Dependency Theory – Part 1

Relational Databases Basics
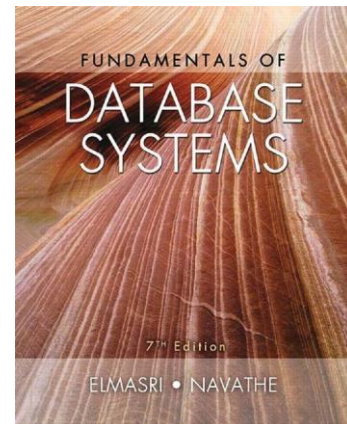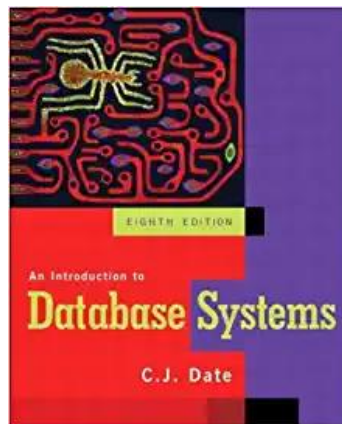
Disclaimer

Dependency theory is much wider, deeper and complex, than any quick video may ever cover.

Refer to these (or any other) books for more information.
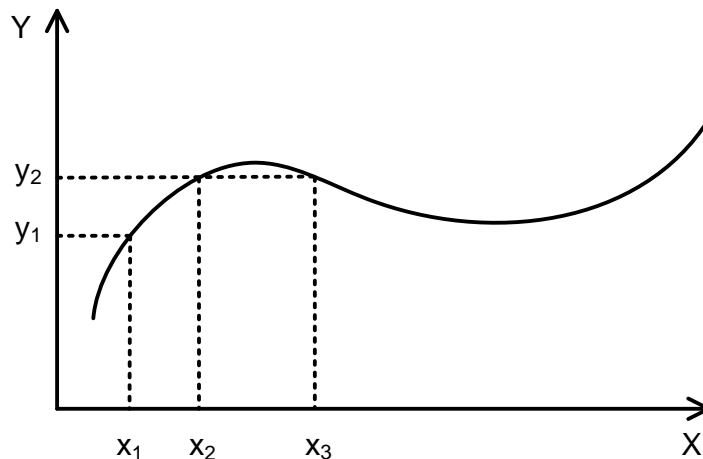
Before we begin…

Most normal forms are based on some dependencies, so we absolutely have to study those dependencies prior to normal forms.

Important! Each and every dependency existence depends on subject matter ONLY. I.e. if subject matter rules change, any dependency may appear or disappear in any relation (without any changes being made to the relation itself).

Dependencies for the 0NF and 1NF

There are none ☺. Later we'll see that 0NF and 1NF do not rely on any dependency.

Functional dependency ({X} → {Y}) – if two or more tuples have the same values in X fields, they have to have the same values in Y fields.

Functional dependency exists	**Functional dependency does not exist**
{Passport} → {Full name}	{Passport} → {Full name}
{Employee ID} → {Work experience}	{Employee ID} → {Work experience}
{Student, Subject} → {Mark}	{Student, Subject} → {Mark}

Once again! Each and every dependency existence depends on subject matter ONLY.

Read and remember!

Full functional dependency ({X} → {Y}) – if removal of any attribute A from X means that the dependency does not hold any more.

Partial functional dependency ({X} → {Y}) – if some attribute A can be removed from X and the dependency still holds.

Dependencies for the 2NF: full and partial functional dependency

result

r_student_id	r_subject_id	r_mark
1731	43	10
1731	42	10
1414	43	10
3443	42	10

Here we have full functional dependency:
{r_student_id, r_subject_id} → {r_mark}

{r_student_id, r_subject_id} → {r_mark}

{r_student_id, **?**} → {**?**}

{**?**, r_subject_id} → {?}

Dependencies for the 2NF: full and partial functional dependency

result

r_student_id	r_subject_id	r_mark	r_payment_id
1731	43	10	1
1731	42	10	1
1414	43	10	2
3443	42	10	1

Here we have full still functional dependency:
{r_student_id, r_subject_id} → **{r_mark}**, and also
partial functional dependency:
{r_student_id, ~~r_subject_id~~} → **{r_payment_id}**.

{r_student_id, r_subject_id} → {r_mark}

{r_student_id, **?**} → {r_payment_id}

Dependencies for the 2NF: just a quick overview

FD – for one X value there is exactly one Y value	$X\{A_1, A_2, ..., A_n\} \rightarrow \{Y\}$
Full FD – all X attributes are needed to determine Y value	$X\{A_1, A_2, ..., A_n\} \rightarrow \{Y\}$
Partial FD – some X attributes are NOT needed to determine Y value	$X\{A_1, \cancel{A_2}, ..., A_n\} \rightarrow \{Y\}$

Dependencies for the 3NF and BCNF

Read and remember!

Transitive dependency ({X} → {Y} → {Z}) – a chain of functional dependencies {X} → {Y} and {Y} → {Z} (where {Y} is neither a candidate key, nor a subset of any key).

Redundant transitive dependency ({X} → {Y} → {Z}) – a chain of functional dependencies {X} → {Y} and {Y} → {Z}, where a dependency {X} → {Z} exists.

Dependencies for the 3NF and BCNF: (redundant) transitive dependency

current_result

cr_student_id	cr_average_mark	cr_current_status
1731	8.34	Good
2352	9.99	The Best!
5632	1.23	Oh, my God… ☹
4534	6.45	Normal

{cr_student_id} → {cr_average_mark} → {cr_current_status}

Here we have transitive dependency: **{cr_student_id}** → **{cr_average_mark}** → **{cr_current_status}**

Dependencies for the 3NF and BCNF: (redundant) transitive dependency

access_control

ac_student_id	ac_pass_id	ac_student_name
1731	34523	Ivanov I.I.
2352	46362	Petrov P.P.
5632	45346	Sidorov S.S.
4534	56745	Sidorov S.S.

{ac_student_id} → {ac_pass_id} → {ac_student_name}

{ac_student_id} → {ac_student_name}

Here we have redundant transitive dependency: **{ac_student_id} → {ac_pass_id} → {ac_student_name}**

Dependencies for the 3NF and BCNF

Read and remember!

Trivial functional dependency ({X} ➔ {Y}) – a functional dependency {X} ➔ {Y}, where X ⊇ Y (i.e. Y is a part of X). Such a dependency always holds.

Nontrivial functional dependency ({X} ➔ {Y}) – a functional dependency {X} ➔ {Y}, where X ⊉ Y (i.e. Y is NOT a part of X). Such a dependency may be violated.

Dependencies for the 3NF and BCNF: (non)trivial functional dependency

result

r_student_id	r_subject_id	r_mark
1731	43	10
1731	42	10
1414	43	10
3443	42	10

{r_student_id, r_subject_id} → {r_student_id}	Trivial
{r_student_id, r_subject_id} → {r_subject_id}	Trivial
{r_student_id, r_subject_id} → {r_mark}	Nontrivial

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