You need to extend your solution for Project 4 to translate Sage AST statements to intermediate code. As with Project 4, this will be done by traversing the Sage AST in ROSE, extracting the necessary information from the AST, and constructing a string that contains the resulting transformed program. This string will be printed by `main` (already provided in Project 4; do not change it). The result should be a valid C program that is equivalent to the input program. The project is due by November 20, 11:59 pm.

**Input Language**

Assume that the input is a C program that satisfies all restrictions described in Project 4, with the following modifications:

- We allow again the relational operators (Section 6.5.8) >, >=, <, and <=. However, the only expressions that contain these operators are the ones used in conditions of loop statements and if statements.
- We also allow the remaining operators for boolean expressions: == and != (equality operators; Section 6.5.9), && and || (logical operators; Section 6.5.13 and Section 6.5.14), and ! (logical negation; Section 6.5.3). As with the relational operators, the only expressions that contain these operators are the ones used in conditions of loop statements and if statements.
- The grammar discussed in class assumes boolean literals `true` and `false`. C does not have these; so, you can ignore these productions of the grammar.

**Translation**

You need to translate all statements including sequences (i.e., `SgBasicBlock`), if-statements and if-then-else statements, while-do loops, do-while loops, for loops, expression statements, and return statements. For expression statements and return statements, use your solution from Project 4. You have to generate intermediate code for each such statement, using the approach discussed in class. The intermediate language is the one described in the lecture notes. Since this intermediate language is a proper subset of C, your output program will be a C program. For example, if the input is

```c
main()
{
    int x = -1, y;
    if (x+1 < 0) y = 1;
}
```

the resulting program could be something like

```c
main()
{
    int _t1, _t2;
    int x = -1, y;
    _t1 = x;
    _t2 = _t1 + 1;
    if (_t2 < 0) goto _l1;
    goto _l2;
    _l1: y = 1;
    _l2: ;
}
```

This is valid C code. In the input program, the boolean conditions in ifs and loops could be arbitrarily complicated, including relational/equality operators with operands that themselves are complex sub-expressions with +, *, etc. In the output program, temporary variables need to be introduced as necessary to handle these sub-expressions.
Output

The result should be a single string value that is returned back to the main function provided for Project 4 (do not change this main; it will be used by the grader). This string should be a valid C program that can be compiled (by gcc on stdlinux) and executed. This output program should be a correct translation of the original program. The only C statements allowed in the output program are the ones described in the three-address code definition from the class notes:

- Assignments: \( x = y \text{ op } z; \ x = \text{ op } y; \ x = y; \ x = y[z]; \ x[y] = z; \) as discussed in class
- Conditional jumps: if (x relop y) goto L;
- Unconditional jumps: goto L;
- Returns: return x; where x is a program variable, a temporary variable, or a constant
- Null statements (Section 6.8.3): just a semicolon, as in _l2: ; from the earlier example. You can use these when you need a noop
- Each of the above statements could be labeled or unlabeled (but null statements should always be labeled). Note that a labeled statement could itself be labeled with another label, i.e., we could have _l4: _l7: _l6: p=1; This is valid C code and could be in the output of your project.

The output will also contain variable declarations from the input program as well as the declarations of all temporary vars.

Details

- Your submission must compile and run on stdlinux, using the ROSE installation in /share/CSE/class/cse5343/...
- During the analysis of the AST, do not print directly to cout. The only printing to cout must be done by main.
- Do not use the ROSE methods unparseToString and unparseToCompleteString.
- Your submission must work correctly on the modfft1.c test program used for Project 4.
- You can name your labels _l1, _l2, _l3, etc. Assume that the input program does not already use such names.
- You do not need to transform the expressions in variable declarations (e.g., in float w=x+y+z;).
- You do need to transform the initialization expressions and increment expressions for loops – for example, all three components of for(w=x+y+z;w<p+q+r;w+=a+b+c) should be transformed.

Project Submission

On or before 11:59 pm on the due date, you should submit a single file intermediate2.cpp containing all of your code; it should work with main from Project 4. Log in to carmen.osu.edu to upload the project. You can submit up to 24 hours after the deadline; if you do so, your project score will be reduced by 10%. If you submit more than 24 hours after the deadline, the submission will not be accepted and you will receive zero points for this project.

Academic Integrity

The project you submit must be entirely your own work. Minor consultations with others in the class are OK, but they should be at a very high level, without any specific details. The work on the project should be entirely your own: all the design, programming, testing, and debugging should be done only by you, independently and from scratch. Sharing your code with others is not acceptable. Submissions that show excessive similarities will be taken as evidence of cheating and dealt with accordingly; this includes any similarities with projects submitted in previous instances of this course. Academic misconduct is an extremely serious offense with severe consequences. Additional details on academic integrity are available from the Committee on Academic Misconduct (see http://oaa.osu.edu/coamresources.html). I strongly recommend that you check this URL. If you have any questions about university policies or what constitutes academic misconduct in this course, please contact me immediately.