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Computer Science - Curriculum Artificial Intelligence

Project Assignment

Database Systems

Database Design and Implementation

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1 Conceptual Design

1.1 Requirements

The requirements for the database are the following:

Ecco il testo contenuto nell'immagine:

"GreenWorld Energy"

The company "GreenWorld Energy" operates decentralized renewable energy production facilities distributed across regions. Each facility is characterized by a name, location, type of energy produced (e.g., solar, wind, hydro), and maximum energy output capacity. The company also manages contracts with customers for energy supply, categorized as residential or commercial, and offers flexible pricing models based on consumption. Each customer has one or more accounts, each identified by a unique code. Every energy contract is linked to a single customer account and includes details such as start date, duration, energy plan, and cost. Facilities are overseen by management teams, each identified by a unique code, team name, and the number of projects managed. Teams are evaluated based on performance metrics such as energy efficiency, uptime, and customer satisfaction. Each team is represented by the main responsible employee and other employees identified by fiscal code, name, surname, date of birth and date of hiring. Additionally, the company supports a feedback system allowing customers to submit ratings and comments regarding service quality. Customers are classified into residential and commercial types, each identified by a unique alphanumeric code, with associated contact details and energy consumption history.

1.2 Analysis

1.2.1 Glossary of Terms

Term	Description	Connections	Synonyms
Region	Area where the facilities are located.	Facility	Location
Facility	Energy production facility. It emits energy for customers	Contract,Teams,Region	
Contract	Energy supply contract. It describes the energy plan. It can be residential or commercial	Account, Facility	Projects
Customer	Customer of GreenWorld Energy. It can be residential or commercial	Account	
Account	Customer account. It associated with only one account and one contract	Contract, Customer, Feedback	
Feedback	Customer feedback. Used to give a score to each team	Account,Team	Ratings, customer satisfaction
Team	Groups of employees that oversees a facility. Each team has a manager	Facility, Employee, Feedback	
Employee	Employee of a GreenWorld Energy's team.	Team	

Table 1: Glossary of Terms

1.2.2 Level of Abstraction

By considering the synonyms of the terms, we can identify the level of abstraction of the terms. The terms can be classified as follows:

- **Region** as Location
- **Facility** as Facility
- **Contract** as Contract
- **Customer** as Customer
- **Account** as Account
- **Feedback** as Feedback
- **Team** as Team
- **Employee** as Employee

1.2.3 Reorganization of Concepts

The concepts can be reorganized as follows:

Facility
Each facility is characterized by a name, location, type of energy produced (e.g., solar, wind, hydro), and maximum energy output capacity. The company also manages contracts with customers for energy supply, categorized as residential or commercial, and offers flexible pricing models based on consumption. Facilities are overseen by management teams

Table 2: Facility's Concepts

Contract
The company also manages contracts with customers for energy supply, categorized as residential or commercial, and offers flexible pricing models based on consumption. Every enegry contract is linked to a single customer account and includes details such as start date, duration, energy plan, and cost.

Table 3: Contract's Concepts

Customer
Each customer has one or more accounts, each identified by a unique code. Customers are classified into residential and commercial types, each identified by a unique alphanumeric code, with associated contact details and energy consumption history. Additionally, the company supports a feedback system allowing customers to submit ratings and comments regarding service quality.

Table 4: Customer's Concepts

Account
Each customer has one or more accounts, each identified by a unique code. Every energy contract is linked to a single customer account and includes details such as start date, duration, energy plan, and cost.

Table 5: Account's Concepts

Feedback
The company supports a feedback system allowing customers to submit ratings and comments regarding service quality.

Table 6: Feedback's Concepts

Team
Facilities are overseen by management teams, each identified by a unique code, team name, and the number of projects managed. Teams are evaluated based on performance metrics such as energy efficiency, uptime, and customer satisfaction. Each team is represented by the main responsible employee

Table 7: Team's Concepts

Employee
Each team is represented by the main responsible employee and other employees identified by fiscal code, name, surname, date of birth and date of hiring.

Table 8: Employee's Concepts

1.2.4 Entity-Relationship Diagram

SKELETON SCHEMA

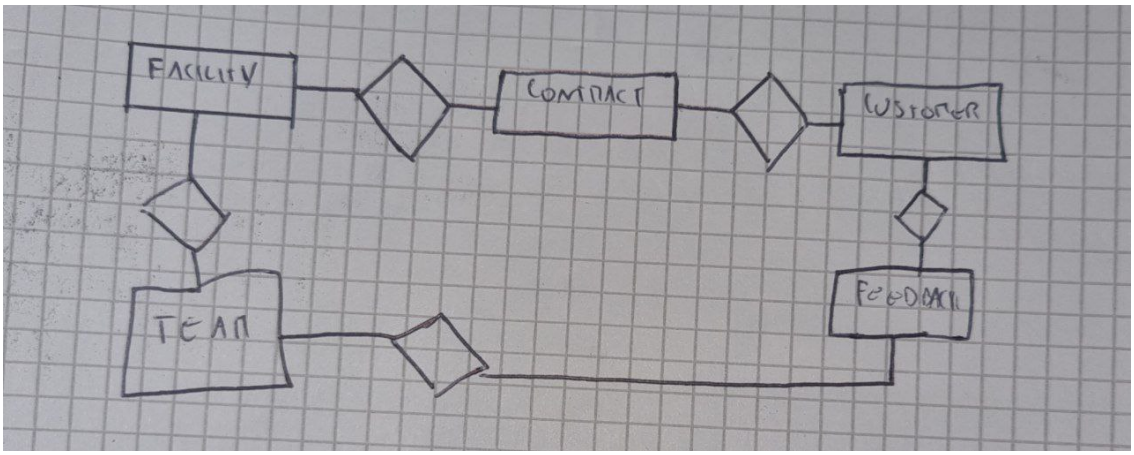

Figure 1: Skeleton Schema

This schema represents the main entities and their relationships. The entities are the following:

- **Facility**
- **Contract**
- **Customer**
- **Feedback**
- **Team**

The purpose of this schema is to have a general idea of the entities and their relationships. The attributes of the entities and the cardinality of the relationships are not included in this schema. Also, some entities are not included in this schema, such as Account and Employee. These entities will be included in the final schema with all the other details.

FINAL SCHEMA

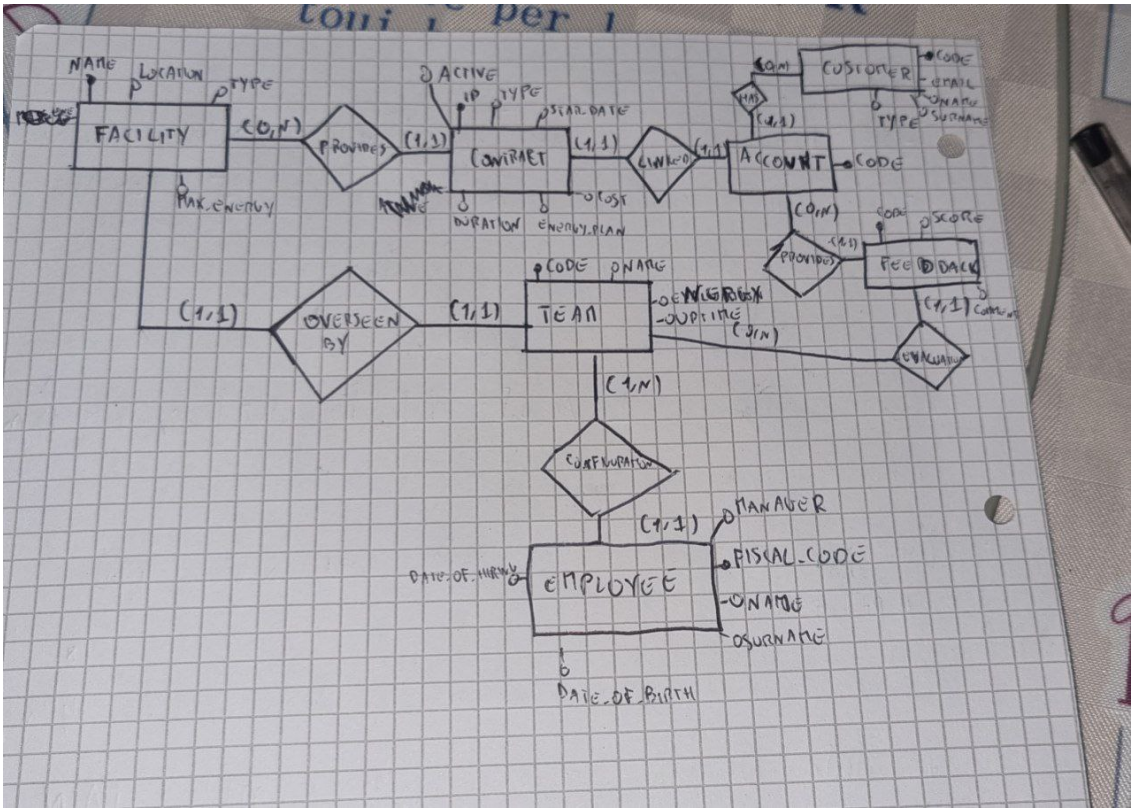

Figure 2: Final Schema

SPOSTA efficiencyScore alla facility. Chiama la provides tra account e feedback GIVES. ACCOUNT- FEEDBACK è 1:1

1.2.5 Business Rules

The business rules are the following:

- A customer can't be a minor
- An employee can't be a minor
- Each feedback must be related to the team that manages the facility where the contract is active
- Each team has got only one main responsible employee
- The sum of energy plan of all contracts related to a facility can't exceed the maximum energy output capacity of the facility

- If an account needs to change type of contract, the old contract must deactivated before the new one is activated
- A customer of a specific type can't have a contract of the other type
- The score of a feedback can be between 0 and 5
- Uptime is the number of hours the facility is active in a day. Between 6 and 8
- Energy efficiency is the percentage of energy produced compared to the maximum energy output capacity of the facility. Between 0 and 100

2 Logical Design

2.1 Volume Table

Lets consider the volumes for a year

Concept	Type	Volume	Description
Facility	E	100	Number of facilities (Given)
Contract	E	600.000	Number of contracts. 100 facilities * 500 contracts per facility * 12 months
Customer	E	300.000	Number of customers.(ASSUMPTION)
Account	E	600.000	Number of accounts. 300.000 customers * 2 accounts per customer on average
Team	E	100	Number of teams. (Given)
Employee	E	500	Number of employees. 5 employees per team * 100 teams (ASSUMPTION)
Feedback	E	600.000	Number of feedbacks. One feedback per account
Provides	R	600.000	Each contract is provided by a single facility
Linked	R	600.000	Each contract is linked to a single account
Has	R	600.000	Each customer 2 accounts on average
OverseenBy	R	100	Each facility is overseen by a single team
Configuration	R	500	Each team constists of 5 employees on average
Gives	R	500.000	Each feedback is given by a single account.Not all accounts give feedback
Evaluation	R	500.000	Each feedback is linked to a single team

Table 9: Volume Table

2.2 Access Table

Operation1: Register a new customer (50 times per day)

Concept	Type	Access	Type
Customer	E	1	W

Table 10: Access Table for Operation1

Total Cost: 2 * 50 = 100 per day
Operation2: Register a new energy contract (50 times per day)

Concept	Type	Access	Type
Contract	E	1	W
Provides	R	1	W
Facility	E	1	R
Linked	R	1	W
Account	E	1	R
Facility	E	1	W
Provides	R	6000	R
Contract	E	6000	R

Table 11: Access Table for Operation2

Total Cost: (2+2+1+2+1+2+6000+6000)*200=2.402.000 per day
Every time we need to update the efficiency score of the facility related to the contracts.
Operation3: Assign a facility to a management team (50 times per day)

Concept	Type	Access	Type
Team	E	1	R
OverseenBy	R	1	W
Facility	E	1	R

Table 12: Access Table for Operation3

Total Cost: (1+2+1)*50=200 per day
Operation4: View the total energy output of a specific facility managed by the

eldest employee (1 per month = 0.03 per day)

Concept	**Type**	**Access**	**Type**
Employee	E	500	R
Configuration	R	1	R
Team	E	1	R
OverseenBy	R	1	R
Facility	E	1	R
Provides	R	6000	R
Contract	E	6000	R

Table 13: Access Table for Operation4

Total Cost: (500+1+1+1+1+6000+6000)*0.03=375.12 per day
In this case we don't have sumEnergyOutput in the schema as attribute of the facility, so we need to compute it every time. If we introduce it, the cost will be

Concept	**Type**	**Access**	**Type**
Employee	E	500	R
Configuration	R	1	R
Team	E	1	R
OverseenBy	R	1	R
Facility	E	1	R

Table 14: Access Table for Operation4 with redundancy

Total Cost: (500+1+1+1+1)*0.03=15.12 per day
But in this case we need to update it every time we add a new contract, so the total cost of **Operation2** will be:

Concept	**Type**	**Access**	**Type**
Contract	E	1	W
Provides	R	1	W
Facility	E	1	R
Facility	E	1	W
Linked	R	1	W
Account	E	1	R
Facility	E	1	W
Provides	R	6000	R
Contract	E	6000	R

Table 15: Access Table for Operation2 with redundancy

Total Cost: (2+2+1+2+2+1+2+6000+6000)*200=2.402.400 per day
So the total cost without redundancy is 2.402.000 + 375.12 = 2.402.375.12, while the total cost with redundancy is 2.402.400 + 15.12 = 2.402.415.12 per day. So we shouldn't keep the redundancy in this case.
Operation5: Print a ranked list of facilities based on their efficiency scores (10 per day)

Concept	**Type**	**Access**	**Type**
Facility	E	100	R

Table 16: Access Table for Operation5

Total Cost: 100*10 = 1000 per day
We can try to remove the redundancy of the efficiencyScore in facilities

Concept	**Type**	**Access**	**Type**
Facility	E	100	R
Provides	R	600.000	R
Contract	E	600.000	R

Table 17: Access Table for Operation5 without redundancy

Total Cost: (100+600.000+600.000)*10 = $3.6 \cdot 10^{14}$ per day

Concept	Type	Access	Type
Contract	E	1	W
Provides	R	1	W
Facility	E	1	R
Linked	R	1	W
Account	E	1	R

Table 18: Access Table for Operation2 without redundancy

Total Cost: (2+2+1+2+1)*200=1.600 per day
Now we don't need to update the the efficiency score everytime we register a new contract.
So the total cost without redundancy is $3.6 \cdot 10^{14}$ + 1600, while the total cost with redundancy is 2.402.000 + 1000 = 2.403.000 per day.
We shouuld keep the redundancy in this case.

2.2.1 Redundancies and Generalization

- **Redundancies:** The number of contracts handled by a team is not stored in the schema, as it can be calculated by counting the number of contracts related to the facility managed by the team. The score of the team can be derived by the following formula: $score = \frac{energy\_efficiency + uptime + AVG(customer\_score)}{3}$ and is not stored in the schema to avoid redundancy. Due to the previous analysis, the redundancy of the efficiency score in the facility is kept, while the redundancy of the sumEnergyOutput in the facility isn't introduced.

- **Generalization:** The schema doesn't contain any generalization since there aren't different operations for theme. There is a **type** attribute in the **Customer** and **Contract** entities so that the business rule related to the type of contract can be enforced.

2.3 UML Schema