This class: Hand in exercises electronically after class
Please start Visual Paradigm
Next class: No reading. Exercises due after class
Keys

• Primary key: one or more attributes that uniquely identify a record.
  – What would you use in a customer database of 100,000 people and no unique customer id?
    • Name not unique
    • Add birthdate, but not guaranteed to be unique
    • Address can change
    • Can use social security number, but not everyone has one
    • Privacy is an issue
  – Issues in choosing a primary key
    • Stability
    • Control
    • Use a system generated key if possible in many cases
  – Which is better: email address or customer ID?
Foreign keys

- Primary key of the independent or parent entity type is maintained as a non-key attribute in the dependent or child entity type.
Foreign keys

Database requires a valid department number when employee is added.
Employee ID is the unique identifier of employees; department number is not needed as part of the employee primary key.
Composite foreign keys

Assume a charter airline: every flight has a different number. What has to change if this is a scheduled carrier?
Composite foreign keys

Flight

<table>
<thead>
<tr>
<th>FlightNbr</th>
<th>FlightDate</th>
<th>DepartTime</th>
<th>ArrivalTime</th>
</tr>
</thead>
<tbody>
<tr>
<td>243</td>
<td>9/24/00</td>
<td>9:00am</td>
<td>11:00am</td>
</tr>
<tr>
<td>253</td>
<td>9/24/00</td>
<td>10:00am</td>
<td>12:30pm</td>
</tr>
<tr>
<td>52</td>
<td>9/24/00</td>
<td>11:00am</td>
<td>2:00pm</td>
</tr>
</tbody>
</table>

FlightSeat

<table>
<thead>
<tr>
<th>FlightNbr</th>
<th>FlightSeat</th>
<th>SeatStatus</th>
<th>SeatDescription</th>
</tr>
</thead>
<tbody>
<tr>
<td>243</td>
<td>8A</td>
<td>Confirmed</td>
<td>Window</td>
</tr>
<tr>
<td>243</td>
<td>7D</td>
<td>Reserved</td>
<td>Aisle</td>
</tr>
<tr>
<td>243</td>
<td>14E</td>
<td>Open</td>
<td>Center</td>
</tr>
<tr>
<td>253</td>
<td>1F</td>
<td>Open</td>
<td>Window</td>
</tr>
<tr>
<td>253</td>
<td>43A</td>
<td>Confirmed</td>
<td>Window</td>
</tr>
</tbody>
</table>

Flight number must be part of the flight seat primary key; this is different than employee and department, where department is not required.
Foreign keys (many-many relationships)

- Primary key of parent is used in primary key of child

Vehicle can be driven by many drivers; driver can drive many vehicles

Show in Visual Paradigm. Set presentation options.
Many-to-many relationships with foreign keys

Never create an entity with vehicle1, vehicle2,... !
Referential integrity

• Referential integrity maintains the validity of foreign keys when the primary key in the parent table changes. (The database software does this.)
  – Every foreign key either matches a primary key (or is null)
  – E.g., you cannot add an employee to an invalid department (or, usually, a null department)

• Cascade rules. Choose among two delete options:
  – Cascade restrict: Rows in the primary key table can’t be deleted unless all corresponding rows in the foreign key tables have been deleted.
    • E.g., when deleting a department, don’t delete all the employees
  – Cascade delete: When rows in the primary key table are deleted, associated rows in foreign key tables are also deleted
    • E.g., when deleting an order, delete all items in the order
MIT Trucking Company

**Exercise**
- Determine and name entity types
- Determine cardinality (1:N, N:N) and type (mandatory/optional) of relationships
- Add identifiers and primary and foreign keys
- Label relationship phrases (if you have time)

**Use Visual Paradigm:**
- Create new entities (toolbar)
- Set attributes and primary keys (properties)
- Let the relationships fill in the foreign keys
- Ignore data type (accept integer default)
- Edit the relationship to be 1-many, 0/1-many if you have time
- Four exercises follow: Use separate diagrams for each
MIT Trucking Company exercise 1

• Trucking company employs mechanics to maintain vehicles. Each mechanic usually assigned to many vehicles. Vehicle always assigned to 1 mechanic.
MIT Trucking Company solution 1

- Trucking company employs mechanics to maintain vehicles. Each mechanic usually assigned to many vehicles. Vehicle always assigned to 1 mechanic.
MIT Trucking Company exercise 2

- Trucking company has several garages. A garage may contain many bays. A bay must be in a garage.
MIT Trucking Company solution 2

- Trucking company has several garages. A garage may contain many bays. A bay must be in a garage.
MIT Trucking Company exercise 3

- Garage employs managers to monitor vehicle availability and repair costs. Each manager is assigned at least 1 and usually many vehicles. A vehicle may or may not have a manager responsible.

- Use Vehicle2 as entity
Garage employs managers to monitor vehicle availability and repair costs. Each manager is assigned at least 1 and usually many vehicles. A vehicle may or may not have a manager responsible.
• Garage maintains a list of specialized repair personnel who are used as necessary. A specialist may work on many vehicles. A vehicle may or may not be repaired by a specialist.

• Use Vehicle3 as entity
MIT Trucking Company solution 4

- Garage maintains a list of specialized repair personnel who are used as necessary. A specialist may work on many vehicles. A vehicle may or may not be repaired by a specialist.

Note the ambiguity of language. Also compare to exercise 3.
Recursive relation

• We’ll cover this in more detail under SQL. Pretend the recursive relation is between two tables, the real one and a virtual copy. In this case, a manager table and an employee table. Proceed as usual, with a small syntax change.