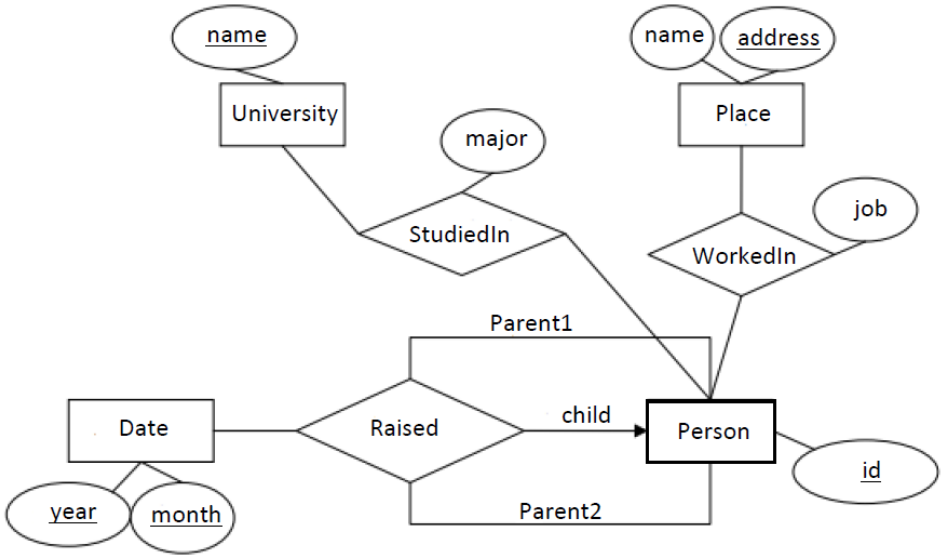
Introduction to Operating Systems and SQL for Data Science

Practice 11 – Entity Relation

ERD



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Introduction

- ERD is a formal modeling of data
- Conceptual database design
- The data is often consists of:
  - *Entities*
  - *Relationships*
- Examples:
  - Movies, actors, directors, roles, awards
  - Students, courses, lecturers, rooms
  - Persons, statuses, friendships, messages, likes

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ERD

- Part 1 - Extracting Tables from ERD.
- Part 2 – ERD questions.

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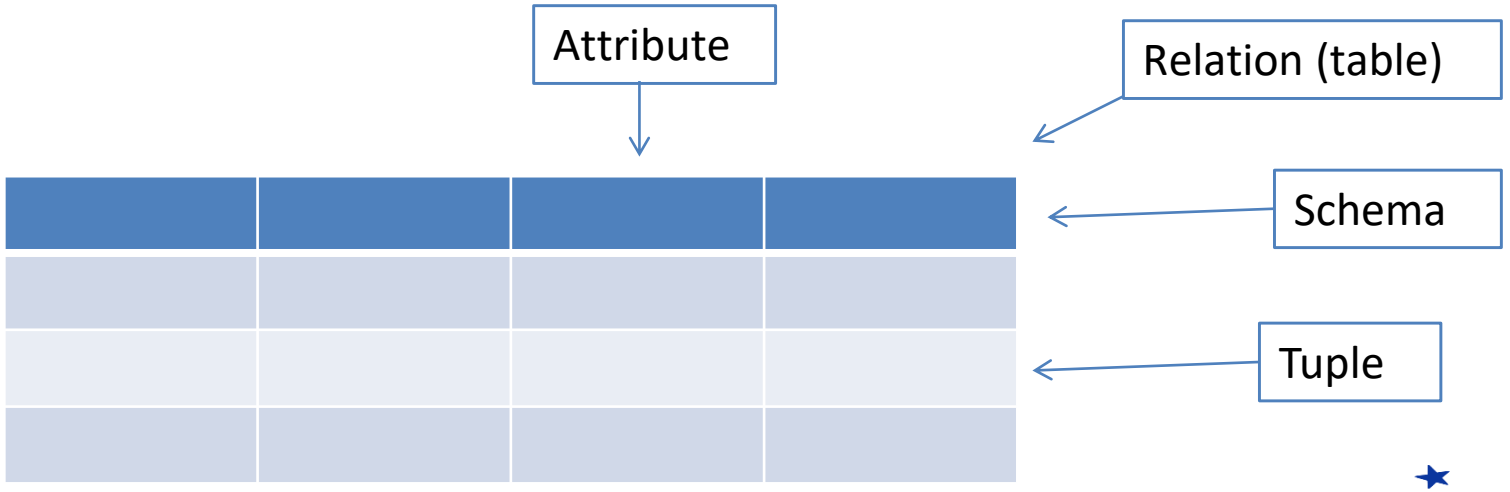
The relational model

- Logical database design
- We may deduce the relational model from the conceptual model
  - For instance, by extracting tables from an ERD
- Basic definitions:



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A table example

- t1 = (foo,bar,baz,{x,y})
- t2 = (quz,bar,foo,{y,z})

- t1[a1] = (baz)
- t2[a2] = ({y,z})

- t1[$\bar{a}$] = (baz,{x,y})
- t2[$\underline{\bar{k}}$] = (quz,bar)

	<u>k1</u>	<u>k2</u>	a1	a2
t1	foo	bar	baz	{x,y}
t2	quz	bar	foo	{y,z}

Vector of all **key** attributes

$\underline{\bar{k}}$ = (k1,k2)

$\bar{a}$ = (a1,a2)

Vector of all **non-key** attributes

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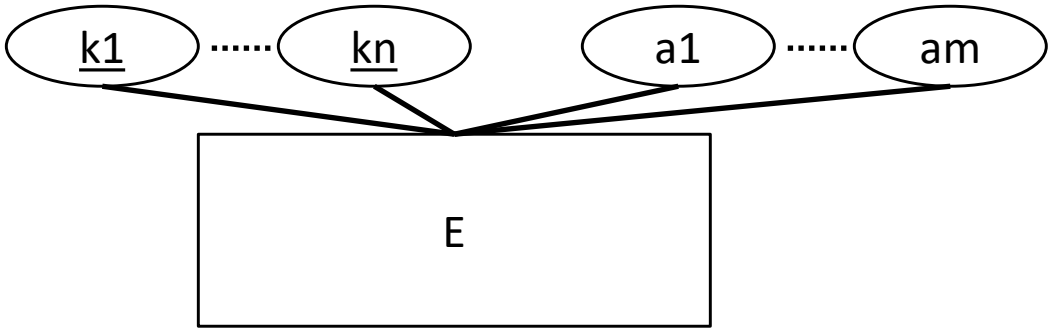
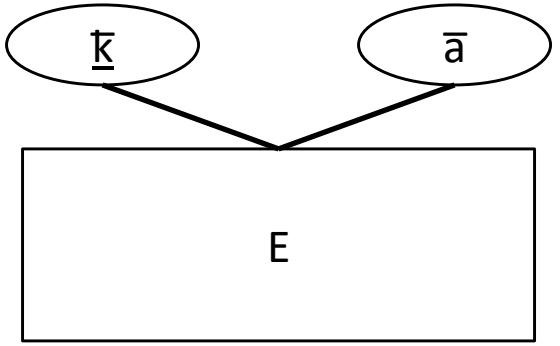
Extracting Tables from ERD

Entities



$\underline{\bar{k}}$ = (k1,…,kn) $\bar{a}$ = (a1,…,am)

- A short representation:



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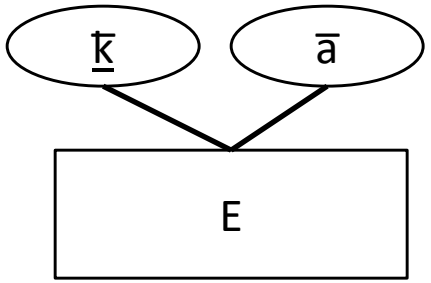
Entities



- Translation to a table:

k̲			ā		
k1	…	kn	a1	…	am

- Constraints:

$$t_1[\underline{k}] = t_2[\underline{k}] \Rightarrow t_1[\bar{a}] = t_2[\bar{a}]$$

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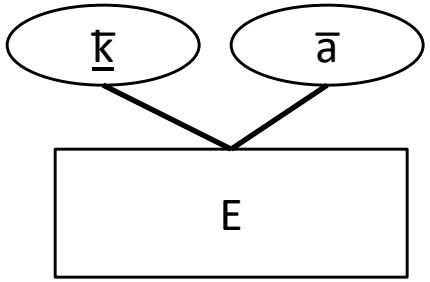
Entities



- We assume $\underline{k}$ can not be empty
- $\bar{a}$ may be empty

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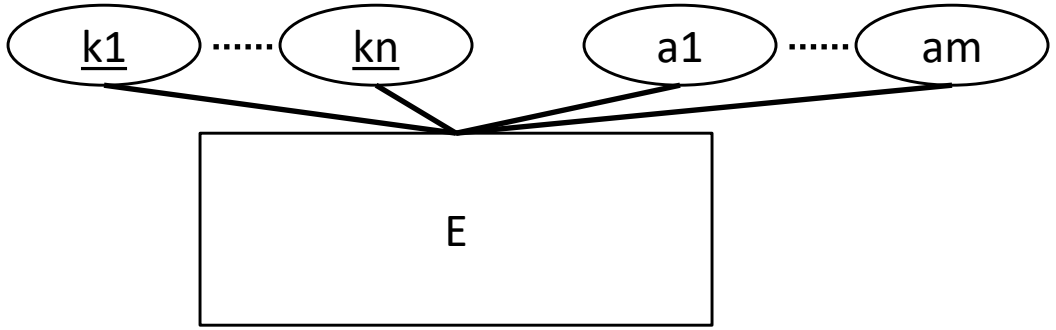
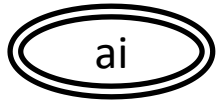
Entities





- Any ai may be multi-valued
  - Multi-valued attributes cannot be a part of the key
- In domain D, for a table row t:
  - for an attribute a_i: $t[a_i] \in D$
  - for a multi-valued attribute a_j: $t[a_j] \in P(D)$
    - a powerset.

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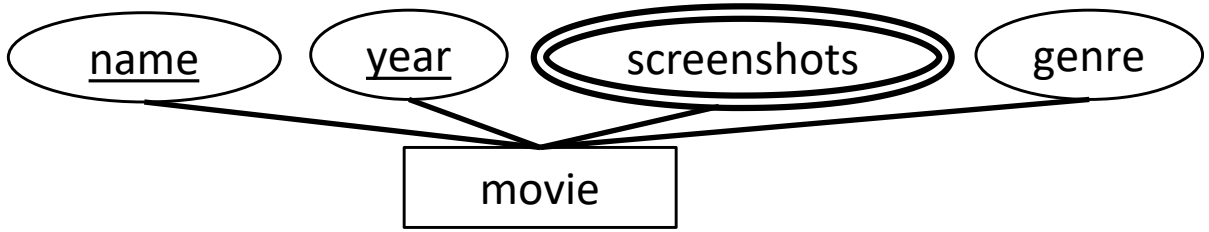
Another Representation of a Multi-Valued Attribute



- A table without multi-valued attributes:

k		a2
name	year	genre
Cold Mountain	2003	Drama

- Tables - one for each multi-valued attribute:

name	year	screenshots
Cold Mountain	2003	screenshot1

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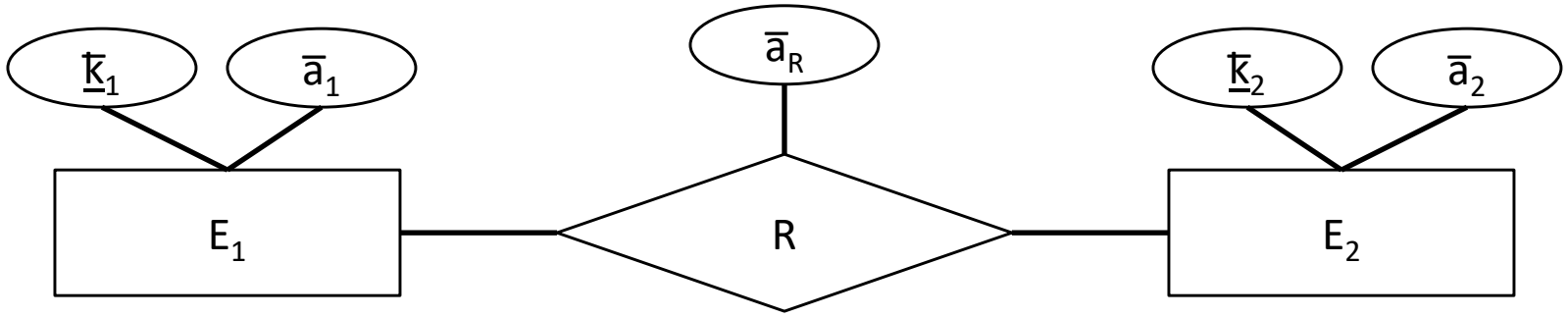
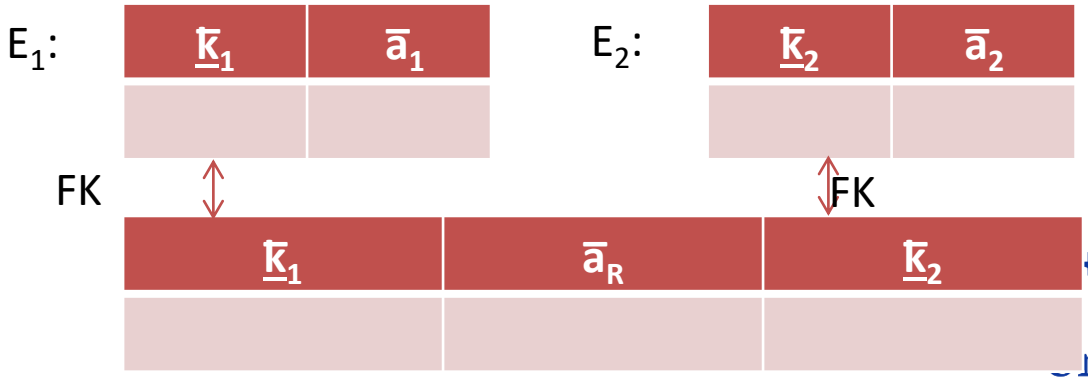
Relationships



- For each $\underline{k}$, $\bar{a}$ may be empty
- Translation to a table:



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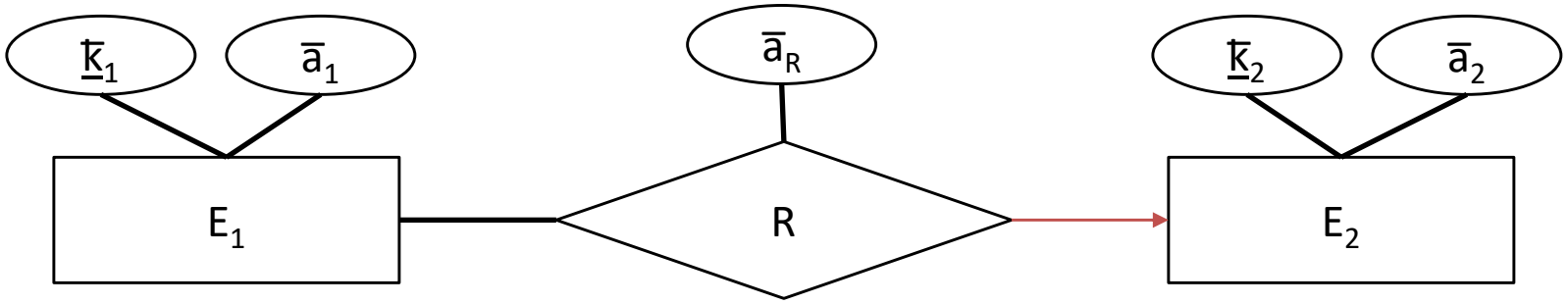
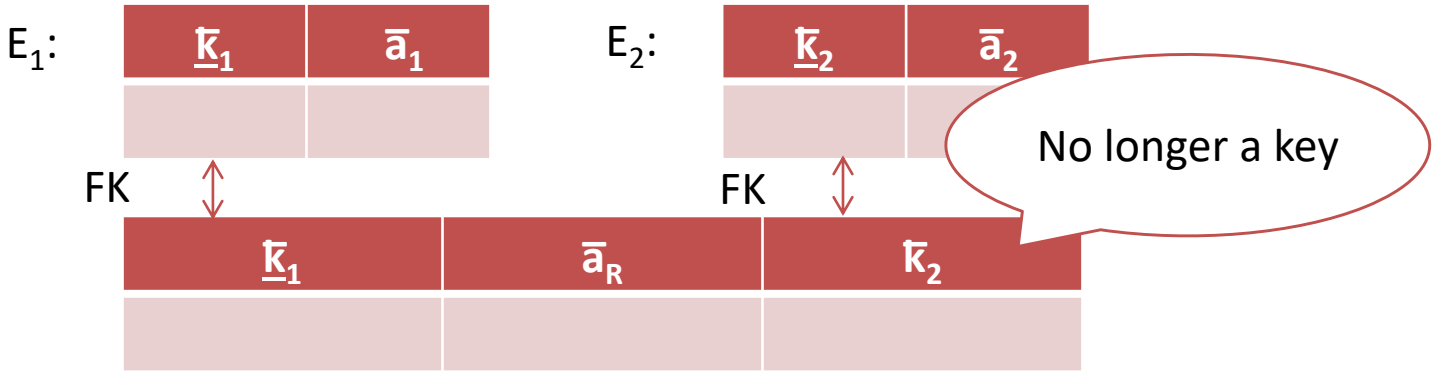
Relationships – many to one



- An E_1 can relate to at most one E_2
- Translation to a table:



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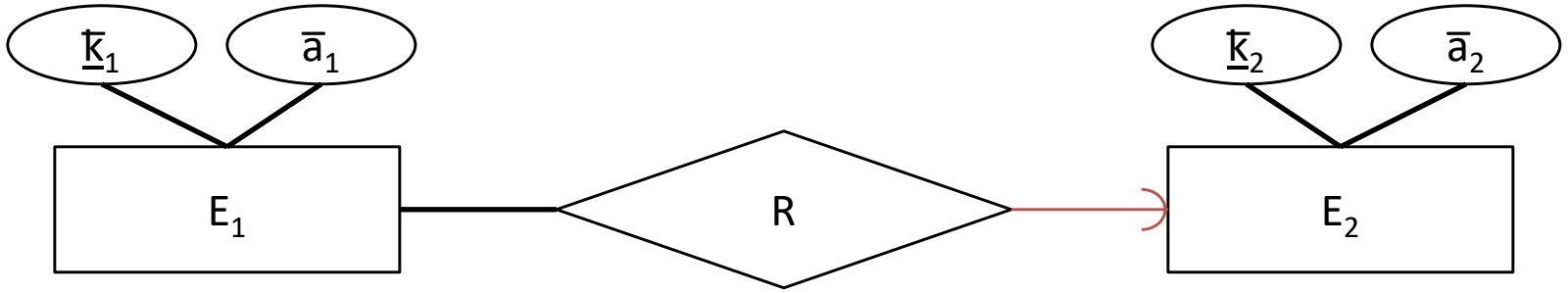
Relationships – unique reference



- An E_1 relates to precisely one E_2
- No table is extracted for R

E_1:

$\underline{k}_1$	$\bar{a}_1$	$\underline{k}_2$

FK

E_2:

$\underline{k}_2$	$\bar{a}_2$

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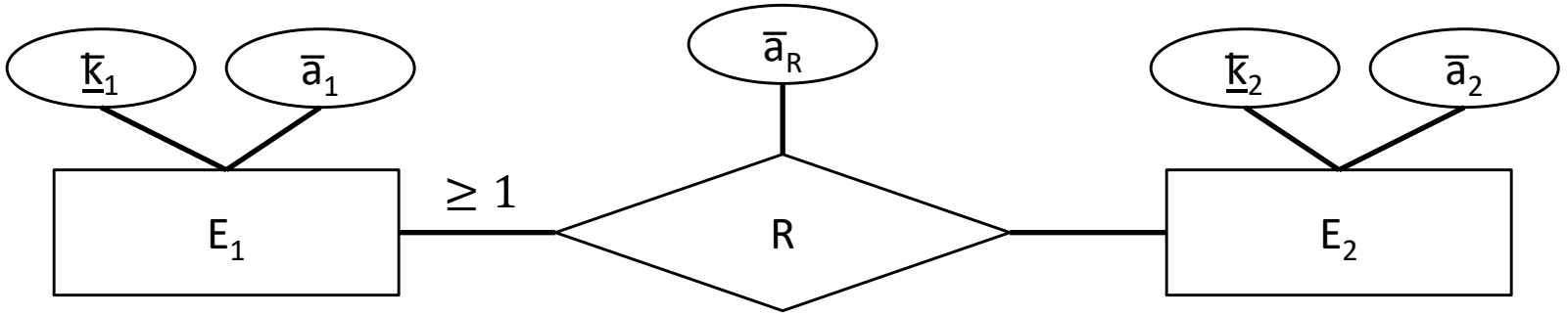
Relationships – degree constraint



- Each entity of type E_2 must relate (with R) to at least one entity of type E_1
- k_1 and k_2 in R are foreign keys

E_1:

$\underline{k}_1$	$\bar{a}_1$

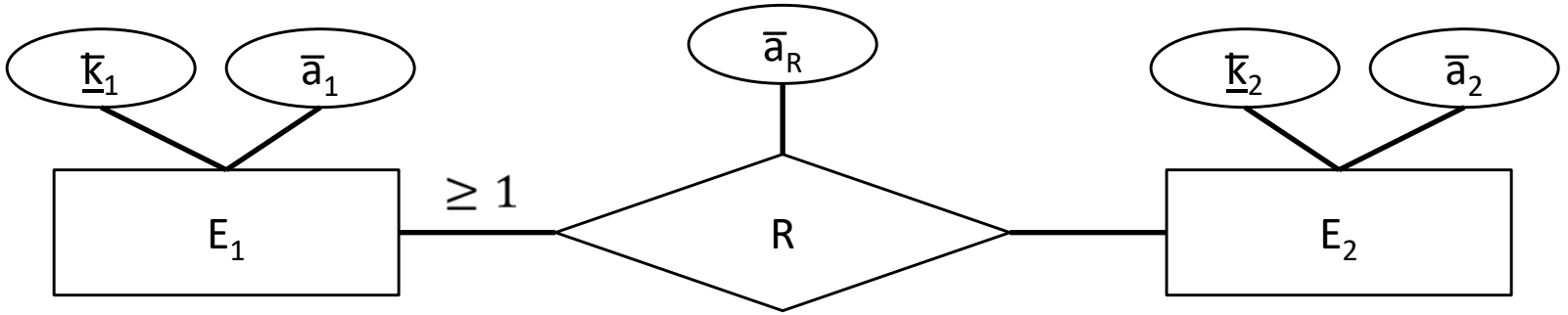
E_2:

$\underline{k}_2$	$\bar{a}_2$

R:

$\underline{k}_1$	$\bar{a}_R$	$\underline{k}_2$

Relationships – degree constraint



- Note that it always holds that:
  - $\pi_{k2}(R) \subseteq \pi_{k2}(E_2)$
  - $\pi_{k1}(R) \subseteq \pi_{k1}(E_1)$

E_2:

$\pi_{k2}(E_2)$	
$\underline{k}_2$	$\bar{a}_2$

E_1:

$\pi_{k1}(E_1)$	
$\underline{k}_1$	$\bar{a}_1$

R:

$\pi_{k1}(R)$		$\pi_{k2}(R)$
$\underline{k}_1$	$\bar{a}_R$	$\underline{k}_2$

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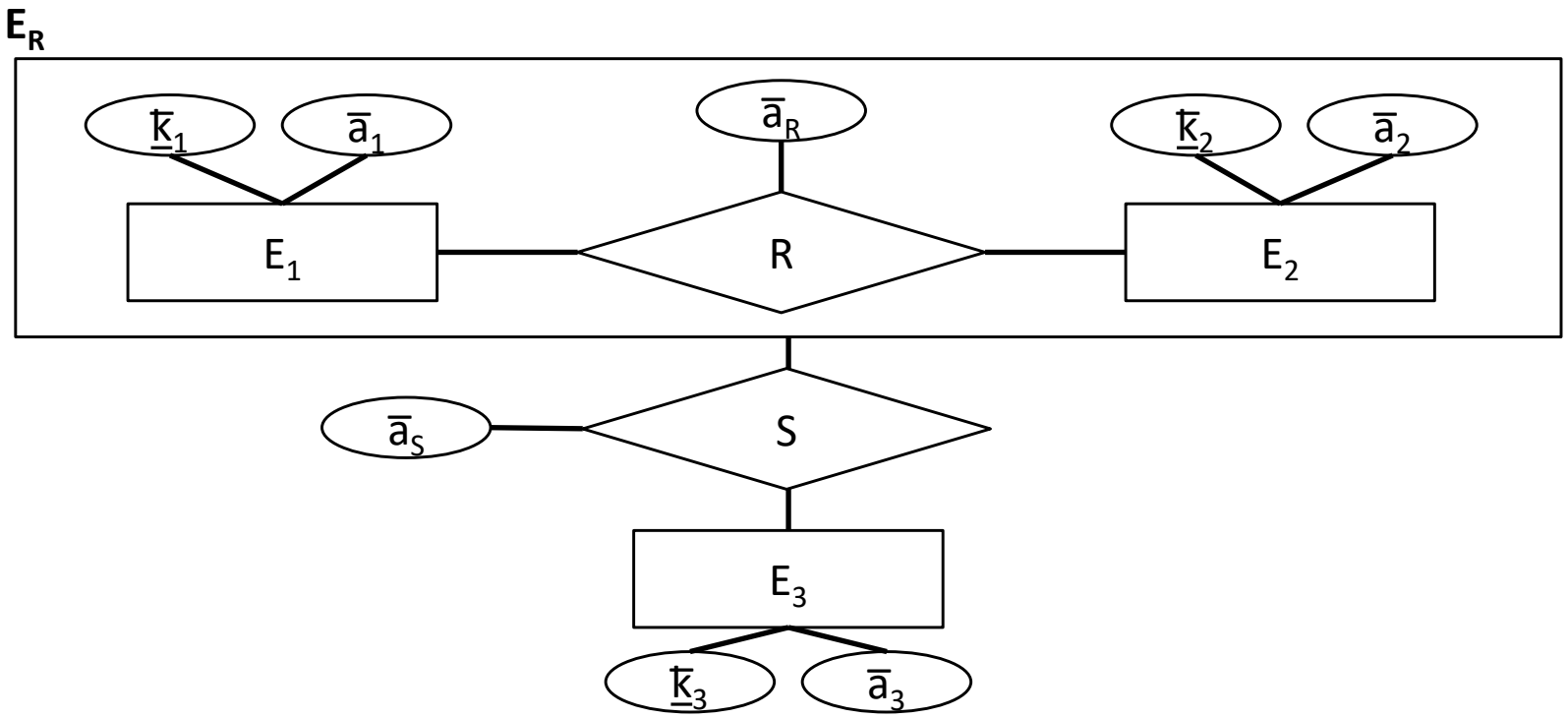
Aggregations



- Turns the relationship into an entity with attributes of the relationship

Aggregations

E1:

$\underline{k}_1$	$\bar{a}_1$

E2:

$\underline{k}_2$	$\bar{a}_2$

E3:

$\underline{k}_3$	$\bar{a}_3$

R:

$\underline{k}_1$	$\underline{k}_2$	$\bar{a}_R$

S:

$\underline{k}_1$	$\underline{k}_2$	$\underline{k}_3$	$\bar{a}_S$

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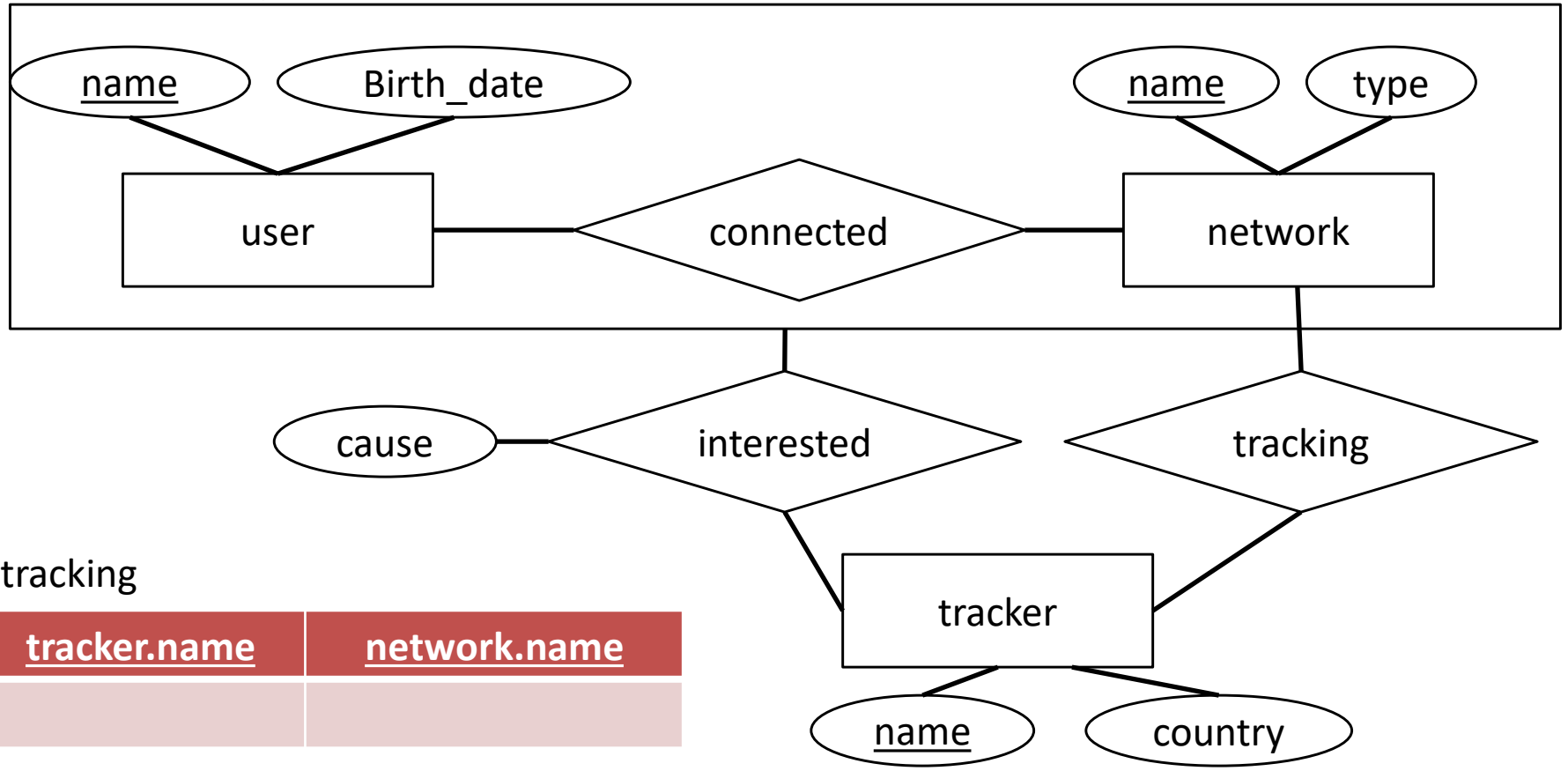
Example



tracking

tracker.name	network.name

interested

tracker.name	network.name	user.name	cause

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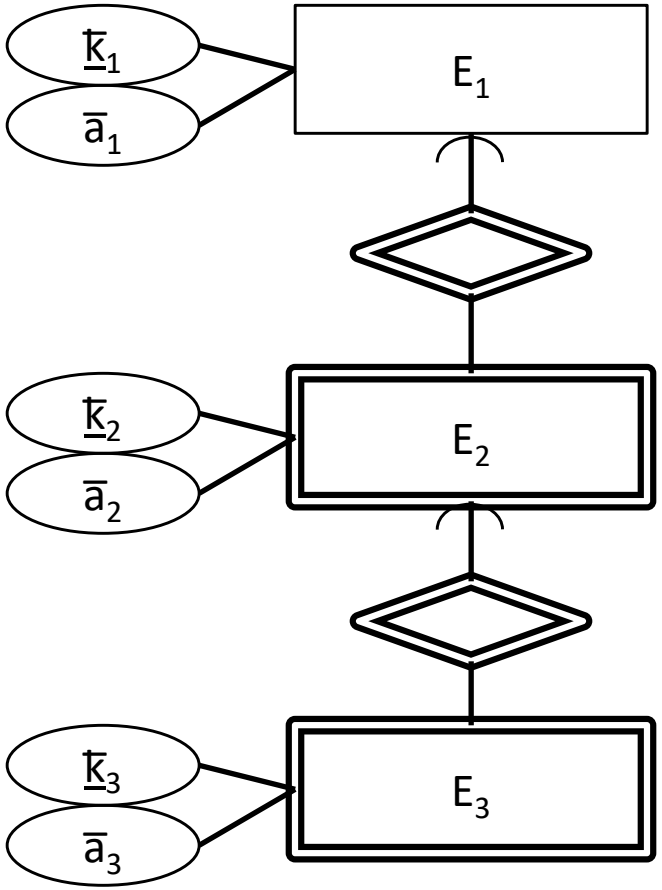
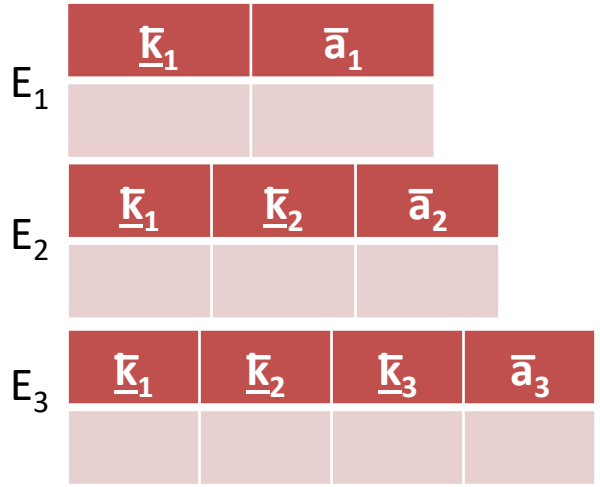
Weak Entities



Translation to tables:



Constraints:

$\pi_{k1}(E_2) \subseteq \pi_{k1}(E_1)$

$\pi_{k1,k2}(E_3) \subseteq \pi_{k1,k2}(E_2)$

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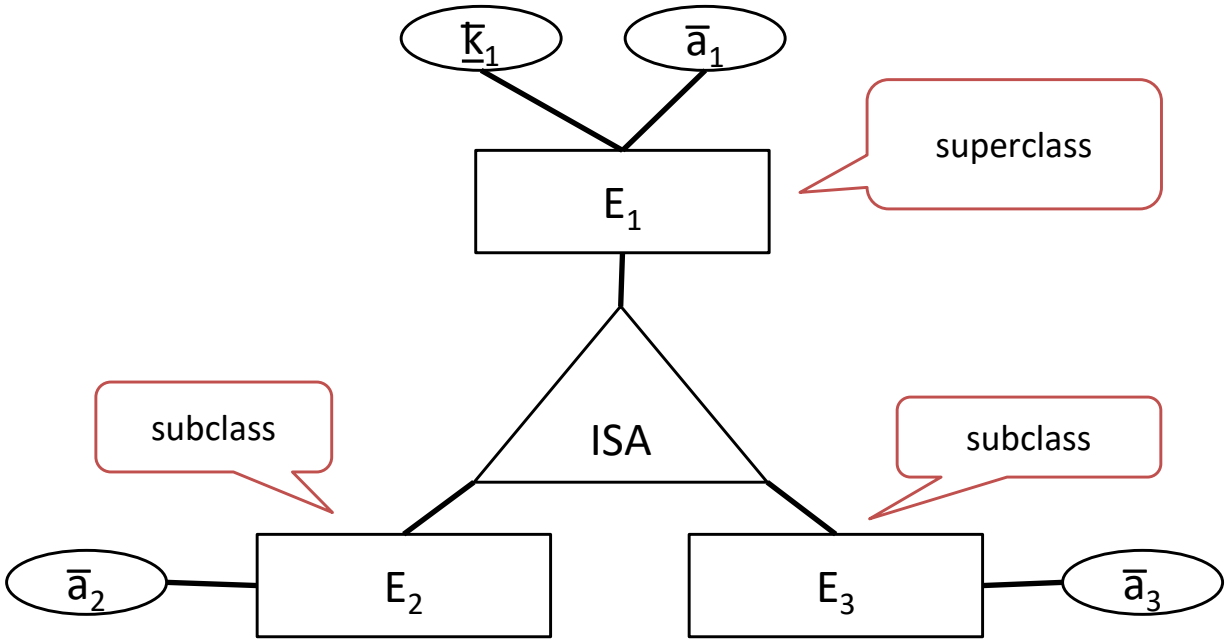
ISA

- ISA – a branching weak entity without key components in the *subclass*



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ISA – Translations and Constraints

Dessert:

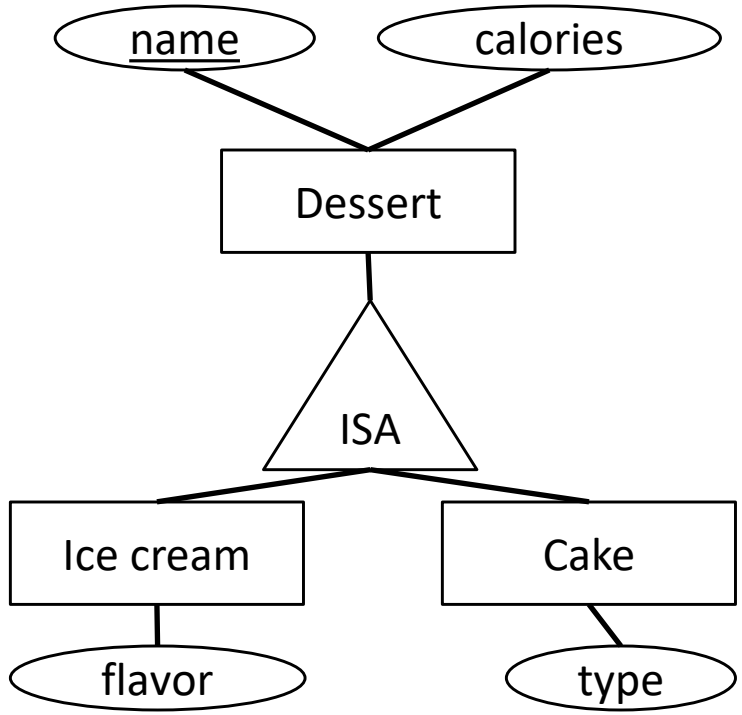
name	calories

Ice cream:

name	flavor

Cake:

name	type



Constraints:

$\pi_{name}(Cake) \subseteq \pi_{name}(Dessert)$

$\pi_{name}(Ice\ cream) \subseteq \pi_{name}(Dessert)$

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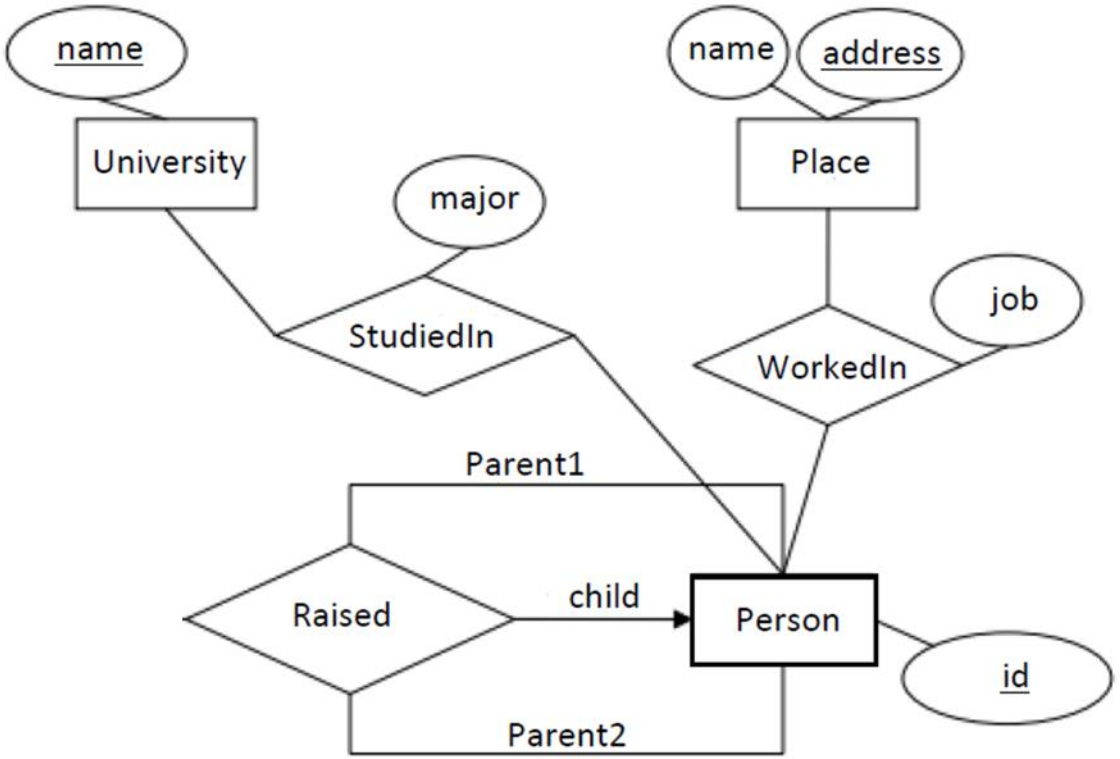
Question 1 - ERD



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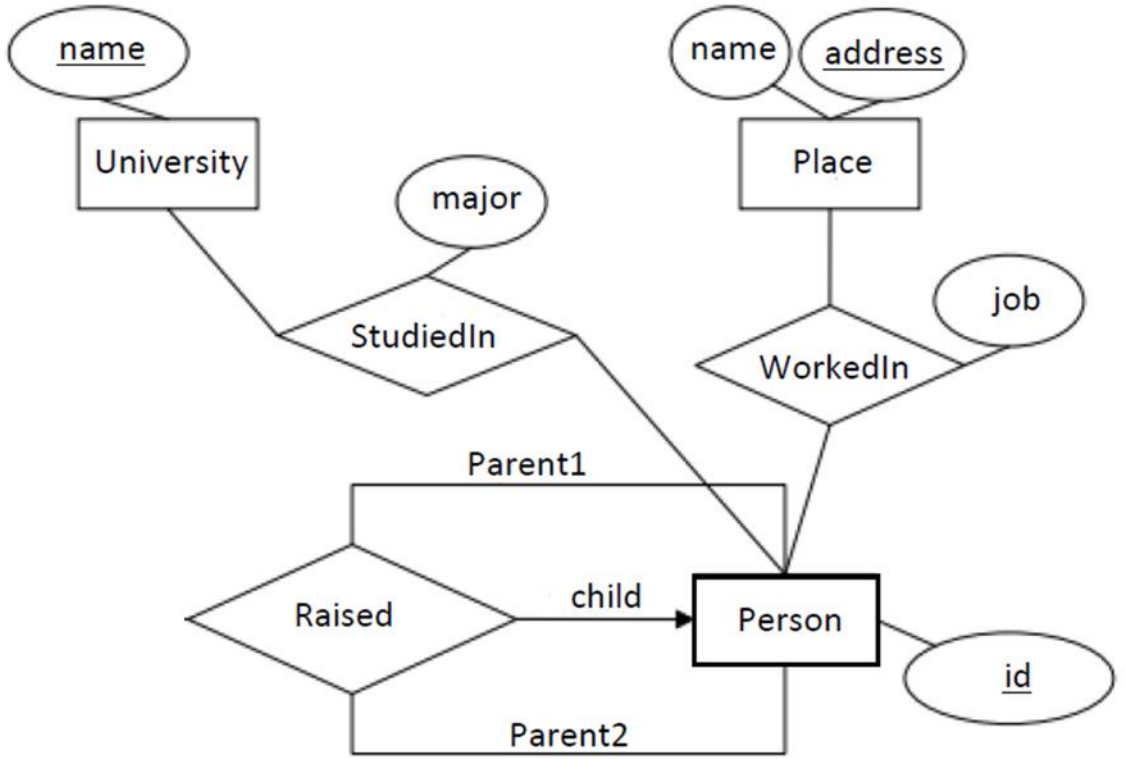
Question 1a

Modify the ERD diagram such that for each university its place will be stored (without adding new entities).



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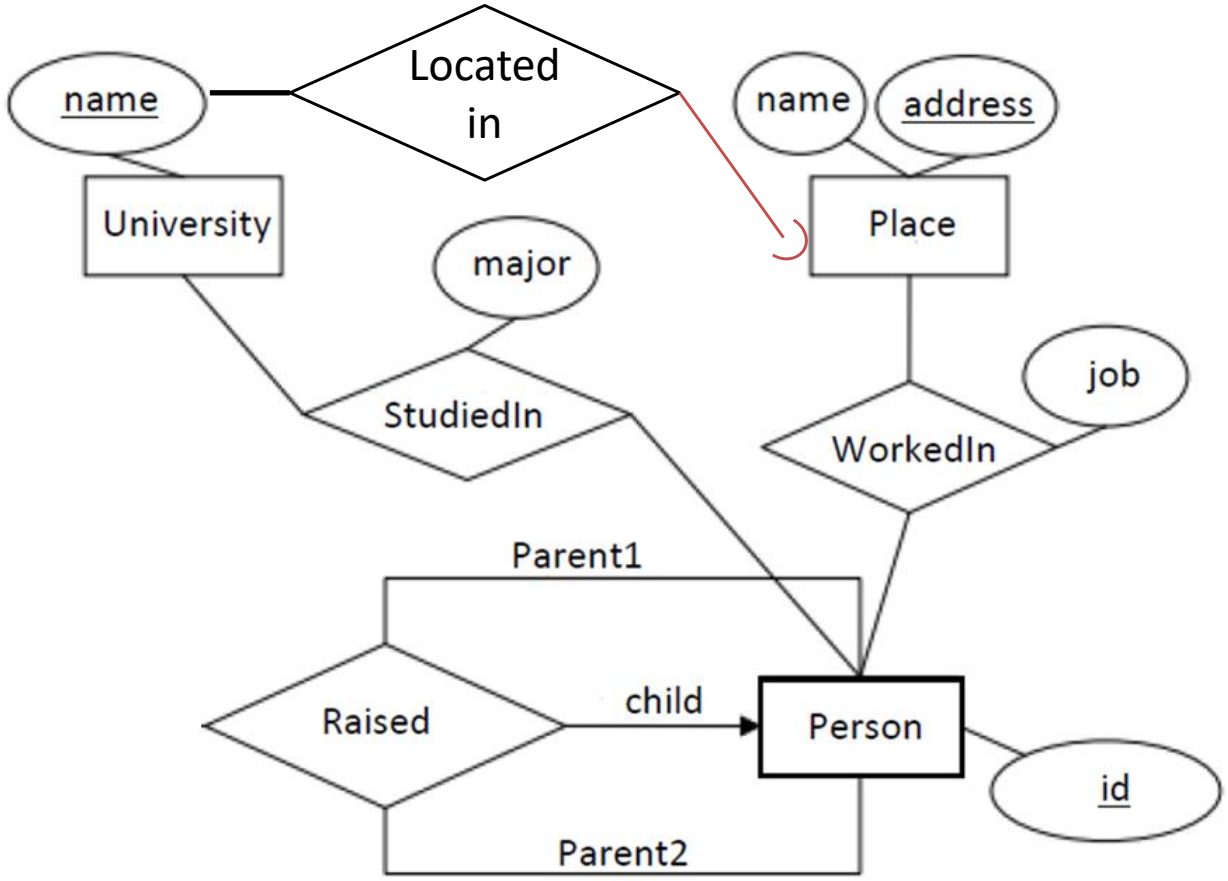
Question 1a

Modify the ERD diagram such that for each university its place will be stored (without adding new entities).



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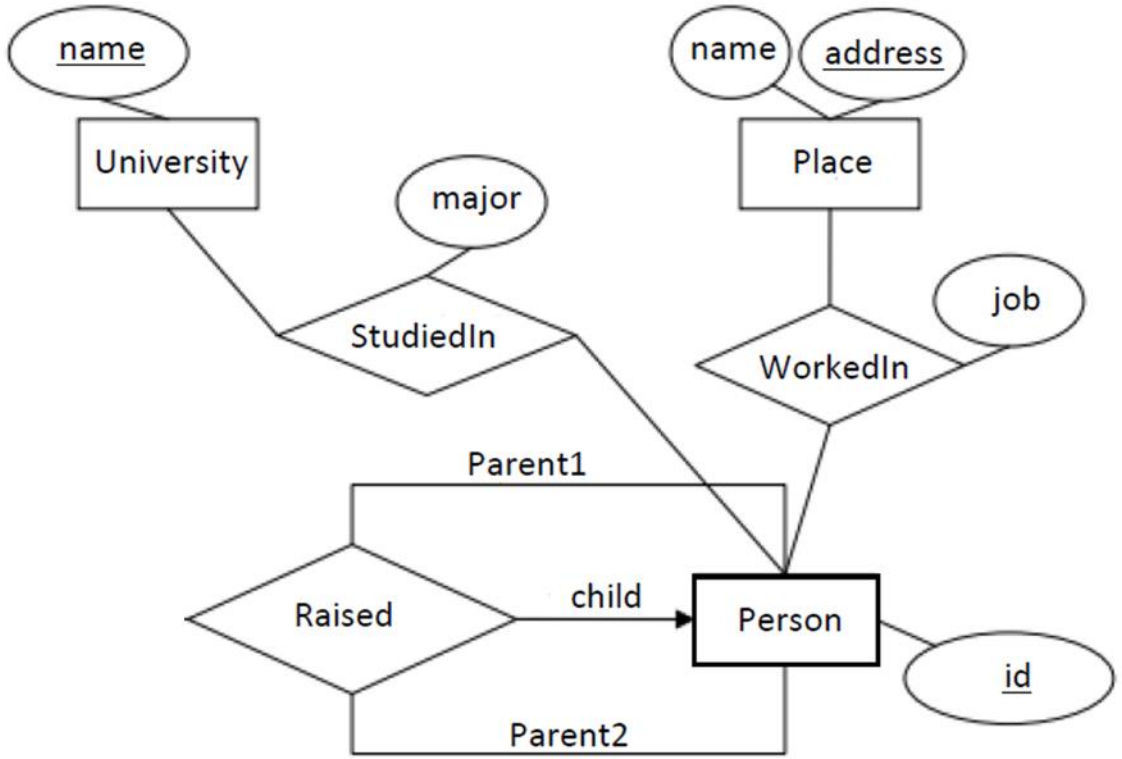
Question 1b

Can parents raise 2 children?



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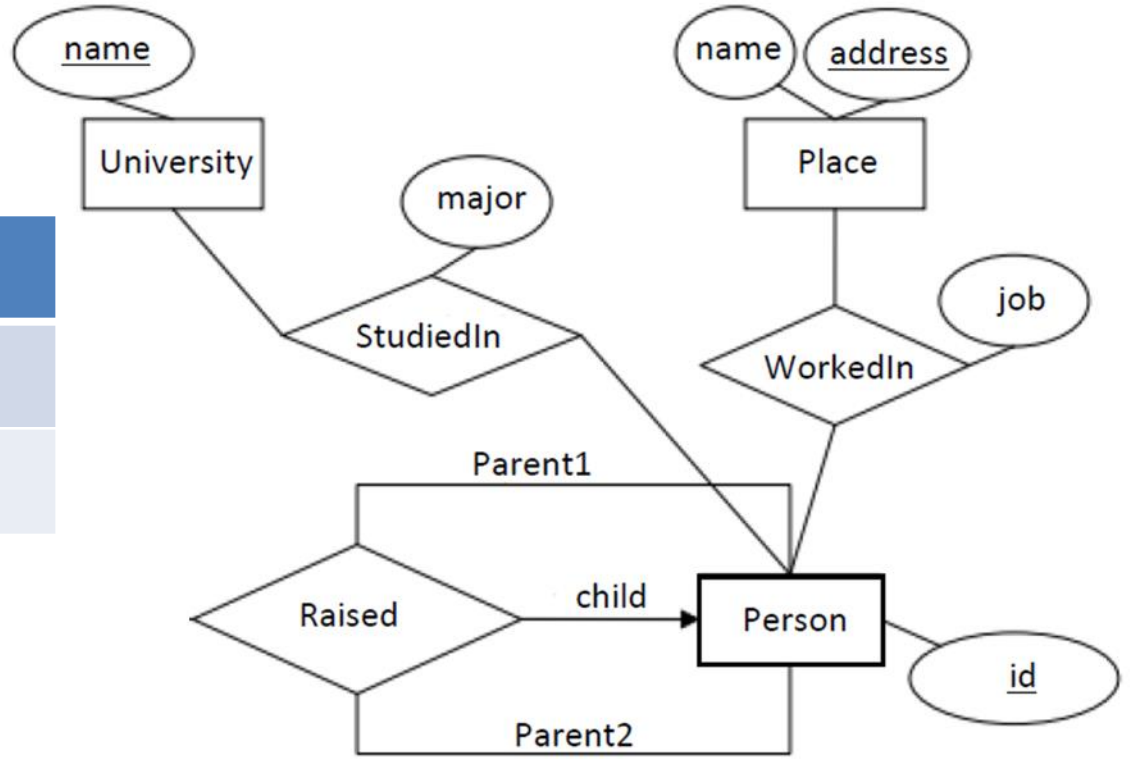
Question 1b

Can parents raise 2 children?

Raised table:

Parent1.id	Parent2.id	Child.id
11	22	33
22	11	44



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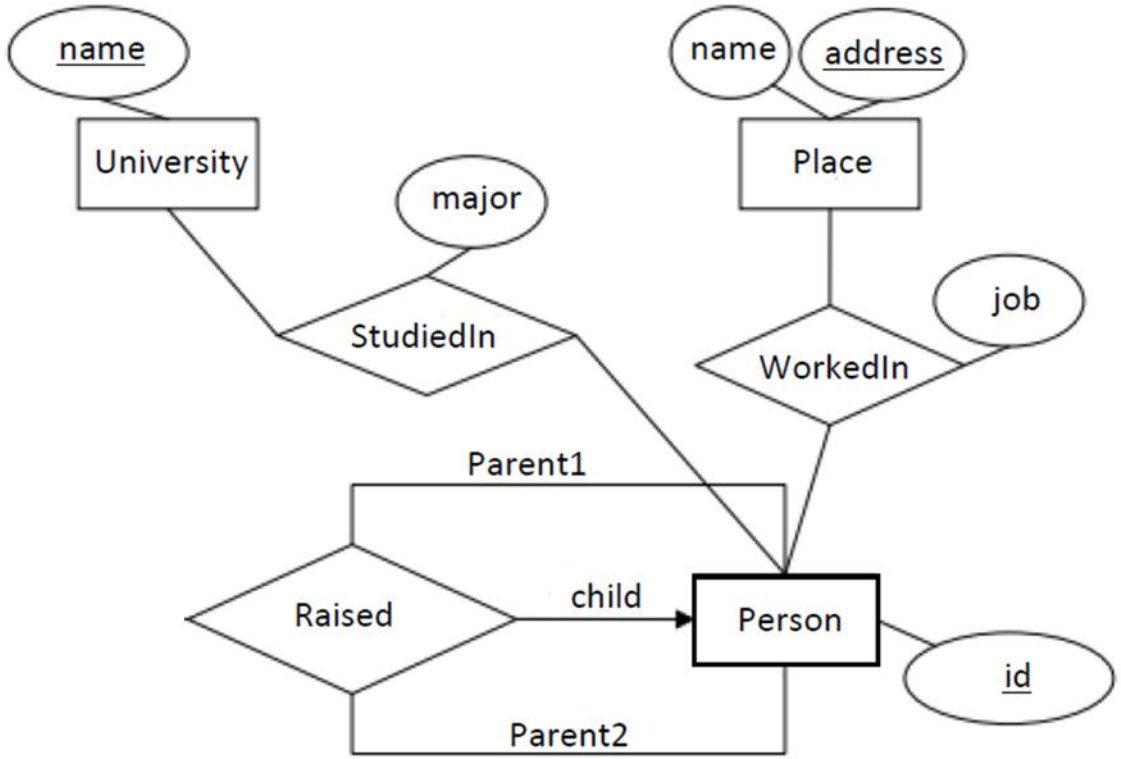
Question 1c

Can parents raise 3 children?



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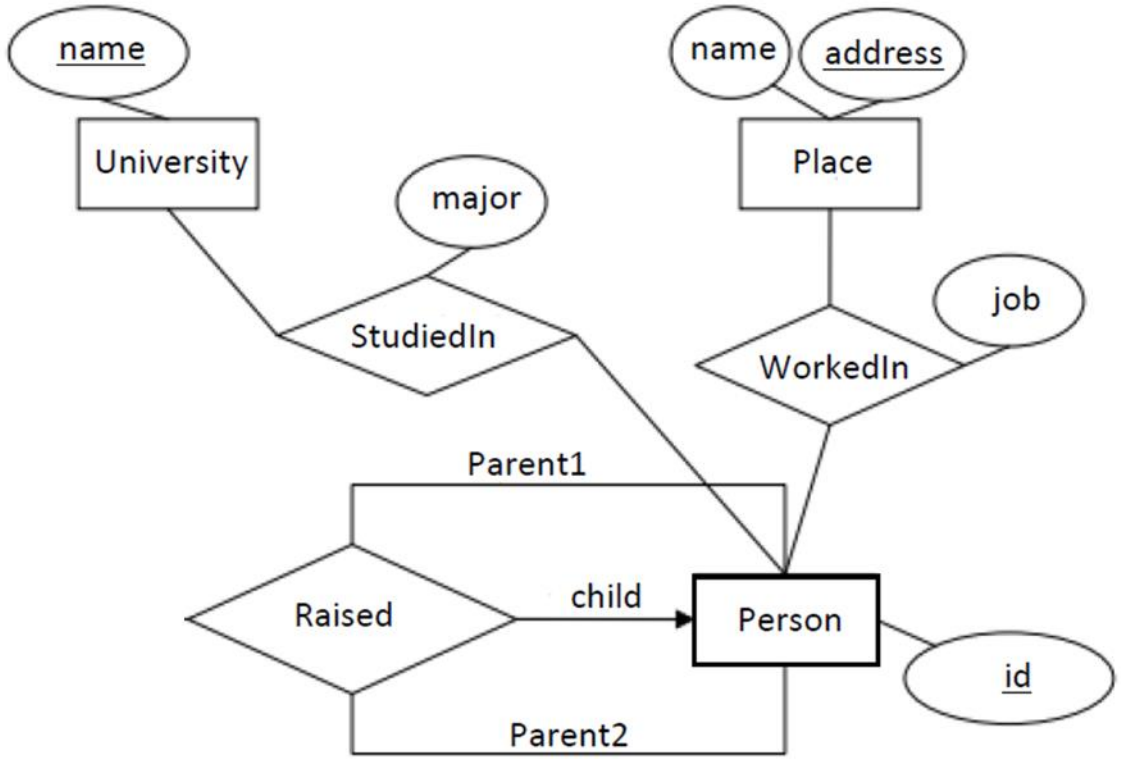
Question 1c

Can parents raise 3 children? no



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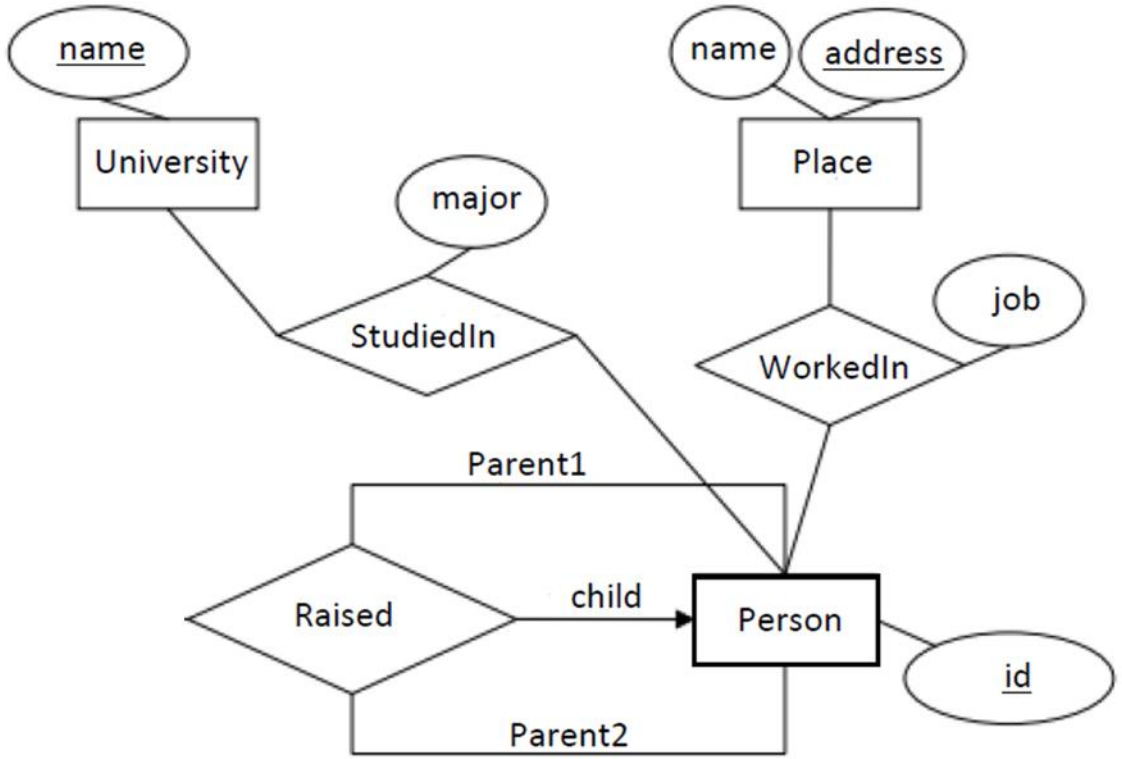
Question 1d

How many parents can raise one child?



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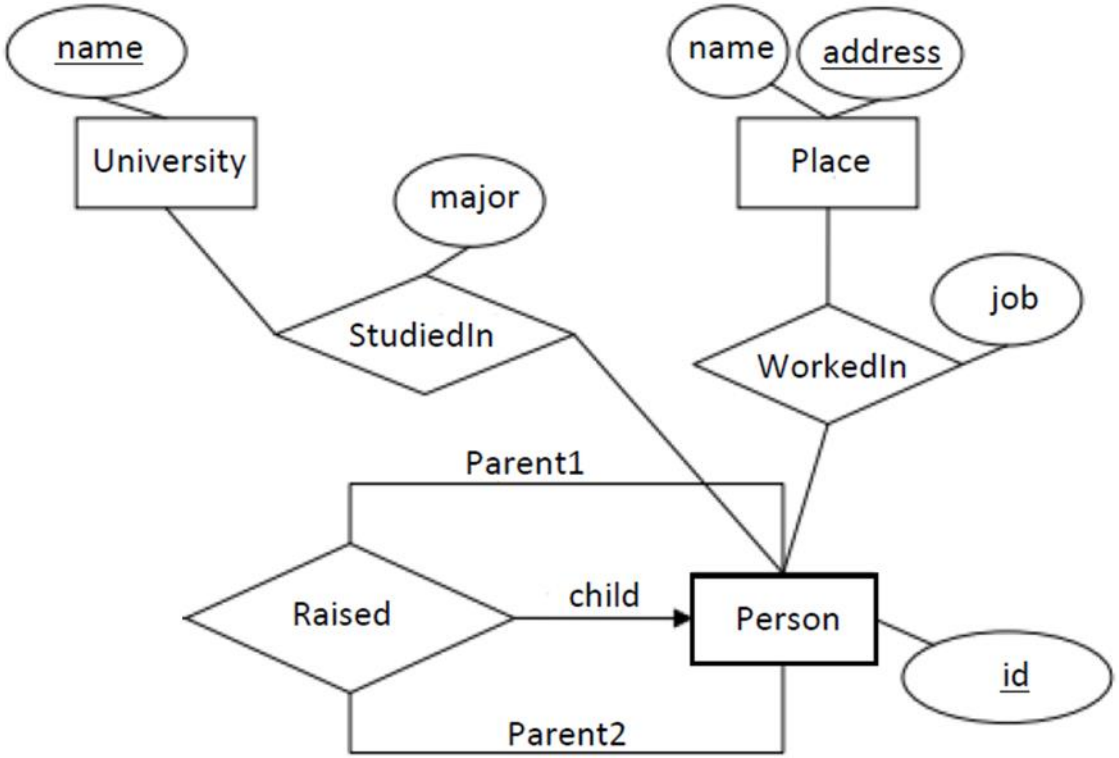
Question 1d

How many parents can raise one child? No limit for now



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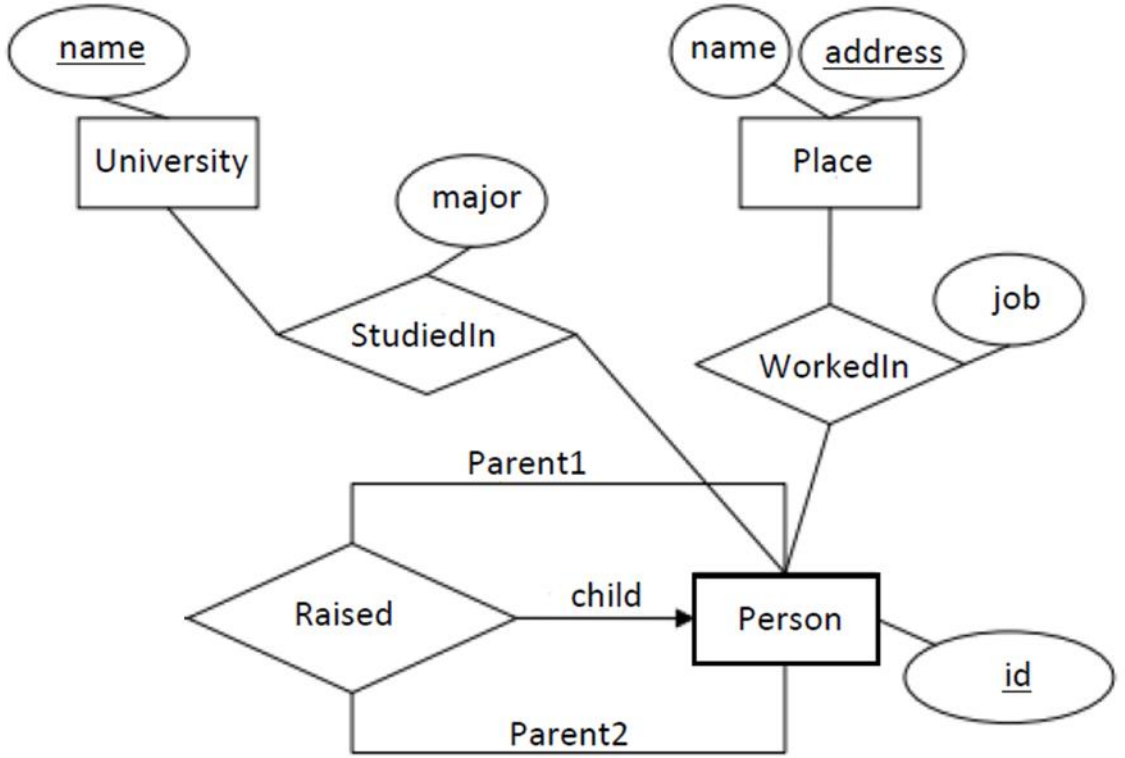
Question 1e

How can we enforce that each child will be raised by at most one pair of parents?



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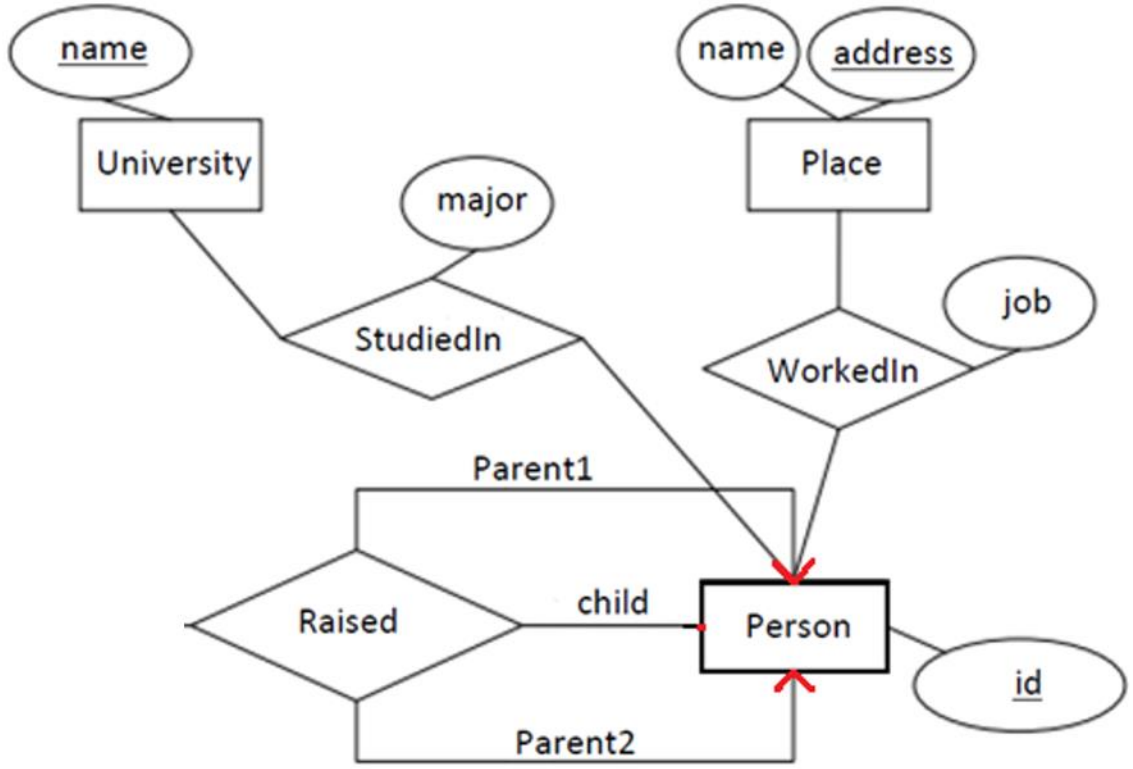
Question 1e – 1st try

How can we enforce that each child will be raised by at most one pair of parents?



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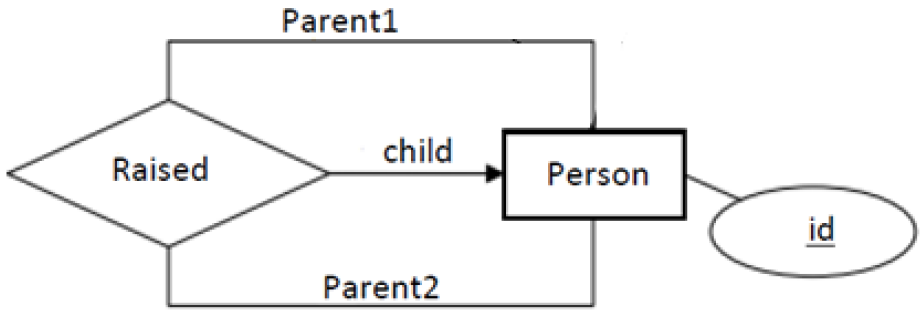
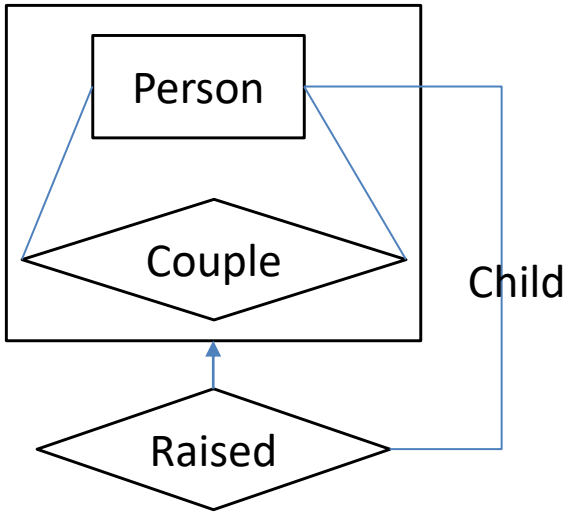
Question 1e – 2nd try

How can we enforce that each child will be raised by at most one pair of parents?





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