

# Normalization algorithms

TEAM INFDEV

Hogeschool Rotterdam  
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- Normalization algorithms
- Normalization from unnormalized table to 1NF.
- Normalization from 1NF to 2NF.
- Normalization from 2NF to BCNF.

# Normalization algorithms

## Normalization in 1NF

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- Find an attribute that is non-atomic, i.e. containing multiple values.
- Remove the non-atomic attribute from the first table creating a new table R1. The primary key of R1 is the primary key of the original relation.

# Normalization algorithms

## Normalization in 1NF

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- Find an attribute that is non-atomic, i.e. containing multiple values.
- Remove the non-atomic attribute from the first table creating a new table R1. The primary key of R1 is the primary key of the original relation.
- Create a new table R2 for this attribute. Add the attributes of the primary key of R1 to R2 and all the sub-attributes of the composite attribute. The attributes of the primary key of R1 in R2 are a foreign key to R1.
- The primary key of R2 is a combination of the primary key of R1 and all the sub-attributes having unique values.

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- Create a new table R2 for this attribute. Add the attributes of the primary key of R1 to R2 and all the sub-attributes of the composite attribute. The attributes of the primary key of R1 in R2 are a foreign key to R1.
- The primary key of R2 is a combination of the primary key of R1 and all the sub-attributes having unique values.
- Repeat the procedure for all non-atomic attributes.

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## Example of normalization in 1NF

**EMP\_PROJ**

SSN	ENAME	PROJS	
		PNUMBER	HOURS

- The composite attribute is PROJS made by the sub-attributes PNUMBER and HOURS.
- Create a table EMP\_PROJ1 containing only SSN (primary key) and ENAME.
- Create a table EMP\_PROJ2 containing SSN,PNUMBER,HOURS. The values of PNUMBER are unique within the composite attribute so the primary key for this table is (SSN,PNUMBER). SSN is a foreign key to EMP\_PROJ1.

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## Alternative algorithm for 1NF

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A simpler alternative is the following: take all the sub-attributes from the composite attribute and replace it with all the sub-attributes as separate attributes.

EMP_PROJ			
<u>SSN</u>	ENAME	PNUMBER	HOURS

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## Normalization in 2NF

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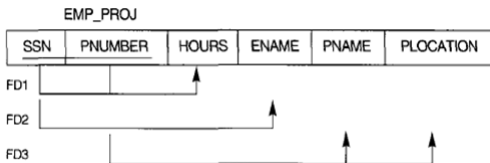
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- Find a non-key attribute that is functionally dependent on a part of the primary key.
- Remove this attribute from the table.
- Create a new relation containing this attribute and the subset of the key the attribute is dependent on. The latter will be the primary key of the new table referenced by the same attribute in the first table.
- Repeat the procedure for all the attributes that have a dependency that breaks 2NF.



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## Example of normalization in 2NF



- The dependencies breaking the 2NF are FD2 and FD3.
- Remove ENAME,PNAME,PLOCATION from EMP\_PROJ, creating a new table EP1.
- Create a table EP2 containing SSN (primary key) and ENAME.
- Create a table EP3 containing PNUMBER (primary key),PNAME,PLOCATION.
- In EP1 SSN is a foreign key to EP2 and PNUMBER is a foreign key to EP3.

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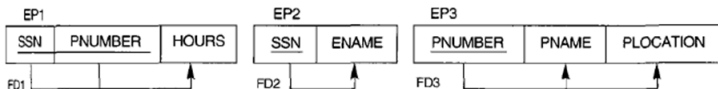
## Example of normalization in 2NF - Result

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## Example of normalization in BCNF

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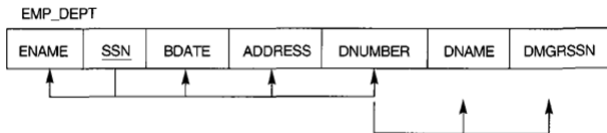
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- Find a functional dependency  $X \rightarrow A$  where  $X$  is not superkey of the table.
- Create a new table  $R1$  without  $A$
- Create a new table  $R2$  and add to it  $X$  and  $A$ .  $X$  is the primary key of  $R2$ .
- The attribute  $X$  in  $R1$  is a foreign key to  $R2$ .

**NOTE:** this normalization algorithm grants the BCNF, which also grants the 3NF. There is another algorithm that grants only the 3NF but with additional properties. We will not see it here.

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## Example of normalization in 3NF/BCNF



- The dependency breaking the 3NF is  $DNUMBER \rightarrow \{DNAME, DMGRSSN\}$ .
- Create a table ED1 containing ENAME,SSN,BDATE,ADDRESS,DNUMBER.
- Create a table ED2 containing DNUMBER,DNAME,DMGRSSN.
- DNUMBER is the primary key of ED2.
- DNUMBER in ED1 is a foreign key to ED2.

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## Example of normalization in 3NF/BCNF - Result

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