Recall the three-level schema architecture:

1. External schema
2. Conceptual schema
3. Physical schema
A view is a relation in the external schema whose instance is determined by the instances of the relations in the conceptual schema.

A view has many of the same properties as a base relation in the conceptual schema:
- its schema information appears in the database schema
- access controls can be applied to it
- other views can be defined in terms of it
Types of Views

- **Virtual**: Views are used only for querying; they are not stored in the database.
- **Materialized**: The query that makes up the view is executed, the view constructed and stored in the database.
SQL DDL: Views

- General form:
  
  `create [materialized] view <name> 
  as <query>`

- Example

  `create view ManufacturingProjects as 
  ( select projno, projname, firstnme, lastname 
    from project, employee 
    where respemp = empno and deptno = 'D21' )`
Accessing a View

Query a view as if it were a base relation.

```
select projname
from ManufacturingProjects
```

What happens when you query a virtual view?
- At compile time, the view definition is found
- The query over the view is modified with the query definition
- The resulting query is optimized and executed
Updating Views

- Modifications to a view’s instance must be propagated back to instances of relations in conceptual schema.
- Some views cannot be updated unambiguously.

**Conceptual Schema**

<table>
<thead>
<tr>
<th>NAME</th>
<th>CITIZENSHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed</td>
<td>Canadian</td>
</tr>
<tr>
<td>Dave</td>
<td>Canadian</td>
</tr>
<tr>
<td>Wes</td>
<td>American</td>
</tr>
</tbody>
</table>

**External Schema**

<table>
<thead>
<tr>
<th>NAME</th>
<th>PASTIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed</td>
<td>Hockey</td>
</tr>
<tr>
<td>Ed</td>
<td>Curling</td>
</tr>
<tr>
<td>Dave</td>
<td>Hockey</td>
</tr>
<tr>
<td>Dave</td>
<td>Curling</td>
</tr>
<tr>
<td>Wes</td>
<td>Hockey</td>
</tr>
<tr>
<td>Wes</td>
<td>Baseball</td>
</tr>
</tbody>
</table>

1. What does it mean to insert (Darryl, Hockey)?
2. What does it mean to delete (Dave, Curling)?

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**Notes**

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According to SQL-92, a view is updatable only if its definition satisfies a variety of conditions:

- The query references exactly one table
- The query only outputs simple attributes (no expressions)
- There is no grouping/aggregation/d\texttt{distinct}
- There are no nested queries
- There are no set operations

These rules are more restrictive than necessary.
Materialized Views

**Problem**
When a base table changes, the materialized view may also change.

- Solution?
  - Periodically reconstruct the materialized view.
  - Incrementally update the materialized view.

- Example: Data warehouses