

OUTLAW: Using Geo-Spatial Associations for Outlier Detection and Visual Analysis of Cargo Routes

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Outline

- ◆ U.S. customs
 - Current Status
 - Goal
- ◆ Example Scenarios and Traditional Data Mining techniques
 - Anomaly Detection with Various Cargo Attributes
 - Discovering Rare Patterns from Correlation of Materials Being Shipped
 - Transshipment
- ◆ OUTLAW architecture
- ◆ Combination of alerts

Current Status

- ◆ Currently U.S. Customs inspects the inbound cargo by a level of profiling (eg: new consignee, country of origin etc.).
- ◆ Audits of certain importers or companies .
- ◆ Data Gathered by different agencies independently.

Goal

- ◆ To Supplement the profiling, by making it targeted towards anomalies.
- ◆ To utilize data available from different agencies.
- ◆ To identify the anomaly before it enters the country.
- ◆ To detect anomalies and raise a combination of alerts

Anomaly Detection with Various Cargo Attributes

Scenario 1: Import of Parts of trucks for a company called Meltro Corp. from Canada



Canada

300km

• March 2001, “Meltro Corp” imports a shipment of truck parts from Toronto going to Denver, Colorado.



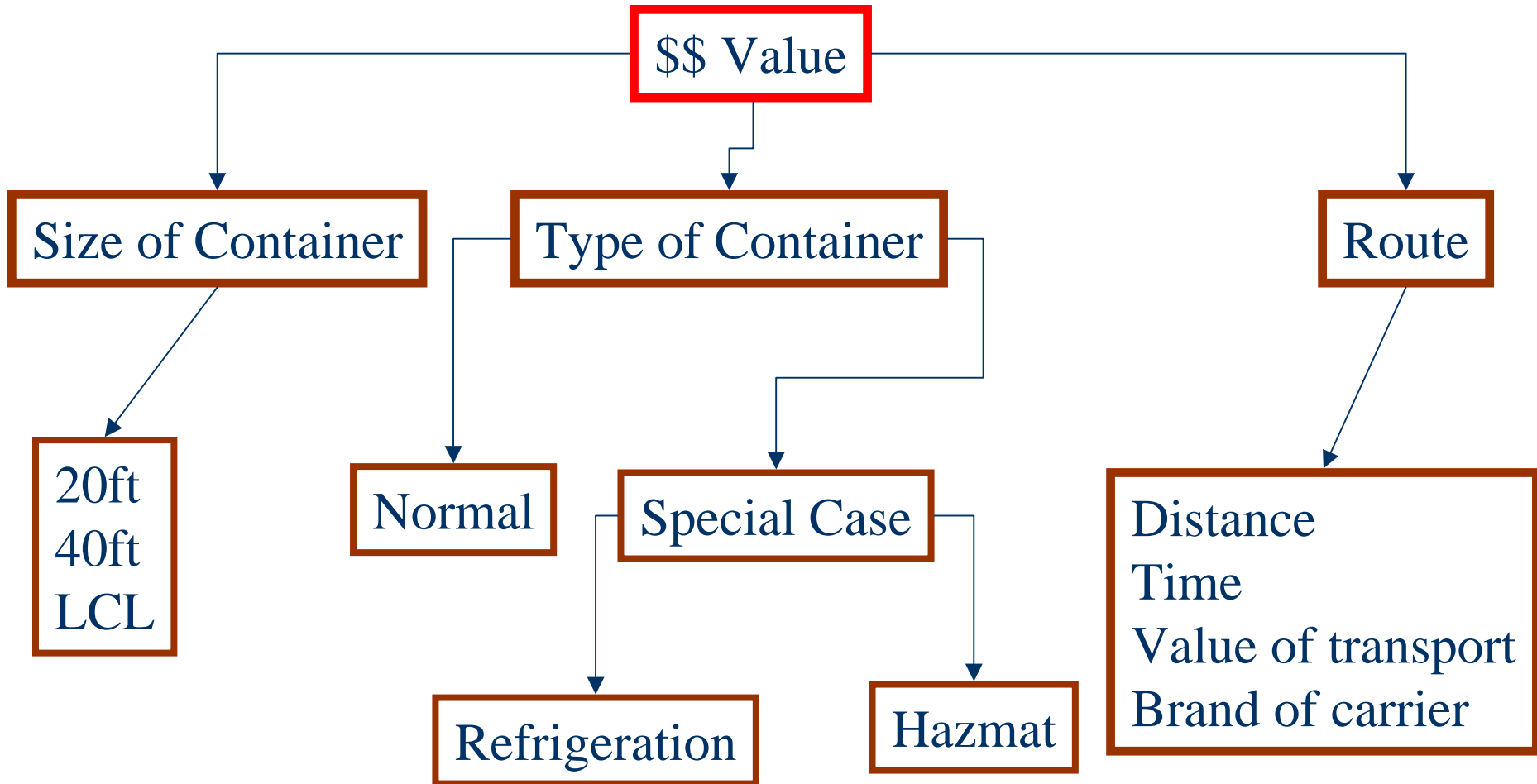
Final Destination

Point of Arrival

Point of Entry

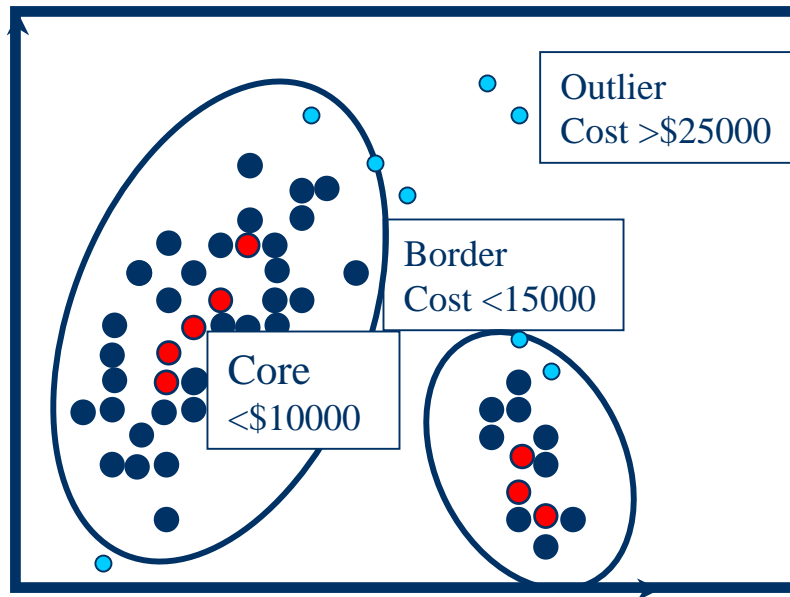
United States

Shipping Route Measurement



Outlier Discovery

- ◆ The value of an attribute or a combination may be at a greater distance than the normal, deviation from the standards set by other similar cargo.



There can be multidimensional outlier discovery, by comparing an n-dimensional vector for each importer

Discovering Rare Patterns from Correlation of Materials Being Shipped

Scenario 2: Company Importing
Fertilizer and another company
importing cyclotrimethylene trinitramine

Scenario: HAZMAT CARGO, TimeLine

Profile: ChemCo a Fertilizer Company, Imports-Chemicals from Canada

Consignee: FarmersFriends

Consignee Location: Wintersburg, Ariz.,

Cargo : Liquid Urea, ammonium nitrate

From: Mexico

Carrier : Truckers Inc..

Consignee: ChemCo

Consignee Location: Phoenix, Ariz.,

Cargo: cyclotrimethylene trinitramine

From: Canada

Permits: valid

Authorized:yes

Carrier: Trojan Carriers.

Or many other shipments

Cargo route overlaid on Map of nuclear power reactors in North America

Source: http://www.insc.anl.gov/pwrmaps/map/north_america.html



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List of Reactors At Wintersburg, Ariz.,

Plant	Type	Country	Status
Palo Verde 1	PWR	United States	Operable
Palo Verde 2	PWR	United States	Operable
Palo Verde 3	PWR	United States	Operable

Data Mining for Correlation of Cargo:

Identifying actionable patterns for Mutually dependent events

- ◆ Events become relevant when they occur together.
- ◆ Analysis for **specific interval of time and a specific region**(defined based on proximity of occurrence).
- ◆ To Identify a pattern as to
 - “ which cargo, when imported will be harmful if a correlated cargo is purchased in the same time frame and specific region”
- OR
 - “Which combination is harmful and is occurring as a rare pattern”
- ◆ These events become relevant with co-occurrence rather than causation

Multidimensional discovery

By Space and Correlation

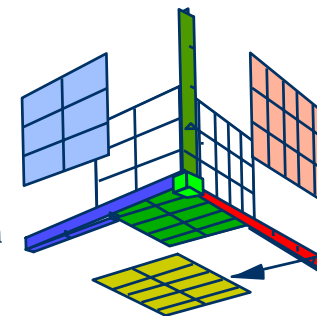
Space

By Space and Time

Correlation

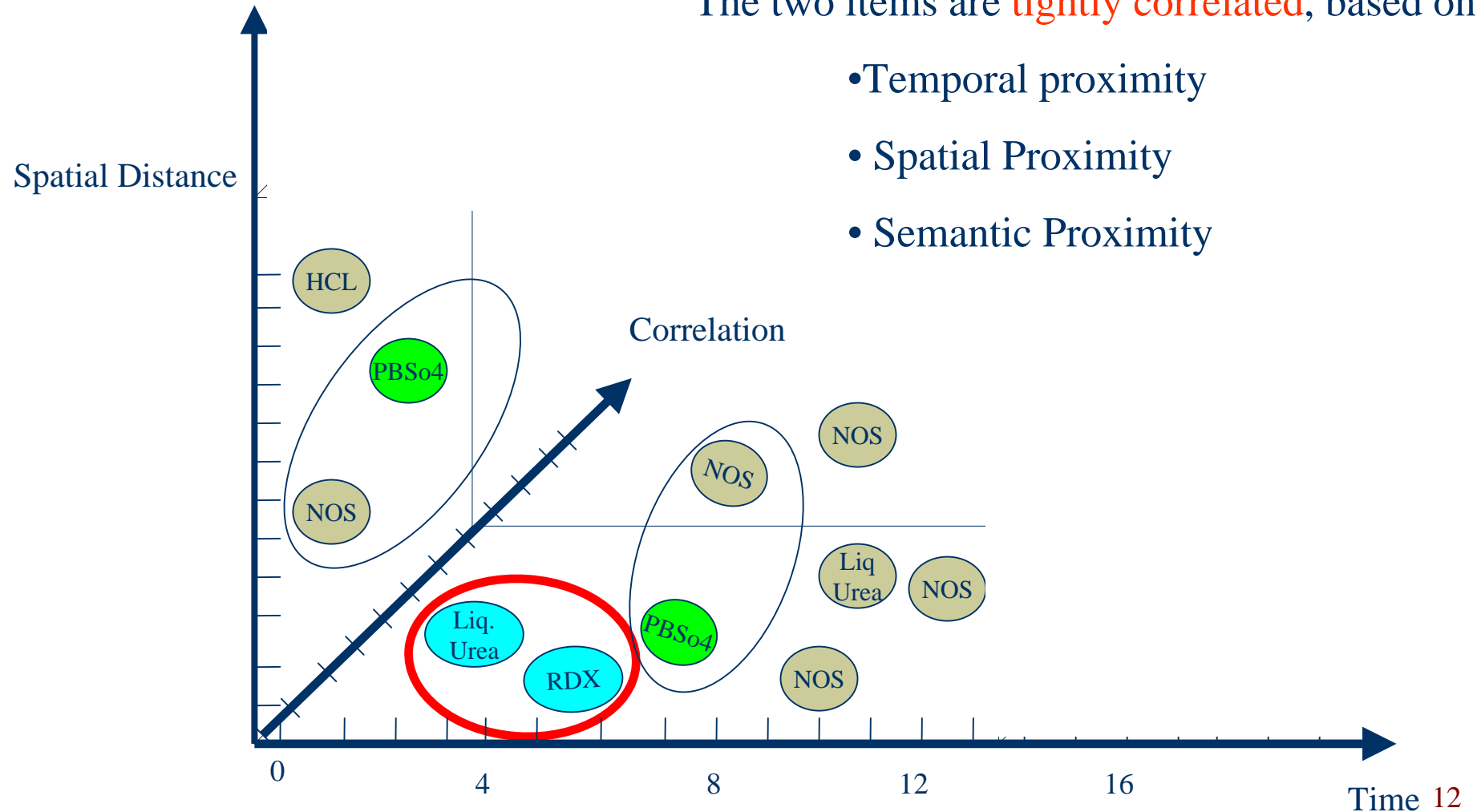
By Correlation and Time

Time



The two items are **tightly correlated**, based on

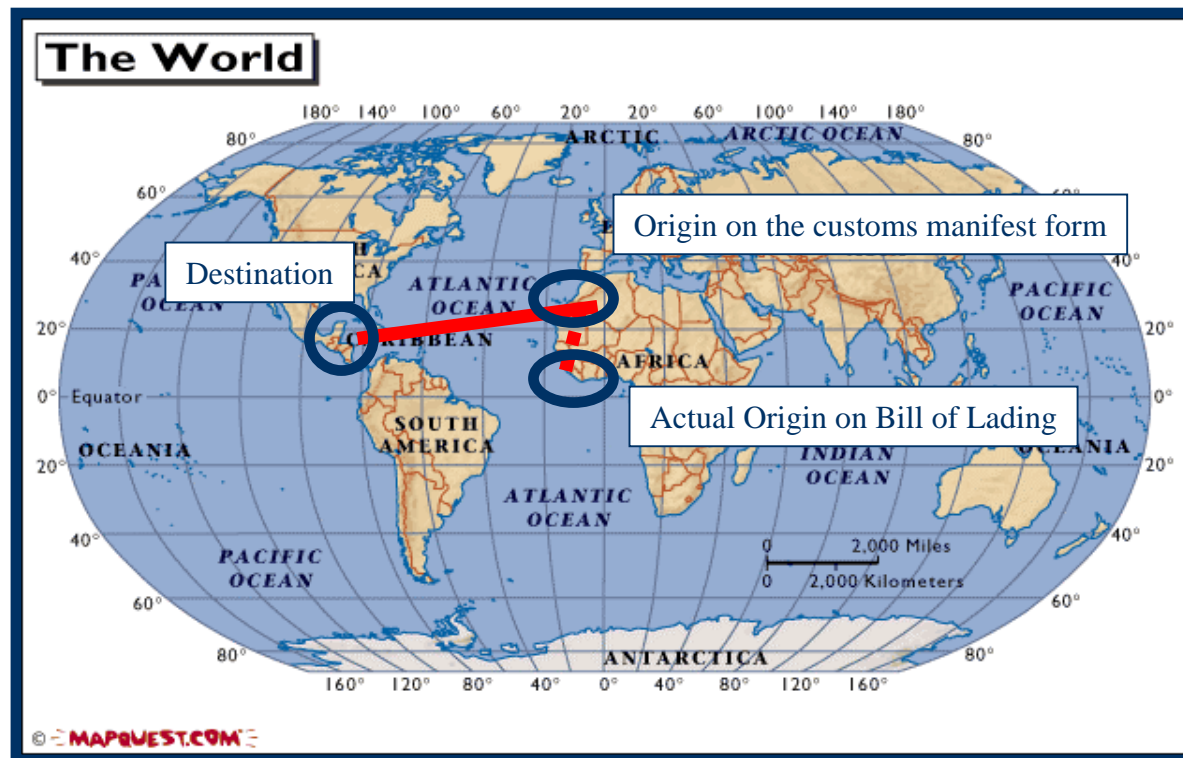
- Temporal proximity
- Spatial Proximity
- Semantic Proximity



Transshipment

A transshipment involves cargo carried by a second or subsequent ship without intermediate processing in order to reach its final destination.

Scenario 3: Cargo of fish from Spain

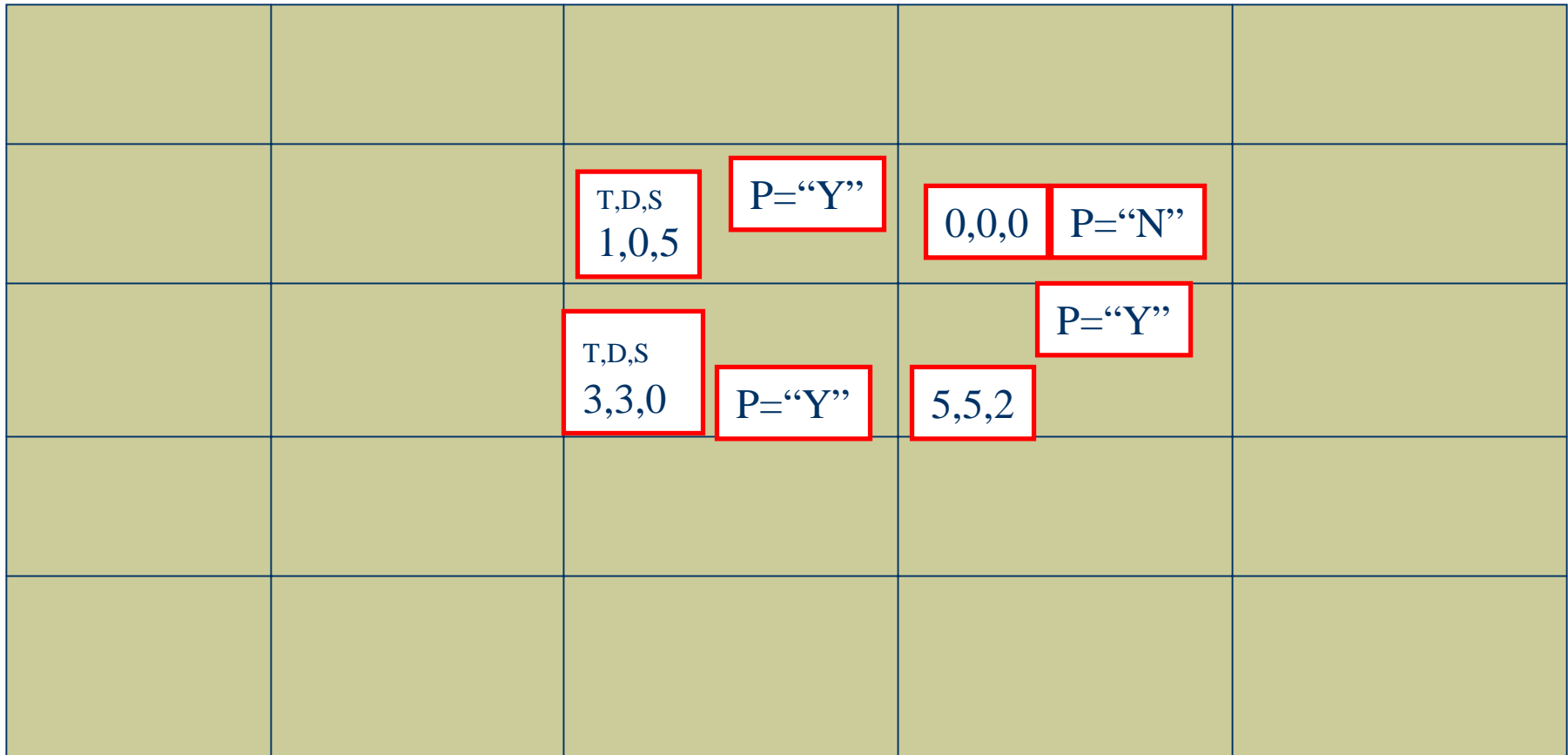


Spatial Data Mining : Mining spatial attributes

- ◆ A geocoded map can be divided into a grid of cells where every cell is associated with a multidimensional vector.
 - Each vector is made up of spatial attributes.
 - Examples of Spatial Attributes
 - Spatial distribution of Terrorist activities(T)
 - Spatial distribution of drug zones(D)
 - Spatial distribution of transshipment hubs(S)
 -
 - Previous occurrence of (T or D or S)=P=“Y/N”

- ◆ The idea is to determine a geospatial correlation between cells based on a correlation of the multidimensional vectors

Associating cargo layer with Drug Distribution layer



World Major Drug Production Map Key

- Opium
- Cocaine
- Marijuana
- Hashish

- Marijuana, Cocaine and Opium
- Marijuana and Opium
- Opium and Hashish



Shipment Route

TDS

Geospatial vector

Data from The National Drug Control Strategy, 1997: FY 1998 Budget Summary

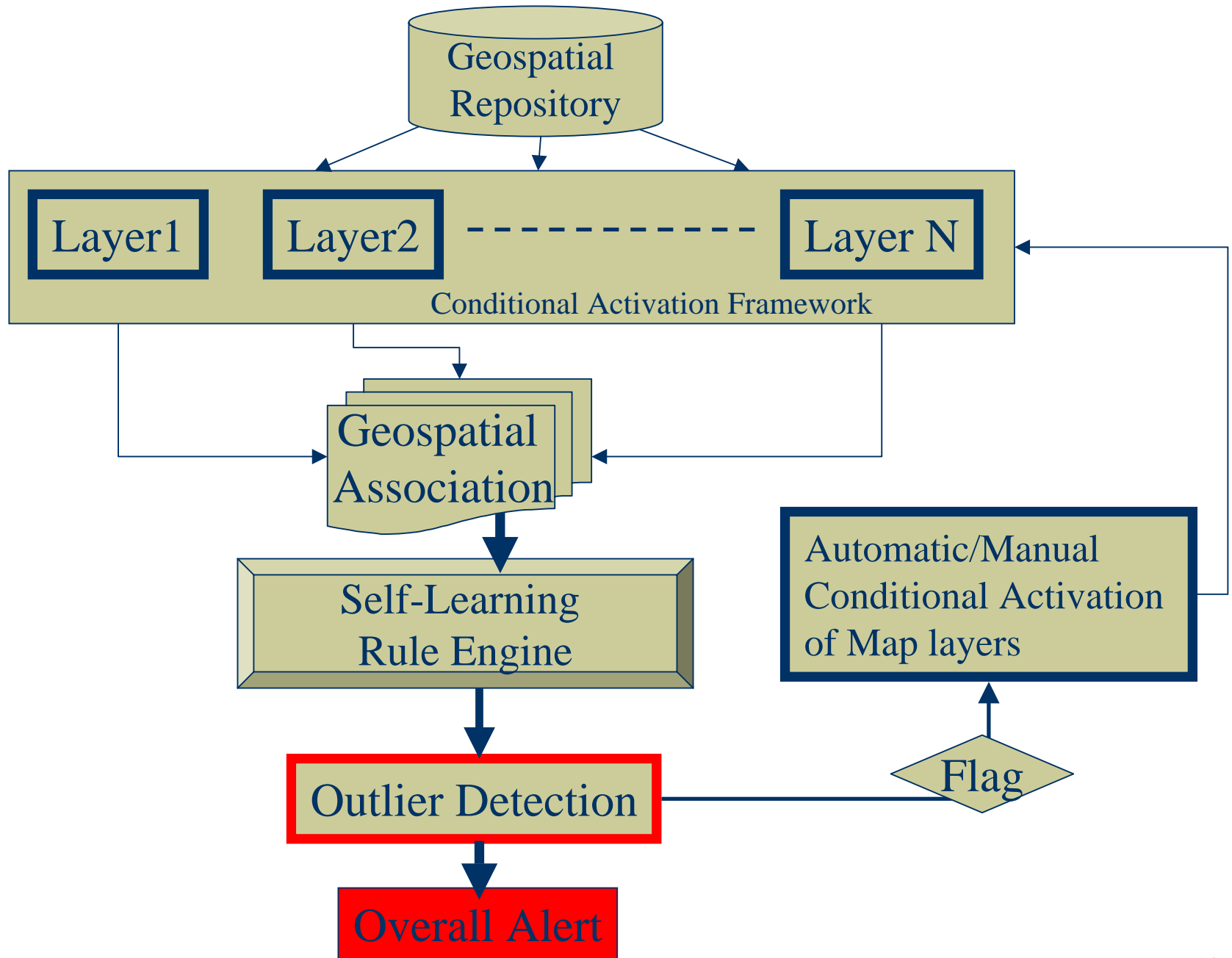
Examples of Other Anomalies that can be checked using data currently available

Anomaly	Commercial Document	Data element for Anomaly
Cargo Incongruent with Origin	Commercial Invoice, Master Bill of Lading	Routing, Item listing
High value cargo and slow mode	Commercial Invoice, Master Bill of Lading	Item values, routing information
Document discrepancy	Any	Documents do not conform to each other
New Shipper or Consignee	Commercial Invoice, Bill of Lading, Certificate of Origin	Shipper or Consignee Sections
Violation of established shipping or commercial patterns by parties	Any	Any – more in timing/receipt of documents (ex. Once-a-week shipper ships twice in one week)
Suspect source area and transship to small ship	Shippers Letter of Instruction, Bill of Lading	Origin of cargo, route
Point of origin	Shippers Letter of Instruction	Pickup location
Illogical commercial transactions	Commercial Invoice	Comparison of Consignee and Cargo (ex. Furniture company receiving garments)

Sample U.S. Import Documents with Major Data Elements

Data Elements	Used Before Shipment							Used During Shipment							
	Pro-Forma Invoice	Packing List	Certificate of Origin	Shipper's Letter of Instruction	Insurance Certificate	Inspection Certificate	Letter of Credit	Commercial Invoice	Transmittal Letter	Customs Form 7501	Bill of Lading	Inland Bill of Lading	Vessel Manifest	Delivery Instruction	Customs Form 3461
1 Invoice Number	x							x							
2 Date of Issuance	x							x							
3 Shipper's/Exporters name & address	x	x	x	x	x	x	x	x	x		x	x	x	x	
4 Exporter Identification Number (EIN)				x	x	x	x				x	x	x	x	
5 Agent of Exporter				x	x	x	x				x	x	x	x	
6 Intermediate Consignee's name & address	x	x		x	x	x	x	x	x		x	x	x	x	
7 Ultimate Consignee's name & address	x	x	x	x	x	x	x	x		x		x	x	x	x
8 Quantity	x	x	x	x	x		x	x	x	x		x	x	x	x
9 Unit Price	x	x		x	x		x	x		x		x	x	x	
10 Total Price	x	x		x	x		x	x	x	x		x	x	x	x
11 Net Weight	x	x	x	x	x	x	x	x				x	x	x	
12 Gross Weight	x	x	x	x	x	x	x	x		x		x	x	x	
13 Description of Merchandise	x	x	x	x				x		x					x
14 Terms of Payment	x							x	x						
15 Incoterms	x			x				x	x						
16 Estimated Shipment Date	x														
17 Currency of Payment	x						x	x	x	x					
18 Time Limit	x						x	x							
19 Miscellaneous Charges (FCA, CIF)	x						x	x							
20 Letter of Credit Number							x	x	x						
21 Letter of Credit Date							x	x	x						
22 Import License number								x							
23 Harmonized Commodity number				x				x							x
24 Ocean Carrier Name			x					x		x	x		x		x
25 Ocean Carrier Route								x			x		x		
26 Voyage Number										x	x		x		x
27 Vessel Flag													x		
28 Foreign Port of Export										x			x		x
29 Loading Pier													x		
30 Port of Unloading										x			x		x
31 Method of Transportation															
32 Country of Ultimate Destination				x						x	x				x
33 Bill of Lading Number							x	x							
34 Marks, Nos. & Kinds of Packages		x	x	x											

System Architecture



A Combination of alerts

- ◆ There can not be just one technique to catch every kind of anomaly.
- ◆ Only by a combinations of alerts can we detect the anomaly.
- ◆ Each alert can have its own weight age

<i>Questions</i>	<i>Alerts</i>
Is the Value of shipping route out of the ordinary?	✓
Is there a possibility of Transshipment?	✗
Is it a Hazmat requiring very high level of secure cargo?	✗
Could this cargo be used as a weapon of mass destruction if used with another material?	✓
Did this company change the carrier, shipper, notify party or owner recently? Or is it a company with no prior history?	✓ Notify party
Can this cargo be correlated to any drug or terrorist related map layer?	✗

Overall Alert: high