

TÖL303G

Gagnasafnsfræði

Snorri Agnarsson

Einindavenslagagnalíkön Entity/Relationship Models

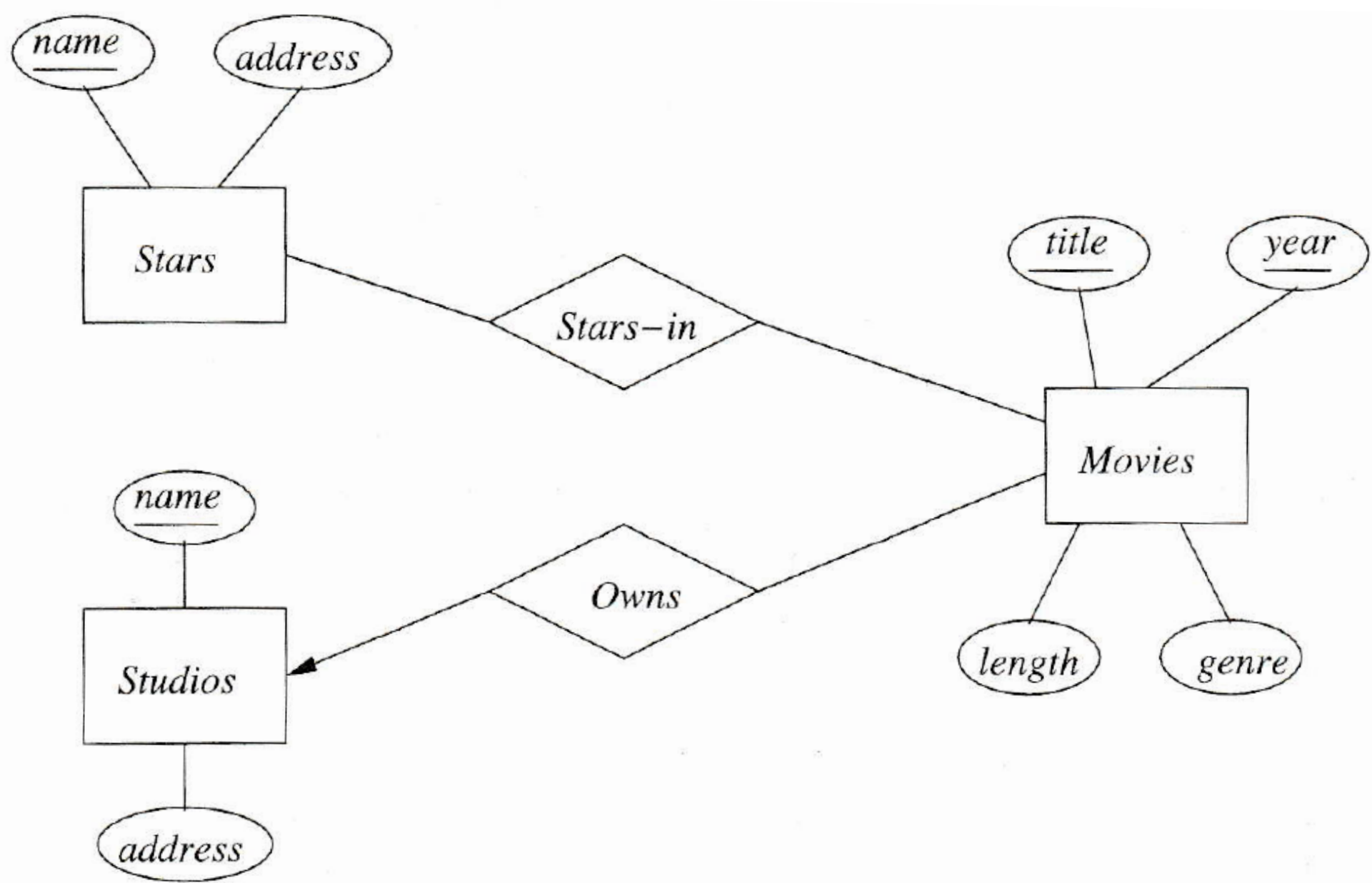


Figure 17: E/R diagram; keys are indicated by underlines

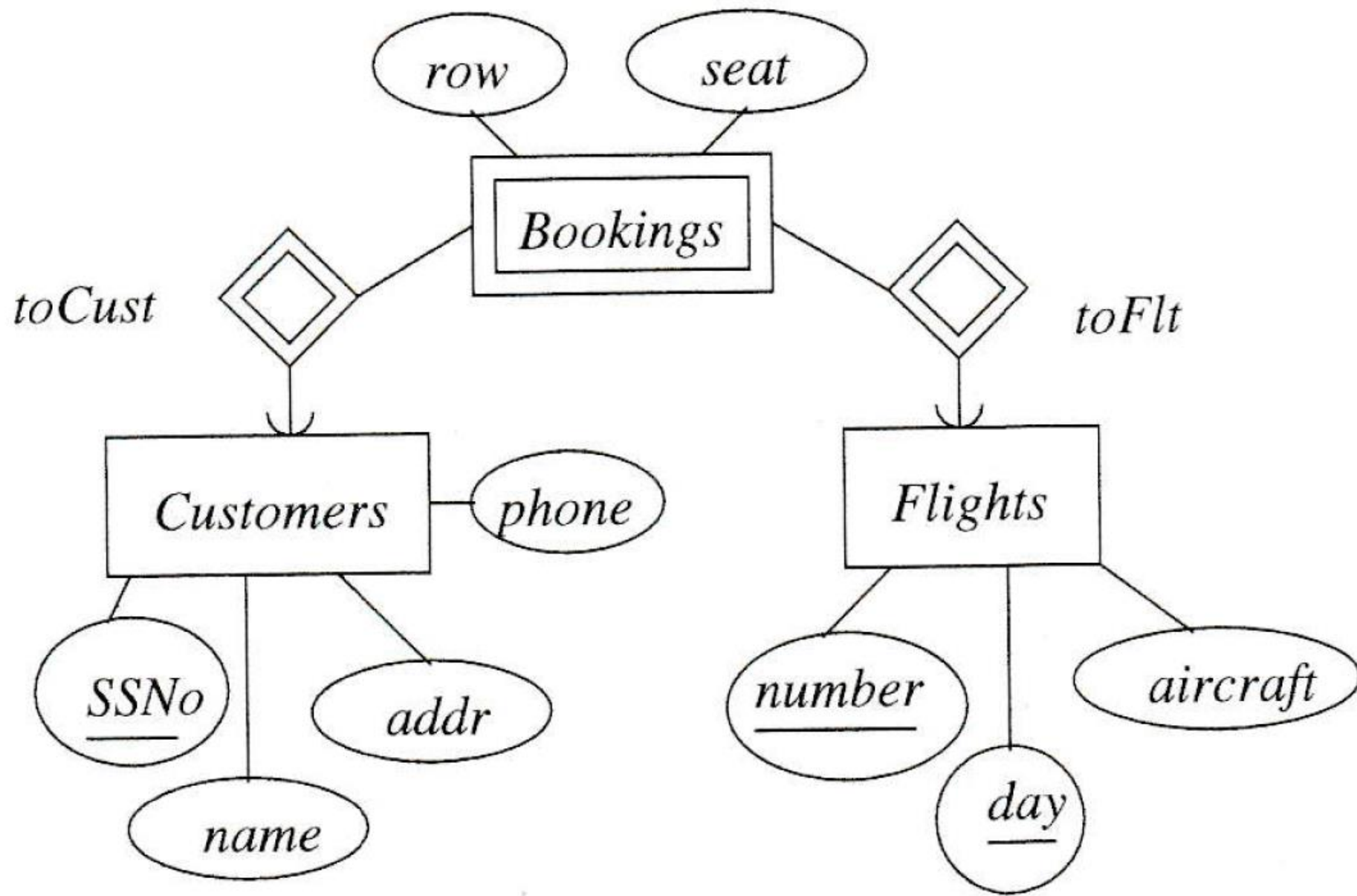


Figure 29: An E/R diagram about airlines

Bygging gagnalíkana með einindavenslalíkaninu – Building E/R models

- Einindavenslalíkanið (E/R model)
 - Vinsælt æðra stigs hugrænt gagnalíkan – A popular high-level conceptual data model
- Einindavenslarit (E/R diagram)
 - Ritháttur einindavenslalíkans – Diagram notation for E/R
- Alls konar rithættir eru til staðar – Various notation variants exist
 - Grunnhugmyndin er samt sú sama – Same basic idea
 - Til dæmis hluti af UML – For example in UML (Unified Modeling Language)

Einindi, eiginleikar, vensl

Entities, attributes, relationships

- Einindavenslalíkan lýsir gögnum sem – The E/R model describes data as
 - Einindum – Entities
 - Eiginleikum – Attributes
 - Venslum – Relationships
 - Athugið að vensl milli eininda kallast **relationship** á ensku, ekki **relation**

Einindi, eiginleikar og vensl – Entities, attributes and relationships

- Einindi – Entities
 - Raunveruleg fyrirbæri (í ytri veruleikanum) með sjálfstæða tilvist
 - Real phenomena with independent existence
- Eiginleikar – Attributes
 - Sérstakir eiginleikar sem lýsa einindum – Attributes that describe entities
 - Samsettir eða einfaldir eiginleikar – Composite or atomic attributes
 - Eingilda eða fjölgilda eiginleikar – Univalued or multivalued attributes
 - Vistaðir eða afleiddir eiginleikar – Stored or derived attributes
- Vensl milli eininda – Relationships between entities
 - Skilgreina samhengi milli eininda – Define correspondences between entities

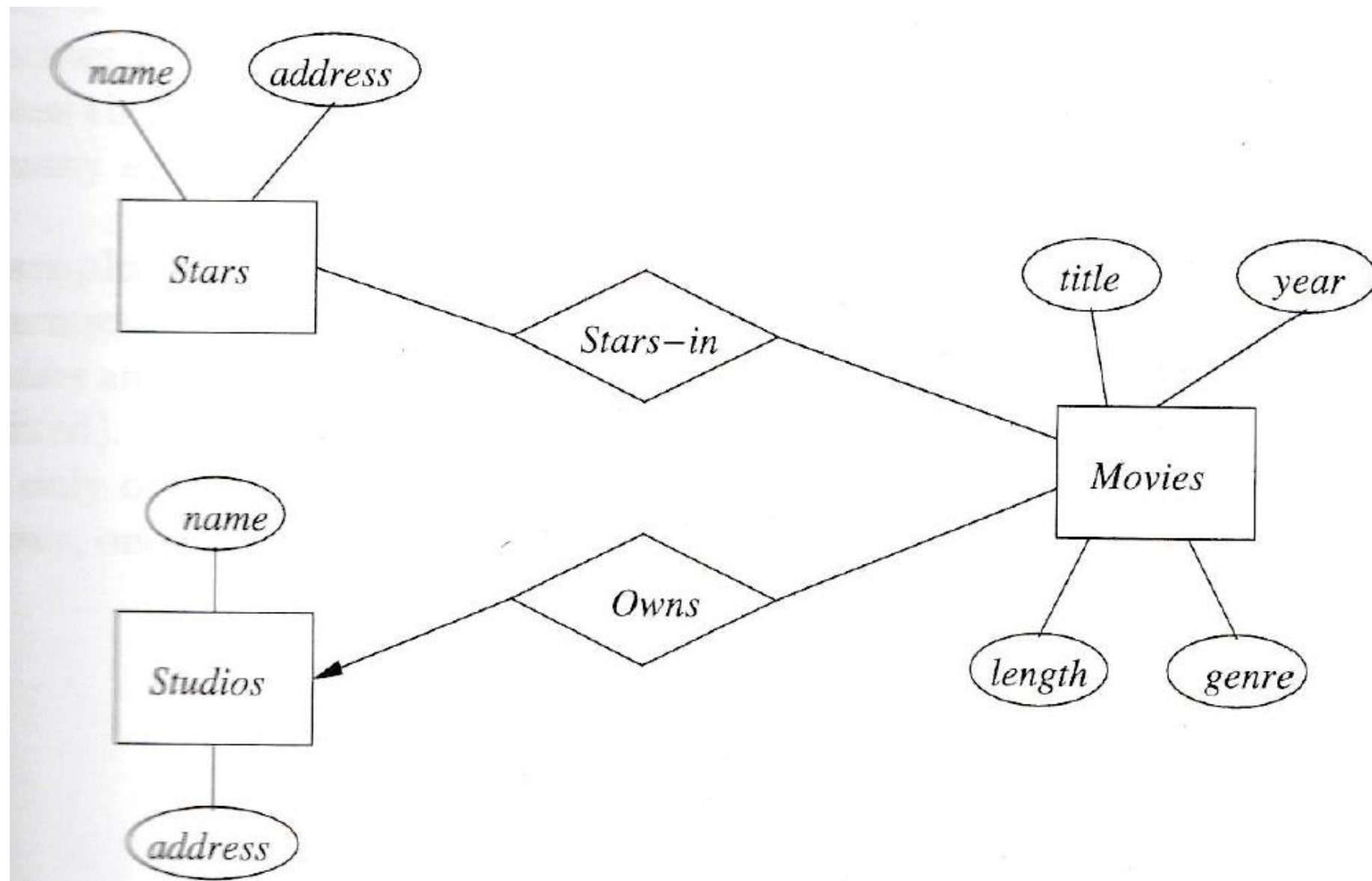


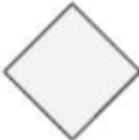




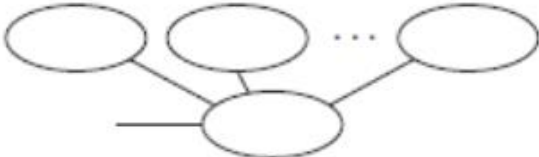



Figure 2: An entity-relationship diagram for the movie database

Symbol	Meaning
	Entity
	Weak Entity
	Relationship
	Identifying Relationship
	Attribute
	Key Attribute
	Multivalued Attribute
	Composite Attribute
	Derived Attribute

Supporting relationship
Skilgreinandi vensl

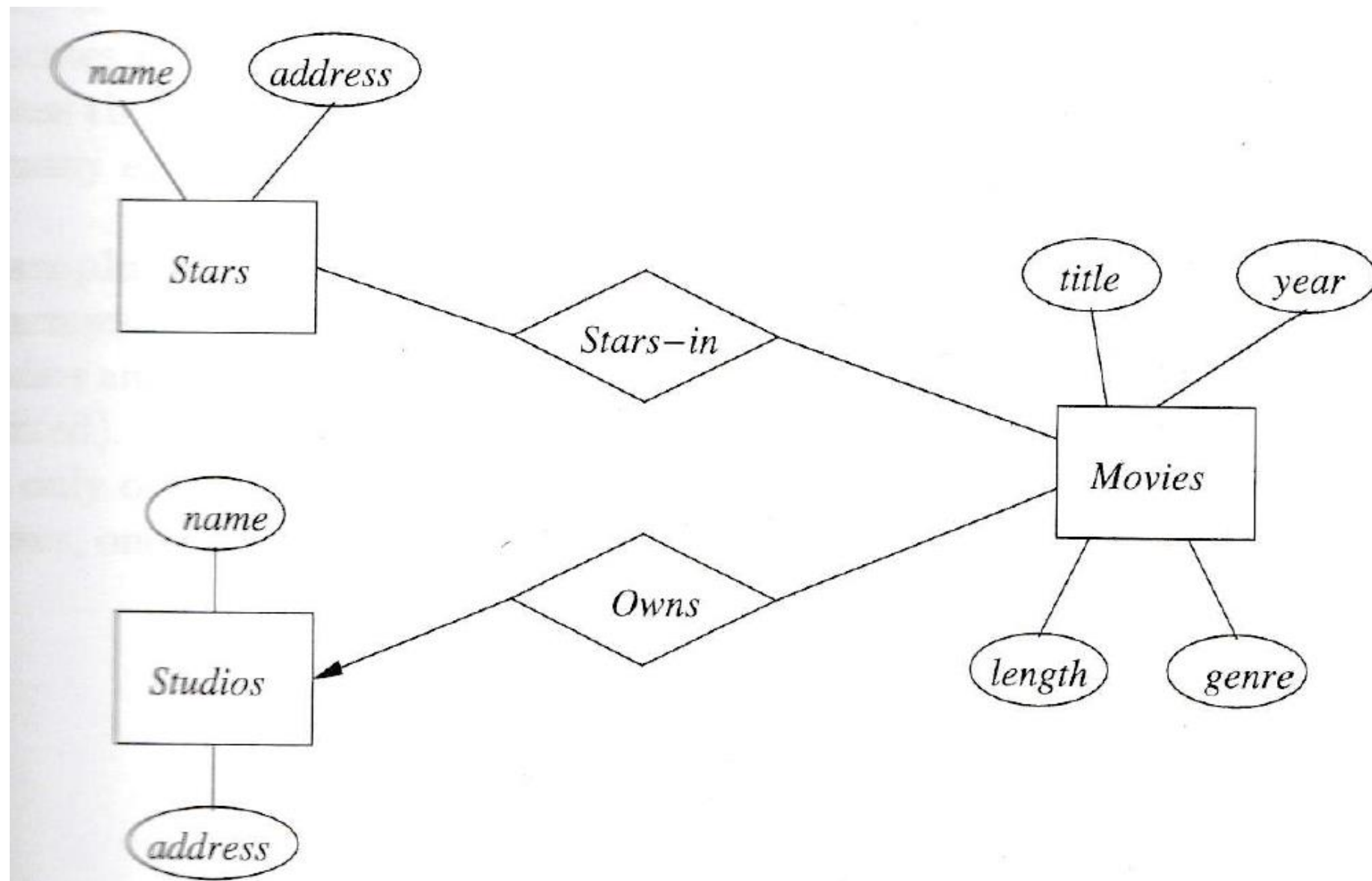
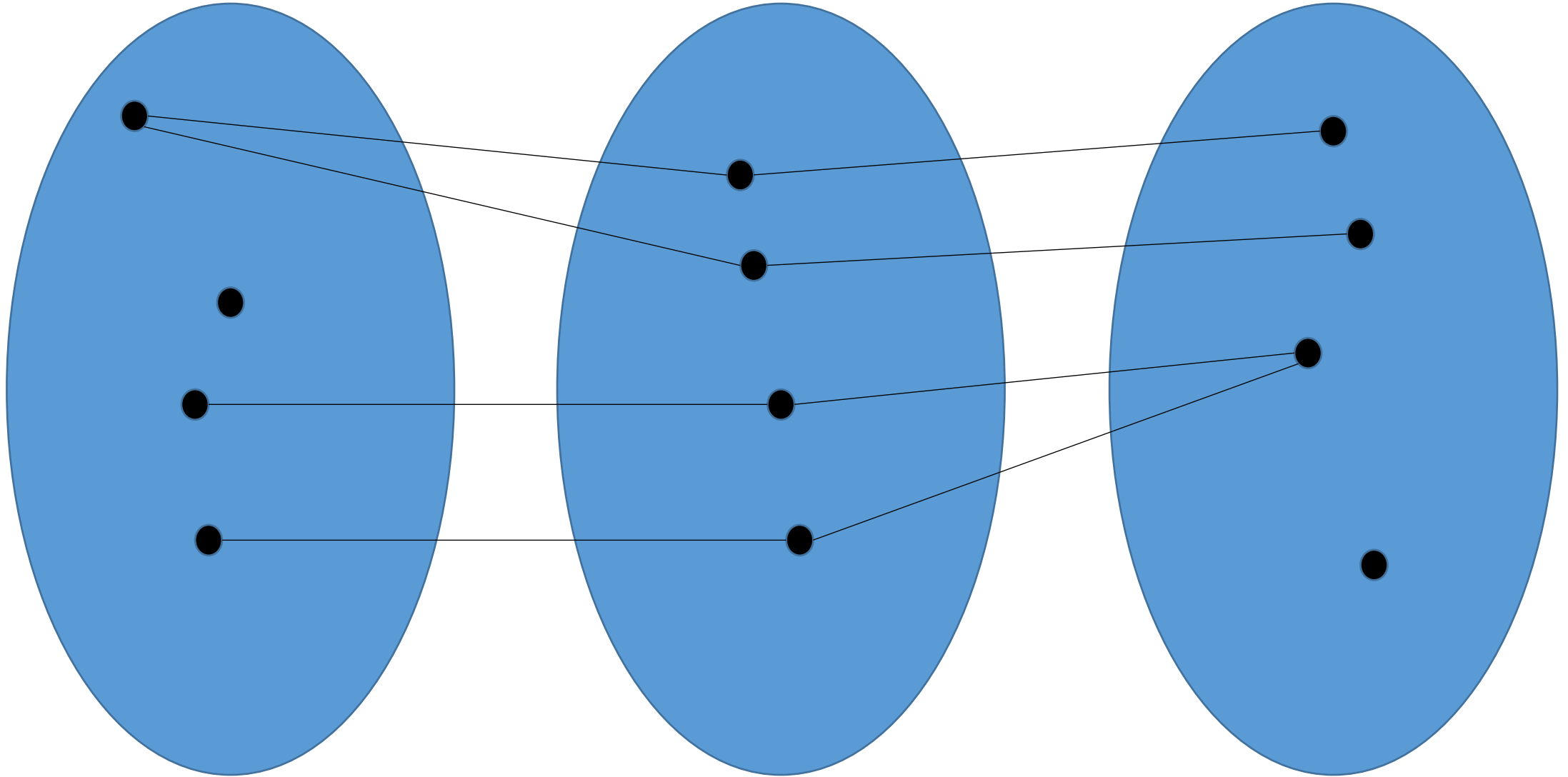


Figure 2: An entity-relationship diagram for the movie database

Stars

Stars-in

Movie



Venslatög, mengi og tilvik – Relationship types, sets and instances

- Venslatag yfir n einindatög – A relationship type over n entity types, E_1, E_2, \dots, E_n
 - Skilgreinir safn tenginga (vensla) meðal einindataganna – Defines a collection of relationships between the entity types
- Venslatilvik – Relationship instances, r_i
 - Sérhvert r_i tengir saman n einstök einindi (e_1, e_2, \dots, e_n) – Each r_i connects n individual entities (e_1, e_2, \dots, e_n)
 - Sérhvert einindi e_j í r_i er fengið úr einindasafninu E_j – Each entity e_j in r_i is from the entity collection E_j

Gráða vensla – Degree of a relationship

- Gráða vensla er fjöldi þeirra einindataga sem þátt taka í venslunum – The degree of a relationship is the number of entity types that take part in the relationship
- Tvíundarvensl – Binary relationship
 - Gráða tveir – Degree two
- Þríundarvensl – Ternary relationship
 - Gráða tveir – Degree three

Studios

Owns

Movies

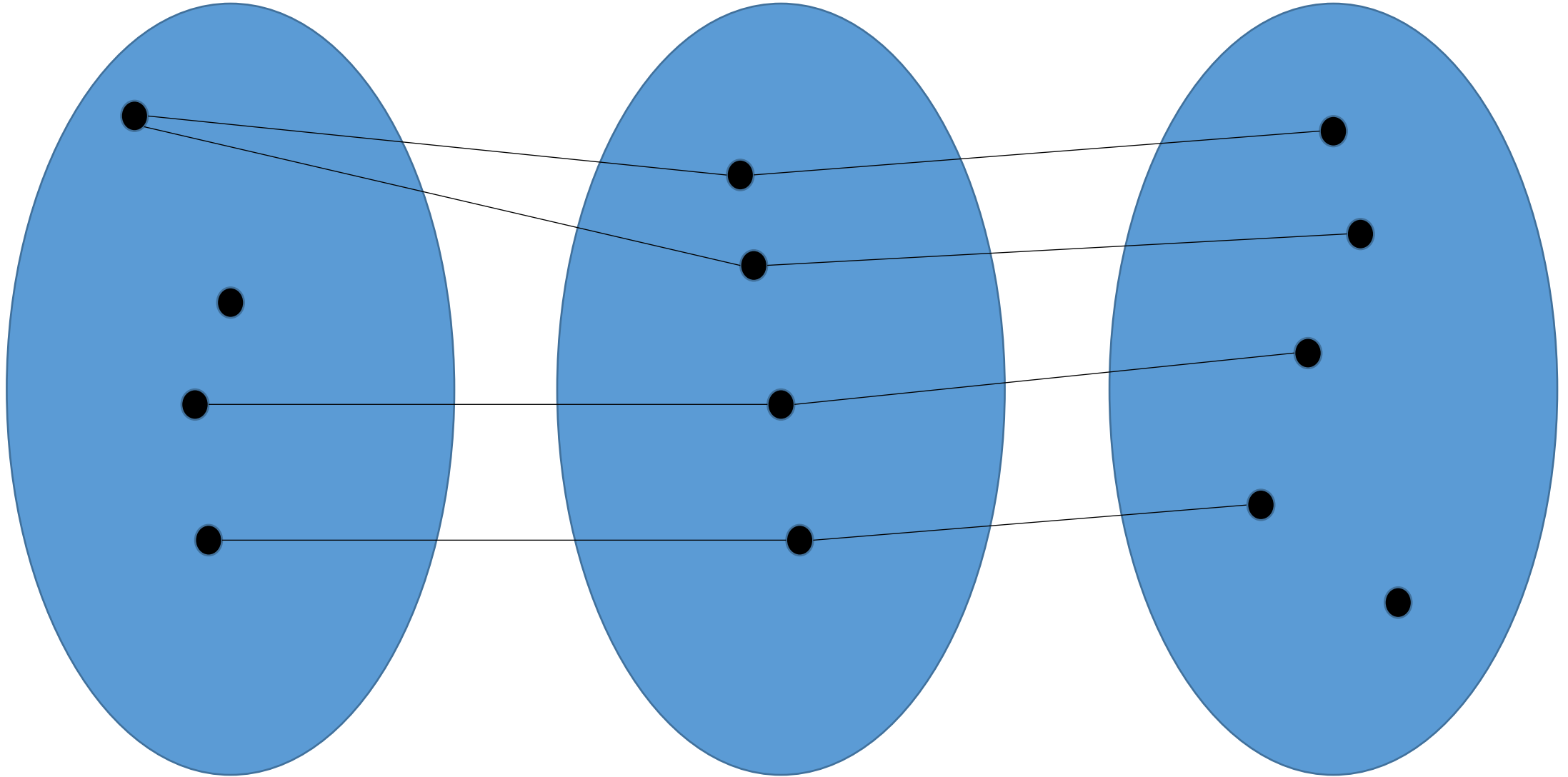


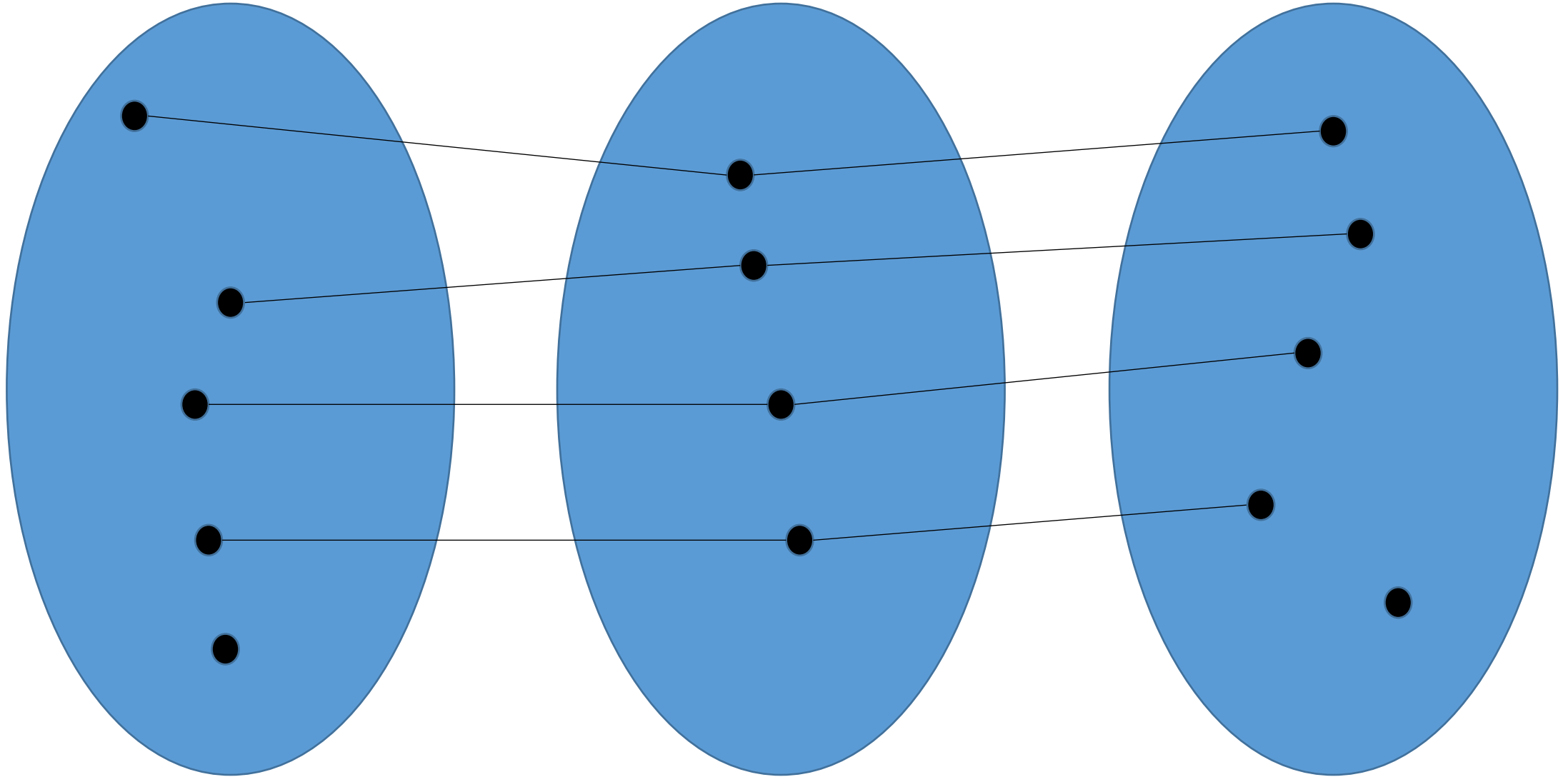


Figure 3: A one-one relationship

Studios

Runs

Presidents



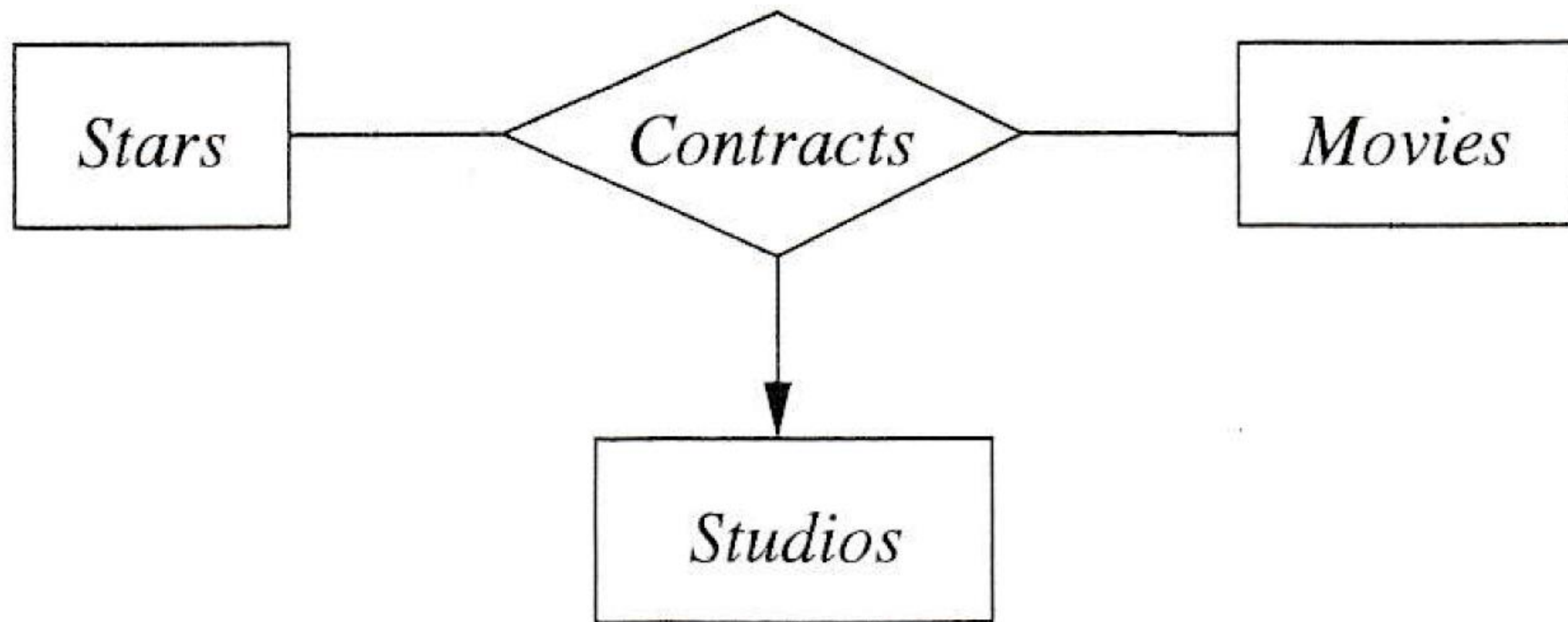
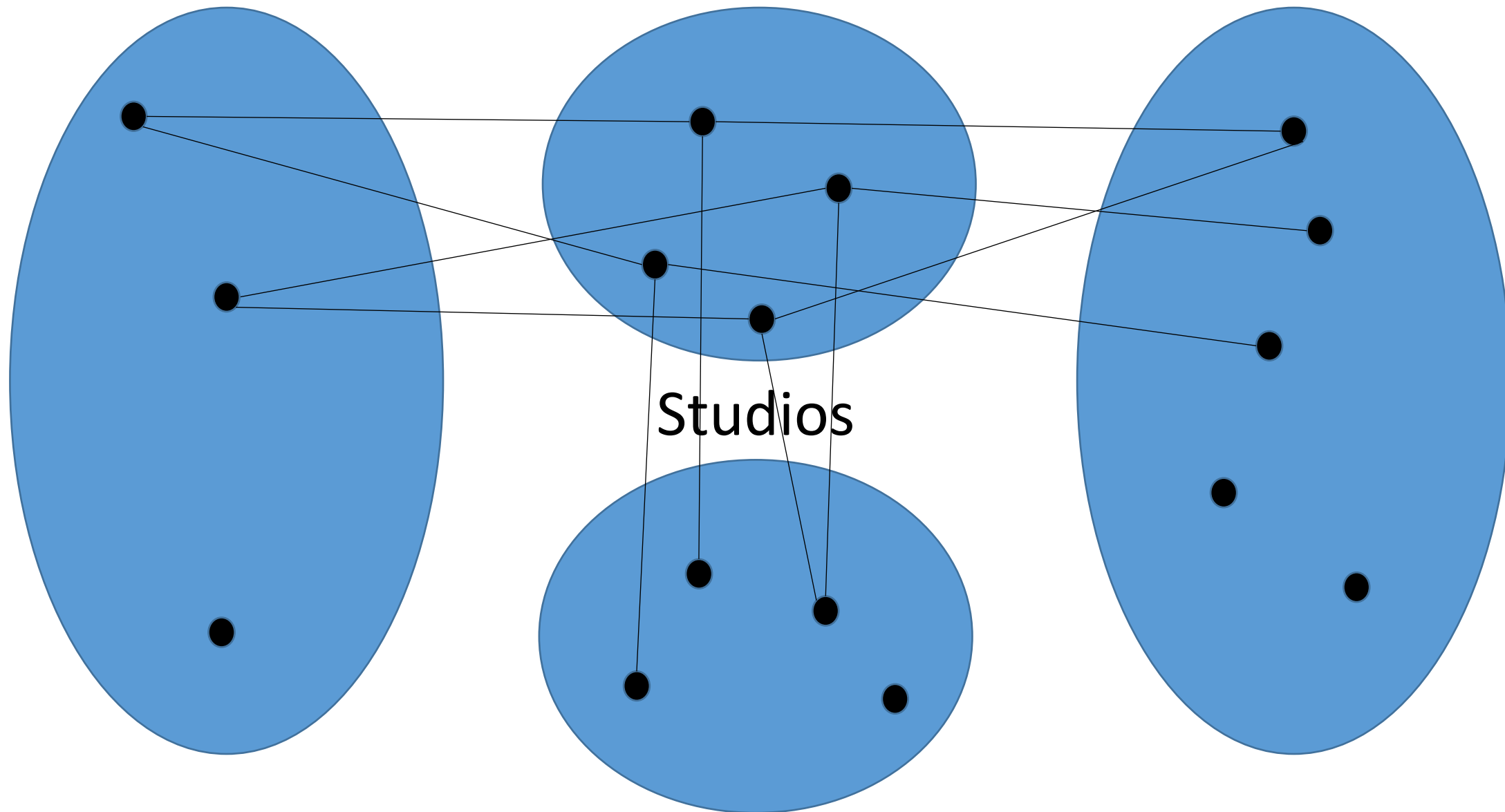


Figure 4: A three-way relationship

Stars

Contracts

Movies



Studios

Æðra stigs hugræn gagnalíkön fyrir gagnagrunnshönnun – High-level conceptual models for database design

- Þarfagreining og kröfulýsing – Analysis of needs and requirements
 - Gagnagrunnshönnuðir tala við væntanlega notendur til að skilja og skjala (document) þarfir (requirements) sem gagnagrunnur þarf að hjálpa til að uppfylla
Database designers interview prospective users to understand and document requirements that a database needs to help fulfill
 - **Niðurstaða/afurð – Result/deliverable:**
Kröfulýsing – Requirements specification
 - **Kröfur á virkni kerfis – Demands for system functionality**

Æðra stigs hugræn gagnalíkön fyrir gagnagrunnshönnun – High-level conceptual models for database design

- Hugmyndafræðilegt skipulag – Conceptual schema
 - Hugmyndafræðileg hönnun – Conceptual design
 - Lýsing á gagnakröfum – Description of data requirements
 - Innifelur lýsingar á gerðum eininda, venslum og skorðum
Includes descriptions of entity types and constraints
 - Getum varpað æðra stigs gagnalíkani yfir í útfærslugagnalíkan
(implementation data model, t.d. venslalíkan) –
We can transform a high level data model into an
implementation data model such as a relational model

Æðra stigs hugræn gagnalíkön fyrir gagnagrunnshönnun – High-level conceptual models for database design

- Rökræn hönnun eða vörpun gagnalíkans – Logical design
 - Niðurstaða er gagnagrunnsskipulag (database schema) í gagnagrunnskerfi (DBMS)
Result is a database schema in a DBMS
- Neðra stigs hönnun – Physical design phase
 - Innri geymslusnið, skipulag skráa eða taflna, vísar, aðgangsleiðir og vélrænar kröfur fyrir gagnagrunninn –
Internal data formats, schemas or file formats, access paths, indexes, physical requirements

Nafnareglur, venjur

Naming rules, conventions

- Veljið nöfn sem gefa til kynna viðeigandi merkingu hinna ýmsu fyrirbæra – Choose descriptive names
- Einindi fá nafnorð – Entities have nouns
- Vensl fá sagnorð – Relationships have verbs
- Veljið nöfn á tvíundarvensl (binary relationship) þannig að unnt sé að lesa einindavenslaritið frá vinstri til hægri, ofan frá og niður – Prefer to name in such a way that we can read from left-to-right, top-to-bottom
 - við munum stundum sjá þessa þumalputtareglu brotna á eftirfarandi myndum, það er auðvelt að taka eftir því
 - We will see this rule broken in some examples

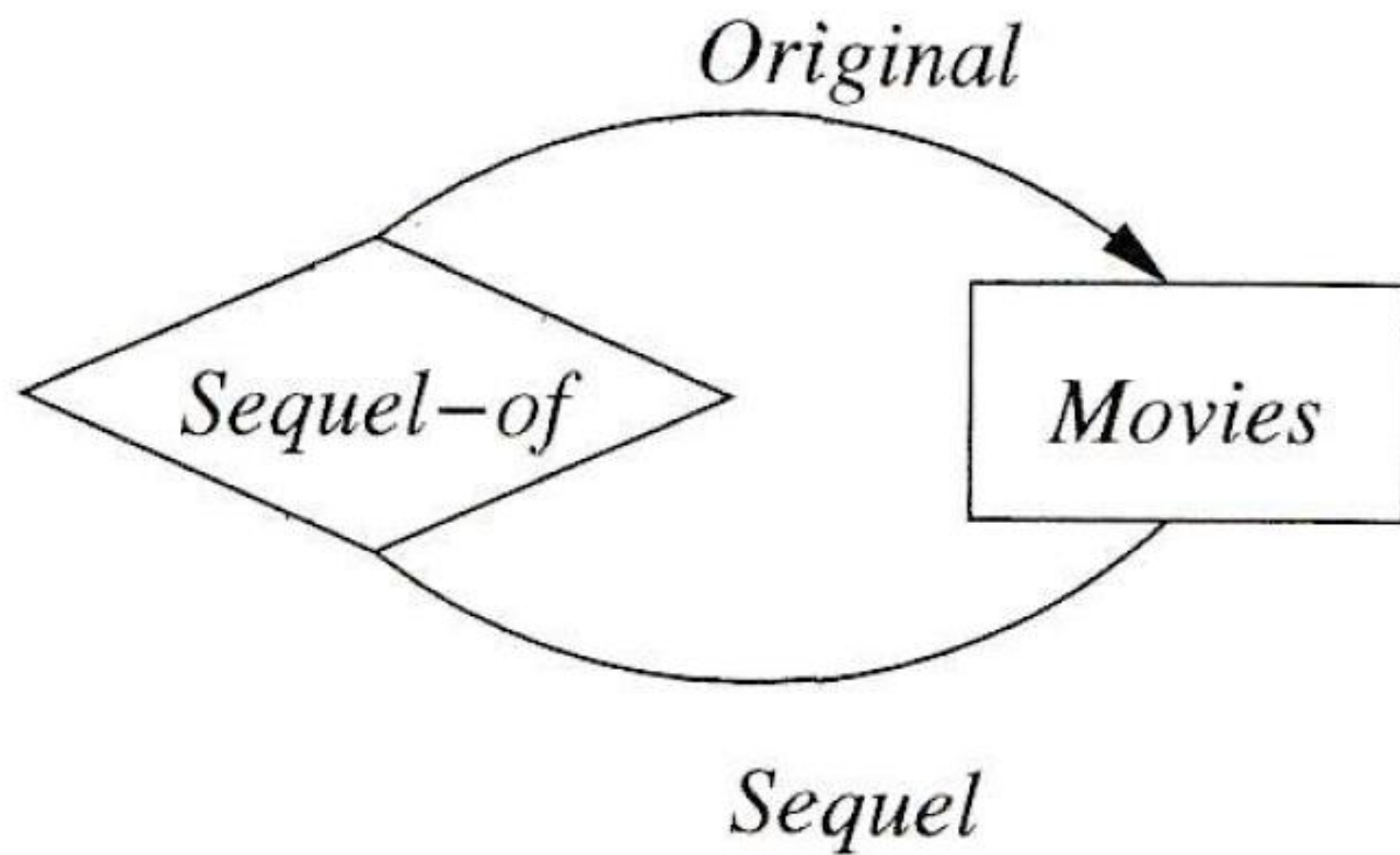


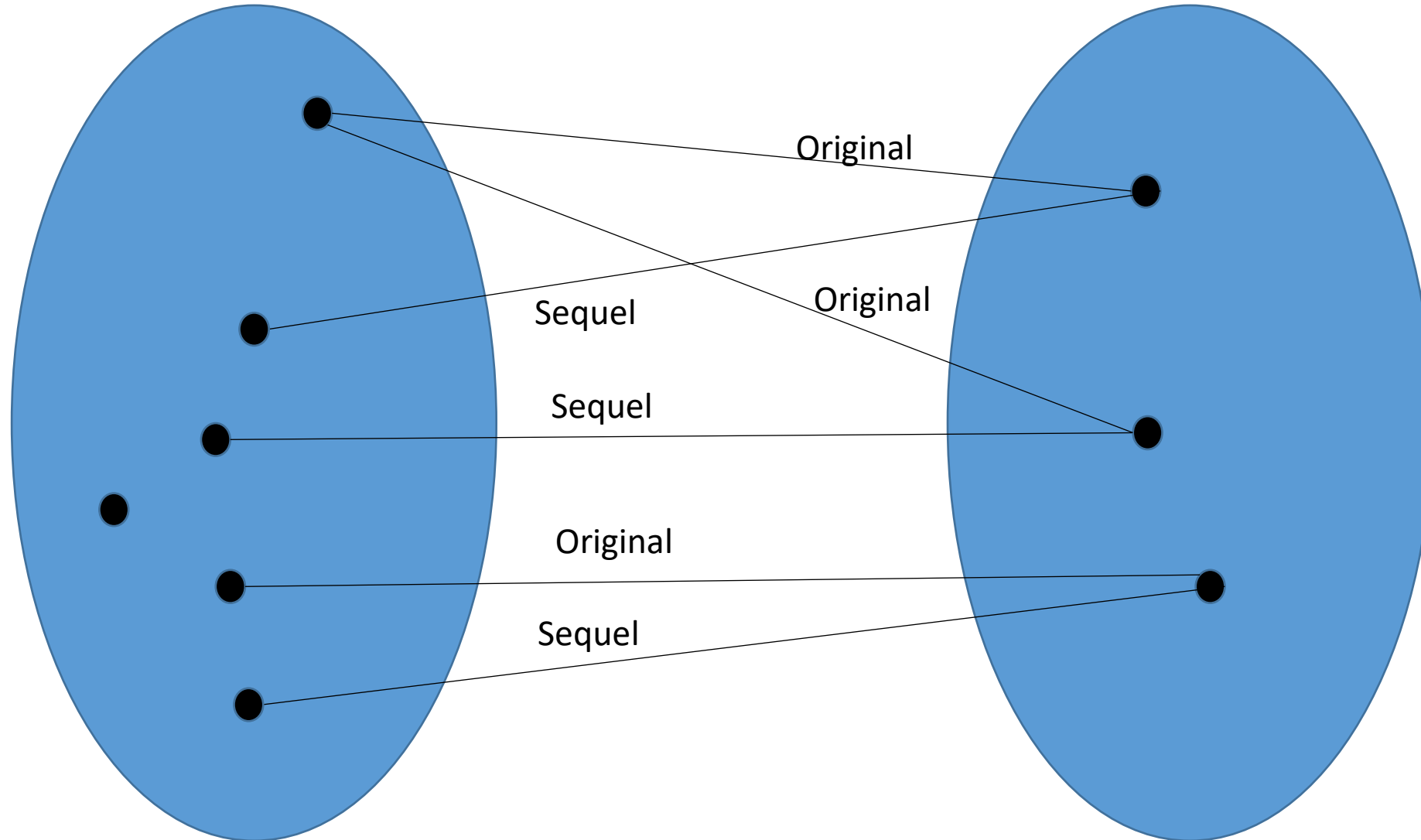
Figure 5: A relationship with roles

Hlutverkanöfn og endurkvæm vensl – Role names and recursive relationships

- Hlutverkanafn (role name) tilgreinir hvaða hlutverk viðkomandi einindi spilar í hverju tilviki vensla –
Role names specify what role the entity in question plays in each instance of a relationship
- Endurkvæm vensl – Recursive relationships
 - Sama gerð eininda tekur þátt í venslum (relationship) á fleiri en einn hátt, í mismunandi hlutverkum –
The same entity type takes part in a relationship in multiple ways
 - Þá þarf að tilgreina hlutverkanafn –
We then need to specify a role name

Movies

Sequel-of



Sequel ákvarðar Original en ekki öfugt

A Sequel determines an Original, but not vice versa

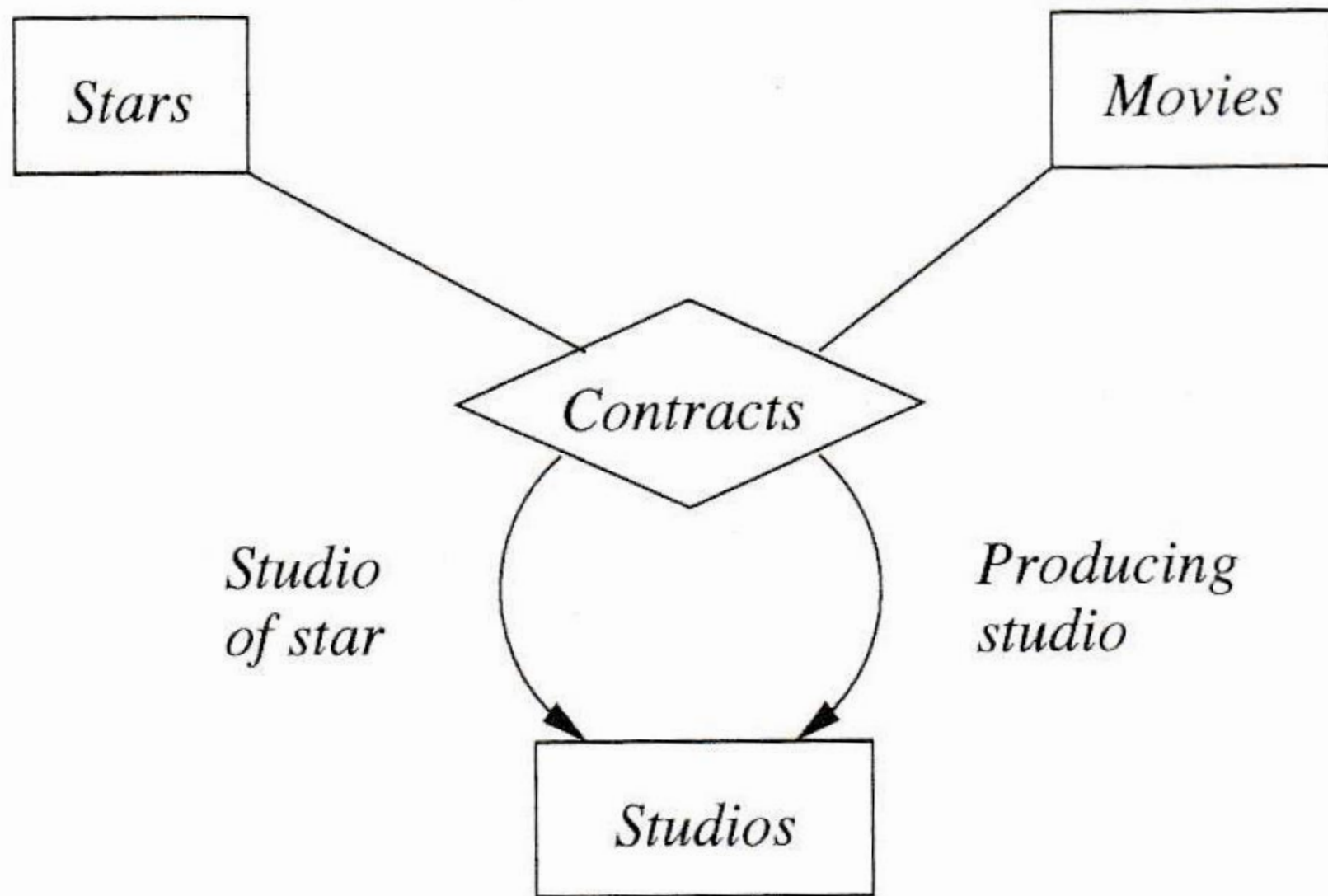


Figure 6: A four-way relationship

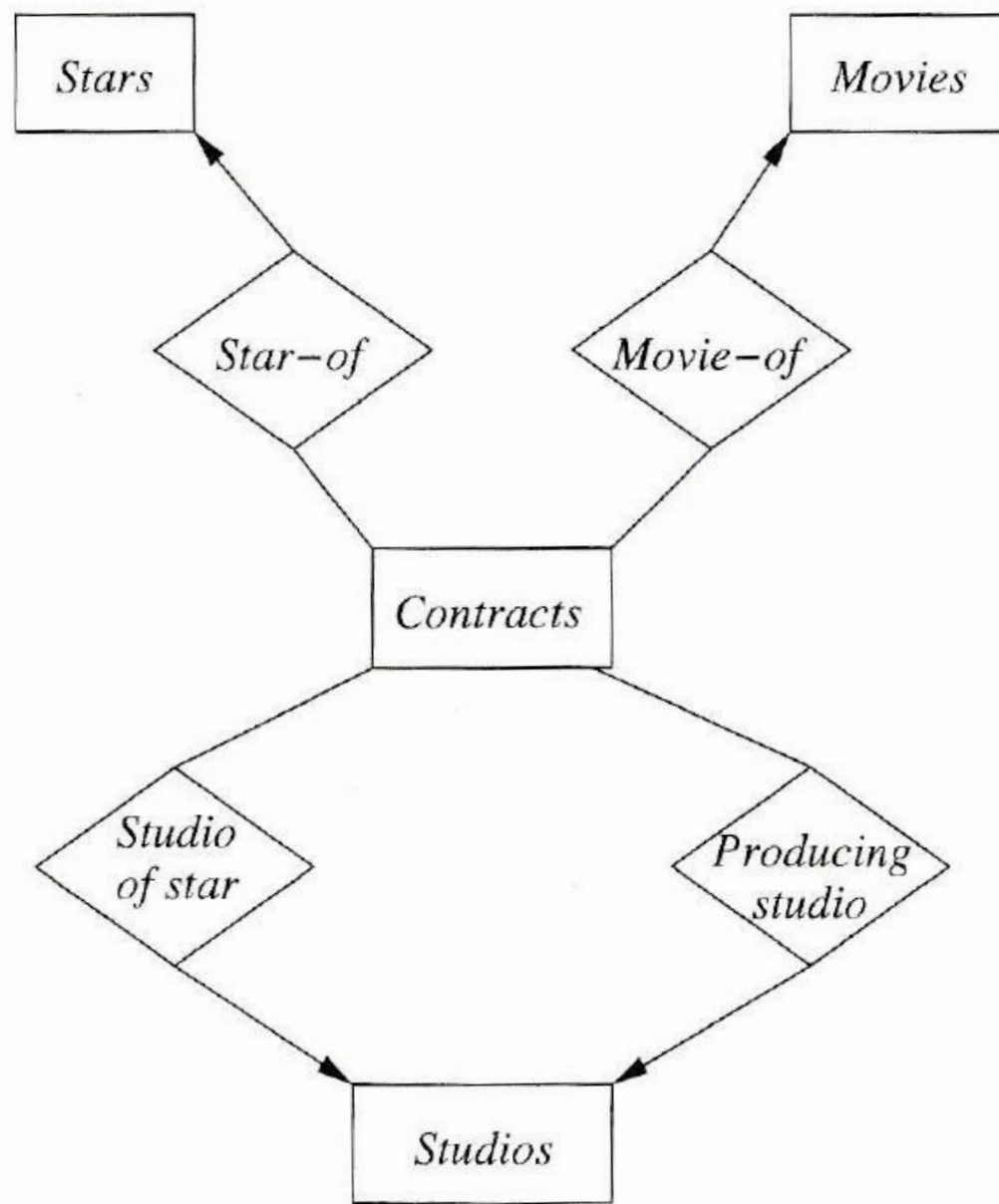


Figure 9: Replacing a multiway relationship by an entity set and binary relationships

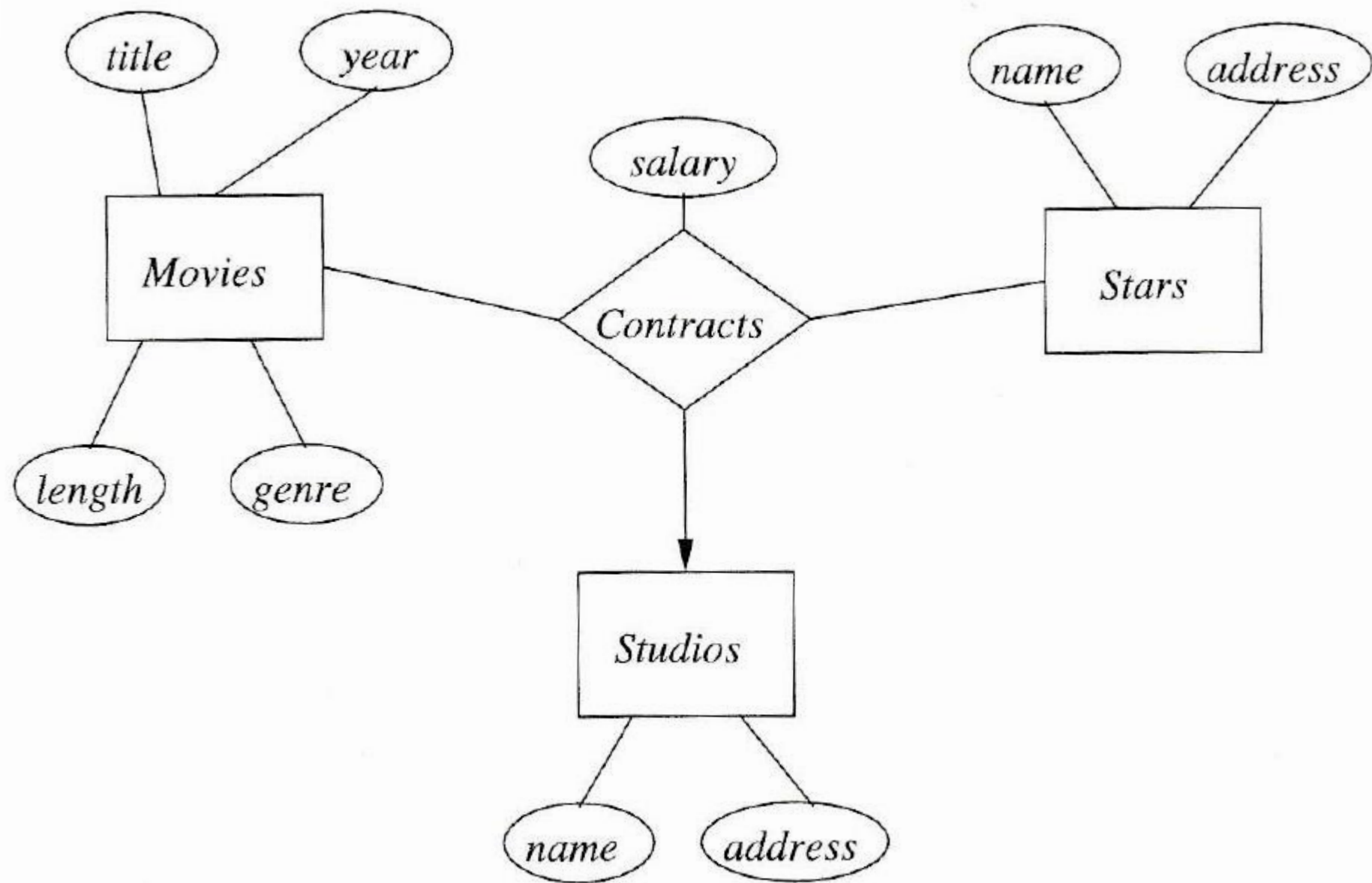


Figure 7: A relationship with an attribute

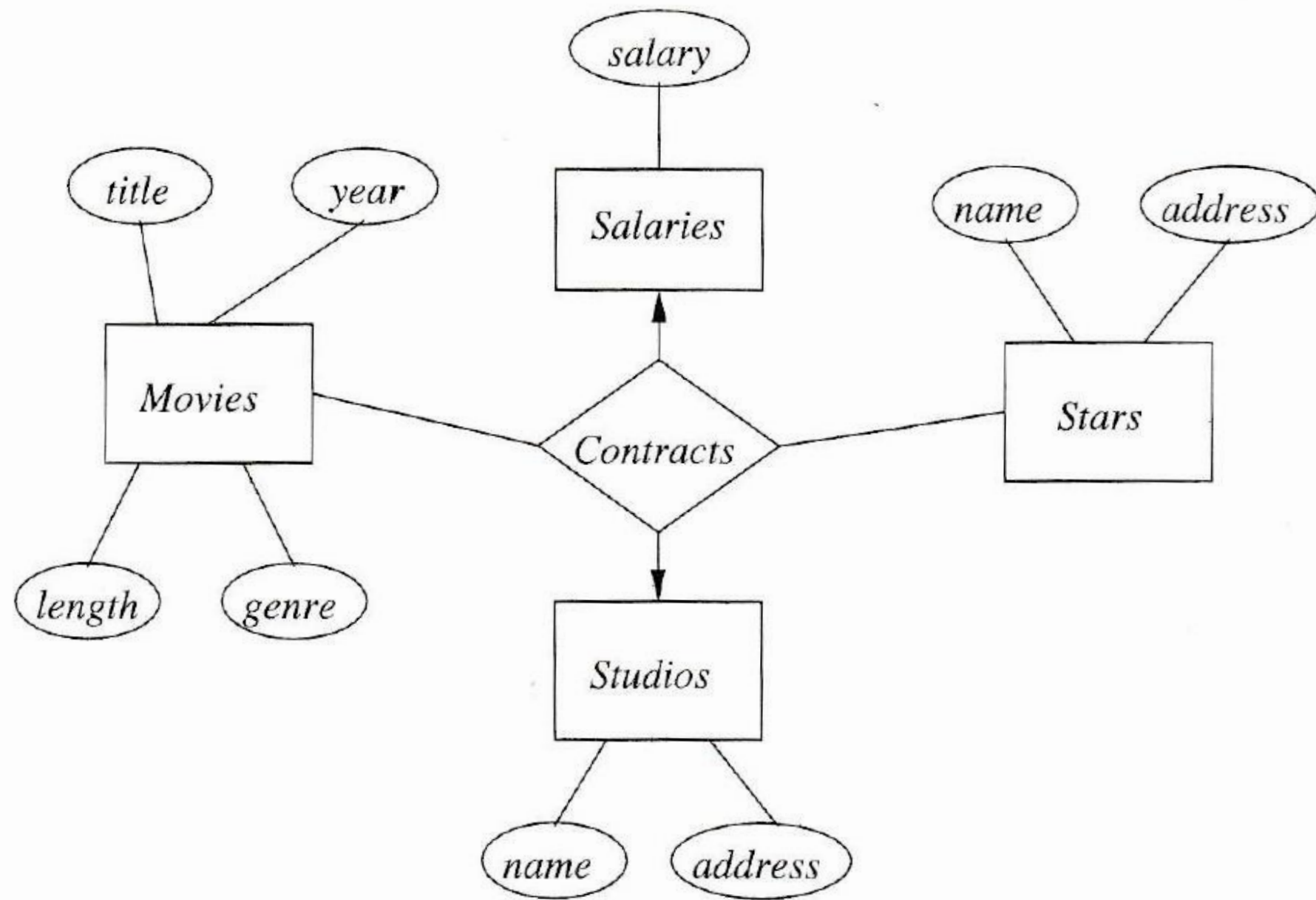


Figure 8: Moving the attribute to an entity set

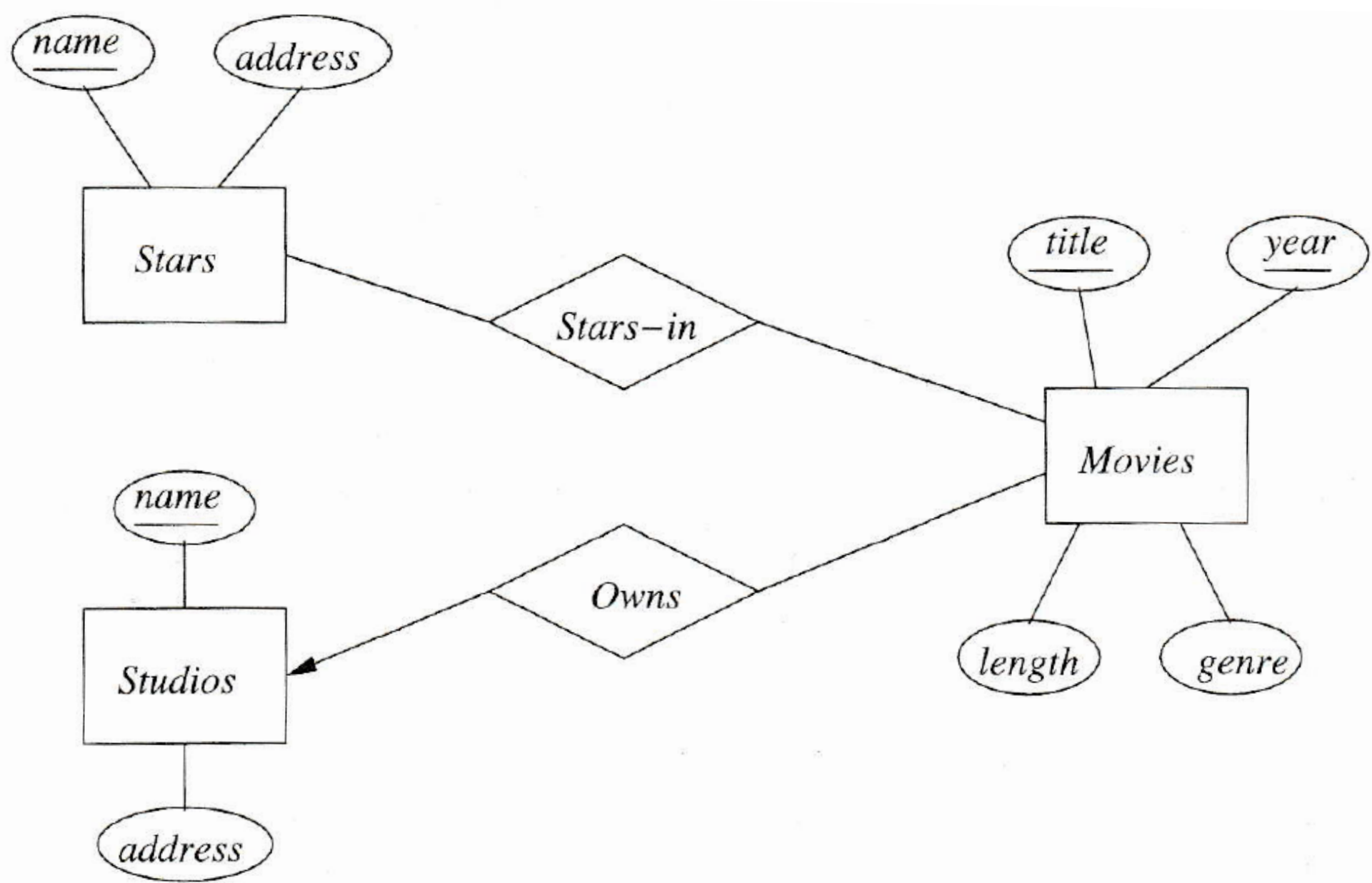


Figure 17: E/R diagram; keys are indicated by underlines



Figure 18: E/R diagram showing referential integrity constraints

Skorður (Constraints):

Sérhver kvikmynd (movie) **verður** að hafa **eitt og aðeins eitt** kvikmyndaver (studio) sem á (Owns) kvikmyndina.

Það er ekki víst að kvikmyndaver eigi neina kvikmynd, en það gæti átt margar.

Sérhver forstjóri (president) **verður** að stjórna (Runs) **einu og aðeins einu** kvikmyndaveri.

Það er ekki víst að kvikmyndaver hafi forstjóra, en sérhvert kvikmyndaver hefur í **mesta lagi einn** forstjóra.



Figure 18: E/R diagram showing referential integrity constraints

Constraints:

Each movie **must** have **one and only one** studio that owns the movie.

It is not certain that a studio owns any movie but may own multiple movies.

Each president **must** run **one and only one** studio.

It is not certain that a studio has a president, but it has **at most one** president.

Tilgreina má fjöldaskorður –
Cardinality constraints are possible



Figure 19: Representing a constraint on the number of stars per movie

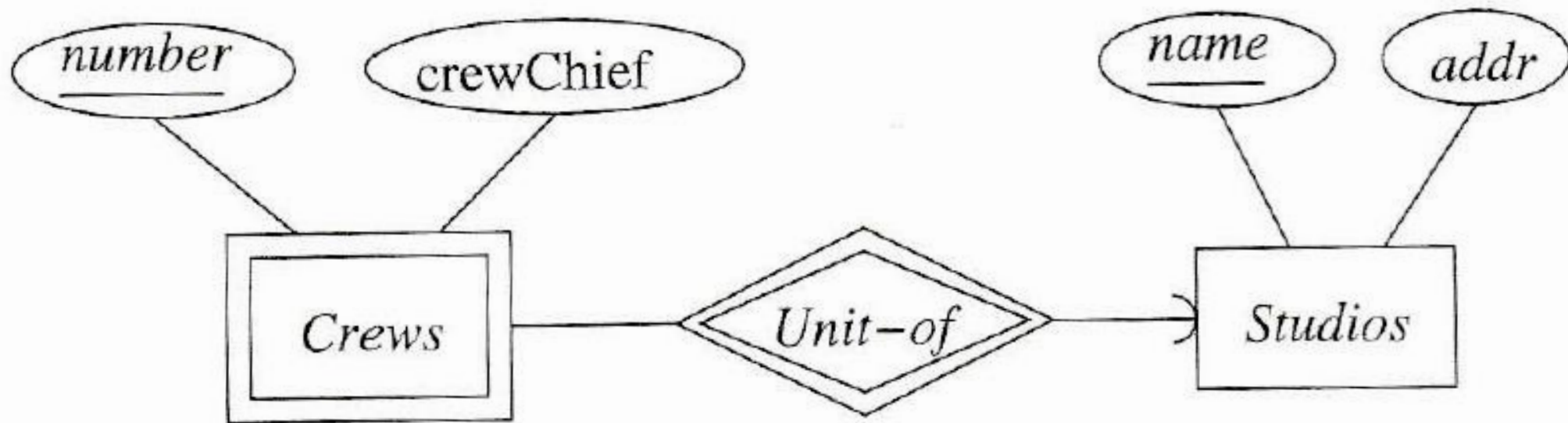


Figure 20: A weak entity set for crews, and its connections

Sérhvert upptökuteymi (crew) **verður** að hafa **eitt og aðeins eitt** kvikmyndaver (studio).

Crew (upptökuteymi) er **veikt einindi**, þ.e. upptökuteymi hefur ekki sjálfstæða tilvist án kvikmyndavers. Unit-of eru **skilgreinandi vensl** (defining relationship, supporting relationship) fyrir upptökuteymi.

Hver er lykillinn fyrir upptökuteymi í töflu upptökuteyma? Athugið að mismunandi upptökuteymi innan mismunandi kvikmyndavera geta haft sama number.

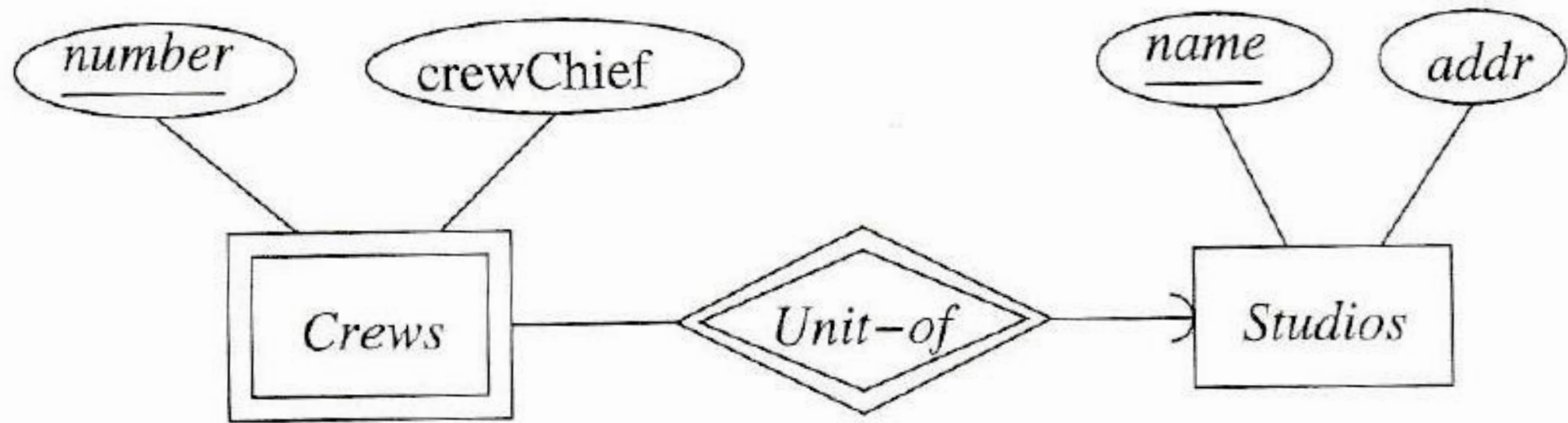


Figure 20: A weak entity set for crews, and its connections

Each film crew **must** have **one and only one** studio.

A crew is a **weak entity**, i.e. a crew has no independent existence without a studio. Unit-of is a **defining relationship**, (supporting relationship) for a crew.

What is the key for a crew in a table of crews? Note that different crews within different studios may have the same number.

Veik einindi – Weak entities

- Hafa ekki sjálfstæða lykla –
Do not have independent keys
 - Finnast gegnum vensl (relationship) við tiltekin einindi af annarri gerð –
Are found through relationships with specified entities of another type
- Hafa **auðkennandi vensl** – Have identifying relationship (supporting relationship)
- Tengir sérhvert veikt einindi við einn **eiganda** –
Connects each weak entity to one **owner**

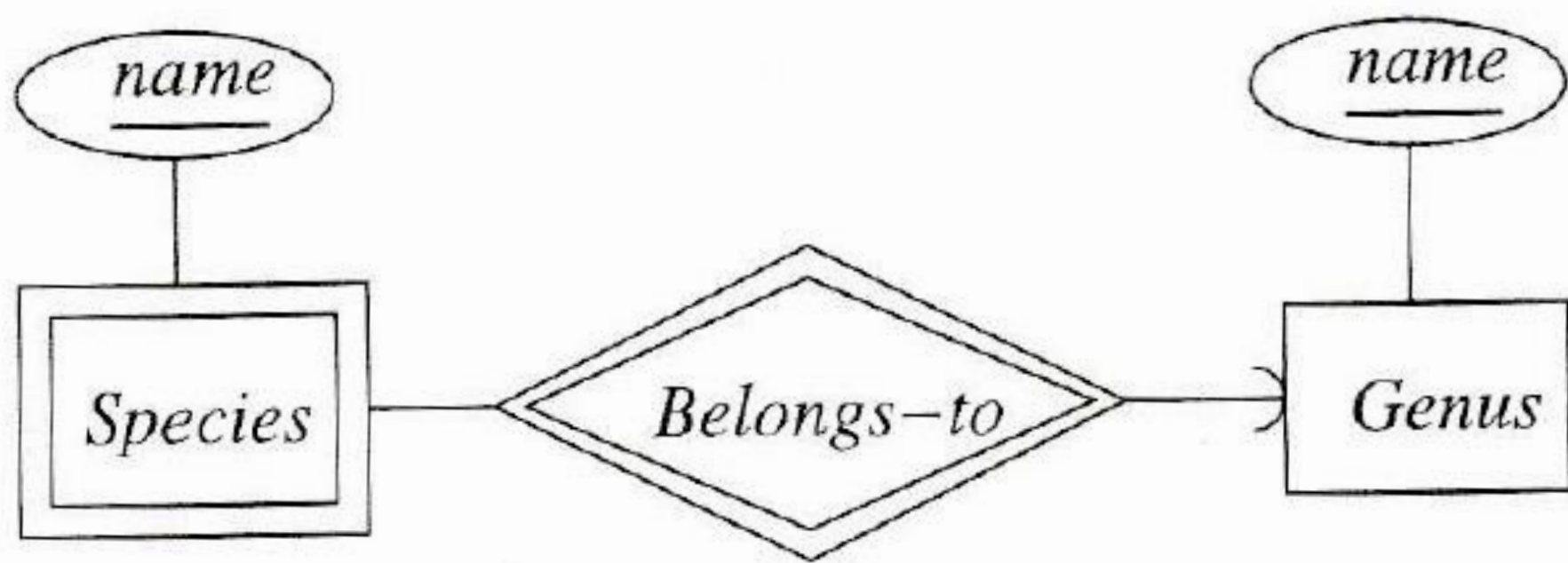


Figure 21: Another weak entity set, for species

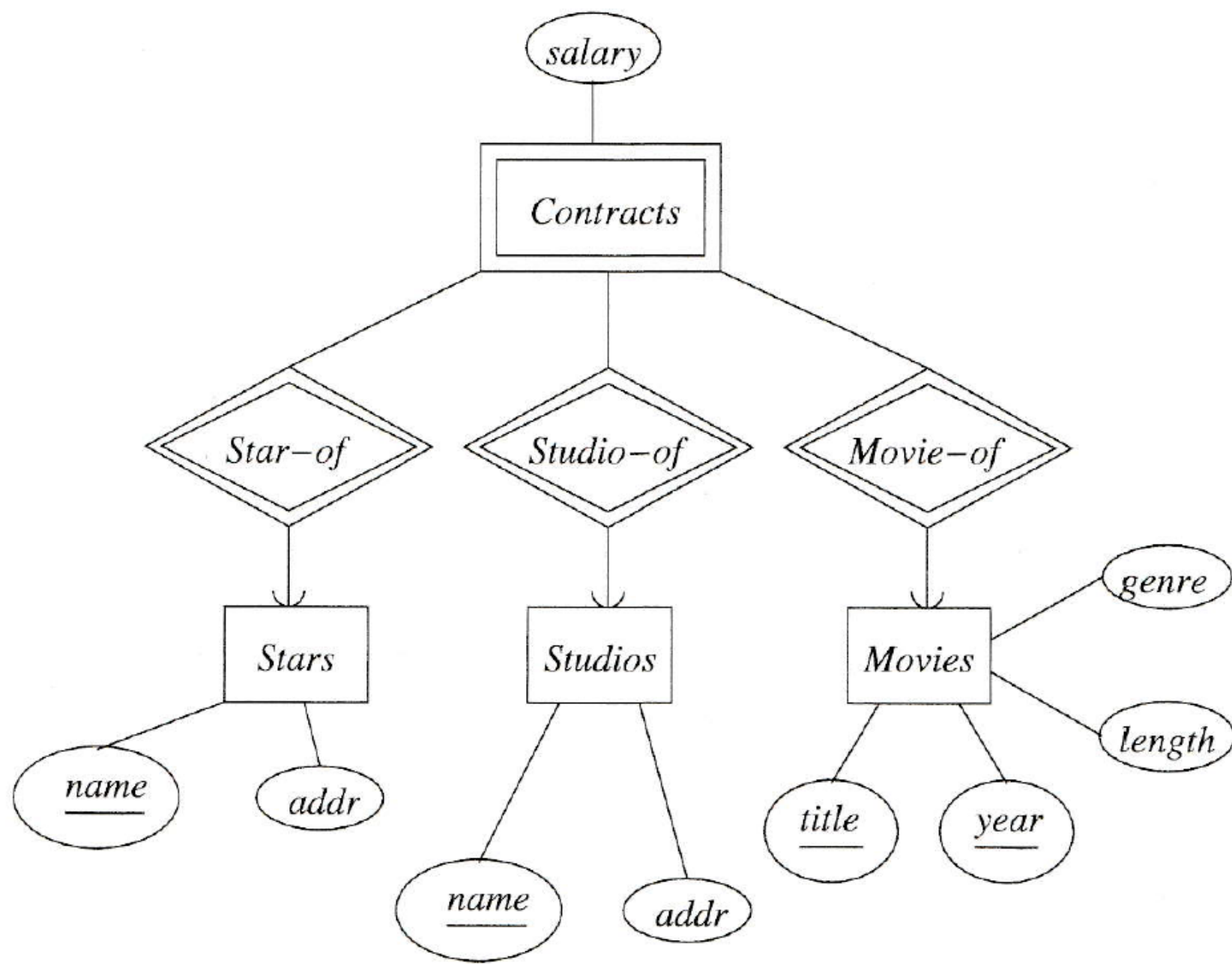


Figure 22: Connecting entity sets are weak

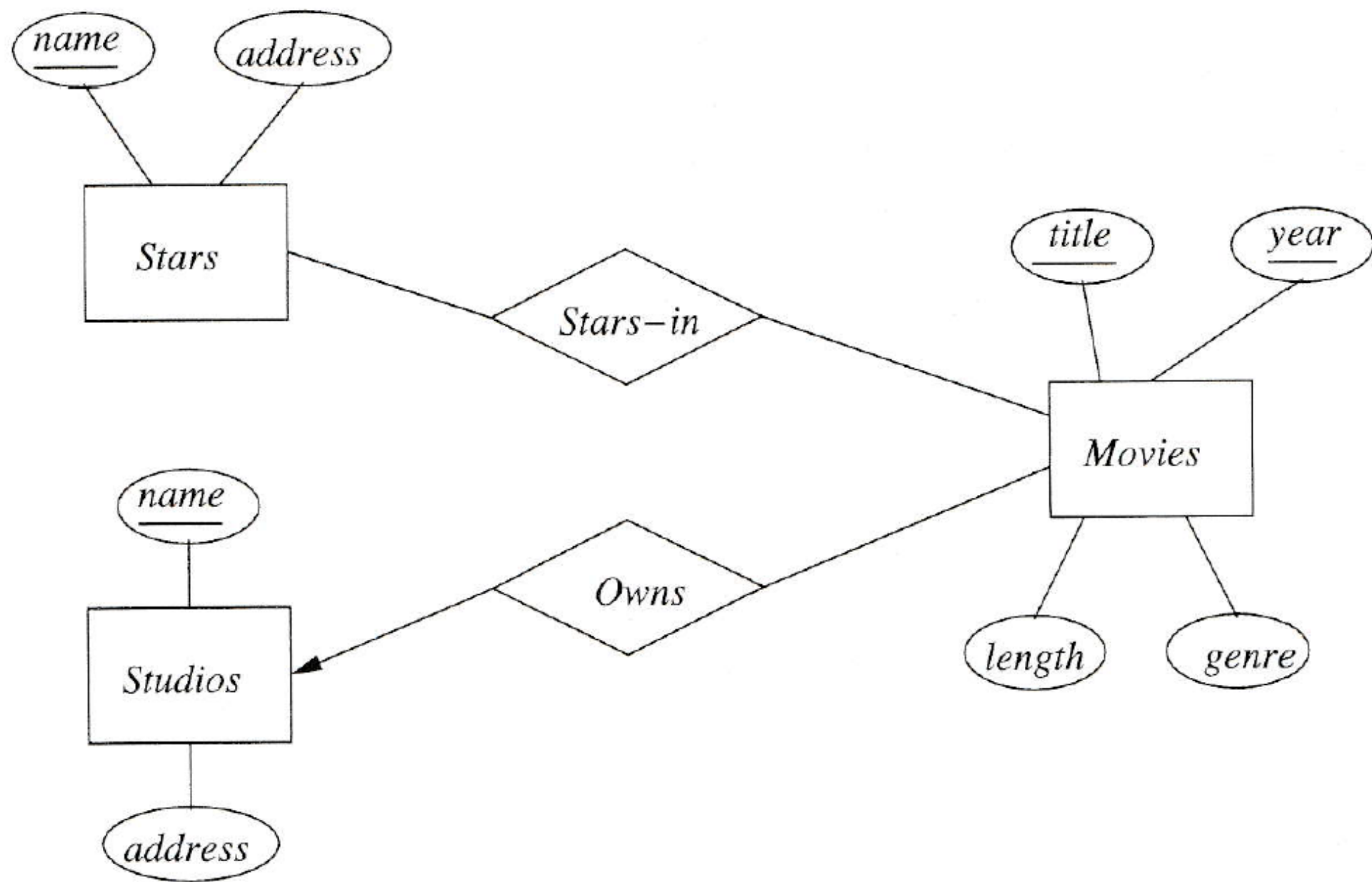


Figure 23: E/R diagram for the movie database

Yfirlit yfir samsvaranir

Einindavenslalíkan (ER model)	Venslalíkan (Relational model)
Einindasafn	Vensl fyrir einindi
1:1 eða 1:N vensl (relationship)	Ytri lykill eða vensl fyrir relationship
M:N vensl (relationship)	Vensl fyrir relationship
Vensl (relationship) af gráðu n	Vensl með n ytri lykla
Einföld eigindi	Eigindi (dálkur)
Samsett eigindi	Safn af einföldum eigindum (dálkum)
Fjölgilda eigindi	Vensl með ytri lykli

Overview of correspondences

E/R model	Relational model
Entity collection	Relation of attributes
1:1 or 1:N relationship	Foreign key or relation for relationship
M:N relationship	Relation for relationship
Relationship of degree n	Relation with n foreign keys
Simple attribute	Attribute (column)
Composite attribute	A collection of simple attributes (columns)
Multivalued attribute	A relation with a foreign key

Aðferðir til að varpa einindavenslalíkani í gagnagrunn

- **Venjuleg einindi:** Fyrir venjulegt einindasafn E (ekki veik) smíðum við vensl (relation, ekki relationship) R sem innihalda alla einfalda eiginleika E . Sérhver n -d í R stendur fyrir einindi í E .
- **Veik einindi:** Fyrir veikt einindasafn smíðum við vensl R og höfum sérhvern einfaldan eiginleika einindanna sem eiginleika (dálk) í R . Látum eiginleikana sem mynda aðallykil eiganda vera ytri lykil í R .
- **1:1 tvíundarvensl:** Fyrir 1:1 tvíundarvensl, reynum að bera kennsl á vensl (relation) sem samsvara einindasöfnum sem taka þátt í R . Til dæmis með ytri lyklum, með samruna vensla, með krosstilvísunum eða með nýjum töflum.
- **1:N tvíundarvensl:** Fyrir 1:N tvíundarvensl, berum kennsl á venslin R sem standa fyrir N -hliðina og finnum lykil þeirra. Búum til nýja töflu (vensl) S sem stendur fyrir tvíundarvenslin og 1-hliðina. Látum lykilinn á R vera ytri lykil þar og setjum aðra dálka sem einfalda eiginleika einindanna á 1-hliðinni (sem relation) plús einfaldir eiginleikar venslanna (relationship).
- **M:N tvíundarvensl:** Fyrir M:N tvíundarvensl smíðum við nýja töflu S þar sem aðallyklar beggja hliða eru ytri lyklar og höfum aðra dálka fyrir einfalda eiginleika venslanna.
- **Fjölgilda eiginleikar:** Fyrir fjölgilda eiginleika A í einindi E með aðallykil K búum við til töflu R þar sem aðallykillinn er (A, K) . Ef fjölgilda eiginleikinn er samsettur þá bætum við dálkum fyrir einfalda hluta eiginleikans.
- **N-undarvensl:** Fyrir N -undarvensl R búum við til nýja töflu S sem stendur fyrir R . Innifelum aðallykla allra þeirra eininda sem þátt taka sem ytri lykila. Innifelum einnig einfalda eiginleika R sem dálka í S .

Methods for mapping an E/R diagram to a database

- **Regular entity:** For a regular entity collection E (not weak) we construct a relation (not relationship) R that contains all the simple attributes of E . Each tuple in R represents an entity in E .
- **Weak entity:** For a weak entity collection we construct a relation R and let each simple attribute of the entity as an attribute (column) in R . Let the attributes that compose the main key of the owner be a foreign key in R .
- **1:1 binary relationship:** For a 1:1 binary relationship try to identify the relations that correspond to the entity collections that take part in the relationship and then either use foreign keys, merging the relations or a new relation for cross-referencing between the relations.
- **1:N binary relationship:** For a 1:N binary relationship, identify the relation R that corresponds for the N-side and find its key. Create a new relation (table) S that stands for the binary relationship and the 1-side. Let the key in R be a foreign key there and put other columns for the simple attributes of the relationship on the 1-side, plus simple attributes of the relationship.
- **M:N binary relationship:** For a M:N binary relationship we create a new table S where the keys of both sides are foreign keys and have other columns for simple attributes of the relationship.
- **Multivalued attributes:** For a multivalued attribute A in entity E with primary key K we create a table R where the primary key is (A, K) . If the multivalued attribute is composite we add columns for the simple parts of the attribute.
- **N-ary relationships:** For a N-ary relationship R we create a new table S that stands for R . Include the primary keys of all the entities that take part as foreign keys. Also include simple attributes of R as columns of S .

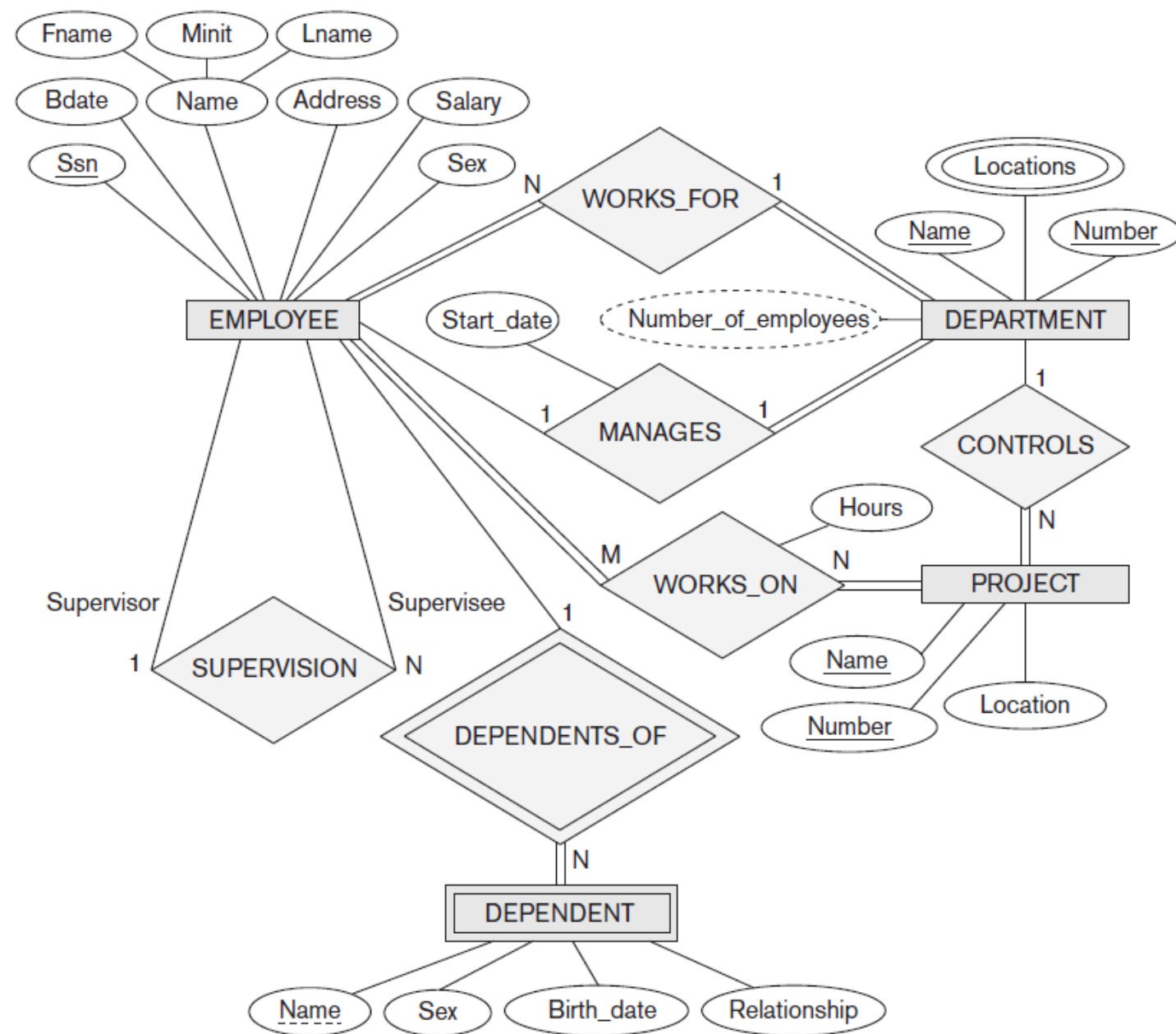
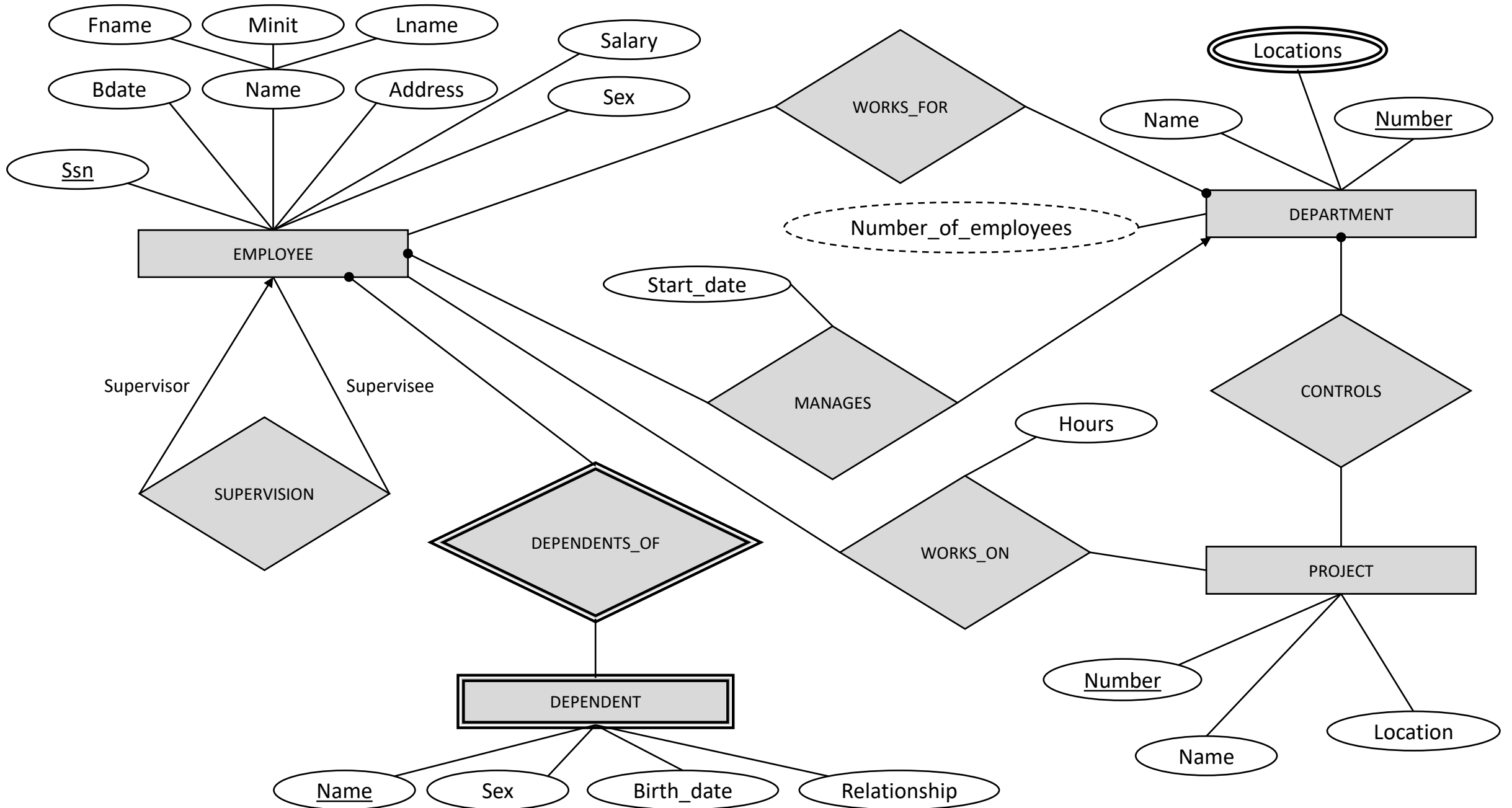


Figure 7.2

An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter and is summarized in Figure 7.14.



EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
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PROJECT

Pname	<u>Pnumber</u>	<u>Plocation</u>	Dnum
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WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
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DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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Figure 9.2

Result of mapping the COMPANY ER schema into a relational database schema.

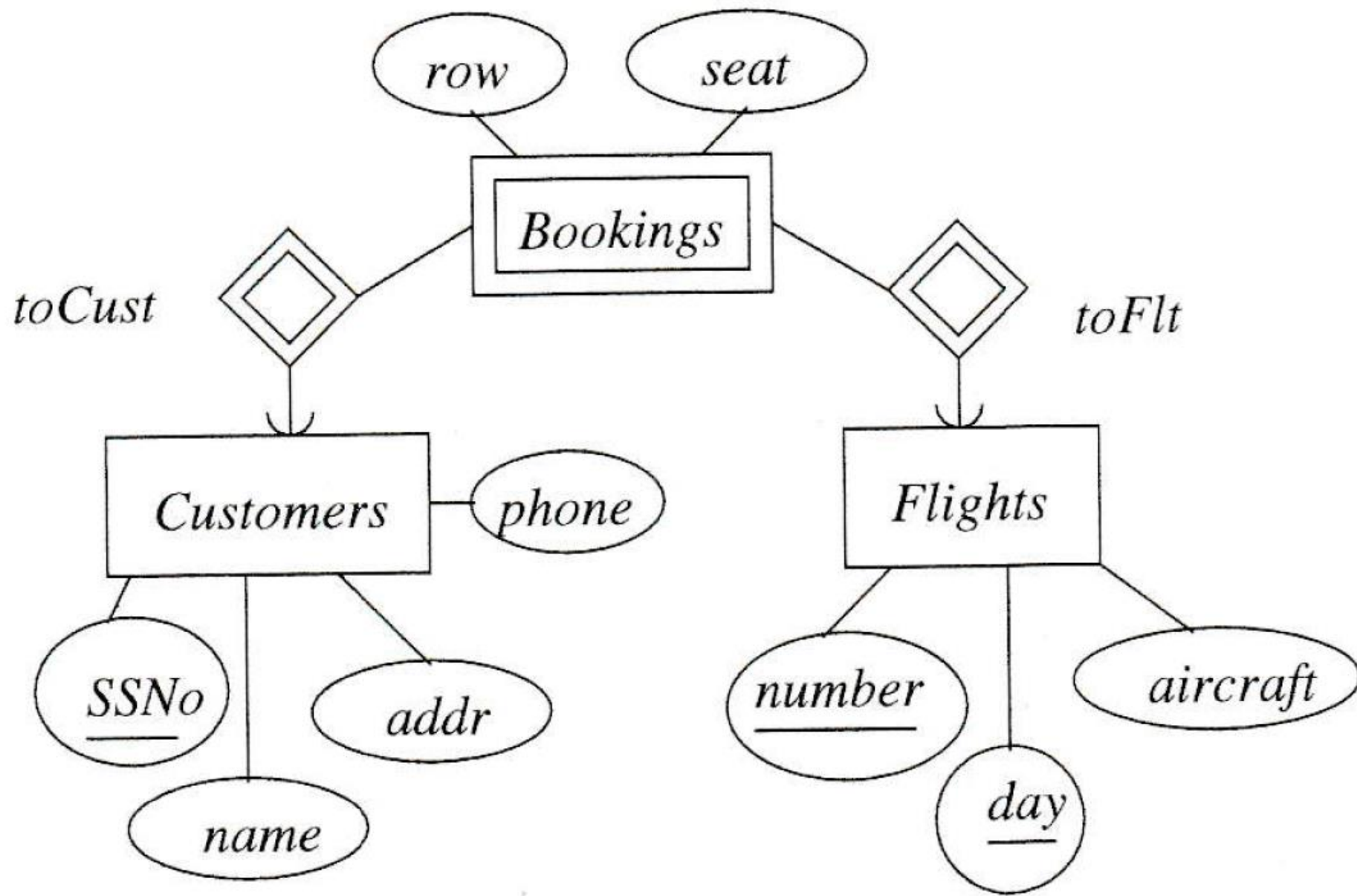


Figure 29: An E/R diagram about airlines