

Optimization

- Compiler Optimization – optimizes the speed of compilation
- Execution Optimization – optimizes the speed of execution

Turn Optimization On/OFF

- For university projects – optimize compilation speed. Fast execution speed is unnecessary.
- For most computer applications produced by software vendors, fast execution is essential. Since they are usually compiled before the customer gets them, compilation speed is incidental.
- Optimizations are usually invoked with compiler directives such as UNIX dash options.

Constant Folding

a = 17;

b = a - 15;

c = a * b;

Original Triples

(1) = a 17

(2) - (1) 15 c 2

(3) = b (2)

(4) * (1) (3) c 34

(5) = c (4)

Optimized Triples

(1) = a 17

(3) = b 2

(5) = c 34

Code Motion/Loop Invariants

Unoptimized Code:

```
for (int a=0;a<10000;a++) {  
    c = 8;    /* loop invariant is located inside the loop */  
    b= a + c;  
    cout << b; }
```

Optimized Code:

```
c = 8;          /* loop invariant is moved outside loop */  
for (int a=0;a<10000;a++) {  
    b= a + c;  
    cout << b; }
```

Saves 19998 loads and 9999 stores.

Reduction in Strength

Substitute a less expensive statement for a more expensive one:

Example 1:

substitute $b = a \ll 1$ for $b = 2 * a$

Trade multiply for a shift

Reduction-in-Strength (cont)

Unoptimized code:

```
int i, j, k, a[601], b[601];
k=25;
i=1;
while(i<25) {
    j=k*i;
    a[j]=b[j];
    i++; }
```

Reduction in strength –
Dead variable elimination –

Optimized code:

```
int k, a[601],b[601];
k=0;
while(k<=600) {
    k+=25;
    a[k]=b[k]; }
```

traded 24 adds for 24 multiplies
i=1 saved 2 loads and 1 store
i++ saved 48 loads, 24 adds, and
24 stores

Loop Unrolling

Unoptimized Code:

```
int k, a[601],b[601];  
k=0;  
while(k<=600) {  
    k+=25;  
    a[k]=b[k]; }  
}
```

Optimized Code:

```
int j, k, a[601],b[601];  
k=0;  
while(k<=600) {  
    k+=50;  
    j=k - 25;  
    a[k]=b[k];  
    a[j]=b[j]; }  
}
```

Savings:

fewer branches (half the number in this case). Fewer branch penalties in pipelining.