Exercise 1. Consider the following UML class diagram.

1. Express it in FOL.
2. Express it in DL-Lite, highlighting parts that are not expressible.
3. Given the ABox $A = \{C(c)\}$ and the boolean conjunctive query $q(x) \leftarrow Rab(x, y), Rab(y, z), A(z)$, return the certain answer by exploiting the DL-Lite rewriting algorithm.

Exercise 2. Model check the Mu-Calculus formula $\mu X.\nu Y.(a \lor [next]X) \land [next]Y$ and the CTL formula $AFAGa$ against the following transition system:

Exercise 3. Check whether CQ $q_1$ is contained in CQ $q_2$, reporting canonical DBs and homomorphism:

$q_1(x_r) \leftarrow e(x_r, x_g), e(x_g, x_b), e(x_b, x_r)$.
$q_2(x) \leftarrow e(x, y), e(y, z), e(z, x), e(z, v)e(v, w), e(w, z)$.

Exercise 4. Compute the certain answers to the CQ $q(x) \leftarrow M(x, y), E(y)$ over the incomplete database (naive tables):

<table>
<thead>
<tr>
<th>E(employee)</th>
<th>M(annager)</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>mgr</td>
</tr>
<tr>
<td>Smith</td>
<td>Smith</td>
</tr>
<tr>
<td>null1</td>
<td>null1</td>
</tr>
<tr>
<td>Brown</td>
<td>Brown</td>
</tr>
</tbody>
</table>

Exercise 5. Compute the weakest precondition for getting $\{x = 100\}$ by executing the following program:

```plaintext
x := y + 50;
if (y > 0) then
  x := y + 100
else x := y + 200;
x := x + y;
```