Carnegie Mellon Univ. Dept. of Computer Science 15-415 - Database Applications

C. Faloutsos

Rel. model - SQL part2

General Overview - rel. model

- Formal query languages
  - rel algebra and calculi
- Commercial query languages
  - SQL
  - QBE, (QUEL)

Overview - detailed - SQL

- DML
  - select, from, where, renaming
  - set operations
  - ordering
  - aggregate functions
  - nested subqueries
- other parts: DDL, embedded SQL, auth etc

DML

General form

select a1, a2, … an
from r1, r2, … rm
where P
[**order by** ….]
[**group by** …]
[**having** …]

Reminder: our Mini-U db

STUDENT		
<u>Ssn</u>	Name	Address
123	smith	main str
234	jones	forbes ave

CLASS		
<u>c-id</u>	c-name	units
15-413	s.e.	2
15-412	o.s.	2

TAKES		
<u>SSN</u>	<u>c-id</u>	grade
123	15-413	A
234	15-413	B

DML - nested subqueries

find names of students of 15-415

select name
from student
where ...

"ssn in the set of people that take 15-415"

DML - nested subqueries

find names of students of 15-415

```
select name
from student
where  ………...
   select ssn
   from takes
   where  c-id =“15-415”
```

DML - nested subqueries

find names of students of 15-415

```
select name
from student
where  ssn in (
   select ssn
   from takes
   where  c-id =“15-415”)
```

DML - nested subqueries

- **‘in’** compares a value with a set of values
- **‘in’** can be combined other boolean ops
- it is redundant (but user friendly!):

select name
from student …..
where c-id = “15-415” ….

DML - nested subqueries

- **‘in’** compares a value with a set of values
- **‘in’** can be combined other boolean ops
- it is redundant (but user friendly!):

select name
from student, takes
where c-id = “15-415” **and**
student.ssn=takes.ssn

DML - nested subqueries

find names of students taking 15-415 and living on “main str”

select name
from student
where address=“main str” **and** ssn **in**
(**select** ssn **from** takes **where** c-id =“15-415”)

DML - nested subqueries

- **‘in’** compares a value with a set of values
- other operators like ‘**in**’ ??

DML - nested subqueries

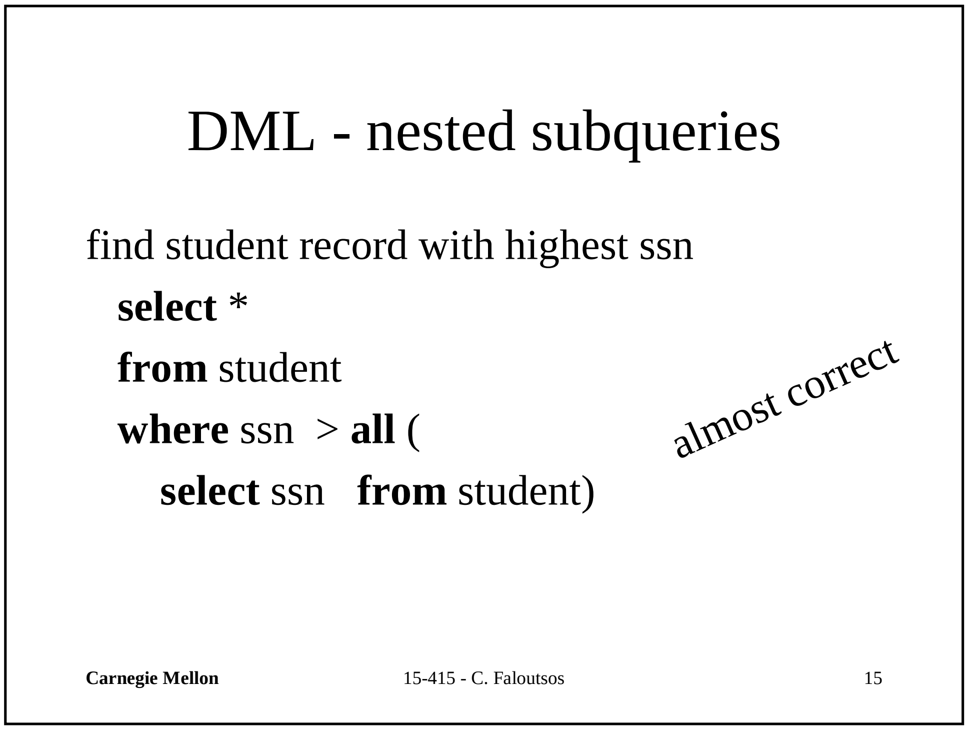
find student record with highest ssn

select *
from student
where ssn
is greater than every other ssn

DML - nested subqueries

find student record with highest ssn

select *
from student
where ssn *greater than every*
select ssn **from** student



DML - nested subqueries

find student record with highest ssn

```
select *
from student
where ssn  > all (
    select ssn   from student)
```

almost correct

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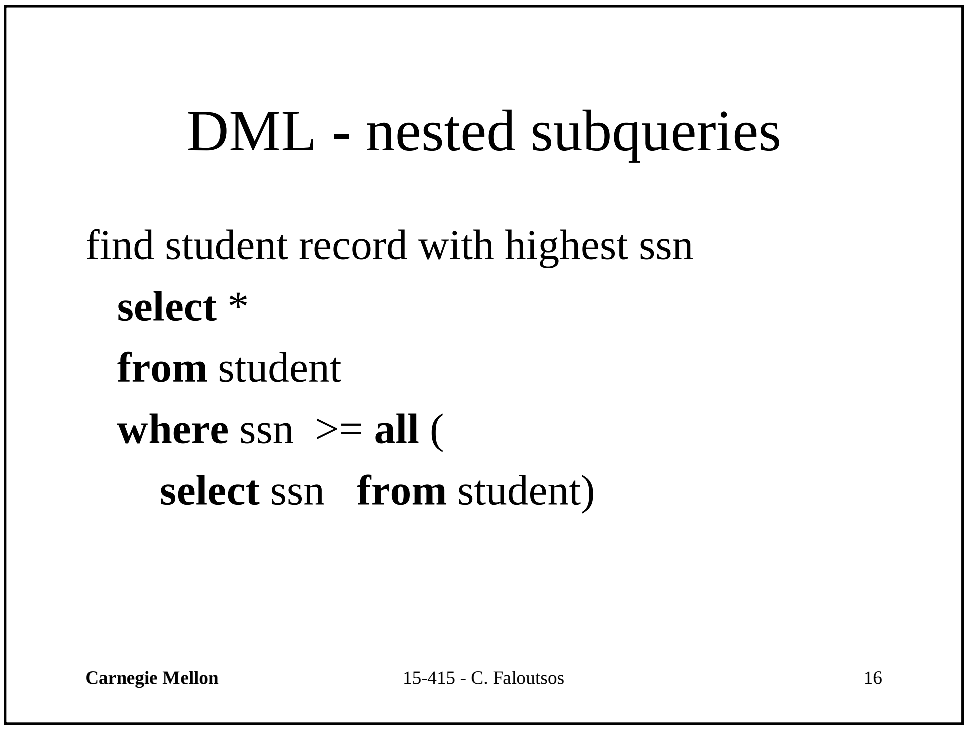

DML - nested subqueries

find student record with highest ssn

```
select *
from student
where ssn  >= all (
    select ssn   from student)
```

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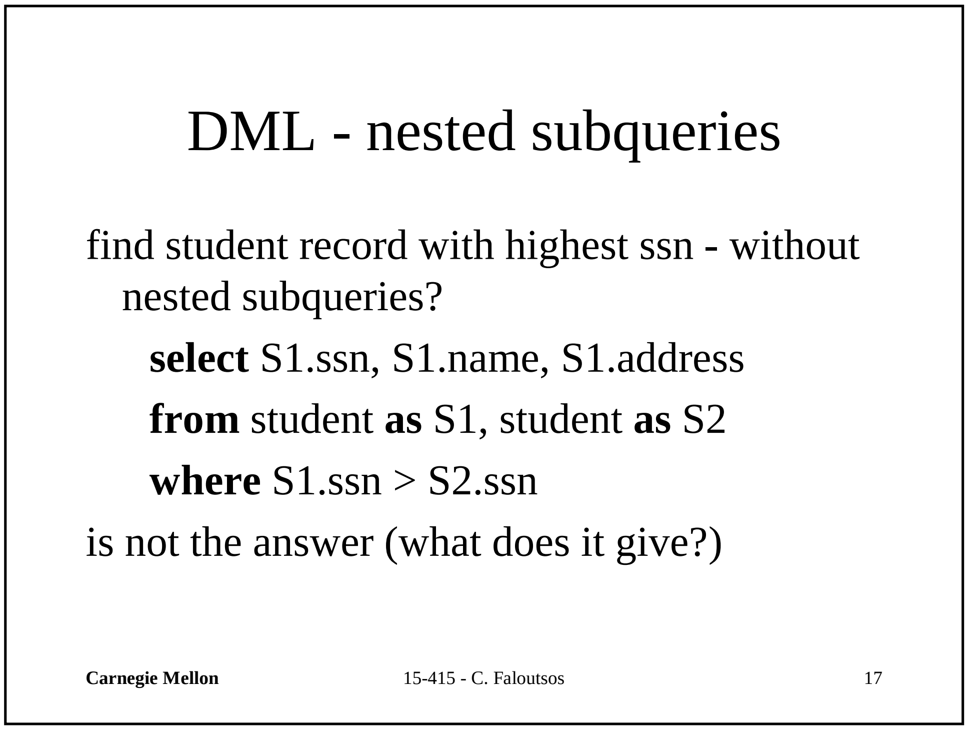


DML - nested subqueries

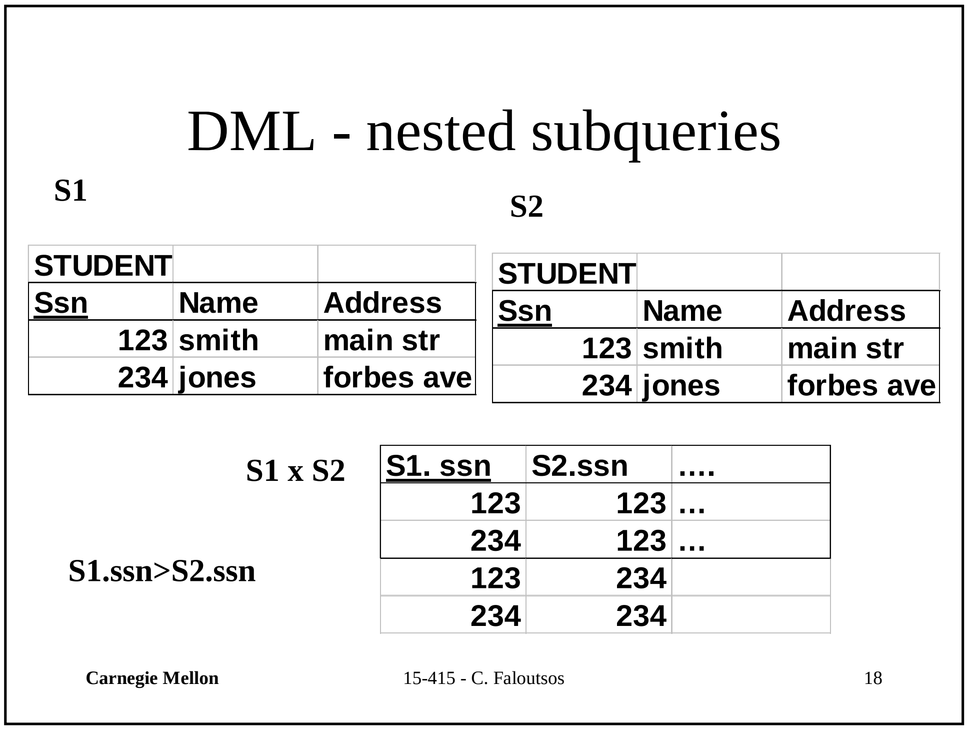
find student record with highest ssn - without nested subqueries?

select S1.ssn, S1.name, S1.address

from student **as** S1, student **as** S2

where S1.ssn > S2.ssn

is not the answer (what does it give?)



DML - nested subqueries

S1

STUDENT		
<u>Ssn</u>	Name	Address
123	smith	main str
234	jones	forbes ave

S2

STUDENT		
<u>Ssn</u>	Name	Address
123	smith	main str
234	jones	forbes ave

S1 x S2

S1.ssn>S2.ssn

<u>S1. ssn</u>	S2.ssn	….
123	123	…
234	123	…
123	234	
234	234	

DML - nested subqueries

select S1.ssn, S1.name, S1.address
from student **as** S1, student **as** S2
where S1.ssn > S2.ssn

gives all but the smallest ssn -

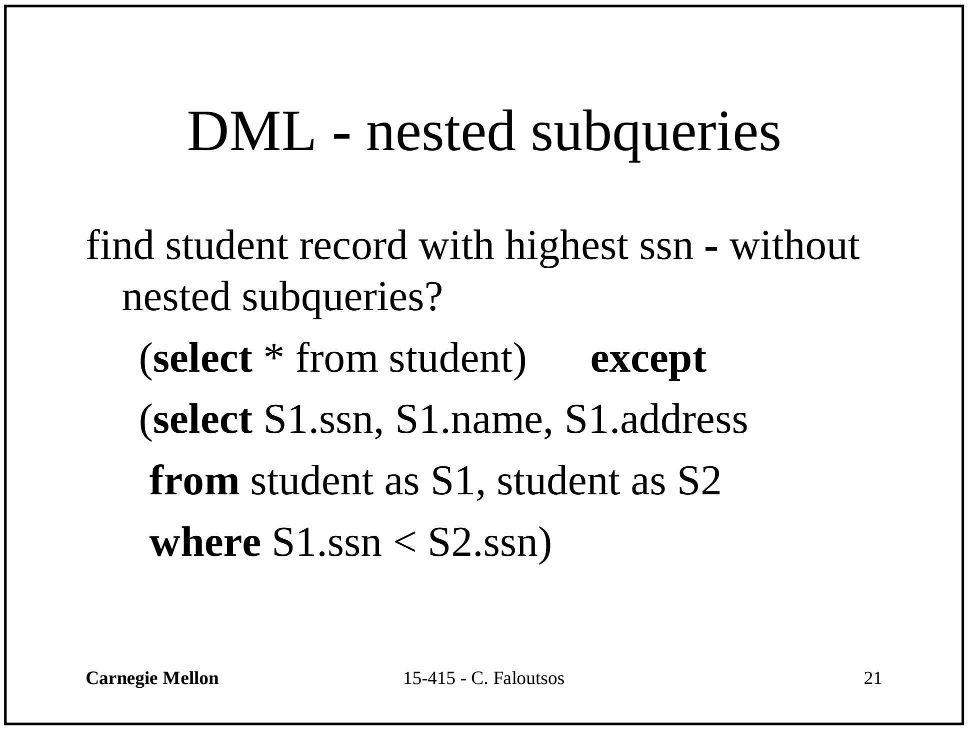
aha!

DML - nested subqueries

find student record with highest ssn - without nested subqueries?

select S1.ssn, S1.name, S1.address
from student **as** S1, student **as** S2
where S1.ssn < S2.ssn

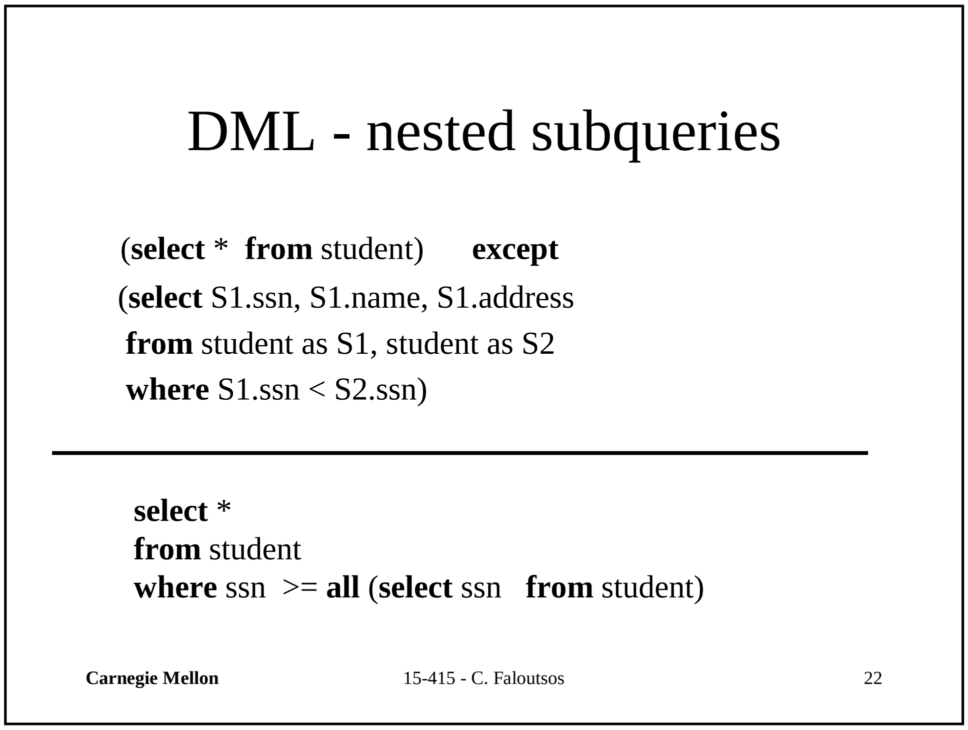
gives all but the highest - therefore….



DML - nested subqueries

find student record with highest ssn - without nested subqueries?

```
(select * from student)      except
(select S1.ssn, S1.name, S1.address
 from student as S1, student as S2
 where S1.ssn < S2.ssn)
```



DML - nested subqueries

```
(select *  from student)      except
(select S1.ssn, S1.name, S1.address
 from student as S1, student as S2
 where S1.ssn < S2.ssn)
```

```
select *
from student
where ssn  >= all (select ssn   from student)
```

DML - nested subqueries

Drill: Even more readable than

select * **from** student
where ssn >= **all** (**select** ssn **from** student)

DML - nested subqueries

Drill: Even more readable than

select * **from** student
where ssn >= **all** (**select** ssn **from** student)

select * **from** student
where ssn **in**
(**select** **max**(ssn) **from** student)

DML - nested subqueries

Drill: find the ssn of the student with the highest GPA

STUDENT		
Ssn	Name	Address
123	smith	main str
234	jones	forbes ave

CLASS		
c-id	c-name	units
15-413	s.e.	2
15-412	o.s.	2

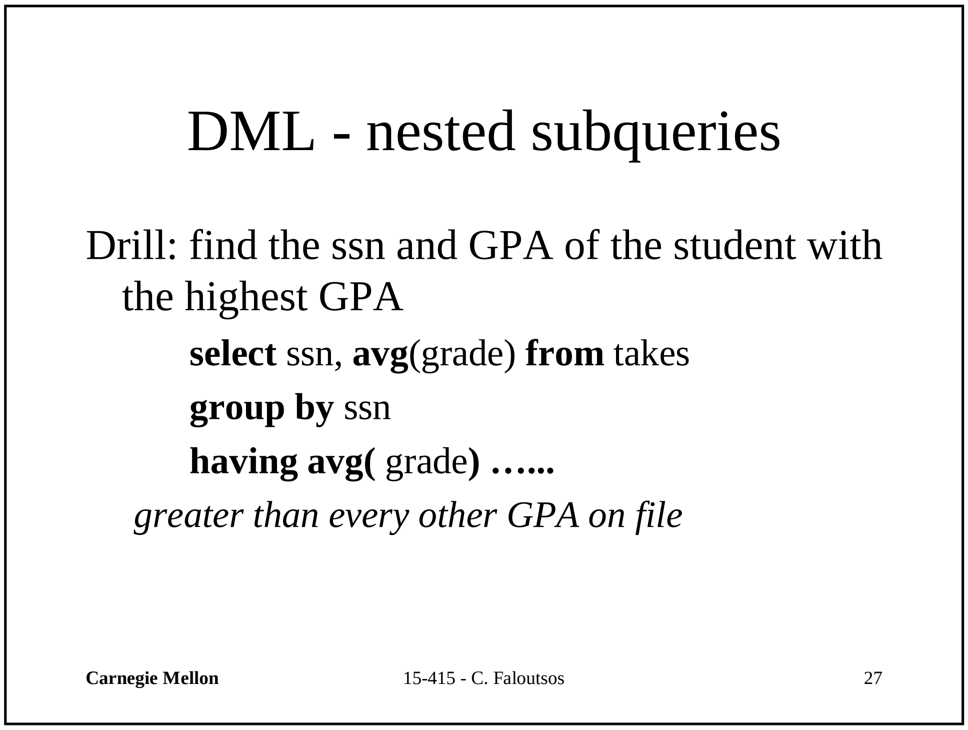
TAKES		
SSN	c-id	grade
123	15-413	A
234	15-413	B

DML - nested subqueries

Drill: find the ssn and GPA of the student with the highest GPA

select ssn, **avg**(grade) **from** takes

~~**where**~~



DML - nested subqueries

Drill: find the ssn and GPA of the student with the highest GPA

select ssn, **avg**(grade) **from** takes
group by ssn
having avg(grade**) …...**

greater than every other GPA on file

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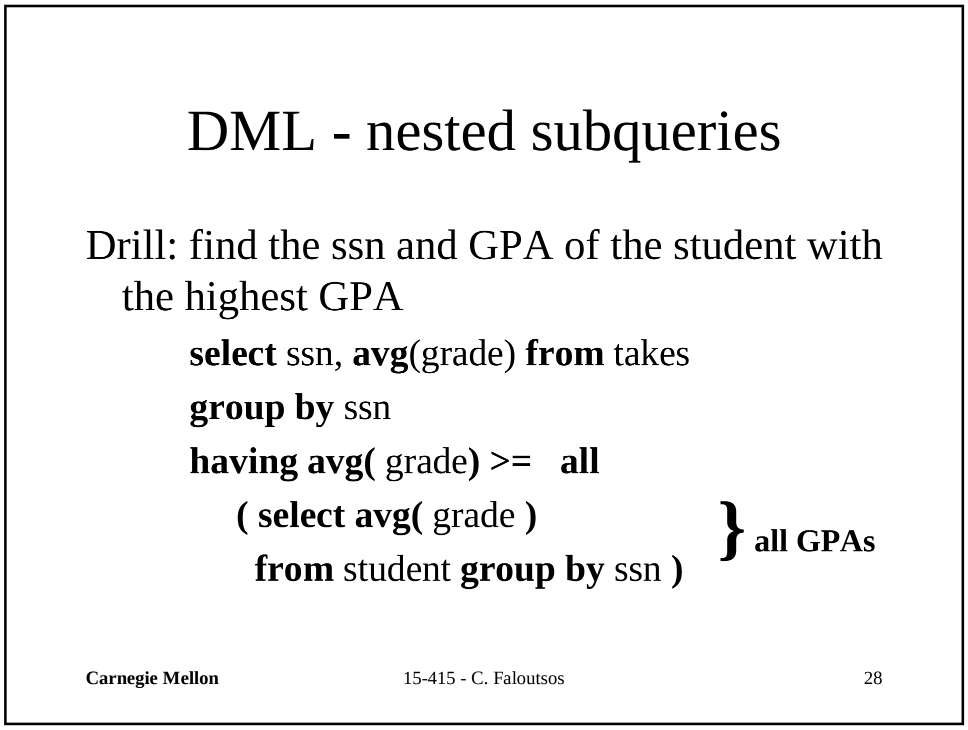

DML - nested subqueries

Drill: find the ssn and GPA of the student with the highest GPA

select ssn, **avg**(grade) **from** takes
group by ssn
having avg(grade**) >= all**
(select avg(grade **)**
from student **group by** ssn **)**

$\}$ **all GPAs**

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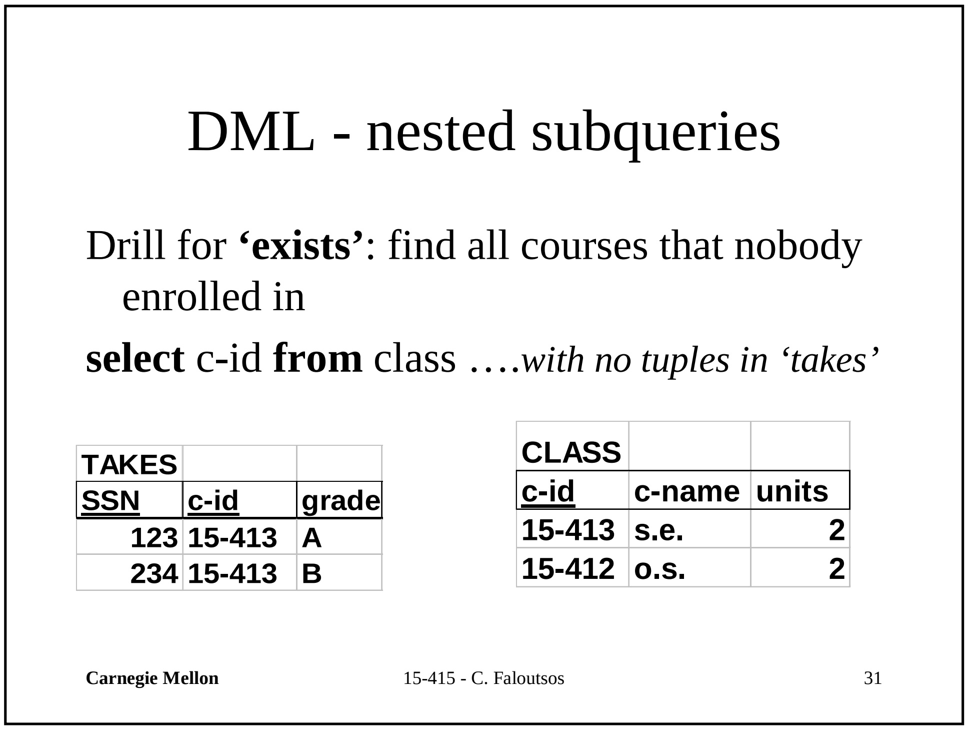
DML - nested subqueries

- **‘in’** and **‘>= all’** compares a value with a set of values
- other operators like these?

DML - nested subqueries

- **<all**(), **<>all**() ...
- ‘<>**all**’ is identical to ‘**not in**’
- >**some**(), >= **some** () ...
- ‘= **some**()’ is identical to ‘**in’**
- **exists**



DML - nested subqueries

Drill for **‘exists’**: find all courses that nobody enrolled in

select c-id **from** class ….*with no tuples in ‘takes’*

TAKES		
SSN	c-id	grade
123	15-413	A
234	15-413	B

CLASS		
c-id	c-name	units
15-413	s.e.	2
15-412	o.s.	2

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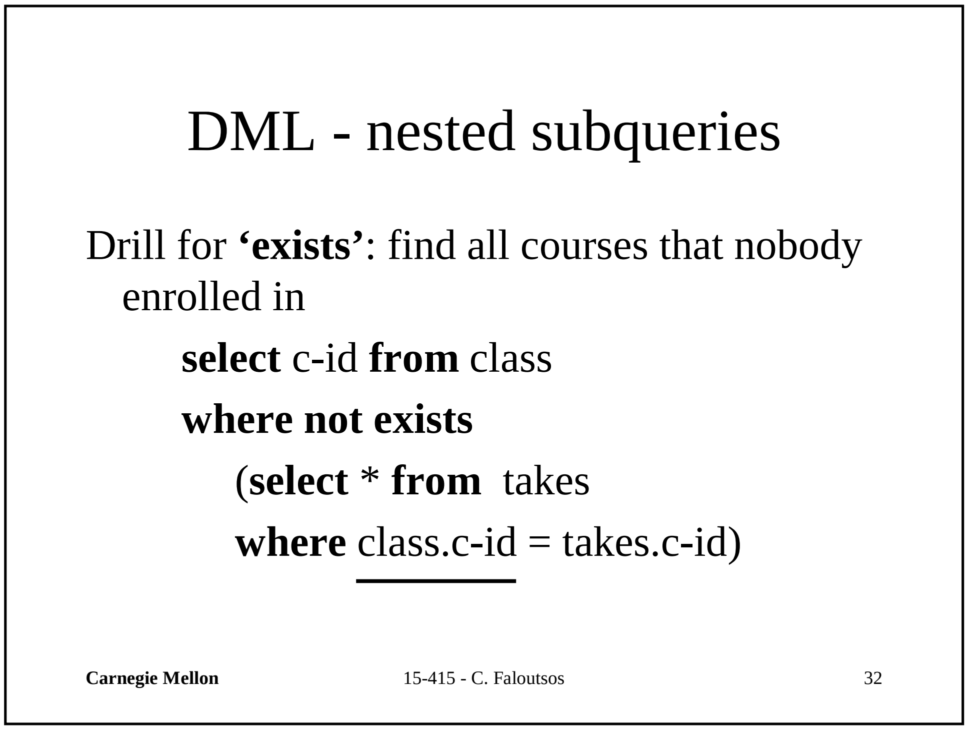

DML - nested subqueries

Drill for **‘exists’**: find all courses that nobody enrolled in

select c-id **from** class
where not exists
(**select** * **from** takes
where class.c-id = takes.c-id)

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DML - derived relations

find the ssn with the highest GPA

select ssn, **avg**(grade) **from** takes
group by ssn
having avg(grade**) >=   all**
  (select avg(grade **)**
   from takes **group by** ssn **)**

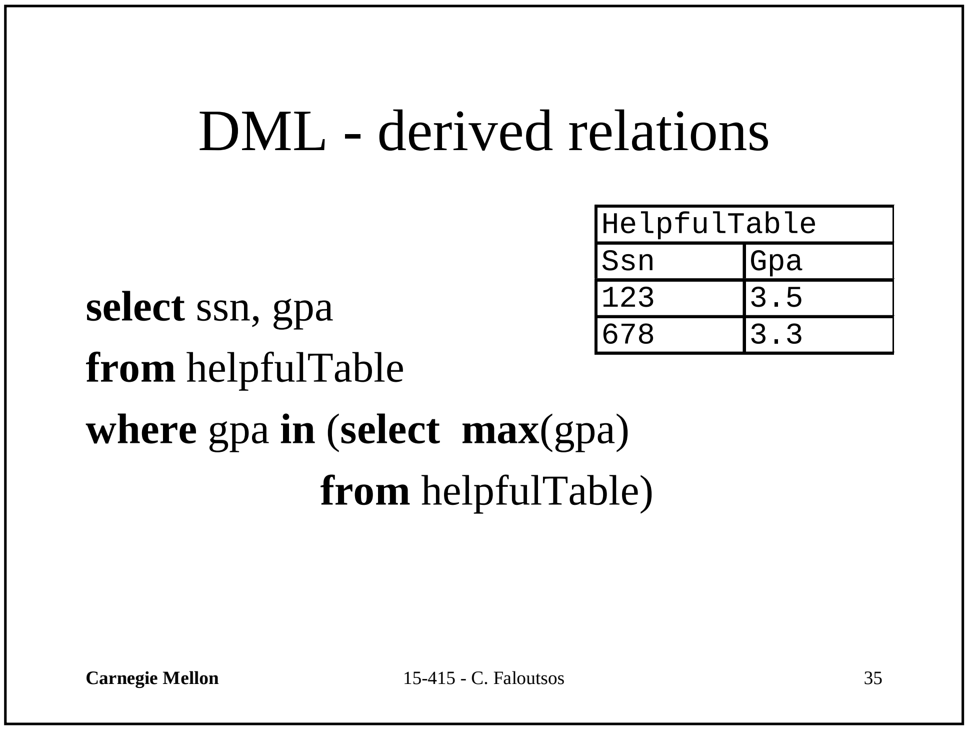
DML - derived relations

find the ssn with the highest GPA

Query would be easier, if we had a table like:
helpfulTable (ssn, gpa):

HelpfulTable	
Ssn	Gpa
123	3.5
678	3.3

then what?



DML - derived relations

HelpfulTable	
Ssn	Gpa
123	3.5
678	3.3

```
select ssn, gpa
from helpfulTable
where gpa in (select  max(gpa)
                  from helpfulTable)
```

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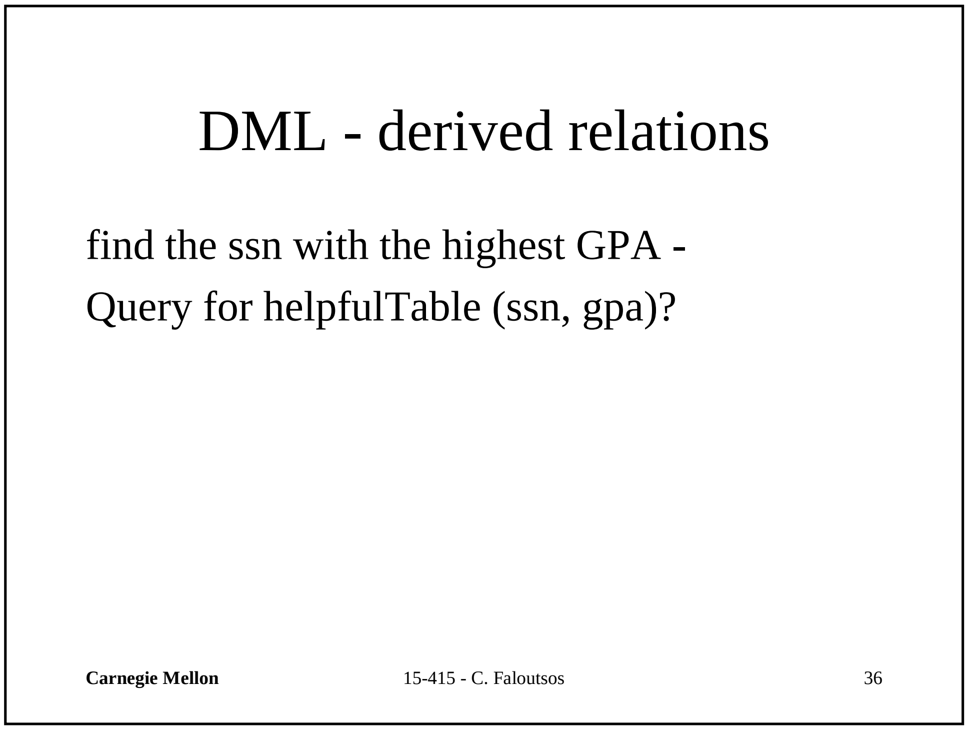

DML - derived relations

find the ssn with the highest GPA -
Query for helpfulTable (ssn, gpa)?

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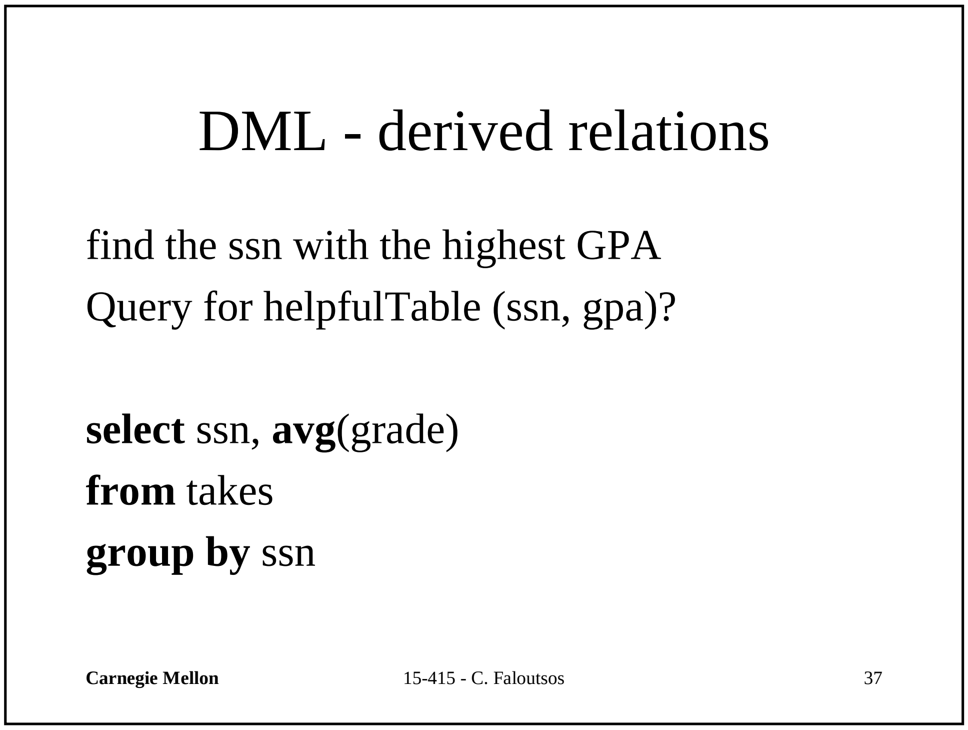
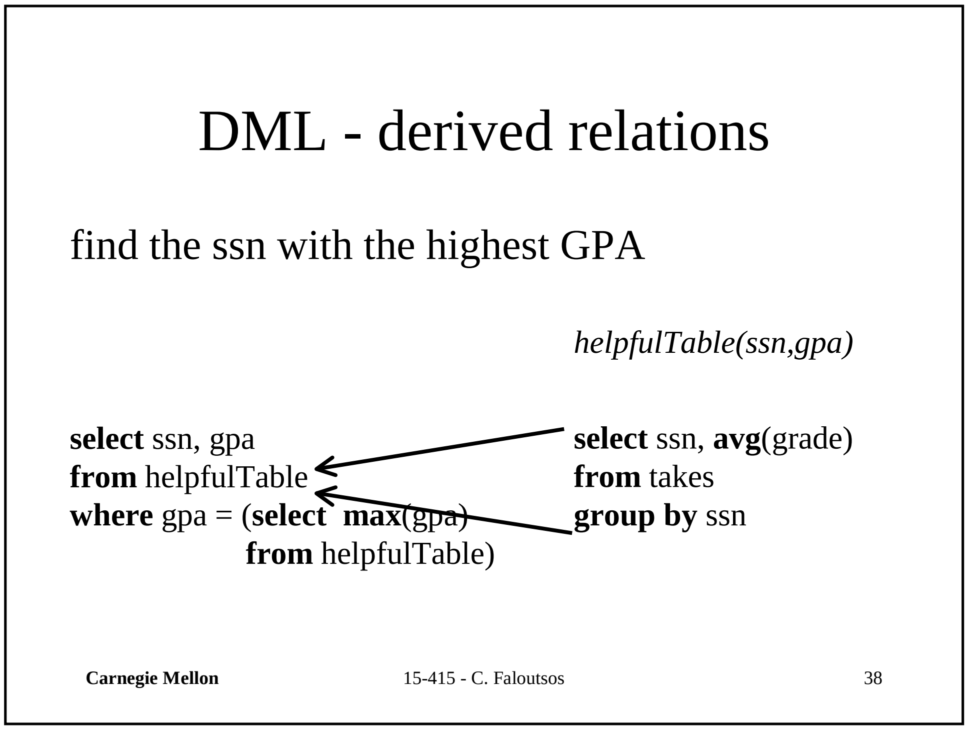


DML - derived relations

find the ssn with the highest GPA

Query for helpfulTable (ssn, gpa)?

select ssn, **avg**(grade)
from takes
group by ssn



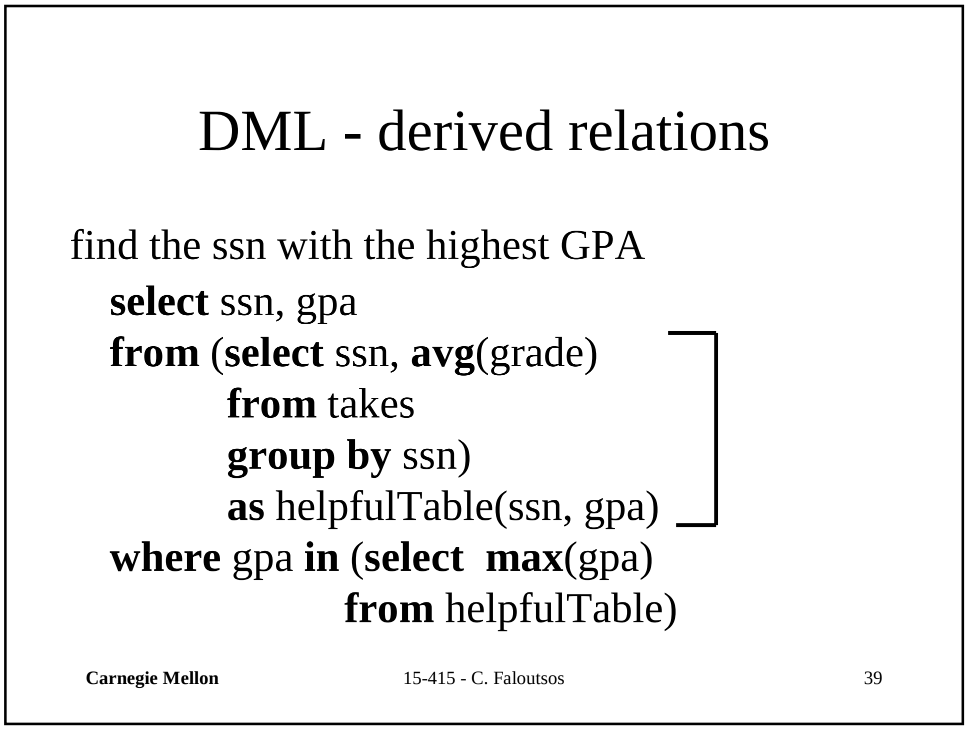
DML - derived relations

find the ssn with the highest GPA

helpfulTable(ssn,gpa)

```
select ssn, gpa
from helpfulTable
where gpa = (select  max(gpa)
             from helpfulTable)
```

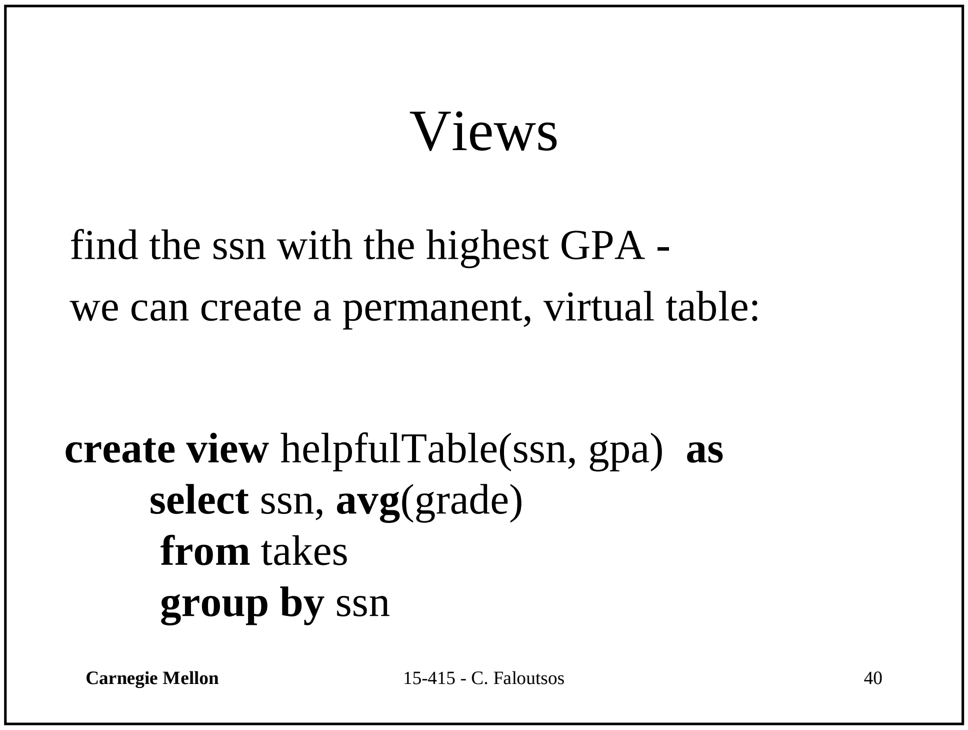
```
select ssn, avg(grade)
from takes
group by ssn
```



DML - derived relations

find the ssn with the highest GPA

```
select ssn, gpa
from (select ssn, avg(grade)
          from takes
          group by ssn)
          as helpfulTable(ssn, gpa)
where gpa in (select  max(gpa)
                    from helpfulTable)
```



Views

find the ssn with the highest GPA -

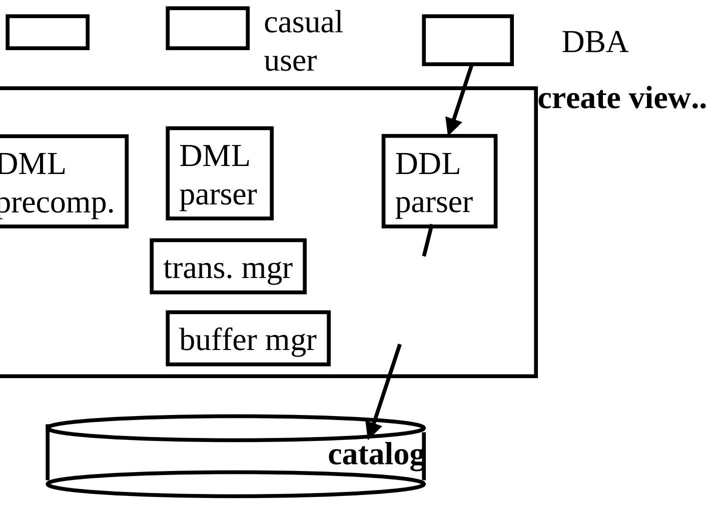
we can create a permanent, virtual table:

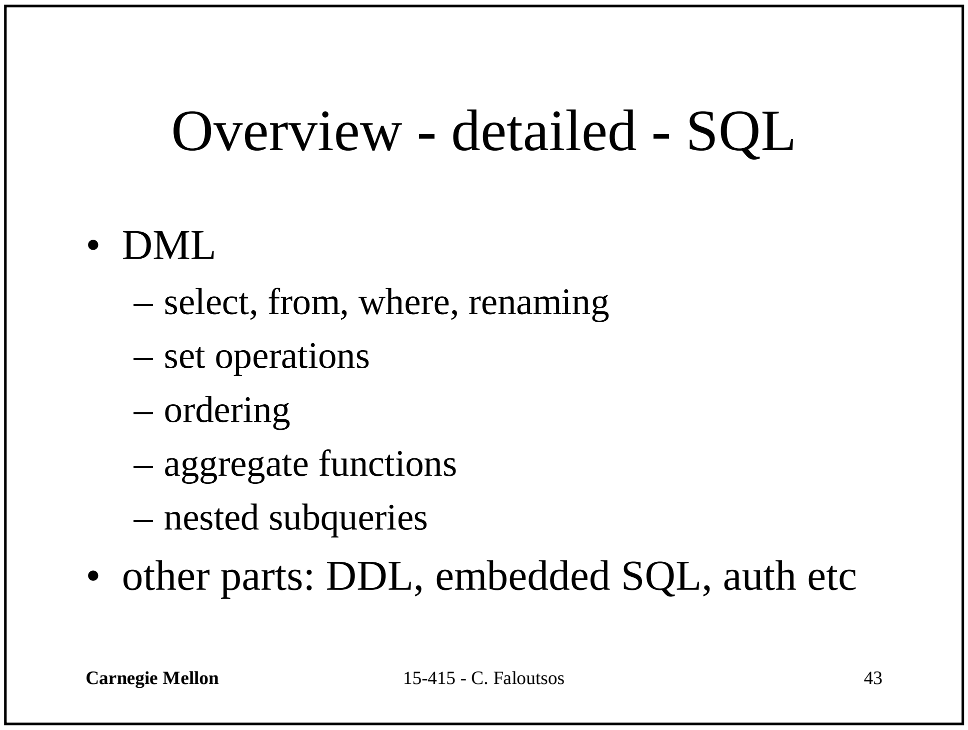
```
create view helpfulTable(ssn, gpa)  as
       select ssn, avg(grade)
        from takes
        group by ssn
```

Views

- views are recorded in the schema, for ever (ie., until ‘**drop view**…’)
- typically, they take little disk space, because they are computed on the fly
- (but: materialized views…)

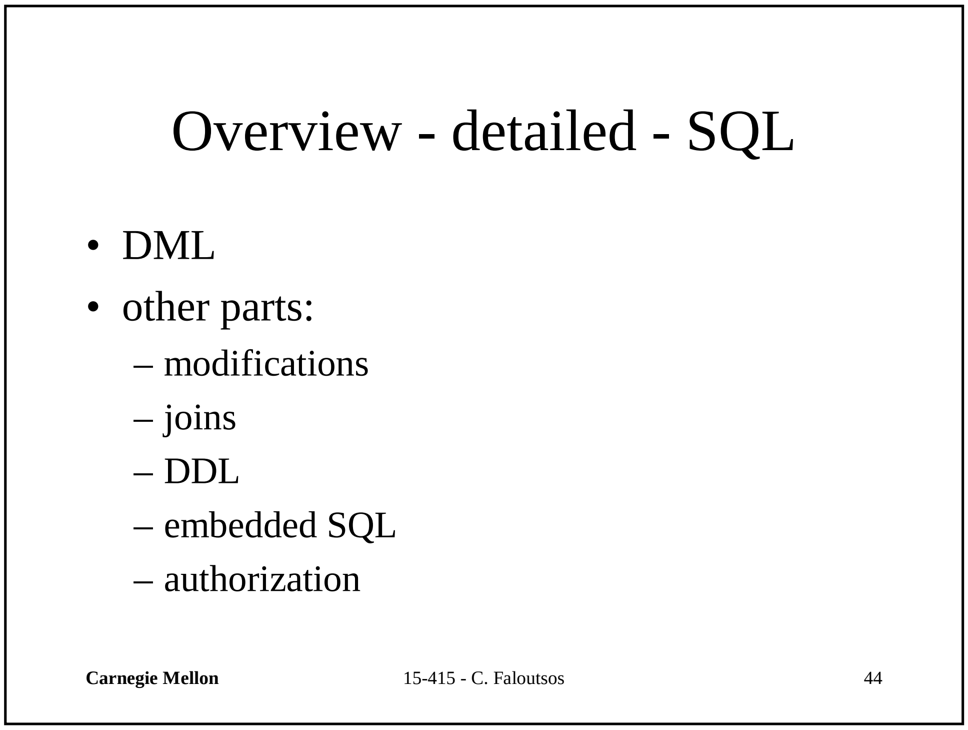
Overview of a DBMS





Overview - detailed - SQL

- DML
  - select, from, where, renaming
  - set operations
  - ordering
  - aggregate functions
  - nested subqueries
- other parts: DDL, embedded SQL, auth etc



Overview - detailed - SQL

- DML
- other parts:
  - modifications
  - joins
  - DDL
  - embedded SQL
  - authorization