Effects of Assignments on Branches

(a) Source Code

```c
for (i = 0; !quit && i < 1000; i++)
    if (a[i] == 0)
        quit = 1;
    else if (odd) {
        sumodd += a[i];
        odd = 0;
    } else {
        sumeven += a[i];
        odd = 1;
    }
```

(b) Control Flow

(d) Paths in Loop

(1) blk 1 nullifies blk 2
(2) blk 1 makes blk 4 jump
(3) blk 1 makes blk 8 fall thru
(4) blk 1 makes blk 9 jump
(5) blk 3 makes blk 8 jump
(6) blk 5 makes blk 4 jump
(7) blk 6 makes blk 4 fall thru
(8) blk 7 nullifies blks 2,9

(c) Explicit Constraints

(1) 8
(2) 8→9
(3) 8→9→2→3→7
(4) 8→9→2→4→5→7
(5) 8→9→2→4→6→7
Logical Correlation between Branches

(a) Source Code

```c
sumneg = sumall = 0;
sumpos = 0;
for (i = 0; i < 1000; i++) {
    if (a[i] < 0)
        sumneg += a[i];
    sumall += a[i];
    if (a[i] > 0)
        sumpos += a[i];
}
```

(b) Control Flow

- Path 4 is not feasible.

(c) Explicit Constraints

1. blk 1 nullifies blk 2
2. blk 1 makes blk 7 jump
3. blk 2 fall thru makes blk 5 jump
4. blk 5 fall thru makes blk 2 jump
5. block 7 nullifies blocks 2,5,7

(d) Paths in Loop

1. 2→4→5→7
2. 2→3→4→5→7
3. 2→4→5→6→7
4. 2→3→4→5→6→7
5. 7F
6. 7J
Ranges of Iterations and Branch Outcomes

(a) Source Code

```
summid = sumall = 0;
for (i = 0; i < 1000; i++) {
    if (i != m && 249 < i && i < 750)
        summid += a[i];
    sumall += a[i];
}
```

(b) Control Flow

(c) Explicit Constraints

1. 2 → 6 → 7
2. 2 → 3 → 6 → 7
3. 2 → 3 → 4 → 6 → 7
4. 2 → 3 → 4 → 5 → 6 → 7
5. 2 → 3 → 4 → 5 → 6 → 7
6. 2 → 3 → 4 → 5 → 6 → 7
7. 2 → 3 → 4 → 5 → 6 → 7
8. 2 → 3 → 4 → 5 → 6 → 7

(d) Paths in Loop

• Iteration constraints propagated thru path 4.
Worst-Case Loop Analysis Algorithm

\[
\text{iterations\_handled} = 0. \\
\text{while} \ (\text{iterations\_handled} < N) \ \text{do} \\
\quad \text{do} \\
\qquad \text{Find longest path available for execution.} \\
\qquad \text{Use this longest path for 1 iteration.} \\
\qquad \text{iterations\_handled} += 1. \\
\text{while} \ (\text{longest path’s caching behavior changes}). \\
\text{iters\_to\_do} = \\
\quad \text{longest path’s required iterations} + \\
\quad \min \ (\text{longest path’s nonrequired iterations,} \\
\quad \text{loop’s nonrequired iterations}). \\
\text{Use this longest path for iters\_to\_do iterations.} \\
\text{iterations\_handled} += \text{iters\_to\_do}. \]