A note on the ER-to-relational mapping: the case of one-to-one relationships

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The mapping of one-to-one relationships

We have to distinguish among 3 different cases:

- $E1(\mathbf{PK1}, A1) - (1,1) - R(A) - (0,1) - E2(\mathbf{PK2}, A2)$

  where $PK1$ is the key of entity $E1$, $A1$ is an attribute of $E1$, A is an attribute of relationship R, $PK2$ is the key of entity $E2$, and $A2$ is an attribute of $E2$

  (the case

  $E1(\mathbf{PK1}, A1) - (0,1) - R(A) - (1,1) - E2(\mathbf{PK2}, A2)$

  is completely symmetric, and thus ignored)

- $E1(\mathbf{PK1}, A1) - (0,1) - R(A) - (0,1) - E2(\mathbf{PK2}, A2)$

- $E1(\mathbf{PK1}, A1) - (1,1) - R(A) - (1,1) - E2(\mathbf{PK2}, A2)$

The case of $(1,1)$ – $(0,1)$ relationships

How can we map the following ER schema into a corresponding relational one (introducing no redundancy, and preserving as much as possible information/constraints)?

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Relational schema:

$E1(\underline{PK1}, A1, PK2, A)$ and $E2(\underline{PK2}, A2)$, where $PK2$ is a foreign key of relation $E1$ that refers to the primary key $PK2$ of relation $E2$.

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- $(1, \_)$ on $E1$ side: $PK2$ NOT NULL in $E1$
- $(\_, 1)$ on $E1$ side: $PK1$ is the primary key
- $(0, \_)$ on $E2$ side: $PK2$ foreign key in $E1$ referring to the primary key of $E2$
- $(\_, 1)$ on $E2$ side: $PK2$ UNIQUE in $E1$

The case of $(0,1)$ – $(0,1)$ relationships

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The case of $(0,1)$ – $(0,1)$ relationships

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- $(0, \_)$ on $E1$ side: $PK2$ **can be NULL in** $E1$
- $(\_, 1)$ on $E1$ side: $PK1$ is the primary key
- $(0, \_)$ on $E2$ side: $PK2$ foreign key in $E1$ referring to the primary key of $E2$
- $(\_, 1)$ on $E2$ side: $PK2$ UNIQUE in $E1$

$E1(\underline{PK1}, A1)$ and $E2(\underline{PK2}, A2, PK1, A)$, where $PK1$ is a foreign key of relation $E2$ that refers to the primary key $PK1$ of relation $E1$, works as well.

The case of $(0,1)$ – $(0,1)$ relationships (contn'd)

How do we choose between the two options? Participation of entities in the relationship can be a criterion.

In case the partecipation of both entities in the relationship is very low, a third option is possible

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Relational schema:

$E1(\underline{PK1}, A1)$, $E2(\underline{PK2}, A2)$, and $R(\underline{PK1}, PK2, A)$ (or $R(PK1, \underline{PK2}, A)$), where $PK1$ is a foreign key of relation R that refers to the primary key $PK1$ of relation $E1$ and $PK2$ is a foreign key of relation R that refers to the primary key $PK2$ of relation $E2$.

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- $(0, \_)$ on $E1$ side: $PK1$ foreign key in R referring to the primary key of $E1$
- $(\_, 1)$ on $E1$ side: $PK1$ is the primary key of R
- $(0, \_)$ on $E2$ side: $PK2$ foreign key in R referring to the primary key of $E2$
- $(\_, 1)$ on $E2$ side: $PK2$ UNIQUE in R

The case of $(1,1)$ – $(1,1)$ relationships

No one of the previous solutions works with

$E1(\mathbf{PK1}, A1)$ – $(1,1)$ – $R(A)$ – $(1,1)$ – $E2(\mathbf{PK2}, A2)$

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Relational schema:

$R(\underline{PK1}, A1, PK2, A2, A)$ (or $R(PK1, A1, \underline{PK2}, A2, A)$)

- $(1,\_)$ on $E1$ side: $PK2$ NOT NULL in R
- $(\_,1)$ on $E1$ side: $PK1$ is the primary key (UNIQUE)
- $(1,\_)$ on $E2$ side: $PK1$ is the primary key (NOT NULL)
- $(\_,1)$ on $E2$ side: $PK2$ UNIQUE in R

The case of one-to-many and many-to-many relationships

A similar analysis can be done for the cases of both one-to-many and many-to-many relationships

Such an analysis allows one to determine

- which constraints can be directly encoded in the relational schema, and
- which ones need to be explicitly forced.