Applied Research Laboratories

The University of Texas at Austin

GCOV: A GNU Coverage Testing Tool

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What is gcov?

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- Gcov is a test coverage program
- Gcov is designed to work exclusively with GCC to analyze programs to help create more efficient, faster running code
- Gcov can be used in concert with gprof, an application which which assesses the parts of code that take the greatest amount of computing time

What can gcov do?

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- With gcov and gprof one could
  - Find how often each line of code executes
  - What lines of code are actually executed
  - How much computing time each section of code uses

What can gcov do for us?

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- Gcov can also be used with testsuites.
- A coverage program tests to see how much of the program is exercised by the testsuite
- With this information, developers can determine which test cases need to be added to the suite to ensure better testing for a higher quality final project

Gcov Options

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- -h, --help
  - Display help about using gcov
- -a, --all-blocks
  - Write individual execution counts for every basic block. With this option you can determine if blocks within a single line are not being executed
- -b, -branch-probabilities
  - Write branch frequencies to the output file, and write branch summary info to the standard output. This option allows you to see how often each branch in your program was taken

Gcov Options

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- -c, --branch-counts
  - Write branch frequencies as the number of branches taken, rather than the percentage of branches taken
- -n, --no-output
  - Do not create the gcov output file
- Within a gcov file the format is <execution_count>:<line_number>:<source line text>
- - is for lines containing no code
- ##### is for lines which were never executed

Gcov an Example

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```
#include <iostream>

int main(void)
{
  int i, total;

  total = 0;

  for (i=0;i<10;i++)
    total +=i;

  if (total !=45)
   std:: cout << ("Failure\n");
  else
   std:: cout << ("Success\n");
  return 0;

}
```

Gcov : An Example

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```
-bash-3.00$ g++ -fprofile-arcs -ftest-coverage gcovTest.cpp
-bash-3.00$ ./a.out
Success
-bash-3.00$ ls
a.out  gcovTest.cpp  gcovTest.cpp~  gcovTest.gcda  gcovTest.gcno
-bash-3.00$ gcov gcovTest.cpp
File `/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/
locale_facets.tcc'
Lines executed:0.00% of 11
/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/locale
_facets.tcc:creating `locale_facets.tcc.gcov'

File `gcovTest.cpp'
Lines executed:90.91% of 11
gcovTest.cpp:creating `gcovTest.cpp.gcov'

File `/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/
stl_algobase.h'
Lines executed:0.00% of 4
/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/stl_al
gobase.h:creating `stl_algobase.h.gcov'

File `/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/iostr
eam'
Lines executed:100.00% of 1
/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/iostream:cr
eating `iostream.gcov'

-bash-3.00$
```

Gcov : An Example

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```
        -:    0:Source:gcovTest.cpp
        -:    0:Graph:gcovTest.gcno
        -:    0:Data:gcovTest.gcda
        -:    0:Runs:1
        -:    0:Programs:1
        -:    1:#include <iostream>
        -:    2:
        -:    3:int main(void)
function main called 1 returned 100% blocks executed 75%
        1:    4:{
        1:    5:  int i, total;
        -:    6:
        1:    7:  total = 0;
        -:    8:
       11:    9:  for (i=0;i<10;i++)
       10:   10:    total +=i;
        -:   11:
        1:   12:  if (total !=45)
    #####:   13:   std:: cout << ("Failure\n");
        -:   14:  else
        1:   15:   std:: cout << ("Success\n");
        1:   16:  return 0;
        -:   17:
function _Z41__static_initialization_and_destruction_0ii called 1 returned 100% blocks executed 100%
        2:   18:}
function _GLOBAL__I_main called 1 returned 100% blocks executed 100%
        2:   19:/*EOF*/
```

Gcov: An Example

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```
-bash-3.00$ gcov gcovTest.cpp -b
File `/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/locale_facets.tcc'
Lines executed:0.00% of 11
Branches executed:0.00% of 10
Taken at least once:0.00% of 10
Calls executed:0.00% of 5
/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/locale_facets.tcc:creating `locale_facets.tcc.gcov'

File `gcovTest.cpp'
Lines executed:90.91% of 11
Branches executed:100.00% of 4
Taken at least once:75.00% of 4
Calls executed:66.67% of 3
gcovTest.cpp:creating `gcovTest.cpp.gcov'

File `/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/stl_algobase.h'
Lines executed:0.00% of 4
Branches executed:0.00% of 2
Taken at least once:0.00% of 2
No calls
/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/bits/stl_algobase.h:creating `stl_algobase.h.gcov'

File `/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/iostream'
Lines executed:100.00% of 1
Branches executed:100.00% of 4
Taken at least once:50.00% of 4
Calls executed:100.00% of 3
/usr/lib/gcc/x86_64-redhat-linux/3.4.4/../../../../include/c++/3.4.4/iostream:creating `iostream.gcov'

-bash-3.00$
```

Gcov: An Example

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```
        -:    0:Source:gcovTest.cpp
        -:    0:Graph:gcovTest.gcno
        -:    0:Data:gcovTest.gcda
        -:    0:Runs:1
        -:    0:Programs:1
        -:    1:#include <iostream>
        -:    2:
        -:    3:int main(void)
function main called 1 returned 100% blocks executed 75%
        1:    4:{
        1:    5:  int i, total;
        -:    6:
        1:    7:  total = 0;
        -:    8:
       11:    9:  for (i=0;i<10;i++)
branch  0 taken 91% (fallthrough)
branch  1 taken 9%
       10:   10:    total +=i;
        -:   11:
        1:   12:  if (total !=45)
branch  0 taken 0% (fallthrough)
branch  1 taken 100%
    #####:   13:    std:: cout << ("Failure\n");
call    0 never executed
        -:   14:  else
        1:   15:    std:: cout << ("Success\n");
call    0 returned 100%
        1:   16:  return 0;
        -:   17:
function _Z41__static_initialization_and_destruction_0ii called 1 returned 100% blocks executed 100%
        2:   18:}
function _GLOBAL__I_main called 1 returned 100% blocks executed 100%
        2:   19:/*EOF*/
call    0 returned 100%
```

Gcov and CppUnit

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```
CPPUNIT_PATH=/home/ehagen

xStats: xStatsM.o xStats.o Stats.o
        g++ -o xStats xStatsM.o xStats.o Stats.o -L${CPPUNIT_PATH}/lib -lstdc++ -lcppunit -ldl -lgpstk -fprofile-arcs -ftest-coverage


Stats.o: Stats.cpp
        g++ -c Stats.cpp -I/home/ehagen/gpstk/src -L/home/ehagen/gpstk/src -lgpstk -fprofile-arcs -ftest-coverage

xStats.o: xStats.cpp xStats.hpp
        g++ -c xStats.cpp -I${CPPUNIT_PATH}/include -I/home/ehagen/gpstk/src -L/home/ehagen/gpstk/src -fprofile-arcs -ftest-coverage

xStatsM.o: xStatsM.cpp
        g++ -c xStatsM.cpp -I${CPPUNIT_PATH}/include -fprofile-arcs -ftest-coverage

clean:
        rm -f *.o
        rm -f *.*.g*
        rm -f *.g*
```

Gcov and CppUnit

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```
bash-3.00$ gcov xStats.gcda
File `/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/locale_facets.tcc'
Lines executed:0.00% of 11
/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/locale_facets.tcc:creating `locale_facets.tcc.gcov'

File `xStats.cpp'
Lines executed:97.17% of 212
xStats.cpp:creating `xStats.cpp.gcov'

File `/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/stl_algobase.h'
Lines executed:0.00% of 4
/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/stl_algobase.h:creating `stl_algobase.h.gcov'

File `/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/basic_string.tcc'
Lines executed:100.00% of 7
/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/basic_string.tcc:creating `basic_string.tcc.gcov'

File `/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/char_traits.h'
Lines executed:100.00% of 1
/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/char_traits.h:creating `char_traits.h.gcov'

File `/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/basic_string.h'
Lines executed:0.00% of 4
/usr/lib/gcc/i386-redhat-linux/3.4.5/../../../../include/c++/3.4.5/bits/basic_string.h:creating `basic_string.h.gcov'

File `Stats.hpp'
Lines executed:91.06% of 179
Stats.hpp:creating `Stats.hpp.gcov'
```

WhereSat Old Version

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```
bash-3.00$ wheresat -b /home/ehagen/Cpptests/xRinexEphemerisStore/TestRinex06.031 -p 1 -e "01/31/2006 04:00:00"
 Navigation File:   /home/ehagen/Cpptests/xRinexEphemerisStore/TestRinex06.031
 Start Time:        01/31/2006 00:00:00
 End Time:          01/31/2006 04:00:00
 PRN:               1

 Prn 1 Earth-fixed position and clock information:

 Date       Time(UTC)   X (meters)          Y (meters)          Z (meters)          Clock Correc (s)
 ==========================================================================================
 01/31/2006 00:00:00  -14657817.772843     527646.832834       -21945787.627871     0.000034
 01/31/2006 00:15:00  -15162237.916183     -1945111.532170     -21526695.430184     0.000034
 01/31/2006 00:30:00  -15784456.191703     -4318087.923765     -20730531.321380     0.000034
 01/31/2006 00:45:00  -16500423.882623     -6546047.567355     -19571600.535211     0.000034
 01/31/2006 01:00:00  -17279382.597326     -8589387.120153     -18070619.418284     0.000034
 01/31/2006 01:15:00  -18085107.851049     -10415476.574351    -16254305.220300     0.000034
 01/31/2006 01:30:00  -18877378.366901     -11999718.090810    -14154854.823981     0.000034
 01/31/2006 01:45:00  -19613609.386383     -13326282.048802    -11809325.689524     0.000034
 01/31/2006 02:00:00  -20250582.138493     -14388494.830482    -9258933.974568      0.000034
 01/31/2006 02:15:00  -20746199.740380     -15188866.300954    -6548287.513343      0.000034
 01/31/2006 02:30:00  -21061196.431346     -15738763.417057    -3724568.264395      0.000034
 01/31/2006 02:45:00  -21160737.053865     -16057745.736908    -836684.249243       0.000034
 01/31/2006 03:00:00  -21015841.512026     -16172594.944842    2065593.076533       0.000034
 01/31/2006 03:15:00  -20604582.829347     -16116081.058410    4932489.895757       0.000034
 01/31/2006 03:30:00  -19913015.007949     -15925516.909991    7715074.401863       0.000034
 01/31/2006 03:45:00  -18935798.565720     -15641159.482588    10366070.869741      0.000034

 Calculated 16 increments for prn 1 .
```

WhereSat New Version Without -v

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```
bash-3.00$ ./WhereSat -b /home/ehagen/Cpptests/xRinexEphemerisStore/TestRinex06.031 -p 1 -e "01/31/2006 04:00:00"
 Navigation File:   /home/ehagen/Cpptests/xRinexEphemerisStore/TestRinex06.031
 Start Time:        01/31/2006 00:00:00
 End Time:          01/31/2006 04:00:00
 PRN:               1

 Prn 1 Earth-fixed position and clock information:

 Date       Time(UTC)   X (meters)     Y (meters)     Z (meters)     Clock Correc (s)
 ==================================================================================
 01/31/2006 00:00:00  -14657817.773   527646.833     -21945787.628   0.000034117
 01/31/2006 00:15:00  -15162237.916   -1945111.532   -21526695.430   0.000034117
 01/31/2006 00:30:00  -15784456.192   -4318087.924   -20730531.321   0.000034117
 01/31/2006 00:45:00  -16500423.883   -6546047.567   -19571600.535   0.000034117
 01/31/2006 01:00:00  -17279382.597   -8589387.120   -18070619.418   0.000034118
 01/31/2006 01:15:00  -18085107.851   -10415476.574  -16254305.220   0.000034118
 01/31/2006 01:30:00  -18877378.367   -11999718.091  -14154854.824   0.000034119
 01/31/2006 01:45:00  -19613609.386   -13326282.049  -11809325.690   0.000034119
 01/31/2006 02:00:00  -20250582.138   -14388494.830  -9258933.975    0.000034120
 01/31/2006 02:15:00  -20746199.740   -15188866.301  -6548287.513    0.000034121
 01/31/2006 02:30:00  -21061196.431   -15738763.417  -3724568.264    0.000034123
 01/31/2006 02:45:00  -21160737.054   -16057745.737  -836684.249     0.000034125
 01/31/2006 03:00:00  -21015841.512   -16172594.945  2065593.077     0.000034127
 01/31/2006 03:15:00  -20604582.829   -16116081.058  4932489.896     0.000034129
 01/31/2006 03:30:00  -19913015.008   -15925516.910  7715074.402     0.000034132
 01/31/2006 03:45:00  -18935798.566   -15641159.483  10366070.870    0.000034134

 Calculated 16 increments for prn 1 .
```

WhereSat New Version with -v

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```
bash-3.00$ ./WhereSat -b /home/ehagen/Cpptests/xRinexEphemerisStore/TestRinex06.031 -p 1 -e "01/31/2006 04:00:00" -v
 Navigation File:   /home/ehagen/Cpptests/xRinexEphemerisStore/TestRinex06.031
 Start Time:        01/31/2006 00:00:00
 End Time:          01/31/2006 04:00:00
 PRN:               1

 Prn 1 Earth-fixed position and clock information:

 Date       Time(UTC)   X (meters)     Y (meters)     Z (meters)      Vx (m/s)     Vy (m/s)   Vz (m/s)   Clock Correc (s)
 ==========================================================================================================================
 01/31/2006 00:00:00  -14657817.773   527646.833      -21945787.628   -488.204    -2784.953   252.724     3.4117e-05
 01/31/2006 00:15:00  -15162237.916   -1945111.532    -21526695.430   -629.682    -2700.876   677.177     3.4117e-05
 01/31/2006 00:30:00  -15784456.192   -4318087.924    -20730531.321   -748.551    -2563.967   1089.414    3.4117e-05
 01/31/2006 00:45:00  -16500423.883   -6546047.567    -19571600.535   -836.765    -2379.648   1482.126    3.4117e-05
 01/31/2006 01:00:00  -17279382.597   -8589387.120    -18070619.418   -887.513    -2154.971   1848.394    3.4118e-05
 01/31/2006 01:15:00  -18085107.851   -10415476.574   -16254305.220   -895.503    -1898.332   2181.820    3.4118e-05
 01/31/2006 01:30:00  -18877378.367   -11999718.091   -14154854.824   -857.178    -1619.129   2476.644    3.4119e-05
 01/31/2006 01:45:00  -19613609.386   -13326282.049   -11809325.690   -770.862    -1327.389   2727.843    3.4119e-05
 01/31/2006 02:00:00  -20250582.138   -14388494.830   -9258933.975    -636.829    -1033.368   2931.215    3.4120e-05
 01/31/2006 02:15:00  -20746199.740   -15188866.301   -6548287.513    -457.289    -747.154    3083.438    3.4121e-05
 01/31/2006 02:30:00  -21061196.431   -15738763.417   -3724568.264    -236.302    -478.279    3182.123    3.4123e-05
 01/31/2006 02:45:00  -21160737.054   -16057745.737   -836684.249     20.380      -235.359    3225.833    3.4125e-05
 01/31/2006 03:00:00  -21015841.512   -16172594.945   2065593.077     305.541     -25.777     3214.090    3.4127e-05
 01/31/2006 03:15:00  -20604582.829   -16116081.058   4932489.896     610.779     144.584     3147.365    3.4129e-05
 01/31/2006 03:30:00  -19913015.008   -15925516.910   7715074.402     926.821     271.543     3027.052    3.4132e-05
 01/31/2006 03:45:00  -18935798.566   -15641159.483   10366070.870    1243.877    352.757     2855.428    3.4134e-05

 Calculated 16 increments for prn 1 .
```