

## Alan G. Labouseur, Ph.D. Alan.Labouseur@Marist.edu

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



CAP=# select * CAP-# from Players:									
pid	name	2	rank						
$\frac{1}{2}$	James Leona	ard	Captain Admiral						
(2 rows) CAP=# select * CAP-# from Items:									
iid	name	(	descr						
A B C D	wand gem mace sword	·   ·   ·							
(4 rows) CAP=# select * CAP-# from Inventory:									
pid	iid	dat	ceacquired						
1 1 2 2	A B B C	202 202 202 202	20-01-23 20-01-23 20-01-23 20-01-23						
(4 rows)									

## Tables of rows and columns: An e-commerce database ("CAP")

Peop	le							Produc	cts					
pid I	prefix	firstName	lastName	suffix	I homeCity	I	DOB	prodId	l name	I	city	1	qty0nHand	priceUSD
1	Dr.	+   Neil	Peart	Ph.D.	Toronto	+-	1952-09-12	p01	Heisenberg Compensator	-+	Dallas	-+-	47	67.50
21	Ms.	l Regina	I Schock	1	Toronto	1	1957-08-31	p02	Universal Translator	I	Newark	1	2399	5.50
3 1	Mr.	I Bruce	I Crump	Jr.	Jacksonville	1	1957-07-17	p03	Commodore PET	1	Duluth	1	1979	65.02
4 1	Mr.	I Todd	I Sucherman	1	l Chicago	Ι	1969-05-02	p04	LCARS module	I	Duluth	1	3	47.00
5 1	Mr.	Bernard	I Purdie	1	I Teaneck	1	1939-06-11	p05	Remo drumhead	1	Dallas	1	8675309	16.61
6 1	Ms.	l Demetra	Plakas	I Esq.	I Santa Monica	1	1960-11-09	p06	Trapper Keeper	1	Dallas	1	1982	2.00
71	Ms.	I Terri Lyne	I Carrington	1	Boston	1	1965-08-04	p07	Flux Capacitor	I	Newark	1	1007	1.00
8 1	Dr.	Bill	Bruford	I Ph.D.	Kent	1	1949-05-17	p08	HAL 9000 memory core	I	Newark	1	200	1.25
9	Mr.	Alan	White	I III	Pelton	I	1949-06-14	p09	Red Barchetta	I	Toronto	Т	1	379000.47

#### Customers

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

#### Agents

pid	I	paymentTerms	I	commissionPct
2	+-	Quarterly	+-	5.00
3	I	Annually	1	10.00
5	T	Monthly	L	2.00
6	I	Weekly	I	1.00

	Orders						
	orderNum	date0rdered	custId	agentId	prodId	l quantityOrdered	totalUSD
	1011	2020-01-23	I 1 I	2	p01	I 1100	58568.40
	1012 I	2020-01-23	4	3	p03	1200	74871.83
	1015 I	2020-01-23	5	3	p05	1000	15696.45
	1016 I	2020-01-23	8	3	p01	1000	60750.00
	1017 I	2020-02-14	1	3	p03	l 500	25643.89
	1018	2020-02-14	1	3	p04	600	22244.16
	1019 I	2020-02-14	1	2	p02	400	1735.36
	1020 I	2020-02-14	4	5	p07	600	575.76
	1021 I	2020-02-14	4	5	p01	1000	64773.00
	1022 I	2020-03-15	1	3	p06	450	709.92
	1023 I	2020-03-15	1	2	p05	500	6550.98
Originally from Detailors Driving and Decomposition and	1024 I	2020-03-15	5	2	p01	880	56133.00
Originally from <u>Database Principles, Programming, and</u>	1025 I	2020-04-01	8	3	p07	888	799.20
Modified over and over by Alan G. Labouseur.	1026 I	2020-05-01	8	5	l p03	I 808	47282.54

## Tables of rows and columns

### People

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

# Tables of rows and <mark>columns</mark>

### People

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

## Tables of rows and <mark>columns</mark>

# All entries in a single column are a single attribute and of a single data type.

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

From Codd Himself.

These rules allow us to achieve excellence in database design across time and space.



There can be *no multi-valued attributes* or values with internal structure at any intersection of a row and a column in a table.

In older terms: *no repeating groups* or *no repeating fields*.

Put another way, all values at the intersection or a row and a column must be **atomic**, meaning that they cannot be subdivided.

There can be *no multi-valued attributes* or values with internal structure at any intersection of a row and a column in a table.

In older terms: *no repeating groups* or *no repeating fields*.

Put another way, all values at the intersection or a row and a column must be **atomic**, meaning that they cannot be subdivided.

pid	name	profession	skills
 007 008 009	Sean Roger Pierce	spy secret agent (on who's side?) stiff-assed Brit	pronounces "S" like "Sh", charm humour, stealth wit, hair

There can be *no multi-valued attributes* or values with internal structure at any intersection of a row and a column in a table.

In older terms: *no repeating groups* or *no repeating fields*.

Put another way, all values at the intersection or a row and a column must be **atomic**, meaning that they cannot be subdivided.

People		
pid name	profession	skills
007 Sean 008 Roger 009 Pierce	spy secret agent (on who's side?) stiff-assed Brit	pronounces "S" like "Sh", charm humour, stealth wit, hair

This is a violation of the 1NF rule.

There can be *no multi-valued attributes* or values with internal structure at any intersection of a row and a column in a table.

In older terms: *no repeating groups* or *no repeating fields*.

Put another way, all values at the intersection or a row and a column must be **atomic**, meaning that they cannot be subdivided.

pid	name	profession	skill1	skill2
 007 008 009	Sean Roger Pierce	spy secret agent (on who's side?) stiff-assed Brit	pronounces "S" like "Sh" humour wit	 charm stealth hair

A slight restructuring of table removes the 1NF violation (but this is still bad design).

# 2. The Access Rows by Content Only Rule

We can only ask for ("query") data by **what's there**, never by **where it is**.

# 2. The Access Rows by Content Only Rule

We can only ask for ("query") data by **what's there**, never by **where it is**.

We **can** ask, "What is the name of pid 007?" We **cannot** ask, "What is the name in the first row?"

People

pid	name	profession	skill1	skill2
 007 008 009	Sean Roger Pierce	spy secret agent (on who's side?) stiff-assed Brit	pronounces "S" like "Sh" humour wit	 charm stealth hair

Tables are sets. The elements of a set have no intrinsic order.  $\{a, b, c\} = \{b, a, c\} = \{c, a, b\}$ 

## 2. The Access Rows by Content Only Rule

We can only ask for ("query") data by **what's there**, never by **where it is**.

We **can** ask, "What is the name of pid 7?" We **cannot** ask, "What is the name in the strow?"

#### People skill1 pid profession skill2 name pronounces "S" like "Sh" 007 Sean spy charm (on who's side?) 800 Roger secret humour stealth 70 009 Pierce stiff-Brit wit hair

Tables are sets. The elements of a set have no intrinsic order. {a, b, c} = {b, a, c} = {c, a, b}

## 3. The All Rows Must Be Unique Rule

Since tables are sets of rows and columns, and because the elements of a set have no intrinsic order, the only way we can insure our ability to get at every row in a table is for every row to be unique.

Were that not the case, some rows in the table would be indistinguishable. (Like crossing the streams, that would be bad.)



## 3. The All Rows Must Be Unique Rule

## People

pid	name	profession	skill1	skill2
 007 008 009	Sean Roger Pierce	<pre>spy secret agent (on who's de?) stiff-assed Brit</pre>	pronounces "S" like "Sh" humour wit	 charm stealth hair

### People

pid	name	profession	skill1	skill2
 007 008 009 007	Sean Roger Pierce Sean	<pre>spy secret agent (on who's 'e?) stiff-assed Brit spy</pre>	pronounces "S" like "Sh" humour wit pronounces "S" like "Sh"	charm stealth hair charm

## Does this database obey the rules?

Peop	ple								Produc	cts						
pid	l prefi	ix I	firstName	lastName	suffix	I homeCity	I	DOB	prodId	l name	I	city	1	qty0nHand	pric	eUSD
1	Dr.	+ 	Neil	Peart	1 Ph.D.	Toronto	+-	1952-09-12	p01	Heisenberg Compensator	-+	Dallas	-+-	47	F 	67.50
2	I Ms.	1	Regina	I Schock	1	I Toronto	1	1957-08-31	p02	Universal Translator	I	Newark	1	2399	l.	5.50
3	Mr.	1	Bruce	I Crump	Jr.	Jacksonville	1	1957-07-17	p03	Commodore PET	1	Duluth	1	1979	É	65.02
4	Mr.	1	Todd	I Sucherman	1	l Chicago	1	1969-05-02	p04	LCARS module	T	Duluth	1	3	E - 1	47.00
5	Mr.	1	Bernard	Purdie	1	I Teaneck	1	1939-06-11	p05	Remo drumhead	T	Dallas	1	8675309	1	16.61
6	I Ms.	1	Demetra	Plakas	I Esq.	I Santa Monica	1	1960-11-09	p06	Trapper Keeper	I	Dallas	1	1982	1	2.00
7	I Ms.	1	Terri Lyne	I Carrington	1	Boston	1	1965-08-04	p07	Flux Capacitor	I	Newark	1	1007	L	1.00
8	I Dr.	1	Bill	Bruford	I Ph.D.	Kent	1	1949-05-17	p08	HAL 9000 memory core	I	Newark	1	200	1	1.25
9	I Mr.	1	Alan	White	III	Pelton	I	1949-06-14	p09	Red Barchetta	I	Toronto	Т	1	3790	00.47

#### Customers

pid	I	paymentTerms	I	discountPct
1	+-	Net 30	+-	21.12
4	I.	Net 15	I.	4.04
5	L	In Advance	L	5.50
7	T	On Receipt	I	2.00
8	I.	Net 30	T	10.00

#### Agents

pid	I	paymentTerms	1	commissionPct
2	+	Quarterly	+-	5.00
3	I	Annually	1	10.00
5	I	Monthly	L	2.00
6	I	Weekly	I	1.00

0	rd	ler	'S
U	IU	er	S

	orderNum	date0rdered	custId	agentId	prodId	l quantityOrdered	l totalUSD
	1011	2020-01-23	1	2	,   p01	1 1100	58568.40
	1012 I	2020-01-23	4	3	l p03	1 1200	74871.83
	1015 I	2020-01-23	5	I 3	l p05	1000	15696.45
	1016 I	2020-01-23	8	I 3	l p01	1000	60750.00
	1017 I	2020-02-14	1	I 3	l p03	I 500	25643.89
	1018	2020-02-14	1	I 3	l p04	600	22244.16
	1019 I	2020-02-14	1	1 2	l p02	400	1735.36
	1020 I	2020-02-14	4	I 5	p07	600	575.76
	1021 I	2020-02-14	4	5 ا	l p01	1000	64773.00
	1022 I	2020-03-15	1	I 3	p06	450	709.92
	1023 I	2020-03-15	1	2	p05	500	6550.98
Originally from Database Driverial as Decomposition and	1024 I	2020-03-15	5	2	l p01	880	56133.00
Derformance by Datrick O'Neil and Elizabeth O'Neil	1025 I	2020-04-01	8	I 3	p07	888	799.20
Modified over and over by Alan G. Labouseur.	1026 I	2020-05-01	8	5	l p03	I 808	47282.54

Expanded Summary

- All entries in a table must be single-valued.
- Each column must have a distinct name.
- All values in a column are values of the same attribute.
- The order of columns is immaterial.
- Every row is distinct (unique).
- The order of rows is immaterial.

Super Keyany field (column) or set of fields that<br/>uniquely identify every row in a table

Candidate Key a minimal super key

**Primary Key** the chosen candidate key

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

Super Key

## any field or set of fields that uniquely identify every row in a table

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

#### Customers

pid	I	paymentTerms	I	discountPct
1	1	Net 30	+-	21.12
4	I.	Net 15	T.	4.04
5	L	In Advance	L	5.50
7	1	On Receipt	T	2.00
8	Т	Net 30	T	10.00

#### Agents

pid	I	paymentTerms	I	commissionPct
2	+-	Quarterly	+	5.00
3	I.	Annually	I.	10.00
5	I	Monthly	I	2.00
6	I	Weekly	I	1.00

#### Orders

orderNum	1	date0rdered	1	custId	agentId	I	prodId	quantityOrdered	totalUS
1011	I	2020-01-23	1	1	1 2	I	p01	l 1100	58568.40
1012	I	2020-01-23	1	4	3	I	p03	I 1200	74871.83
1015	L	2020-01-23	I	5	I 3	I	p05	I 1000	15696.45
1016	L	2020-01-23	T	8	3	I	p01	1 1000	60750.00
1017	L	2020-02-14	Ι	1	3	١	p03	I 500	25643.89
1018	L	2020-02-14	1	1	I 3	I	p04	I 600	22244.16
1019	L	2020-02-14	I	1	I 2	I	p02	I 400	1735.36
1020	I	2020-02-14	T	4	5 ا	١	p07	I 600	575.76
1021	I	2020-02-14	1	4	5 ا	١	p01	I 1000	64773.00
1022	L	2020-03-15	T	1	I 3	I	p06	I 450	709.92
1023	L	2020-03-15	T	1	1 2	I	p05	1 500	6550.98
1024	I	2020-03-15	1	5	1 2	I	p01	I 880	56133.00
1025	I	2020-04-01	1	8	I 3	I	p07	I 888	799.20
1026	I	2020-05-01	I	8	5	I	p03	I 808	47282.54

Originally from <u>Database Principles, Programming, and</u> <u>Performance</u> by Patrick O'Neil and Elizabeth O'Neil. Modified over and over by Alan G. Labouseur.

## Candidate Key a minimal super key

Peop	le							Produc	cts
pid	prefix	firstName	lastName	suffix	I homeCity	I	DOB	prodId	I name I city   qtyOnHand   priceUSD
1	Dr.	Neil	Peart	I Ph.D.	Toronto		1952-09-12	p01	Heisenberg Compensator   Dallas   47   67.50
2	Ms.	l Regina	I Schock	1	I Toronto	Ι	1957-08-31	p02	Universal Translator   Newark   2399   5.50
3	Mr.	I Bruce	I Crump	Jr.	Jacksonville	1	1957-07-17	p03	Commodore PET   Duluth   1979   65.02
4	Mr.	I Todd	I Sucherman	1	l Chicago	Ι	1969-05-02	p04	LCARS module   Duluth   3   47.00
5	Mr.	Bernard	Purdie	1	I Teaneck	1	1939-06-11	p05	Remo drumhead   Dallas   8675309   16.61
6	Ms.	Demetra	Plakas	I Esq.	I Santa Monica	T	1960-11-09	p06	Trapper Keeper   Dallas   1982   2.00
7	Ms.	I Terri Lyne	I Carrington	1	Boston	1	1965-08-04	p07	Flux Capacitor   Newark   1007   1.00
8	Dr.	Bill	Bruford	I Ph.D.	Kent	1	1949-05-17	p08	HAL 9000 memory core   Newark   200   1.25
9	Mr.	Alan	I White	III	Pelton	Ι	1949-06-14	p09	I Red BarchettaI Toronto I1   379000.47

#### Customers

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

#### Agents

igenito												
pid	ļ	paymentTerms	I	commissionPct								
2	1	Quarterly	+	5.00								
3	T	Annually	I	10.00								
5	I	Monthly	I	2.00								
6	I	Weekly	I	1.00								

#### Orders

orderNum	date0rdered	1	custId	1	agentId	I	prodId	quantityOrdered	totalUSD
1011	2020-01-23		1	I	2	Ì	p01	1100	58568.40
1012 I	2020-01-23	1	4	I	3	I	p03	I 1200 I	74871.83
1015 I	2020-01-23	1	5	I	3	I	p05	1 1000 1	15696.45
1016 I	2020-01-23	1	8	I	3	I	p01	1000	60750.00
1017 I	2020-02-14	Ι	1	I	3	I	p03	I 500 I	25643.89
1018 I	2020-02-14	1	1	I	3	I	p04	I 600 I	22244.10
1019 I	2020-02-14	1	1	I	2	I	p02	I 400 I	1735.3
1020 I	2020-02-14	T	4	I	5	١	p07	I 600 I	575.7
1021 I	2020-02-14	1	4	I	5	I	p01	1 1000	64773.0
1022 I	2020-03-15	1	1	I	3	I	p06	I 450 I	709.9
1023 I	2020-03-15	Ι	1	I	2	I	p05	I 500 I	6550.9
1024 I	2020-03-15	1	5	I	2	I	p01	880	56133.0
1025 I	2020-04-01	1	8	I	3	I	p07	I 888 I	799.2
1026 I	2020-05-01	Ι	8	I	5	I	p03	I 808 I	47282.5

Originally from <u>Database Principles, Programming, and</u> <u>Performance</u> by Patrick O'Neil and Elizabeth O'Neil. Modified over and over by Alan G. Labouseur.

## **Primary Key** the chosen candidate key

People	Products
pid   prefix   firstName   lastName   suffix   homeCity   DOB	prodId   name   city   qtyOnHand   priceUSD
1   Dr.  Neil  Peart  Ph.D.  Toronto  1952-09-122   Ms.  Regina  Schock   Toronto  1957-08-313   Mr.  Bruce  Crump  Jr.  Jacksonville  1957-07-174   Mr.  Todd  Sucherman   Chicago  1969-05-025   Mr.  Bernard  Purdie   Teaneck  1939-06-116   Ms.  Demetra  Plakas  Esa  Santa Monica  1960-11-09	p01IHeisenberg Compensator IDallasI47  67.50p02IUniversal TranslatorINewark2399  5.50p03ICommodore PETIDuluth1979  65.02p04ILCARS moduleIDuluth3  47.00p05IRemo drumheadIDallas8675309  16.61p06ITrapper KeeperIDallas1982  2.00
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	p00I Hupper ReceptionI burlasI burlasI burlasp07I Flux CapacitorI Newark I1007 I1.00p08I HAL 9000 memory coreI Newark I200 I1.25p09I Red BarchettaI Toronto I1 I 379000.47
Customers Agents	_
pid   paymentTerms   discountPct pid   paymentTerms   commissionPct	
1   Net 30       1       21.12         4   Net 15       1       4.04         5   In Advance       5.50         7   On Receipt       2.00         8   Net 30       1	2
Orders	
orderNum I	dateOrdered   custId   agentId   prodId   quantityOrdered   totalUSD
1011   1012   1015   1016   1017   1018	2020-01-23       I       I       2       I       p01       I       1100       58568.40         2020-01-23       I       4       I       3       I       p03       I       1200       74871.83         2020-01-23       I       5       I       3       I       p05       I       1000       I       15696.45         2020-01-23       I       8       I       3       I       p01       I       1000       60750.00         2020-02-14       I       I       I       3       I       p03       I       500       25643.89         2020-02-14       I       I       3       I       p04       600       22244.16
1019   1020   1021   1022   1023   1024	2020-02-14       I       1       I       2       I       902       I       400       I       1735.36         2020-02-14       I       4       I       5       I       p07       I       600       I       575.76         2020-02-14       I       4       I       5       I       p01       I       1000       I       64773.00         2020-03-15       I       I       3       I       p06       I       450       709.92         2020-03-15       I       I       2       I       p05       I       500       I       6550.98         2020-03-15       I       5       2       I       p01       I       880       56133.00
DescriptionDatabase Principles, Programming, and1025  Performanceby Patrick O'Neil and Elizabeth O'Neil.1026  Modified over and over by Alan G. Labouseur.1026	2020-04-01               8         3   p07               888   799.20         2020-05-01               8         5   p03               808   47282.54

## **Primary Key** the chosen candidate key

People									Products							
pid	prefix	firstName	lastName	suffix	I homeCity	I	DOB	prodId	l name	I	city	I	qty0nHand	priceUSD		
1	Dr. I	Neil	l Peart	l Ph.D.	Toronto	+-	1952-09-12	p01	Heisenberg Compensator	1	Dallas	-+-	47	67.50		
21	Ms. I	Regina	I Schock	1	I Toronto	Ι	1957-08-31	p02	Universal Translator	I	Newark	1	2399	5.50		
3 1	Mr. I	Bruce	I Crump	Jr.	Jacksonville	1	1957-07-17	p03	Commodore PET	1	Duluth	1	1979	65.02		
4 1	Mr. I	Todd	I Sucherman	1	l Chicago	I	1969-05-02	p04	LCARS module	T	Duluth	1	3	47.00		
5 1	Mr. I	Bernard	Purdie	1	I Teaneck	I	1939-06-11	p05	Remo drumhead	T	Dallas	1	8675309	16.61		
6 1	Ms. I	Demetra	Plakas	I Esq.	I Santa Monica	1	1960-11-09	p06	Trapper Keeper	T	Dallas	1	1982	2.00		
71	Ms. I	Terri Lyne	I Carrington	1	Boston	1	1965-08-04	p07	Flux Capacitor	I	Newark	T	1007	1.00		
8 1	Dr. I	Bill	Bruford	I Ph.D.	Kent	1	1949-05-17	p08	HAL 9000 memory core	T	Newark	1	200	1.25		
91	Mr. I	Alan	White	III	Pelton	Ι	1949-06-14	p09	Red Barchetta	I	Toronto	Т	1	379000.47		

#### Customers

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

#### Agents

pid		paymentTerms	1	commissionPct
2	i	Quarterly	i	5.00
3	T	Annually	1	10.00
5	I	Monthly	L	2.00
6	١	Weekly	I	1.00

#### Orders

orderNum	date0rdered	1	custId	agentId	1	prodId	l quantityOrdered	1	totalUSD
1011	2020-01-23	-+-	1	2	1	p01	l 1100	+-	58568.40
1012	2020-01-23	1	4	3	١	p03	1200	L	74871.83
1015	2020-01-23	1	5	3	I	p05	1000	I	15696.45
1016	2020-01-23	1	8	3	I	p01	1000	L	60750.00
1017	2020-02-14	Ι	1	3	١	p03	l 500	I	25643.89
1018	2020-02-14	1	1	3	I	p04	600	L	22244.10
1019	2020-02-14	T	1	2	I	p02	400	L	1735.30
1020	2020-02-14	T	4	5	١	p07	600	L	575.76
1021	2020-02-14	1	4	5	١	p01	1000	L	64773.00
1022	2020-03-15	1	1	3	I	p06	450	L	709.92
1023	2020-03-15	Ι	1	2	I	p05	500	I	6550.98
1024	2020-03-15	T	5	2	١	p01	880	l	56133.0
1025	2020-04-01	1	8	3	I	p07	888	I	799.20
1026	2020-05-01	1	8	5	I	p03	808	L	47282.5

Originally from <u>Database Principles, Programming, and</u> <u>Performance</u> by Patrick O'Neil and Elizabeth O'Neil. Modified over and over by Alan G. Labouseur.

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

People	Products
pid   prefix   firstName   lastName   suffix   homeCity   DOB	prodId   name   city   qtyOnHand   priceUSD
1D.INeilIPeartIPh.D.ITorontoI1952-09-122IMs.IReginaISchockIITorontoI1957-08-313IMr.IBruceICrumpIJr.IJacksonvilleI1957-07-174IMr.IToddISuchermanIIChicagoI1969-05-025IMr.IBernardIPurdieITeaneckI1939-06-116Ms.IDemetrixIPlakasIEsq.ISanta Monica1960-11-097IMs.ITerri <lyn< td="">ICarrington IIBostonI1965-08-048Dr.IBillIBrufordIPh.D.IKentI1949-05-179Mr.IAlanIWriteIIIIIIPelton1949-06-14</lyn<>	p01  Heisenberg Compensator   Dallas  47  67.50p02  Universal Translator   Newark  2399  5.50p03  Commodore PET  Duluth  1979  65.02p04  LCARS module  Duluth  3  47.00p05  Lemo drumhead  Dallas  8675309  16.61p06  Thapper Keeper  Dallas  1982  2.00p07  Flux Capacitor  Newark  1007  1.00p08  HAL 2000 memory core  Newark  200  1.25p09  Red Barchetta  Toronto  1  379000.47
Customers Agents	
pid   paymentTerms   discountPct pid   paymentTerms   commissionPct	
1   Net 30       1       21.12       2   Quarterly         5.00         4   Net 15       1       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       10.00       10.00	
Orders	
orderNum	dateOrdered   custId   agentId   prodId   quantityOrdered   totalUSD
1011         1           1012         1           1015         1           1016         1           1017         1           1018         1           1019         1           1019         1           1020         1           1021         1           1022         1           1023         1           1024         1           1025         1           1026         1	2020-01-23       I       I       2       I       p01       I       1100       58568.40         2020-01-23       I       4       I       3       I       p03       I       1200       74871.83         2020-01-23       I       5       I       3       I       p05       I       1000       I       15696.45         2020-01-23       I       8       I       3       I       p01       I       1000       I       60750.00         2020-02-14       I       1       I       3       I       p03       I       500       I       25643.89         2020-02-14       I       1       I       3       I       p04       I       600       I       22244.16         2020-02-14       I       1       I       I       I       I       600       575.76         2020-02-14       I       4       I       I       I       000       64773.00         2020-02-14       I       4       I       I       I       000       64773.00         2020-03-15       I       I       I       I       I       I       000       6550.98

# 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.

## SELECT FROM WHERE

## People

pid   prefix	firstName   lastNa	ame   suffix   homeCity	I DOB
1   Dr. 2   Ms. 3   Mr. 4   Mr. 5   Mr. 6   Ms. 7   Ms. 8   Dr. 9   Mr.	<pre>-++</pre>	Ph.D.   Toronto   I Toronto   Jr.   Jacksonvill nan     Chicago     Teaneck   Esq.   Santa Monic gton     Boston d   Ph.D.   Kent   III   Pelton	<pre>       1952-09-12       1957-08-31 e   1957-07-17       1969-05-02       1939-06-11 a   1960-11-09       1965-08-04       1949-05-17       1949-06-14</pre>

## SELECT some columns FROM WHERE

	<b>I</b>						
	pid	prefix	firstName	lastName	suffix	homeCity	I DOB
	1 2 3 4 5 6 7	++   Dr.     Ms.     Mr.     Mr.     Ms.     Ms.	Neil Regina Bruce Todd Bernard Demetra Terri Lyne	+   Peart   Schock   Crump   Sucherman   Purdie   Plakas   Carrington	-+   Ph.D.     Jr.       Esq. 	<pre>I Toronto I Toronto I Jacksonville I Chicago I Teaneck I Santa Monica I Boston I Kont</pre>	<pre>+</pre>
	9	I Mr. I	Alan	l White	III	l Pelton	1949-06-14
_							

### People

# SELECTsome columnsFROMsome tableWHERE

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

SELECTsome columnsFROMsome tableWHEREsome condition holds true

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

SELECTfirstNameFROMPeopleWHEREhomeCity = 'Toronto'

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

## SQL Script for AD&D database: Players, Items, and Inventory tables, and a few queries

```
create table Players (
  pid int not null.
  name text,
  rank text,
primary key (pid)
);
insert into Players(pid, name, rank)
values (1, 'James', 'Captain'),
      (2, 'Leonard', 'Admiral');
select *
from Players;
create table Items (
  iid char(1) not null,
  name text,
  descr text,
primary key (iid)
);
insert into Items (iid, name, descr)
values ('A', 'wand', '...'),
      ('B', 'gem', '...'),
      ('C', 'mace', '...'),
      ('D', 'sword', '...');
select *
from Items;
```

```
create table Inventory (
   pid
                int
                        not null references Players(pid),
  iid
                char(1) not null references Items(iid),
   dateAcquired date,
  primary key(pid, iid)
);
insert into Inventory (pid, iid, dateAcquired)
values (1, 'A', '2020-01-23'),
      (1, 'B', '2020-01-23'),
       (2, 'B', '2020-01-23'),
      (2, 'C', '2020-01-23');
select *
from Inventory;
-- Players and their Items
select Players.name, Items.name
from Players inner join Inventory on Players.pid = Inventory.pid
             inner join Items on Inventory.iid = Items.iid;
-- Unused Items
select *
from Items
where iid not in (select iid
                  from Inventory);
-- Item use count v1
select iid, count(iid)
from Inventory
group by iid
order by count(iid) DESC;
```