"MACHINE LEARNING-BASED ALGORITHM FOR MANAGEMENT AND PLANNING OF WORK SHIFTS"

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- Problem statement

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1 Business Challenge
Leroy Merlin, APPersonam

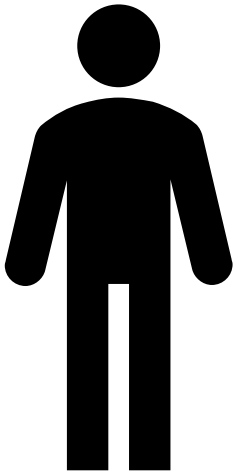
Leroy Merlin

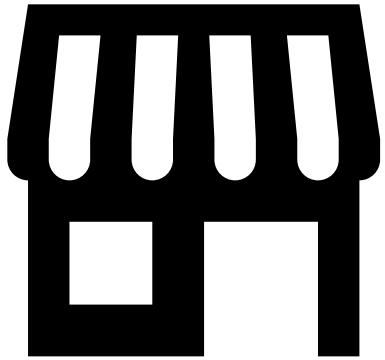
- **11 Countries** in the world
- **48 Stores** in Italy
- **14 Departments** in each *store*
- Up to **20 Sales Advisors** per each team in each *department*

Role of the Sales Advisor

Responsibility of sales within the department

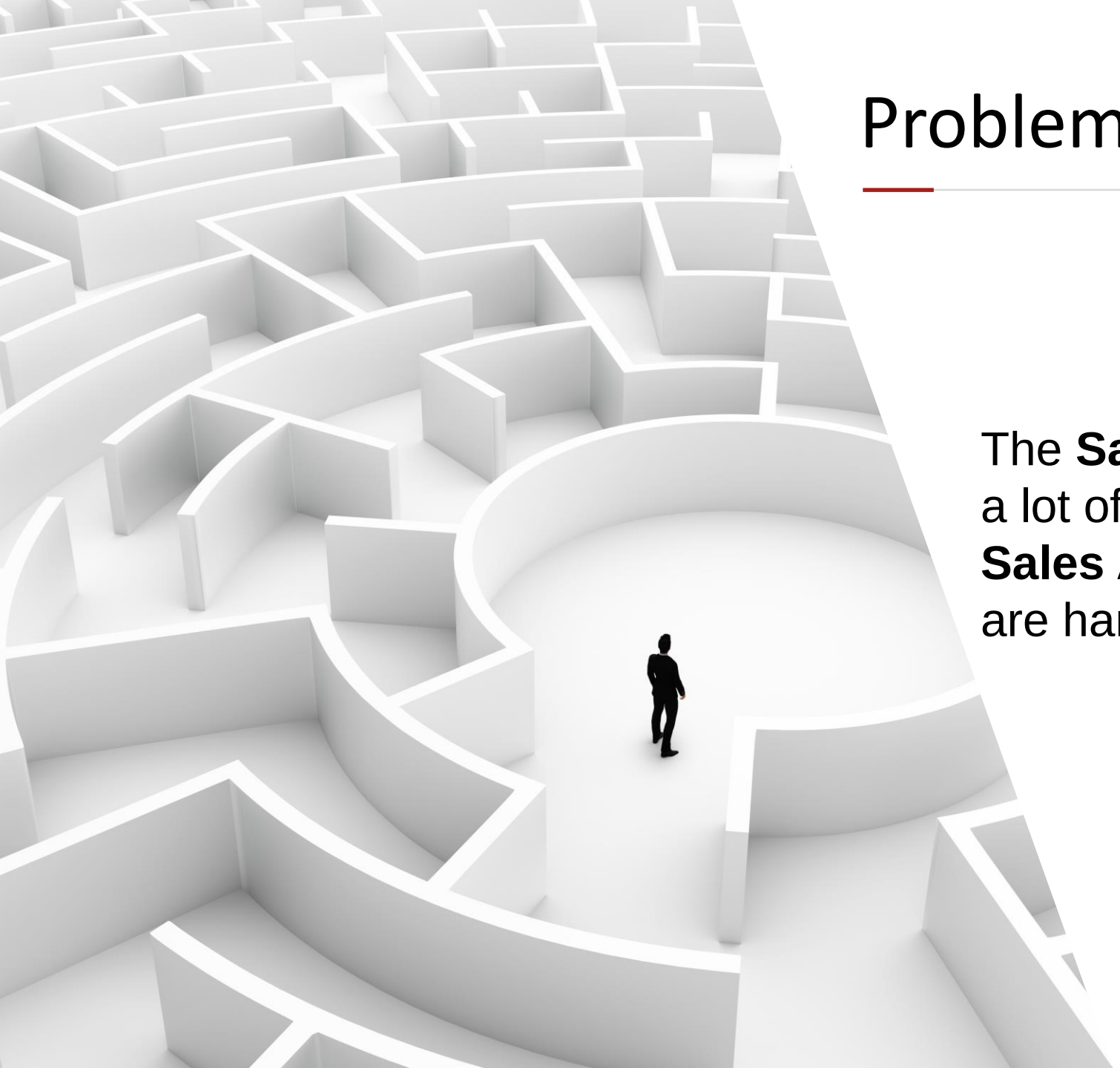
- Temporary contract full time - 40 hours per week
- Temporary contract part-time - 20 hours per week
- Permanent contract full time - 38 hours per week
- Permanent contract part-time - 20 hours per week





Pain Points

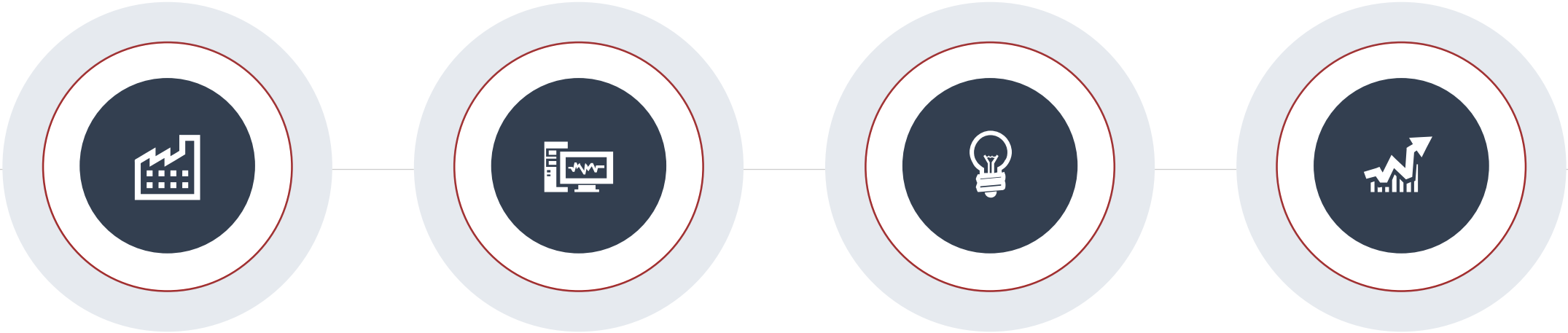
- The **Sales area Manager** occupied from 2 to 5 hours per week to create the work shifts of his team
- Timetables are **handwritten** on paper every week
- The **Sales Advisors** cannot express their preferences for the work shifts
- There is **no archive** of this information



Problem statement

The **Sales area Manager** currently spend a lot of **time** doing the work shifts of the **Sales Advisors** because the **timetables** are handwritten every week.

APPersonam



BUSINESS NEED

TECHNOLOGY

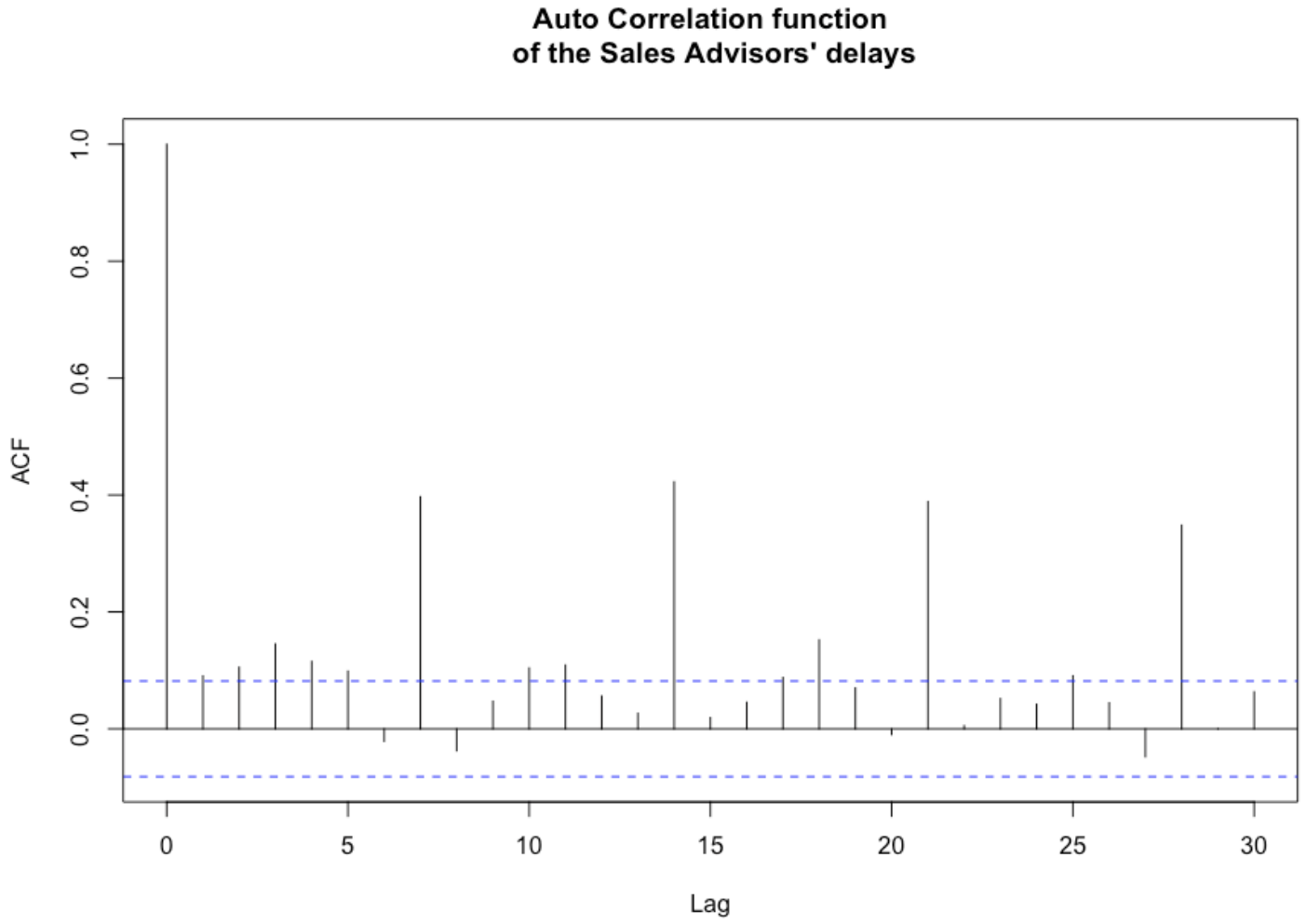
MODELING

RESULTS

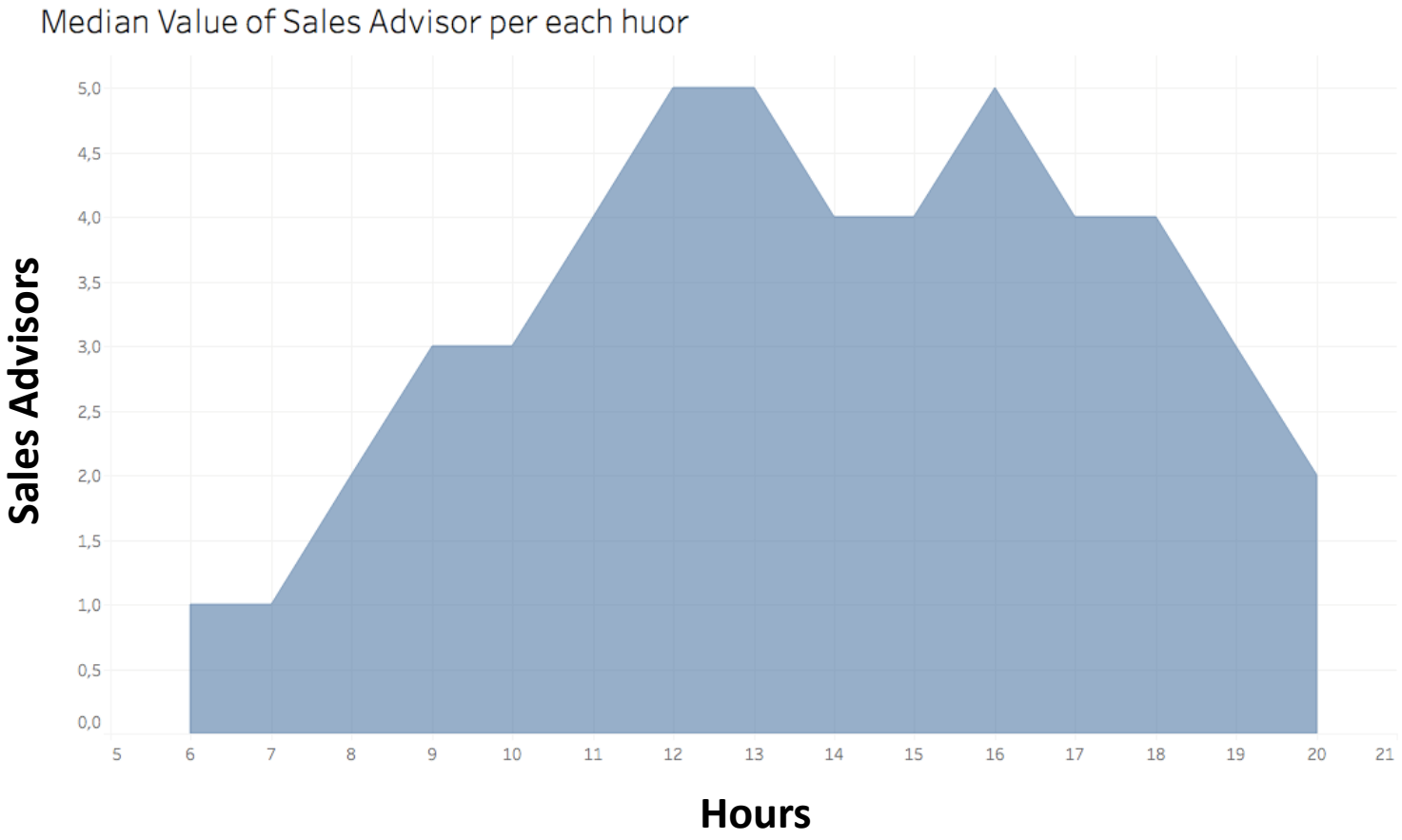
2 Technology
Data Description and Analysis

Inquiring the dependent variable

- We want to analyze the delays for the dependent variable: the **amount of Sales Advisors** per each hour
- We want to understand the past trough **Time Series Analysis**
- A selected hour is more similar **7,14,21 days before** instead of continuous days
- Data sources: **Stamping card at work**



Area under the hourly distribution



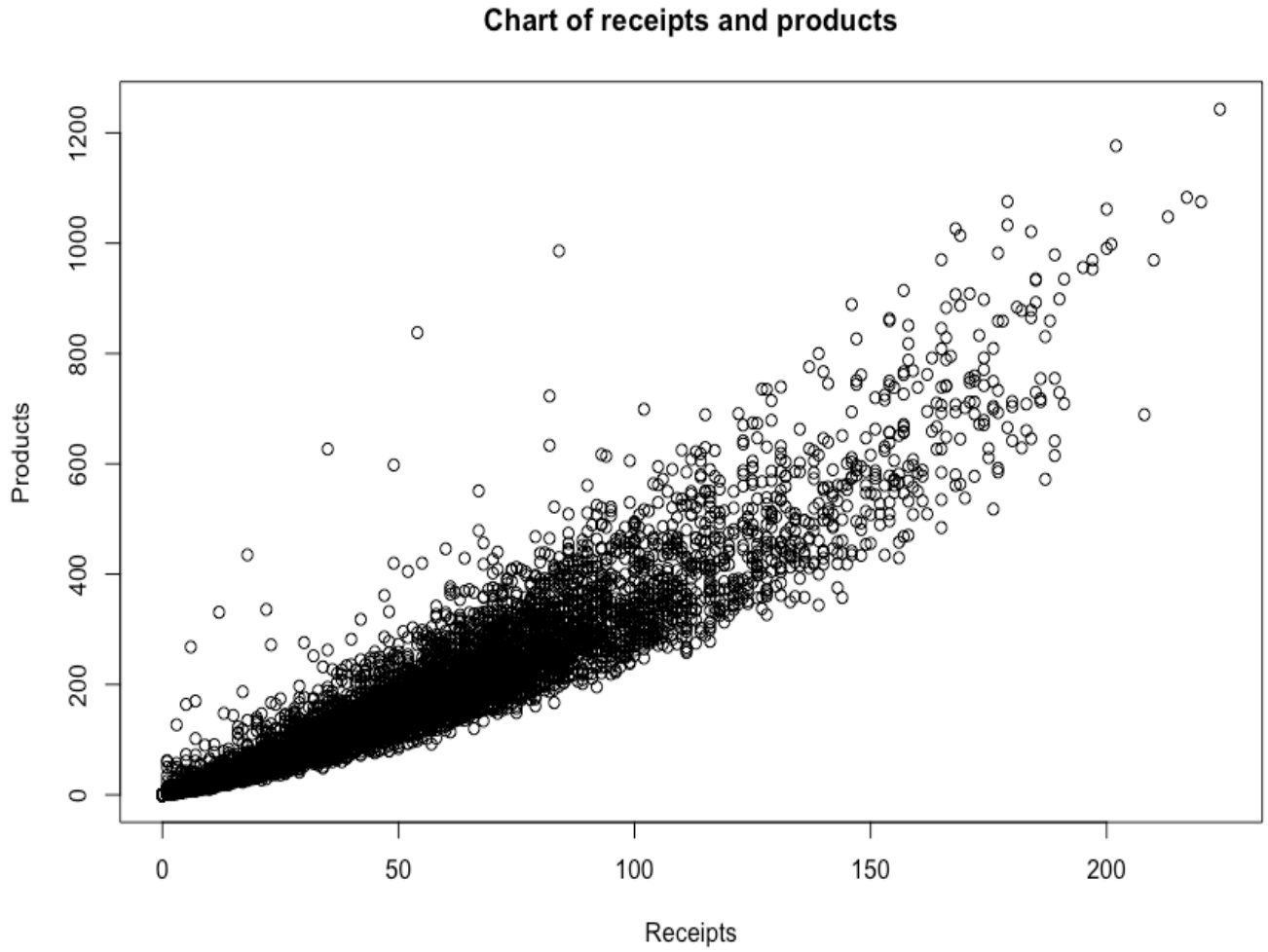
- The final algorithm has as a **variable of interest** the number of *sales advisors* allocated during the workday **per each hour**, per each *department* of each LM's *store* in Italy
- We can see that there are **two peaks** in the distribution when the number of Sales Advisor within a hour **is maximum**

Choose the predictors

- Number of receipts
- Number of products sold

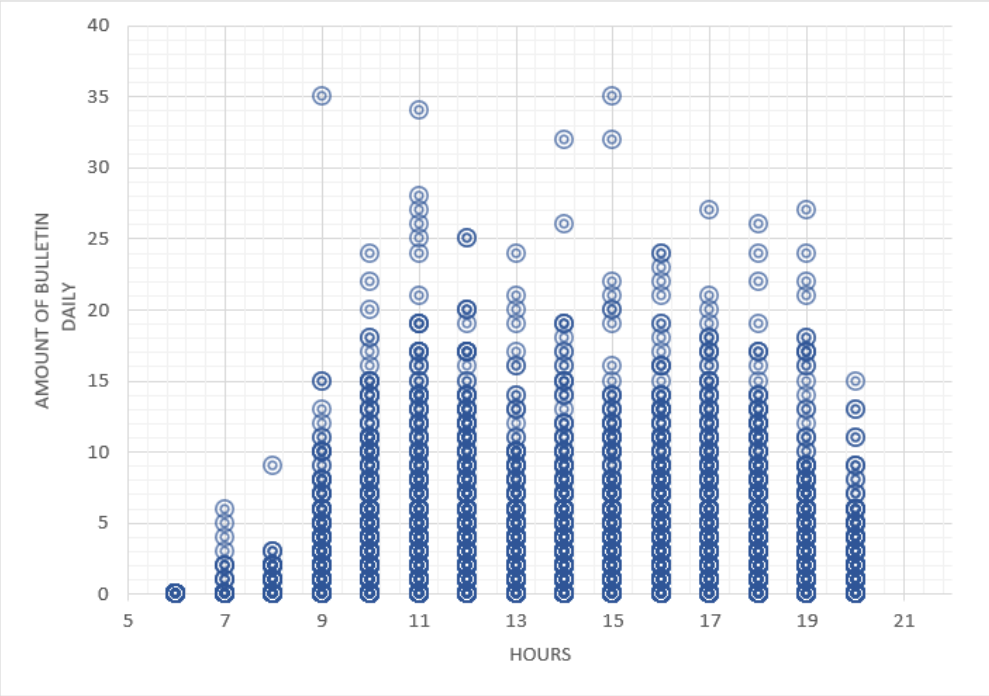
- Number of sales bulletins
- Number of quotes

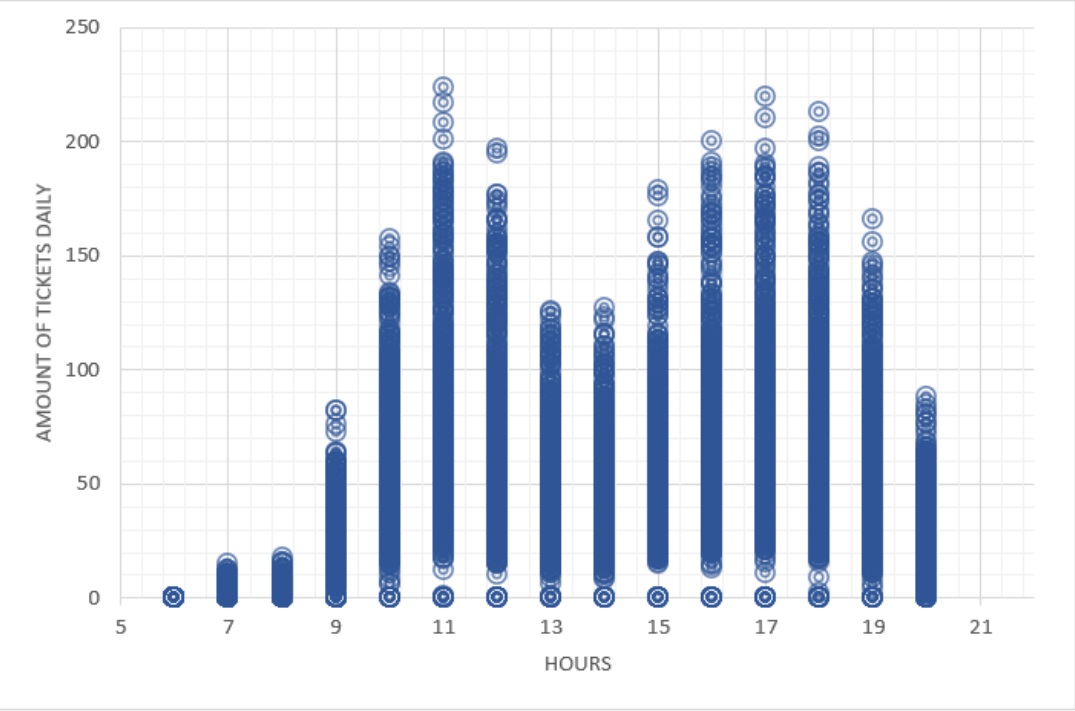
- Number of orders
- Turnover



Comparing the independent variables' distributions

- We are comparing the variables **Number of Bulletin and the Number of Receipts** in the same *department*
- Both are **descrete distribution**
- There are **two peaks** corresponding to the moment when the **maximum amount of client** is present in the *department*





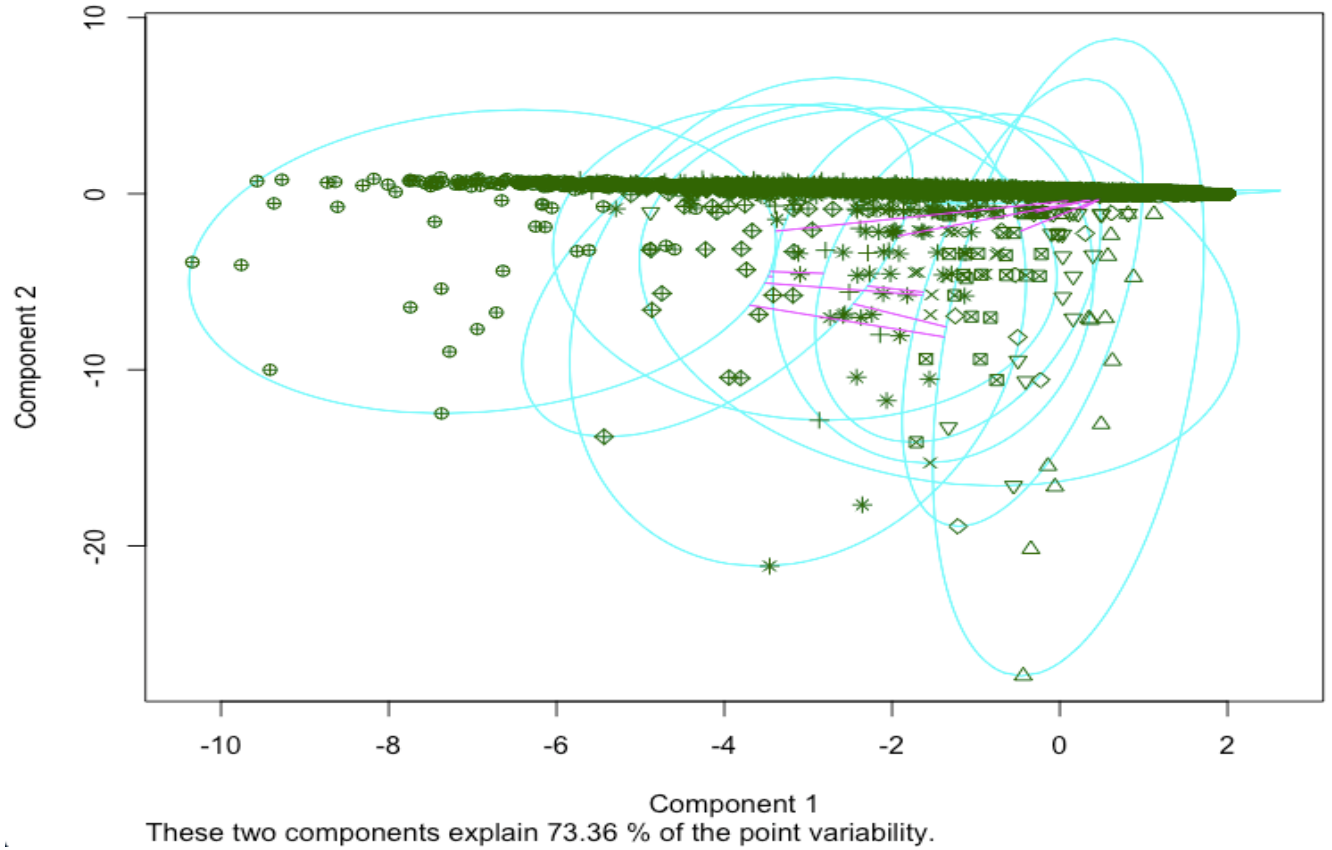
Standardization of the variables

$$MM(X_{ij}) = \frac{X_{ij} - X_{\min}}{X_{\max} - X_{\min}}$$

Min-max normalization

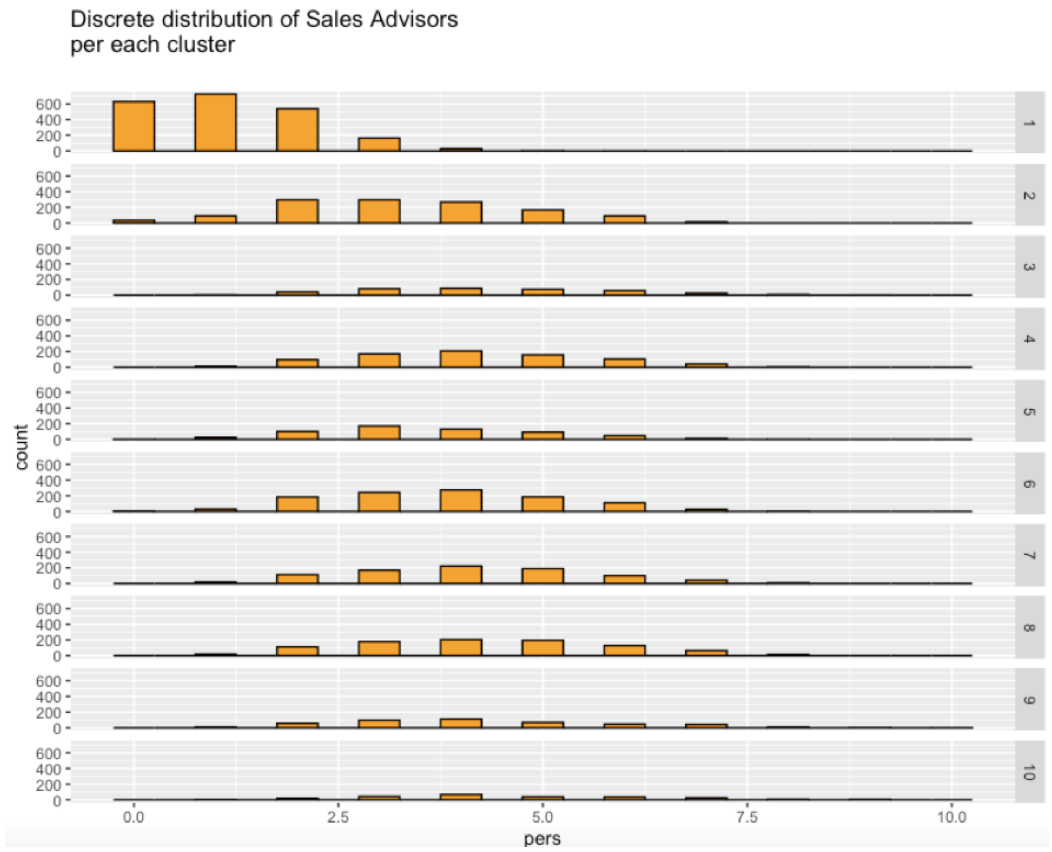
Min-Max normalization is the process of taking data measured in its engineering units and **transforming it to a value between 0 and 1**. Whereby the lowest (min) value is set to 0.0 and the highest (max) value is set to 1.0. This provides an easy way **to compare values that are measured using different scales or different units of measure**. The normalized value is defined as:

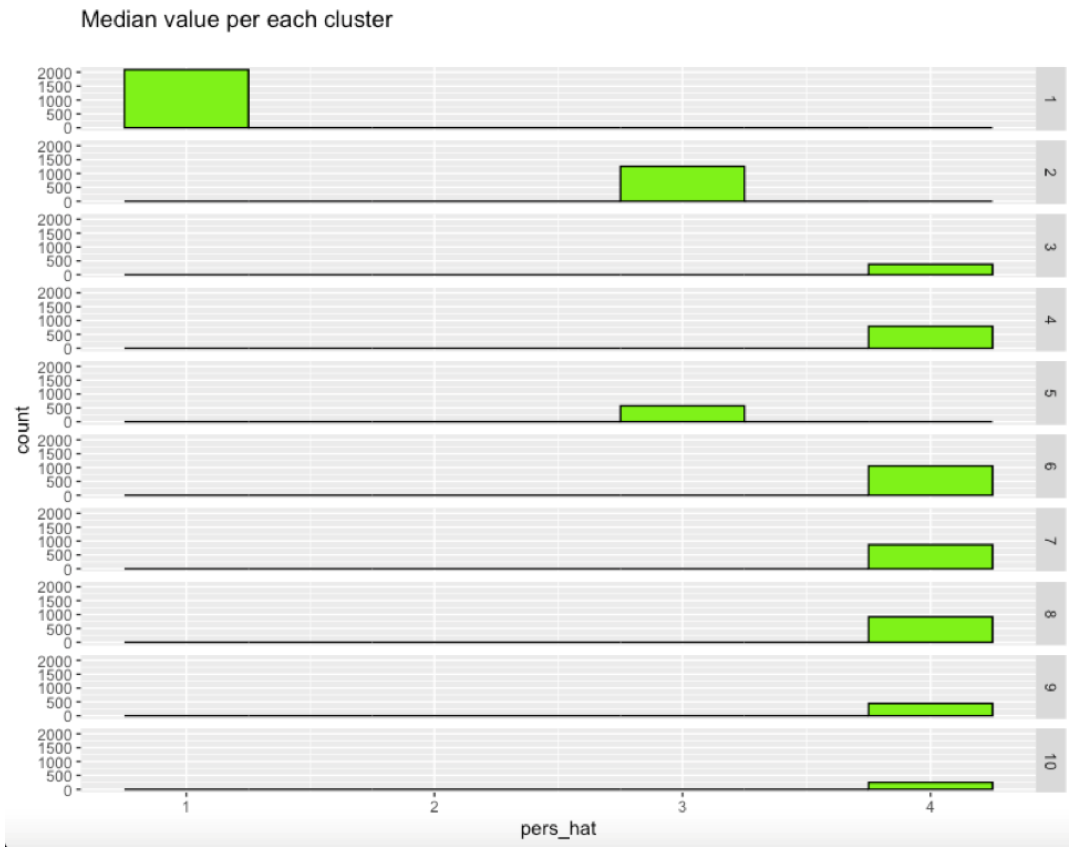
Clustering Algorithm



- The clustering model PAM (**Partitioning around medoids**) has been applied;
- It is very similar to a K-means algorithm, but instead to have '*virtual*' medoids within the cluster, PAM has **real observation as medoids**;
- The **number of K cluster**, and so medoids, should be **fixed *a priori*.** In general it has been put the maximum number of Sales Advisors seen in all historical data;
- *E.g.* In this case **K=10.**

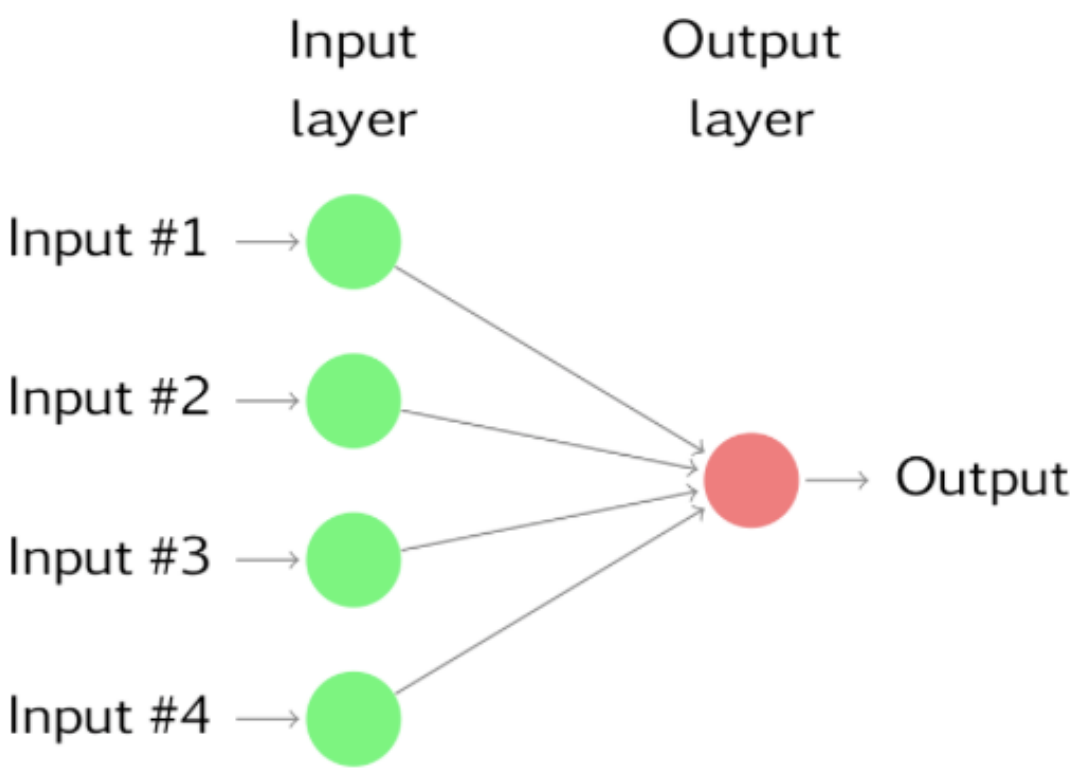
Clustering outcomes

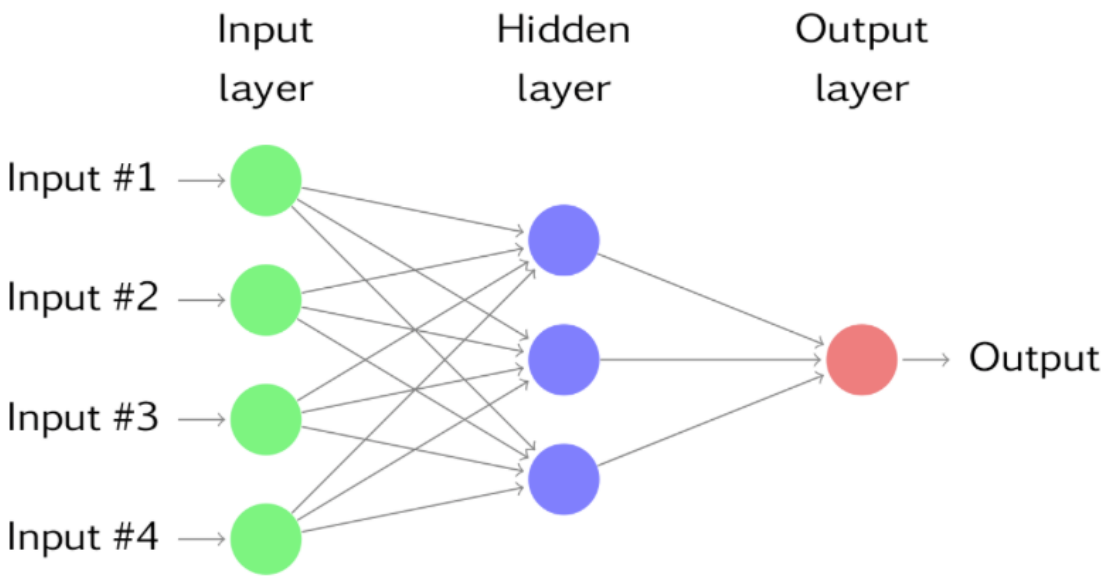




3 Classification and Regression Models
Machine learning, Neural Networks

Neural Networks





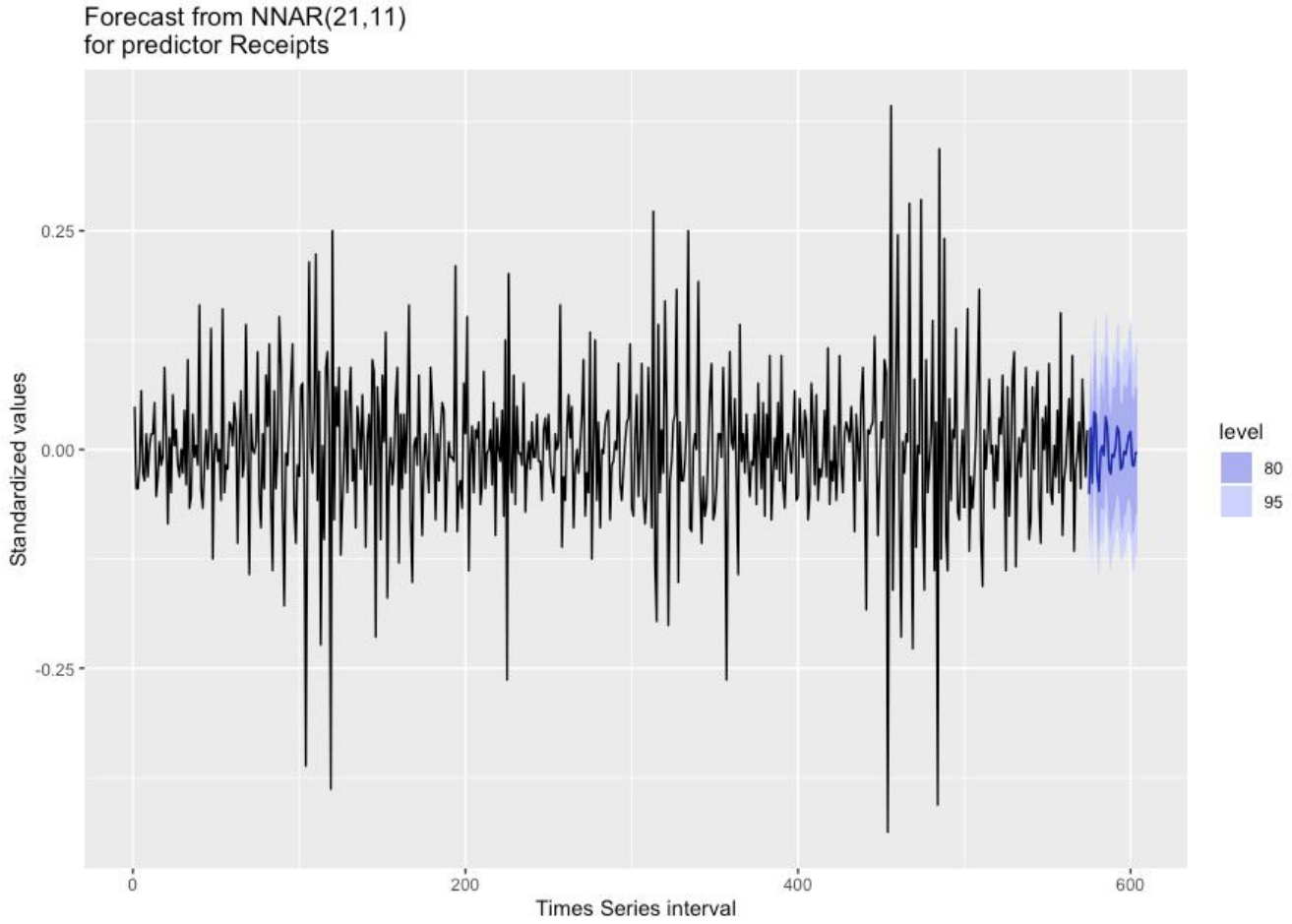
Confusion Matrix

Prediction	References (Number of Sales Advidors hourly)		
	1	3	4
1	**433**	4	0
3	2	**324**	19
4	0	11	**921**

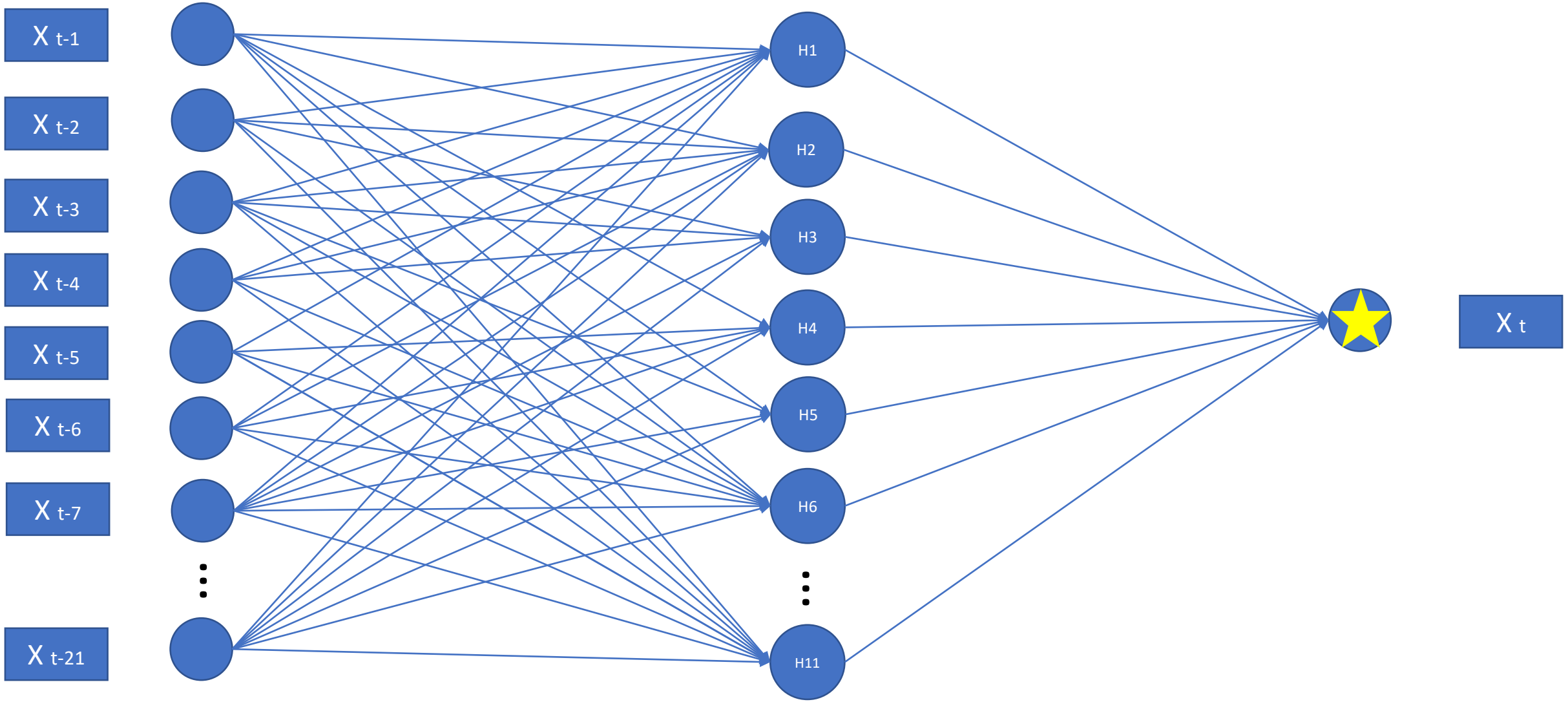
- Trough **repeated cross validation** we train the Neural Network model
- The dataset set is splitted in **data train** (70%) and **data test** (30%)
- **Accuracy** : 0.9791
- **95% Confidence Interval** : (0.9712, 0.9853)

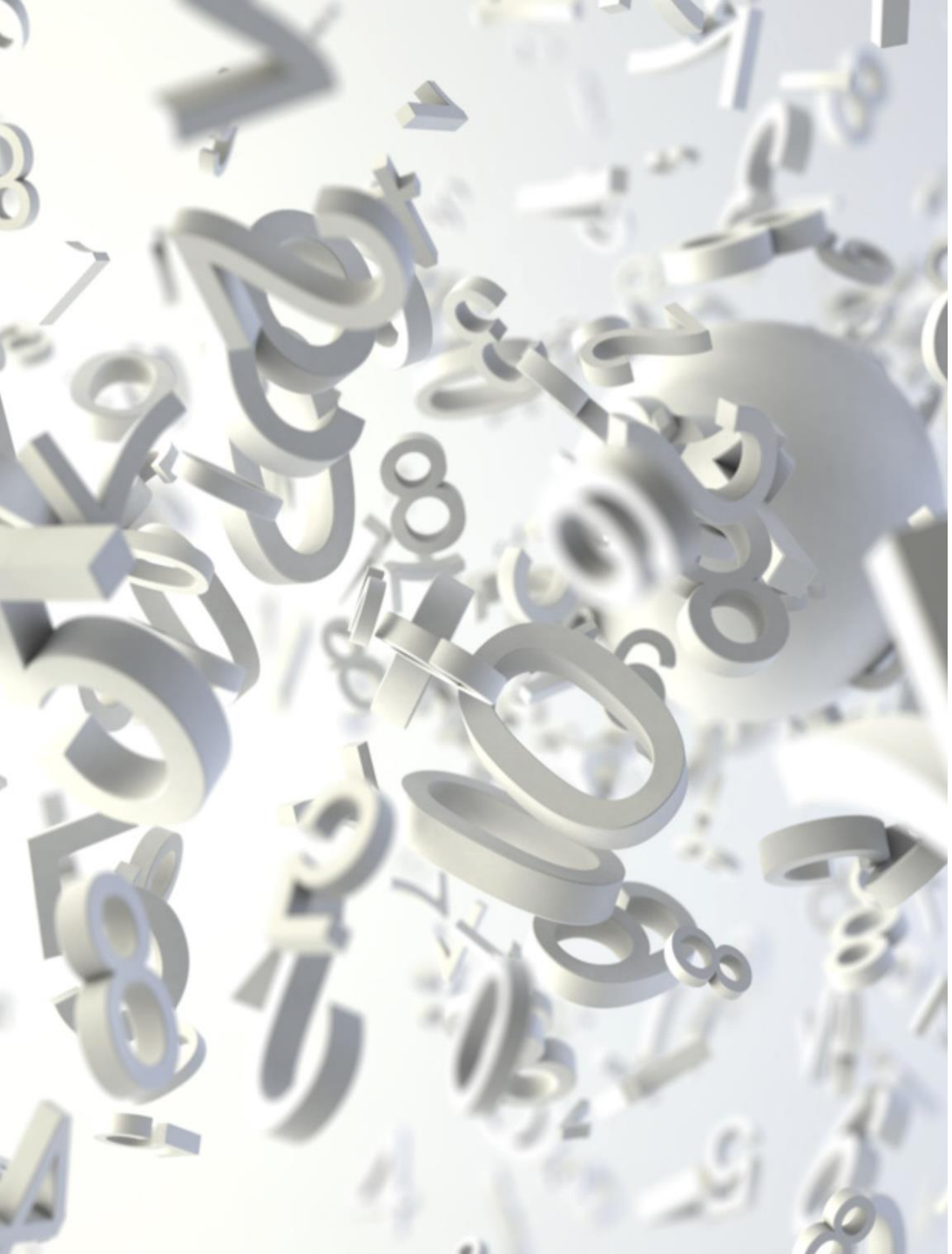
Neural Networks Auto Regressive

- We want to **predict** the value per each our of **each predictors**
- *nnetar()* is a function implemented by R.J. Hyndman (2007) in the *package forecast* in **R**
- The data of the **previous 21 days are put as input** in the Auto Regressive Neural Network with **one Hidden Layer with 11 neurons**

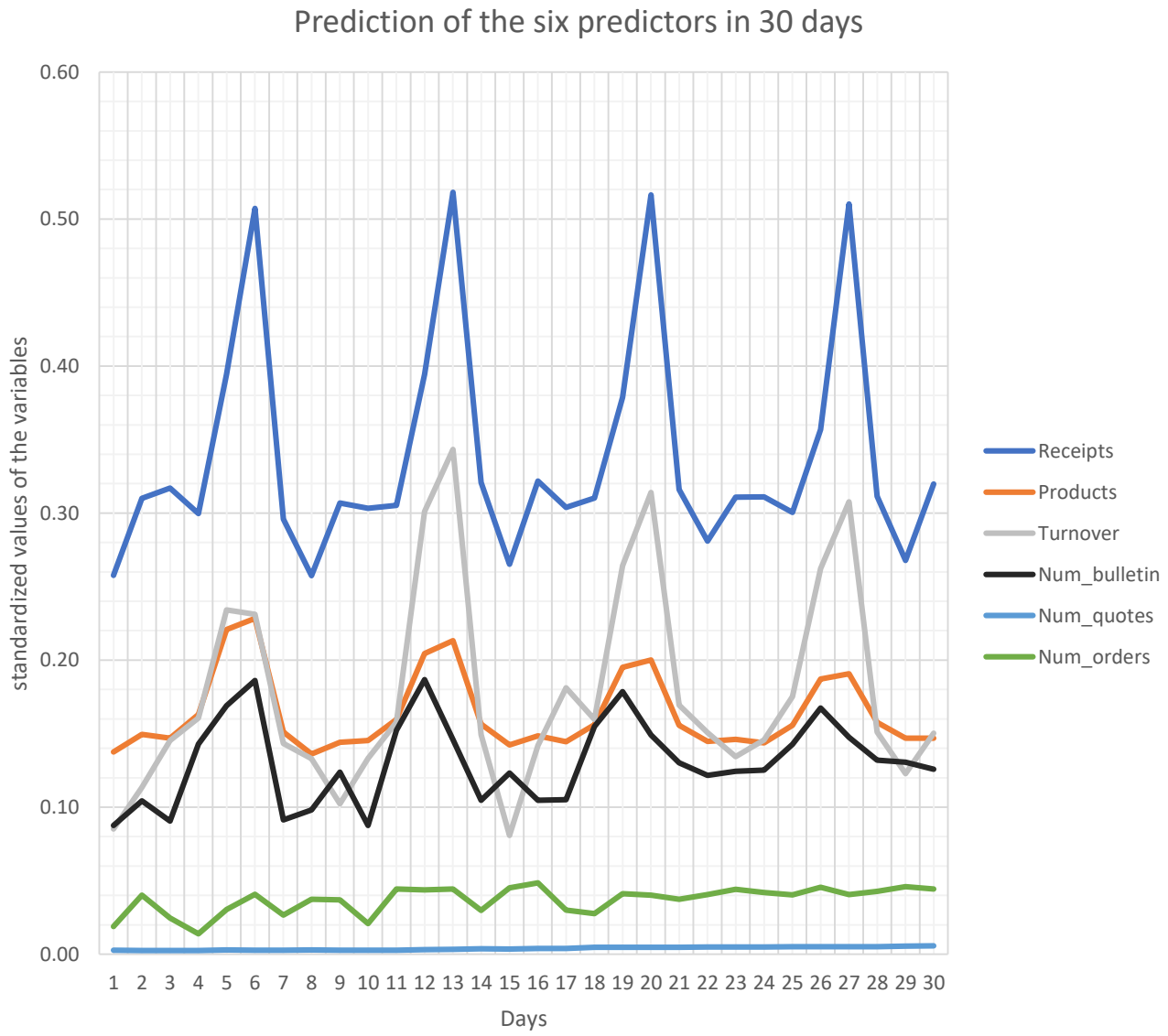


Auto Regressive Neural Networks





Features Forecast



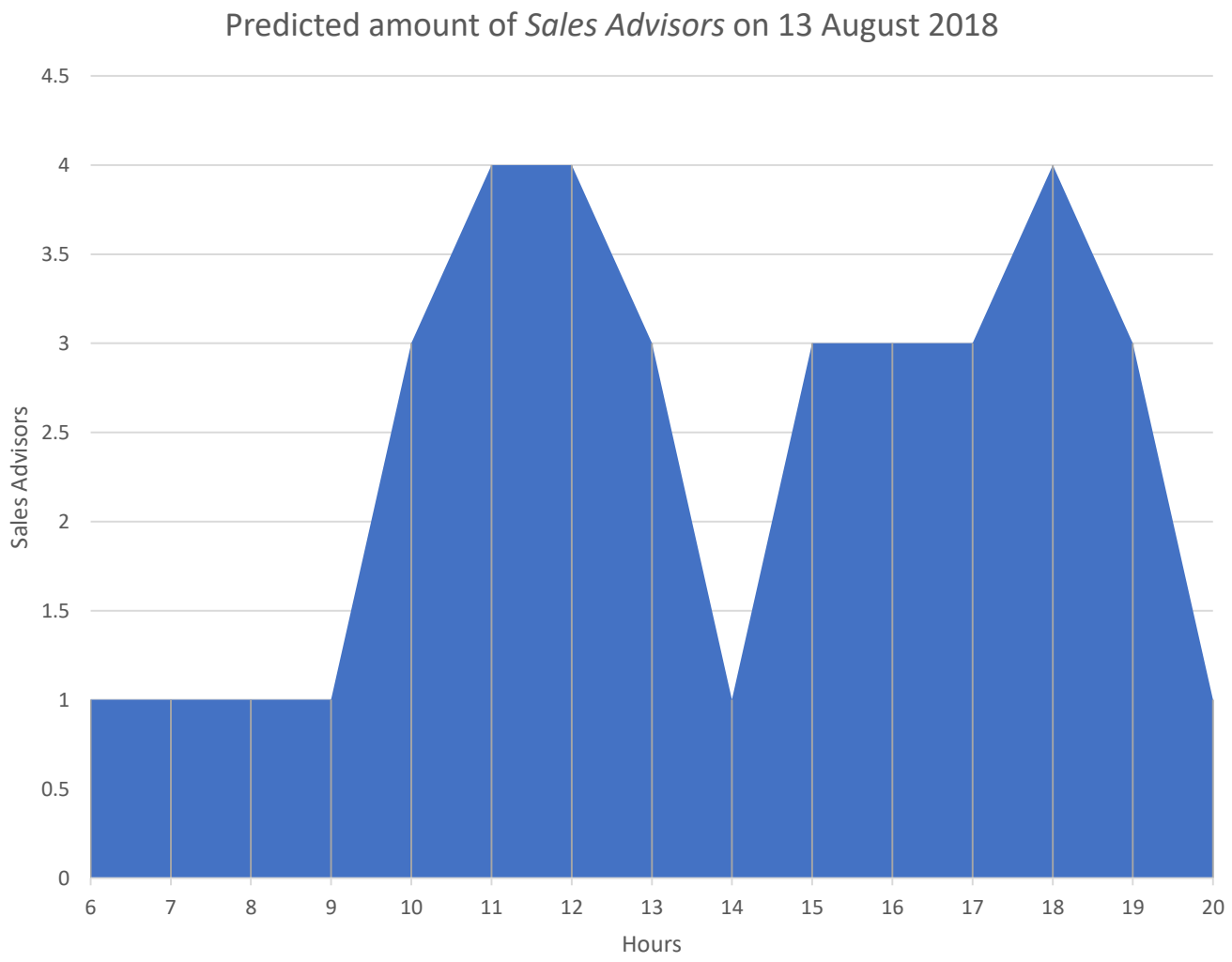
4 Results and Deployment
Evaluation of APPersonam

Algorithm outcome

	H_6	H_7	H_8	H_9	H_10	H_11	H_12	H_13	H_14	H_15	H_16	H_17	H_18	H_19	H_20
01/08/18	1	1	1	3	1	3	3	3	1	3	3	3	3	3	1
02/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
03/08/18	1	1	1	3	1	3	3	3	1	3	3	3	3	3	1
04/08/18	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1
05/08/18	1	3	3	3	3	4	3	3	3	3	3	3	4	3	1
06/08/18	1	1	1	1	3	4	4	3	1	3	3	3	4	3	1
07/08/18	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1
08/08/18	1	1	1	3	1	3	3	3	1	3	3	3	3	3	1
09/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
10/08/18	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1
11/08/18	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1
12/08/18	1	1	1	1	3	4	4	3	3	3	3	3	4	3	1
13/08/18	1	1	1	1	3	4	4	3	1	3	3	3	4	3	1
14/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
15/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
16/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
17/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
18/08/18	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1
19/08/18	1	1	1	1	3	4	4	3	3	3	3	3	4	3	1
20/08/18	1	1	1	1	3	4	4	3	1	3	3	3	4	3	1
21/08/18	1	1	1	3	3	3	3	3	1	3	3	3	4	3	1
22/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
23/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
24/08/18	1	1	1	3	3	3	3	3	1	3	3	3	4	3	1
25/08/18	1	1	1	3	3	3	3	3	3	3	3	3	3	3	1
26/08/18	1	1	1	1	3	4	4	3	3	3	3	3	4	3	1
27/08/18	1	1	1	1	3	4	4	3	3	3	3	3	4	3	1
28/08/18	1	1	1	3	3	3	3	3	3	3	3	3	4	3	1
29/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1
30/08/18	1	1	1	3	3	3	3	3	1	3	3	3	3	3	1

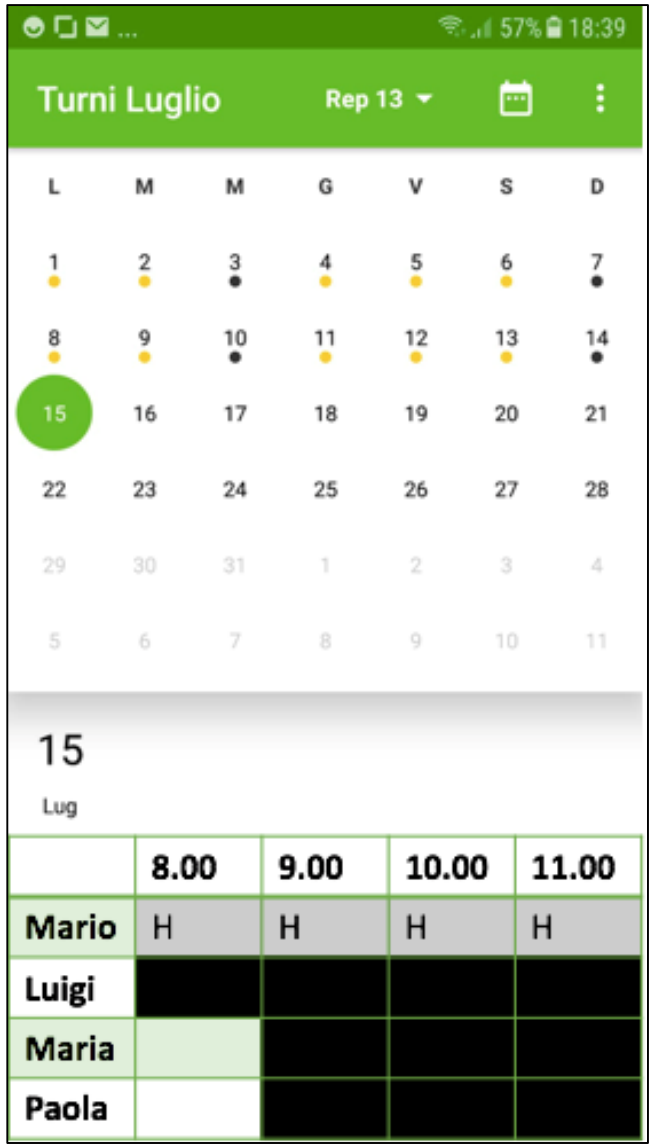
Detailed Prediction for a specific day

- We have the precited **amount of Sales Advisors per each hour**
- This daily view is presented to the **Sales Area Manager**
- The Sales Area Manager will **modify or confirm** the work shift for his purposes



APPersonam for Android devices

- Monthly view for **the Sales Advisors**
- **Detailed** work shift view per each day
- The user can see displayed accurately his **team timetables**
- With this **digital solution**, it is easier to keep track of the data along time to **improve the whole algorithms**

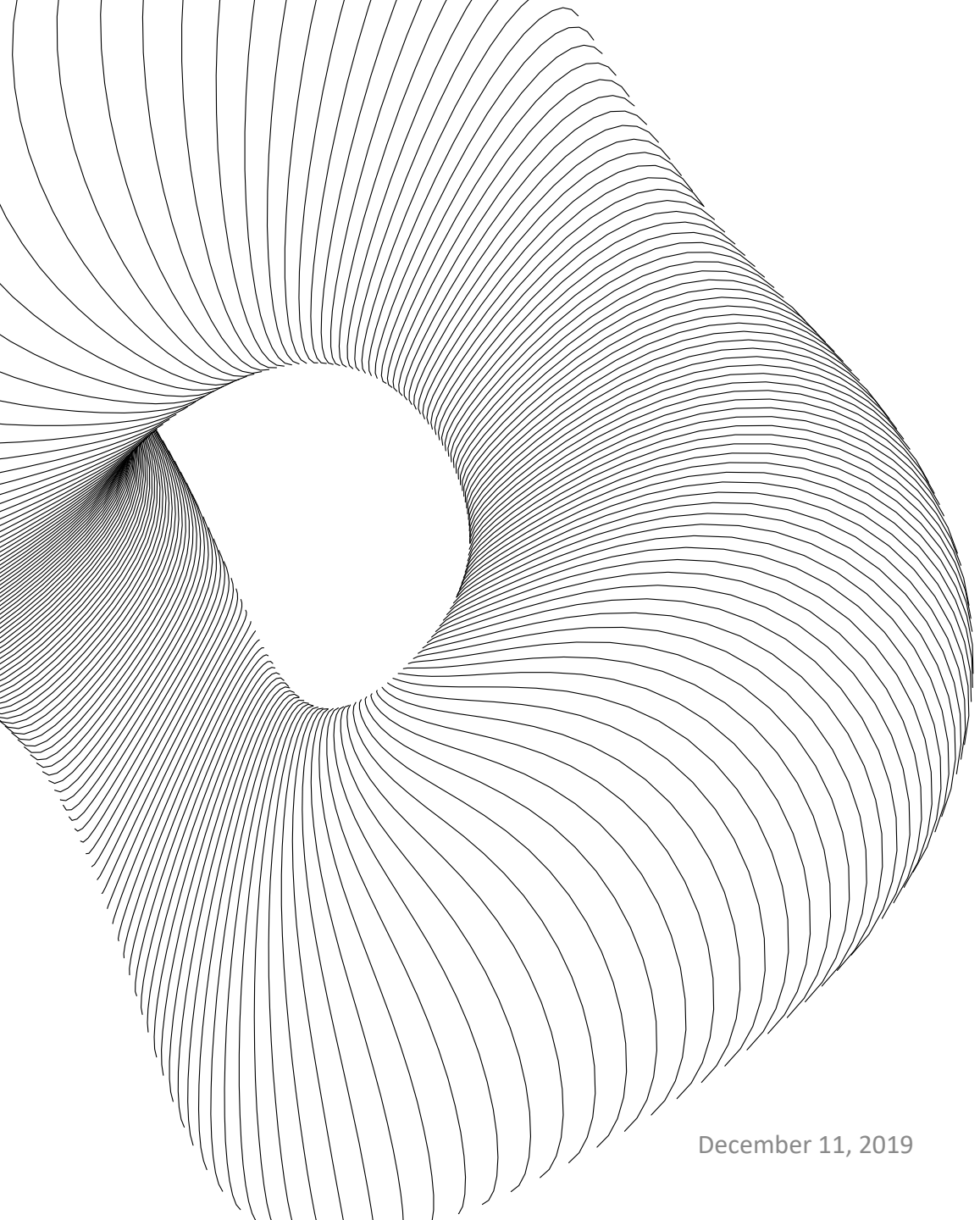


Conclusion and Further Consideration

We can see that **it is possible to estimate** the number of sales advisors per each hour of each day, 30 days in advance, per each one of the 14 departments of each of the 48 stores in Italy. **The algorithm** to estimate the amount of *sales advisors* **is a step by step method** to solve this problem.

Thank you!

Questions?



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