Data and Applications - Project
Team 17 - DNA 5'

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1 Introduction to the Mini-World

This database accounts for all the essential and infrastructural bodies required for functioning of a hypothetical city.

Modern cities face increasing challenges in managing their resources and services effectively. To address these challenges, a City Management Database has been designed to track and optimize the financial budget of cities, with a primary focus on improving healthcare, and key institutions such as the police and banks. This database serves as a comprehensive solution to ensure data-driven decision-making and better overall urban governance.

2 Purpose

The primary purpose of the City Management Database is to centralize, manage, and analyze financial data for cities, enabling government officials, policymakers, and other stakeholders to make informed decisions about resource allocation. By optimizing budget allocation, this database aims to enhance the quality of healthcare, infrastructure, and the efficiency of key institutions.

3 Users of the database

1. **Government Officials:** City mayors, council members, and department heads can use the database to allocate resources and make informed decisions.
2. **Financial Analysts:** Professionals analyzing financial trends and making recommendations for budget allocation.
3. **Law enforcement:** The federal agencies and law enforcement, and different departments in it for better investigating crimes and other disputes.
4. **Citizens:** In some cases, citizens may have limited access to view specific public information, promoting transparency and civic engagement.

4 Views of the Database

1. **Financial Overview:** Provides a summary or high-level view of the city's overall financial health, including revenues, expenditures, and budget allocations for various sectors.
2. **Healthcare Management:** Offers insights into healthcare budgets, patient data, and medical facility utilization.

3. **Federal Instituitions** Gives access to personal records of individual's past to help decisions like offering loans, criminal investigation and tax-income reports.

4. **Institution Efficiency** Evaluates the performance and budget utilization of key institutions like the police and banks.

5 Applications of the database

1. **Budget Allocation:** The database helps allocate resources efficiently by identifying areas that require increased funding.

2. **Policy Development:** Policymakers can use data from the database to develop and fine-tune urban policies.

3. **Performance Assessment:** The database allows tracking and assessment of institutional performance to ensure accountability.

4. **Data-Driven Decision-Making:** Enables data-driven decision-making by providing timely and accurate information.

5. **Public Transparency** Provides citizens with insights into how their tax money is being used and encourages civic engagement.

5.1 Secure Access

Access to the database is secured through authentication and authorization mechanisms. Data encryption and strict user access controls ensure that only authorized personnel can view, modify, or add data, safeguarding sensitive financial information

5.2 Strategic Insights

The database provides strategic insights by offering historical data, forecasts, and predictive analytics. Users can identify trends and patterns to make informed decisions for the future, enabling long-term urban planning.

5.3 Alleviating Data Redundancy

To reduce data redundancy, the database uses a normalized database design, avoiding data duplication by organizing data into separate tables. For instance, rather than storing the same information about a healthcare facility in multiple places, data on the facility is stored in one central location and referenced where needed. This minimizes the risk of errors and inconsistencies in data.

6 Database Requirements

6.1 Assumptions

- In a practical city landscape, there are myriads of institutions that work together, but for the sake of the project, we keep it simple and focus on the essentials.

6.2 Strong Entity types

6.2.1 Citizen

- **CIN (Citizen Identification Number):** *Primary Key, Single attribute, int*
  This is a unique number given to each citizen to identify them (like SSN/Aadhar/etc)
- **Name:** *Composite Attribute, string*
  The name of a person, composed of firstname and lastname
- **DOB (Date Of Birth):** *Composite Attribute, string*
  Date of birth is composed of year, month and day.
- **Address:** *Composite Attribute, string*
  Door number, Street, Block, Constituency
- **Income:** *Single attribute, float*
  The total income of a person.
- **Tax:** *Single and Derived attribute, float*
  from the total income of a person, taxes on them are calculated.
- **Income Category:** *Single and Derived attribute, boolean*
  from the total income of a person, it's decided if the person is above poverty line(APL) or below poverty line (BPL).

6.2.2 Neighbourhoods

- **PIN (Postal index number):** *Primary Key, Single attribute, int*
  Each neighbourhood has an unique postal index number for identification.
- **Representative:** *Single attribute, string*
  Each neighbourhood has an elected representative in the governing council of the city.
  They are identified by their CIN.
- **Landmark:** *Multivalued attribute, string*
  The neighbourhood can have some popular landmarks.Ex: Malls, Amusement parks.
  The No. of diseases reported per month in the neighbourhood.

- **Neighbourhood Type:** *Single attribute, string*
  Each neighbourhood belongs to a specific type. Example - Residential, Commercial etc.

6.2.3 Banks

- **Bank code:** *Primary Key, Single attribute, string*
  Each bank has an unique code given to it by central bank. Ex: IFSC code for the bank which will be unique for every bank.
- **Interest rates:** *Multivalued attribute, float*
  The banks have various schemes which have different interest rates.
- **Management cost:** *Composite attribute, float*
  Money spent on different operations like employee salary, infrastructure, interests paid, repo rate.
- **Revenue generated:** *Composite attribute, float*
  Money gained from loan repayments, selling collaterals, dividends.

6.2.4 LEA (Law Enforcement Agency)

- **LEA code:** *Primary Key, Single attribute, string*
  Each Law enforcement agency has an unique code to identify it.
- **Name:** *Composite attribute, string*
- **Record of all the cases:** *Multivalued attribute, list*
  It shall have record of the arrests it has made, charge sheets filed, evidence related to each crime.
- **List of employees:** *Multivalued attribute, list of people*
  There are multiple employees in various ranks.
- **Budget Allocated:** *Single attribute, int*
  The budget allocated to the different agencies by the government.

6.2.5 Hospitals

- **NMPI (National Medicare Provider Identifier):** *Primary Key, Single attribute, string*
  Each Hospital has an unique code to identify it.
- **Name:** *single attribute, string*

- **Patient capacity** *Composite attribute, int*
  The Hospital shall has an average capacity of patients it can provide treatment at a given point of time, which depends on the sophistication of the treatment offered. Example: Emergency Unit, Surgical Ward, Pediatric Ward, Clinics.

- **Employees:** *Composite attribute, list of people*
  The hospital will have certain number of employees, doctors in various departments, nurses and other employed receptionists.

- **Budget allocated:** *single attribute, float*
  Money allocated to a hospital.

6.3 Weak entity types

6.3.1 Patient

- **Patient ID:** *Partial Key, Single attribute, string*
  Each patient is given a patient ID when they are admitted by the hospital.

- **CIN:** *Partial Key, Single attribute, string*
  Each patient can also be identified their CIN.

- **Disease:** *Multivalued attribute, string*
  The disease patient has, is an attribute. Patient can have multiple diseases.

- **Doctor:** *Multivalued attribute, string*
  Each patient is associated with some doctors.

- **Cost for Treatment:** *Single attribute, int*
  The expenditure of the patient can be used for availing health insurances.

6.3.2 Crimes

- **FIR number:** *Partial Key, Single attribute, string*
  Each patient is given a patient ID when they are admitted.

- **Inspector:** *Multivalued Attribute, string*
  Each reported crime shall be assigned to officers of various departments and they shall work in coordination to solve the case.

- **Type of crime:** *Multivalued attribute, string*
  Ex: Murder, assault, theft, Cybercrime.

- **List of Charges:** *Multivalued attribute, string*
  There can be various criminal charges according to the Penal Code that the criminal can be tried for.

6.3.3 Bank Accounts

- **Account ID:** *Partial Key, Single attribute, string*
  Each bank account is uniquely identified by an ID that comprises of branch where opened, the bank win which it was opened etc...
- **Money deposited:** *Single attribute, float*
  The amount of money in the account.
- **Nominee:** *Single attribute, CIN*

6.4 Relationship types

6.4.1 `Citizen` lives in a `Neighborhood`

- **Degree:** 2
- **Participating Entity types:** `Citizen`, `Neighborhood`
- **Cardinality ratio:** N:1
- **Participation constraint:** total participation for both entities.
- **(min, max) constraint pair:** (1,1) - (1,N) [Multiple citizens live in a given neighborhood, every citizen lives in exactly one neighborhood, every neighborhood has atleast one citizen in it]

6.4.2 `Hospital` serves a `Neighborhood`

- **Degree:** 2
- **Participating Entity types:** `Hospital`, `Neighborhood`
- **Cardinality ratio:** N:M
- **Participation constraint:** Total participation for hospital and partial for neighbourhood.
- **(min, max) constraint pair:** (1,N)-(0,N) [Multiple hospitals can serve multiple neighborhoods, every hospital serves atleast one neighborhood but not every neighborhood may have a hospital]

6.4.3 `Citizen` opens a `Bank account` under a `Bank`

- **Degree:** 3
- **Participating Entity types:** `Citizen`, `Bank account`, `Bank`
- **Cardinality ratio:** N:1:M
- **Participation constraint:** Partial participation for `citizen` and `bank` and total participation for `bank account`.
- **(min, max) constraint pair:** (0,N)-(1,1)-(0,N) [Citizens can have multiple bank accounts (but not all citizens may have one), every bank account is associated with exactly one citizen and one bank, banks have multiple bank accounts under them (but not all banks may have accounts, like in the case of a newly created bank)]

6.4.4 Diseased `Citizens` visit a `Hospital` and become `Patient`

- **Degree:** 3
- **Participating Entity types:** `Citizen`, `Hospital`, `Patient`
- **Cardinality ratio:** N:M:1
- **Participation constraint:** partial participation for `citizen` and `hospital` and total participation for `patient`.
- **(min, max) constraint pair:** (0,N)-(0,N)-(1,1) [Citizens may get sick multiple times (but not all citizens necesarrily get sick), hospitals get multiple patients (but not all hospitals need to have one), but a given patient is associated with exactly one citizen and hospital at a time]

6.4.5 `Bank` gives loan to `other entity`

- **Degree:** 1 (in case of bank giving loan to another bank) or 2.
- **Participating Entity types:** `Bank`, `any entity`
- **Cardinality ratio:** N:M
- **Participation constraint:** Partial participation for both the entities.
- **(min, max) constraint pair:** (0,N)-(0,N) [Multiple banks may give loans to multiple entities, but not all banks may give loan and not all entities might need loans]
- **Attributes of the Relationship:**

- **Loan amount:** *Single attribute, float*
  Amount sanctioned.
- **Interest rate:** *Single attribute, percentage, float*
- **Repayment period:** *Single attribute, years, float*

6.4.6 `Citizen`(s) (victim) report a `Crime` to `LEA` against `Citizen`(s) (suspect) in a `Neighbourhood`(s)

- **Degree:** 4 (because the number of distinct entities is 4)
- **Participating Entity types:** `Citizen` (victim), `Crime`, `LEA`, `Citizen` (suspect), `Neighbourhood`
- **Cardinality ratio:** L:1:M:N:P
- **Participation constraint:** Partial participation for `citizen` (both victim and suspect), total participation for `crime`, partial participation for `LEA`, partial participation for `Neighbourhood`
- **(min, max) constraint pair:** (0,N)-(1,1)-(0,N)-(0,N)-(0,N) [A victim may be a part of multiple crimes (and not all people become victims), a specific crime report comes exactly once in this relationship, a LEA (but not all LEA) may have multiple reports under it, a person (but not all people) may be suspects in a crime, a neighborhood (but not all) may have multiple crimes reported in it]

7 Functional Requirements

7.1 Modifications

- **Insert:**
  - When a person is born, insert a new entity into `Citizen`
  - A new entity is inserted into `Neighborhood` if the city gets expanded
  - When new hospital is built, insert a new entity into `Hospital`
  - For every patient visiting a hospital, the hospital inserts a new entity into `Patient`
  - For every customer of a bank, the bank inserts a new entity into `Bank Account`
- **Update:**
  - Update the income of a person on a regular basis in `People`
  - Update the interest rates as and when they are revised in `Bank`

- Update the representative after elections in `Neighbourhood`

- **Delete:**
  - When a person dies, delete the entity in `Citizen`
  - When a hospital closes down, delete the entity in `Hospital`
  - For every customer closing the bank account, the bank deletes the entity in `Bank Account`
  - Upon shutdown of a Law Enforcement Agency, the entity is deleted from `LEA`
  - For every crime with justice settled, the LEA deletes the entity from `Crime`

7.2 Retrievals

- **Selection:**
  - Select all the people below a certain income level.
  - Select all the people who are law enforcers.
  - Select all the people who are infected by a disease.

- **Projection:**
  - Project all the diseases present in the city from the disease attribute of patient.
  - Project all the crimes that have happened in a location.

- **Aggregate:**
  - Total number of people affected by a disease.
  - Average tax collected per person.
  - Find the LEA with the largest allocated budget.

- **Search:**
  - Search and match a particular apartment name from the address string

- **Analysis:**
  - We can analyse the crime rate in neighbourhoods and enhance the security in those neighbourhoods where crime rates are higher
  - Analyse the distribution of hospitals and find which neighbourhoods less access to hospitals allowing us to improve the equitable distribution healthcare services.
  - Analyse how the budget allocated was spent and devise plans for more efficient utilization of the budget
  - Analyse income levels in different neighbourhood and determine which areas are underdeveloped.

8 Summary

The City Management Database shines as a beacon of transparency, providing open access to vital financial information for citizens and policymakers. Its robust maintenance ensures data accuracy and security, safeguarding the city's financial health for the long term. By offering insights and historical data, it empowers decision-makers to shape sustainable urban policies. The database's transparency builds trust and accountability, promoting civic engagement and informed decision-making. In this synergy of transparency and maintenance, the database becomes an invaluable asset for the city's long-term well-being.