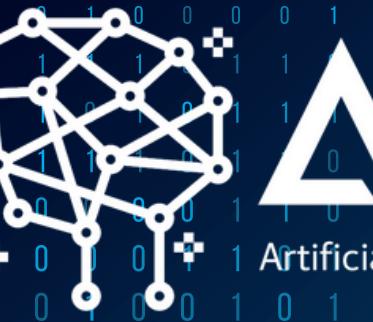


AI-NEKEN

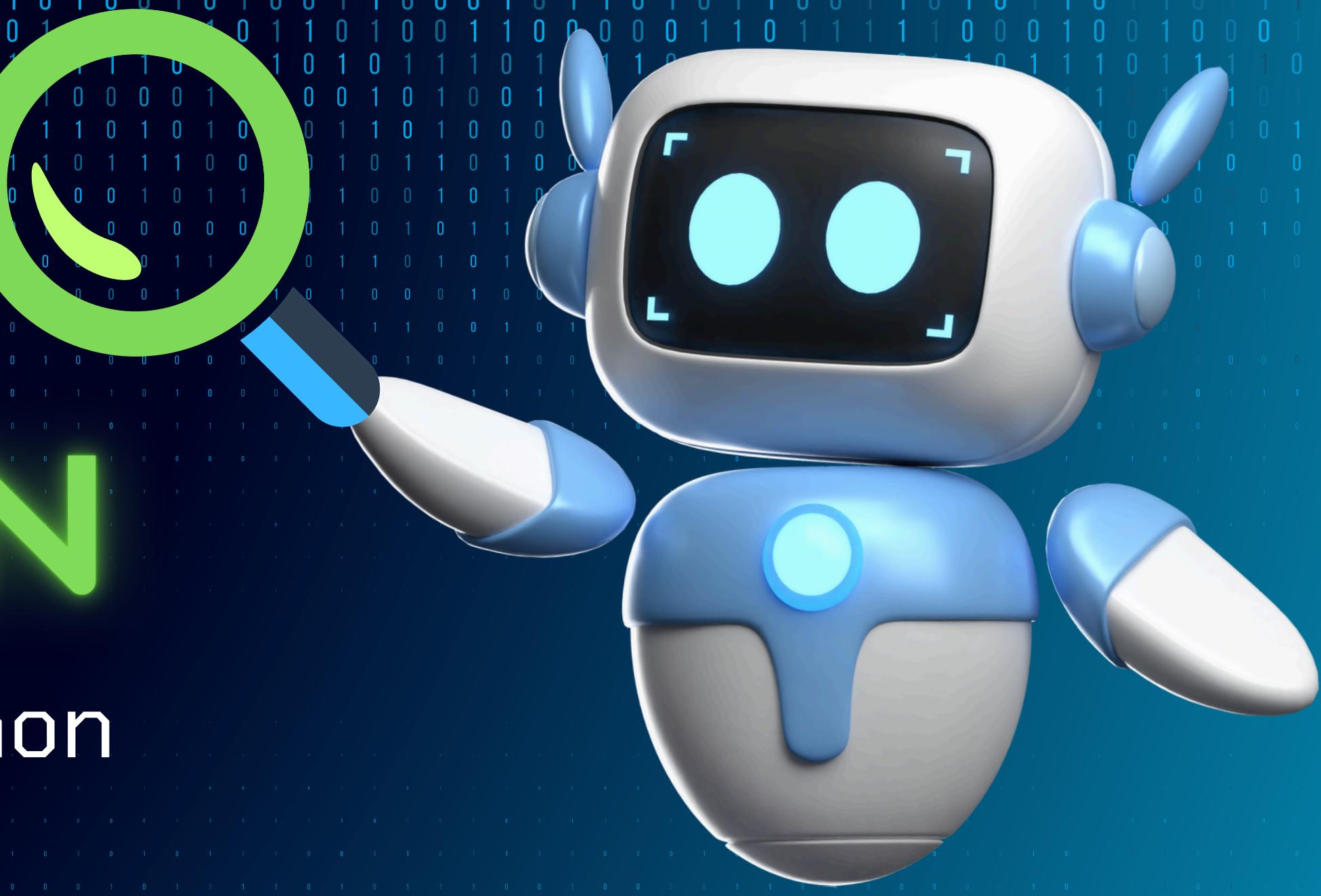
AI2S & Cybertec Hackathon

05-06 April 2025



ΔΙ2S

Artificial Intelligence Student Society



1

TASK 1: TIME SERIES FORECASTING

STRATEGY

Supply chains involve many different items, but each item often has a relatively short time series. This motivates a "horizontal" modeling approach.

- 1) Deep Learning Models (RNN, LSTM, DeepAR, TFT)
- 2) Standard Machine Learning (LightGBM)
- 3) Classical Statistical Models (Holt-Winters, ARIMA, etc...)

POTENTIAL PROBLEMS

NOISY TIME SERIES

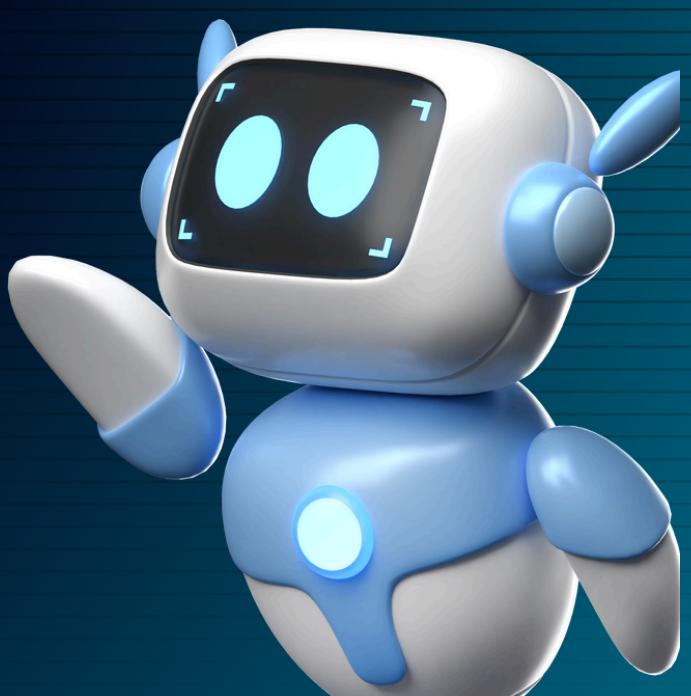
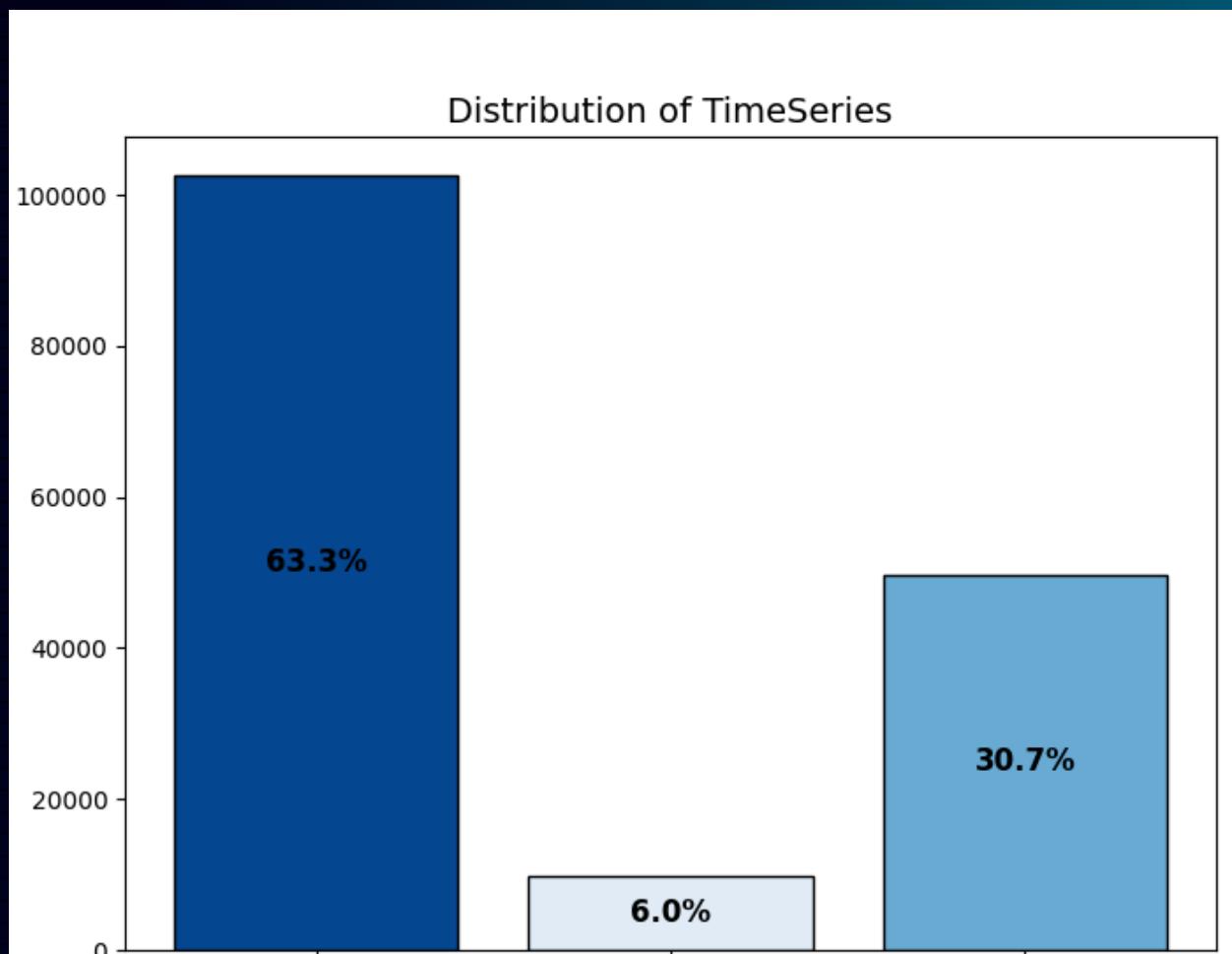
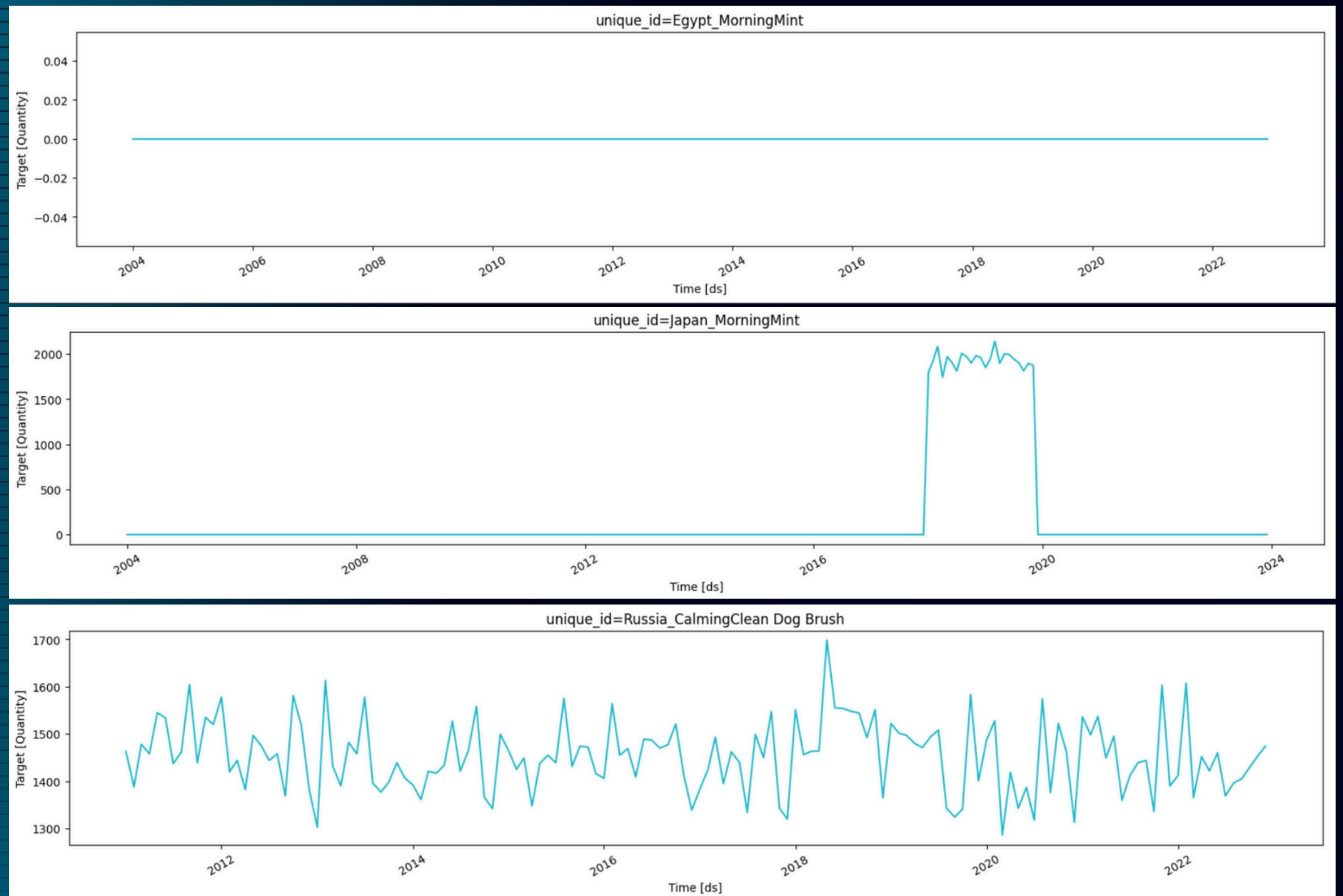
Time series in supply chains are often **highly noisy**, influenced by irregular demand patterns and imperfect data collection.

MODEL ASSUMPTIONS

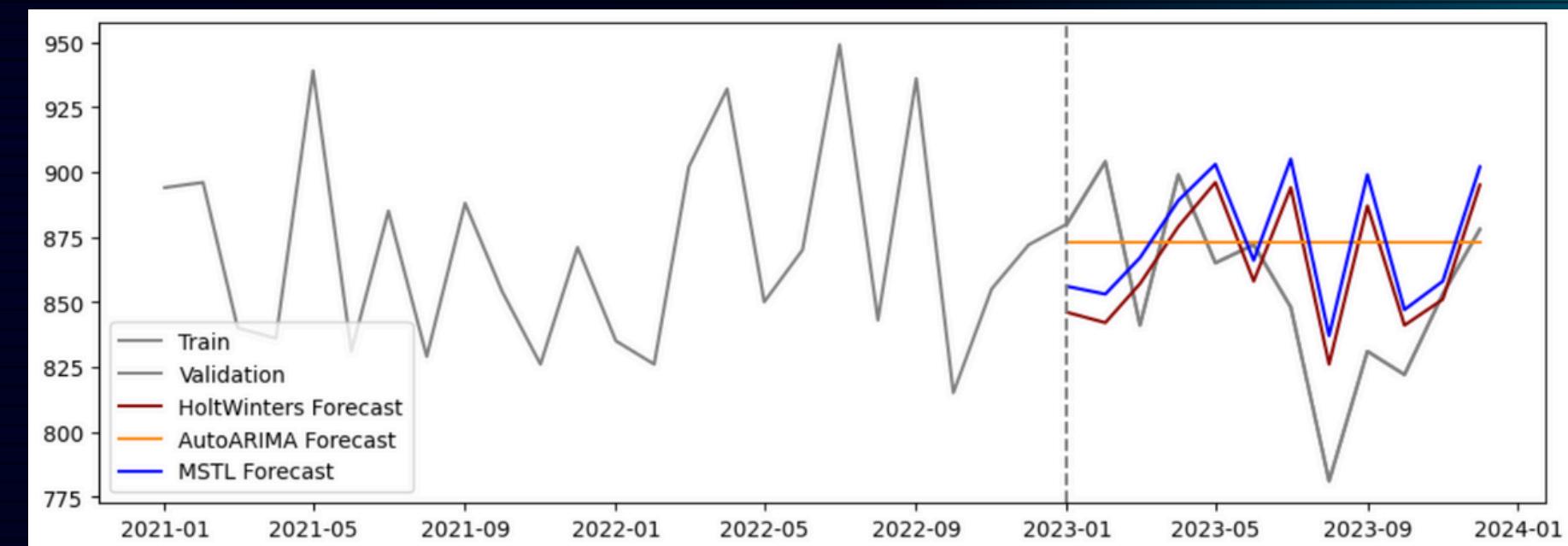
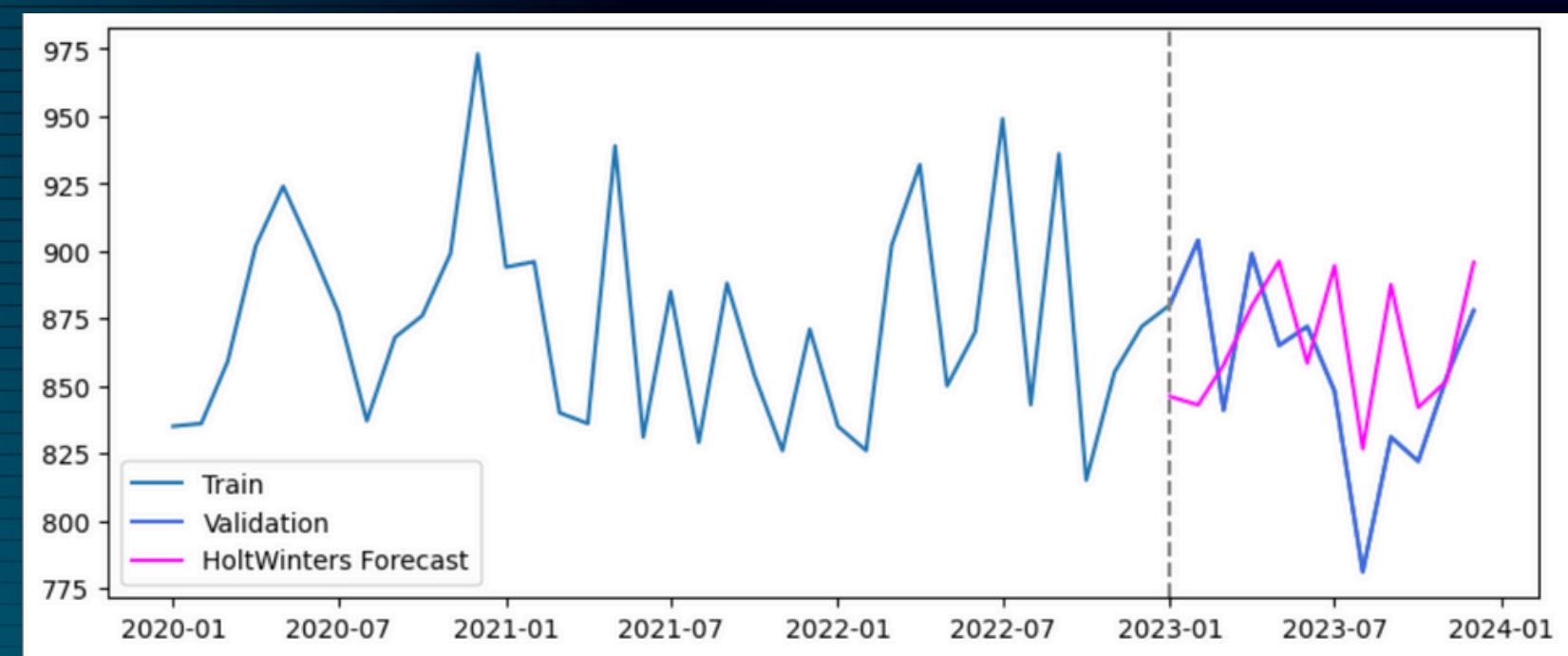
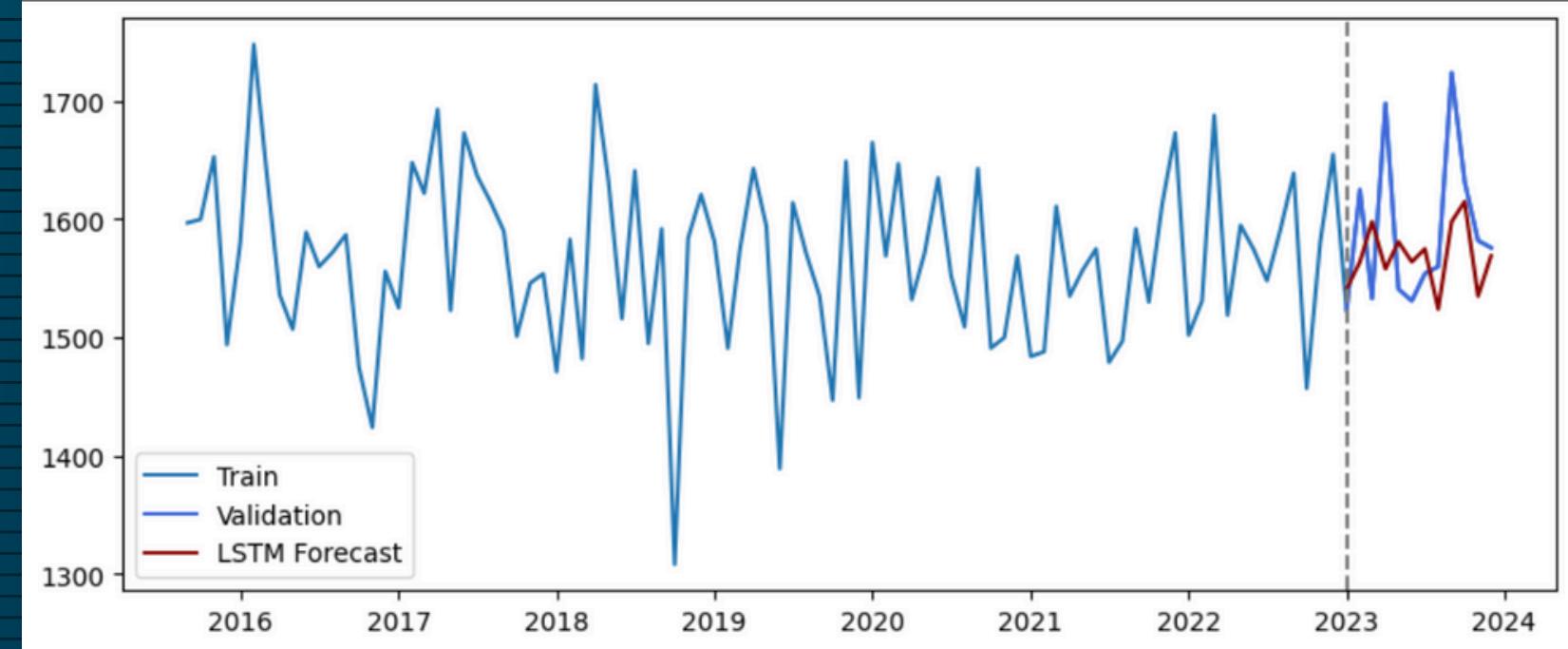
Many popular models assume data follows a **Gaussian** distribution, which may **not** be **valid in supply chain scenarios** with discrete-counting data.

INSUFFICIENT DATA SIZE

The real dimension of the dataset was smaller than expected. Zero paddings across series required a dedicated **pre-processing phase**.



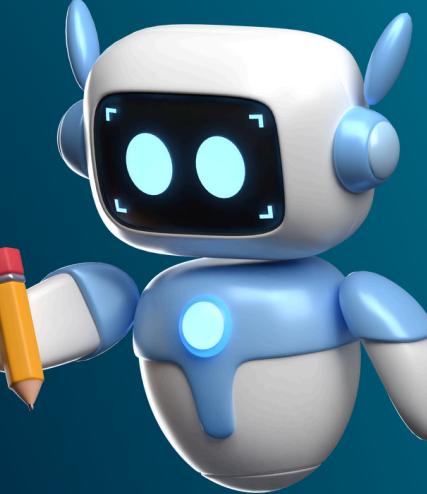
MODEL PERFORMANCE: SOME PLOTS



TOWARDS ENSEMBLE-MODELS APPROACH

- Last Trial : to combine predictions from multiple models
- Each model might capture different aspects of the data.
- **Weak models together can outperform a single complex model by compensating for each other's weaknesses.**
- Main Benefit: Ensemble methods can reduce overfitting, improve generalization, and lead to better overall model performance.

TIME-SERIES FORECASTING: TAKEAWAYS



LSTM

- Delivered acceptable performance although careful tuning.
- It served as a neural baseline for sequence modeling

LIGHTGBM

- Delivered decent performance with careful tuning.
- It served as a reliable neural baseline for sequence modeling

DEEPMAR / TFT

- Convergence issues during training phase
- Too ambitious for the dataset size and structure
- Worth exploring in richer scenarios

CLASSICAL MODELS

- A great surprise :)
- Holt-Winters method gave meaningful results
- Ensemble approach seemed promising

FUTURE DIRECTIONS

Kernel Methods
and
Physics-Informed AI



2

TASK 2: PRODUCTION BALANCING

STRATEGY

Supply chains involve production planning, in order to both balance the production rate between the various plants and satisfy the local demand.

This kind of problem can be solved via linear programming.

PROBLEM FORMALIZATION

COST FUNCTION

In this problem we don't have to consider production and shipment cost, so we have to optimize **only** the workload.

MAXIMUM CAPACITY

We have to ensure that each plant produces at most its nominal capacity.

EXACTLY SATISFY THE DEMAND

Considering both internal production and imports we want to exactly satisfy the demand.

ALGORITHM EMPLOYED: SAT SOLVER FOR LINEAR PROGRAMMING

This algorithm of Linear Programming employs SAT constraints to look for the optimal solution.

- Converts the constraints in boolean values
- Finds a feasible solution
- Checks the constraints, moving towards the best direction (minimizing the cost function)
- Iterates until either it is proven not to exist a better solution



This solver works ONLY if feasible solutions exist, like in our case

RESULT: Perfect Balance

Evaluation: 0.0

3

TASK 3: BALANCE PRODUCTION MINIMIZING COSTS

STRATEGY

Additionally to the previous problem, supply chain requires to take into account also production and shipment costs.

The chosen approach is analogous to the previous one, just adding to the cost function to minimize the total cost (sum of production and shipment for each plant)

PROBLEM FORMALIZATION

COST FUNCTION

In this problem we have to minimize both the **production cost** and the **workload** for each plant.

MAXIMUM CAPACITY

We have to ensure that each plant produces at most its nominal capacity.

EXACTLY SATISFY THE DEMAND

Considering both internal production and imports we want to exactly satisfy the demand.

RESULTS

Evaluation: 0.0, 112796306.320

- Also in this case we were able to reach perfect balance, with a total cost of \$112mln world-wide.

Country,Product,Month,Quantity
Australia,BreathBliss Mints,Apr2004,0
Australia,BreathBliss Mints,Aug2004,1515
Australia,BreathBliss Mints,Dec2004,606
Australia,BreathBliss Mints,Feb2004,1484
Australia,BreathBliss Mints,Jan2004,0
Australia,BreathBliss Mints,Jul2004,1820
Australia,BreathBliss Mints,Jun2004,619
Australia,BreathBliss Mints,Mar2004,0
Australia,BreathBliss Mints,May2004,0
Australia,BreathBliss Mints,Nov2004,0
Australia,BreathBliss Mints,Oct2004,637
Australia,BreathBliss Mints,Sep2004,1378
Australia,BreatheEasy Inhalant,Apr2004,743
Australia,BreatheEasy Inhalant,Aug2004,1827
Australia,BreatheEasy Inhalant,Dec2004,2051
Australia,BreatheEasy Inhalant,Feb2004,0

Head of the 02_output_productionPlan.csv

Country,Product,Month,Quantity
Australia,BreathBliss Mints,Apr2004,0
Australia,BreathBliss Mints,Aug2004,0
Australia,BreathBliss Mints,Dec2004,0
Australia,BreathBliss Mints,Feb2004,0
Australia,BreathBliss Mints,Jan2004,0
Australia,BreathBliss Mints,Jul2004,0
Australia,BreathBliss Mints,Jun2004,0
Australia,BreathBliss Mints,Mar2004,0
Australia,BreathBliss Mints,May2004,0
Australia,BreathBliss Mints,Nov2004,0
Australia,BreathBliss Mints,Oct2004,0
Australia,BreathBliss Mints,Sep2004,0
Australia,BreatheEasy Inhalant,Apr2004,1957
Australia,BreatheEasy Inhalant,Aug2004,1827
Australia,BreatheEasy Inhalant,Dec2004,1699
Australia,BreatheEasy Inhalant,Feb2004,1675

Head of the 02_output_productionPlan.csv

RESULTS COMPARISON

Country,Product,Month,Quantity
Australia,BreathBliss Mints,Apr2004,0
Australia,BreathBliss Mints,Aug2004,1515
Australia,BreathBliss Mints,Dec2004,606
Australia,BreathBliss Mints,Feb2004,1484
Australia,BreathBliss Mints,Jan2004,0
Australia,BreathBliss Mints,Jul2004,1820
Australia,BreathBliss Mints,Jun2004,619
Australia,BreathBliss Mints,Mar2004,0
Australia,BreathBliss Mints,May2004,0
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Australia,BreathBliss Mints,Sep2004,1378
Australia,BreatheEasy Inhalant,Apr2004,743
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Head of the 02_output_productionPlan.csv

Country,Product,Month,Quantity
Australia,BreathBliss Mints,Apr2004,0
Australia,BreathBliss Mints,Aug2004,0
Australia,BreathBliss Mints,Dec2004,0
Australia,BreathBliss Mints,Feb2004,0
Australia,BreathBliss Mints,Jan2004,0
Australia,BreathBliss Mints,Jul2004,0
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Australia,BreathBliss Mints,Mar2004,0
Australia,BreathBliss Mints,May2004,0
Australia,BreathBliss Mints,Nov2004,0
Australia,BreathBliss Mints,Oct2004,0
Australia,BreathBliss Mints,Sep2004,0
Australia,BreatheEasy Inhalant,Apr2004,1957
Australia,BreatheEasy Inhalant,Aug2004,1827
Australia,BreatheEasy Inhalant,Dec2004,1699
Australia,BreatheEasy Inhalant,Feb2004,1675

Head of the 03_output_productionPlan.csv

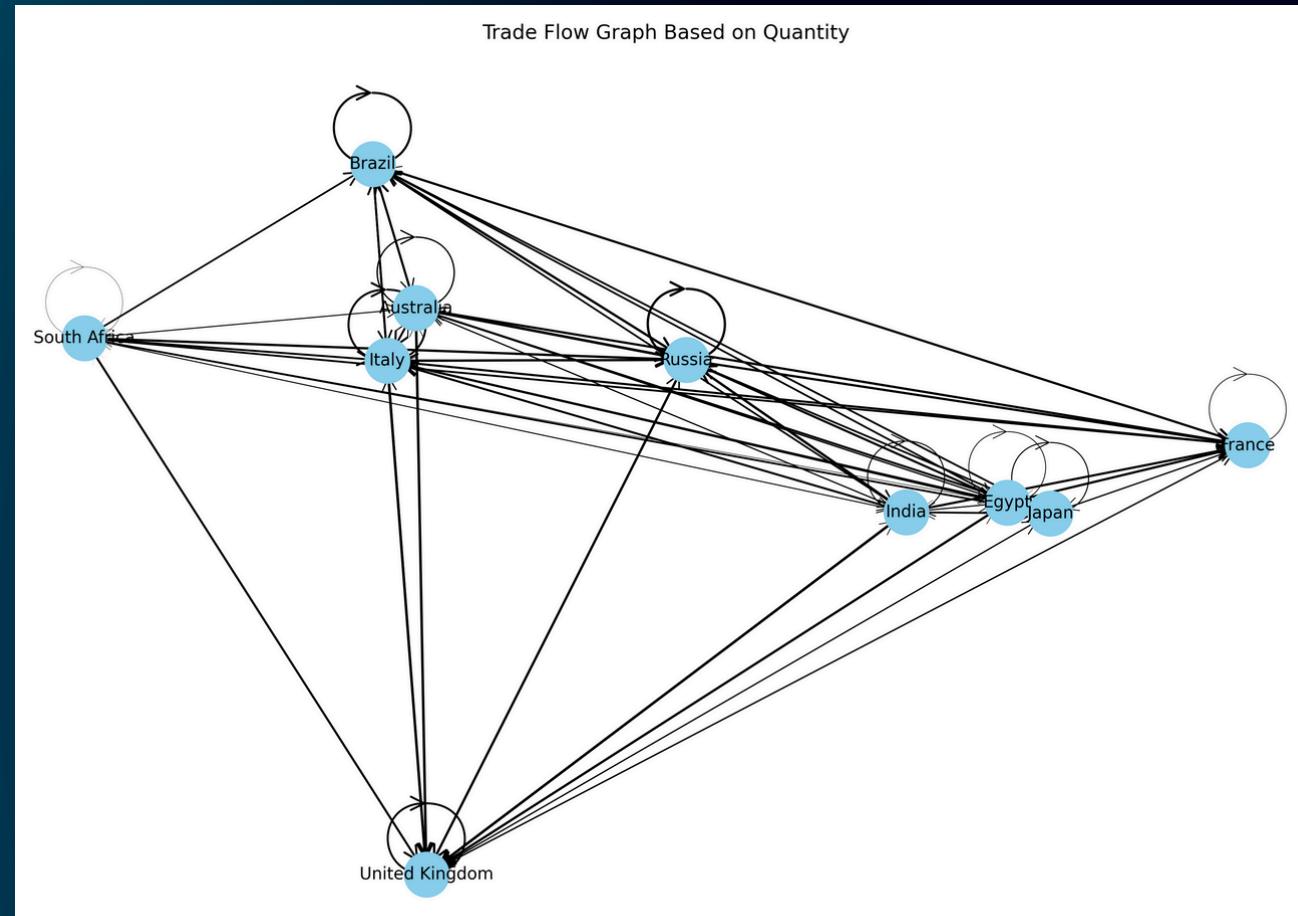
Origin,Destination,Product,Month,Quantity
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Australia,Japan,MorningMint,Dec2004,0
Australia,Japan,FreshStart Toothpaste,Jan2004,0
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Head of the 02_output_shipments.csv

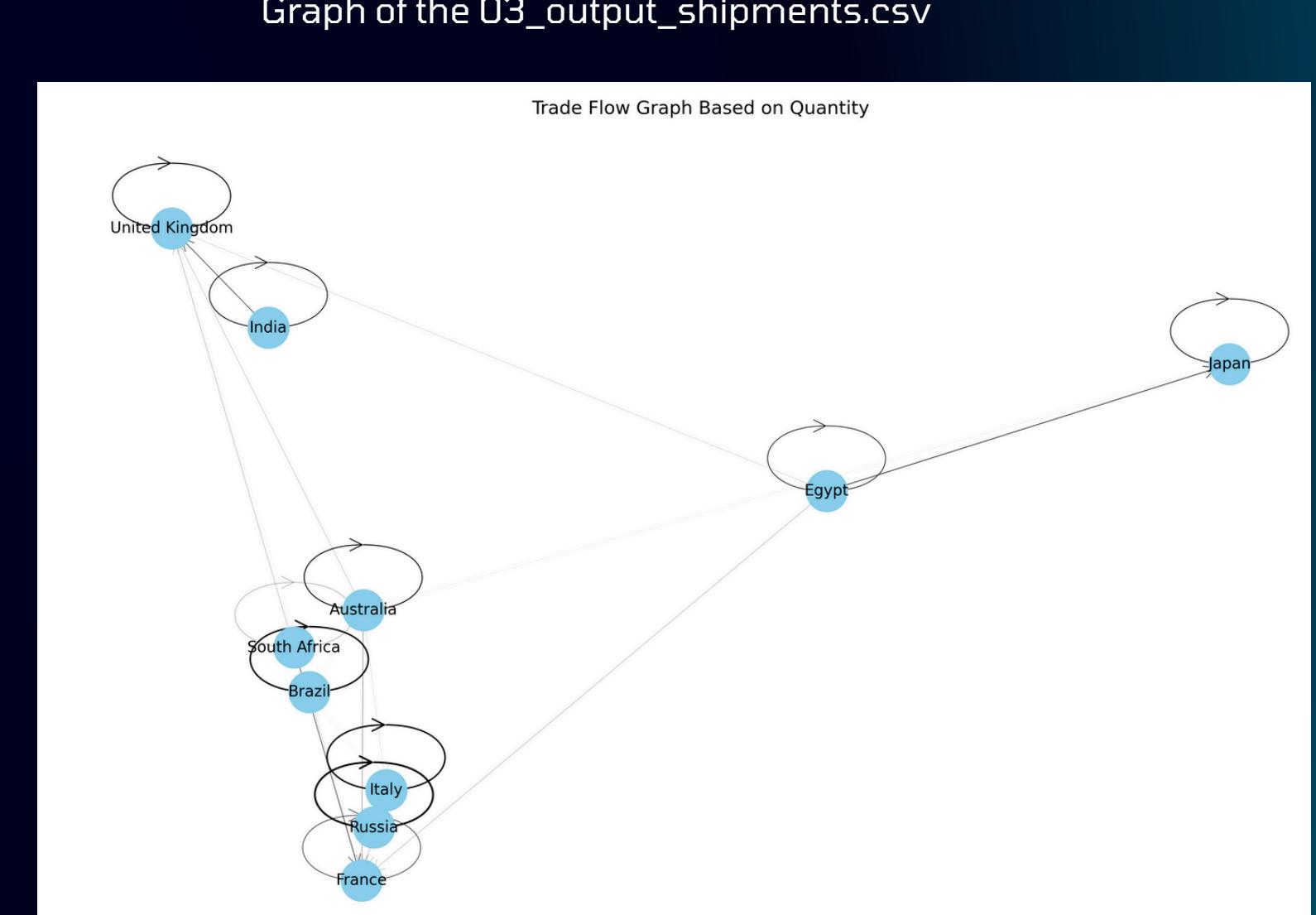
Origin,Destination,Product,Month,Quantity
Australia,Japan,MorningMint,Jan2004,0
Australia,Japan,MorningMint,Feb2004,0
Australia,Japan,MorningMint,Mar2004,0
Australia,Japan,MorningMint,Apr2004,0
Australia,Japan,MorningMint,May2004,0
Australia,Japan,MorningMint,Jun2004,0
Australia,Japan,MorningMint,Jul2004,0
Australia,Japan,MorningMint,Aug2004,0
Australia,Japan,MorningMint,Sep2004,0
Australia,Japan,MorningMint,Oct2004,0
Australia,Japan,MorningMint,Nov2004,0
Australia,Japan,MorningMint,Dec2004,0
Australia,Japan,FreshStart Toothpaste,Jan2004,0
Australia,Japan,FreshStart Toothpaste,Feb2004,0
Australia,Japan,FreshStart Toothpaste,Mar2004,0
Australia,Japan,FreshStart Toothpaste,Apr2004,0

Head of the 03_output_shipments.csv

RESULTS COMPARISON



Graph of the 02_output_shipments.csv



**THANKS FOR YOUR
ATTENTION!**