

SAP MACHINE LEARNING PROJECT

SUMMER INTERNSHIP FINAL REPORT

SAP MACHINE LEARNING ALGORITHM PROJECT

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### **Abstract**

SAP is a company that owns ERP (Enterprise Resource Planning) software solutions which offer integrated modules for client companies. These modules cover all aspects of business management. Employees of SAP describes ERP software solutions as neural systems of companies.

During the first weeks, tutorials and some small projects were assigned to trainees to make sure that they understood the company and the working environment in it. After the period for adaptation, a group consists of 4 people including the supervisor, started the internship project. The main goal of the project was to design multiple machine learning algorithms for a platform in SAP called Sap Fiori and find out the best possible algorithm suitable for the task. The task of machine learning algorithms was to learn the actions of the users in the platform and improve the notification system.

The project helped to trainees to learn the basics of machine learning, which can be important in future career plans. Additionally, it was crucial to experience the working environment as a team in an office such as holding presentations on small projects, case studies on the main project, sharing duties between team members, etc.

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## 1. Introduction

The main objective of the report is to give general information about the company, detailed information about the internship project, and express the experience during the internship.

The main parts of the report as follows:

1. The Abstract part provides a summary of the internship final report including company description and internship description & analysis.
2. Company Information part provides general information about the internship company such as short history, products, etc.
3. Project Background part provides detailed information about departments that are related to the project, status of the project, motivation of the project and related literature
4. Internship Project part consists of project objective, responsibilities of team members, tools used in the project, expected outcomes for the project, all the details for the project, and the result of the project.
5. Internship Experience part provides information about what I learned during the internship, relations to the undergraduate education, difficulties that I faced during the project, and typical day in the office.
6. Conclusions part provides a concise summary of the major points of the internship
7. Recommendations part describes the recommendations of the trainee, which would help the future Project 302 Students.

The project helped to learn the basics of Machine Learning by practicing to solve a real problem. At the same time, it helped trainees to learn the working environment and shape their ideas on their future career plans.

## 2. Company Information

### 2.1 General Overview

SAP Türkiye Yazılım ve Üretim A.Ş

Address: Anel İş Merkezi Saray Mahallesi, Site Yolu Sokak No:5 Kat:6, 34768 Ümraniye,  
İstanbul Türkiye

Phone Number: (0216) 633 03 00

Web Site: <https://www.sap.com/turkey/index.html>

Dietmar Hopp, Hasso Plattner (the owner of the Company), Hans-Werner Hector, Klaus Tschira and Claus Wellenreuther founded SAP Software in 1972. The origin of inspiration came from the potential of technology in Business Management, and then, SAP has altered how the companies do their businesses (Guru99, n.d.). The headquarter of the Company is in Walldorf Germany.

SAP (Systems Applications and Products) is an ERP (Enterprise Resource Planning) software which provides help to companies to manage their operations, customer relations, and other related functions. There are integrated modules in the SAP system which covers, every aspect of the business management (Guru99, n.d.). There are several benefits of the software such as elimination of duplication, redundancy, and discontinuity in data stored in a

company, real-time data sharing across different departments, gives centralized enterprise management systems to companies, and it results in and an increase in productivity and quality, a decrease in overheads, material cost, etc. (Makela, 2017).

The main competitors of SAP are also their business partners such as Microsoft, IBM, and Oracle (Owler, n.d.).

There are 96 498 employees in SAP around the World. Approximately every year, there is an increase in the number of employees around 2000-8000 (Liu, 2019). Additionally, SAP has lots of branch companies around the world which makes the actual number of employees more than the statistic.

There are hundreds of companies which are customers of SAP such as Shell, Hershey, IBM, HP, etc. (Nagori, 2019).

### **2.2 Products**

There are a bunch of products offered by SAP, but the main products are SAP ECC (Enterprise Resource Planning Component) and SAP Hana. SAP ECC is where all the main actions are executed and stored. All the other main modules are in ECC (Wadge, 2015). On the other hand, SAP Hana is the newest database system which based on Linux Server and written in C++. The database has several advantages. For example, the database system is quite fast due to no need to load data from disk (Guru99, n.d.).

### **2.3 Organizational Chart**

In SAP, there are different types of departments across the World. However, in SAP Turkey, it can be divided into three departments: Sales Department, Assistance Department, and Technology Development Department.

Employees are the links between the company and customers in the Sales Department. The first objective is to sell the products, furthermore in to help and understand the unique needs of customers (Levinson, 2018).

Employees handle the problems of customers during the usage of the SAP systems in their companies in the Assistance Department.

Employees are responsible for project knowledge, signs of progress, updates, and status in the project development processes in the Technology Development Department.

### **3. Project Background**

#### **3.1 Department Information**

In the project, I didn't directly work with a department. I worked with, two supervisors.

The Main Supervisor: Huseyin Demirkale

Title: Senior Technology Consultant

E-mail: [huseyin.demirkale@sap.com](mailto:huseyin.demirkale@sap.com)

The Backup Supervisor: Mehmet Sait Doger

Title: Business Development Specialist

E-mail: [mehmet.sait.doger@sap.com](mailto:mehmet.sait.doger@sap.com)

The main supervisor of the project is in the Assistant Department, which assists customers before, during, and after the sales of products on technological subjects. Additionally, he has the background of a computer engineering, therefore he has a contact



with the technology development department which is helpful in the internship project since the project requires a machine learning algorithm to improve the SAP Fiori Platform.

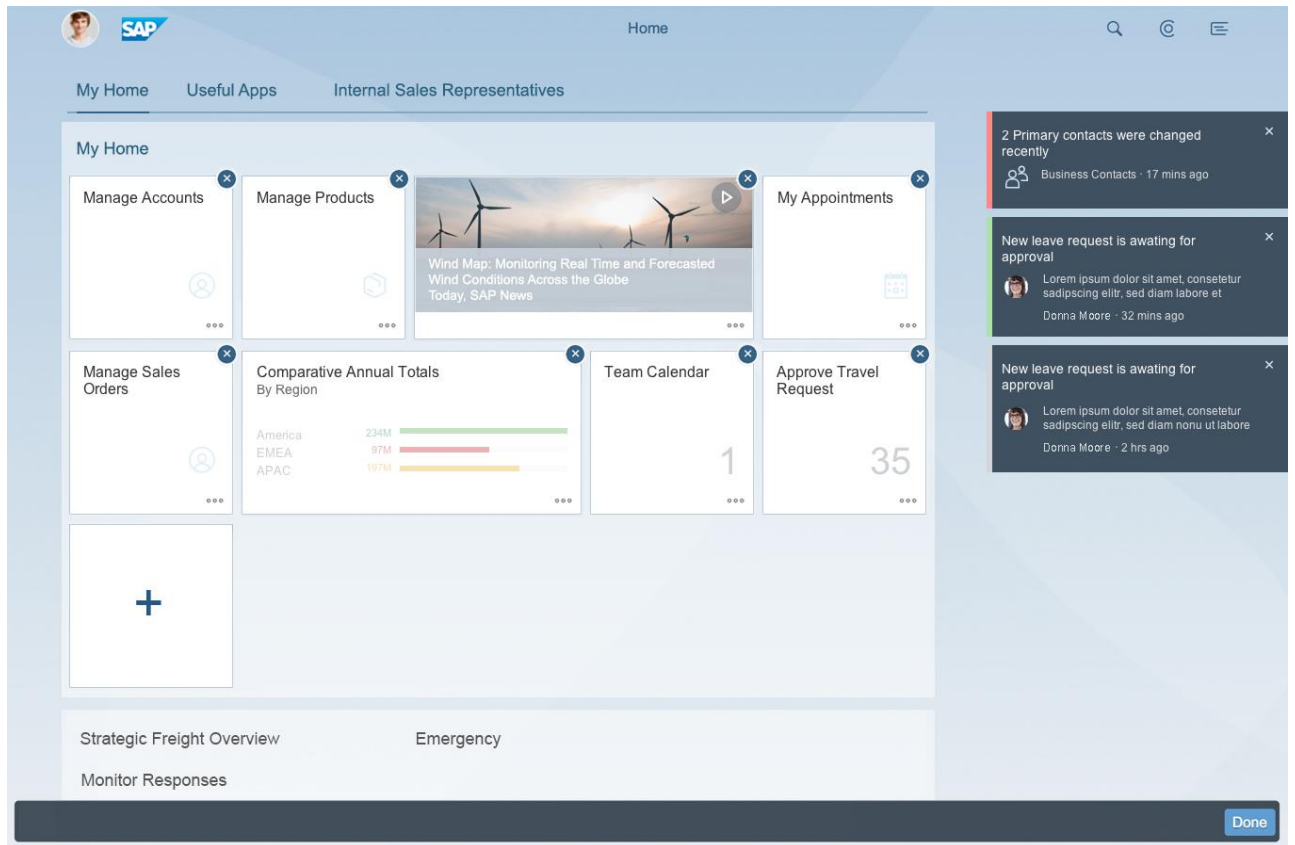
The backup supervisor of the internship has an also similar job and experience excluding computer engineering. He was responsible for the internship at the beginning. The objective is to learn the SAP and the working environment; therefore, he designed a small project which is a detailed report on ISO 2018 and ISO 2019 by using python and analysis on the competitors of SAP by analysing 5 Forces of Competitive Forces. After these analyses, he designed regular meetings and sprints to make trainees the working environment at SAP. After this process, trainees returned and started their actual internship project.

### **3.2 Project Status**

The idea of the project has shaped during the interview with the supervisor. However, the main reason for the project not to start was that the supervisor has no enough time. Therefore, at the beginning of the internship, the project was in the beginning status.

### **3.3 Project Motivation**

The main motive of the project was to develop a machine learning algorithm which could improve the SAP Fiori Platform (Picture 1) notification system. Sap Fiori is an SAP software which provides a bunch of different apps such as work approvals, financial apps, calculation apps, etc (Tutorials Point, n.d.). The system was required to predict the actions of the users by using the stored data of actions by the users. As a result, when a user forgets to make a regular action in a specific time zone, the notification will be sent, and the usability and quality of the service will be improved.



Picture 1. Sap Fiori Platform

## 3.4 Related Literature

There are lots of different possible algorithms that could be used to implement the machine learning algorithm for the defined problem earlier. The followings were the possible machine learning algorithms that are discussed and analysed by the project team.

1. KNN Algorithm: KNN is a non-parametric machine learning algorithm. It means that there are no initial assumptions over the data set, which makes the algorithm more suitable for real-life scenarios. Additionally, KNN is a lazy algorithm, which means that the training phase is very fast, but the model needs to hold all the data in the algorithm which makes the prediction slow and the memory usage high (Zhang, 2016). In terms of the project at the beginning, there would be less data by users, and

it would be sensible to use the KNN algorithm. However, when data collections by users get large as time went by, the KNN algorithm would slow down and not efficient.

2. Random Forest: Random Forest is an ensemble machine learning algorithm which produces random decisions trees by randomly selecting items from the training set and then form groups for the test objects. There are several advantages of the algorithm such as not overfitting the data compared to single decision trees, flexible and very high accuracy, no need to scale the data and missing data don't affect the accuracy (Breiman, 2001). In terms of the project, the Random Forest algorithm is suitable to use in the project, especially, it runs correctly when the data size is large compared to single decision trees.
3. Neural Networks: Neural Networks is a set of algorithms to recognize the patterns which are inspired by how the human brain works. It consists of neurons which take inputs, does some calculations, and produces an output. A neural network is a collection of neurons which are connected (Nicholson, n.d.). The main advantage of the algorithm for the internship project is that more data makes the algorithm more efficient. Additionally, once the data trained, the predictions are quite fast. The only drawback of the algorithm for the project is training is very costly and time-consuming.

## 4. Internship Project

### 4.1 Project Objective

The objective of the project was to develop a machine learning algorithm that predicts the actions of the users in terms of frequency, period, and day in Sap Fiori Platform. Therefore, the project consisted of two different subprojects. The first subproject was to learn and predict day and period. For example, User 1 generally does the Action 1 in every Monday in time-period 9-12. The second subproject was to learn and predict frequency and period. For instance, User 1 generally does the Action 1 in every two days in time-period 1-3.

SAP does not allow trainees to access source codes or any other information due to security reasons. Since there was no actual data or source code of the SAP Fiori platform to work on, it was decided to create an algorithm which produces the own data for the project. For the first subproject, it was needed to create data which consists of id, action, day, and period. The fundamental assumption was that there is a bias between user & action, action & day and action & period. Similarly, for the second subproject, it was needed to create data which consists of id, action, frequency, and period. The fundamental assumption was that there is a bias between user & action, action & frequency and action & period. Since the algorithm could produce different kinds of data sets, there could be tests on the machine learning algorithms with different size and type of data with various bias ratios such as 10 actions versus 100 actions, or more bias between actions & users versus less bias between actions & users.

After the design of the algorithm which created the data, the main goal of the project was to develop machine learning algorithms. There were three possible algorithms which are

KNN, Random Forest and Neural Networks in a way that these machine learning algorithms as compatible with the created data sets.

### 4.2 Responsibilities

The team consisted of 4 people: one team leader, one supervisor, and two team members.

1. Supervisor: Huseyin Demirkale
2. Team Leader: Furkan Reha Tutaş
3. Team Member: Can Alver
4. Team Member: Ahmet Can Aytekin

My duty was to inform the supervisor about the project status and get information about the new expectations and missing parts of the project and according to the knowledge, arrange the weekly duties among the team members. Additionally, my other duties were developing the data production algorithm, analysing and testing the machine learning algorithms with differently produced data sets and helping the development of the machine learning algorithms (KNN, Random Forest and Neural Network).

Supervisor of the project was responsible for keep track of the project status weekly, getting weekly verbal reports and meetings to check and give new responsibilities and tasks to team members.

Aytekin was responsible for researching, analysing, and design of the machine learning algorithms. On the other hand, Alver assisted to test the designed machine learning algorithms with the differently produced data sets.

### 4.3 Tools

For the project, there were two programming languages and tools were used. For the data producing algorithm and the testing algorithms of machine learning algorithms, the team used Python in PyCharm and for the machine learning algorithms the team used R in R Studio.

### 4.4 Expected Output

The expected output of the first subproject was to predict the day and period pair for given queries which consist of user and action pairs. Similarly, for the second subproject, the expected output was to predict frequency and period pair for given queries which are same as for the first subproject. Additionally, after the prediction period, it must have reached a high accuracy rate in the analysis of the algorithms. For example, the probability of a day to occur in an action is %20 (weekends not included) and accuracy of prediction for days must have been sufficiently higher than this ratio.

### 4.5 Details

There were several steps to the project during the internship.

The first step was to develop an algorithm to produce data sets which have desired properties.

1. To achieve the bias between user & action, action & day, action & frequency and action & period in both of the subprojects, the team used the random library of Python. A user enters the boundaries for the bias probabilities between these pairs and then random probabilities are generated for every possible pair. While producing the data sets, these probabilities were used to affect the data sets production process and,

in the end, these probabilities were approximately reached in the data set. The following pictures show the first subproject data production process.

```
Enter the Action Size: 100
Actions: A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15 A16 A17 A18 A19 A
Enter the User Size: 10
Ids: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Days: M T R TH F
Periods: 9-12 1-3 3-5

Enter the Bias Lower Limit for User and [Actions]: 1
Enter the Bias Upper Limit for User and [Actions]: 1
User-Bias-[Action]: (1: A72 A80 A91 A73 A52 A93 A50 A2 A26 A45 A90 A18) (2: A19 A22 A20 A6 A40
Action-Bias-Day: (A0: TH) (A1: F) (A2: TH) (A3: TH) (A4: T) (A5: TH) (A6: TH) (A7: F)
Action-Bias-Period: (A0: 9-12) (A1: 1-3) (A2: 1-3) (A3: 9-12) (A4: 3-5) (A5: 1-3)

Enter the Data Size: 100000

Probability of an Action to Occur (Without Bias): 1.00%
Enter the Lower Bias Percentage for User-Bias-[Actions] between %0 and %100: 10
Enter the Upper Bias Percentage for User-Bias-[Actions] between %0 and %100: 90
Bias Percentage Values for each Id (Bias btw Id-[Actions])
{1: 29, 2: 29, 3: 28, 4: 52, 5: 15, 6: 19, 7: 61, 8: 41, 9: 31, 10: 24, 11: 47,

Probability of an Day to Occur (Without Bias): 20.00%
Enter the Lower Bias Percentage for Action-Bias-Day between %0 and %100: 10
Enter the Upper Bias Percentage for Action-Bias-Day between %0 and %100: 90
Bias Percentage Values for each Action (Bias btw Action-Day)
{'A0': 56, 'A1': 62, 'A2': 43, 'A3': 69, 'A4': 66, 'A5': 66, 'A6': 52, 'A7': 53,

Probability of an Period to Occur (Without Bias): 33.33%
Enter the Lower Bias Percentage for Action-Bias-Period between %0 and %100: 10
Enter the Upper Bias Percentage for Action-Bias-Period between %0 and %100: 90
Bias Percentage Values for Each Action (Bias btw Action-Period)
{'A0': 53, 'A1': 55, 'A2': 55, 'A3': 51, 'A4': 49, 'A5': 52, 'A6': 75, 'A7': 75,
```

Picture 2. Input Screen

```
id action day period
23 A65 F 3-5
29 A8 TH 1-3
6 A48 T 1-3
20 A12 R 9-12
9 A18 T 3-5
4 A37 R 9-12
9 A45 TH 1-3
13 A22 R 3-5
19 A19 F 1-3
6 A65 TH 3-5
21 A12 R 9-12
2 A29 F 1-3
28 A28 M 9-12
16 A50 T 3-5
```

Picture 3. Sample Data

```
Actions: A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15 A16 A17 A18 A19 A20 A21 A22 A23
Ids: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Days: M T R TH F
Periods: 9-12 1-3 3-5
User-Bias-[Action]: (1: A72 A80 A91 A73 A52 A93 A50 A2 A26 A45 A90 A18) (2: A19 A22 A20 A6 A40
Action-Bias-Day: (A0: TH) (A1: F) (A2: TH) (A3: TH) (A4: T) (A5: TH) (A6: TH) (A7: T) (A8: F)
Action-Bias-Period: (A0: 9-12) (A1: 1-3) (A2: 1-3) (A3: 9-12) (A4: 3-5) (A5: 1-3) (A6: 9-12) (

Bias Ratio Report btw Id-Action
*****
Action-Bias-Ratio for 1 and A72 A80 A91 A73 A52 A93 A50 A2 A26 A45 A90 A18: 29.74%
Action-Bias-Ratio for 2 and A19 A22 A20 A6 A40 A15 A29 A30 A1: 29.42%
Action-Bias-Ratio for 3 and A97 A60 A46 A75 A42 A7 A68 A5 A88 A25 A1: 28.83%
Action-Bias-Ratio for 4 and A95 A28 A37 A91: 52.21%
Action-Bias-Ratio for 5 and A69: 16.37%
Action-Bias-Ratio for 6 and A97 A43 A31 A4 A30 A65 A56 A76 A29: 19.74%
Action-Bias-Ratio for 7 and A15 A13 A45 A35 A34 A63 A76 A6 A97: 61.28%
Action-Bias-Ratio for 8 and A66 A88 A24 A67 A53 A72 A55 A99: 41.14%
Action-Bias-Ratio for 9 and A82 A1 A19 A28 A48 A18 A42 A3 A53 A24 A96 A98 A67 A55 A17: 31.78%
Action-Bias-Ratio for 10 and A87 A28 A16 A22 A61 A9 A47 A69 A80 A2 A95 A12 A19 A46: 24.43%
Action-Bias-Ratio for 11 and A92 A9: 47.55%
Action-Bias-Ratio for 12 and A30 A19 A56 A37 A81 A57 A85 A29 A33 A11 A62 A67: 51.02%
Action-Bias-Ratio for 13 and A75 A91 A50 A42 A11 A53 A86 A85 A2 A67: 54.44%
Action-Bias-Ratio for 14 and A42 A59 A5 A88: 57.04%
Action-Bias-Ratio for 15 and A20 A4 A70 A8 A65 A69 A23: 66.04%
Action-Bias-Ratio for 16 and A28 A68: 32.22%
Action-Bias-Ratio for 17 and A17 A87 A47 A14 A62 A77 A73 A95 A18 A27 A78 A19 A74: 40.85%
Action-Bias-Ratio for 18 and A37 A55 A19 A93 A48 A39 A6: 39.57%
Action-Bias-Ratio for 19 and A17 A8 A85 A60 A22 A15 A59 A53 A1 A51 A90 A98 A10 A32: 31.95%
Action-Bias-Ratio for 20 and A27 A75 A52 A12: 54.70%
Action-Bias-Ratio for 21 and A0 A15 A34 A6 A78 A67 A40 A90 A41 A46 A18 A38 A98: 35.93%
Action-Bias-Ratio for 22 and A0: 31.44%
Action-Bias-Ratio for 23 and A2 A30 A37 A11 A22 A69 A98 A51: 35.31%
Action-Bias-Ratio for 24 and A73 A56 A44 A62 A21 A96 A86 A35 A98: 31.55%
```

Picture 4. Actual Probabilities Occurred

- As mentioned earlier in the report, the second subproject required the algorithm to produce frequencies in the data sets. The keyword frequency means how many days have passed after the last time a specific action and user pair occurred. As an example, Let's assume that User 1 did the Action 1 at 01/01/2019 and then the same user did the same action at 05/01/2019 and then for the second project the value of frequency is the subtraction of the days and it is 4. In real-world, it can be achieved as follows. For every user and action pairs, there is a dictionary which is originally empty. When a user action pair has occurred look at the table if there is no date recorded, record the date of the action occurred and it is done, if there is a date, find the difference between the recorded date and the date of the action occurred and

update the dictionary with occurred, after that record the difference to the data set as frequency for the user & action pair.

3. To be able to analyse the result of machine learning algorithms' predictions, biases between user & action, action & day, action & frequency and action & period were recorded. There are examples at Picture 4 (User-Bias-[Action], Action-Bias-Day and Action-Bias-Period) for the subproject 1. Additionally, Action-Bias-Frequency is recorded instead of Action-Bias-Day.
4. To test the machine learning algorithms, it was needed to have testing queries. The task was to find more frequently occurred user & action pairs. The algorithm counts every unique user & action pairs and stores in a dictionary and then calculates the average. According to user input, it accepts user & action pairs which occurs more than the multiplication of user input and the average occurrence per pair. In conclusion, after the creation of data sets, the testing algorithm creates the query for the specific data set.

The second step was to develop machine learning algorithms for both of the subprojects: KNN, Random Forest, and Neural Networks.

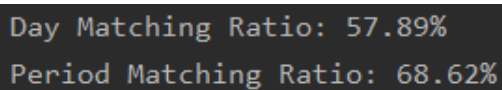
1. The First Algorithm used for both of the subprojects is KNN. The first step was to train user, action, and day/frequency, and then, predict day/frequency for the given query. The second step was to train user, action, day/frequency, and period, and then, predict periods for the given query. The final step was to output the table that consists of user and action which comes from the query of the data sets, and day/frequency and period from KNN algorithm predictions. To improve the performance of the KNN function of R, the data set could be trained to recognize



the best k-value however it costs sufficient amount of time and not always gives a better result than the standard algorithm.

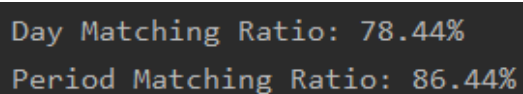
2. In the project, it was a failure to use Random Forest. The reason was random forest function in R requires numbers while data sets are discrete and nonnumerical. To achieve numerical value, the data sets converted into numerical values such as Monday to 0. However, the algorithm didn't give the expected result, and this was the main reason neural networks is used.
3. For the Neural Networks, a similar process to KNN, followed and nnet, predict and createPartition functions of R libraries used. As similar to the case in KNN, the p-value of the model can be optimized to achieve more accurate results however, it takes quite a time. For example, to optimize the p-value for a data set sized 500,000 approximately takes 6 hours of computation.

The final step was to analyse the accuracy rates of algorithms. For both of the subprojects to check accuracy rates, take results from the algorithms and check with the report recorded for every single user & action pairs with the corresponding day or frequency and period. When the accuracy rates compared, it observed that Neural Networks works better to predict the day or frequency and period. On the other hand, the KNN training time is fast, and the accuracy rate for small numbers of data sets are higher. Following pictures show the comparison for a huge sized data set (data size: 300,000 unique action size: 200, unique user size: 50) for both KNN and Neural Networks for the first subproject which predicts day and period.



Day Matching Ratio: 57.89%  
Period Matching Ratio: 68.62%

*Picture 5. KNN Accuracy Rates*



Day Matching Ratio: 78.44%  
Period Matching Ratio: 86.44%

*Picture 6. Neural Networks Accuracy Rates*

### 4.6 Results

At the end of the project, an algorithm to create sample data, two different types of algorithms to predict day/frequency and period for user & action pairs and an algorithm to check the accuracy rates of results developed. However, the project only consisted of the algorithms therefore, the project didn't end. The algorithms are needed to redesign for Sap Fiori Platform, by whom has access to source codes and the database of the website which is not allowed to access by trainees.

## 5. Internship Experience

### 5.1 Learning

During the internship, there are several important things I have experienced, and they have affected my career plans.

1. I learned to sit in a chair for 10 hours every day. It seems like it is an easy thing to experience however, for my personality, it was very hard to adapt.
2. I experienced the environment of a real job in a large office.
3. I experienced the differences between the jobs, especially the difference between the duties, works, and environment of computer engineering and management which affects my future career plans. I have decided that the jobs related to coding are more entertainment and more suitable for me, by experiencing both the duties of a computer engineer and manager.
4. I learned how to talk, dress, and behave in an office.
5. I learned how to ask for help in a situation no one cares about the problems you have faced.

6. I learned to work in a team as a team leader and also as a team member.
7. I learned some basics in Machine Learning.

### **5.2 Relation to Undergraduate Education**

I have used an approach that I have learned at the university. The approach is that clearly coding is very important to understand the code after the coding process such as the use comments, vice choice of variable names, etc. I recognized during the internship that this suggestion is very crucial in coding a program.

### **5.3 Difficulties**

During the internship, I have faced two major problems.

1. Since my supervisor frequently works outside of the company, the arraignments of meetings were quite challenging. Therefore, we generally communicate across e-mail or phone calls.
2. Since it was my first experience in an office, time management and self-management were difficult for me. Therefore, I used an excel document to plan my daily duties and the timing of tasks.

### **5.4 Typical Day**

Working in an office was nearly same every day. The first thing I do was to make a meeting with the team members and decide what to do in the day. Additionally, apart from the project, there were regular small tasks which were assigned by employees in the office, such as preparing an excel, reading an article, research on some companies, etc. The last

thing to finish the day was to make a meeting with teammates to discuss what we have done during the day, and if needed, decide what to do at weekends or home.

## **6. Conclusions**

Main points of the internship were to help me to

1. Learn the basics of machine learning
2. Experience working environment in an office
3. How to behave in a working environment
4. How to lead a team
5. How to be a team member
6. How to manage time and duties
7. Decide on future career plans

As a conclusion, the internship was crucial for my future career plans, and during the internship, I get more ready for my future career.

## **7. Recommendations**

There are several suggestions for trainees before and during the internship.

1. Learn all the details before the internship starts, including what the company demands, what specific work they are expecting for a trainee to do, etc.
2. Ask about what technologies or materials are needed to learn to be comfortable in the office before the internship starts.
3. Learn the subjects and technologies before the internship starts. At least begin to learn, not to lose any time during the internship.
4. Visit the office before the internship starts and try to meet people around the office to be comfortable during the internship.
5. Don't hesitate to ask questions and push them to take attention. They can easily ignore your questions, demands, etc. due to lots of work in the office.
6. Focus on planning, time-management, and self-management to not have problems during the internship project.

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