Problem Statement

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Identify Nouns

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The Oxford Fire Department wants to create a database that keeps track of hazardous materials used by companies in the city. They currently use a manual system but find that it is hard to keep current. In addition, they would like to have the database be accessible from anywhere to its employees. The firetrucks will have devices capable of accessing the database so that a quick scan of the database can be performed as the engine is responding to a fire. Information about a hazardous product includes a unique material identifier and the material name. For each uniquely identified product, information about its suppliers, including a unique supplier number, a name, and a phone number is needed. Several suppliers may supply a specific hazardous material as identified by its identifier. The final information kept about a hazardous product is its unit of measure. This includes a unique code and a description. The fire department inspects all firms in the city on an annual basis. During this inspection, all hazardous material on the firm’s premises is inventoried. The fire department identifies each firm using a unique identification number. It also stores the firm’s name, address, phone number of firm, the date the inventory was made, and the number of units of the product stored by the firm. This inventory count is actual number of units found on the day of the inventory. The fire department is not interested in storing a historical record of hazardous products used.

Unnormalized Data

- Hazardous product
  - Material identifier
  - Material name
  - Suppliers
    - Supplier number
    - Name
    - Phone numbers
  - Unit of Measure
    - Unique Code
    - Description
- Firm
  - Identification number
  - Name
  - Address
  - Phone number
  - Inventory Date
  - Product stored
    - Units

Database Normalization

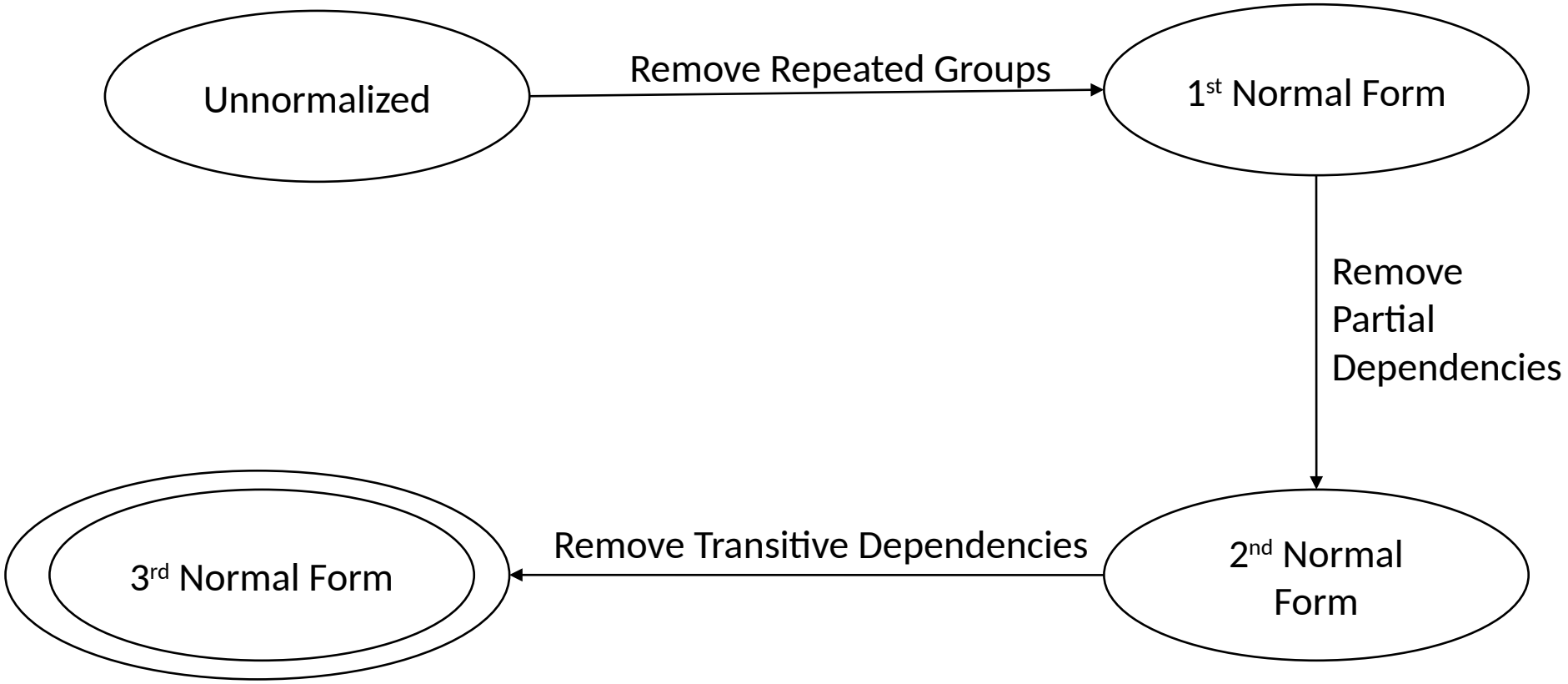
Purpose of Normalization

- It is used to remove the duplicate data and database anomalies from relational tables.
- Normalization helps to reduce redundancy and complexity by examining new data types used in the table.
- It is helpful to divide the large database table into smaller tables and link them using relationship.
- It avoids duplicate data and repeating groups in a table.
- It reduces the chances for anomalies to occur in a database.

Different Normal Forms

- Unnormalized
- 1st Normal Form
- 2nd Normal Form
- 3rd Normal Form
- Higher Normal Forms (BCNF, Fourth, Fifth, …)

Convert from Unnormalized to 3NF



Unnormalized

HospitalRecords

RecordID	PatientID	PatientName	PatientAddress	Doctors	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	Doctor ID: Doctor Name 3454: Jackson Grant 3444: Rebecca Mixon 2356: Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454, 2333	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356	January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, Doctors(DoctorID, DoctorName), VisitDate, Charges)

Unnormalized

HospitalRecords

RecordID	PatientID	PatientName	PatientAddress	Doctors	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	Doctor ID: Doctor Name 3454: Jackson Grant 3444: Rebecca Mixon 2356: Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454, 2333	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356	January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, Doctors(**DoctorID**, DoctorName), VisitDate, Charges)

First Normal Form (1NF)

- A relation is in first normal form if every attribute in that relation is singled valued attribute.
- Attribute/column domain(data type) doesn’t change
- Each attribute/column has a unique name
- Order makes no difference

Convert from unnormalized to 1NF by flattening

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	DoctorID	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(RecordID, PatientID, PatientName, PatientAddress, DoctorID, DoctorName, VisitDate, Charges)

Convert from unnormalized to 1NF by flattening – Identify suitable PK

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	DoctorID	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(RecordID, PatientID, PatientName, PatientAddress, DoctorID, DoctorName, VisitDate, Charges)

Convert from unnormalized to 1NF by flattening – Identify suitable PK

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	**DoctorID**	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, **DoctorID**, DoctorName, VisitDate, Charges)

Second Normal Form (2NF)

- Table should be in 1NF
- No partial Dependencies

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	**DoctorID**	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, **DoctorID**, DoctorName, VisitDate, Charges)

Converting to 2NF from 1NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	**DoctorID**	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, **DoctorID**, DoctorName, VisitDate, Charges)

Converting to 2NF from 1NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	**DoctorID**	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, **DoctorID**, DoctorName, VisitDate, Charges)

Converting to 2NF from 1NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	**DoctorID**	DoctorName	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	3454	Jackson Grant	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	3444	Rebecca Mixon	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	2356	Stephanie Martin	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	3454		November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	2333		November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	2356		January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, **DoctorID**, DoctorName, VisitDate, Charges)

Converting to 2NF from 1NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	January 3, 2022	344.33

Doctors

DOCTORID	DoctorName
3454	Jackson Grant
3444	Rebecca Mixon
2356	Stephanie Martin
2333	

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, VisitDate, Charges)

Doctors(**DoctorID**, DoctorName)

Converting to 2NF from 1NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	January 3, 2022	344.33

RecordDoctors

RecordID	**DoctorID**
100101	3454
100101	3444
100101	2356
111221	3454
111221	2333
122108	2356

Doctors

DOCTORID	DoctorName
3454	Jackson Grant
3444	Rebecca Mixon
2356	Stephanie Martin
2333	

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, VisitDate, Charges)

Doctors(**DoctorID**, DoctorName)

RecordDoctors(**RecordID**, **DoctorId**)

2NF Set of Tables

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	January 3, 2022	344.33

RecordDoctors

RecordID	**DoctorID**
100101	3454
100101	3444
100101	2356
111221	3454
111221	2333
122108	2356

Doctors

DOCTORID	DoctorName
3454	Jackson Grant
3444	Rebecca Mixon
2356	Stephanie Martin
2333	

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, VisitDate, Charges)

Doctors(**DoctorID**, DoctorName)

RecordDoctors(**RecordID**, **DoctorId**)

Third Normal Form (3NF)

- Be in 2NF
- No transitive dependencies

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, VisitDate, Charges)

Convert to 3NF from 2NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, VisitDate, Charges)

Convert to 3NF from 2NF

HospitalRecords

RECORDID	PatientID	PatientName	PatientAddress	VisitDate	Charges
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
100101	321001	John Doe	101 Road Ave.	February 14, 2021	2355.87
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
111221	435220	Jessica Landy	343 House Circle	November 11, 2021	34543.92
122108	435220	Jessica Landy	343 House Circle	January 3, 2022	344.33

HospitalRecords(**RecordID**, PatientID, PatientName, PatientAddress, VisitDate, Charges)

Convert to 3NF from 2NF by removing transitive dependencies

HospitalRecords

RecordID	PatientID	VisitDate	Charges
100101	321001	02/14/2021	2355.87
111221	435220	11/11/21	34543.92
122108	435220	01/03/22	344.33

Patients

PATIENTID	PatientName	PatientAddress
321001	John Doe	101 Road Ave.
435220	Jessica Landy	343 House Circle

HospitalRecords(**RecordID**, PatientID, VisitDate, Charges)

Patients(**PatientID**, PatientName, PatientAddress)

Convert to 3NF from 2NF by removing transitive dependencies

HospitalRecords

RecordID	PatientID	VisitDate	Charges
100101	321001	02/14/2021	2355.87
111221	435220	11/11/21	34543.92
122108	435220	01/03/22	344.33

RecordDoctors

RecordID	**DoctorID**
100101	3454
100101	3444
100101	2356
111221	3454
111221	2333
122108	2356

Doctors

DOCTORID	DoctorName
3454	Jackson Grant
3444	Rebecca Mixon
2356	Stephanie Martin
2333	

Patients

PATIENTID	PatientName	PatientAddress
321001	John Doe	101 Road Ave.
435220	Jessica Landy	343 House Circle

HospitalRecords(**RecordID**, PatientID, VisitDate, Charges)

RecordDoctors(**RecordID**, **DoctorId**)

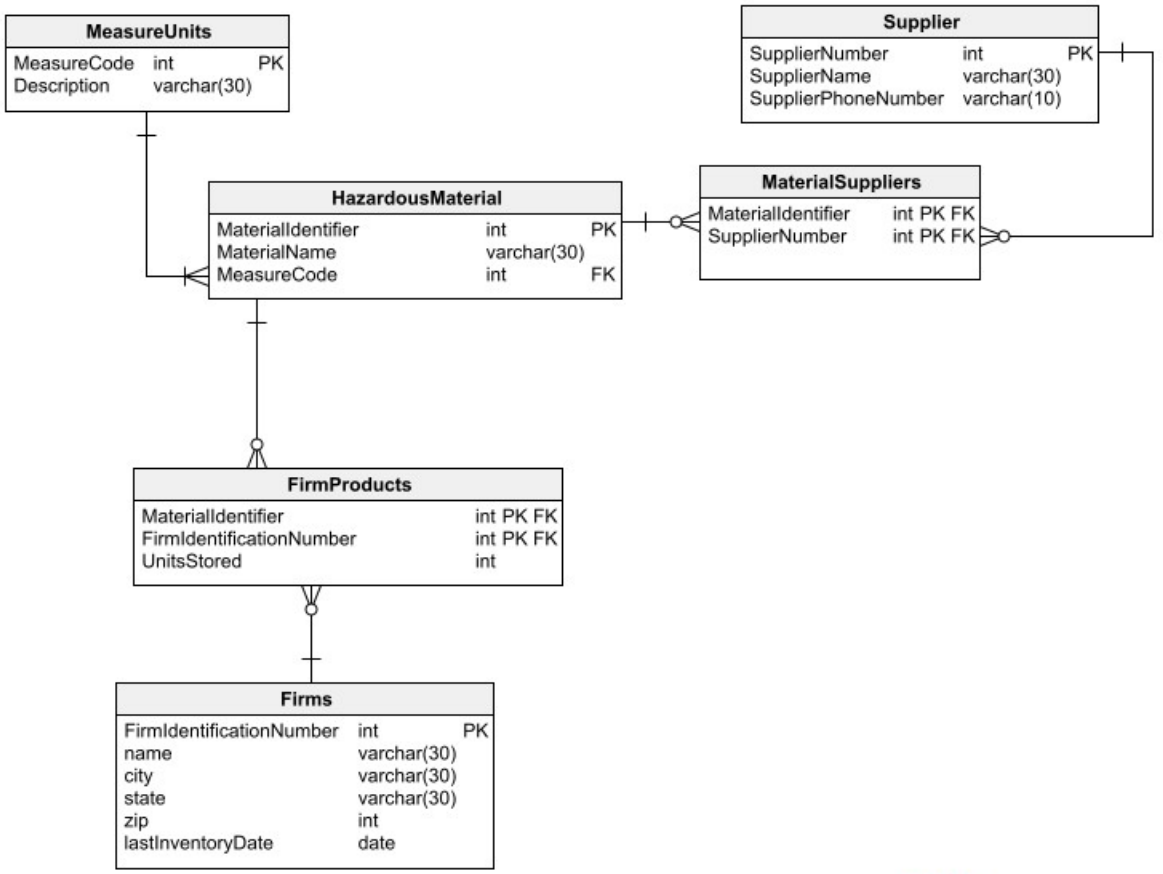
Doctors(**DoctorID**, DoctorName)

Patients(**PatientID**, PatientName, PatientAddress)

Unnormalized Data

- Hazardous product
  - Material identifier
  - Material name
  - Suppliers
    - Supplier number
    - Name
    - Phone numbers
  - Unit of Measure
    - Unique Code
    - Description
- Firm
  - Identification number
  - Name
  - Address
  - Phone number
  - Inventory Date
  - Product stored
    - Units

ERD for Problem Statement



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