goto in C

The goto statement allows transfer of control to any labelled point with a function. For example, this code:

```c
for (int i = 1; i <= 10; i++) {
    printf("%d\n", i);
}
```

can be written as:

```c
int i = 1;
loop:
    if (i > 10) goto end;
    i++;
    printf("%d", i);
    printf("%d\n");
    goto loop;
end:
```

goto in C

- goto statements can result in very difficult to read programs.
- goto statements can also result in slower programs.
- In general, use of goto is considered poor programming style.
- Do not use goto without very good reason.
- kernel & embedded programmers sometimes use goto.

MIPS Programming

Writing correct assembler directly is hard.
Recommended strategy:
- develop the solution in C
- map to “simplified” C
- translate each simplified C statement to MIPS instructions

Simplified C
- does not have while, compound if, complex expressions
- does have simple if, goto, one-operator expressions

Simplified C makes extensive use of
- labels ... symbolic name for C statement
- goto ... transfer control to labelled statement

Example:

Mapping C into MIPS

Things to do:
- allocate variables to registers/memory
- place literals in data segment
- transform C program to:
  - break expression evaluation into steps
  - replace control structures by goto
Standard C
```
int main(void) {
    int x = 17;
    int y = 25;
    printf("%d\n", x + y);
}
```

Simplified C
```
int main(void) {
    int x, y, z;
    x = 17;
    y = 25;
    z = x + y;
    printf("%d", z);
    printf("\n");
}
```

while: C to simplified C
```
int main(void) {
    int x, y, z;
    x = 17;
    y = 25;
    z = x + y;
    printf("%d", z);
    printf("\n");
}
```

MIPS
```
main:
    li $t0, 17
    li $t1, 25
    add $t2, $t1, $t0
    move $a0, $t2
    li $v0, 1
    syscall
    li $a0, '\n'
    li $v0, 11
    syscall
    jr $ra
```
if: C to simplified C

Standard C
```c
if (i < 0) {
    n = n - i;
} else {
    n = n + i;
}
```

Simplified C
```c
if (i >= 0) goto else1;
    n = n - i;
else1:
    n = n + i;
end1:
```

Note: you can’t use else as a label in C

if/and: C to simplified C

Standard C
```c
if (i < 0 && n >= 42) {
    n = n - i;
} else {
    n = n + i;
}
```

Simplified C
```c
if (i >= 0) goto else1;
if (n < 42) goto else1;
    n = n - i;
else1:
    n = n + i;
end1:
```

if: simplified C to MIPS

Simplified C
```c
if (i >= 0) goto else1;
    n = n - i;
else1:
    n = n + i;
end1:
```

MIPS
```mips
# assume i in $t0
# assume n in $t1
bge $t0, 0, else1
sub $t1, $t1, $t0
go end1
else1:
    add $t1, $t1, $t0
end1:
```

if/and: simplified C to MIPS

Simplified C
```c
if (i >= 0) goto else1;
if (n < 42) goto else1;
    n = n - i;
else1:
    n = n + i;
end1:
```

MIPS
```mips
# assume i in $t0
# assume n in $t1
bge $t0, 0, else1
blt $t1, 42, else1
sub $t1, $t1, $t0
go end1
else1:
    add $t1, $t1, $t0
end1:
```
odd-even: C to simplified C

Standard C

```c
if (i < 0 || n >= 42) {
    n = n - i;
} else {
    n = n + i;
}
```

Simplified C

```c
if (i < 0) goto then1;
if (n >= 42) goto then1;
goto else1;
then1:
    n = n - i;
    goto end1;
else1:
    n = n + i;
end1:
```

Example Printing First 10 Integers

Convert to goto and simple C statements and decide where variables will be stored.

```c
int main(void) {
    int i; // in register $t0
    i = 0;
    loop:
        if (i >= 10)
            goto end;
        i++;
        printf("%d", i);
        printf("\n");
        goto loop;
    end:
        return 0;
}
```