CSCI 240
Normalization

Example Relation

EmployeeNumber	FirstName	LastName	Department	EmailAddress	Phone
101	Mary	Jacobs	Administration	Mary.Jacobs@ourcompany.com	360-285-8110
102	Rosalie	Jackson	Administration	Rosalie.Jackson@ourcompany.com	360-285-8120
103	Richard	Bandalone	Legal	Richard.Bandalone@ourcompany.com	360-285-8210
104	George	Smith	Human Resources	George.Smith@ourcompany.com	360-285-8310, 360-285-8391, 206-723-8392
105	Alan	Adams	Human Resources	Alan.Adams@ourcompany.com	360-285-8320
106	Ken	Evans	Finance	Ken.Evans@ourcompany.com	360-285-8410
107	Mary	Abernathy	Finance	Mary.Abernathy@ourcompany.com	360-285-8420, 360-285-8491

Types of Keys

A key is a combination of 1+ columns that can identify a row!

Candidate Key	Uniquely Identifies rows
Primary Key	Candidate Key used to uniquely ID rows for the relation
Composite Key	Candidate Key using more than one field
Surrogate Key	A generated field to arbitrarily create a candidate key

Auto Increment

Student ID	Student Name	Student Address	Student Contact
1	Ted Tedson	123 Teddy street	867-5309
2	Ned Nedson	456 Neddy street	555-5555

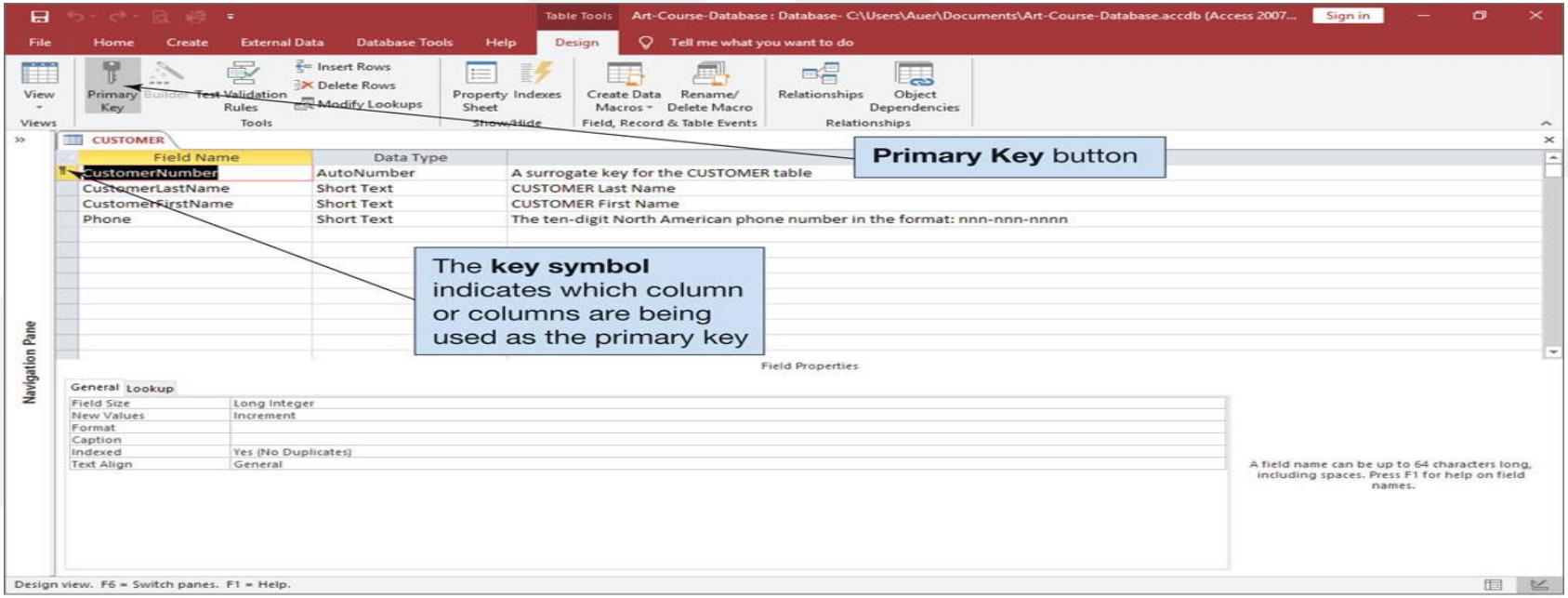
ID increased by one for every record inserted.

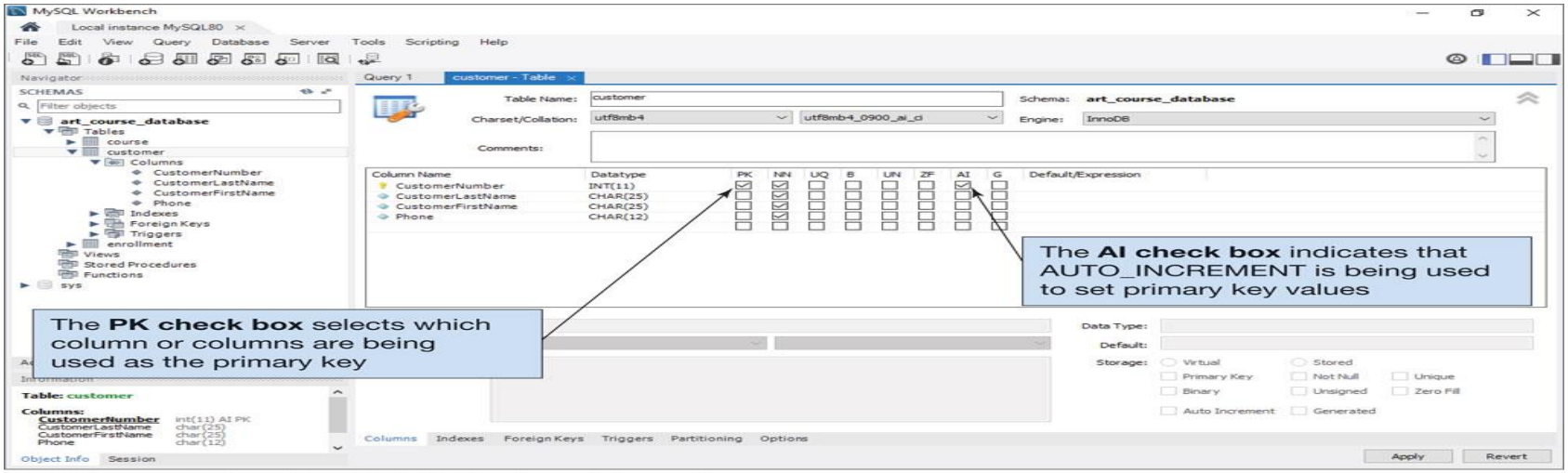
Auto Increment

Student ID	Student Name	Student Address	Student Contact
1	Ted Tedson	123 Teddy street	867-5309
2	Ned Nedson	456 Neddy street	555-5555

ID increased by one for every record inserted.

Defining a Primary Key





Relationships

Student's primary Key

Student ID	Student Name	Student Address	Student Contact
1	Ted Tedson	123 Teddy street	867-5309
2	Ned Nedson	456 Neddy street	555-5555

Foreign Key in Class

Class ID	Class Name	Location	Teacher	Student_ID
1	Awesome DBs	B101	V.V.	1
2	Awesomer OSs	B101	V.V.	2

Referential Integrity

Student ID	Student Name	Student Address	Student Contact
1	Ted Tedson	123 Teddy street	867-5309
2	Ned Nedson	456 Neddy street	555-5555

Every Class must relate to a Student?

Class ID	Class Name	Location	Teacher	Student_ID
1	Awesome DBs	B101	V.V.	1
2	Awesomer OSs	B101	V.V.	2

Null Values

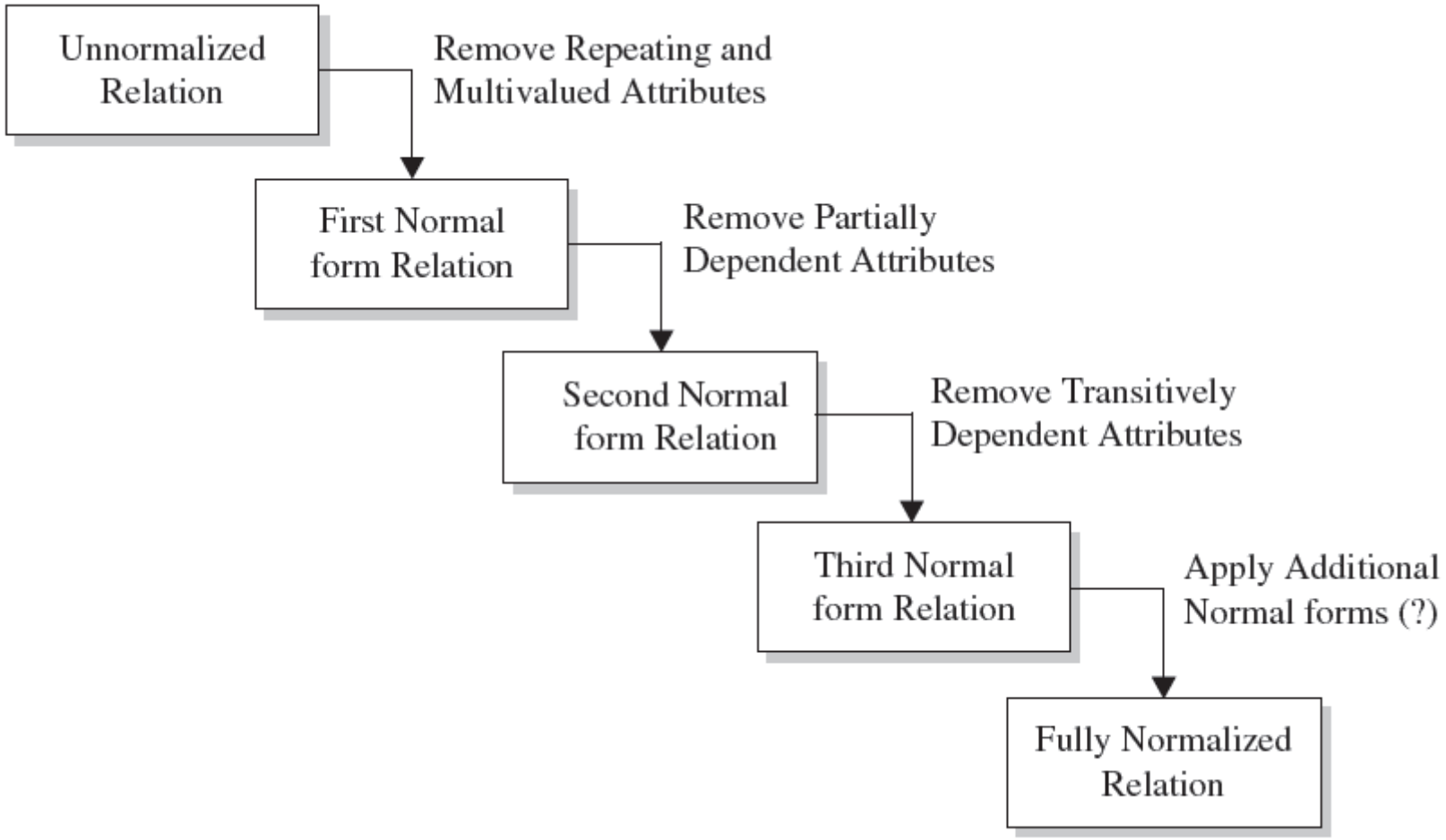
ItemNumber	ItemName	Color	Quantity
110	T-shirt, Small	Red	15
111	T-shirt, Small	Blue	25
115	T-shirt, Small	Green	22
120	T-shirt, Medium	Red	45
125	T-shirt, Medium	Green	52
310	Baseball Cap, Fits All	Red	38
311	Baseball Cap, Fits All	Blue	54
400	Spring Hat		120

Functional Dependency

Student ID	Student Name	Student Address	Student Contact
1	Ted Tedson	123 Teddy street	867-5309
2	Ned Nedson	456 Neddy street	555-5555

All Data in the table is dependent on the Primary Key.

Normalization



Timklenthuc.blogspot.com

First Normal Form (1NF)

- The domain of each attribute of an entity contains only atomic values;
- Each attribute contains only a single value from the domain.

ItemNumber	ItemName	Color	Quantity
110	T-shirt, Small	Red	15
111	T-shirt, Small	Blue	25
115	T-shirt, Small	Green	22
120	T-shirt, Medium	Red	45
125	T-shirt, Medium	Green	52
310	Baseball Cap, Fits All	Red	38
311	Baseball Cap, Fits All	Blue	54
400	Spring Hat		120

https://www.youtube.com/watch?v=jgUeOjImOOw

First Normal Form (1NF)

- The domain of each attribute of an entity contains only atomic values;
- Each attribute contains only a single value from the domain.

ItemNumber	ItemName	Color	Quantity
110	T-shirt, Small	Red	15
111	T-shirt, Small	Blue	25
115	T-shirt, Small	Green	22
120	T-shirt, Medium	Red	45
125	T-shirt, Medium	Green	52
310	Baseball Cap, Fits All	Red	38
311	Baseball Cap, Fits All	Blue	54
400	Spring Hat		120

Not Atomic. Need another Column: Size

Second Normal Form (2NF)

- It is in 1NF and;
- Does not have any non-prime attribute that is functionally dependent on a subset of a candidate key.

TABLE_PURCHASE_DETAIL

Customer ID	Store ID	Purchase Location
1	1	Los Angeles
1	3	San Francisco
2	1	Los Angeles
3	2	New York
4	3	San Francisco

What is significant about Purchase Location?

https://www.youtube.com/watch?v=9L10Q1nAfyg

Second Normal Form (2NF)

TABLE_PURCHASE

Customer ID	Store ID
1	1
1	3
2	1
3	2
4	3

TABLE_STORE

Store ID	Purchase Location
1	Los Angeles
2	New York
3	San Francisco

Third Normal Form (3NF)

- It is in 2NF and;
- Every non-prime attribute is non-transitively dependent on the primary key

TABLE_BOOK_DETAIL

Book ID	Genre ID	Genre Type	Price
1	1	Gardening	25.99
2	2	Sports	14.99
3	1	Gardening	10.00
4	3	Travel	12.99
5	2	Sports	17.99

https://www.youtube.com/watch?v=_K7fcFQowy8

Third Normal Form (3NF)

TABLE_BOOK

Book ID	Genre ID	Price
1	1	25.99
2	2	14.99
3	1	10.00
4	3	12.99
5	2	17.99

TABLE_GENRE

Genre ID	Genre Type
1	Gardening
2	Sports
3	Travel

More Examples

PrescriptionNumber	Date	Drug	Dosage	CustomerName	CustomerPhone	CustomerEmailAddress
P10001	10/17/2019	DrugA	10mg	Smith, Alvin	575-523-2233	ASmith@somewhere.com
P10003	10/17/2019	DrugB	35mg	Rhodes, Jeff	575-645-3455	JRhodes@somewhere.com
P10004	10/17/2019	DrugA	20mg	Smith, Sarah	575-523-2233	SSmith@somewhere.com
P10007	10/18/2019	DrugC	20mg	Frye, Michael	575-645-4566	MFrye@somewhere.com
P10010	10/18/2019	DrugB	30mg	Rhodes, Jeff	575-645-3455	JRhodes@somewhere.com

More Examples

CustomerEmailAddress	CustomerName	CustomerPhone
ASmith@somewhere.com	Smith, Alvin	575-523-2233
JRhodes@somewhere.com	Rhodes, Jeff	575-645-3455
MFrye@somewhere.com	Frye, Michael	575-645-4566
SSmith@somewhere.com	Smith, Sarah	575-523-2233

PrescriptionNumber	Date	Drug	Dosage	CustomerEmailAddress
P10001	10/17/2019	DrugA	10mg	ASmith@somewhere.com
P10003	10/17/2019	DrugB	35mg	JRhodes@somewhere.com
P10004	10/17/2019	DrugA	20mg	SSmith@somewhere.com
P10007	10/18/2019	DrugC	20mg	MFrye@somewhere.com
P10010	10/18/2019	DrugB	30mg	JRhodes@somewhere.com

More Examples

StudentNumber	LastName	FirstName	DormName	DormCost
100	Smith	Terry	Stephens	3,500.00
200	Johnson	Jeff	Alexander	3,800.00
300	Abernathy	Susan	Horan	4,000.00
400	Smith	Susan	Alexander	3,800.00
500	Wilcox	John	Stephens	3,500.00
600	Webber	Carl	Horan	4,000.00
700	Simon	Carol	Stephens	3,500.00

More Examples

StudentNumber	LastName	FirstName	DormName
100	Smith	Terry	Stephens
200	Johnson	Jeff	Alexander
300	Abernathy	Susan	Horan
400	Smith	Susan	Alexander
500	Wilcox	John	Stephens
600	Webber	Carl	Horan
700	Simon	Carol	Stephens

DormName	DormCost
Alexander	3,800.00
Horan	4,000.00
Stephens	3,500.00

More Examples

EmployeeNumber	FirstName	LastName	Department	EmailAddress	DepartmentPhone
101	Mary	Jacobs	Administration	Mary.Jacobs@ourcompany.com	360-285-8100
102	Rosalie	Jackson	Administration	Rosalie.Jackson@ourcompany.com	360-285-8100
103	Richard	Bandalone	Legal	Richard.Bandalone@ourcompany.com	360-285-8200
104	George	Smith	Human Resources	George.Smith@ourcompany.com	360-285-8300
105	Alan	Adams	Human Resources	Alan.Adams@ourcompany.com	360-285-8300
106	Ken	Evans	Finance	Ken.Evans@ourcompany.com	360-285-8400
107	Mary	Abernathy	Finance	Mary.Abernathy@ourcompany.com	360-285-8400

More Examples

EmployeeNumber	FirstName	LastName	Department	EmailAddress
101	Mary	Jacobs	Administration	Mary.Jacobs@ourcompany.com
102	Rosalie	Jackson	Administration	Rosalie.Jackson@ourcompany.com
103	Richard	Bandalone	Legal	Richard.Bandalone@ourcompany.com
104	George	Smith	Human Resources	George.Smith@ourcompany.com
105	Alan	Adams	Human Resources	Alan.Adams@ourcompany.com
106	Ken	Evans	Finance	Ken.Evans@ourcompany.com
107	Mary	Abernathy	Finance	Mary.Abernathy@ourcompany.com

Department	DepartmentPhone
Administration	360-285-8100
Finance	360-285-8400
Human Resources	360-285-8300
Legal	360-285-8200

More Examples

Electric toothbrush models

Manufacturer	Model	Model full name	Manufacturer country
Forte	X-Prime	Forte X-Prime	Italy
Forte	Ultraclean	Forte Ultraclean	Italy
Dent-o-Fresh	EZbrush	Dent-o-Fresh EZbrush	USA
Brushmaster	SuperBrush	Brushmaster SuperBrush	USA
Kobayashi	ST-60	Kobayashi ST-60	Japan
Hoch	Toothmaster	Hoch Toothmaster	Germany
Hoch	X-Prime	Hoch X-Prime	Germany

More Examples

Electric toothbrush manufacturers

Manufacturer	Manufacturer country
Forte	Italy
Dent-o-Fresh	USA
Brushmaster	USA
Kobayashi	Japan
Hoch	Germany

Electric toothbrush models

Manufacturer	Model	Model full name
Forte	X-Prime	Forte X-Prime
Forte	Ultraclean	Forte Ultraclean
Dent-o-Fresh	EZbrush	Dent-o-Fresh EZbrush
Brushmaster	SuperBrush	Brushmaster SuperBrush
Kobayashi	ST-60	Kobayashi ST-60
Hoch	Toothmaster	Hoch Toothmaster
Hoch	X-Prime	Hoch X-Prime

More Examples

Students

IDSt	LastName	IDProf	Prof	Grade
1	Mueller	3	Schmid	5
2	Meier	2	Borner	4
3	Tobler	1	Bernasconi	6

More Examples

Students

ID	LastName
1	Mueller
2	Meier
3	Tobler

Professors

IDProf	Professor
1	Bernasconi
2	Borner
3	Schmid

Grades

IDStIDProf	Grade	
1	3	5
2	2	4
3	1	6

More Examples

Tournament winners

Tournament	Year	Winner	Winner's date of birth
Indiana Invitational	1998	Al Fredrickson	21 July 1975
Cleveland Open	1999	Bob Albertson	28 September 1968
Des Moines Masters	1999	Al Fredrickson	21 July 1975
Indiana Invitational	1999	Chip Masterson	14 March 1977

More Examples

Tournament winners

Tournament	Year	Winner
Indiana Invitational	1998	Al Fredrickson
Cleveland Open	1999	Bob Albertson
Des Moines Masters	1999	Al Fredrickson
Indiana Invitational	1999	Chip Masterson

Winner's dates of birth

Winner	Date of birth
Chip Masterson	14 March 1977
Al Fredrickson	21 July 1975
Bob Albertson	28 September 1968

More Examples

Students

FirstName	LastName	Knowledge
Thomas	Mueller	Java, C++, PHP
Ursula	Meier	PHP, Java
Igor	Mueller	C++, Java

More Examples

Students

FirstName	LastName	Knowledge
Thomas	Mueller	C++
Thomas	Mueller	PHP
Thomas	Mueller	Java
Ursula	Meier	Java
Ursula	Meier	PHP
Igor	Mueller	Java
Igor	Mueller	C++

CSCI 240
Normalization