



UNIVERSITÀ DI TRENTO

Department of Information Engineering and Computer Science

Bachelor's Degree in Informatica

FINAL DISSERTATION

TITLE
Subtitle (optional)

Supervisor

.....

Student

.....

Academic year 2019/2020

Contents

Summary	2
1 State of art	2
1.1 Terminology	2
1.2 Time series forecasting	2
1.3 Queueing theory	2
1.4 Literature review	3
1.5	3
2 Data analysis	3
2.1 Time series analysis	3
3 Methodology	3
3.1 Time series forecasting	3
4 Results	3
4.1 Pellentesque	3
5 Conclusions	3
5.1 Pellentesque	3
References	3

Summary

Sommario è un breve riassunto del lavoro svolto dove si descrive l'obiettivo, l'oggetto della tesi, le metodologie e le tecniche usate, i dati elaborati e la spiegazione delle conclusioni alle quali siete arrivati.

Il sommario dell'elaborato consiste al massimo di 3 pagine e deve contenere le seguenti informazioni:

- contesto e motivazioni
- breve riassunto del problema affrontato
- tecniche utilizzate e/o sviluppate
- risultati raggiunti, sottolineando il contributo personale del laureando/a

1 State of art

This chapter gives an overview of the available methods of time series forecasting and queue analysis.

1.1 Terminology

- *Inflow/outflow rate*: The number of customers that enter/exit the supermarket in a given interval.
- *Arrival rate*: The number of customers that arrive at the checkouts in a given interval.
- *Service rate*: The maximum number of customers that can be served by each terminal in a given interval.
- *Dwell time*: Time spent by a customer in the supermarket.

1.2 Time series forecasting

A *time series* is a collection of observations made sequentially through time. *Time series forecasting* is the use of a model to predict future values based on previous observations.

A time series can be decomposed into four components:

- *Trend*: Linear/nonlinear increasing or decreasing behavior of the series over time.
- *Seasonality*: Repeating patterns or cycles behavior over time.
- *Noise*: Variability of the observations not explainable by the model.

1.3 Queueing theory

Queueing theory is the mathematical study of waiting lines, or queues. A queueing model is constructed so that queue lengths and waiting time can be predicted.

There are various types of queueing models, but the best representation of a supermarket queue is probably given by the $M/M/c$ model, that represent a system with an infinite queue capacity, where the inflow rate follow a Poisson distribution and the service rate of the c servers follow an exponential distribution. The customers are served in FCFS order (First Come First Served).

This model could be used to predict the queue length given the arrival rate and service time distributions. The main issue with this analytical approach in the context of supermarkets is that the arrival time and service time cannot be expressed with a probability distribution with constant mean, since this rates change greatly between different hours and days. The formulae provided can still be used if the measurements are in discrete intervals.

1.4 Literature review

There are various studies that try to analyze and predict the queue length in different settings.

1.5

2 Data analysis

This chapter describes the analysis

2.1 Time series analysis

3 Methodology

asasfasf

3.1 Time series forecasting

4 Results

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Donec sed nunc orci. Aliquam

4.1 Pellentesque

5 Conclusions

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Donec sed nunc orci. Aliquam nec nisl vitae sapien pulvinar dictum quis non urna. Suspendisse at dui a erat aliquam vestibulum. Quisque ultrices pellentesque pellentesque. Pellentesque egestas quam sed blandit tempus. Sed congue nec risus posuere euismod. Maecenas ut lacus id mauris sagittis egestas a eu dui. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Pellentesque at ultrices tellus. Ut eu purus eget sem iaculis ultricies sed non lorem. Curabitur gravida dui eget ex vestibulum venenatis. Phasellus gravida tellus velit, non eleifend justo lobortis eget.

5.1 Pellentesque

Bibliography