Research Report

Monday 11/25/2013

Happy Holidays!

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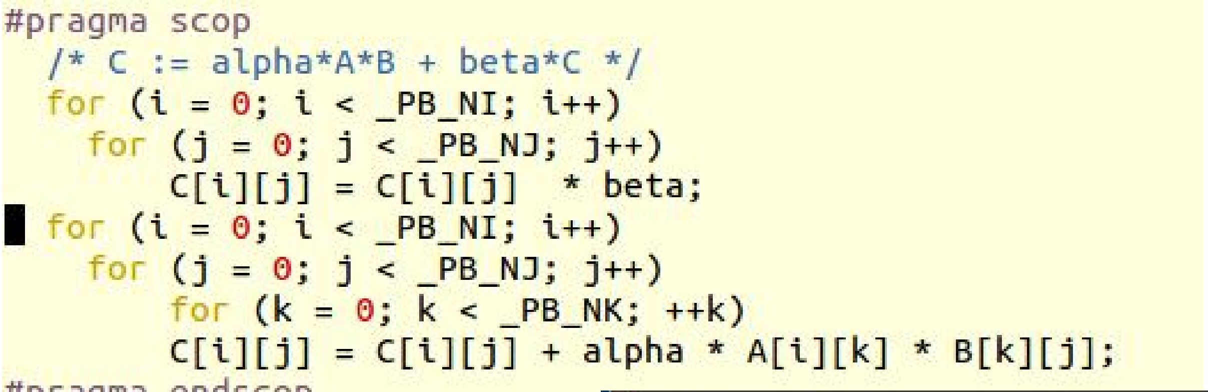
review of the issues to solve/What I needed to do

- Needed to reconstruct loops and array accesses from the trace only
- Needed to write script to post process NLR outputs
- Needed to test with different programs (traces)
- Others
  - Lulesh (using INRIA PPCG)
  - PNNL benchmark

Progress & Problems

- Reconstruct from the trace
  - Looks like NLR works on *simple* (perfect) loop nest and *simple* loop iterators (lower =0, upper = N) but not (yet) imperfect loop or more complex loop bounds
  - gemver.c and gemm.c (perfect loop version) successfully constructed and analyzed
  - Imperfect loop nests (e.g. gemm.c and covariance.c) or complex loop bounds (covariance.c) failed
  - Example (both success and failed cases) in next slides

success program other than gemver.c (i.e. gemm.c)

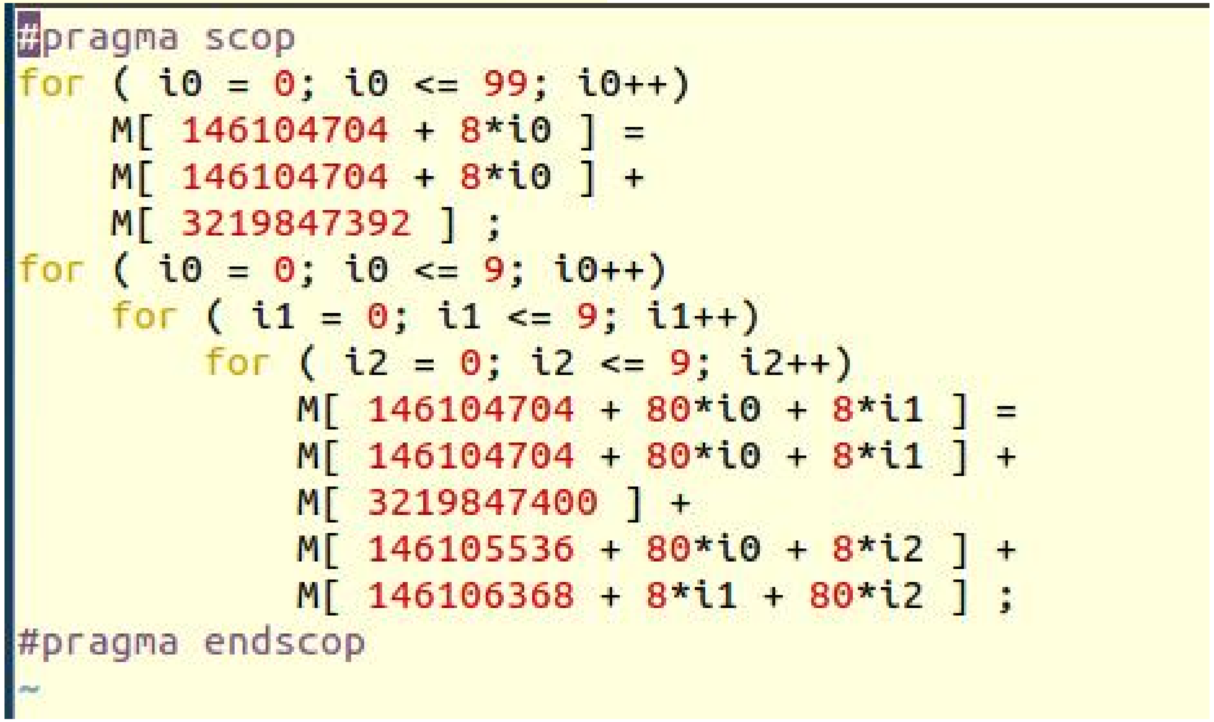


```
#pragma scop
  /* C := alpha*A*B + beta*C */
  for (i = 0; i < _PB_NI; i++)
    for (j = 0; j < _PB_NJ; j++)
        C[i][j] = C[i][j]  * beta;
  for (i = 0; i < _PB_NI; i++)
    for (j = 0; j < _PB_NJ; j++)
        for (k = 0; k < _PB_NK; ++k)
        C[i][j] = C[i][j] + alpha * A[i][k] * B[k][j];
#pragma endscop

}
```

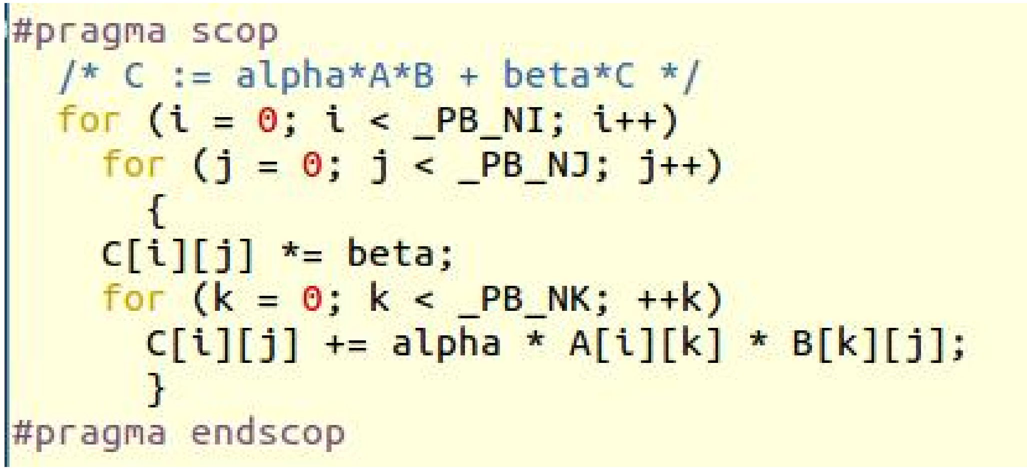
Above: original scop

>>>Right: constructed from trace (Loop Boundary set to 10), note that the constructed scop did not recover the first nested loop but the code is correct.



```
#pragma scop
for ( i0 = 0; i0 <= 99; i0++)
    M[ 146104704 + 8*i0 ] =
    M[ 146104704 + 8*i0 ] +
    M[ 3219847392 ] ;
for ( i0 = 0; i0 <= 9; i0++)
    for ( i1 = 0; i1 <= 9; i1++)
        for ( i2 = 0; i2 <= 9; i2++)
            M[ 146104704 + 80*i0 + 8*i1 ] =
            M[ 146104704 + 80*i0 + 8*i1 ] +
            M[ 3219847400 ] +
            M[ 146105536 + 80*i0 + 8*i2 ] +
            M[ 146106368 + 8*i1 + 80*i2 ] ;
#pragma endscop
~
```

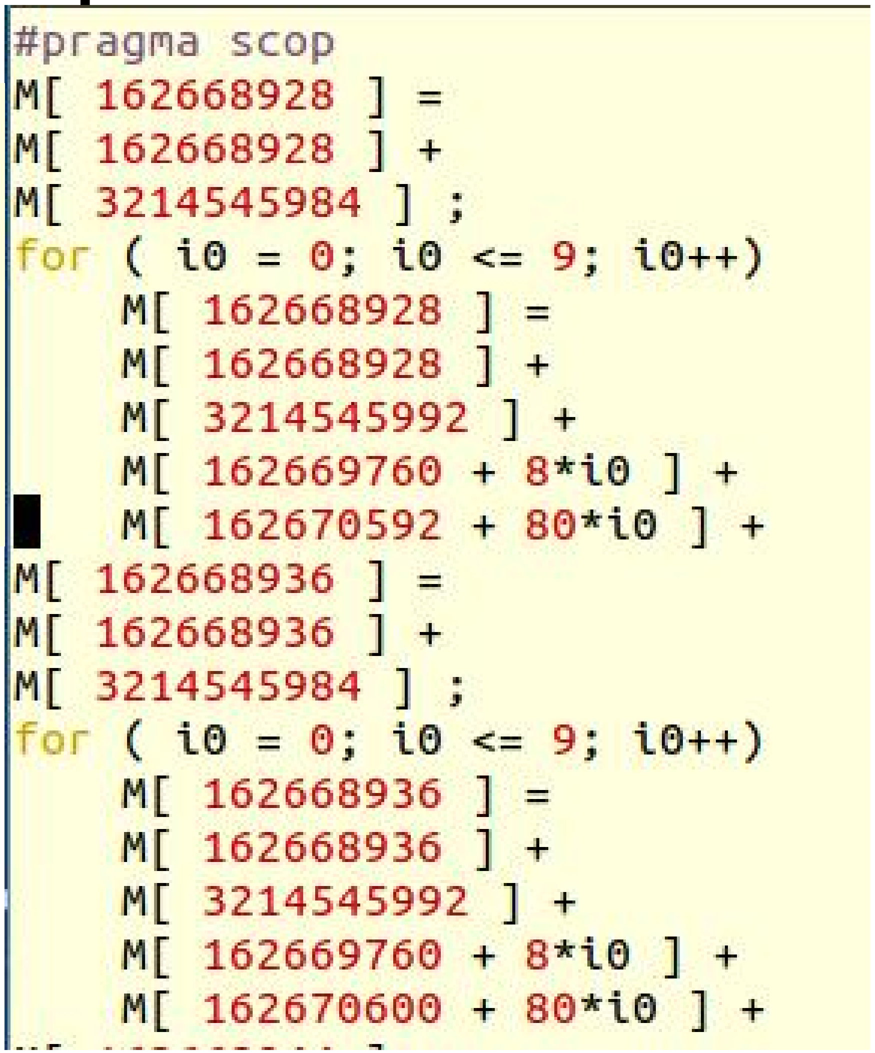
failed program: gemm.c with imperfect loop nest



```
#pragma scop
  /* C := alpha*A*B + beta*C */
  for (i = 0; i < _PB_NI; i++)
    for (j = 0; j < _PB_NJ; j++)
      {
    C[i][j] *= beta;
    for (k = 0; k < _PB_NK; ++k)
      C[i][j] += alpha * A[i][k] * B[k][j];
      }
#pragma endscop
```

Above: original scop

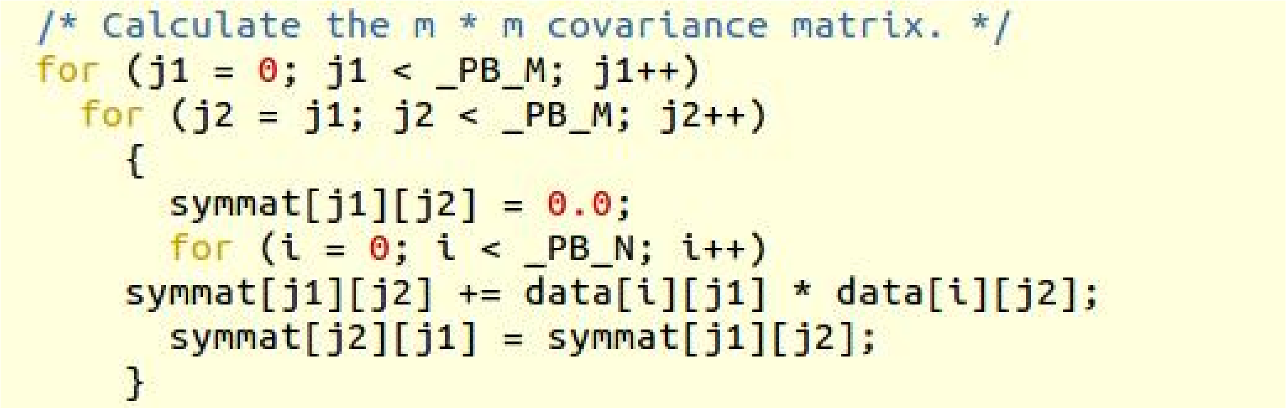
>>>Right: constructed from trace (loop boundary set to 10), the code is not correctly reconstructed because the first 9 lines of code got repeated 100 times, where in reality it should be a loop (or a loop nest)



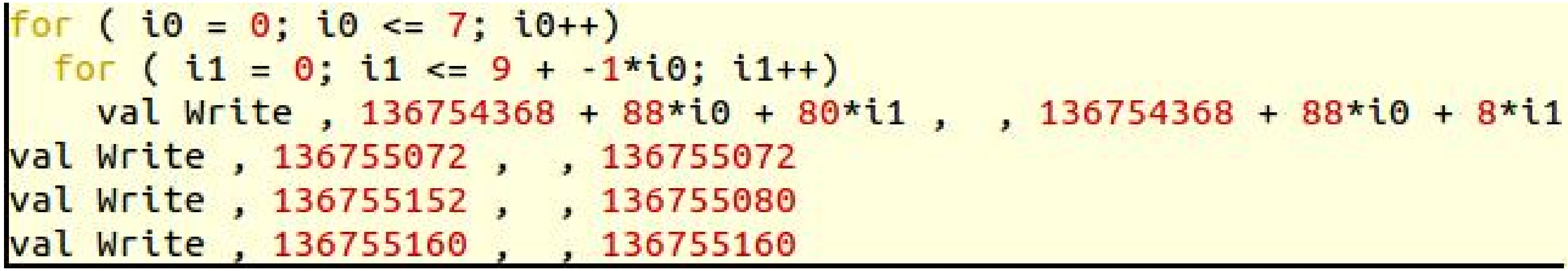
```
#pragma scop
M[ 162668928 ] =
M[ 162668928 ] +
M[ 3214545984 ] ;
for ( i0 = 0; i0 <= 9; i0++)
    M[ 162668928 ] =
    M[ 162668928 ] +
    M[ 3214545992 ] +
    M[ 162669760 + 8*i0 ] +
    M[ 162670592 + 80*i0 ] +
M[ 162668936 ] =
M[ 162668936 ] +
M[ 3214545984 ] ;
for ( i0 = 0; i0 <= 9; i0++)
    M[ 162668936 ] =
    M[ 162668936 ] +
    M[ 3214545992 ] +
    M[ 162669760 + 8*i0 ] +
    M[ 162670600 + 80*i0 ] +
```

failed program: covariance.c with complex loop bounds

Right: part of the original scop



```
/* Calculate the m * m covariance matrix. */
for (j1 = 0; j1 < _PB_M; j1++)
  for (j2 = j1; j2 < _PB_M; j2++)
    {
      symmat[j1][j2] = 0.0;
      for (i = 0; i < _PB_N; i++)
    symmat[j1][j2] += data[i][j1] * data[i][j2];
      symmat[j2][j1] = symmat[j1][j2];
    }
```



```
for ( i0 = 0; i0 <= 7; i0++)
  for ( i1 = 0; i1 <= 9 + -1*i0; i1++)
    val Write , 136754368 + 88*i0 + 80*i1 ,  , 136754368 + 88*i0 + 8*i1
val Write , 136755072 ,  , 136755072
val Write , 136755152 ,  , 136755080
val Write , 136755160 ,  , 136755160
```

Above: part of the reconstructed code. The original code is not correctly reconstructed from trace (loop boundary still set to 10). As you can see from above, the loop bounds are not correctly calculated.

The plan

- Discuss with Prof. Ketterlin about the two issues 1) imperfect loop nest 2) complex boundary
- Migrate NLR to Windows Platform
- Integrate NLR to PoCC (adding one more source code to the Collection)
- Any possibility of doing dependency analysis without candl?
- Energy Tuning Project
  - Lulesh benchmark using PPCG
  - PNNL benchmark