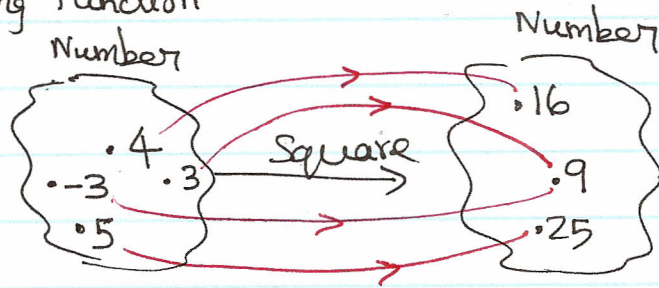
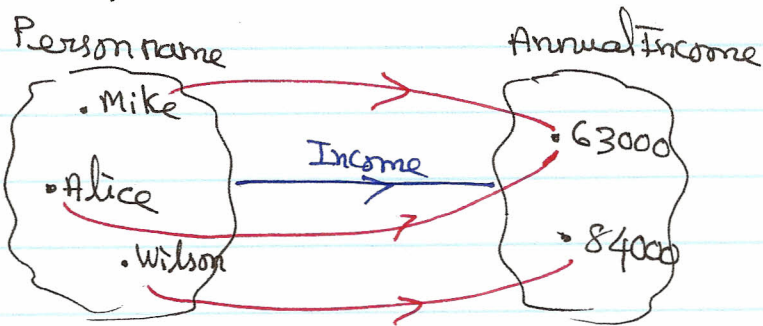


# Normalization (Decomposition: Top-down design strategy)

Mapping function



$Square(\text{number}) \rightarrow \text{Number}$



$Income(\text{Personname}) \rightarrow \text{Annualincome}$

Referred to Functional Dependency

Determinant  $\xrightarrow{\text{determines}}$  Dependent

Address(PID)  $\rightarrow$  AddressString

## Zeroth NF (0NF)

Student

<u>PID</u>	SSN	Phone	<u>Course</u>
std1	SSA	305-782-1288	COP3530, CDA4101
std2	SSB	786-485-1520	COP3337

Can have multiple values in a row

Limitation: Width of columns cannot be determined

Storage space requirement for the table cannot be estimated correctly.

Referred to

First Normal Form (1NF): has no repeating group attribute

<u>PID</u>	SSN	Phone
std1	SSA	305-782-1288
std2	SSB	786-485-1520

<u>PID</u>	<u>Course</u>
std1	COP3530
std1	CDA4101
std2	COP337

Course

<u>CourseNr</u>	<u>Section</u>	Enrollment	Title
COP2250	01	34	Programming I <small>Intro to Programming</small>
COP2250	02	32	Programming I <small>Intro to programming</small>
COP3804	01	16	Programming II
COP4703	01	35	Info Retrieval

Functional dependencies: (FDs)

{ CourseNr, Section } → { Enrollment }

{ CourseNr } → { Title }

Limitations (Anomalies)

**Insertion anomaly** { Insertion of a new fact COP6540 → Intro to Bigdata cannot be stored in the table w/o section value. because section is part of the primary key that cannot be null.

**Update anomaly** { update of a fact COP2250 → Programming I Intro to Programming Difficult to guarantee the consistency in updating all instances of this fact.

**Deletion anomaly** { deletion of COP3804 01 because of low enrollment also deletes the fact COP3804 → Programming II

The reason for these anomalies is the determinant of a FD (CourseNr → Title) is a subset of the Primary key (CourseNr, Section). This is referred to Partial Dependency.

CourseOffer 2NF — no repeating no group attribute  
no partial dependency.

<u>CourseNr</u>	<u>Section</u>	Enrollment
COP2250	01	34
COP2250	02	32
<del>COP3804</del>	<del>01</del>	<del>16</del>
COP4703	01	35

Course

<u>CourseNr</u>	<u>Title</u>
COP225	<del>Intro to Prog</del> Programming I
COP3804	Programming II
COP4703	Info Retrieval
COP6540	Intro to Big Data

# Second Normal Form (2NF)

No repeating group attribute  
No partial dependencies

Student

PID	Name	Street	City	State	County
std1	Jim Watson	11250 SW 78st	Miami	FL	Dade
std2	Maria Brown	10830 SW 12st	Miami	FL	Dade
std3	Alice Smith	7830 SW 15st	Ft Lauderdale	FL	Broward

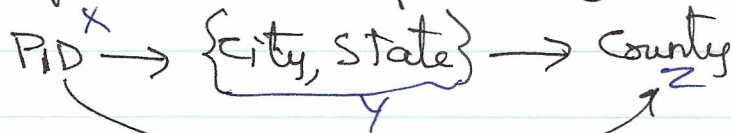
Limitations:

**Insertion anomaly** { Insert a fact {East Miami, FL} → {Dade} cannot be inserted in the table w/o a student PID value.

**Update anomaly** { Update a fact {Miami, FL} → <sup>Miami-Dade</sup> Dade we cannot guarantee consistency of this update on all occurrences.

**Deletion anomaly** { Deletion of a fact std3 row will also remove the fact {Ft Lauderdale, FL} → Broward

The ~~reason~~ reason for these anomalies is the presence of Transitive dependency



We remove transitive dependency to overcome these anomalies that will result in 3rd NF.

Student						Zone		
PID	Name	Street	City	State	County	City	State	County
std1	Jim Watson	11250 SW 78st	Miami	FL	Dade	Miami	FL	Miami Dade
std2	Maria Brown	10830 SW 12st	Miami	FL	Dade	Miami	FL	Miami Dade
<del>std3</del>	<del>Alice Smith</del>	<del>7830 SW 15st</del>	<del>Ft Lauderdale</del>	<del>FL</del>	<del>Broward</del>	<del>Ft Lauderdale</del>	<del>FL</del>	<del>Broward and</del>
						East Miami	FL	Dade

0th NF

↓ removal of repeating group attributes

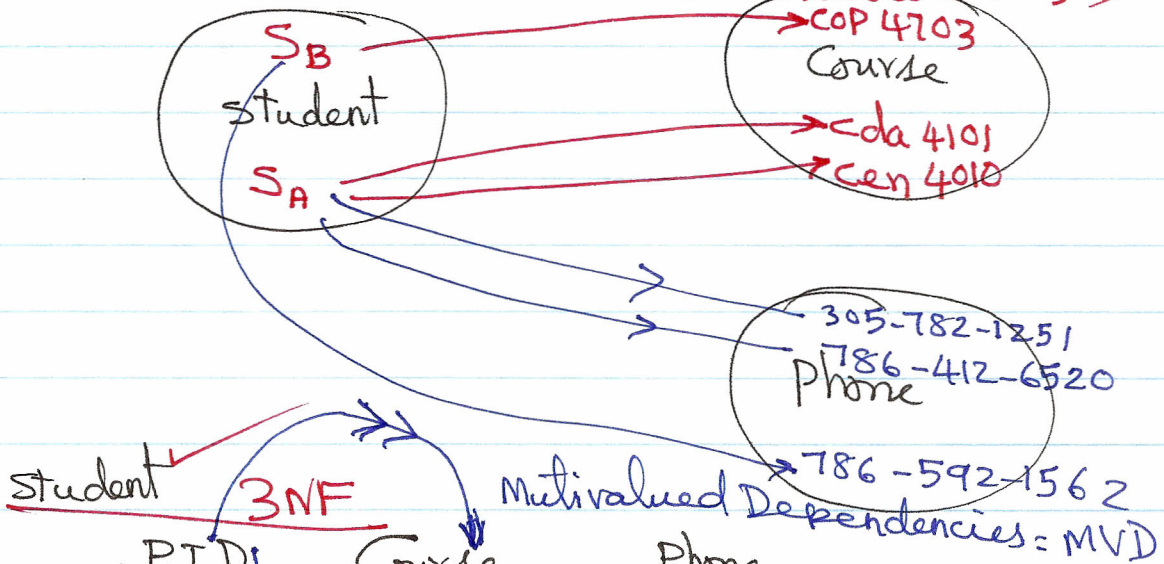
1st NF

↓ removal of partial dependencies

2nd NF

↓ removal of transitive dependencies

3rd NF (The determinant of each FD must be a candidate key)



PID	Course	Phone
SA	cda4101	305-782-1251
SA	cda4101	786-412-6520
SA	cen4010	305-782-1251
SA	cen4010	786-412-6520
SB	COP4703	786-592-1562

Anomalies

Insertion: Sc → 305-562-1520

This cannot be inserted w/o course for Sc.

Update: SA → ~~786-412-6520~~ 786-385-1275

Cannot be updated consistently on all occurrences.

Deletion: SB drops COP4703

Deletion of SB row will also remove  
SB → 786-592-1562

4NF (after removal MVD)

Registration

PID	Course
SA	eda4101
SA	cen 4010
<del>SB</del>	<del>cop 4703</del>

Student

PID	Phone
SA	305-782-1251
SA	<del>786-385-1275</del> <del>786-412-6520</del>
SB	786-592-1562
Sc	<del>786</del> 305-562-1520