Exercise 1: Compiling into Java Bytecode

To compile a Java statement or expression into Java Bytecode, we can define the function $\text{xlat}$. This function takes as input a Java statement or a Java expression and returns a sequence of Java Bytecode instructions. To access local variables, we assume an auxiliary function $\text{slot}$ that takes the name of a local variable and returns the slot of that variable on the stack. We illustrate these two functions on two simple examples:

$$
\text{xlat}(e_1 \cdot e_2) \equiv \begin{align*}
\text{xlat}(e_1) \\
\text{xlat}(e_2) \\
"\text{imul}"
\end{align*}
$$

That is, we translate a multiplication into the sequence of instructions corresponding to the description First evaluate $e_1$, then $e_2$, then execute the instruction $\text{imul}$”.

The next example simply evaluates the local integer variable $x$:

$$
\text{xlat}(x) \equiv "\text{iload}" \text{slot}(x)
$$

Here, the code produced by $\text{xlat}$ states Load the value of the variable stored at the slot of $x$.”

(a) Give the translation for the statement $x = e$; where $x$ is a local integer variable and $e$ some integer expression, i.e., specify what $\text{xlat}(x = e;) \text{ expands to}$. 

(b) Give the translation for the statement $e_1.f = e_2$; where $e_1$ evaluates to some object of class $C$, $f$ is an integer field, and $e_2$ is an integer expression, i.e., specify what $\text{xlat}(e_1.f = e_2;) \text{ expands to}$. 

Exercise 2: Graph Search

Consider the following graph and heuristic function.

![Graph](image)

heuristic\(v\) = \[
\begin{cases}
4 & \text{if } v = q_0 \\
1 & \text{if } v = q_1 \\
3 & \text{if } v = q_2 \\
1 & \text{if } v = q_3 \\
1 & \text{if } v = q_4 \\
2 & \text{if } v = q_5 \\
1 & \text{if } v = q_6 \\
0 & \text{if } v = q_7 \\
0 & \text{if } v = q_8
\end{cases}
\]

(a) For each search technique covered in the lecture (DFS, BFS, Greedy, and A*) give the order in which the nodes are closed. If multiple decisions are possible at a step, choose one and make this choice explicit (i.e., state the choice you made).

(b) Is the heuristic admissible if node \(q_8\) is the goal state? Justify your claim.