP collection of court case summaries, based on 422 court cases out of a total of 489 collected by UNODC

## Supply and Demand

\*OSCE, Analyzing the Business Model of Trafficking in Human Begins to Better Prevent the Crime

# World Map of Modern Slavery 2018

Estimated Absolute Number of Victims



## Article & Sources:

<https://howmuch.net/articles/modern-slavery-map-2018>

The Global Slavery Index 2018 - <https://www.globalslaveryindex.org>

International Monetary Fund - <https://www.imf.org/>

<https://traffickinginstitute.org/breaking-down-global-estimates-of-human-trafficking-human-trafficking-awareness-month-2022/>

©Sustainable Rescue Foundation

net

6

The Netherlands is predominantly a country of destination of victims of trafficking in human beings, but is also a country of origin and transit.

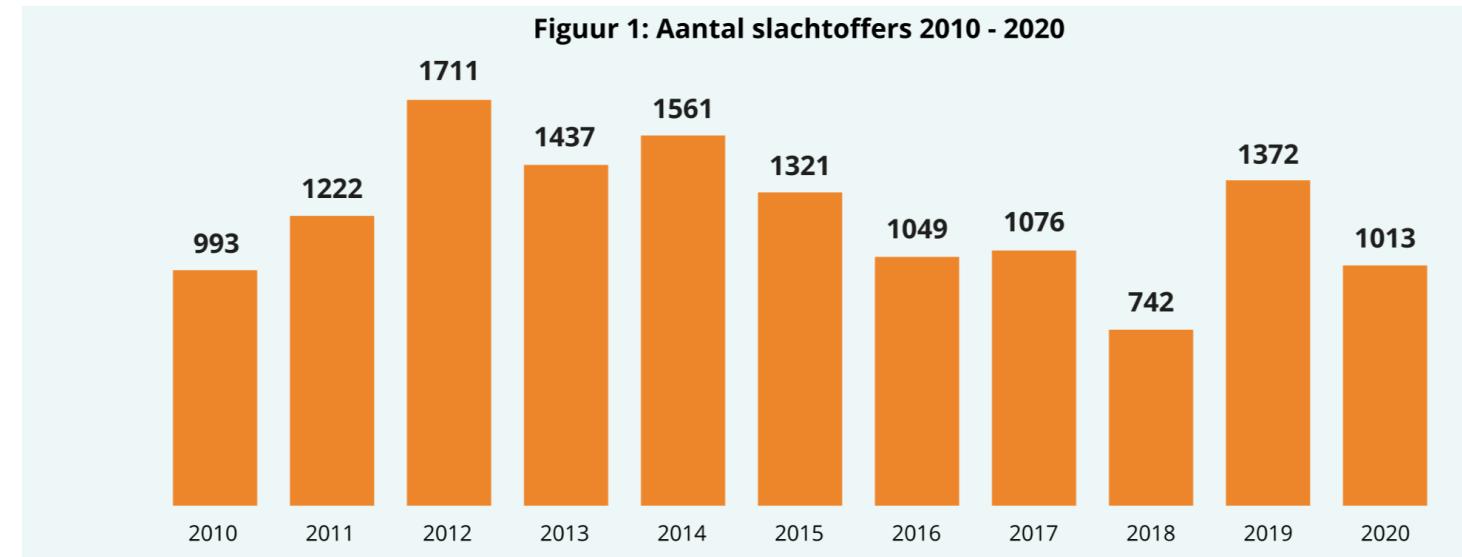


### Coordination Center against Human Trafficking

Provides insight into the nature and extent of human trafficking through victim registration, data analysis and (anonymous) reports

The **Multiple Systems Estimate methodology** uses existing lists of victims using a statistical formula based on the concept of the capture-recapture method. This makes visible the “dark figure” of victims by analysing the overlaps between the lists.

In 2016, This estimate revealed that only 10% of all victims are detected in the Netherlands. The actual total number of victims is 17,800 (range 14,000-23,900).

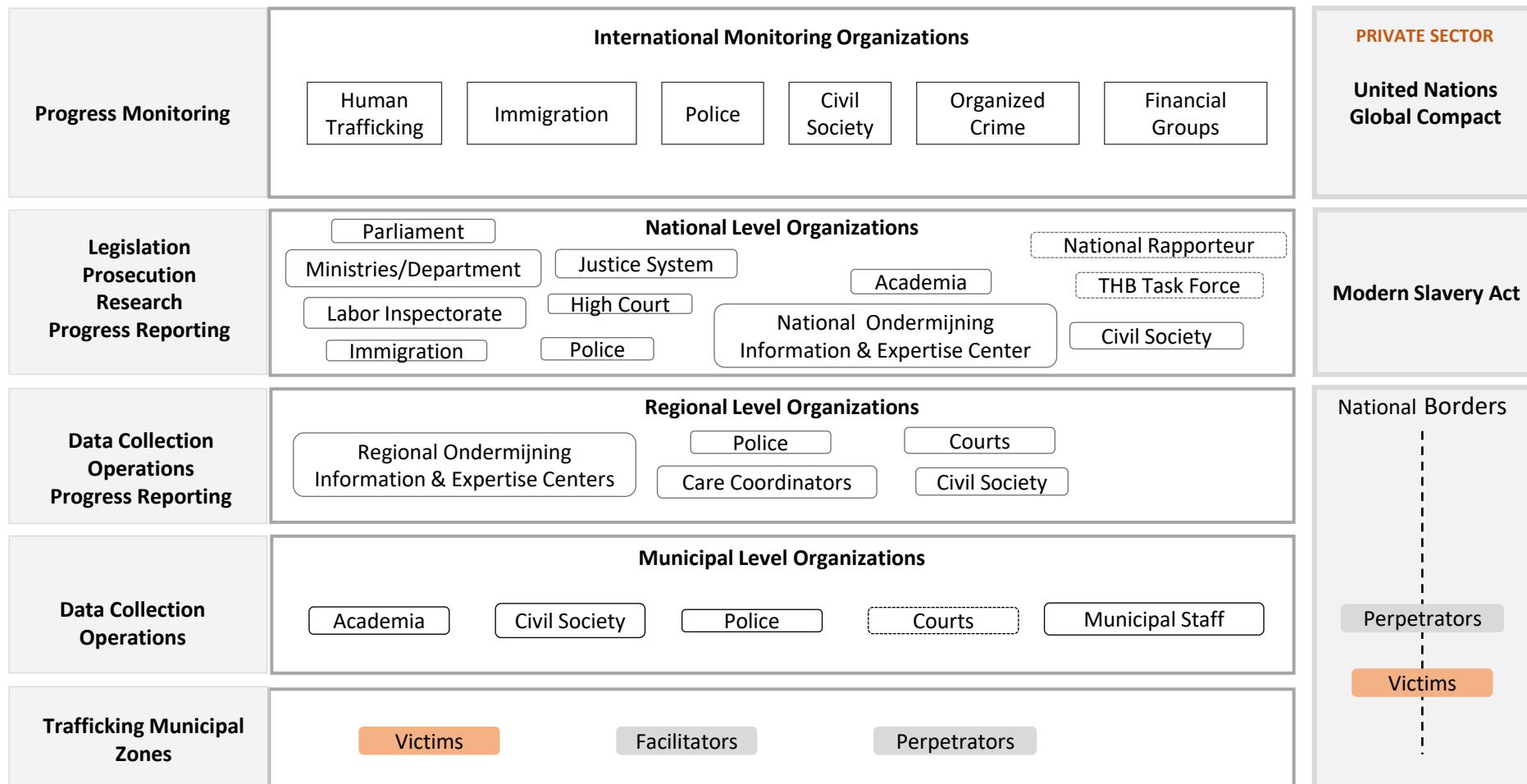


**Over the last eight years an average of 57% of all reported victims were of Dutch Nationality**

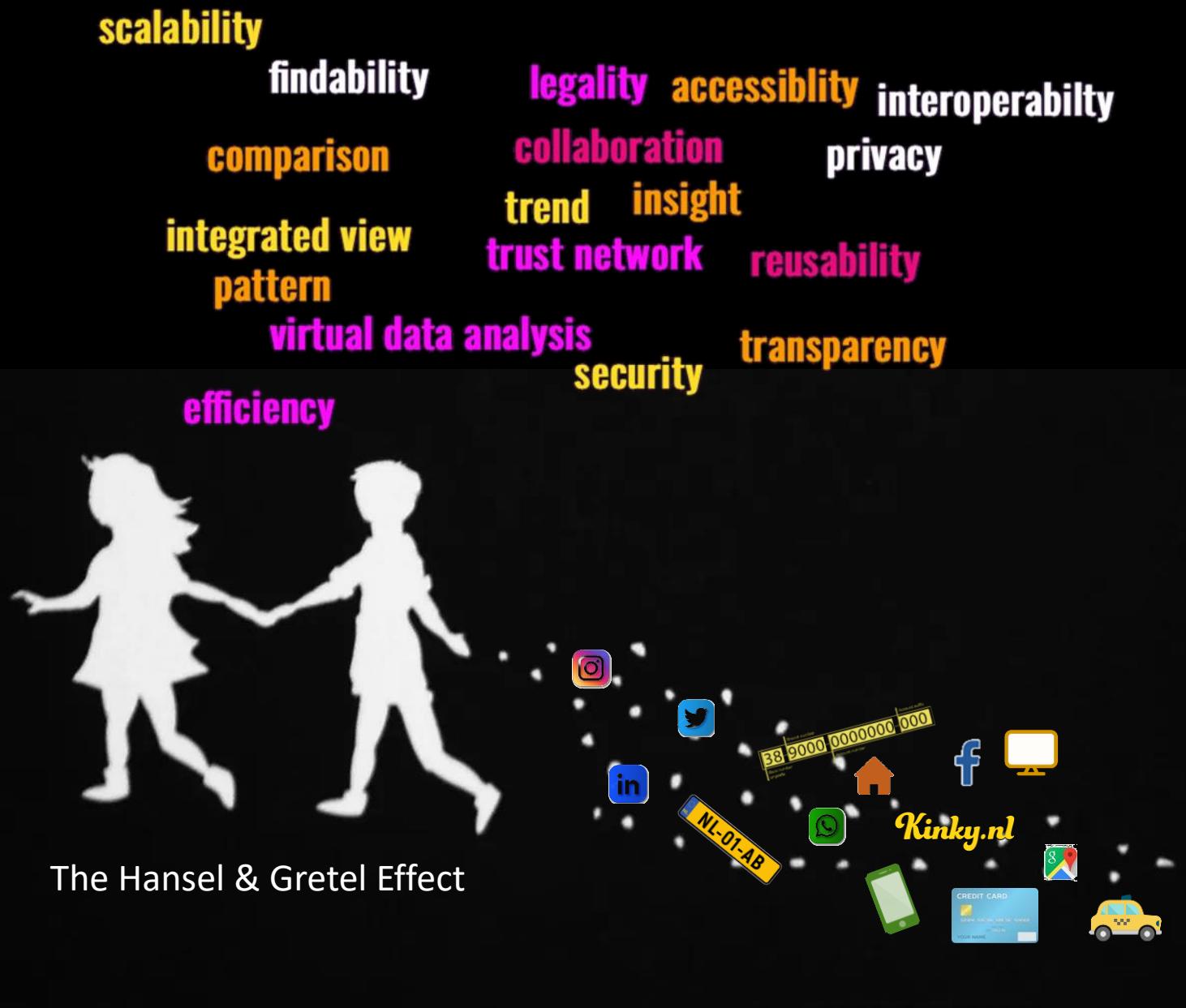
**Colofon Mensenhandel in Nederland, het beeld van 2020 is een uitgave van CoMensha, hét landelijke Coördinatiecentrum tegen Mensenhandel.**  
Uitgave © Juli 2021

Multiple Systems Estimation for estimating the number of victims of human trafficking across the world, UNODC Research and Trend Analysis  
Branch, Jan Van Dijk, and Peter G. M. van der Heijden

# The Human Trafficking Landscape\* Reveals the Complex Nature of Operations, Governance, and Monitoring



Data is shared within organizations, between and across all layers – except in the private sector, which operates on ethical behavior with little/no legal reporting obligation.



The Hansel & Gretel Effect

## TECHNOLOGY IN ACTION

- Privacy Enhancing Technology  
Multi-Party Computation
- Natural Language Processing
- Crime Scripts
- Knowledge Graphs / Machine Learning
- Entity Resolution
- BIG Data
- Artificial Intelligence

# Public Private Partnership



Seksuele uitbuiting van Roemeense vrouwen in Nederland  
**MENSENHANDEL FIELDLAB LOVITURA**



OPENBAAR MINISTERIE



Belastingdienst



Koninklijke Marechaussee



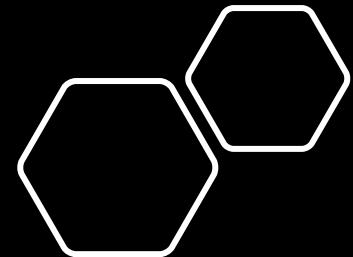
Financial Intelligence Unit - Nederland

**ADVISORY BOARD**

## Romania-Europol-Rotterdam (AVIM) Data Sharing Results in Hotel Sting Operation: Arrest & Victim in Shelter



- What can you do with this case in your own role?
- What could other organizations do?
- Which interventions could be done?



### Information Shared

- Romanian woman kidnapped and brought to NL for forced prostitution
- Rotterdam address
- Romanian license plate
- Kinky.nl advert with telephone number



# Transform breadcrumbs into criminal network insights



## Property information

- When was it sold? Who owns it?

## Mortgage applications

- Additional personal information and connected individuals
- Other properties owned by same people

## Landlord information

- Other individuals at address
- Timeline
- Profile of high-risk properties

## Car/Life insurance

- Other individuals and personal details (phones, addresses, names, bank details)

## Bank accounts

- Risky counterparty accounts (to speak with foreign authorities)
- Related account information

## Border checks

- Dates and times of travel
- Potential routes

## Kinky.nl

- Other at-risk individuals
- Device information
- Photo metadata
- Cookies

## Lovitura Field Lab:

Police Surveil 10 Elenas from their database

Investigative Approach: Find Bottlenecks



If the same Elenas were unknowingly participating in the police field lab project, it could expose both them and NGO staff to physical harm from traffickers or pimps.

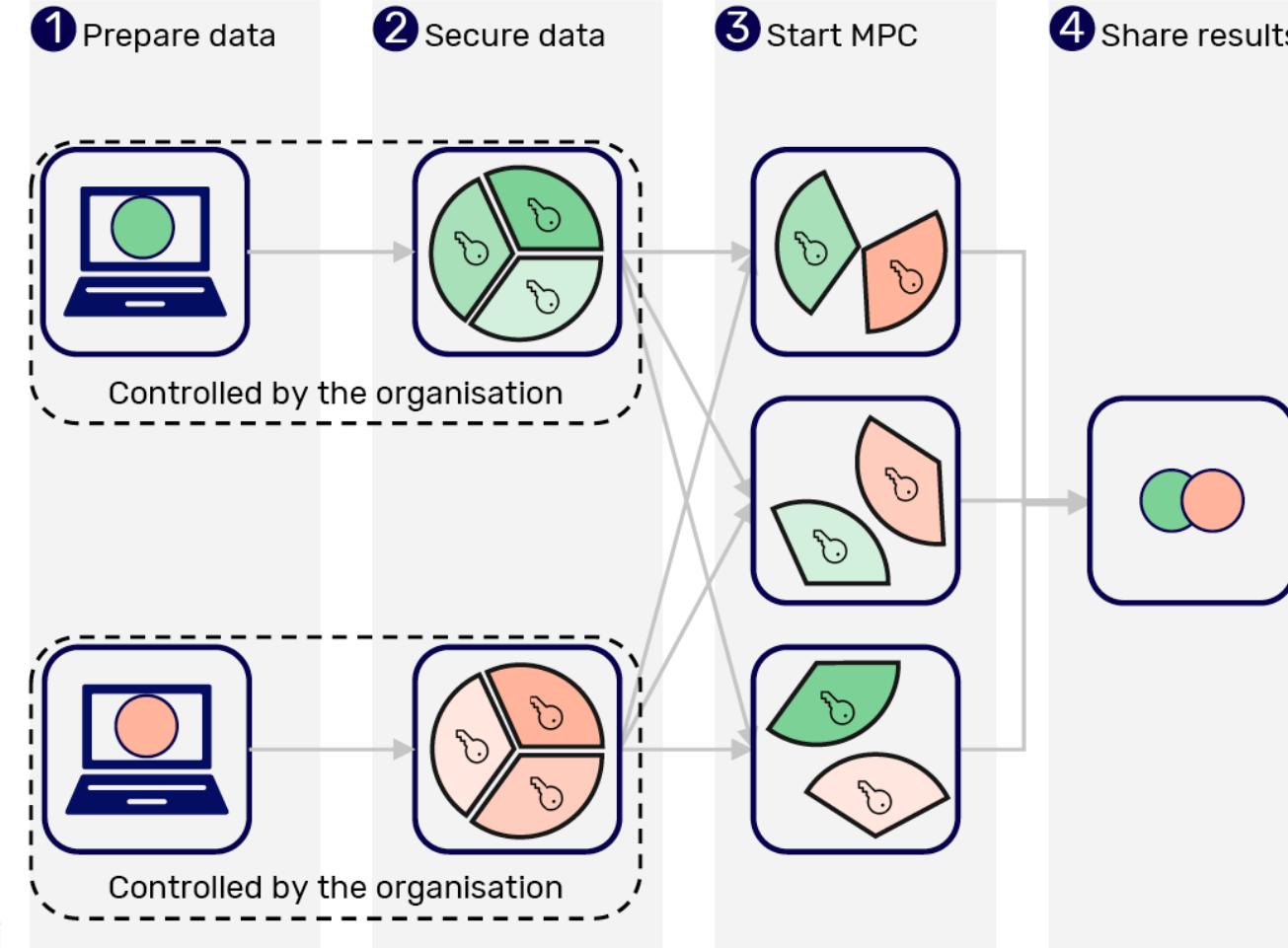


**Sustainable Rescue Foundation:**  
Data-Driven, Victim-Centered Approach  
Interviews with 10 Elenas in partnership with NGOs



# MPC enables a group of organisations to calculate certain insights without sharing individual organisation's data

## Visualisation of multi-party computation



## Steps in the process

- 1 The Data Provider, the organisation providing the data, internally collects and prepares the data
- 2 The Data Provider uses the MPC portal to fragment and encrypt the data locally. As this is a local operation, no other organisation is involved or has access to the data
- 3 The Data Provider uploads the secured data via the MPC portal to the three (or more) different computational nodes. The computational nodes compute the partial results based on the encrypted data
- 4 The partial results are combined to create the result of the computation

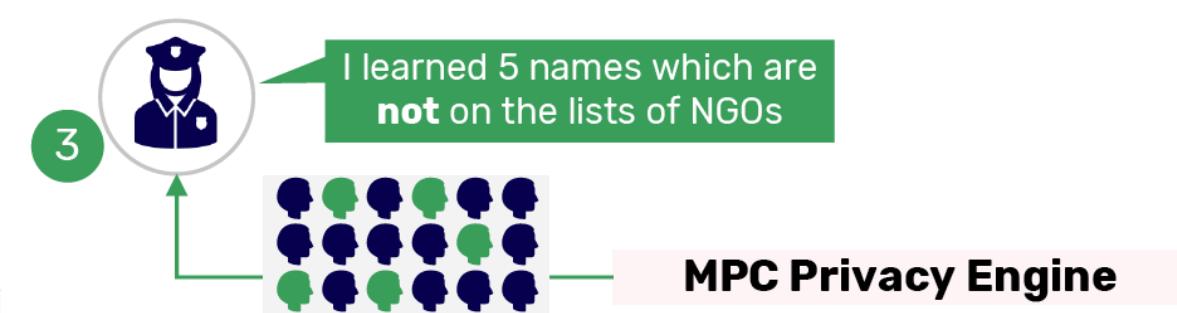
## Other examples of MPC applications

- [Large scale data collaboration on cyber threats](#)
- [Electricity grid monitoring](#)

Source: [Roseman Labs](#)

Monitoring Human Trafficking, April 2022. Data Sharing Coalition. All rights reserved.

# The successful execution of the PoC increased the awareness and trust of law enforcement agencies and NGOs in MPC



## Explanation Proof of Concept

- 1 The Law enforcement agency (LEA) wants to select 5 names which are not on the lists of the NGOs. The LEA can not share their list due to regulation. The NGOs will not share theirs as they fear to break the trust relationship with their informants
- 2 The LEA and NGOs use the MPC Privacy Engine to jointly perform the comparison without disclosing any individual's name
- 3 The LEA learns 5 names which are not on the lists of NGOs

	Law enforcement agency		Name on list of NGO or LEA
	NGO		Name not on list NGO
	Shared in encrypted and fragmented way		

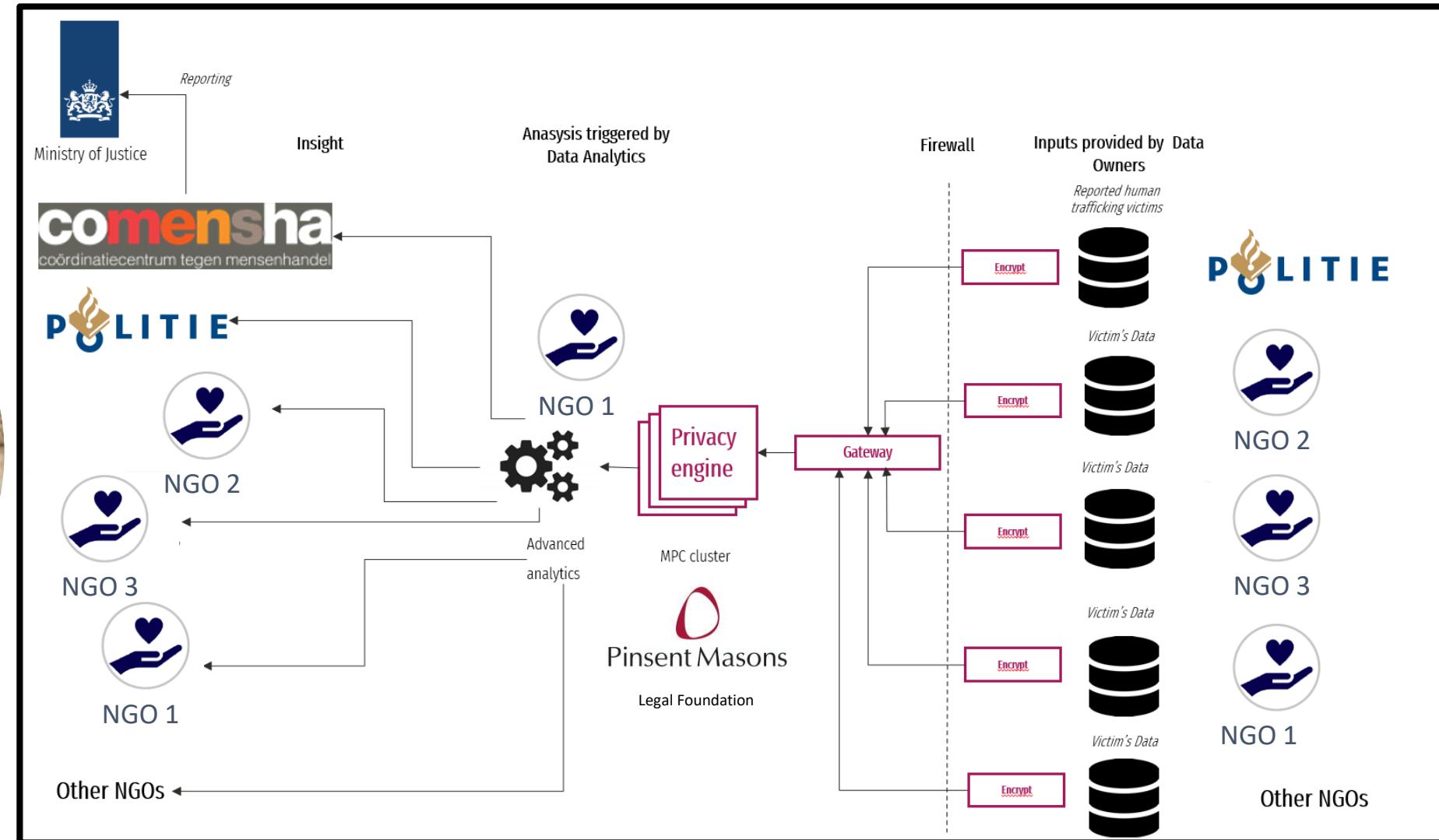
# MPC Sandbox: Collaborative analysis of human trafficking data using a Virtual Data Lake

Use Case 1: Improve national victim metrics



Use Case 2: NGO collaboration on client movement

Use Case 3: TBD



Courtesy Roseman Labs

# Interviews with 10 Elenas



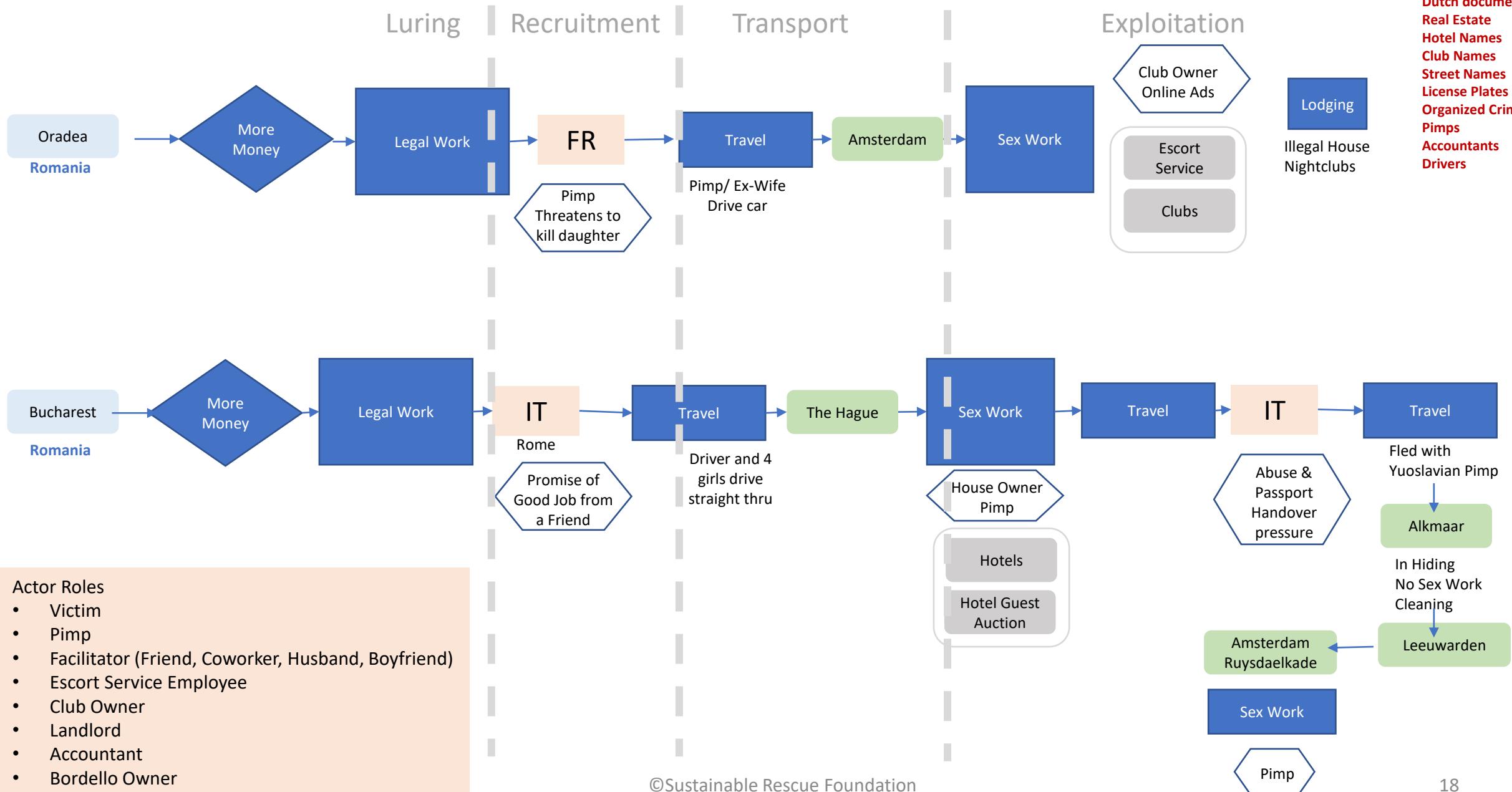
Pick up the breadcrumbs!

- A: Did he take you to **work** every day?  
E: No. I was going with my **girlfriend**. Sometimes he took us, but mostly it was by **metro** or **tram**. We didn't want to be home with him. To avoid him, at night we went to the **Red Light** and in the day we went to **Ruysdaelkade**.
- A: Why did you want to avoid him?  
E: He wasn't bad, we just didn't like him anymore.
- A: Your **friend** was not in love with him anymore?  
E: She was because after I left, she stayed with him a few more years until she grew up a bit and then she kicked him out. She said, "I don't want this anymore and if you make problems, I will go to the **police**." So he left her alone.
- A: That was kind!  
E: Yes. My **girlfriend** told me later on that we were the last **girls** he took. Before us, he had more **girls**. He was very bad with them. I think we were lucky.
- A: So you were in school in **Romania** and met the **man** your **girlfriend** was in love with. Did it go very fast?  
E: It was a matter of weeks before we left **Romania**. I think that he really influenced my **girlfriend**'s decision, and she was seeing me a lot.
- A: How did he take you to **Holland**?  
E: He brought us in a **car**. I remember I was very scared when I got here. I said to my **girlfriend**, "Please, I want go home. I don't know what is happening here."
- A: After you arrived in **Holland**, did he take you to the **house**? Did you have to start working immediately?  
E: We stayed in a **hotel** for a couple of weeks in **Oostpoort**, I think. Then because we didn't have **papers**, we worked at the **Candy Club** in **Amsterdam**. It is a **club** where **girls** without **papers** can **work**. Now it is closed. We worked there until we got our **papers**.
- A: Was it a **sex club**?  
E: Yes.
- A: In **Amsterdam**?  
E: I think also in **Oost**.
- A: That was the beginning. After that you went to the **Red Light District**?  
E: Yes.
- A: Was that your own decision?  
E: He decided that where and when we worked.
- A: Do you remember how much **money** you had to give to him?  
E: Half of everything.
- A: Approximately, how much **money** did you make in a day?  
E: There were nights when I made a thousand, fourteen hundred, thirteen hundred that I'll never forget. And there were times that he took everything because he said that I owe him for something. I started to get smarter. I'd say, "sorry, but I only made **€100 today**." "sorry, but I only made **€50 today**, look – here is your half **€25**." I think that is why he let me go after **three months**.

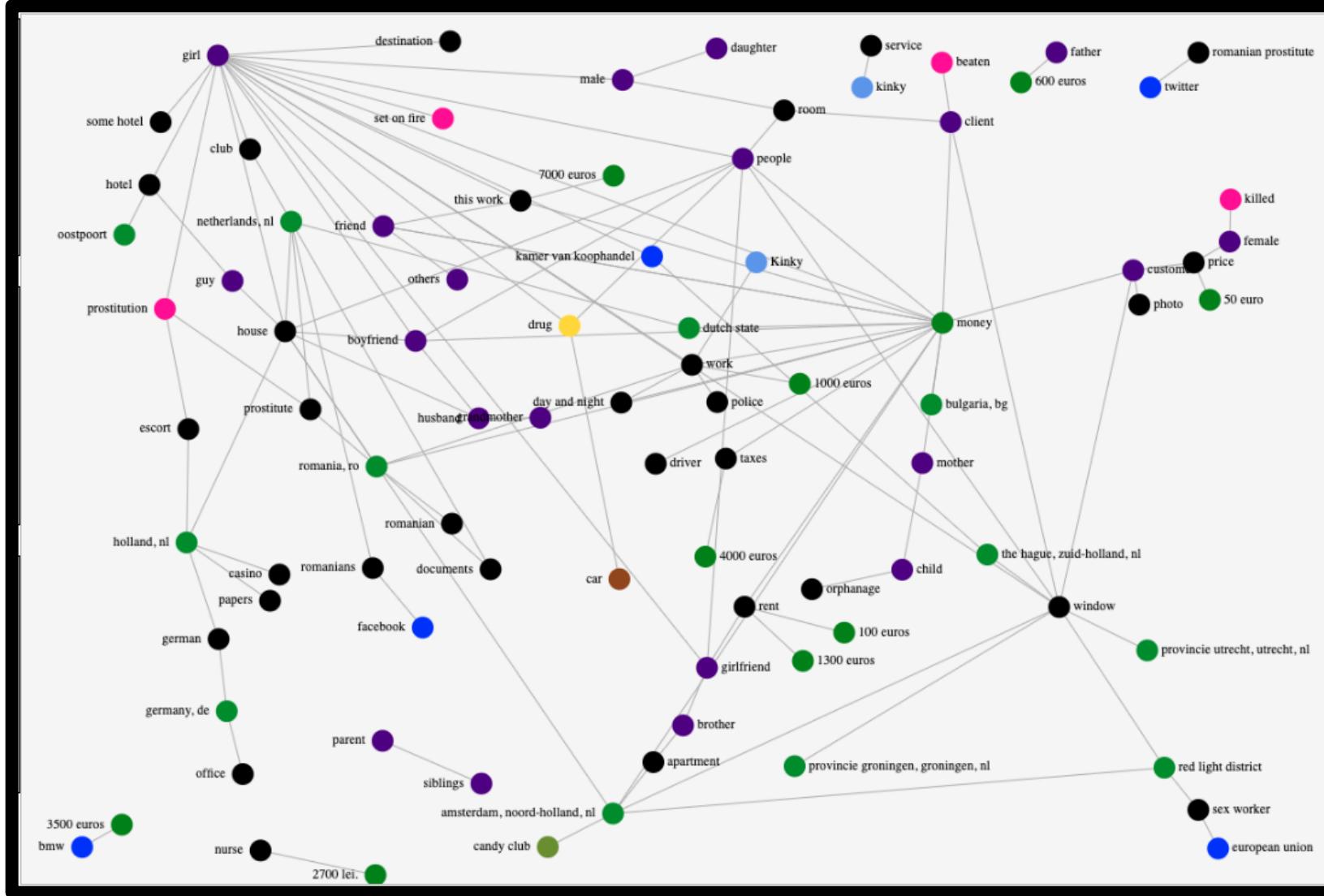
# Develop Crime Script for Intervention & Prevention

BREADCRUMBS

Social Media  
Dutch Bank Account  
Western Union  
Dutch documentation  
Real Estate  
Hotel Names  
Club Names  
Street Names  
License Plates  
Organized Crime  
Pimps  
Accountants  
Drivers



Knowledge graphs put data in context via linking and semantic metadata and provides a framework for data integration, unification, analytics and sharing



**Identify & Analyze:**

**Meaningful Entities**

**Relationships**

**Locations**

**Sentiment**

# Finding Financial Breadcrumbs in the Netherlands

## TYPES OF DATA

### DIRECT FINANCIAL DATA

Direct financial data refers to financial data that regard the financial position and/or transactions of the actors involved:

- bank records
- data from the tax authorities
- data from currency exchange offices
- data from FIU-the Netherlands where various entities are legally obliged to report unusual transactions
- data from the Credit Registration Office where credit providers are legally obliged to register all granted loans

### INDIRECT FINANCIAL DATA

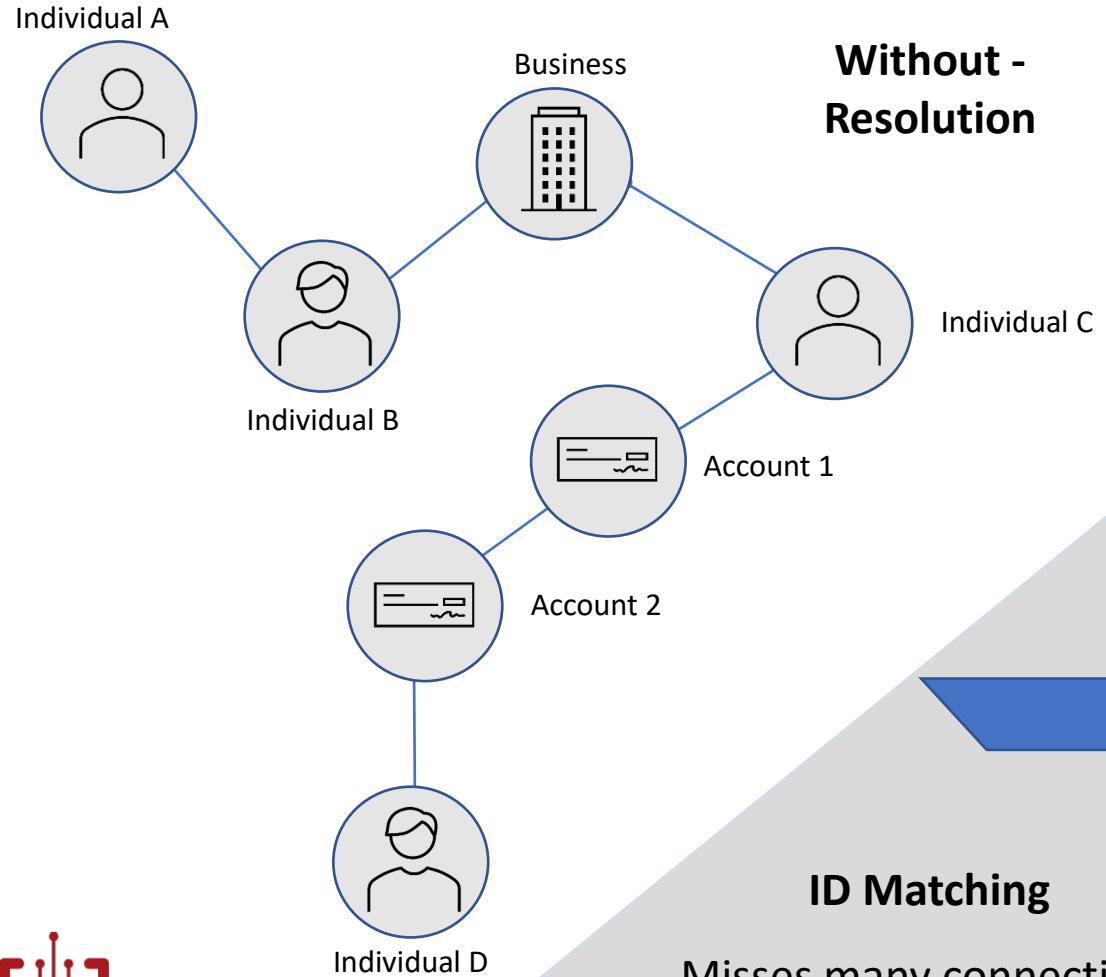
Indirect financial data refers to data that provide information on the financial position of the actors, but that are not financial data.

- municipal personal records database that show where and how (in what kind of property) the actors live or information from the land registry office where property is registered
- registered vehicles and driving licenses
- business registration Chamber of Commerce (Kamer van Koophandel) and/or are involved in or with corporate entities
- adverse media monitoring: information posted on Facebook, other social media accounts and WhatsApp or text messages that can provide insights in the lifestyle and the pattern of spending of the actors involved.

Brenda C.M. Oude Breuil, Anne-Jetske L.M. Schaap and Anna Merz

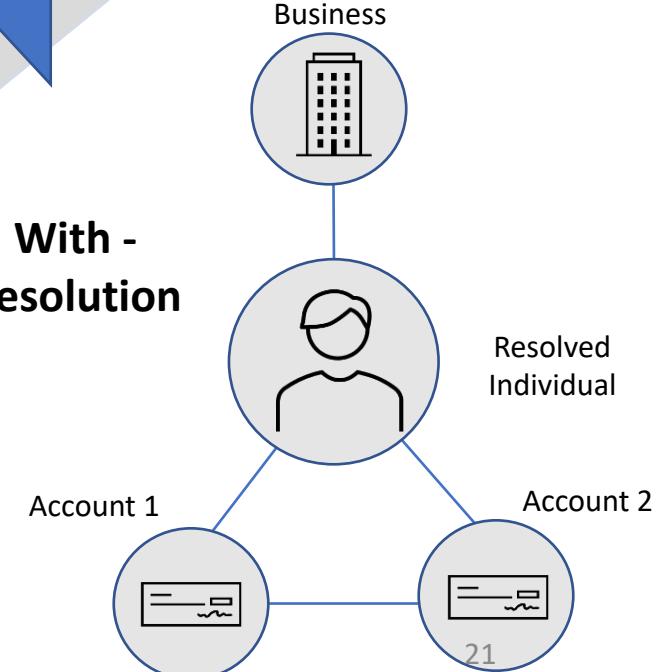


# Linking records: Entity Resolution

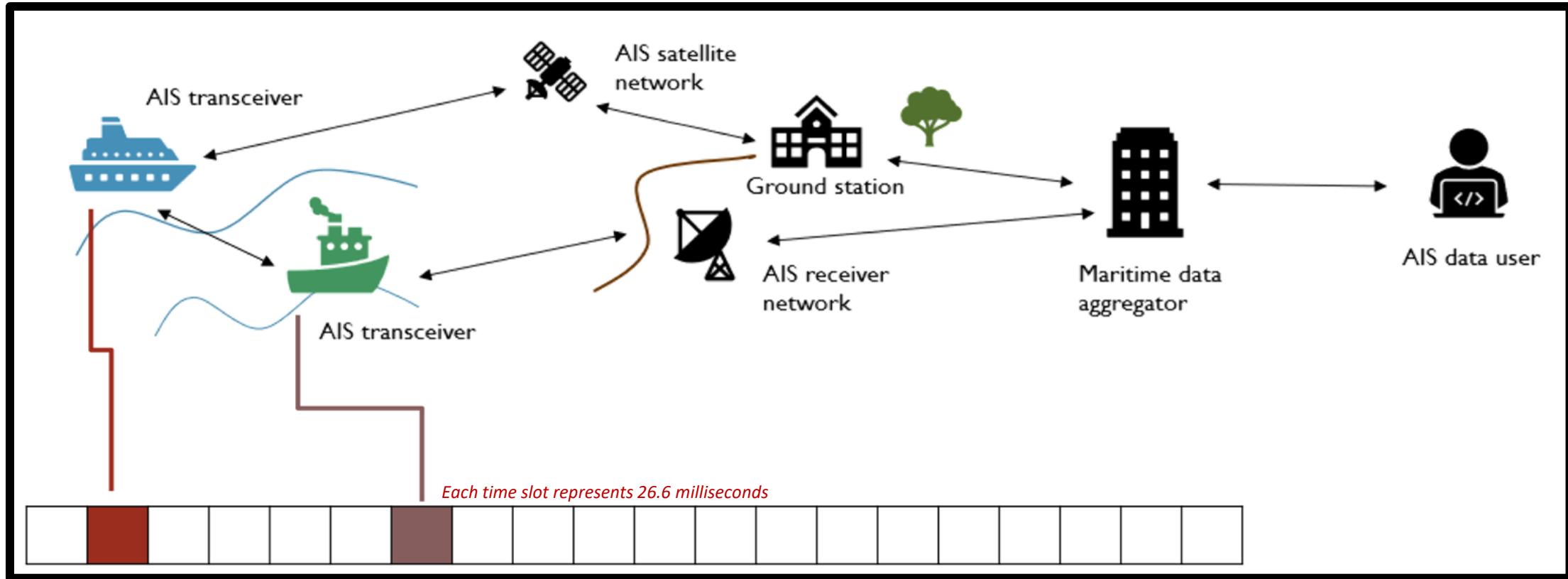


**Rule Matching**  
Misses complex identity manipulation

**Knights' AI Entity Resolution**  
Human-like identity linking



The Automatic Identification System is an automated, autonomous tracking system that is extensively used in the maritime world to exchange navigational information



Reference: [Lloyd's List Intelligence \(2017\). Understanding AIS.](#)

AIS information is used to serve various purposes and facilitates the work of people in various occupations, such as Port Authorities, Ship Owners, Managers, Agents and Brokers, Vessels' crews, Rescue teams, Hotels and Tour operators, Passengers or recreational sailors, Environmental Protection agents, and Researchers.



# Data Format of AIS Messages

While the AIS requirements in Resolution 74\* state that cyber security mechanisms should be implemented, it is important to note that since the AIS protocol is **publicly accessible**, authentication, encryption, and integrity protection is NOT used.

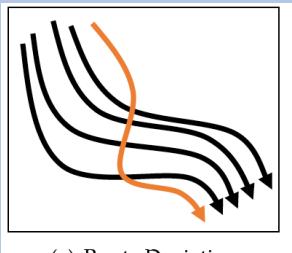
Type	Data	
Static	<ul style="list-style-type: none"><li>• MMSI number</li><li>• Call sign &amp; call name</li><li>• Length &amp; beam</li><li>• Ship type</li><li>• Antenna location (aft/bow; port/starboard)</li></ul>	 <i>Transmitted 6 minutes or on request</i>
Dynamic	<ul style="list-style-type: none"><li>• Ship position (PO), accuracy, and integrity</li><li>• Time in UTC</li><li>• Course over ground (COG)</li><li>• Speed over ground (SOG)</li><li>• Heading (HE)</li><li>• Rate of turn (ROT)</li><li>• Navigational status, e.g., at anchor (STA)</li></ul>	 <i>Automatically transmitted 2-5 seconds</i>
Voyage related	<ul style="list-style-type: none"><li>• Draught</li><li>• Hazardous cargo (type)</li><li>• Destination (DST), and estimated time of arrival</li></ul>	
Safety related	<ul style="list-style-type: none"><li>• Text messages</li></ul>	

Wolsing, K.; Roepert, L.; Bauer, J.; Wehrle, K. Anomaly Detection in Maritime AIS Tracks: A Review of Recent Approaches. *J. Mar. Sci. Eng.* 2022, 10, 112.

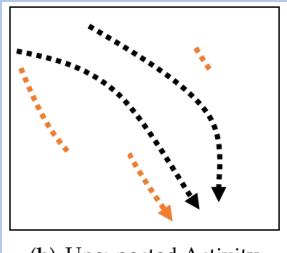
\*Zhen, R.; Jin, Y.; Hu, Q.; Shao, Z.; Nikitakos, N. Maritime Anomaly Detection within Coastal Waters Based on Vessel Trajectory Clustering and Naïve Bayes Classifier. *J. Navig.* 2017, 70, 648–670.



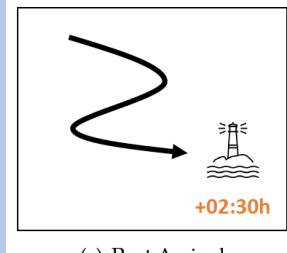
Anomalies in AIS monitoring are behaviours that are not expected to occur during regular operations



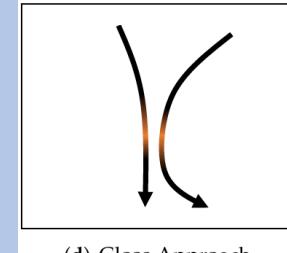
A ship takes a different route than normal



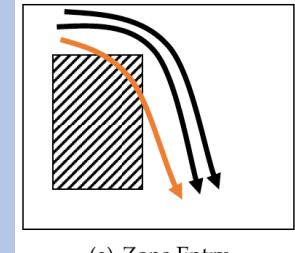
The coordinates of a ship are not in an expected sequence



A ship arrival is longer (or shorter) than expected



For a given amount of time, ships are close to each other



A ship enters an unexpected zone such as undep water or restricted waters

Wolsing, K.; Roepert, L.; Bauer, J.; Wehrle, K. Anomaly Detection in Maritime AIS Tracks: A Review of Recent Approaches. *J. Mar. Sci. Eng.* 2022, 10, 112. <https://doi.org/10.3390/jmse10010112>

With the amount of accessible AIS data, there is a growing need for the automatic detection of AIS data anomalies



# Can we use AIS data anomalies as a surveillance tool for criminal activities?



TERRORISM  
AT SEA



ILLEGITIMATE  
TRAFFICKING  
OF NUCLEAR  
MATERIAL



DRUG  
TRAFFICKING



FIREARMS  
TRAFFICKING



HUMAN TRAFFICKING /  
SMUGGLING OF  
MIGRANTS



PIRACY



FISHERIES CRIME

- AIS transceivers of Iranian-flagged tankers were tampered with to disguise the identity of the vessels in order to evade sanctions on oil exports
- Rendezvous of ships on the open ocean for the purpose of smuggling or drug trade
- On-off switching of AIS transceivers or route deviations used for pirate attacks

Baldazzi, M.; Pasta, A.; Wilhoit, K. A security evaluation of AIS automated identification system. In Proceedings of the 30th Annual Computer Security Applications Conference (ACSAC), New Orleans, LA, USA, 8–12 December 2014; pp. 436–445

Kowalska, K.; Peel, L. Maritime anomaly detection using Gaussian Process active learning. In Proceedings of the 2012 15th International Conference on Information Fusion, Singapore, 9–12 July 2012; pp. 1164–1171.

Singh, S.K.; Heymann, F. Machine Learning-Assisted Anomaly Detection in Maritime Navigation using AIS Data. In Proceedings of the IEEE/ION Position, Location and Navigation Symposium (PLANS), Portland, OR, USA, 20–23 April 2020; pp. 832–838.

Rong, H.; Teixeira, A.P.; Guedes Soares, C. Data mining approach to shipping route characterization and anomaly detection based on AIS data. Ocean Eng. 2020, 198, 106936.

AIS is a BIG  
data source  
with great  
potential at  
both national  
and  
international  
levels



Pick up the *Dynamic* breadcrumbs!

## Role Reversal: Too Much Data and not Enough Processing Capacity

A single file covering one day of maritime traffic around Denmark provided by the DMA is about 2GB in size and contains about 10 million location records. This means a month of data is about 60GB and **a year of data is about 700GB, covering over 3 billion data points.**

Such huge volumes of AIS data create challenges in data analysis.

Just copying this data takes time, let alone trying to visualize, and analyze the data.

AIS data is an opportunity for open-source intelligence, because AIS data is publicly available.



*Apache Spark is a lightning-fast unified analytics engine for big data and machine learning. The largest open source project in data processing.*

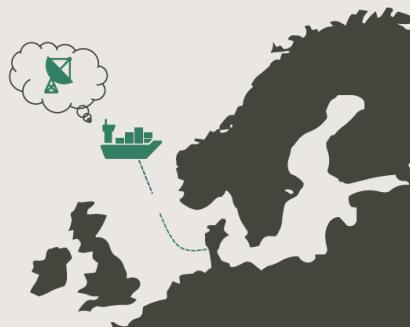
# Proof of Concept: One Day of AIS Surveillance in Danish Waters

## PROOF OF CONCEPT | OUTLIER MODEL: FLAG SHIPS (STEP 2)

### SITUATION 1: UNEXPECTED ACTIVITY

Unexpected activity is when the ship does not transmit its coordinates.

- ✖ A threshold based on typical activity.
- ✖ The maximum time between two consecutive signals



Data source: AIS data of Denmark of the 1<sup>st</sup> of January 2017

### SITUATION 1 FOUND IN THE DATA:



The outlier model detects all boats that have not transmitted a signal for a long time. One example is shown here.

- ✖ Thousands of coordinates are plotted, showing the ship route is missing intervals.

## PROOF OF CONCEPT | OUTLIER MODEL: FLAG SHIPS (STEP 2)

### SITUATION 2: CLOSE APPROACH

A close approach is when two vessels are closer than a certain distance for a given amount of time, when not in the harbour. Therefore, the following needs to be defined:

- ✖ Maximum distance
- ✖ Minimum duration of time
- ✖ Harbour coordinates to exclude



Data source: AIS data of Denmark of the 1<sup>st</sup> of January 2017

### SITUATION 2 FOUND IN THE DATA:

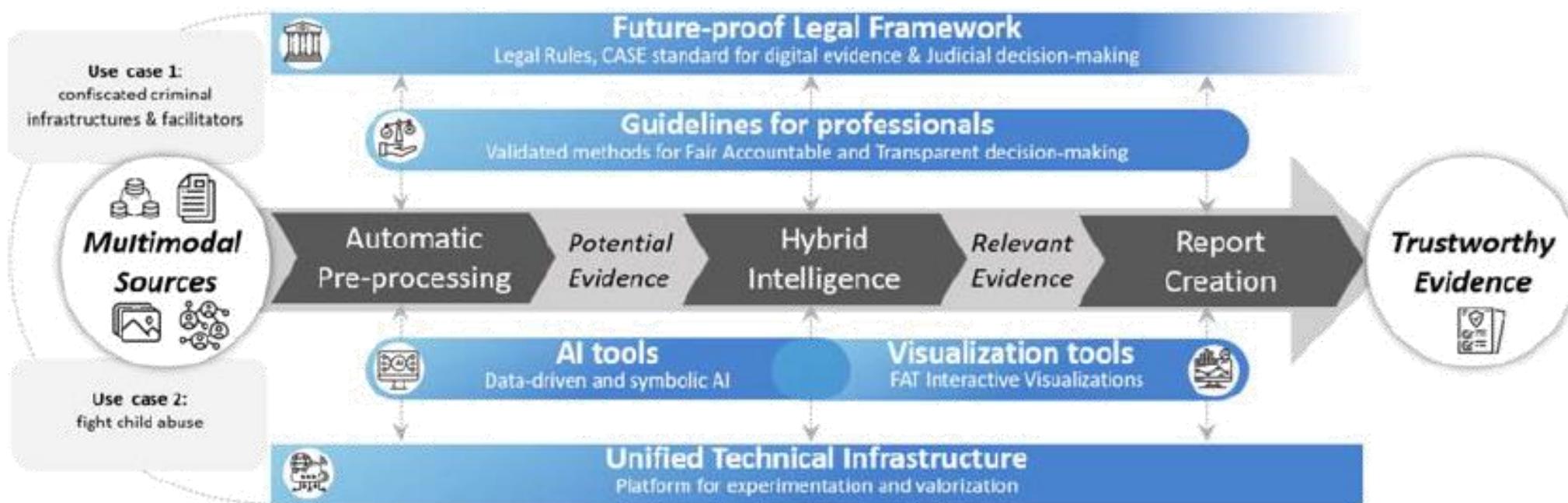


The outlier model detects all boats that have been within 500 meter of each other for more than 5 minutes (blue points):

- ✖ All coordinates near shore are left out

## AI4Intelligence: From Multimodal Data to Trustworthy Evidence in Court

The sheer mass and variety of data from multiple sources has created a key challenge to police and prosecution to gain criminal convictions. Investigative teams face a labour-intensive manual task to sift through millions of data points to obtain effective court evidence. AI4Intelligence addresses the conversion of gathered multimodal data into trustworthy evidence ready for court.



AI4Intelligence will explore compliance issues for digital evidence and merge technical aspects with legal procedural requirements. Deliverables will consist of AI and visualization software, guidelines for intelligence professionals, a legal framework including its representation in the CASE standard for digital evidence and a unified technical infrastructure.

# Solving Crime in No Time: The Strength of Digital Forensics



In the digital world, birds don't eat breadcrumbs... Data Scientists do!



**Rosoka**

KNIGHTS ANALYTICS  
Strength in Simplicity



AMSTERDAM  
DATA  
COLLECTIVE



©Sustainable Rescue Foundation



Pinsent Masons



UNIVERSITY  
OF AMSTERDAM

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Photo by [Joshua Sortino](#) on [Unsplash](#)