Supply Chain use cases empowered by AI

—

Sattwati Kundu

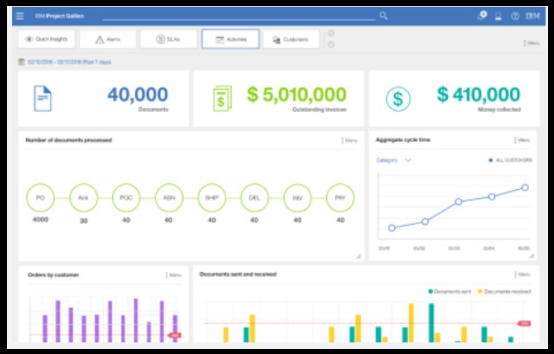
Sr. Data Scientist & Manager Data Science
IBM Software

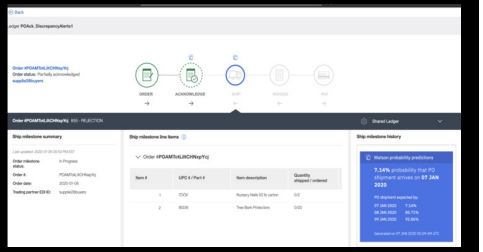
Agenda

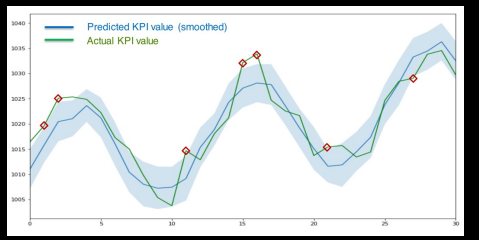
- Common Supply Chain use cases
- Some solutions from IBM
- User centric solution
- How can AI help?
- Anomaly Detection techniques
- One use case and demo
- Explain insights
- Hands on

Supply chain Use cases

- Embedded artificial intelligence (AI) insights for better decisions and provides multi-party B2B transaction.
- Document tracking and providing insights.
- Forecasting demand.
- Inventory management.
- Route optimization.
- Out of stock prediction.
- Cycle time (milestone) prediction.







Watson Supply Chain Business Network

- Automatically identifies document types, tracks and map them to correct workflows
- Enable the client to understand of their partner trading network, its performance and track specific processes and documents
- Predict milestones

Document types

- Identify document types through document meta data
- Invoice, PO, Acknowledgement, payment, shipment, Advance Shipment notices, etc. over 50 different document types store valuable information about the transaction
- AI models unearth pattern in these document types between 2 trading partners

NLU

- Watson Conversations is used to engage with users through a natural language interface
- Watson Natural Language Understanding is used understand the context of the conversation and to understand which types of documents are relevant within that context

Milestone Predictor

- Predict the timing of business milestones based on the flow of documents in SCBN
- Enable the client to understand business processes and predict potential delays
- Machine learning models are used to create a model to predict the typical elapsed time between milestones

User centric solution

“I’m far more interested in what's inside the [EDI] document to drive the business and get me the insights I need. I want to know the status of the order-to-cash process from soup to nuts until it's paid.”

Responsibilities

- Ensures order-to-cash (OTC) and purchase-to-pay (P2P) processes meet customer requirements and objectives
- Communicates OTC and P2P risks to team and problem solve for resolutions
- Defines operational efficiencies for cost or service improvements

Tasks

- Monitors if POs and ASNs (among other document transactions) are received and properly flow — if not, investigate why
- Works with vendors to get accurate information and resolve issues
- Addresses, communicates, and resolves order issues quickly

Pain Points

- Resolving disagreements with customers / vendors on causes of error and getting accurate data (ie, orders not delivered in full — tracking down what really happened)
- Prioritizing which projects will meet current business objectives, and managing her limited bandwidth

Customer Fulfillment Manager

Also known as:

- Order Fulfillment Manager,
- Vendor Relations Manager,
- Logistics Manager,
- Accounts Payable / Receivable,
- Supply Chain Customer Support

AI to analyze various document types.

Monitors all EDI document transactions

Example issues: Vendor claims that POs weren't received, customer disputes that invoices were sent, or understand why specific POs are closing

Dashboard to visualize different document types

Drill down to get into specific trading partner data to resolve issues

Use natural language query to fetch records

For thousands of transactions, what is that requires attention

Is an exceptionally high number of POs causing delay for delivery for a specific customer?

Is it because of holiday season?

Pin-point and drill down into specific data by identifying anomalies in patterns

Anomaly Detection

Sensor Data

Varying signal becomes flat line

Varying signal becomes a near vertical line

Unusual peaks and troughs within normal range

Flat line becomes a varying signal

Gaps in data -Equipment offline.

No sensor data captured.

Relationships between correlated signals outside of the predicted range

Building Occupancy Data

High footprint because of event

Zero/low occupancy because of holiday / holiday season

Supply Chain

High order quantity due to Black Friday sale

Delayed deliveries due to weather (hurricane disrupts deliveries).

Energy Usage

Detect abnormal energy usage in enterprise buildings because of high occupancy of equipment malfunctioning

Anomaly detection - Techniques

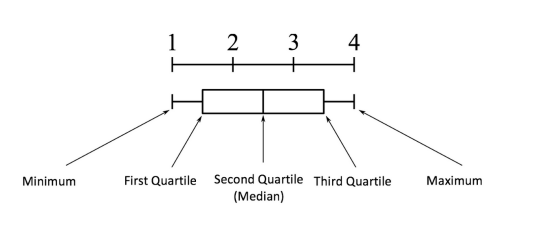
What are Anomalies?

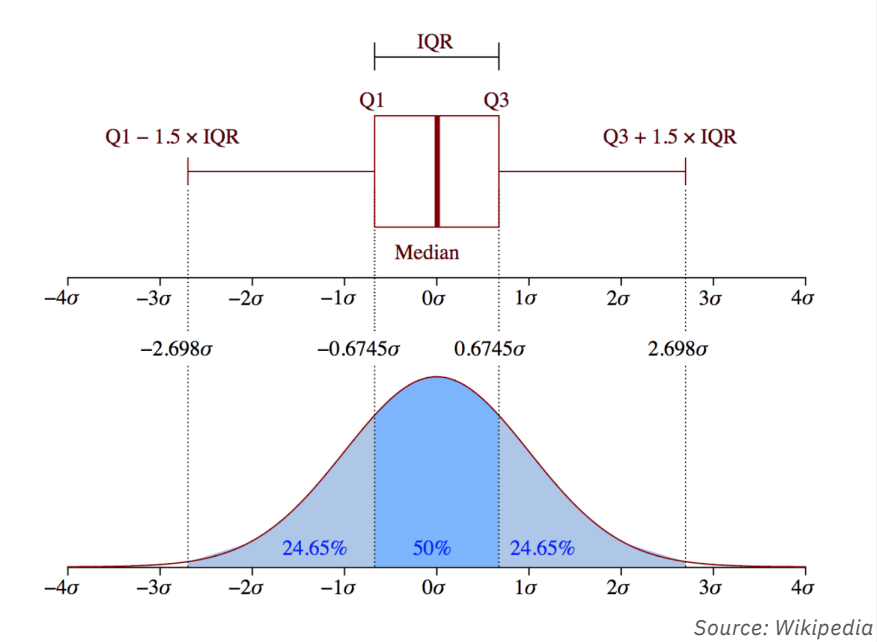
- Data points that stand out amongst other data points in the dataset.
- Do not confirm the normal behaviour in the data.
- Outliers
- Change in events
- Drifts

Techniques

- Statistical thresholding methods like IQR
- Clustering based methods
- Supervised methods with labels of *Anomaly*
- Prediction based anomaly detection

IQR



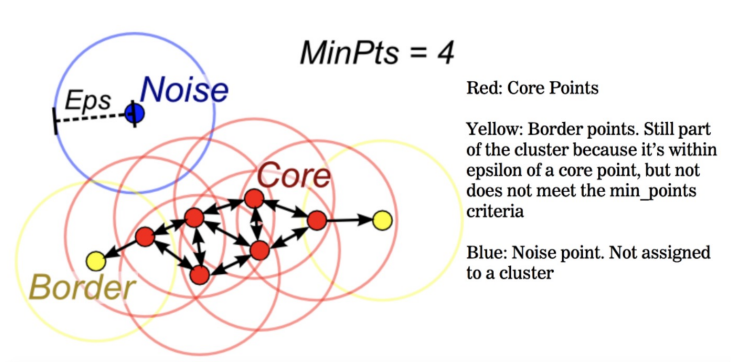


Source: Wikipedia

IQR is a concept in statistics that is used to measure the statistical dispersion and data variability by dividing the dataset into quartiles.

Interquartile Range (IQR) is important because it is used to define the outliers. It is the difference between the third quartile and the first quartile (IQR = Q3 - Q1). Outliers, in this case, are defined as the observations that are below (Q1 – 1.5x IQR) or above (Q3 + 1.5x IQR)

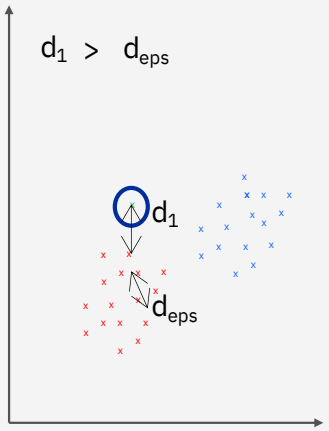
Cluster based



— *eps:* Define maximum distance between two points to consider them as neighbours.

— *min_points:* Minimum number of points to form a cluster.

The way this algorithm creates the clusters is by looking at how many neighbours each point has, considering neighbours all the points closer than a certain distance (*eps*). If more than *min_points* are neighbours, then a cluster is created, and this cluster is expanded with all the neighbours of the neighbours.



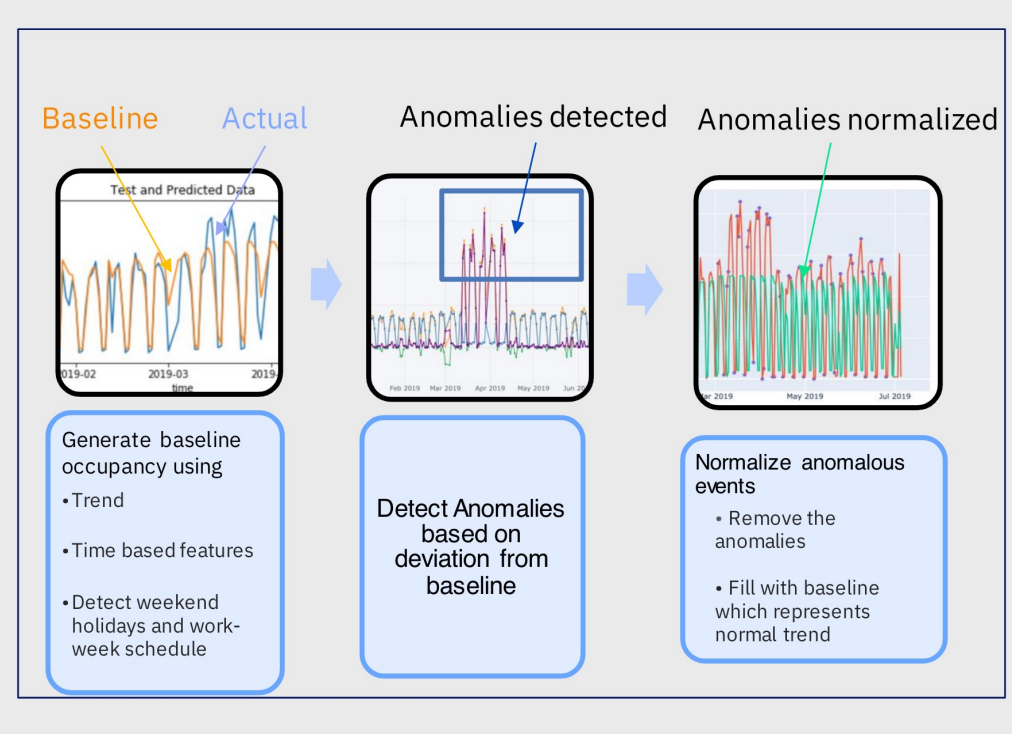
- Calculate the distance from the new points to all the Core points and look for the minimum dist to closest neighbour
- Compare the distance to the closest neighbour inside a cluster with *eps*
- If the distance is larger than *eps* the point is labelled as **anomalous**

Prediction based

- Mostly applied to time-series data
- unsupervised or semi supervised in nature
- Identify a pattern or trend and seasonality
- Predict what is expected as normal
- Detect deviations

Challenges

- Don’t learn from anomalies
- Hence, remove obvious anomalies first
- No label, hence, validation becomes tough
- Incorporating feedback learning into model is difficult



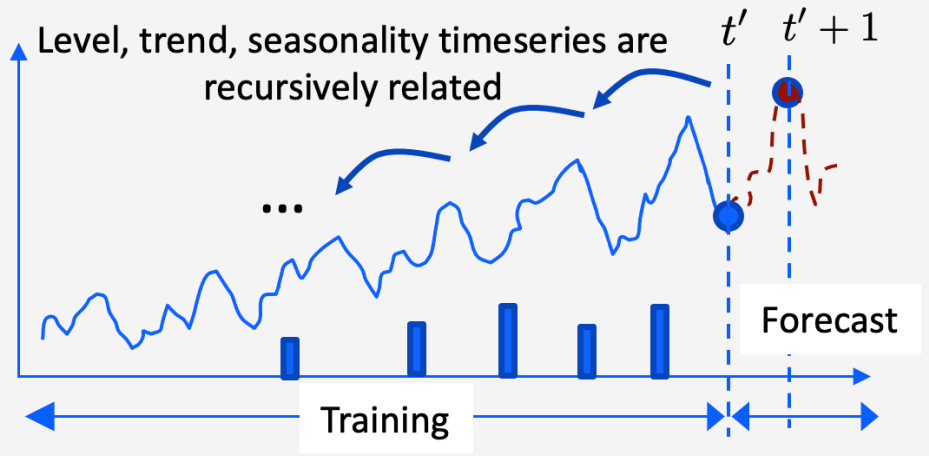
Anomaly Explainability

Why do we need to Explain?

- It's our responsibility to deliver AI that is trustworthy
- Making insights more meaningful and consumable

How can we achieve it?

- Using IBM proprietary library / OS libraries LIME/SHAP to explain
- Textual explanations & Visualizations



Why

- Top influencers for anomalous day's prediction
- Analyzing historical influencers
- Trend (difference with last season)

What

- Deviations from prediction
- Deviation from last season (quantifying trend)
- Average deviations
- Severity

On 6th Aug 2021, the POValue increased by **1,269,408,726** from previous week which is **1051%** more than average weekly trend of **110,242,212**

Day of anomaly: 6th Aug 2021, Friday
Deviation from Prediction: **1,491,532,924**
Severity: **High**
Historical Influencers: Top **10** historical days influencing prediction are on **Fridays**