Symbol tables in MIPS

Construct the symbol table for the following MIPS assembly program.

```
begin:
label: beq $0, $0, after
jr $4

after:
sw $31, 16($0)
lis $4
abc0: abc1: .word after

loadStore:
lw $20, 4($0)
sw $20, 28($0)
```

1  Error-checking MIPS programs

Identify the errors in the following assembly language program.

```
label: label: .word label
.word ; 0
.word aaaaa
.word 1 2 3
.word 2147483648 abcde:
.word ,
```
3 Bitwise operations in MIPS

Bitwise operations enable precise manipulation of bit patterns. The bitwise operations that will be useful in this course are the following

- Inclusive Or (|)
- And (&)
- Left shift (<<)
- Right shift (>>)

Assume 4 bit integers. What should each of the following computations produce, assuming we are using logical right shifting?

1. 3 & 5
2. 3 | 5
3. 3 << 2
4. 3 >> 2
5. 13 << 2
6. 13 >> 2

Briefly summarize how each operation works and its utility with respect to writing an assembler.

4 Binary output

Write pseudocode for a function called `output_word` that takes a 32-bit integer as input and outputs each of its four bytes to standard output.

You can assume a function called `output_byte` is available. This function takes an integer as input and first checks if the integer is small enough that it can be represented in 8 bits. If so, it outputs the corresponding byte; otherwise it produces an error.

How would you use this above function (in conjunction with the symbol table) to assemble the `.word foo` where foo is a label in an assembly program?