

2 Relational Data Model and SQL

2.1 Scenario – Dream Destinations

Dream Destinations Ltd is a company that provides a top quality service in bespoke, tailor-made holiday packages. They arrange everything from flights, hotel accommodation and trips to destinations within the Caribbean. At present they only record data from phone calls and e-mails on paper note pads and these are put inside filing cabinets. They have no methods for storing customer, hotel or flight information and have difficulty in keeping track of information. They only advertise by word of mouth, cold calling telesales and advertising through print media such as their own travel brochure which can be found in travel agents.

Dream Destinations Ltd have realised that should something happen to the paper files, e.g. an office fire, their data would be lost as they have no way of keeping data. They want to be able to access the required information quickly and efficiently. They also need a means of advertising themselves to increase their customer base. They have asked for us to create a means of storing their client, booking and property information.

2.2 The Relational Model

Relational Database Management Systems (RDBMS) have become the prevalent means of managing data. RDBMS comprises of software facilitating storage, entry and data retrieval. Modern RDBMS rely on the Relational Data Model to organise records within. Relational databases are organised in entities, attributes, and tuples. A tuple (or a record) is a set of attributes. An attribute contains a single piece of information, and an entity is a collection of tuples. A phone book, for example, can be thought of as a database file, it contains a list of records or tuples. Each tuple consists of three attributes: name, address and telephone number.

Relational model, which is at the heart of all RDBMS's (Relational Database Management Systems). In simple terms, data is manipulated in *tables* (sometimes called *Relations*), at a conceptual level several layers above how the data is actually stored.

The Table/Relation Concept

client table

clientno	fname	lname	telno	preftype	maxrent
CR76	John	Kay	0207-774-5632	Villa	500
CR56	Aline	Stewart	0141-848-1825	Apartment	475
CR74	Mike	Ritchie	01475-392178	Studio	525
CR62	Mary	Tregear	01224-196720	Villa	550

Each table must have a unique name (**client** in this case). Each row (record) is a series of interconnected data items, a client in this case. The **client** table shows 4 rows/4 clients.

A cell must hold one Atomic value (e.g. a value that wouldn't normally be divided into any smaller parts). Values can be Text (e.g. letters or Alphanumeric characters), Numbers (so that associated mathematical operations can be performed) or other types such as Dates, Times or Currency.

The **client** table contains a set of clients that use the Dream Destinations Ltd service. Each column must have a unique column name (to that table), which indicates the kind of data items shown in the column 'below'.

Every table is supposed to mirror a mathematical set and as such there is no significance in the row or column ordering. Theoretically there are also no duplicate rows allowed (actual databases may allow duplicates). A *table* is sometimes called a *relation* in mathematics.

Operations on a table are based on the mathematical principles of *selection*, *projection*, *join* and *product* (these terms come from an area of mathematics called Relational Algebra). In reality these operations are performed through a language such as SQL.

2.2.1 Starting Access

In Windows the Access database package can be started by finding the Access menu item (which is typically under the Microsoft Office menu) or by clicking on the Access icon if one is visible on the screen.

Activity 1:

The first exercises in this chapter use the database **SQLLabSessions.accdb**.

This is available through the online supplementary resources. After saving this file in your hard drive use the File ->Open menu item to start a new database session.

The File Format

Microsoft Access saves each database in a single file with the extension **.accdb**. Note that this is unusual – most other databases save information in several files with differing file extensions.

Note that Access file formats have changed significantly between versions. Access 97 files can be loaded and updated in Access 2000 or Access XP, however once the changes are saved it may no longer be possible to open the file in the previous version.

The Main Interface

Unlike Microsoft Word or Excel, Access offers the available features and facilities for each database through a dialog box on the left hand side of the page which is open while the database is in use.



Despite the many versions of Access that have been made available in recent years (Access 97, Access 2000, Access XP), the core functionality has remained the same. Microsoft has frequently changed the GUI, so items may be placed differently on screen, for example some versions of Access 2007 places the items to create new *Tables*, *Queries*, *Forms*, *Reports* etc. under the Create tab.

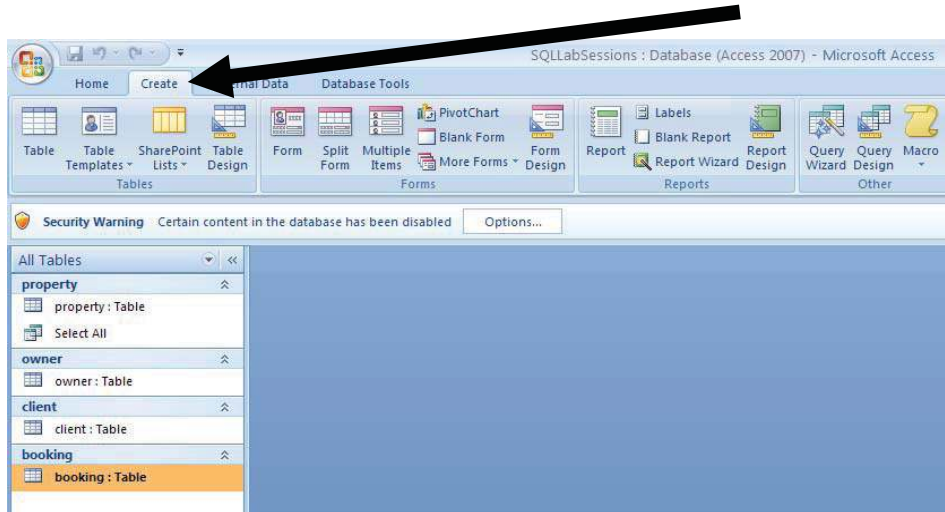
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Clicking on the *Table* button allows new tables to be created

Existing Tables to have the design changed (*Design*)

Double click on an existing tables to be used (to *Open*)

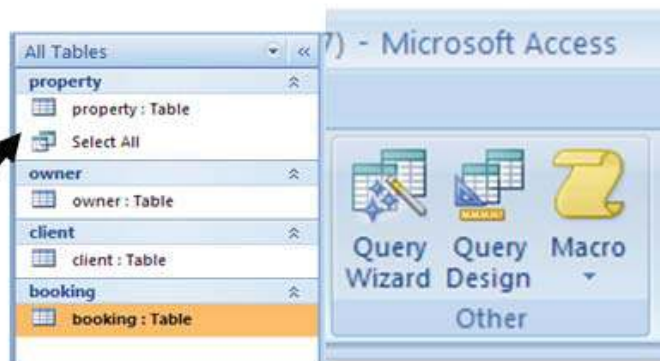
Here four existing tables can be seen, *property*, *owner*, *client* and *booking* (all have the word *Table* after them)



Clicking on the *Query Design* (under the *Create* tab) button allows creation of new queries

Double click on an existing query (in this case called *Select All*) to be used (to *Open*)

Your database does not have any queries designed yet.



Dream Destinations: Tables Used for Exercises.

The *SQLLabSessions* database contains four tables, *PROPERTY*, *OWNER*, *CLIENT* and *BOOKING*. **property** is a table containing property to be rented out information such as property number, street, country, rental cost and the yearly income.

owner is a table containing the details of the owners of the properties.

client contains the details of people who want to rent the properties.

booking contains the details of clients who have booked a stay at a property.

Activity 2: To view these tables, double click on the table name. Close the tables after examining them, but leave the database open.

ownerno	fname	lname	address	telno
CO40	Tina	Murphy	63 Well St, Glasgow, G42	0141-943-1728
CO46	Joe	Keogh	2 Fergus Dr, Aberdeen, AB2 7SX	01224-861212
CO87	Carol	Farrel	6 Achray St, Glasgow, G32 9DX	0141-357-7419
CO93	Tony	Shaw	12 Park Pl, Glasgow, G4 0QR	0141-225-7025

It is worth noting that if you have more than one table open, Access creates tabs so that you can switch between tables.

clientno	propertyno	bookingdate	comment
CR56	PA14	16/07/2007	Non smoking required
CR76	PG4	09/07/2007	special diet
CR56	PG4	17/12/2007	
CR62	PA14	03/09/2007	allergies
CR56	PG36	10/09/2007	

Data Manipulation

SQL is the standard database language, supported to some extent by every database product on the market today. Until the mid 1980s, almost all mainframe databases were either hierarchical or network databases, which lacked a rigorous mathematical foundation and were often implemented in a messy or inefficient style. In 1970, E.F. Codd published a paper which provided a relational model for databases based on set theory. It took ten years for IBM to produce System R based on this relational model, which included a query language called sequel. During the period 1980 to 1983 IBM announced versions for various Operating Systems and machines. Such was the power of IBM at the time that many other companies announced a version of SQL for their machines, either as a replacement or as an alternative for their proprietary language.

- To prevent there from being multitudes of versions with differing dialects, ANSI and the ISO standards committee have produced documents detailing various standards and extensions, SQL1, SQL2 (SQL92) and SQL3. SQL1 was produced in its initial form in 1987. The second version was published in 1992 and is still having subsidiary sections added.

The current standard is SQL3, which can still be regarded as a draft. There are few databases that actually support this standard – most of them offer SQL92 compatibility.

Dream Destinations: Database Tables

`property` table

propertyno	street	country	type	rooms	rent	yearincome	ownerno
PA14	16 Holhead	Barbados	Villa		6 500	12000	CO46
PG16	5 Novar Dr	Antigua	Apartment		2 400	8000	CO87
PG21	18 Dale Rd	St Kitts	Apartment		3 450	9500	CO40
PG36	2 Manor Rd	Barbados	Studio		1 475	11075	CO93
PG4	6 Lawrence St	Barbados	Villa		4 525	14050	CO87
PL94	6 Argyll St	Barbados	Villa		4 550	15000	CO93
*							



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Sources: Keuzegids Master ranking 2013; Elsevier 'Beste Studies' ranking 2012; Financial Times Global Masters in Management ranking 2012

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owner table

ownerno	fname	lname	address	telno
CO46	Joe	Keogh	2 Fergus Dr, Aberdeen, AB2 7SX	01224-861212
CO87	Carol	Farrel	6 Achray St, Glasgow, G32 9DX	0141-357-7419
CO40	Tina	Murphy	63 Well St, Glasgow, G42	0141-943-1728
CO93	Tony	Shaw	12 Park Pl, Glasgow, G4 0QR	0141-225-7025

client table

clientno	fname	lname	telno	preftype	maxrent
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booking table

clientno	propertyno	bookingdate	comment
CR56	PA14	16/07/2007	Non smoking required
CR76	PG4	09/07/2007	special diet
CR56	PG4	17/12/2007	
CR62	PA14	03/09/2007	allergies
CR56	PG36	10/09/2007	

2.2.2 Starting and Editing SQL

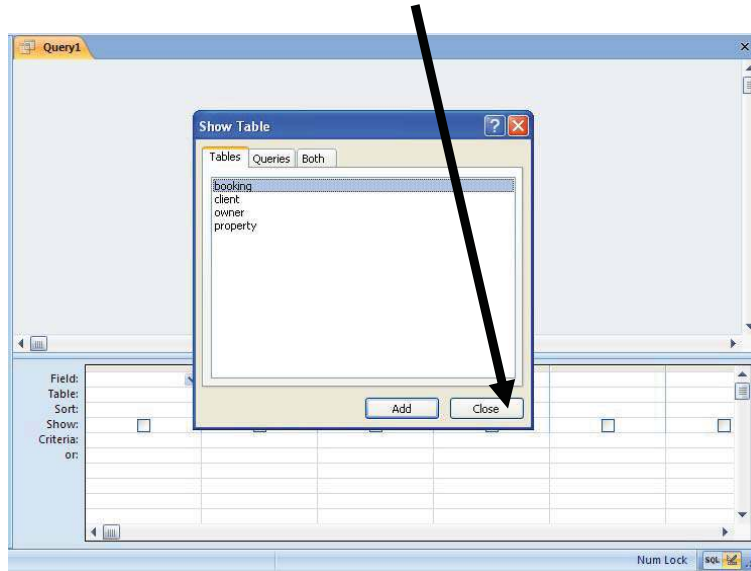
What is a Query?

A Query can be classified as a question that we require the database to provide an answer to. Example queries could be questions such as 'Which property has an income of more than £11,000 per year?' or 'What will the rental figures look like if we increase them by 5%?'

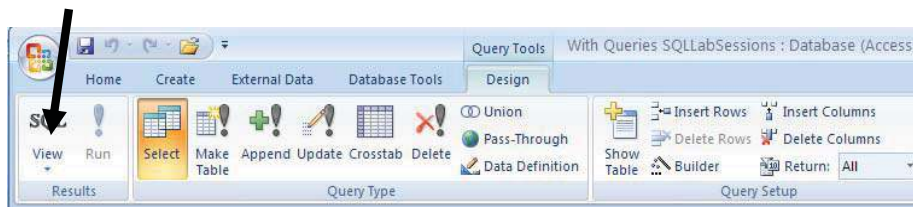
After creating the query, we execute/run it (or in Access terminology we **Open** it) and the database produces a response (e.g. brings us the information we asked for). Queries can be edited and then re-executed if they are not quite correct.

The Access Query Mechanism

Clicking on the **CREATE** tab and the *Query Design* button (only click this once) opens the Query design view. Click on the **Close** button.



You will notice that your top toolbar will be on the **Query Tools, Design** tab. Click on the **SQL View** button once.



A blank database (and the database supplied with text) will have no queries saved so the dialog box will contain two entries offering ways to create a new query.

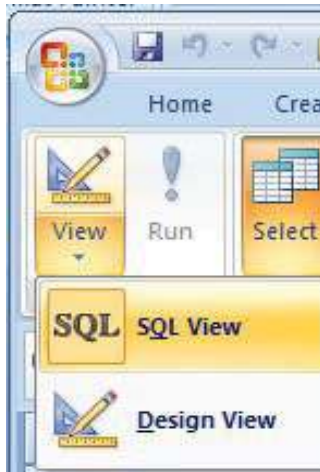


Activity 3: Follow the above steps to get to the **SQL View** of a query.

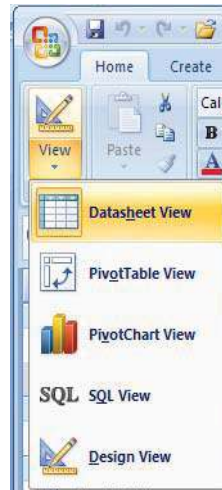
The Three Main Views

As you have not created an SQL query, you will only have access to two views (**SQL** and **Design**, see below), once you have created a query, you will have access to more views.

Views Before Creating a Query

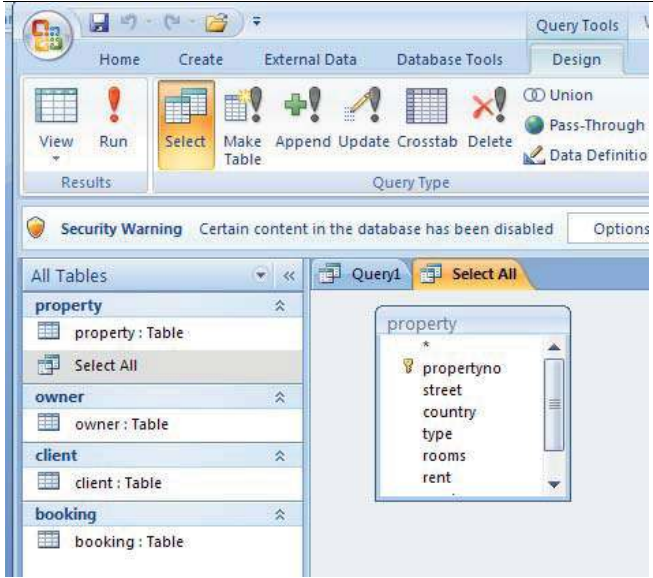
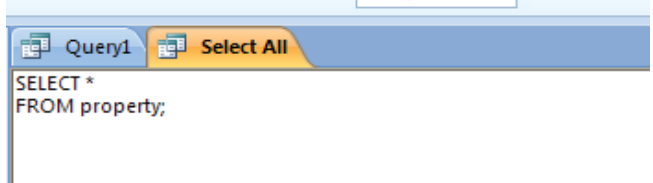
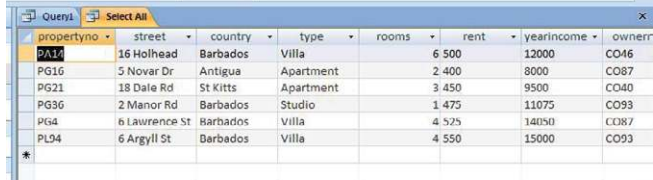


Views After Creating a Query



An advertisement for the AXA Global Graduate Program 2015. It features a portrait of a young woman with red hair on the left. On the right, the text reads: '> Apply now', 'REDEFINE YOUR FUTURE', 'AXA GLOBAL GRADUATE PROGRAM 2015'. At the bottom right is the AXA logo and the slogan 'redefining / standards'. A small vertical text on the left edge of the image reads 'agence edg. © Photonistop'.



<p>The Design View</p> <p>The design view allows query creation using a drag and drop principle. Although easier to use and learn, this interface is not transferable to other databases and will not allow all queries to be written.</p>																																																									
<p>The SQL View</p> <p>The SQL view allows the SQL source to be viewed in a primitive text editor. This is the principle way of entering and editing SQL text used on this course</p>																																																									
<p>The Datasheet View</p> <p>The datasheet view actually 'runs' the query and generates the result. This is the same as selecting 'Open' on a query through the Query manager interface.</p>	 <table border="1" data-bbox="719 1055 1374 1234"> <thead> <tr> <th>propertyno</th> <th>street</th> <th>country</th> <th>type</th> <th>rooms</th> <th>rent</th> <th>yearincome</th> <th>ownerr</th> </tr> </thead> <tbody> <tr> <td>PG14</td> <td>16 Holhead</td> <td>Barbados</td> <td>Villa</td> <td>6</td> <td>500</td> <td>12000</td> <td>CO16</td> </tr> <tr> <td>PG16</td> <td>5 Novar Dr</td> <td>Antigua</td> <td>Apartment</td> <td>2</td> <td>400</td> <td>8000</td> <td>CO87</td> </tr> <tr> <td>PG21</td> <td>18 Dale Rd</td> <td>St Kitts</td> <td>Apartment</td> <td>3</td> <td>450</td> <td>9500</td> <td>CO40</td> </tr> <tr> <td>PG36</td> <td>2 Manor Rd</td> <td>Barbados</td> <td>Studio</td> <td>1</td> <td>475</td> <td>11075</td> <td>CO93</td> </tr> <tr> <td>PG4</td> <td>6 Lawrence St</td> <td>Barbados</td> <td>Villa</td> <td>4</td> <td>525</td> <td>14050</td> <td>CO87</td> </tr> <tr> <td>PL04</td> <td>6 Argyll St</td> <td>Barbados</td> <td>Villa</td> <td>4</td> <td>550</td> <td>15000</td> <td>CO93</td> </tr> </tbody> </table>	propertyno	street	country	type	rooms	rent	yearincome	ownerr	PG14	16 Holhead	Barbados	Villa	6	500	12000	CO16	PG16	5 Novar Dr	Antigua	Apartment	2	400	8000	CO87	PG21	18 Dale Rd	St Kitts	Apartment	3	450	9500	CO40	PG36	2 Manor Rd	Barbados	Studio	1	475	11075	CO93	PG4	6 Lawrence St	Barbados	Villa	4	525	14050	CO87	PL04	6 Argyll St	Barbados	Villa	4	550	15000	CO93
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Writing a query consists of the following phases:

- Write the query in *SQL view*
- View the query in *Datasheet view*
- Return to *SQL view* if changes are required

Activity 4: Creating a simple query

YOU HAVE ALREADY OPENED THE SQL query interface to create a new query. You will see:



Now replace the content above (`SELECT *`) with the following:

```
SELECT * FROM property;
```

This syntax requires to select every record from the *property* table. Note: You must make sure that the ; is at the end and there is only ONE of them per query.

Click on either the **Datasheet View** from the *View* menu item or the **Run** button (they both do the same) to run the query.



Switch back and forth from **SQL** to **Datasheet View** to see how Access switches modes.

2.2.3 Data Manipulation using SQL

SQL statements use the following reserved words:

Select	Used to retrieve data from the database, the most commonly used statement
Insert Delete Update	Used to enter (insert), remove (delete) or change (update) rows from a table. Together with <i>Select</i> , collectively known as the DML or Data Manipulation Language
Create Alter Drop	Used to set up (create), change (alter) or remove (drop) data structures such as tables, views or indexes. Collectively known as the DDL or Data Definition Language
Grant Revoke Validate	Used to give (grant) or remove (revoke) access rights to data and data structures within an SQL database

Not all of these are valid in Access, but are part of the SQL standard. A reserved word is one that is specified as part of the core language and cannot be redefined by the user. Hence attempting to name a column 'select' will result in an error.

2.3 The SELECT statement

The Select statement is used to pull out and display information from a table. Its basic structure has this form:

```
SELECT select-list
FROM table;
```

select-list is a series of column names each separated by comma.

```
SELECT propertyno FROM property;
SELECT country FROM property;
SELECT propertyno, country FROM property;
```



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The items after the **SELECT** keyword can be one or more of the following, separated by commas:

	Example	Explanation
One or more column name(s)	country	Show the country column
*	*	Show all columns
Arithmetic expression	rent+1000	Show rent + 1000
Text expression	fname&lname	Combine the two columns called fname and lname together
Application Function	round(rent, 2)	Round rent to a certain number of places

Activity 5: The following examples demonstrate variations on the **SELECT** statement. Type these queries in and verify that they produce the results indicated. Make sure that you save each of the queries as it will help you with your coursework.

Remember – you must use the column heading names, if you are not sure which table the column header comes from, look back at the print out of the tables in this handout.

Examples – Try these out to see the result

Display all columns and rows from table property.

```
SELECT * FROM property;
```

propertyno	street	country	type	rooms	rent	yearincome	ownerno
PA14	16 Holhead	Barbados	Villa		6 500	12000	CO46
PG16	5 Novar Dr	Antigua	Apartment		2 400	8000	CO87
PG21	18 Dale Rd	St Kitts	Apartment		3 450	9500	CO40
PG36	2 Manor Rd	Barbados	Studio		1 475	11075	CO93
PG4	6 Lawrence St	Barbados	Villa		4 525	14050	CO87
PL94	6 Argyll St	Barbados	Villa		4 550	15000	CO93
*							

Display propertyno, street and their countries.

```
SELECT propertyno, street, country FROM property;
```

propertyno	street	country
PA14	16 Holhead	Barbados
PG16	5 Novar Dr	Antigua
PG21	18 Dale Rd	St Kitts
PG36	2 Manor Rd	Barbados
PG4	6 Lawrence St	Barbados
PL94	6 Argyll St	Barbados
*		

Display all properties, along with the amount that a 50% rise would make to the rent. Note that this doesn't change the value in the property table.

```
SELECT propertyno, (rent/100*50)+rent FROM property;
```

propertyno	Expr1001
PA14	750
PG16	600
PG21	675
PG36	712.5
PG4	787.5
PL94	825

Note that Access generates a column name (as the mathematical expression $(rent/100*50)+rent$ can't be used). To force a more sensible name to be used, use 'AS columnname'.

Activity 6: Try `SELECT propertyno, (rent/100*50)+rent AS newrent FROM property;`

propertyno	newrent
PA14	750
PG16	600
PG21	675
PG36	712.5
PG4	787.5
PL94	825

Display all the unique property numbers.

```
SELECT DISTINCT propertyno FROM booking;
```

propertyno
PA14
PG36
PG4

Concatenate and display the property number and type of property in one column.

```
SELECT propertyno&"-"&type AS proptype FROM property;
```

proptype
PA14-Villa
PG16-Apartme
PG21-Apartme
PG36-Studio
PG4-Villa
PL94-Villa
*

Concatenate means combine two pieces of text together into one. This operation is used with text. Microsoft uses & to concatenate (as seen in Excel).

2.4 Exercises

In the following exercises, the query must be specified to produce the suggested result. There are spaces for you to write the SQL query in. **Note:** that you may have to use the AS command to get correct column headings in SQL.

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1. Display all the information in the table called `client`

SQL:

clientno	fname	lname	telno	preftype	maxrent
CR56	Aline	Stewart	0141-848-1825	Apartment	475
CR62	Mary	Tregear	01224-196720	Villa	550
CR74	Mike	Ritchie	01475-392178	Studio	525
CR76	John	Kay	0207-774-5632	Villa	500

2. Display the `propertyno` and `country` for each property

SQL:

propertyno	country
PA14	Barbados
PG16	Antigua
PG21	St Kitts
PG36	Barbados
PG4	Barbados
PL94	Barbados

3. Display all the distinct types of property

SQL:

type
Apartment
Studio
Villa

4. Display a list of the monthly income of each rental property (calculated from yearly income/12)

SQL:

propertyno	ownerno	Expr1002
PA14	CO46	1000
PG16	CO87	666.666666666667
PG21	CO40	791.666666666667
PG36	CO93	922.916666666667
PG4	CO87	1170.833333333333
PL94	CO93	1250

5. Display a list of the distinct property locations

SQL:

country
Antigua
Barbados
St Kitts

6. Display the property number, and the new rent figure given a 12% rise in the rent figure. Name the new column `increase`

SQL:

propertyno	increase
PA14	560
PG16	448
PG21	504
PG36	532
PG4	588
PL94	616
*	

7. Display the first name and last name of each client as a single column separated by a hyphen (name the column `clientname`), along with new rent figure given a 5% increase in the maximum rent figure (name the new column `newmax`)

SQL:

clientname	newmax
Aline-Stewart	498.75
Mary-Tregear	577.5
Mike-Ritchie	551.25
John-Kay	525
*	

2.5 Summary

Relational Database Management Systems (RDBMS) have become the prevalent means of managing data. RDBMS comprises of software facilitating storage, entry and data retrieval. Relational databases are organised in entities, attributes, and tuples. A tuple (or a record) is a set of attributes. An attribute contains a single piece of information, and an entity is a collection of tuples. Relations in a database are represented using entities (or tables), with rows containing unique tuples. A cell must hold one atomic value (e.g. a value that wouldn't normally be divided into any smaller parts). Values can be Text (e.g. letters or Alphanumeric characters), Numbers (so that associated mathematical operations can be performed) or other types such as Dates, Times or Currency.

Standard Query Language (SQL) is the most widely-accepted database language, supported to some extent by every database product on the market today. Data retrieval in a database is performed using queries written in a query language. A Query can be classified as a question that we require the database to provide an answer to. The `Select` statement is used in SQL to pull out and display information from a table. Its basic structure has this form:

```
SELECT select-list
FROM table;
```

In addition to data retrieval, SQL supports other operations for managing data. These include:

Select	Used to retrieve data from the database, the most commonly used statement
Insert Delete Update	Used to enter (insert), remove (delete) or change (update) rows from a table. Together with <code>Select</code> , collectively known as the DML or Data Manipulation Language
Create Alter Drop	Used to set up (create), change (alter) or remove (drop) data structures such as tables, views or indexes. Collectively known as the DDL or Data Definition Language
Grant Revoke Validate	Used to give (grant) or remove (revoke) access rights to data and data structures within an SQL database