COMP 3311
DATABASE MANAGEMENT SYSTEMS

LECTURE 7 EXERCISES
STRUCTURED QUERY LANGUAGE (SQL)

EXAMPLE RELATIONAL SCHEMA AND DATABASE

Sailor(sailorId, sName, rating, age)

Boat(boatId, bName, color)

Reserves(*sailorId, boatId, rDate*)

Attribute names in italics are foreign key attributes.

Sailor

sailorId	sName	rating	age
22	Dustin	7	45
29	Brutus	1	33
31	Lubber	8	55
32	Andy	8	25
58	Rusty	10	35
64	Horatio	7	35
71	Zorba	10	16
74	Horatio	9	35
85	Art	3	25
95	Bob	3	63
99	Chris	10	30

11 tuples

Reserves

sailorId	*boatId*	rDate
22	101	10/10/17
22	102	10/10/17
22	103	08/10/17
22	104	07/10/17
31	102	10/11/17
31	103	06/11/17
31	104	12/11/17
64	101	05/09/17
64	102	08/09/17
74	103	08/09/17
99	104	08/08/17

11 tuples

Boat

boatId	bName	color
101	Interlake	blue
102	Interlake	red
103	Clipper	green
104	Marine	red
105	Serenity	Cyan

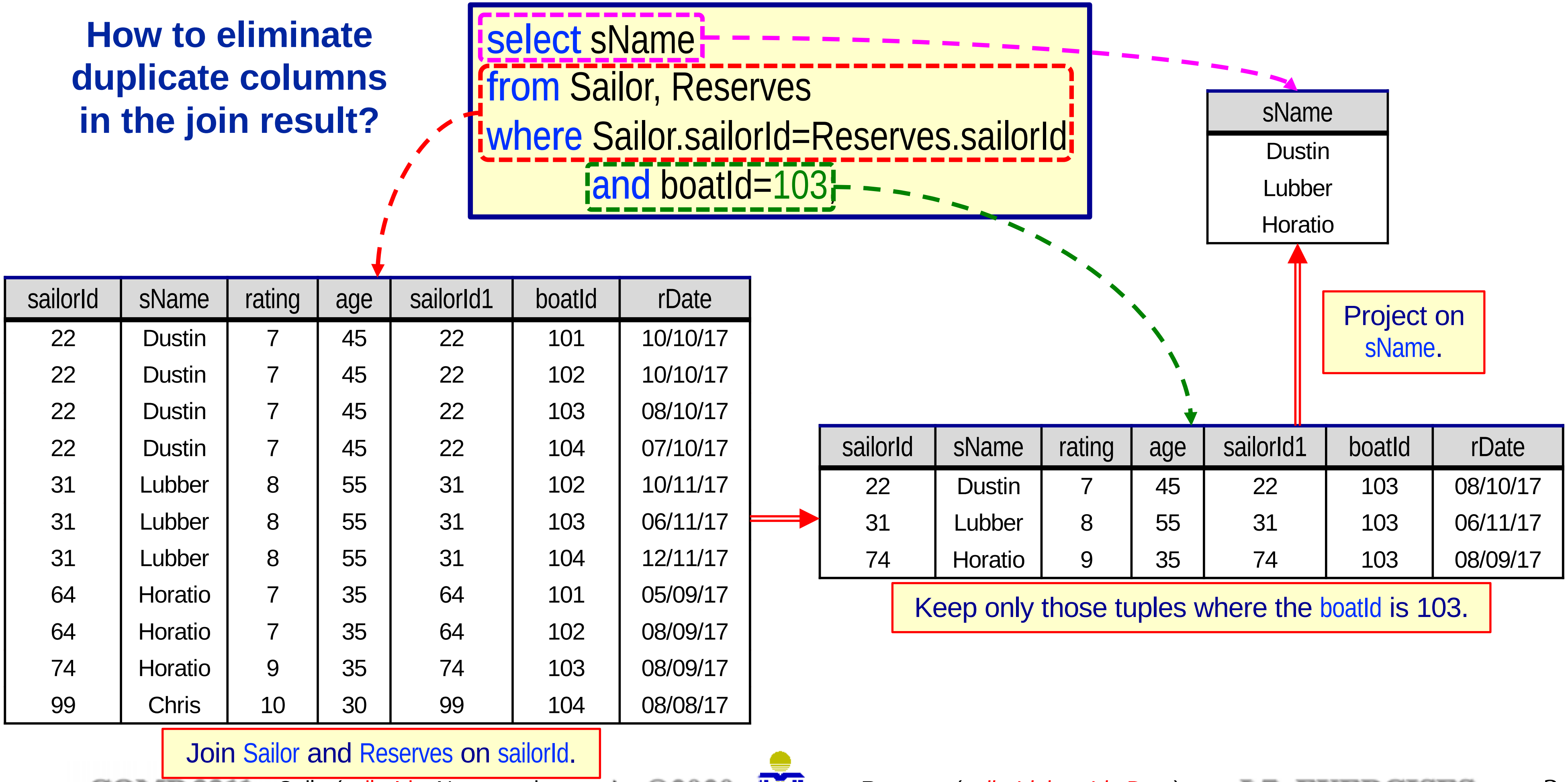
5 tuples

EXERCISE 1

Find the names of sailors who have reserved boat 103.

☞ **Dustin, Lubber, Horatio**

How to eliminate duplicate columns in the join result?



```
select sName
from Sailor, Reserves
where Sailor.sailorId=Reserves.sailorId
      and boatId=103
```

sailorId	sName	rating	age	sailorId1	boatId	rDate
22	Dustin	7	45	22	101	10/10/17
22	Dustin	7	45	22	102	10/10/17
22	Dustin	7	45	22	103	08/10/17
22	Dustin	7	45	22	104	07/10/17
31	Lubber	8	55	31	102	10/11/17
31	Lubber	8	55	31	103	06/11/17
31	Lubber	8	55	31	104	12/11/17
64	Horatio	7	35	64	101	05/09/17
64	Horatio	7	35	64	102	08/09/17
74	Horatio	9	35	74	103	08/09/17
99	Chris	10	30	99	104	08/08/17

Join Sailor and Reserves on sailorId.

sailorId	sName	rating	age	sailorId1	boatId	rDate
22	Dustin	7	45	22	103	08/10/17
31	Lubber	8	55	31	103	06/11/17
74	Horatio	9	35	74	103	08/09/17

Keep only those tuples where the boatId is 103.

Project on sName.

sName
Dustin
Lubber
Horatio

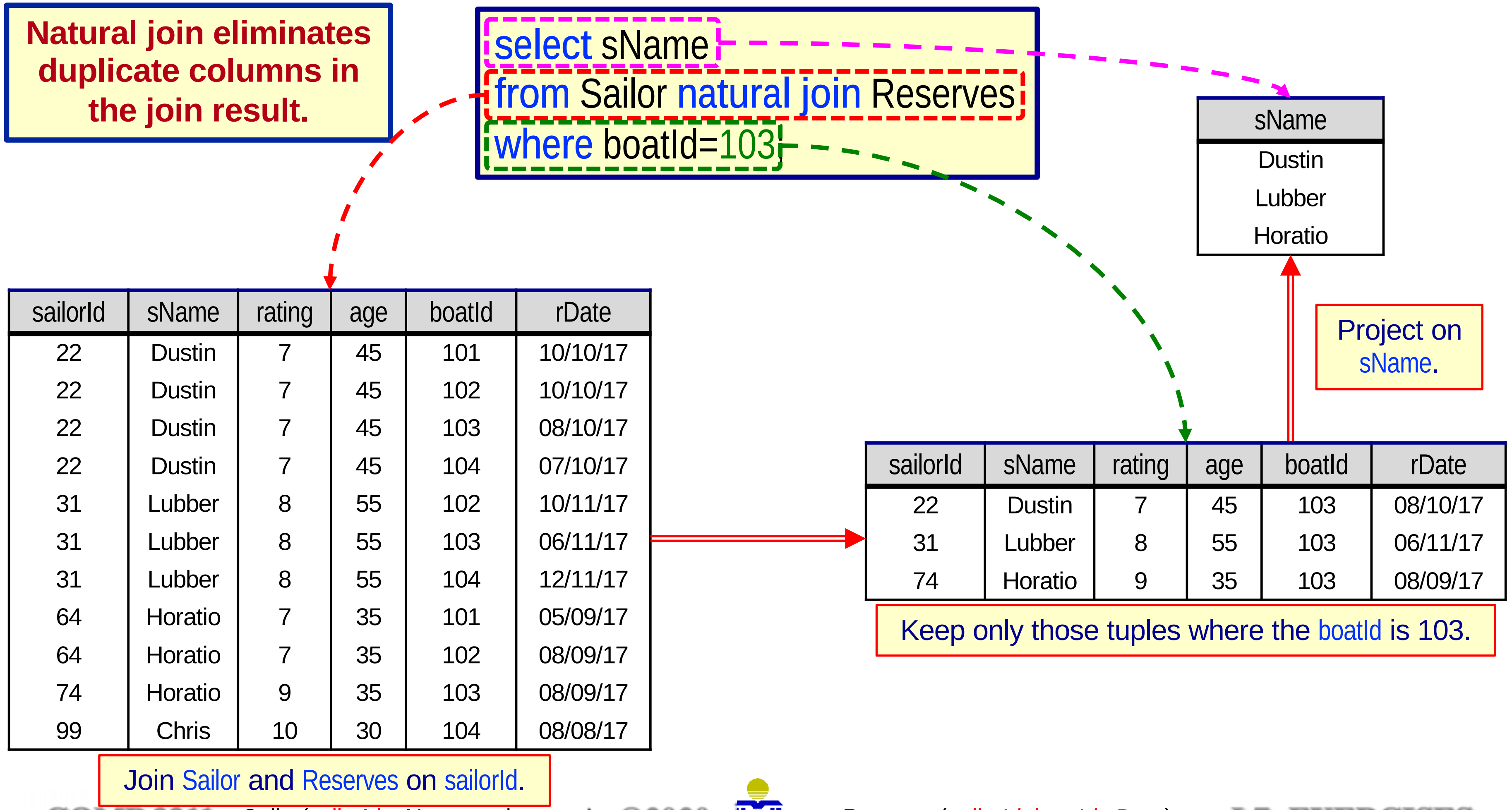
Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

EXERCISE 1 (CONTD)

Find the names of sailors who have reserved boat 103.

☞ **Dustin, Lubber, Horatio**



Natural join eliminates duplicate columns in the join result.

```
select sName
from Sailor natural join Reserves
where boatId=103
```

sailorId	sName	rating	age	boatId	rDate
22	Dustin	7	45	101	10/10/17
22	Dustin	7	45	102	10/10/17
22	Dustin	7	45	103	08/10/17
22	Dustin	7	45	104	07/10/17
31	Lubber	8	55	102	10/11/17
31	Lubber	8	55	103	06/11/17
31	Lubber	8	55	104	12/11/17
64	Horatio	7	35	101	05/09/17
64	Horatio	7	35	102	08/09/17
74	Horatio	9	35	103	08/09/17
99	Chris	10	30	104	08/08/17

Join Sailor and Reserves on sailorId.

sailorId	sName	rating	age	boatId	rDate
22	Dustin	7	45	103	08/10/17
31	Lubber	8	55	103	06/11/17
74	Horatio	9	35	103	08/09/17

Keep only those tuples where the boatId is 103.

Project on sName.

sName
Dustin
Lubber
Horatio

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

EXERCISE 2

Find the ids and names of sailors who have reserved either a red or a green boat.

☞ **(22, Dustin), (31, Lubber), (64, Horatio), (74, Horatio), (99, Chris)**

```
select distinct Sailor.sailorId, sName
from Sailor, Reserves, Boat
where Sailor.sailorId=Reserves.sailorId
        and Reserves.boatId=Boat.boatId
        and (color='red' or color='green');
```

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

Boat(boatId, bName, color)

Join Sailor and Reserves on sailorId and Reserves and Boat on boatId.

sailorId	sName	rating	age	sailorId1	boatId	rDate	boatId1	bName	color
22	Dustin	7	45	22	101	10/10/17	101	Interlake	blue
22	Dustin	7	45	22	102	10/10/17	102	Interlake	red
22	Dustin	7	45	22	103	08/10/17	103	Clipper	green
22	Dustin	7	45	22	104	07/10/17	104	Marine	red
31	Lubber	8	55	31	102	10/11/17	102	Interlake	red
31	Lubber	8	55	31	103	06/11/17	103	Clipper	green
31	Lubber	8	55	31	104	12/11/17	104	Marine	red
64	Horatio	7	35	64	101	05/09/17	101	Interlake	blue
64	Horatio	7	35	64	102	08/09/17	102	Interlake	red
74	Horatio	9	35	74	103	08/09/17	103	Clipper	green
99	Chris	10	30	99	104	08/08/17	104	Marine	red

EXERCISE 2 (CONTD)

Find the ids and names of sailors who have reserved either a red or a green boat.

☞ **(22, Dustin), (31, Lubber), (64, Horatio), (74, Horatio), (99, Chris)**

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

Boat(boatId, bName, color)

```
select distinct Sailor.sailorId, sName
from Sailor, Reserves, Boat
where Sailor.sailorId=Reserves.sailorId
        and Reserves.boatId=Boat.boatId
        and (color='red' or color='green');
```

sailorId	sName	rating	age	sailorId1	boatId	rDate	boatId1	bName	color
22	Dustin	7	45	22	102	10/10/17	102	Interlake	red
22	Dustin	7	45	22	103	08/10/17	103	Clipper	green
22	Dustin	7	45	22	104	07/10/17	104	Marine	red
31	Lubber	8	55	31	102	10/11/17	102	Interlake	red
31	Lubber	8	55	31	103	06/11/17	103	Clipper	green
31	Lubber	8	55	31	104	12/11/17	104	Marine	red
64	Horatio	7	35	64	102	08/09/17	102	Interlake	red
74	Horatio	9	35	74	103	08/09/17	103	Clipper	green
99	Chris	10	30	99	104	08/08/17	104	Marine	red

Keep only those tuples where the boat color is red or green.

sailorId	sName
22	Dustin
22	Dustin
22	Dustin
31	Lubber
31	Lubber
31	Lubber
64	Horatio
74	Horatio
99	Chris

Project on sailorId and sName.

Keep only unique tuples.

sailorId	sName
22	Dustin
31	Lubber
64	Horatio
74	Horatio
99	Chris

EXERCISE 2 (CONTD)

Find the ids and names of sailors who have reserved either a red or a green boat.

☞ **(22, Dustin), (31, Lubber), (64, Horatio), (74, Horatio), (99, Chris)**

```
select distinct Sailor.sailorId, sName
from Sailor, Reserves, Boat
where Sailor.sailorId=Reserves.sailorId
          and Reserves.boatId=Boat.boatId
          and (color='red’ and color='green');
```

Sailor(sailorId, sName, rating, age)

Reserves(*sailorId*, *boatId*, rDate)

Boat(boatId, bName, color)

Why is it necessary to qualify sailorId in the select clause?

☞ sailorId **is ambiguous in the join result.**
Should we take it from Sailor **or** Reserves**?**
(For some operations it will make a difference!)

What do we get if we replace or with and in the query?

☞ **No result since there is no boat whose color is both red and green!**

EXERCISE 2 (CONTD)

Find the ids and names of sailors who have reserved either a red or a green boat.

☞ **(22, Dustin), (31, Lubber), (64, Horatio), (74, Horatio), (99, Chris)**

```
select distinct sailorId, sName
from Sailor natural join Reserves natural join Boat
where color='red' or color='green';
```

sailorId	sName
22	Dustin
31	Lubber
64	Horatio
74	Horatio
99	Chris

Keep only unique tuples.

Use natural join to eliminate duplicate columns in the join result.

sailorId	sName	rating	age	boatId	rDate	bName	color
22	Dustin	7	45	102	10/10/17	Interlake	red
22	Dustin	7	45	103	08/10/17	Clipper	green
22	Dustin	7	45	104	07/10/17	Marine	red
31	Lubber	8	55	102	10/11/17	Interlake	red
31	Lubber	8	55	103	06/11/17	Clipper	green
31	Lubber	8	55	104	12/11/17	Marine	red
64	Horatio	7	35	102	08/09/17	Interlake	red
74	Horatio	9	35	103	08/09/17	Clipper	green
99	Chris	10	30	104	08/08/17	Marine	red

Keep only those tuples where the boat color is red or green.

sailorId	sName
22	Dustin
~~22~~	~~Dustin~~
~~22~~	~~Dustin~~
31	Lubber
~~31~~	~~Lubber~~
~~31~~	~~Lubber~~
64	Horatio
74	Horatio
99	Chris

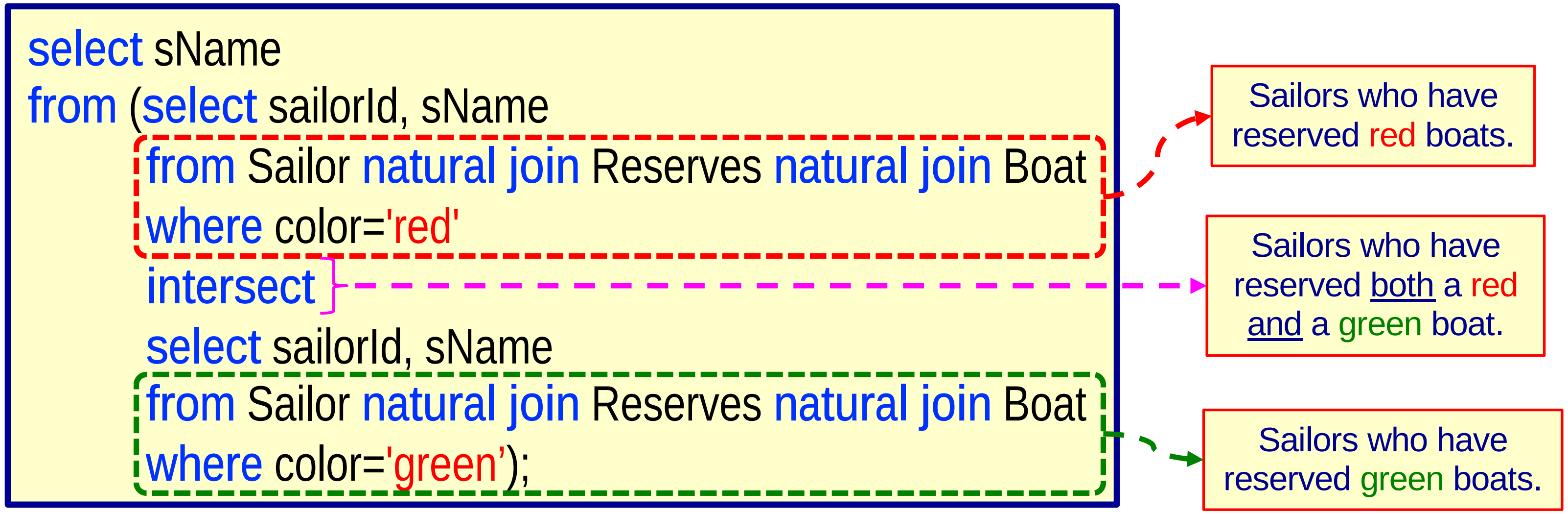
Project on sailorId and sName.

EXERCISE 3

Find the names of sailors who have reserved both a red and a green boat.

Use intersect

☞ **Dustin, Lubber**



```
select sName
from (select sailorId, sName
        from Sailor natural join Reserves natural join Boat
        where color='red'
        intersect
        select sailorId, sName
        from Sailor natural join Reserves natural join Boat
        where color='green');
```

Sailors who have reserved red boats.

Sailors who have reserved both a red and a green boat.

Sailors who have reserved green boats.

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

Boat(boatId, bName, color)

EXERCISE 3 (CONTD)

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

Boat(boatId, bName, color)

Find the names of sailors who have reserved both a red and a green boat.

Use intersect

☞ **Dustin, Lubber**

from Sailor, Reserves, Boat where Sailor.sailorId=Reserves.sailorId and Reserves.boatId=Boat.boatId and color='red'

sailorId	sName	rating	age	boatId	rDate	bName	color
22	Dustin	7	45	102	10/10/17	Interlake	red
22	Dustin	7	45	104	07/10/17	Marine	red
31	Lubber	8	55	102	10/11/17	Interlake	red
31	Lubber	8	55	104	12/11/17	Marine	red
64	Horatio	7	35	102	08/09/17	Interlake	red
99	Chris	10	30	104	08/08/17	Marine	red

Sailors who have reserved red boats.

select Sailor.sailorId, sName

sailorId	sName
22	Dustin
22	Dustin
31	Lubber
31	Lubber
64	Horatio
99	Chris

Why are there no duplicates in the result?

∩

select sName

sName
Dustin
Lubber

from Sailor, Reserves, Boat where Sailor.sailorId=Reserves.sailorId and Reserves.boatId=Boat.boatId and color='green'

sailorId	sName	rating	age	boatId	rDate	bName	color
22	Dustin	7	45	103	08/10/17	Clipper	green
31	Lubber	8	55	103	06/11/17	Clipper	green
74	Horatio	9	35	103	08/09/17	Clipper	green

Sailors who have reserved green boats.

select Sailor.sailorId, sName

sailorId	sName
22	Dustin
31	Lubber
74	Horatio

EXERCISE 3 (CONTD)

What happens if we remove sailorId from the inner select clauses?

Find the names of sailors who have reserved both a red and a green boat.

Use intersect

☞ **Dustin, Lubber**

```
select sName
from (select sName
          from Sailor natural join Reserves natural join Boat
          where color='red'
          intersect
          select sName
          from Sailor natural join Reserves natural join Boat
          where color='green');
```

Sailors who have reserved red boats.

Sailors who have reserved both a red and a green boat.

Sailors who have reserved green boats.

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

Boat(boatId, bName, color)

EXERCISE 3 (CONTD)

What happens if we remove sailorId from the inner select clauses?

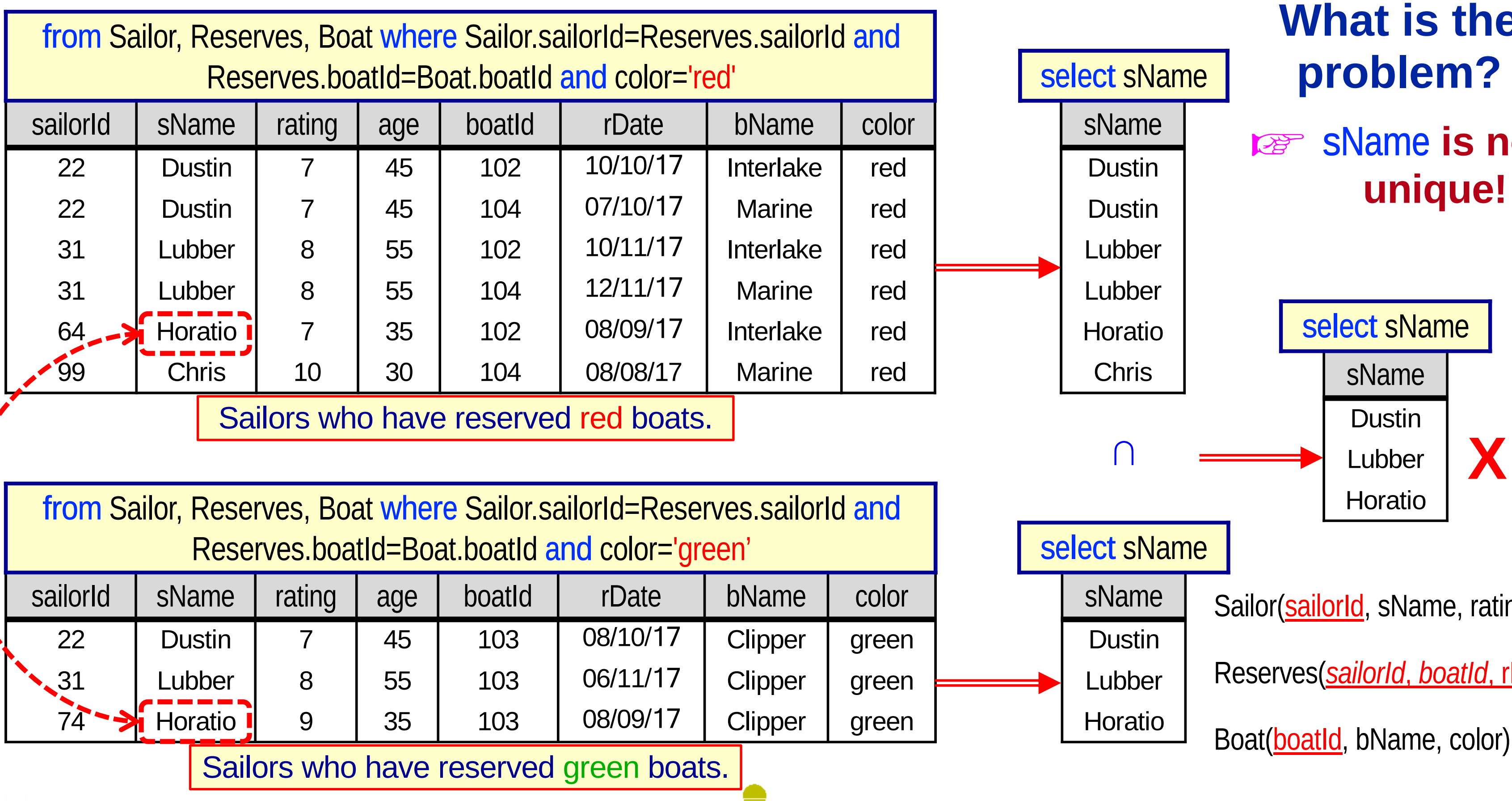
Find the names of sailors who have reserved both a red and a green boat.

Use intersect

☞ **Dustin, Lubber**

What is the problem?

☞ sName **is not unique!**



from Sailor, Reserves, Boat where Sailor.sailorId=Reserves.sailorId and Reserves.boatId=Boat.boatId and color='red'

sailorId	sName	rating	age	boatId	rDate	bName	color
22	Dustin	7	45	102	10/10/17	Interlake	red
22	Dustin	7	45	104	07/10/17	Marine	red
31	Lubber	8	55	102	10/11/17	Interlake	red
31	Lubber	8	55	104	12/11/17	Marine	red
64	Horatio	7	35	102	08/09/17	Interlake	red
99	Chris	10	30	104	08/08/17	Marine	red

Sailors who have reserved red boats.

select sName

sName
Dustin
Dustin
Lubber
Lubber
Horatio
Chris

∩

select sName

sName
Dustin
Lubber
Horatio

X

from Sailor, Reserves, Boat where Sailor.sailorId=Reserves.sailorId and Reserves.boatId=Boat.boatId and color='green'

sailorId	sName	rating	age	boatId	rDate	bName	color
22	Dustin	7	45	103	08/10/17	Clipper	green
31	Lubber	8	55	103	06/11/17	Clipper	green
74	Horatio	9	35	103	08/09/17	Clipper	green

Sailors who have reserved green boats.

select sName

sName
Dustin
Lubber
Horatio

Sailor(sailorId, sName, rating, age)

Reserves(*sailorId*, *boatId*, rDate)

Boat(boatId, bName, color)

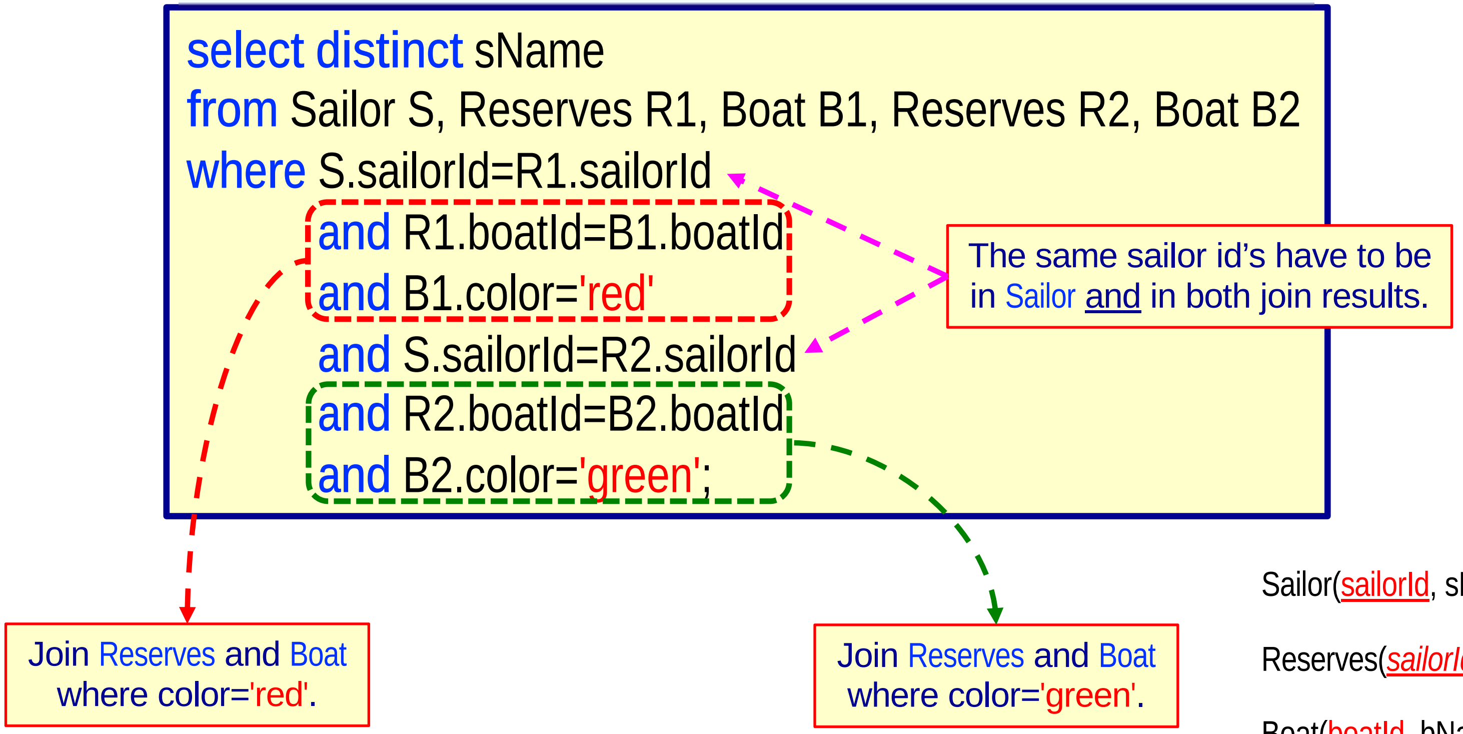
EXERCISE 3 (CONTD)

Find the names of sailors who have reserved both a red and a green boat.

Use Join

☞ Dustin, Lubber

☞ Hint: You need to use correlation names.



```
select distinct sName
from Sailor S, Reserves R1, Boat B1, Reserves R2, Boat B2
where S.sailorId=R1.sailorId
      and R1.boatId=B1.boatId
      and B1.color='red'
      and S.sailorId=R2.sailorId
      and R2.boatId=B2.boatId
      and B2.color='green';
```

The same sailor id's have to be in Sailor and in both join results.

Join Reserves and Boat where color='red'.

Join Reserves and Boat where color='green'.

Sailor(sailorId, sName, rating, age)

Reserves(sailorId, boatId, rDate)

Boat(boatId, bName, color)

EXERCISE 3 (CONTD)

Find the names of sailors who have reserved <u>both</u> a red <u>and</u> a green boat.

Use Join

☞ **Dustin, Lubber**

Only 22 and 31 are in both join results <u>and</u> in Sailor.

Sailor

sailorId	sName	rating	age
22	Dustin	7	45
29	Brutus	1	33
31	Lubber	8	55
32	Andy	8	25
58	Rusty	10	35
64	Horatio	7	35
71	Zorba	10	16
74	Horatio	9	35
85	Art	3	25
95	Bob	3	63
99	Chris	10	30

Result of join Reserves and Boat where color='red'.

R1.boatId=B1.boatId and B1.color='red'

sailorId	boatId	rDate	bName	color
22	102	10/10/17	Interlake	red
22	104	07/10/17	Marine	red
31	102	10/11/17	Interlake	red
31	104	12/11/17	Marine	red
64	102	08/09/17	Interlake	red
99	104	08/08/17	Marine	red

$\text{JOIN}_{\text{sailorId}}$

R2.boatId=B2.boatId and B2.color='green'

sailorId	boatId	rDate	bName	color
22	103	08/10/17	Clipper	green
31	103	06/11/17	Clipper	green
74	103	08/09/17	Clipper	green

Result of join Reserves and Boat where color='green'.

<u>Note</u>
Duplicate columns are not shown in the join result.

select distinct sName

sName
Dustin
Lubber

Sailor(<u>sailorId</u>, sName, rating, age)

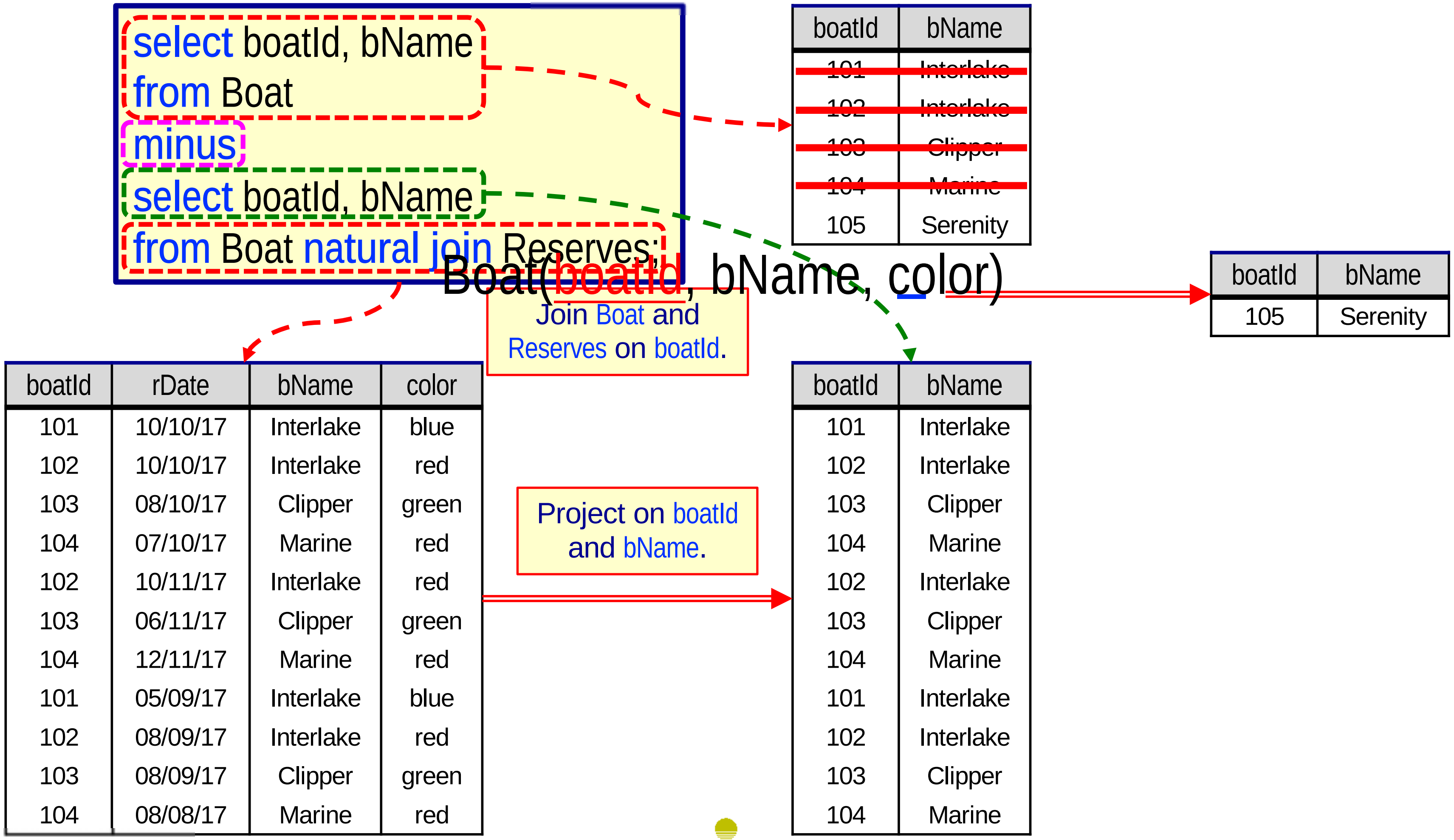
Reserves(<u>*sailorId*, *boatId*, rDate</u>)

Boat(<u>boatId</u>, bName, color)

EXERCISE 4

Find the ids and names of boats that have never been reserved.

☞ **(105, Serenity)**



```
select boatId, bName
from Boat
minus
select boatId, bName
from Boat natural join Reserves;
```

Boat(boatId, bName, color)

Join Boat and Reserves on boatId.

boatId	rDate	bName	color
101	10/10/17	Interlake	blue
102	10/10/17	Interlake	red
103	08/10/17	Clipper	green
104	07/10/17	Marine	red
102	10/11/17	Interlake	red
103	06/11/17	Clipper	green
104	12/11/17	Marine	red
101	05/09/17	Interlake	blue
102	08/09/17	Interlake	red
103	08/09/17	Clipper	green
104	08/08/17	Marine	red

Project on boatId and bName.

boatId	bName
101	Interlake
102	Interlake
103	Clipper
104	Marine
102	Interlake
103	Clipper
104	Marine
101	Interlake
102	Interlake
103	Clipper
104	Marine

boatId	bName
~~101~~	~~Interlake~~
~~102~~	~~Interlake~~
~~103~~	~~Clipper~~
~~104~~	~~Marine~~
105	Serenity

boatId	bName
105	Serenity

EXERCISE 4 (CONT'D)

Find the ids and names of boats that have never been reserved.

☞ **(105, Serenity)**

Is this a correct solution?

Yes!

```
select Boat.boatId, bName
from Boat left outer join Reserves
        on Boat.boatId=Reserves.boatId
where Reserves.boatId is null;
```

Boat

boatId	bName	color
101	Interlake	blue
102	Interlake	red
103	Clipper	green
104	Marine	red
105	Serenity	Cyan

left outer join

Reserves

sailorId	boatId	rDate
22	101	10/10/17
22	102	10/10/17
22	103	08/10/17
22	104	07/10/17
31	102	10/11/17
31	103	06/11/17
31	104	12/11/17
64	101	05/09/17
64	102	08/09/17
74	103	08/09/17
99	104	08/08/17

<----------------- Boat -----------------> <----------------- Reserves ---------------->

from Boat left outer join Reserves on Boat.boatId=Reserves.boatId

boatId	bName	color	sailorId	boatId	rDate
101	Interlake	blue	64	101	05/09/17
101	Interlake	blue	22	101	10/10/17
102	Interlake	red	22	102	10/10/17
102	Interlake	red	64	102	08/09/17
102	Interlake	red	31	102	10/11/17
103	Clipper	green	22	103	08/10/17
103	Clipper	green	31	103	06/11/17
103	Clipper	green	74	103	08/09/17
104	Marine	red	22	104	07/10/17
104	Marine	red	99	104	08/08/17
104	Marine	red	31	104	12/11/17
105	Serenity	cyan	(null)	(null)	(null)

Boat(boatId, bName, color)

Reserves(sailorId, boatId, rDate)

EXERCISE 5

Find the ids and names of sailors who have not reserved boat 103.

☞ **(29, Brutus), (32, Andy), (58, Rusty), (64, Horatio), (71, Zorba), (85, Art), (95, Bob), (99, Chris)**

Is this a correct solution?

No! Why?

```
select distinct Sailor.sailorId, sName
from Sailor, Reserves
where Sailor.sailorId=Reserves.sailorId
        and boatId<>103;
```

Does not include sailors who have not reserved any boat (i.e., sailors who do not appear in Reserves).

sailorId	sName	rating	age	boatId	rDate
22	Dustin	7	45	101	10/10/17
22	Dustin	7	45	102	10/10/17
22	Dustin	7	45	104	07/10/17
31	Lubber	8	55	102	10/11/17
31	Lubber	8	55	104	12/11/17
64	Horatio	7	35	101	05/09/17
64	Horatio	7	35	102	08/09/17
99	Chris	10	30	104	08/08/17

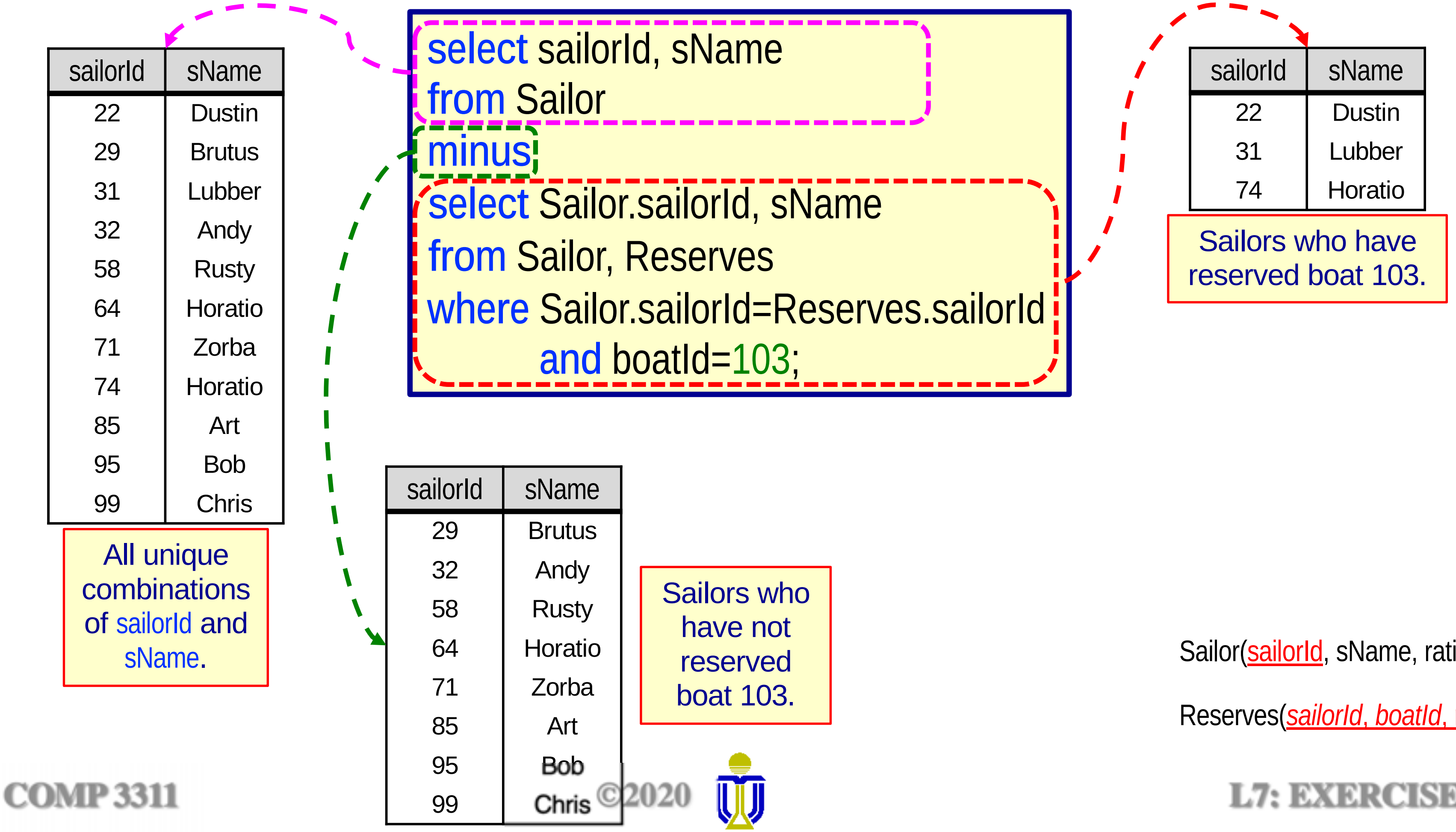
sailorId	sName
22	Dustin
31	Lubber
64	Horatio
99	Chris

X

EXERCISE 5 (CONT'D)

Find the ids and names of sailors who have not reserved boat 103.

☞ **(29, Brutus), (32, Andy), (58, Rusty), (64, Horatio), (71, Zorba), (85, Art), (95, Bob), (99, Chris)**



sailorId	sName
22	Dustin
29	Brutus
31	Lubber
32	Andy
58	Rusty
64	Horatio
71	Zorba
74	Horatio
85	Art
95	Bob
99	Chris

All unique combinations of sailorId and sName.

```
select sailorId, sName
from Sailor
minus
select Sailor.sailorId, sName
from Sailor, Reserves
where Sailor.sailorId=Reserves.sailorId
          and boatId=103;
```

sailorId	sName
22	Dustin
31	Lubber
74	Horatio

Sailors who have reserved boat 103.

sailorId	sName
29	Brutus
32	Andy
58	Rusty
64	Horatio
71	Zorba
85	Art
95	Bob
99	Chris

Sailors who have not reserved boat 103.

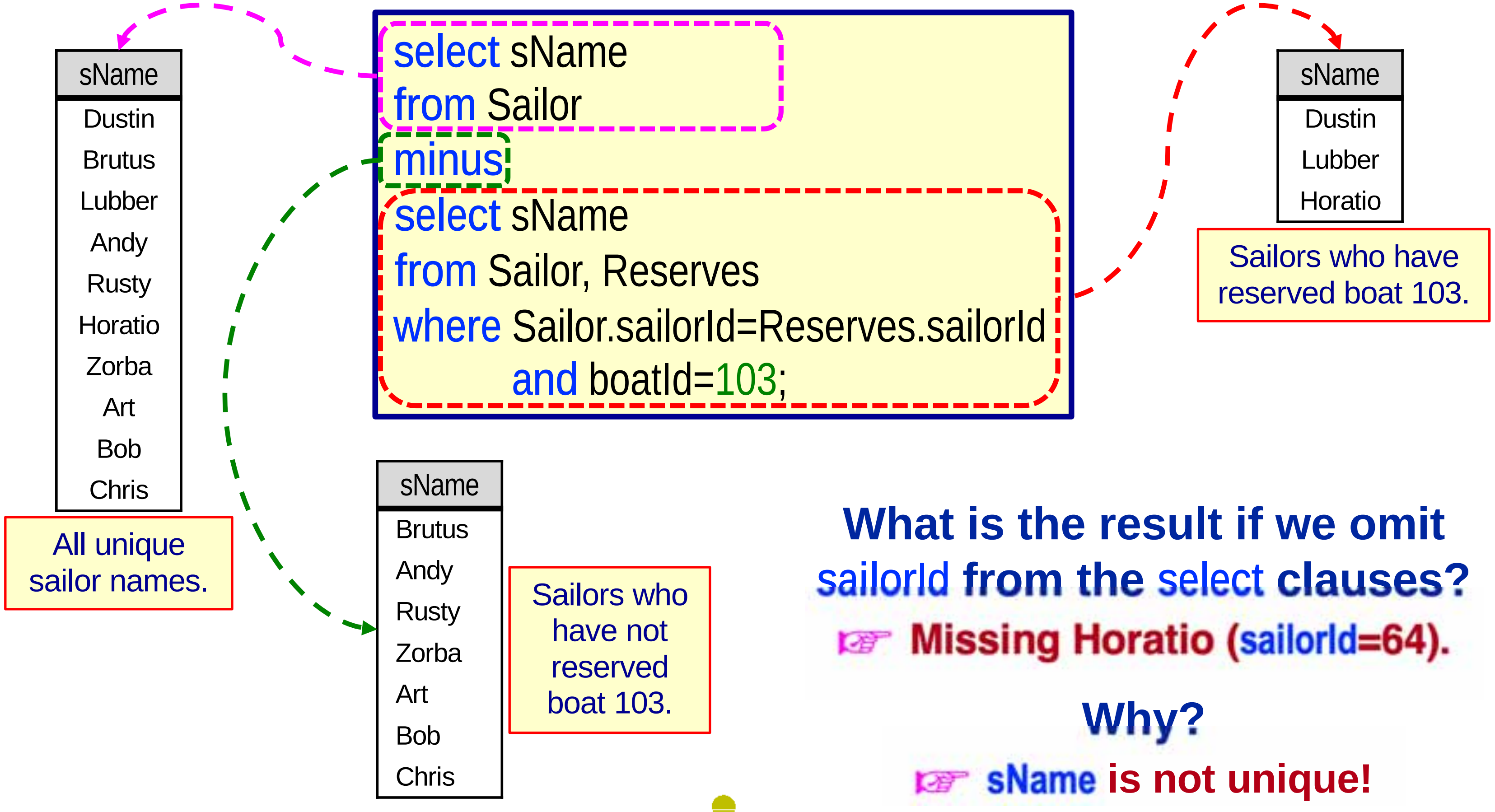
Sailor(sailorId, sName, rating, age)

Reserves(*sailorId, boatId*, rDate)

EXERCISE 5 (CONT'D)

Find the ids and names of sailors who have not reserved boat 103.

☞ **(29, Brutus), (32, Andy), (58, Rusty), (64, Horatio), (71, Zorba), (85, Art), (95, Bob), (99, Chris)**



```
select sName
from Sailor
minus
select sName
from Sailor, Reserves
where Sailor.sailorId=Reserves.sailorId
        and boatId=103;
```

sName
Dustin
Brutus
Lubber
Andy
Rusty
Horatio
Zorba
Art
Bob
Chris

All unique sailor names.

sName
Dustin
Lubber
Horatio

Sailors who have reserved boat 103.

sName
Brutus
Andy
Rusty
Zorba
Art
Bob
Chris

Sailors who have not reserved boat 103.

What is the result if we omit sailorId from the select clauses?

☞ **Missing Horatio (sailorId=64).**

Why?

☞ **sName is not unique!**

EXERCISE 6

Find the names and ids of those sailors who have the same name.

☞ **(Horatio, 64), (Horatio, 74)**

```
select S1.sName, S1.sailorId
from Sailor S1, Sailor S2
where S1.sName=S2.sName
      and S1.sailorId<>S2.sailorId;
```

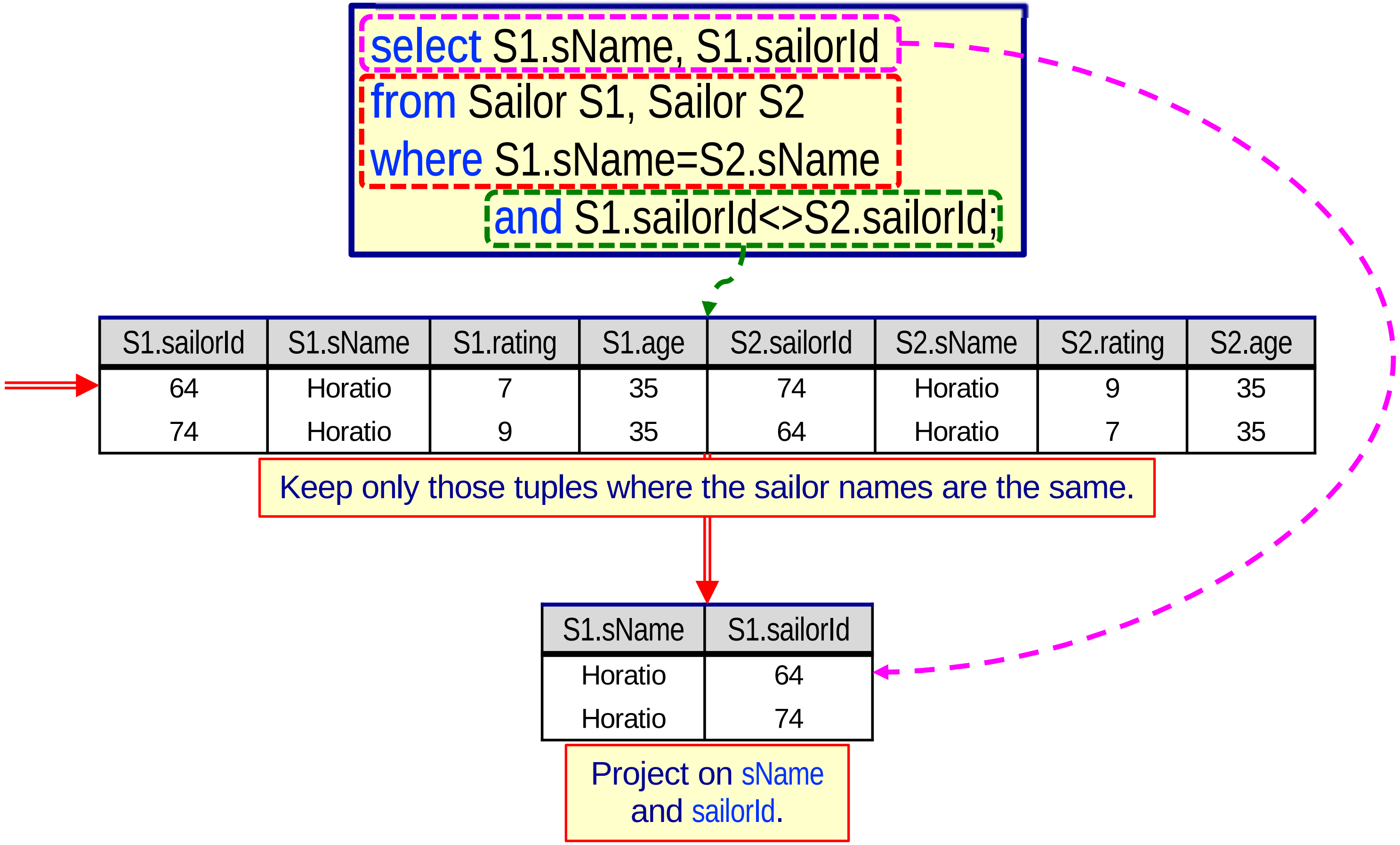
Join Sailor with itself.

S1.sailorId	S1.sName	S1.rating	S1.age	S2.sailorId	S2.sName	S2.rating	S2.age
22	Dustin	7	45	22	Dustin	7	45
29	Brutus	1	33	29	Brutus	1	33
31	Lubber	8	55	31	Lubber	8	55
32	Andy	8	25	32	Andy	8	25
58	Rusty	10	35	58	Rusty	10	35
64	Horatio	7	35	64	Horatio	7	35
64	Horatio	7	35	74	Horatio	9	35
71	Zorba	10	16	71	Zorba	10	16
74	Horatio	9	35	74	Horatio	9	35
74	Horatio	9	35	64	Horatio	7	35
85	Art	3	25	85	Art	3	25
95	Bob	3	63	95	Bob	3	63
99	Chris	10	30	99	Chris	10	30

EXERCISE 6 (CONTD)

Find the names and ids of those sailors who have the same name.

☞ **(Horatio, 64), (Horatio, 74)**



```
select S1.sName, S1.sailorId
from Sailor S1, Sailor S2
where S1.sName=S2.sName
        and S1.sailorId<>S2.sailorId;
```

S1.sailorId	S1.sName	S1.rating	S1.age	S2.sailorId	S2.sName	S2.rating	S2.age
64	Horatio	7	35	74	Horatio	9	35
74	Horatio	9	35	64	Horatio	7	35

Keep only those tuples where the sailor names are the same.

S1.sName	S1.sailorId
Horatio	64
Horatio	74

Project on sName and sailorId.