CREATING ALGORITHMS FOR USER-INDEPENDENT MANIFEST VERIFICATION IN CONTAINER NON-INTRUSIVE INSPECTION (NII)

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SO WHAT? WHO CARES?

Goal: Automatically verify Manifest and Container Cargo Loads at a high volume and velocity without impacting inspection quality

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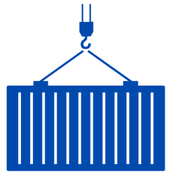
Issue: Object detection algorithms perform " analysis in a vacuum", relying primarily on NII Images without taking into account the full context of the shipment, limiting their ability to perform accurate Manifest Verification.

Sub-Issue: Training sets based on real tagged images are scarce, oftentimes leading to algorithmic bias and false positives

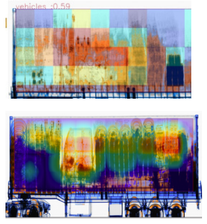


SPACE: Artificial Intelligence for Non-Intrusive Inspection (AI-NII)

TRL 4: Technology validated in lab

PROBLEM: DATA AVAILABILITY

Cargo X-Ray Scan "analysis in a vacuum" and lack of high-quality training sets



SOLUTION :PATTERN BASED MODEL

Use historical Manifest & NII Data to uncover patterns, which serve as a high-quality training set, calibrated by and to local trade cadences

RESULTS : TRAINED EFFECTIVE ALGORITHM

Comprehensive localized training set
7.5s Total analysis time
650% NII Performance Increase

200,000 IMAGES, 167,374 PARAMETERS, 263 HS CODES

CHALLENGE 1

BUILDING A PATTERN BASED DATA MODEL

RELATIONSHIP BASED GRAPH

TARGETING RULES METHOD

UFF 1.0/2.0 COMPLIANT

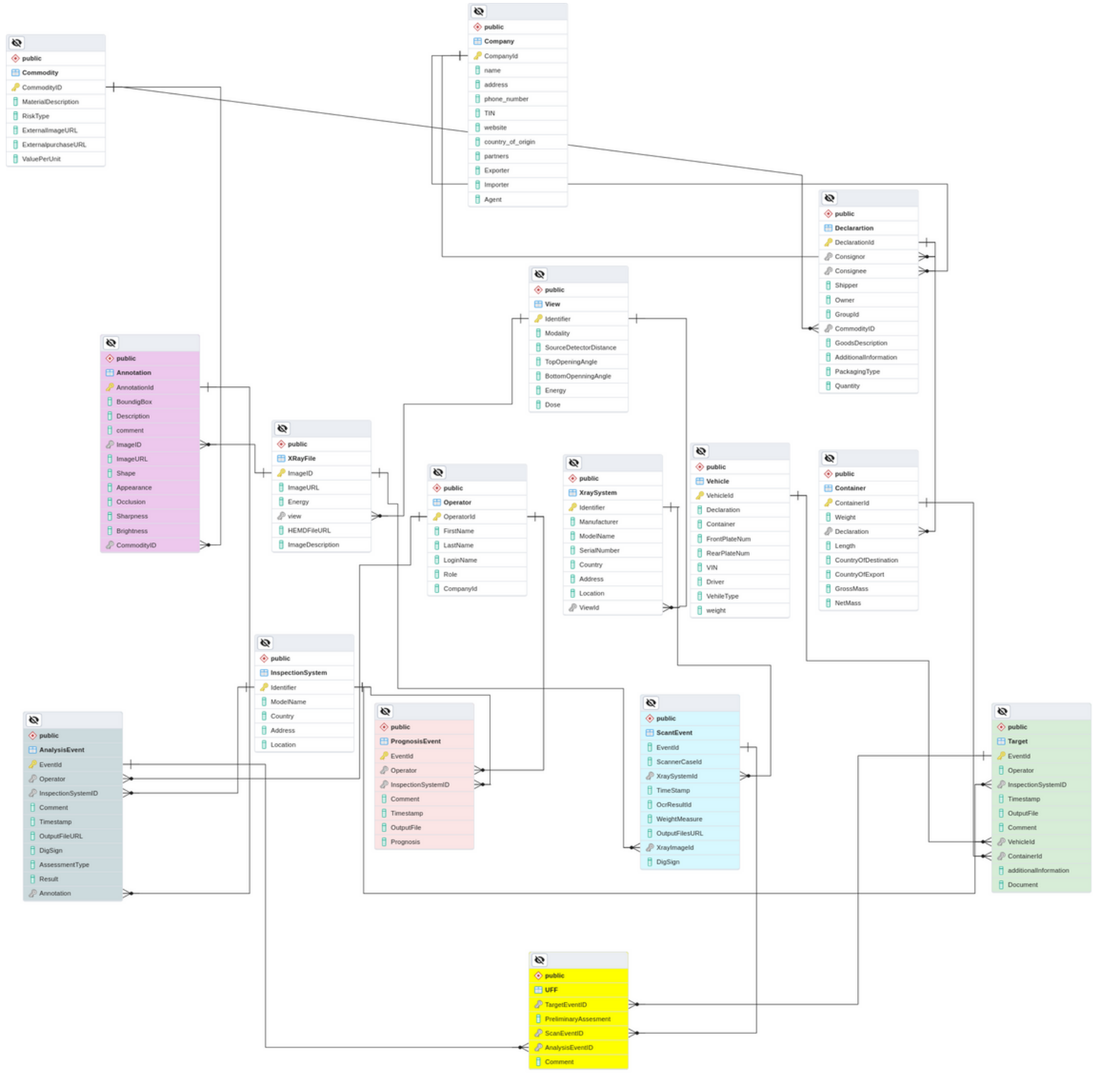
MULTI-IMAGE FORMAT

SUPPORT FOR WCO DATA MODEL

AUTOMATIC EXTERNAL ENRICHMENT VIA CONNECTED DATA SOURCES (I.E. FUTURE MARKETPLACE PHOTOS OF GOODS)

SCALABLE FOR ADDITIONAL SENSORS

AUTOMATIC/MANUAL INPUT

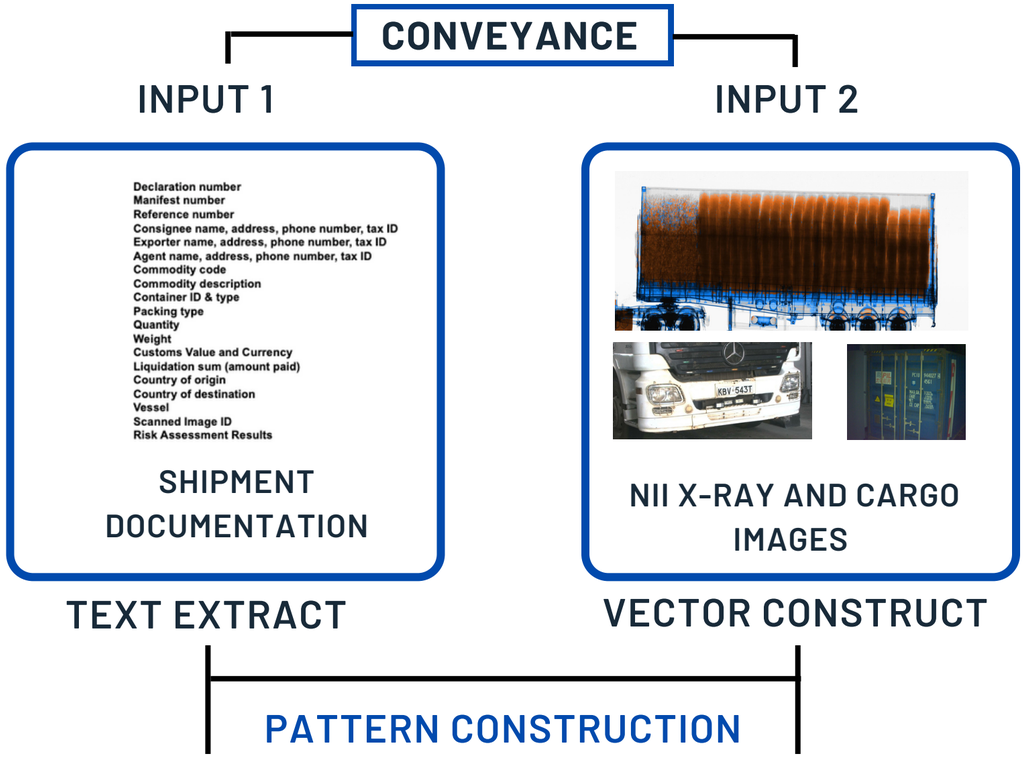


CHALLENGE 2

BUILDING A PATTERN BASED TRAINING SET

90% of a Nations trade has the same cadence, which is fully documented in Customs Inspections.

The pattern based approach extracts data from Manifest, Declarations and NII Scans and merges it to derive patterns. These patterns serve as a holistic, self-sustaining training set for Manifest Verification algorithms.



UNIFIED PATTERNS EXAMPLES

IMPORTER X = EXPORTER T= GOODS Y + GOODS U = **IMAGE Z**

IMPORTER X = EXPORTER T= TRAILER Y + GOODS U = **IMAGE Z**

IMPORTER X = EXPORTER T= BROKER I + GOODS U = **IMAGE Z**

IMPORTER X = EXPORTER T= ORIGIN1 + GOODS U = **IMAGE Z**

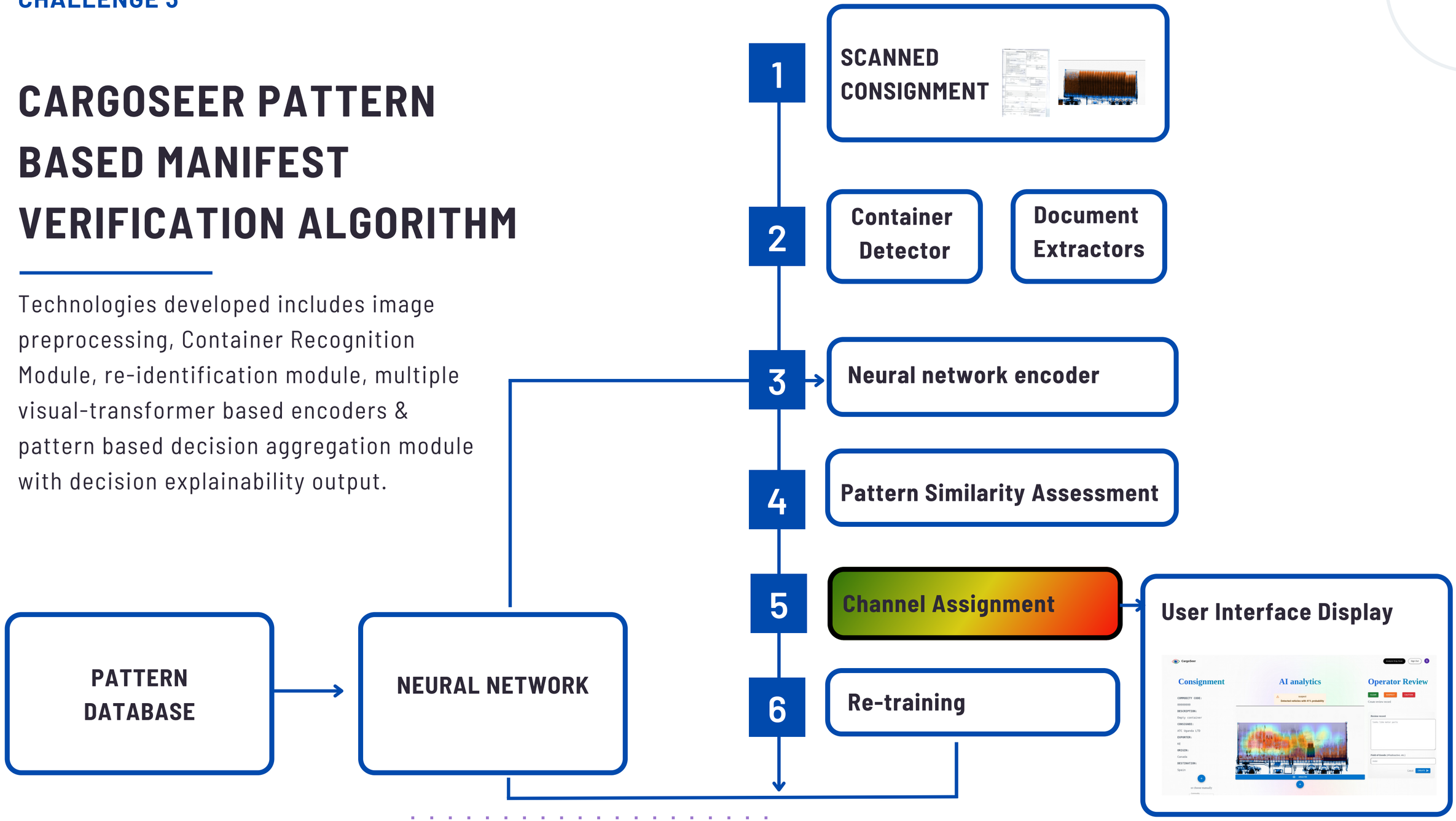
IMPORTER X = BROKERI= VESSEL2 + GOODS U = **IMAGE Z**

AVERAGE OF 10,000 PATTERNS PER CONVEYANCE

CHALLENGE 3

CARGOSEER PATTERN BASED MANIFEST VERIFICATION ALGORITHM

Technologies developed includes image preprocessing, Container Recognition Module, re-identification module, multiple visual-transformer based encoders & pattern based decision aggregation module with decision explainability output.



PROOF OF TECHNOLOGY ON CUSTOMER DATASET

1. All conveyance and inspection data was received from customer
2. Pattern Database created from declaration, manifest, and scans
3. Data wealth includes: **200,000** images, **263** Unique HS Codes, **167,374** parameters (i.e. importer/broker/weight/pkg), **9,453** Trailers
4. Conveyances were filtered according to **"operator flagged"** and **"operator cleared"**
5. Conveyances were divided into 60% training (including "operator flagged"), 20% validation, and 20% test
6. Analysis was calibrated @ 1:0- **no tolerance** for false positives
7. Following training, validation, and test, **all** conveyances were manually verified using a specially developed and enriched operator interface (1s)

Human Operators identified 2% as Fraudulent Conveyances with an avg. analysis time of 5 minutes*

Pattern Based Algorithm identified 15% as Fraudulent Conveyances @ 0% False Positives with an avg. analysis time of 7.5 seconds

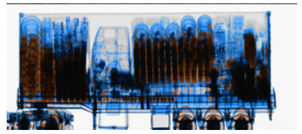
*Time as reported by the Customer

AI FLAGGED SHIPMENTS

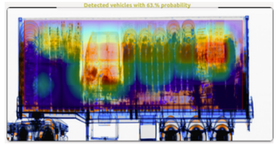
650% ACCURACY PERFORMANCE INCREASE

2% FRAUD DETECTION------> 15%FRAUD DETECTION

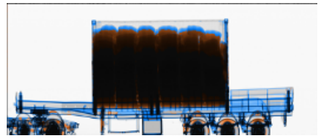
DECLARED AS CAR PARTS



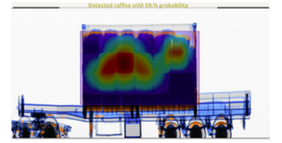
VEHICLE IDENTIFIED



DECLARED AS BLACK TEA

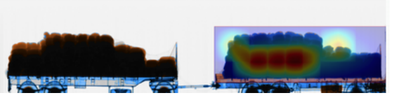


IDENTIFIED AS COFFEE

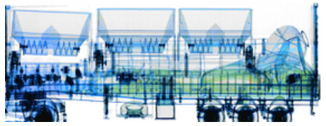


DECLARED AS 25 TONS

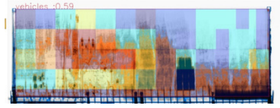
IDENTIFIED AS 50 TONS



DECLARED AS FIRE BRICKS



IDENTIFIED AS MACHINES



THANK YOU

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