INF1343, Week 5

Translating ER into Relations; Normalization

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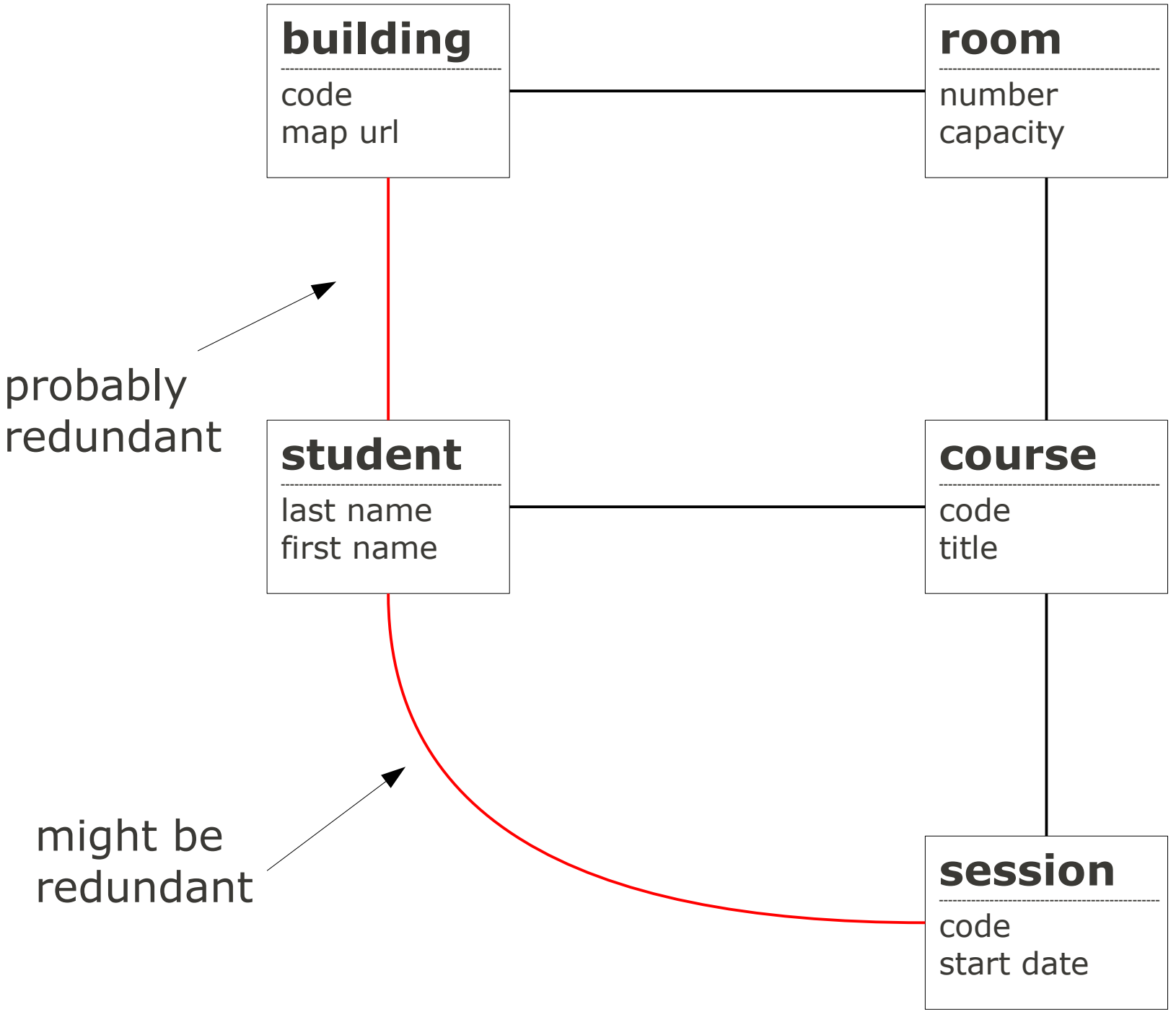
University of Toronto
January 31, 2011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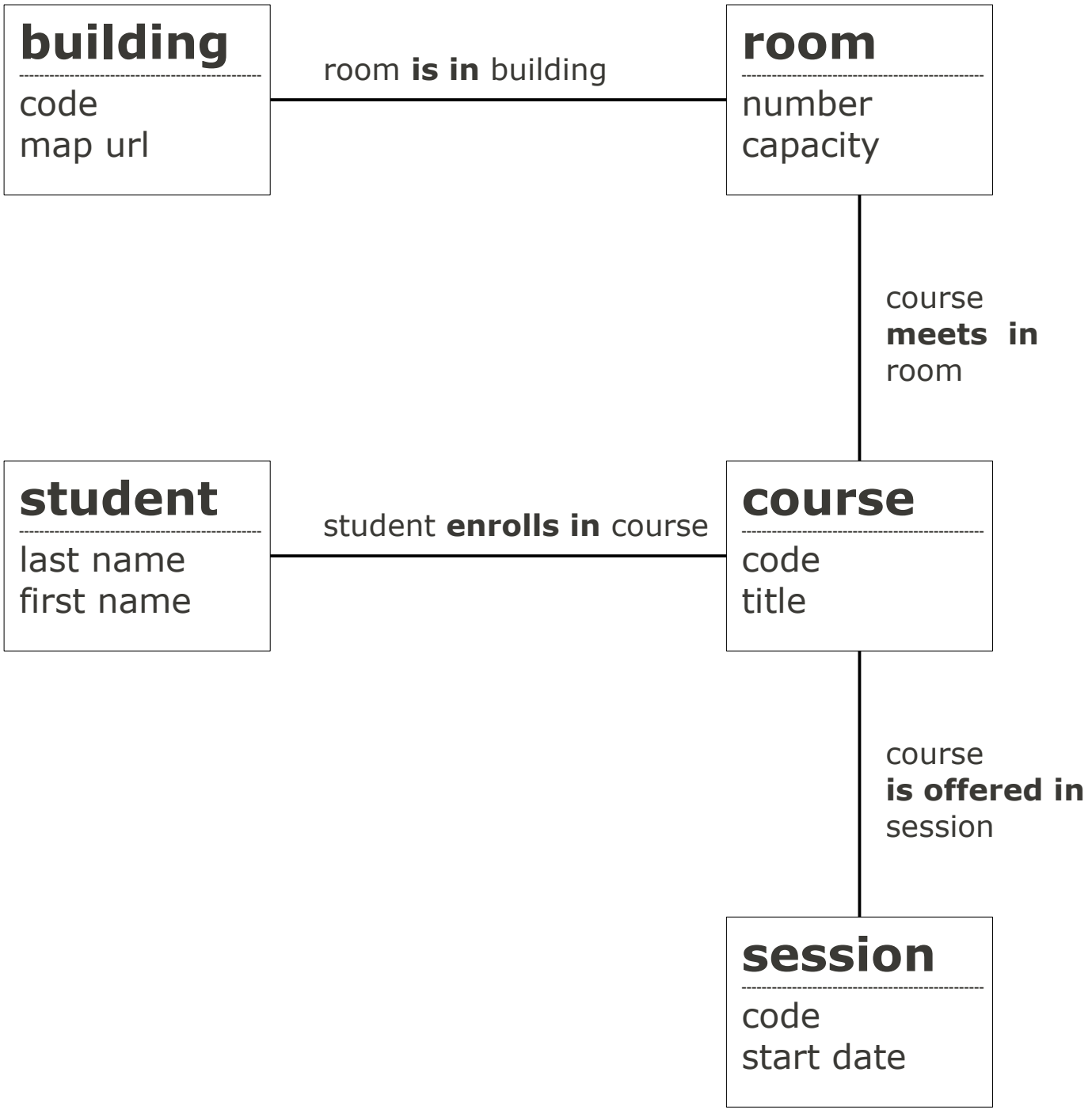
start date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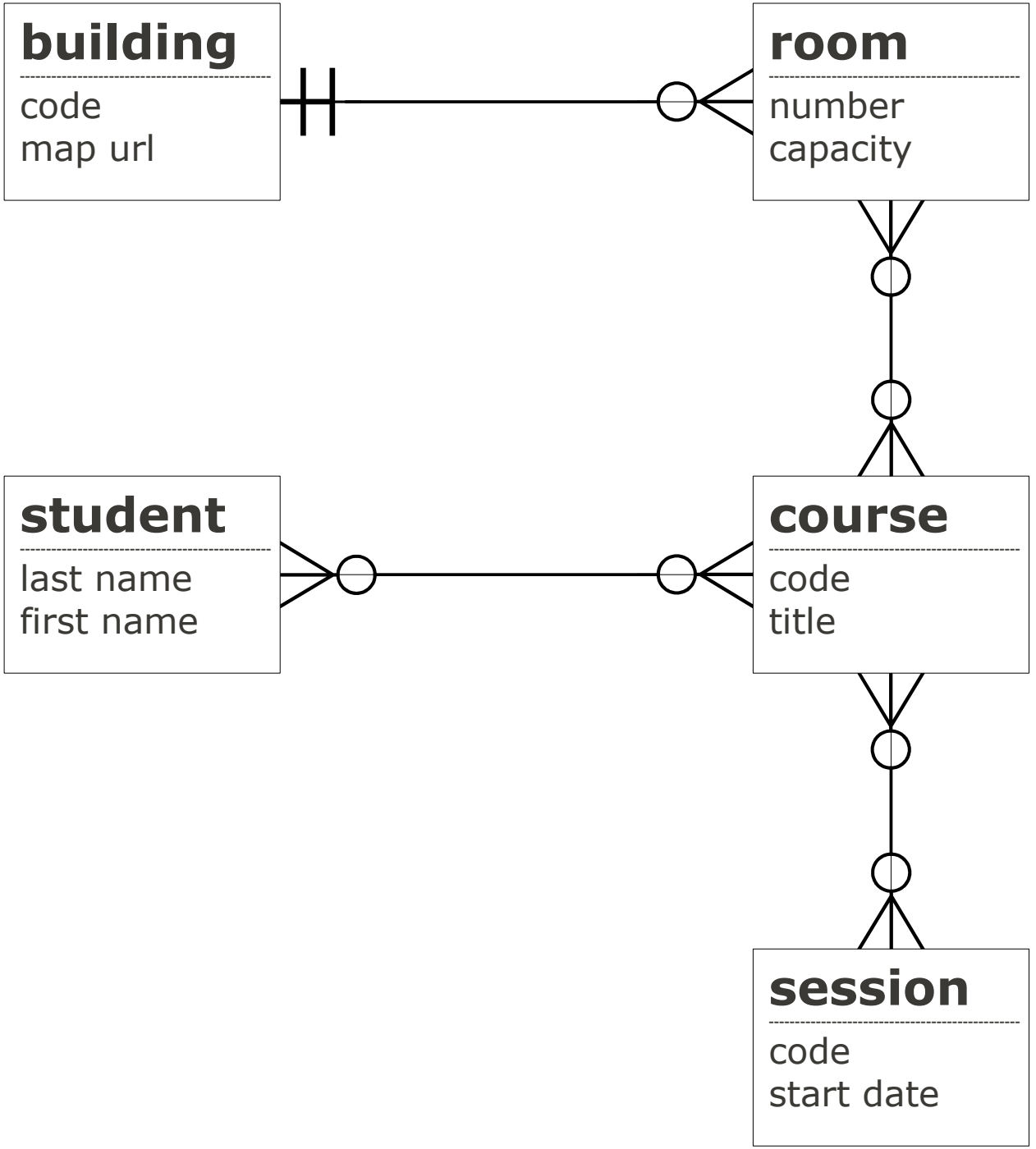
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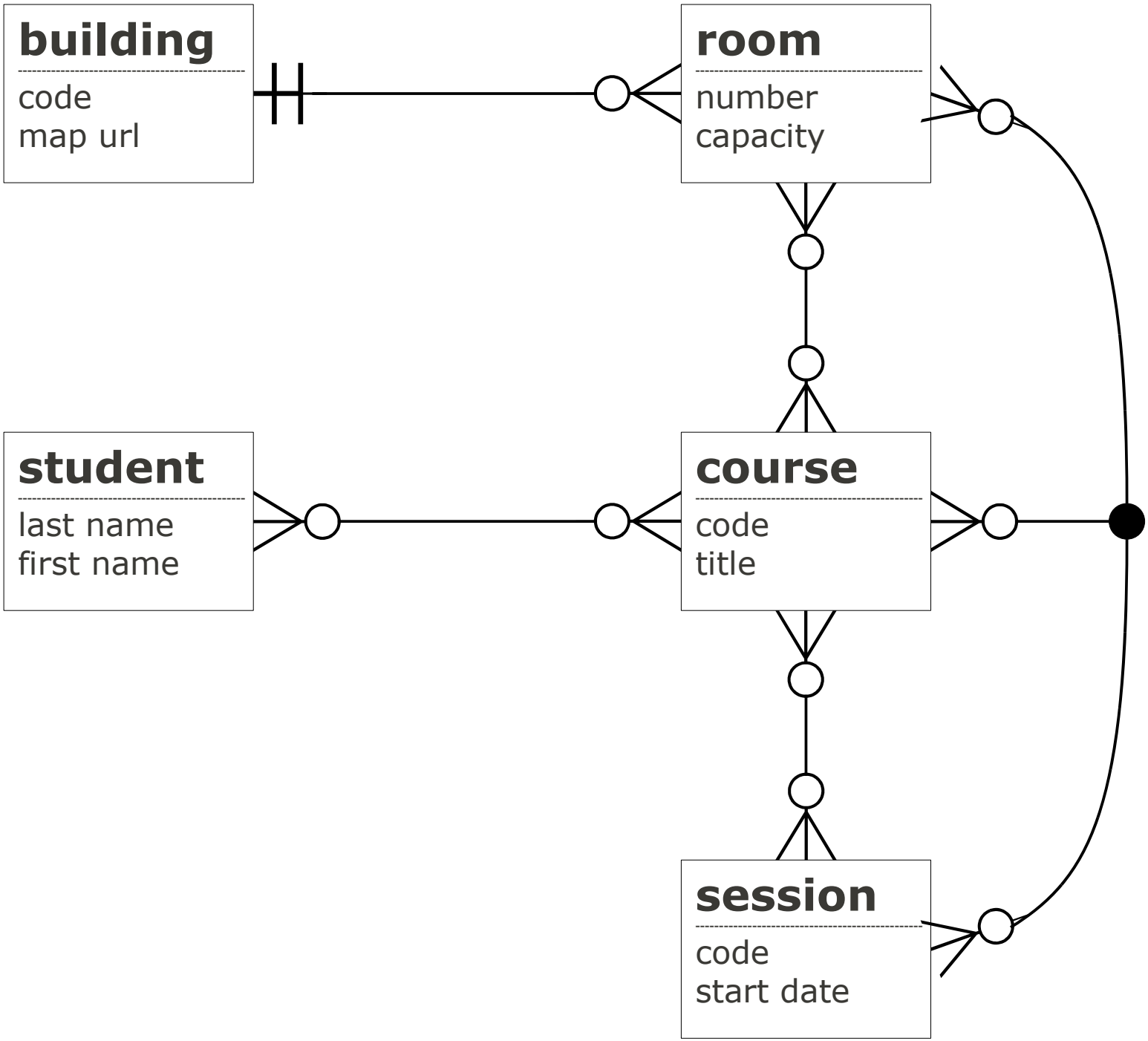
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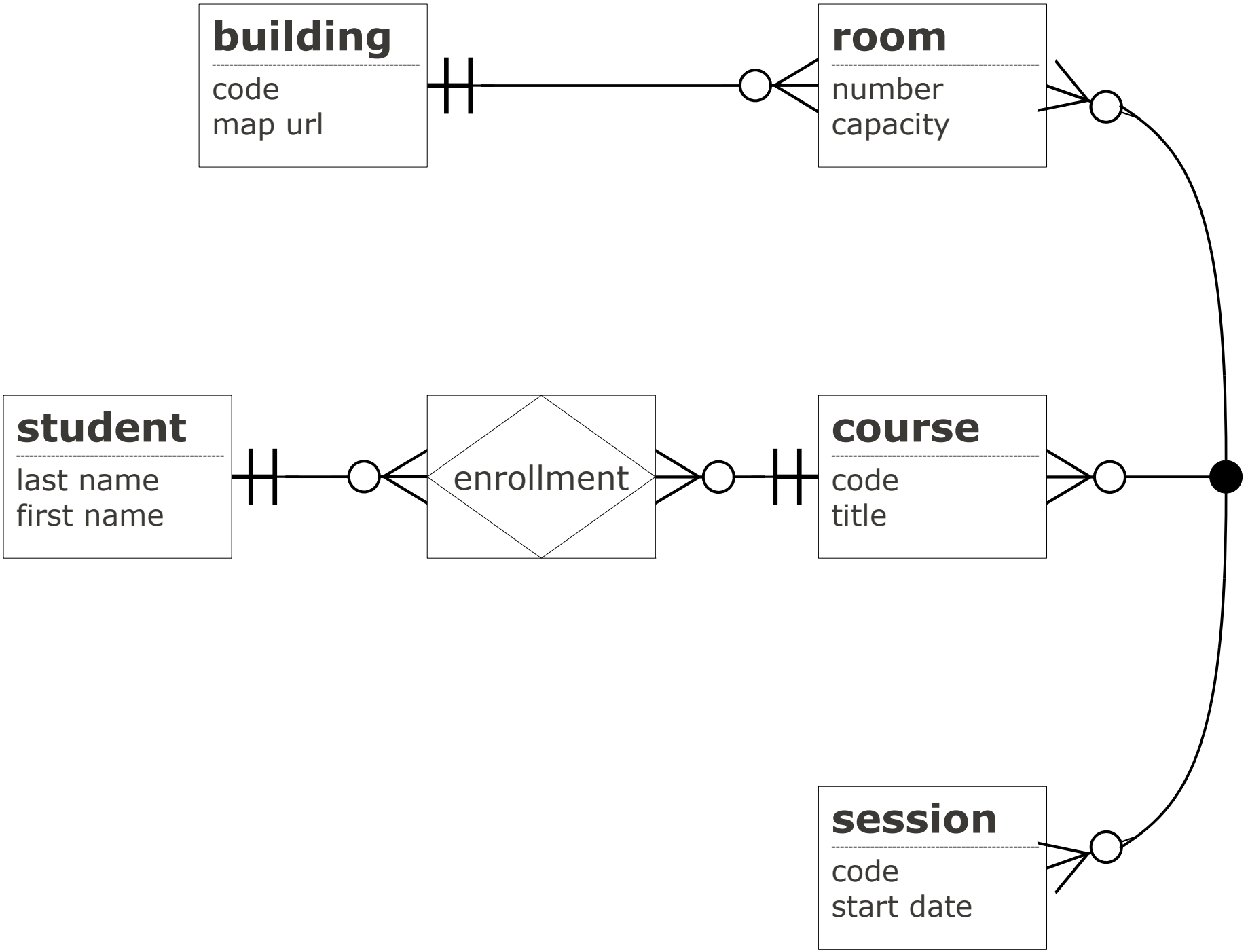
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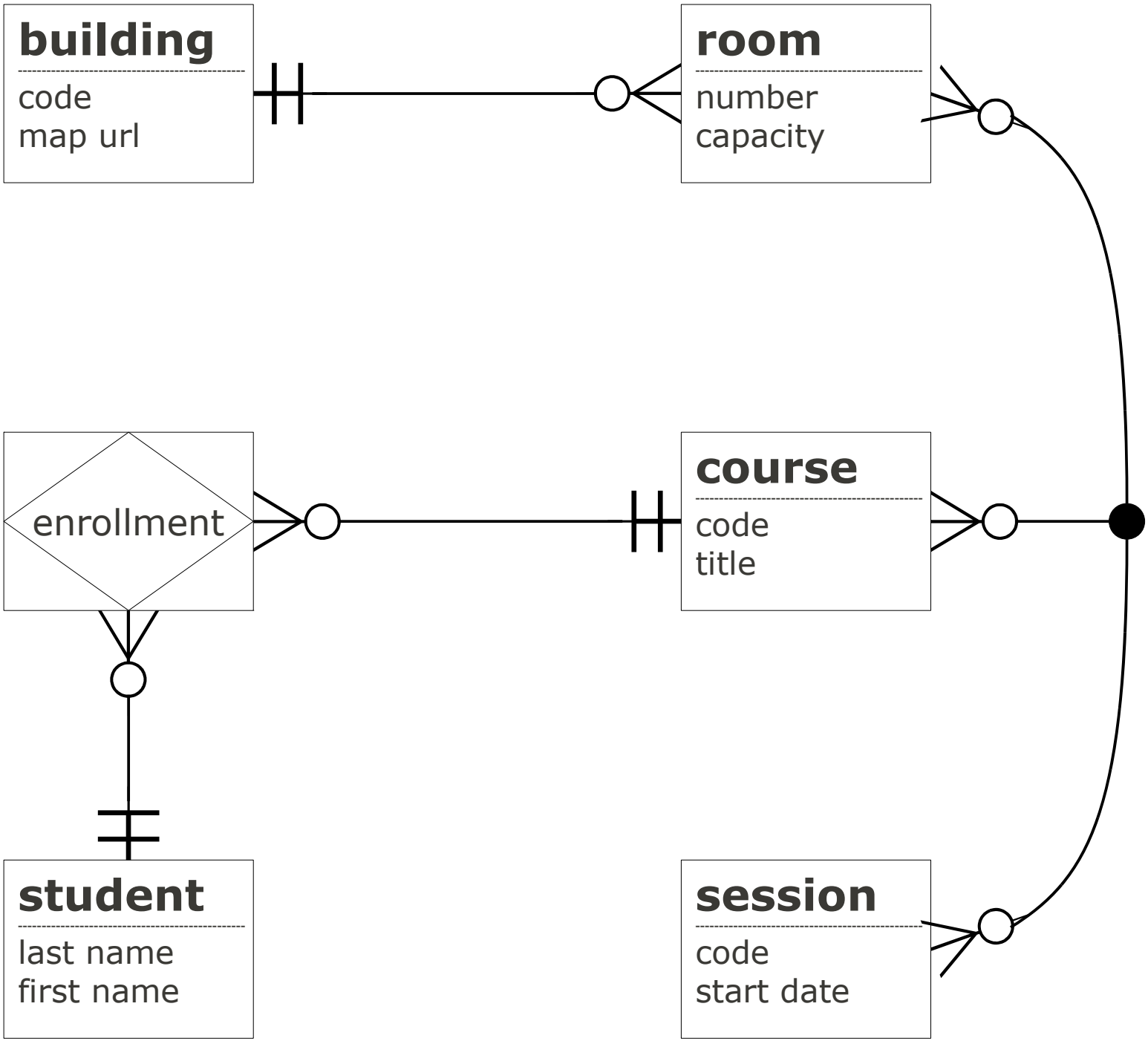
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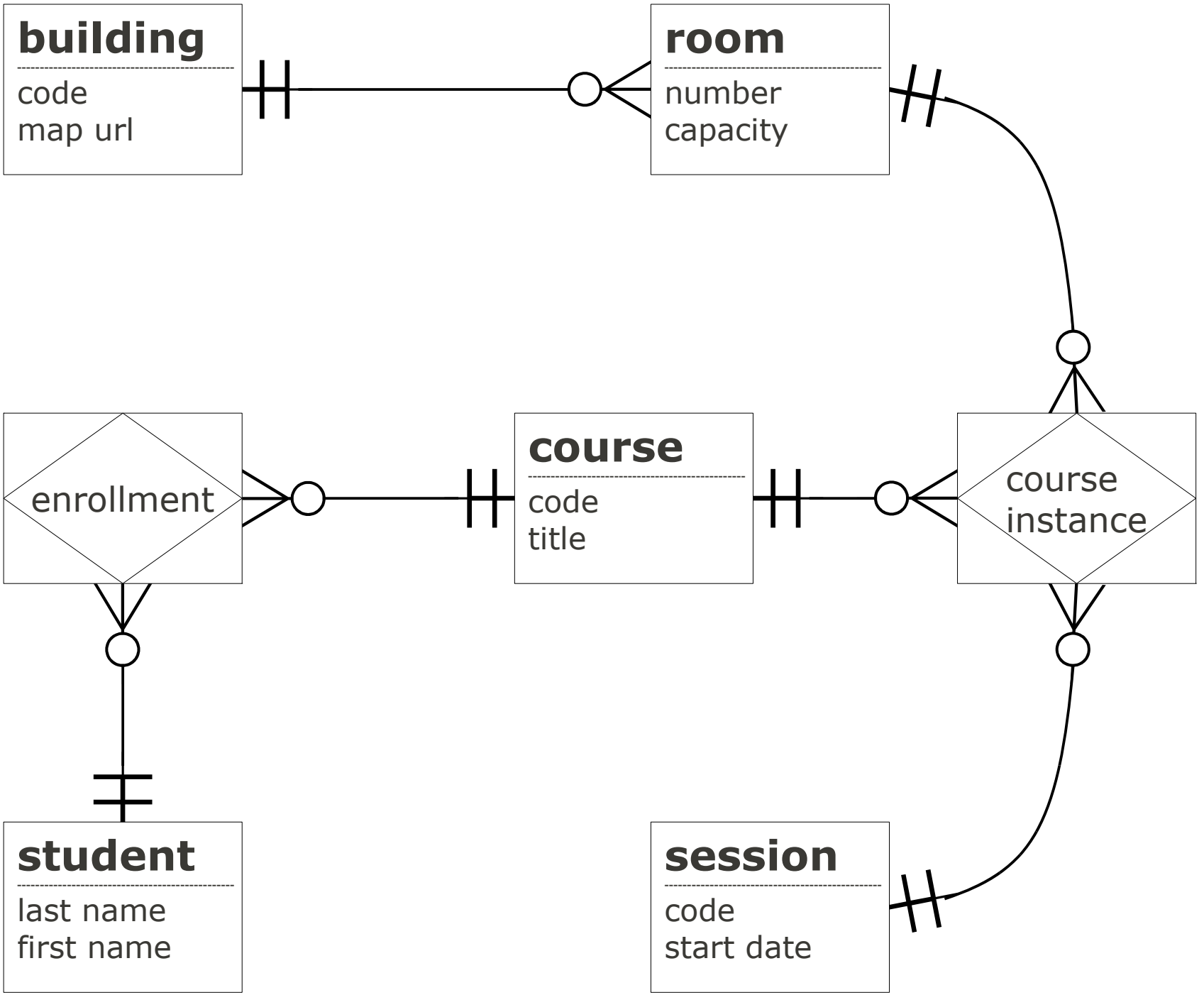
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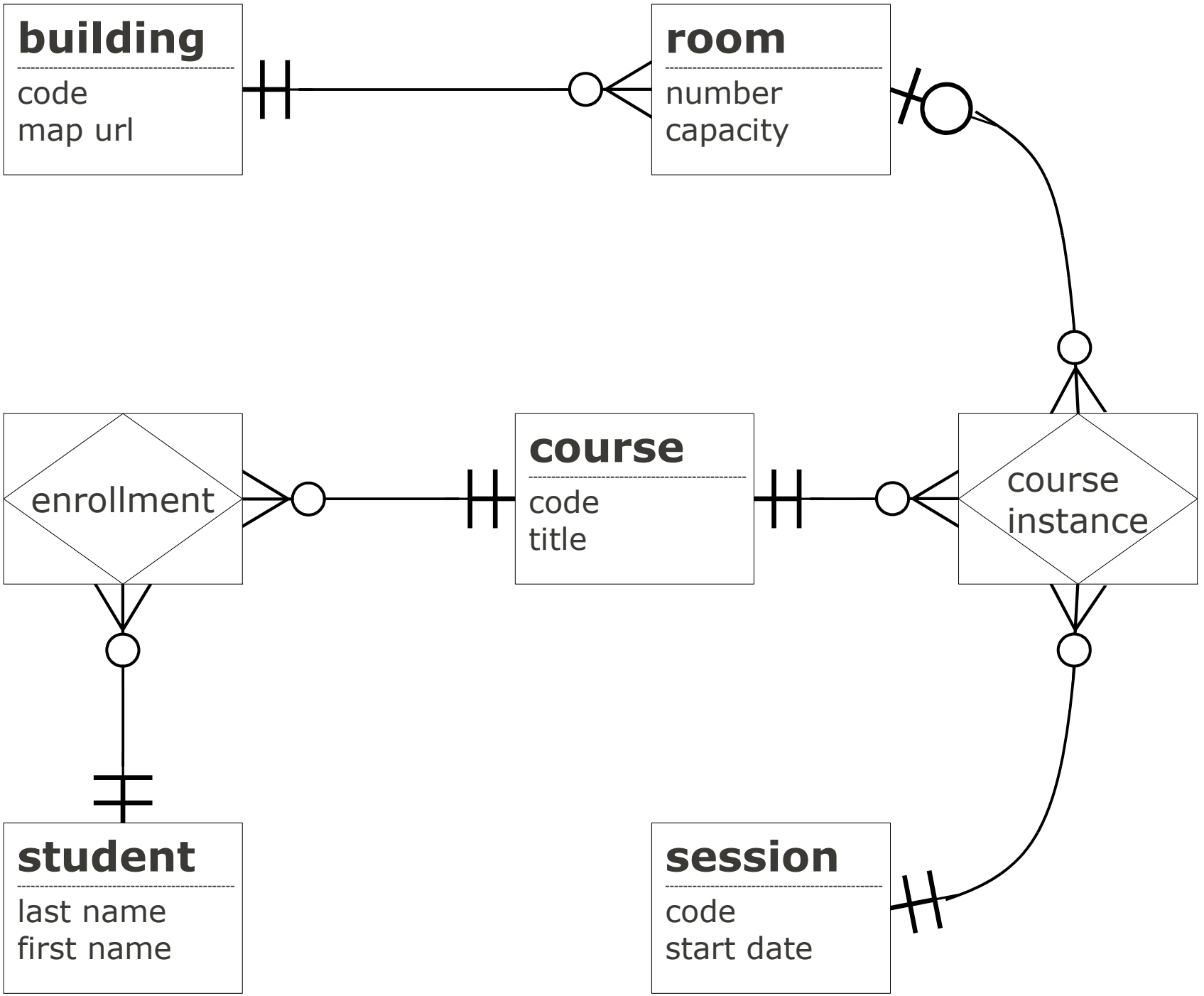
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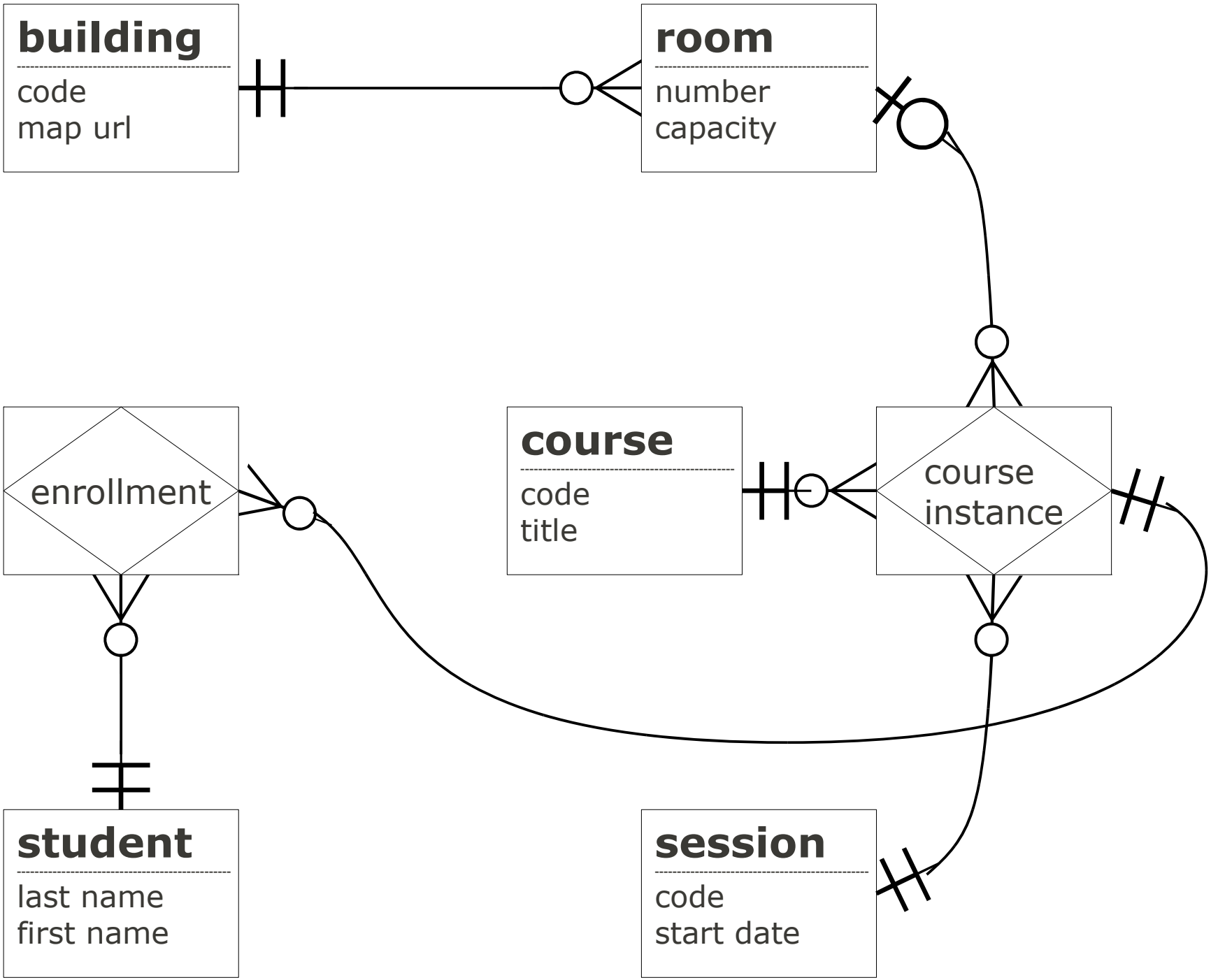
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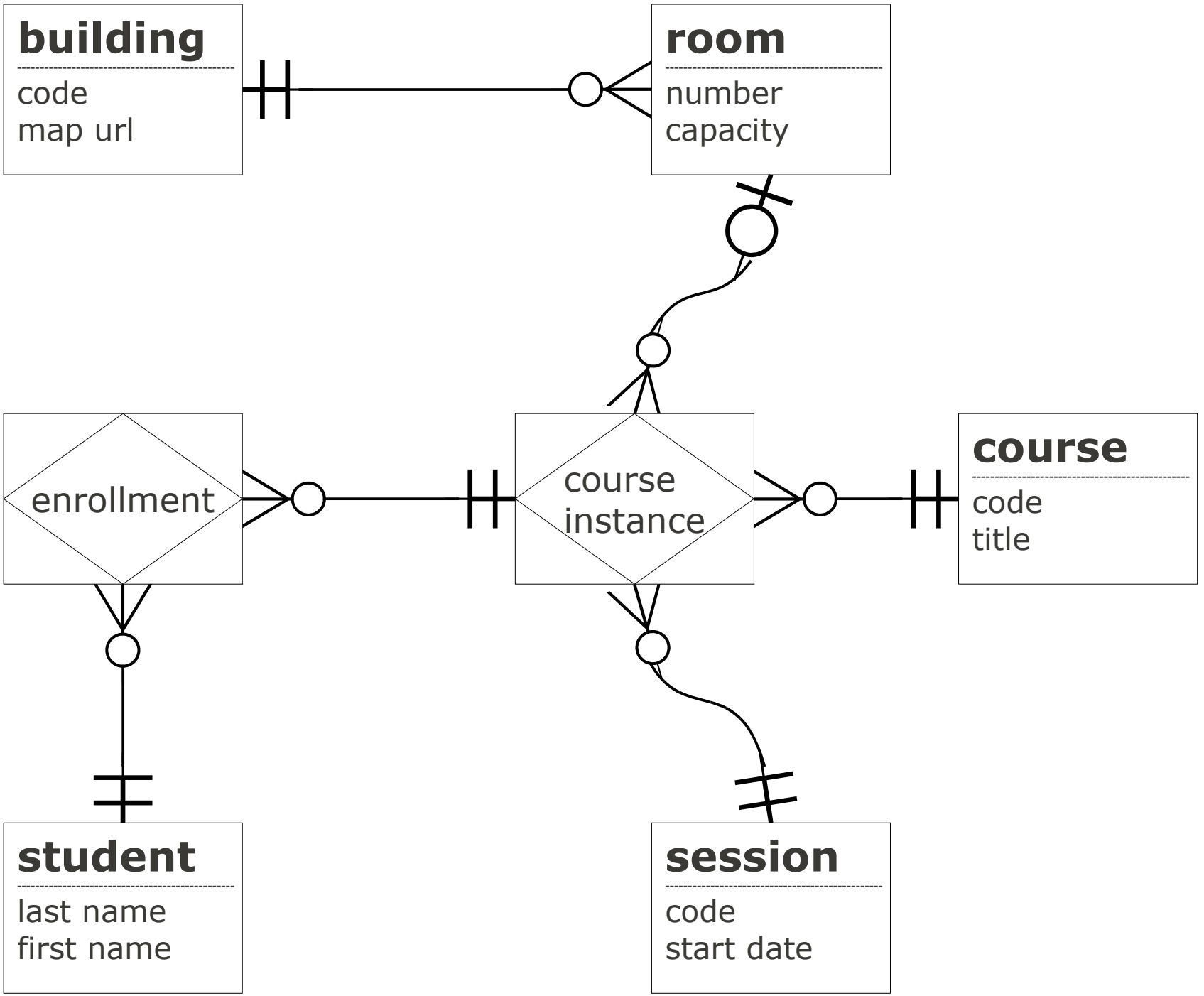
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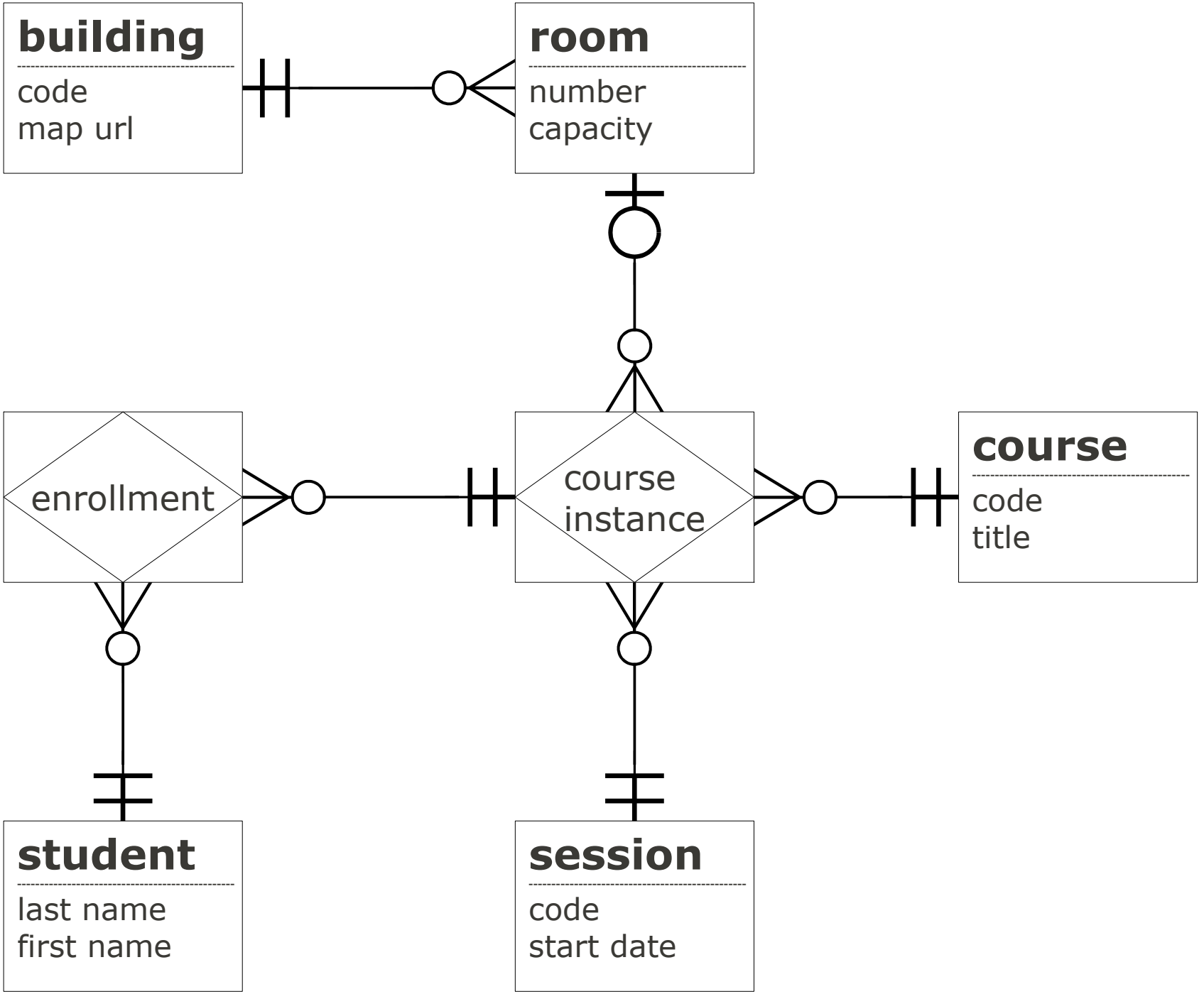
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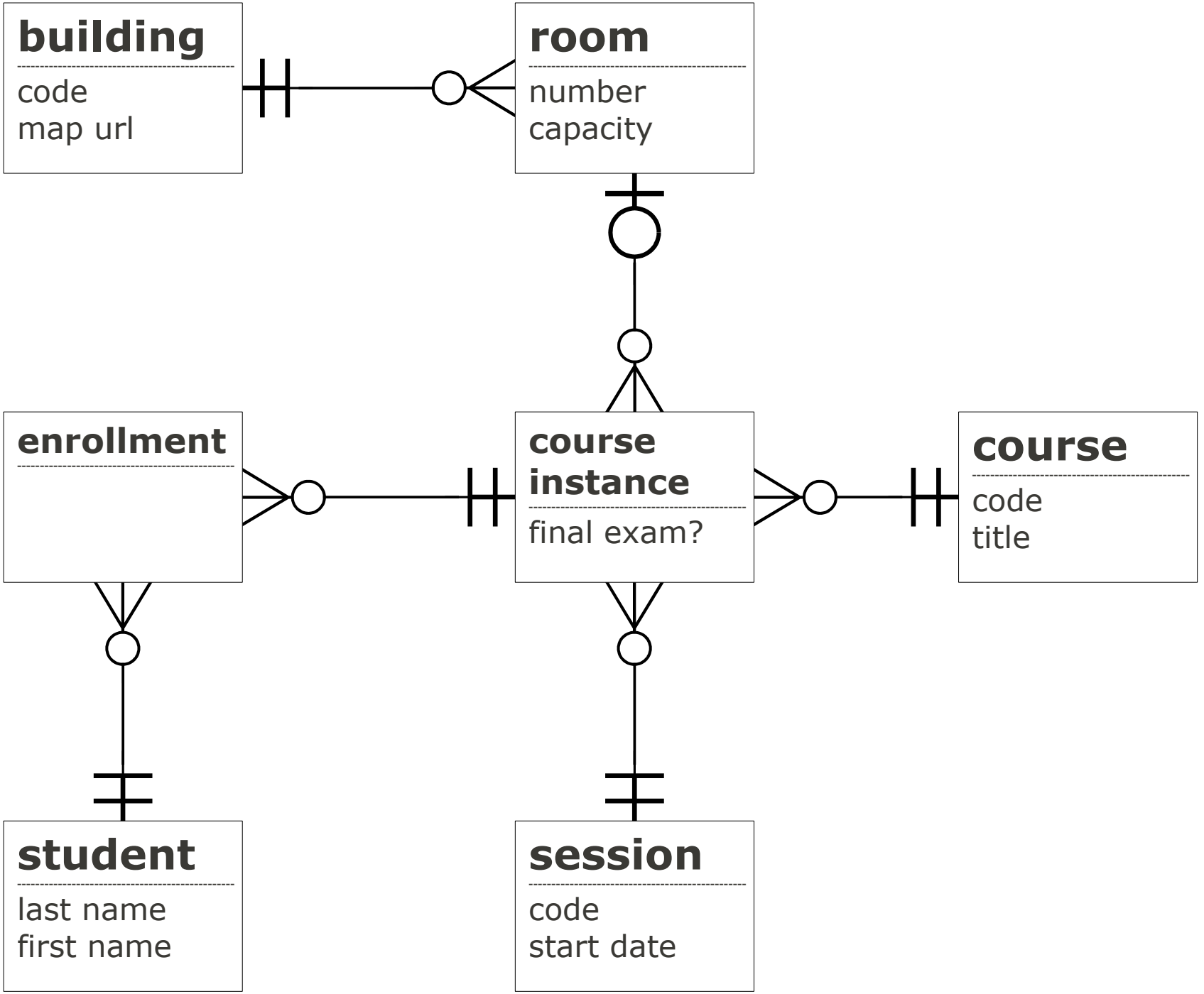
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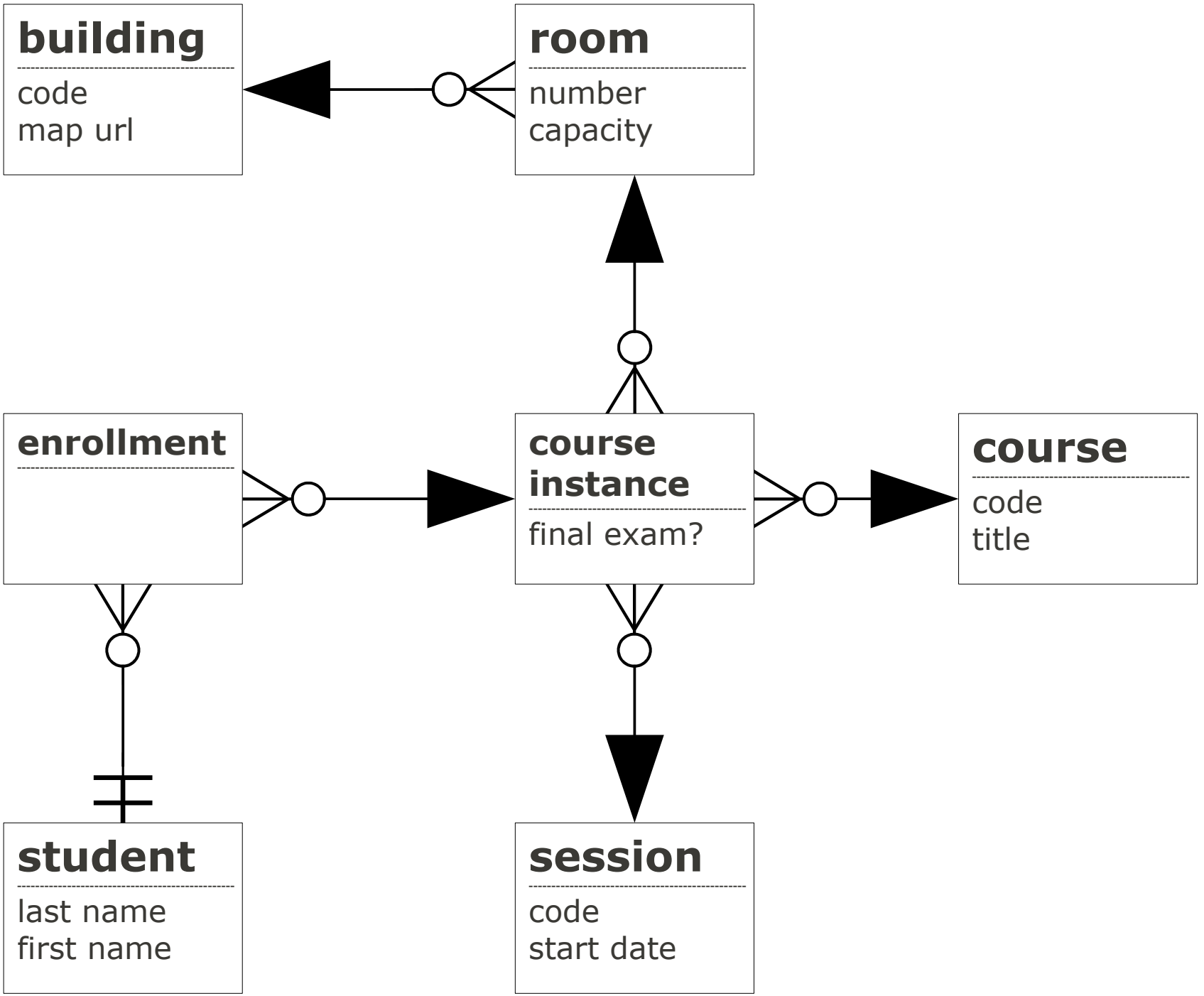
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course instance
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start date

ER for M

ER to Relations

Entities:

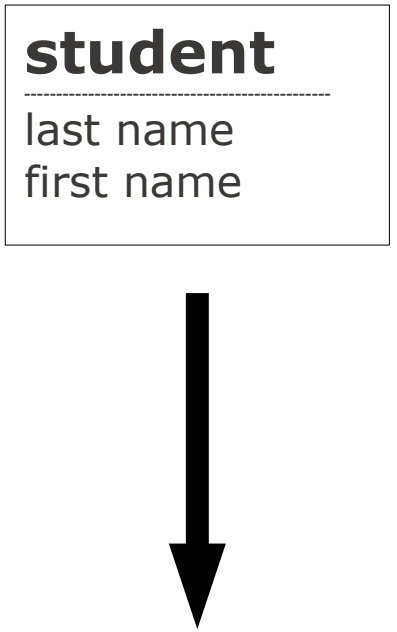
→ tables

1:M relationships:

→ primary and foreign keys

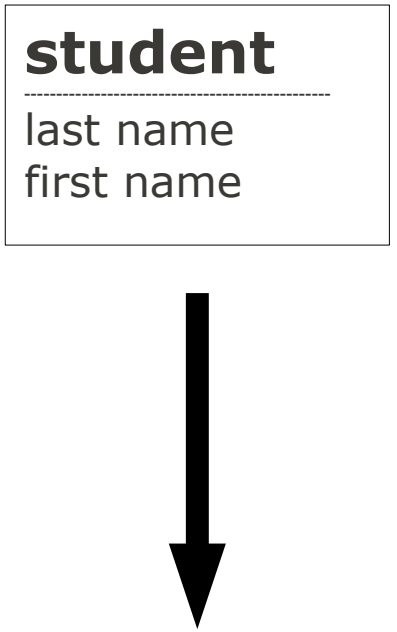
Step 1

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



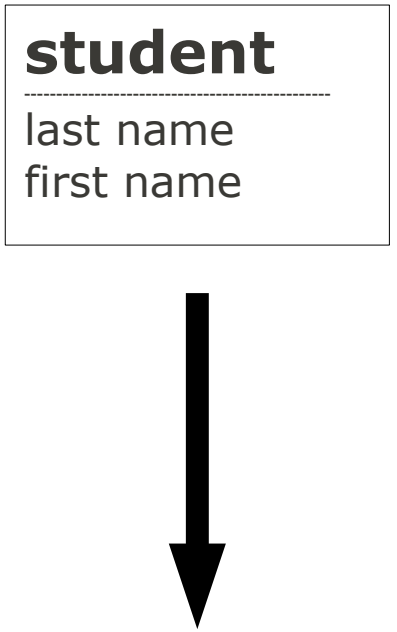
student

first_name	last_name



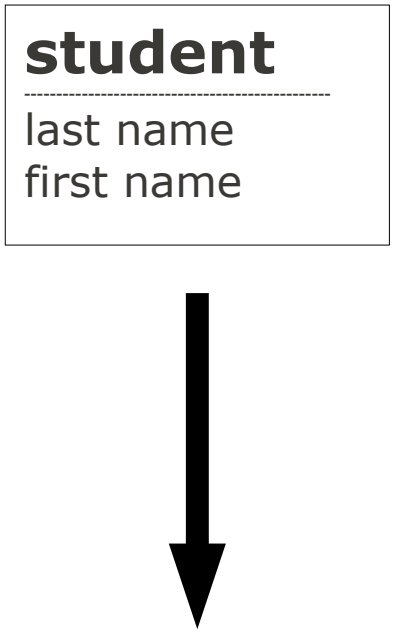
student

name	domain
last_name	
first_name	



student

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



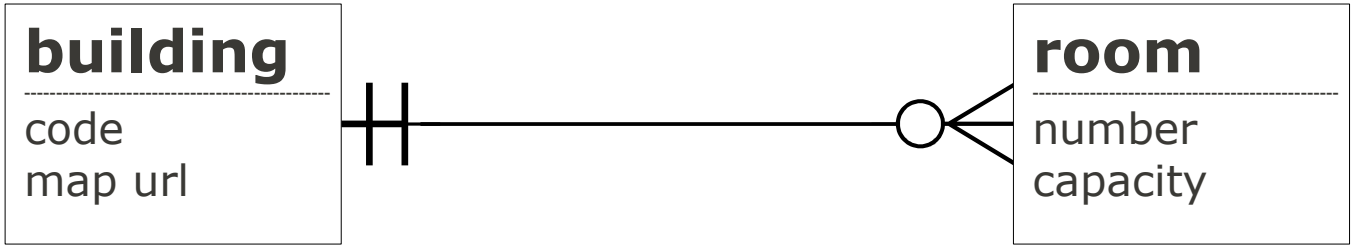
student

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

(do this for every entity)

Steps 2-4

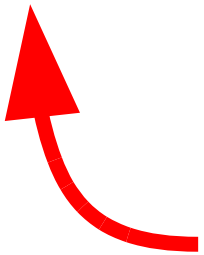
Creating primary and foreign keys to represent relationships



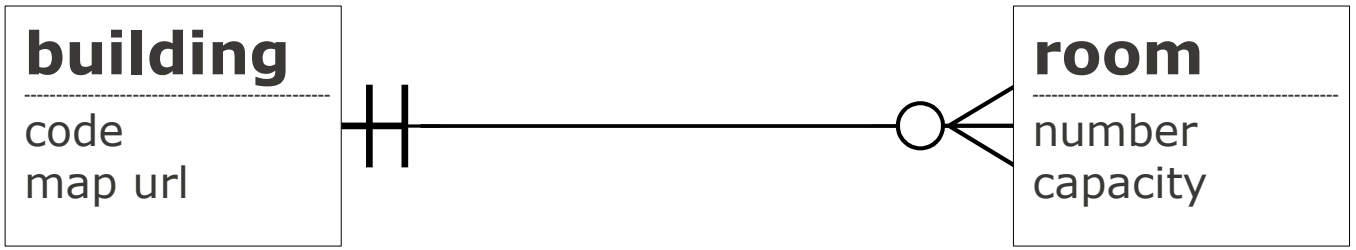
building

name	domain	NULL
code	varchar(100)	NO
map_url	varchar(100)	YES

room



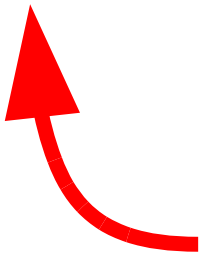
name	domain	NULL
number	integer	NO
capacity	integer	YES



building

name	domain	NULL
code	varchar(100)	NO
map_url	varchar(100)	YES

room



name	domain	NULL
number	integer	NO
capacity	integer	YES
building_???		

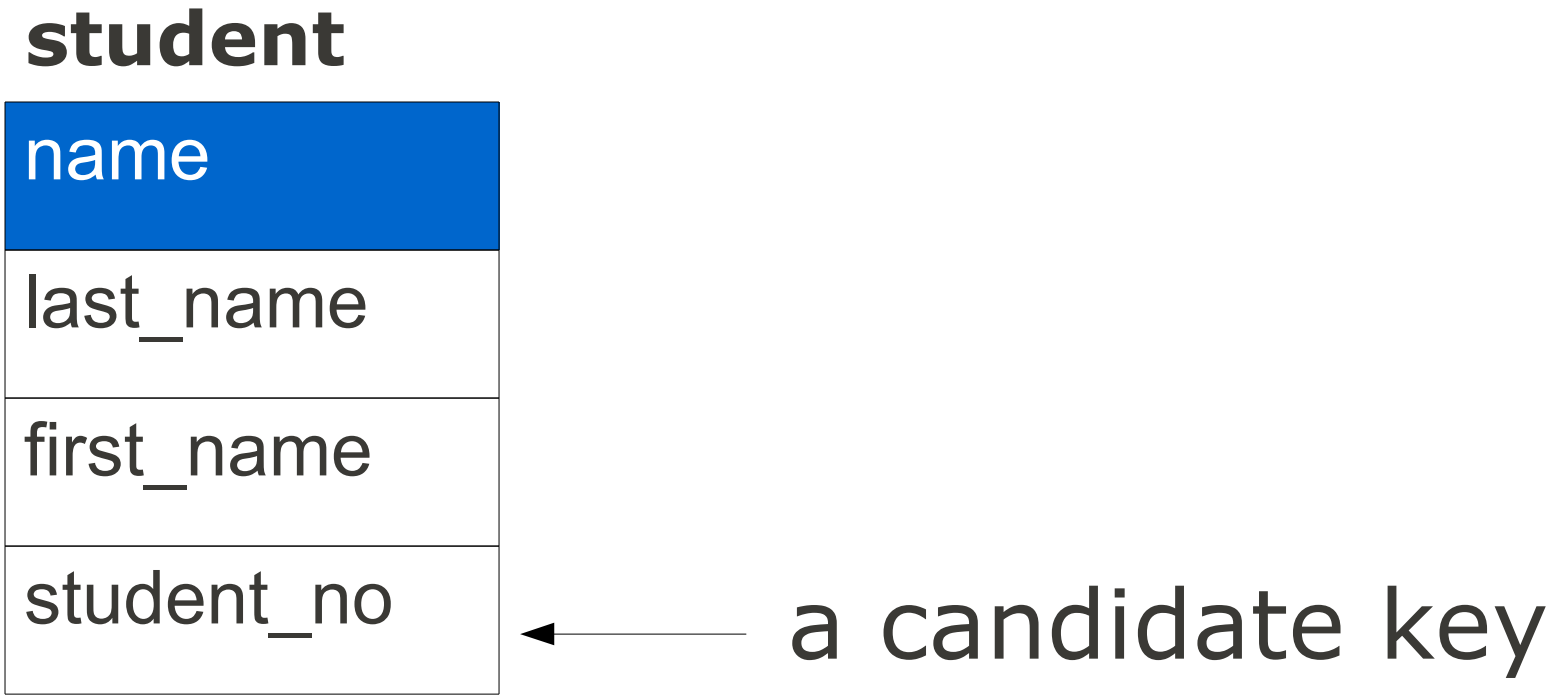
Keys

student

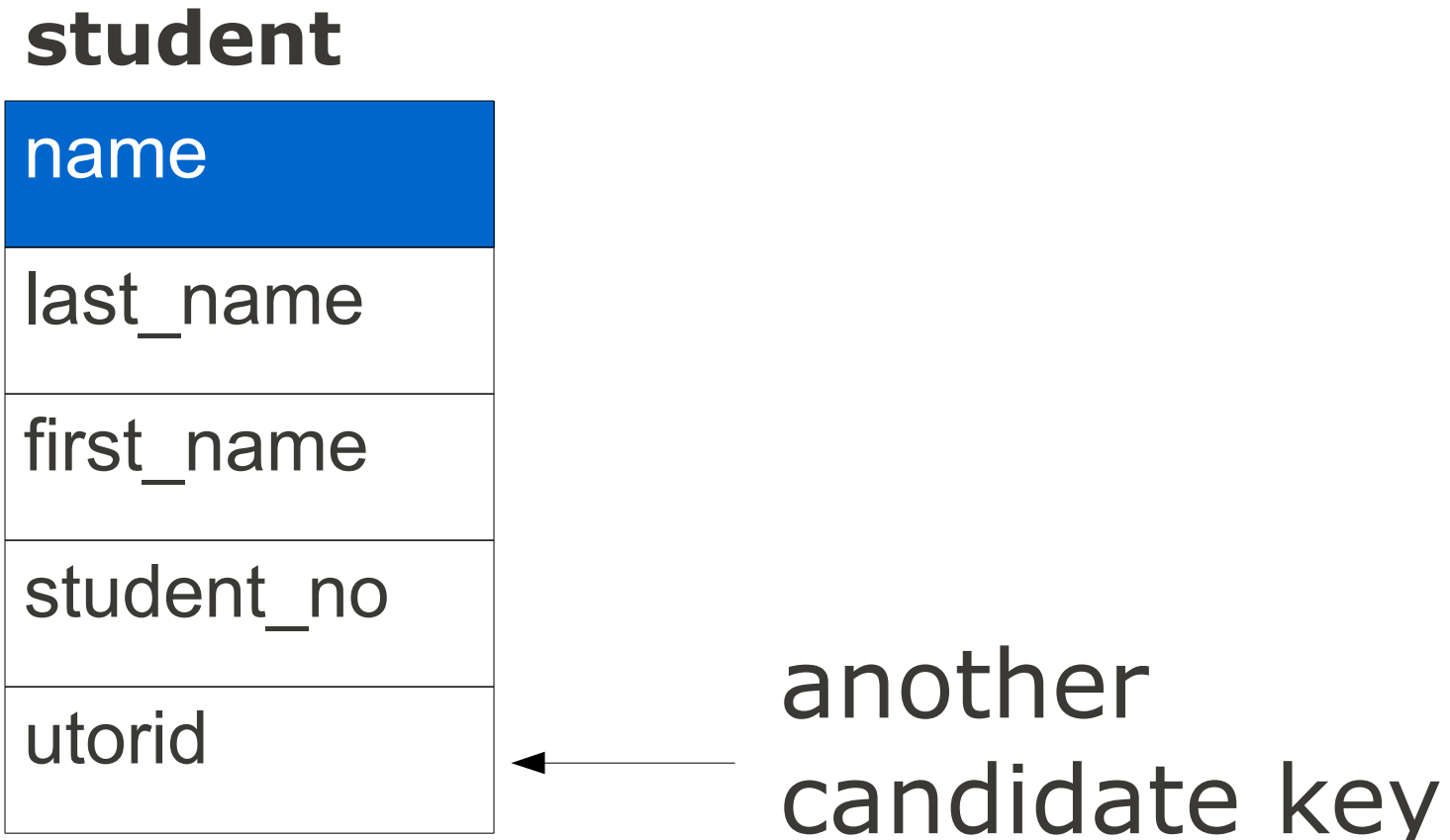
name
last_name
first_name

no key!

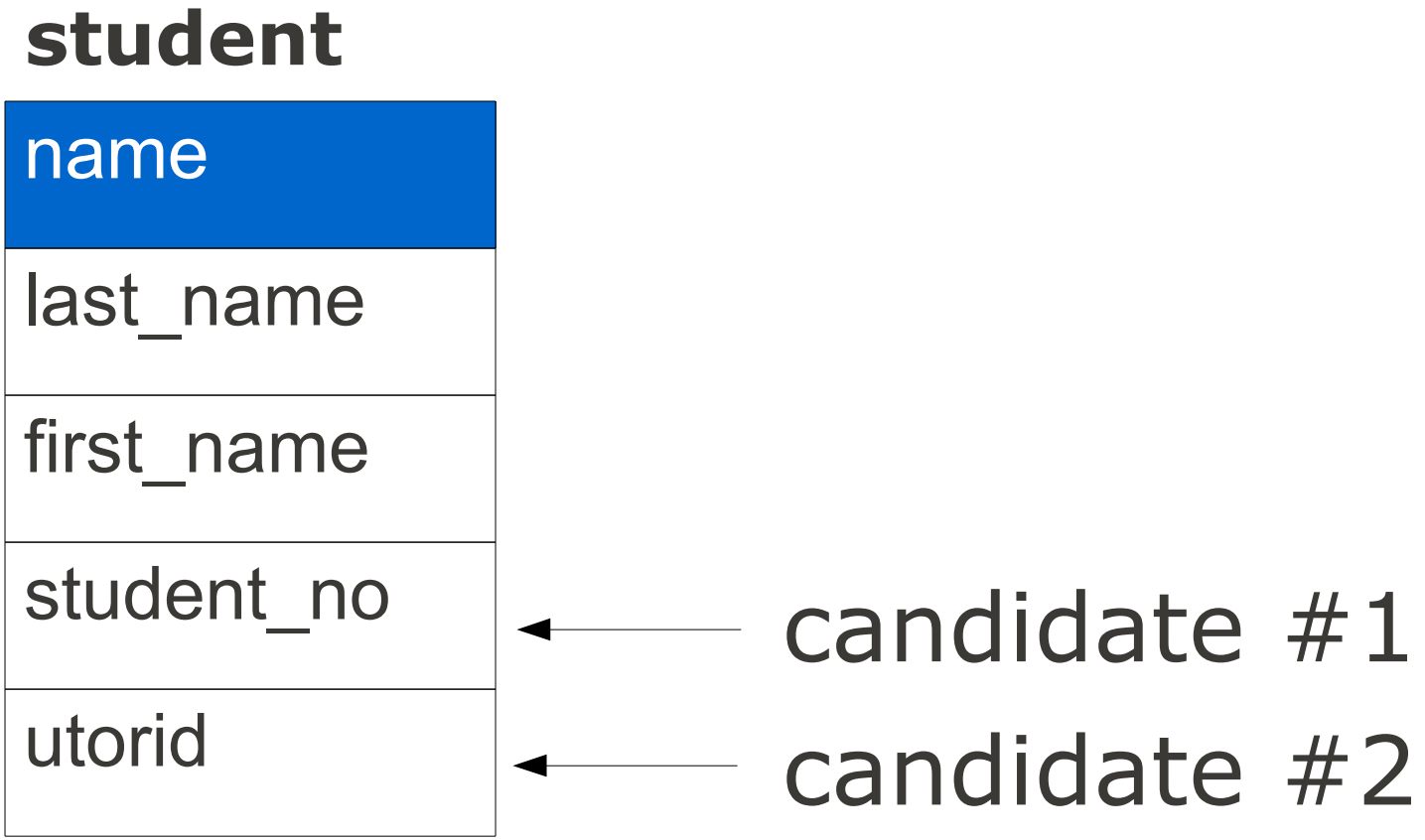
Keys


student
name
last_name
first_name
student_no
a candidate key

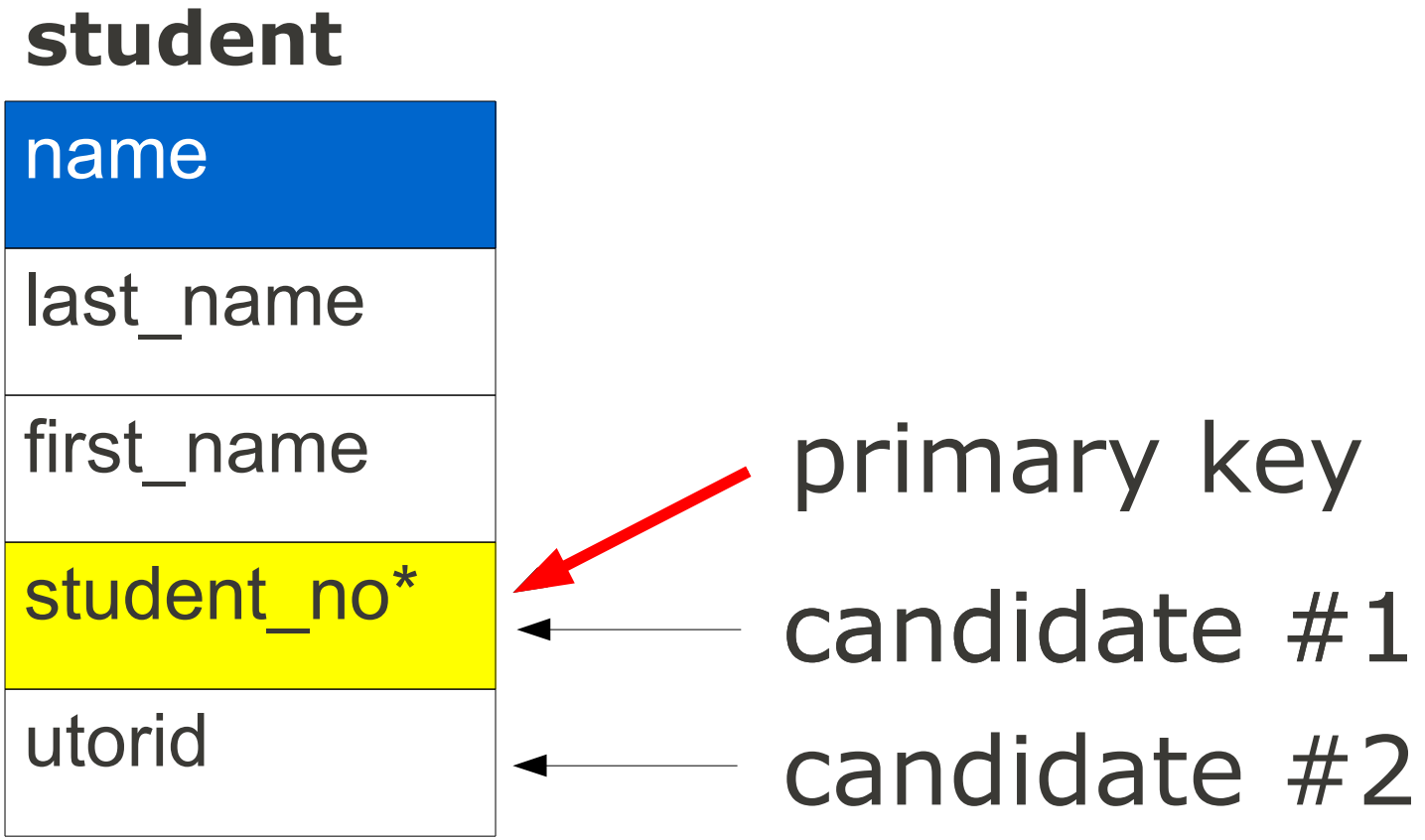
Keys


student
name
last_name
first_name
student_no
utorid
another
candidate key

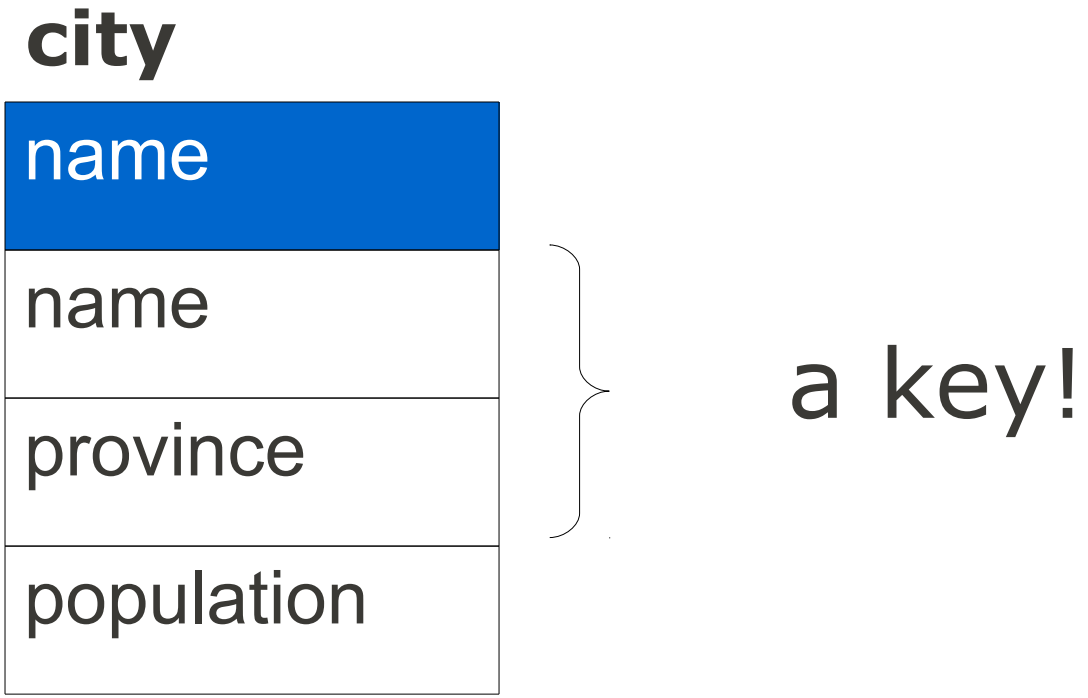
Keys


student
name
last_name
first_name
student_no
utorid
candidate #1
candidate #2

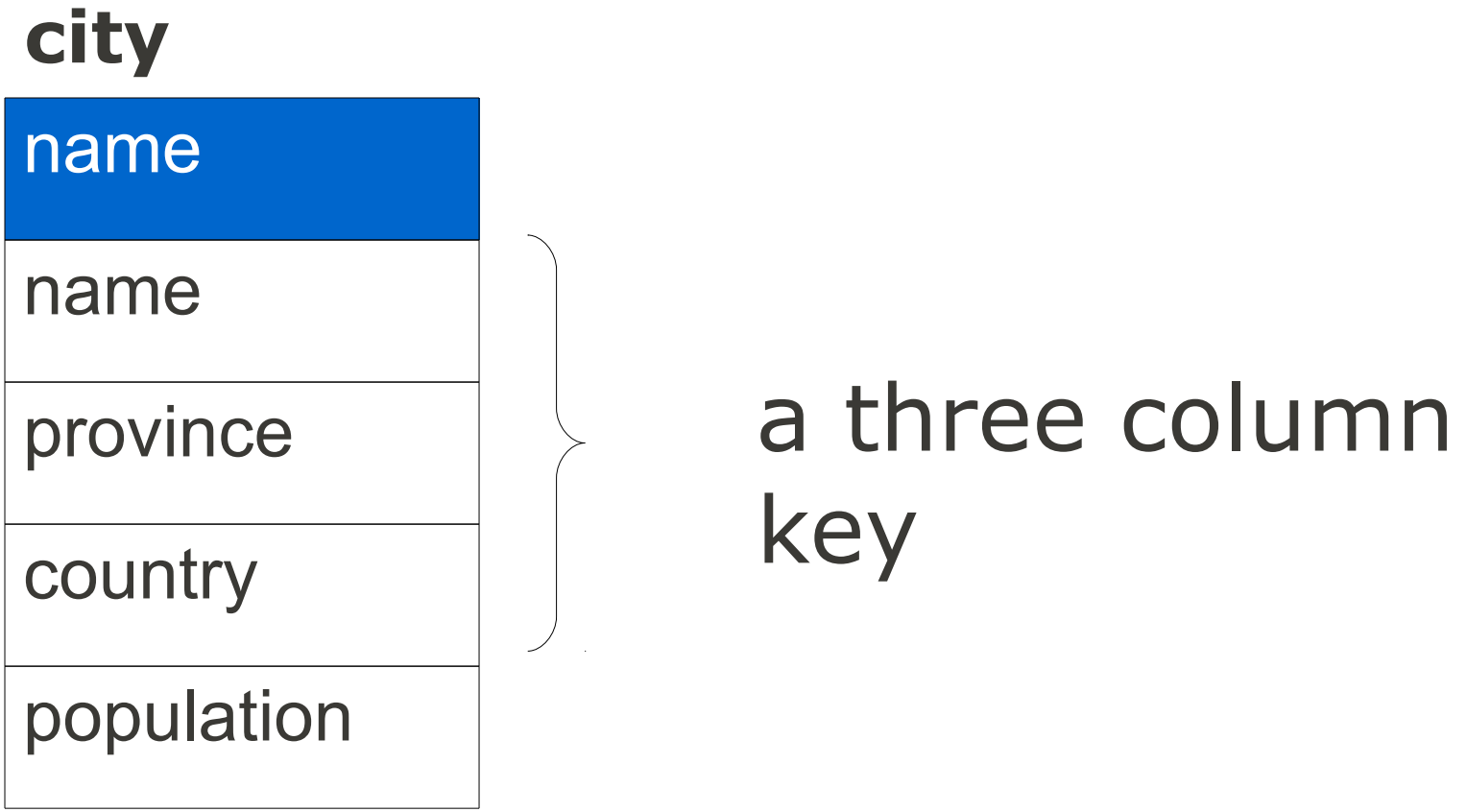
Keys


student
name
last_name
first_name
student_no*
utorid
primary key
candidate #1
candidate #2

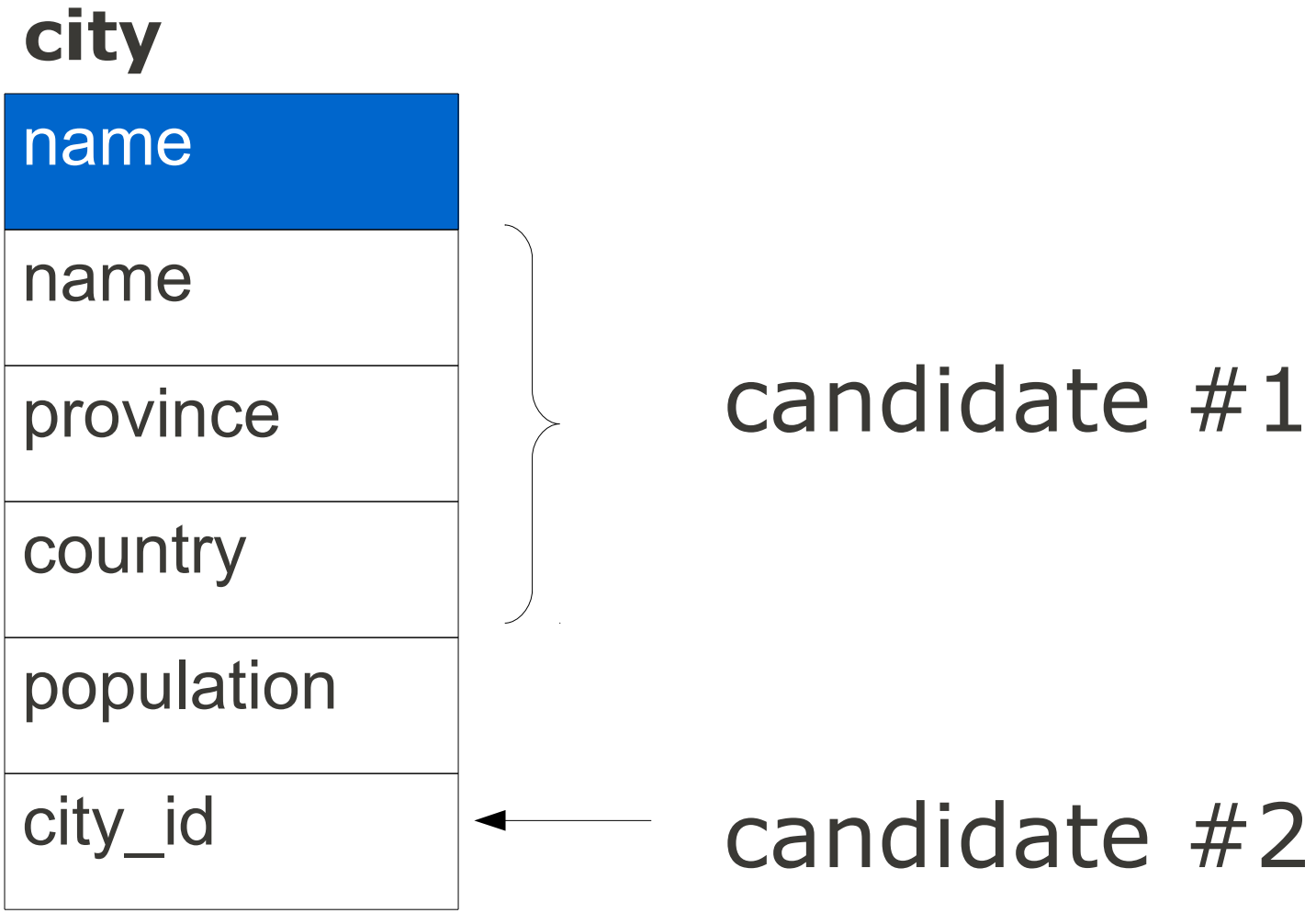
Multi-Column Keys



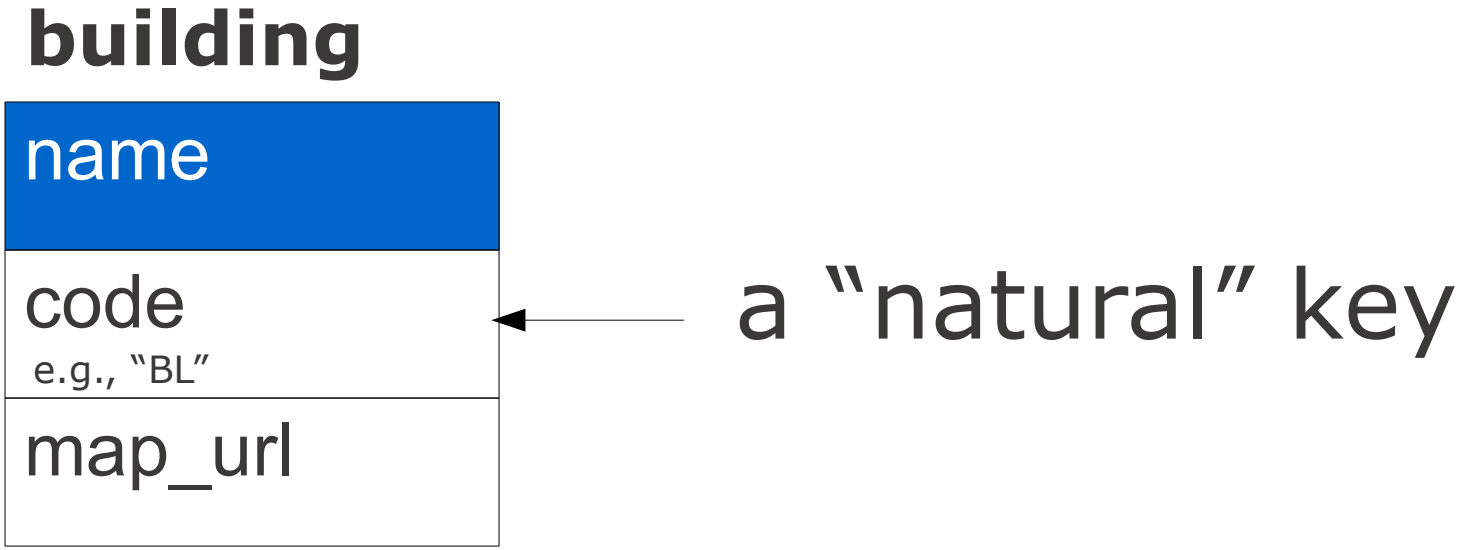
Multi-Column Keys



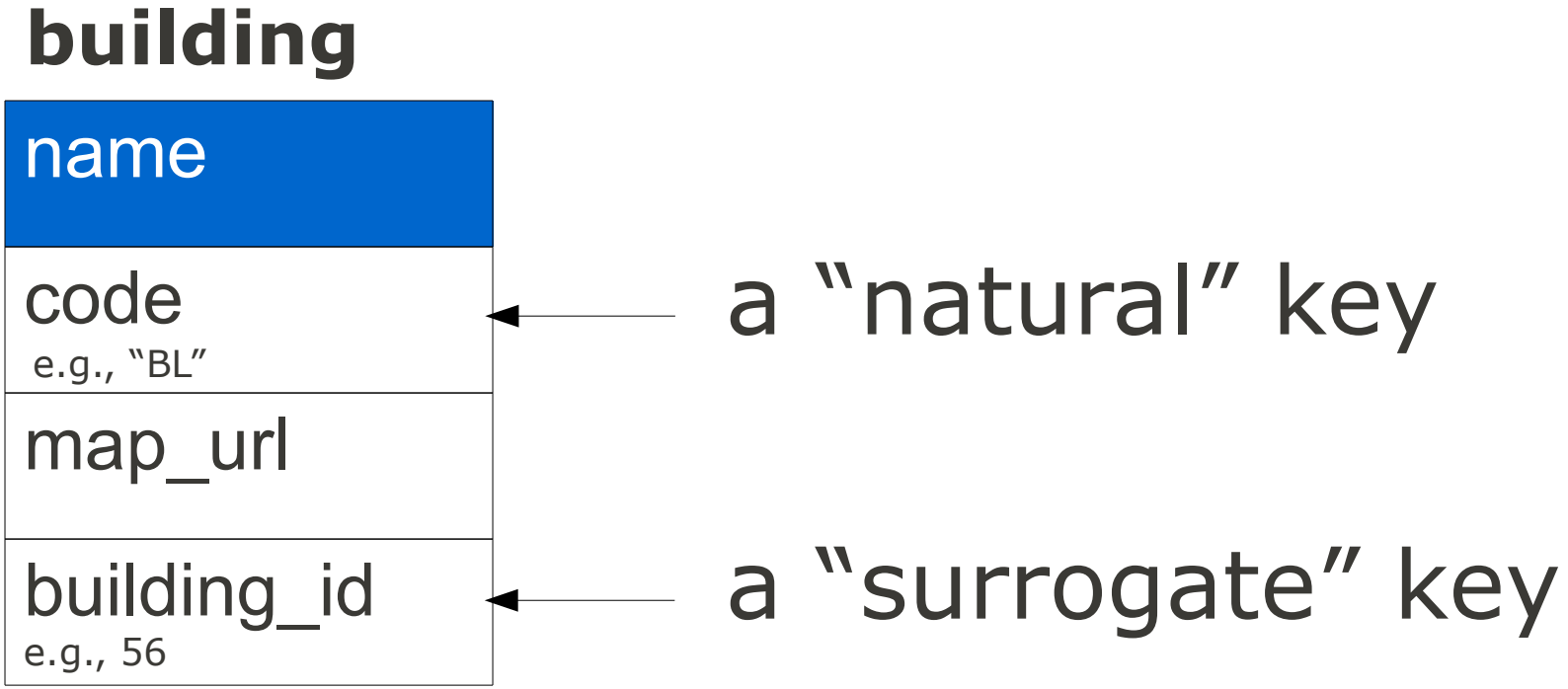
Multi-Column Keys



“Natural” Keys



“Natural” Keys



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."

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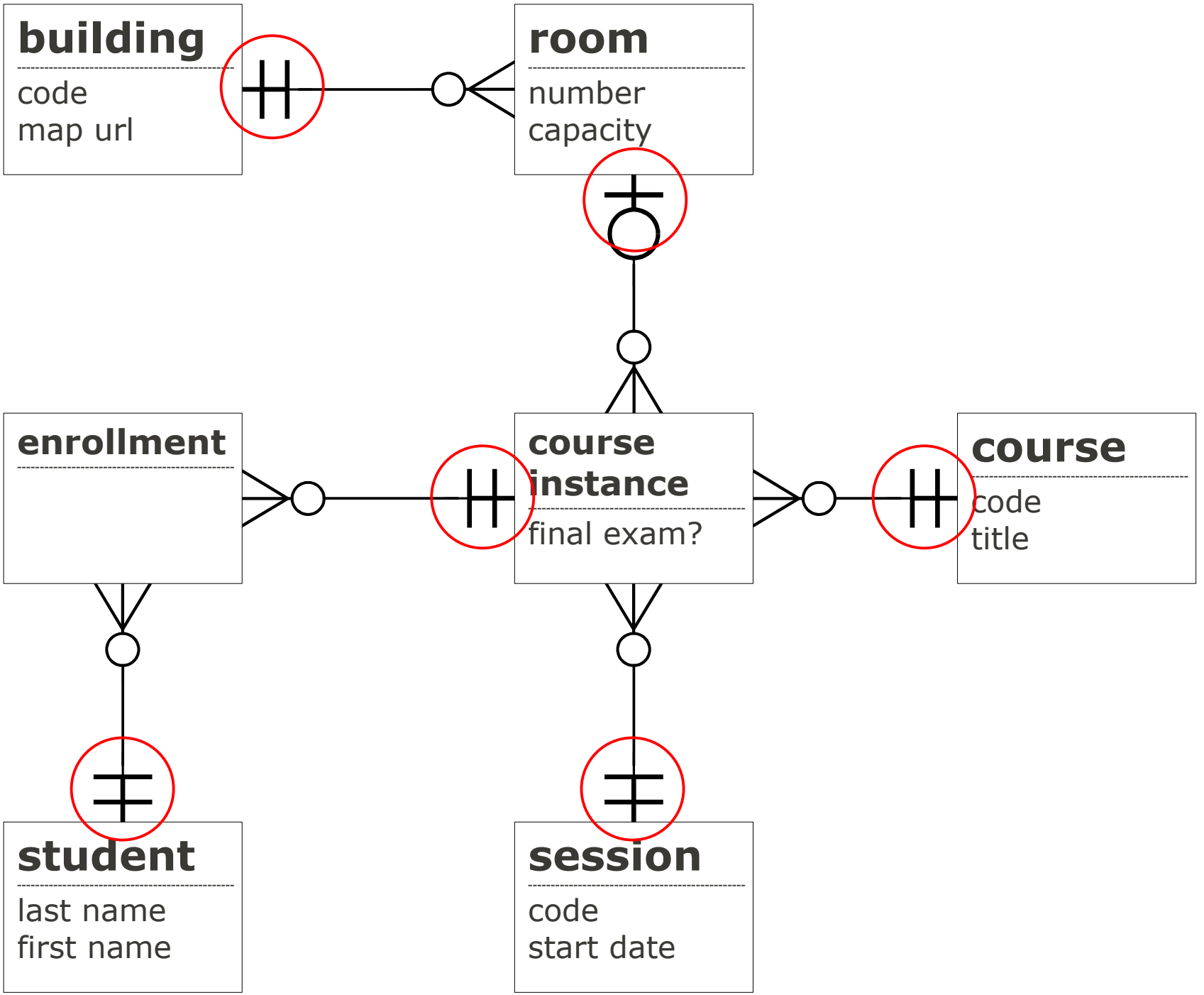
building
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last name
first name
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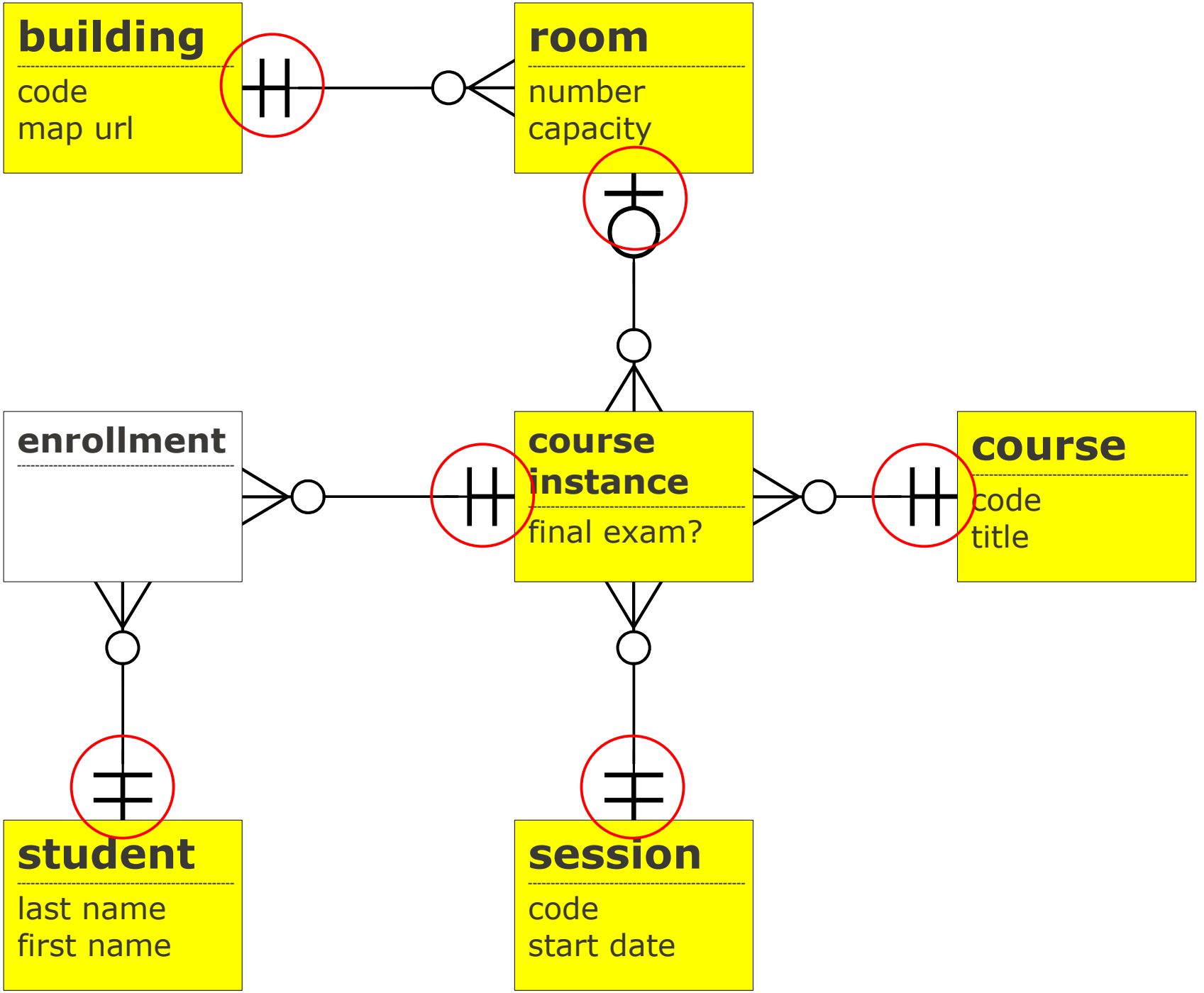
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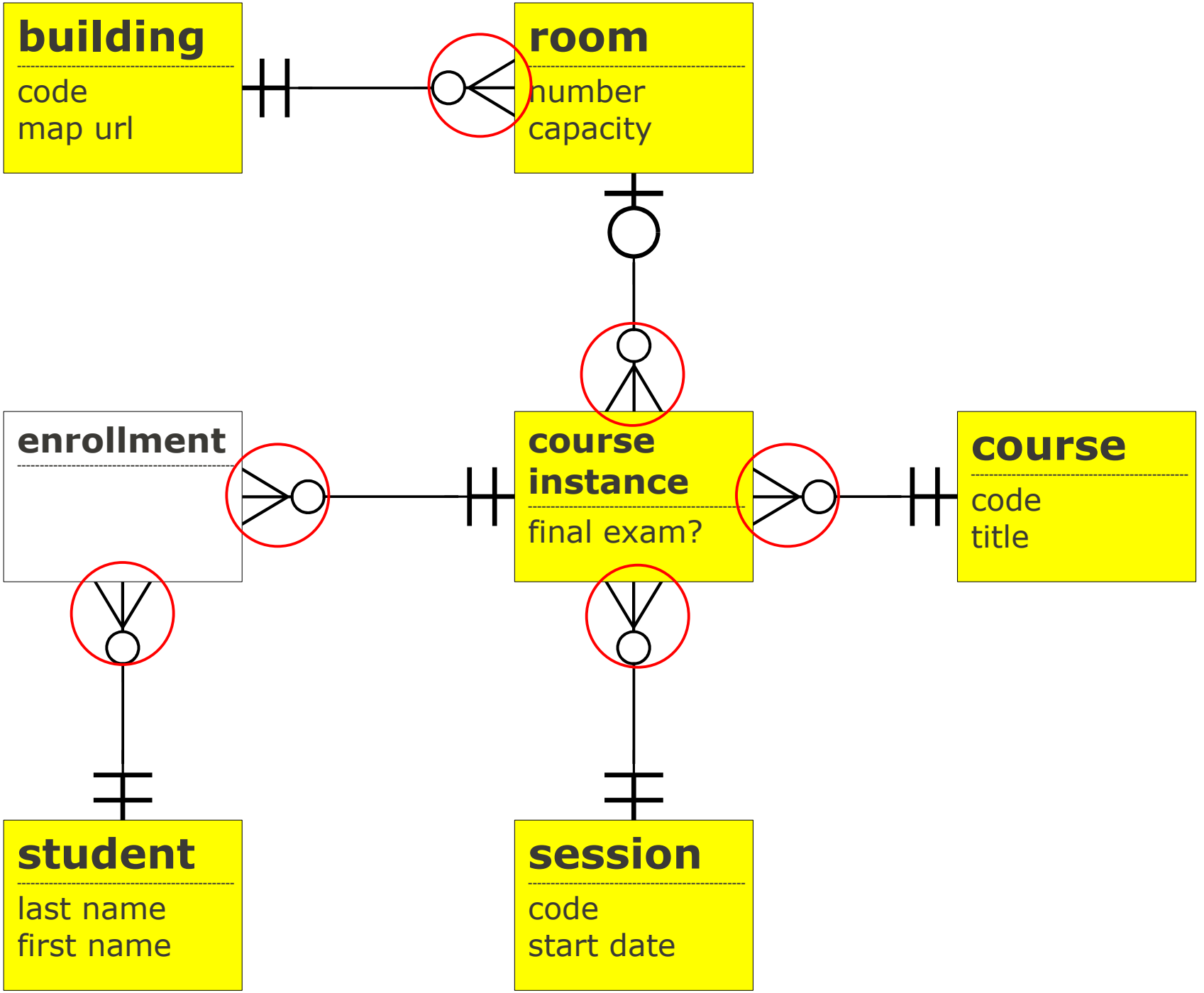
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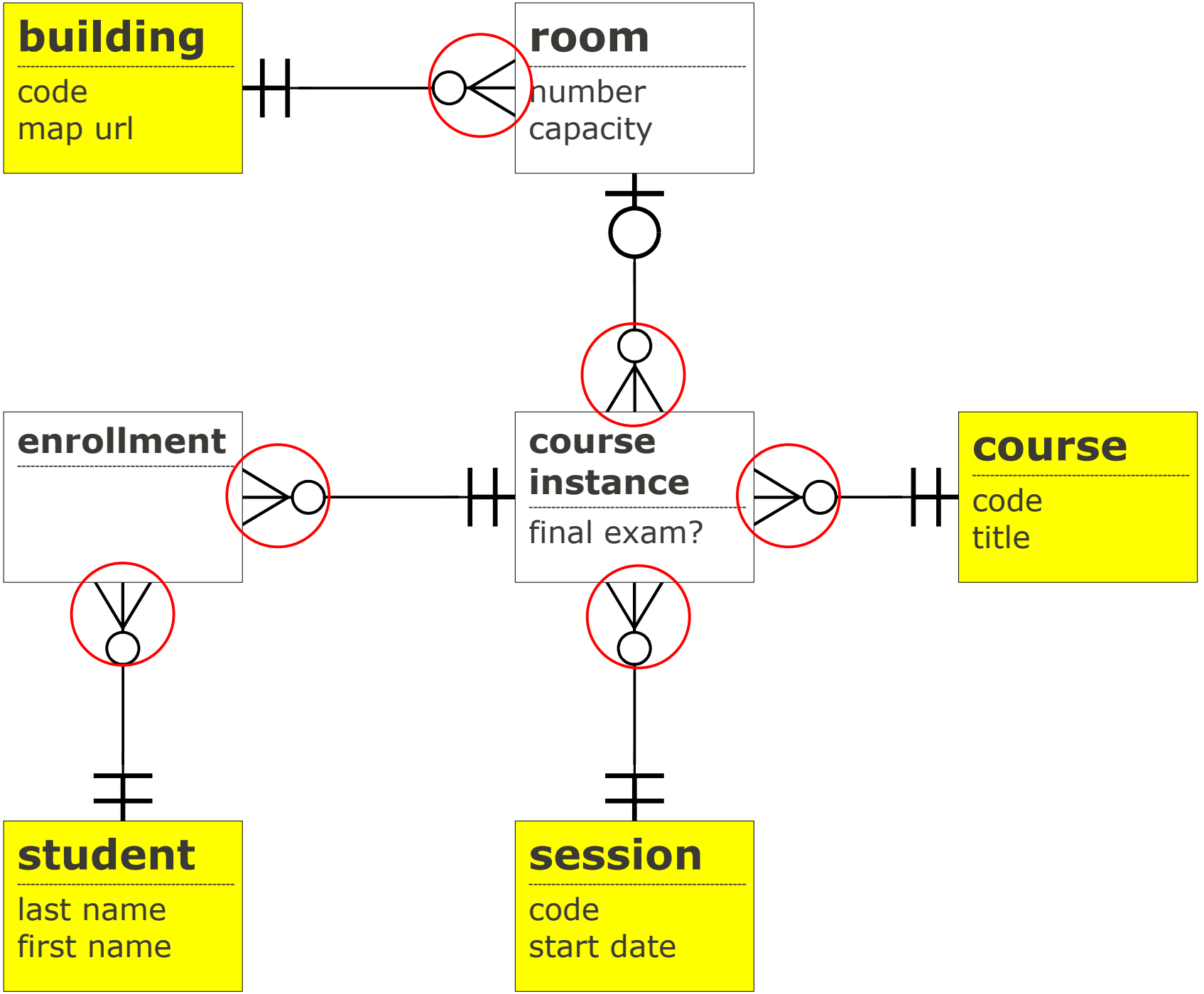
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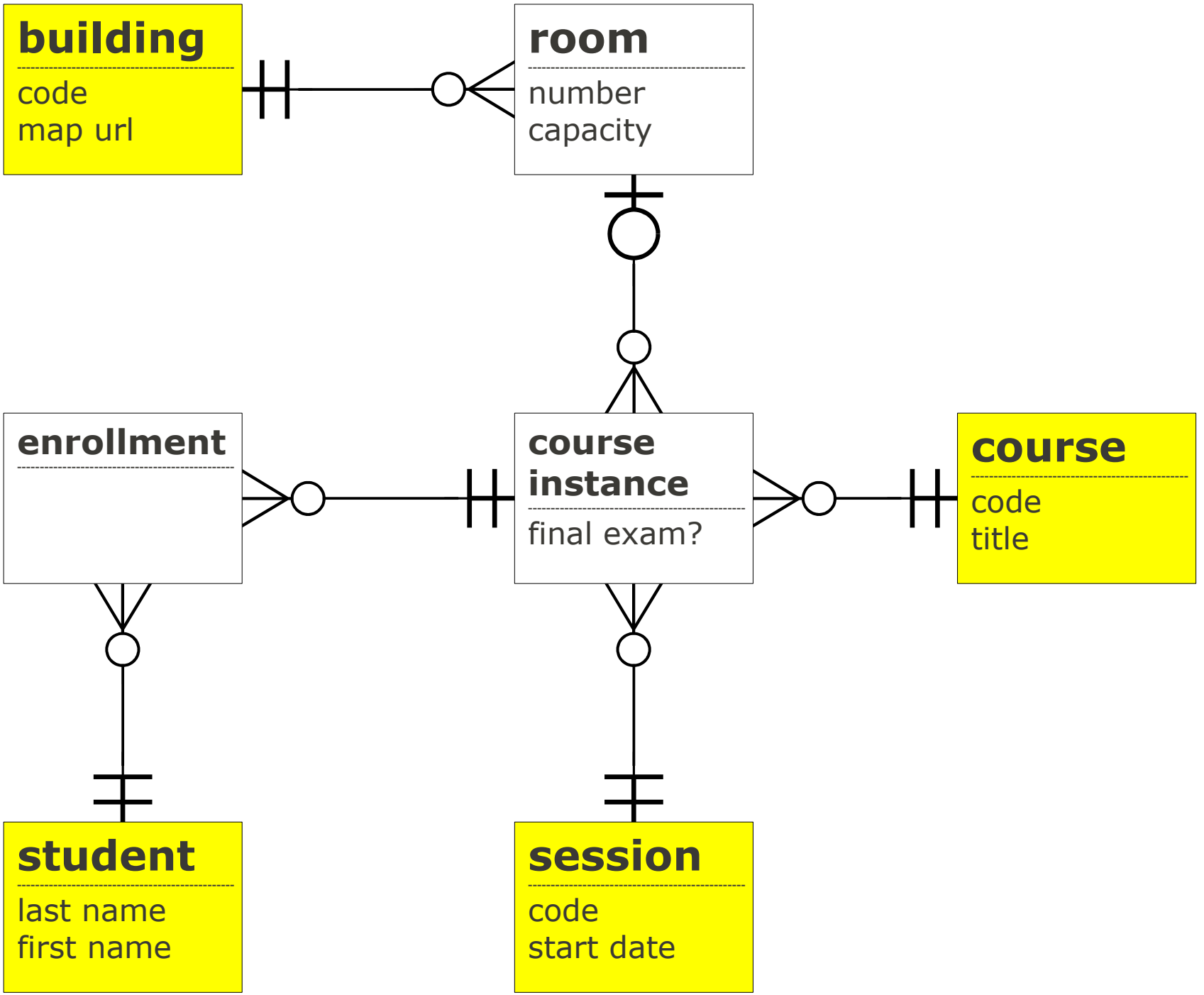
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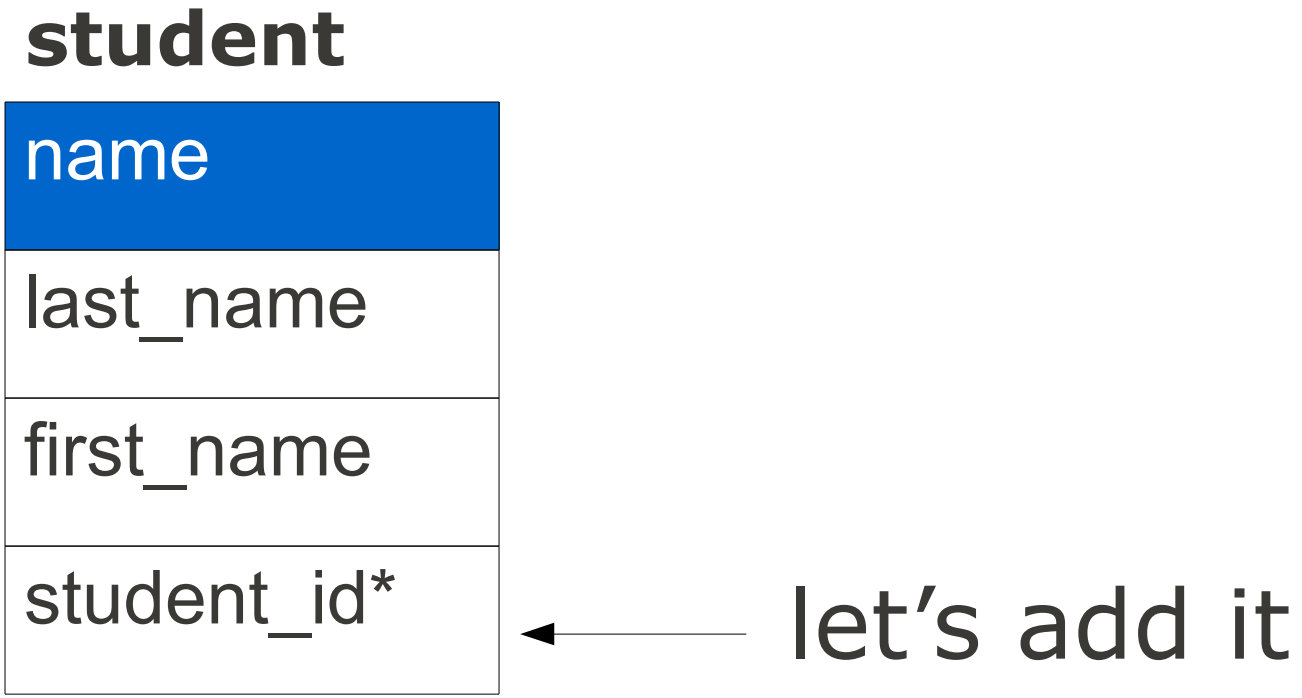
Step 2

"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."

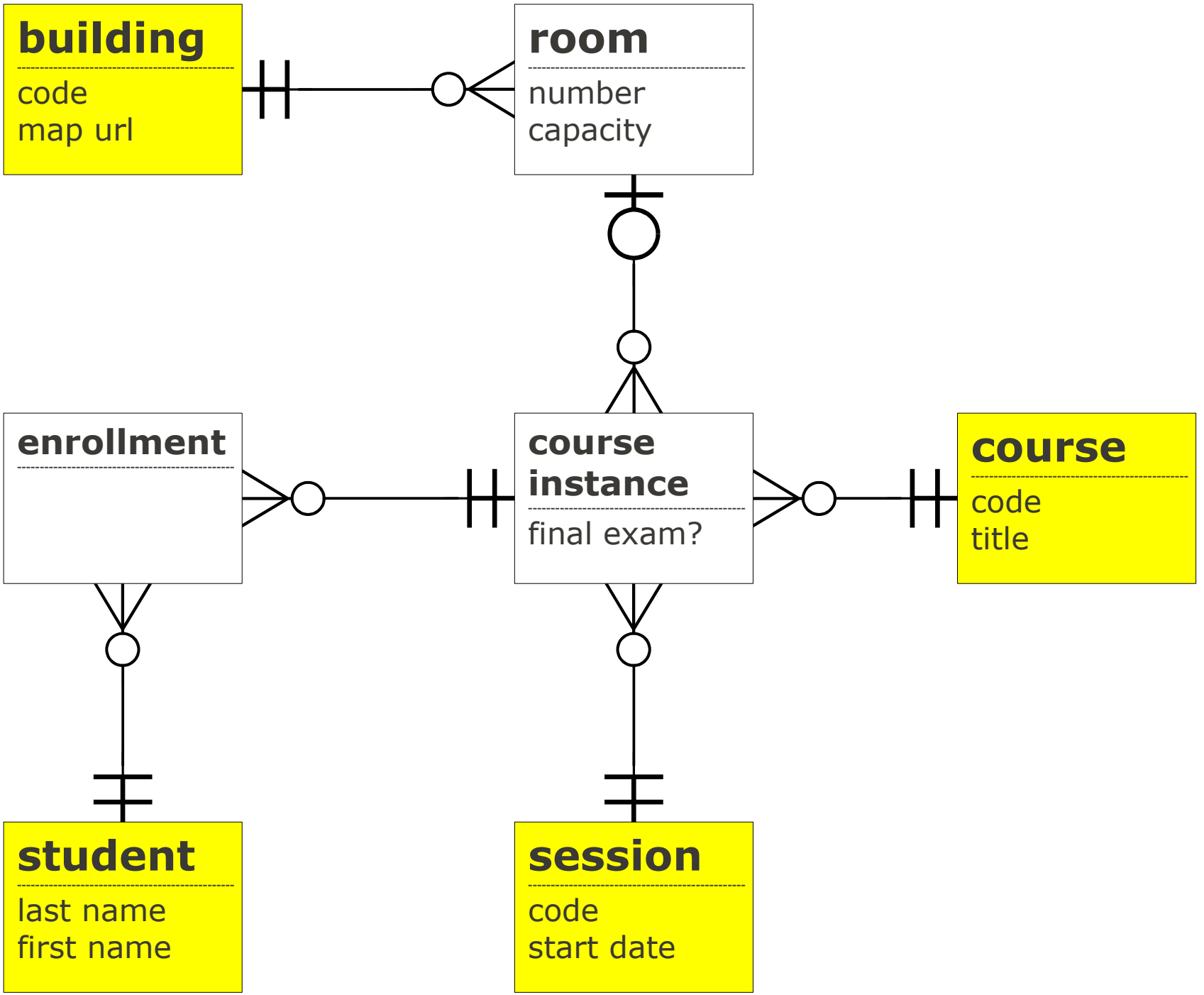
student

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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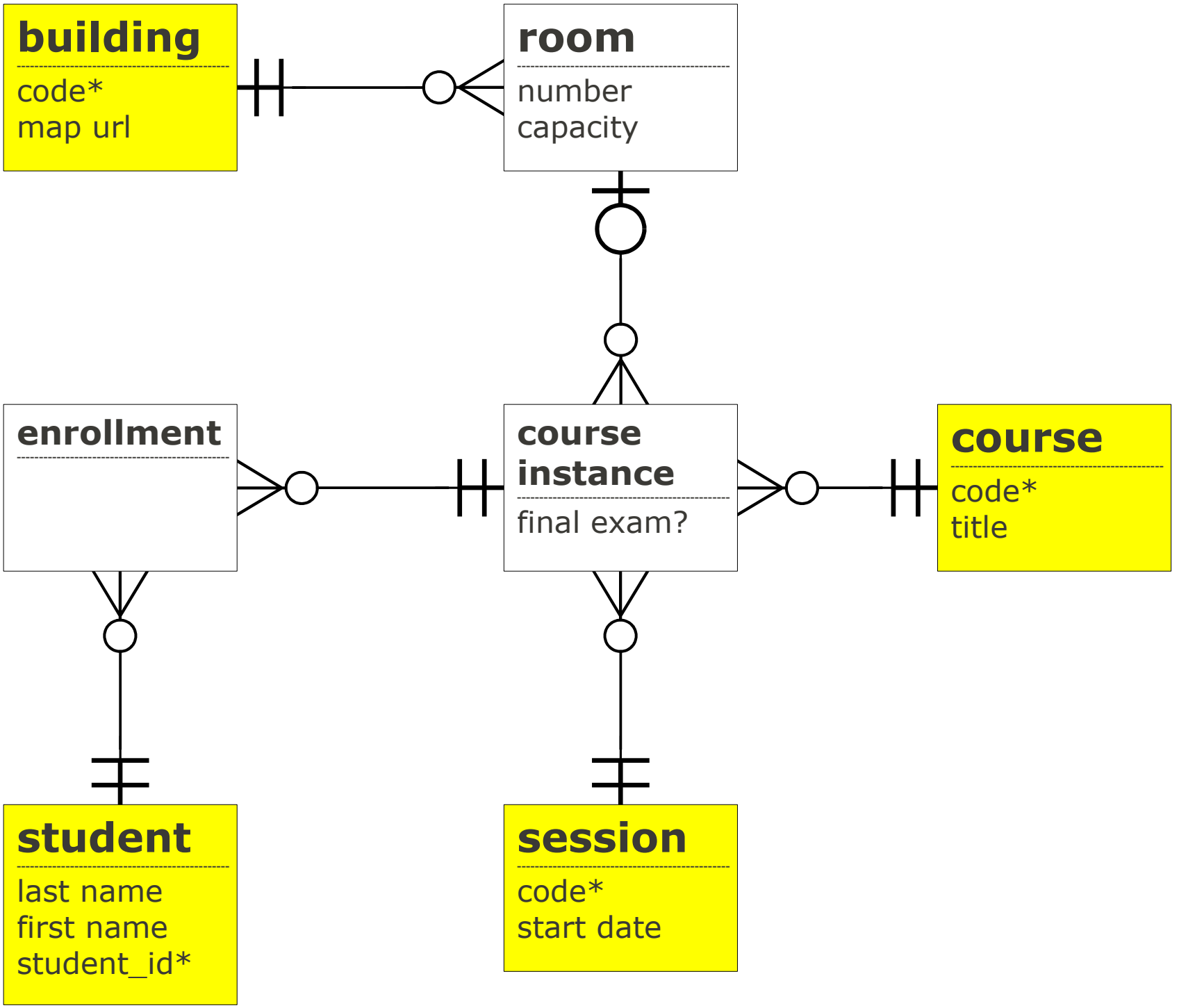
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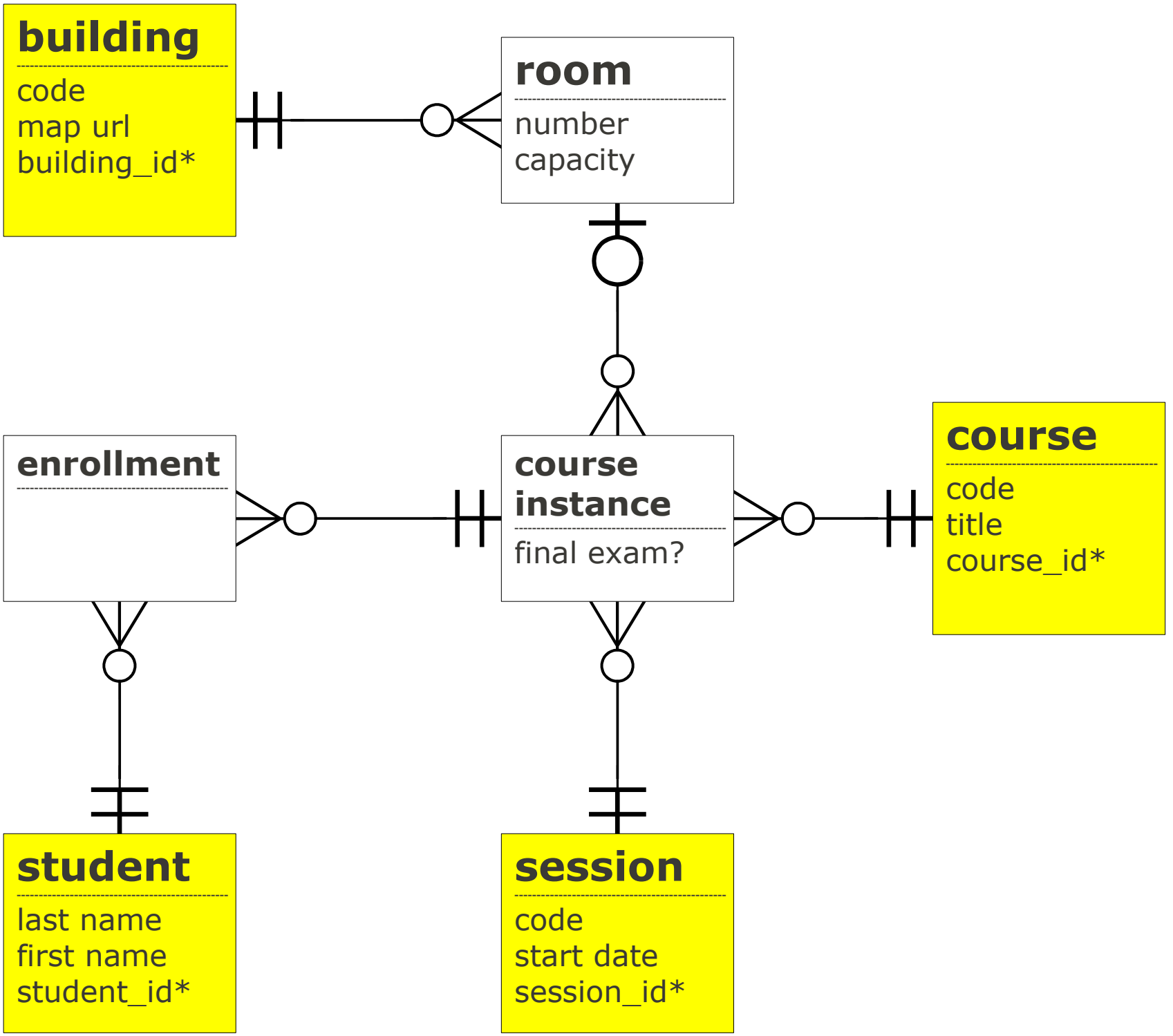
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student_id*
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start date
session_id*

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."

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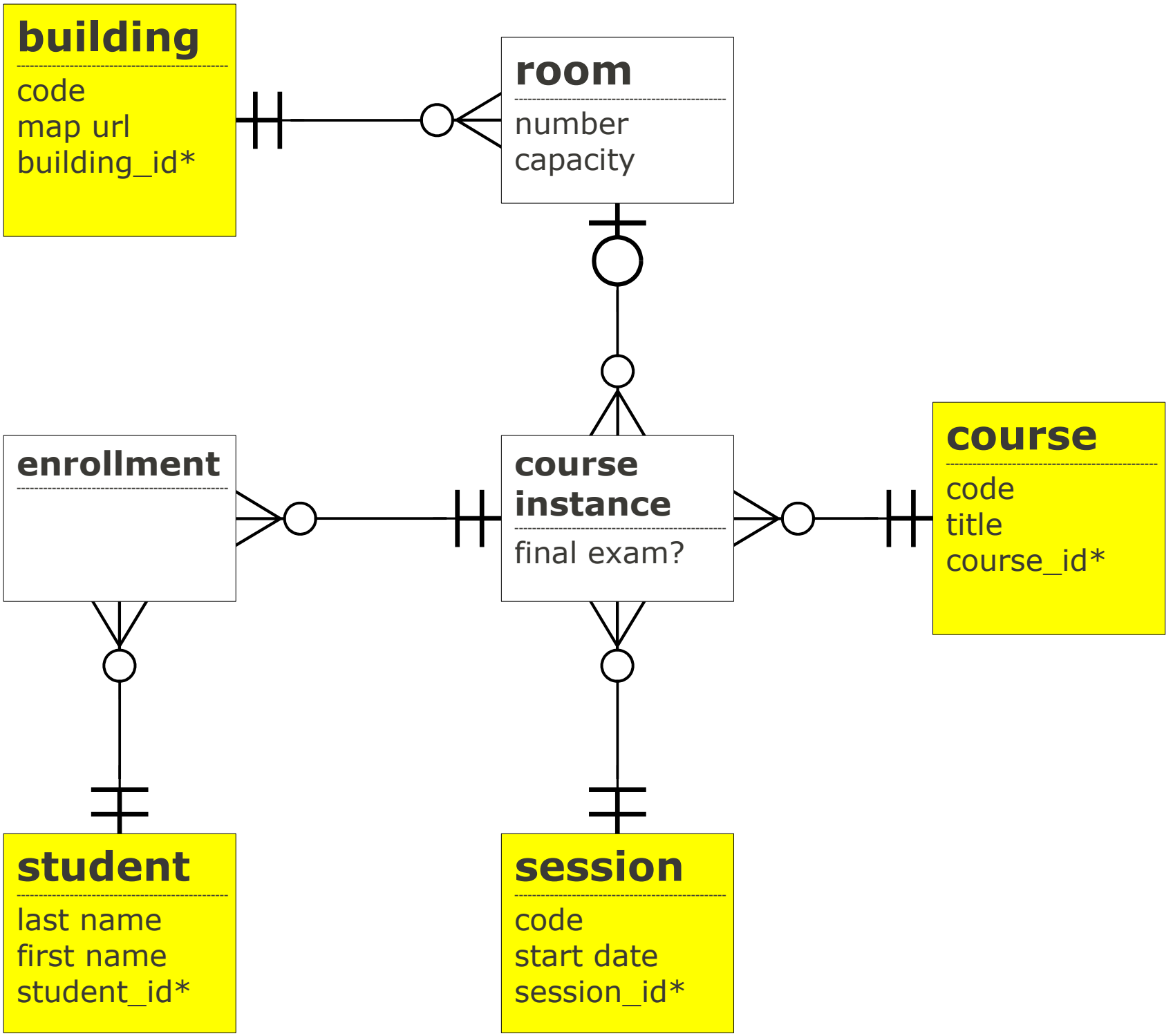
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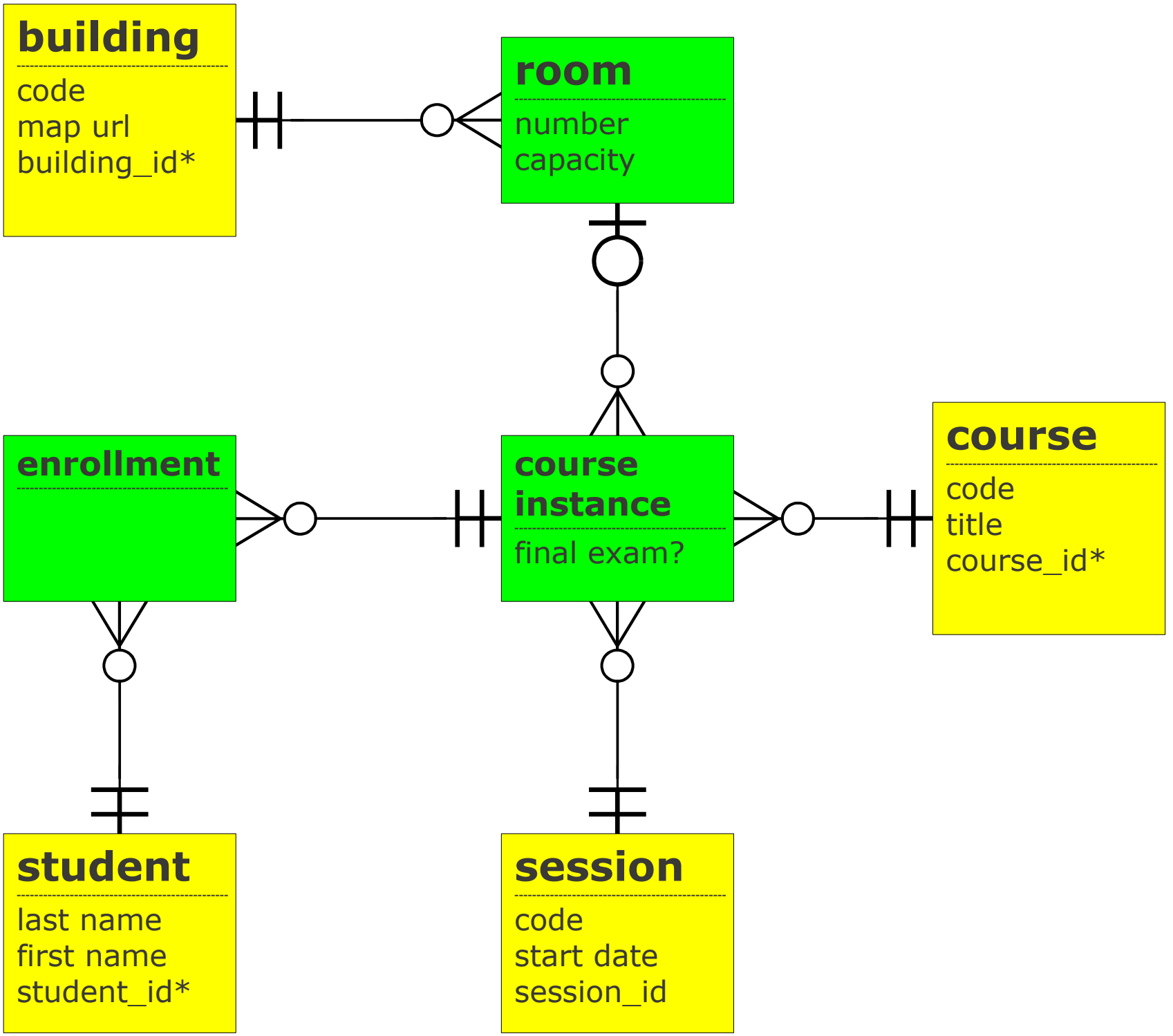
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first name
student_id*
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session_id

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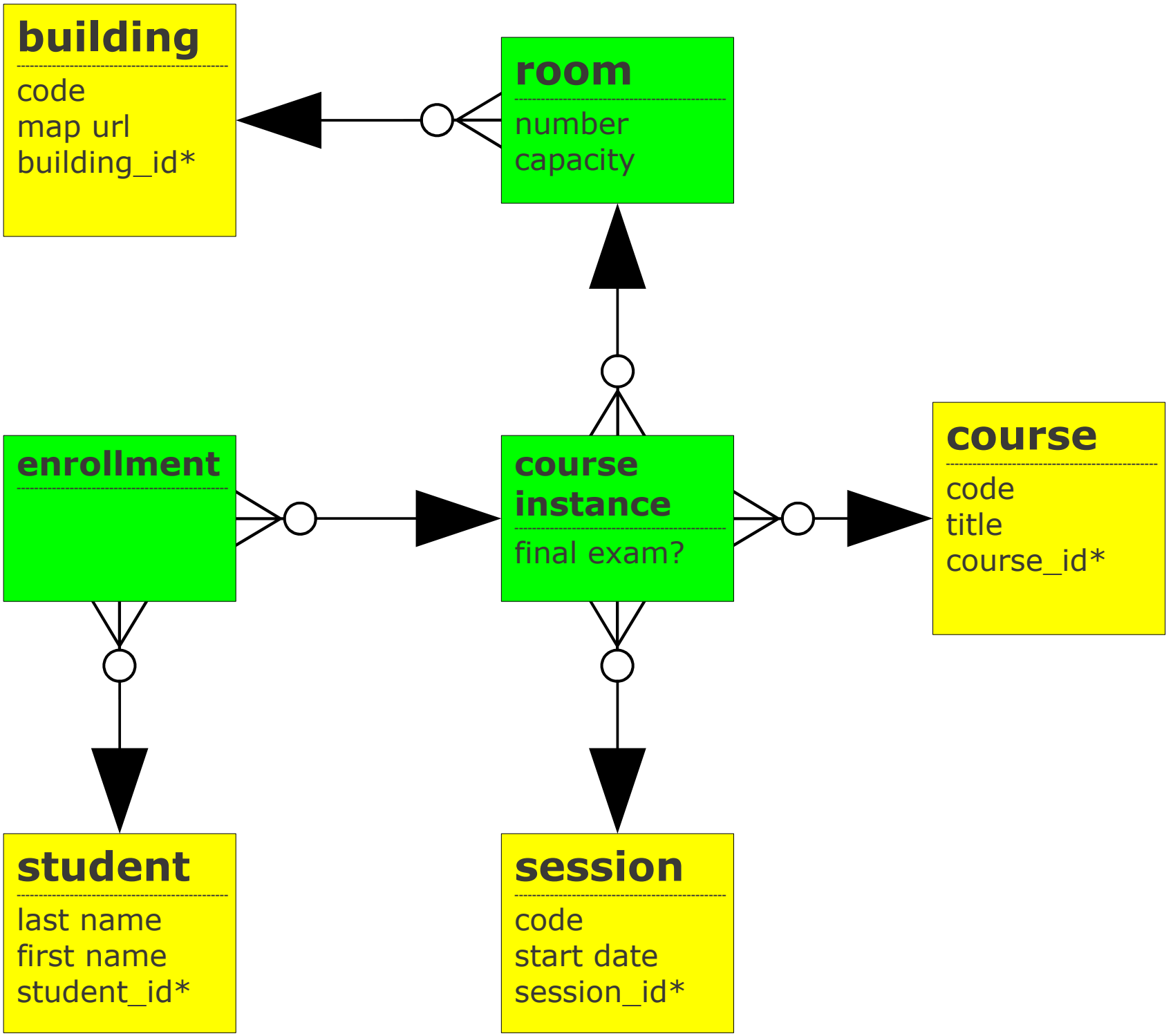
"For each entity that is at the 'many' end of one or more relationships, include the primary key of each parent entity in the table as foreign keys."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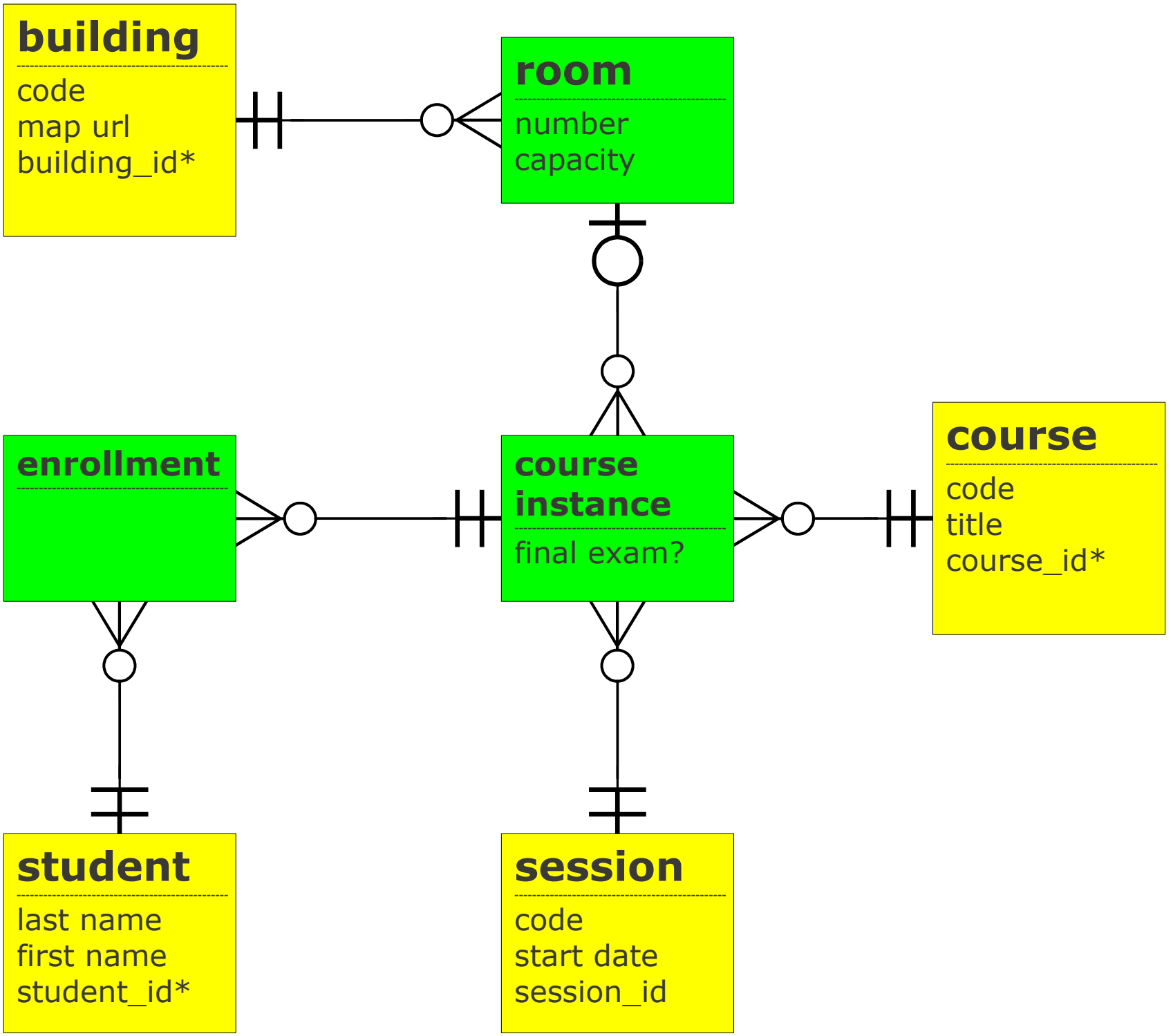
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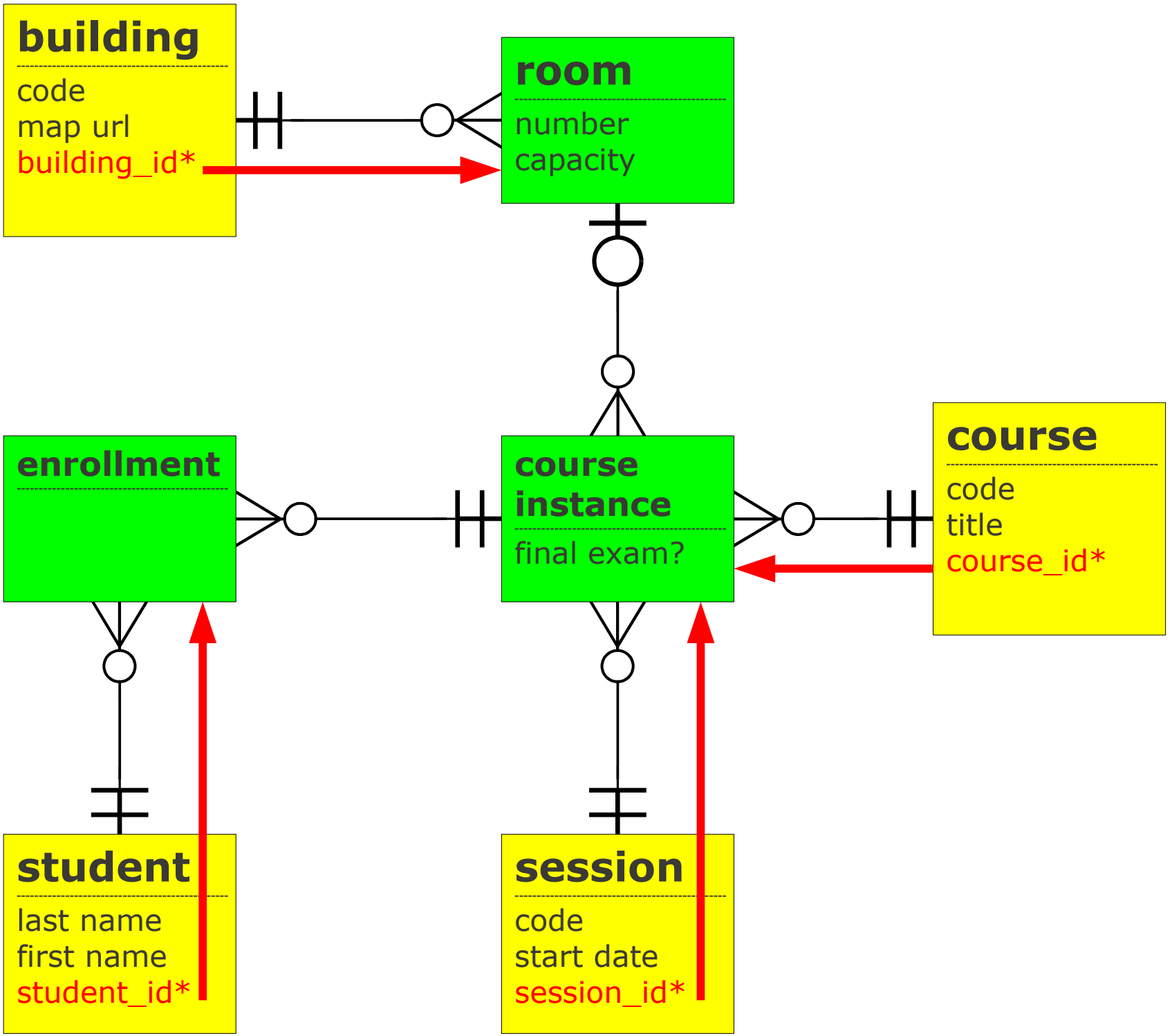
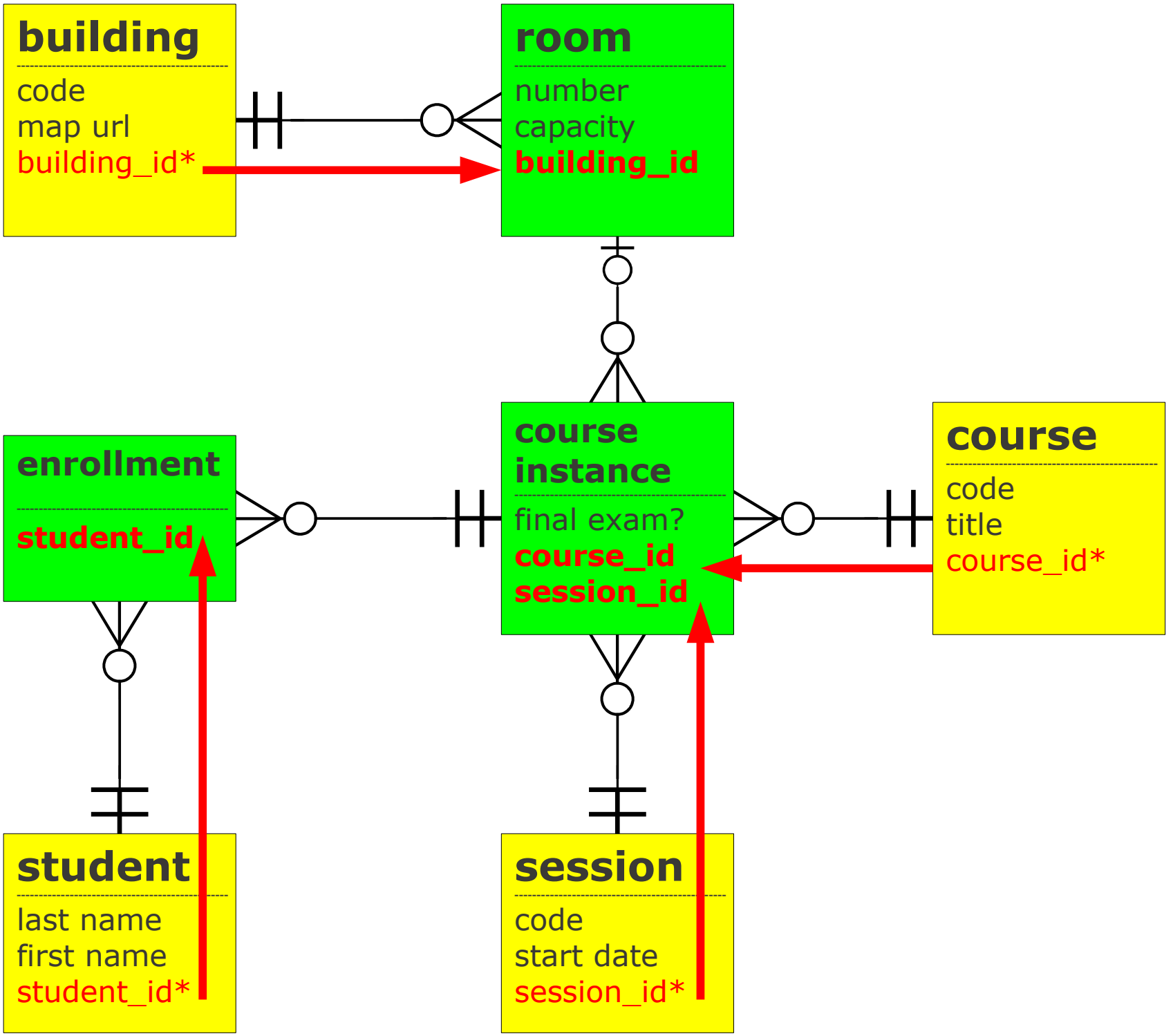
start date
session_id


building
code
map url
building_id*
room
number
capacity
enrollment
course instance
final exam?
course
code
title
course_id*
student
last name
first name
student_id*
session
code
start date
session_id*


building
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enrollment
student_id
student
last name
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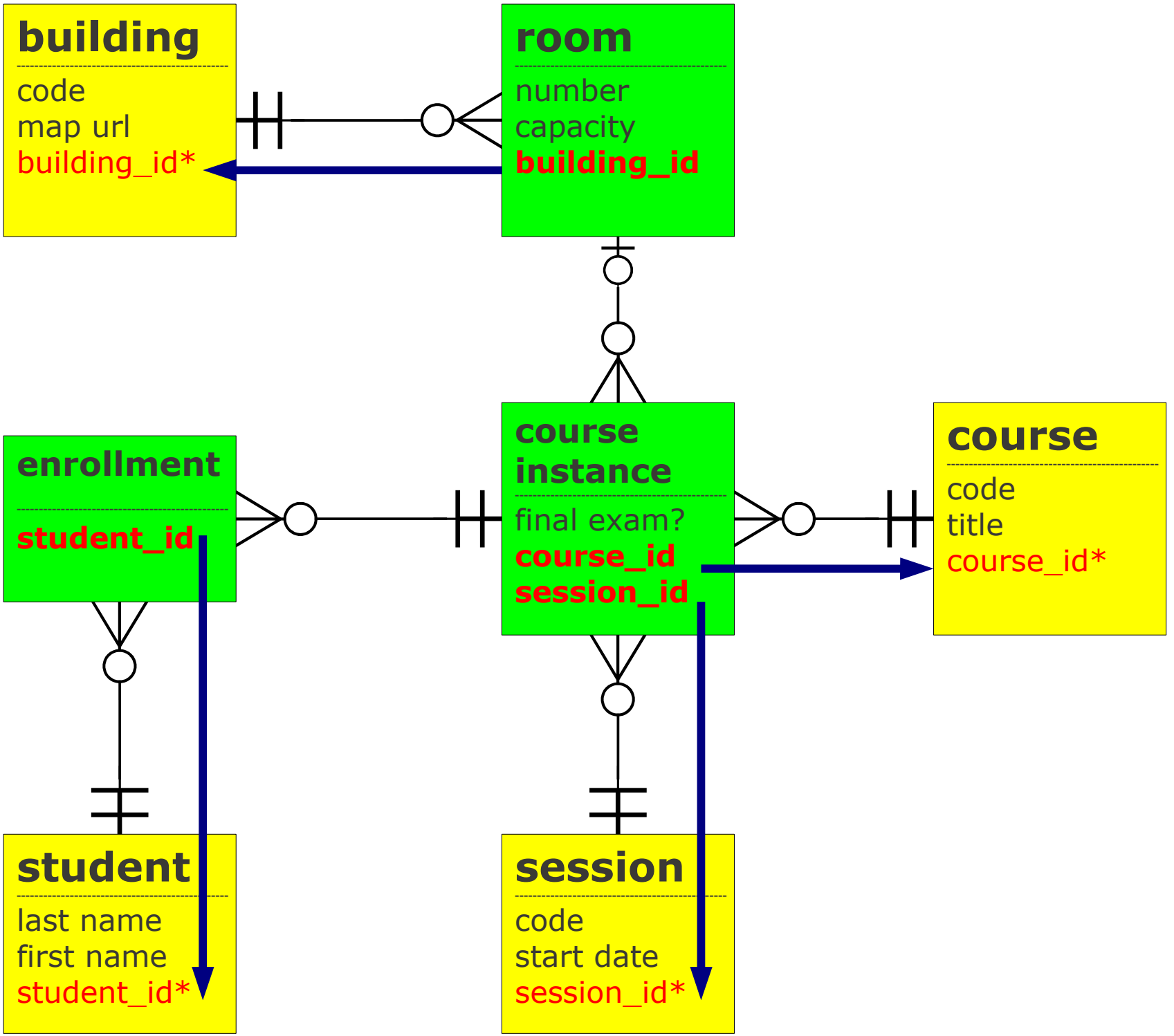
code
start date
session_id*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course instance
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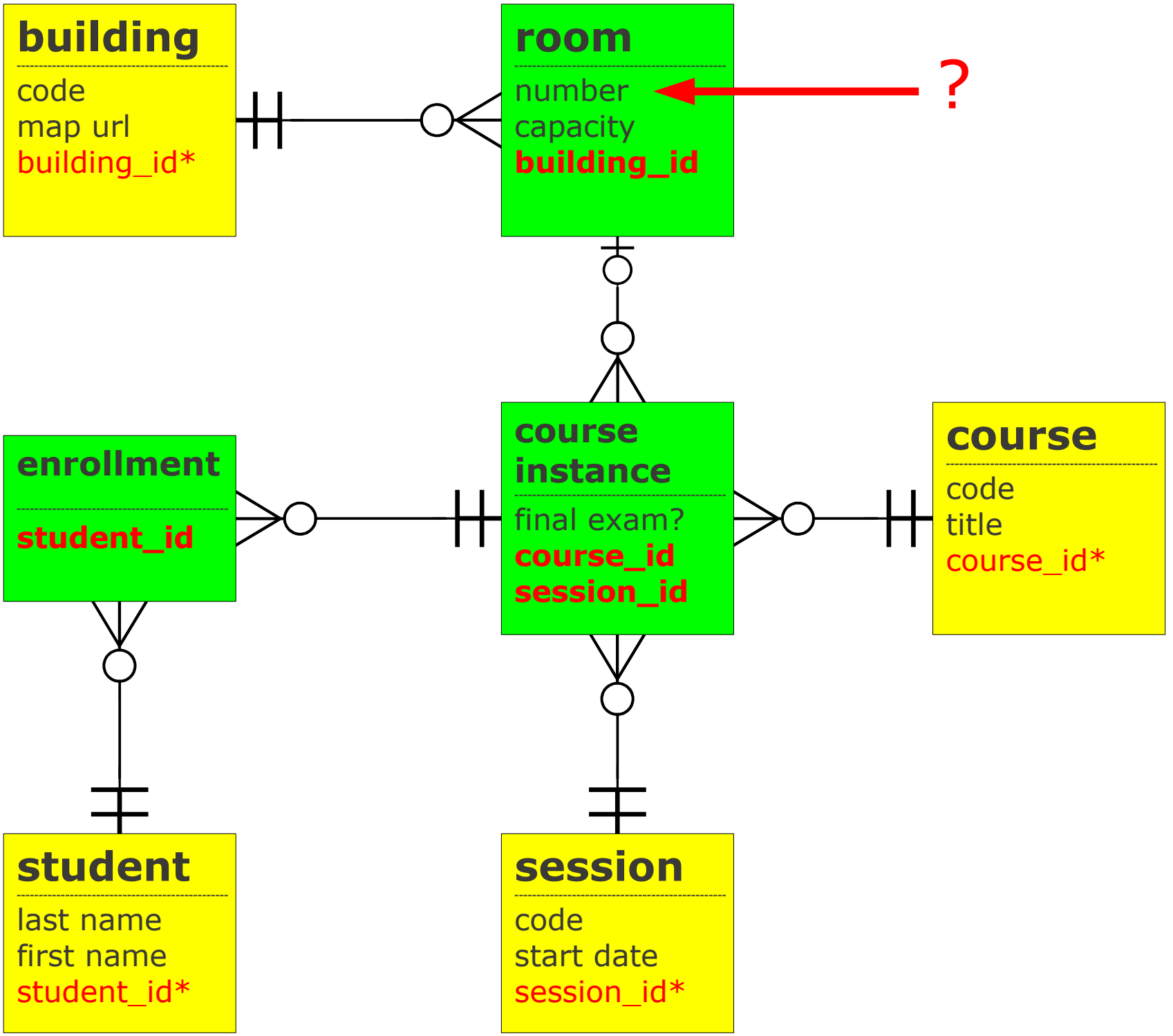
course
code
title
course_id*
enrollment
student_id
student
last name
first name
student_id*
session
code
start date
session_id*

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."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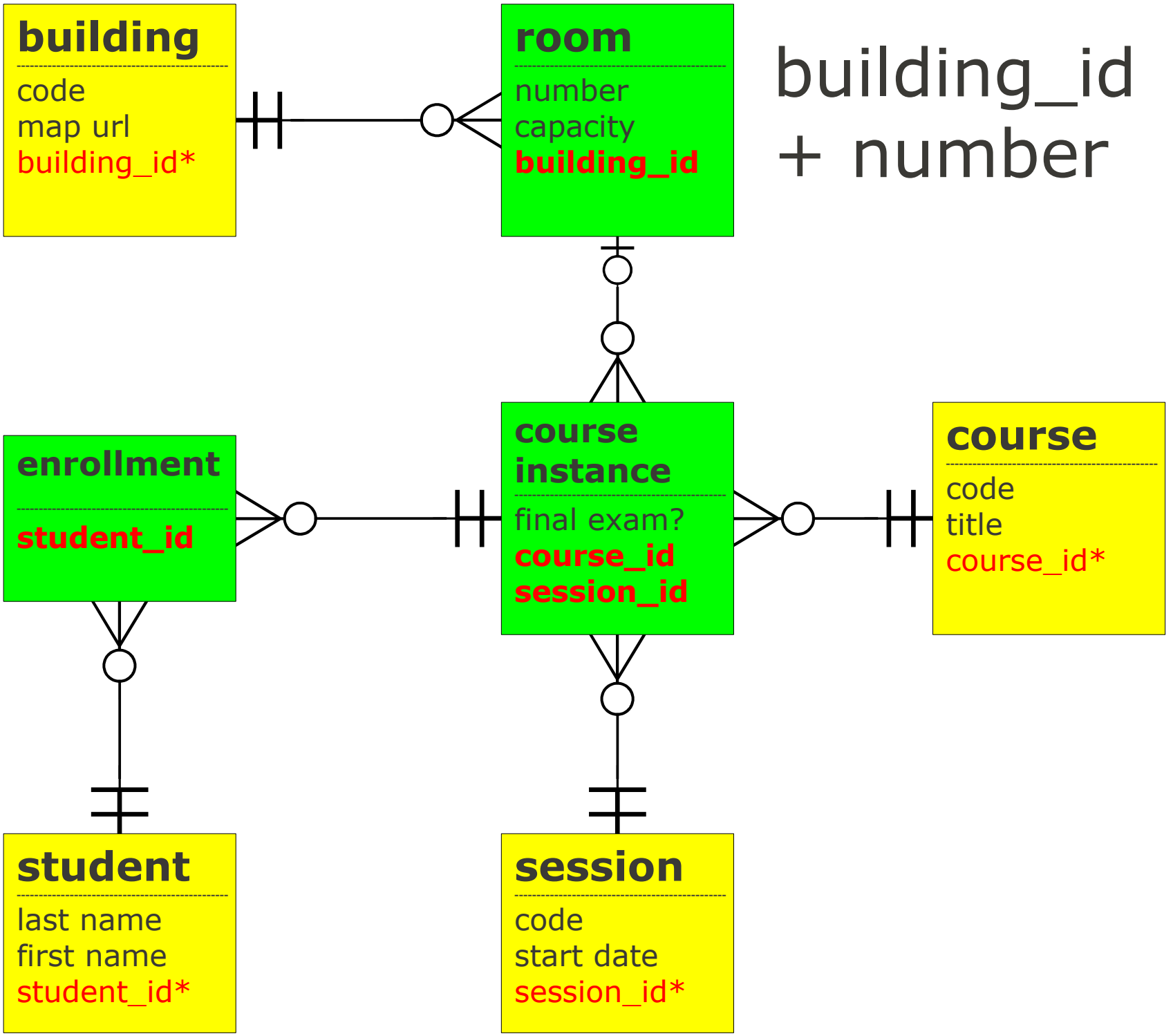
final exam?
course_id
session_id
course
code
title
course_id*
student
last name
first name
student_id*
session
code
start date
session_id*

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."


building
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enrollment
student_id
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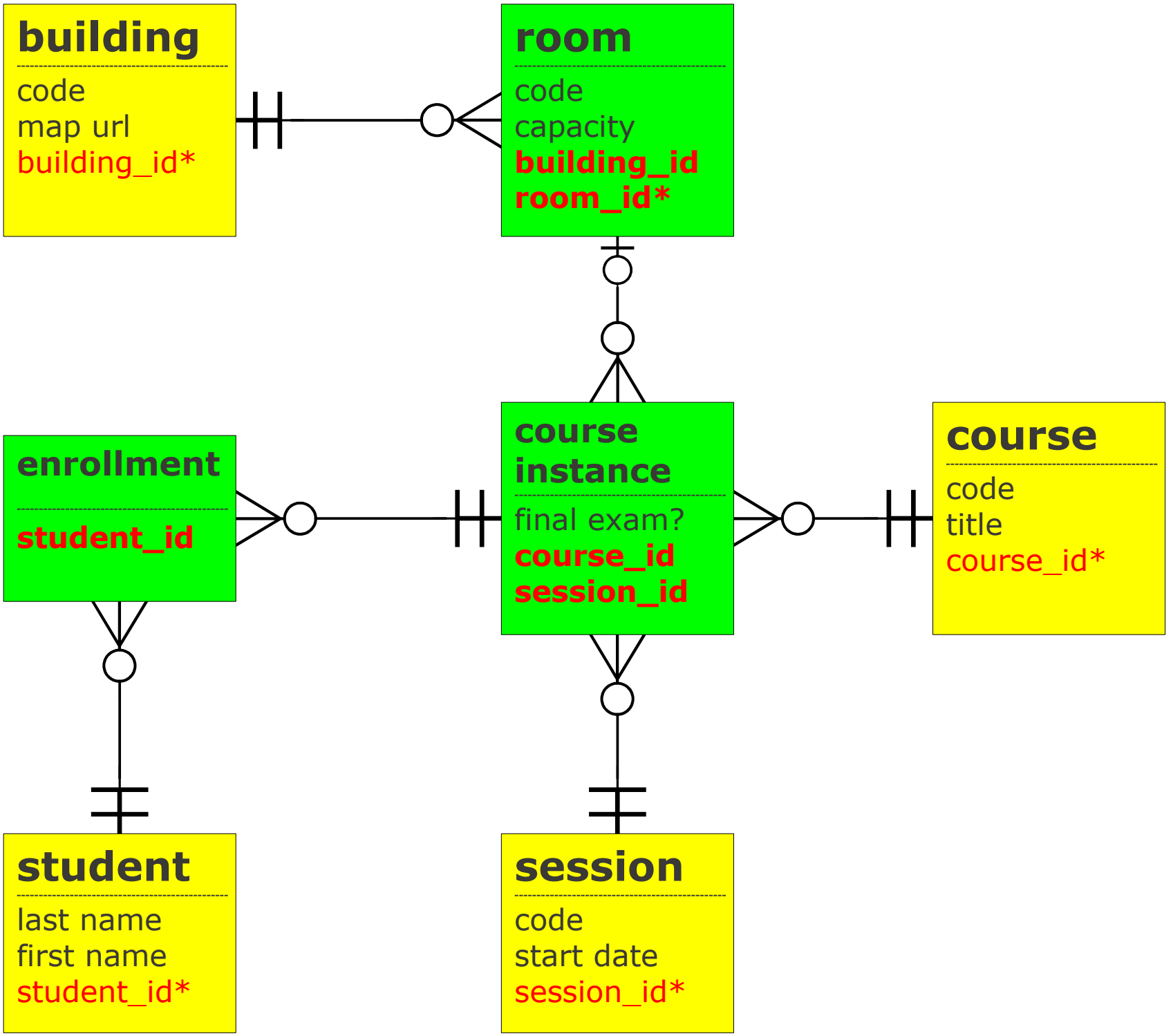
final exam?
course_id
session_id
course
code
title
course_id*
student
last name
first name
student_id*
session
code
start date
session_id*

Step 4c

If necessary, add a field!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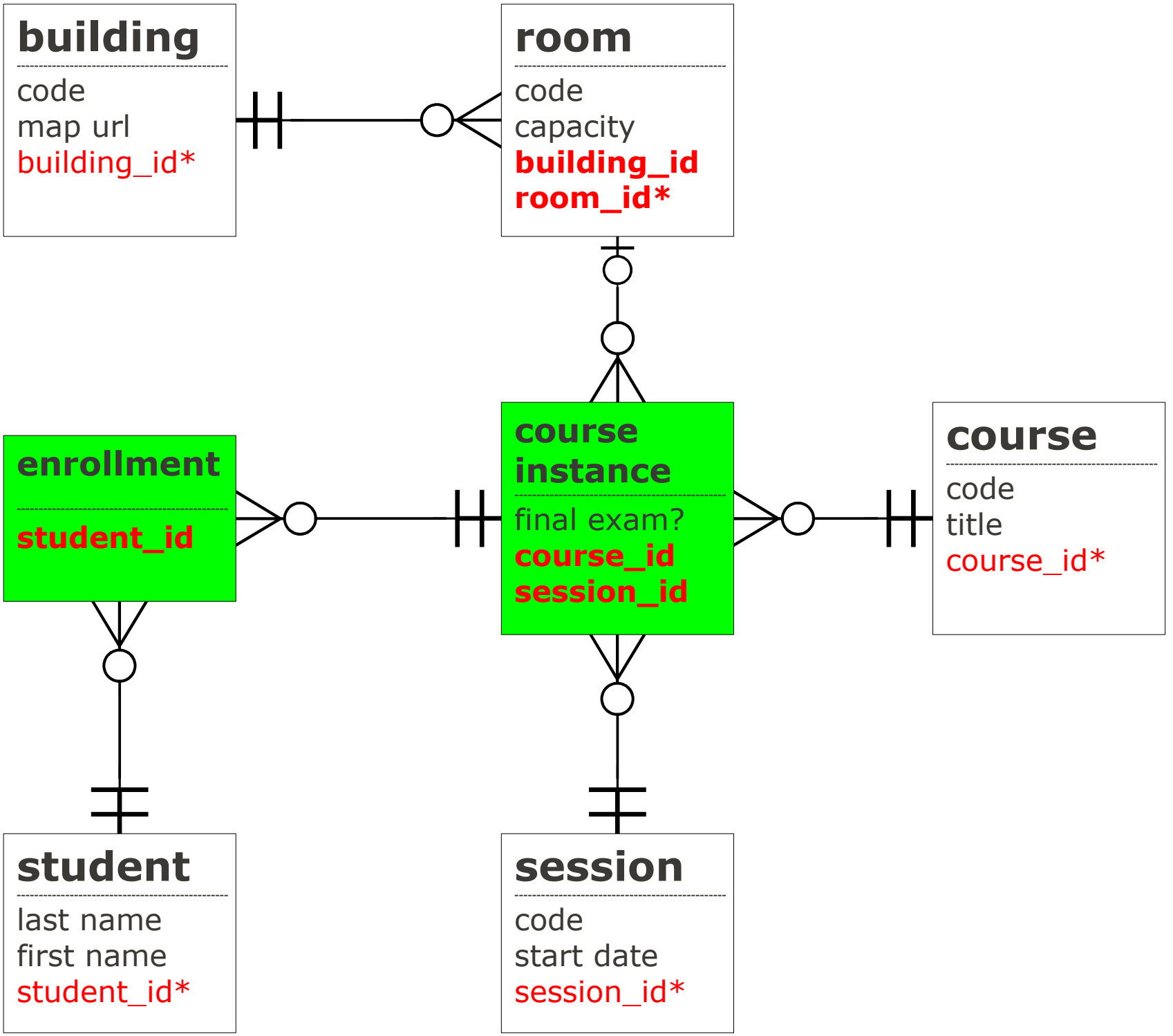
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course_id
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course_id*
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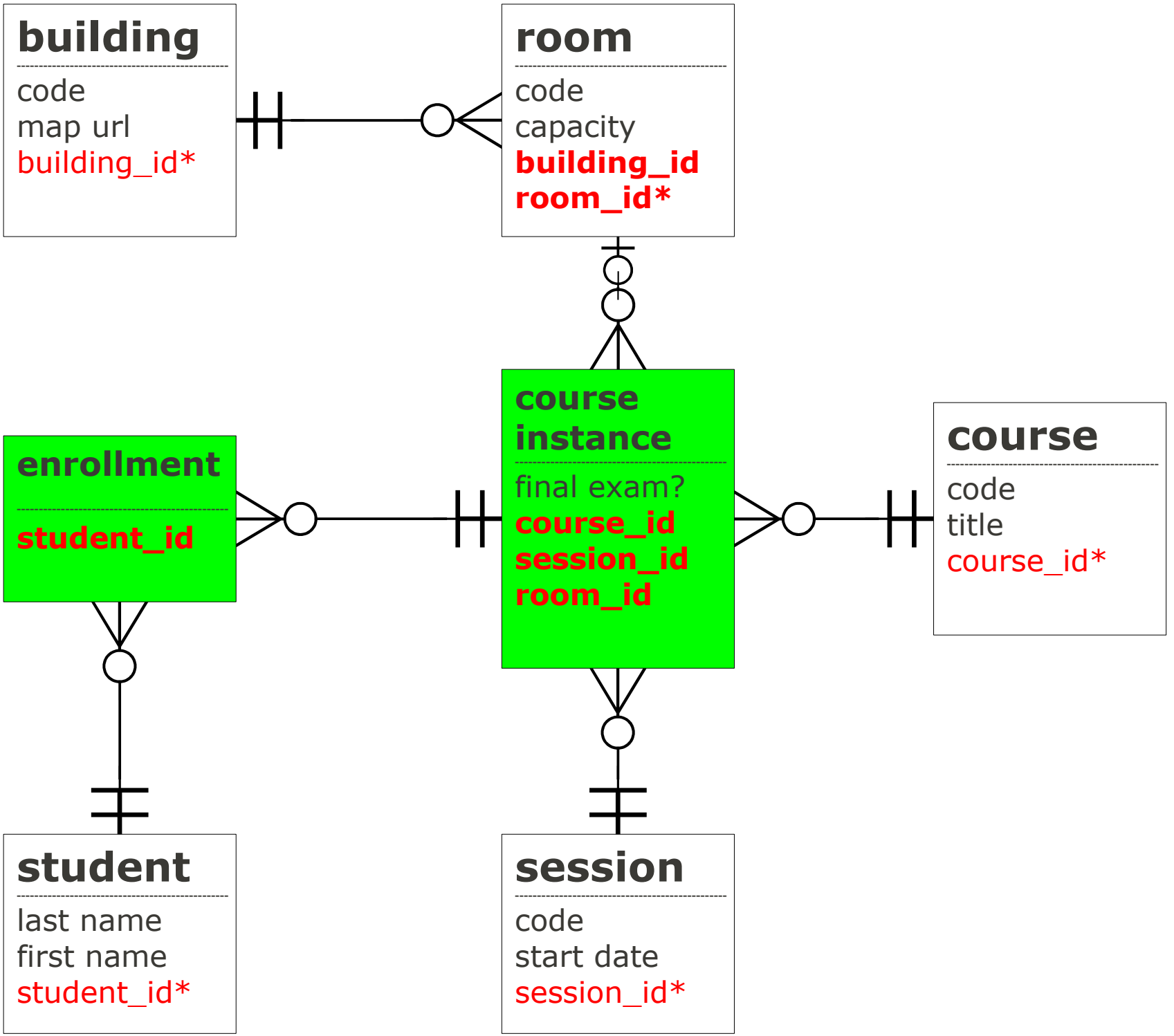
last name
first name
student_id*
session
code
start date
session_id*

Step 4d

Go back to step 3!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course_id
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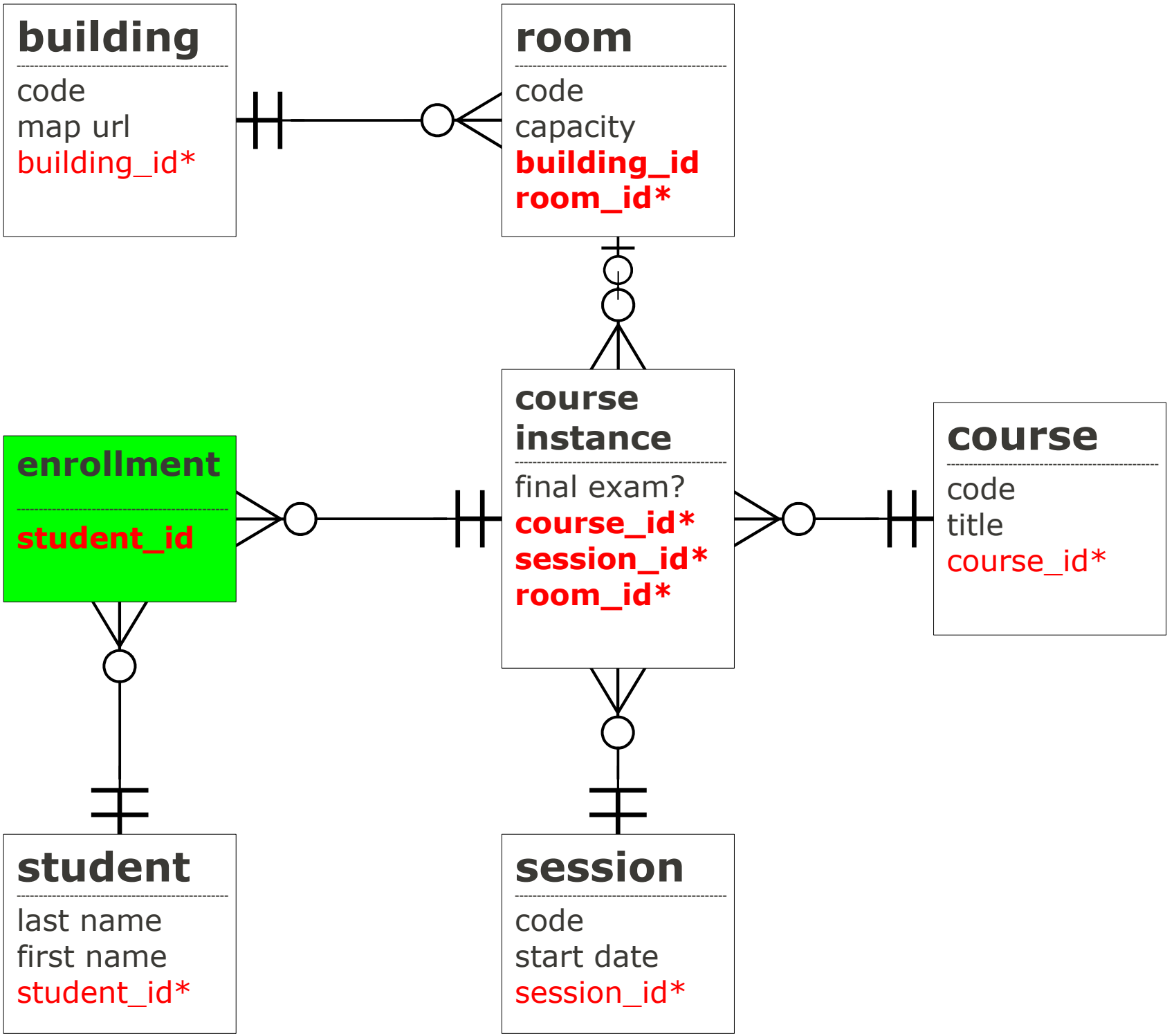
course_id*
enrollment
student_id
student
last name
first name
student_id*
session
code
start date
session_id*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enrollment
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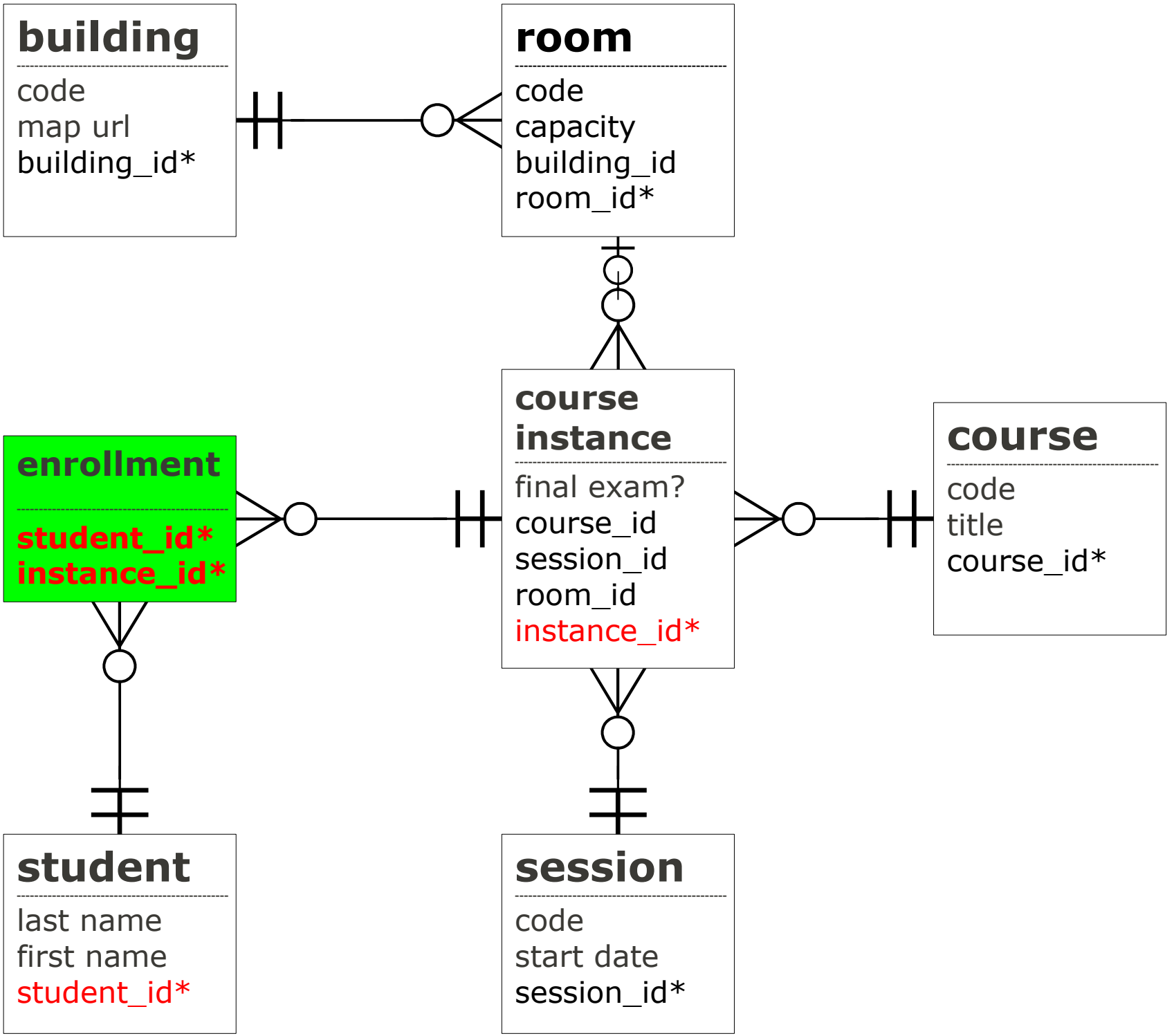
start date
session_id*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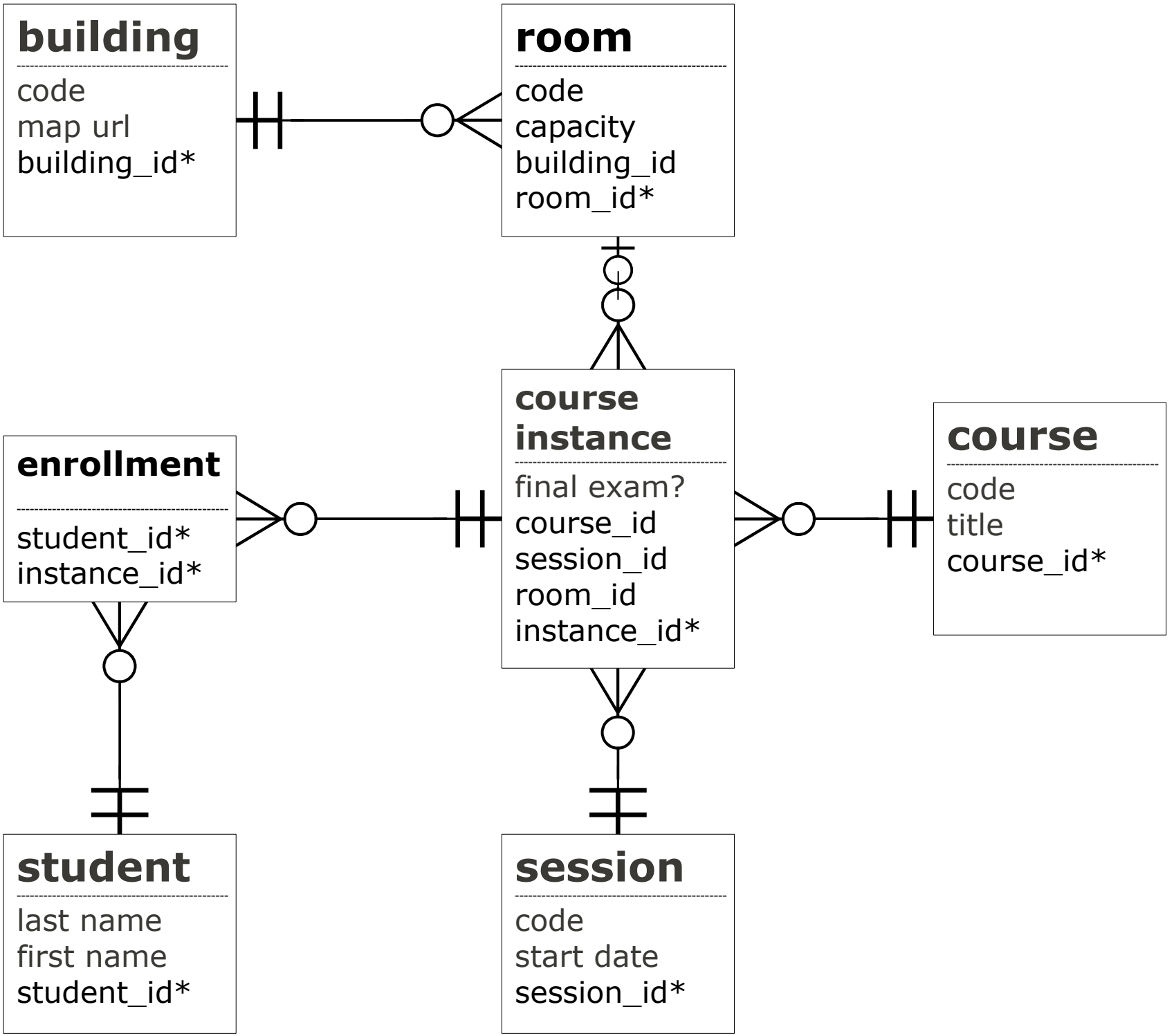
first name
student_id*
session
code
start date
session_id*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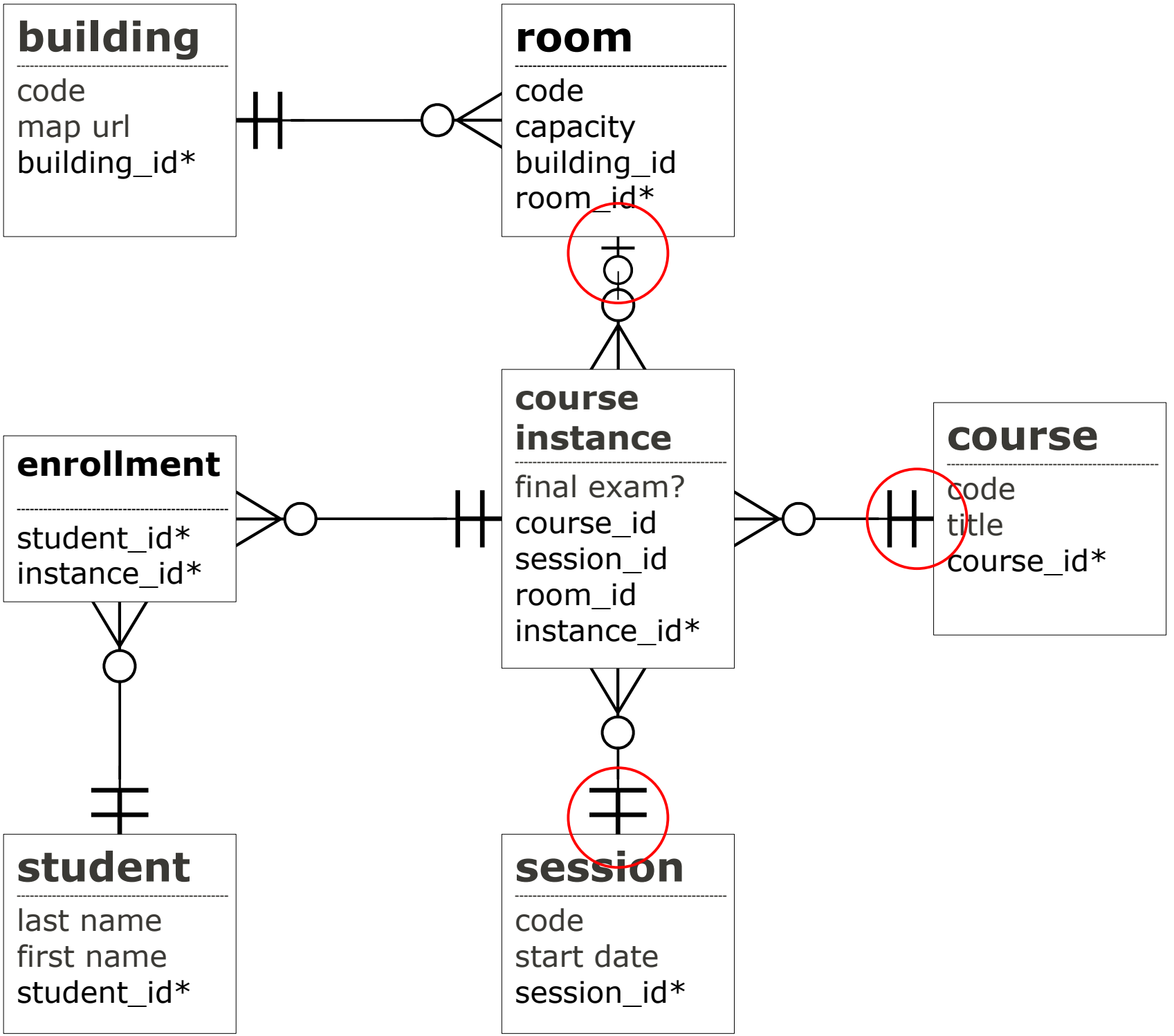
room_id
instance_id*
course
code
title
course_id*
enrollment
student_id*
instance_id*
student
last name
first name
student_id*
session
code
start date
session_id*

course_instance

name	type	null	key
instance_id	int	NO	PRI
course_id	int		
session_id	int		
room_id	int		
final_exam	bool		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course instance
final exam?
course_id
session_id
room_id
instance_id*
course
code
title
course_id*
enrollment
student_id*
instance_id*
student
last name
first name
student_id*
session
code
start date
session_id*

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!

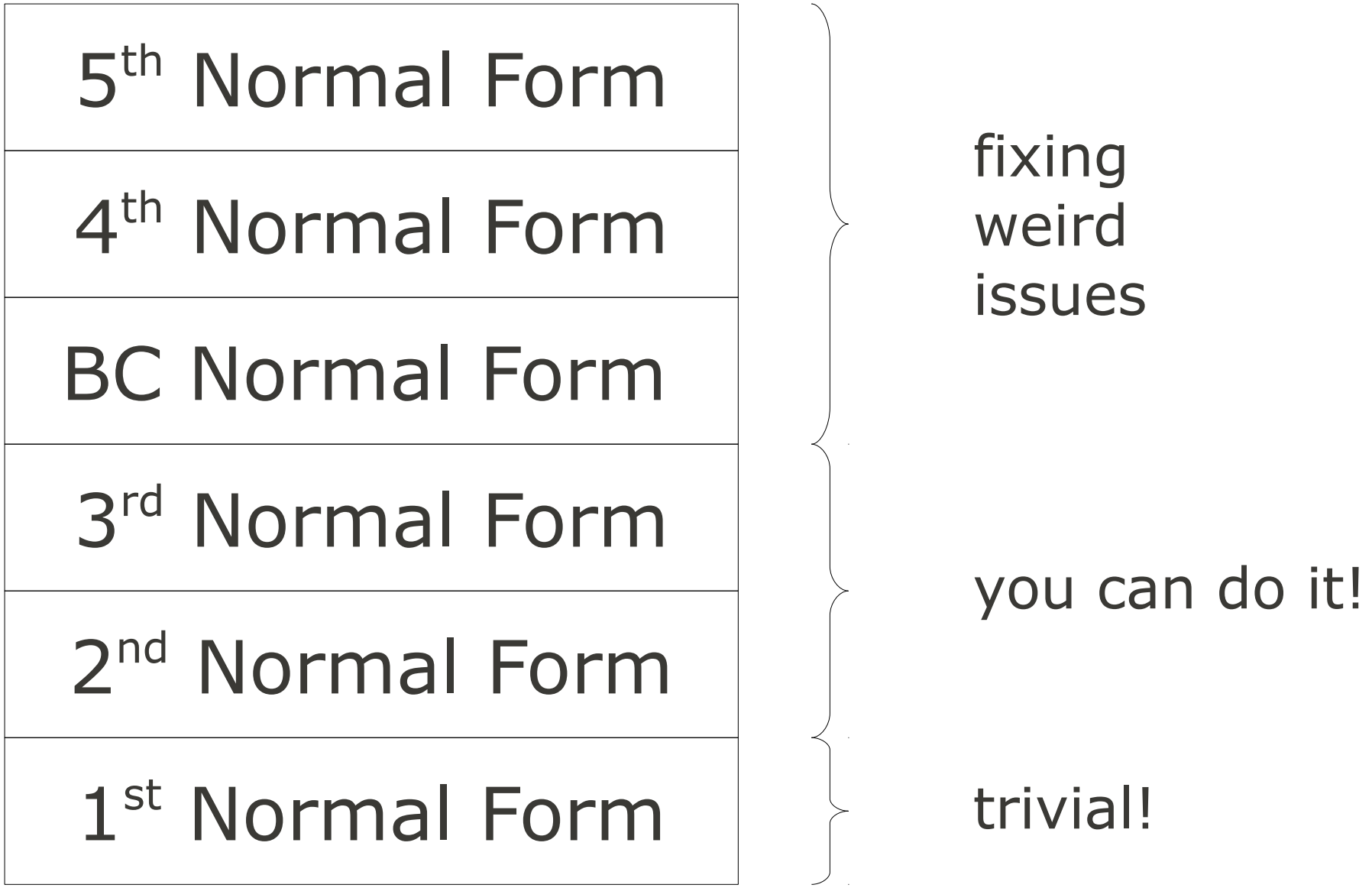
Normalization

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



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”	

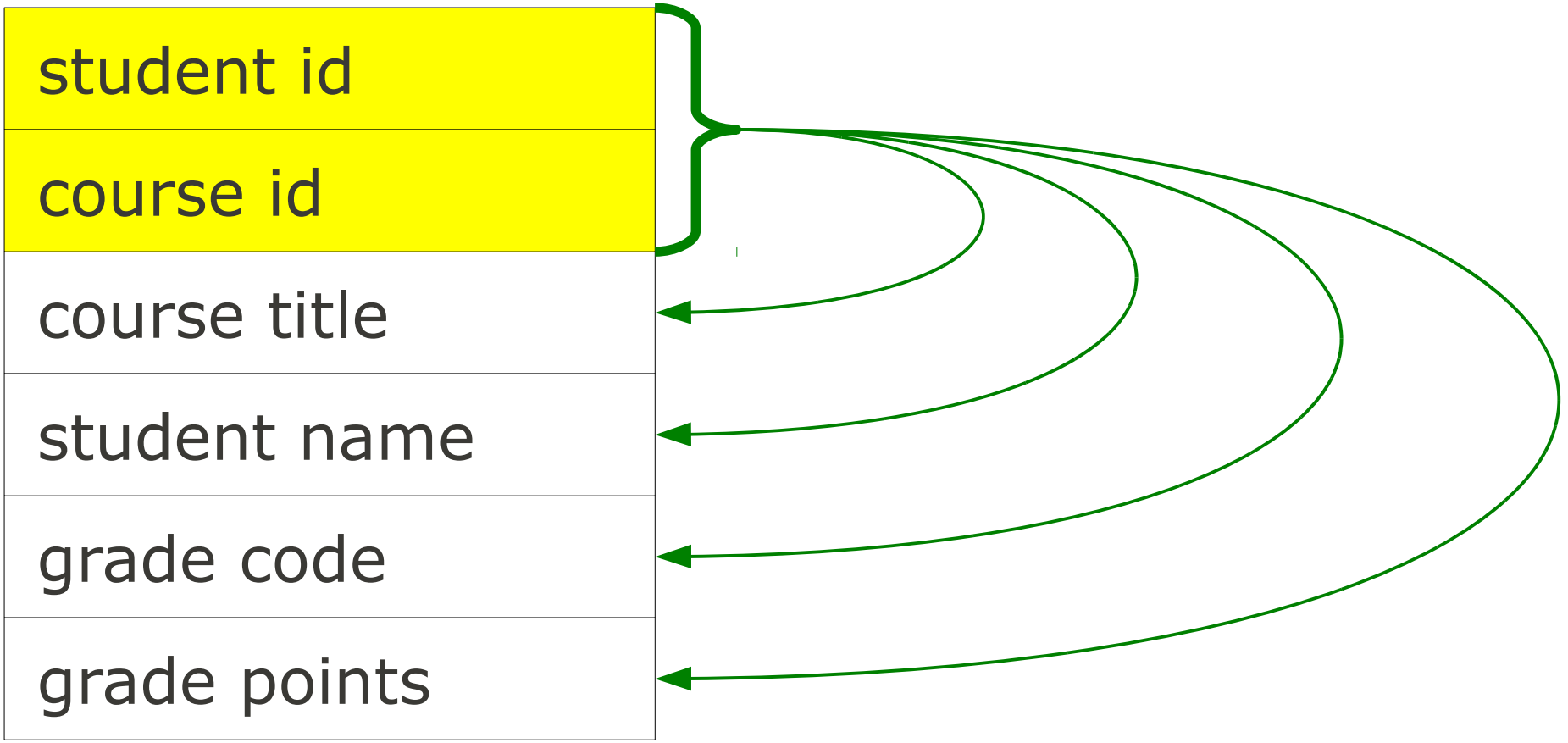
The Right Solution

pet_id	owner
1	Bob
2	Gwen

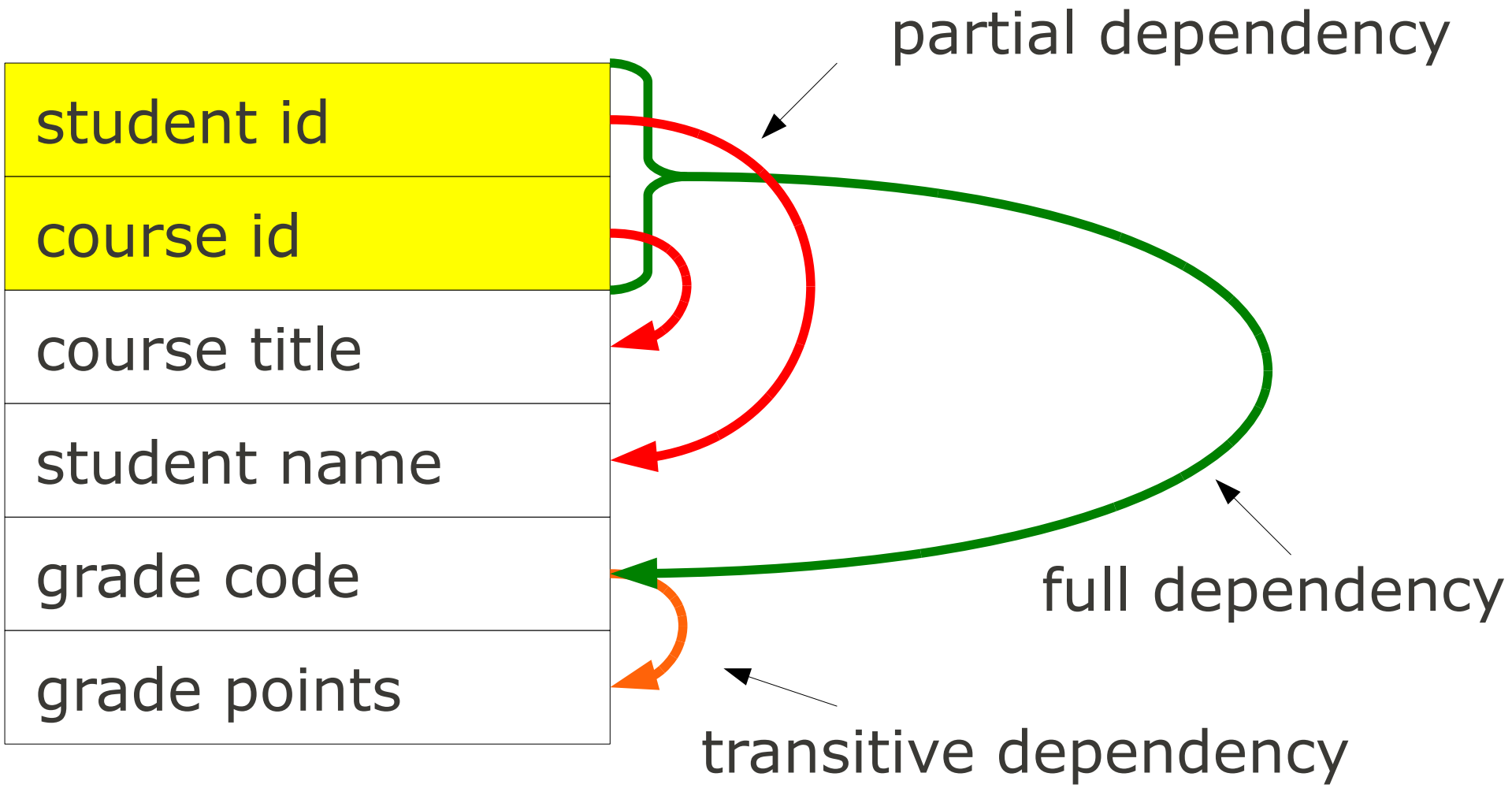
pet_id	names
1	Slim
1	the Serpent
1	Ribbon
2	Fluffy
2	Big Dog

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!"



"Each attribute must describe the key,
the whole key, and nothing but the key."
"So help me Codd!"

2NF and 3NF

2NF:

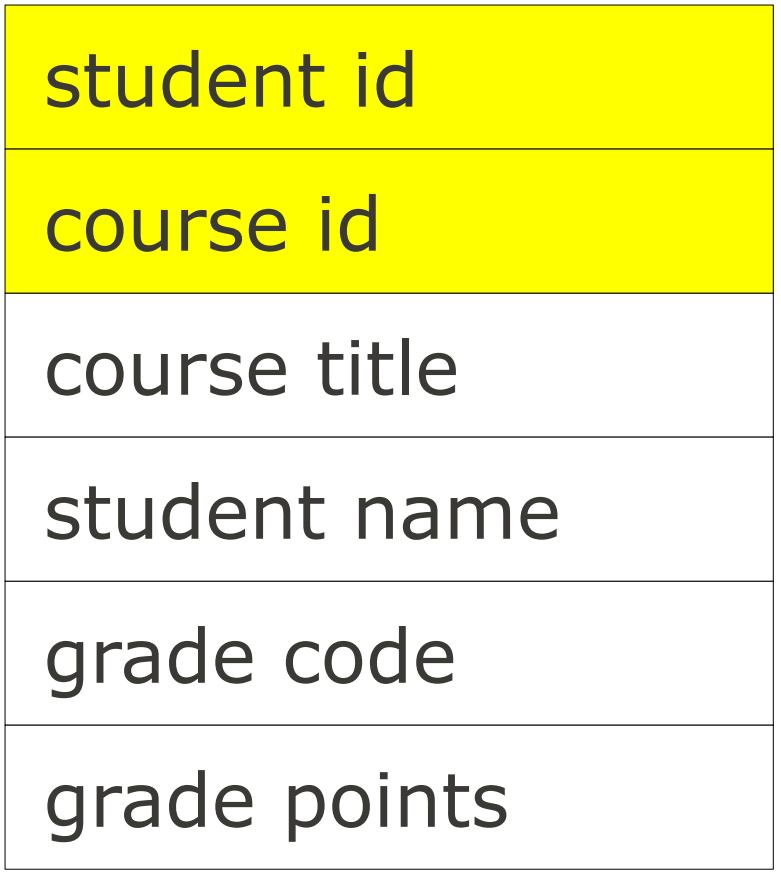
no partial dependencies
("the whole key")

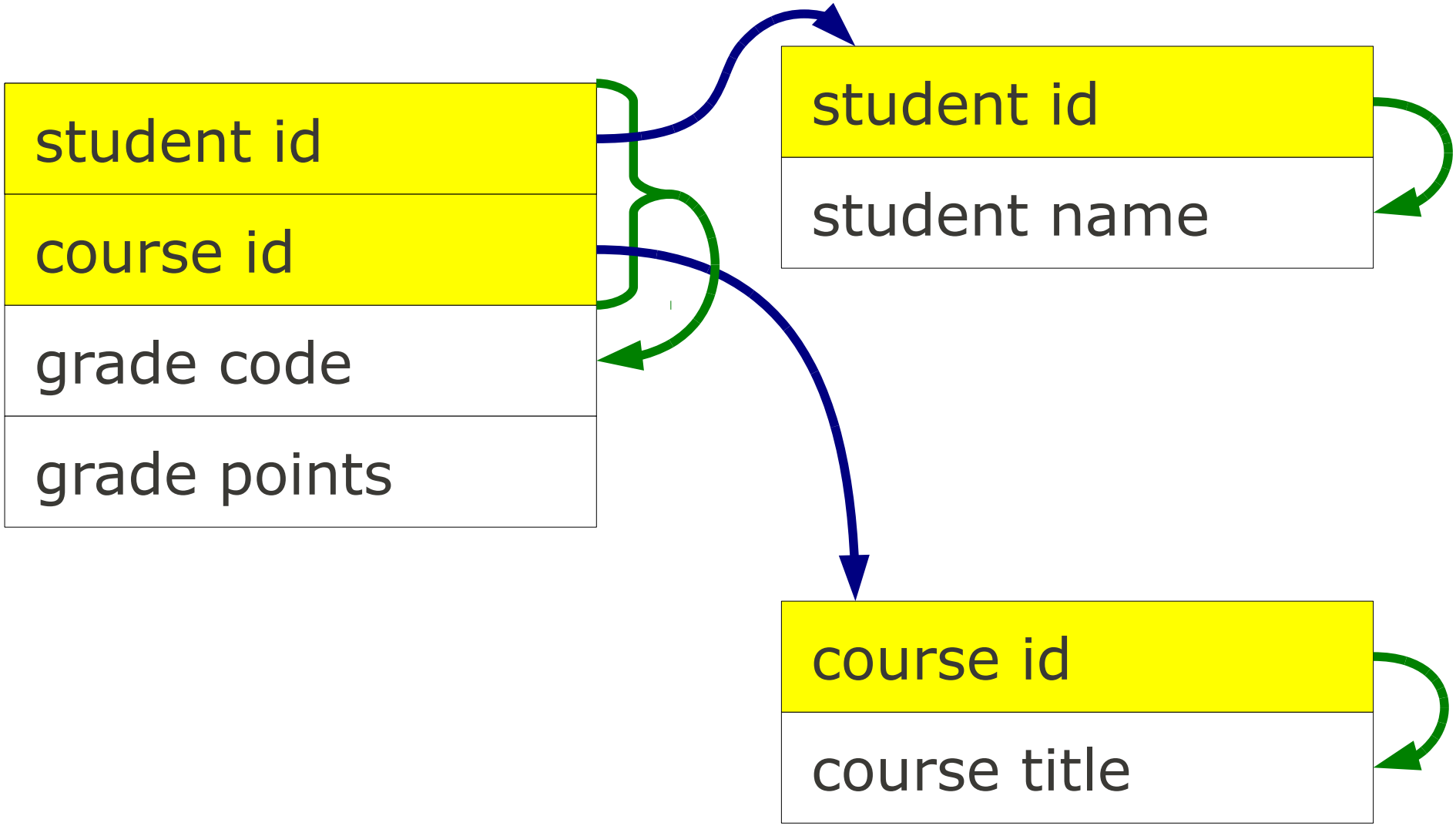
3NF:

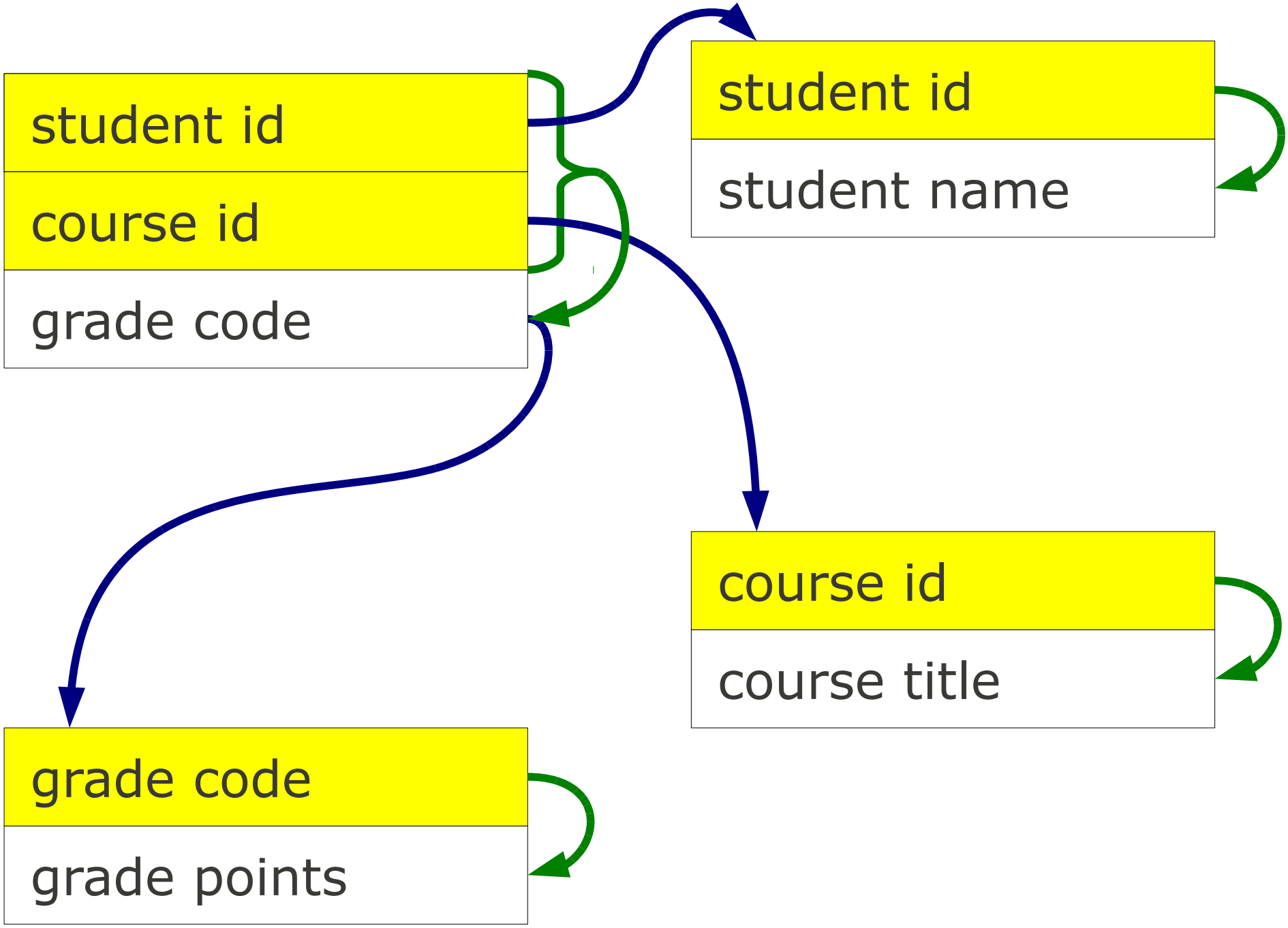
2NF + no transitive dependencies
("nothing but the key")

Reaching 2NF and 3NF

Decomposition
(break up tables into several)

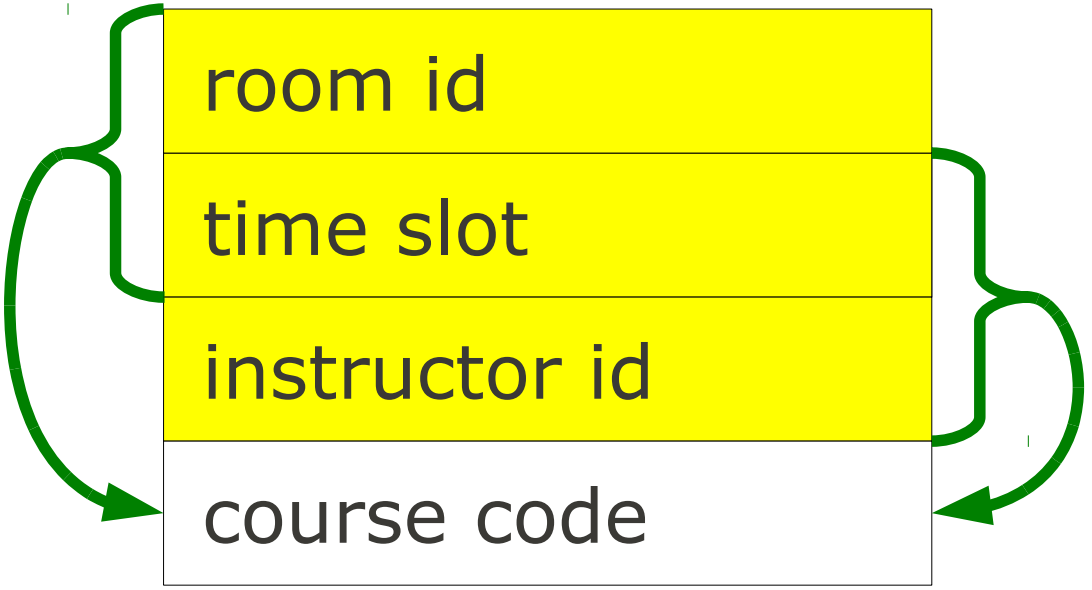

student id
course id
course title
student name
grade code
grade points


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

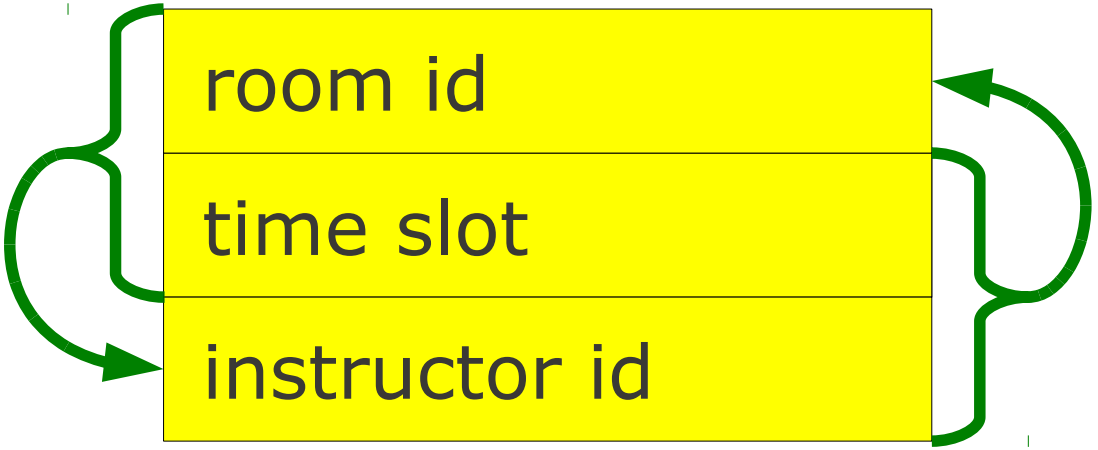

student id
course id
grade code
student id
student name
course id
course title
grade code
grade points

BCNF

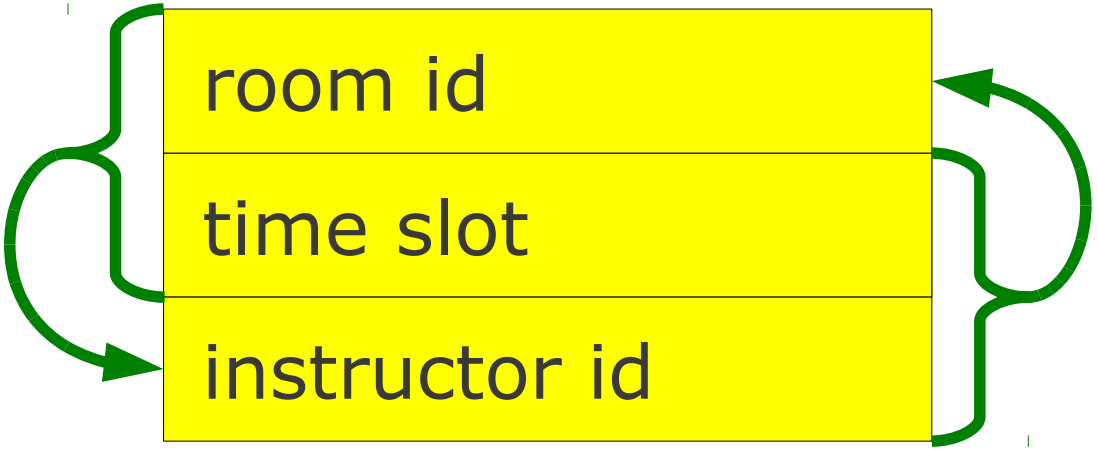
"all determinants must be candidate keys"



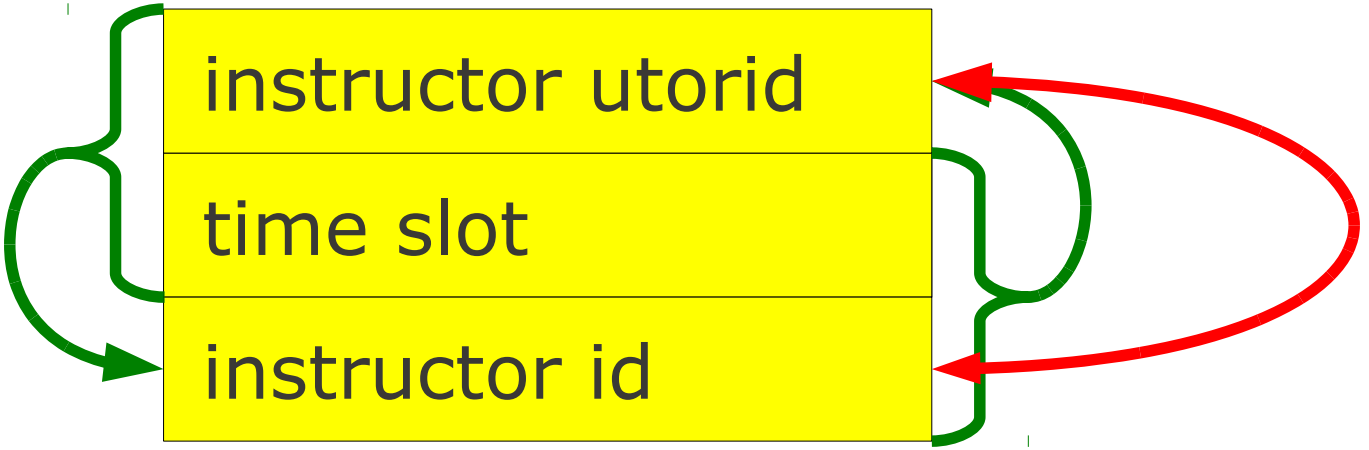
overlapping candidate keys



dependencies between keys

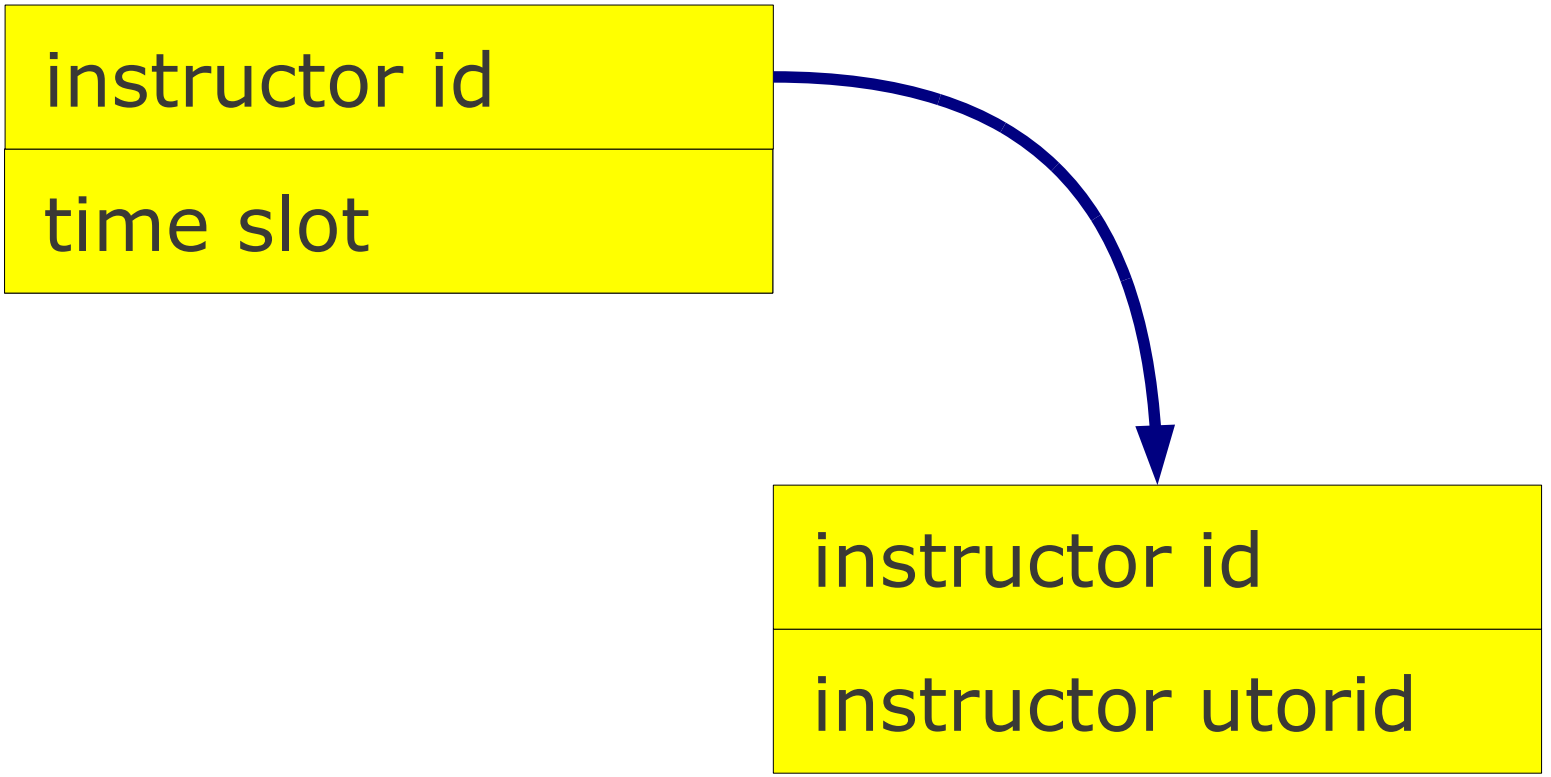


dependencies between keys

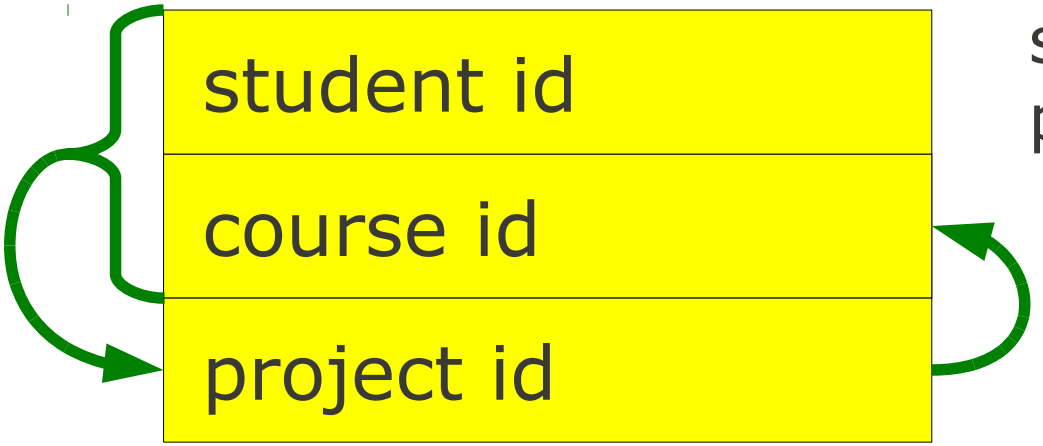


this is 3NF, but not BCNF

(“so help me Codd”)



decompose it



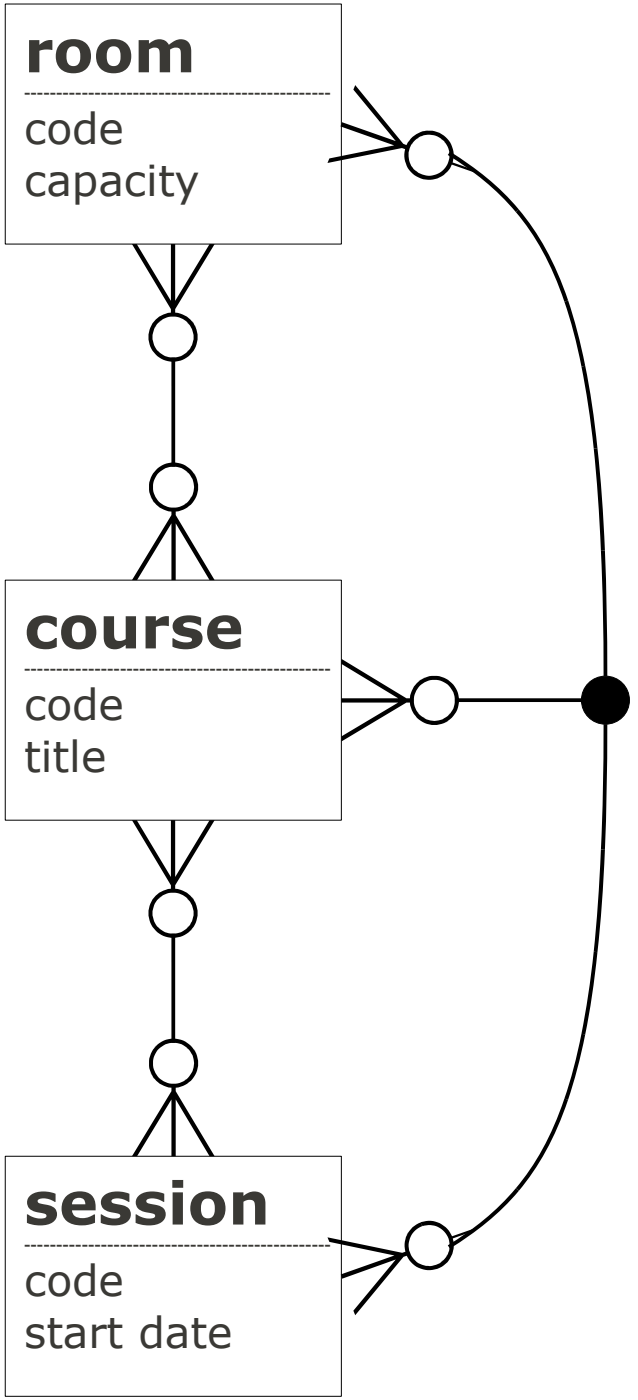
student, course → project
project → course

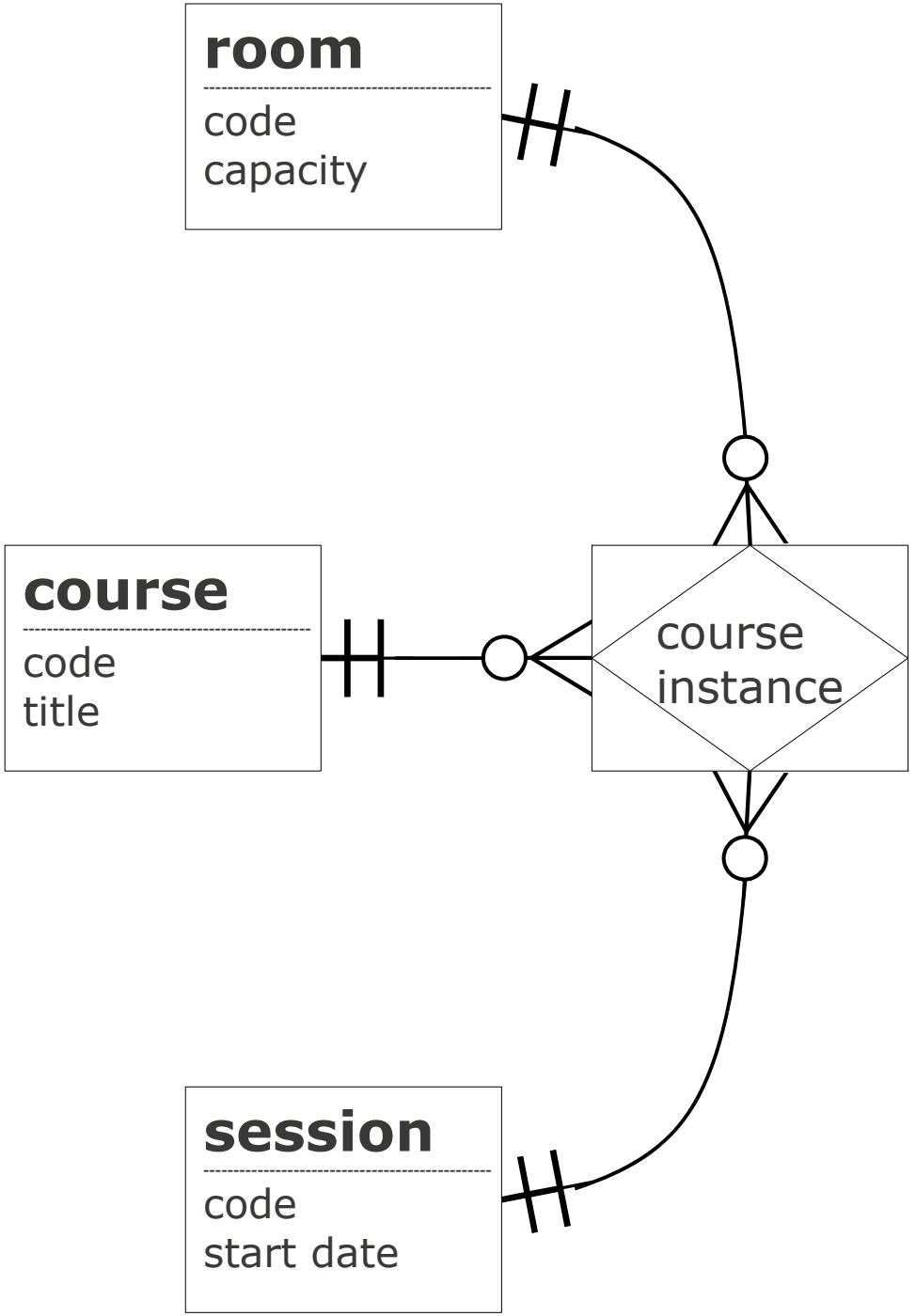
some relations cannot be decomposed into BCNF

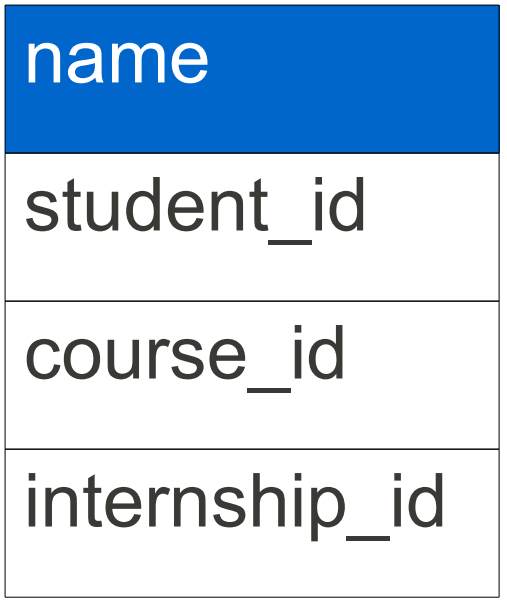
(“so help me Codd”)

4NF

Mistaking binary relationships for ternary


room
code
capacity
course
code
title
session
code
start date


room
code
capacity
course
code
title
course
instance
session
code
start date


name
student_id
course_id
internship_id

5NF

“We could break it up yet more”

Questions?