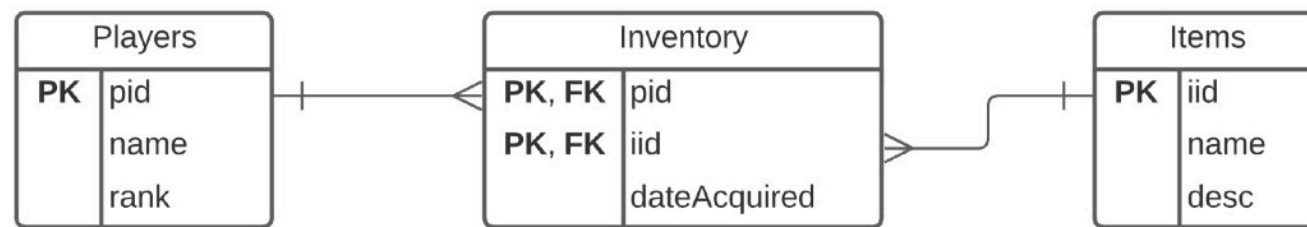

Entity-Relationship Modeling



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Relational Modeling

Tables of rows and columns:
Our AD&D-like game



```
CAP=# select *  
CAP=# from Players;
```

pid	name	rank
1	James	Captain
2	Leonard	Admiral

(2 rows)

```
CAP=# select *  
CAP=# from Items;
```

iid	name	descr
A	wand	...
B	gem	...
C	mace	...
D	sword	...

(4 rows)

```
CAP=# select *  
CAP=# from Inventory;
```

pid	iid	dateacquired
1	A	2020-01-23
1	B	2020-01-23
2	B	2020-01-23
2	C	2020-01-23

(4 rows)

Relational Modeling

Tables of rows and columns: Our e-commerce database (“CAP”)

People

pid	prefix	firstName	lastName	suffix	homeCity	DOB
1	Dr.	Neil	Peart	Ph.D.	Toronto	1952-09-12
2	Ms.	Regina	Schock		Toronto	1957-08-31
3	Mr.	Bruce	Crump	Jr.	Jacksonville	1957-07-17
4	Mr.	Todd	Sucherman		Chicago	1969-05-02
5	Mr.	Bernard	Purdie		Teaneck	1939-06-11
6	Ms.	Demetra	Plakas	Esq.	Santa Monica	1960-11-09
7	Ms.	Terri Lyne	Carrington		Boston	1965-08-04
8	Dr.	Bill	Bruford	Ph.D.	Kent	1949-05-17
9	Mr.	Alan	White	III	Pelton	1949-06-14

Products

prodId	name	city	qtyOnHand	priceUSD
p01	Heisenberg Compensator	Dallas	47	67.50
p02	Universal Translator	Newark	2399	5.50
p03	Commodore PET	Duluth	1979	65.02
p04	LCARS module	Duluth	3	47.00
p05	Remo drumhead	Dallas	8675309	16.61
p06	Trapper Keeper	Dallas	1982	2.00
p07	Flux Capacitor	Newark	1007	1.00
p08	HAL 9000 memory core	Newark	200	1.25
p09	Red Barchetta	Toronto	1	379000.47

Customers

pid	paymentTerms	discountPct
1	Net 30	21.12
4	Net 15	4.04
5	In Advance	5.50
7	On Receipt	2.00
8	Net 30	10.00

Agents

pid	paymentTerms	commissionPct
2	Quarterly	5.00
3	Annually	10.00
5	Monthly	2.00
6	Weekly	1.00

Orders

orderNum	dateOrdered	custId	agentId	prodId	quantityOrdered	totalUSD
1011	2020-01-23	1	2	p01	1100	58568.40
1012	2020-01-23	4	3	p03	1200	74871.83
1015	2020-01-23	5	3	p05	1000	15696.45
1016	2020-01-23	8	3	p01	1000	60750.00
1017	2020-02-14	1	3	p03	500	25643.89
1018	2020-02-14	1	3	p04	600	22244.16
1019	2020-02-14	1	2	p02	400	1735.36
1020	2020-02-14	4	5	p07	600	575.76
1021	2020-02-14	4	5	p01	1000	64773.00
1022	2020-03-15	1	3	p06	450	709.92
1023	2020-03-15	1	2	p05	500	6550.98
1024	2020-03-15	5	2	p01	880	56133.00
1025	2020-04-01	8	3	p07	888	799.20
1026	2020-05-01	8	5	p03	808	47282.54

Originally from *Database Principles, Programming, and Performance* by Patrick O’Neil and Elizabeth O’Neil.
Modified over and over by Alan G. Labouseur.

Relational Modeling

Primary Key the chosen candidate key; uniquely identifies every row in the table.

People

pid	prefix	firstName	lastName	suffix	homeCity	DOB
1	Dr.	Neil	Peart	Ph.D.	Toronto	1952-09-12
2	Ms.	Regina	Schock		Toronto	1957-08-31
3	Mr.	Bruce	Crump	Jr.	Jacksonville	1957-07-17
4	Mr.	Todd	Sucherman		Chicago	1969-05-02
5	Mr.	Bernard	Purdie		Teaneck	1939-06-11
6	Ms.	Demetra	Plakas	Esq.	Santa Monica	1960-11-09
7	Ms.	Terri Lyne	Carrington		Boston	1965-08-04
8	Dr.	Bill	Bruford	Ph.D.	Kent	1949-05-17
9	Mr.	Alan	White	III	Pelton	1949-06-14

Products

prodId	name	city	qtyOnHand	priceUSD
p01	Heisenberg Compensator	Dallas	47	67.50
p02	Universal Translator	Newark	2399	5.50
p03	Commodore PET	Duluth	1979	65.02
p04	LCARS module	Duluth	3	47.00
p05	Remo drumhead	Dallas	8675309	16.61
p06	Trapper Keeper	Dallas	1982	2.00
p07	Flux Capacitor	Newark	1007	1.00
p08	HAL 9000 memory core	Newark	200	1.25
p09	Red Barchetta	Toronto	1	379000.47

Customers

pid	paymentTerms	discountPct
1	Net 30	21.12
4	Net 15	4.04
5	In Advance	5.50
7	On Receipt	2.00
8	Net 30	10.00

Agents

pid	paymentTerms	commissionPct
2	Quarterly	5.00
3	Annually	10.00
5	Monthly	2.00
6	Weekly	1.00

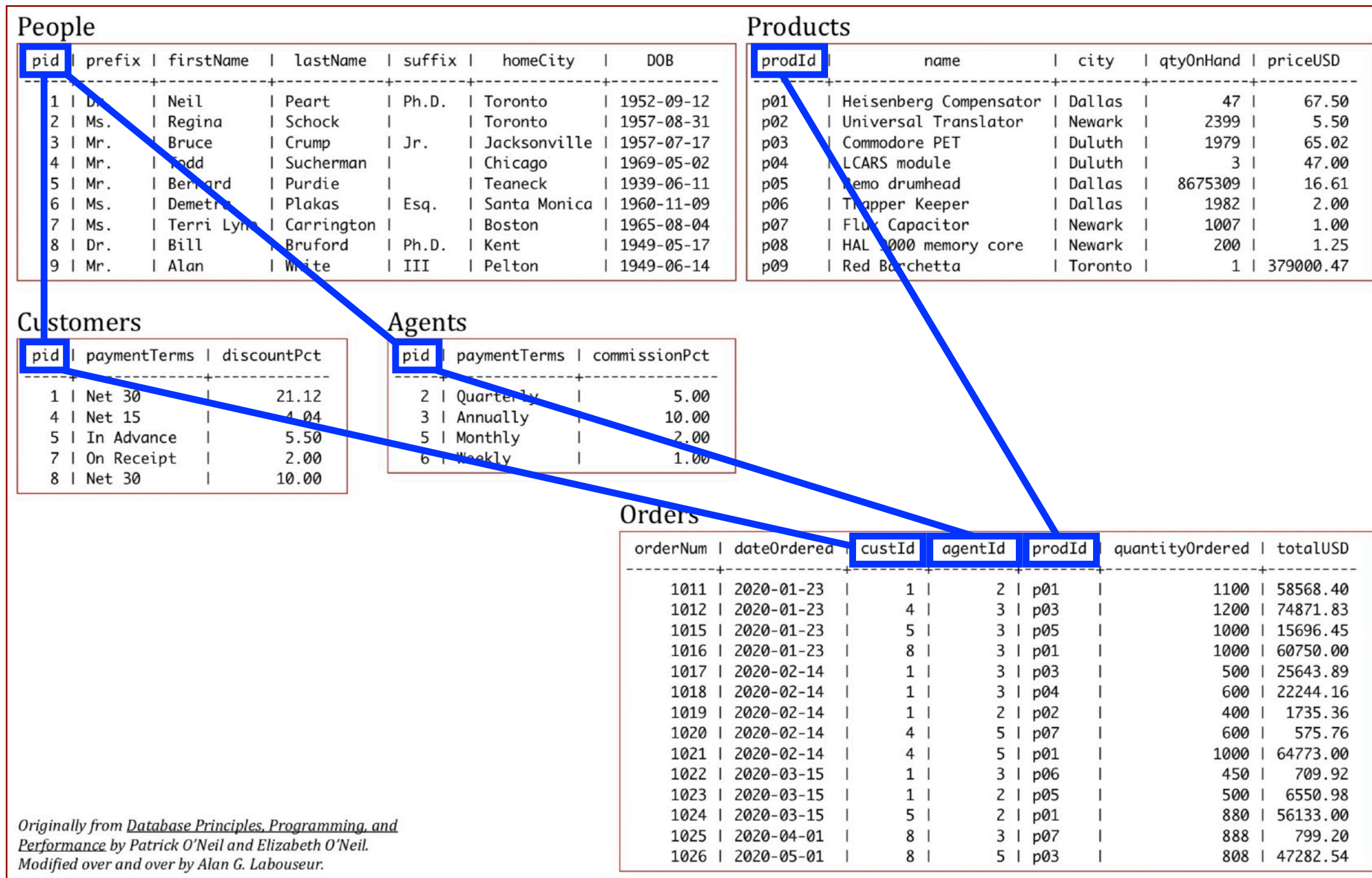
Orders

orderNum	dateOrdered	custId	agentId	prodId	quantityOrdered	totalUSD
1011	2020-01-23	1	2	p01	1100	58568.40
1012	2020-01-23	4	3	p03	1200	74871.83
1015	2020-01-23	5	3	p05	1000	15696.45
1016	2020-01-23	8	3	p01	1000	60750.00
1017	2020-02-14	1	3	p03	500	25643.89
1018	2020-02-14	1	3	p04	600	22244.16
1019	2020-02-14	1	2	p02	400	1735.36
1020	2020-02-14	4	5	p07	600	575.76
1021	2020-02-14	4	5	p01	1000	64773.00
1022	2020-03-15	1	3	p06	450	709.92
1023	2020-03-15	1	2	p05	500	6550.98
1024	2020-03-15	5	2	p01	880	56133.00
1025	2020-04-01	8	3	p07	888	799.20
1026	2020-05-01	8	5	p03	808	47282.54

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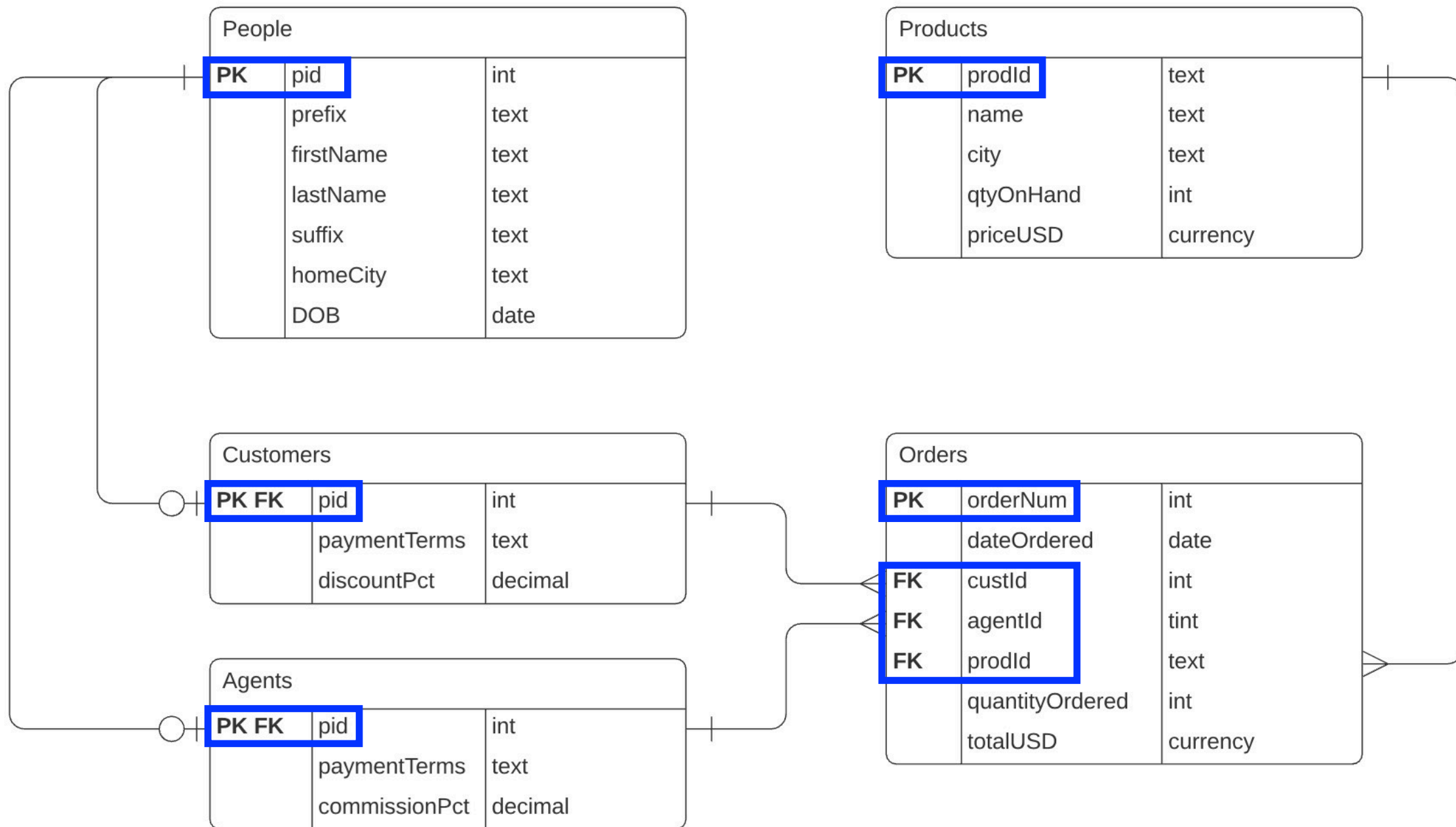
Relational Modeling

Foreign Key a value in one table that must match the primary key of another table



Relational Modeling

CAP Database



Relational Modeling

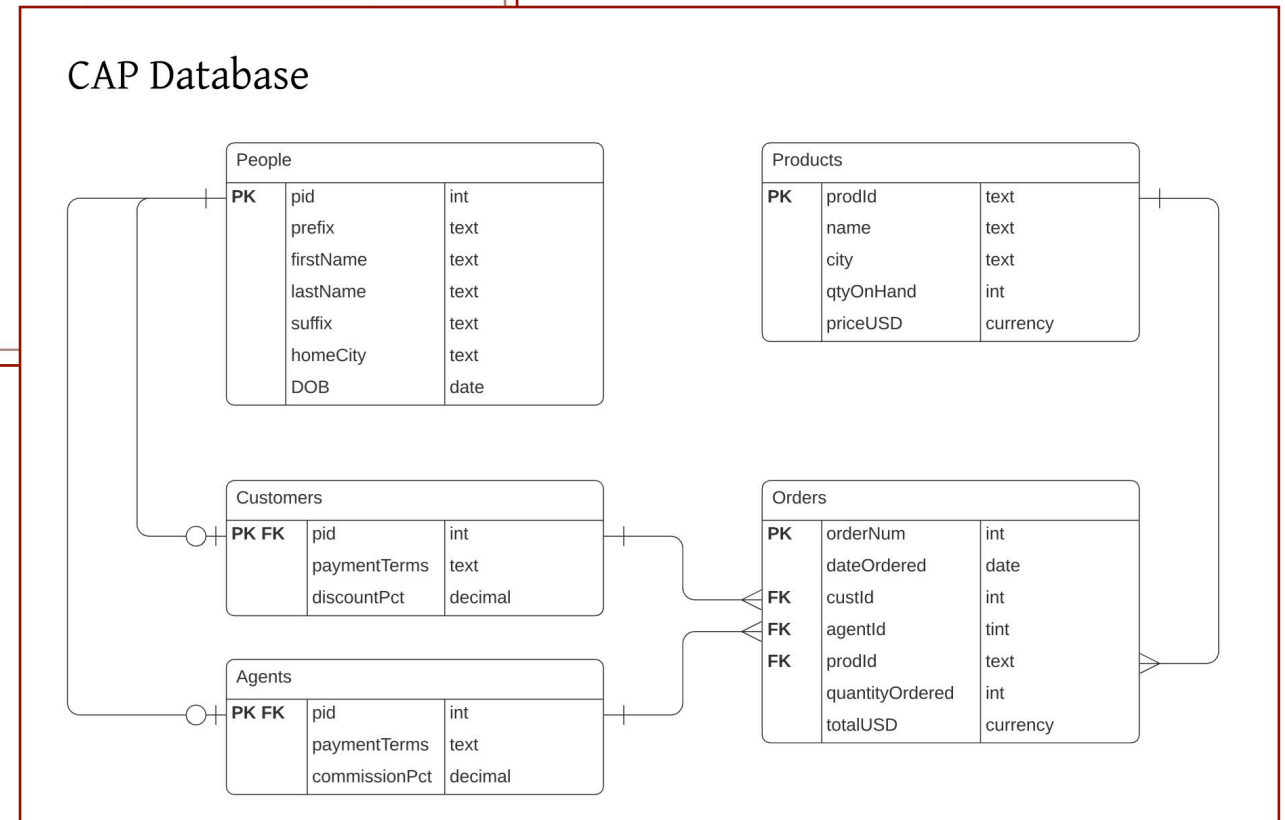
Database Snapshot

People							Products				
pid	prefix	firstName	lastName	suffix	homeCity	DOB	prodId	name	city	qtyOnHand	priceUSD
1	Dr.	Neil	Peart	Ph.D.	Toronto	1952-09-12	p01	Heisenberg Compensator	Dallas	47	67.50
2	Ms.	Regina	Schock		Toronto	1957-08-31	p02	Universal Translator	Newark	2399	5.50
3	Mr.	Bruce	Crump	Jr.	Jacksonville	1957-07-17	p03	Commodore PET	Duluth	1979	65.02
4	Mr.	Todd	Sucherman		Chicago	1969-05-02	p04	LCARS module	Duluth	3	47.00
5	Mr.	Bernard	Purdie		Teaneck	1939-06-11	p05	Remo drumhead	Dallas	8675309	16.61
6	Ms.	Demetra	Plakas	Esq.	Santa Monica	1960-11-09	p06	Trapper Keeper	Dallas	1982	2.00
7	Ms.	Terri Lyne	Carrington		Boston	1965-08-04	p07	Flux Capacitor	Newark	1007	1.00
8	Dr.	Bill	Bruford	Ph.D.	Kent	1949-05-17	p08	HAL 9000 memory core	Newark	200	1.25
9	Mr.	Alan	White	III	Pelton	1949-06-14	p09	Red Barchetta	Toronto	1	379000.47

Customers			Agents		
pid	paymentTerms	discountPct	pid	paymentTerms	commissionPct
1	Net 30	21.12	2	Quarterly	5.00
4	Net 15	4.04	3	Annually	10.00
5	In Advance	5.50	5	Monthly	2.00
7	On Receipt	2.00	6	Weekly	1.00
8	Net 30	10.00			

Orders						
orderNum	dateOrdered	custId	agentId	prodId	quantityOrdered	totalUSD
1011	2020-01-23	1	1			
1012	2020-01-23	4	4			
1015	2020-01-23	5	5			
1016	2020-01-23	8	8			
1017	2020-02-14	1	1			
1018	2020-02-14	1	1			
1019	2020-02-14	1	1			
1020	2020-02-14	4	4			
1021	2020-02-14	4	4			
1022	2020-03-15	1	1			
1023	2020-03-15	1	1			
1024	2020-03-15	5	5			
1025	2020-04-01	8	8			
1026	2020-05-01	8	8			

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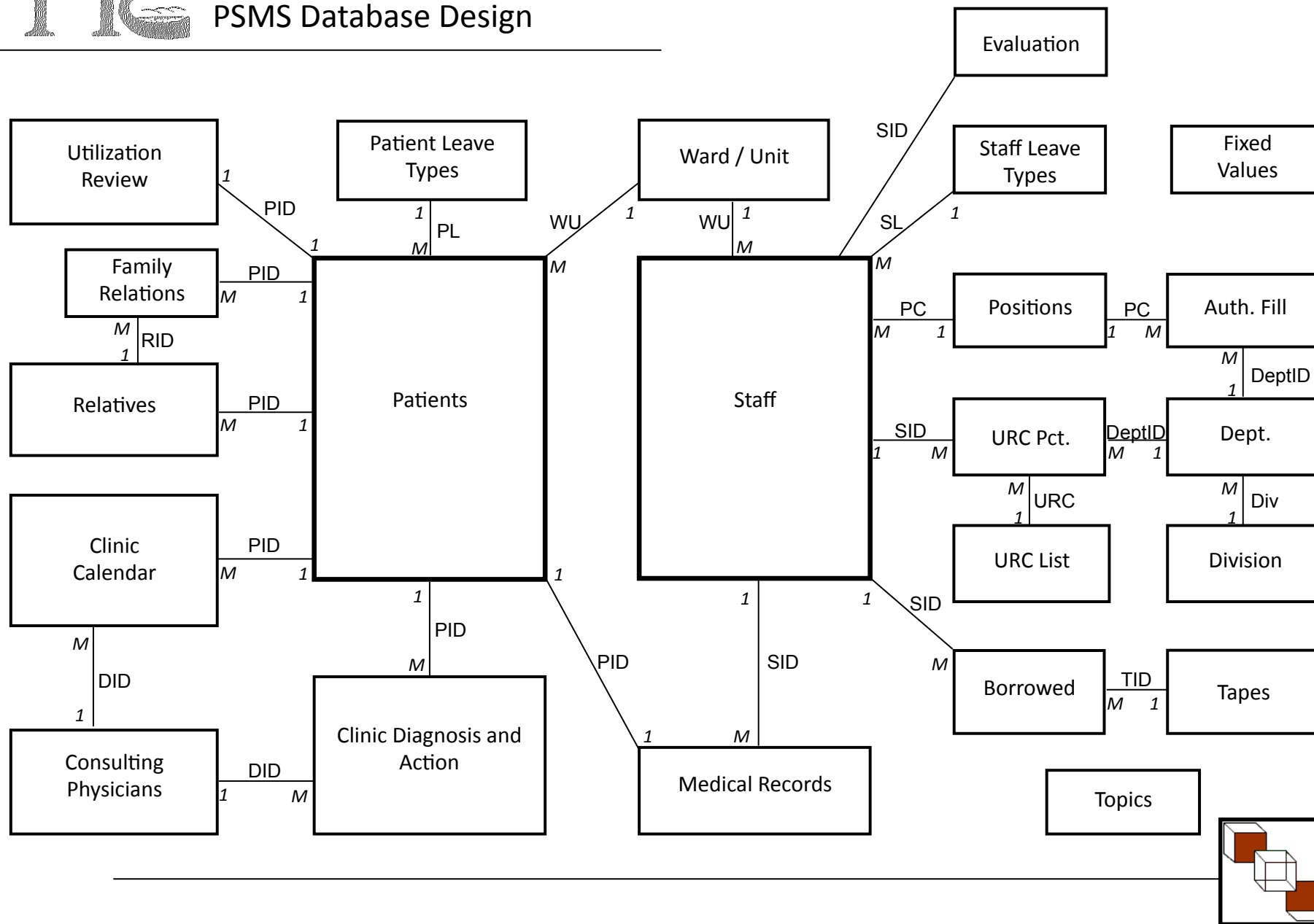


E/R Diagram

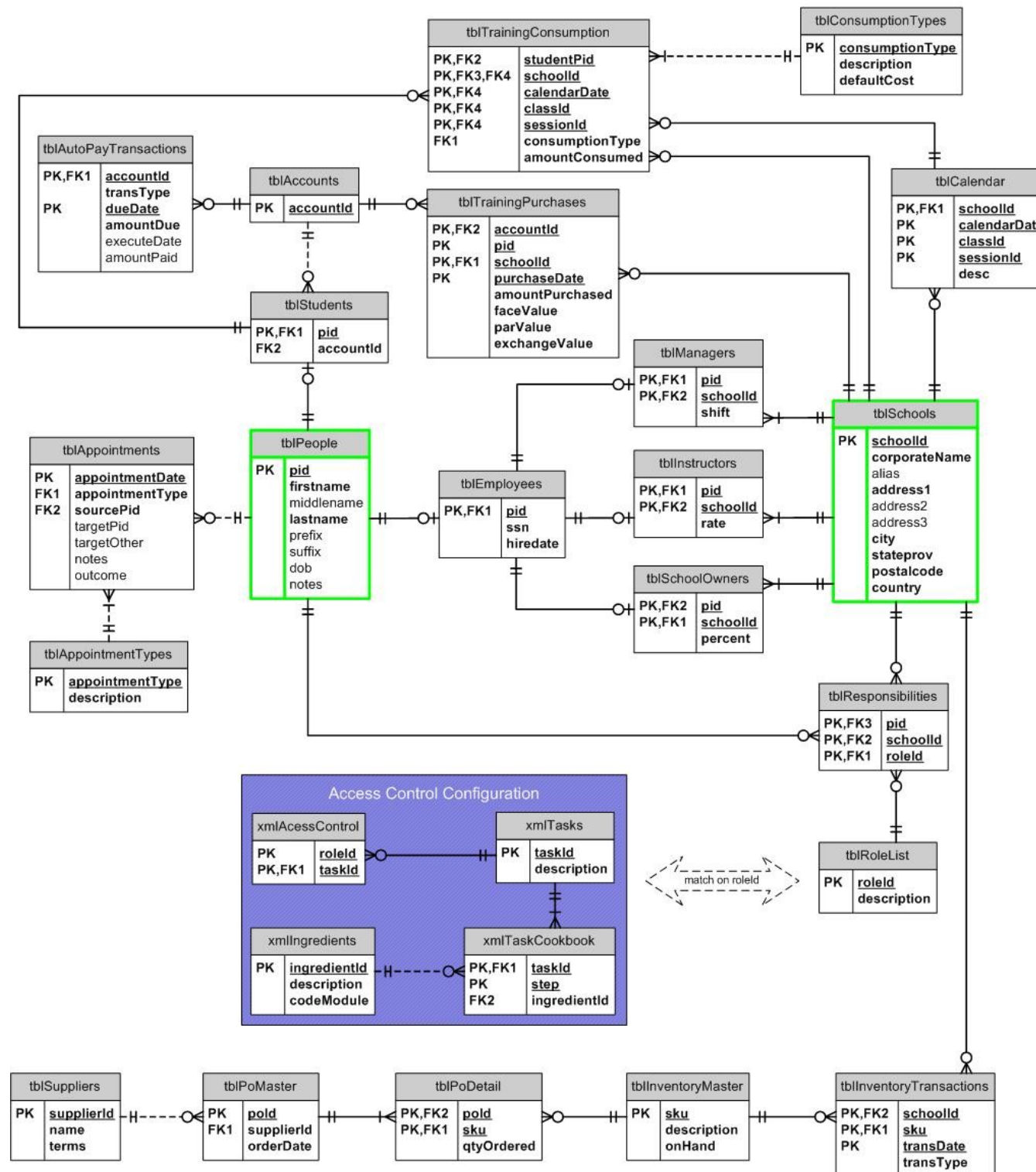
Relational Modeling



PSMS Database Design



Relational Modeling



Keys and Referential Integrity

The enforcement of the Primary Key (PK) — Foreign Key (FK) relationship is perhaps the most important aspect of Relational Databases. This property is called **referential integrity**. It insures consistency and accuracy, and thus leads to data quality. Data cannot become information without it.

Because of the importance of keys, it's critical that we — as database designers and data architects — **never** let end users control the content of key fields. For that reason, *artificial keys* are often a smart choice.

An *artificial key* is one that we make up. CWID is an example. PID and ProdID are others.

SQL as DDL - Creating Tables

-- People --

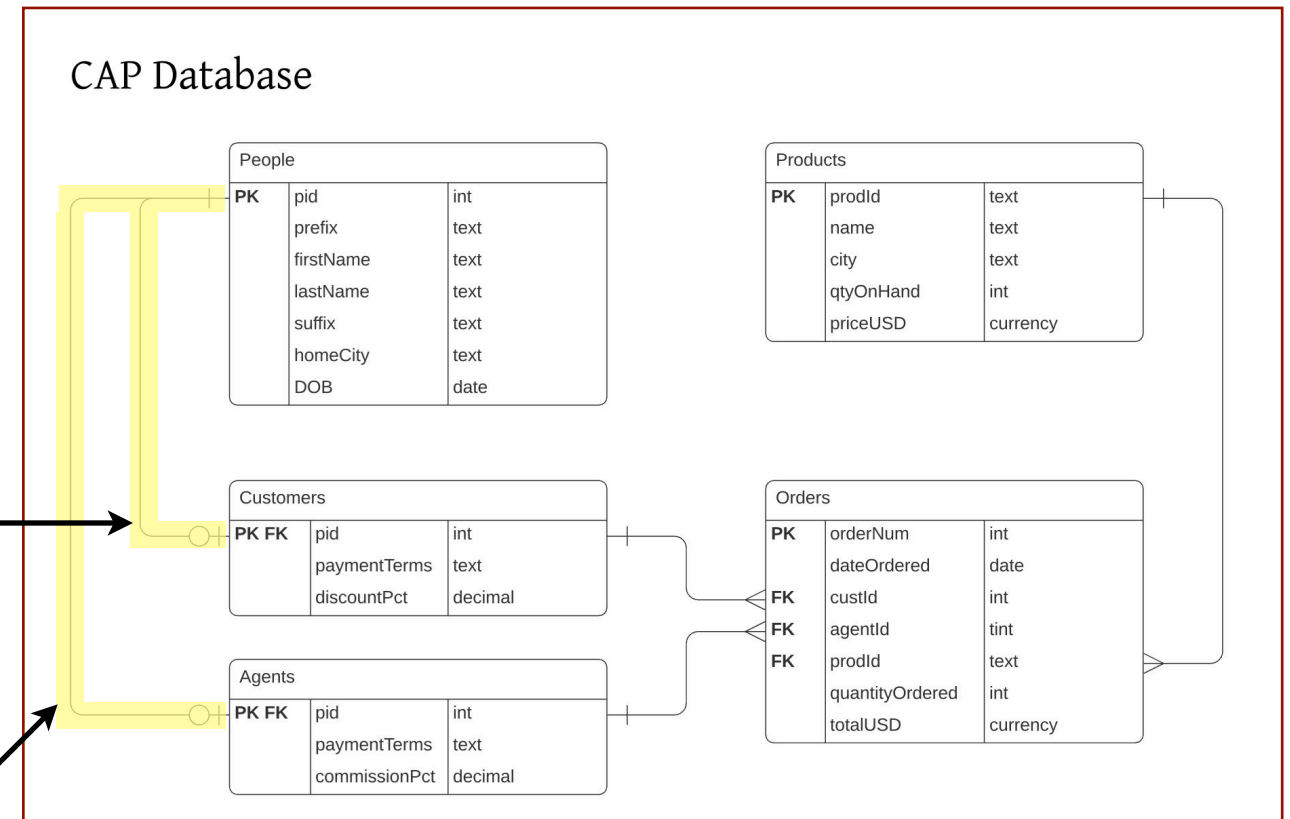
```
CREATE TABLE People (  
  pid          int not null,  
  prefix       text,  
  firstName    text,  
  lastName     text,  
  suffix       text,  
  homeCity    text,  
  DOB          date,  
  primary key(pid)  
);
```

-- Customers --

```
CREATE TABLE Customers (  
  pid          int not null references People(pid),  
  paymentTerms text,  
  discountPct decimal(5,2),  
  primary key(pid)  
);
```

-- Agents --

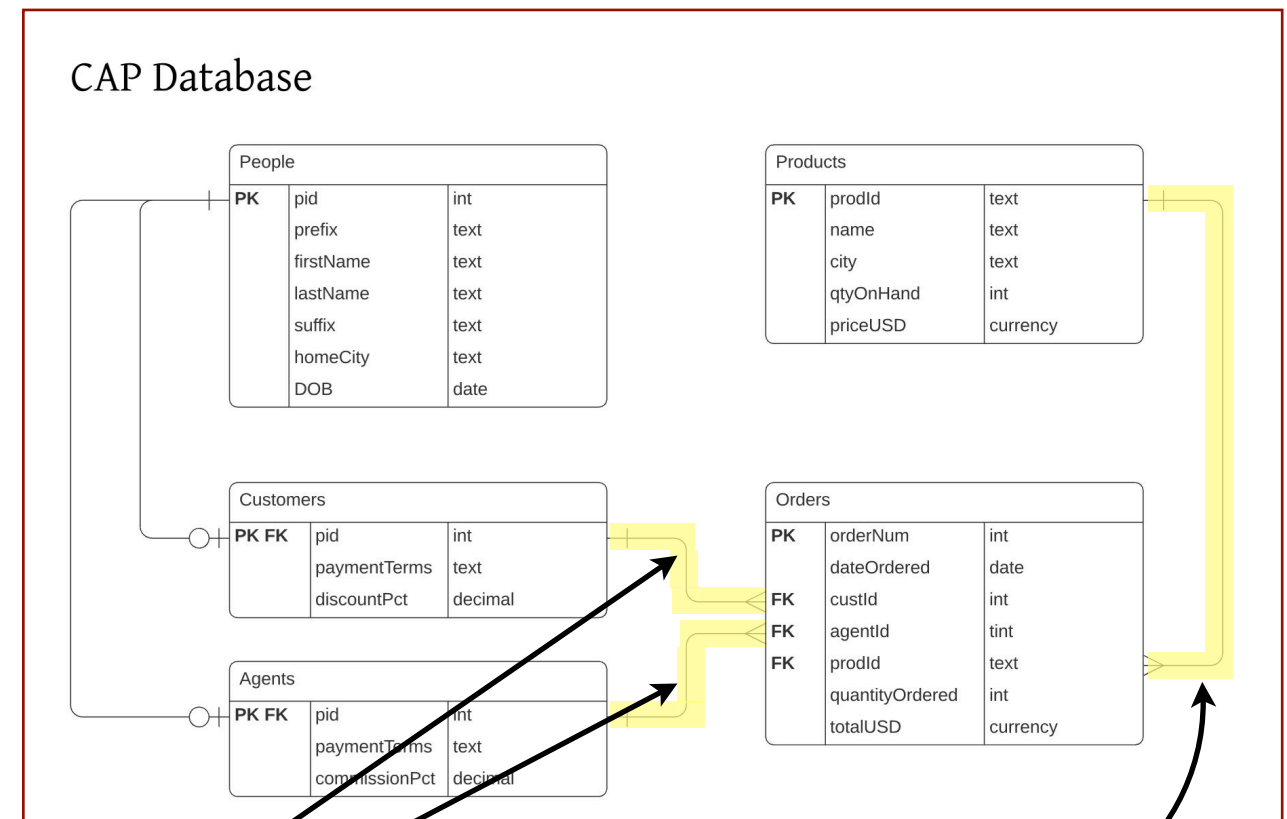
```
CREATE TABLE Agents (  
  pid          int not null references People(pid),  
  paymentTerms text,  
  commissionPct decimal(5,2),  
  primary key(pid)
```



SQL as DDL - Creating Tables

```
CREATE TABLE Products (  
  prodId    text not null,  
  name      text,  
  city      text,  
  qtyOnHand int,  
  priceUSD  currency(10,2),  
  primary key(prodId)  
);
```

```
-- Orders --  
CREATE TABLE Orders (  
  orderNum    int    not null,  
  dateOrdered date  not null,  
  custId      int    not null references Customers(pid),  
  agentId     int    not null references Agents(pid),  
  prodId      text  not null references Products(prodId),  
  quantityOrdered integer,  
  totalUSD    currency(12,2),  
  primary key(orderNum)  
);
```

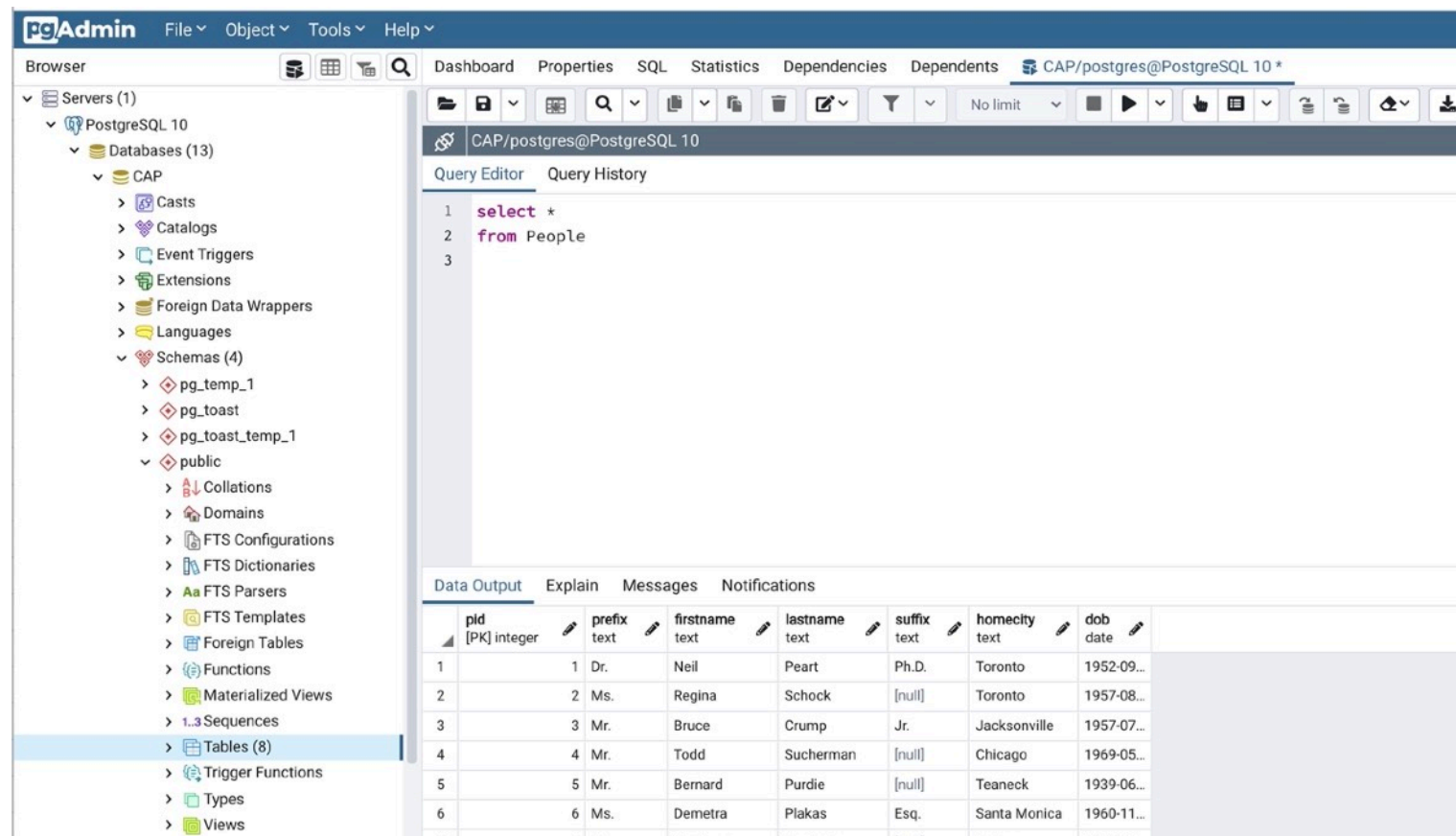


Referential Integrity

A **proper** relational database will enforce the Primary Key (PK) — Foreign Key (FK) relationship not matter what.

We cannot break it.

But let's try...



The screenshot shows the pgAdmin interface. On the left, the 'Browser' pane displays a tree view of the database structure, including 'Servers (1)', 'PostgreSQL 10', 'Databases (13)', 'CAP', and 'Schemas (4)'. The 'public' schema is expanded, showing various objects like 'Collations', 'Domains', 'Functions', and 'Tables (8)'. The main window shows the 'Query Editor' with the following SQL query:

```
1 select *
2 from People
3
```

Below the query editor, the 'Data Output' tab is active, displaying a table with 8 columns: 'pid [PK] integer', 'prefix text', 'firstname text', 'lastname text', 'suffix text', 'homecity text', and 'dob date'. The table contains 6 rows of data:

pid [PK] integer	prefix text	firstname text	lastname text	suffix text	homecity text	dob date
1	Dr.	Neil	Peart	Ph.D.	Toronto	1952-09...
2	Ms.	Regina	Schock	[null]	Toronto	1957-08...
3	Mr.	Bruce	Crump	Jr.	Jacksonville	1957-07...
4	Mr.	Todd	Sucherman	[null]	Chicago	1969-05...
5	Mr.	Bernard	Purdie	[null]	Teaneck	1939-06...
6	Ms.	Demetra	Plakas	Esq.	Santa Monica	1960-11...