



# Last Week × Q4Me

-2

Book vs. Slides

W04: CH02 (2<sup>nd</sup> Ed.), CH03 (1<sup>st</sup> Ed.)

Note-taker for the Course

[clockwork.ryerson.ca/ClockWork/user/notetakingnotetakers/Login.aspx](http://clockwork.ryerson.ca/ClockWork/user/notetakingnotetakers/Login.aspx)

Lab

?

Last Weeks

?

# Last Week × Q4U

-1

Weak entity set, identifying entity set & relationship set?

ISA, total vs. partial, overlapping vs. disjoint?

What is relation?

What is foreign key set?

Is foreign key set a key set?

# Last Week × Q4U

0

Weak entity set, identifying entity set & relationship set? W03a-8:17

ISA, total vs. partial, overlapping vs. disjoint? W03a-30:48

What is relation? W03b-7

What is foreign key set? W03b-29

Is foreign key set a key set? No!



Logical Level | Relational Data Model



# Today

2



Data Modeling  
in  
RDBMS

Real World Entity

Conceptual Level | Entity-Relationship Model (E/R)

| Logical Level | Relational Model

| Physical Level | SQL

Computable Entity

# Data Modeling × Logical Level

3

1. How entities, attributes, relationships should be represented.
2. Update Schema

# Data Modeling × Logical Level

4

There are other representations as well.

There are other logical models as well.

There are other data models at logical level as well.

~1960: Object Oriented

1969: Relational: Mathematical Relation

1996: XML



# Relational

5

Edgar Frank “Ted” Codd, IBM, 1969, 1970

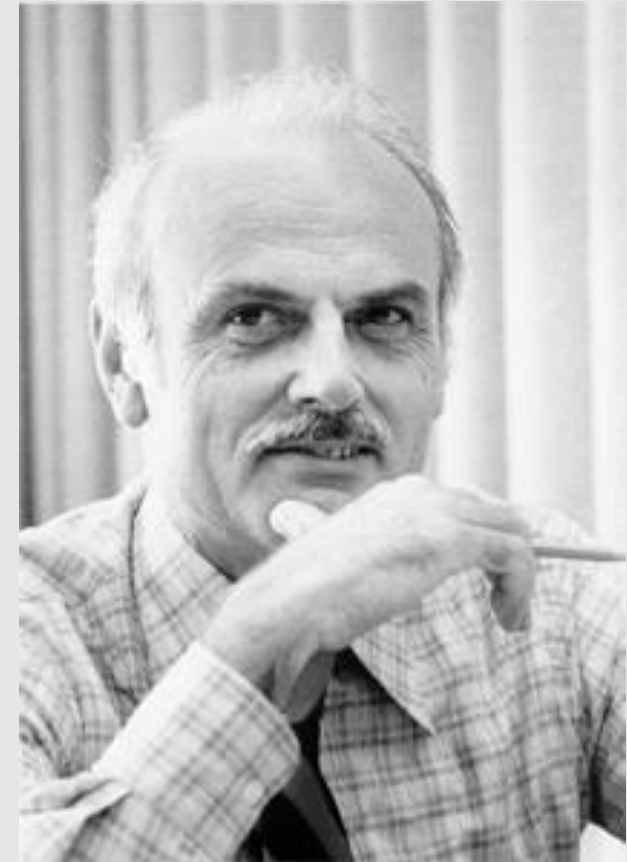
## ***Information Retrieval***

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## **A Relational Model of Data for Large Shared Data Banks**

E. F. Codd

*IBM Research Laboratory, San Jose, California*



# Relational

6

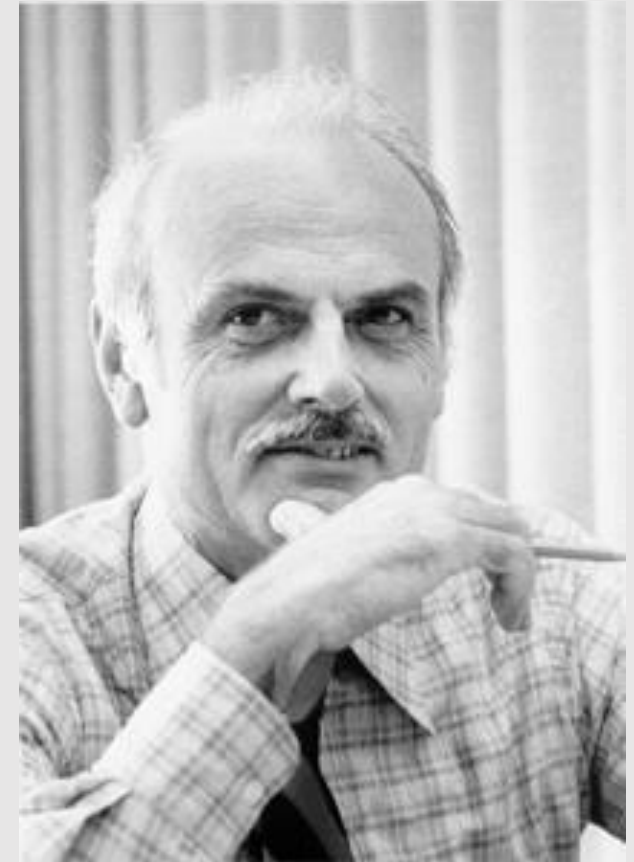
Data instance is represented in terms of Tuple  
Tuples are grouped in Relation

Data Definition Language (DDL)

Data Manipulation Language (DML)

→ Relational Algebra

Solid Mathematical Model



# Relational × Relation (R)

7

Two dimensional table, e.g., Movie Relation

Schema	<u>Title</u>	Language	RunningTime
Tuple 1	<i>2001: A Space Odyssey</i>	<i>English</i>	<i>142</i>
Tuple 2	<i>Rosemary's Baby</i>	<i>English</i>	<i>136</i>
Tuple 3	<i>The Birds</i>	<i>English</i>	<i>119</i>
...	...	...	...

Informally: Relation	Table
Tuple	Row
Attribute	Column

# Relational × Relation (R)

8

Everything is Relation (Table)

# Entity & Relationship 2 Relation

9



Data Modeling  
in  
RDBMS

Real World Entity

Conceptual Level | Entity & Relationship

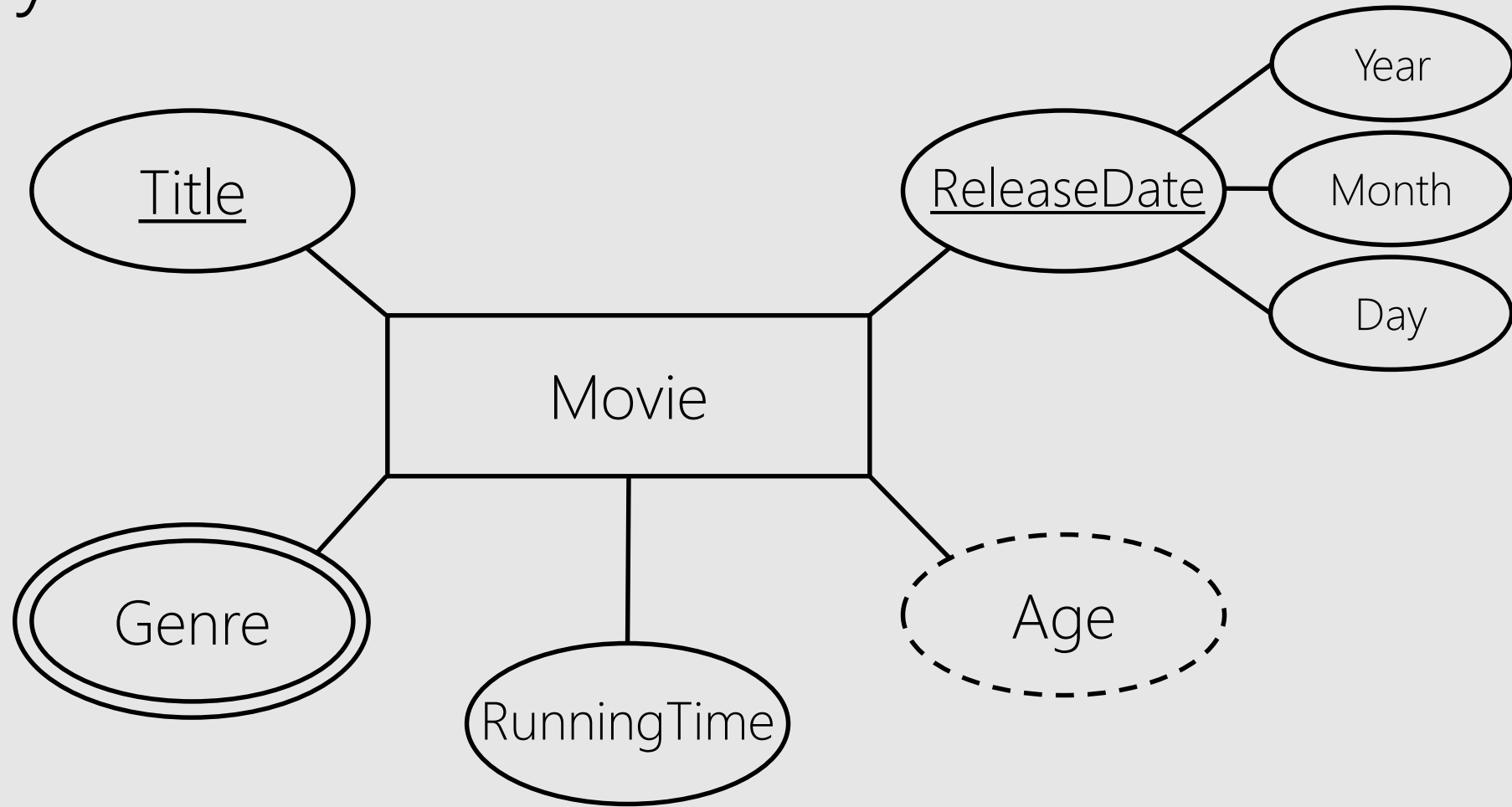
| Logical Level | Relation (Table)

| Physical Level | SQL

Computable Entity

# Entity2Relation

10



# Entity2Relation (E2R)

11

$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

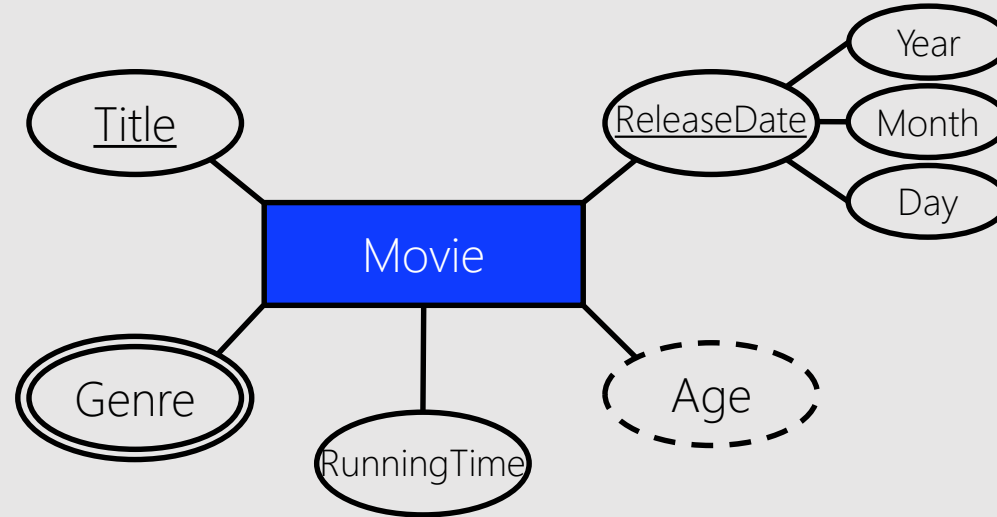
$R_2$ : Genre(Title)

$R_3$ : MovieGenre(Movie.Title, Movie.ReleaseYear, Movie.ReleaseMonth, Movie.ReleaseDay, Genre.Title)



# E2R × Entity Set

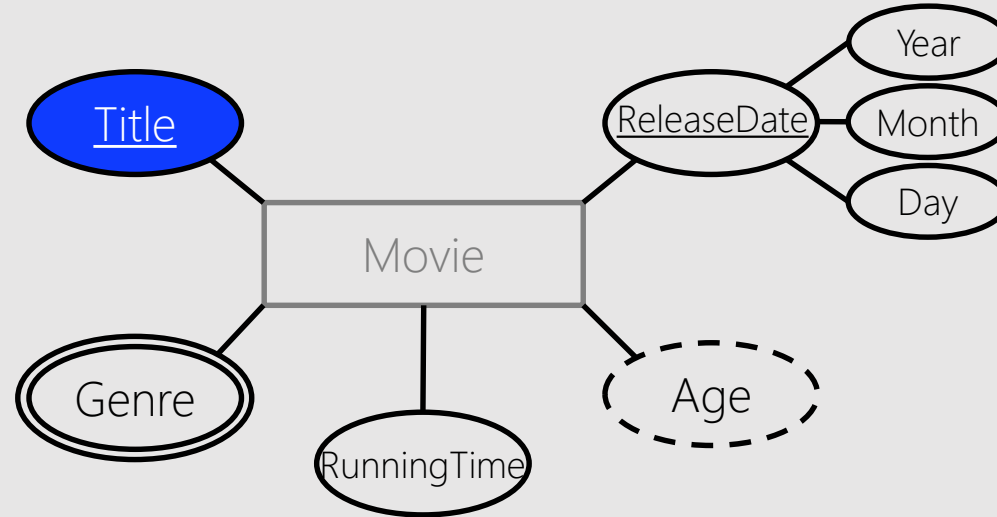
12



$R_1$ : Movie()

# E2R × Entity Set × Attribute

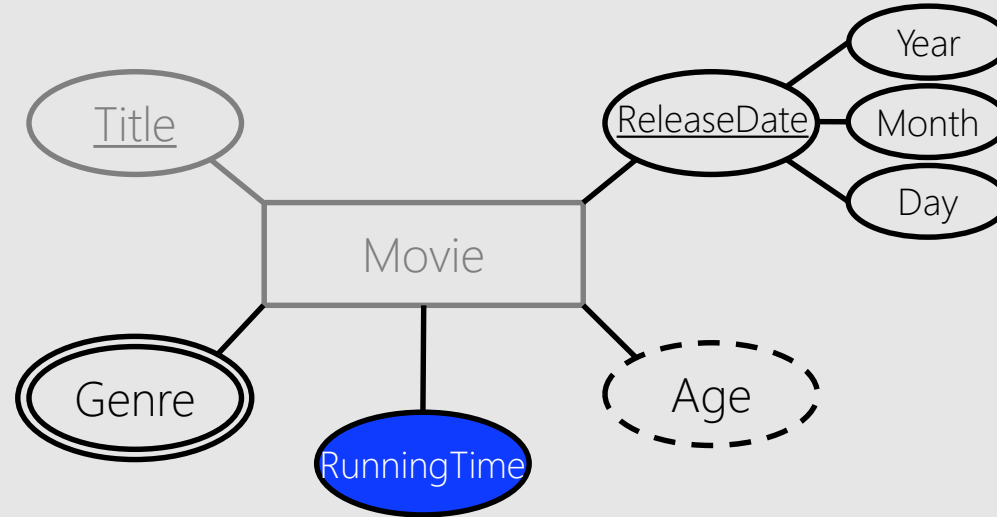
13



$R_1$ : Movie(Title)

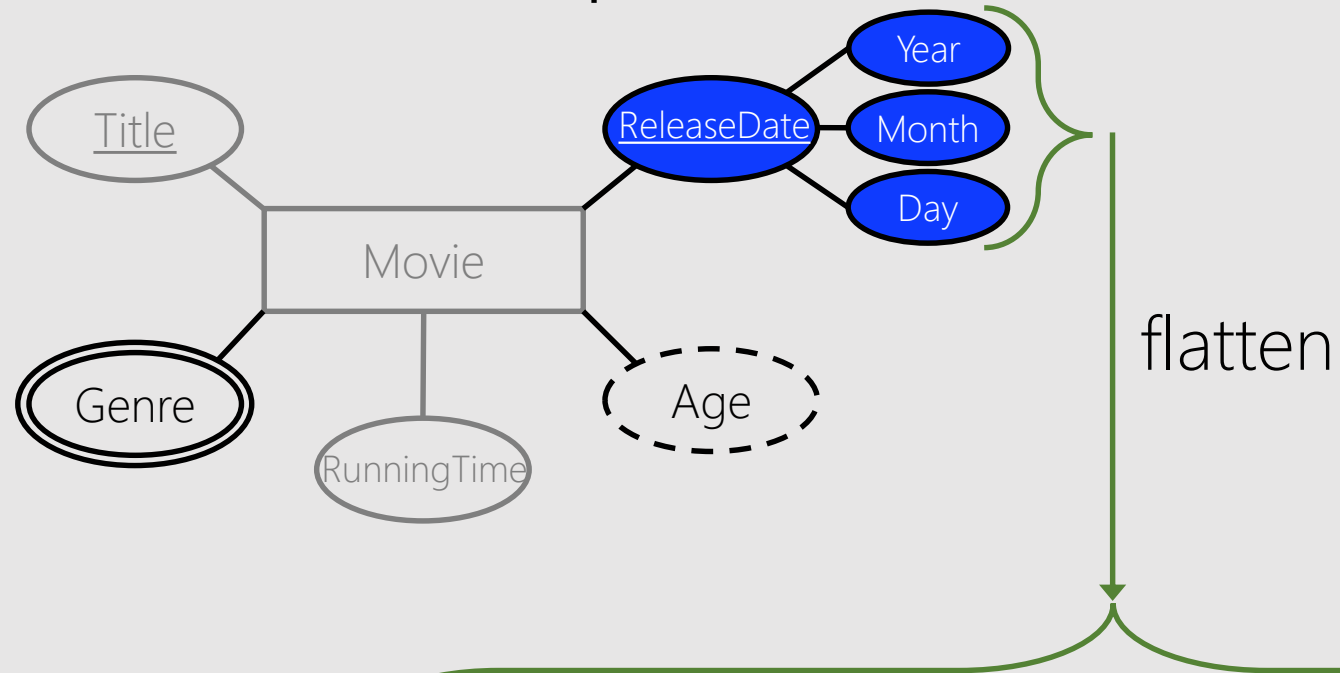
# E2R × Entity Set × Attribute

14



$R_1$ : Movie(Title, RunningTime)

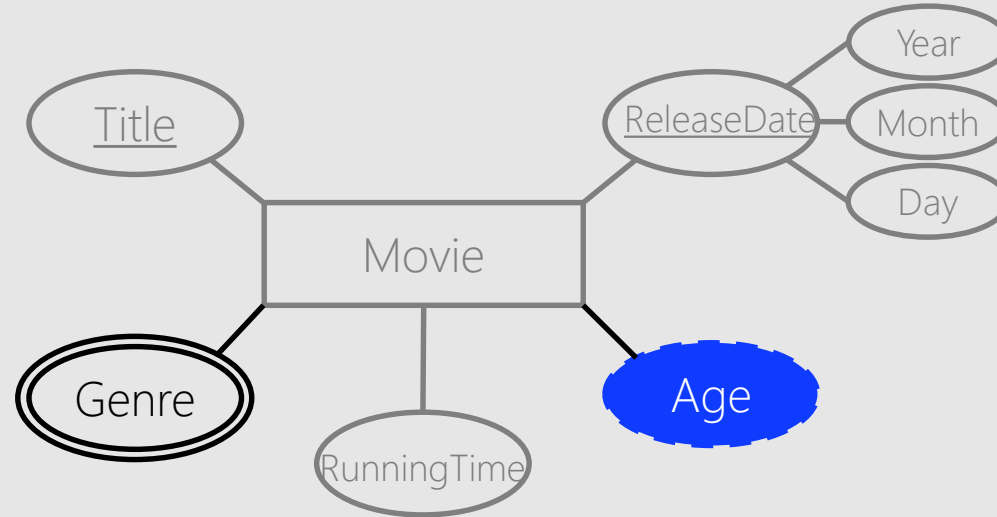
# E2R × Entity Set × Composite Attribute 15



$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay)

# E2R × Entity Set × Derived Attribute

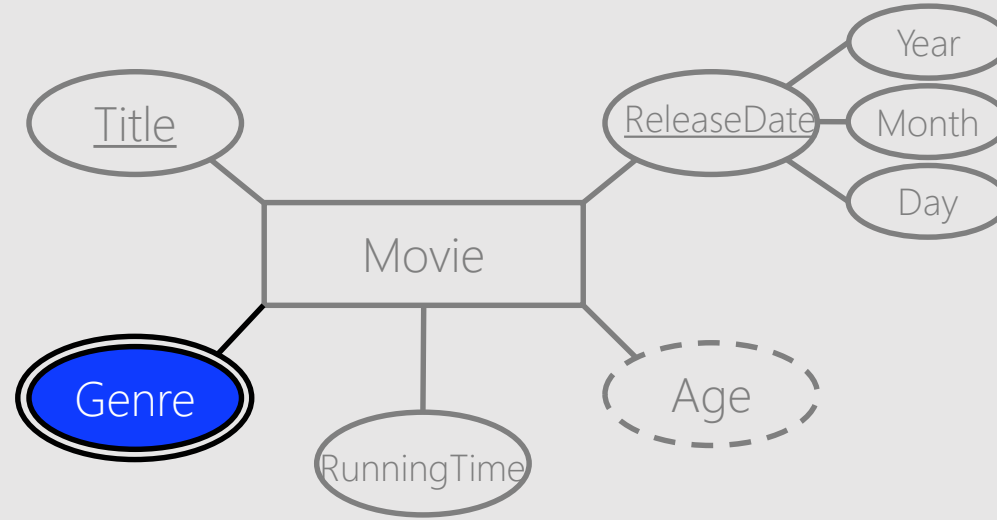
16



$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

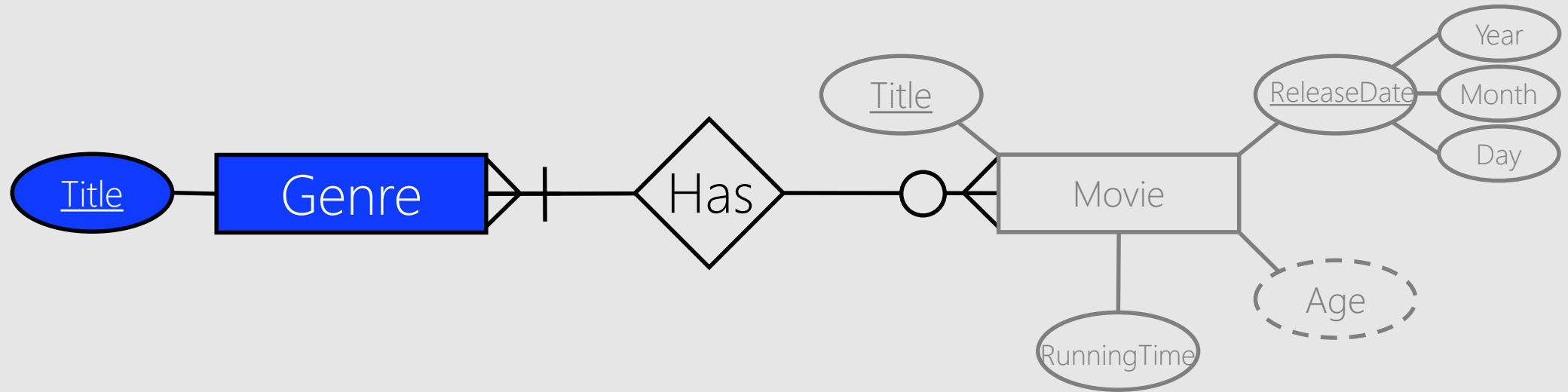
# E2R × Entity Set × Multivalued Attribute 17

Relational model  
does not allow  
multivalued  
attributes!



$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

# E2R × Entity Set × Multivalued Attribute 18

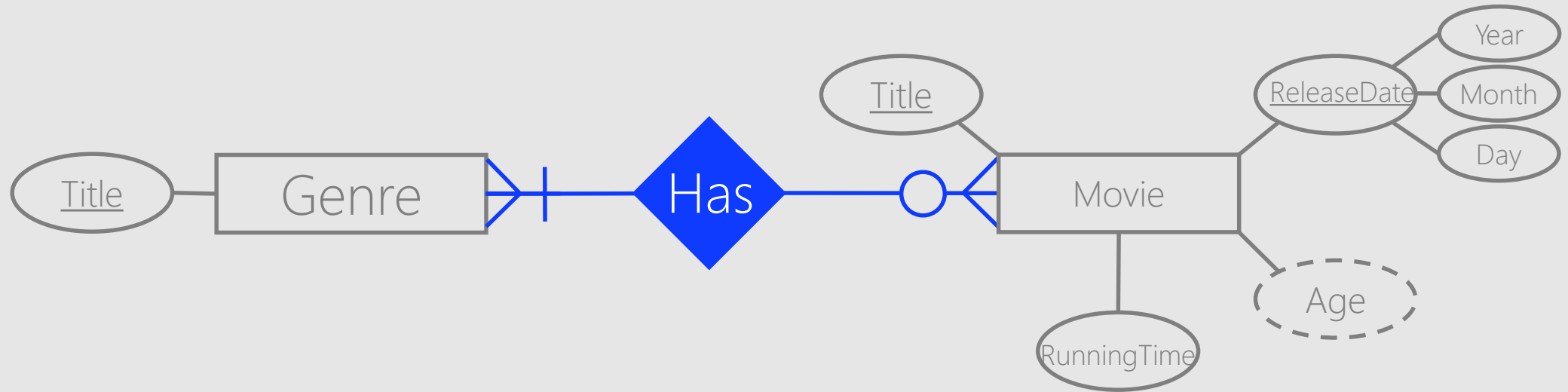


$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

$R_2$ : Genre(Title)



# E2R × Entity Set × Multivalued Attribute 19

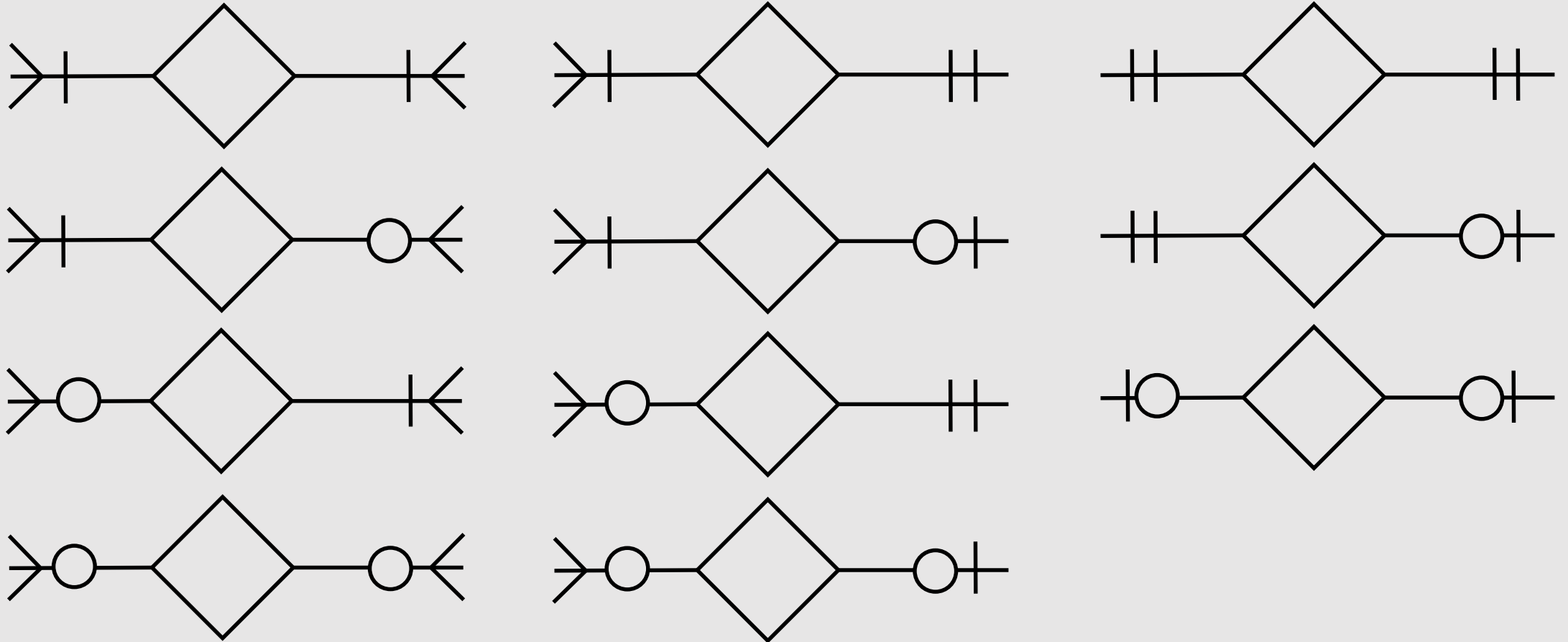


$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

$R_2$ : Genre(Title)

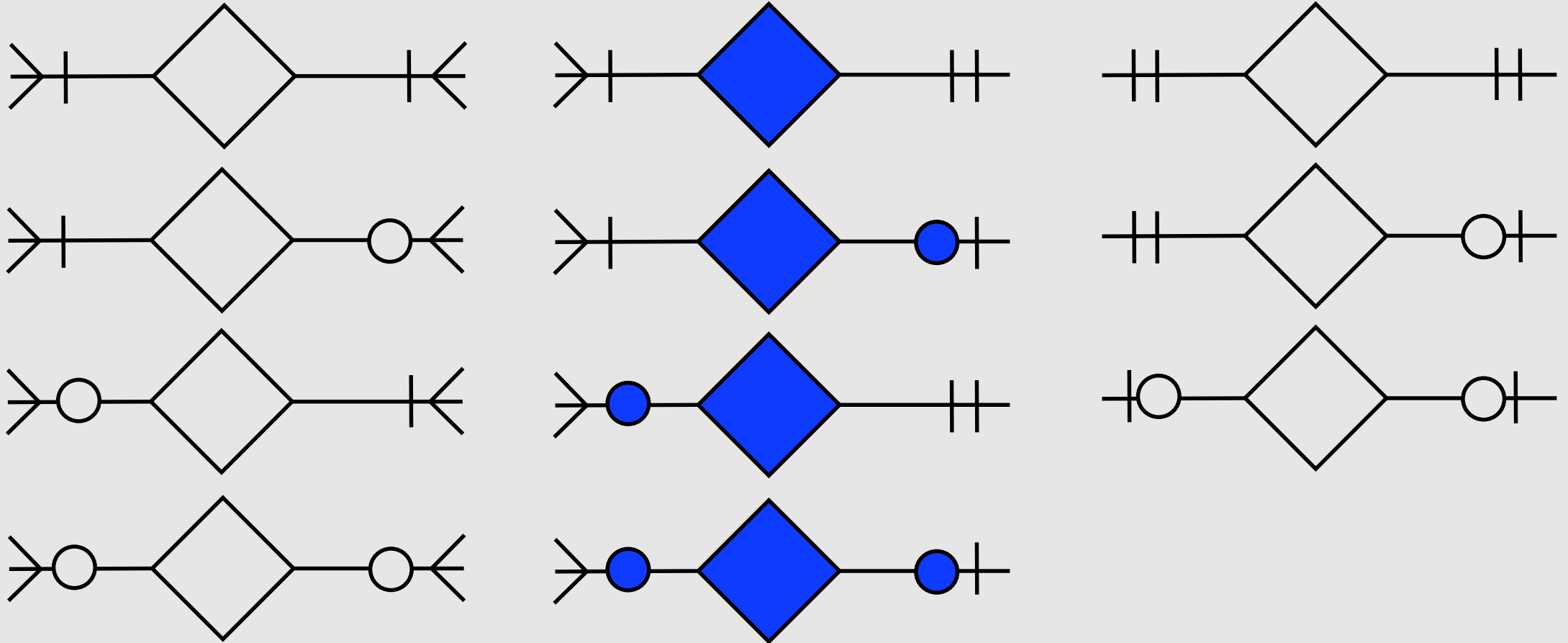
# Relationship2Relation (R2R)

20



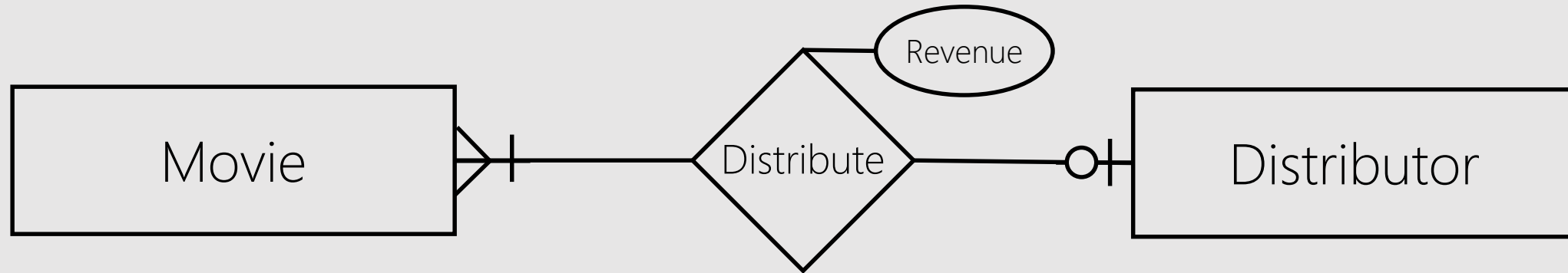
# Relationship2Relation (R2R)

21



# R2R × Many-One (One-Many)

22



$m_1$

$m_2, d_3, \$20M$

$d_1$

$m_2$

~~$m_2, d_1, \$28M$~~   
 ~~$m_2, d_1, \$20M$~~

$d_2$

$m_3$

$m_3, d_3, \$35M$

$d_3$

$m_4$

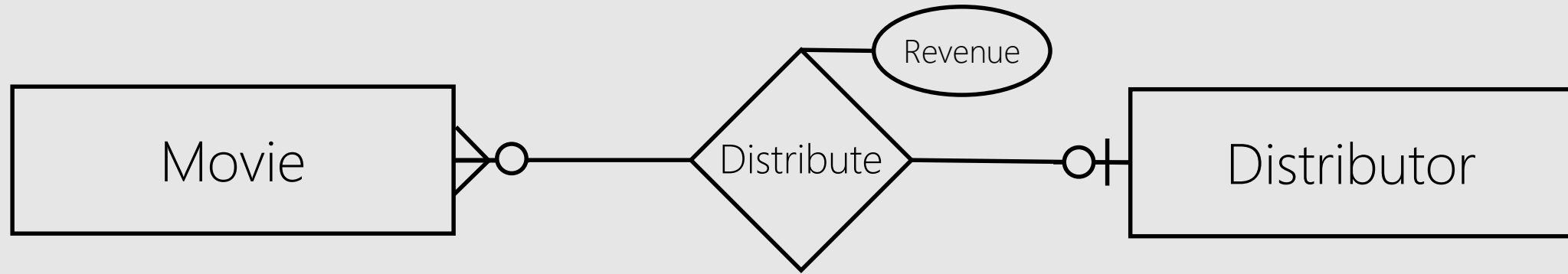
$m_4, d_2, \$27M$

$m_5$

$m_5, d_1, \$13M$

# R2R × Many-One (One-Many)

23



$m_1$

$m_2$

$m_3$

$m_4$

$m_5$

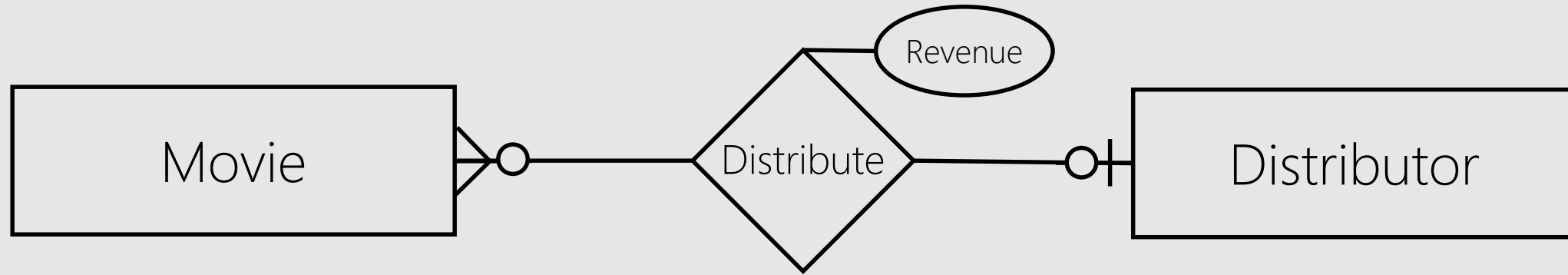
$d_1, m_5, \$13M$

$d_2, m_4, \$27M$

$d_3, m_2, \$20M, m_3, \$35M$

# R2R × Many-One (One-Many)

24



NULL, NULL,  $m_1$

$d_3$ , \$20M,  $m_2$

$d_3$ , \$35M,  $m_3$

$d_2$ , \$27M,  $m_4$

$d_1$ , \$13M,  $m_5$

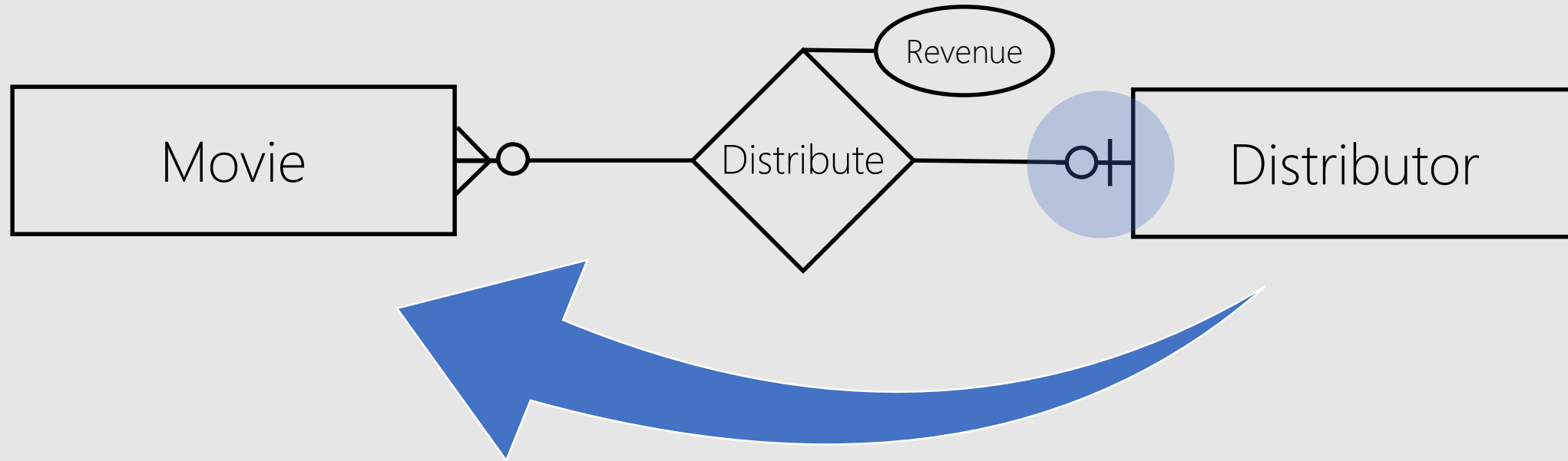
$d_1$

$d_2$

$d_3$

# R2R × Many-One (One-Many)

25

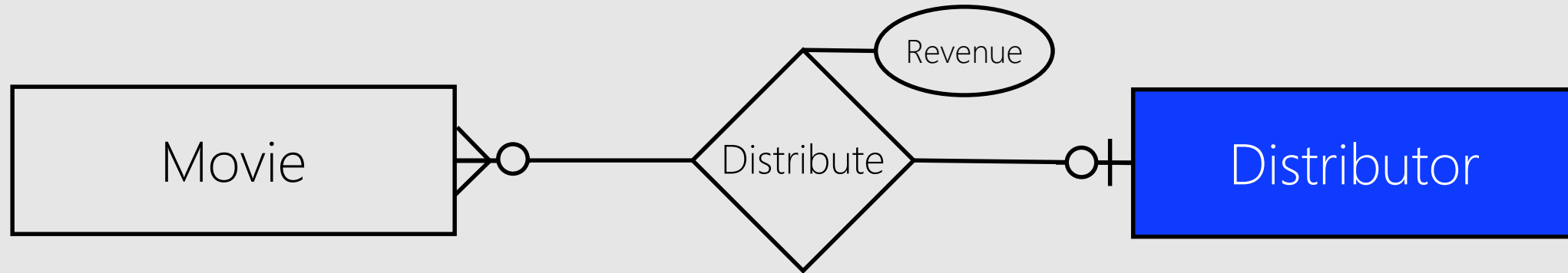


Everything goes to entity set with cardinality one (i.e., many side)  
Because it only needs to store one entity from other entity set



# R2R × Many-One (One-Many)

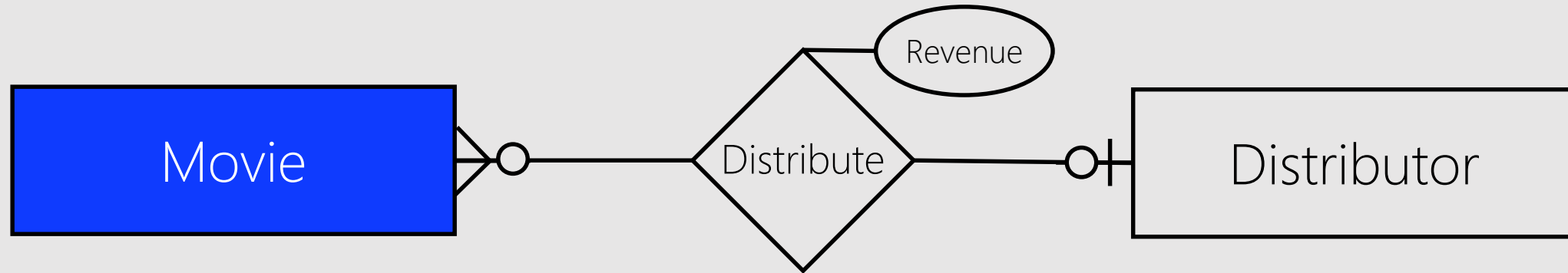
26



$R_1$ : Distributor(Name, Address, POBox, Website, ...)

# R2R × Many-One (One-Many)

27

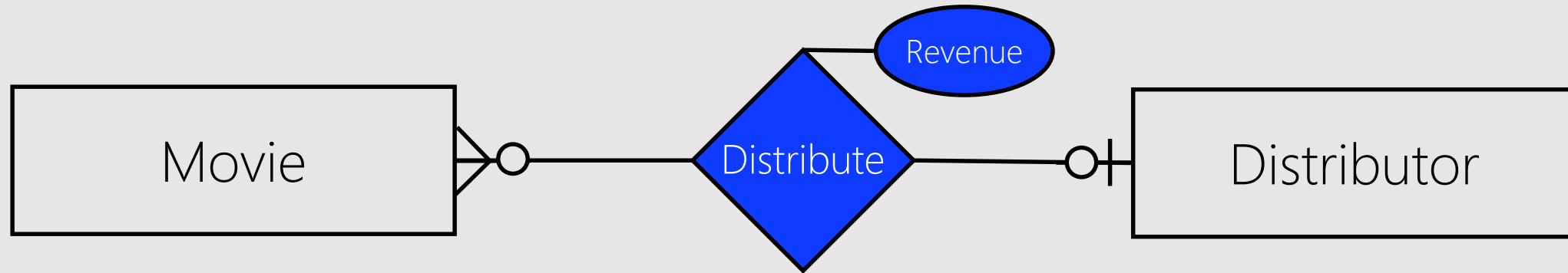


$R_1$ : Distributor(Name, Address, POBox, Website, ...)

$R_2$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age)

# R2R × Many-One (One-Many)

28



$R_1$ : Distributor(Name, Address, POBox, Website, ...)

$R_2$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age, ...  
Distributor.Name, Revenue)

# R2R × Many-One (One-Many)

29

R<sub>1</sub>: Distributor(Name, Address, POBox, Website, ...)

R<sub>2</sub>: Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age, ...)

Distributor.Name, Revenue)

Primary Key (PK) from other relation: Foreign Key (FK)

# R2R × Many-One (One-Many)

30

R<sub>1</sub>: Distributor(Name, Address, POBox, Website, ...)

R<sub>2</sub>: Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age, ...)

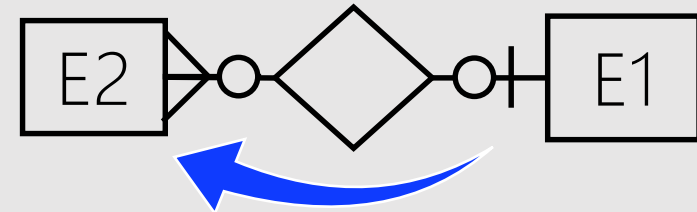
Distributor.Name, Revenue)

must be optional (Why?)

# R2R × Many-One (One-Many)

31

Input: Many-One relationship btw. E2 and E1, i.e.,  
Output: Relations R1 for E1 and R2 for E2.

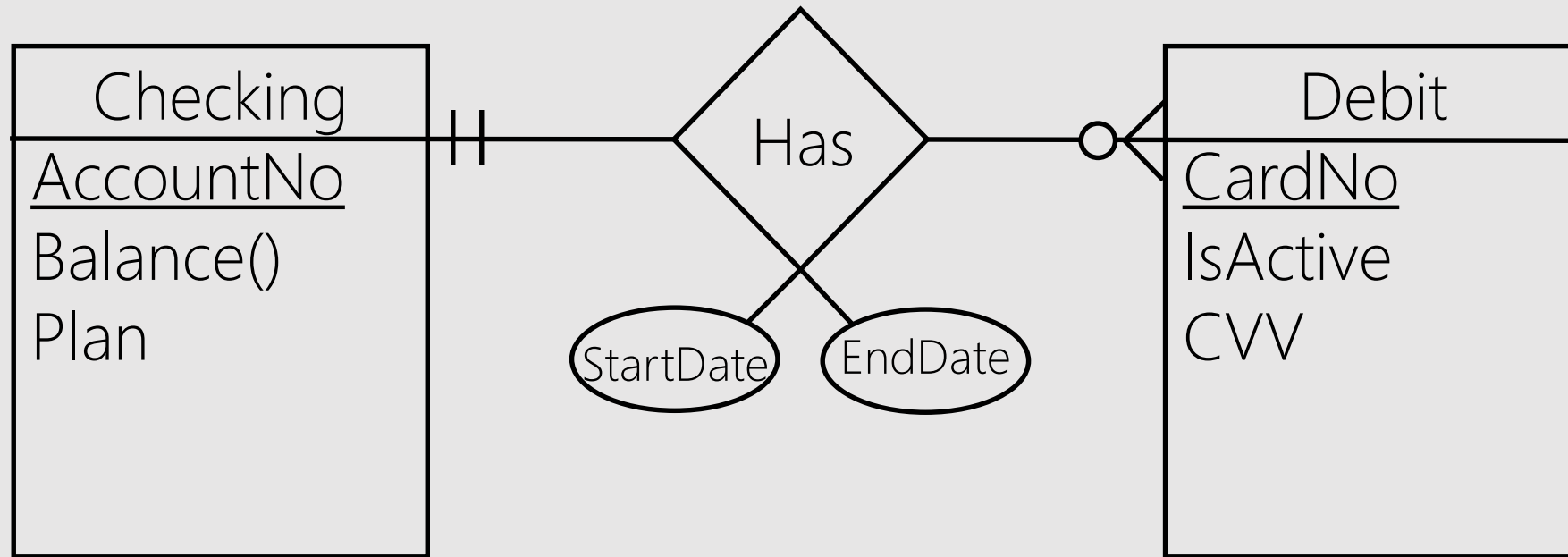


- 1) For E1, create relation R1 with the same attributes and keys as in E1
- 2) For E2, create relation R2 with the same attributes and keys as in E2
- 3) **[Foreign Key Set]** Add key set of E1 to R2
- 4) Add attributes of relationship set to R2
- 5) If E2 ordinality is optional then make foreign key set optional  
else make foreign key set mandatory

Here, we do not care about E1's ordinality! Later we fix it.

# R2R × Many-One × Banking

32





# R2R × Many-One × Banking

33

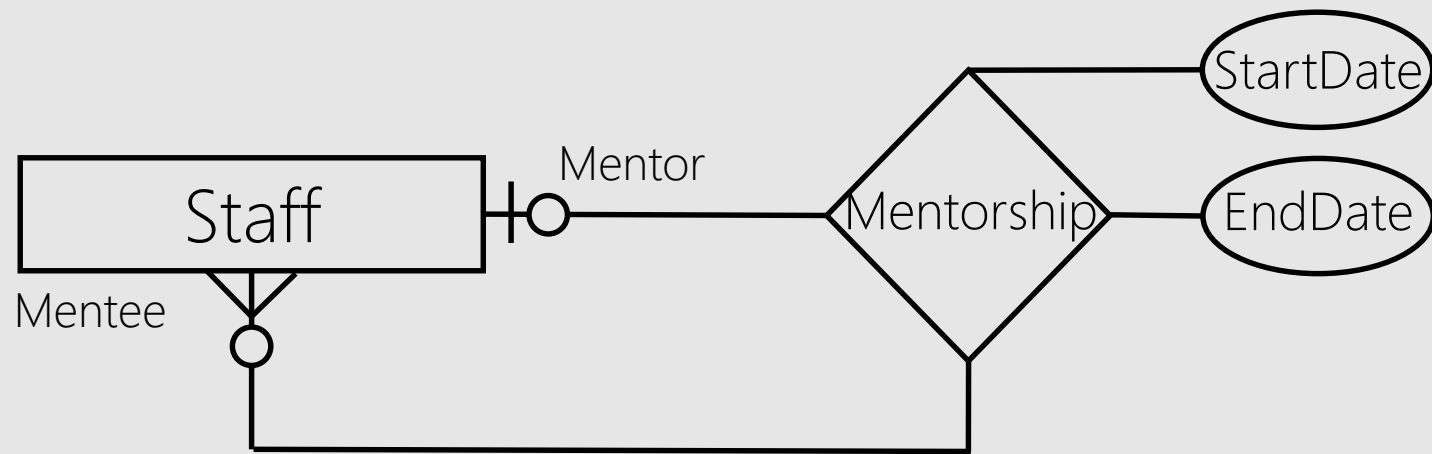
Checking(AccountNo, Balance, Plan)

Debit(CardNo, IsActive, CVV, Checking.AccountNo, StartDate, EndDate)

must be mandatory!

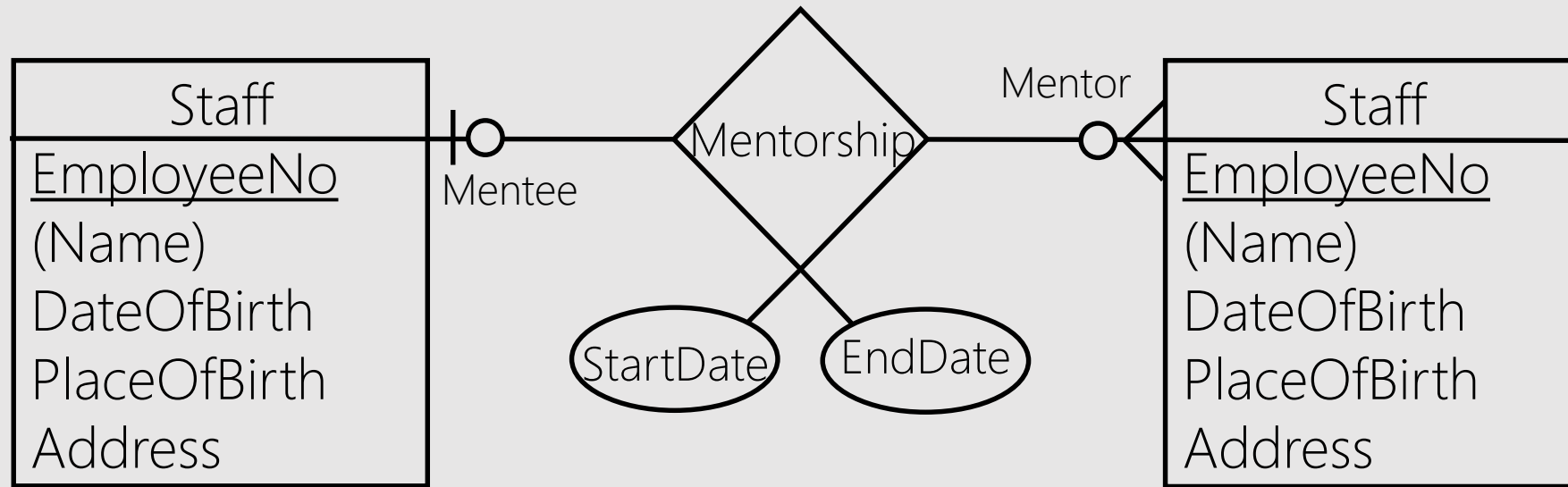
# R2R × Many-One × Self (Unary)

34



# R2R × Many-One × Self (Unary)

35

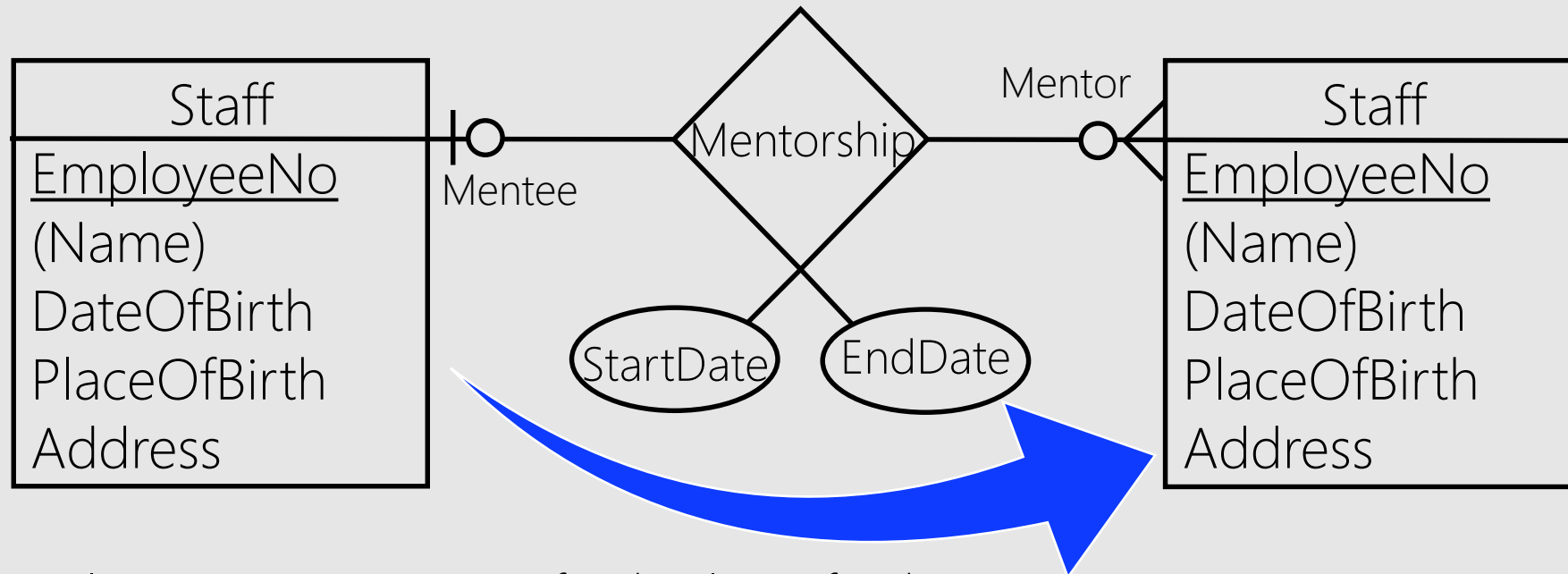


Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)

Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)

# R2R × Many-One × Self (Unary)

36



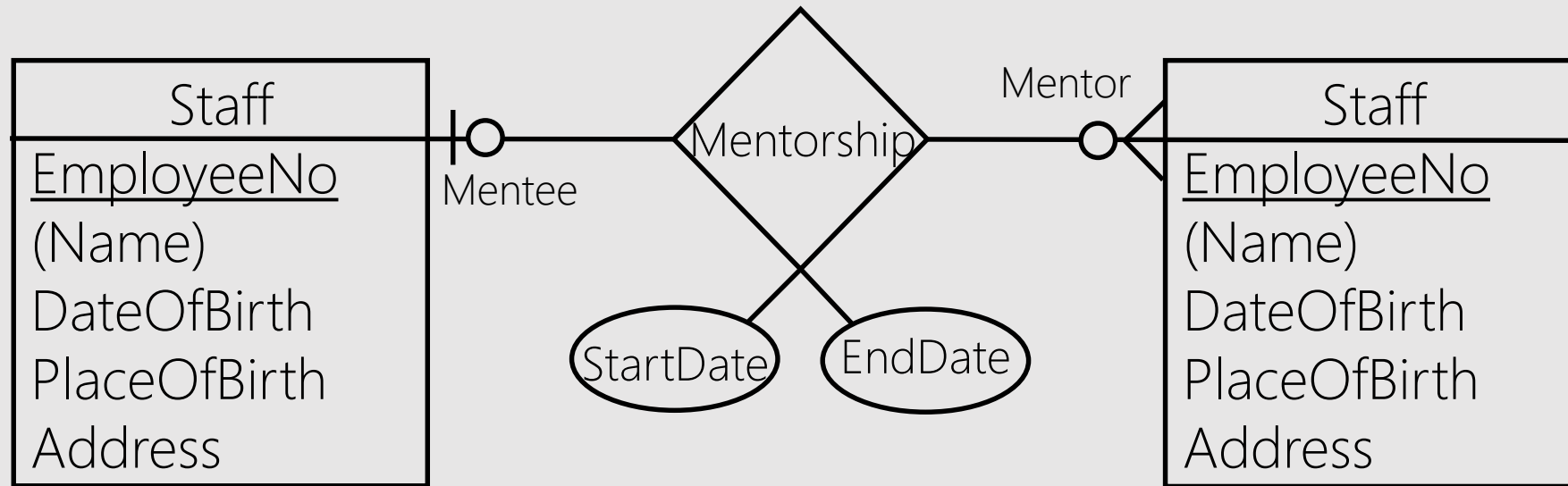
Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)

Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth, EmployeeNo, StartDate, EndDate)

FK

# R2R × Many-One × Self (Unary)

37



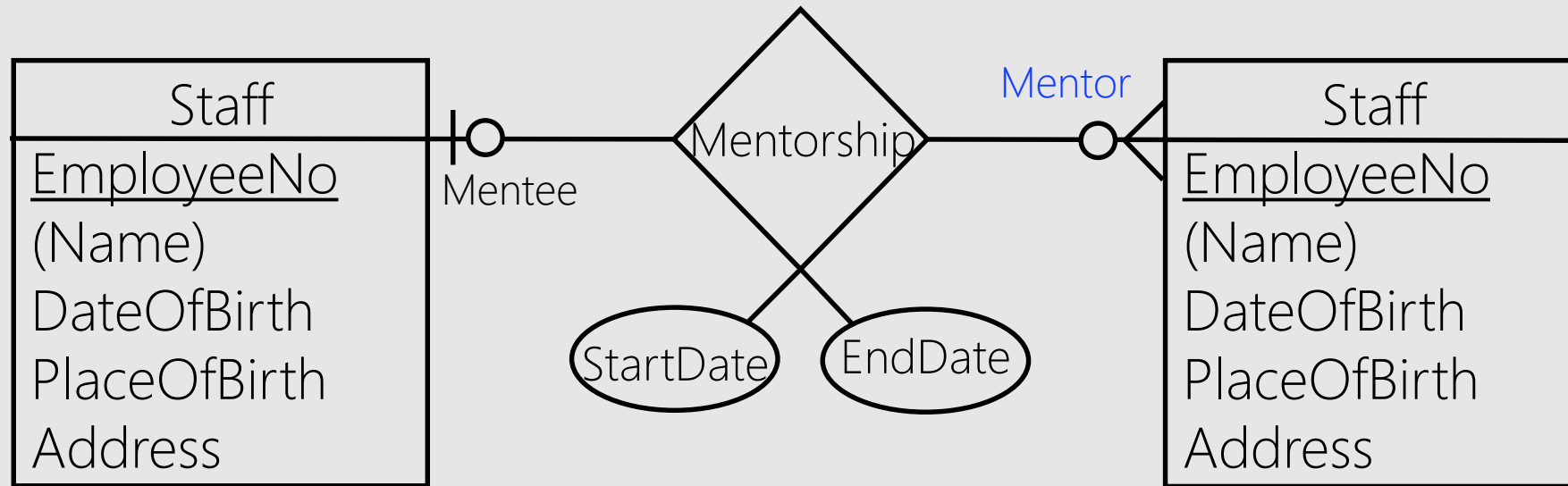
Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)

Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth, EmployeeNo, StartDate, EndDate)

Name conflict!

# R2R × Many-One × Self (Unary)

38



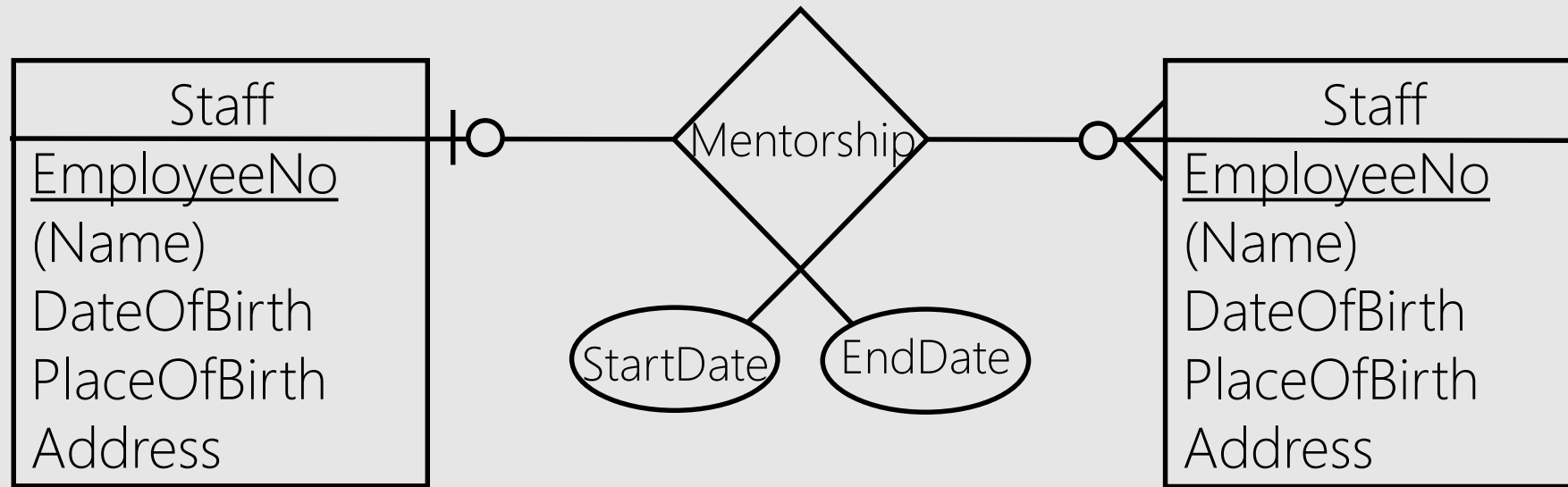
Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)

Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth, MentorNo, StartDate, EndDate)

By convention, change attribute name to the role

# R2R × Many-One × Self (Unary)

39



Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)

Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth, MentorNo, StartDate, EndDate)

must be optional!

R2R × Many-One × Self (Unary)

40

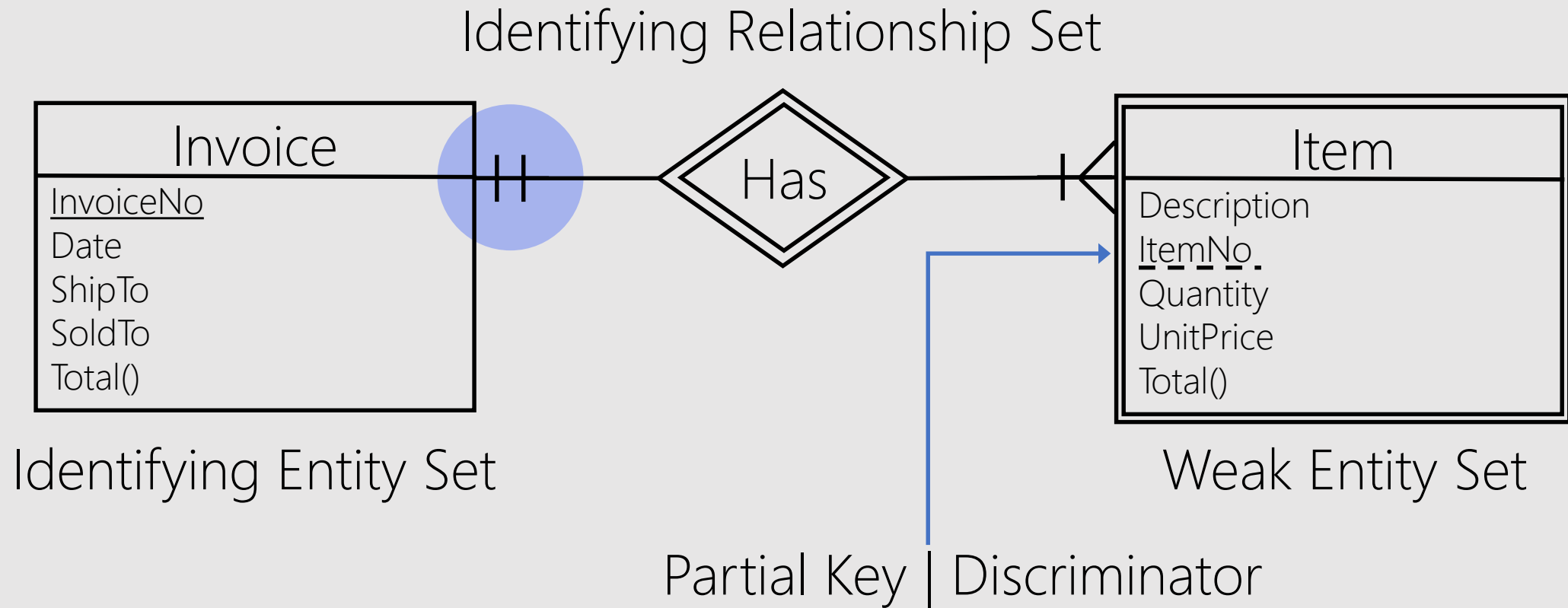
~~Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth)~~

Staff(EmployeeNo, Name, DateOfBirth, PlaceOfBirth, MentorNo, StartDate, EndDate)



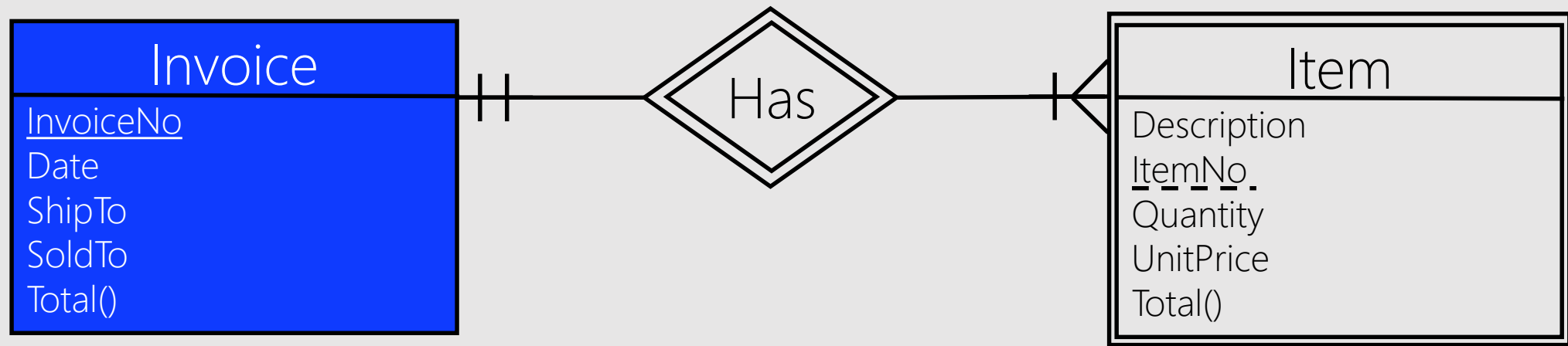
# R2R × Many-One × Weak Entity Set

41



# R2R × Many-One × Weak Entity Set

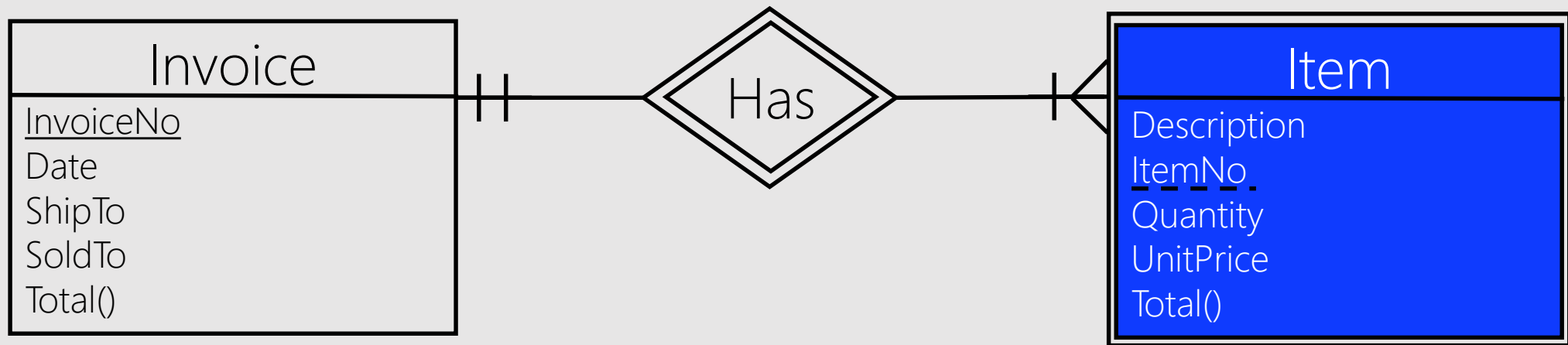
42



Invoice(InvoiceNo, Date, ShipTo, SoldTo, Total)

# R2R × Many-One × Weak Entity Set

43

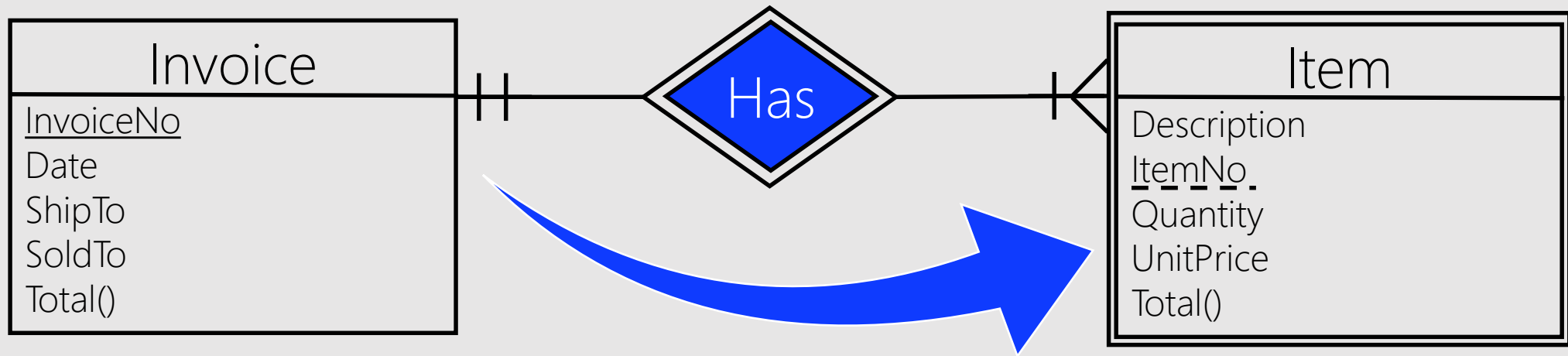


Invoice(InvoiceNo, Date, ShipTo, SoldTo, Total)

Item(ItemNo, Description, Quantity, UnitPrice, Total)

# R2R × Many-One × Weak Entity Set

44



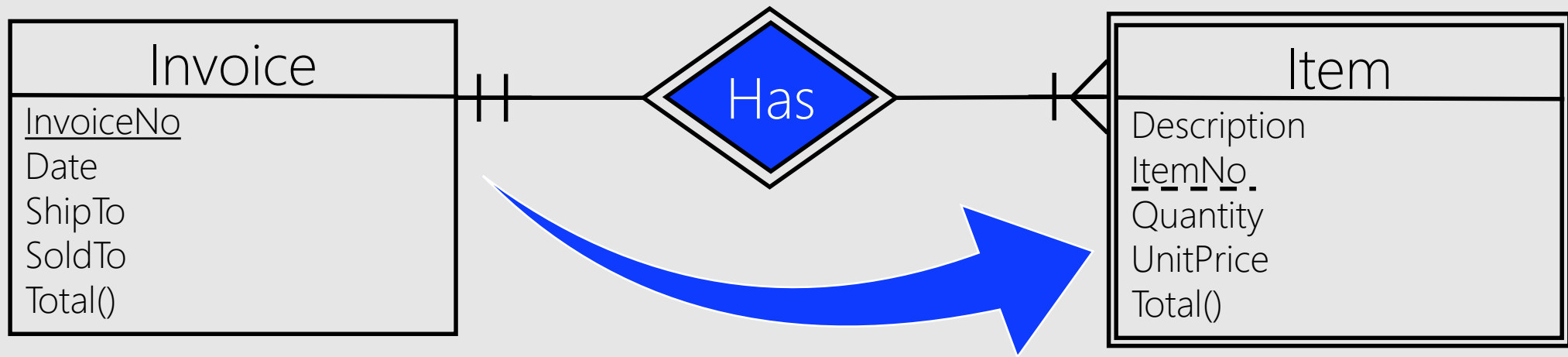
Invoice(InvoiceNo, Date, ShipTo, SoldTo, Total)

Item(ItemNo, Description, Quantity, UnitPrice, Total, InvoiceNo)

Foreign Key

# R2R × Many-One × Weak Entity Set

45



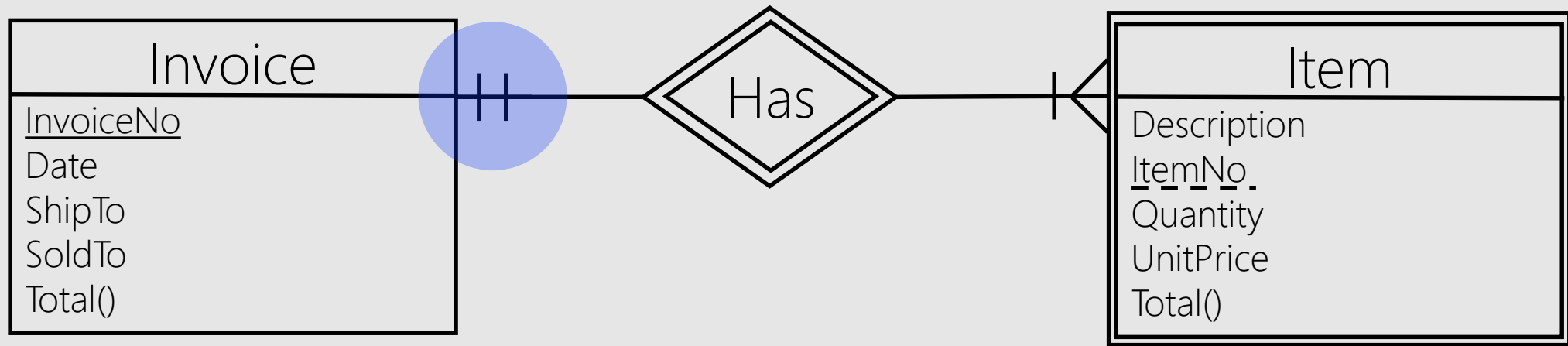
Invoice(InvoiceNo, Date, ShipTo, SoldTo, Total)

Item(ItemNo, Description, Quantity, UnitPrice, Total, InvoiceNo)

Primary Key = {partial key set} U {primary key set of identifying entity set}

# R2R × Many-One × Weak Entity Set

46



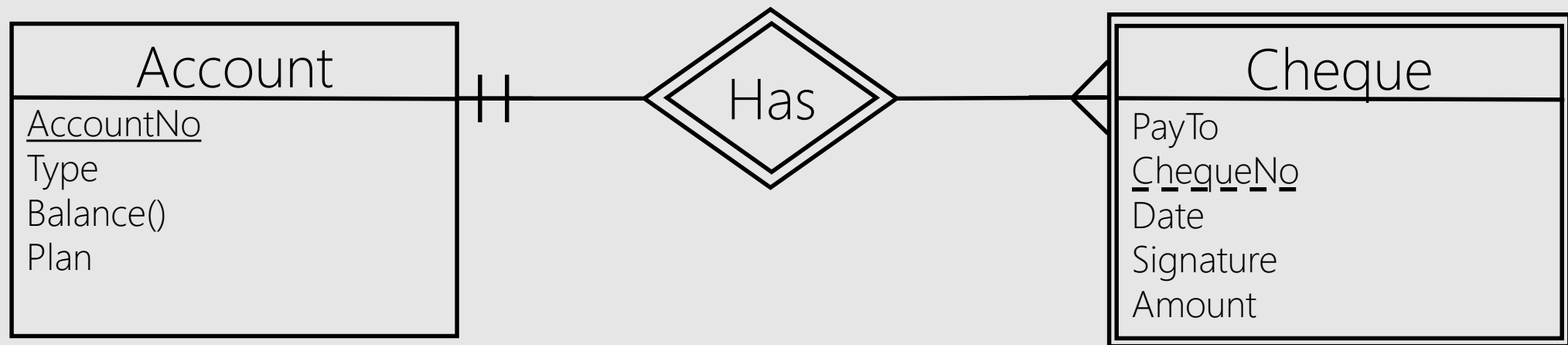
Invoice(InvoiceNo, Date, ShipTo, SoldTo, Total)

Item(InvoiceNo, ItemNo, Description, Quantity, UnitPrice, Total)

Already mandatory. (Why?)

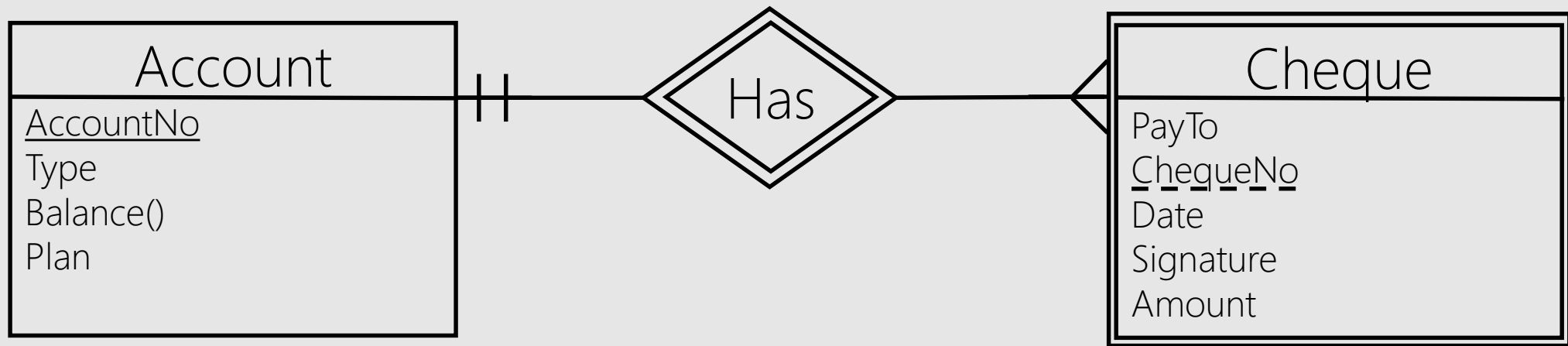
# R2R × Many-One × Weak Entity Set

47



# R2R × Many-One × Weak Entity Set

48



Account(AccountNo, Type, Balance, Plan)

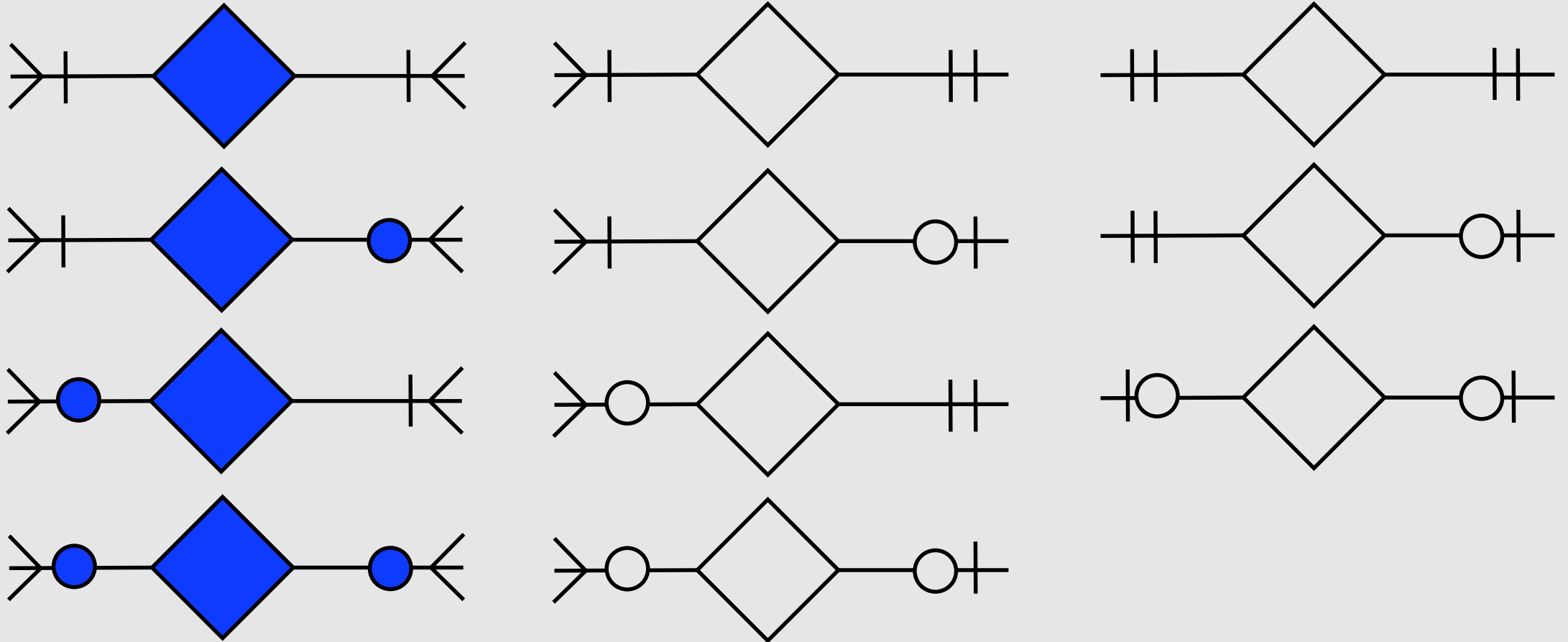
Cheque(AccountNo, ChequeNo, Date, Signature, PayTo, Amount)

FK & member of PK set



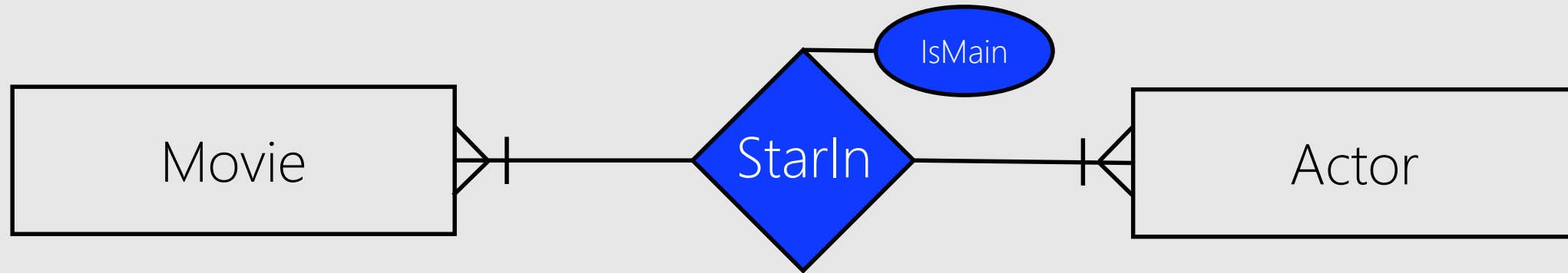
# Relationship2Relation (R2R)

49



# R2R × Many-Many

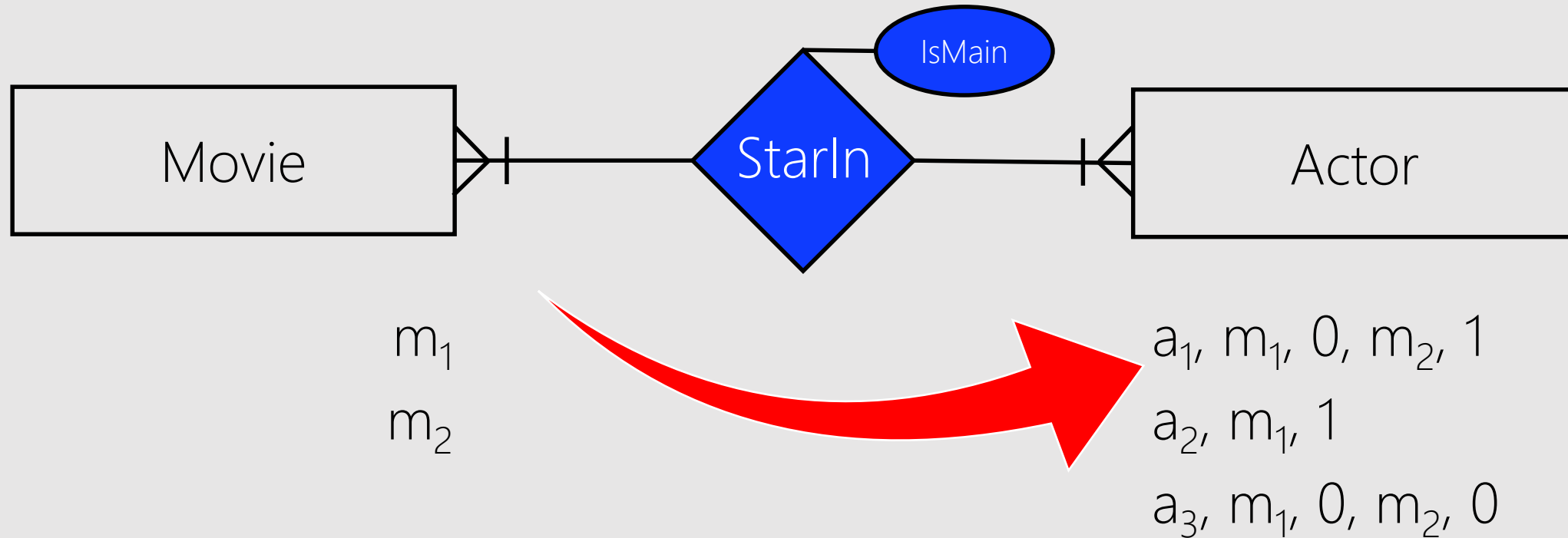
50



$m_1$	$m_1, a_1, 0$	$a_1$
$m_2$	$m_1, a_2, 1$	$a_2$
	$m_1, a_3, 0$	$a_3$
	$m_2, a_1, 1$	
	$m_2, a_3, 0$	

# R2R × Many-Many

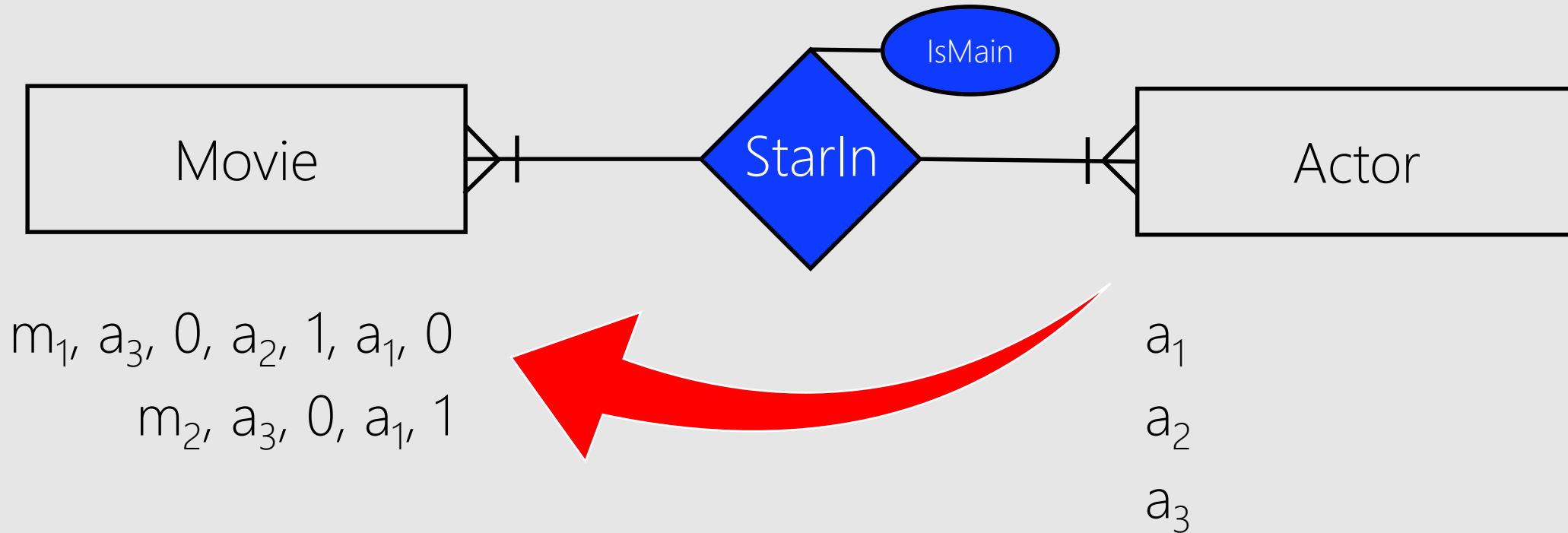
51



Maximum number of movies is not known!

# R2R × Many-Many

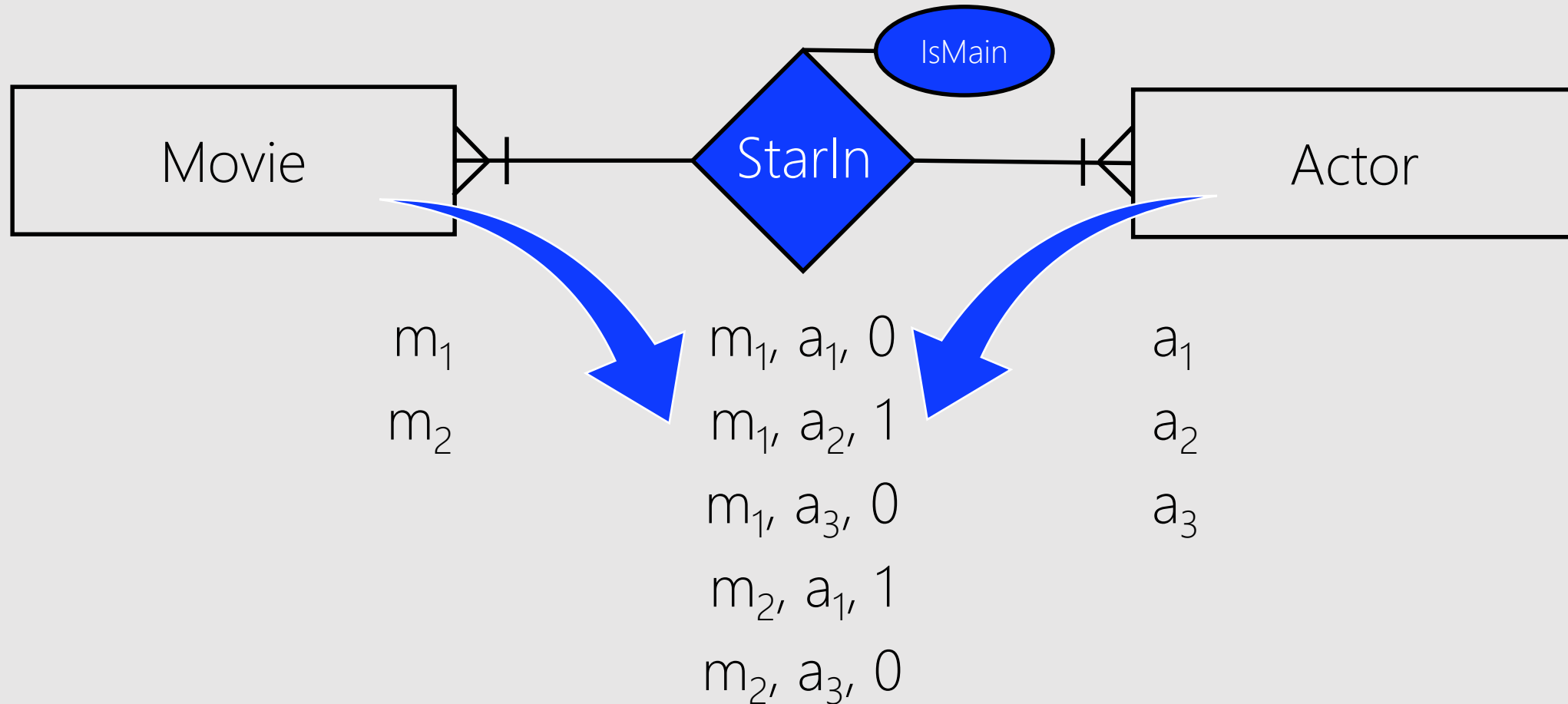
52



Maximum number of actors is not known!

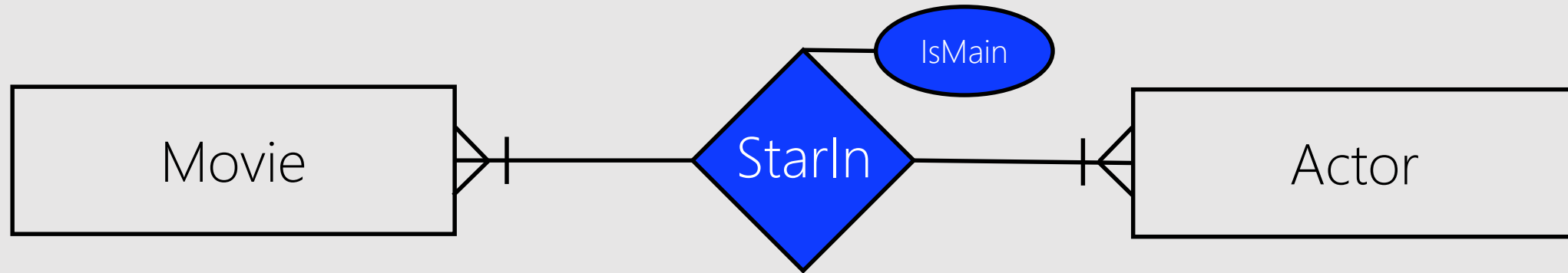
# R2R × Many-Many

53



# R2R × Many-Many

54



$R_1$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age)

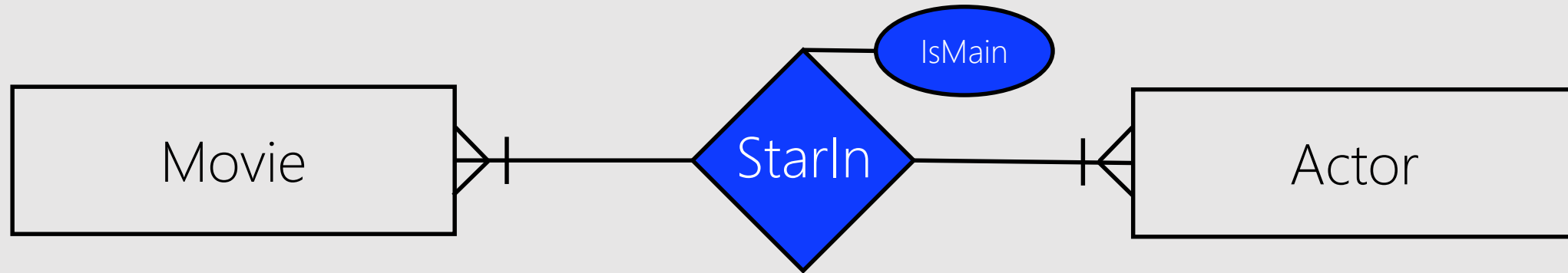
$R_2$ : Actor(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age)

$R_3$ : StarIn(Title, ReleaseYear, ReleaseMonth, ReleaseDay, FirstName, LastName, DateOfBirth, IsMain)

FK<sub>1</sub> FK<sub>2</sub>

# R2R × Many-Many

55



$R_1$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age)

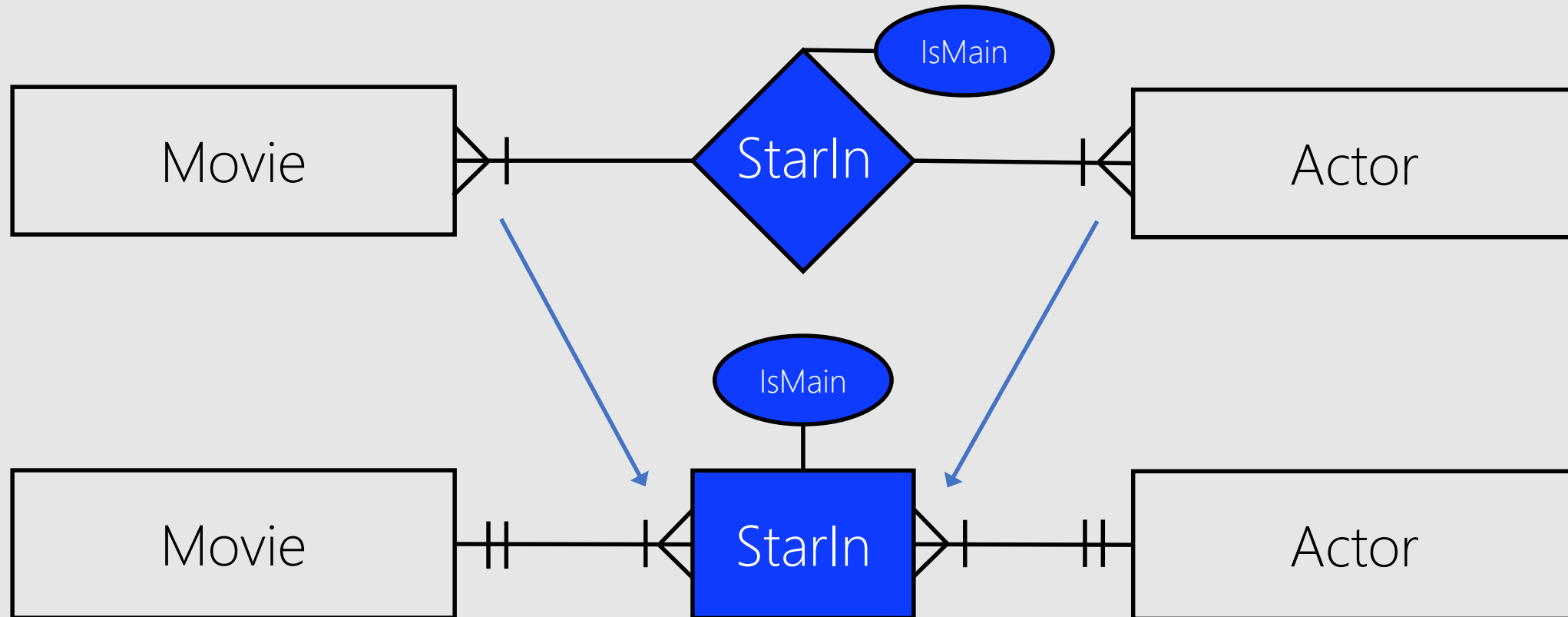
$R_2$ : Actor(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age)

$R_3$ : StarIn(Title, ReleaseYear, ReleaseMonth, ReleaseDay, FirstName, LastName, DateOfBirth, IsMain)

$PK = FK_1 \cup FK_2$

# R2R × Many-Many

56

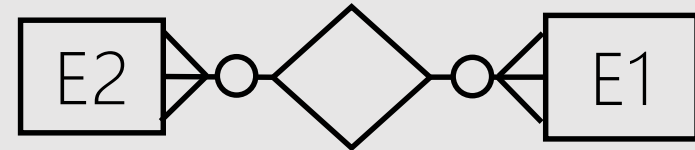




# R2R × Many-Many

57

Input: Many-Many relationship btw. E2 and E1, i.e.,

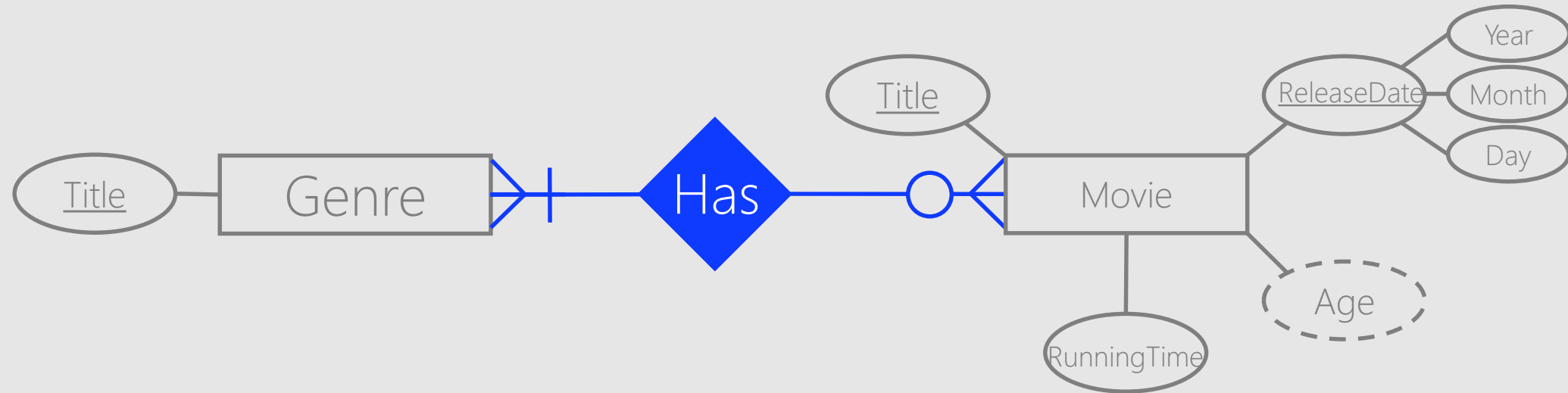


Output: Relations R1 for E1, R2 for E2, and R3 for relationship.

- 1) For E1, create relation R1 with the same attributes and keys as in E1
- 2) For E2, create relation R2 with the same attributes and keys as in E2
- 3) For many-many relationship set, create **new** relation R3
- 4) **[Foreign Key Set  $FK_1$ ]** Add key set of E1 to R3
- 5) **[Foreign Key Set  $FK_2$ ]** Add key set of E2 to R3
- 6) Add attributes of relationship set to R3
- 7) **[Primary Key Set]** Create key set for R3 from foreign key sets (step 4 & 5)  
 $PK = FK_1 \cup FK_2$

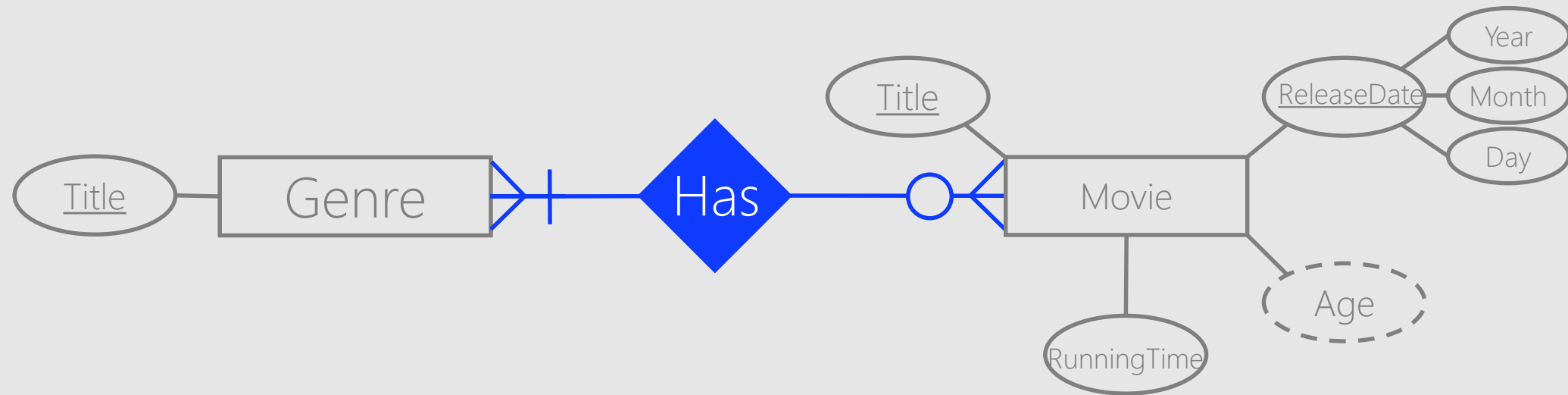
Herein, we do not care about ordinality! We fix it later.

# E2R × Entity Set × Multivalued Attribute 58



$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)  
 $R_2$ : Genre(Title)

# E2R × Entity Set × Multivalued Attribute 59

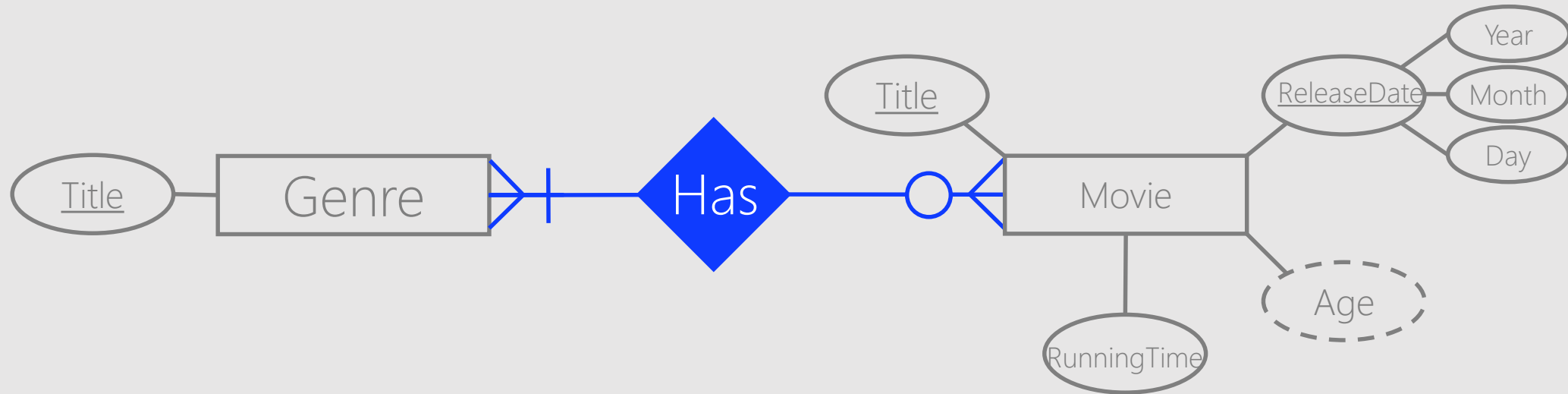


$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

$R_2$ : Genre(Title)

$R_3$ : MovieGenre(Title, ReleaseYear, ReleaseMonth, ReleaseDay, Title)

# E2R × Entity Set × Multivalued Attribute 60



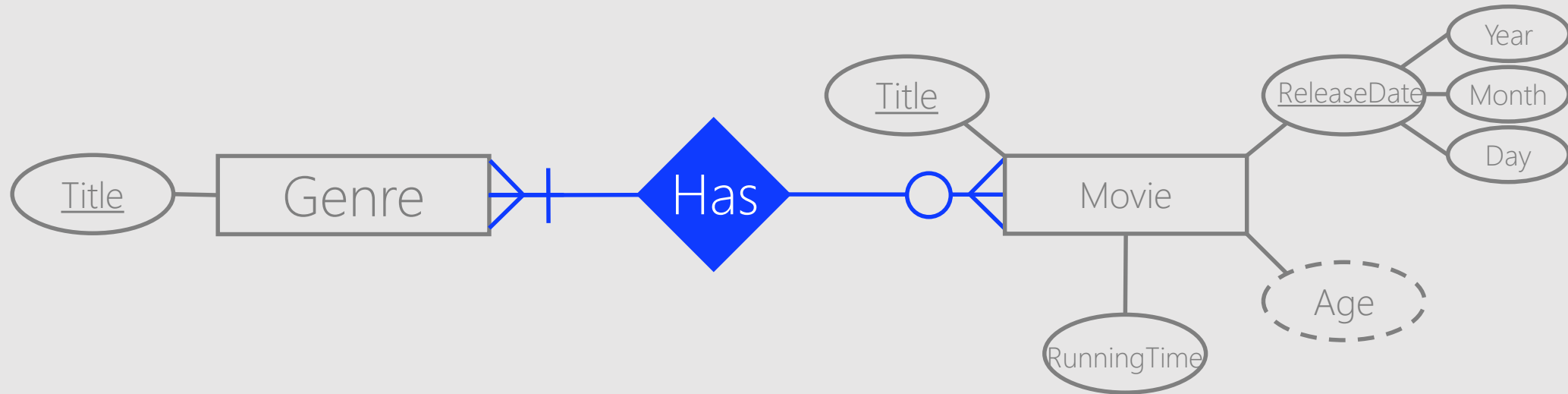
$R_1$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

$R_2$ : Genre(Title)

$R_3$ : MovieGenre(Title, ReleaseYear, ReleaseMonth, ReleaseDay, Title)

Name conflict!

# E2R × Entity Set × Multivalued Attribute 61



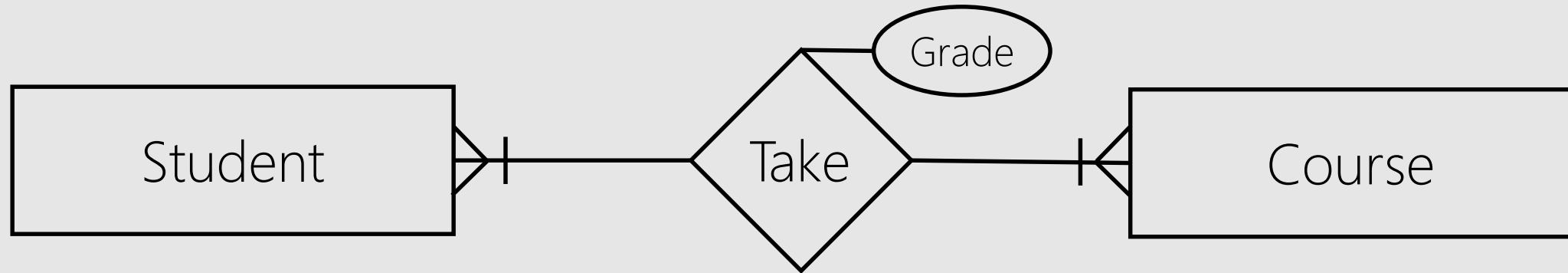
R<sub>1</sub>: Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

R<sub>2</sub>: Genre(Title)

R<sub>3</sub>: MovieGenre(MovieTitle, ReleaseYear, ReleaseMonth, ReleaseDay, GenreTitle)

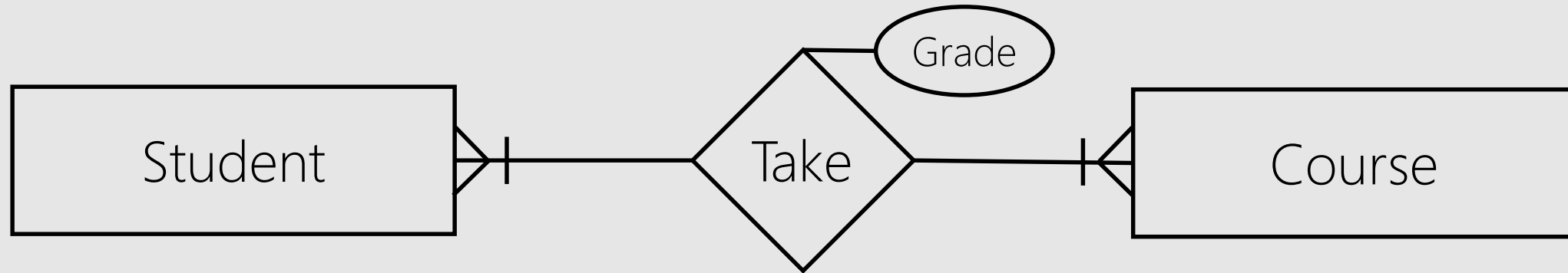
# R2R × Many-Many

62



# R2R × Many-Many

63



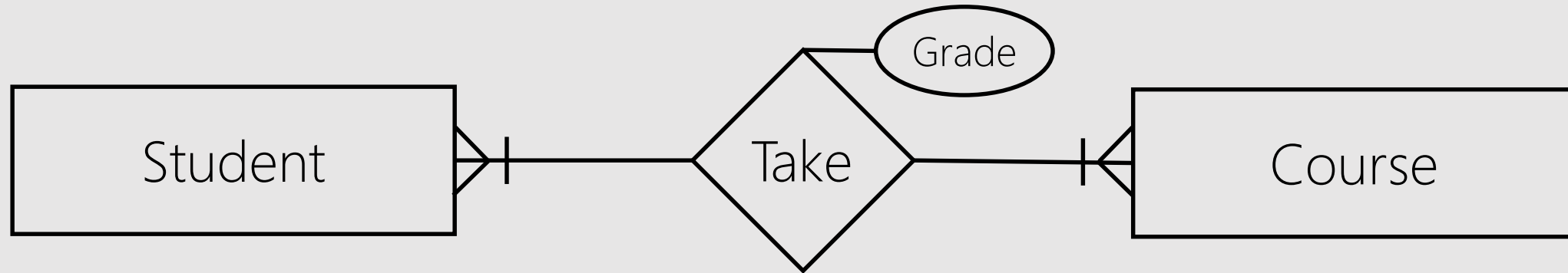
$R_1$ : Student(StudentNo, FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

$R_2$ : Course(Title, Code, Credit, IsRequired, ...)

$R_3$ : StudentCourse(StudentNo, Code, Grade)

# R2R × Many-Many

64



$R_1$ : Student(StudentNo, FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

$R_2$ : Course(Title, Code, Credit, IsRequired, ...)

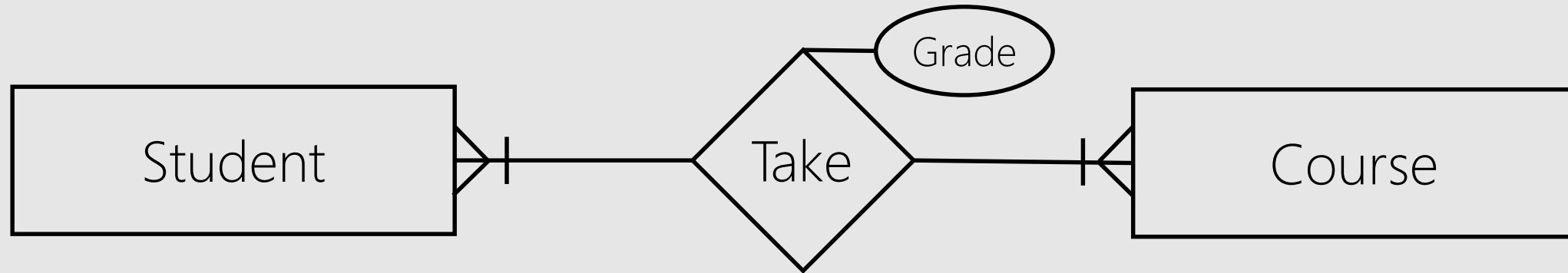
$R_3$ : StudentCourse(StudentNo, Code, Grade)

There is a problem not in conversion, but in design. Where? Solution?



# R2R × Many-Many

65



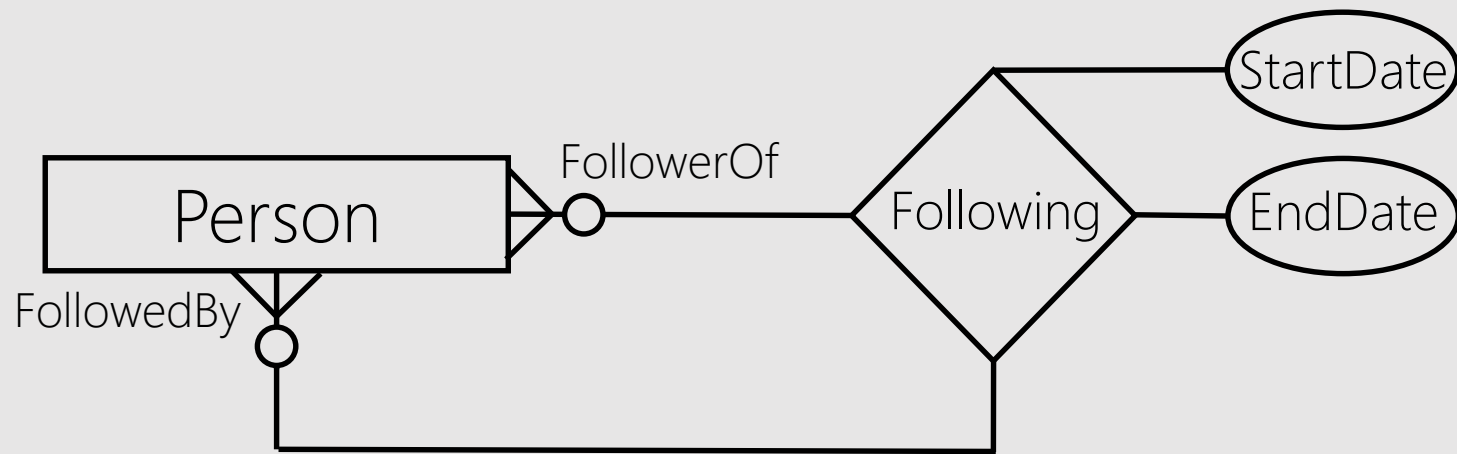
$R_1$ : Student(StudentNo, FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

$R_2$ : Course(Title, Code, Term, Credit, IsRequired, ...)

$R_3$ : StudentCourse(StudentNo, Code, Term, Grade)

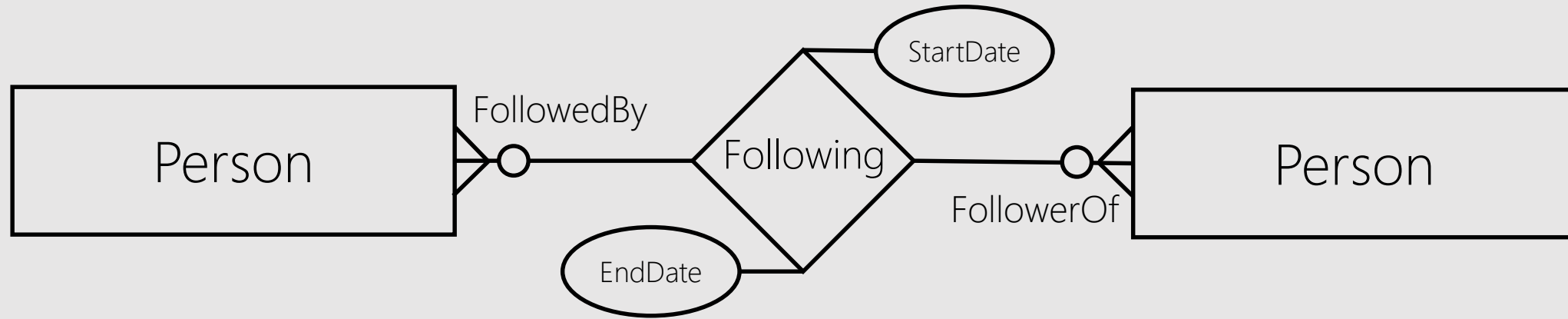
# R2R × Many-Many × Self (Unary)

66



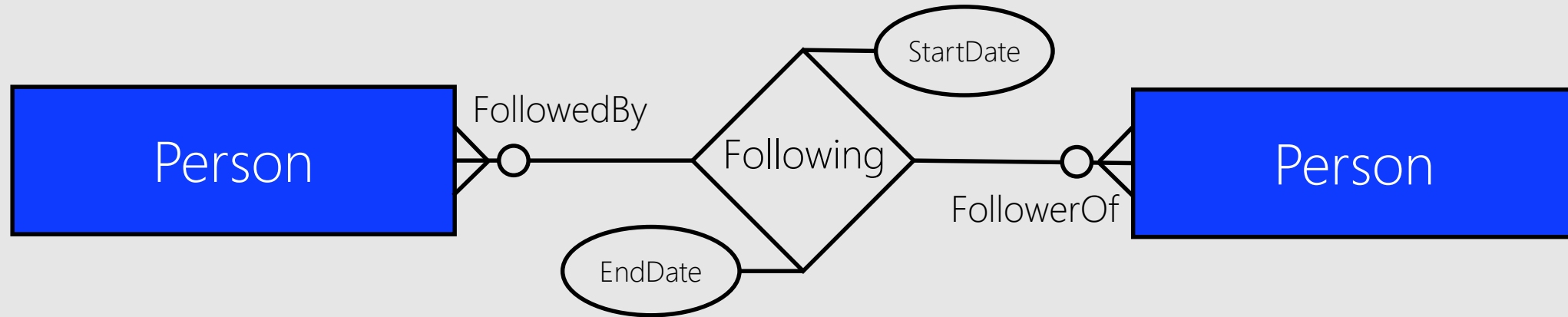
# R2R × Many-Many × Self (Unary)

67



# R2R × Many-Many × Self (Unary)

68

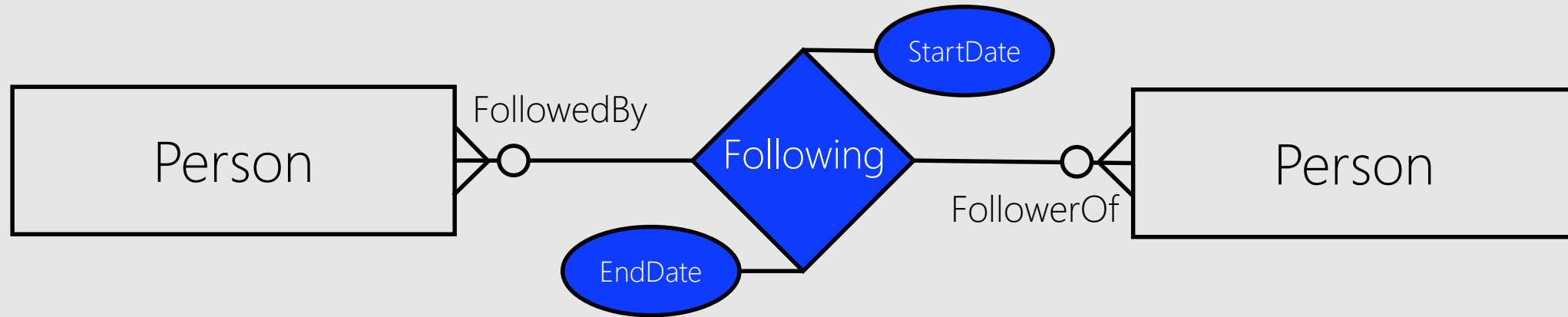


$R_1$ : Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

$R_2$ : Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

# R2R × Many-Many × Self (Unary)

69



R<sub>1</sub>: Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

R<sub>2</sub>: Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

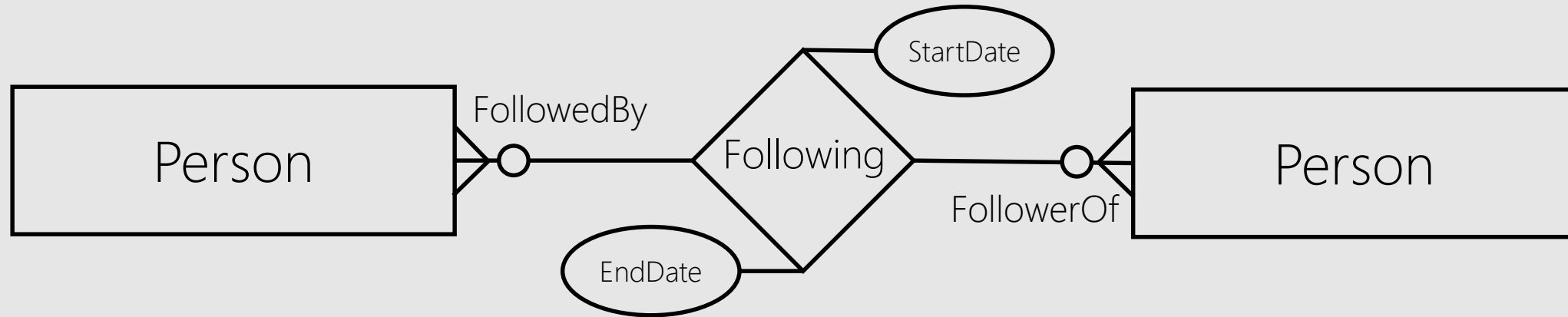
R<sub>3</sub>: Followership(FirstName, LastName, DateOfBirth, PlaceOfBirth,  
FirstName, LastName, DateOfBirth, PlaceOfBirth,  
StartDate, EndDate)

FK1

FK2

# R2R × Many-Many × Self (Unary)

70



R<sub>1</sub>: Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

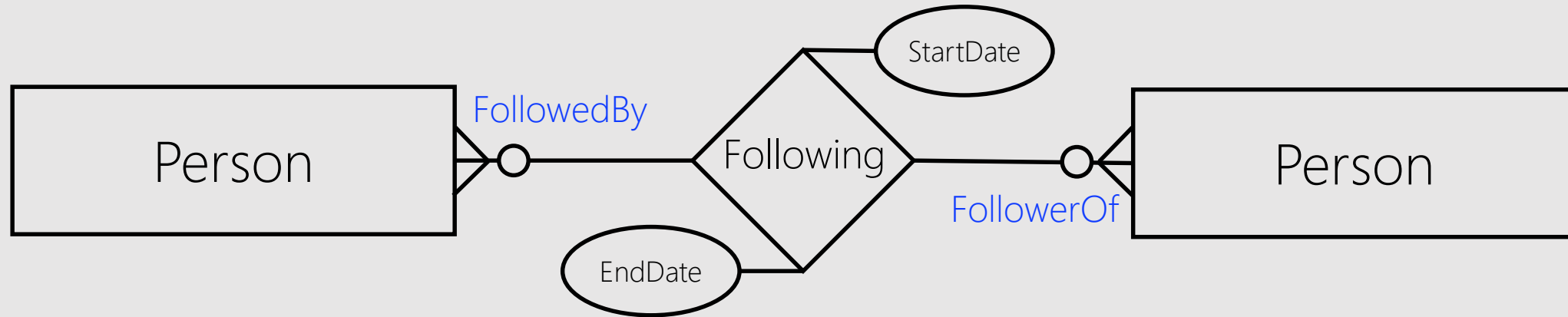
R<sub>2</sub>: Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

R<sub>3</sub>: Followership(FirstName, LastName, DateOfBirth, PlaceOfBirth,  
FirstName, LastName, DateOfBirth, PlaceOfBirth,  
StartDate, EndDate)

Naming conflict!

# R2R × Many-Many × Self (Unary)

71



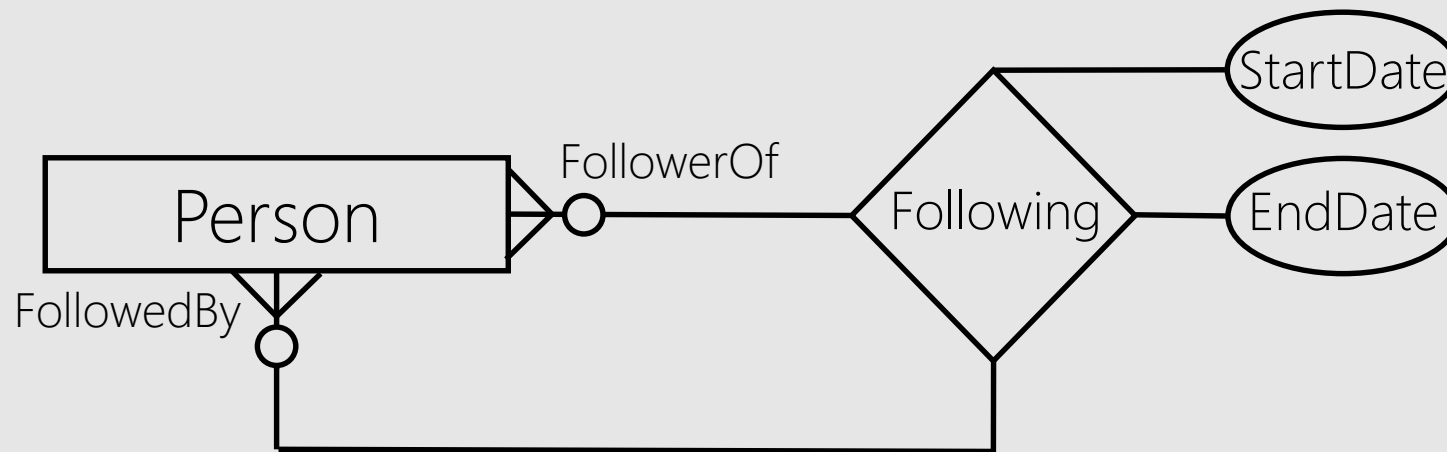
R<sub>1</sub>: Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

R<sub>2</sub>: Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

R<sub>3</sub>: Followership(FollowerFirstName, FollowerLastName, FollowerDateOfBirth, FollowerPlaceOfBirth,  
FollowedFirstName, FollowedLastName, FollowedDateOfBirth, FollowedPlaceOfBirth,  
StartDate, EndDate)

# R2R × Many-Many × Self (Unary)

72



$R_1$ : Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)

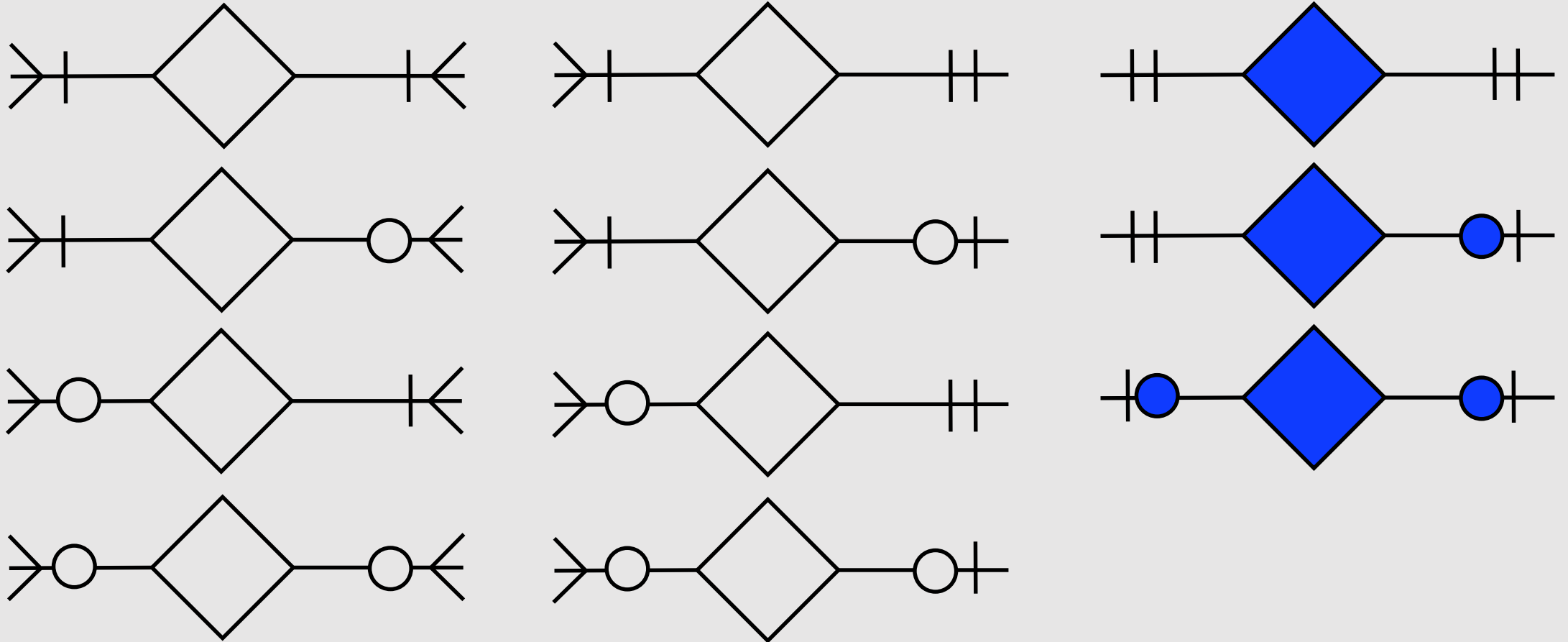
~~$R_2$ : Person(FirstName, LastName, DateOfBirth, PlaceOfBirth, Age, ...)~~

$R_2$ : Followership(FollowerName, FollowerName, FollowerDateOfBirth, FollowerPlaceOfBirth,  
FollowedFirstName, FollowedLastName, FollowedDateOfBirth, FollowedPlaceOfBirth,  
StartDate, EndDate)



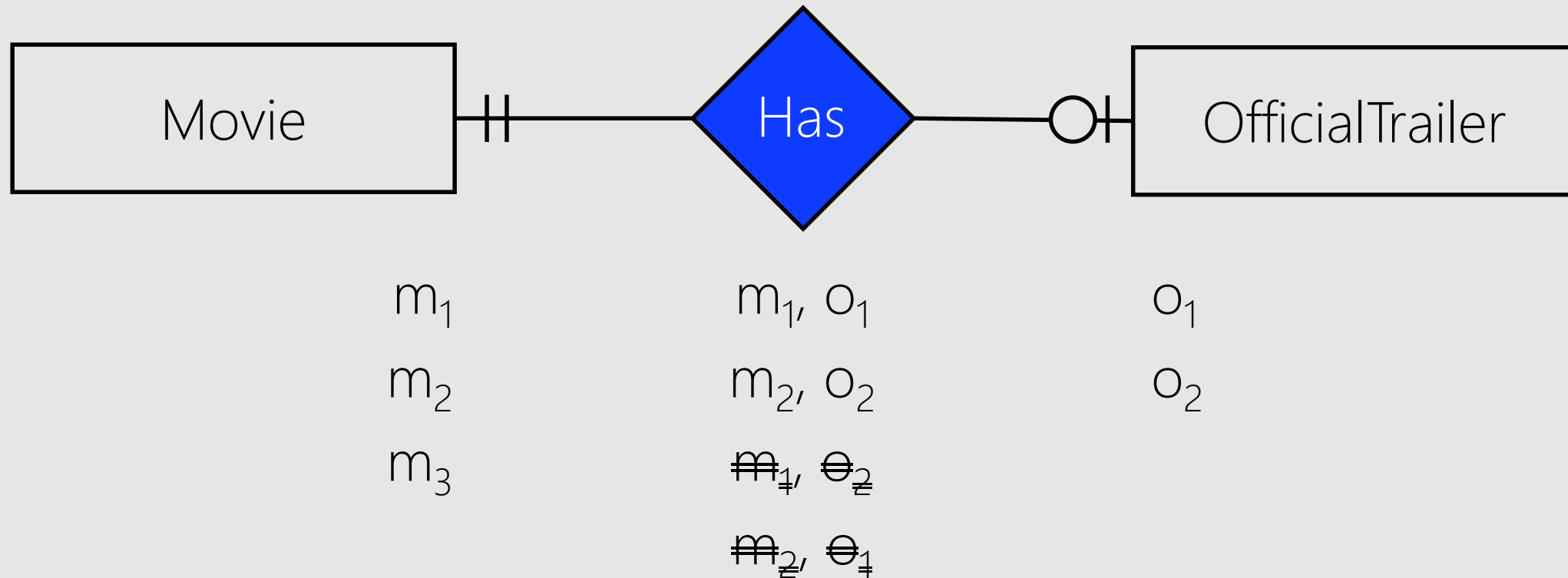
# Relationship2Relation (R2R)

73



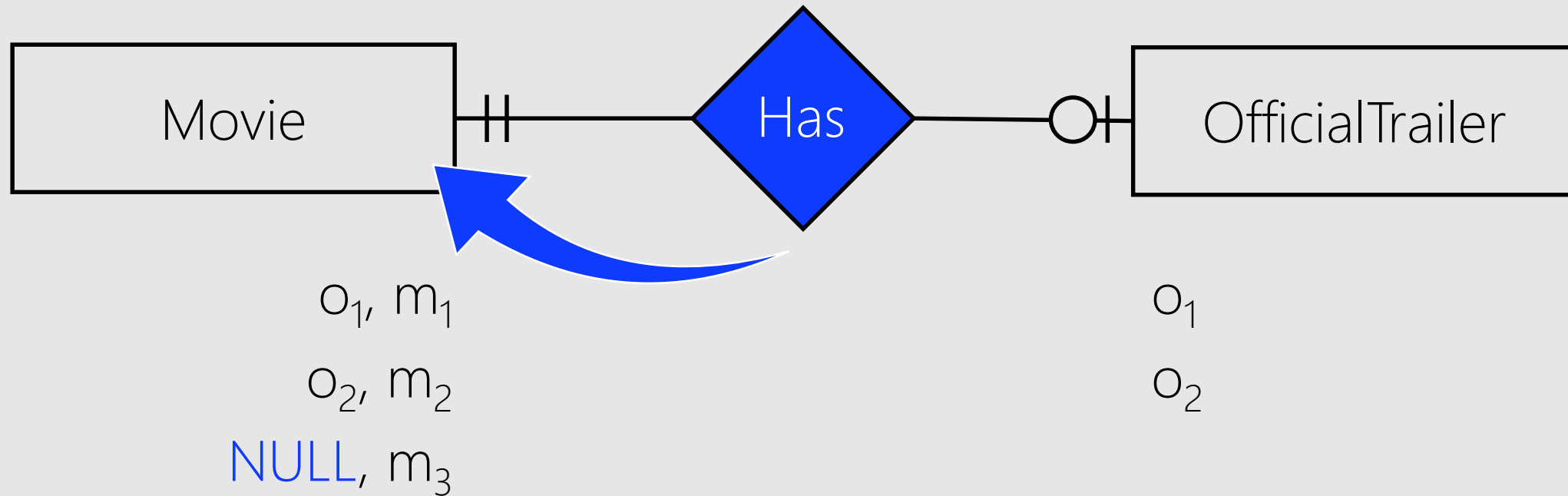
# R2R × One-One

74



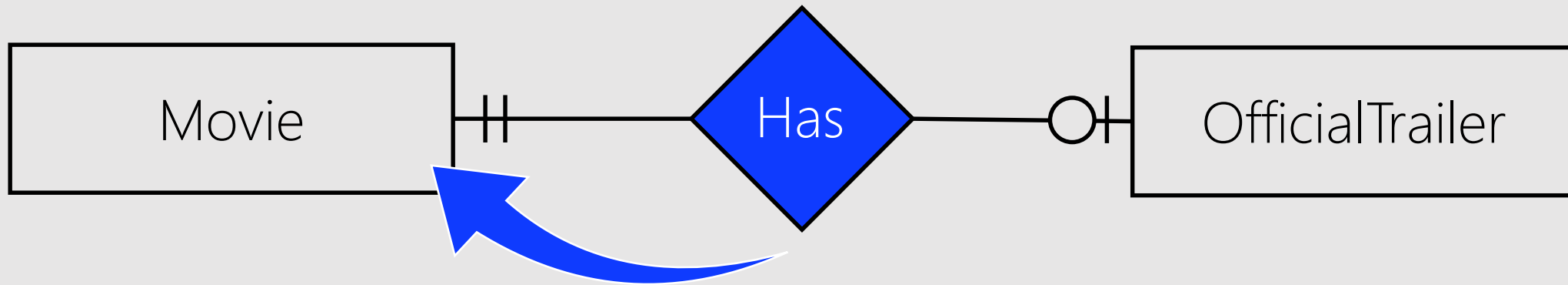
# R2R × One-One (Approach I)

75



# R2R × One-One (Approach I)

76



$R_1$ : OfficialTrailer(Url, RunningTime)

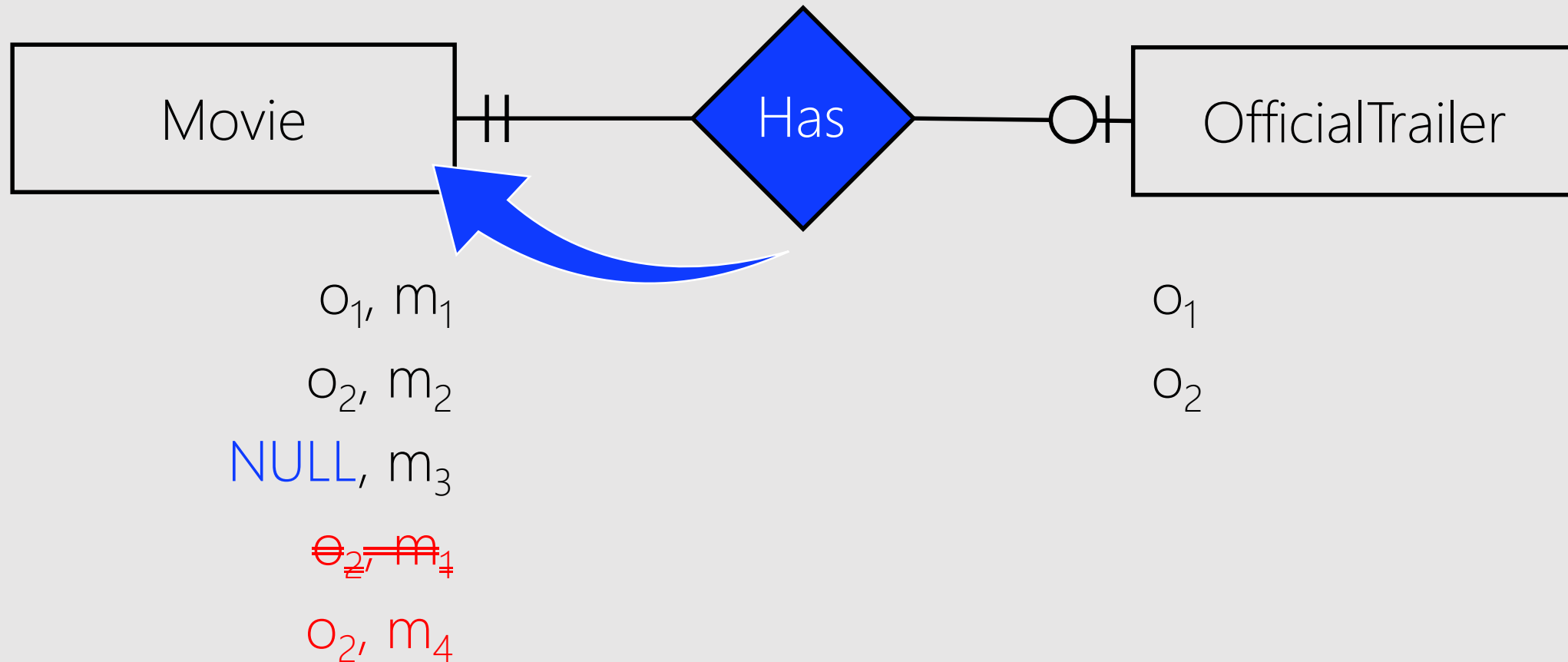
$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age, Url)

FK

There is a problem! Where? Solution?

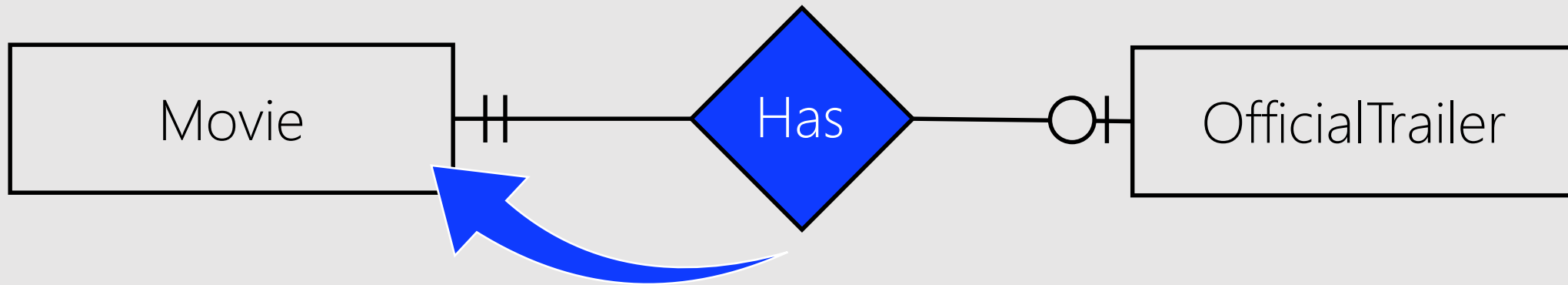
# R2R × One-One (Approach I)

77



# R2R × One-One (Approach I)

78



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age, Url)

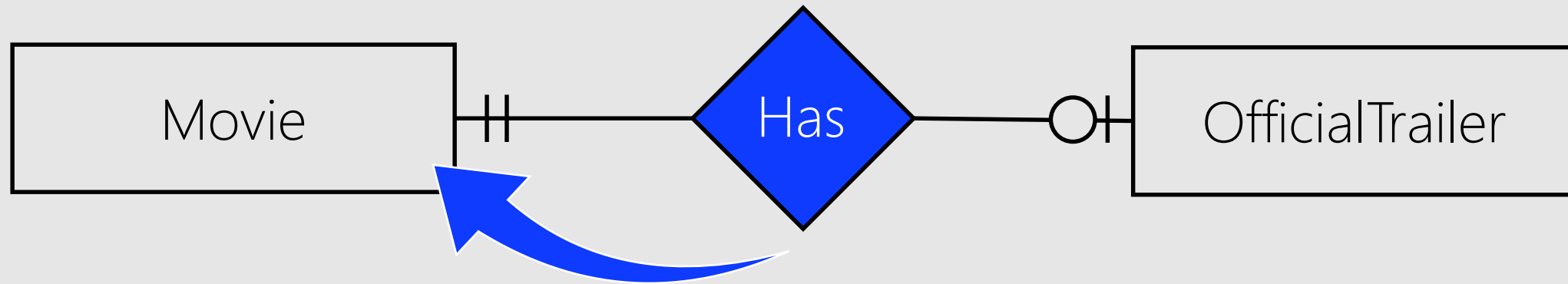
The Movie relation allows an official trailer belongs to multiple movies!

We have to make Url unique. How? By being part of key set?



# R2R × One-One (Approach I)

79



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age, Url)

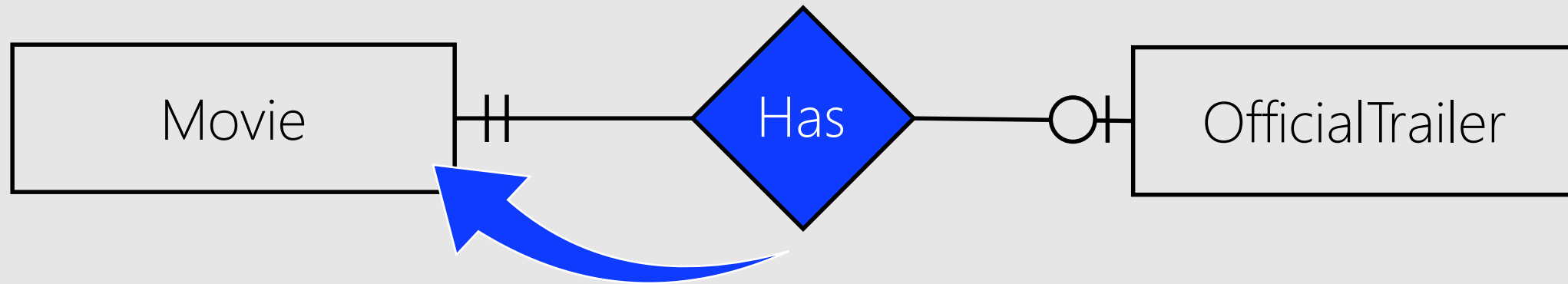
The Movie relation allows an official trailer belongs to multiple movies!

We have to make Url unique. How? By being part of key set? **No! it does not solve the issue.**

By being a new key set?

# R2R × One-One (Approach I)

80



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age, Url)

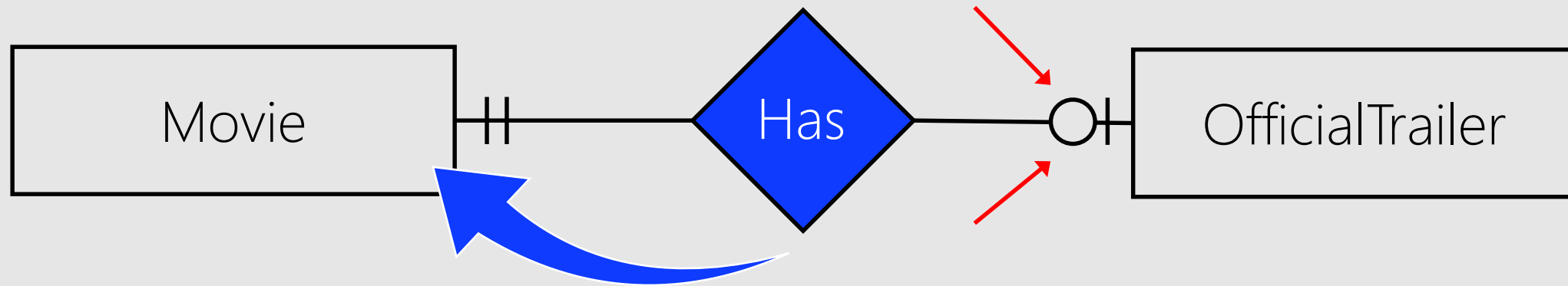
New key set for  $R_2$ :

Secondary Key Set = {Url}



# R2R × One-One (Approach I)

81



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age, Url)

New key set for  $R_2$ :

SK={Url} but if we choose this as key set, it should be mandatory!

# R2R × Candidate Key Set (CK)

82

Candidate key is a possible key set whose attributes accept no value (NULL)

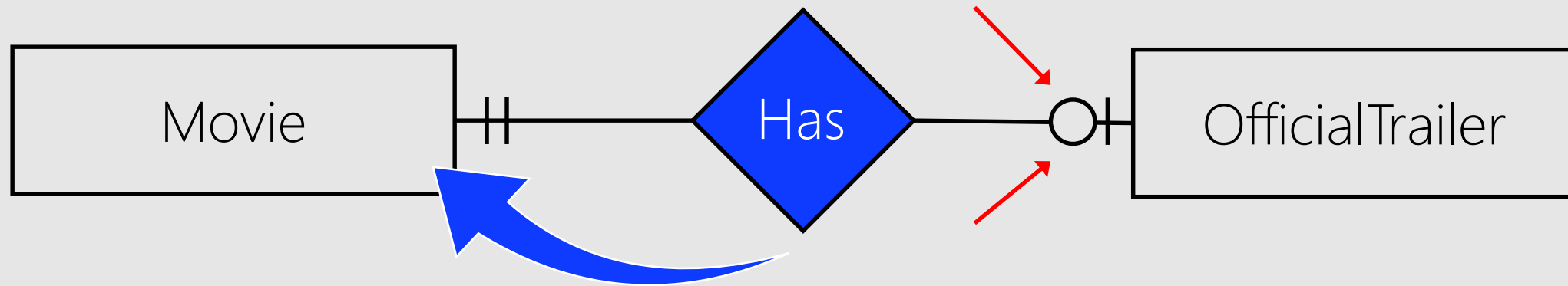
In contrast to primary key set which MUST have value for all its attributes, CK's attributes could be either mandatory or optional.

It is not called ~~Secondary~~ Key Set!

This way we have MULTIPLE key sets for a relation (table).

# R2R × One-One (Approach I)

83



$R_1$ : OfficialTrailer(Url, RunningTime)

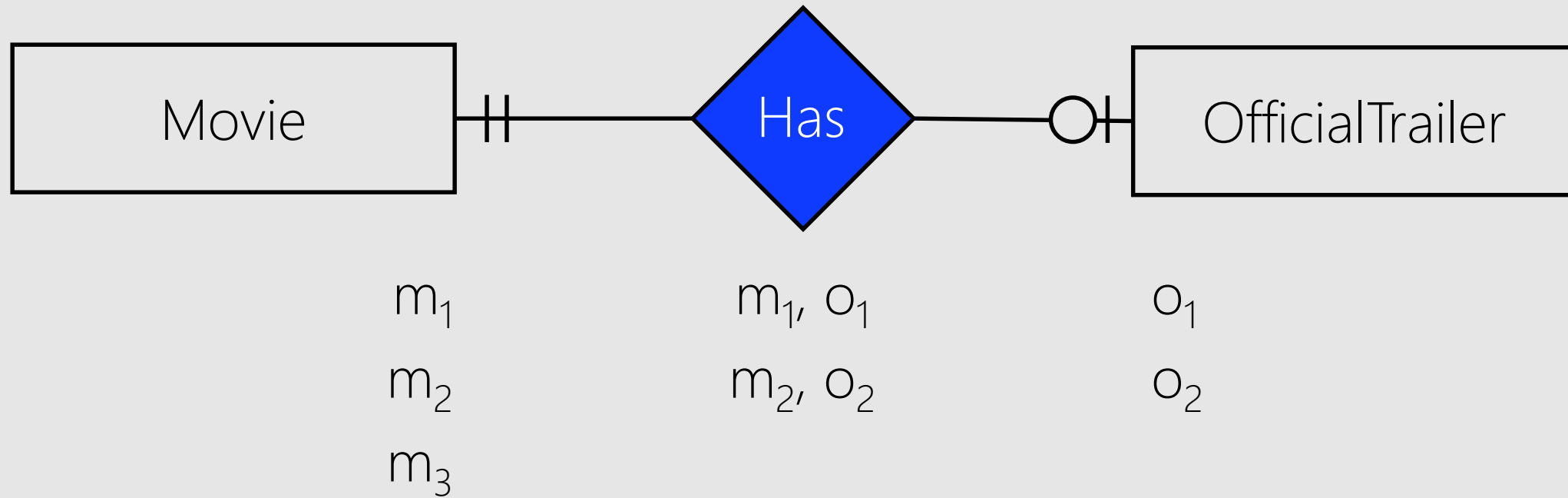
$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age, Url)

New key sets for  $R_2$ :

~~PK2~~ = CK = FK = {Url}

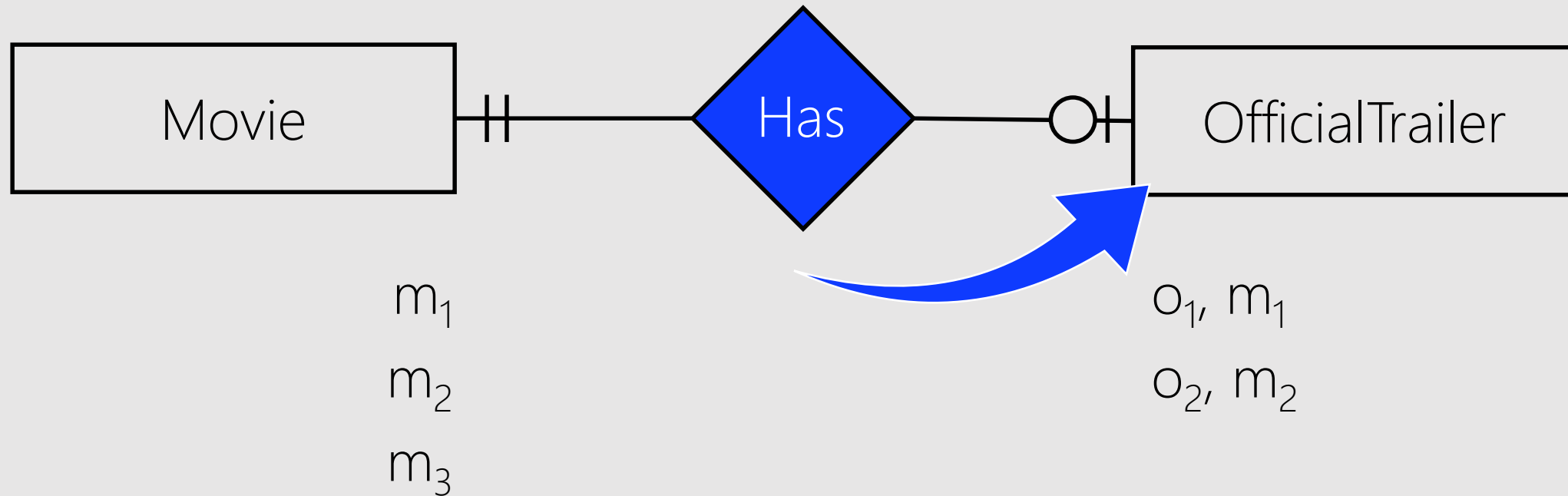
# R2R × One-One

84



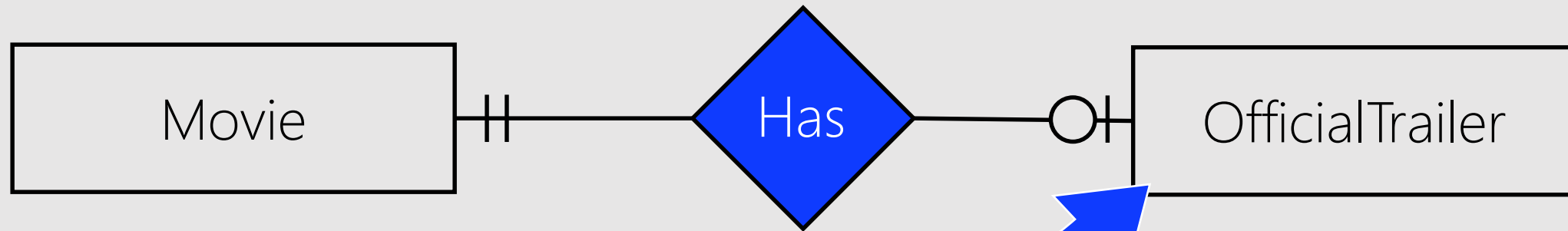
# R2R × One-One (Approach II)

85



# R2R × One-One (Approach II)

86



$R_1$ : OfficialTrailer(Url, RunningTime, Title, ReleaseYear, ReleaseMonth, ReleaseDay)  
 $R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

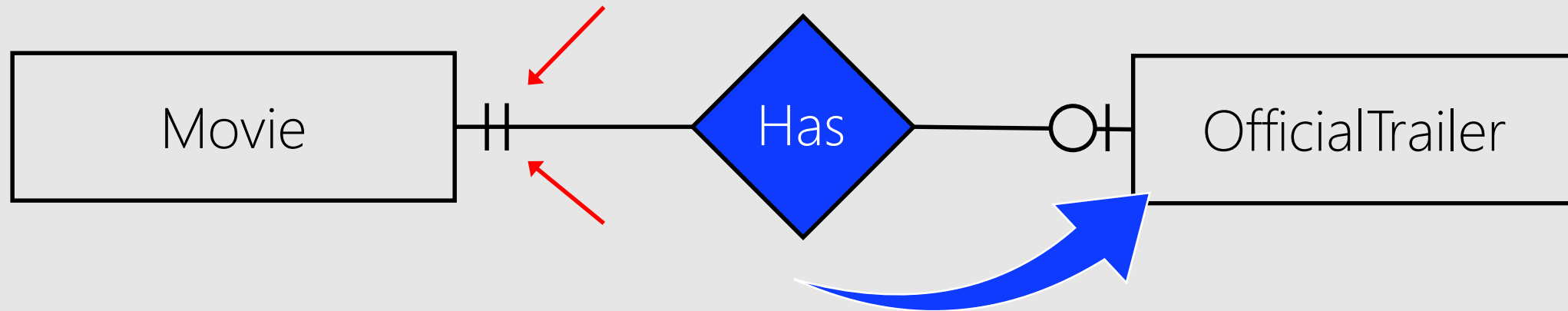
A blue arrow points from the 'Has' relationship to the 'OfficialTrailer' entity. A blue bracket labeled 'FK' spans the attributes Title, ReleaseYear, ReleaseMonth, and ReleaseDay in the  $R_1$  schema.

New key set for  $R_1$ :

CK=FK={Title, ReleaseYear, ReleaseMonth, ReleaseDay}

# R2R × One-One (Approach II)

87



$R_1$ : OfficialTrailer(Url, RunningTime, Title, ReleaseYear, ReleaseMonth, ReleaseDay)

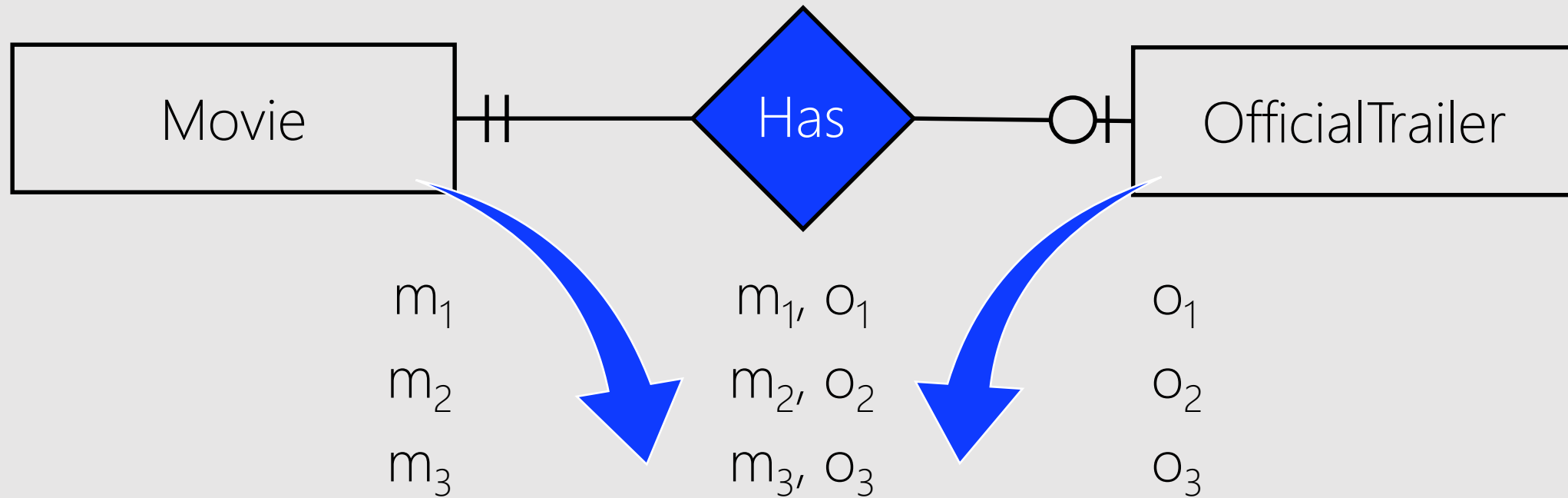
$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

New key set for  $R_1$ :

CK=FK={Title, ReleaseYear, ReleaseMonth, ReleaseDay} [Make CK mandatory!](#)

# R2R × One-One (Approach III)

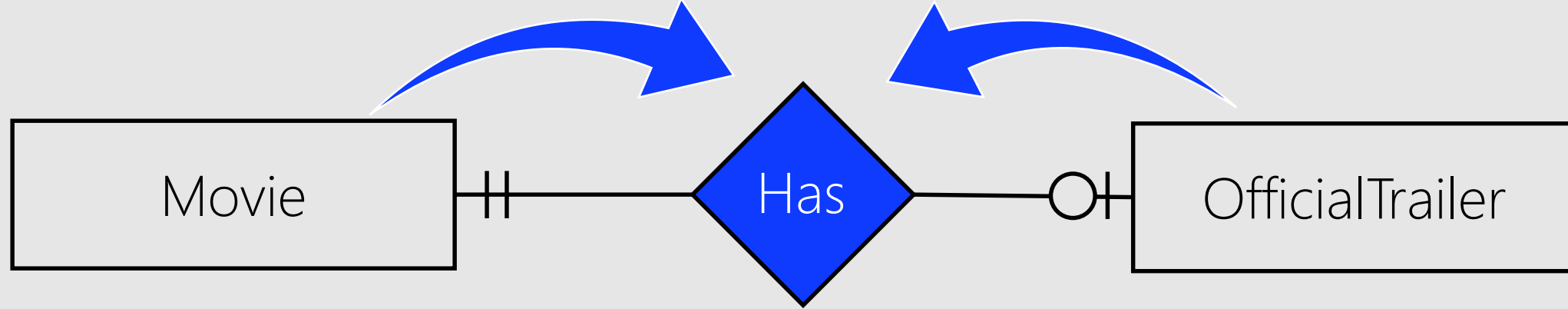
88





# R2R × One-One (Approach III)

89



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

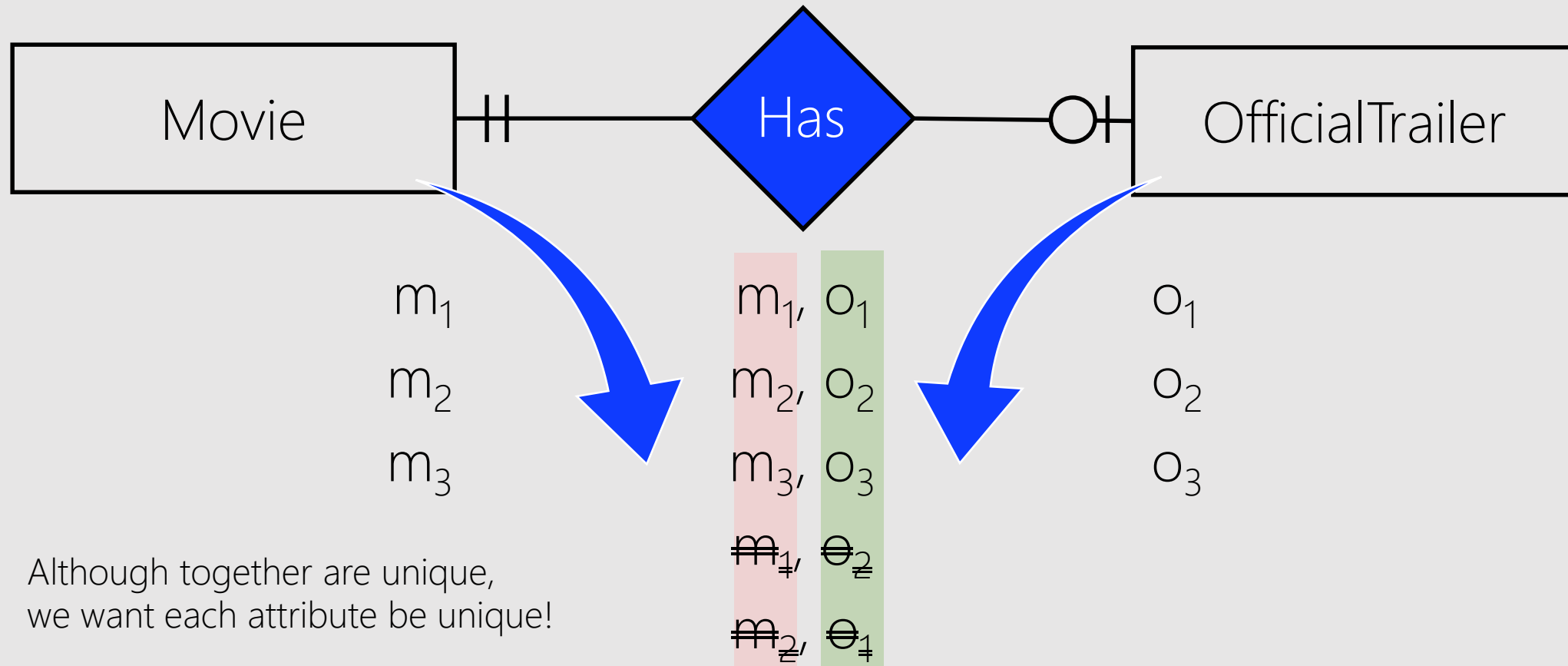
$R_3$ : MovieOfficialTrailer(Title, ReleaseYear, ReleaseMonth, ReleaseDay, Url)

$FK_1$

$FK_2$

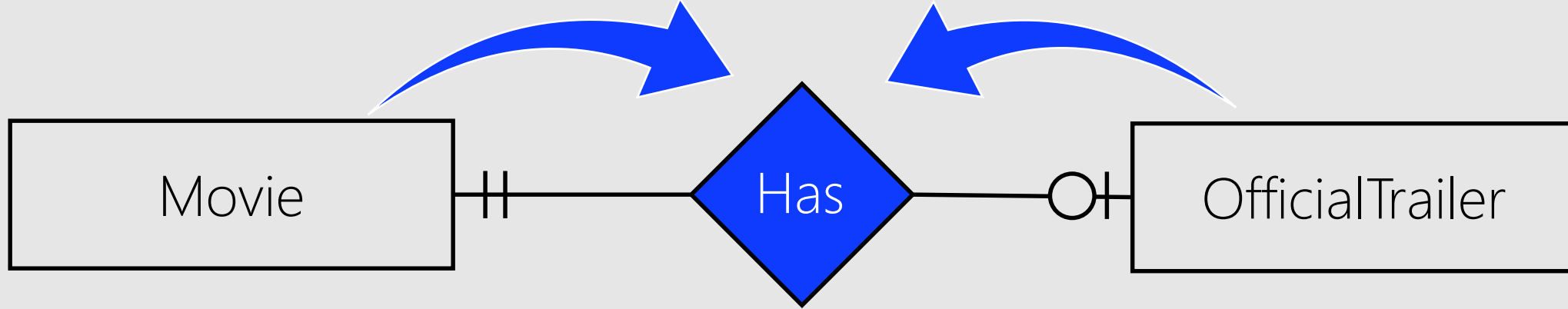
# R2R × One-One (Approach III)

90



# R2R × One-One (Approach III-a)

91



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

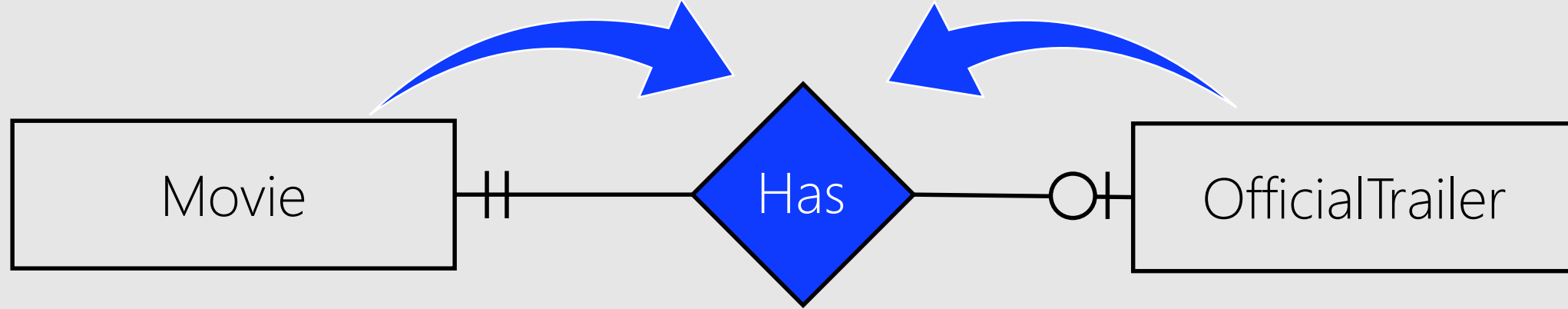
$R_3$ : MovieOfficialTrailer(Title, ReleaseYear, ReleaseMonth, ReleaseDay, Url)

New key set for  $R_3$ :

CK={Url} and mandatory (Why?)

# R2R × One-One (Approach III-b)

92



$R_1$ : OfficialTrailer(Url, RunningTime)

$R_2$ : Movie(Title, RunningTime, ReleaseYear, ReleaseMonth, ReleaseDay, Age)

$R_3$ : MovieOfficialTrailer(Title, ReleaseYear, ReleaseMonth, ReleaseDay, Url)

New key set for  $R_3$ :

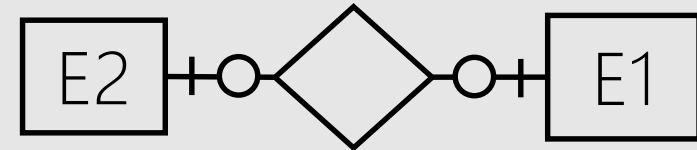
CK={Title, ReleaseYear, ReleaseMonth, ReleaseDay} and mandatory.

# R2R × One-One

93

Input: One-One relationship btw. E2 and E1, i.e.,

Output: Relations R1 for E1, R2 for E2, and/or R3 for relationship.

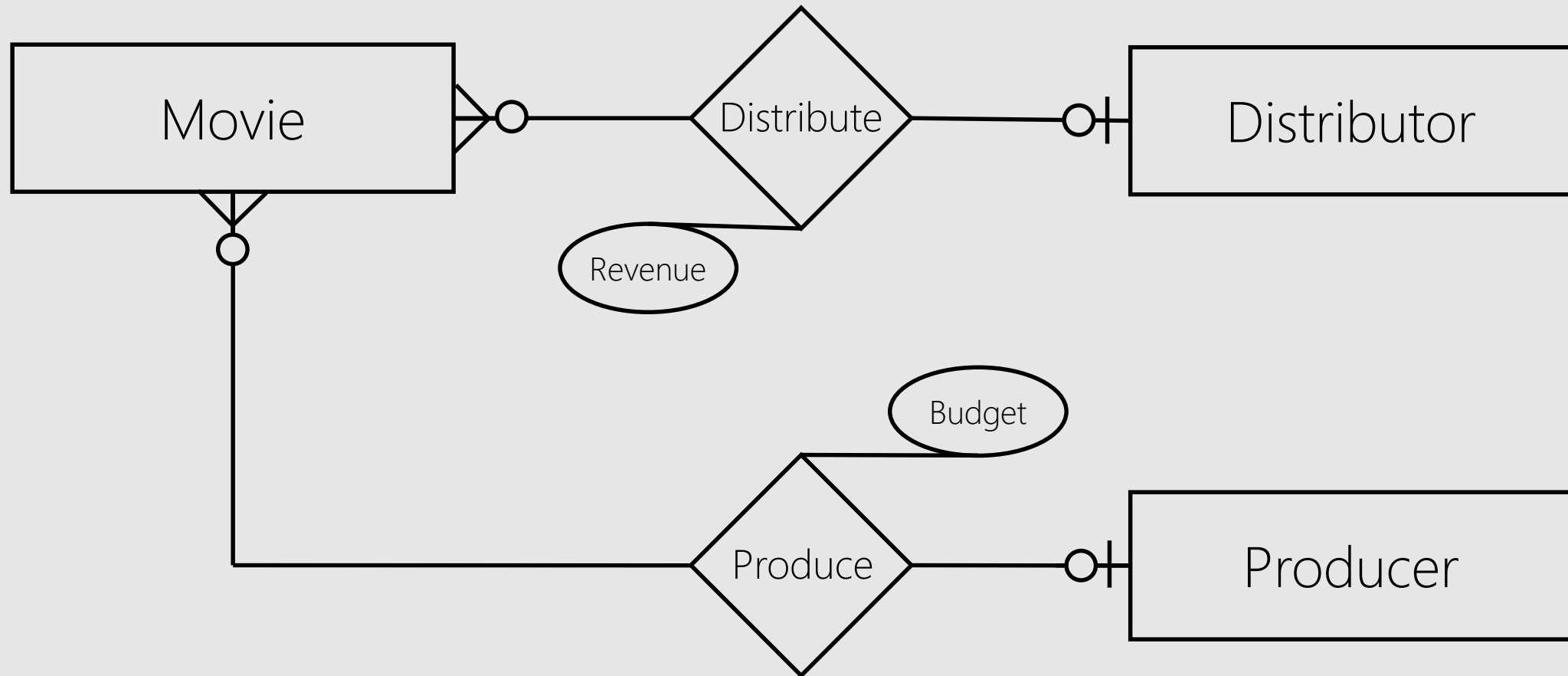


- 1) For E1, create relation R1 with the same attributes and keys as in E1
- 2) For E2, create relation R2 with the same attributes and keys as in E2
- 3) Do only one of the followings
  - a) [Foreign & Candidate Key Set FK, CK]  
Add key set of E1 to R2 & make them candidate key of R2  
If E1's ordinality is mandatory, make CK mandatory
  - b) [Foreign & Candidate Key Set FK, CK]  
Add key set of E2 to R1 & make them candidate key of R1  
If E2's ordinality is mandatory, make CK mandatory
  - c) For one-one relationship set, create new relation R3
    - I) [Foreign & Primary Key Set FK, PK] Add key set of E1 to R3 & make them primary key of R3
    - II) [Foreign & Candidate Key Set FK, CK] Add key set of E2 to R3 & make them candidate key of R3 and mandatory



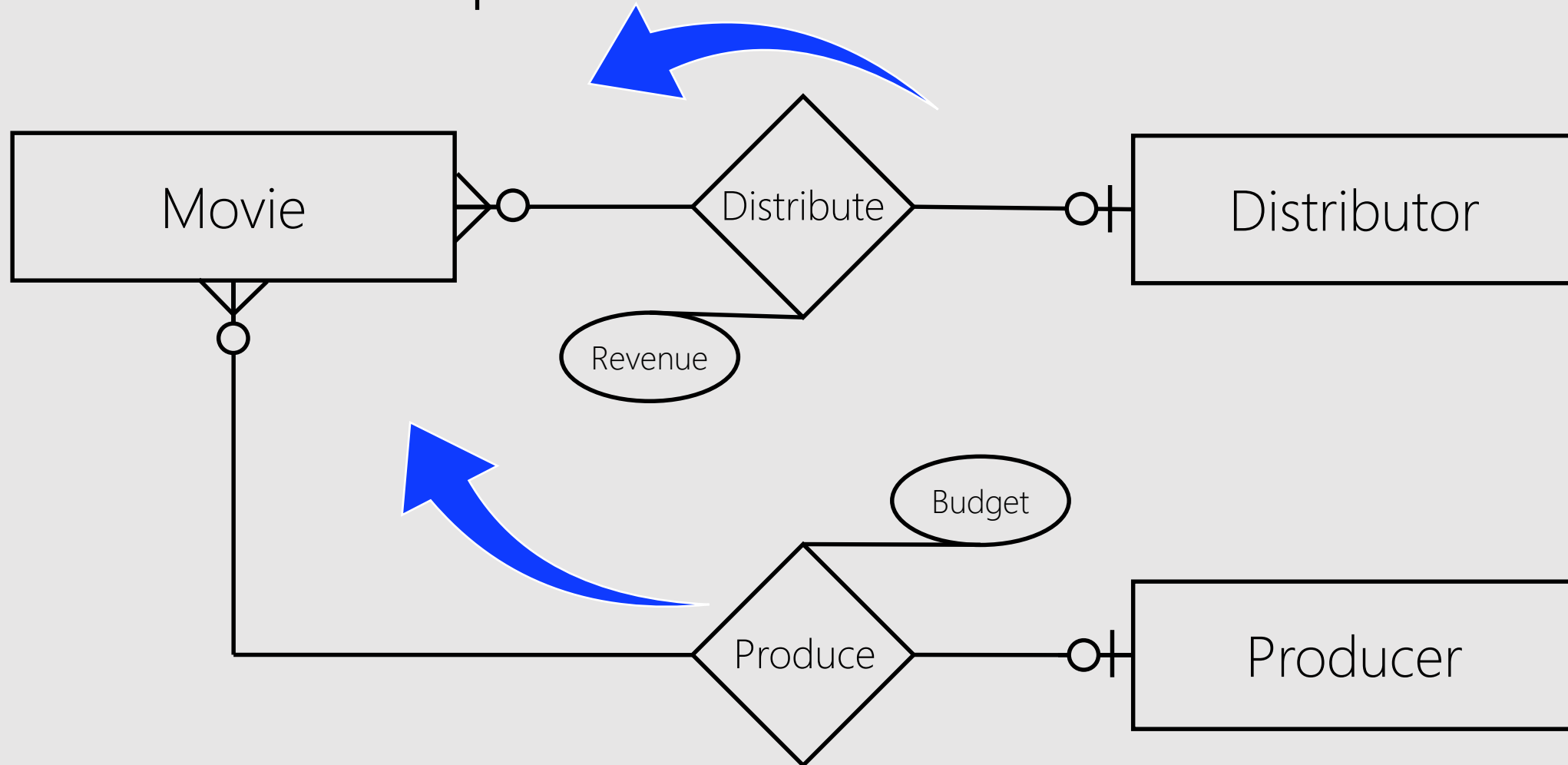
# R2R × Multiple

95



# R2R × Multiple

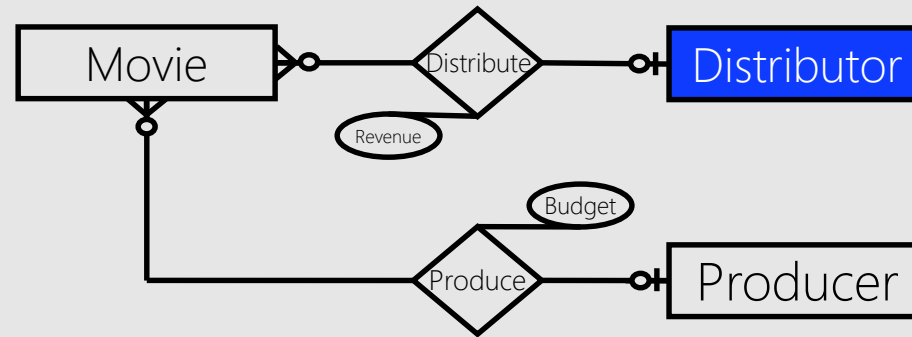
96





# R2R × Multiple

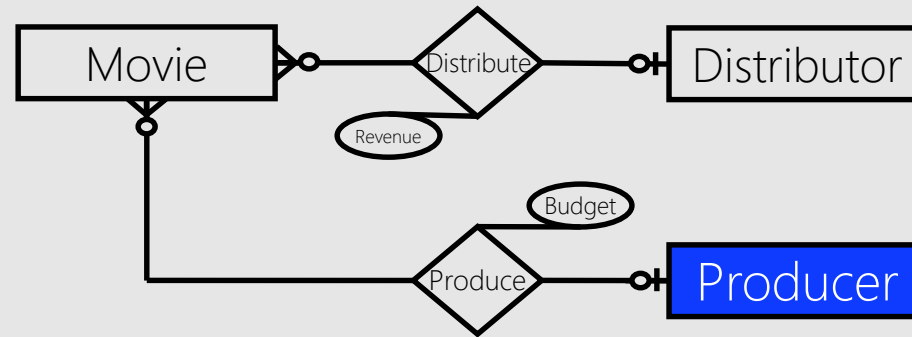
97



$R_1$ : Distributor(Name, Address, Phone, ...)

# R2R × Multiple

98

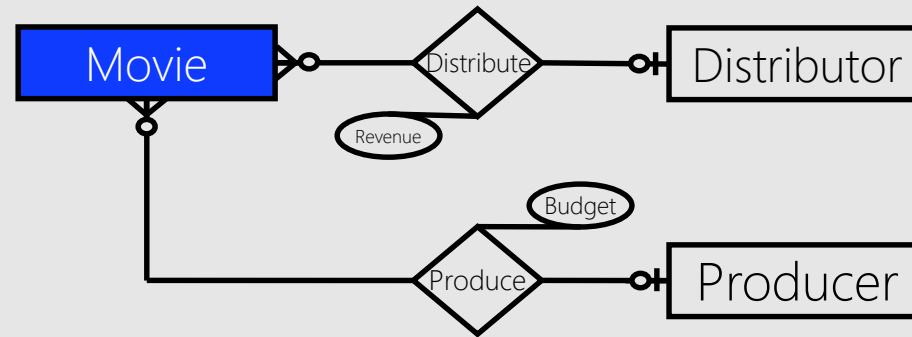


$R_1$ : Distributor(Name, Address, Phone, ...)

$R_2$ : Producer(Name, Studio, Address, Phone, ...)

# R2R × Multiple

99



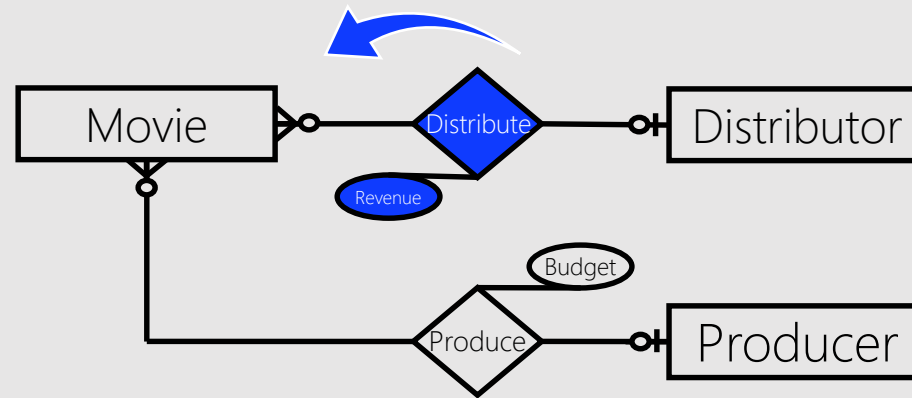
$R_1$ : Distributor(Name, Address, Phone, ...)

$R_2$ : Producer(Name, Studio, Address, Phone, ...)

$R_3$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime)

# R2R × Multiple

100



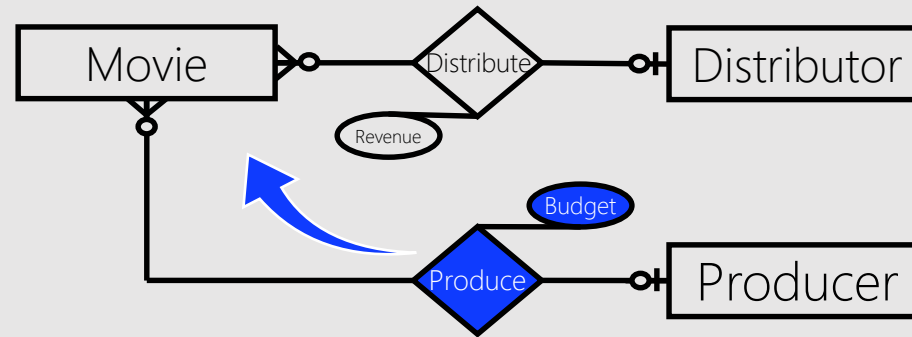
$R_1$ : Distributor(Name, Address, Phone, ...)

$R_2$ : Producer(Name, Studio, Address, Phone, ...)

$R_3$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime,  
DistributorName, Revenue)  
FK<sub>1</sub>

# R2R × Multiple

101



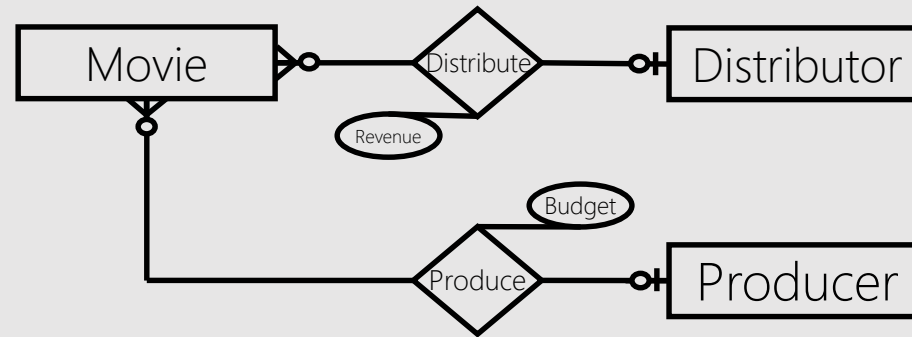
$R_1$ : Distributor(Name, Address, Phone, ...)

$R_2$ : Producer(Name, Studio, Address, Phone, ...)

$R_3$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime,  
DistributorName, Revenue  
ProducerName, Budget)  
FK<sub>2</sub>

# R2R × Multiple

102



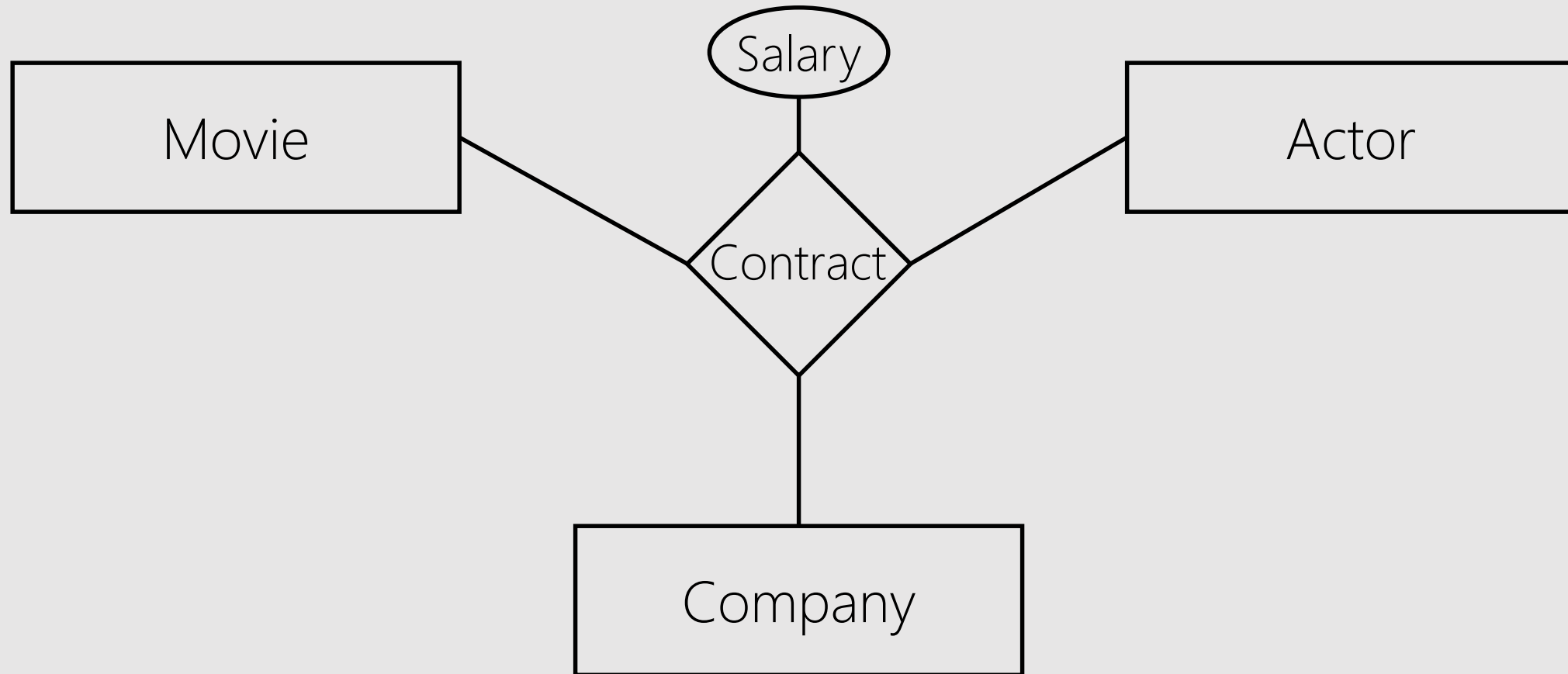
R<sub>1</sub>: Distributor(Name, Address, Phone, ...)

R<sub>2</sub>: Producer(Name, Studio, Address, Phone, ...)

R<sub>3</sub>: Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, DistributorName, Revenue, ProducerName, Budget)

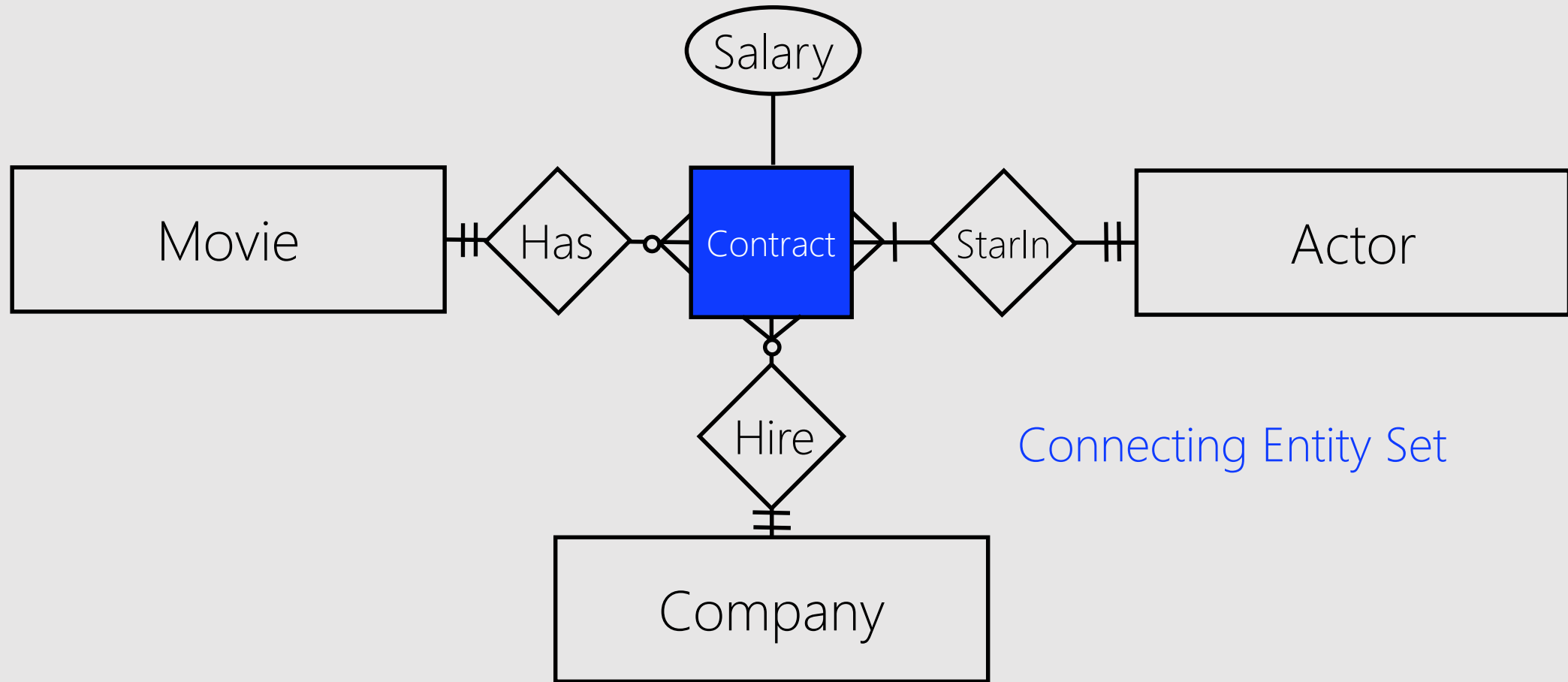
# R2R × Ternary

103



# R2R × Ternary-2-Binary

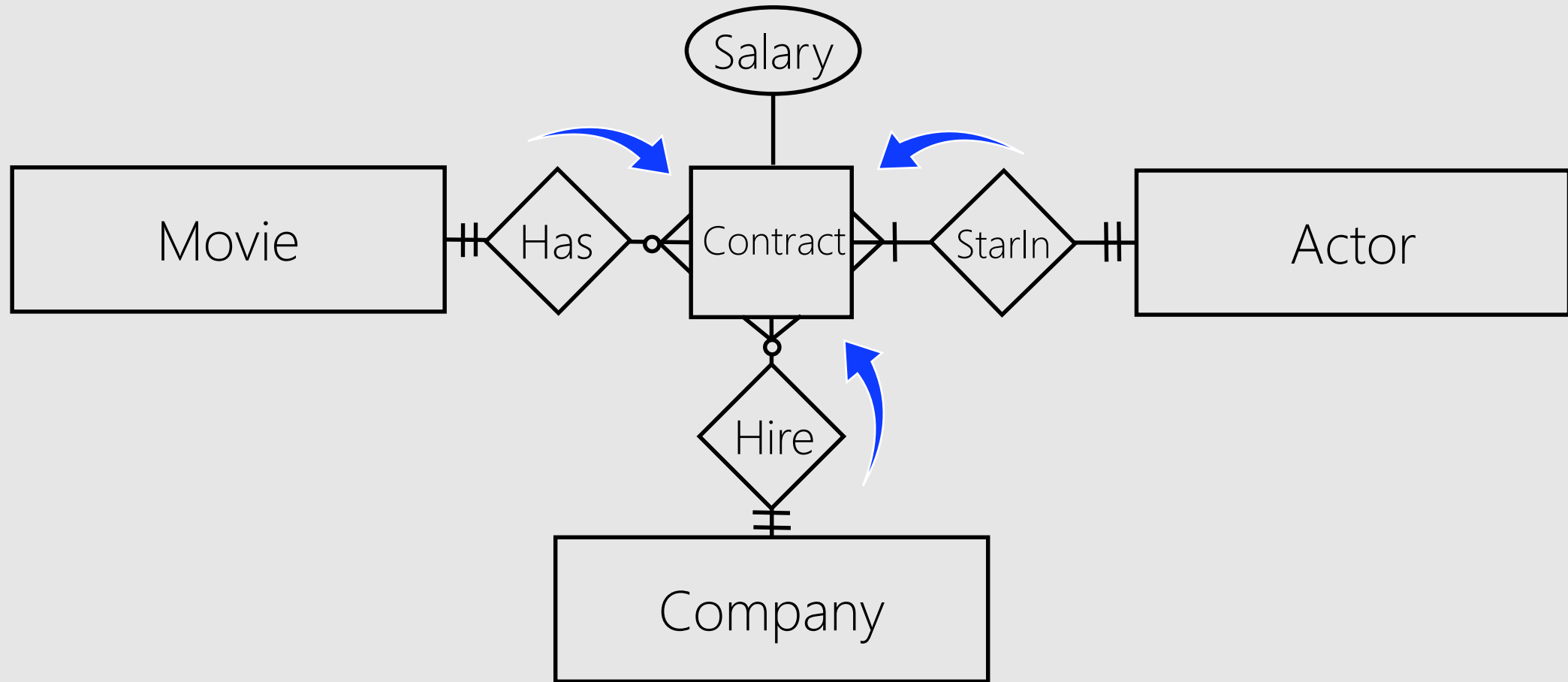
104





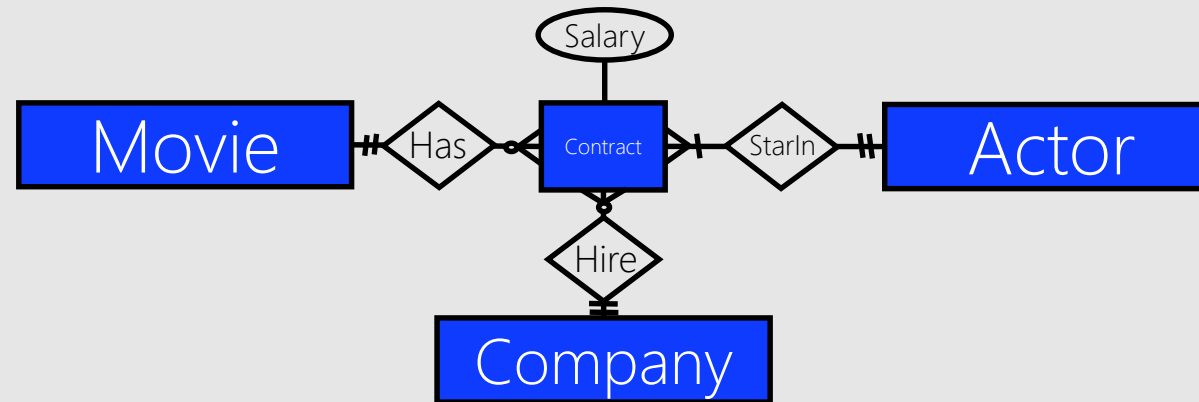
# R2R × Ternary-2-Binary

105



# R2R × Ternary-2-Binary

106



$R_1$ : Company(Name, Address, Phone, ...)

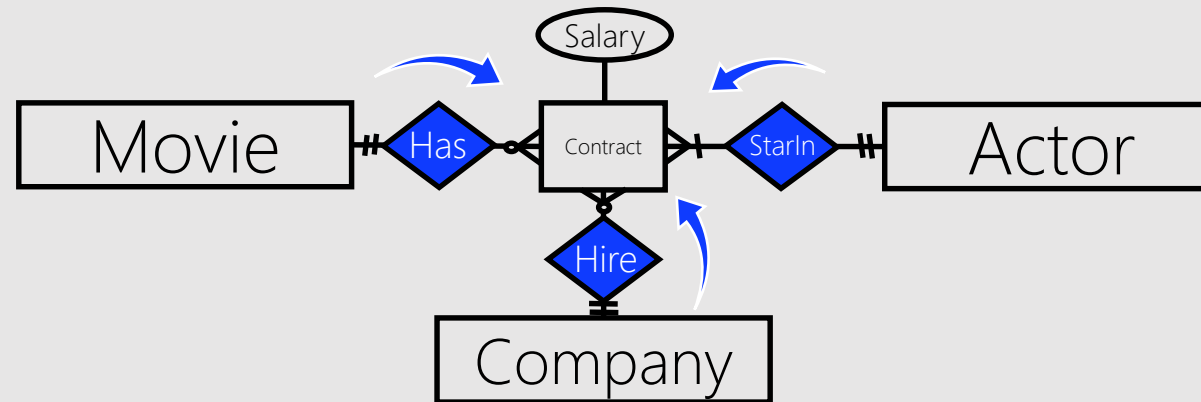
$R_2$ : Actor(FirstName, LastName, DateOfBirth, PlaceOfBirth, ...)

$R_3$ : Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime)

$R_4$ : Contract(Salary)

# R2R × Ternary-2-Binary

107



R<sub>1</sub>: Company(Name, Address, Phone, ...)

R<sub>2</sub>: Actor(FirstName, LastName, DateOfBirth, PlaceOfBirth, ...)

R<sub>3</sub>: Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime)

R<sub>4</sub>: Contract(Salary,

CompanyName,

FK<sub>1</sub>

ActorFirstName, ActorLastName, ActorDateOfBirth,

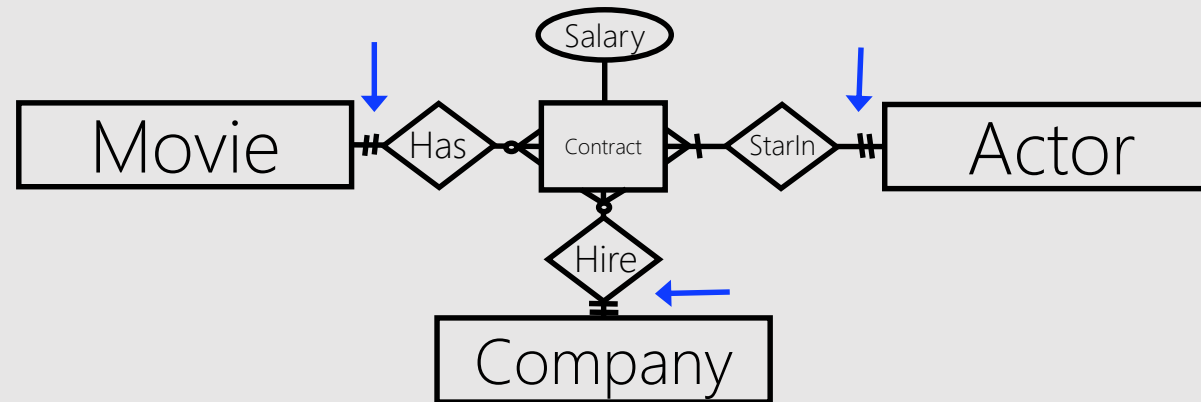
FK<sub>2</sub>

MovieTitle, MovieReleaseYear, ReleaseMonth, ReleaseDay)

FK<sub>3</sub>

# R2R × Ternary-2-Binary

108



R<sub>1</sub>: Company(Name, Address, Phone, ...)

R<sub>2</sub>: Actor(FirstName, LastName, DateOfBirth, PlaceOfBirth, ...)

R<sub>3</sub>: Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime)

R<sub>4</sub>: Contract(Salary,

CompanyName,

ActorFirstName, ActorLastName, ActorDateOfBirth,

MovieTitle, MovieReleaseYear, ReleaseMonth, ReleaseDay)

FK<sub>1</sub> Mandatory

FK<sub>2</sub> Mandatory

FK<sub>3</sub> Mandatory

# R2R × Surrogate Key

109

Sometimes primary key set gets large,  
e.g., Movie's PK={Title, ReleaseYear, ReleaseMonth, ReleaseDay}  
e.g., Actor's PK={FirstName, LastName, DateOfBirth}

It replicates itself when becomes FK to other relations.

Not convenient!

# R2R × Surrogate Key

110

One attribute key (not a set)

The values are system-generated, e.g., [AUTONUMBER](#), i.e., 1,2,3,...,

Usually named [Id](#) | [RowId](#)

Surrogate key vs. natural key set | business key set:

The values of generated surrogate key have NO meaning in real-world!

Surrogate key is just for data engineers convenience.

[Old \(natural\) primary key set becomes mandatory candidate key.](#)

[Old \(natural\) primary key set becomes mandatory candidate key.](#)

# R2R × Surrogate Key

111

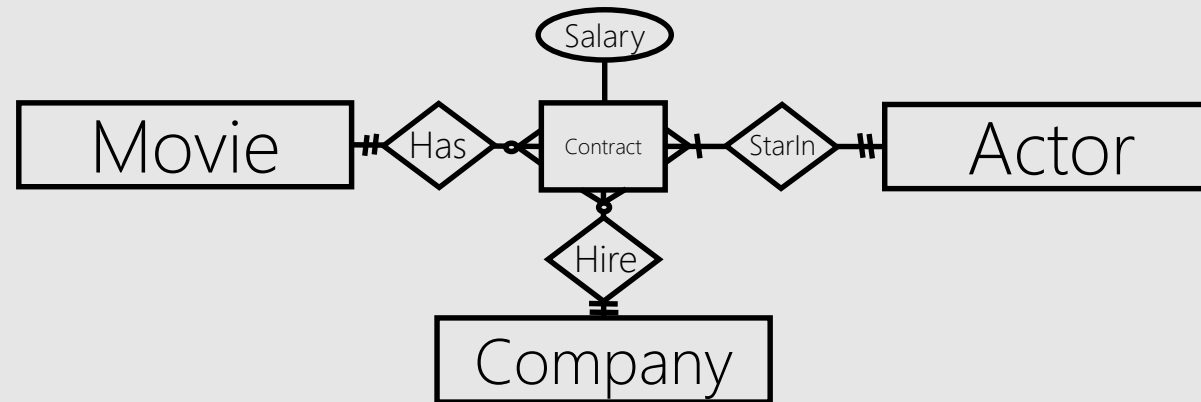
Movie(Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age, ...)

Becomes:

Movie(Id, Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime, Age, ...)  
CK={Title, ReleaseYear, ReleaseMonth, ReleaseDay} and Mandatory

# R2R × Ternary-2-Binary

112



R<sub>1</sub>: Company(Id, Name, Address, Phone, ...)

CK={Name}

R<sub>2</sub>: Actor(Id, FirstName, LastName, DateOfBirth, PlaceOfBirth, ...)

CK={FirstName, LastName, DateOfBirth}

R<sub>3</sub>: Movie(Id, Title, ReleaseYear, ReleaseMonth, ReleaseDay, RunningTime)

CK={Title, ReleaseYear, ReleaseMonth, ReleaseDay}

R<sub>4</sub>: Contract(Id, Salary, CompanyId, ActorId, MovieId)

FK<sub>1</sub>

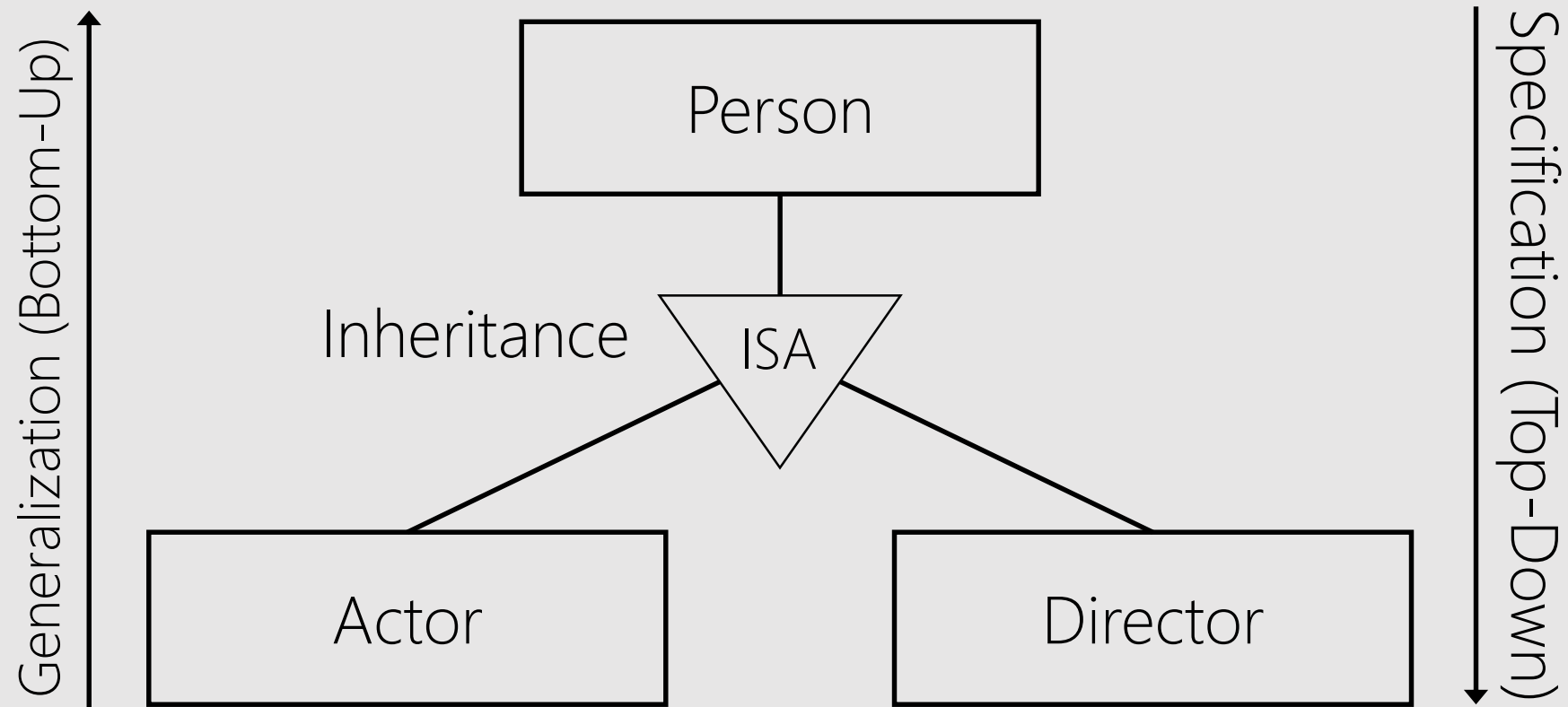
FK<sub>2</sub>

FK<sub>3</sub>



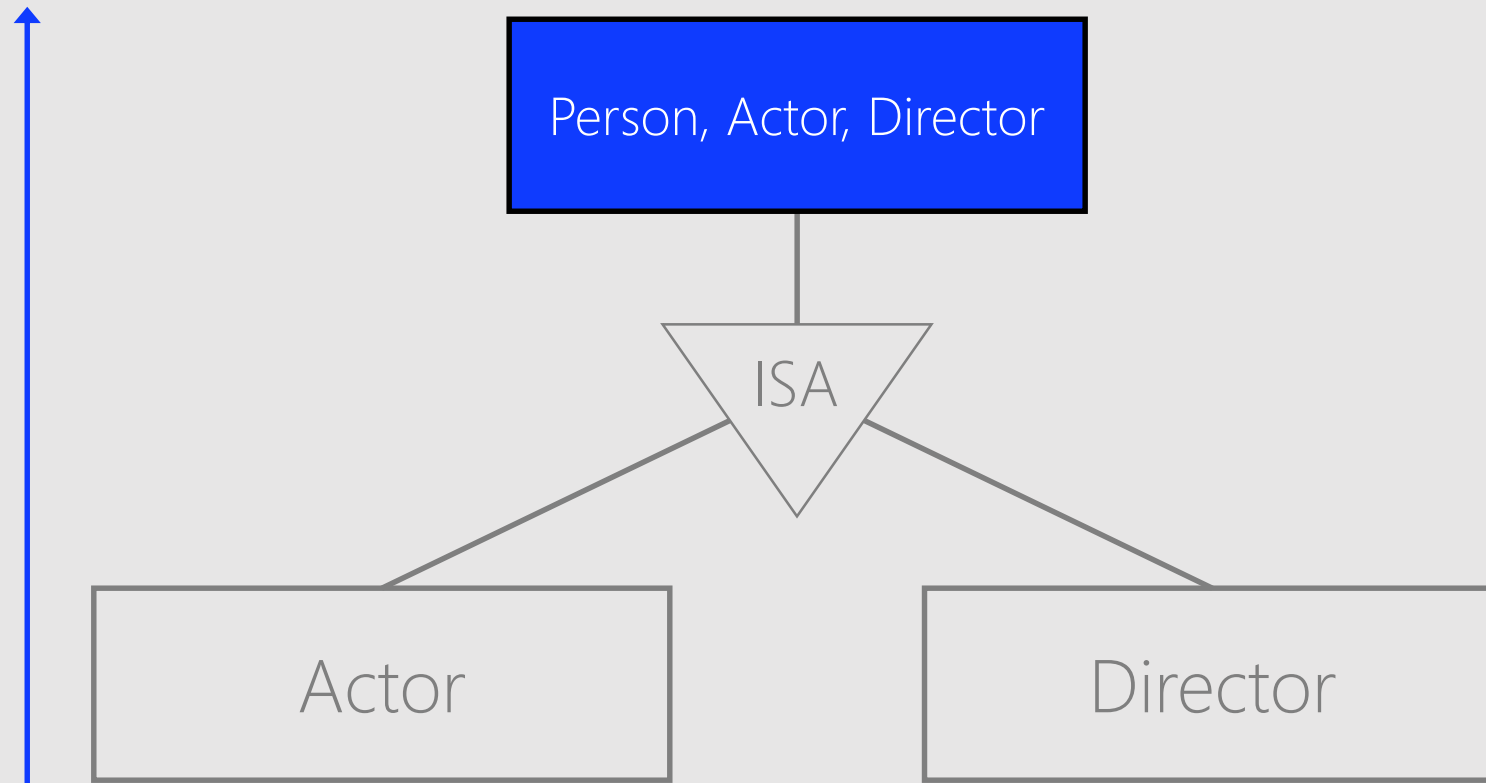


ISA 2 Relation Mapping



# R2R × Single Relation (Approach I)

115



# R2R × Single Relation (Approach I)

116

Person, Actor, Director

$R_1$ : Person(Id, FirstName, LastName, DateOfBirth, PlaceOfBirth, ...  
    PersonType,  
    ActorBestLine, ActorMovieCount,  
    DirectorBestMovie, DirectorMovieCount)

CK={FirstName, LastName, DateOfBirth}

# R2R × Single Relation (Approach I)

117

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

# R2R × Single Relation (Approach I)

118

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Partial Specification

# R2R × Single Relation (Approach I)

119

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Partial and Overlapping Specification

# R2R × Single Relation (Approach I)

120

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

These numbers are not movie titles! What are they?



# R2R × Single Relation (Approach I)

121

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

These numbers are not movie titles! What are they?

Foreign key values from Movie relation primary key.

# R2R × Single Relation (Approach I)

122

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Is it possible to have Partial and Disjoint specification?

# R2R × Single Relation (Approach I)

123

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Is it possible to have Partial and Disjoint specification? Yes.

**Partial:** Make PersonType optional

**Disjoint:** If there is a value it MUST be only Director or Actor, not both.

# R2R × Single Relation (Approach I)

124

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Is it possible to have Total and Disjoint specification?

# R2R × Single Relation (Approach I)

125

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Is it possible to have Total and Disjoint specification? Yes.

**Total:** Make PersonType mandatory

**Disjoint:** If there is a value it MUST be only Director or Actor, not both.

# R2R × Single Relation (Approach I)

126

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

Is it possible to have Total and Overlapping specification?

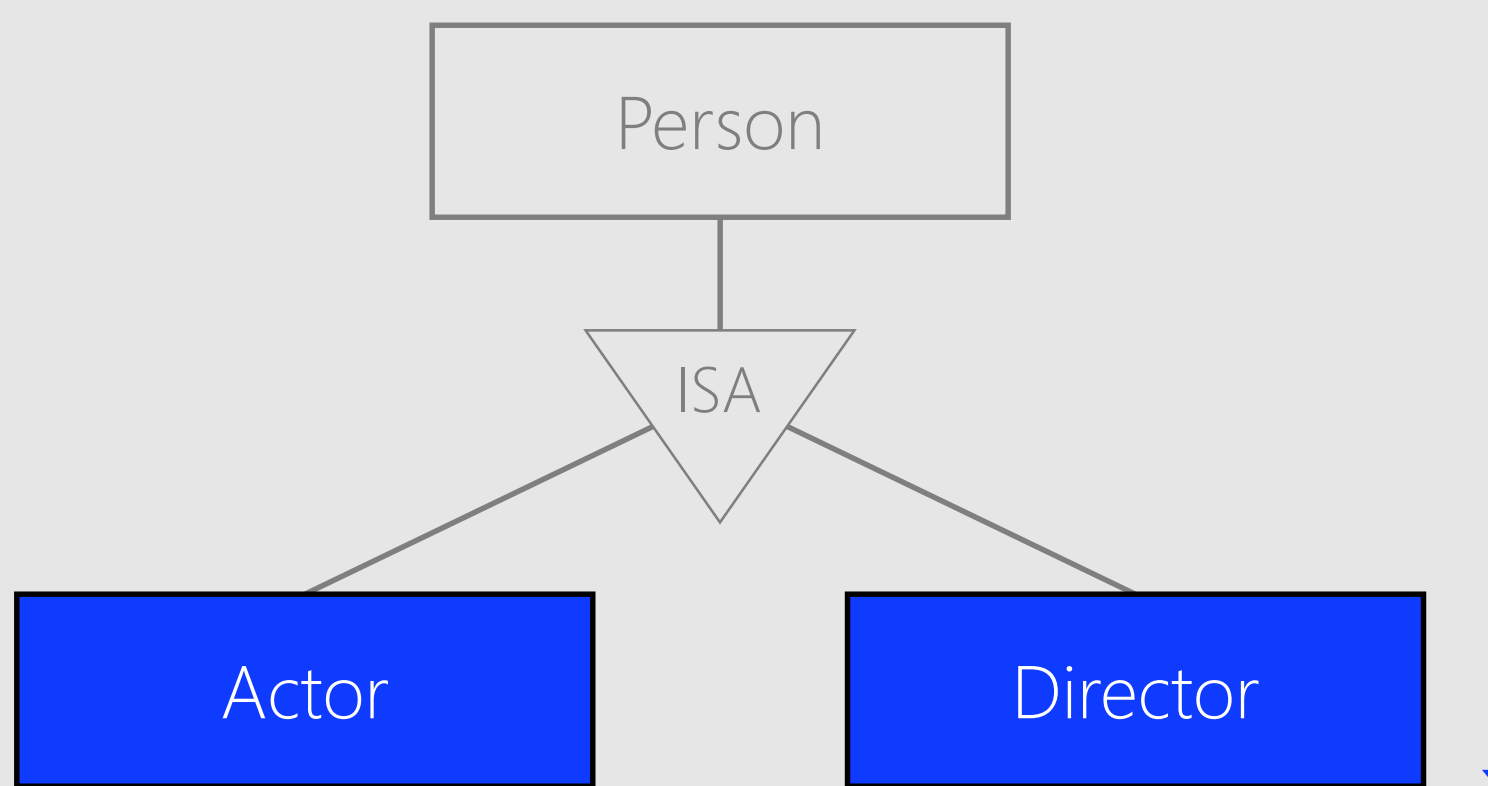
# R2R × Single Relation (Approach I)

127

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	PersonType	ActorBestLine	ActorMovieCount	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	Director	NULL	NULL	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	Director	NULL	NULL	203	47
3	John	Travolta	Feb. 18, 1954	USA	Actor	You ...	61	NULL	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	Actor	Say 'w...	125	NULL	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	Actor	I believe ..	51	NULL	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL	NULL	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	ActorDirector	A good ..	69	803	35

One big merged entity set to have all types of entities.  
Person, Actor, and Director share same relationship sets.

R2R × Relation per Subclass (Approach II) 128





# R2R × Relation per Subclass (Approach II) 129

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	203	47
3	Clint	Eastwood	May 31, 1930	USA	803	35

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	ActorBestLine	ActorMovieCount
1	John	Travolta	Feb. 18, 1954	USA	You ...	61
2	Samuel	Jackson	Dec. 21, 1948	USA	Say 'w...	125
3	Uma	Thurman	Apr. 29, 1970	USA	I believe ..	51
4	Clint	Eastwood	May 31, 1930	USA	A good ..	69

This is the similar to when we did not have ISA in E/R. Redundancy!

# R2R × Relation per Subclass (Approach II) 130

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	203	47
3	Clint	Eastwood	May 31, 1930	USA	803	35

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	ActorBestLine	ActorMovieCount
1	John	Travolta	Feb. 18, 1954	USA	You ...	61
2	Samuel	Jackson	Dec. 21, 1948	USA	Say 'w...	125
3	Uma	Thurman	Apr. 29, 1970	USA	I believe ..	51
4	Clint	Eastwood	May 31, 1930	USA	A good ..	69

This is the similar to when we did not have ISA in E/R. **Update Anomaly!**

# R2R × Relation per Subclass (Approach II) 131

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	203	47
3	Clint	Eastwood	May 31, 1930	USA	803	35

Partial and Disjoint?  
 Partial and Overlapping?  
 Total and Disjoint?  
 Total and Overlapping?

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	ActorBestLine	ActorMovieCount
1	John	Travolta	Feb. 18, 1954	USA	You ...	61
2	Samuel	Jackson	Dec. 21, 1948	USA	Say 'w...	125
3	Uma	Thurman	Apr. 29, 1970	USA	I believe ..	51
4	Clint	Eastwood	May 31, 1930	USA	A good ..	69

# R2R × Relation per Subclass (Approach II) 132

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	DirectorBestMovie	DirectorMovieCount
1	Stanley	Kubrick	Jul. 26, 1928	USA	102	13
2	Alfred	Hitchcock	Aug. 13, 1899	England	203	47
3	Clint	Eastwood	May 31, 1930	USA	803	35

Partial and Disjoint? N/A

Partial and Overlapping? N/A

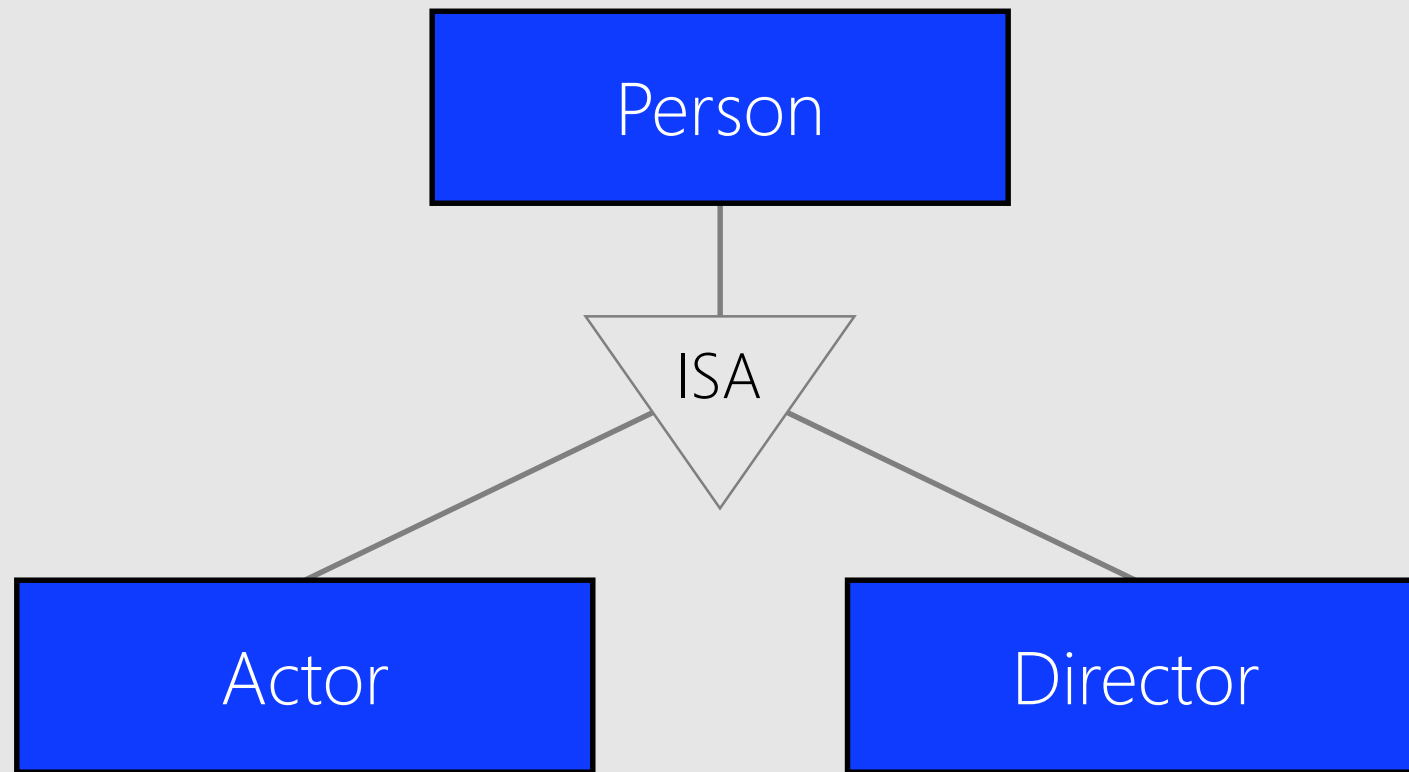
Total and Disjoint? Yes.

Total and Overlapping? Yes. Replicate

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	ActorBestLine	ActorMovieCount
1	John	Travolta	Feb. 18, 1954	USA	You ...	61
2	Samuel	Jackson	Dec. 21, 1948	USA	Say 'w...	125
3	Uma	Thurman	Apr. 29, 1970	USA	I believe ..	51
4	Clint	Eastwood	May 31, 1930	USA	A good ..	69

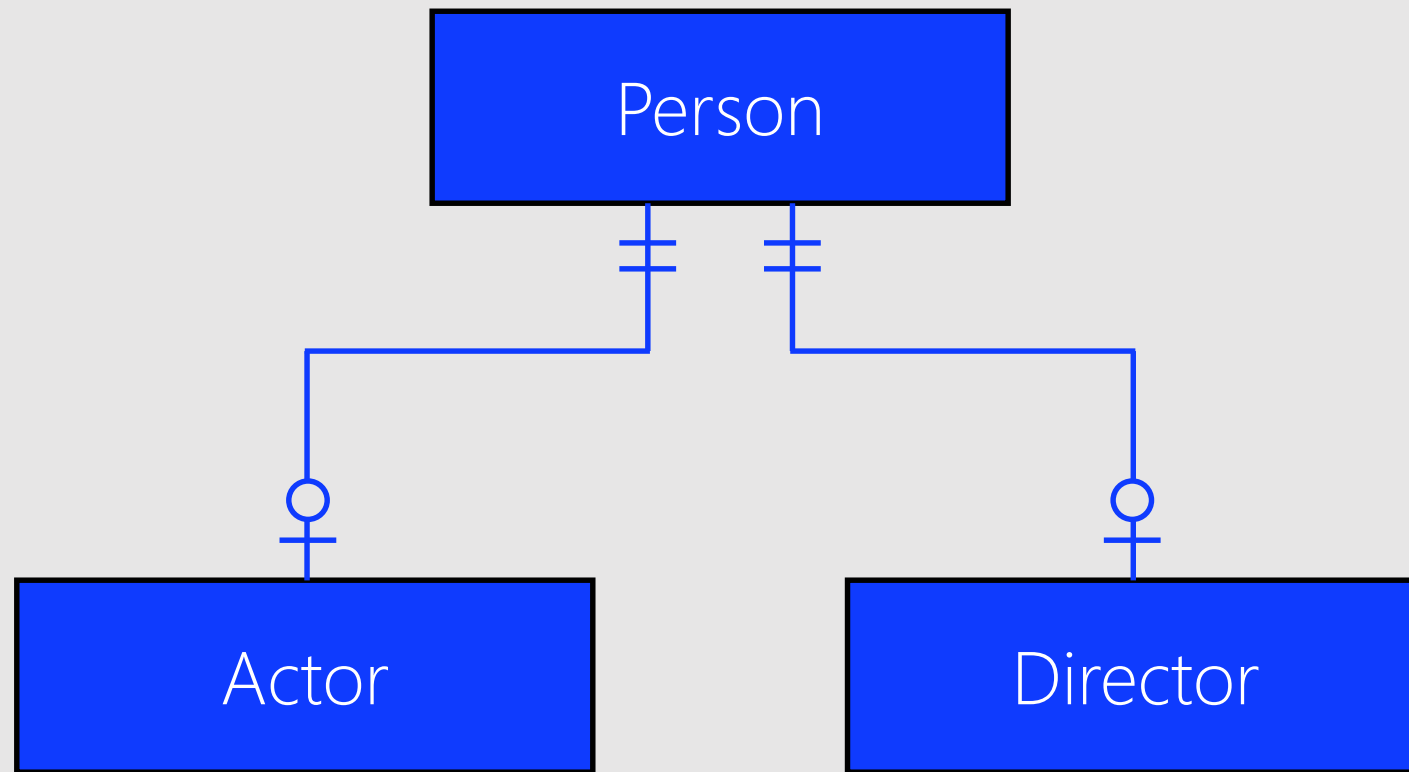
# R2R × Relation per All (Approach III)

133

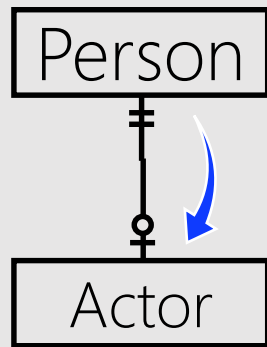


# R2R × Relation per All (Approach III)

134



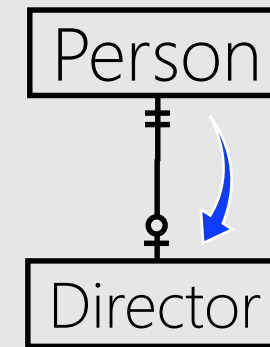
# R2R × Relation per All (Approach III-a) 135



Id	ActorBestLine	ActorMovieCount	PersonId
1	You ...	61	3
2	Say 'w...	125	4
3	I believe ..	51	5
4	A good ..	69	7

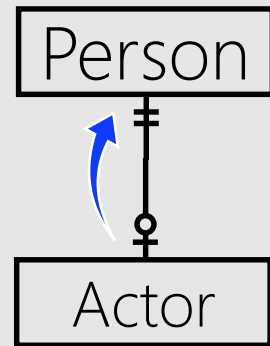
Id	FirstName	LastName	DateOfBirth	PlaceOfBirth
1	Stanley	Kubrick	Jul. 26, 1928	USA
2	Alfred	Hitchcock	Aug. 13, 1899	England
3	John	Travolta	Feb. 18, 1954	USA
4	Samuel	Jackson	Dec. 21, 1948	USA
5	Uma	Thurman	Apr. 29, 1970	USA
6	Hossein	Fani	Sept. 11, 1983	Iran
7	Clint	Eastwood	May 31, 1930	USA

Foreign Key &  
Mandatory Candidate Key



Id	DirectorBestMovie	DirectorMovieCount	PersonId
1	102	13	1
2	203	47	2
3	803	35	7

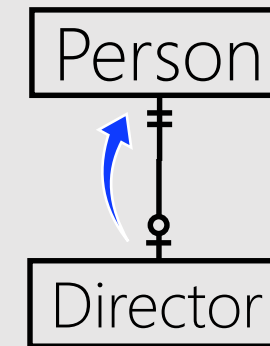
# R2R × Relation per All (Approach III-b) 136



Id	ActorBestLine	ActorMovieCount
1	You ...	61
2	Say 'w...	125
3	I believe ..	51
4	A good ..	69

Id	FirstName	LastName	DateOfBirth	PlaceOfBirth	ActorId	DirectorId
1	Stanley	Kubrick	Jul. 26, 1928	USA	NULL	1
2	Alfred	Hitchcock	Aug. 13, 1899	England	NULL	2
3	John	Travolta	Feb. 18, 1954	USA	1	NULL
4	Samuel	Jackson	Dec. 21, 1948	USA	2	NULL
5	Uma	Thurman	Apr. 29, 1970	USA	3	NULL
6	Hossein	Fani	Sept. 11, 1983	Iran	NULL	NULL
7	Clint	Eastwood	May 31, 1930	USA	4	3

Foreign Key &  
Candidate Key



Id	DirectorBestMovie	DirectorMovieCount
1	102	13
2	203	47
3	803	35



# R2R × Relation per All (Approach III)

137

Partial & Disjoint?

Partial & Overlapping?

Total & Disjoint?

Total & Overlapping?