Scientific Paper for the
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Titel

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The food delivery market has grown over the last few years but is now almost saturated. In order to survive, delivery services have to improve their way of working. Volo has done this step by introducing an improved travelling salesman algorithm to save resources and time for the drivers. But the path finding algorithm can still be improved by tuning the time component which cannot be calculated by the algorithm itself. This interdisciplinary project has the goal to create a reliable forecast for the preparation times of food for restaurants so the driver can arrive right on time.

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1 Introduction

The food delivery market is a fast growing market with an giant volume. Rocket internet predicts the market to have a value of 90 billion Euro by 2019. CITE!! This money attracts many companies which fight for the supremacy in the market. In order to achieve this goal they have to differentiate from their competitors. Some do this by being the cheapest, others have the biggest variety of restaurants they offer and still others try to optimize the process from ground up.
An example is is the Munich based startup called VOLO. The idea of VOLO is to provide a great and effective experience in food delivery. Starting with premium restaurants with an appealing shop, followed by an process optimized driver fleet for the restaurants and fast deliveries. The optimized and fast deliveries are backed by an underlying algorithm. The algorithm is based on the travelling salesman algorithm and calculates the best solution for a number of drivers who have to fulfill a number of deliveries. It assigns each driver a route and deliveries he has to fulfill including the route the driver should take and the time needed to complete the task. This enables drivers have less empty drives and to minimize idle times from which the company and the driver profits. The driver is able to earn more money from loaded times and tips and the company has to pay few idle times where the driver is not used.
This algorithm is perfect from the point in time the driver instantly picks up the food, leaves the restaurant and starts driving. The only problem is that the food is almost never ready at the moment the algorithm sends the driver to the restaurant. It is crucial for a food delivery to pick the meal up at the exactly right time. On the one hand being late is bad, because if the customer gets his food cold or too late he is likely not to order again from the company. On the other hand when the driver is too early at the restaurant he has to wait for the order to be prepared. In this case the time gain is lost and with it the advantage over the other competitors. This is why VOLO has the need to create a forecast which tells the algorithm the forecasted preparation time for the food so the driver can be send to the restaurant just in time. The following chapters will explain the proceeding to solve the problem. It will start with the resources used to generate knowledge, then focus on the methodology used to forecast and it will finish with evaluating the result and a conclusion.

2 Review of Literature and Research

2.1 Research

In order to get a good overview over the problem, a search in Google Scholar was done. The goal was to find similar problems and approaches to it. Different words were chosen for the search, like "preparation time", "meal", "restaurant" and "forecast". The results did not give the right output for this problem. Most of the forecasting in restaurant was about the amount of staff needed, the amount of meals which will be sold over a period or the size a buffet has to be. These topics did not fit the problem given because the problem stated is pretty unique. On the one hand, most of the delivery services have their own fleet of drivers and are not that time critical as volo is. On the other hand has not yet a company combined a food delivery fleet with a routing algorithm. This is why a custom approach had to be made.
A plan with different steps was created. As a first step, a solid base about forecasting had to be made by searching for basics of forecasting. In the second step, this knowledge should be applied to the case before evaluating it in a third step.

2.2 Approach and Basics

After searching for fitting materials, the book "Forecasting: Principles and Practice" by R. Hyndman and A. Athanasopoulos was chosen as a starting point, since it covers the topic pretty good for forecasting beginners. After reading the book it was determined to follow the steps the book suggests to create the forecast. The book had five basic steps for forecasting.
First of all, you have to define the problem. This is simple but often the most time consuming part of the whole task. The forecaster has to talk to everybody who uses the forecast as well as the people who support the data to generate it. Questions regarding the way it will be used, by who it is required and how it fits into the process of the ones who required it have to be asked. Also the people who support the forecast with collecting data, maintaining the data and use the forecast for future planning have to be figured out. After the problem is defined, in a second step, all information available is gathered. This requires to get all statistical data available, but often there will be not enough historical data to create a decent statistical model. The available data is combined with the expertise of the people who collected this

data and use the forecasts. In the next step, preliminary analysis is done. The data is put into a graph to get a first rough overview over the behavior. This is a simple way to see patterns, trends, seasonalities or business cycles. Outliers can be spotted and can be questioned early. Now the real forecasting can begin. In the next step the model is chosen and fitted to the data. The models are created from the historical data and all other knowledge which can support the forecast. Different potential models are used and later compared. This is done in the last step, when the model is used and evaluated. This is done by comparing the outcomes of the different models with the actual events which are forecasted.
Now that there is a basic approach, more information about the different models is needed. This information is taken from PowerPoint slides which are provided by the Department of Logistics. The slides are from lectures with forecasting as a topic and are used to get a rough overview over different simple algorithms often used for forecasting.

2.2.1 Time Series

Since the events are happening on a time line, time series decomposition was the choice. Time series can have different patterns that is why putting the data in a graph first is very useful. The book and the slides likewise addressed common patterns and methods which can be used on time series and improve forecasts. The time series can then be split into different parts to support the corresponding pattern. There are three types of time series patterns. The first pattern is the trend. The trend is an decrease or increase over a long period of time. The second second is the season pattern. It is influenced by seasonal factors and has a known and fixed time period and. The third one is the cyclic pattern. Cyclic pattern influence usually has fluctuations of at least 2 years and the period is not fixed. The available data should be transformed to a time series and divided into suitable components, in case patterns are present.

2.2.2 Algorithms for Forecasting

Now that the time series is investigated for patterns, it is time to forecast. The book and slides offer different algorithms to fulfill this task. Three algorithms are chosen to be presented more closely.

2.2.2.1 Moving Average

A classical method is the moving average. It is used to calculate the next forecast value of a time series iteratively. For the time series it is done by taking all prior events in account for the next value. The calculated values are independent. The formula for the average at time t is: m(t)= 1/n E (n-1, 0) x(t-1)

2.2.2.2 Weighted Moving Average

The window which is taken into the calculation of the next value can also be weighted. In contrast to the normal Moving Average, a window for the amount of values included in the creation of the average value. The window moves with the time series. When a calculating the next value, the first value is removed from the window. This way only a specific amount of values stays in the calculation.

2.2.3 Simple Exponential Smoothing

Cite papers with `\cite{BibTeX key}`
A comprehensive introduction to Operations Research: Winston (2007)

3 Methodology

The following part explains the single steps of the forecasting process for this Interdisciplinary Project in detail.The forecast will be presented from the very beginning. First of all, the problem will be defined properly. Then the information needed will be specified and gathered. This data is then analyzed in a preliminary step and after this models for the data will be examined. In the end the result of the models will be evaluated and further proceeding will be explained in the final conclusion.

3.1 Section One

3.1.1 Subsection One

Refer to symbols or abbreviations with
`\gls{symbolname} \glstext{symbolname} \glsfirst{symbolname}`:
first $\mathbb{N}$ additional $\mathbb{N}$ first $\mathbb{N}$
Bachelorarbeit (BA) Diplomarbeit (DA) Masterarbeit (MA)

Refer to other sections with `\ref{labelname}`:
A reference to this subsection: 3.1.1

Include figures with
`\begin{figure}`
`...`
`\caption{An example figure}\label{fig:example}\end{figure}`

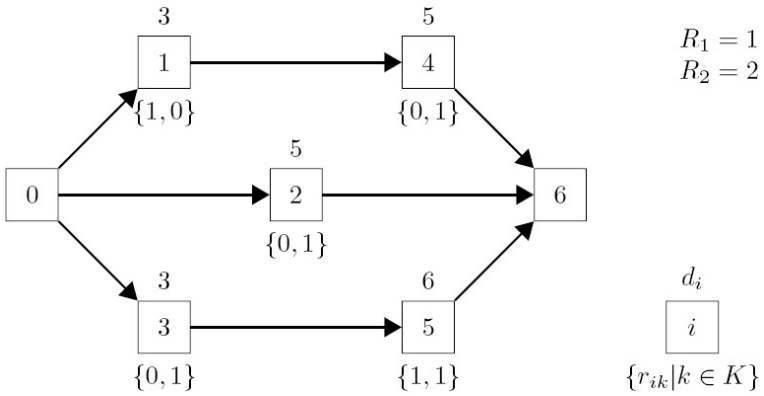

Figure 3.1: An example figure

Include only PostScript images (.eps) if you want to create a PostScript document using dvips and only .pdf, .png, .jpeg and .gif images if your goal is a PDF document using pdflatex.

4 Results

Include tables with

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\begin{table}
\caption{An example table}\label{tab:example}
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Table 4.1: An example table

Parameter	Levels				
A	1	2	3	4	
B	1	2	3	4	
C	1	2	3	4	5
D	1	2	3	4	
E	1	2	3	4	

5 Conclusion

Bibliography

Winston, Wayne L. 2007. *Operations research: Applications and algorithms*. 4th ed. Brooks/Cole Thomson Learning, Belmont 2007.

Appendix

1 Appendix One

2 Appendix Two

Ehrenwörtliche Erklärung

Ich erkläre hiermit ehrenwörtlich, dass ich die vorliegende Arbeit selbständig angefertigt habe. Die aus fremden Quellen direkt und indirekt übernommenen Gedanken sind als solche kenntlich gemacht.

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Ort, Datum

Unterschrift