AI for fighting Environmental crime

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The project has been selected for funding by the EC within the Horizon Europe programme, under the topic HORIZON-CL3-2021-FCT-01-09 - Fight against organised environmental crime

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Outline

1. EMERITUS Project
2. Use Case 1:
   Artificial Intelligence in Soil Protection
   - Detecting Landfills
   - Detecting Illegal Constructions
     - Land Change Detection

1. Use Case 2:
   Network Science Anomaly Detection in Waste Transportation
   - Detecting Anomalies
   - Fraudulent Patterns

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20 PARTNERS

8 COUNTRIES
Austria
Belgium
Greece
Italy
Moldova
Portugal
Spain
United Kingdom

LEAs & BORDER GUARDS

Carabinieri (IT)	Moldavian Police (MD)
City of Turin - Local police (IT)	Moldavian Env. Inspect (MD)
Romanian Env.al Guard (RO)	Hellenic BG (GR)
Romanian BG (RO)	Ayuntamento de Malaga (ES)

TECHNOLOGY PROVIDERS

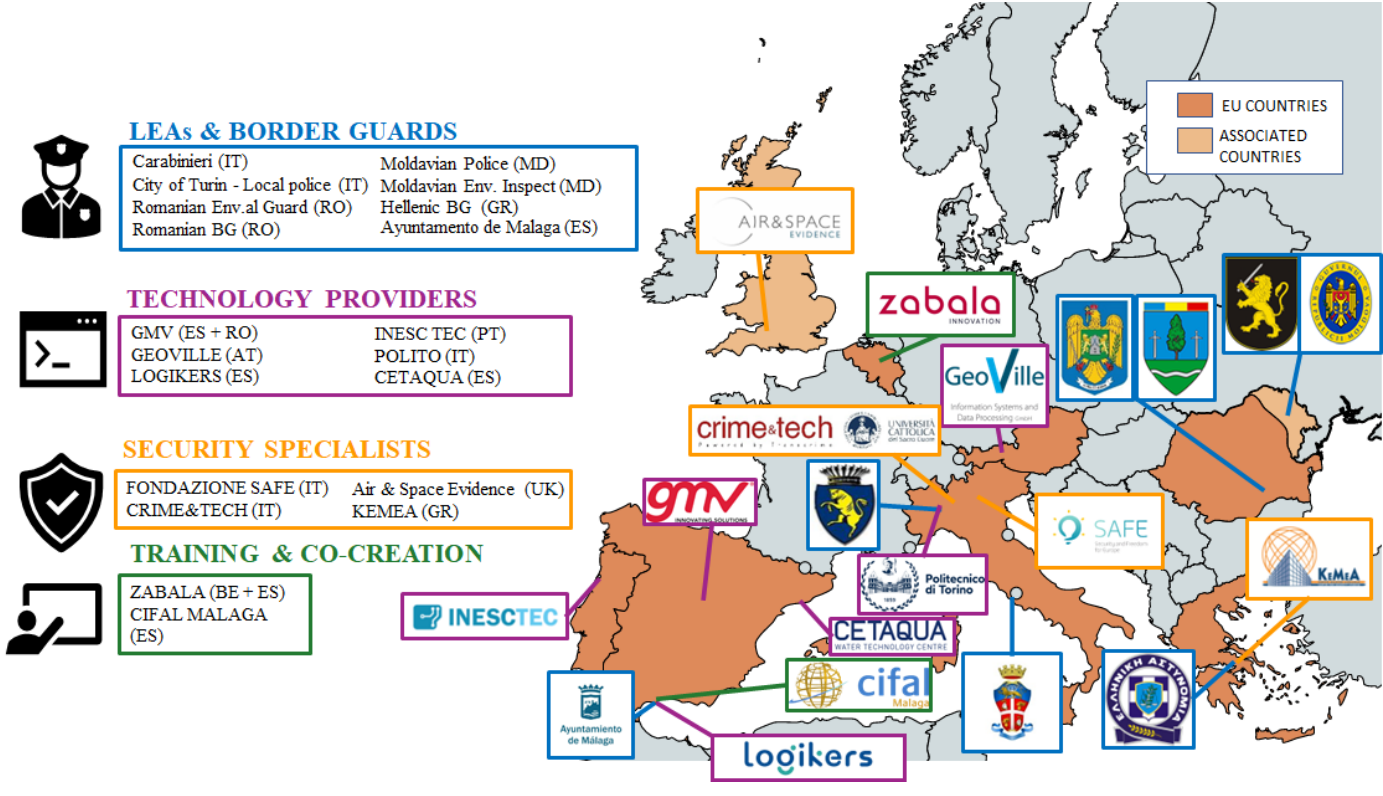
GMV (ES + RO)	INESC TEC (PT)
GEOVILLE (AT)	POLITO (IT)
LOGIKERS (ES)	CETAQUA (ES)

SECURITY SPECIALISTS

FONDAZIONE SAFE (IT)	Air & Space Evidence (UK)
CRIME&TECH (IT)	KEMEA (GR)

TRAINING & CO-CREATION

ZABALA (BE + ES)
CIFAL MALAGA (ES)



OBJECTIVES

- *Laying the foundations for a new generation of* ***technological tools at support of Law Enforcement Agencies and Border Guards investigation of environmental crimes integrating satellites, drones, AI and others***
- *To realize and implement a* ***protocol*** *for effective environmental crime investigation, leveraging on the integration of innovative monitoring and analysis* ***technologies****, and on a complementary* ***training programme***

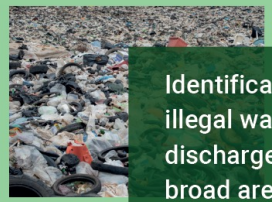
Use cases

Four relevant **use cases** have been identified to ensure that the project results can translate into technologies and operative support fitting in real-world scenarios and needs, as well as to test the EMERITUS results with actual data and operators.

Water contaminant source detection

Waste storage centres monitoring

Cross-border illegal waste trafficking monitoring



Identification of illegal waste discharge sites in broad areas

UC2 - Industrial Storage Centres Monitoring

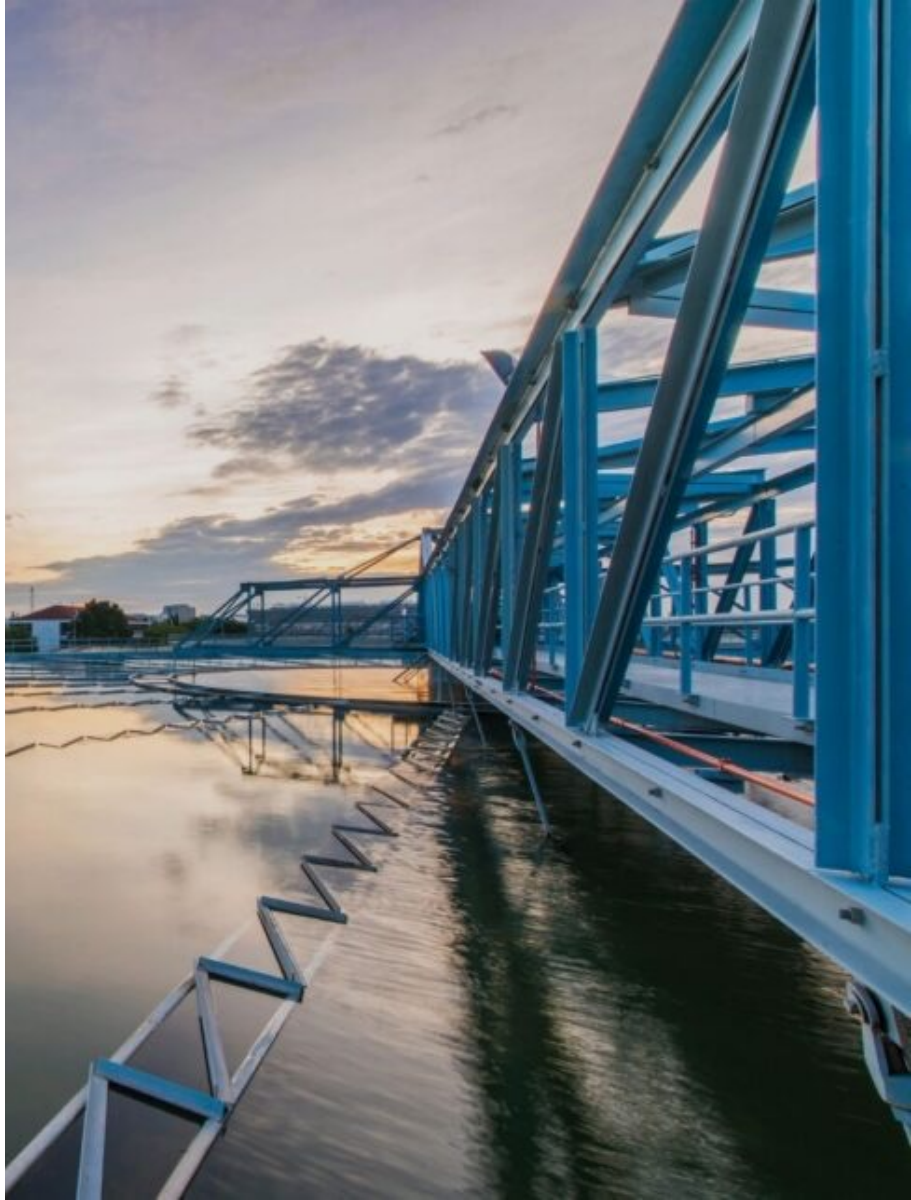
Waste storage centres monitoring, including hazardous materials (i.e., radiological and chemical)

Location: industrial site on river in Piedmont, Italy

Technology sources: drones, satellites, sensors, AI, blockchain

Context: land, air, water

Involved partners: LOCAL POLICE OF TURIN, CARABINIERI, gmv INNOVATING SOLUTIONS, logikers, Politecnico di Torino



UC3 - Cross-border illegal trafficking via land

Cross-border illegal waste trafficking, illegal waste storage and dumping detection

Location: cross border monitoring across Romania and Moldova

Technology sources: satellites, drones, AI/ML

Context: land, air

Involved partners:

Romanian Border Police

GARDA NAȚIONALĂ DE MEDIU

Romanian National Environmental Guard

Moldovian Police

Moldovian Inspectorate for Environmental Protection

GMV INNOVATING SOLUTIONS

GMV Romania

UC4 - Identification of illegal waste sites and link with trafficking

Identification of illegal waste sites + thermal sites (fires), and intelligence tool to identify/monitor exports

Location: Greece

Technology sources: satellites, AI

Context: land, exports

Involved partners:

Hellenic police

Artificial Intelligence in Soil Protection

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Model for Waste Classification and Detection: approach

DATA SOURCE

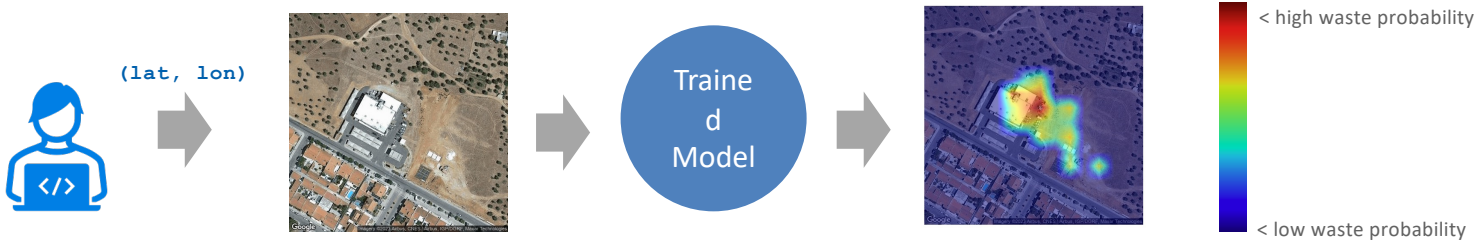
Public dataset:
-> Aerial Waste dataset.

Data Collected:
-> Partnership with Portuguese territory observation entity.

Very High-Resolution Images

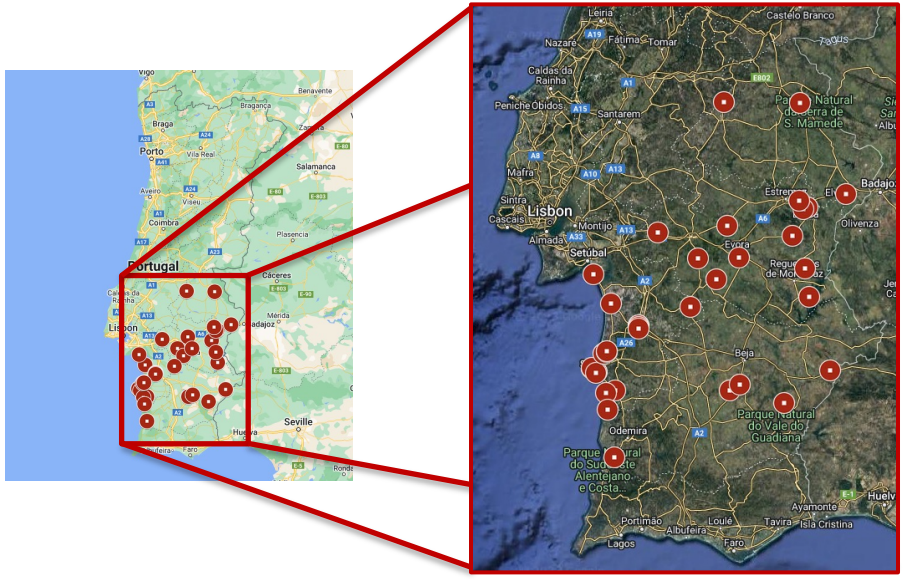
Model Training

Model for Waste Classification and Detection: approach



1. Location input
2. Download input image
3. Model query
4. Classification + Explainability

Waste Detection: *Case study*



Locations of interest

Same location with different zoom

prefix - image identifier - source - details level

PT_id01_google_zoom18.png

zoom: 16

zoom: 18

zoom: 19

Locations of interest

Query sample: classification and location.

We are querying images of zoom 18.

Why?
Similar than training resolution!

zoom: 18

Locations of interest

Query sample: classification and location.

We are querying images of zoom 18.

Why?
Similar than training resolution!

✅ Waste detected!

Locations of interest

Query sample: classification and location.

We are querying images of zoom 18.

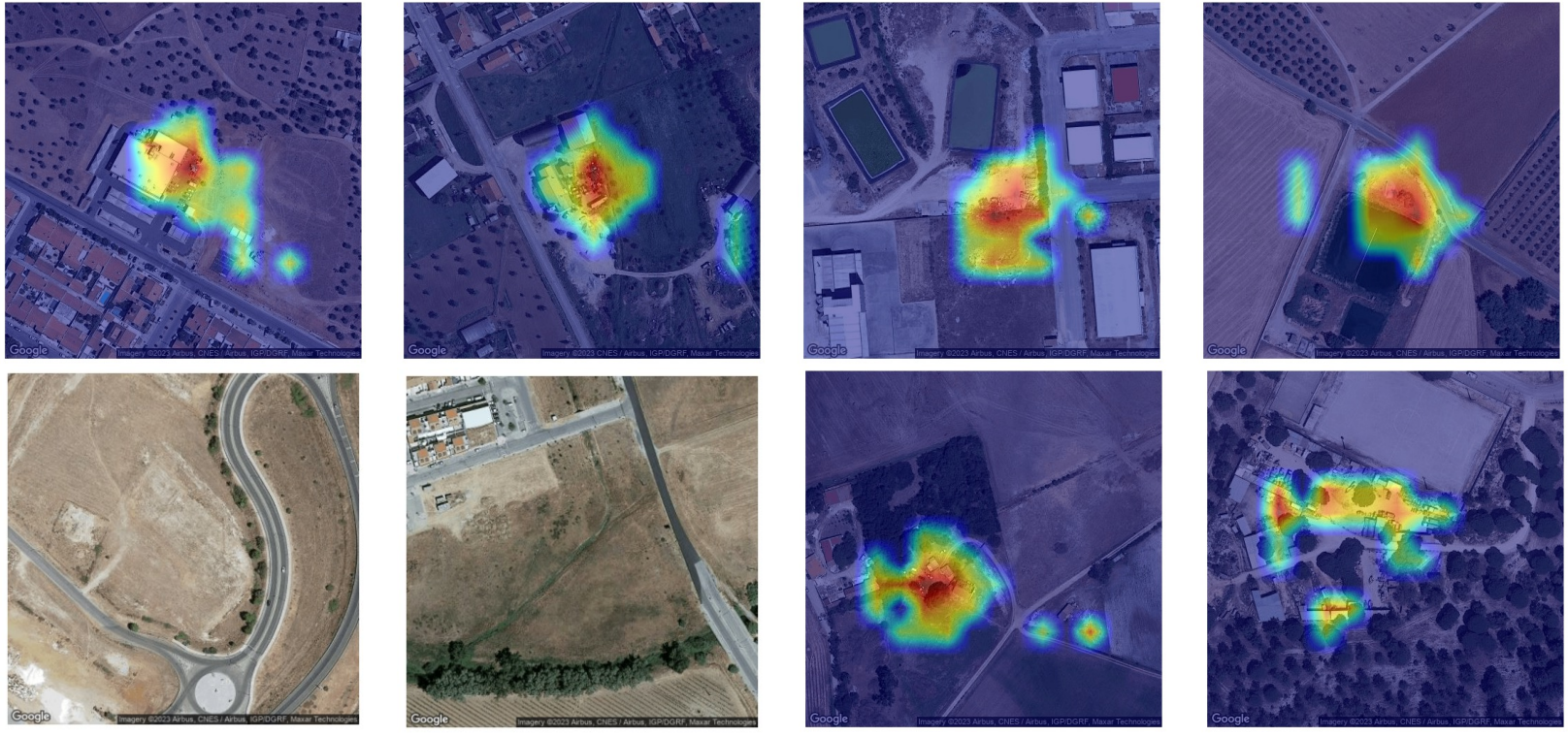
Why?
Similar than training resolution!

✅ Waste detected!

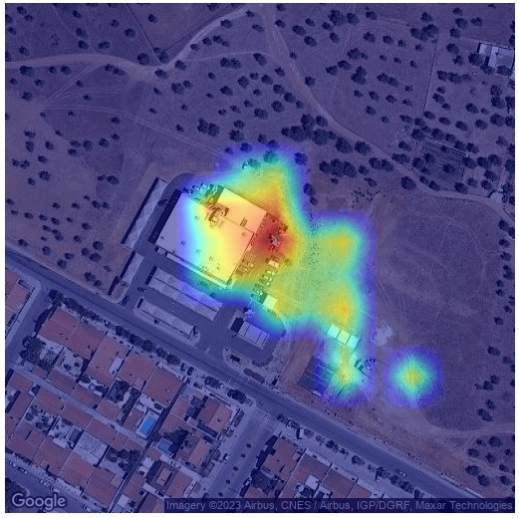
Highlighted pixels reveal the most contributory information:

Waste location!

Waste Detection: *Case study*



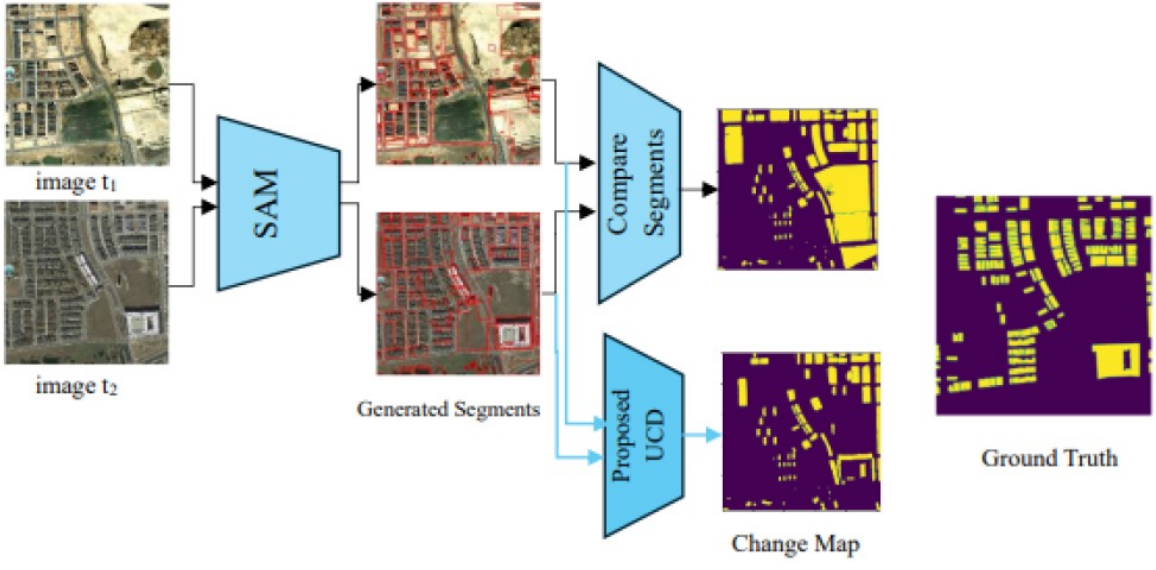
Waste Detection: *Case Study*



2023: positive detection

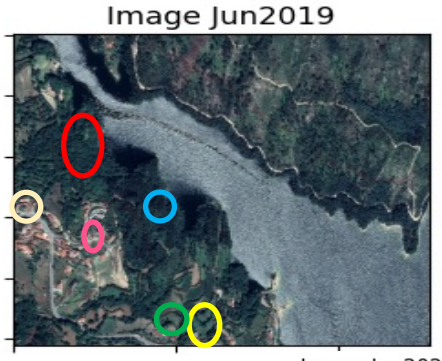
2024: negative detection

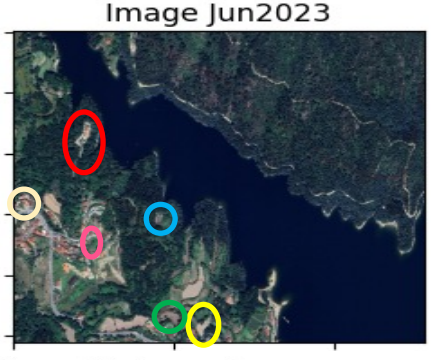
Illegal Constructions
Model for Land Change Detection: approach

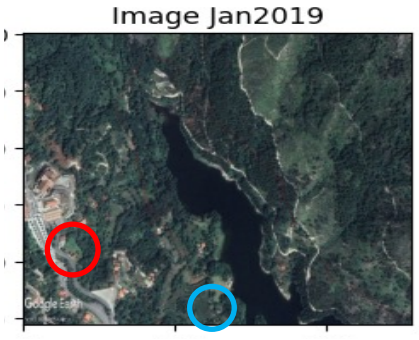


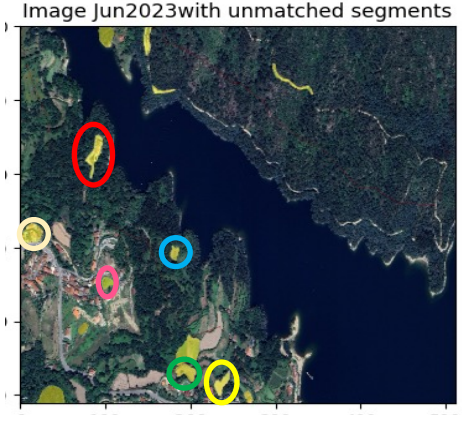
Model for Land Change Detection: case study II

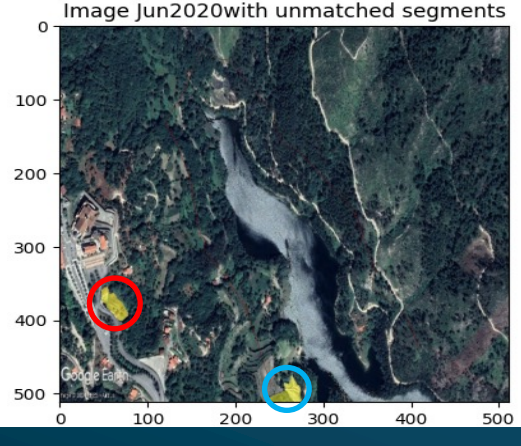
Model for Land Change Detection: case study II











Network Science
Anomaly Detection in Waste Transportation

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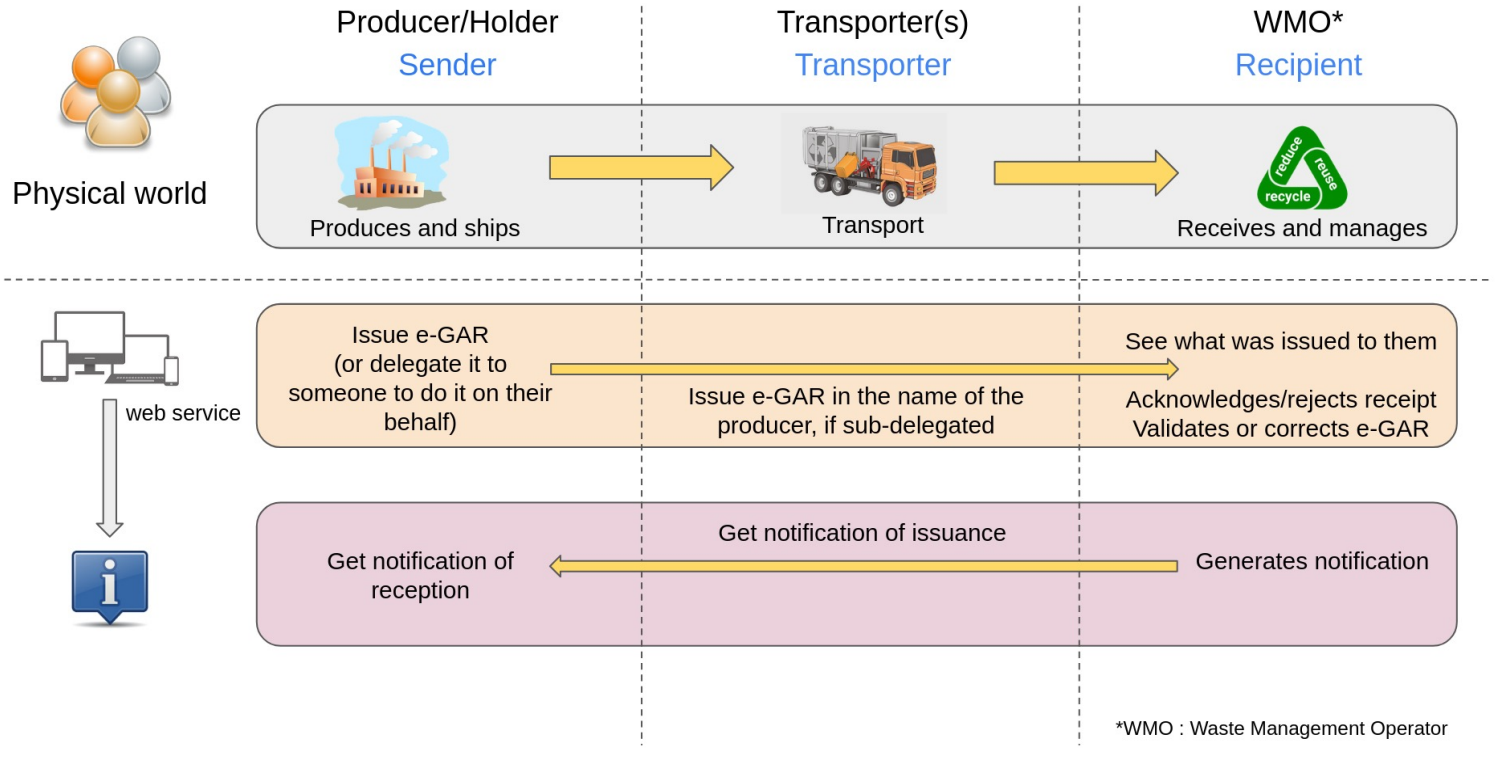
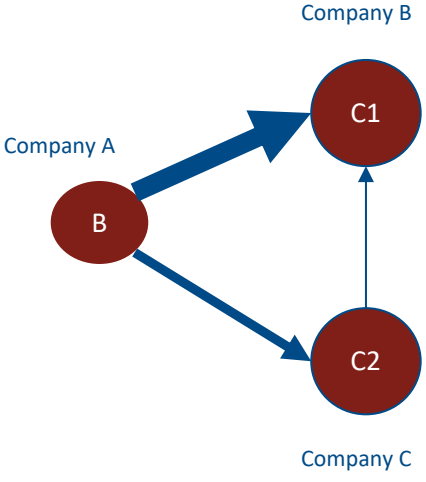
Problem Definition



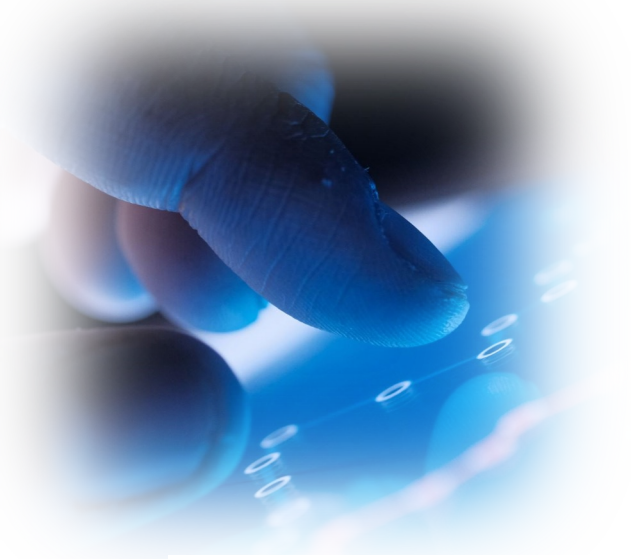
Problem Definition

Data	Source	Destination	Product	Unities
15/06/2025	Company 12	Company 13	asdc	15
15/06/2025	Company 1	Company 4	dsads	23
15/06/2025	Company 6	Company 6	daskjklj	27
15/06/2025	Company 10	Company 9	wewew	77
15/06/2025	Company 3	Company 12	vxcijve	65
15/06/2025	Company 12	Company 14	weew	57
15/06/2025	Company 8	Company 13	erte	95
15/06/2025	Company 10	Company 11	jkjlkj	18
15/06/2025	Company 4	Company 10	kkjklmlkm	36
15/06/2025	Company 7	Company 9	mnkn	31
15/06/2025	Company 11	Company 5	werewr	96
15/06/2025	Company 4	Company 13	werewr	15



Find instances of illegal transport/disposal of waste by

- Tracking the movement of waste/materials through the entries in Waste Registration logs. (MIRRs)
- Monitoring the appearance and disappearance of waste to detect omissions by identifying discrepancies in data
- Identifying false or suspicious data, as well as imbalances and inconsistencies in the records
- Analyse trends to understand the activities of key players and anticipate potential problems.

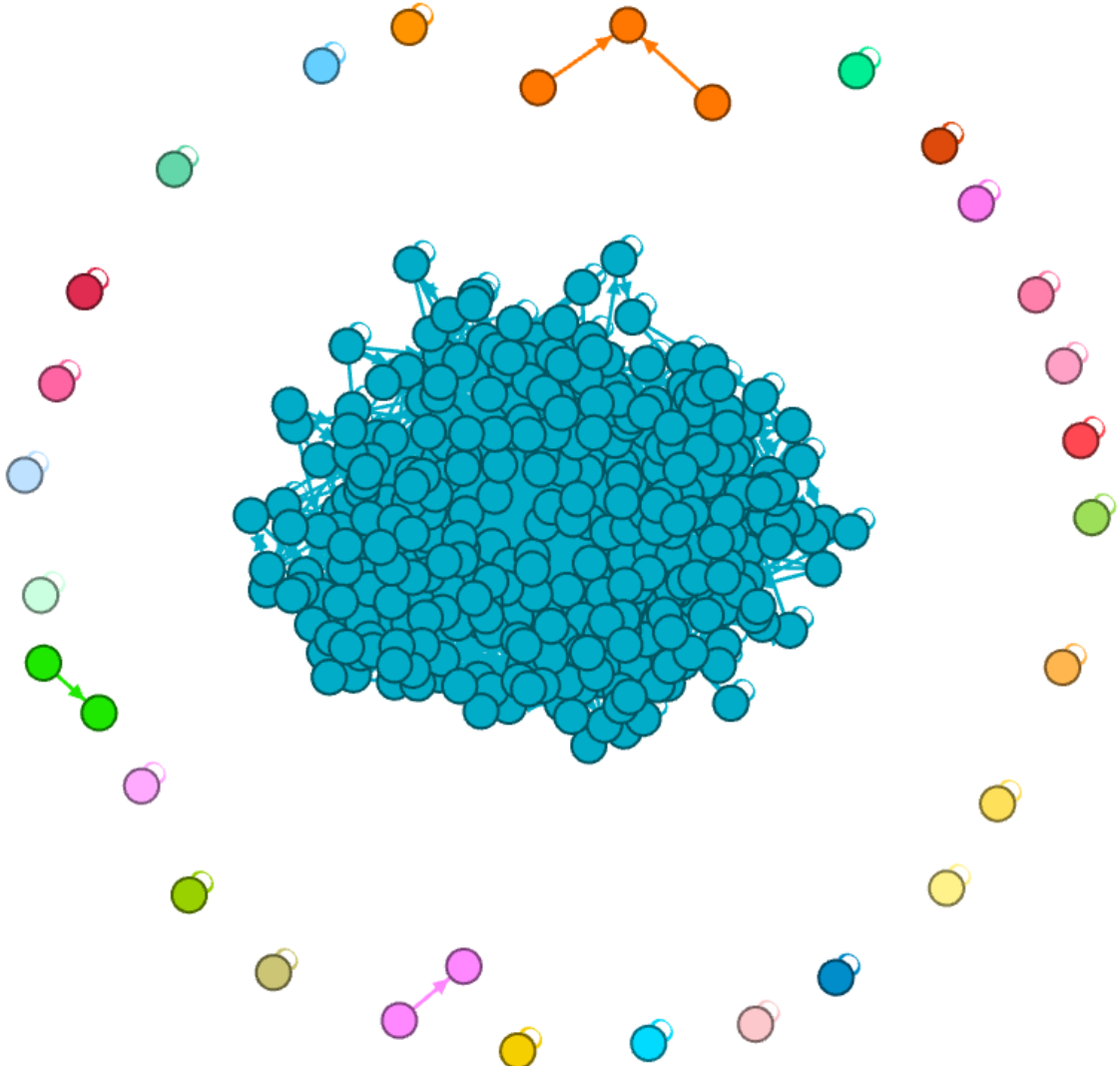


Detecting Anomalies

- Anomaly detection is the process of identifying unusual patterns or observations in data that do not conform to expected behavior.

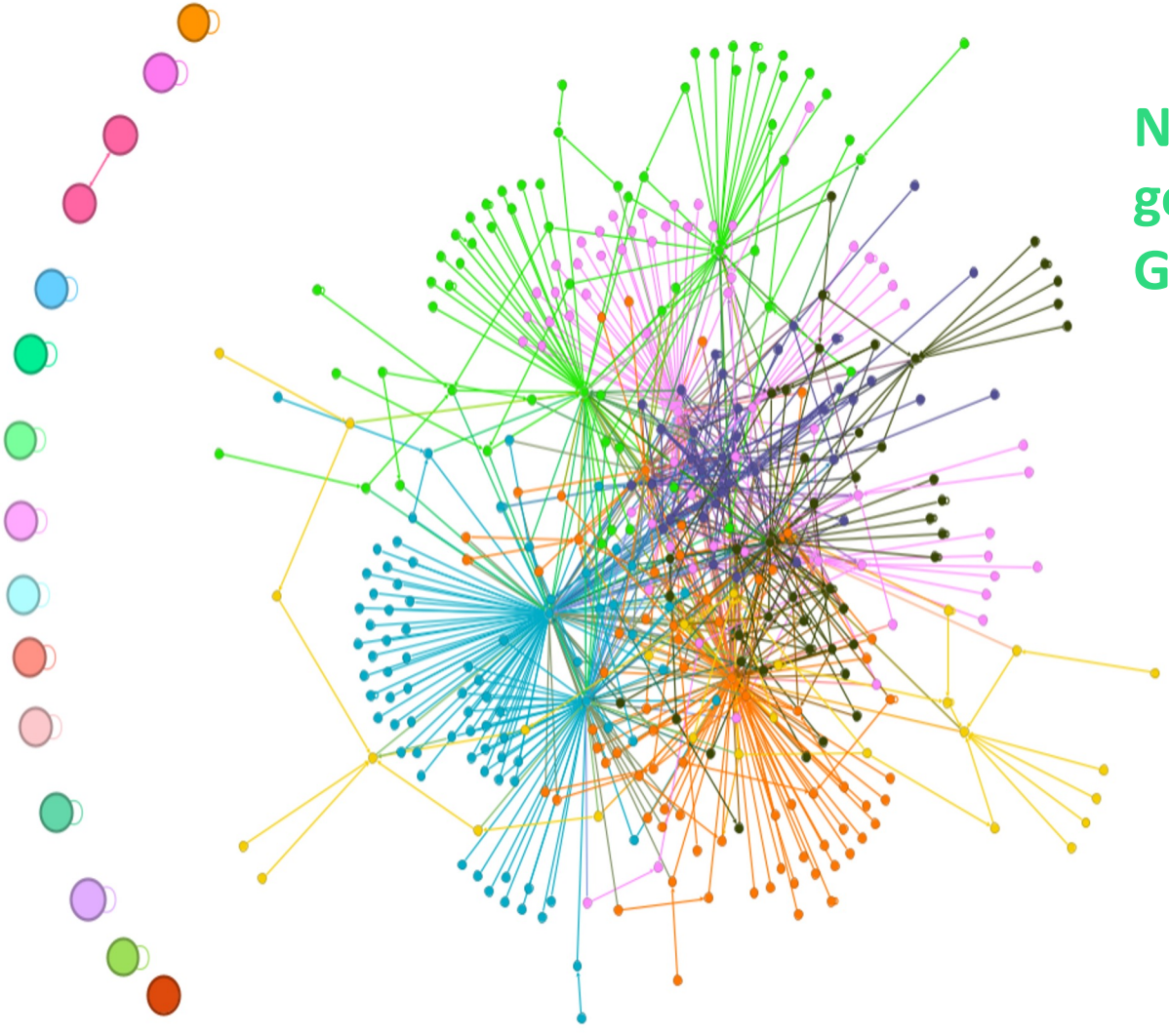
- In this case to detect discrepancies, inconsistencies, imbalances and illegal transports.

- Isolated Subgraphs
- Community Detection
- Isolation Forest (iForest)
- Local Outlier Factor (LOF)
- K-means
- Autoencoder



Isolated nodes in e-GAR network

- Not connected to the network
- 90% of them not found in MIRR
- Sending transports to self

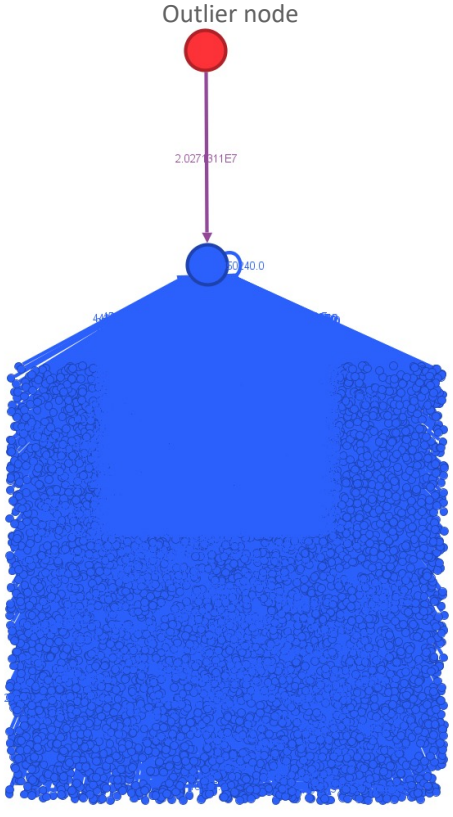


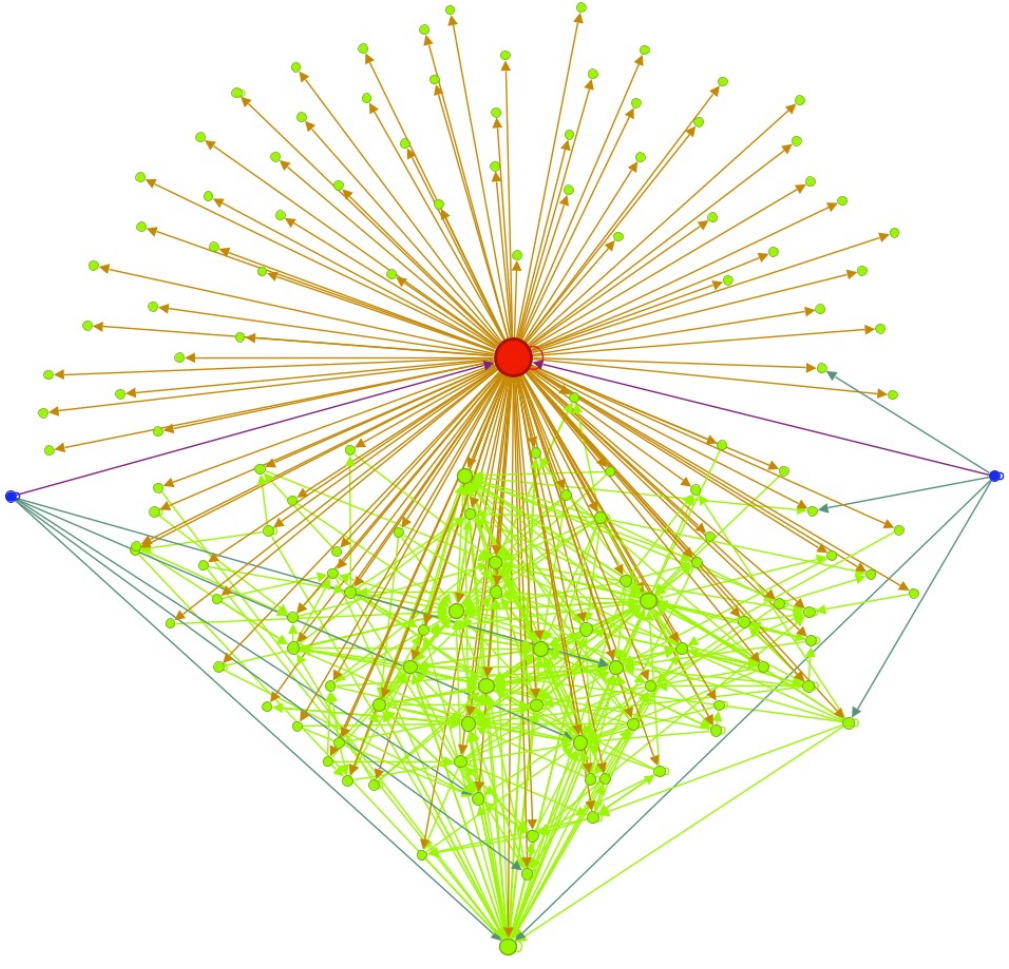
Nodes with dangerous goods transport only (e-GAR)

- Isolated nodes found
- Highly connected communities
- Peripheral nodes of independent entities bringing in the waste

Highest ranking outlier node

- Independent producer with only one transport more than 20M kilos of waste.
- Unregistered user not found in form B.
- Corresponding MIRR declared with quantity 99.9% less.
- Highest incoming transport of the adjacent node among thousands of transports.

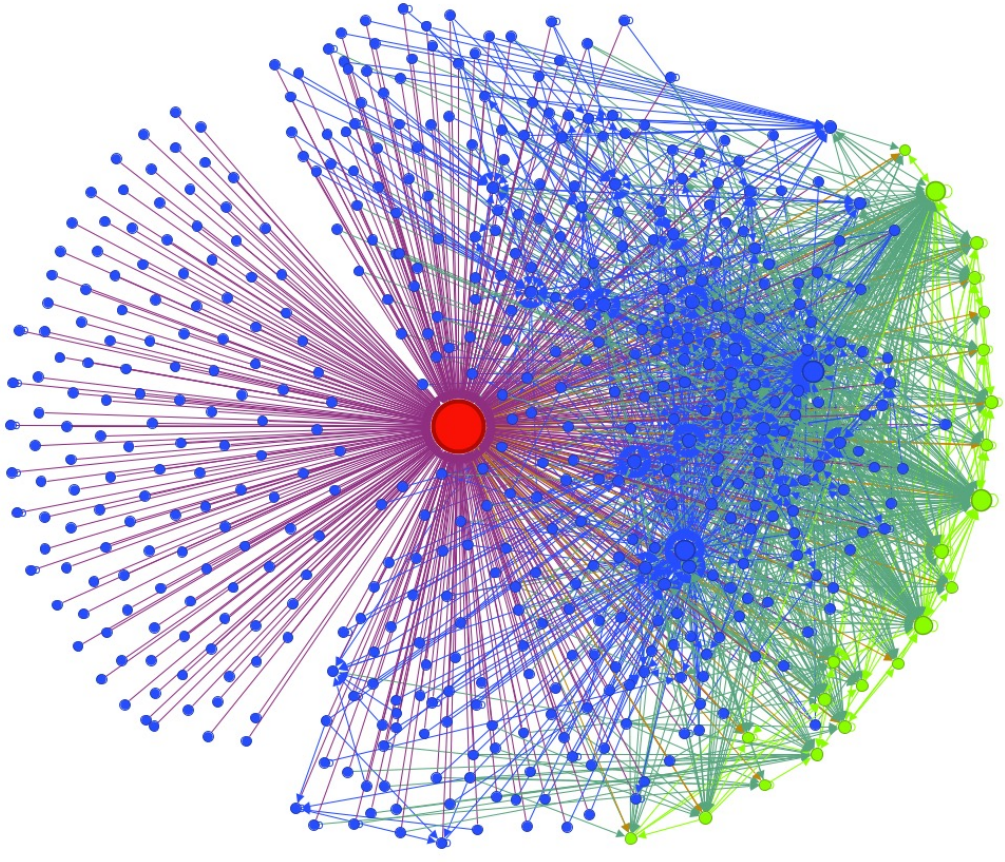




Top outlier node

- Very low incoming to outgoing quantity ratio (weighted imbalance ratio < -0,8)
- Sending to large number of independent entities
- 90% dissimilarity between MIRR and eGAR

*Blue nodes incoming and green nodes outgoing waste transports



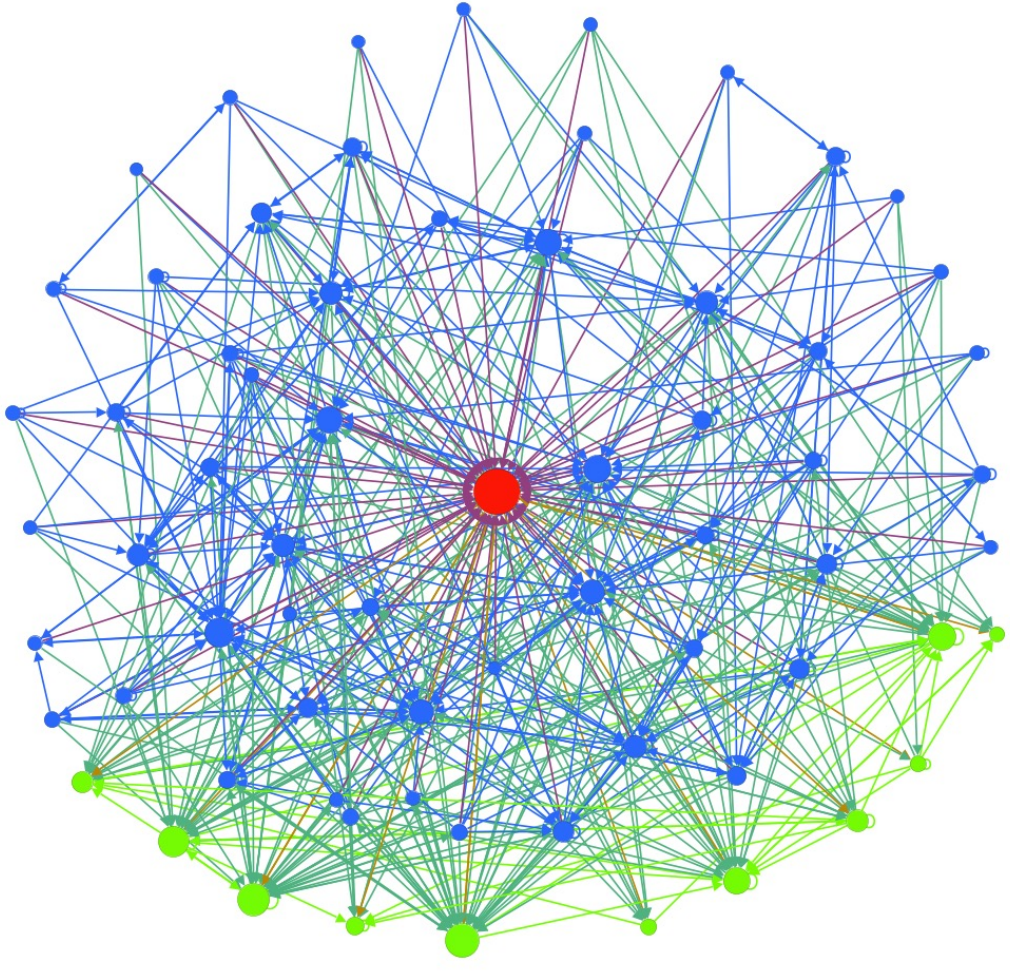
Sink node

- Behavior contrasting to previous node
- 96% of received weight is for disposal
- Outgoing weight registered in MIRR is 30% less than eGAR

*Blue nodes incoming and green nodes outgoing waste transports

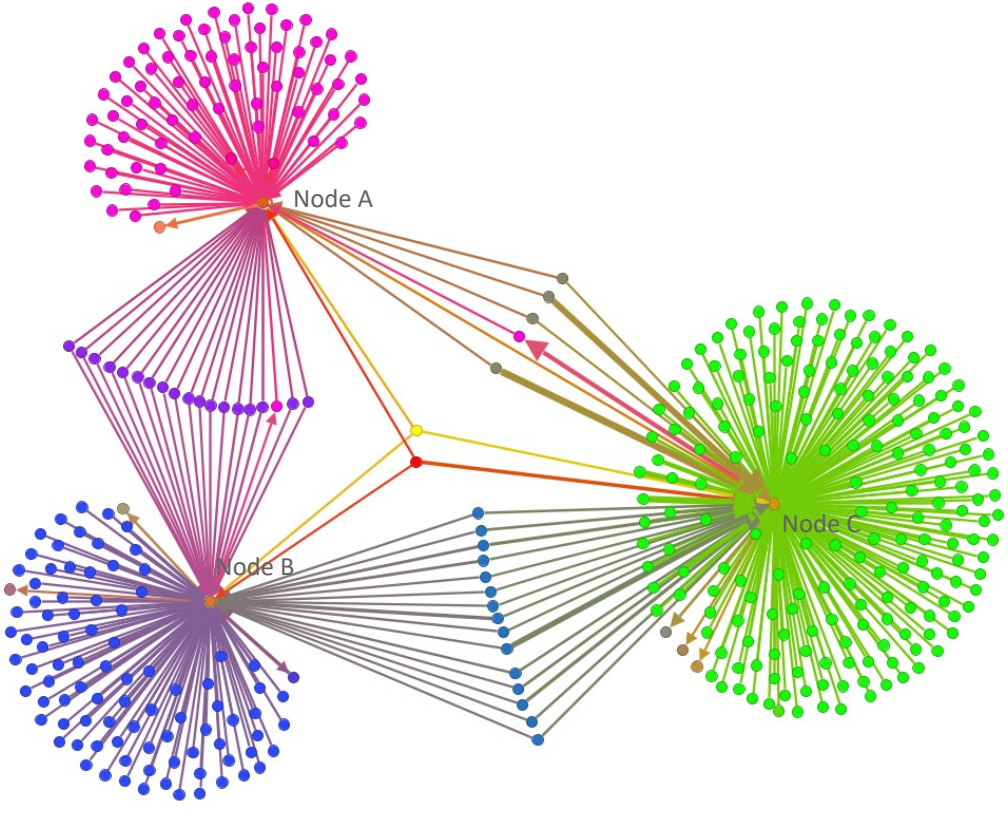
Outlier

Network quite balanced with transports to well connected nodes but a large difference of 50% between MIRR and eGAR entries incoming quantities.



*Blue nodes incoming and green nodes outgoing waste transports

Fraudulent Patterns



THANK YOU

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