

# A Novel Approach for Handling Diverse Energy Consumption Issues in Large Passenger and Cruise Ships

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Ευρωπαϊκή Ένωση  
Ευρωπαϊκά Διαρθρωτικά  
και Επενδυτικά Ταμεία

ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ ΔΥΤΙΚΗ ΕΛΛΑΔΑ 2014-2020  
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

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# Prediction of Energy Consumption in Large Cruise Ships

- ❑ Energy Consumption in large cruise ships is a complex and challenging issue.
- ❑ The equivalent of energy consumption in cruise ships is energy consumption in giant buildings like skyscrapers or small villages.
- ❑ Energy consumption in cruise ships can be divided into two large theoretical segments:
  - ❑ Energy spent for ship's movement
  - ❑ Energy spent for customers and crew's services provision

# Related Work

## Simulation For Energy Consumption

- ❑ Zhang et al. (2010)
  - ❑ Agent Based Simulation for office energy consumption
- ❑ Guangrong et al. (2013)
  - ❑ Multi-domain simulation method for ship energy flow
- ❑ Baldi et al. (2018)
  - ❑ Combination of direct measurements and computational models of the energy system of the ship

## Machine Learning for Energy Consumption

- ❑ Seyedzadeh et al. (2018)
  - ❑ ML algorithms for energy consumption in buildings
- ❑ Guzhov and Krolin (2018)
  - ❑ Combination of mathematical statistics and neural network for predicting energy consumption in buildings
- ❑ Rajasekaran et al. (2017)
  - ❑ Combination of KNN and Markov Chain algorithms for handling energy management issues

# Our Approach

## Our goals

- Prediction of energy demands at various ship's cites

## Our assumptions

- Energy demands at ship's cites is being affected by the number of passengers are gathered at these cites at a given time .
- Energy Consumption at crowded cites such as Disco Room and Casino is determined by passengers' personal choices for entertainment during their voyage.
- These personal choices can be considered as peculiarity of the age group they are categorized to.
- The Energy demands for each cite of the ship, can be expressed by unique energy thresholds

# Our Approach

## Our Data

### Real Data

- Spatial Data: Layout of each ship's Deck.

### Virtual Data

- Based on a series of meetings with shipping companies we created realistic compositions of passengers, categorized by age groups.

## Simulation of passengers' movement

- With the use of AnyLogic software, we run different experiments to replicate passengers' movement from their cabins to different facilities of entertainment.
- We estimated the passengers' gatherings at given cite for each period of time.

# Our Approach

## ML Algorithms

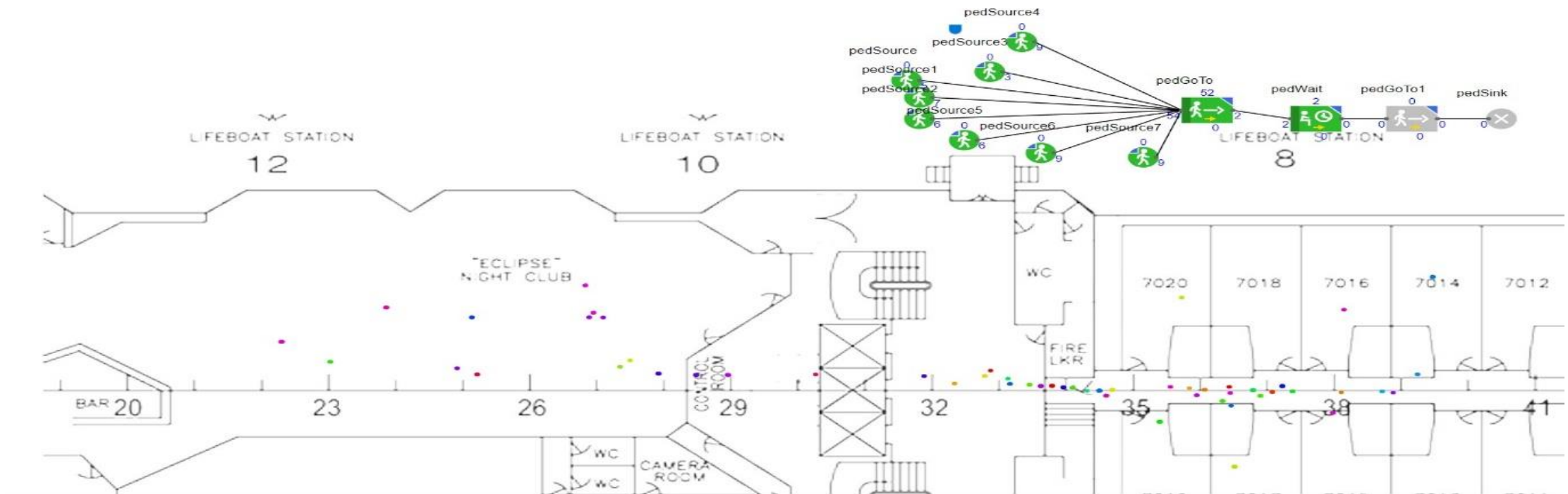
- Decision Trees
- K-NN Algorithm

## Production of meaningful insights

- The combination of simulation techniques and ml algorithms, reveal undetected patterns of passengers' composition associated to specific energy demands at different cites of the ship.
- These patterns can be further discussed with ship's stakeholders to facilitate decision making.

# Experiments

## Agent-Based Simulation

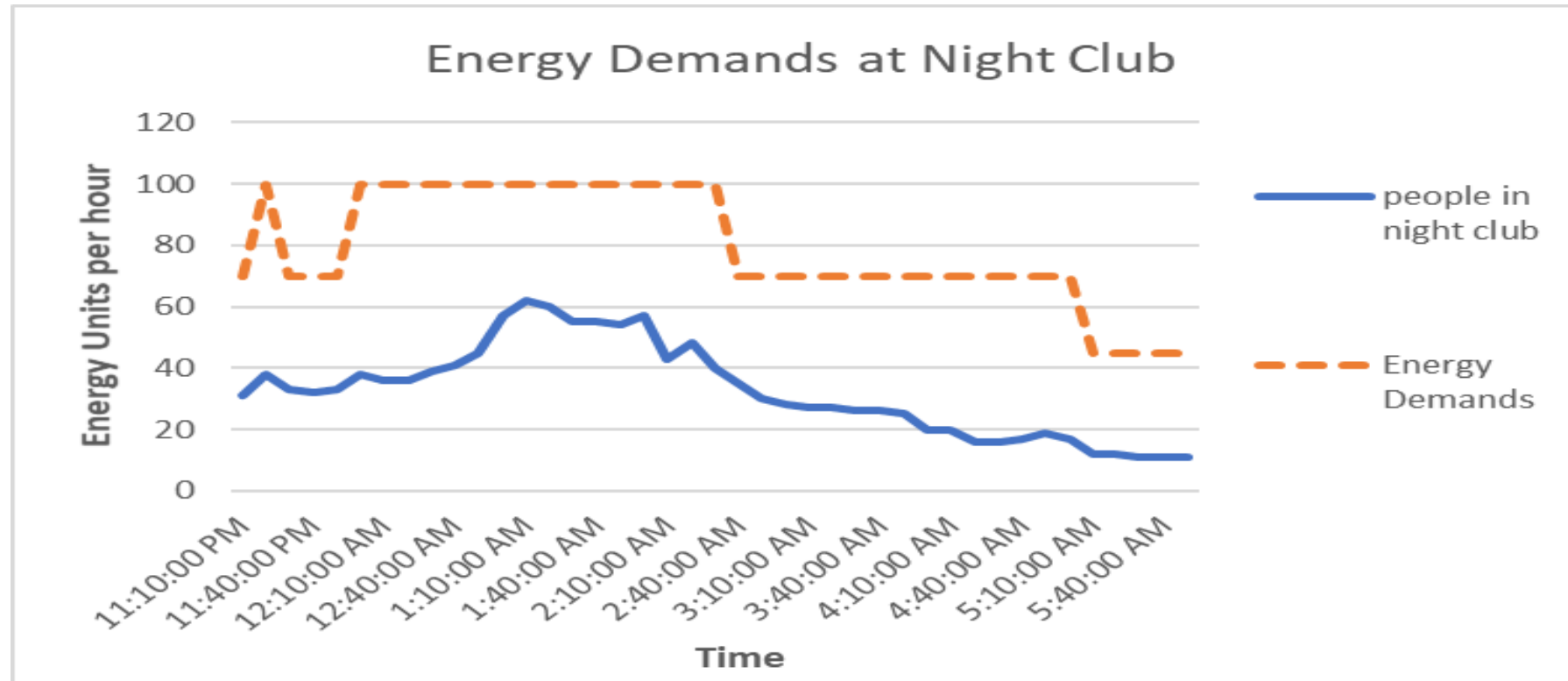


An instance of a simulated energy consumption scenario in the nightclub



# Experiments

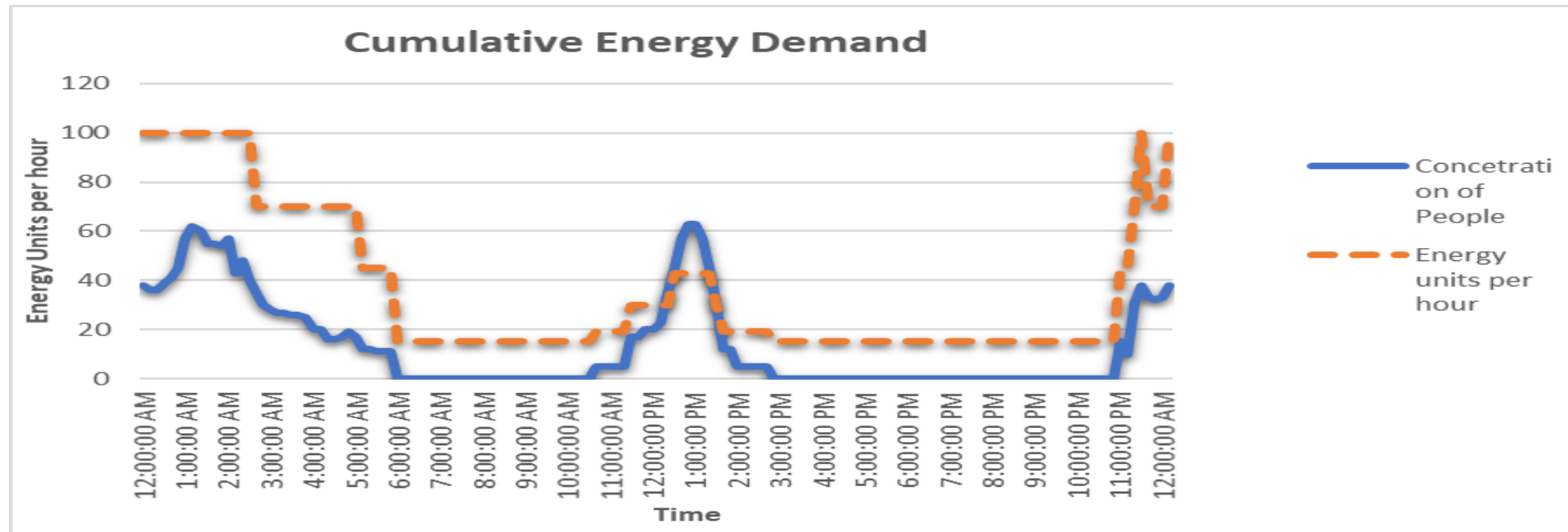
## Estimating Energy demands at ship's Night Club



Energy demands corresponding to passengers' concentration in the nightclub

# Experiments

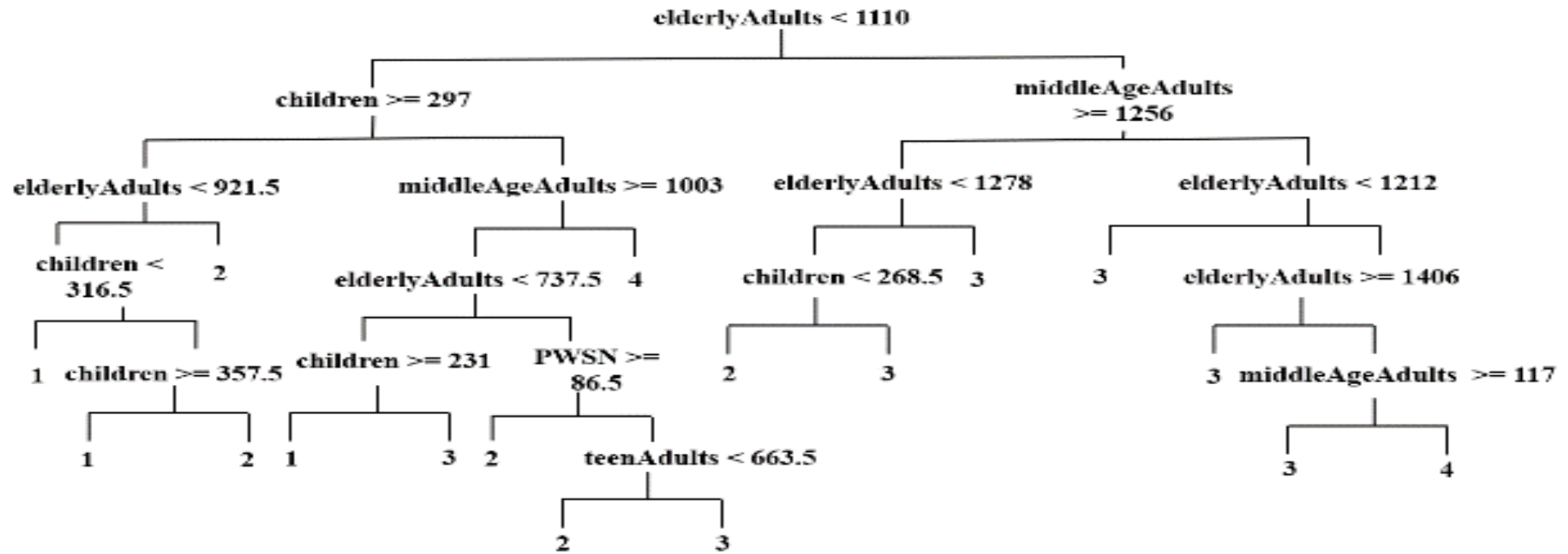
## Data Analysis and Synthesis



Cumulative concentration of passengers in four major ship's facilities and corresponding energy demand

# Experiments

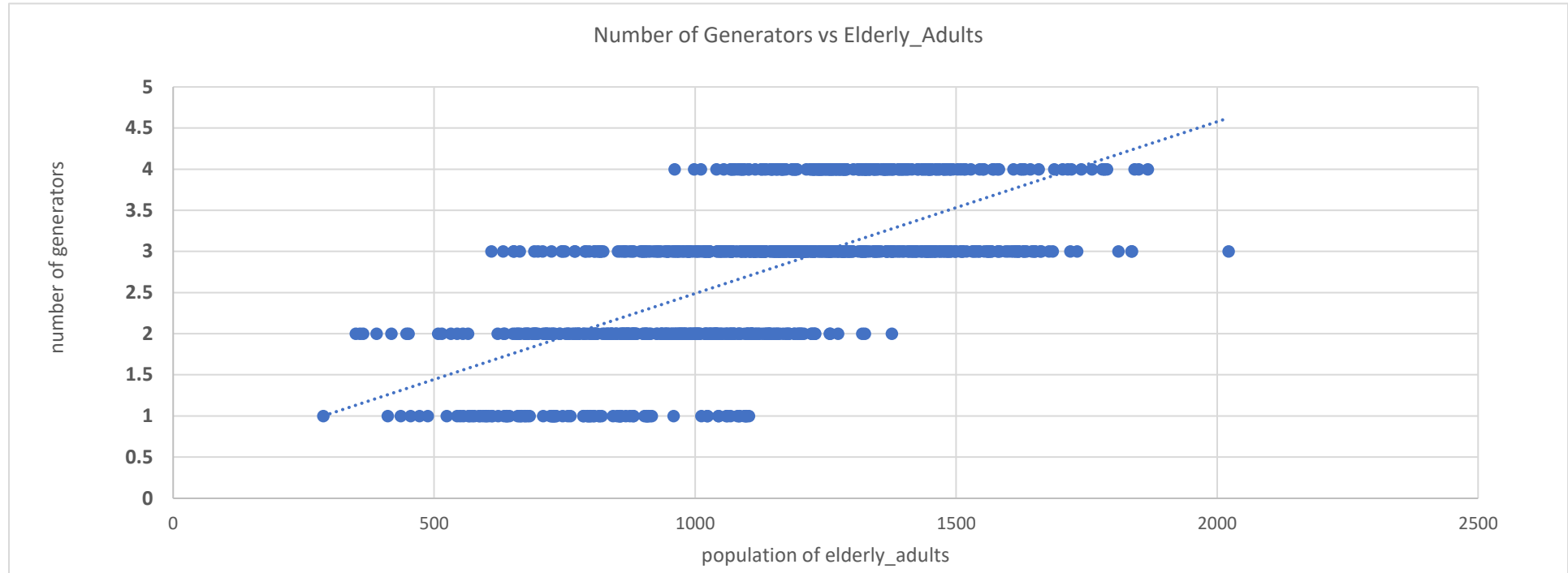
## ML algorithms



Decision Tree classification ('children', 'teenAdults', 'middleAgeAdults' and 'elderlyAdults' correspond to the 1-14, 15-34, 35-54 and  $\geq 55$  age groups, respectively)

# Experiments

## Triggering insights



Scatter plot - number of generators vs population of elderly passengers

# Summary

- ❑ Agent-Based simulation can be further exploited to predict energy demands in large passenger and cruise ships.
- ❑ Agent-Based simulation produce data such as passengers' gatherings in a way that no other method can.
- ❑ The combination of simulation techniques with ML algorithms can produce deep and meaningful insights.
- ❑ Modeling of passengers' behavior produce a series of recommendations towards better energy management.

# Future Work

- ❑ Run similarly experiments for more than 4 cites.
- ❑ Find and utilize more real data into our models.
- ❑ Engage different type of machine learning algorithms.

Any Questions?

Thank you!

# Acknowledgements

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*ζεμάτη αντιδέσεις!*