UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Foundations of Databases A.Y. 2022-2023
Homework 2 – Conceptual and Logical Design

Master Degree in Computer Engineering
Master Degree in Cybersecurity
Master Degree in ICT for Internet and Multimedia

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Team acronym	prime	
Last Name	**First Name**	**Student Number**
Akkurt	Aysima Merve	2071495
Aghababaei	Ali	2071412
Sulku	Erjol	2080616
Shokrpour	Shima	2041490
Mohammadi	Mohammad	2041467
Norouzimehmandoustolia	Elham	2052056
Kumar	Sandeep	2041363

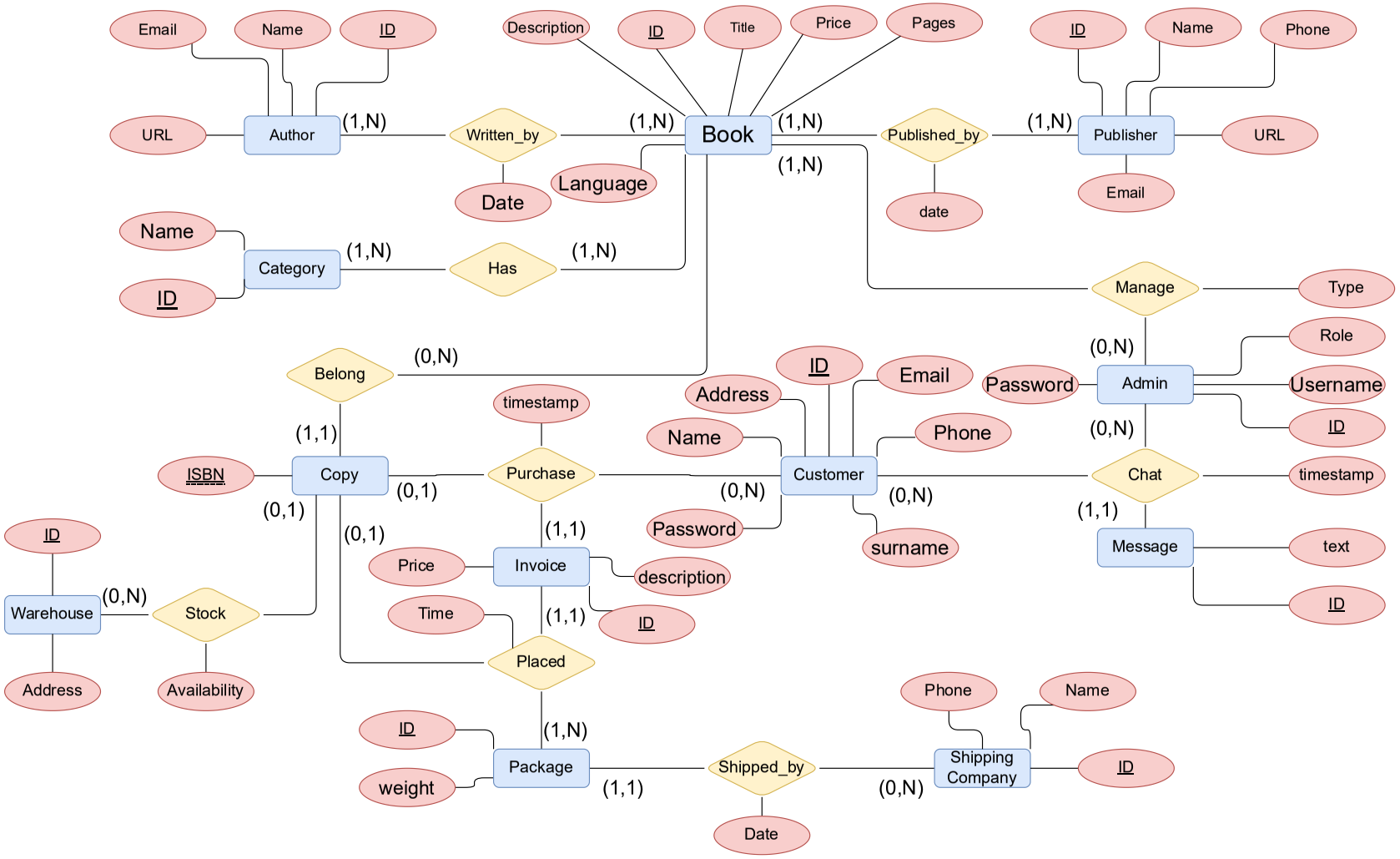
Conceptual Design

Variations to the Requirement Analysis

We changed some parts of the last homework to make it better as follows:

Owner, Inventory, Sales are removed and other entities which are mentioned in the following tables have been added to our schema. A modern database is needed which makes a bookshop able to sell its books through an online platform. This system has customers and admins as users. Customers login with their email and password and can take a look at the items of the shop and buy them or chat with the support department. Admins can login with their username and password and modify the books in the website or answer the customers(based on their role in the system). Every book in the system has its own publisher and writer and the copies of these books are held in the warehouses. After a purchase is made , Items are packed into a package and they are sent to the customer using different shipping companies in maximum 3 working days.

Entity-Relationship Schema


Email
Name
ID
URL
Author
(1,N)
Written_by
Date
Description
ID
Title
Price
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(1,N)
Book
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Language
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Published_by
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Publisher
URL
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(1,1)
Message
text
ID
ID
Warehouse
(0,N)
Stock
Address
Availability
Price
Invoice
description
Time
(1,1)
ID
Placed
ID
weight
(1,N)
Package
(1,1)
Shipped_by
Date
(0,N)
Phone
Name
Shipping Company
ID

Data Dictionary

Entities Table

Entity	Description	Attributes	Identifier
Book	the Catalogue of the Books in our website which shows the book and its description to the customers	• ID: Book identifier (serial) • Description: a brief information about the book (text) • Title: title of the book(text) • price: the cost of the book (float) • pages: the number of pages of the book (integer) • Language: the language of the book in which the book is written to	ID
Author	the author of the book who has written it	• ID: author identifier (serial) • Name: Full name of the author(text) • URL: the link to the personal webpage of the author(text) • Email: email address of the author(text)	ID
Copy	the physical book which is held in the warehouse and will be delivered to the customer	• ISBN: The International Standard Book Number is a numeric commercial book identifier that is intended to be unique. (serial)	ISBN

Publisher	The company who published the book	• ID: publisher identifier (serial) • Name: the name of the publishing company (text) • URL: publisher website link (text) • Phone: the phone number to access the publisher (integer) • Email: the publisher email (text)	ID
Customer	the customer of the bookshop who logs in with their username and password and purchase the book, they can also chat with admins	• ID: identifier of the customer (serial) • Name: first name of the customer (text) • Address: the address of the customer which the books will be delivered to (text) • Email: email of the customer which is used also to log in • Phone: the phone number of the customer (integer) • surname: the last name of the customer (text) • Password: the password which is used to login to the system (text)	ID

Admin	the admin of the system who logs in with username and password and can edit the information of each book,add or delete the books and chat with customers	• ID: identifier of the admin (serial) • Role: the role of the admin in the system,they can be in Support department or the ones who add or delete the books, change prices or write description of the books(Manage department) (text) • username: the username to login(text) • password: the pass word to login(text)	ID
Message	the messages in the chat between customer and admins	• ID: identifier of the message(serial) • text: the text of the message written by admin and customer (text)	ID
Invoice	the invoice or bill created after the customer purchase containing the information about order	• ID: identifier of the invoice (serial) • Price: the price of the purchase • description: the notes about the purchase (text)	ID
Warehouse	the warehouse of the shop which stores the physical books	• ID: identifier of the warehouse (serial) • address: the address of where the warehouse is located (text)	ID

Category	the genre of the books	• ID: identifier of the category(serial) • Name: the name of the category (text)	ID
Package	the package containing of a customer purchase and will be delivered	• ID: identifier of the package (serial) • weight: the weight of the package to calculate the cost of delivery (float)	ID
shipping company	the company which collect the packages and delivers it to customer	• ID: identifier of the company • Name: name of the company • Phone: phone number of the company	ID

Relationships Table

Relationship	Description	Component Entities	Attributes
`Written_by`	it associates a book to an author and identifies the author who has written the book	• Author (1,N): an author has written several books and at least one • Book (1, N)	date: the date in which the book was written by author
`Published_by`	it associates a book to a publisher and identifies which publisher published the book	• Book (1, N) • Publisher (1,N)	date: the date in which the book was published by publisher

Has	it associates a Book to Categories and identifies the categorie(s) of a book	• Book (1, N) • Category (1, N)	
Manage	it relates an admin to a book and shows which admin modified the book	• Book (1, N) • Admin (0,N): multiple admins can manage a book	Type: it shows the type of the management,it could be add,remove,modify
Chat	it associates a customer to an admin and the message which has been used to chat between them	• Admin (0, N) • Customer (0, N) • Message (1, 1): a message is associated between one and only one customer and admin	timestamp: the time of the chat took place at
Belong	it associates a copy to a book	• Book (0, N) • Copy (1, 1): a copy can belong to one and only one book	
Purchase	it associates a customer to a copy and the invoice created for this order	• Customer (0, N) • Copy (0, 1): a copy can be purchased only by one customer • Invoice (1, 1)	timestamp: the time in which the purchase took place at
Stock	it associates a Copy to a warehouse and identifies a copy is held in which warehouse	• Copy (0, 1) • warehouse (0, N)	availability: a boolean which tells us if a book is available or not

Placed	it associates a copy to an invoice (which was made through the purchase) to a packages,it shows which packages contains the copies bought by the customer	• invoice (1, 1) • Copy (0, 1) • Package (1, 1)	Time: time of the package was packed
Shipped_by	it relates a package to a shipping company and shows the package was shipped by which company	• Package (1, 1) • Shipping Company (0, N)	date: date of the shipping

External Constraints

- The admin can changes the book(add,delete,change price,change description) depending on his Role
- The customer can only purchase the book which is available in the warehouses.
- The package should be shipped by the shipper due to time limit that is announced in the website(for example it says in 3 working days it will be delivered)
- The customer should only chat to the admin whose Role is Support.

Functional Requirements Satisfaction Check

The system must allow:

- **To store customer information**

All the information about the customer are stored as attributes. There are attributes like:

1. Address
2. Name
3. ID
4. E-mail
5. Phone

Address is a necessary information about the functionality of the bookstore since the shipper must know where he needs to send the products that are bought by the customer.

- **To store information about the books**

Each book will have its own details. The attributes of this entity are:

1. ID
2. Title
3. Description
4. Language
5. Price
6. Pages

They will hold all the necessary information about this entity.

- **To manage multiple purchases by each customer**

The "Copy" entity and its 'Purchase' relationship with "Customer" and the cardinality of these relations make it possible that a customer can buy multiple copies of the same book or different books.

- **To store information about the purchases that are done**

The ternary 'Purchase' relationship between 'Customer', 'Copy', 'Invoice' ensures that every purchase will be stored in the database together with the timestamp which will hold information about the time when a customer has purchased a copy of a book

- **The Ability to add new books on the system of the bookshop and modifies data related to existing books**

The menage relationship between the admin and the book entity make it possible for admin to add, delete, update the data that is stored for a book.

- **Admin and customers to log in**

Both entities 'Admin' and 'Customer' have attributes which will help them to log into the application. Admin will log in using username and password. The customers will log in using email and their passwords.

- **Has to store information about the packages that are created and the company that will ship a package**

'Package' entity and '`Shipped_by`' relationship ensures that this requirement will be satisfied. The 'Package' will store information about all the copies that are purchased by a customer in the same timestamp. `Shipped_by` on the other hand relates the package with the company that will deliver it.

- **The database will store information about different authors and publisher**

Author and Publisher are two entities in our database that will contain the required data and meet this criteria. The unique ID assigned to each author and publisher will serve as their identify. In addition, there will be more characteristics concerning other information.

Logical Design

Transformation of the Entity-Relationship Schema

Redundancy Analysis

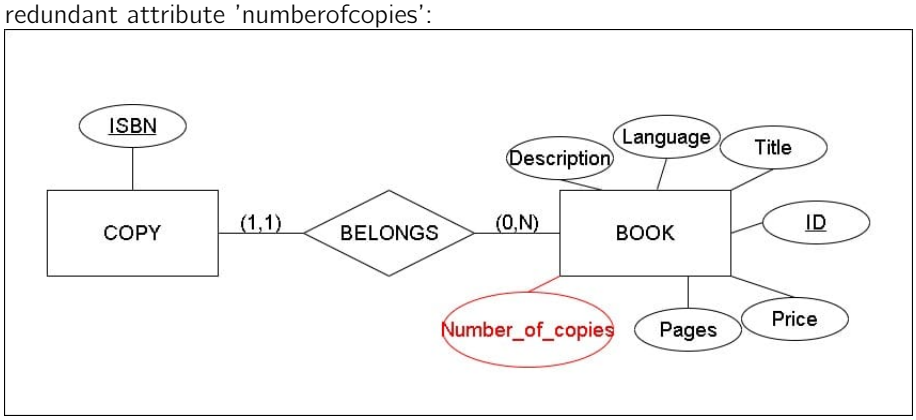
The schema does not contain any cycle of entities.

Choice of Principal Identifiers

The main identifiers comply with the selection criteria.

Analysis of Database Load

Since there is not any derived attribute in the provided ER-Schema, we provide the load analysis as if the Book entity had the number of copies as derived attribute. Consider the following two operations that involve the redundant attribute 'numberofcopies':



O1 - Insert new copy : store a new copy together with its book ID.

O2 - Print data about a book: print all the data about a book, including the number of copies

O3 - Summarise data about all the books: summarise all the data about all the books, including the number of copies In Table 3 the two operations are described. Table 3: Operations description and frequency

Table 3: Operations description and frequency

Operation	Description	Frequency	Type
O1 : Add new copy	store a new copy together with book ID	100/day	Online
O2 : Print data about a book	print all the data about a book, including the number of copies	2/day	Online
O3 : Summarize data about all the books	summarize all the data about all the books, including the number of copies	1/week	Batch

In Table 4 we report the access/volume data related to O1 with redundancy. The Book entity has a read access to get the current value for "numberofcopies" attribute, and a write access to update this value.

Table 4: Access/volume Table for Operation 1 with redundancy .

O1				
Concept	Construct	Access	Type	Average Access
Copy	Entity	1	W	1x100x2=200
Belong	Relationship	1	W	1x100x2=200
Book	Entity	1	R	1x100x1=100
Book	Entity	1	W	1x100x2=200
Total Access				700

In Table 5 we report the access/volume data related to O2 with redundancy. The presence of redundancy allows us to perform one access to the Book entity to get all the required information.

Table 5: Access/volume Table for Operation 2 with redundancy

O2				
Concept	Construct	Access	Type	Average Access
Book	Entity	1	R	1x2x1=2
Total Access				2

In Table 6 we report the access/volume data related to O1 without redundancy. In this case we have to consider the insertion of a new instance in copy, and the insertion of a new instance in belong to store the book the copy joined.

Table 6: Access/volume Table for Operation 1 without redundancy

O1				
Concept	Construct	Access	Type	Average Access
Copy	Entity	1	W	1x100x2=200
Belong	Relationship	1	W	1x100x2=200
Total Access				400

In Table 7 we report the access/volume data related to O2 without redundancy. We considered 20 copies on average for each book.

Table 7: Access/volume Table for Operation 2 without redundancy

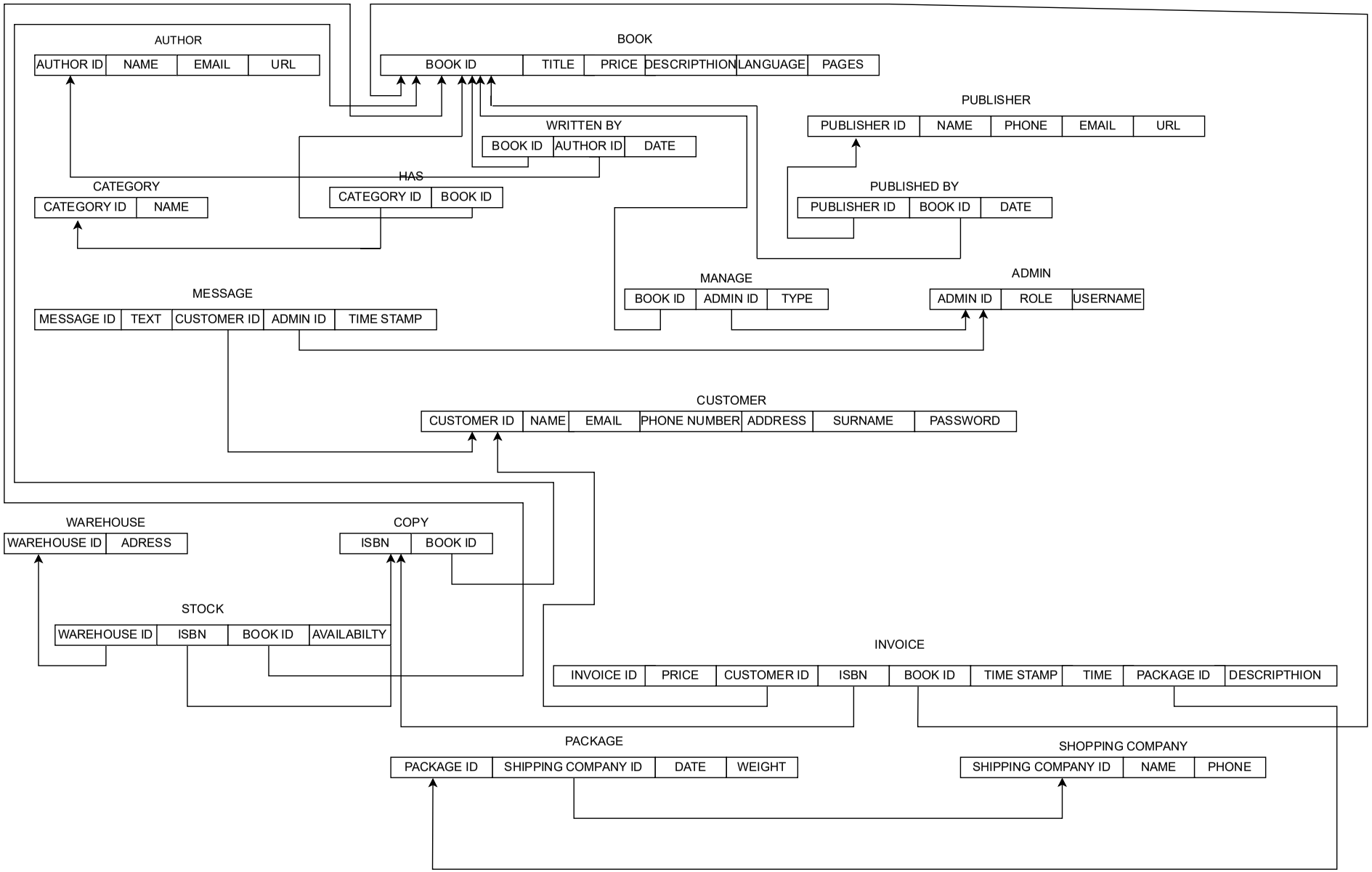
O2				
Concept	Construct	Access	Type	Average Access
Book	Entity	1	R	1x2x1=2
Belong	Relationship	20	R	20x2x1=40
Total Access				42

In Table 8 we report the final access count with and without redundancy. According to the obtained results, removing the redundant attribute from the group entity improves the load analysis.

Table 8: Comparison of the number of accesses for each operation

Operation	With Redundancy	Without Redundancy
O1	700	400
O2	2	42
Total Access/Week	702	442

Relational Schema


AUTHOR
AUTHOR ID
NAME
EMAIL
URL
BOOK
BOOK ID
TITLE
PRICE
DESCRIPTHION
LANGUAGE
PAGES
PUBLISHER
PUBLISHER ID
NAME
PHONE
EMAIL
URL
WRITTEN BY
BOOK ID
AUTHOR ID
DATE
CATEGORY
CATEGORY ID
NAME
HAS
CATEGORY ID
BOOK ID
PUBLISHED BY
PUBLISHER ID
BOOK ID
DATE
MANAGE
BOOK ID
ADMIN ID
TYPE
ADMIN
ADMIN ID
ROLE
USERNAME
MESSAGE
MESSAGE ID
TEXT
CUSTOMER ID
ADMIN ID
TIME STAMP
CUSTOMER
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NAME
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ADDRESS
SURNAME
PASSWORD
WAREHOUSE
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ISBN
BOOK ID
STOCK
WAREHOUSE ID
ISBN
BOOK ID
AVAILABILTY
INVOICE
INVOICE ID
PRICE
CUSTOMER ID
ISBN
BOOK ID
TIME STAMP
TIME
PACKAGE ID
DESCRIPTHION
PACKAGE
PACKAGE ID
SHIPPING COMPANY ID
DATE
WEIGHT
SHOPPING COMPANY
SHIPPING COMPANY ID
NAME
PHONE

Data Dictionary

Relation	Attribute	Description	Domain	Constraints
Book	Book ID	Book identifier	serial	Primary Key
	Title	title of the book	text	Not Null
	Price	the cost of the book	float	Not Null
	Pages	the number of pages of the book	integer	Not Null
	Language	the language of the book in which the book is written to	text	Not Null
	Description	a brief information about the book	text	
	ISBN	the physical book which is held in the warehouse and will be delivered to the customer	serial	Foreign Key to Copy
Author	Author ID	author identifier	serial	Primary Key
	Name	Full name of the author	text	Not Null
	URI	the link to the personal webpage of the author	text	
	Email	email address of the author	text	
Publisher	Publisher ID	publisher identifier	serial	Primary Key
	Name	the name of the publishing company	text	Not Null
	URL	publisher website link	text	
	Phone	the phone number to access the publisher	integer	Not Null
	Email	the publisher email	text	Not Null
Category	Category ID	identifier of the category	serial	Primary Key
	Name	the name of the category	text	Not Null
Copy	ISBN	The International Standard Book Number is a numeric commercial book identifier that is intended to be unique	serial	Primary Key
	Book ID	Book identifier	serial	Foreign Key to Book, Not Null
ShippingCompany	Shipping Company ID	identifier of the company	serial	Primary Key
	Name	name of the company	text	Not Null
	Phone	phone number of the company	integer	Not Null
Customer	Customer ID	identifier of the customer	serial	Primary Key
	Name	first name of the customer	text	Not Null
	Address	the address of the customer which the books will be delivered to	text	Not Null
	Email	email of the customer which is used also to log in	text	Not Null

	Phone	the phone number of the customer	integer	Not Null
	surname	the last name of the customer	text	Not Null
	Password	the password which is used to login to the system	text	Not Null
Invoice	Invoice ID	identifier of the invoice	serial	Primary Key
	Price	the price of the purchase	float	Not Null
	Description	the description about the purchase	text	
	Customer ID	identifier of the customer	serial	Foreign Key to Customer, Not Null
	ISBN	The International Standard Book Number is a numeric commercial book identifier that is intended to be unique	serial	Foreign Key to Copy, Not Null
	Book ID	Book identifier	serial	Foreign Key to Book, Not Null
	Timestamp	the time in which the purchase took place at	timestamp	Not Null
Package	Package ID	identifier of the package	serial	Primary Key
	weight	the weight of the package to calculate the cost of delivery	float	Not Null
	Shipping Company ID	identifier of the company	serial	Foreign Key to Shipping Company, Not Null
	Date	date when the shipping has started	text	Not Null
Warehouse	Warehouse ID	Identifier of the warehouse	serial	Primary Key
	address	the address of where the warehouse is located	text	Not Null
`Written_by`	Book ID	Book identifier	serial	Foreign Key to Book, Not Null
	Author ID	author identifier	serial	Foreign Key to Author, Not Null
	Date	The date in which the book was written by author	date	
`Published_by`	Book ID	Book identifier	serial	Foreign Key to Book, Not Null
	Publisher ID	publisher identifier	serial	Foreign Key to Publisher, Not Null
	Date	The date in which the book was published by publish	date	Not Null

Has	Category ID	identifier of the category	serial	Foreign Key to Category, Not Null
	Book ID	Book identifier	serial	Foreign Key to Book
Admin	Admin ID	identifier of the admin	serial	Primary Key
	Role	the role of the admin in the system,they can be in Support department or the ones who add or delete the books, change prices or write description of the books(Manage department)	text	Not Null
	username	the username to login	text	Not Null
	password	the pass word to login	text	Not Null
Manage	Admin ID	identifier of the admin	serial	Foreign Key to Manage
	Book ID	Book identifier	serial	Foreign Key to Book, Not Null
	Type	it shows the type of the management,it could be add,remove,modify	text	Not Null
Message	ID	identifier of the message	serial	Primary key
	Text	the text of the message written by admin and customer	text	Not Null
	Admin ID	identifier of the admin	serial	Foreign Key to Admin, Not Null
	Customer ID	identifier of the customer	serial	Foreign Key to Customer, Not Null
	timestamp	the time of the chat took place at	timestamp	Not Null
Stock	Warehouse ID	Identifier of the warehouse	serial	Primary Key
	ISBN	The International Standard Book Number is a numeric commercial book identifier that is intended to be unique	serial	Foreign Key to Copy, Not Null
	Book ID	Book identifier	serial	Foreign Key to Book, Not Null
	availability	a boolean which tells us if a book is available or not	bool	Not Null

External Constraints

- The admin can changes the book(add,delete,change price,change description) depending on his Role: we have to check the manageType and adminRole attributes to be compatible.
- The customer can only purchase the book which is available in the warehouses: a copy should be purchased

if it's stockAvalability is TRUE.

- The package should be shipped by the shipper due to time limit that is announced in the website(for example it says in 3 working days it will be delivered): the placedTime and shipped_ byDate should not violate this limit.
- The customer should only chat to the admin whose Role is Support: the adminRole must be Support.

Group Members Contribution

- Ali Aghababaei contributed the variation of the requirements analysis part;
- Ali Aghababaei,Elham Norouzimehmandoustolia,Mohammad Mhammadi and Ejrol sulku contributed the design of the ER-Schema;
- Ali Aghababaei contributed to the Entities table;
- Ali Aghababaei contributed to the Relationship table;
- Ali Aghababaei and Erjol Sulku contributed to the External Constraints and Functional Requirements Check
- Aysima Merve Akkurt contributed to the Redundancy Analysis;
- Aysima Merve Akkurt contributed to the Choice of Principal Identifiers;
- Aysima Merve Akkurt contributed to the Analysis of Database Load
- Elham Norouzimehmandoustolia and Erjol Sulku contributed to the Relational Schema
- Elham Norouzimehmandoustolia and Erjol Sulku contributed to the Data Dictionary
- Ali Aghababaei contributed to the External Constraints