

Last Week × Q4Me

-2

Book on D2L

The First 10%

Book vs. Slides

W01: CH01

W02: CH04 (2nd Ed.), CH02 (1st Ed.)

SQLite vs. MySQL

SQLite

Changing Lab Sections

Front Desk | TA

Lab Assignments

?

Roman Polanski

PlaceOfBirth=France

Last Week × Q4U

-1

Data Modeling (Data Odyssey)?

Data Modeling in Memory: Pros & Cons?

Data Modeling in File: Pros & Cons?

Transaction?

ACID Properties?

Database Management System (DBMS)?

Main Advantage of DBMS?

Our Role in DBMS in this Course?

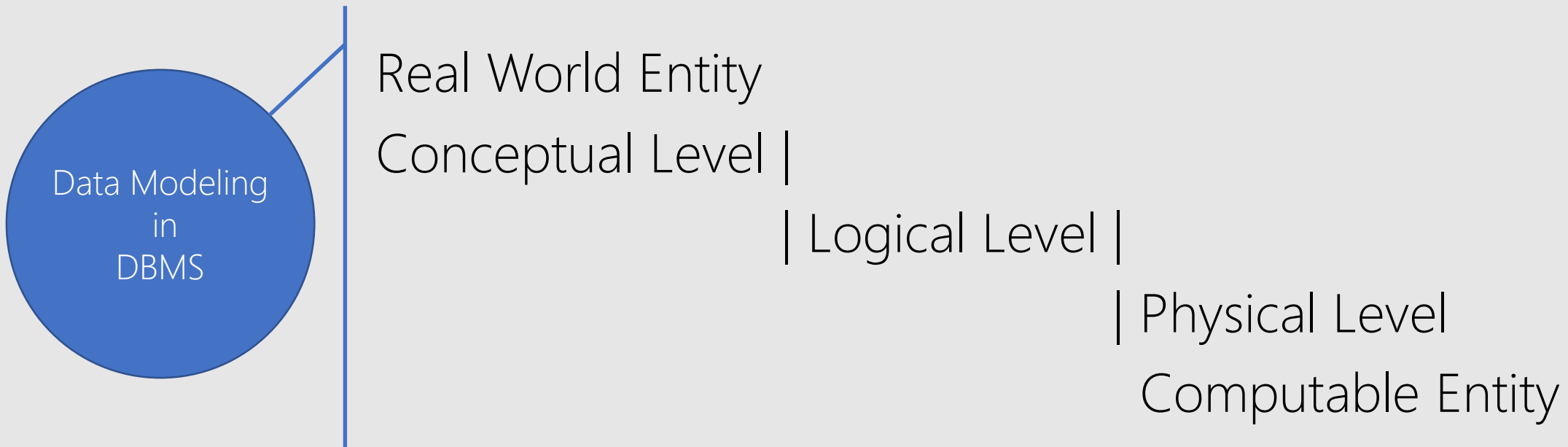
Last Week × Q4U

0

Data Modeling (Data Odyssey)?	W01-25
Data Modeling in Memory: Pros & Cons?	W01-60
Data Modeling in File: Pros & Cons?	W01-70
Transaction?	W01-72
ACID Properties?	W01-73
Database Management System (DBMS)?	W01-86
Main Advantage of DBMS?	W01-87
Our Role in DBMS in this Course?	W01-88

2019: A Data Odyssey × Real World

1



2019: A Data Odyssey × Real World

2



Data Modeling
in
RDBMS

Real World Entity

Conceptual Level | Entity-Relationship Model

| Logical Level | Relational Model

| Physical Level | SQL

Computable Entity

Today

3



Data Modeling
in
RDBMS

Real World Entity

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

| Logical Level | Relational Model

| Physical Level | SQL

Computable Entity

Last Week | Welcome | Entity | Attribute | Relationship | Extended ER (EER)

Oops!

4



Data Modeling
in
RDBMS

Real World Entity: Any Type of Entity?

No!

Image?

No!

Voice?

No!

Movie?

No!

Document?

No!

Spatial (Map)?

No!



Conceptual Level | Entity-Relationship Model

Entity-Relationship Model (E/R)

6

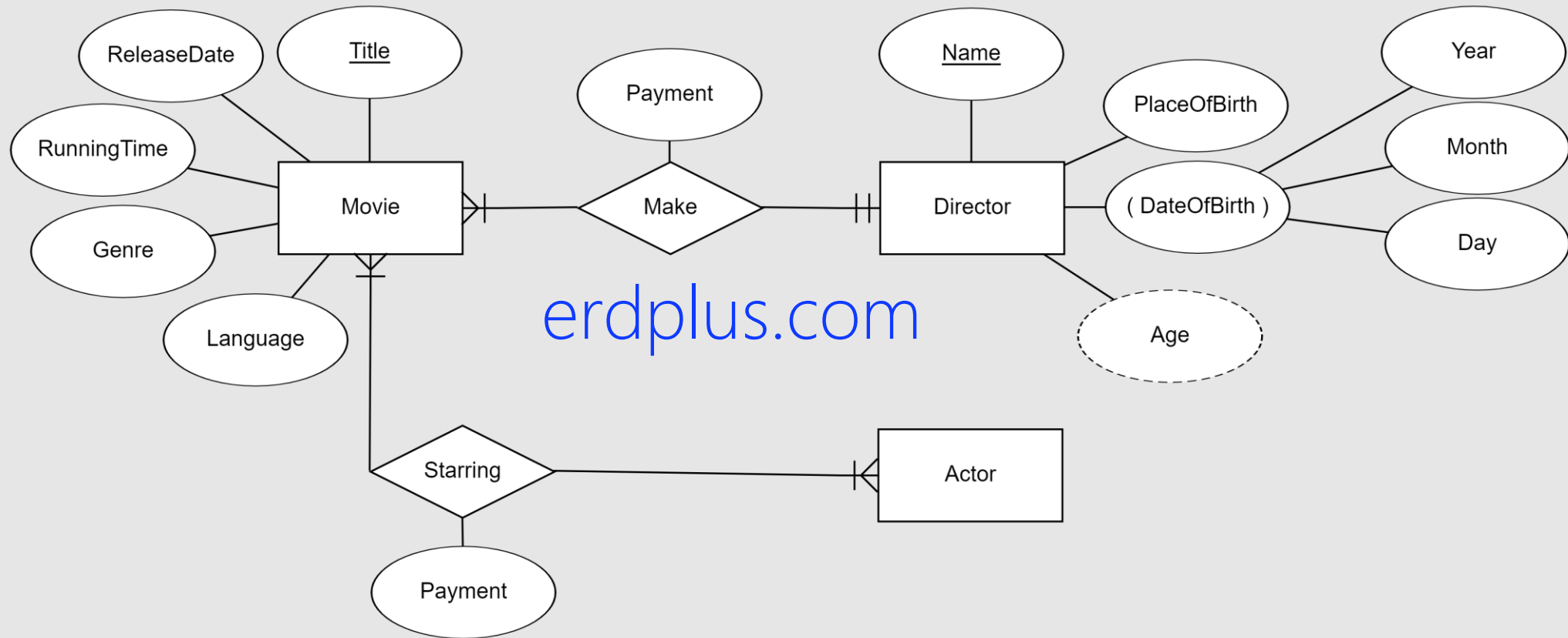
1. Identify Real World Entities, Attributes, Relationships
2. Create Graphical Schema: ER Diagram

A picture is worth a thousand words!

All data engineers All over the world understand ERD!

E/R × ERD

7



E/R × Entity (e_i)

8

Real world thing that exists & is distinguishable from other things

e_1 =The Birds, e_2 =Rosemary's Baby, e_3 =L.A. Confidential
 e_4 =Alfred Hitchcock, e_5 =Roman Polanski, e_6 =James Cameron
 e_7 =Tippi Hedren, e_8 =Mia Farrow, e_9 =John Cassavetes
 e_{10} =Ebrahim Bagheri, e_{11} =Hossein Fani, ...

E/R × Entity Set (E)

9

A set of entities of the same type that share the same properties

Movie = { e_1 =The Birds, e_2 =Rosemary's Baby, e_3 =L.A. Confidential, ...}

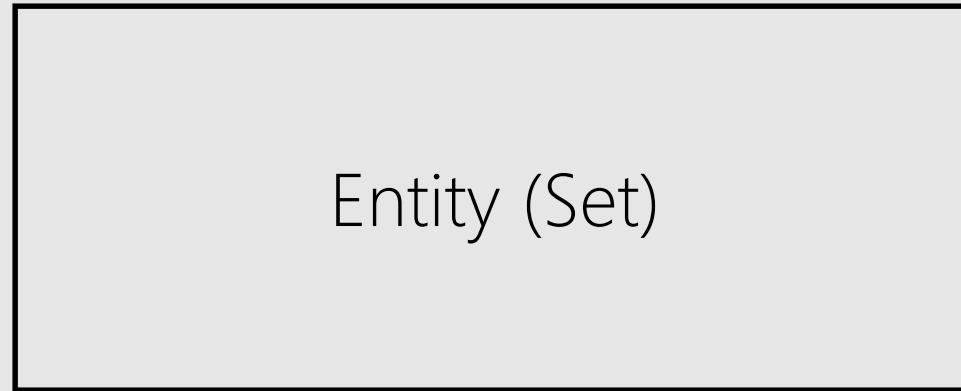
Director = { e_4 =Alfred Hitchcock, e_5 =Roman Polanski, e_6 =James Cameron, ...}

Actor = { e_7 =Tippi Hedren, e_8 =Mia Farrow, e_9 =John Cassavetes, ...}

Lecturer = { e_{10} =Ebrahim Bagheri, e_{11} =Hossein Fani, ...}

E/R × Entity Set (E)

10



E/R × Entity Set

11

Movie

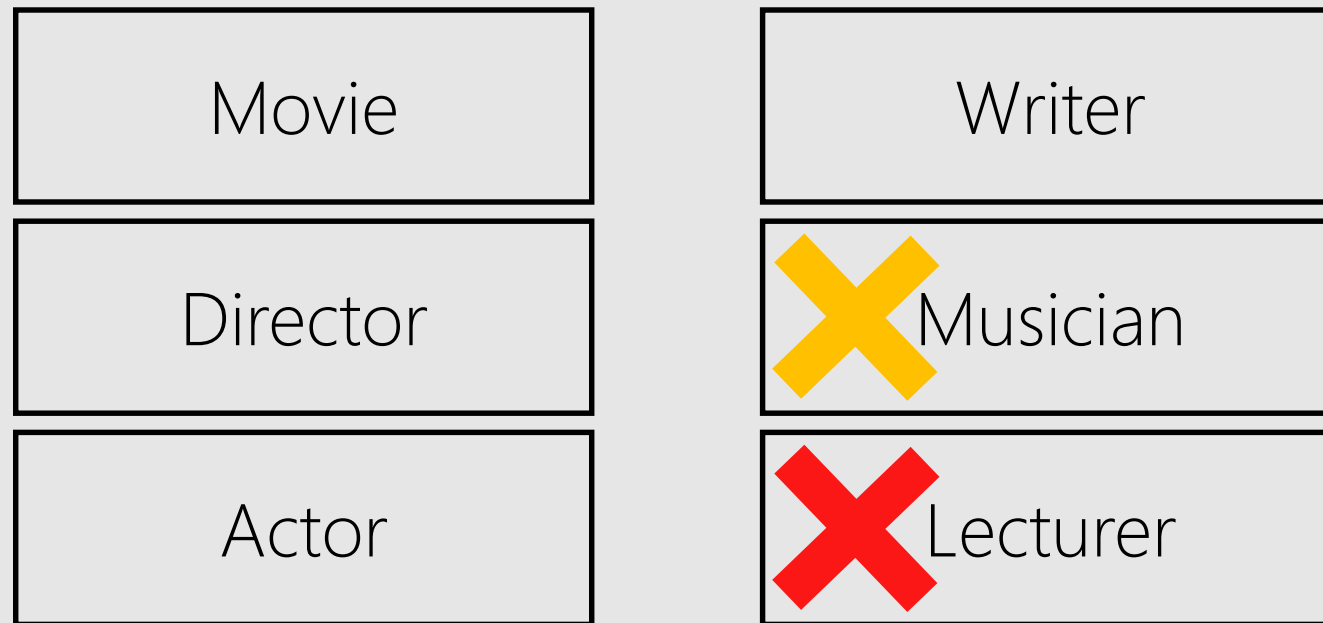
Actor

Director

E/R × Entity Set × Faithfulness

12

Design should be faithful to the specifications of the application



E/R × Attribute

13

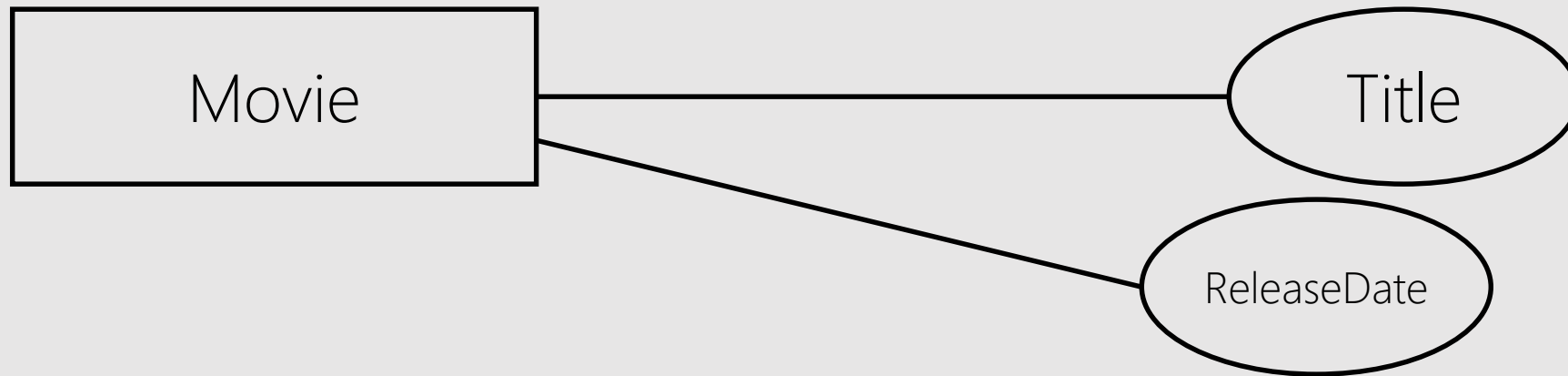
Properties of entities in entity set



E/R × Attribute

14

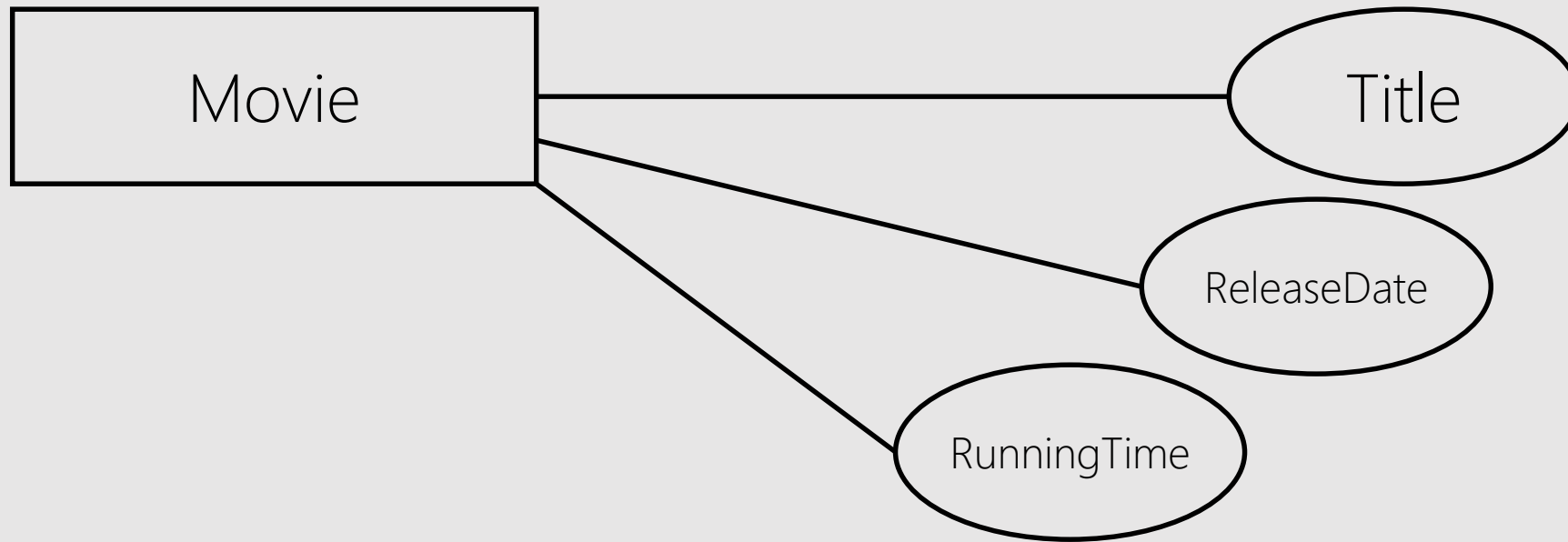
Properties of entities in entity set



E/R × Attribute

15

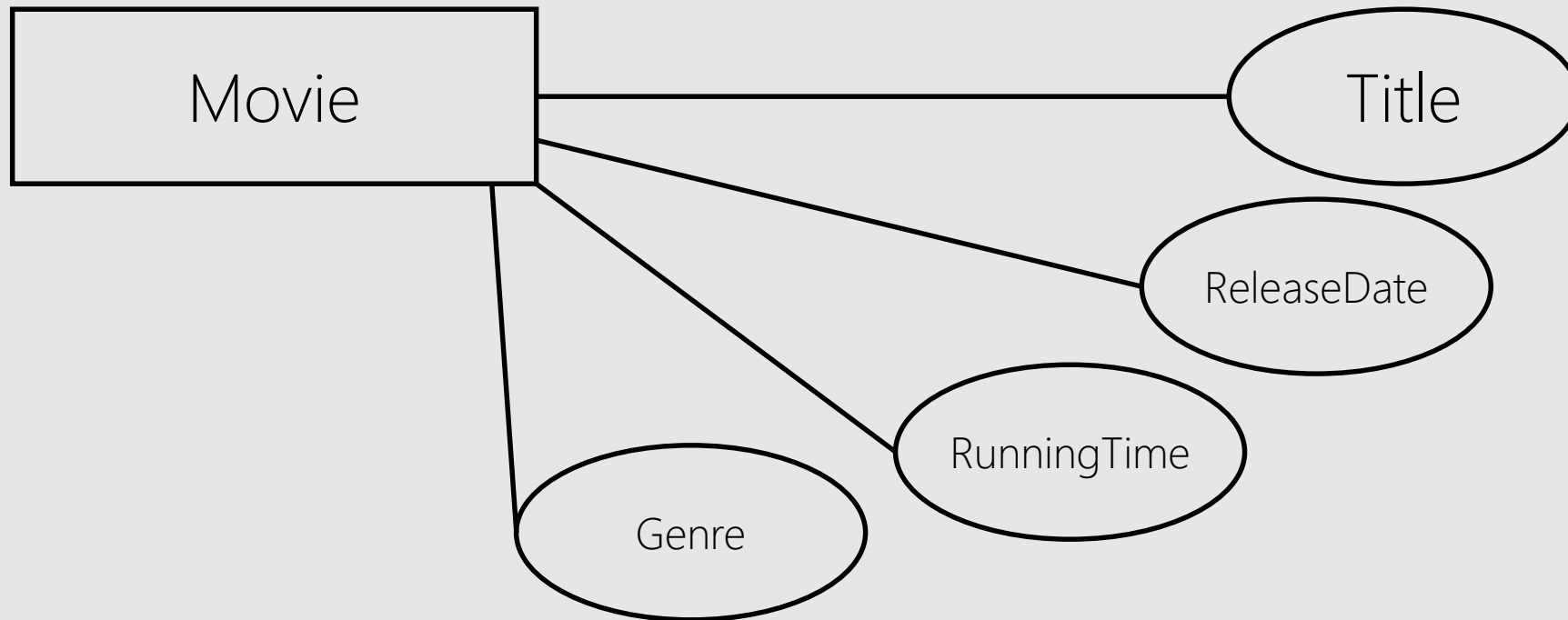
Properties of entities in entity set



E/R × Attribute

16

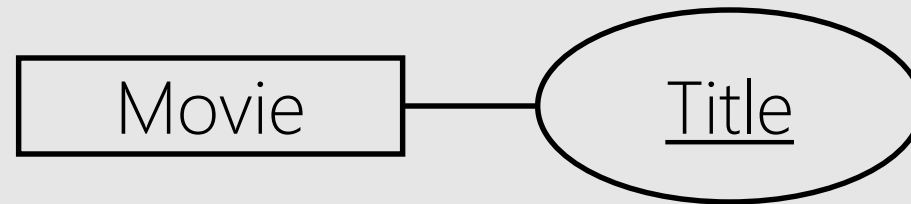
Properties of entities in entity set



E/R × Attribute × Key

17

An attribute or a set of attributes uniquely identify an entity in entity set



A movie is identified by its Title

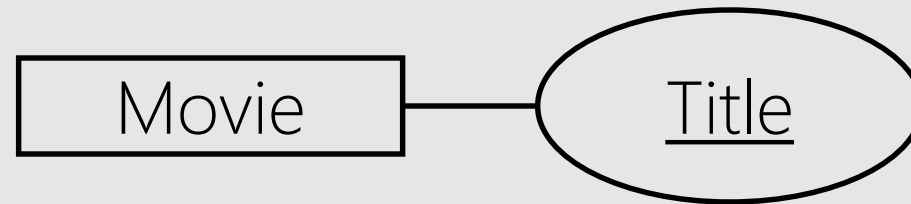
Two movies cannot have same value for Title

The value in Title identifies one and only one movie

E/R × Attribute × Key

18

An attribute or a set of attributes uniquely identify an entity in entity set

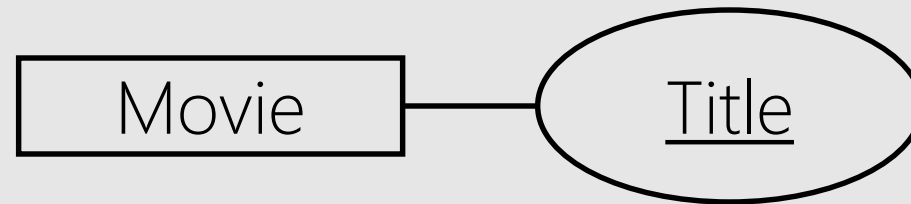


Is it wise to declare Title by itself as a key?

E/R × Attribute × Key

19

An attribute or a set of attributes uniquely identify an entity in entity set



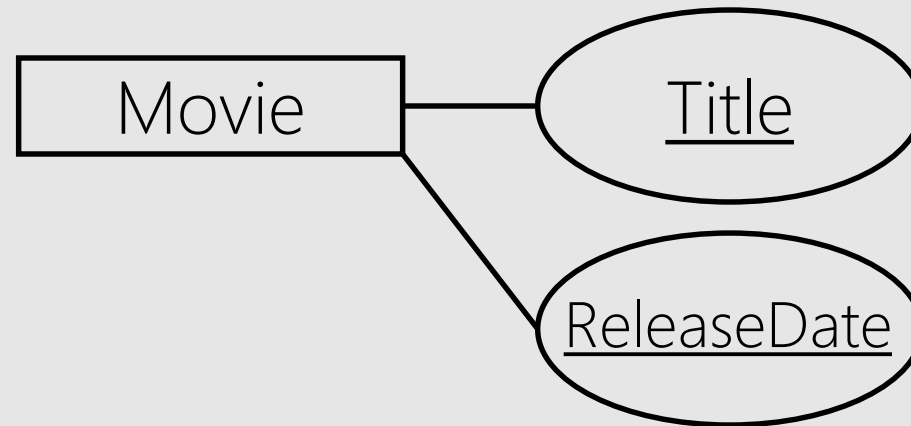
Is it wise to declare Title by itself as a key?

1. *Rosemary's Baby (1968) by Roman Polanski*
2. *Rosemary's Baby (2014) (TV Mini-Series) by Agnieszka Holland*
3. *Rosemary's Baby (2015) by Dane Kissel*

E/R × Attribute × Key

20

An attribute or a set of attributes uniquely identify an entity in entity set



Is it still wise to declare {Title, ReleaseDate} as the key?

E/R × Attribute × Key

21

An attribute or a set of attributes uniquely identify an entity in entity set

How about {Title, ReleaseDate, RunningTime, Genre} as the key?

At worst case, all attributes together are the key!
No duplicate entity in the entity set!

E/R × Attribute × Key

22

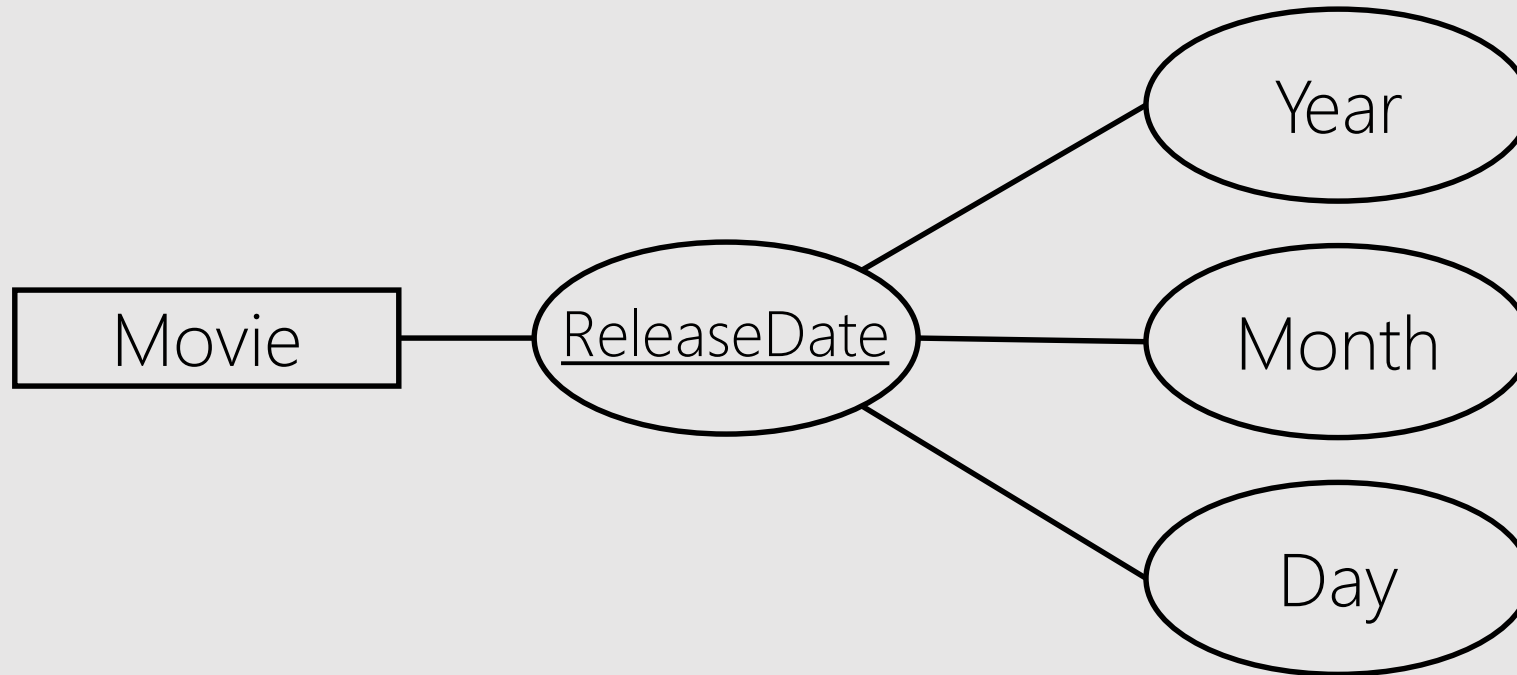
An attribute or a set of attributes uniquely identify an entity in entity set

Keys MUST have value.

E/R × Attribute × Composite

23

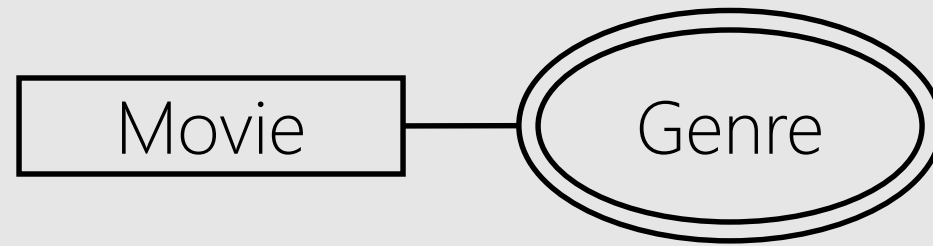
Properties of entities in entity set



E/R × Attribute × Multivalued

24

Properties of entities in entity set



e_1 .Title='The Birds'

e_1 .ReleaseDate=March 28, 1963

e_1 .RunningTime=119

e_1 .Genre={'Drama', 'Horror', 'Mystery'}

e_2 .Title='Rosemary's Baby'

e_2 .ReleaseDate=June 12, 1968

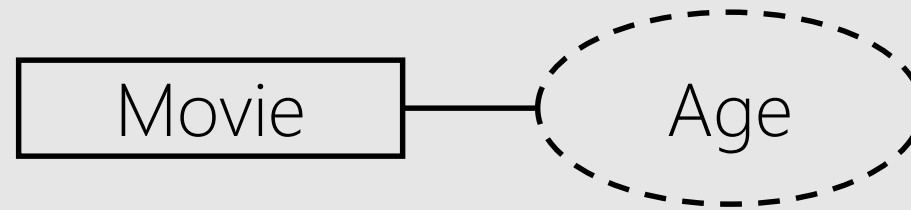
e_2 .RunningTime=136

e_2 .Genre={'Drama', 'Horror'}

E/R × Attribute × Derived

25

Properties of entities in entity set



e_1 .Title='The Birds'

e_1 .ReleaseDate=March 28, 1963

e_1 .RunningTime=119

e_1 .Genre={'Drama', 'Horror', 'Mystery'}

e_1 .Age=YEAR(e_1 .ReleaseDate-NOW)

e_2 .Title='Rosemary's Baby'

e_2 .ReleaseDate=June 12, 1968

e_2 .RunningTime=136

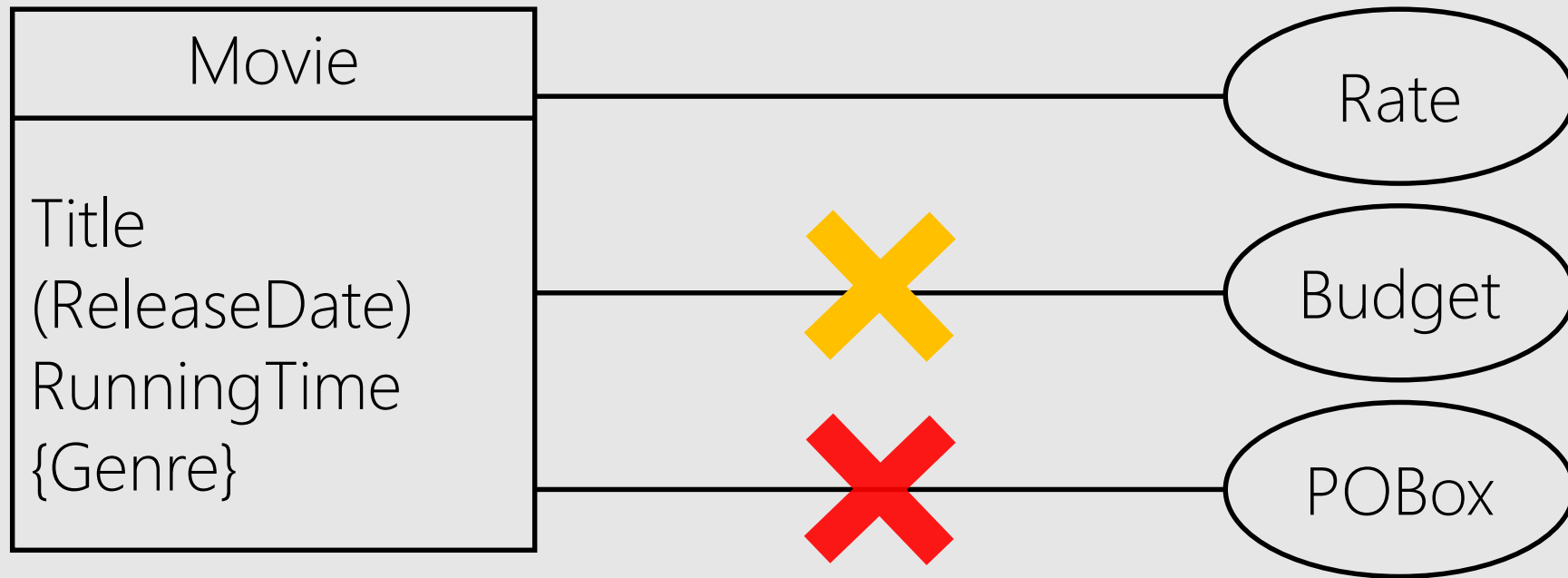
e_2 .Genre={'Drama', 'Horror'}

e_2 .Age=YEAR(e_2 .ReleaseDate-NOW)

E/R × Attribute × Faithfulness

26

Design should be faithful to the specifications of the application



E/R × Attribute × Domain (Data Type) 27

Standard E/R model does not have!

Movie	
Title	(string)
(ReleaseDate)	(date)
RunningTime	(float)
{Genre}	(string)
Age()	(integer)

E/R × Attribute × Multiple Keys

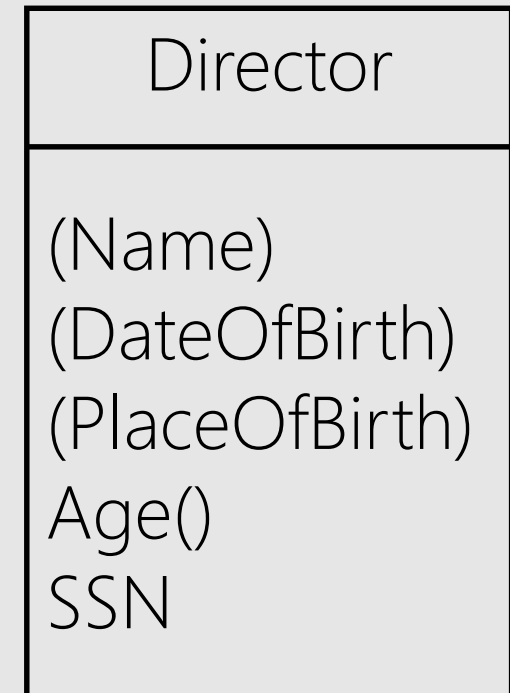
28

Standard E/R model does not have!

$K_1 = \{\text{Name, DateOfBirth}\}$

$K_2 = \{\text{SSN}\}$

Choose?



E/R × Attribute × Multiple Keys

29

Standard E/R model does not have!

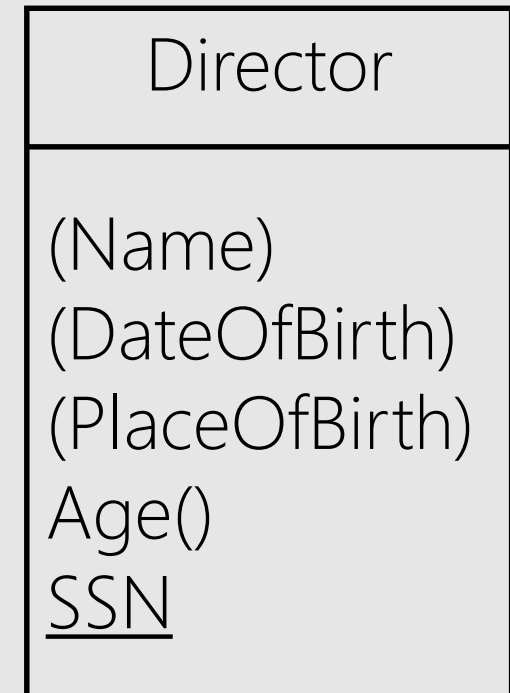
$K_1 = \{\text{Name, DateOfBirth}\}$

$K_2 = \{\text{SSN}\}$

Choose?

Simplicity counts!

K_2 is called Primary Key (PK)



E/R × Attribute × Multiple Keys

30

Standard E/R model does not have!

$K_1 = \{\text{Name, DateOfBirth}\}$

$K_2 = \{\text{SSN}\}$

Choose?

Real world matters as well!

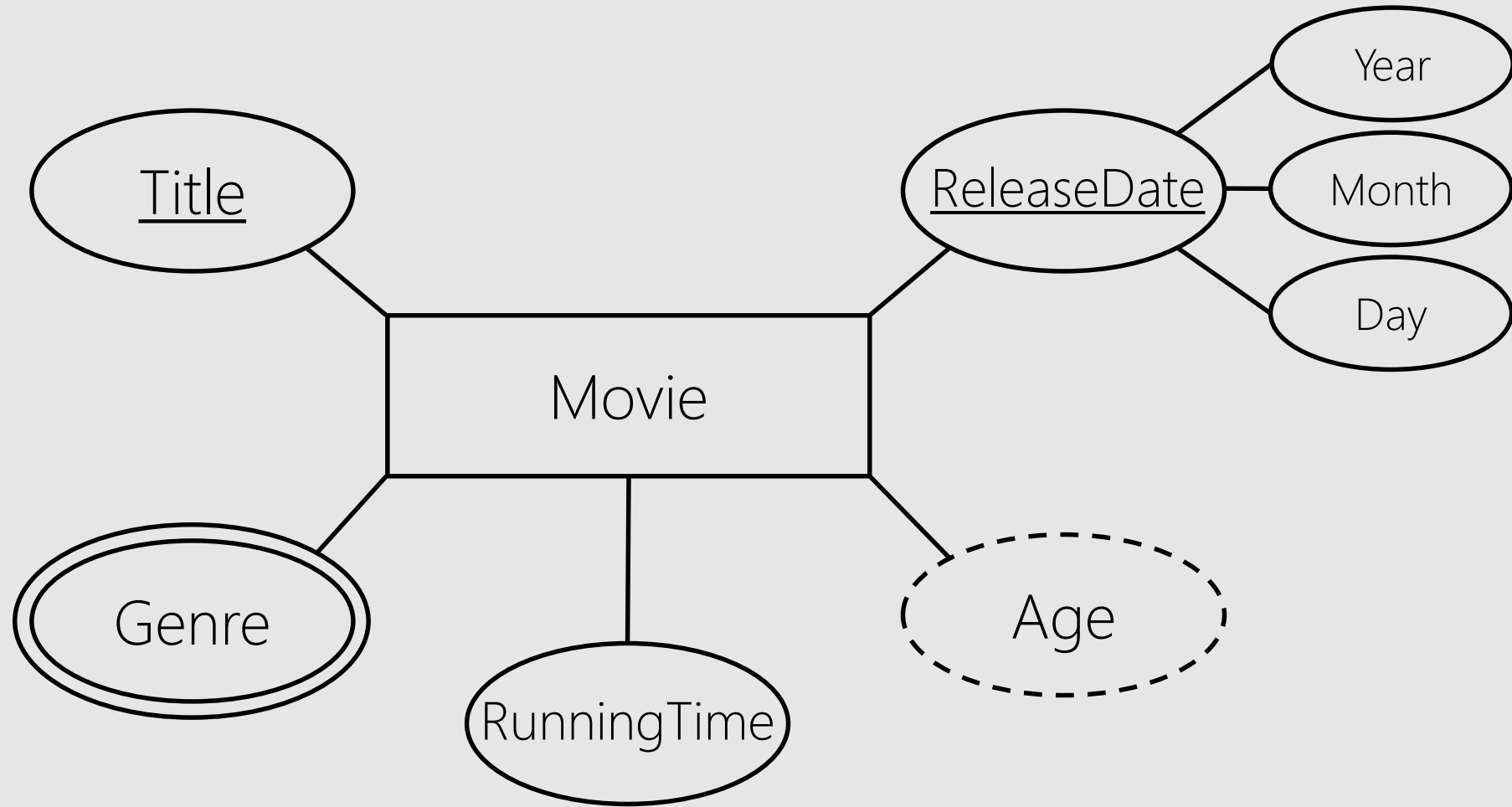
SSN is not available for all Directors!

K_1 is called Primary Key (PK)



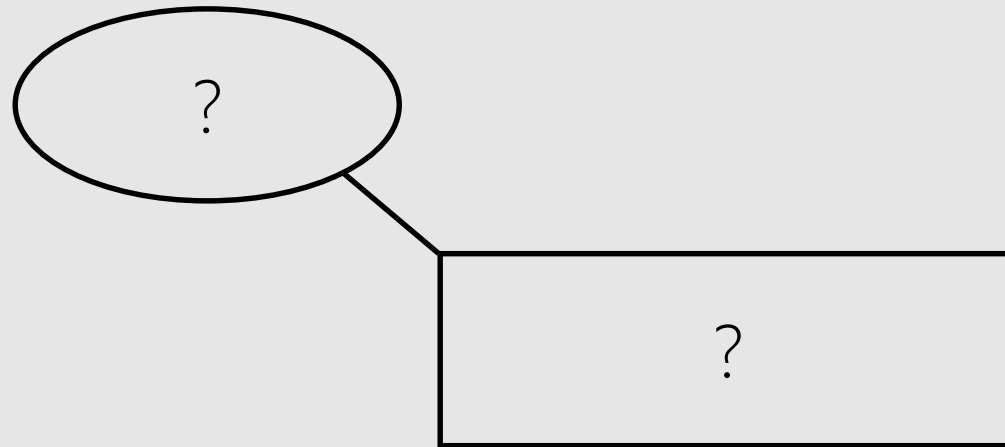
E/R × Movie Schema

31

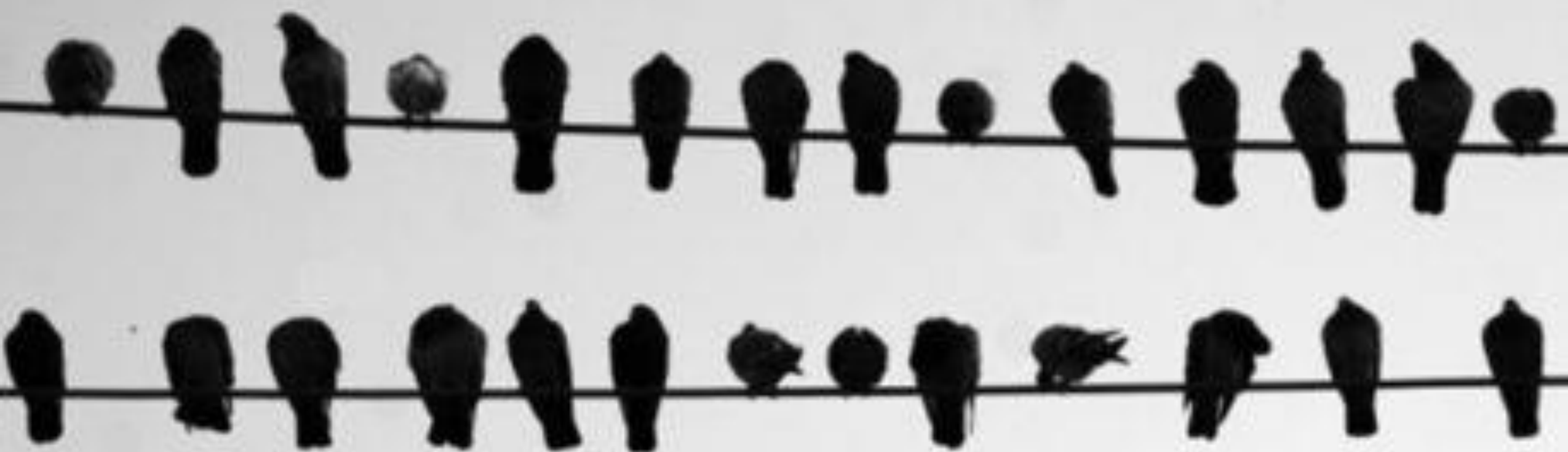


E/R × Your System (15mins)

32



ALFRED HITCHCOCK S



E/R × Relationship (r)

34

An association among entities

Movie (E_1)

$e_1.Title='The Birds'$

$e_1.ReleaseDate=March 28, 1963$

$e_1.RunningTime=119$

$e_1.Genre={'Drama', 'Horror', 'Mystery' }$

$e_1.Age=51$

Director (E_2)

$e_2.Name='Alfred Hitchcock'$

$e_2.DateOfBirth=August 13, 1899$

$e_2.PlaceOfBirth=England$

$e_2.SSN=NULL$

$r = (e_1, e_2) = ({\text{'The Birds', 'March 28, 1963'}}, {\text{'Alfred Hitchcock', 'August 13, 1899'}})$

E/R × Relationship (r)

35

An association among entities

Movie (E_1)

e'_1 .Title='Rosemary's Baby'

e'_1 .ReleaseDate=June 12, 1968

e'_1 .RunningTime=136

e'_1 .Genre={'Drama', 'Horror'}

e'_1 .Age=51

Director (E_2)

e'_2 .Name='Roman Polanski'

e'_2 .DateOfBirth=August 18, 1933

e'_2 .PlaceOfBirth=France

e'_2 .SSN=NULL

$r' = (e'_1, e'_2) = (\text{'Rosemary's Baby', 'June 12, 1968'}, \text{'Roman Polanski', 'August 18, 1933'})$

E/R × Relationship Set (R)

36

$r = (e_1, e_2) = (\{\text{'The Birds'}, \text{'March 28, 1963'}\}, \{\text{'Alfred Hitchcock'}, \text{'August 13, 1899'}\})$

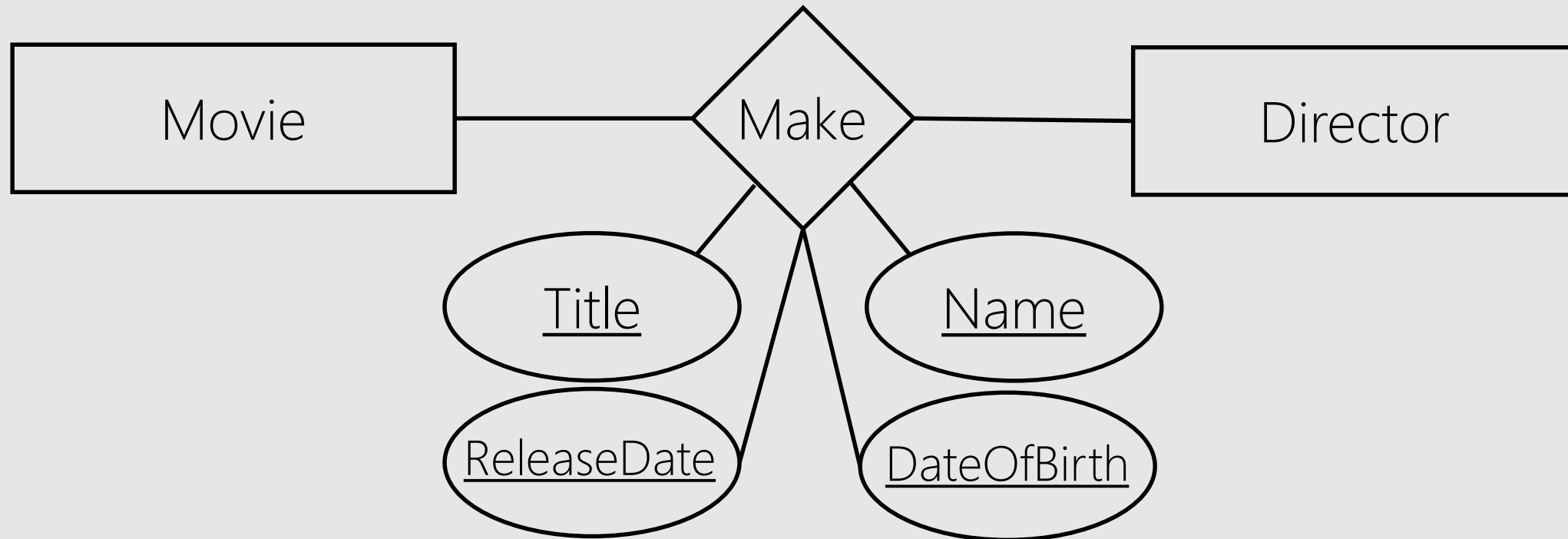
$r' = (e'_1, e'_2) = (\{\text{'Rosemary's Baby'}, \text{'June 12, 1968'}\}, \{\text{'Roman Polanski'}, \text{'August 18, 1933'}\})$

$R = \{r, r', \dots\}$

Binary Relationships

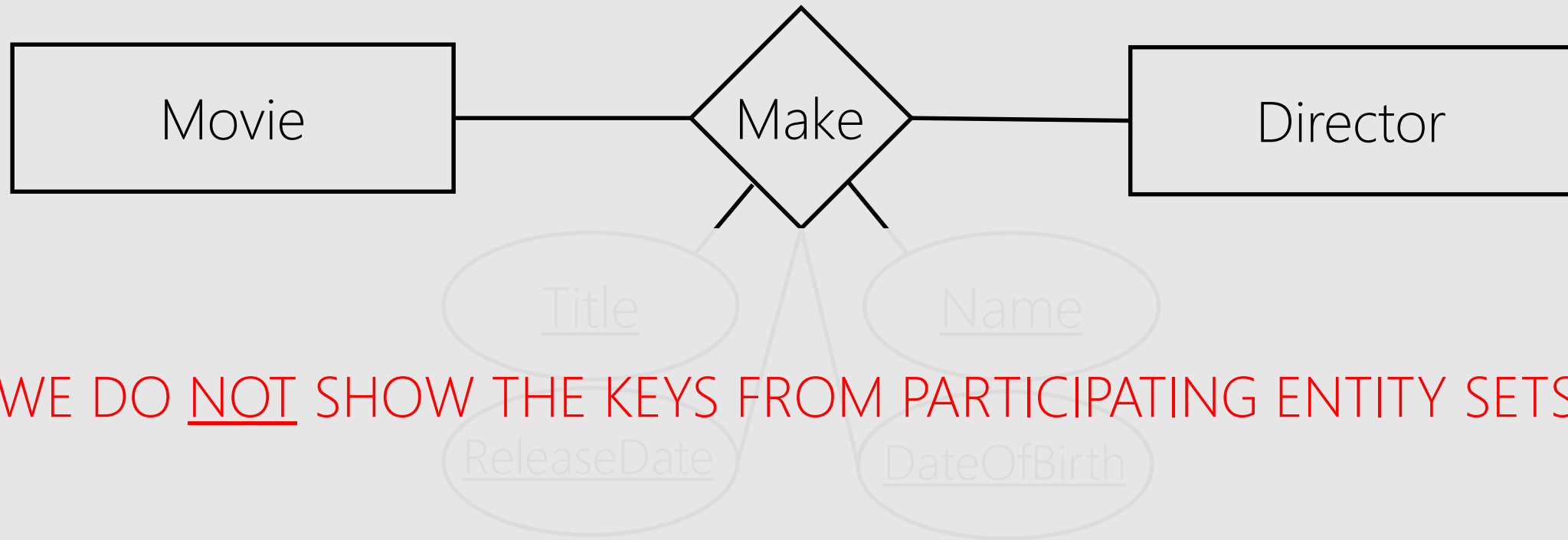
E/R × Relationship Set (R)

37



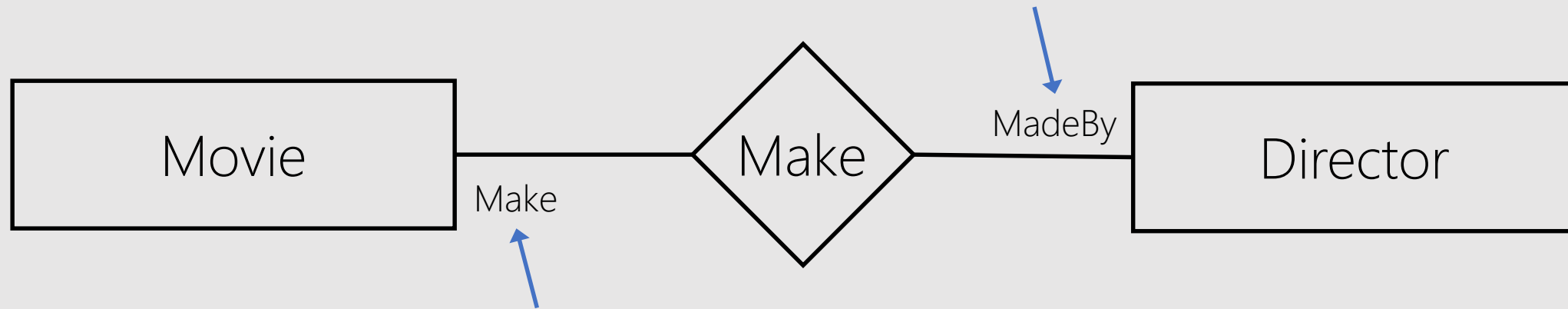
E/R × Relationship Set (R)

38



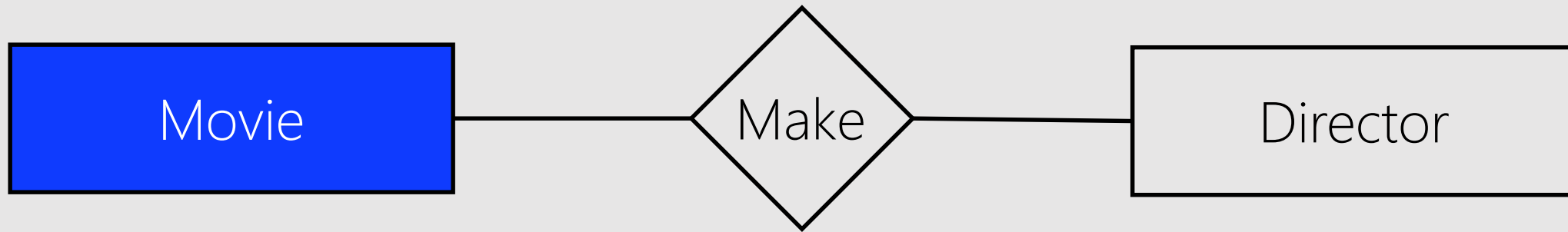
E/R × Relationship Set × Role

39



When not clear, the role in relationship SHOULD be mentioned

E/R × Relationship Set × Participation 40



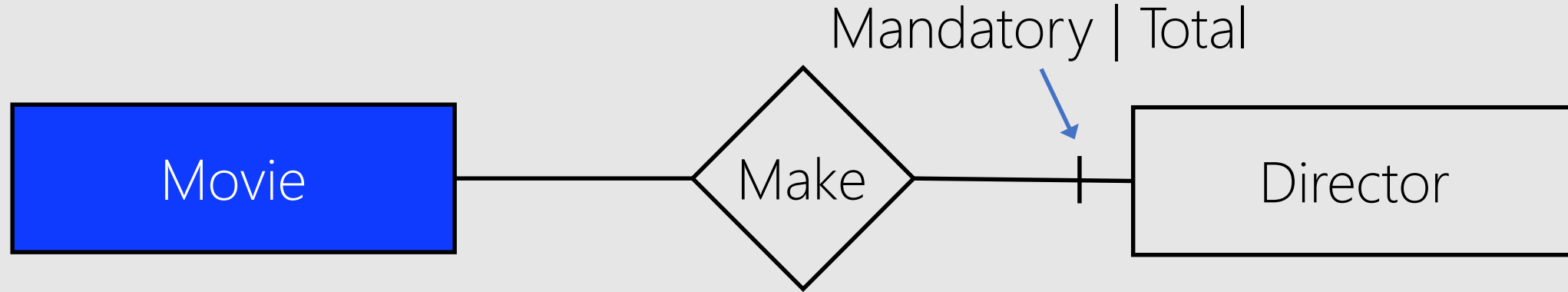
A Movie MUST participate in Make relationship?

A Movie MUST have Director?

Is there a Movie in the system without Director?

E/R × Relationship Set × Participation

41

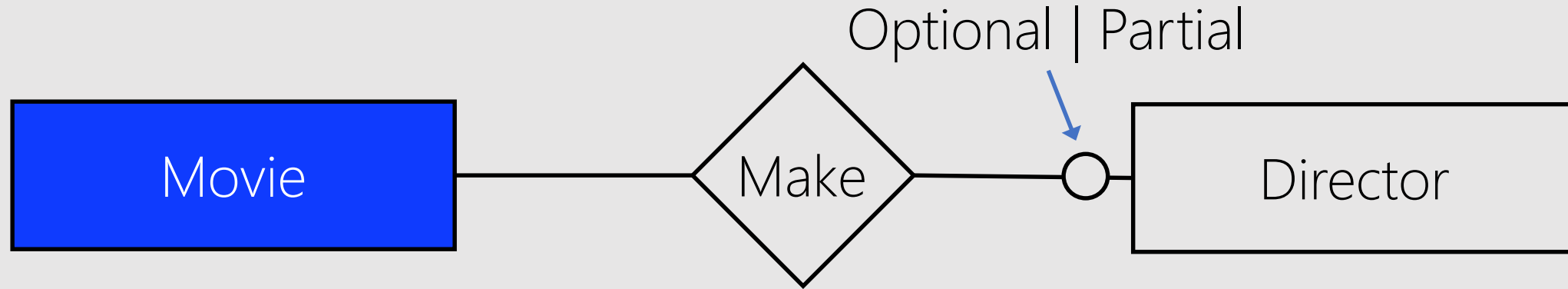


A Movie MUST participate in Make relationship? Yes.

A Movie MUST have Director? Yes.

Is there a Movie in the system without Director? No!

E/R × Relationship Set × Participation 42



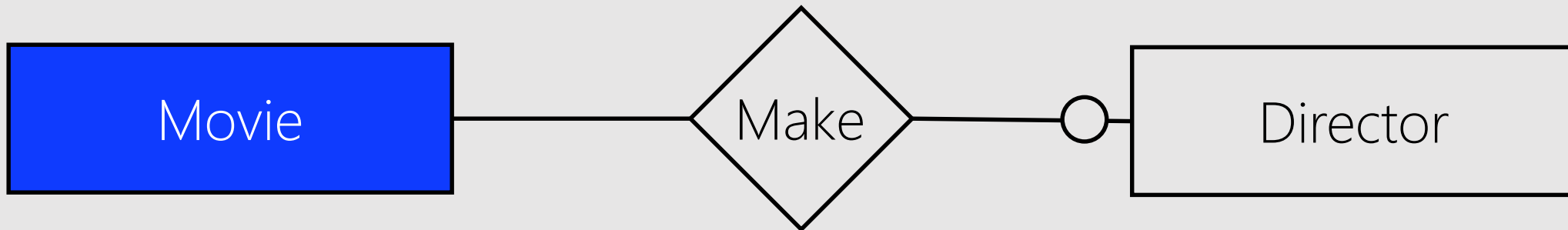
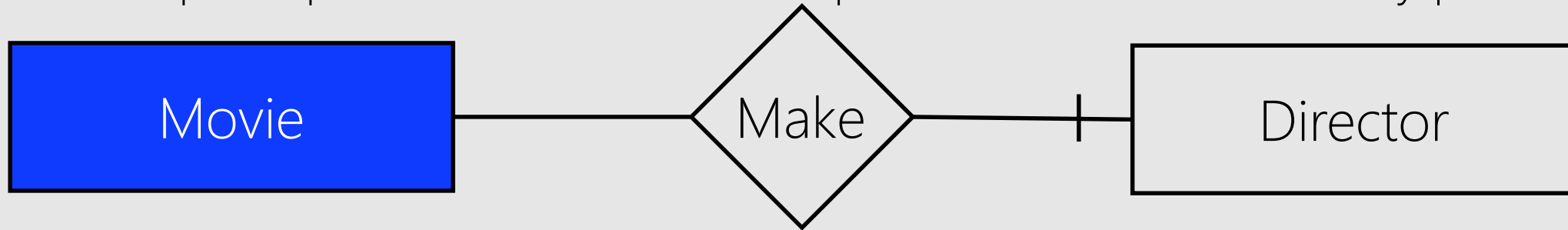
A Movie MUST participate in Make relationship? No!

A Movie MUST have Director? No!

Is there a Movie in the system without Director? Yes.

E/R × Relationship Set × Participation 43

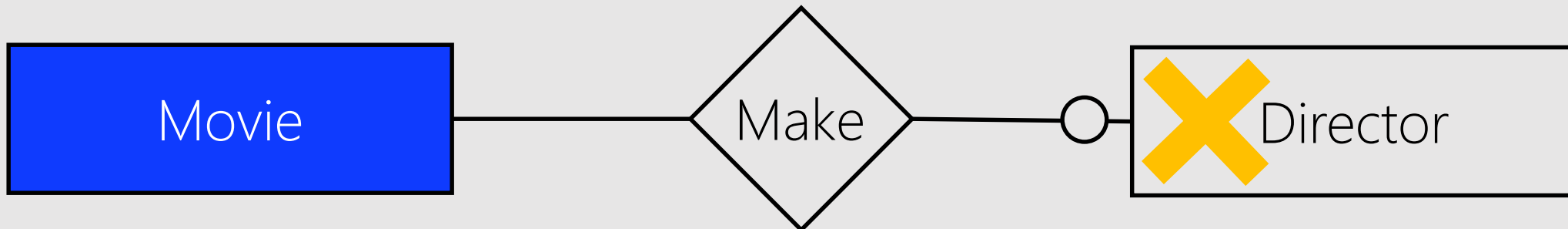
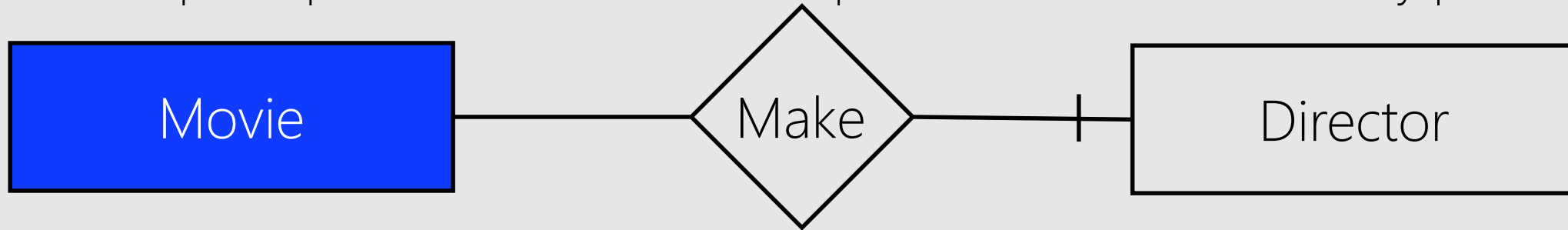
Movie's participation in Make relationship with Director is mandatory | total.



Movie's participation in Make relationship with Director is optional | partial.

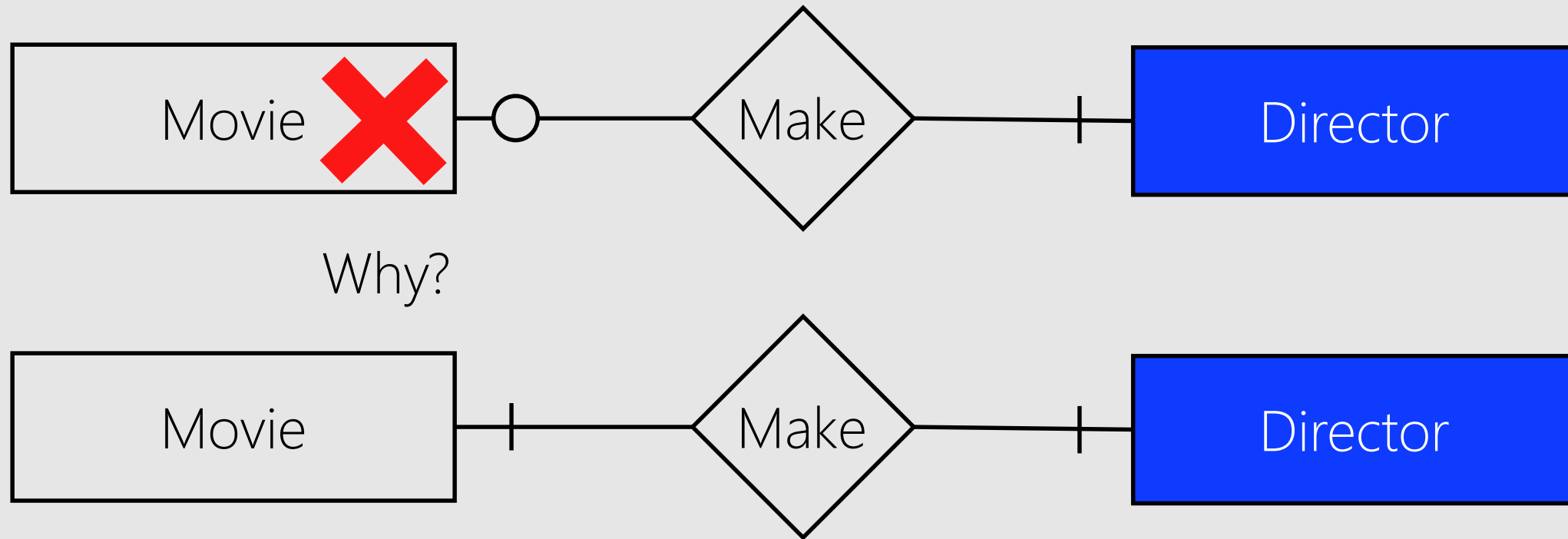
E/R × Relationship Set × Participation 44

Movie's participation in Make relationship with Director is mandatory | total.



Movie's participation in Make relationship with Director is optional | partial.

E/R × Relationship Set × Participation 45



E/R × Relationship Set × Participation 46

Participation is the minimum number of times an entity in one entity set can be associated with an entity in the related entity set.

Either 0 or 1

Participation also called Ordinality

E/R × Relationship Set × Multiplicity 47

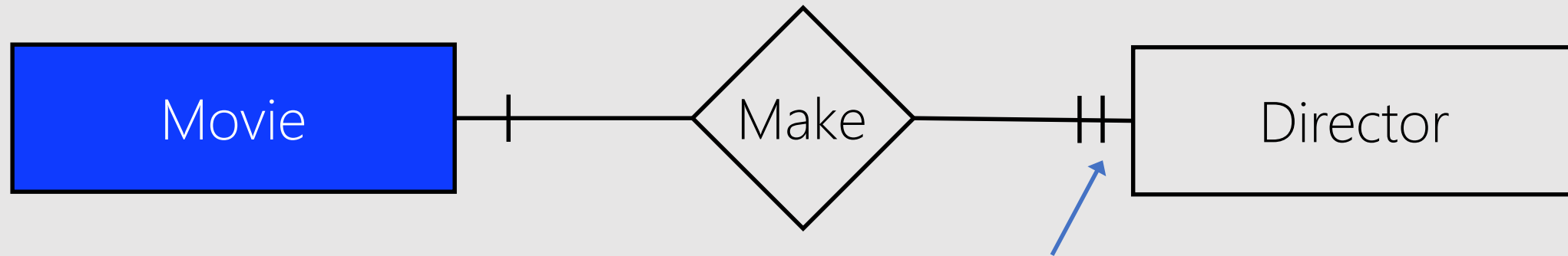
Multiplicity is the maximum number of times an entity in one entity set can be associated with an entity in the related entity set.

Either 1 or Many

Multiplicity also called Cardinality

E/R × Relationship Set × Multiplicity

48



A Movie participate in Make relationship with how many Director
at max? 1



Barton Fink

Fargo

O Brother, Where Art Thou?

The Man Who Wasn't There

No Country for Old Men

Burn After Reading

A Serious Man

True Grit

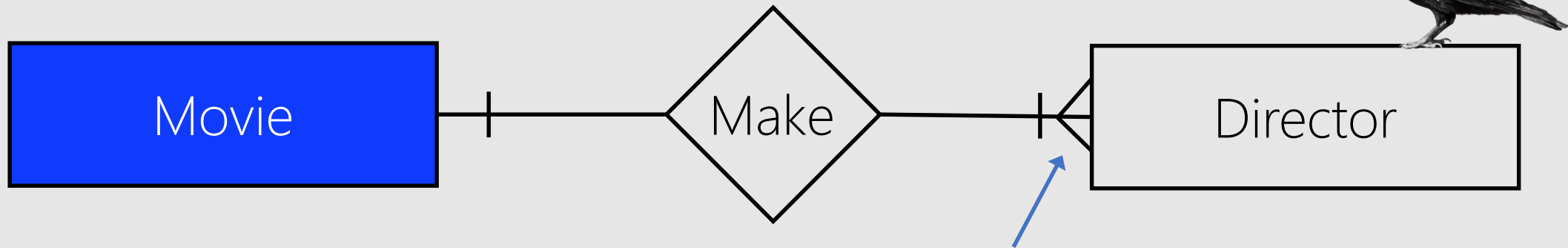
Inside Llewyn Davis

Unbroken

Bridge of Spies

Hail, Caesar!

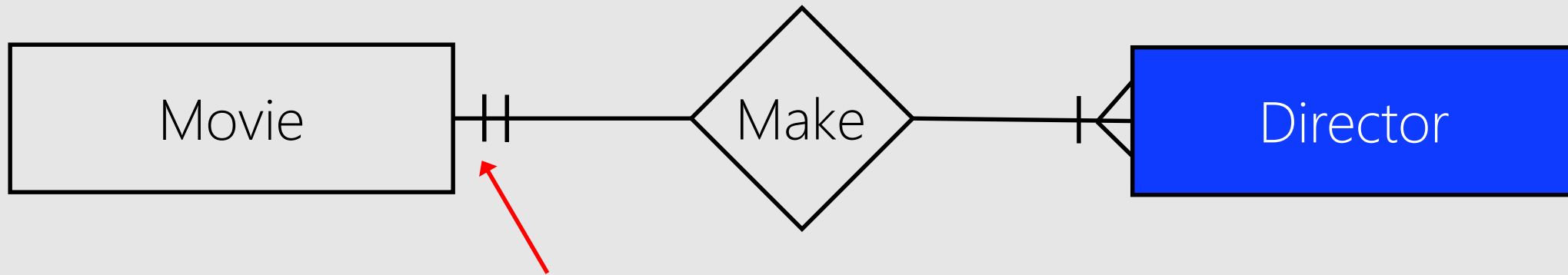
E/R × Relationship Set × Multiplicity 50



A Movie participate in Make relationship with how many Director
at max? Many (More than 1)

E/R × Relationship Set × Multiplicity

51



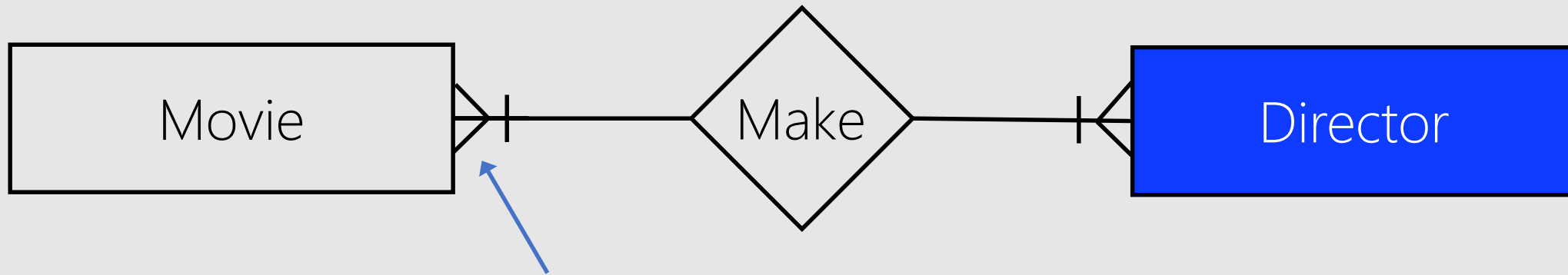
How about Director multiplicity (cardinality) in Make relationship?

1

A Director entity is not able to Make more than one Movie entity!

E/R × Relationship Set × Multiplicity

52



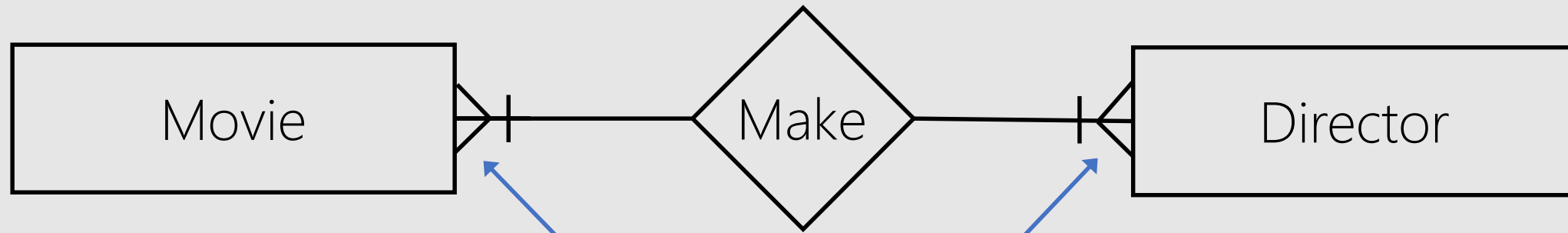
How about Director multiplicity (cardinality) in Make relationship?

Many

A Director entity is able to Make more than one Movie entity.

E/R × Relationship Set × Multiplicity

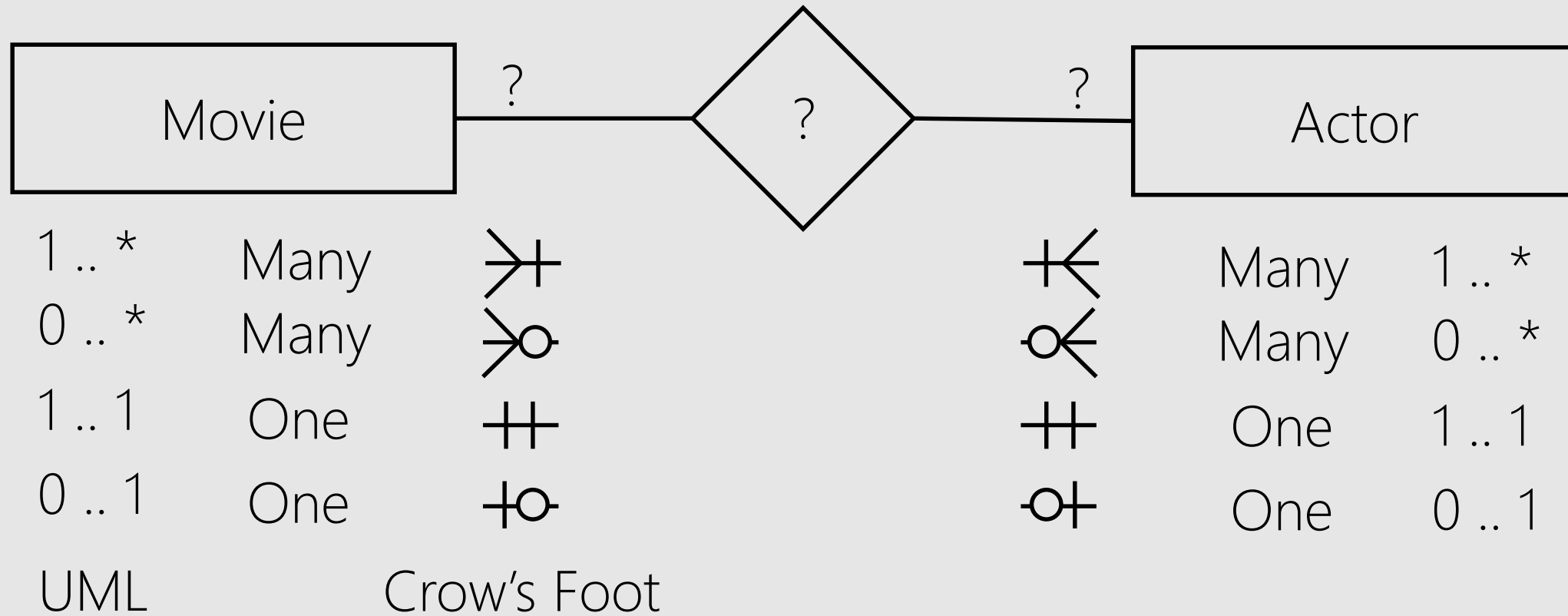
53



Make is a Many-Many Relationship (Set)

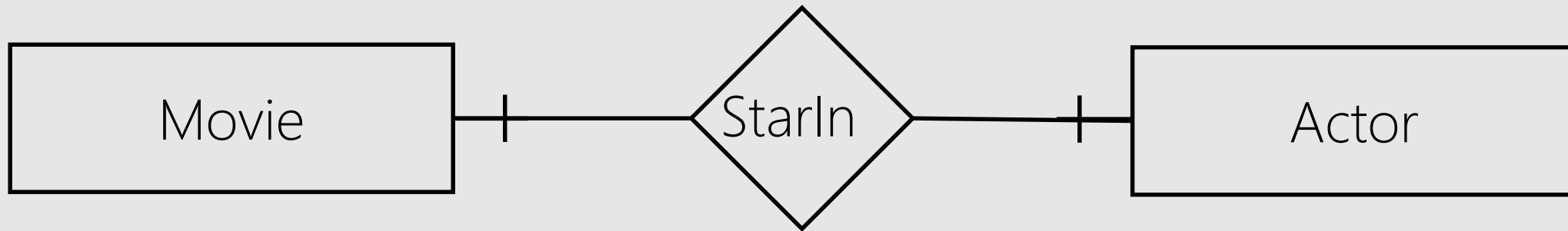
E/R × Relationship Set × Practice

54



E/R × Relationship Set × Practice

55



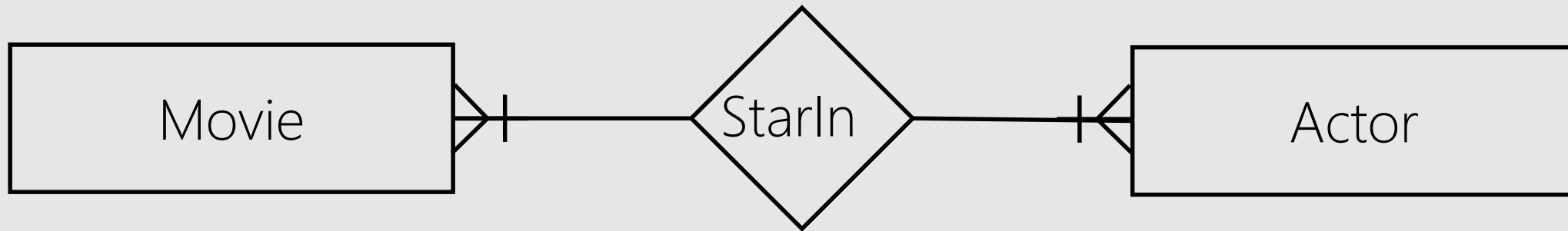
Participation: StarIn is a Mandatory Relationship (Set) for Movie and Actor

A Movie must have at least one Actor entity

An Actor must StarIn at least one Movie entity

E/R × Relationship Set × Practice

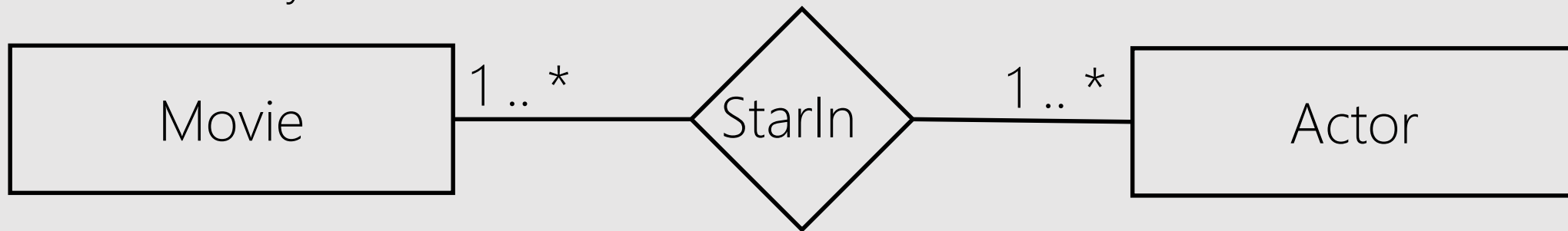
56



Multiplicity: StarIn is a Many-Many Relationship (Set)

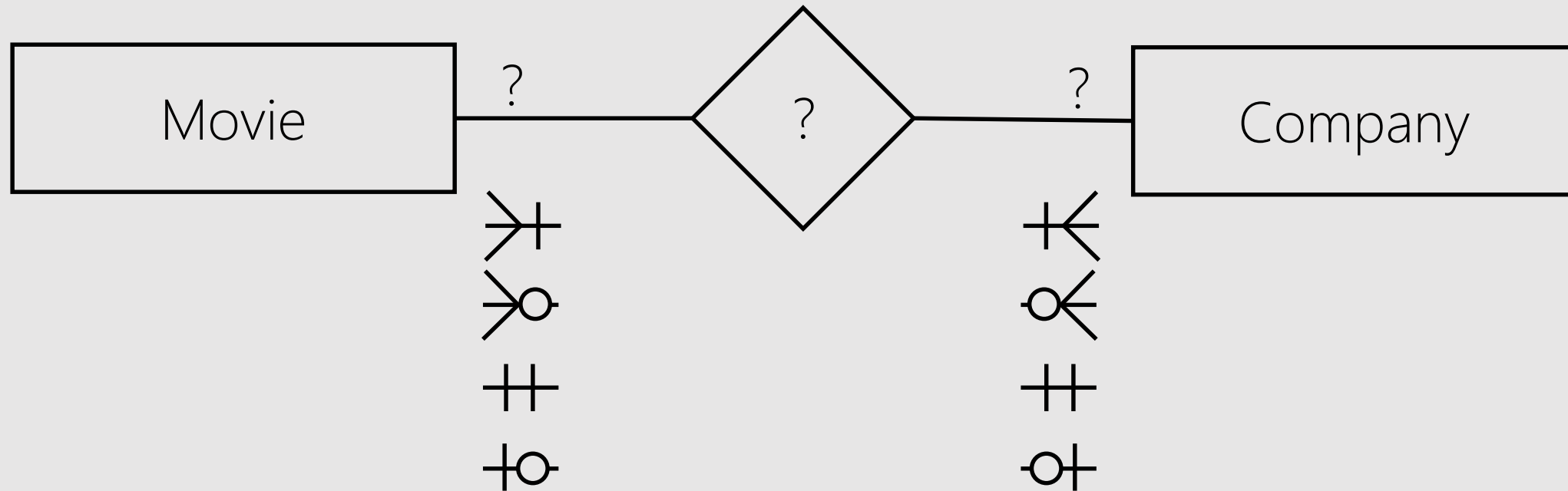
A Movie may have more than one Actor entities

An Actor may StarIn more than one Movie entities



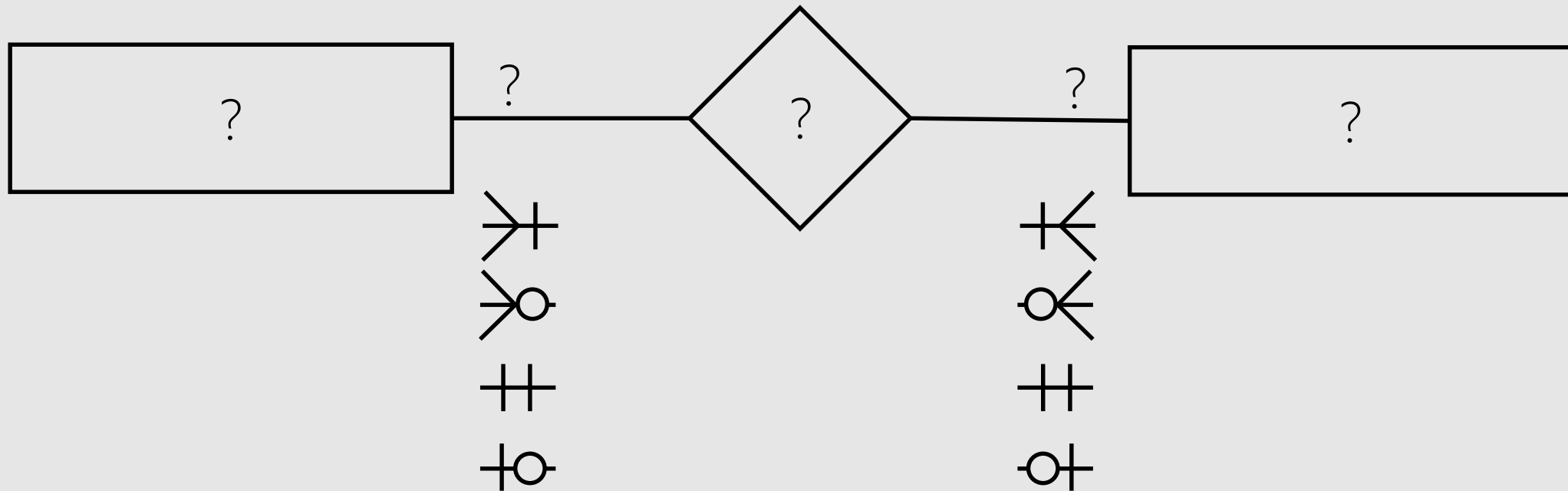
E/R × Relationship Set × Practice II

57



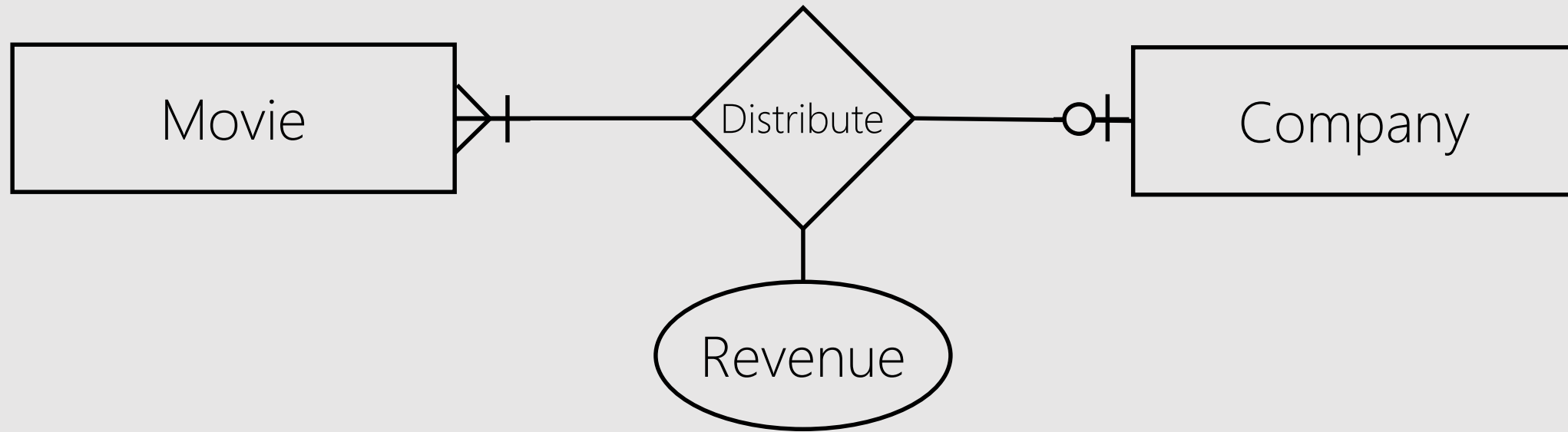
E/R × Your System (15mins)

58



E/R × Relationship Set × Attribute

59

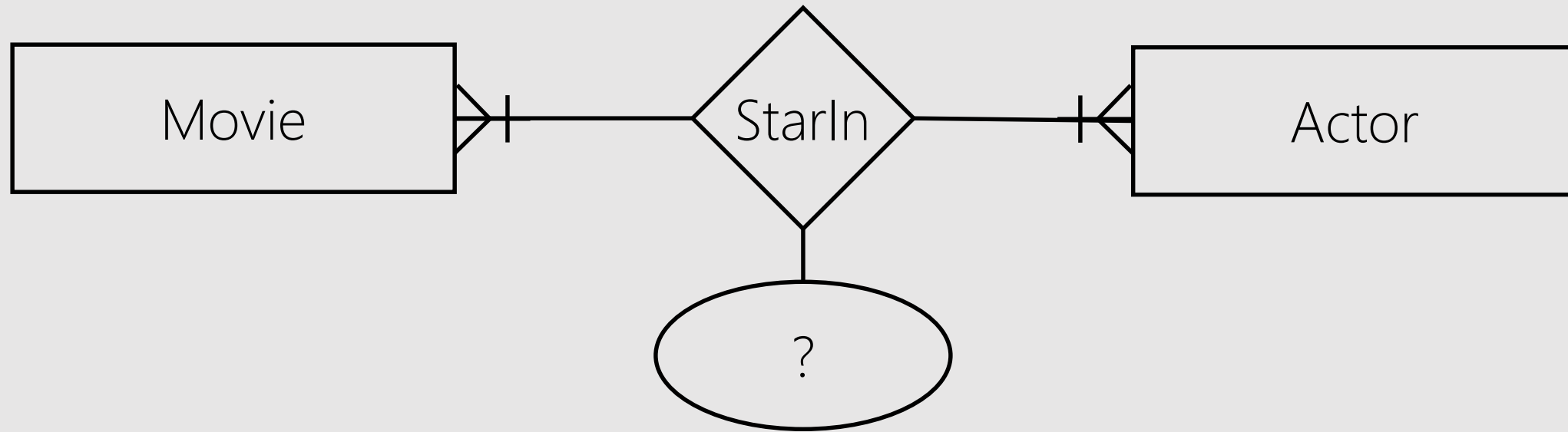


Revenue exist if and only if there is a relationship between a Movie entity and a Company entity.

e.g., *'Universal Pictures' made '\$11.4 million' by distributing 'The Birds'.*

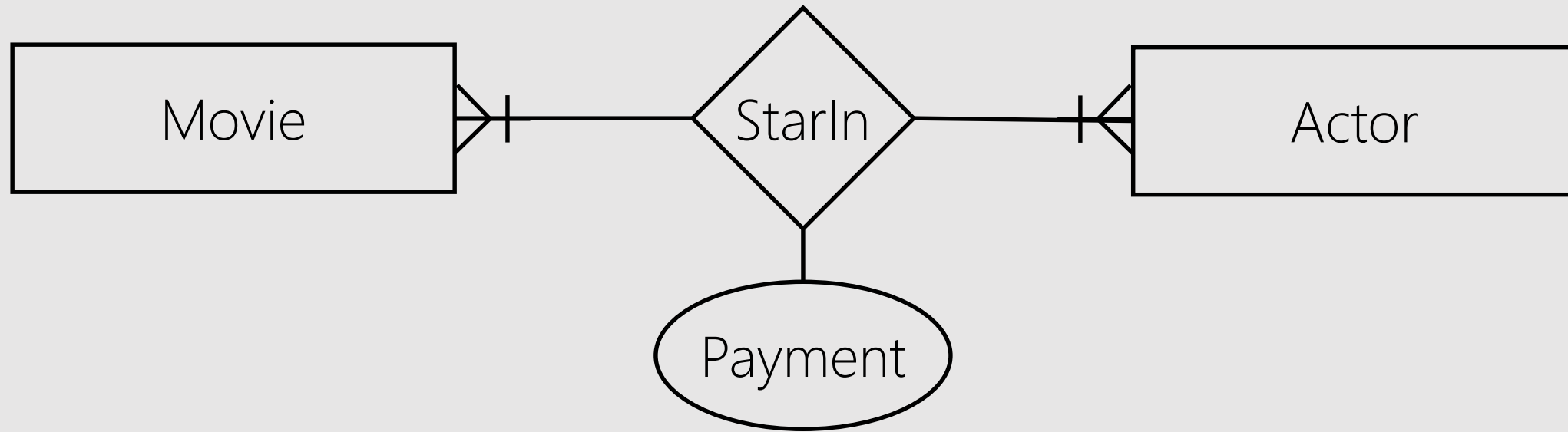
E/R × Relationship Set × Attribute

60



E/R × Relationship Set × Attribute

61

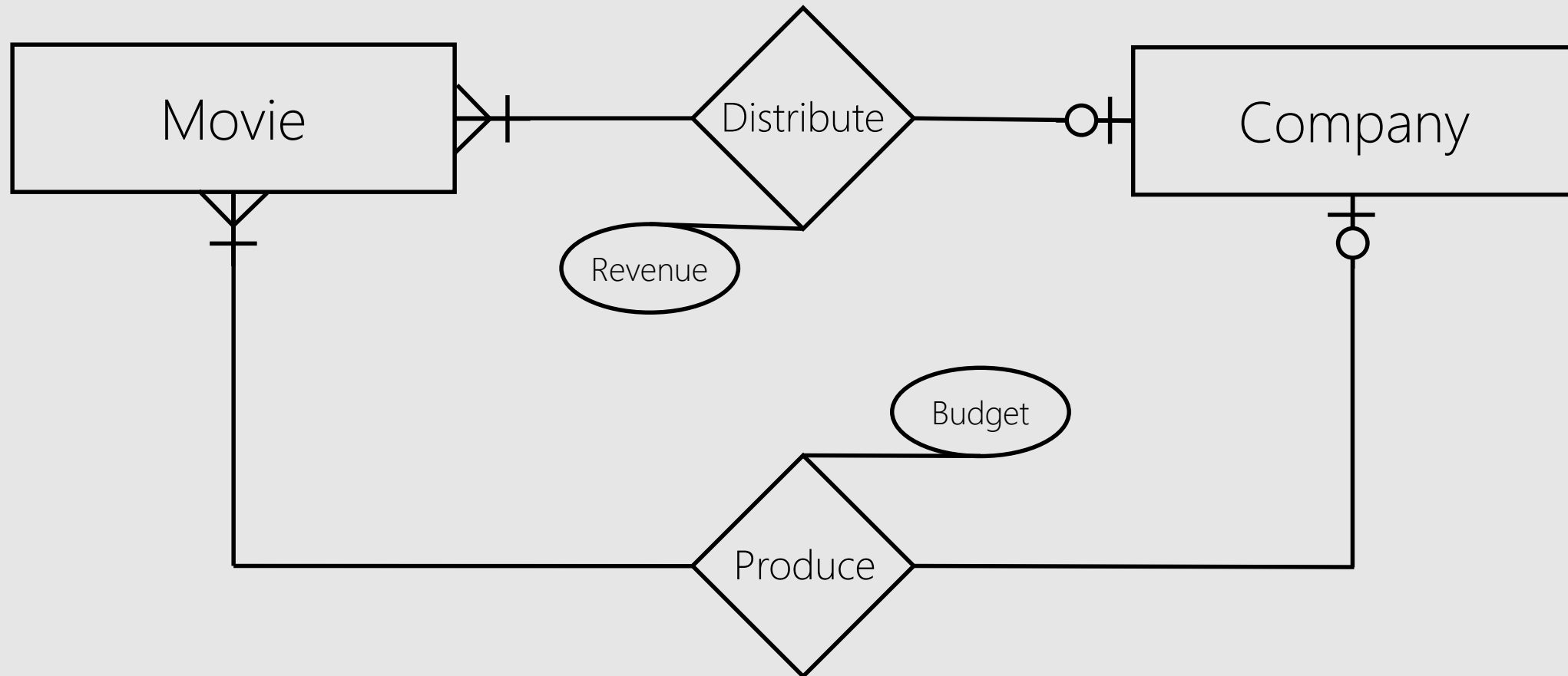


Payment exist if and only if there is a relationship between a Movie entity and an Actor entity.

e.g., *'Tippi Hedren' was paid '\$X' by starring in 'The Birds'.*

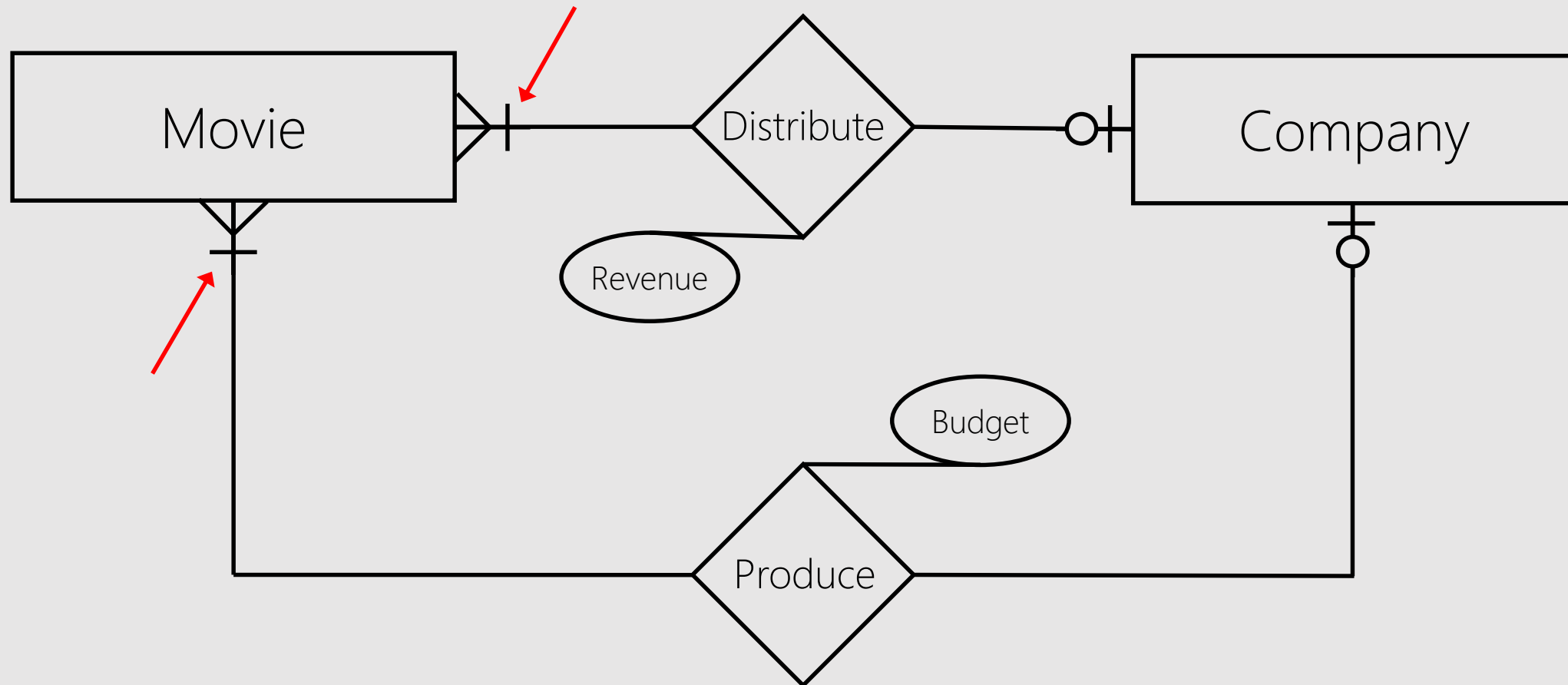
E/R × Relationship Set × Multiple

62



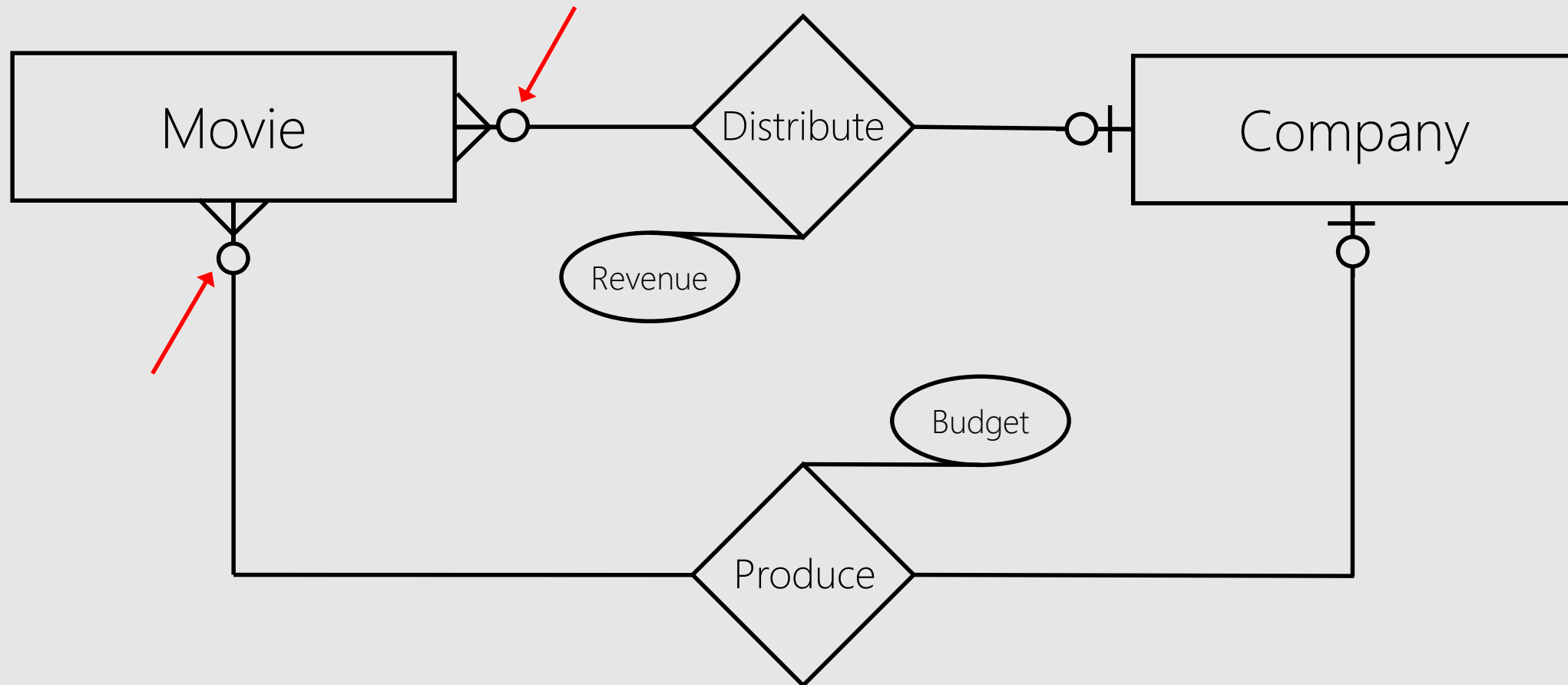
E/R × Relationship Set × Multiple

63



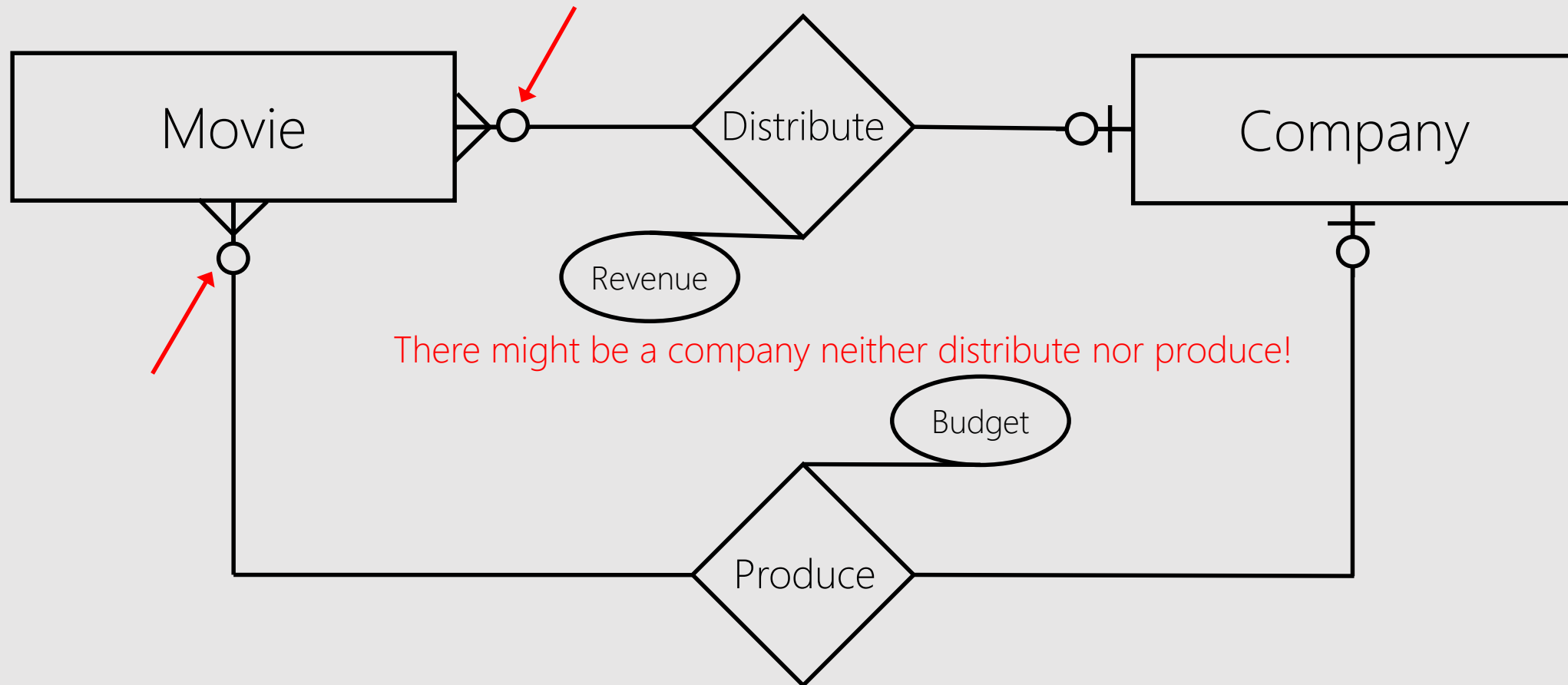
E/R × Relationship Set × Multiple

65



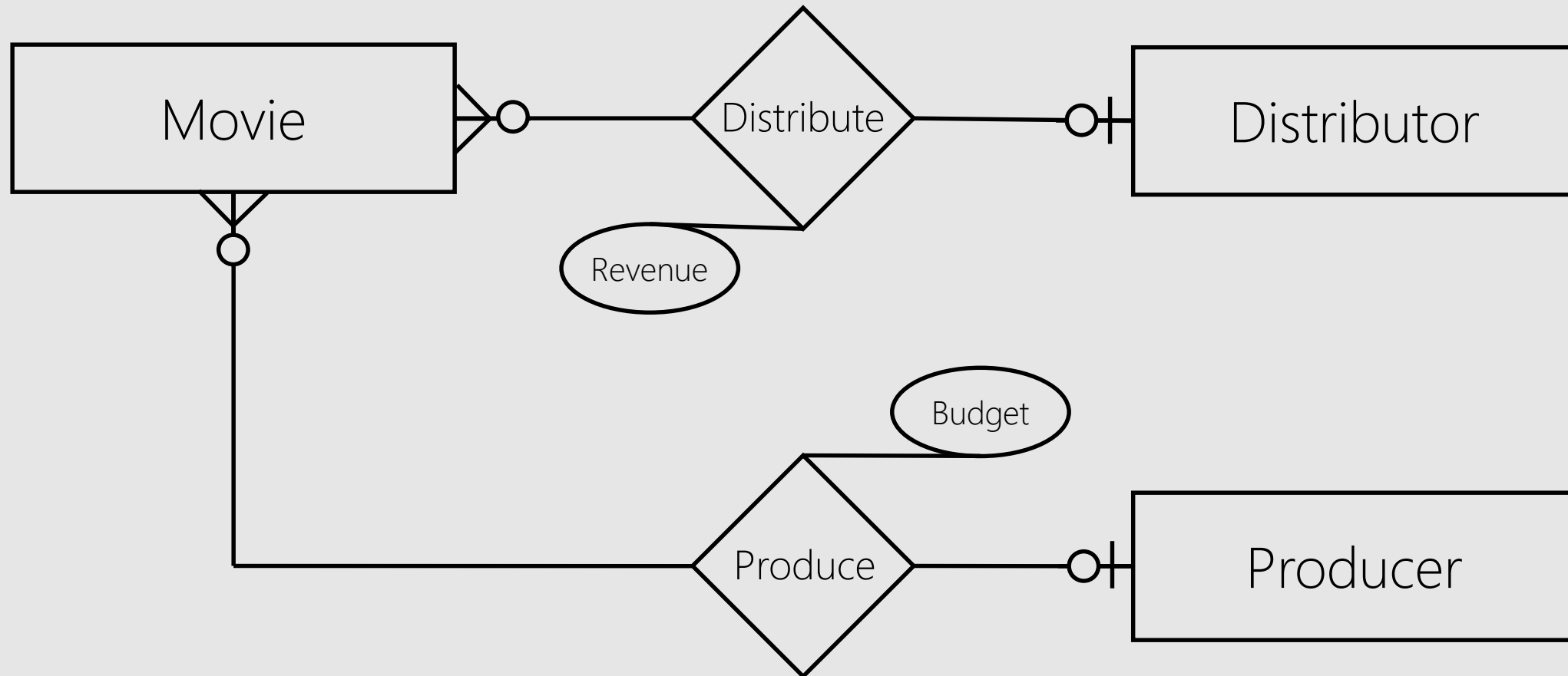
E/R × Relationship Set × Multiple

66

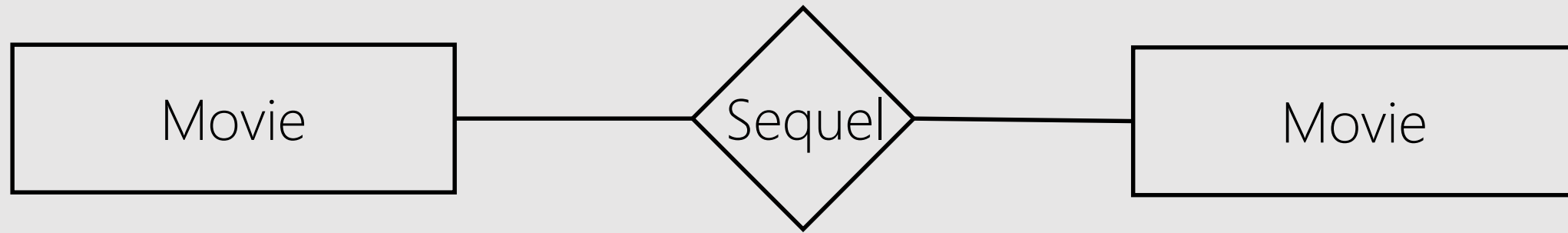


E/R × Relationship Set × Multiple

67

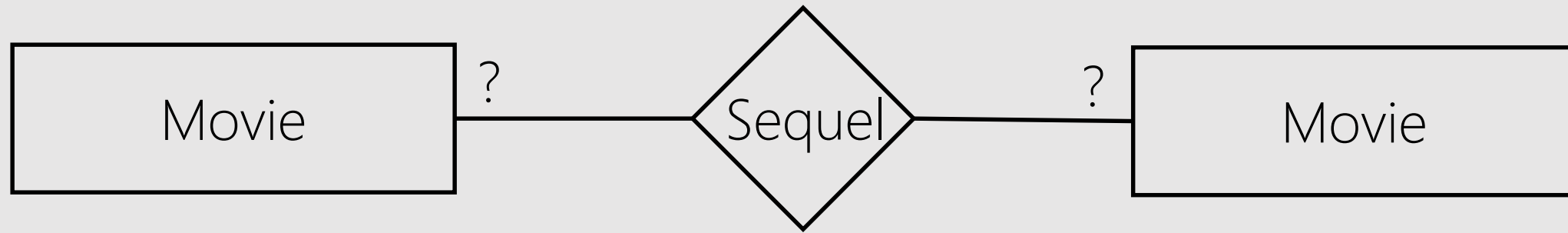


E/R × Relationship Set × Self (Unary) 68



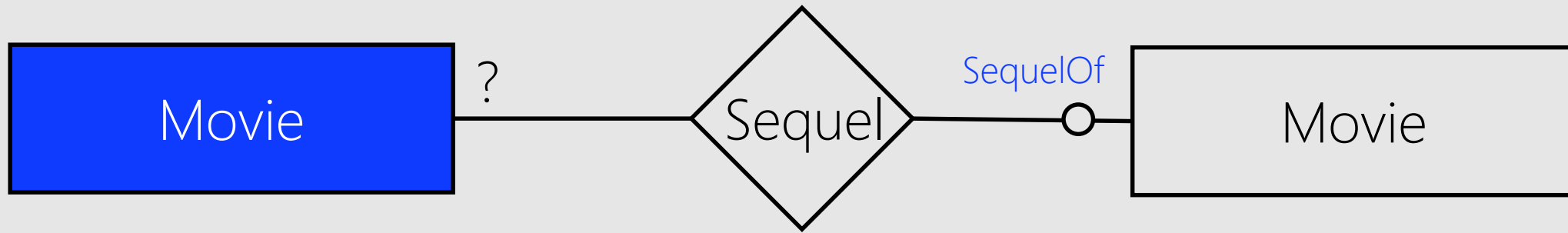
The Matrix
The Matrix Reloaded
The Matrix Revolutions

E/R × Relationship Set × Self (Unary) 69



Participation (Ordinality)
Multiplicity (Cardinality)

E/R × Relationship Set × Self (Unary) 70



Participation: Optional | Partial

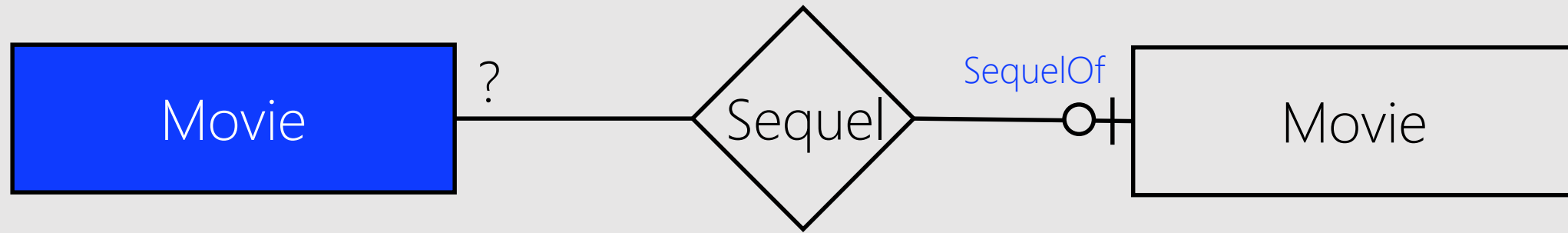
A Movie entity not SequelOf any Movie entity

A Movie entity is SequelOf 0 Movie entity

e.g., 'The Bird', 'The Matrix'!

E/R × Relationship Set × Self (Unary)

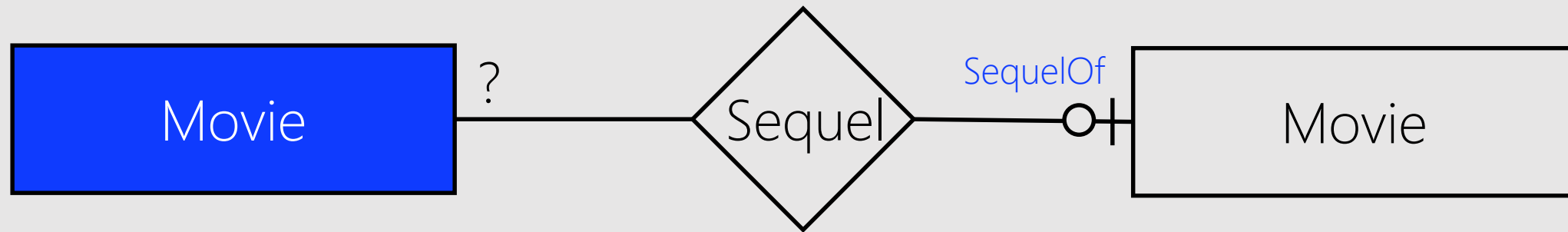
71



Multiplicity: 1

A Movie entity can be a SequelOf 1 Movie entity at max

E/R × Relationship Set × Self (Unary) 72

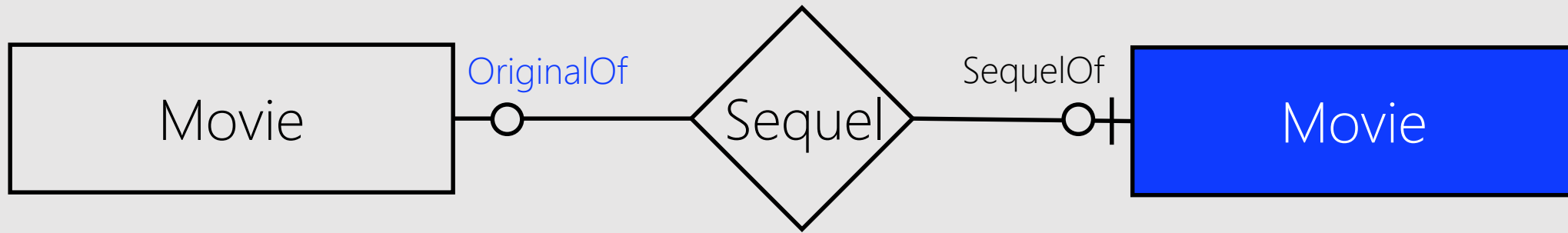


The Matrix
The Matrix Reloaded
The Matrix Revolutions

Two blue arrows originate from the text below. The first arrow starts from 'The Matrix Reloaded' and points to 'The Matrix'. The second arrow starts from 'The Matrix Revolutions' and points to 'The Matrix Reloaded', indicating a reverse chronological sequence.

E/R × Relationship Set × Self (Unary)

73

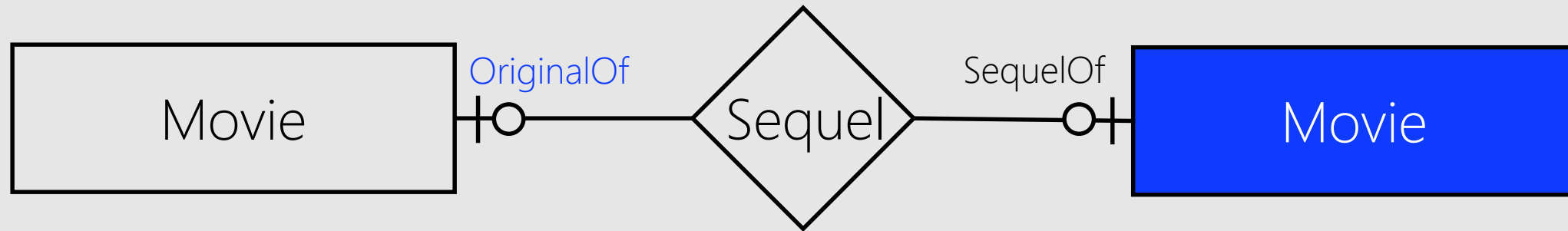


Participation: 1

A Movie entity may not be OriginalOf any sequel
A Movie entity may be OriginalOf 0 Movie entity
e.g., 'The Birds'

E/R × Relationship Set × Self (Unary)

74

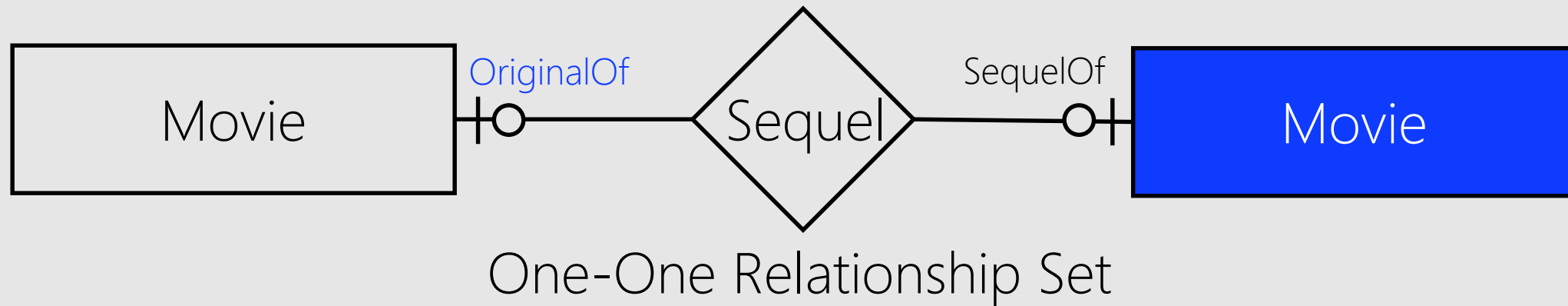


Multiplicity: 1

A Movie entity might be OriginalOf 1 Movie entity at max

E/R × Relationship Set × Self (Unary)

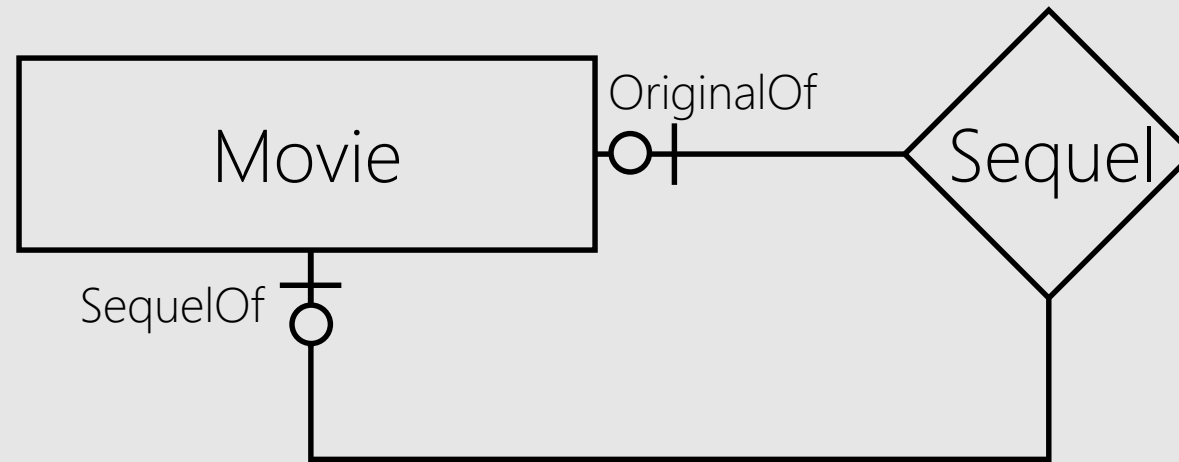
75



The Matrix
→ The Matrix Reloaded
→ The Matrix Revolutions

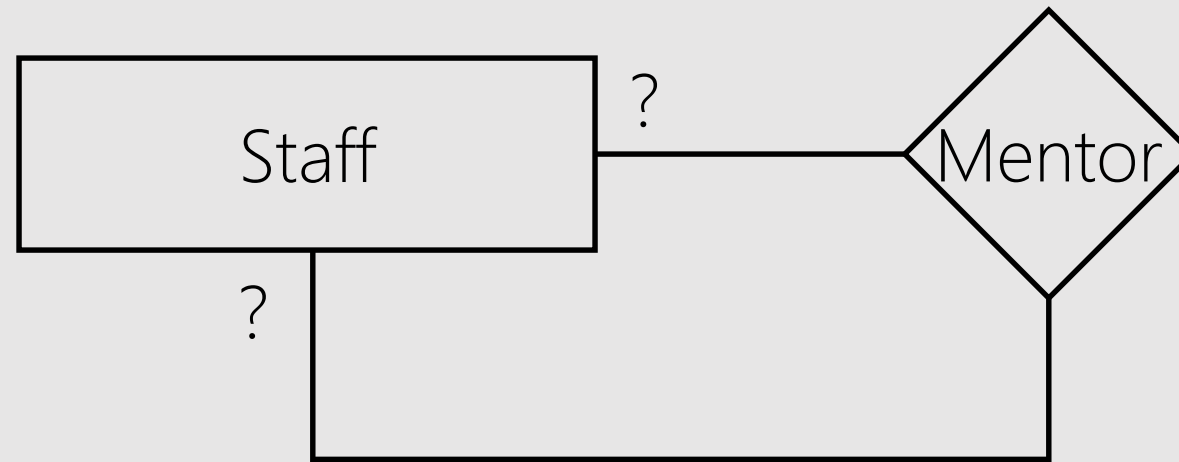
E/R × Relationship Set × Self (Unary)

76



E/R × Relationship Set × Self (Unary)

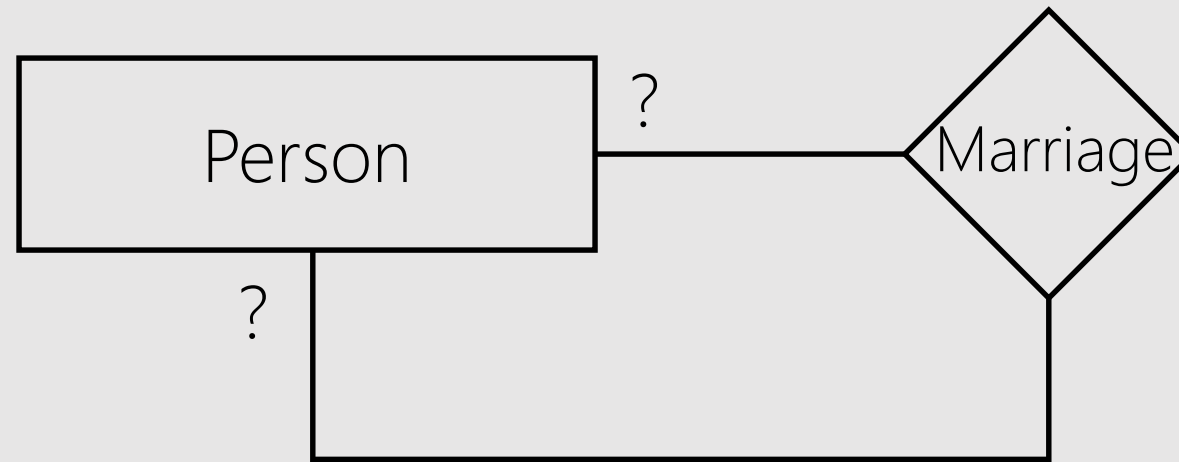
77



Hint 4 Self Relationship Set
when there is hierarchy between entities in entity set

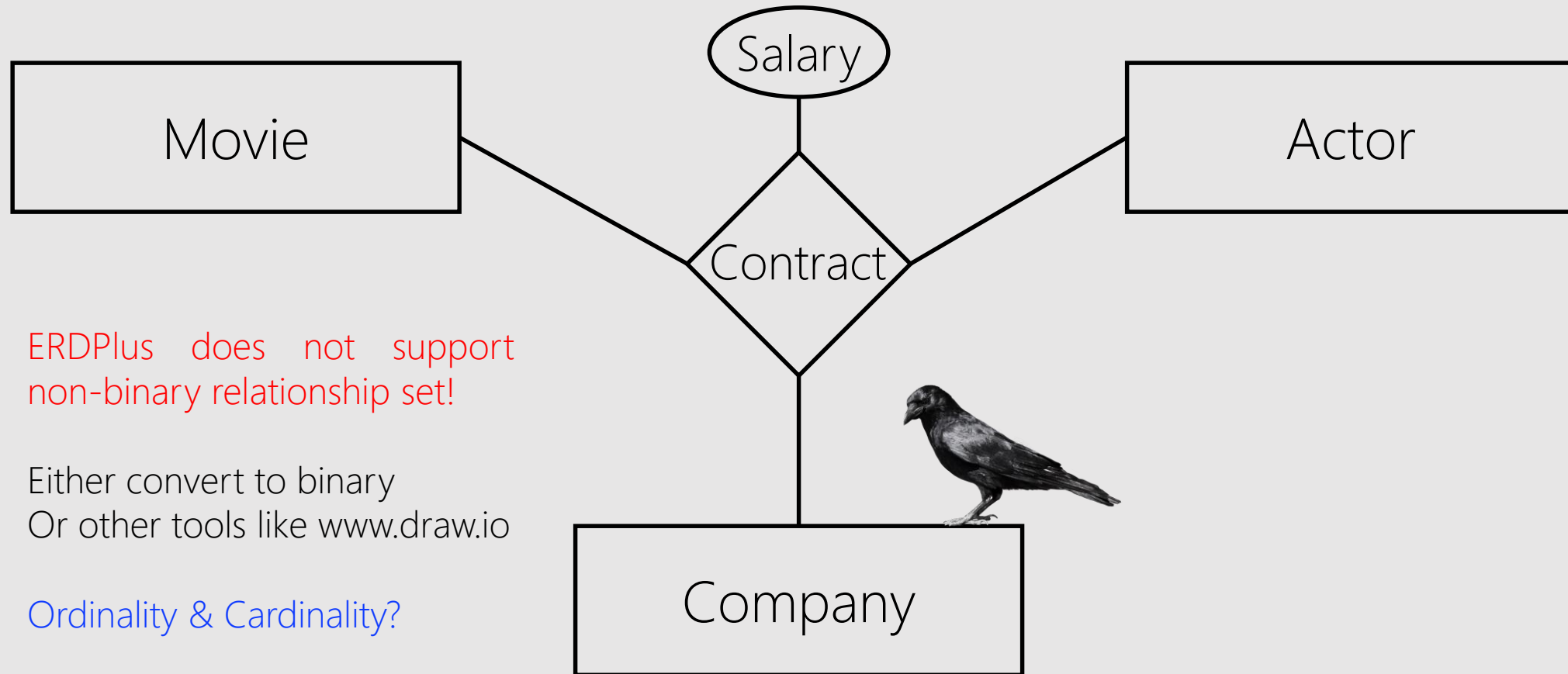
E/R × Relationship Set × Self (Unary)

78



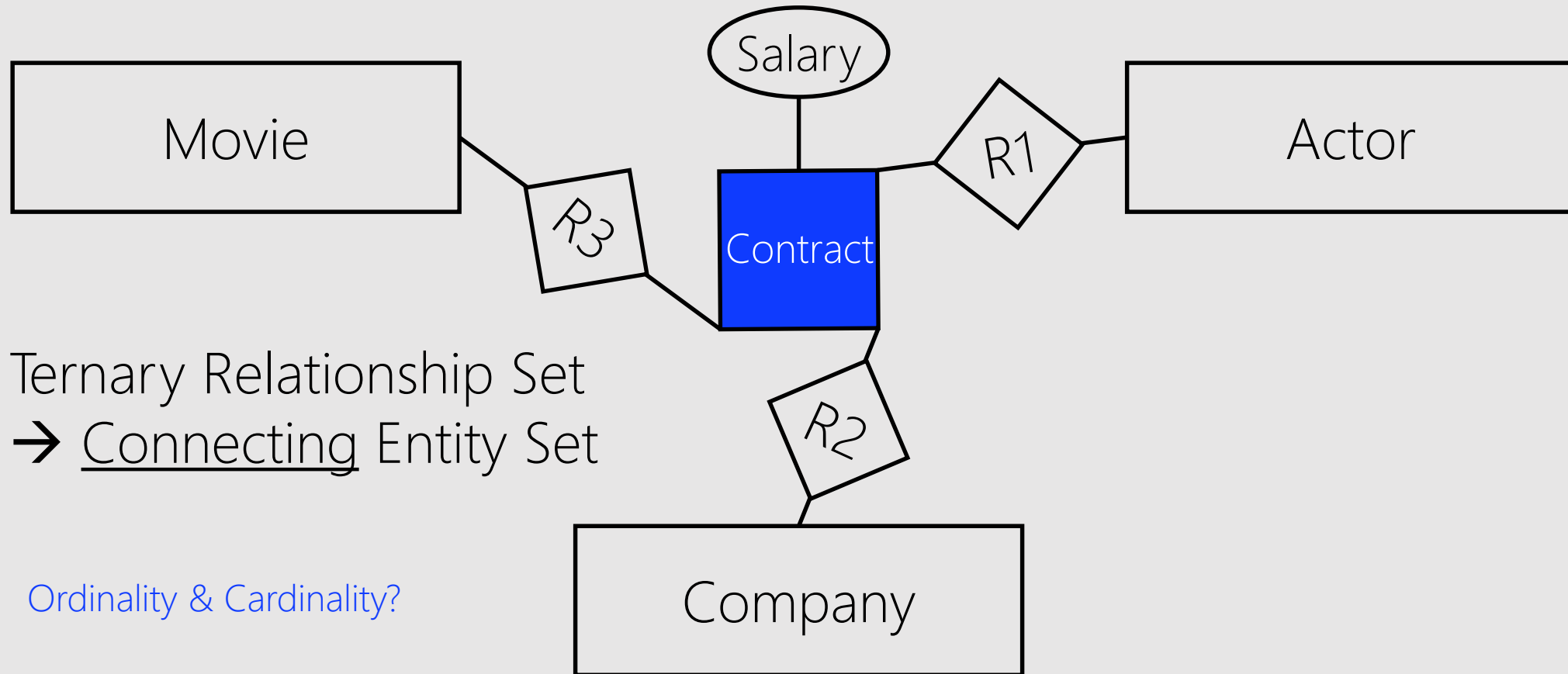
E/R × Ternary Relationship Set

79



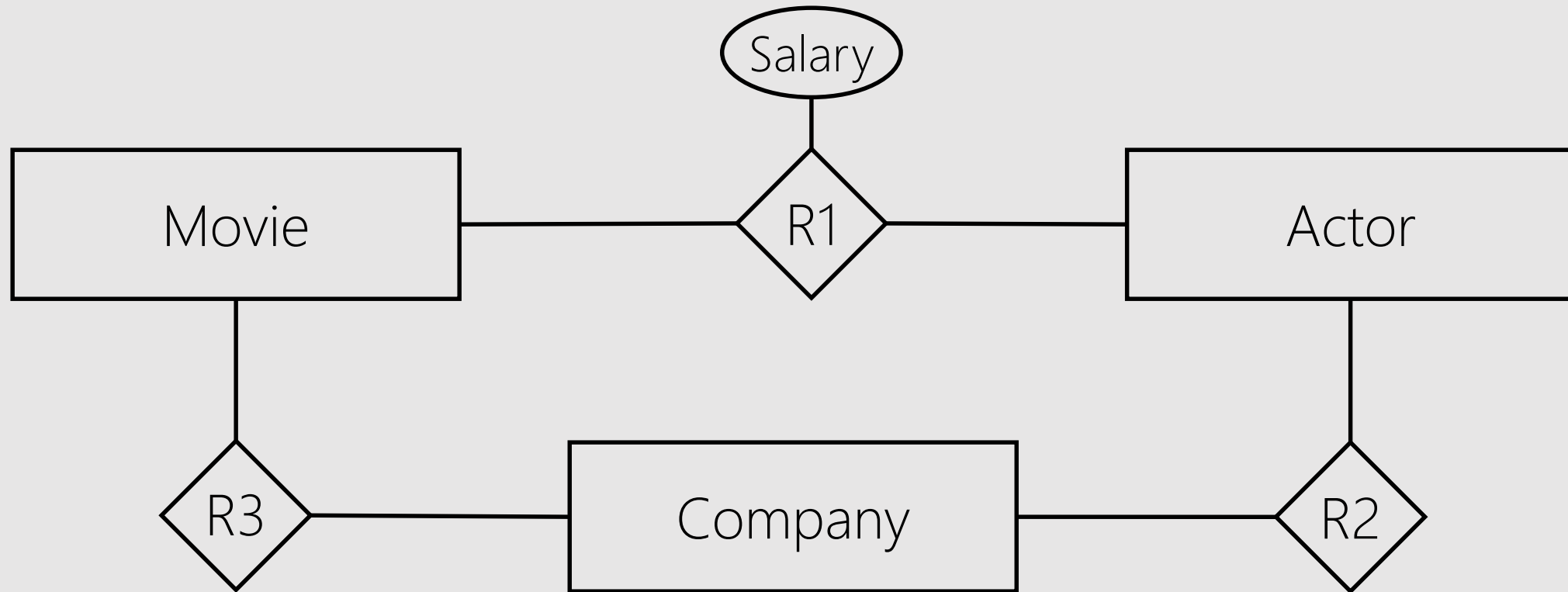
E/R × Ternary-2-Binary

80



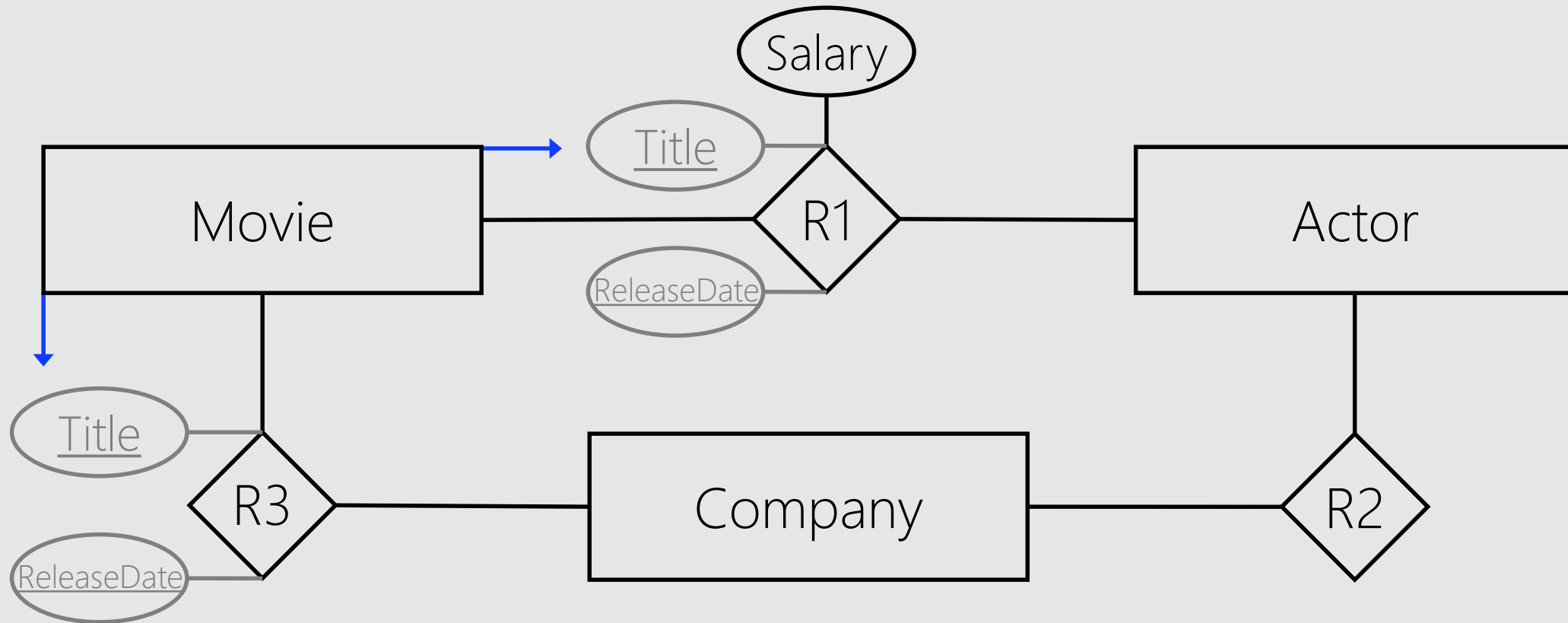
E/R × Circular Relationship Sets

81



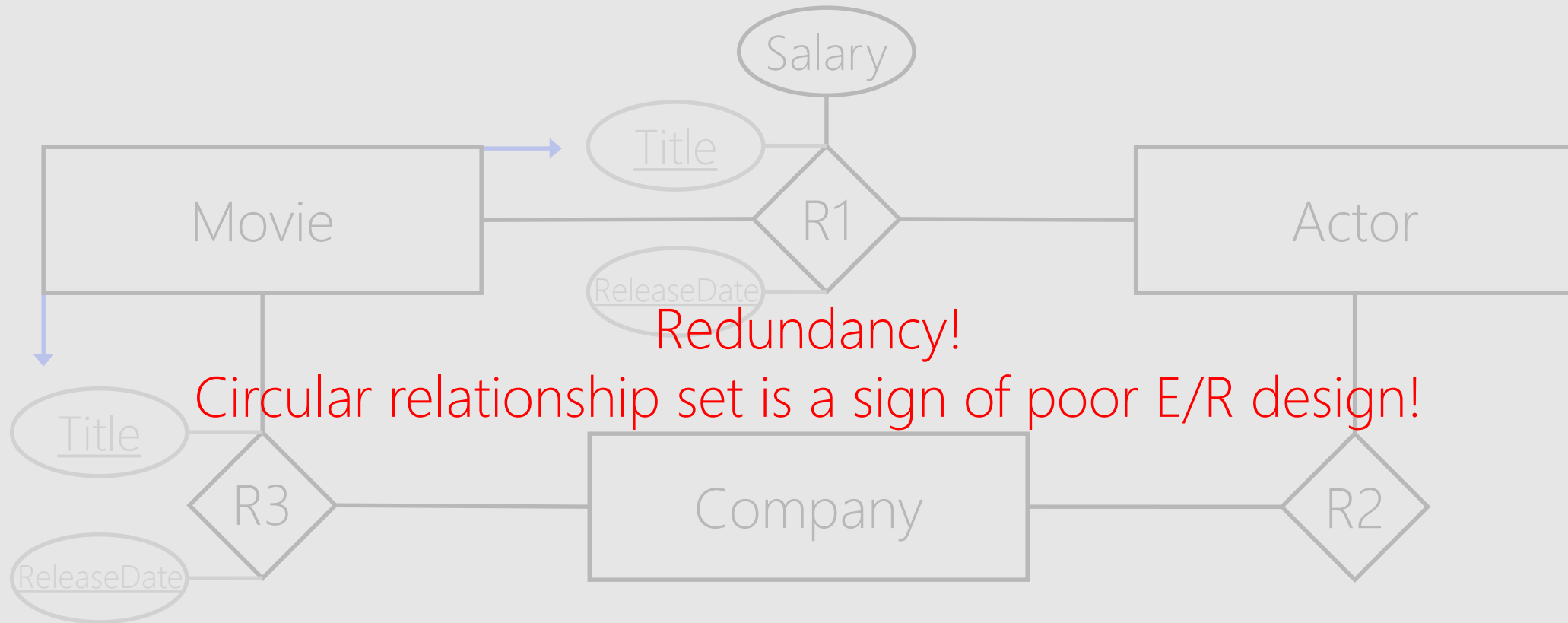
E/R × Circular Relationship Sets

82



E/R × Circular Relationship Sets

83



E/R × Multiway (n-ary) Relationship Set 84

