ARE YOU MAKING THE MOST OF AI, ML, AND THE IOT?

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HOW TO MAKE THE MOST OF AI, ML AND THE IOT

- Review of Artificial Intelligence, Machine Learning, & the Internet of Things
  - Definitions, uses & how they work with each other
- Deep Dive on Machine Learning
  - What it is, can do, short comings,
  - Why use it, & where is it used
- Desired Outcomes & Case Studies
  - A network of connected things and people
  - Collects and shares data

HOW TO MAKE THE MOST OF AI, ML AND THE IOT

- Artificial Intelligence (AI)
  - Ability of a digital computer to perform tasks
  - The computer requires data and direction
- Machine Learning (ML)
  - Subset of AI
  - Specific sets of algorithms to solve specific problems
- Internet of Things (IoT)
  - A network of connected things and people
  - Collects and shares data – acts as a conduit

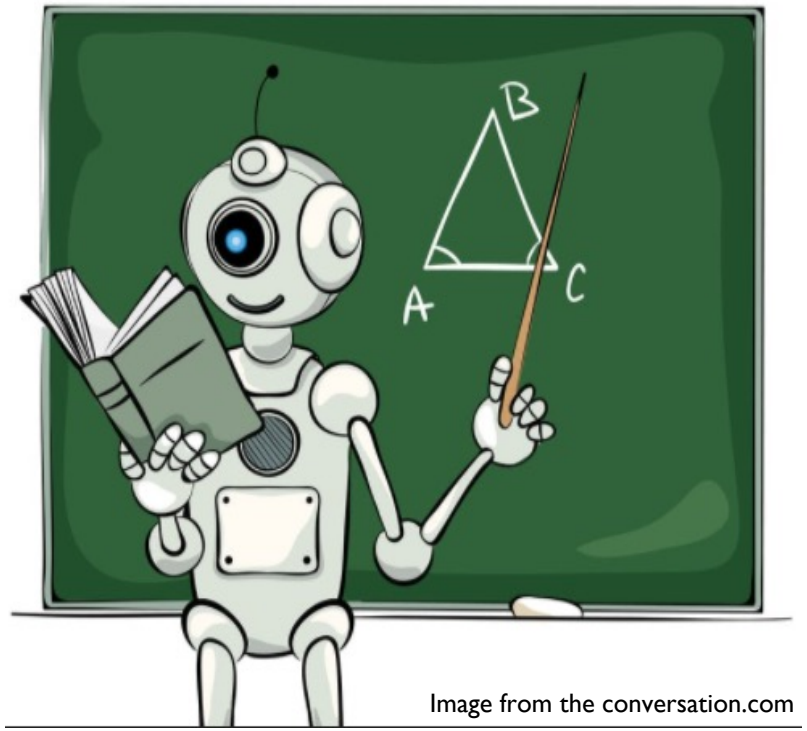


Image from the conversation.com

WHAT IS MACHINE LEARNING?

- Subset of Artificial Intelligence
  - a set of base algorithms that improve through experience (new data sets)
  - constantly evolving as new data is provided – pairs well with IoT
- Useful for finding unknown patterns and relationships
  - sales, plant, store, forecasting
- Useful to gain insight and efficiency
  - future forward view

WHAT CAN MACHINE LEARNING DO?

- ✓ Groups data by finding underlying relationships between points that are not noticed by us (humans)
- ✓ Works best with numerical data
- ✓ Provides a visualization of the relationships and its strength
- ✓ Useful in any field

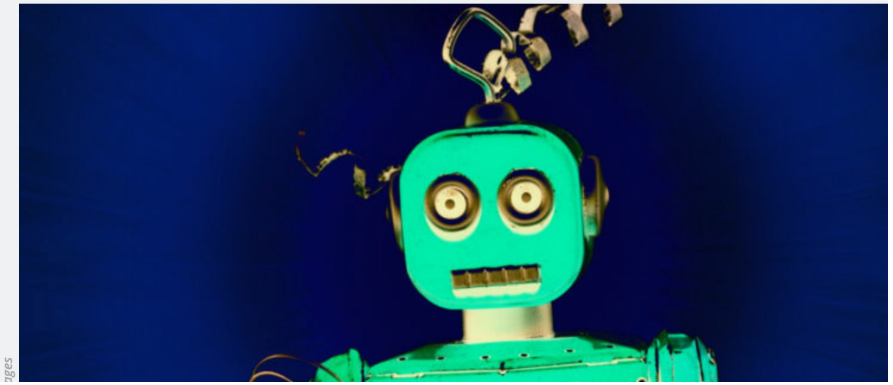
SHORTCOMINGS

ARE YOU OUT OF YOUR VULCAN MIND —

ChatGPT goes temporarily “insane” with unexpected outputs, spooking users

Reddit user: "It's not just you, ChatGPT is having a stroke."

BENJ EDWARDS - FEB 21, 2024 4:57 PM UTC



NEWS | 26 July 2022

Could machine learning fuel a reproducibility crisis in science?

‘Data leakage’ threatens the reliability of machine-learning use across disciplines, researchers warn.

- Can be correct but…
  - Depends on the data quality
  - Depends on the algorithm
- Not entirely predictive
  - Provides plausible outcomes based on data reviewed
  - Only as good as the data provided

Google images

WHY USE MACHINE LEARNING?

- Quickly find patterns in data
  - Finding relations in parts, in service hours, and link that to weather, time of day
- Group data by likeness
  - Grouping products together in the warehouse, purchasing products together
- Provide insight into new products
  - Providing insight on how a new part or product will perform
- Forecast equipment failures
  - Preventing injuries and down time through signaling a need for PM sooner

WHERE IS IT USED?

- Manufacturing & Supply Chain
  - Assess where new product/parts belong or their potential sales or lifespan
  - Improve planning of resources
  - Warehouse location selection
  - “Others bought these products when buying this one”

HOW TO BEST USE IT?

1. Identify the problem or problems
   - What needs to be fixed?
   - What function or step in a process needs more insight?
2. Figure out the best way to solve it
   - What algorithm is best for the situation?
   - What data does it need

Desired Outcomes

What success looks like in the real world:

- A 34% decrease in redundant inventory and 31% in cost using clustering
- An 85% decrease in well ruptures using regression
- A marked improvement in number of emergency orders using classification

MACHINE LEARNING AND SUPPLY CHAIN

- Inventory Management
- Forecasting Events
- Overall Supply Chain Management

MACHINE LEARNING AND INVENTORY MANAGEMENT

Issues finding the optimal amount of inventory to have as safety stock

- Demand Patterns
  - What is being ordered and how often
- Ideal demand to meet
- Ease of procurement
- Supplier lead time
- Type of item – perishable, consumable

HOW AND WHEN TO APPLY MACHINE LEARNING

Inventory Management is best paired with:

- Regression – oddities in inventory levels
  - Inventory is below its threshold before it should be
  - Larger than normal variance in order arrival for a specific supplier
- Clustering - align part ordering for critical spares
  - Certain algorithms will find and group parts together that can then be ordered together to reduce costs and shorts
  - Tie it to the decommission and disposal schedule

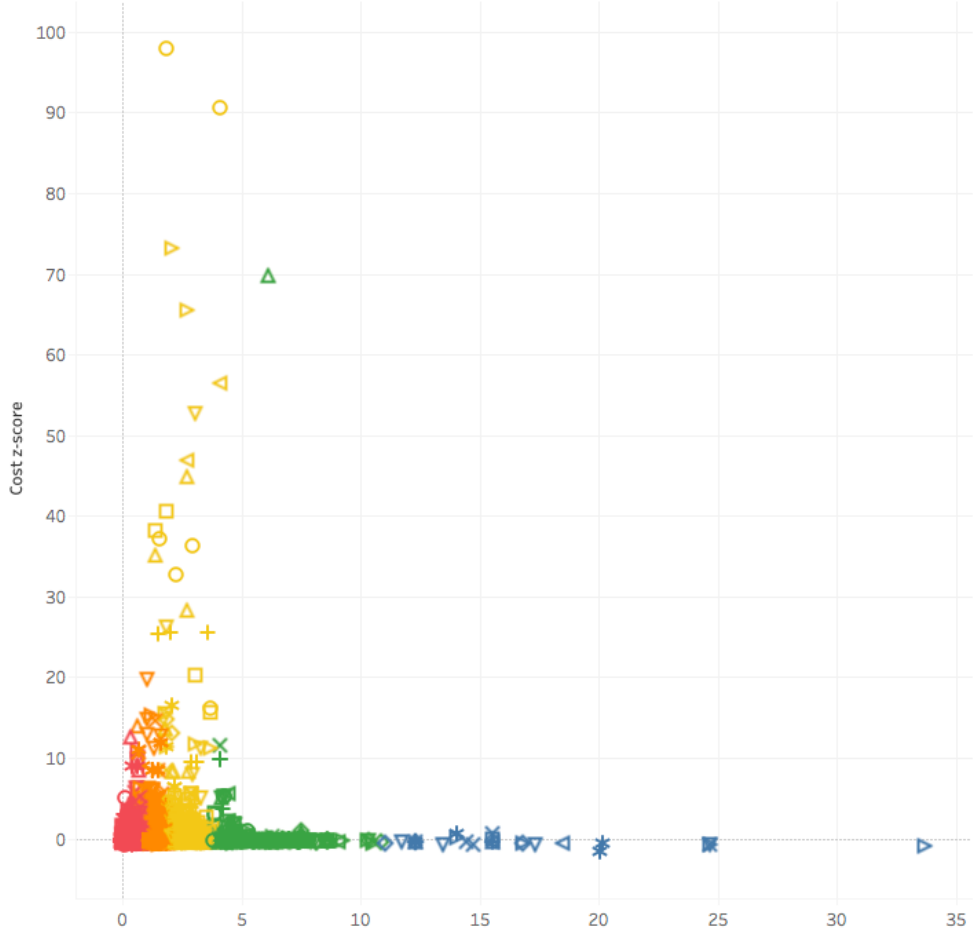
Case Study Results Using Clustering

US DOD, Canadian DND, UK MOD had significant issues with inventory

- Excess inventory in the billions
- Incorrect parts on hand
- Unable to maintain assets

Took part lists from Canadian DND subcontractors and applied k-Means clustering algorithm

- Result was 5 clusters
- Each group had a set of attributes



Porter D. M. (2018) Using K-Means Clustering to Create Cost and Demand Functions that Decrease Excess Inventory and Better Manage Inventory in Defense

Case Study Results

With the attribute information I created algorithms for each cluster

- Algorithms were part specific and would minimize cost while maximize availability
- Algorithms also helped set required ordering quantities and ordering schedules

End Result: A 34% decrease in excess inventory, and 31% decrease in cost, while achieving the required 100% part availability.

MACHINE LEARNING AND FORECASTING EVENTS

Issues with finding probability that an event will occur or what sales could be

- Operational Failure
  - Machine or asset is failing sooner than it should be – mean time to failure is shorter than expected, mean time between failures is getting shorter
- Miscalculating Demand
  - Severely over or under estimating the demand of a new item or service

MACHINE LEARNING AND FORECASTING EVENTS

Forecasting can be paired with:

Regression:

- Use it to provide insight into the probability of an event occurring
  - Split prior data into groups of event occurred, event did not occur
    - Find patterns in the data leading up to an event, use that to create probability of event occurring in the new data

MACHINE LEARNING AND FORECASTING EVENTS

Forecasting can be paired with:

Clustering:

- Use it to provide insight on the potential demand or lifespan
  - Use prior data to create clusters based on attributes, apply new data to see which cluster it belongs with
  - Use cluster data to set inventory thresholds or to flag for a replacement

Association Learning – Naïve Bayes:

- Use it to effectively create maintenance schedules
  - Based on prior data, the likelihood of a failure is X%

Case Study Results Using Regression

O&G company needed to better predict frack ruptures (events)

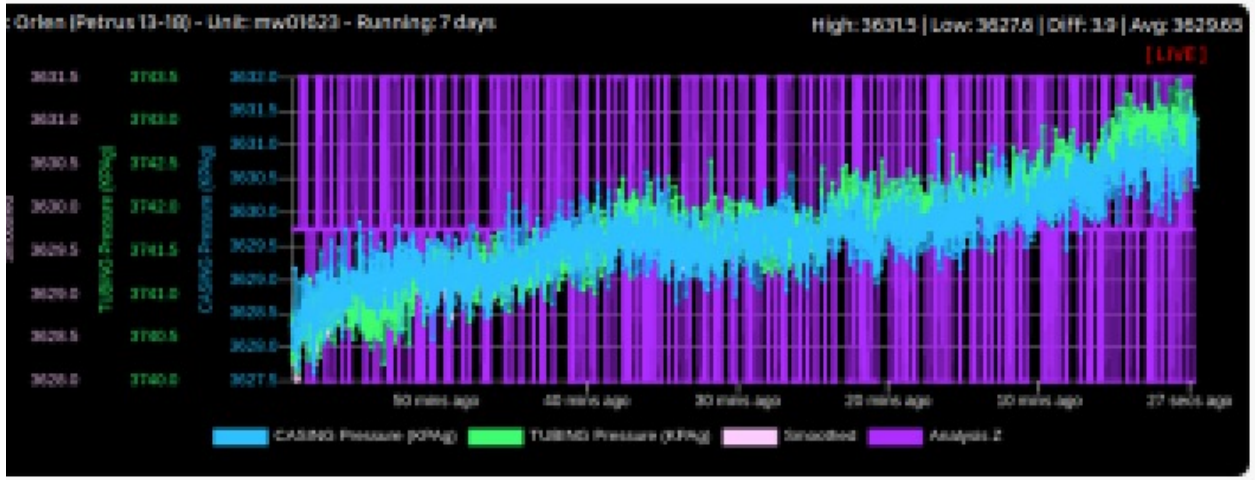
- Ruptures cause leaks
- Disruptive to other wells
- Expensive in terms of lost time and clean up

Pulled data on 30 wells, regressed data based on event time and pressure

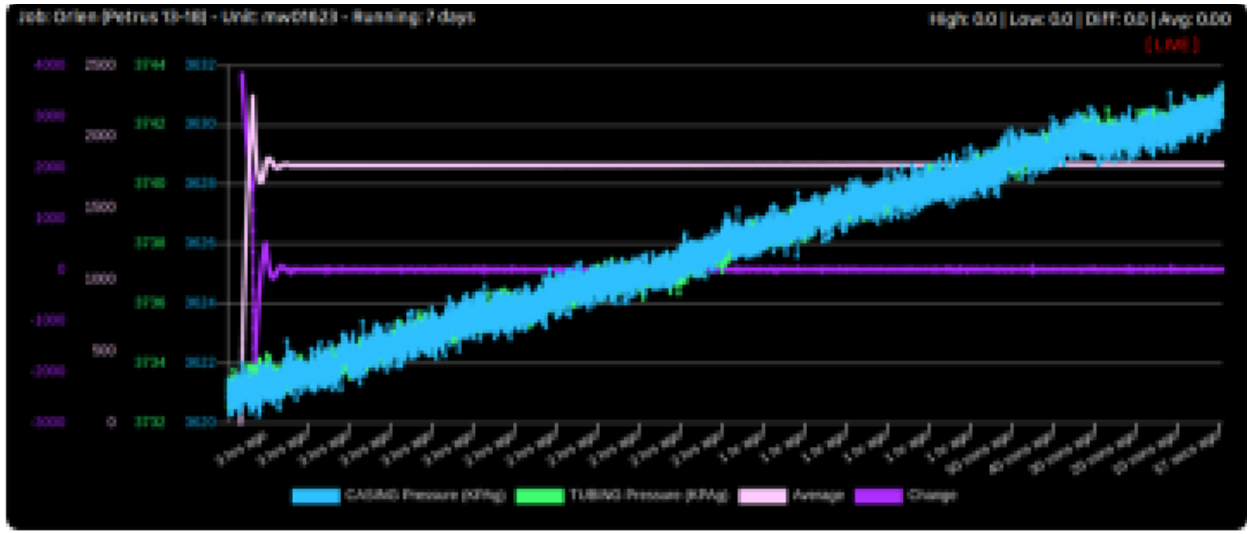
- Found 3 different types of events each with a unique signature
- Result was patterned pressure changes before an event

Case Study Results Using Regression

O&G company needed to better predict frack ruptures



Original algorithm outcome in purple. Fracking data in blue and green. Result: hundred's of alarms but no event



My algorithm outcome in pink and purple. Event data in blue and green. Result: no alarm and no event

Case Study Results

I used patterned pressure events to create algorithms that read data in real time

- Algorithms looked at new pieces of data and predicted an event
- Tested on real data in real time

End Result: Over 85% predictive ability while providing enough lead time to the operators to prevent the event from happening

MACHINE LEARNING AND SUPPLY CHAIN

Ensuring the right part, piece of information or fund is in the right place at the right time in the right quantity

- Inventory issues
  - Short or excess parts
  - Incorrect parts
- Demand Forecasting
  - Inaccurate forecasts
- Service Level
  - Is required service level being met?

HOW AND WHEN TO APPLY MACHINE LEARNING

Supply Chain Management is best paired with:

Clustering: k-Means or k-Nearest Neighbors

- Use it to find patterns in part ordering and grouping parts
  - Can be used to alter current part classification groups
    - Better classes for parts will allow for better part management
  - Alter procurement schedule
    - If one part is being used less, others that are similar can also be used less

HOW AND WHEN TO APPLY MACHINE LEARNING

Supply Chain Management is best paired with:
Association Learning

- Predicting how a new piece of equipment will match its specs
  - Compare new equipment specs to current and old equipment actual data
    - Can help predict how the new equipment may respond in certain situations
      - » Helps with RUL, and setting up PM's
- Adding a new part to the correct class
  - View attributes of new part and compares to attributes in classes then selects the best fit classification for the new item
- Demand Forecasting
  - Provides insight on: part or material unavailability, seasonality impacts, like parts

Case Study Results Using Clustering

Manufacturing company needed to increase part availability

- Parts were not always available for PM's
- Caused unplanned down time
- Expensive in terms of lost time and emergency orders

Reviewed part classification structure

- 16 classes of parts were reduced to 6 via clustering
- Result was that certain classes had part inventory monitored more frequently, and others had thresholds set, flagging an order when a part dipped below it

Case Study Results

New Classes improved part availability as the 6 classes were better defined

- Each class had strict monitoring rules based on the part attributes
- Reduced shorts and excess parts, as well as unplanned down time

End Result: Significant reduction in unplanned down time, PM's happened on time, significant reduction in emergency orders which saved cost

SETTING UP FOR SUCCESS

- Select a specific question for the model to “answer”
  - “When will this asset fail”
- Ensure that every piece of data is properly labeled & entered
- Select appropriate algorithm for the data and the desired result
- Choose key parameters that best measure the desired outcome (health, or failure)
- Allow the ML algorithm to review as much previous data as possible
  - The outcome can be used to highlight where the actual issues are

CONCLUDING REMARKS

Machine Learning is a very useful tool to add to your company to improve its performance in the various departments of Supply Chain

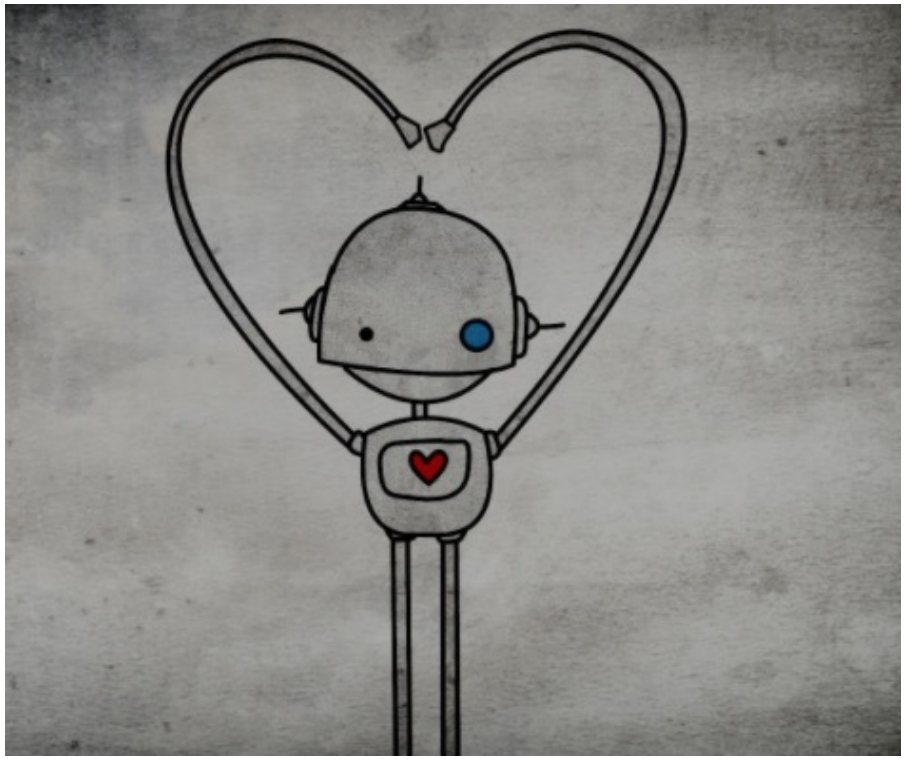


Image from pictures.4ever.eu

QUESTIONS OR COMMENTS?

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