

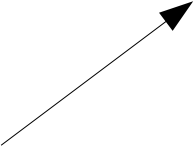
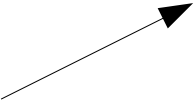
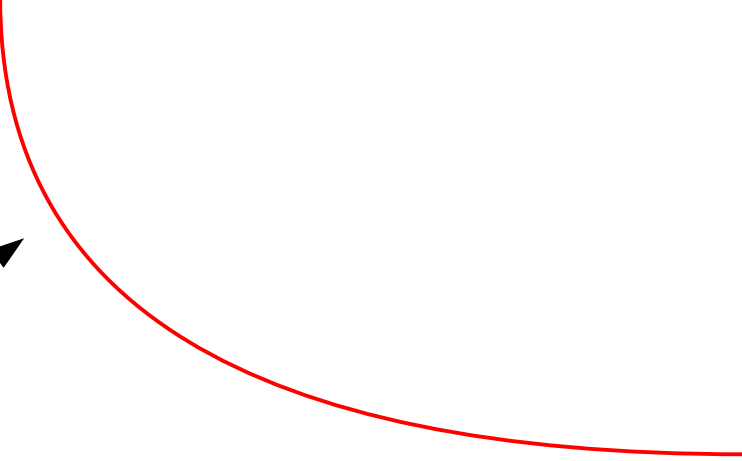
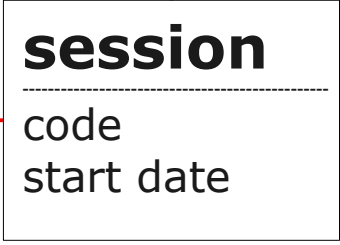
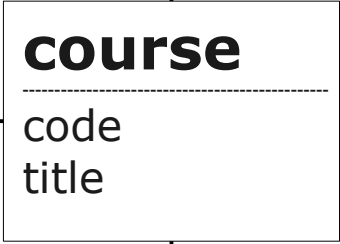
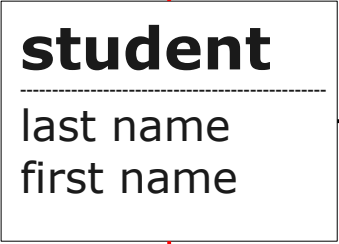
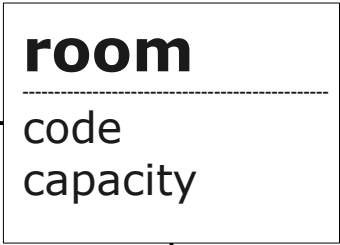
CCT395, Week 5

Translating ER into Relations; Normalization

Yuri Takhteyev
University of Toronto
October 6, 2010

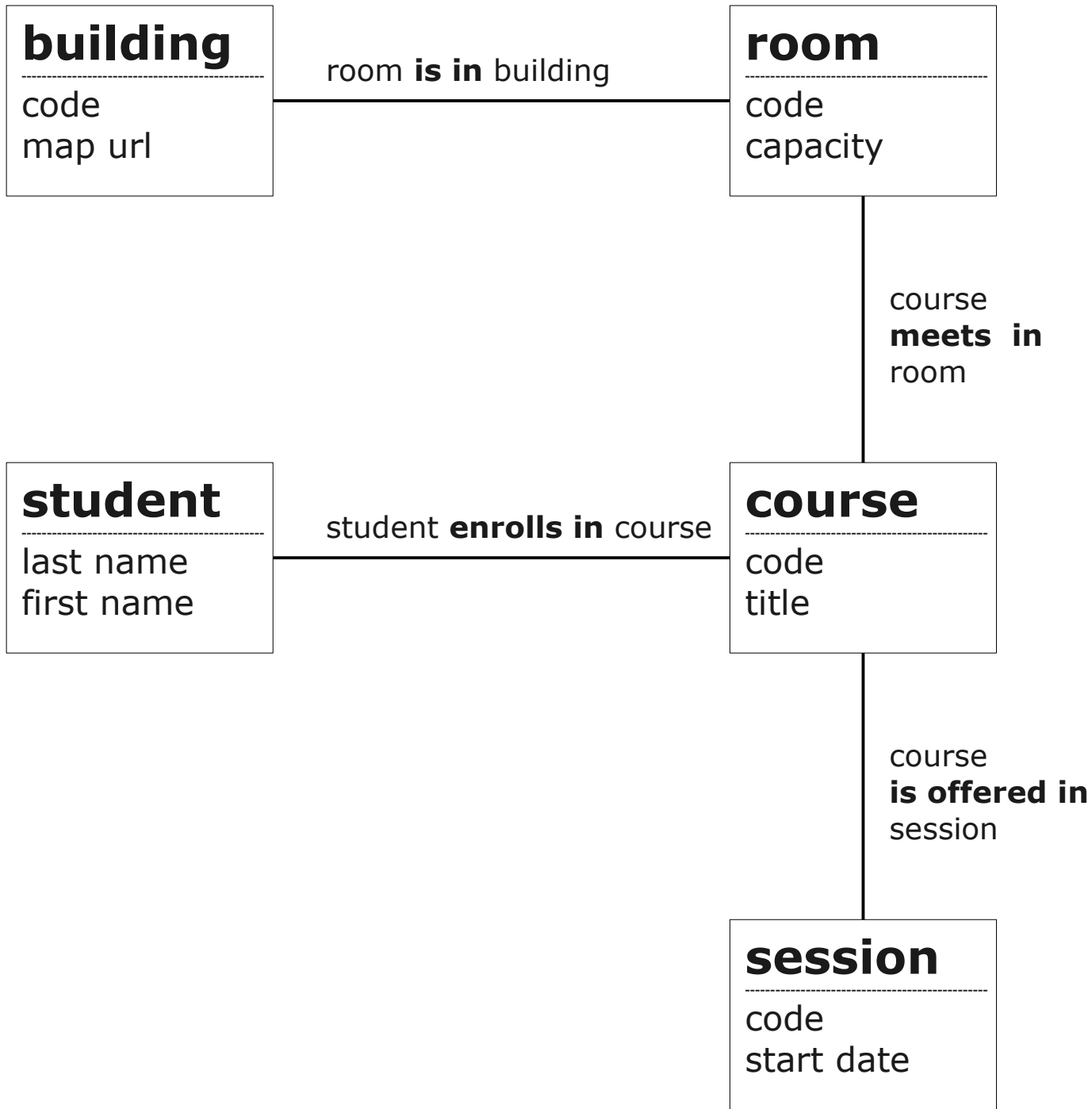


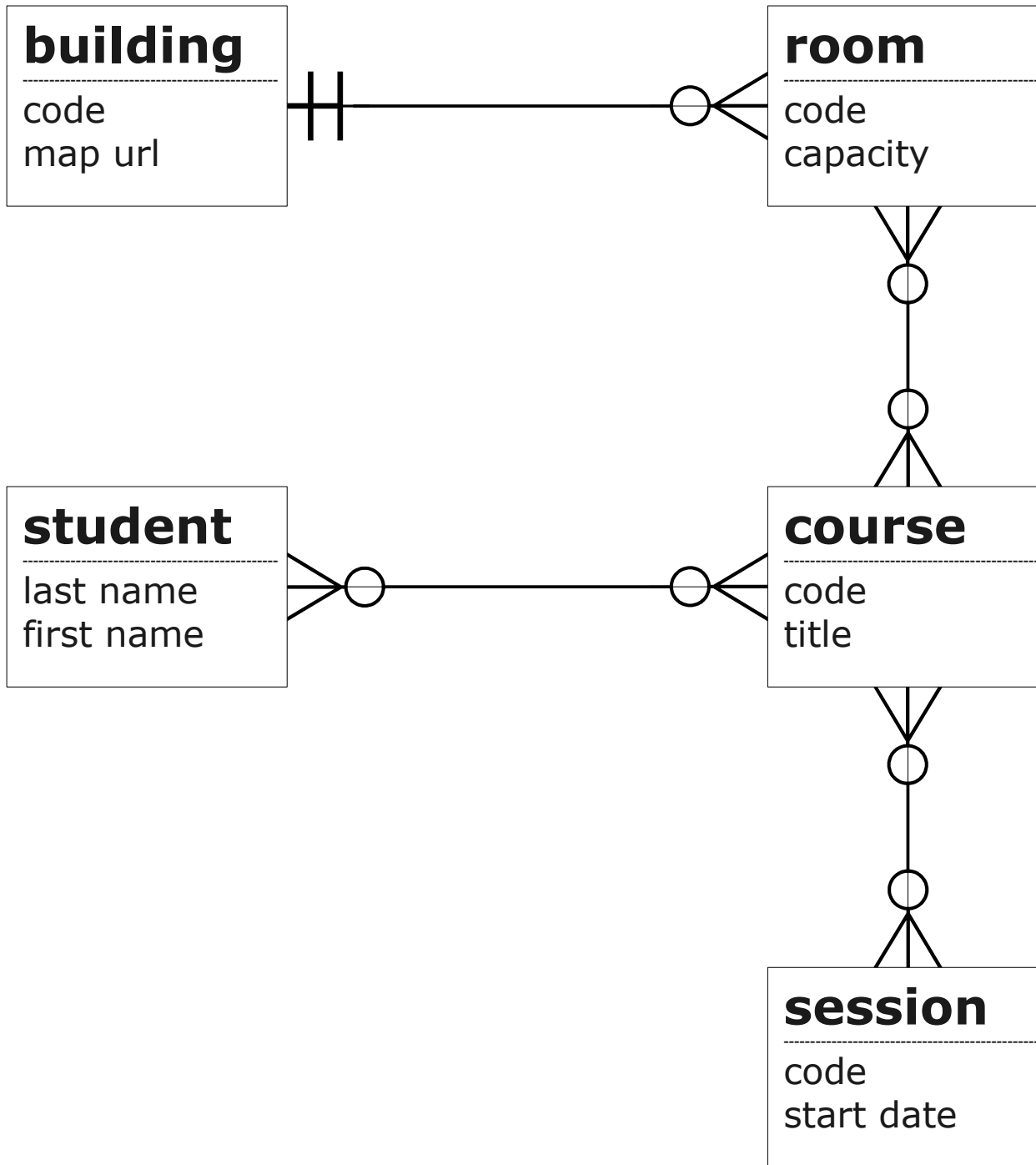
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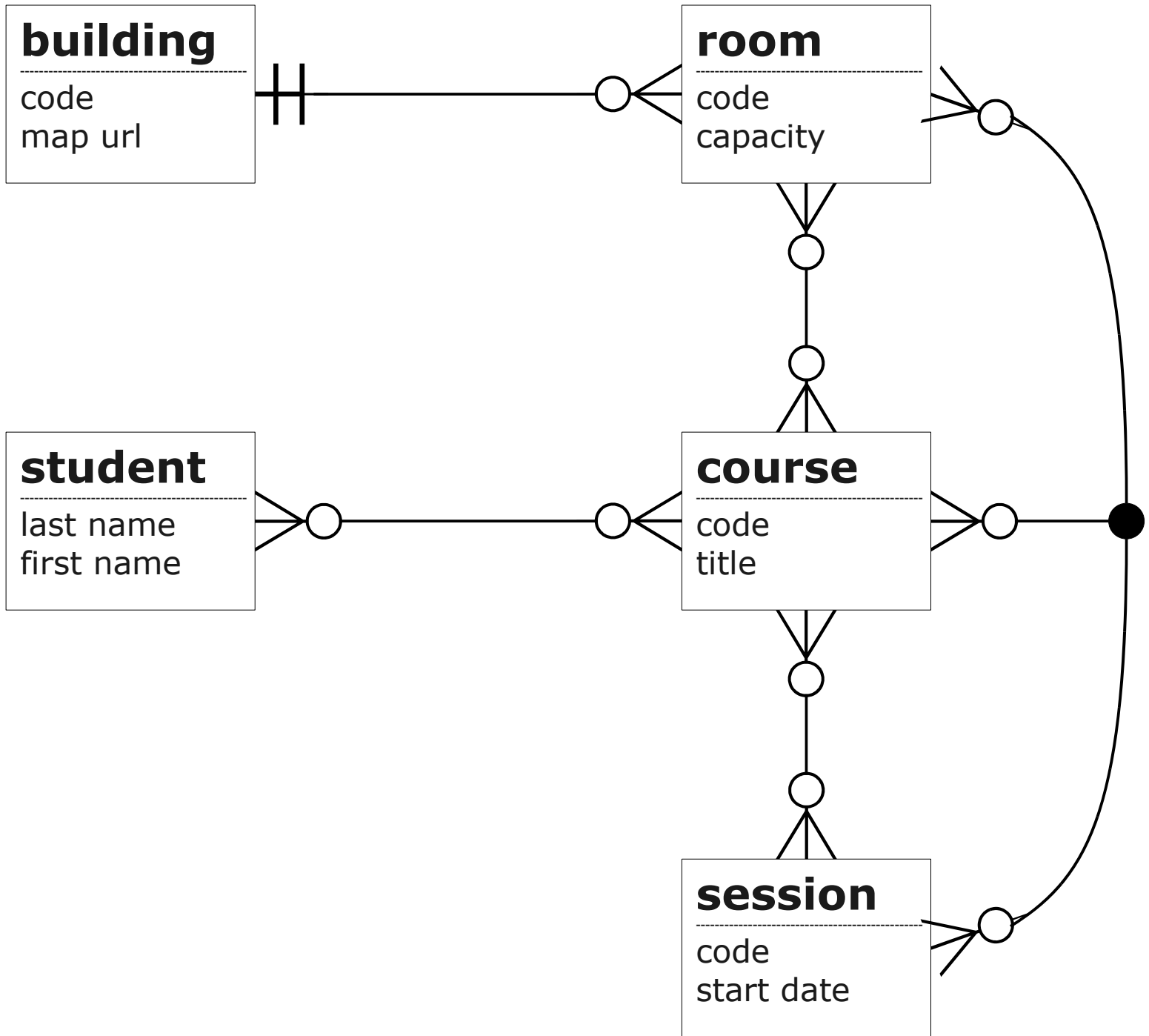


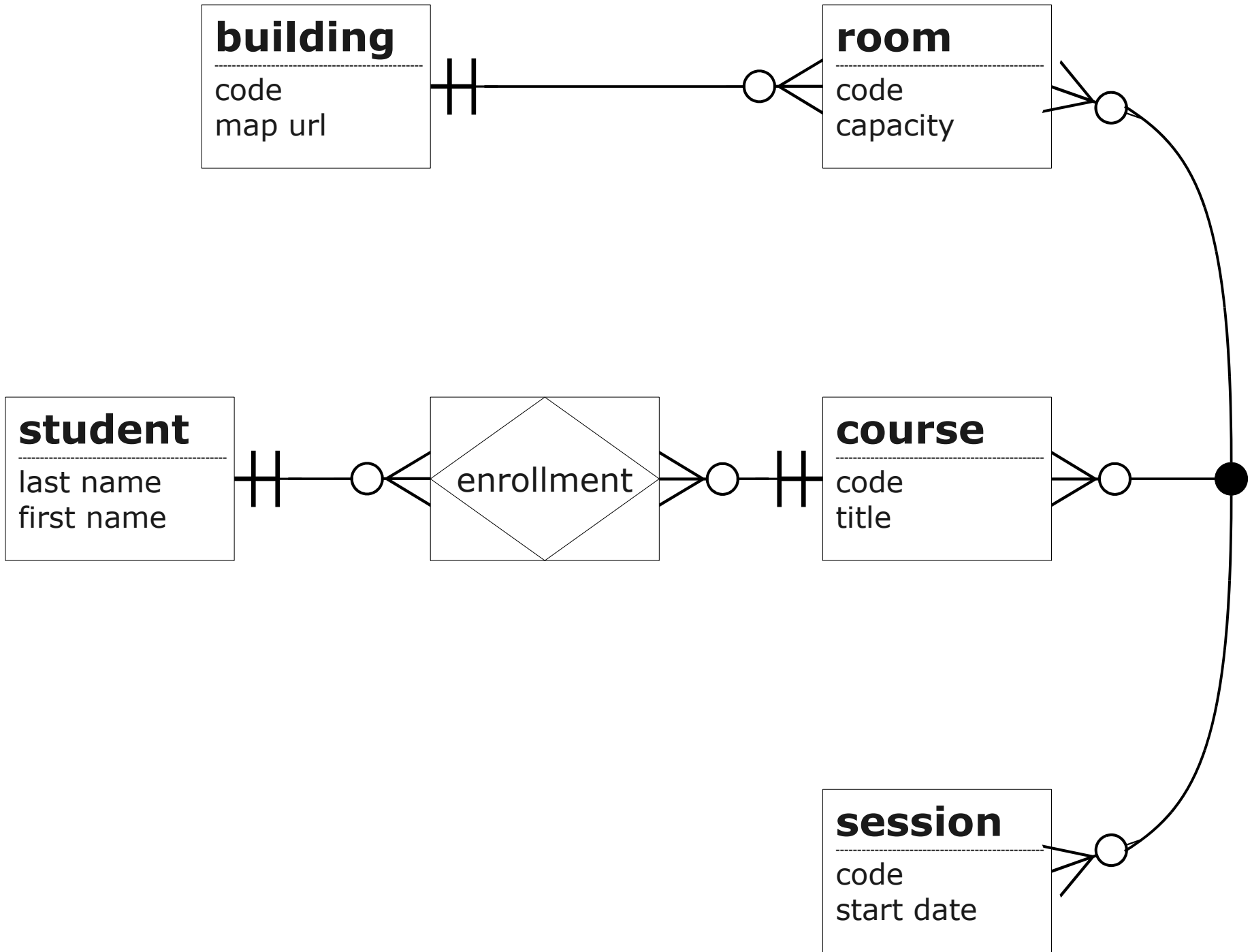
probably
redundant

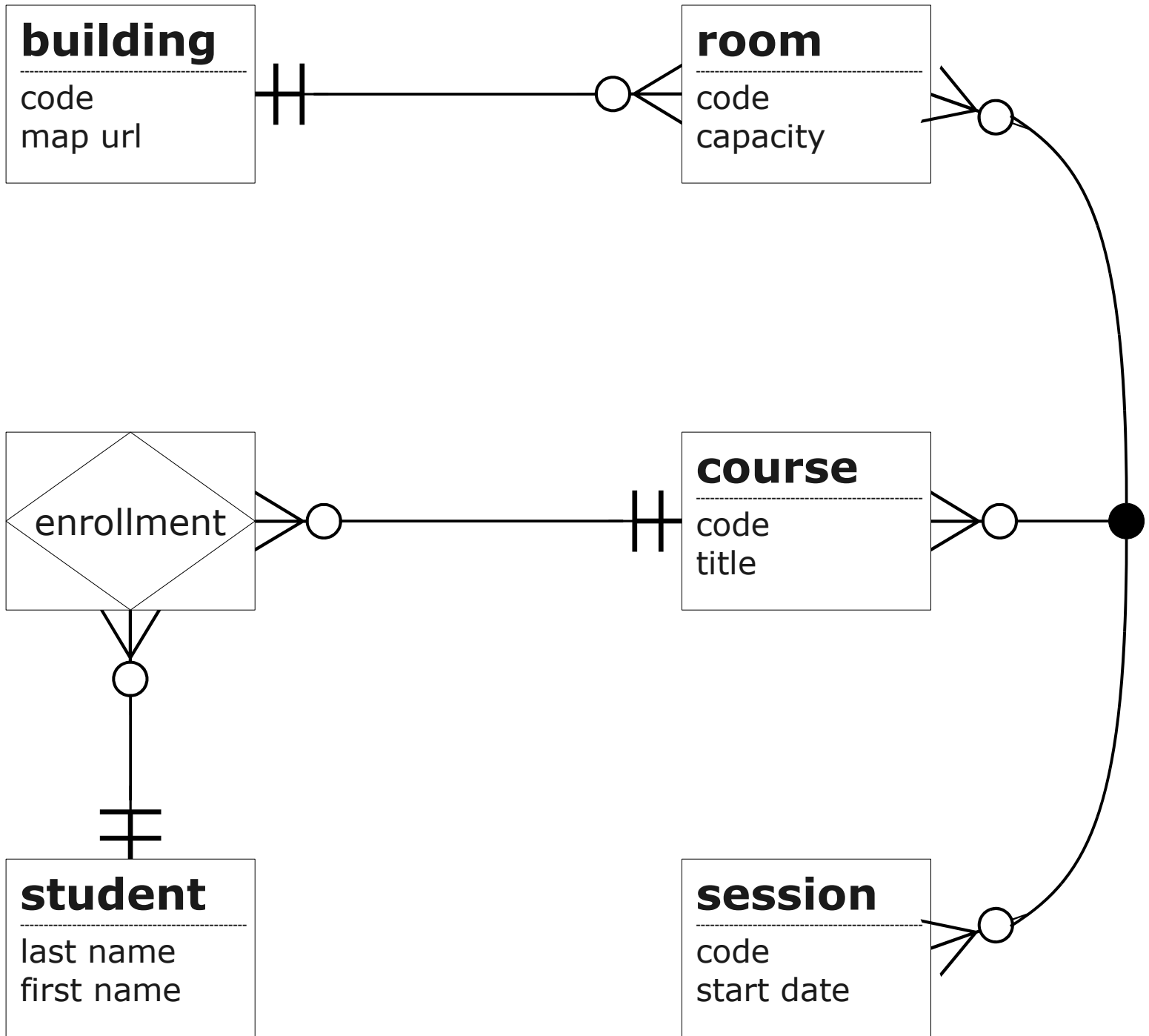
might be
redundant

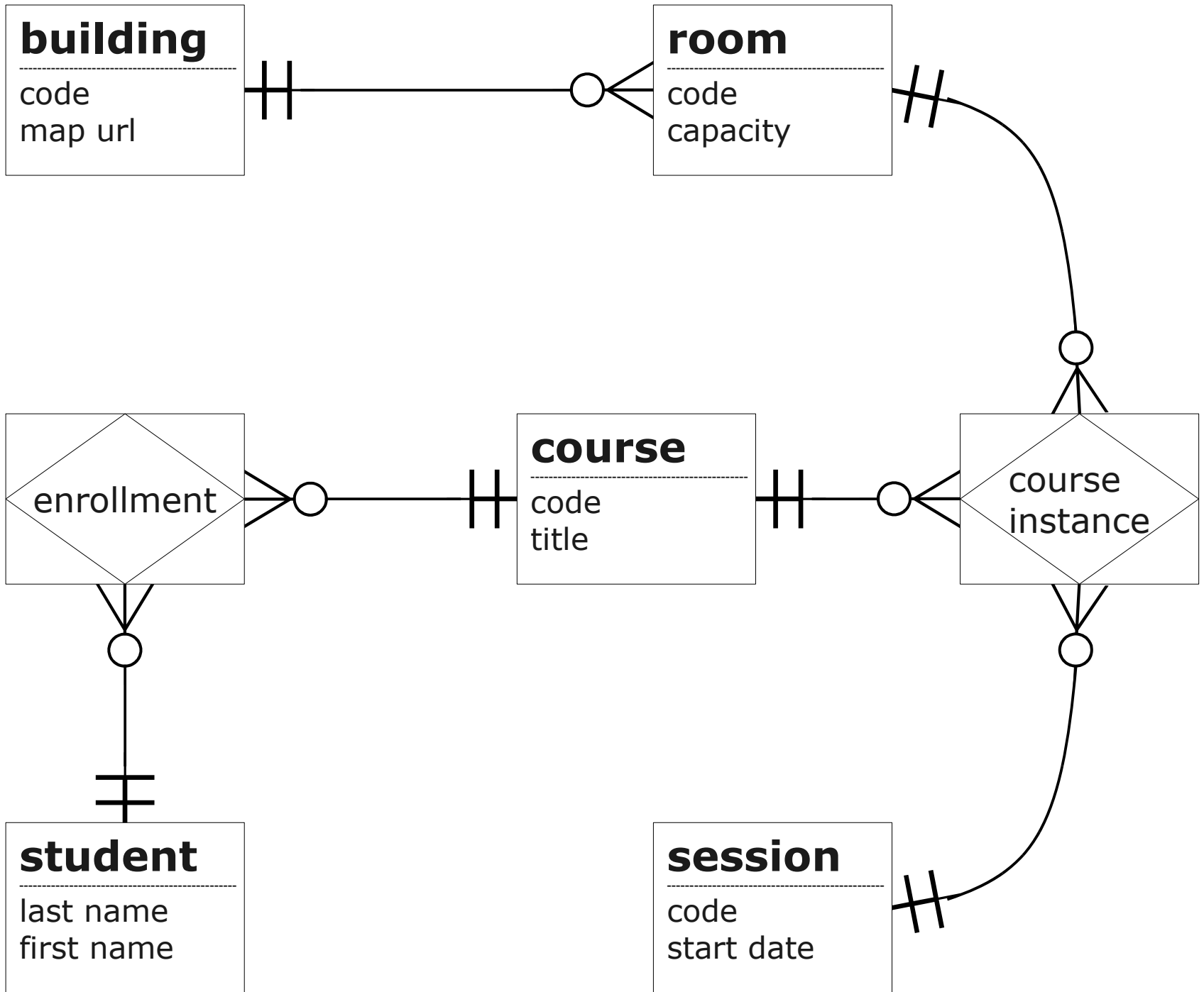


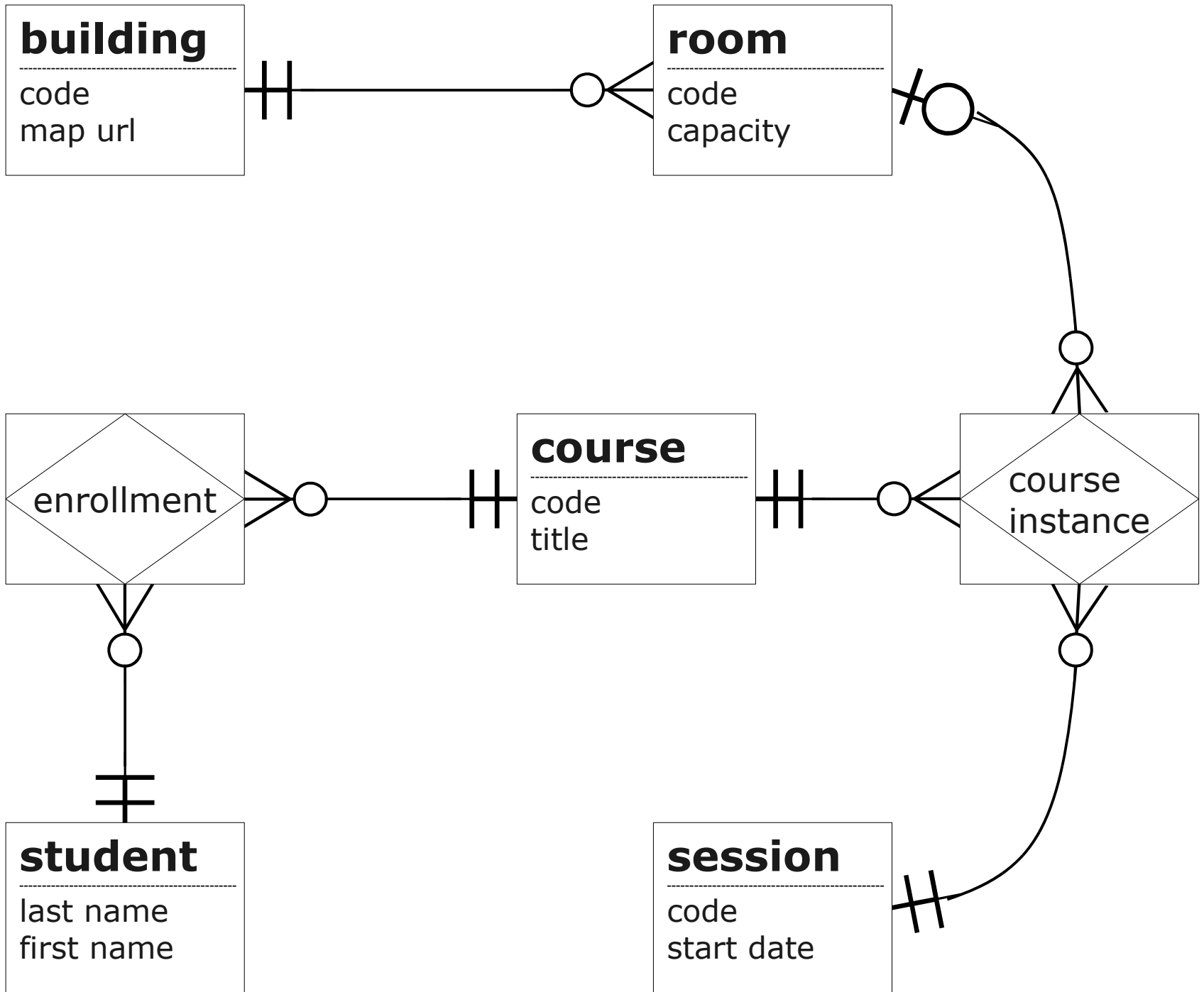


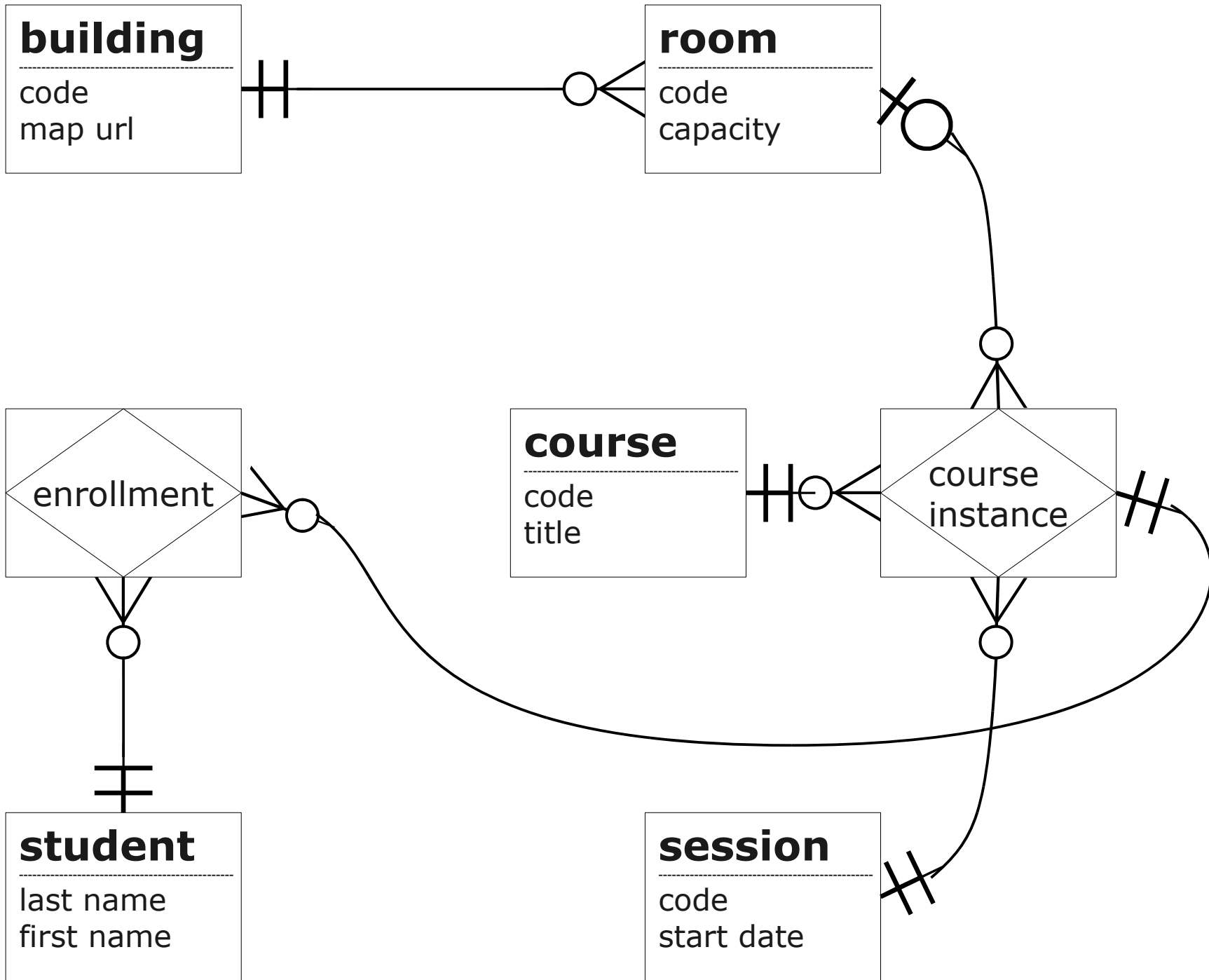


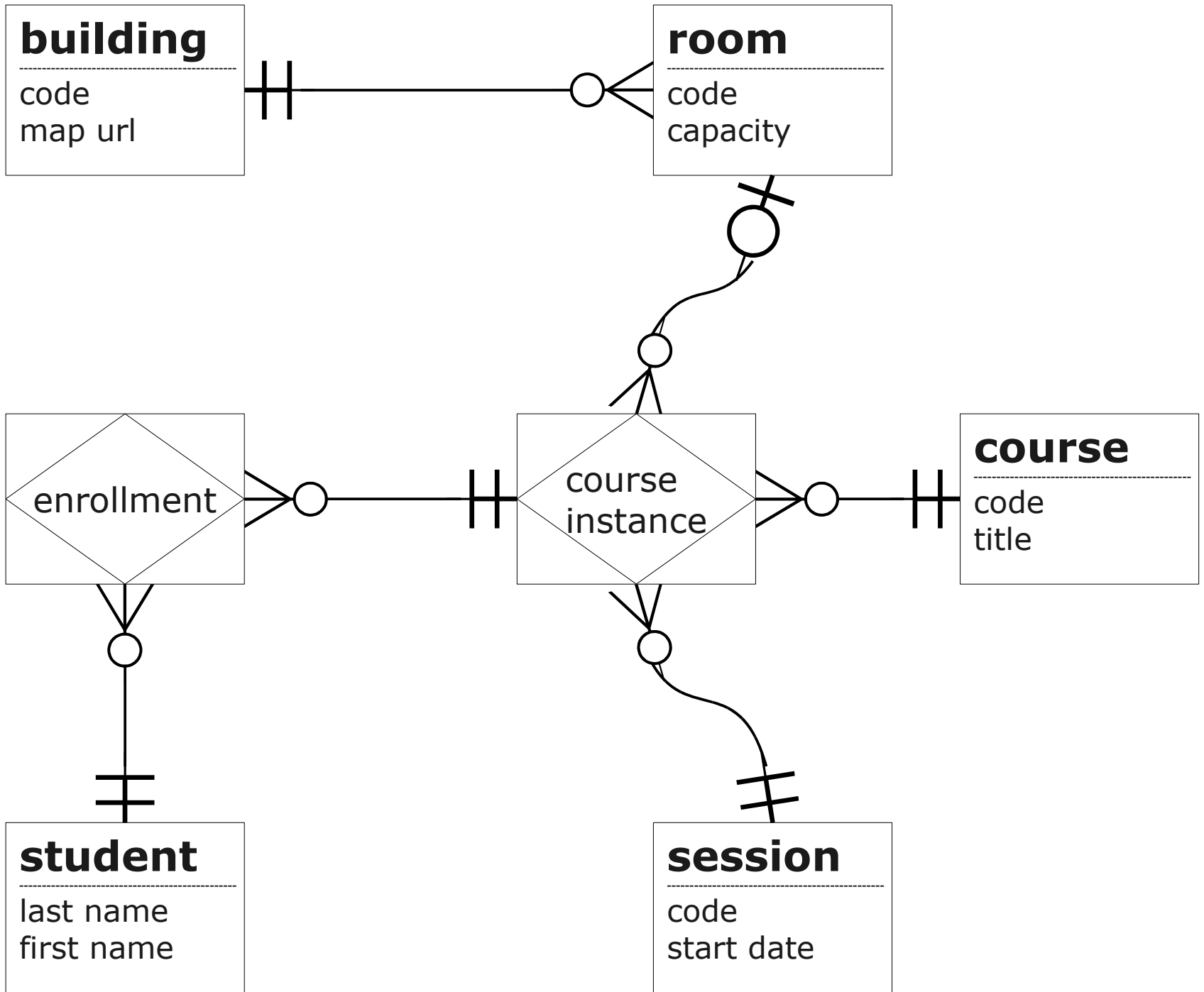


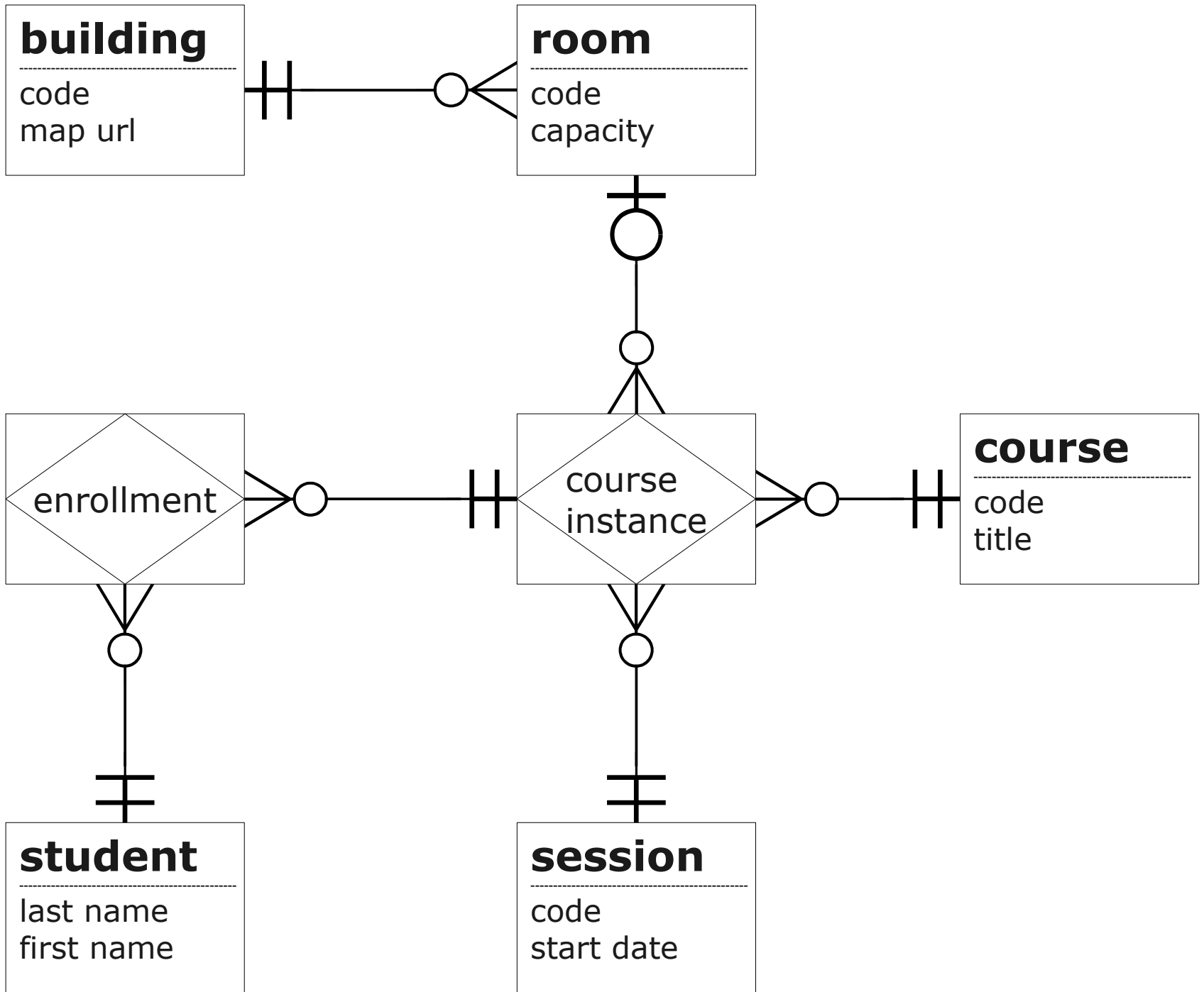


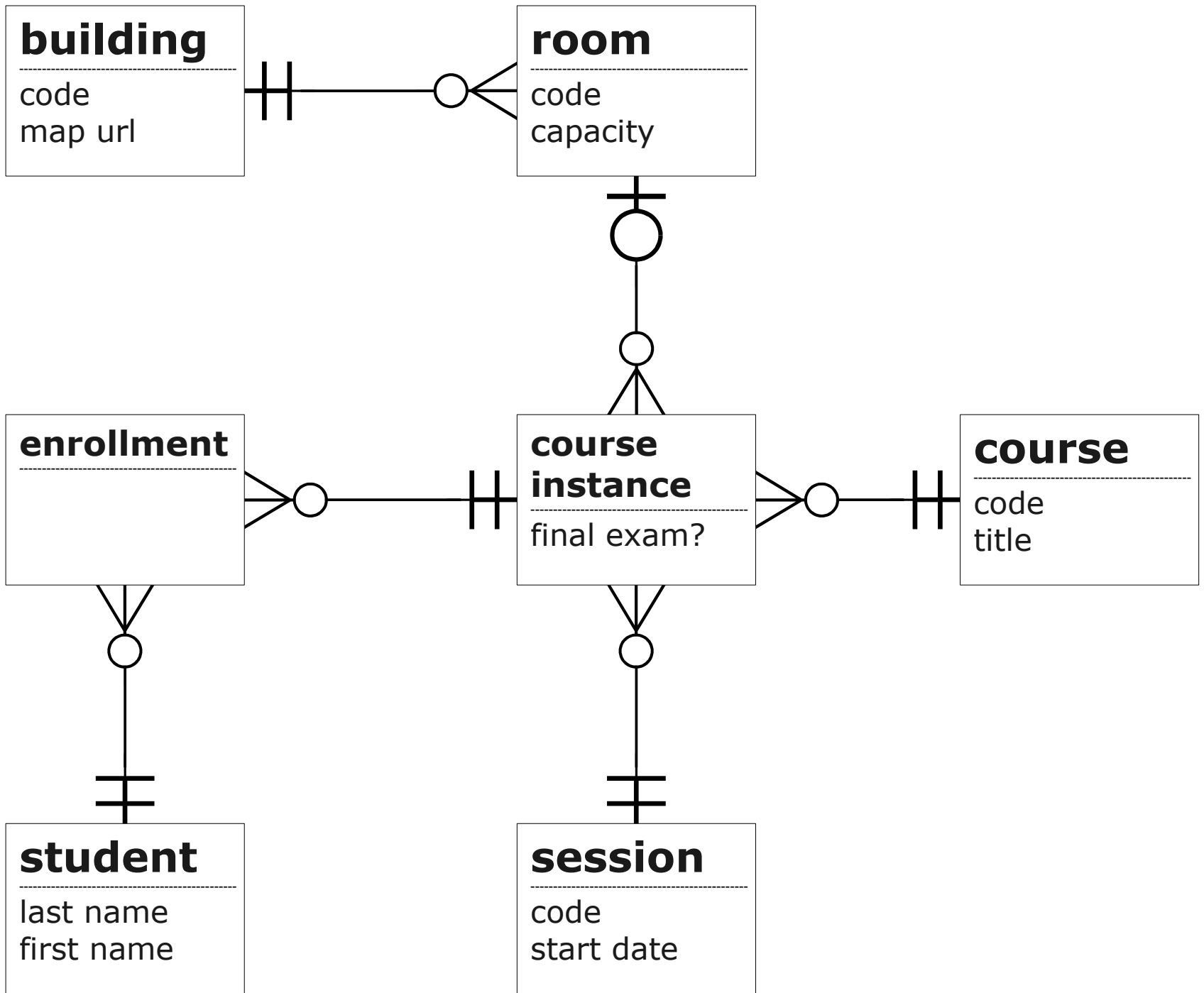


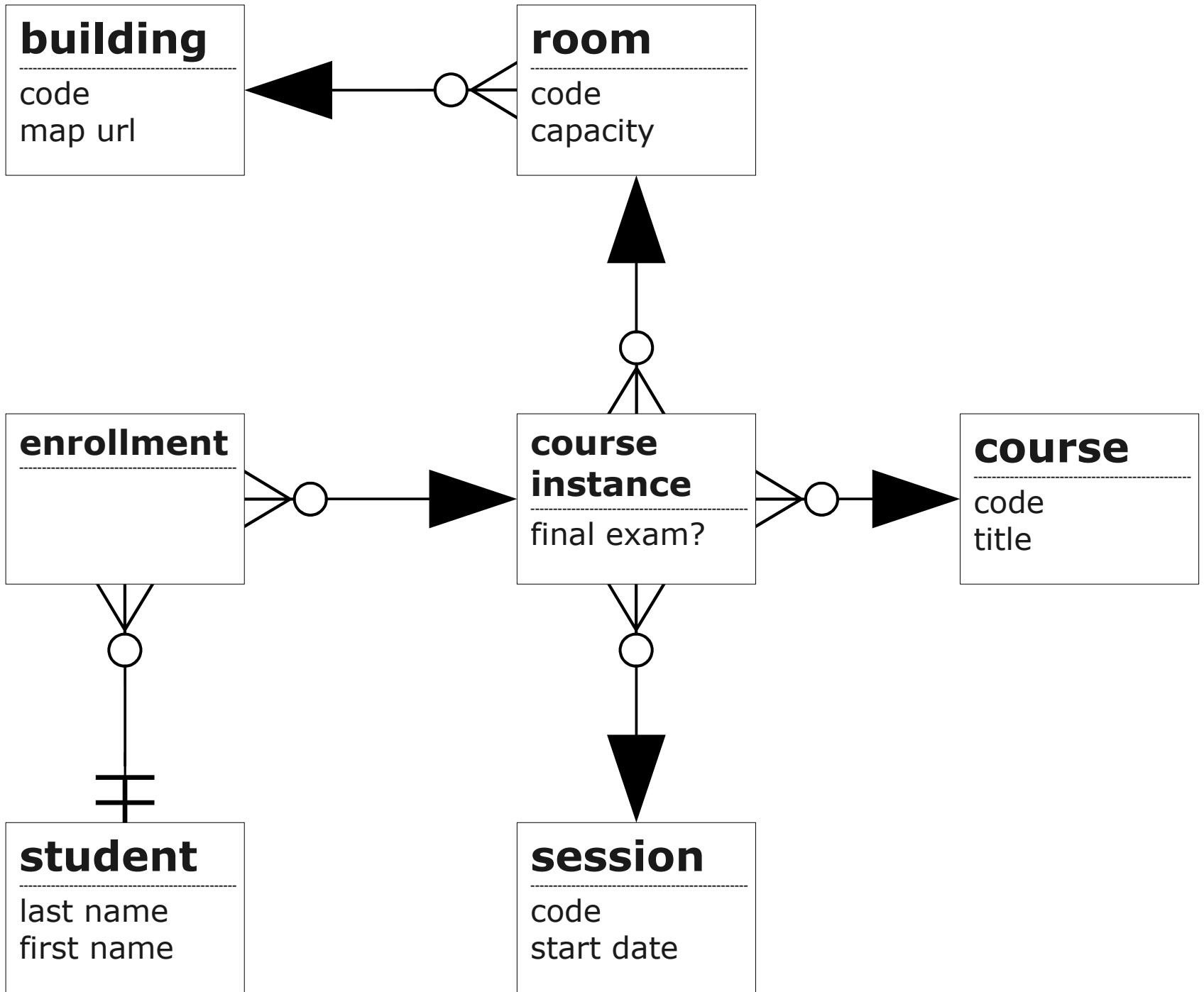






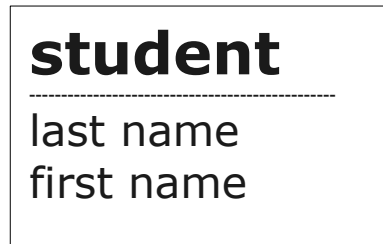






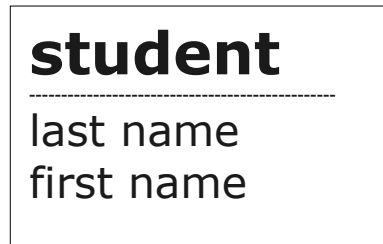
Step 1

“Create one table for each entity”
(after breaking up M:M)



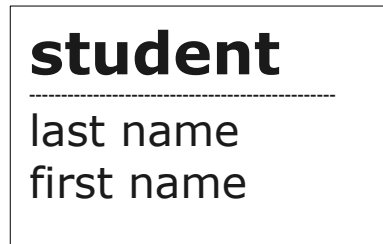
student

first_name	last_name



student

name	domain
last_name	
first_name	



student

name	domain
last_name	varchar(100)
first_name	varchar(100)

student

last name
first name



student

name	domain	NULL
last_name	varchar(100)	YES
first_name	varchar(100)	NO

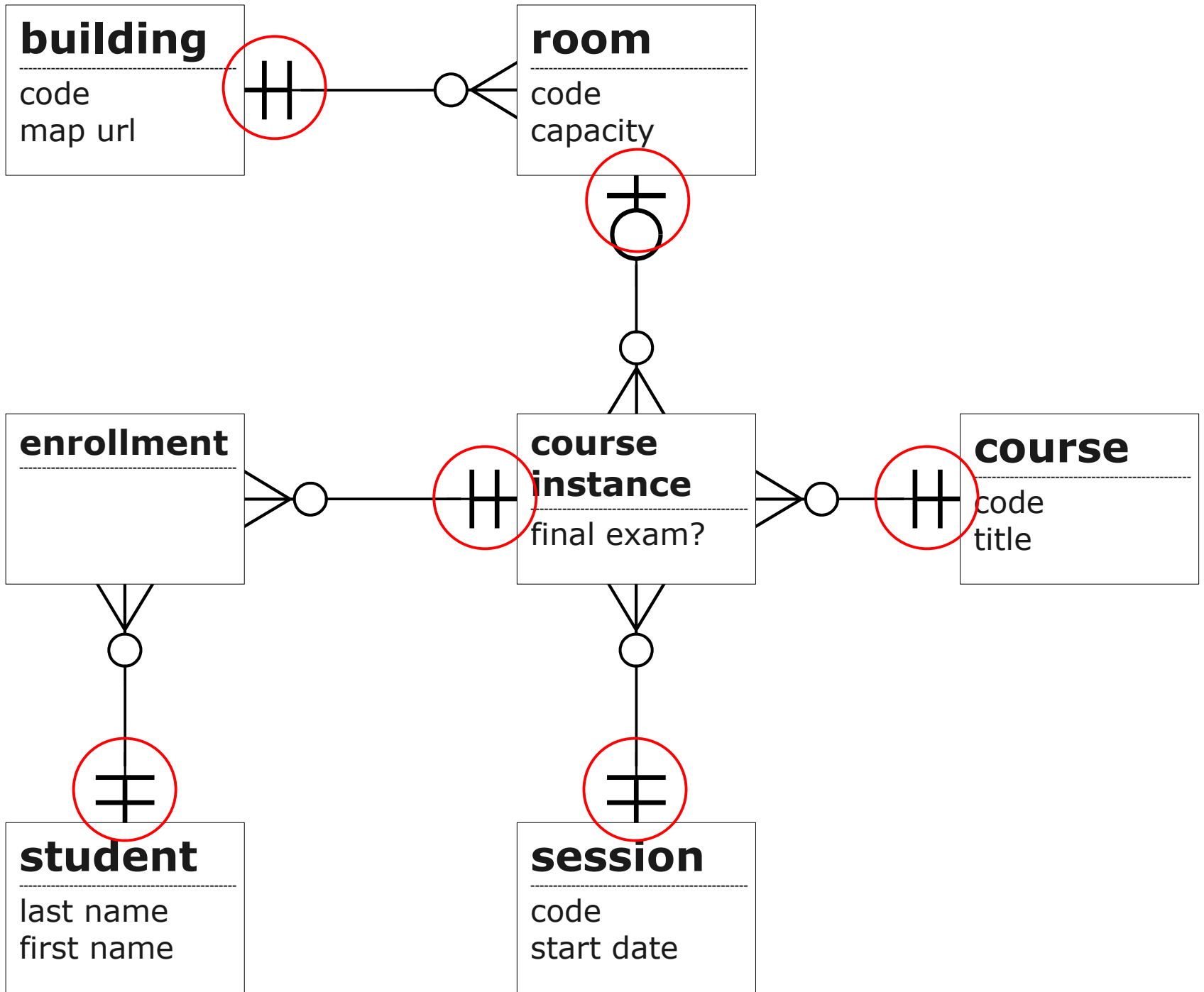
(do this for every entity)

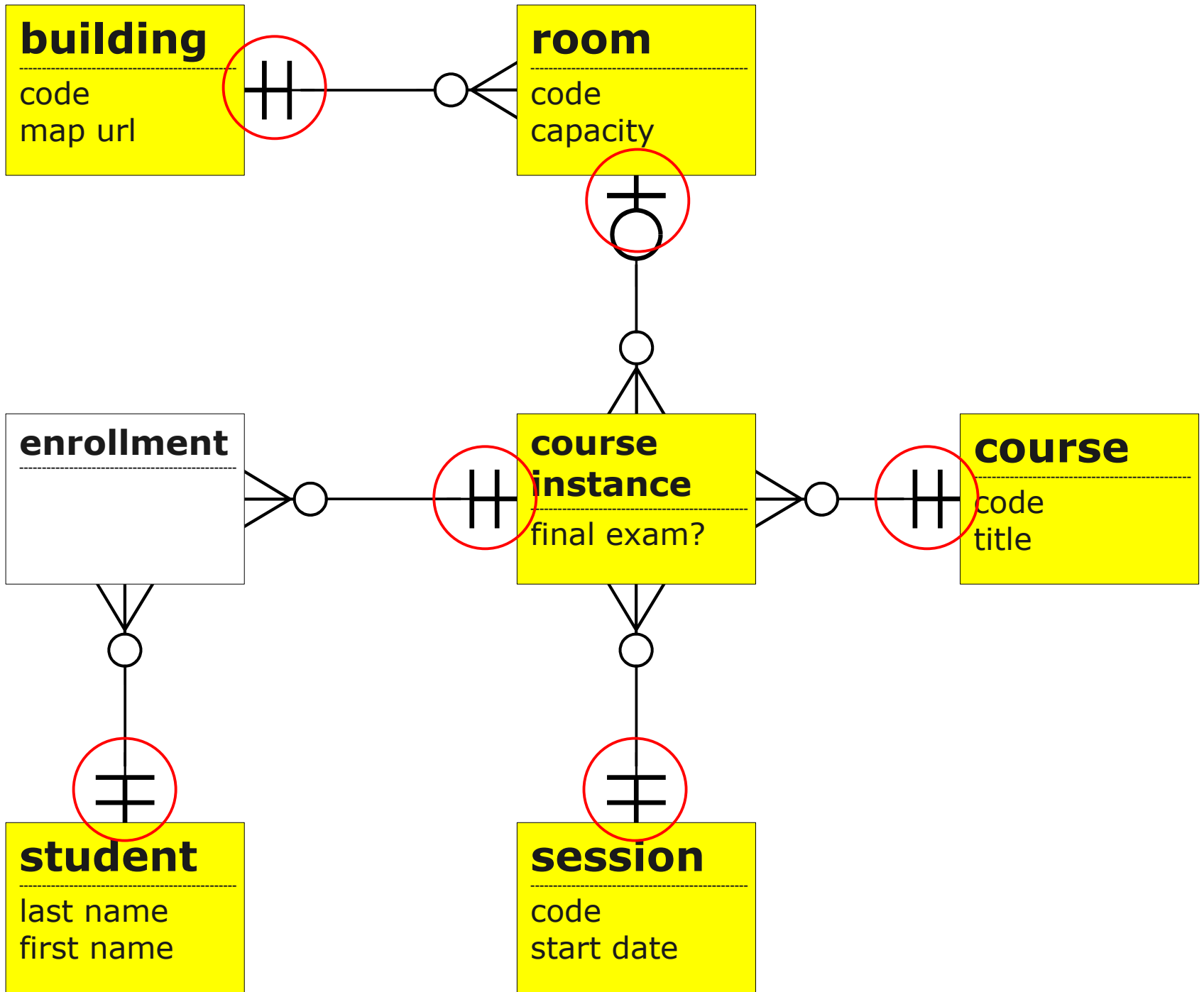
Step 2

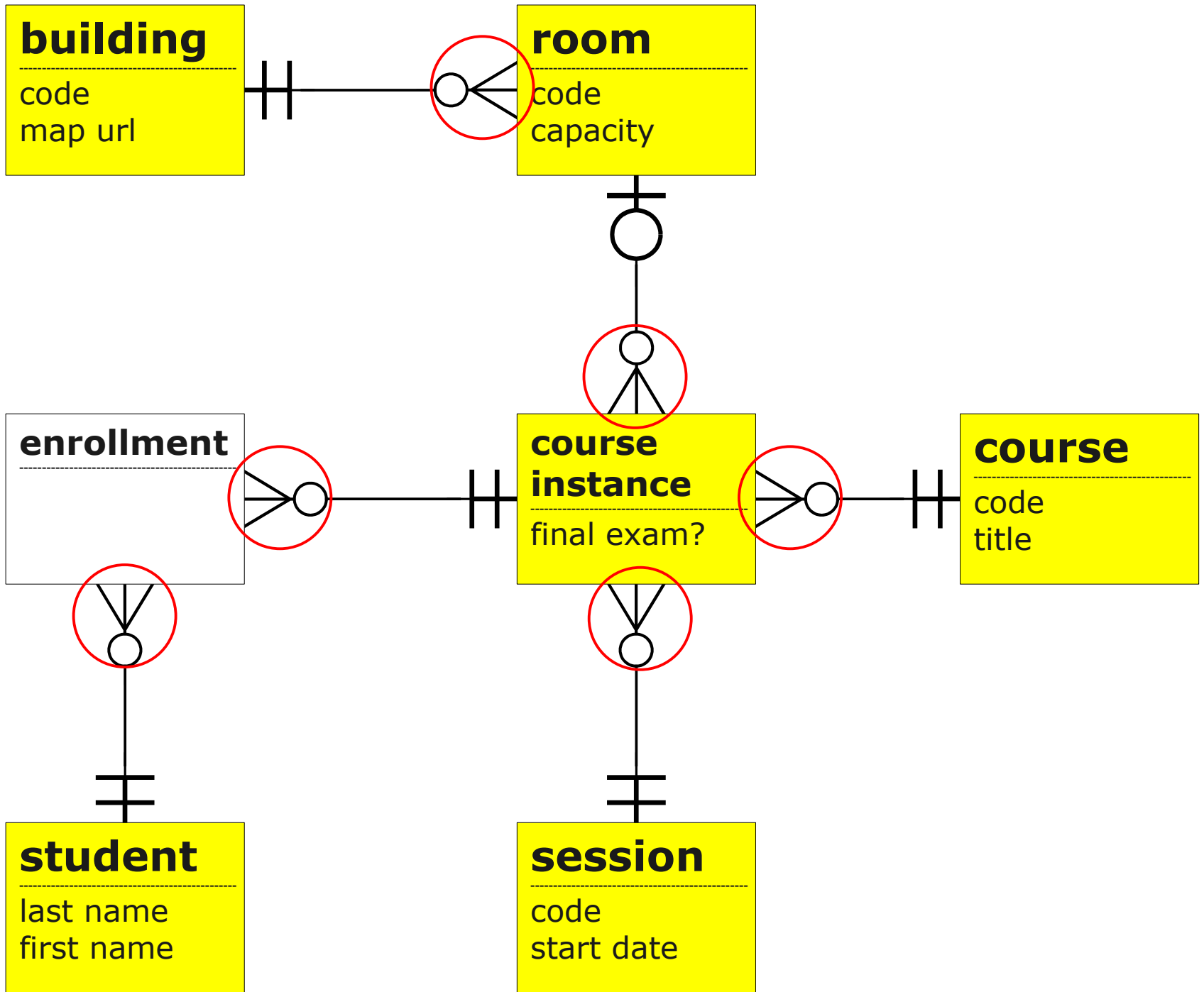
“For each entity that is only on the ‘one’ end of one or more relationships and not at the ‘many’ end of any relationship, create a single-column primary key... if no natural primary key is available.”

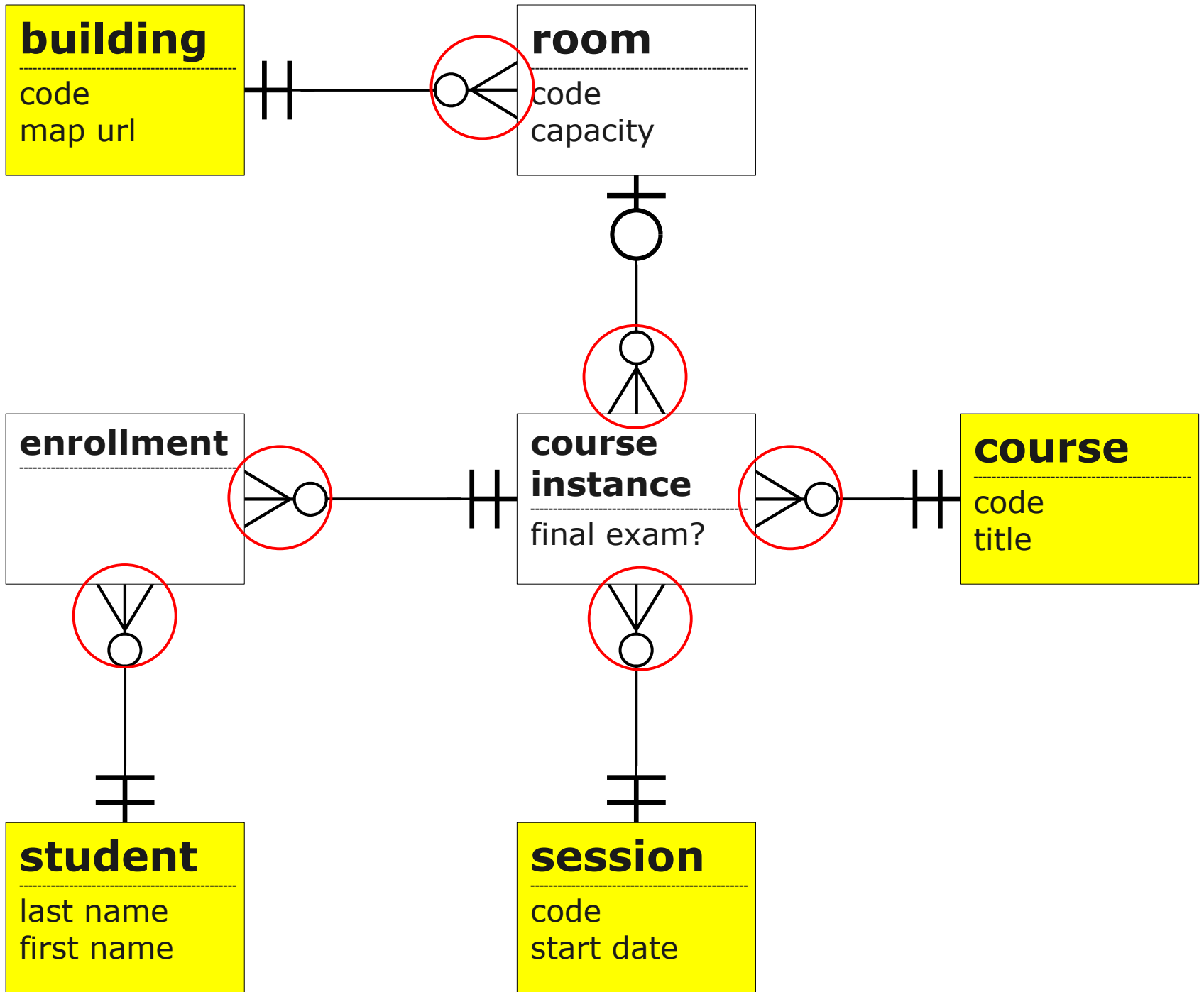
Step 2

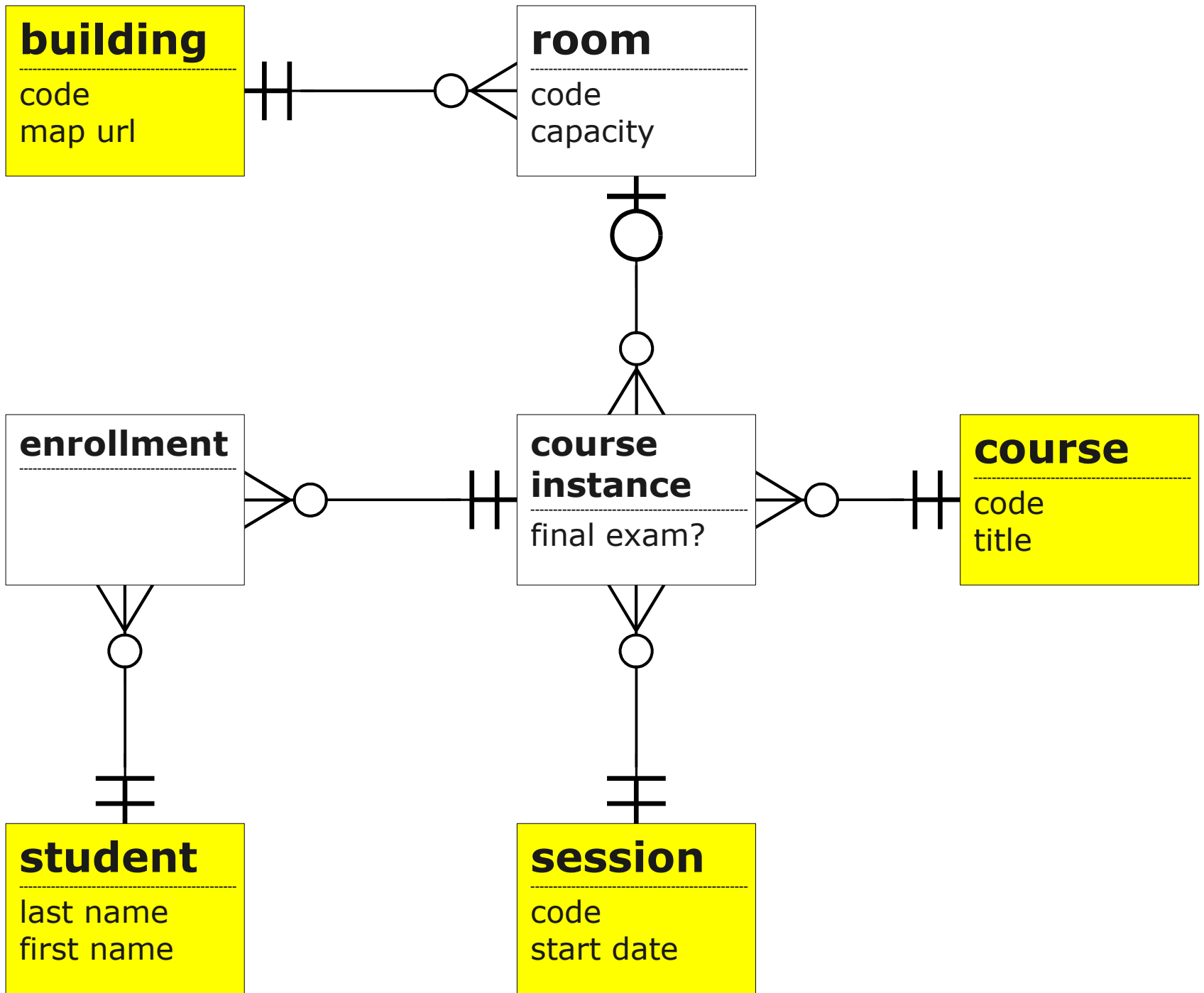
“For each entity that is only on the ‘one’ end of one or more relationships and not at the ‘many’ end of any relationship, create a single-column primary key... if no natural primary key is available.”











Step 2

“For each entity that is only on the ‘one’ end of one or more relationships and not at the ‘many’ end of any relationship, **create a single-column primary key... if no natural primary key is available.”**

Keys

student

name
last_name
first_name

no key!

Keys

student

name
last_name
first_name
student_no



a candidate key

Keys

student

name
last_name
first_name
student_no
utorid

another
candidate key



Keys

student

name

last_name

first_name

student_no

utorid



candidate #1



candidate #2

Keys

student

name
last_name
first_name
student_no*
utorid

primary key

candidate #1

candidate #2



Multi-Column Keys

city

name
name
province
population



a key!

Multi-Column Keys

city

name
name
province
country
population



a three column
key

Multi-Column Keys

city

name
name
province
country
population
city_id

candidate #1

← candidate #2

Step 2

“For each entity that is only on the ‘one’ end of one or more relationships and not at the ‘many’ end of any relationship, **create a single-column primary key... if no natural primary key is available.”**

student

name
last_name
first_name

student

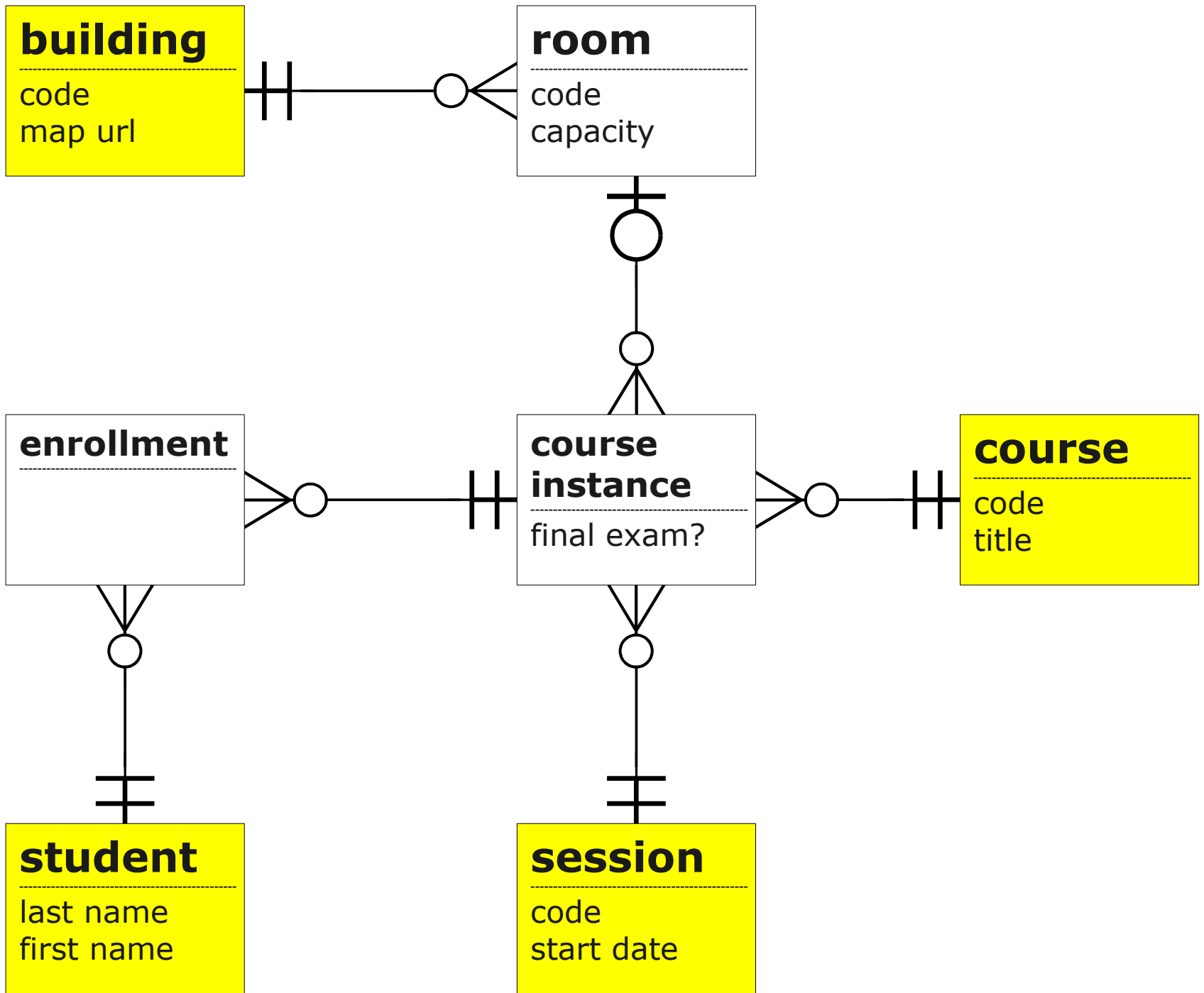
name
last_name
first_name
student_id*

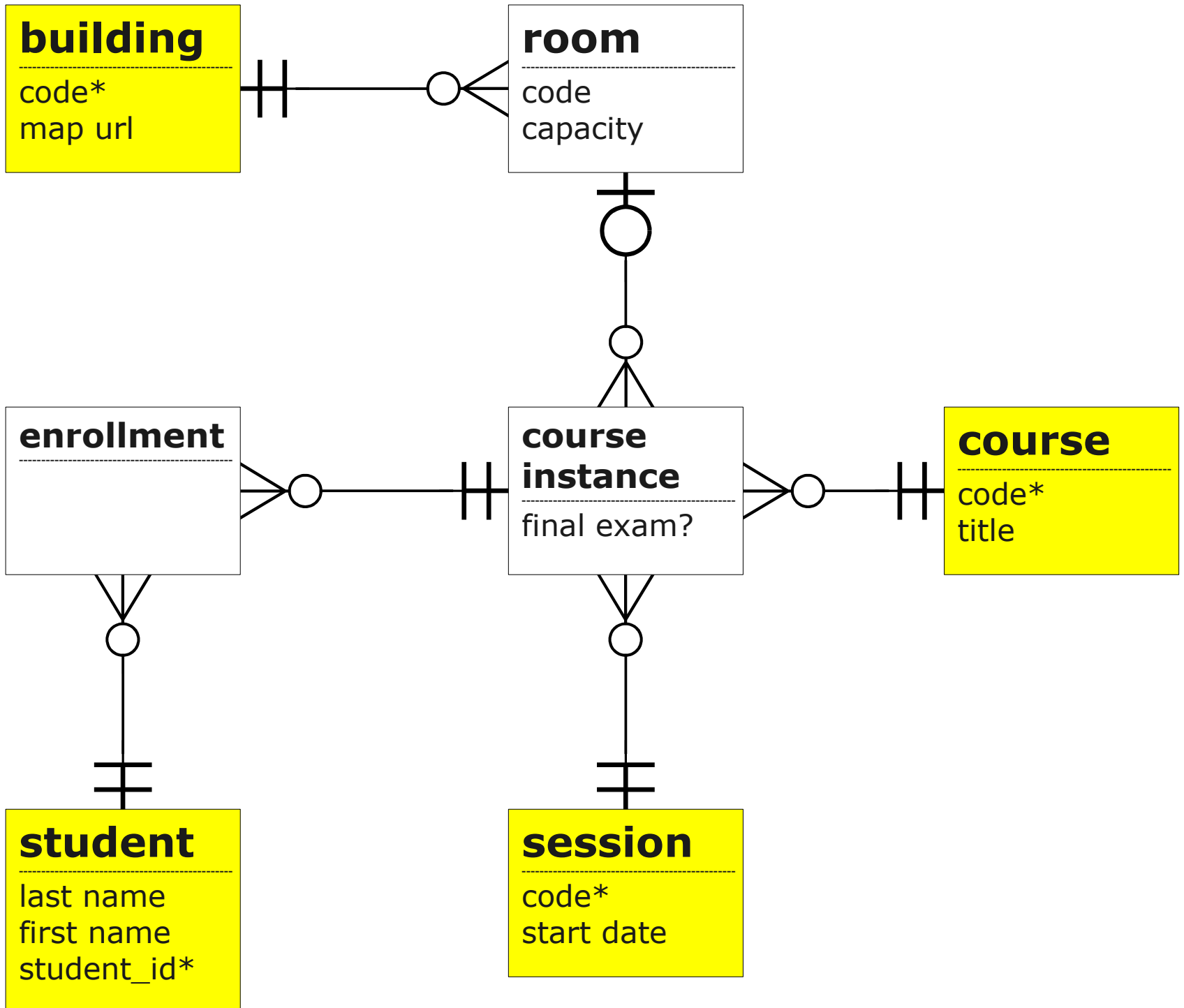


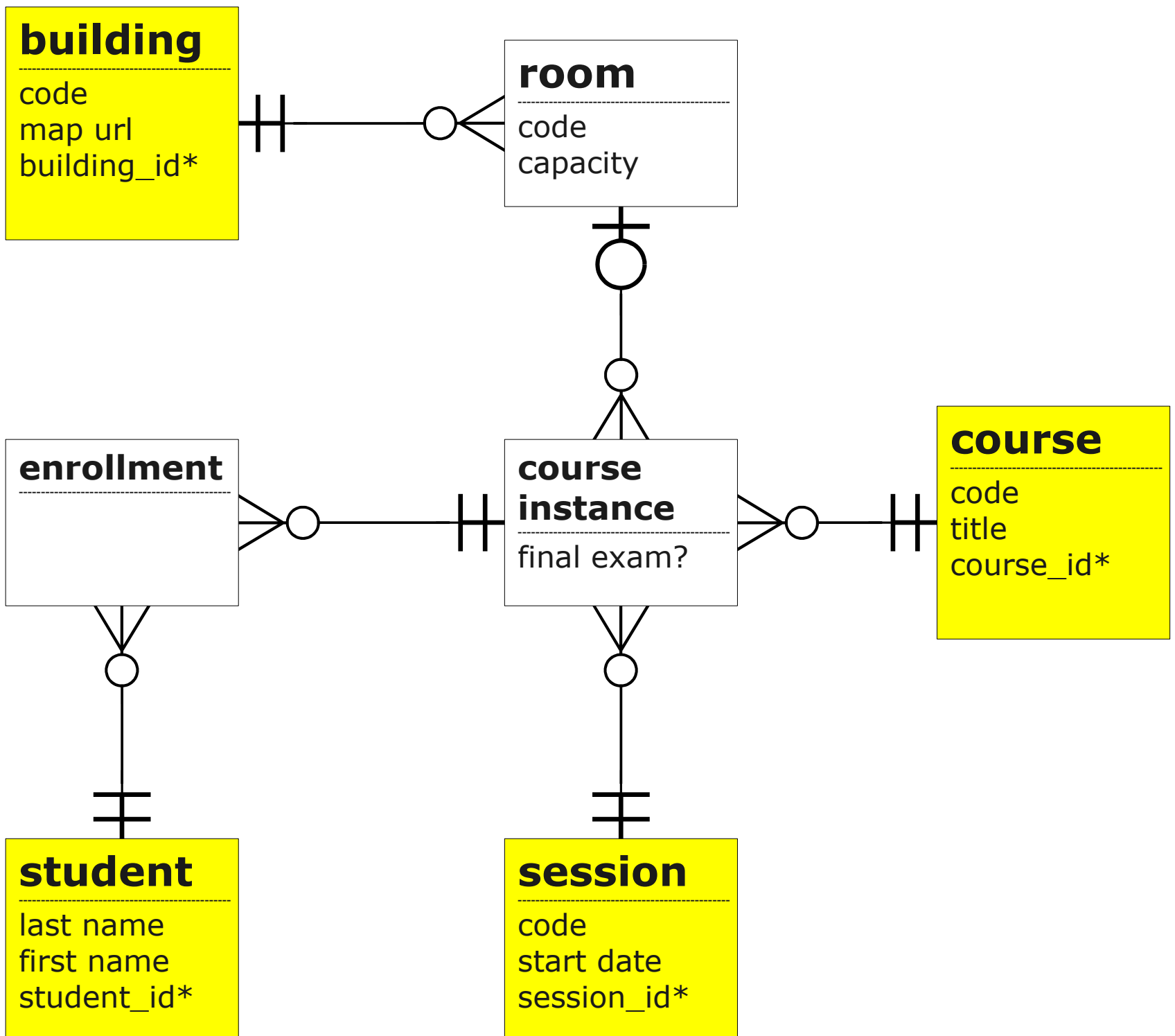
let's add it

student

name	type	null	key
last_name	varchar(100)	YES	
first_name	varchar(100)	NO	
student_id	int	NO	PRI





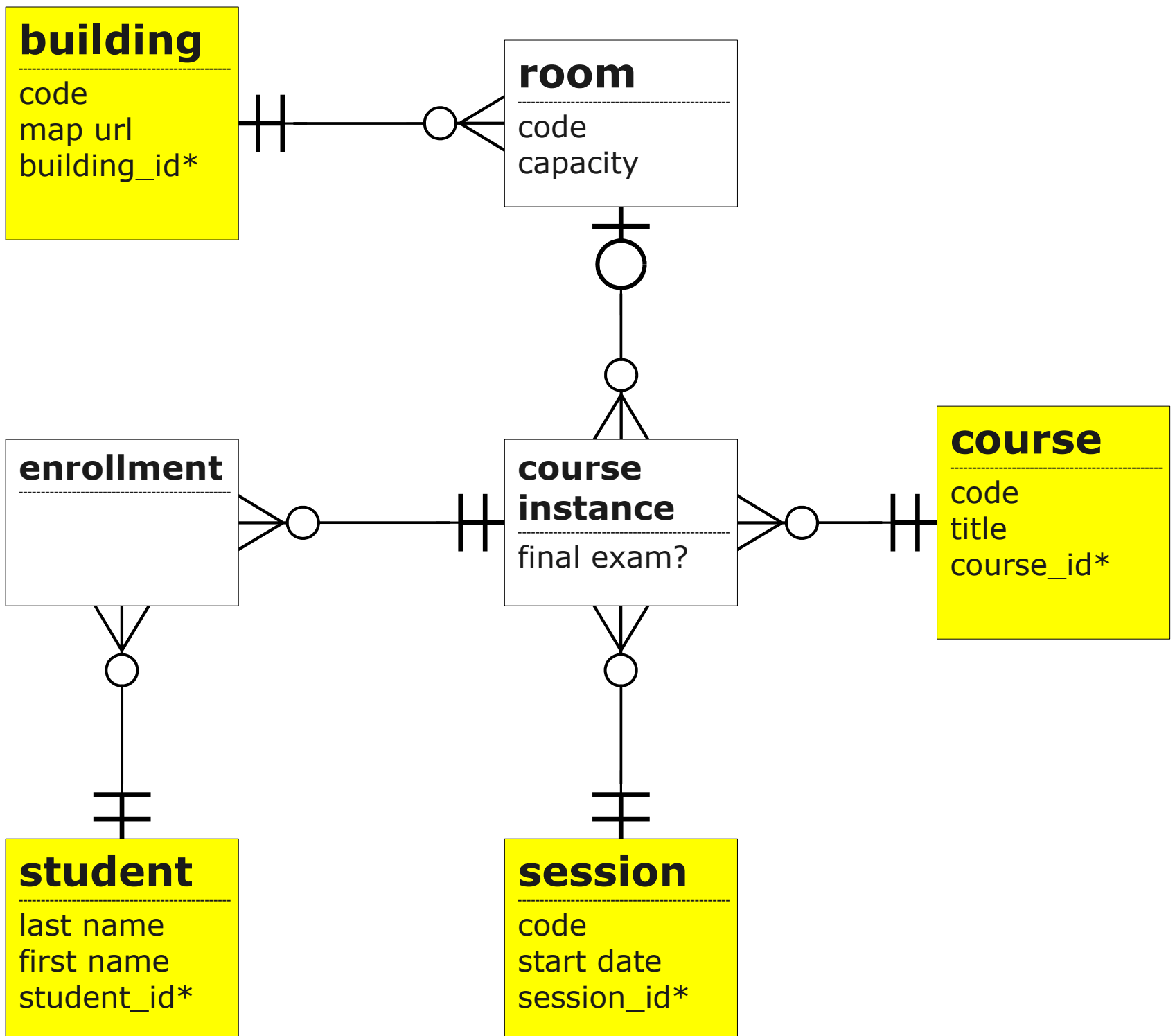


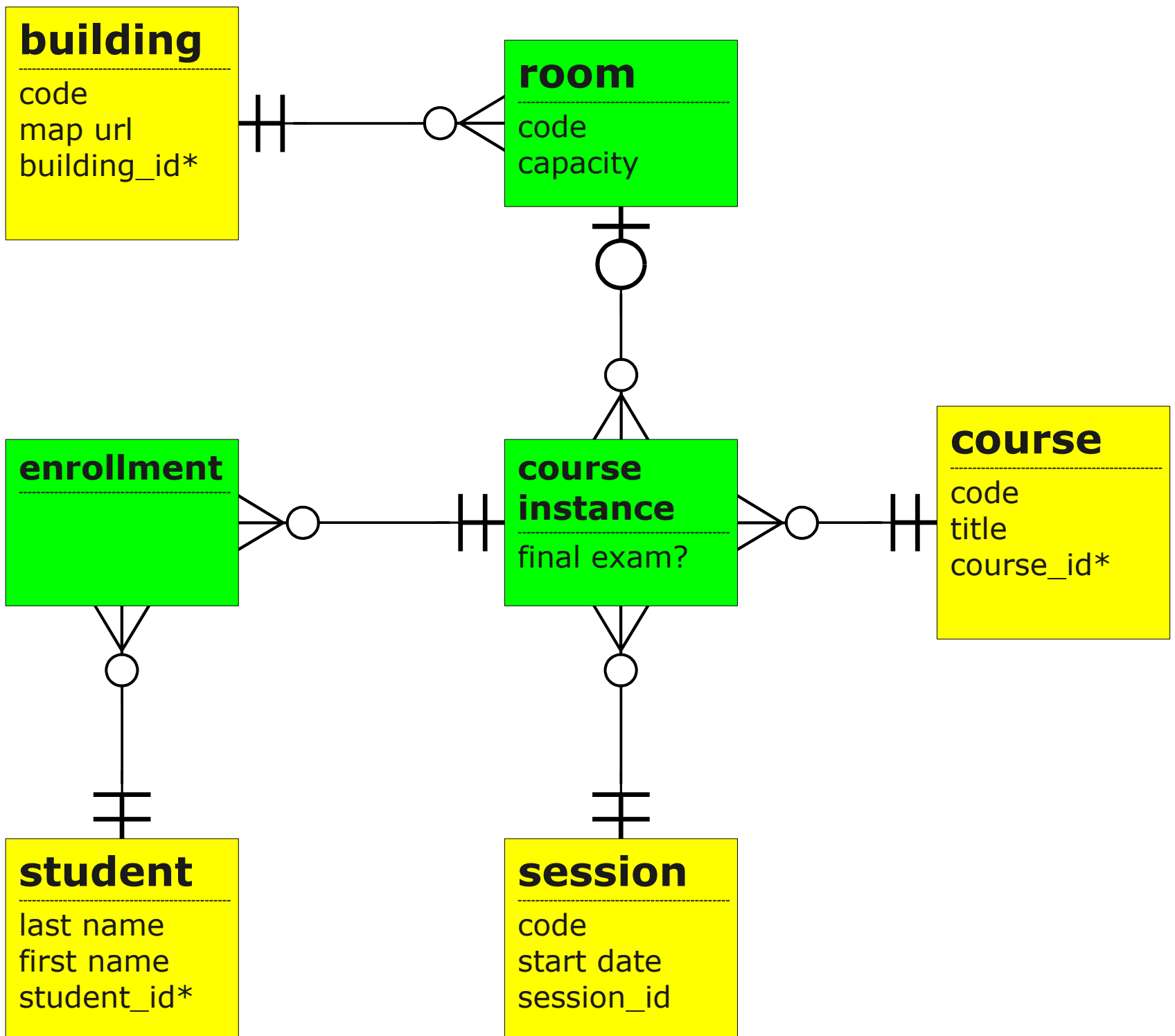
Step 3

“For each entity that is at the ‘many’ end of one or more relationships, include the primary key of each parent entity in the table as foreign keys.”

Step 3

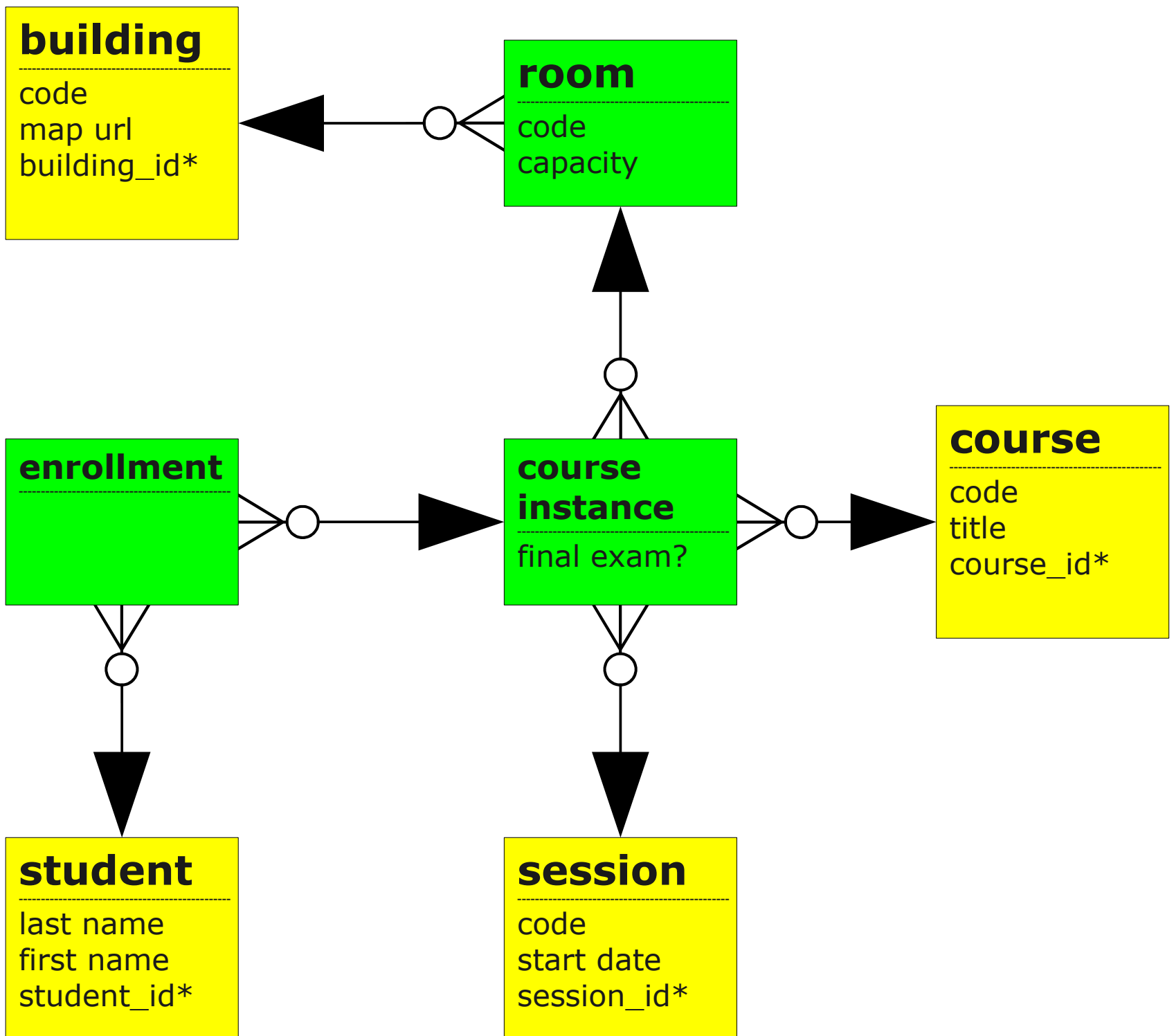
“For each entity that is at the ‘many’ end of one or more relationships, include the primary key of each parent entity in the table as foreign keys.”

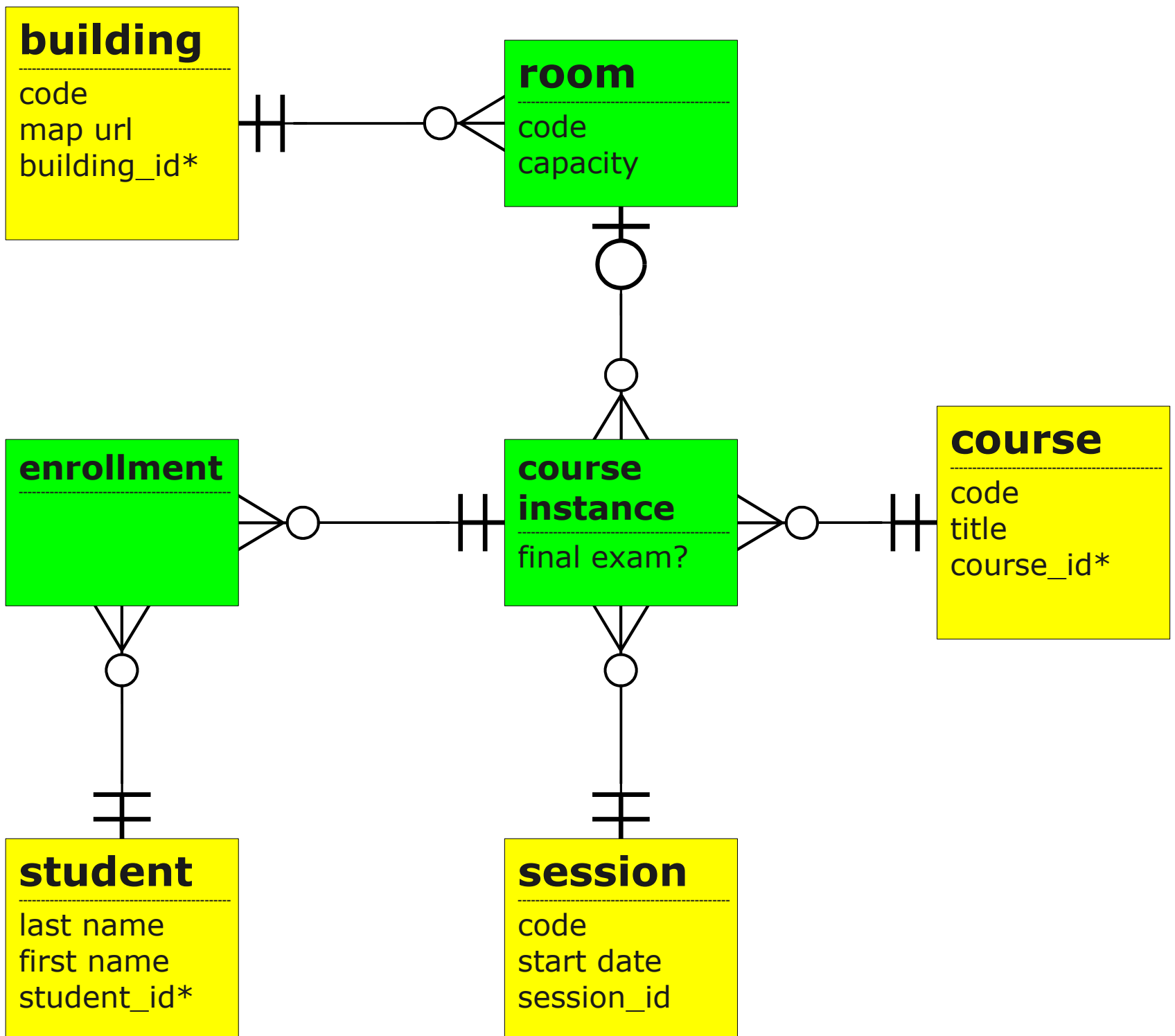


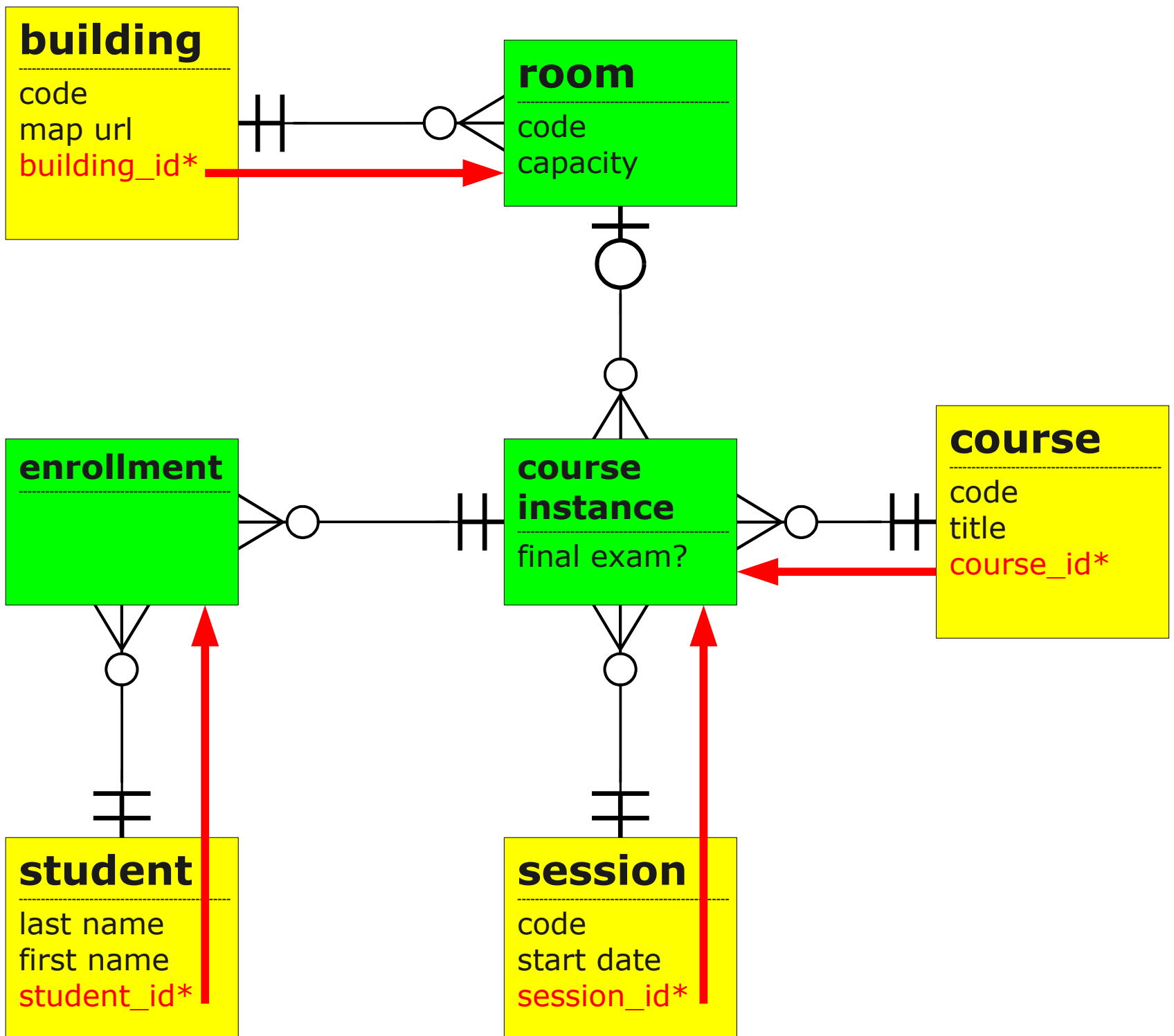


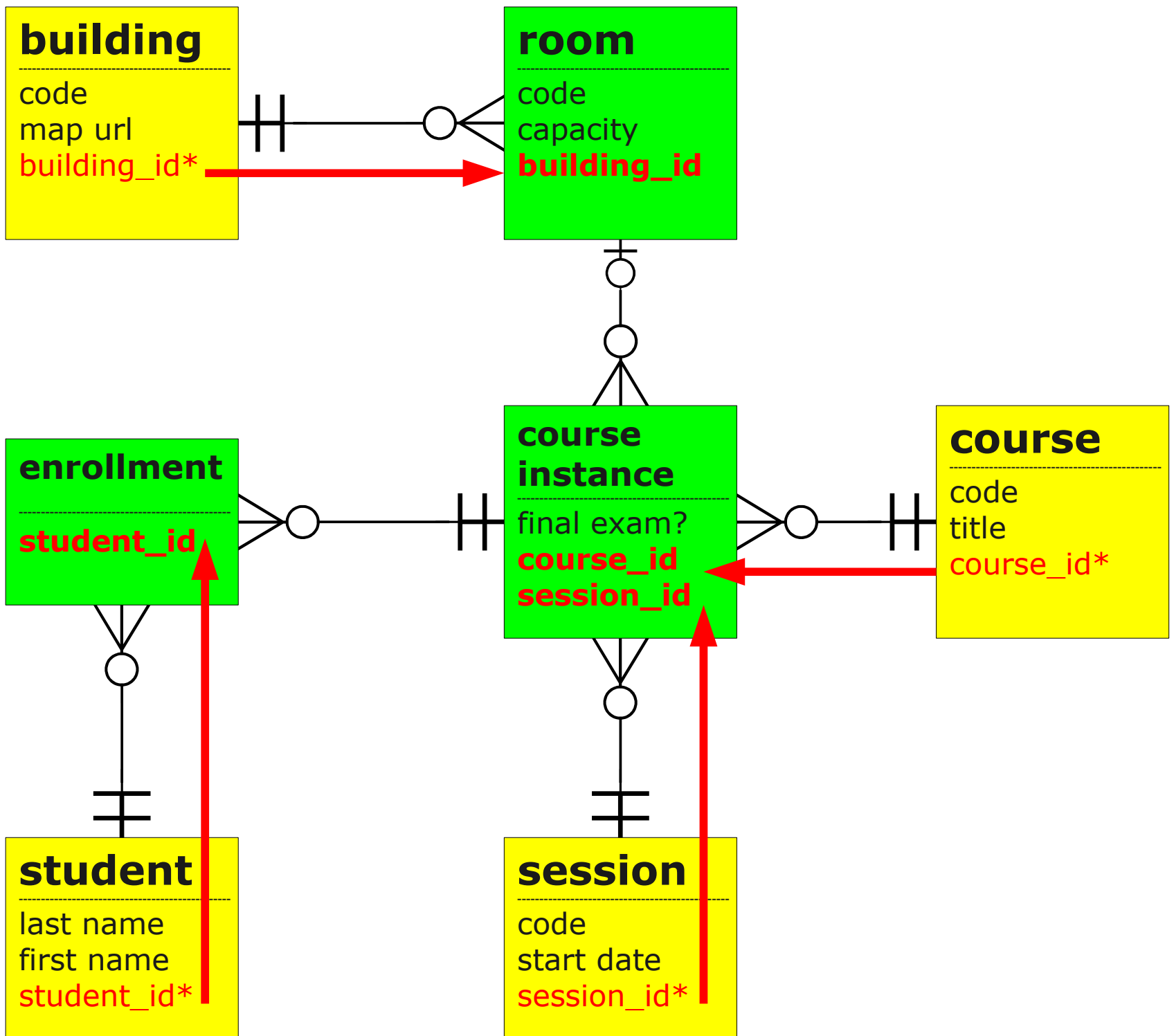
Step 3

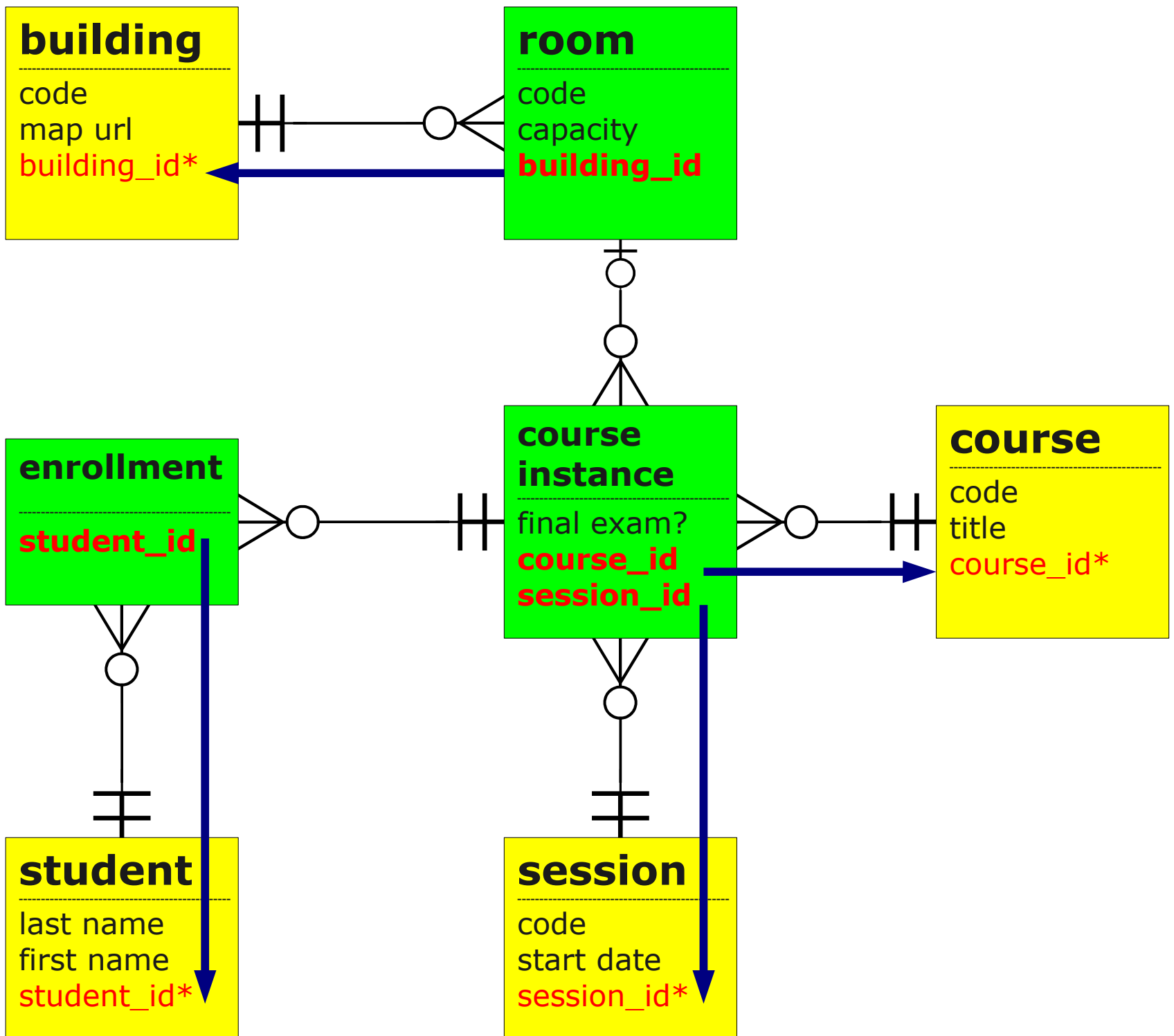
“For each entity that is at the ‘many’ end of one or more relationships, include the primary key of each parent entity in the table as foreign keys.”





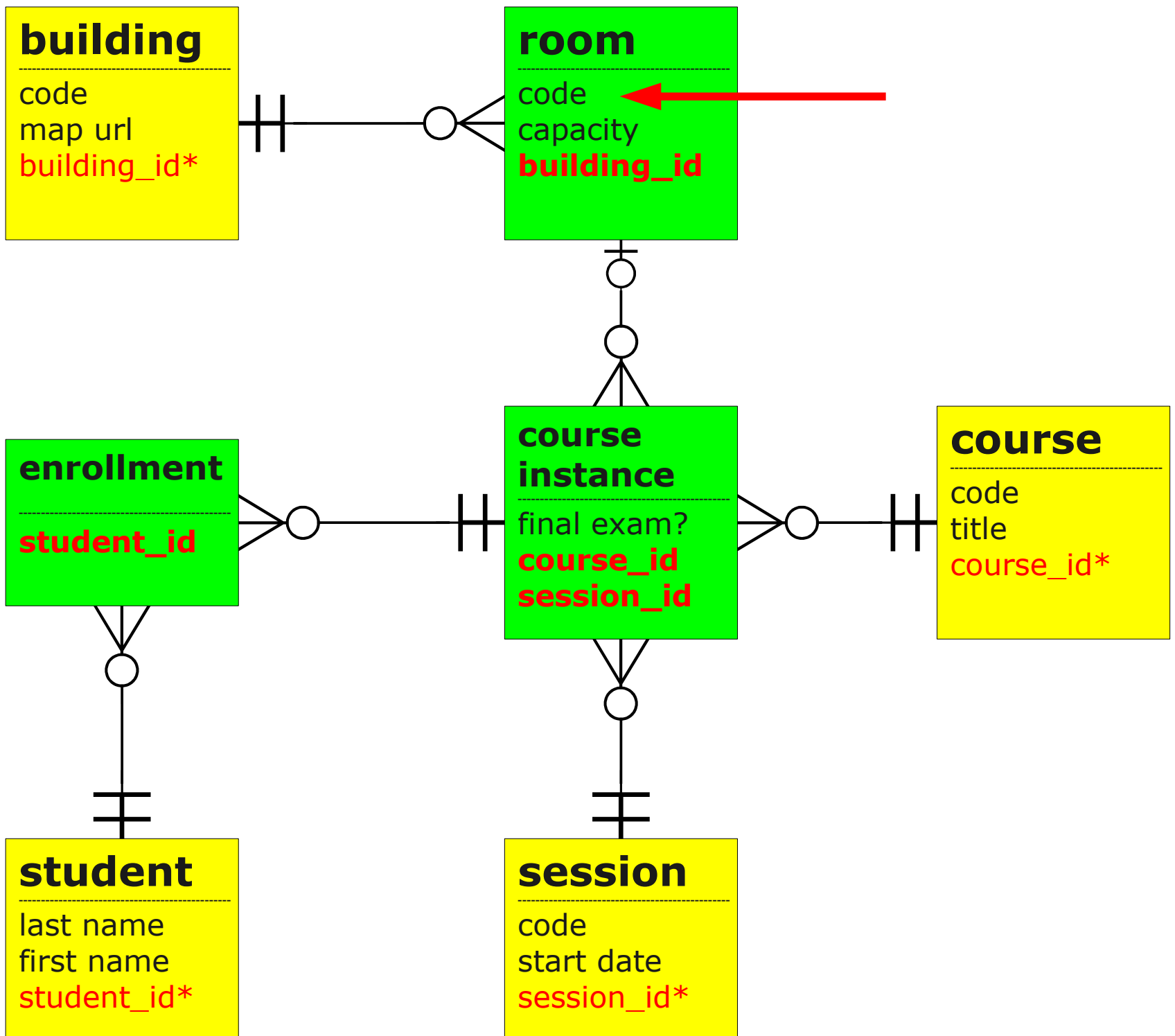






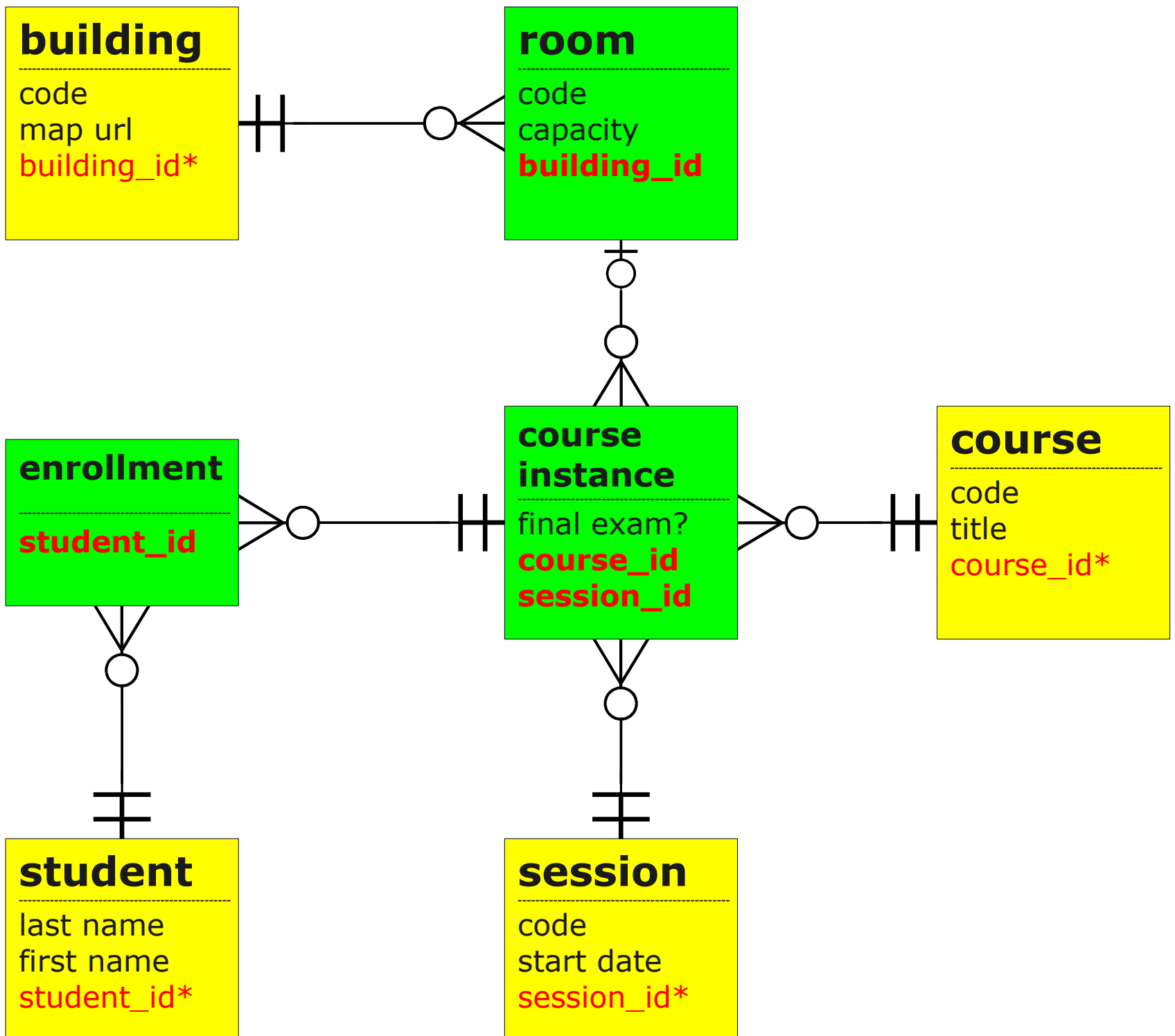
Step 4a

“If an entity at the ‘many’ end of one or more relationships, has a natural primary key, use that single key as a the primary key.”



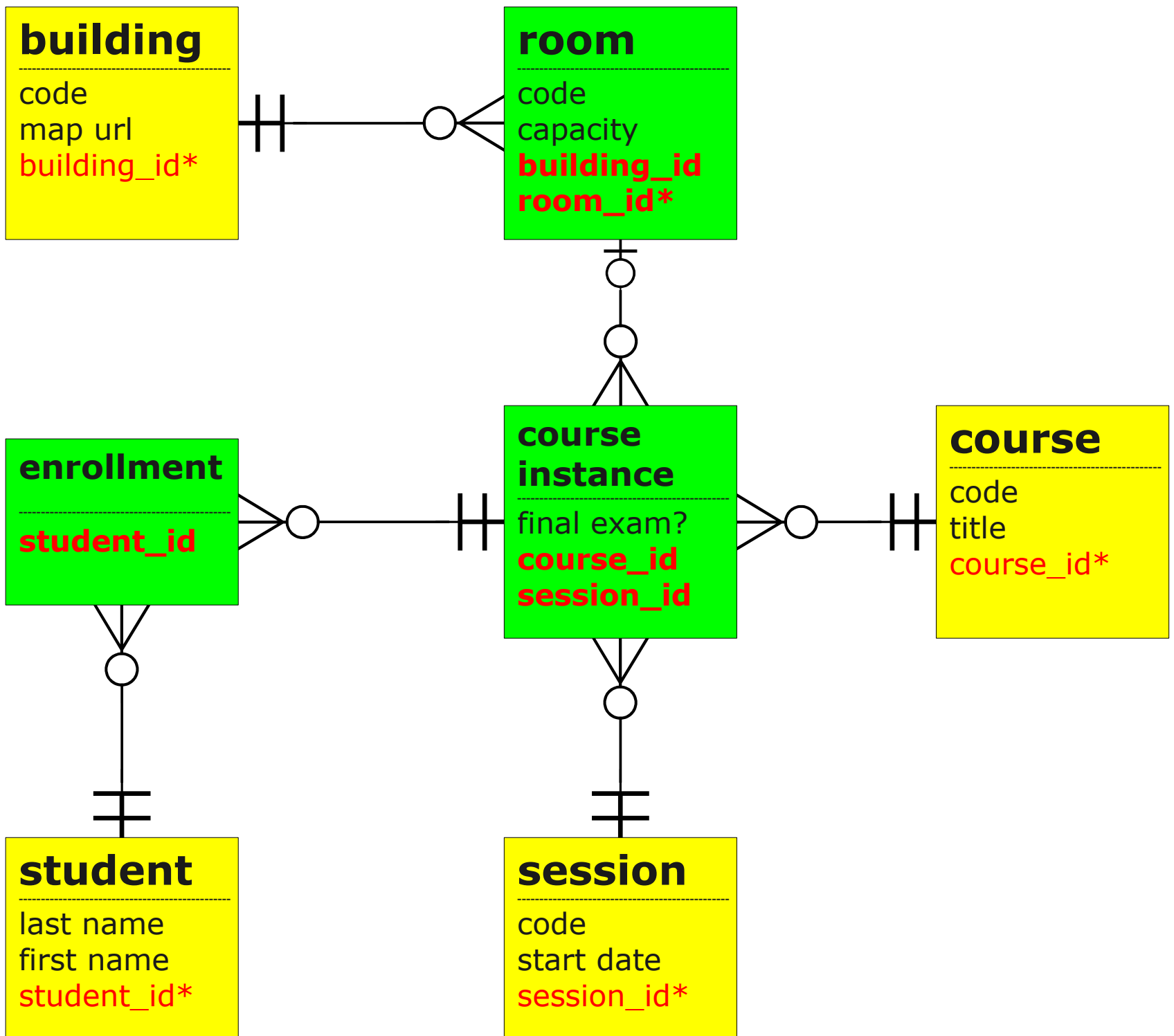
Step 4b

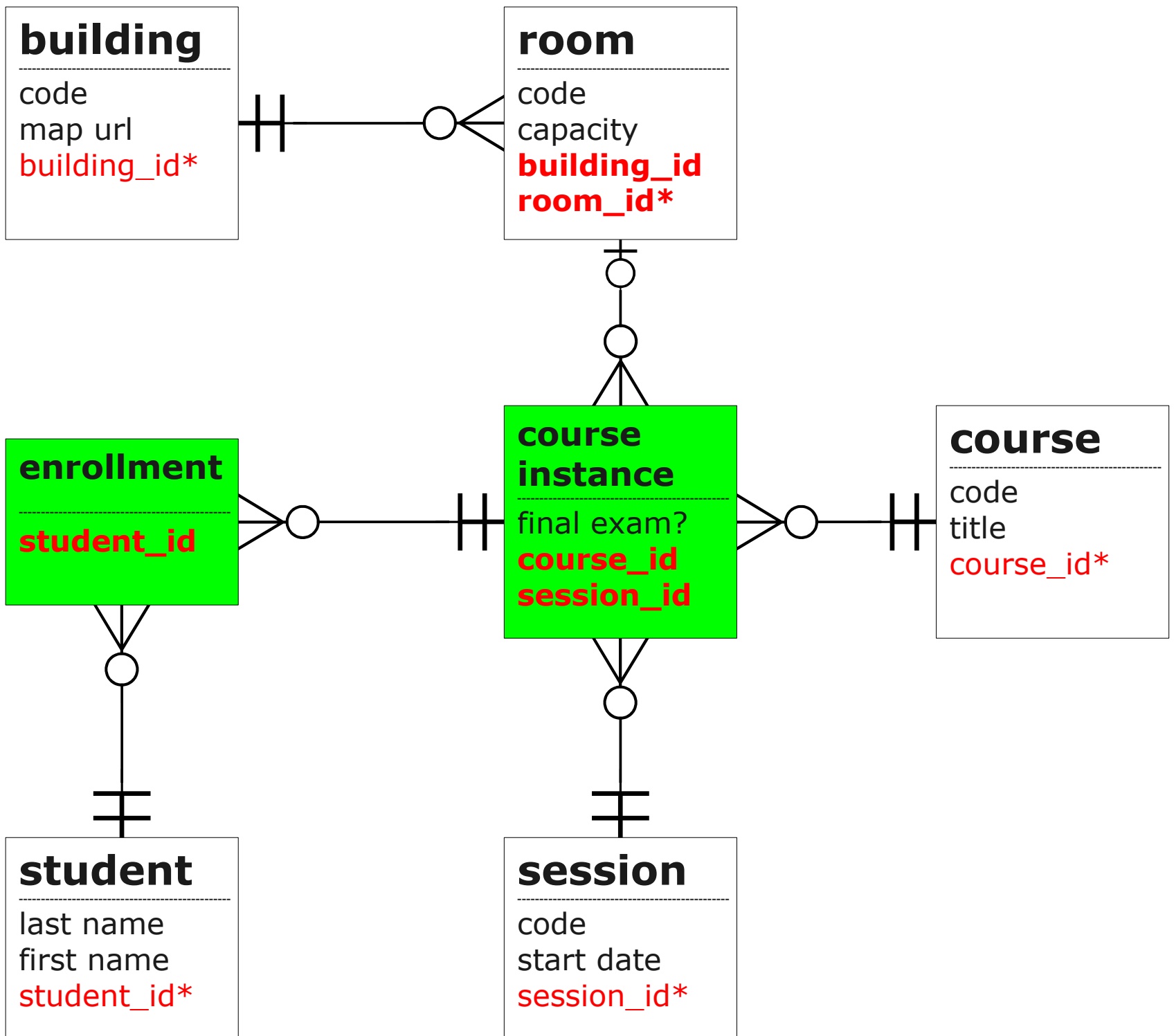
“Otherwise, concatenate the primary key of its parent with any other column or columns needed for uniqueness to form the table’s primary key.”



Step 4c

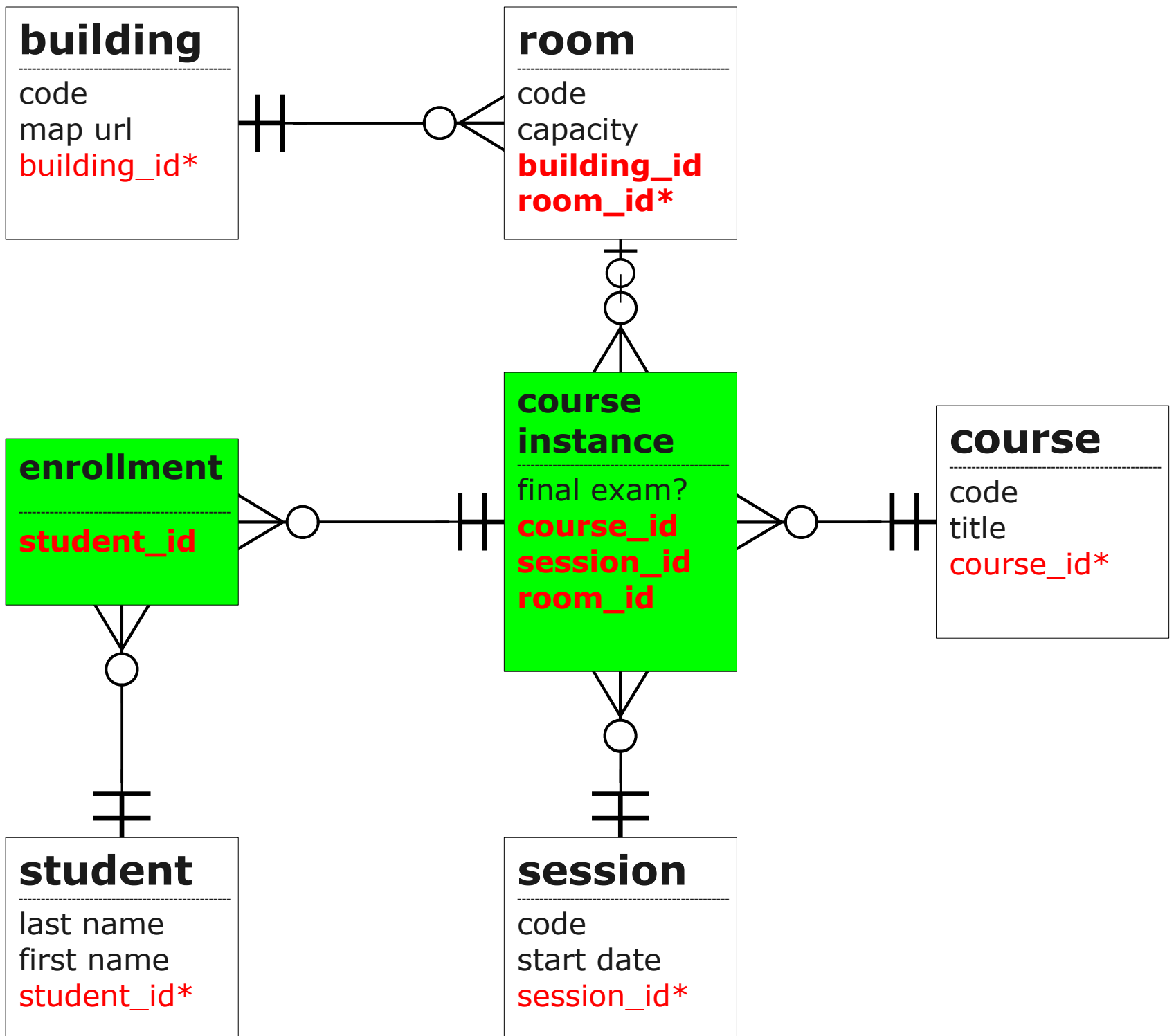
If necessary, add a field!

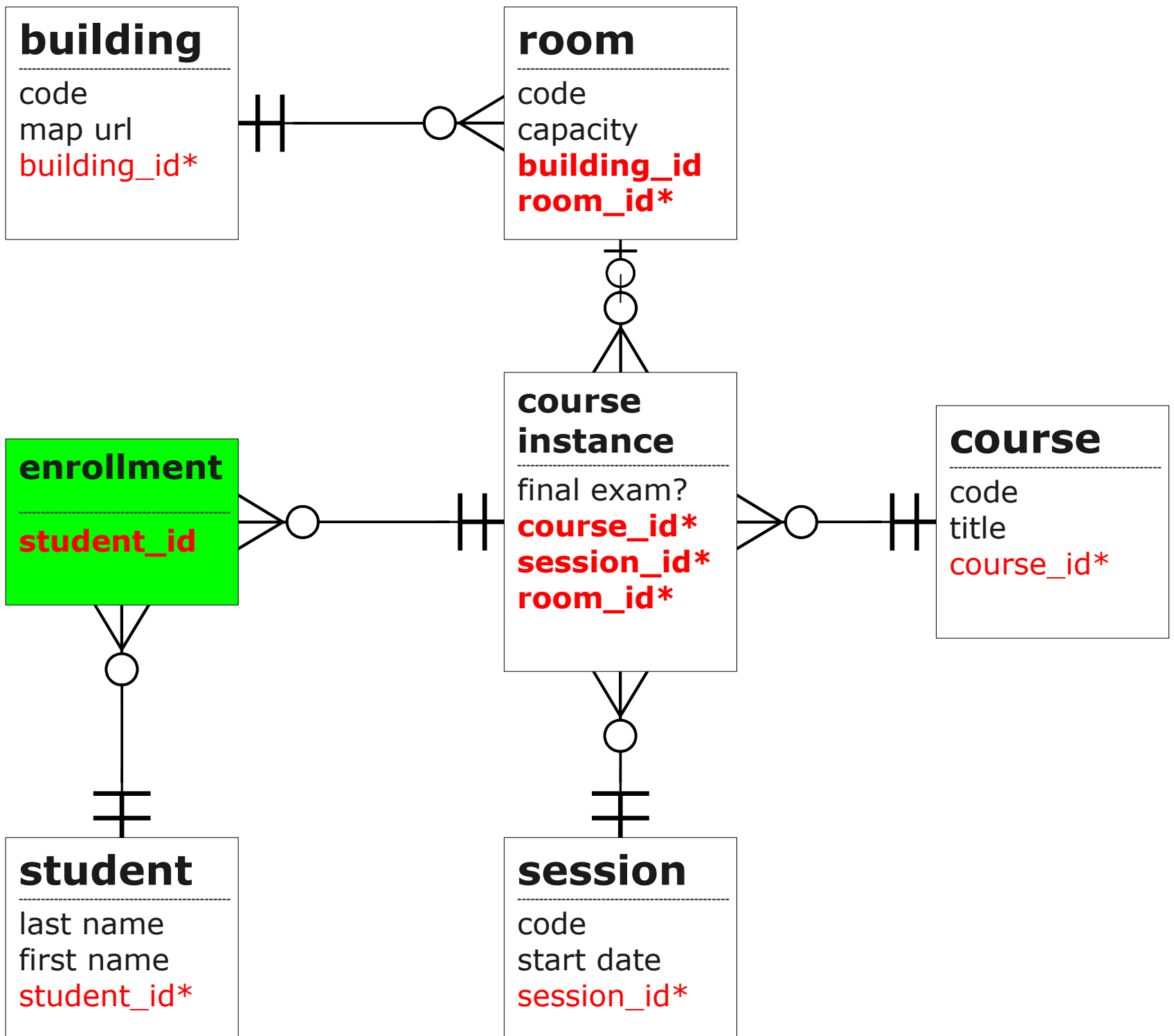


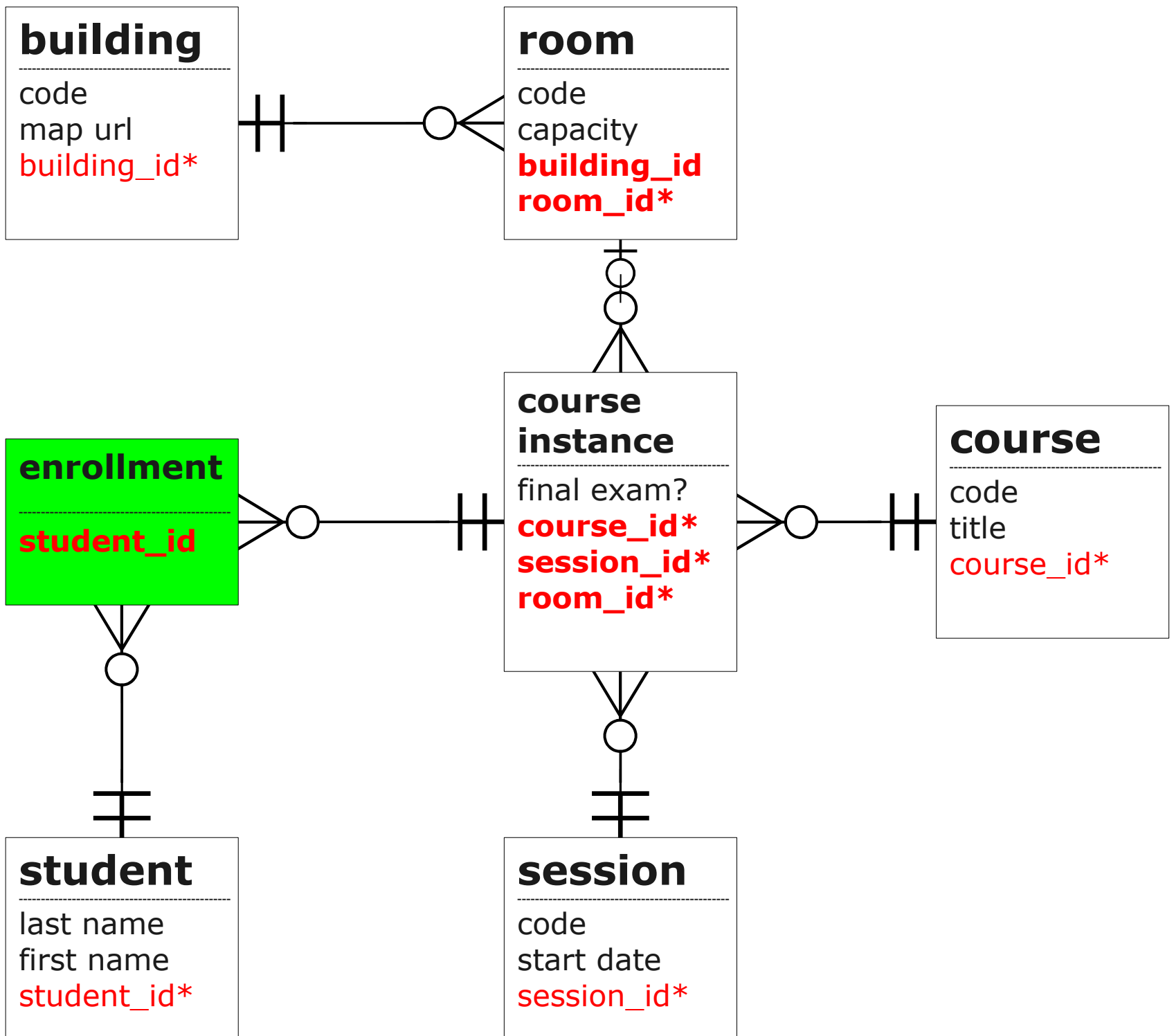


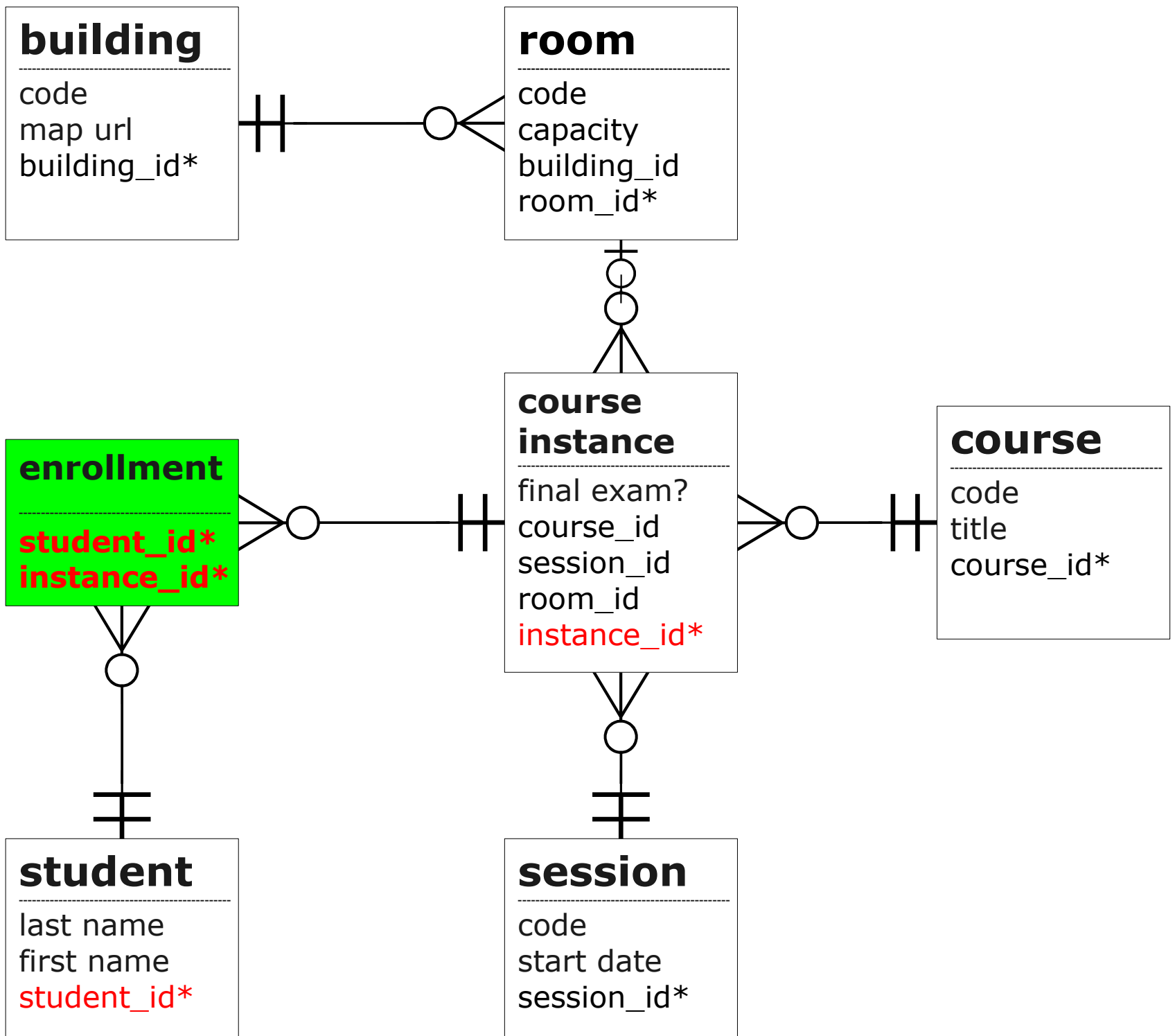
Step 4d

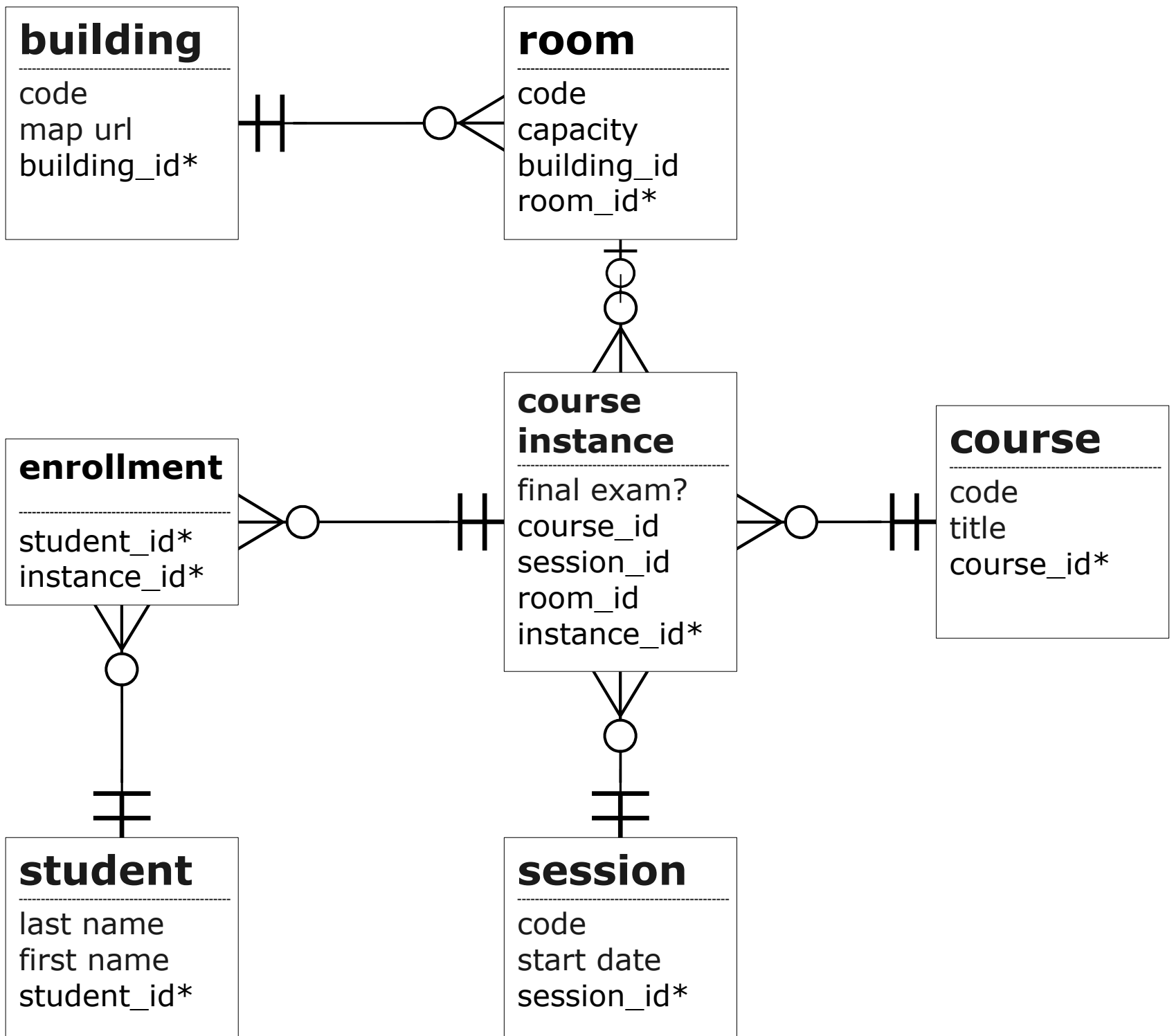
Go back to step 3!





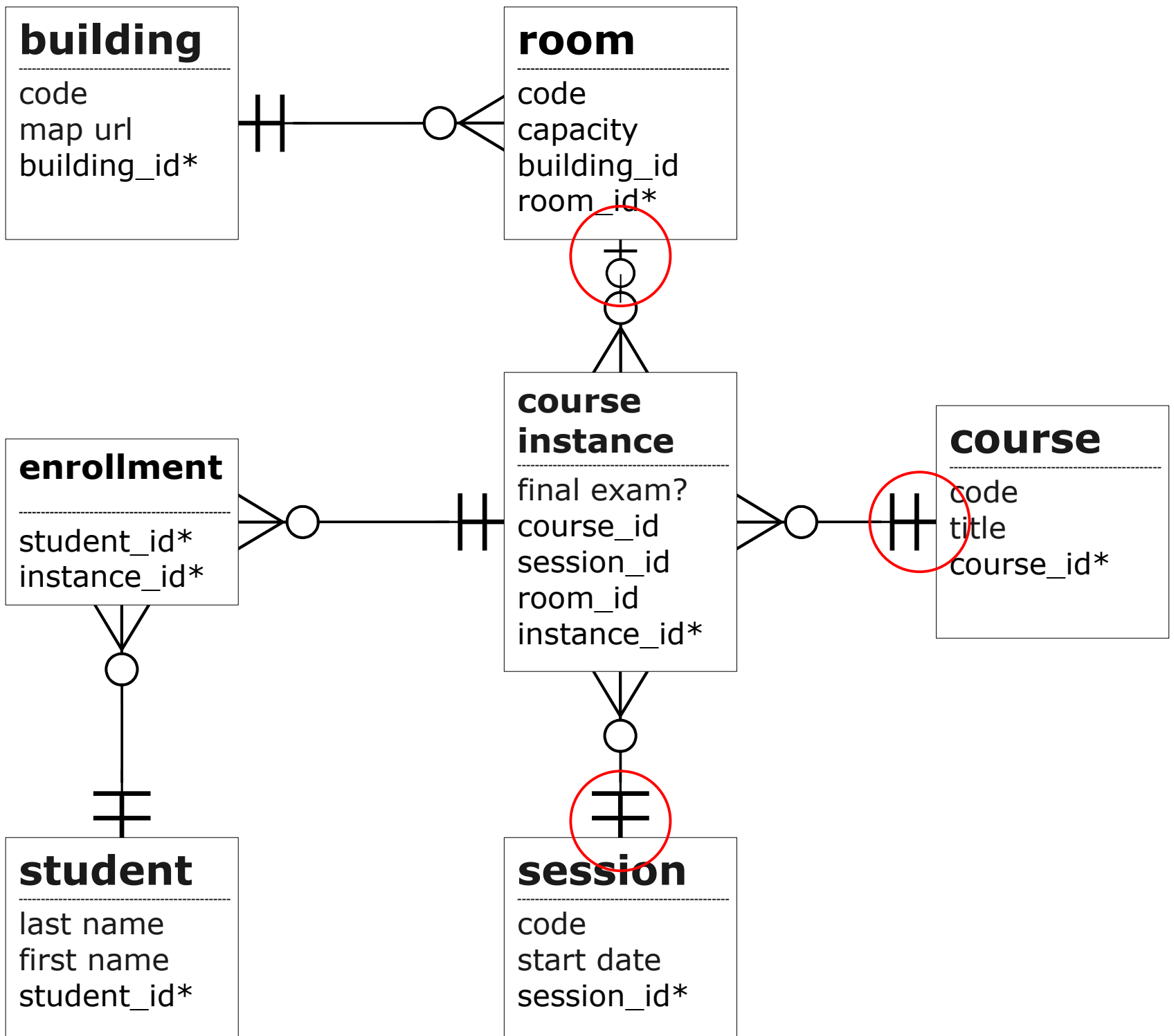






course_instance

name	type	null	key
instance_id	int	NO	PRI
course_id	int		
session_id	int		
room_id	int		
final_exam	bool		



course_instance

name	type	null	key
instance_id	int	NO	PRI
course_id	int	NO	
session_id	int	NO	
room_id	int	YES	
final_exam	bool	YES	

Step 5

Normalize!

Normalization

Checking that the table does not
have any well-known problems

What Problems?

problem type	cause	solution
update	redundancy	decomposition
insertion	redundancy	decomposition
deletion	redundancy	decomposition

Normal Forms

5th Normal Form

4th Normal Form

BC Normal Form

3rd Normal Form

2nd Normal Form

1st Normal Form

fixing
weird
issues

you can do it!

trivial!

1NF

No multi-valued attributes

pet_id	owner	names
1	Bob	“Slim”, “the Serpent”, “Ribbon”
2	Gwen	“Fluffy”, “Big Dog”

The Wrong Solution

pet_id	owner	name1	name2	name3
1	Bob	"Slim"	"the Serpent"	"Ribbon"
2	Gwen	"Fluffy"	"Big Dog"	

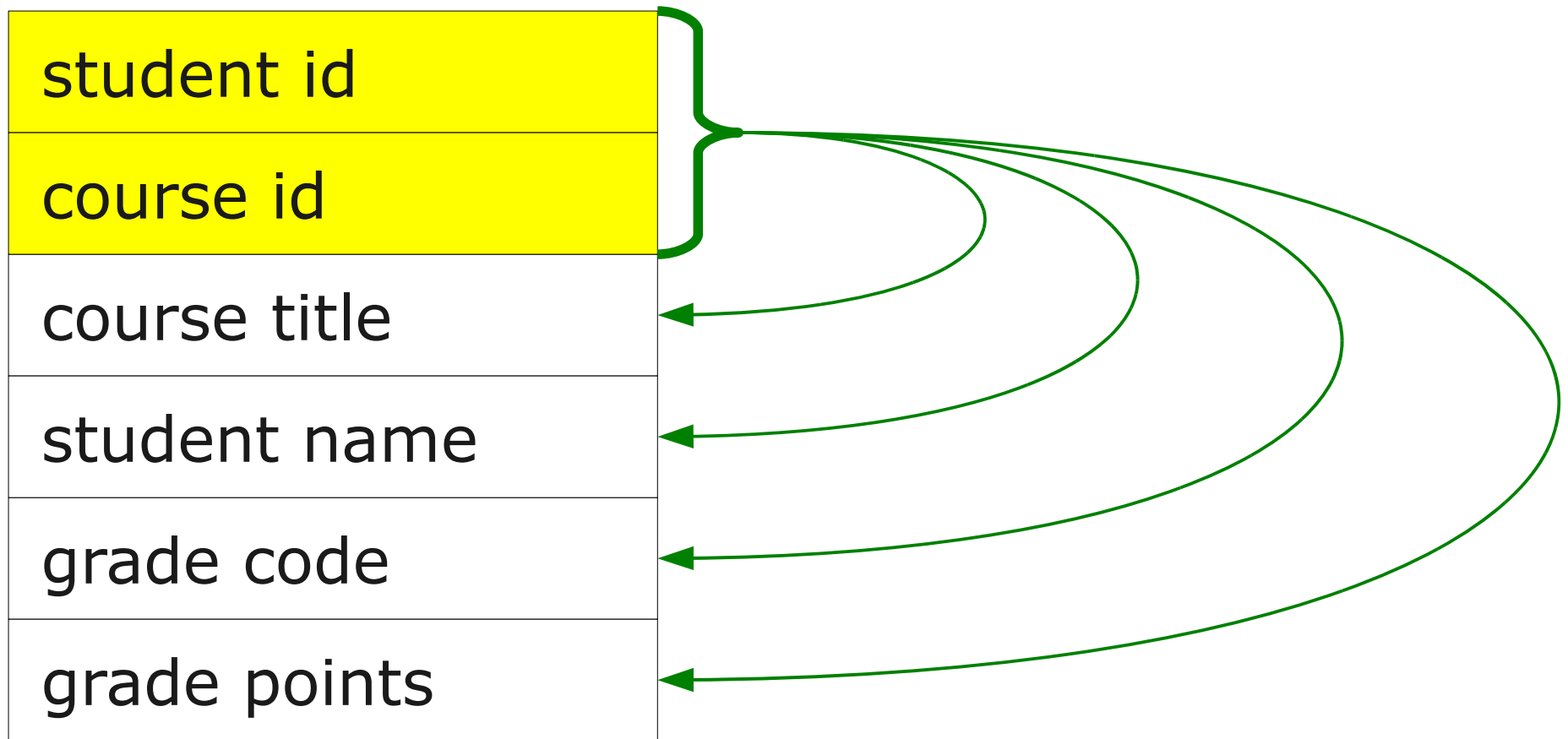
The Right Solution

pet_id	owner
1	Bob
2	Gwen

pet_id	names
1	Slim
1	the Serpent
1	Ribbon
2	Fluffy
2	Big Dog

2NF and 3NF

Getting rid of
“functional dependencies”

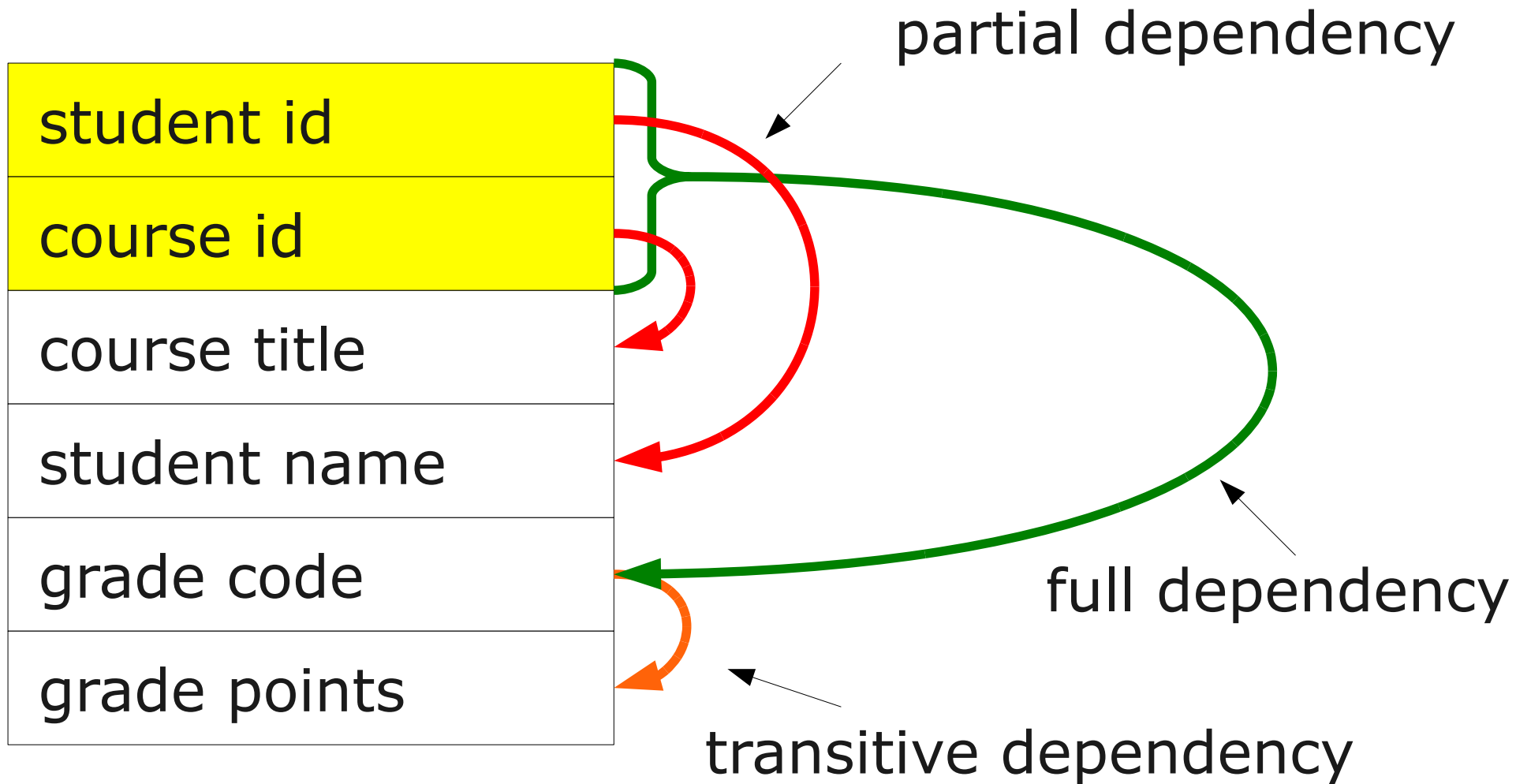


“Each attribute must describe the key,
the whole key, and nothing but the key.”

“So help me Codd!”

student id
course id
course title
student name
grade code
grade points

“Each attribute must describe the key...”



“Each attribute must describe the key,
the whole key, and nothing but the key.”

“So help me Codd!”

2NF and 3NF

2NF:

no partial dependencies
("the whole key")

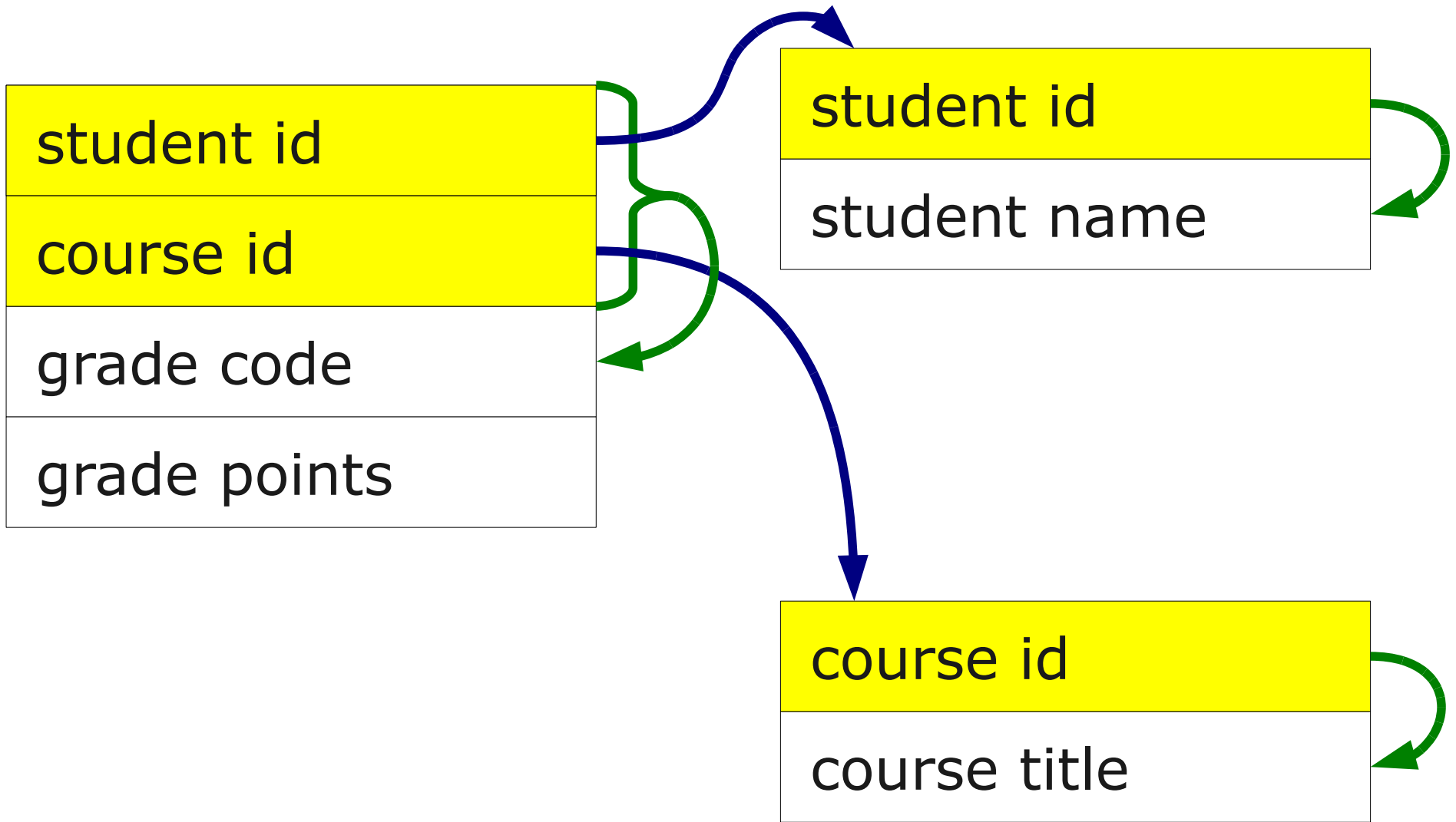
3NF:

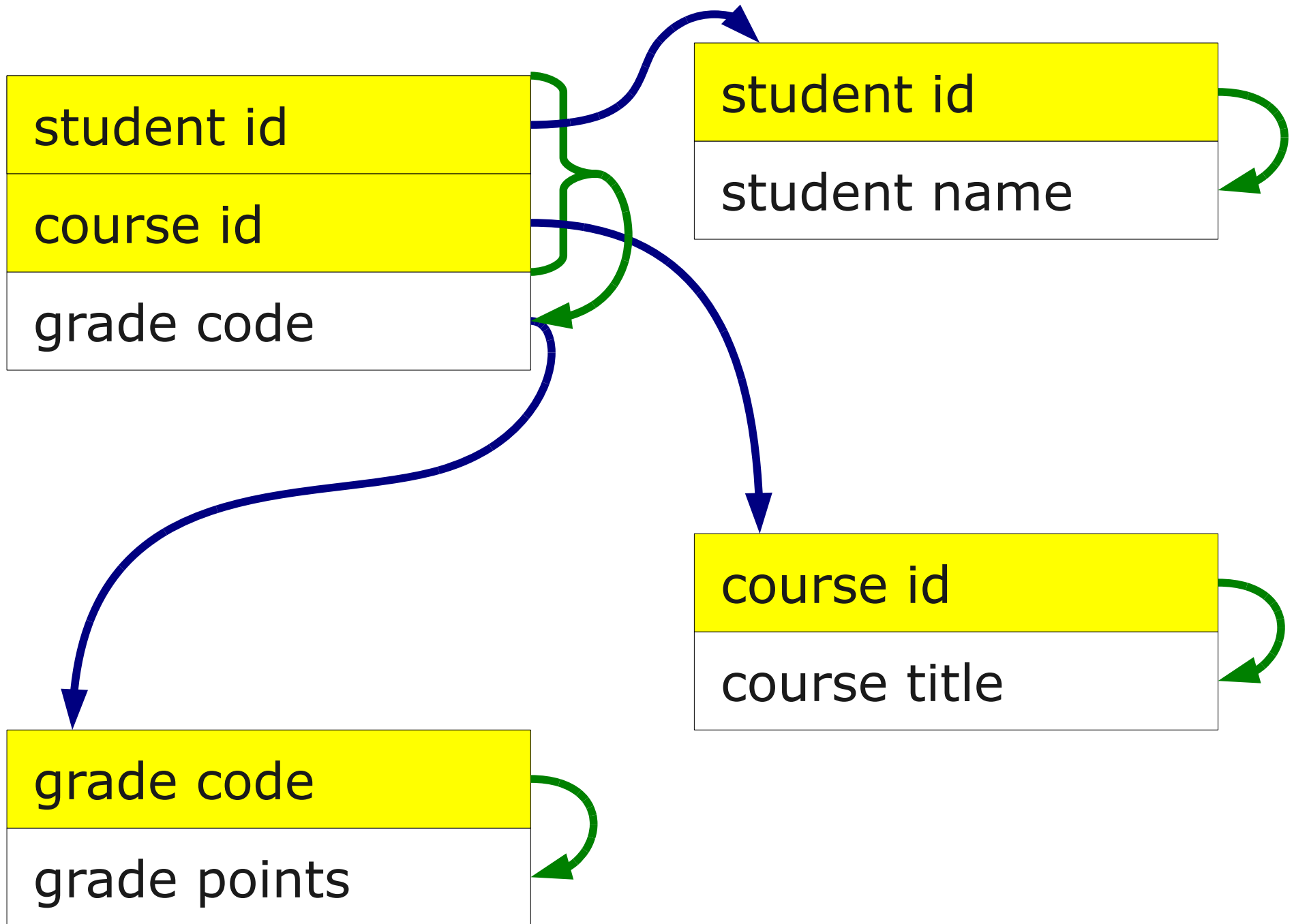
2NF + no transitive dependencies
("nothing but the key")

Reaching 2NF and 3NF

Decomposition
(break up tables into several)

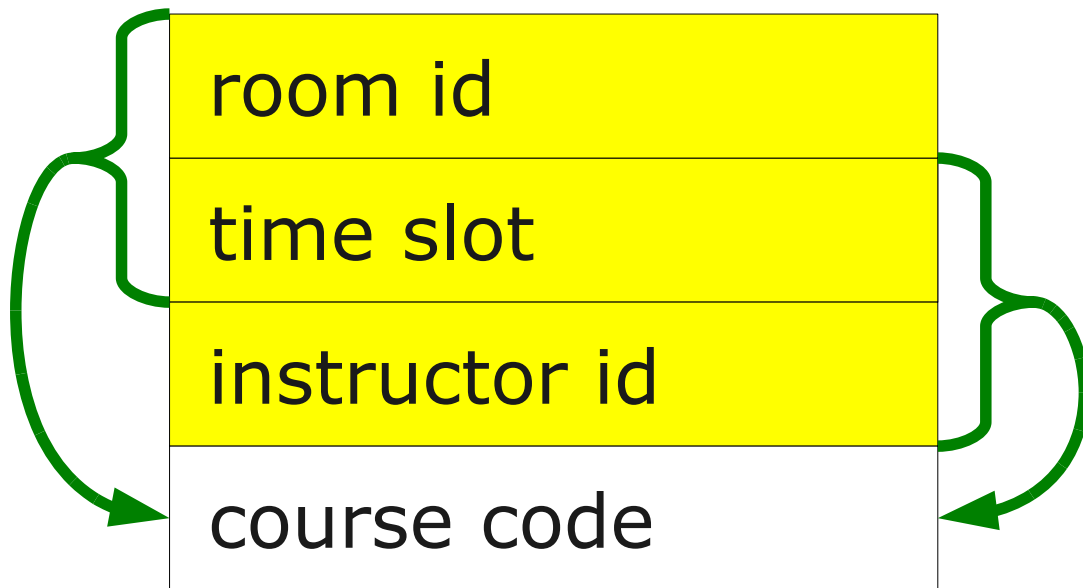
student id
course id
course title
student name
grade code
grade points



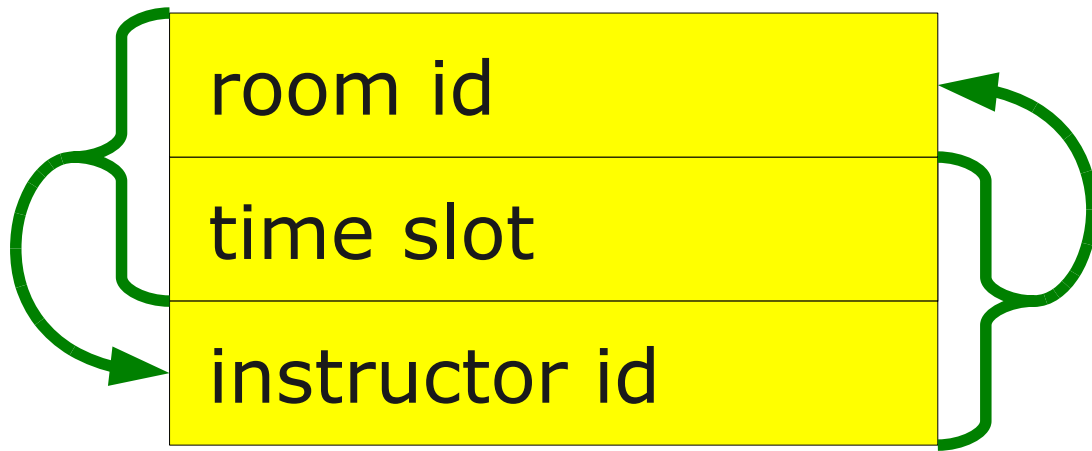


BCNF

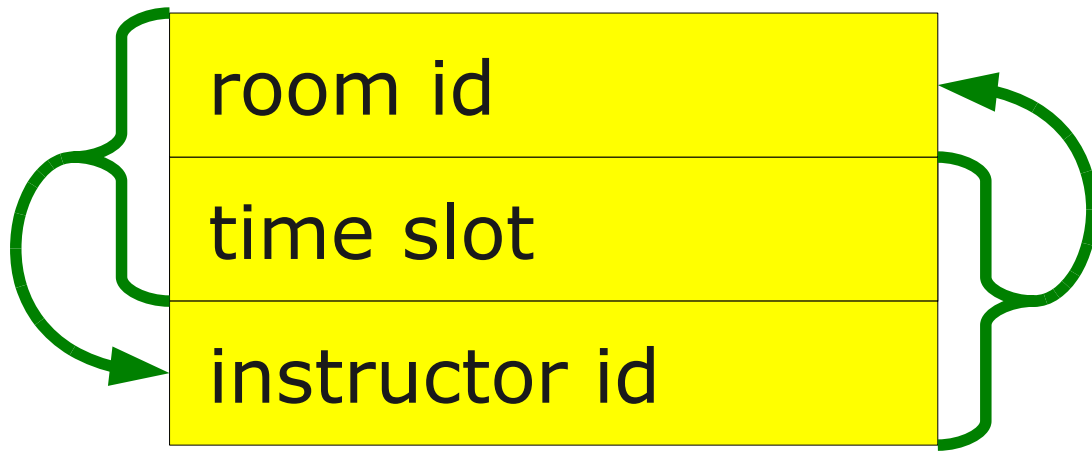
“all determinants must be candidate keys”



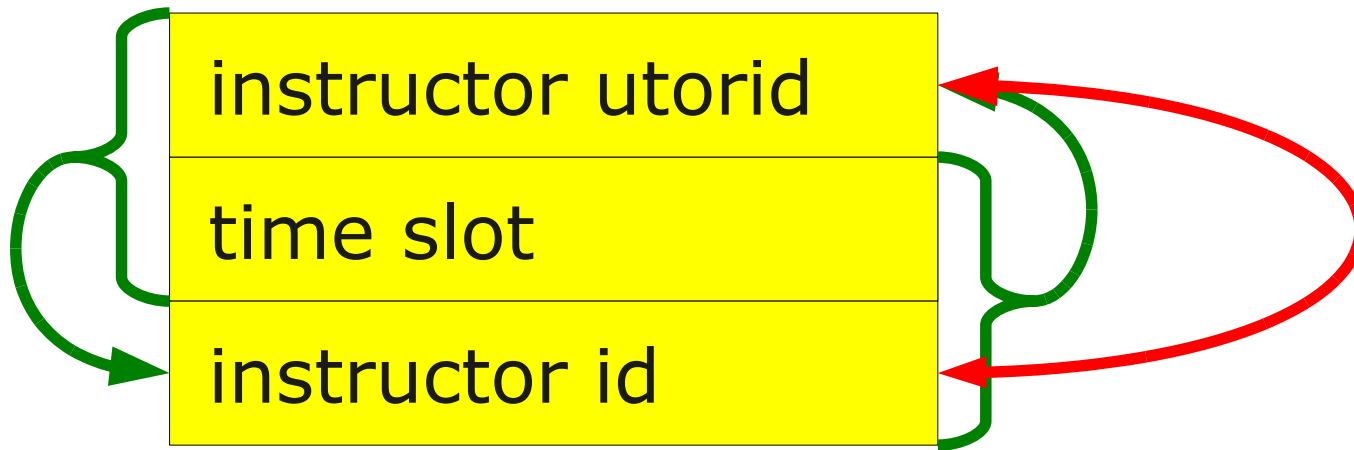
overlapping candidate keys



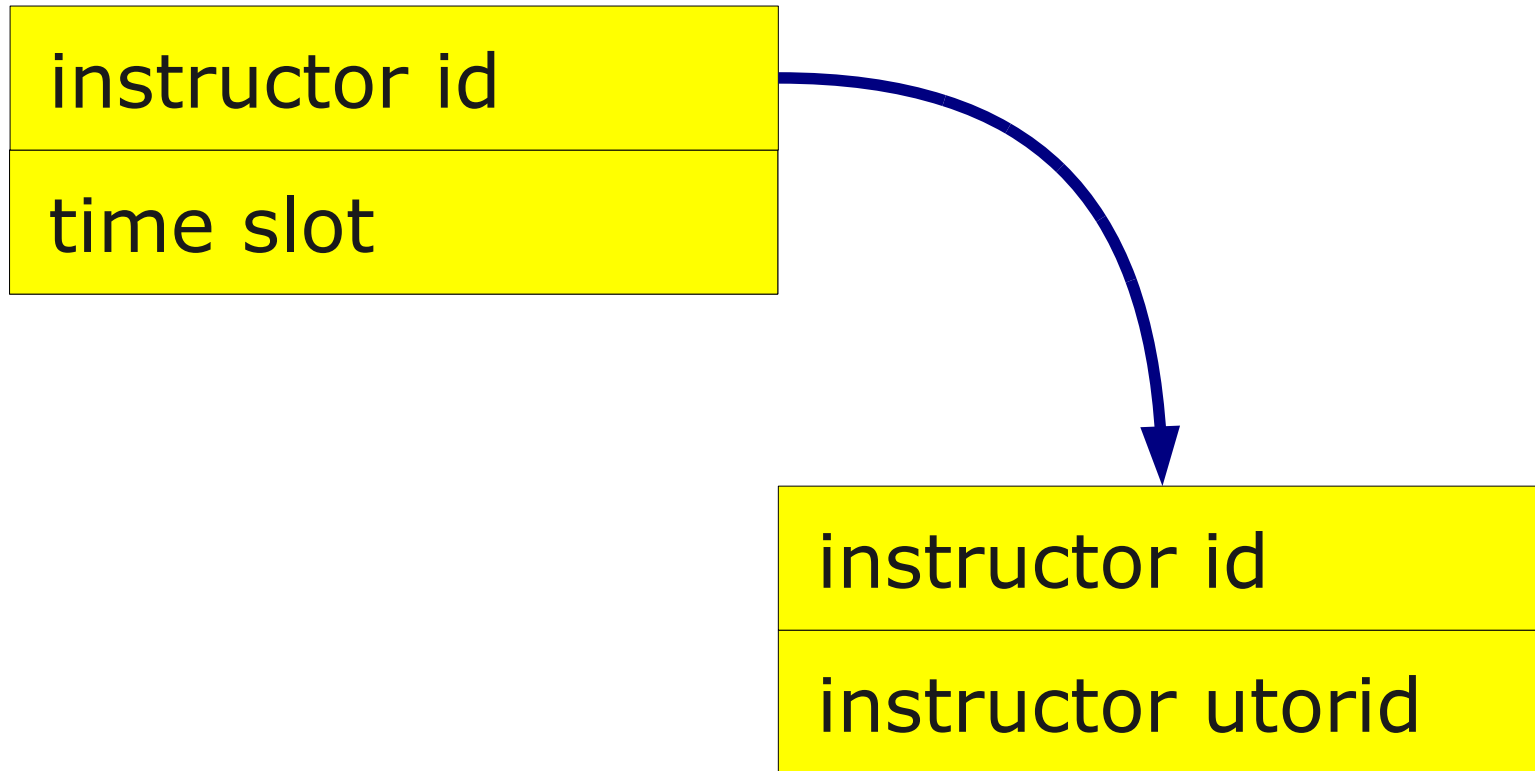
dependencies between keys



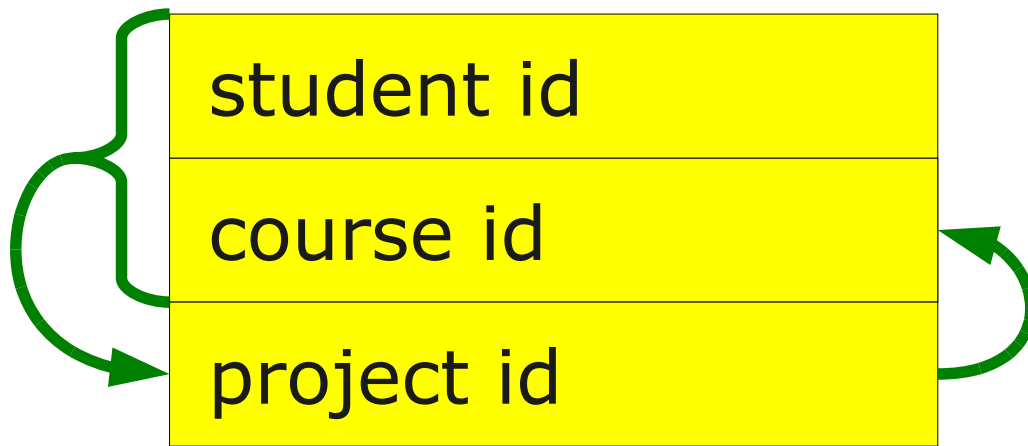
dependencies between keys



this is 3NF, but not BCNF
("so help me Codd")



decompose it

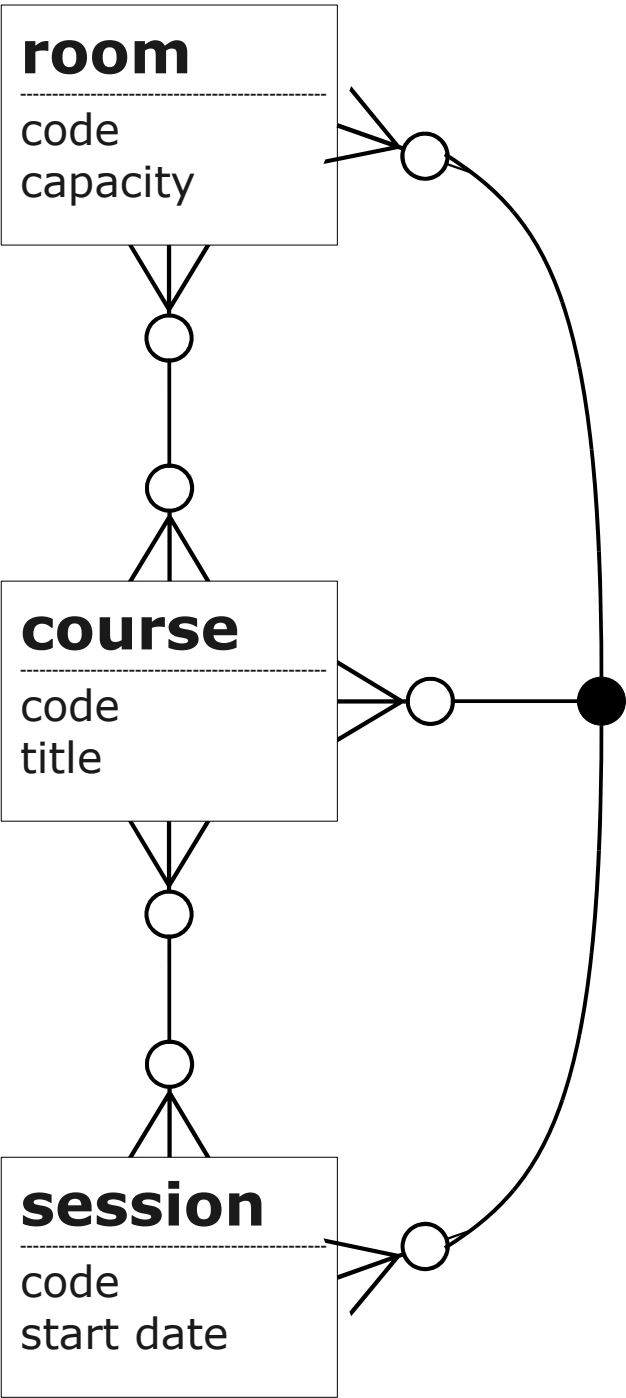


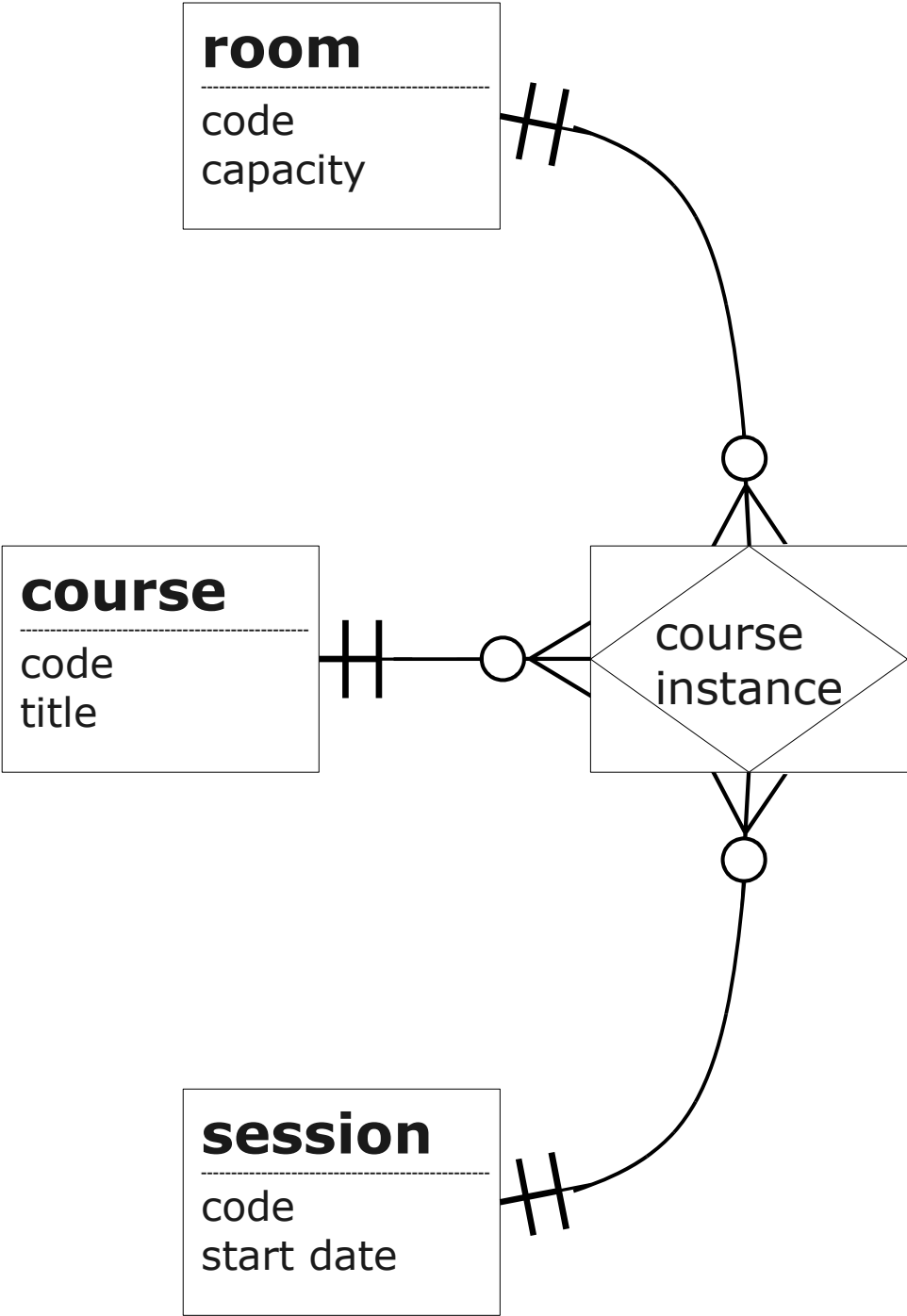
student, course \rightarrow project
project \rightarrow course

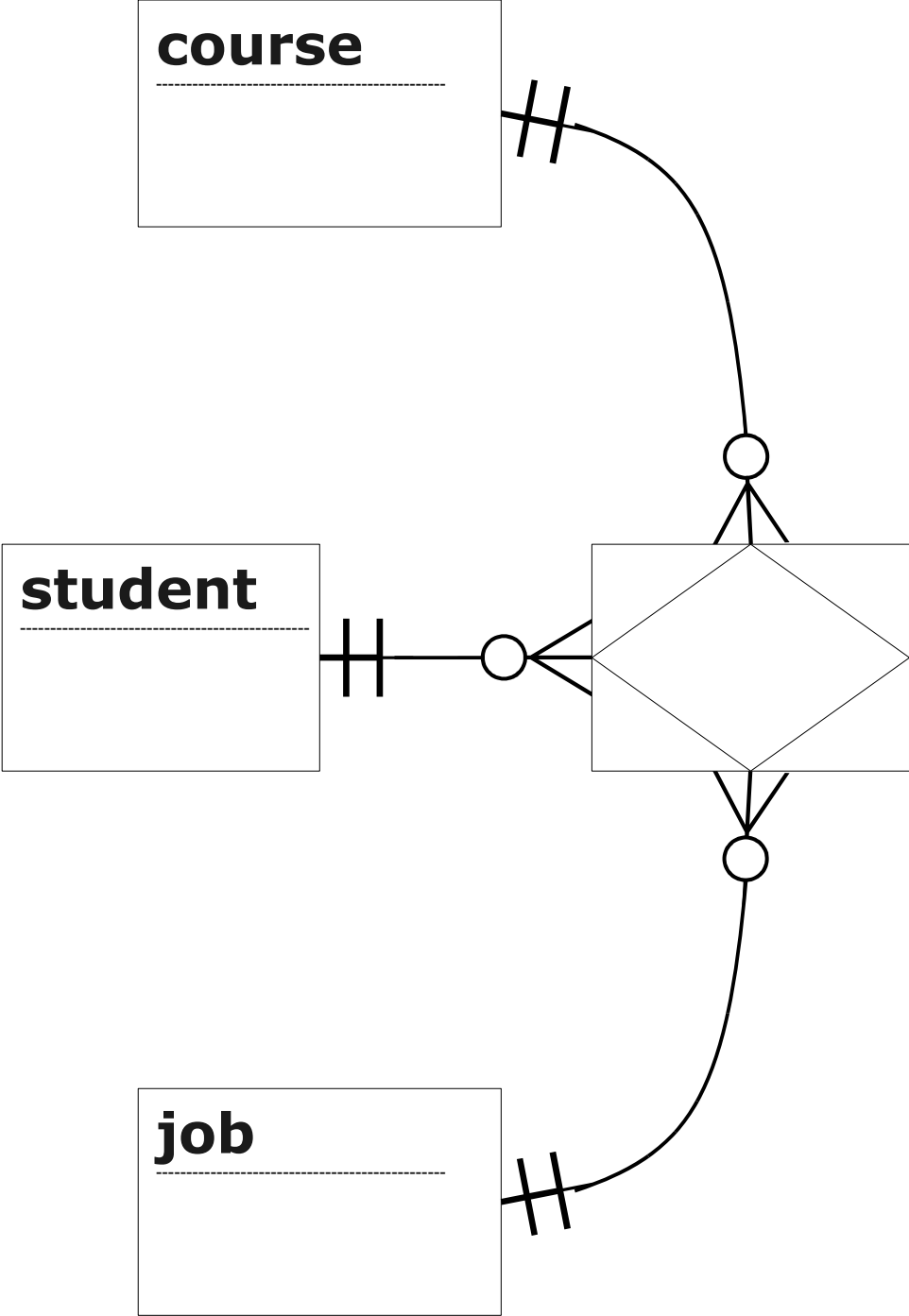
some relations cannot be
decomposed into BCNF
("so help me Codd")

4NF

Mistaking binary relationships
for ternary







5NF

“We could break it up yet more”

Questions?