Introduction to relational data

A picture containing table

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Graphical user interface, table

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**Psql Shell Commands**

* \list -> list all the databases
* CREATE DATABASE database\_name -> Replace database\_name with the name of the database
* \c database\_name -> connect to a database, replace database\_name with the database name you want to connect to
* CREATE TABLE table\_name (column data\_type) ->
  + CREATE TABLE people (pk SERIAL PRIMARY KEY, name VARCHAR(256) NOT NULL, height\_cm INT, gender VARCHAR(256),date\_of\_birth DATE);
  + CREATE TABLE address (pk SERIAL PRIMARY KEY, house\_number INT, street\_name VARCHAR(256), city VARCHAR(256), country VARCHAR(256));
* \d -> show all the tables in the database
* \d table\_name -> describe the column and data type of a table, replace table\_name with the actual table name
* ALTER TABLE table\_name ADD column\_name INT, ADD FOREIGN KEY (column\_name) REFERENCES table\_name\_to\_reference(pk\_column\_name); -> Add a foreign key to a table, replace table\_name with the name of the table, column\_name with the column name to be created, table\_name\_to\_reference with the targeted table to reference and pk\_column\_name with the column name of the primary key of that table.
  + ALTER TABLE address ADD people\_pk INT, ADD FOREIGN KEY (people\_pk) REFERENCES people(pk);

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* CREATE TABLE people (pk SERIAL PRIMARY KEY, name VARCHAR(256) NOT NULL, height\_cm INT, gender VARCHAR(256),date\_of\_birth DATE);
* CREATE TABLE address (pk SERIAL PRIMARY KEY, house\_number INT, street\_name VARCHAR(256), city VARCHAR(256), country VARCHAR(256));
* ALTER TABLE address ADD people\_pk INT, ADD FOREIGN KEY (people\_pk) REFERENCES people(pk);
* ALTER TABLE people ADD address\_pk INT, ADD FOREIGN KEY (address\_pk) REFERENCES address(pk);
* CREATE TABLE cars (pk SERIAL PRIMARY KEY, engine\_size\_cc INT, colour VARCHAR(256), manufacturer VARCHAR(256), model VARCHAR(256), year INT, people\_pk INT, FOREIGN KEY (people\_pk) REFERENCES people(pk));
* CREATE TABLE pets (pk SERIAL PRIMARY KEY, species VARCHAR(256), coat VARCHAR(256), age INT, people\_pk INT, FOREIGN KEY (people\_pk) REFERENCES people(pk));
* INSERT INTO people (name,height\_cm, gender, date\_of\_birth) VALUES ('Ben',167,'Male','1978-03-14');
* INSERT INTO pets (species, coat, age, people\_pk) VALUES ('cat', 'black', 3, 1);

Relational modelling limitations

**CSV type to table**

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CREATE TABLE csv\_data (pk SERIAL PRIMARY KEY, id VARCHAR(100), source VARCHAR(5), type VARCHAR(20), start INT, stop INT);

**People and connection to table**

A close-up of a stethoscope

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By Splitting to smaller network for the above

Diagram

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CREATE TABLE small\_network (pk SERIAL PRIMARY KEY, name VARCHAR(100) NOT NULL, first\_connection\_pk INT, second\_connection\_pk INT);

CREATE TABLE bigger\_network (pk SERIAL PRIMARY KEY, name VARCHAR(100) NOT NULL, first\_connection\_pk INT, second\_connection\_pk INT, third\_connection\_pk INT);

**\* Note ^ structure will have to keep editing/create the table when there is new network, therefore, using a junction table can solve it**

CREATE TABLE people\_nodes (pk SERIAL PRIMARY KEY, name VARCHAR(100) NOT NULL);

CREATE TABLE connections (first\_pk INT, second\_pk INT);

**Family tree to table**

Diagram

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CREATE TABLE family\_tree (pk SERIAL PRIMARY KEY, name VARCHAR(100) NOT NULL, parent\_one\_pk INT, parent\_two\_pk INT);

Database good practice

Normalisation is the process of correctly disaggregating data sets, such that each data point is atomic represented only a single time and can be efficiently represented by the relational model

Graphical user interface, text

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Remove attributes column and make it to a table, make sequencing factory into a table

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CREATE TABLE ec (pk SERIAL PRIMARY KEY, EC\_name VARCHAR(256));

CREATE TABLE sequencing (pk SERIAL PRIMARY KEY, sequencing\_factory VARCHAR(256), factory\_location VARCHAR(256));

CREATE TABLE genes (pk SERIAL PRIMARY KEY, gene\_id VARCHAR(256) NOT NULL, entity VARCHAR(256), source VARCHAR(256), start INT, stop INT, sequencing\_pk INT, ec\_pk INT, FOREIGN KEY (sequencing\_pk) REFERENCES sequencing(pk), FOREIGN KEY (ec\_pk) REFERENCES ec(pk));

CREATE TABLE products (genes\_pk INT, type VARCHAR(256), product VARCHAR(256), FOREIGN KEY (genes\_pk) REFERENCES genes(pk));

CREATE TABLE attributes (pk SERIAL PRIMARY KEY, key VARCHAR(256), value VARCHAR(256));

CREATE TABLE gene\_attribute\_link (gene\_pk INT, attributes\_pk INT, FOREIGN KEY (gene\_pk) REFERENCES genes(pk), FOREIGN KEY (attributes\_pk) REFERENCES attributes(pk));

Simple inserts and simple queries

INSERT INTO sequencing(sequencing\_factory, factory\_location) VALUES('Sanger','UK');

INSERT INTO ec(ec\_name) values('oxidoreductase');

INSERT INTO genes(gene\_id, entity, source, start, stop, sequencing\_pk, ec\_pk) VALUES('Gene1', 'Chromosome', 'ena', 190, 255, 1, 1);

INSERT INTO ec(ec\_name) VALUES('transferase');

INSERT INTO genes(gene\_id, entity, source, start, stop, sequencing\_pk, ec\_pk) VALUES('Gene2', 'Chromosome', 'ena', 375, 566, CURRVAL('sequencing\_pk\_seq'), CURRVAL('ec\_pk\_seq'));

**\* Note CURRVAL is postgres keyword, return the latest value of a column**

INSERT INTO genes(gene\_id, entity, source, start, stop, sequencing\_pk, ec\_pk) VALUES('Gene3', 'Chromosome', 'ena', 780, 980, CURRVAL('sequencing\_pk\_seq'), 1), ('GENE4', 'Plasmid', 'ena' ,1001, 111, CURRVAL('sequencing\_pk\_seq'), CURRVAL('ec\_pk\_seq'));

INSERT INTO products (genes\_pk, type, product) VALUES(1,'gene','mrna'),(1,'cds','protein'),(2,'gene','mrna'),(2,'cds','protein'), (3,'gene','mrna'),(3,'cds','protein'), (4,'gene','mrna'),(4,'cds','protein');

INSERT INTO attributes(key,value) VALUES ('ID', 'genen:b001'), ('Name', 'thrL'), ('biotype', 'protein\_coding'), ('description' , 'thr operon leader peptide'),('Name', 'fucA'), ('description' , 'Fructokinase A'), ('Name', 'timB'), ('description', 'Triosphosphate isomerase'), ('Name', 'gluA'), ('description', 'Glucose isomerase');

INSERT INTO gene\_attribute\_link (gene\_pk, attributes\_pk) VALUES (1,1), (1,2), (1,3), (1,4), (2,3), (2,5), (2,6), (3,3), (3,7), (3,8), (4,3), (4,9), (4,10);

INSERT INTO genes(gene\_id, entity, source, start, stop, sequencing\_pk, ec\_pk) VALUES('Gene5', 'Plasmid', 'ena', 768, 888, 1, 2) RETURNING pk;

**\* Note RETURNING is a postgres keyword which will return the column value after the value is inserted**

Queries and table joins

SELECT \* FROM genes,ec; -> act as a normal join, will duplicate rows

SELECT \* FROM genes,ec WHERE genes.ec\_pk = ec.pk; -> act as a inner join

SELECT gene\_id,entity,start,stop,ec\_name,sequencing\_factory FROM genes, ec, sequencing WHERE genes.ec\_pk=ec.pk AND genes.sequencing\_pk=sequencing\_pk;

SELECT gene\_id, key, value FROM genes, attributes, gene\_attribute\_link WHERE genes.pk=gene\_attribute\_link.gene\_pk AND attributes.pk=gene\_attribute\_link.attributes\_pk;

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Query performance

**Creating index** -> CREATE INDEX index\_name on table(column\_name);

CREATE INDEX entity\_index on genes(entity);

SELECT \* FROM genes WHERE entity\_index = 'Chromosome';

**EXPLAIN AND ANALYZE**->

* EXPLAIN SELECT \* FROM genes,ec WHERE genes.ec\_pk=ec.pk; -> show the cost of the query
* EXPLAIN ANALYZE SELECT \* FROM genes,ec WHERE genes.ec\_pk=ec.pk; -> show the cost + execution time

**Optimize the join by doing subquery first** -> SELECT sub.\*, ec.\* FROM (SELECT \* FROM genes WHERE entity='Chromosome') sub JOIN ec ON sub.ec\_pk=ec.pk;

**OR**

**Denormalizing the table(combining table to reduce join)**-> CREATE TABLE genes\_with\_ec (pk SERIAL PRIMARY KEY, gene\_id VARCHAR(256) NOT NULL, entity VARCHAR(256), source VARCHAR(256), start INT, stop INT, sequencing\_pk INT, ec\_name VARCHAR(256), FOREIGN KEY (sequencing\_pk) REFERENCES sequencing(pk));

**OR**

**Create materialized view(create a table that take data from a table)**->

**CREATE MATERIALIZED VIEW materialized\_table\_name AS select\_statement;**

CREATE MATERIALIZED VIEW gene\_ec\_view AS SELECT gene\_id, entity, source, start, stop, sequencing\_pk, ec\_name FROM genes, ec WHERE genes.ec\_pk=ec.pk;

**\* Note this does not update the data if any changes is made on the original table, to update the data use this command**

**REFRESH MATERIALIZED VIEW materialized\_table\_name;**

REFRESH MATERIALIZED VIEW gene\_ec\_view;

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Altering the database

**DROP DATABASE database\_name;** -> Delete the database

**DROP TABLE table\_name;** ->Delete the table

**ALTER TABLE table\_name DROP COLUMN column\_name CASCADE;** -> Delete a column from a table, adding **CASCADE** will update the materialized view too

**ALTER TABLE table\_name ADD COLUMN column\_name data\_type;** -> Add a column into a table

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books = Book.objects.filter(publication\_data\_\_gte='1980-01-01', publication\_data\_\_lte='2000-01-01')