Intro to Code Development in C

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Outline

- Languages and compilers available
- Example: write – build – test
- Libraries
- Debugging
- **`make`**

hello.c

```
> cat hello.c
#include <stdio.h>

void main()
{
   printf ("Hello World!\n");
}

> cc hello.c
> ./a.out
Hello World!
>
>
> which cc
/opt/sun/sunstudio12/bin/cc
>
```

Languages and compilers

- Fortran 95 (and '90 and '77)
  - `f95` (SunStudio 12)
  - `pgf95` (Portland Group)
- C
  - **`cc`** (SunStudio 12)
  - **`pgcc`** (Portland Group)
  - **`gcc, gcc4`** (GNU)

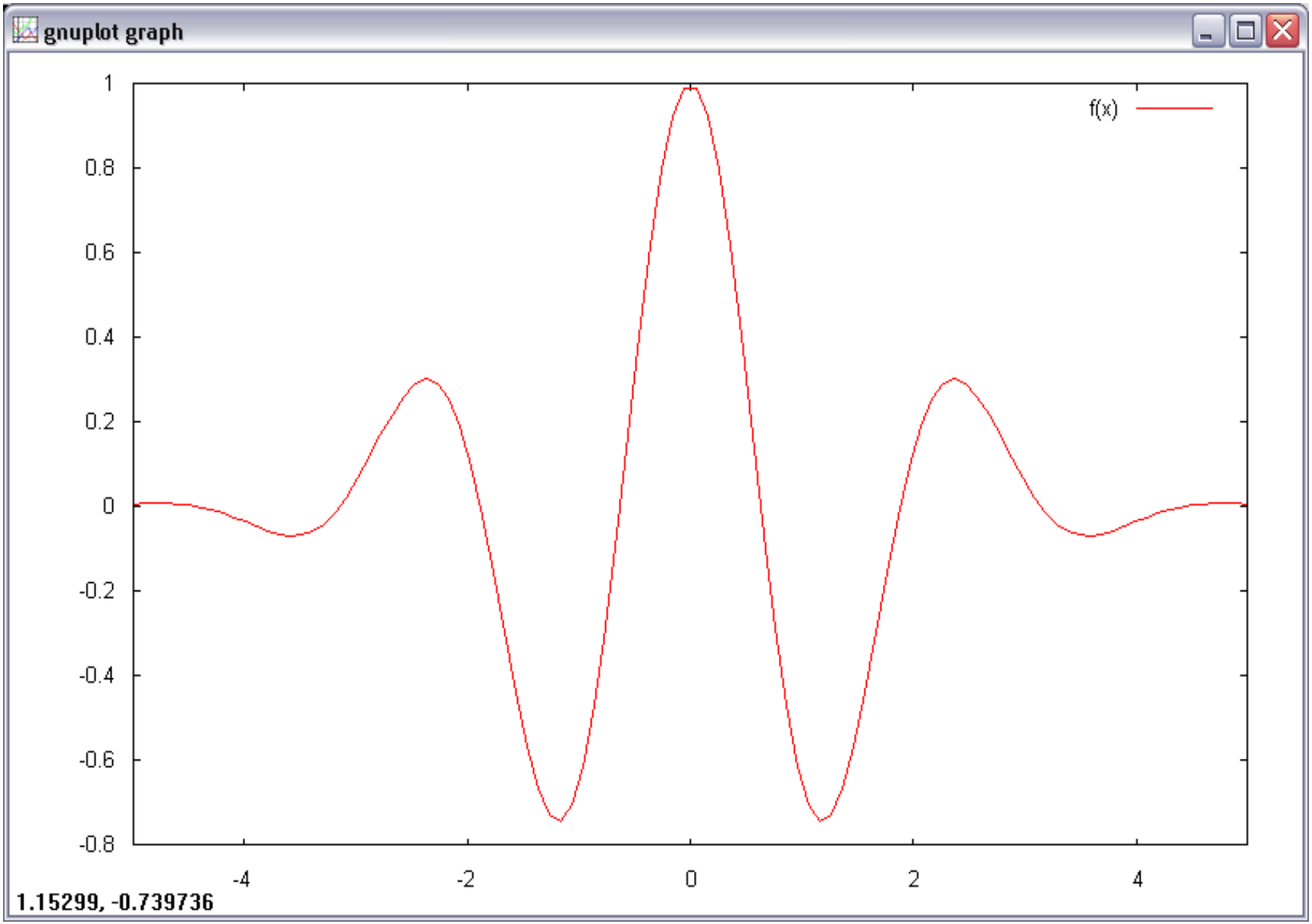
Languages and compilers

- C++
  - `cc` (SunStudio 12)
  - `pgcpp, pgCC` (Portland Group)
  - `g++, g++4` (GNU)
- Java - Matlab - R - Python - Perl ...
  - http://wiki.ace-net.ca/index.php/Available_Software

Example

- Integrate this:

$$\int \exp(-ax^2)\cos(bx)\, dx$$


gnuplot graph
f(x)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-4
-2
0
2
4
1.15299, -0.739736

int1.c

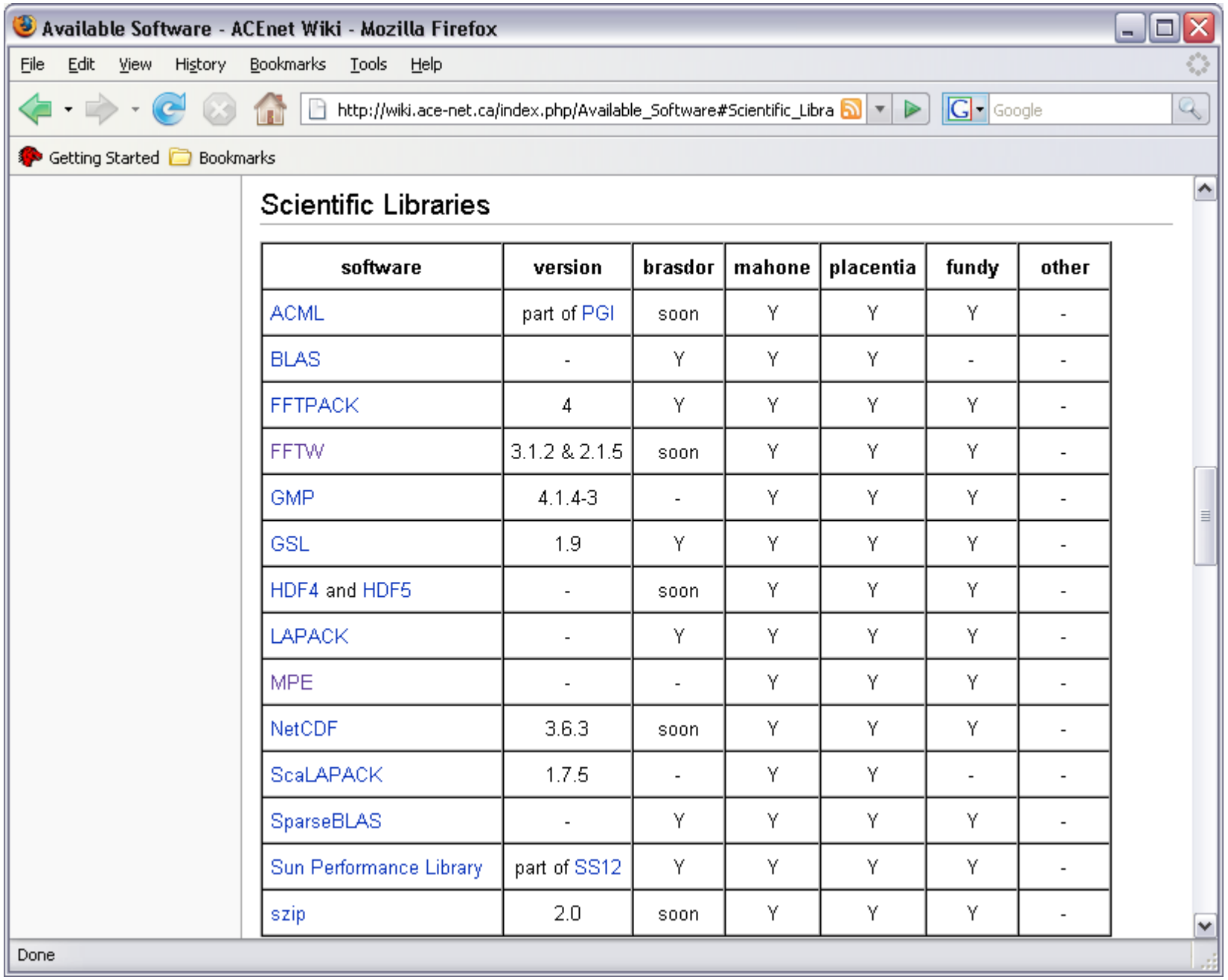
```
#include <stdio.h>
#include <math.h>

double f(double x, double a, double b) {
   double f = exp(-a*x*x)*cos(b*x);
   return(f);
}

int main(int argc, char *argv[]) {
   double xleft=-4.5,xright=4.5;
   int    n=100;
   double dx = (xright-xleft)/n;
   double s = 0.0, x;
   for (int i=0; i<n; i++) {
      x = (xleft - dx/2) + i*dx;
      s += f(x,0.2,2.5)*dx;
   }
   printf("The integral is %lf\n", s);
}
```

int1.c

```
> cc int1.c
int1.o(.text+0x49): In function `f':
: undefined reference to `exp'
int1.o(.text+0x71): In function `f':
: undefined reference to `cos'
>
> cc int1.c -lm
> a.out
The integral is -0.008604
>
> cc int1.c -lm -o int1
> int1
The integral is -0.008604
>
```

A Few Libraries

- FFTW
  - *fast Fourier transforms*
- HDF, netCDF
  - *data exchange formats*
- BLAS, LAPACK
  - *linear algebra*
- GSL
  - *Gnu Scientific Library*
- ...many more...



Scientific Libraries

software	version	brasdor	mahone	placentia	fundy	other
ACML	part of PGI	soon	Y	Y	Y	-
BLAS	-	Y	Y	Y	-	-
FFTPACK	4	Y	Y	Y	Y	-
FFTW	3.1.2 & 2.1.5	soon	Y	Y	Y	-
GMP	4.1.4-3	-	Y	Y	Y	-
GSL	1.9	Y	Y	Y	Y	-
HDF4 and HDF5	-	soon	Y	Y	Y	-
LAPACK	-	Y	Y	Y	Y	-
MPE	-	-	Y	Y	Y	-
NetCDF	3.6.3	soon	Y	Y	Y	-
ScaLAPACK	1.7.5	-	Y	Y	-	-
SparseBLAS	-	Y	Y	Y	Y	-
Sun Performance Library	part of SS12	Y	Y	Y	Y	-
szip	2.0	soon	Y	Y	Y	-

int2.c


```
#include <stdio.h>
#include <math.h>

double f(double x, double a, double b) {
   double f = exp(-a*x*x)*cos(b*x);
   return(f);
}
int main(int argc, char *argv[]) {
   double xleft, xright;
   int    n;
   printf("Enter no. of intervals and left and right
   integration limits: " );
   scanf("%d %lf %lf", n, xleft, xright);
   double dx = (xright-xleft)/n;
   double s = 0.0, x;
   for (int i=0; i<n; i++) {
      x = (xleft - dx/2) + i*dx;
      s += f(x,0.2,2.5)*dx;
   }
   printf("The integral is %lf\n", s);
}
```

int2.c

```
> cc int2.c -lm
> ./a.out
Enter no. of intervals and left and right integration limits:
   100 -4.5 4.5
Segmentation fault
>
```

What's wrong!?

diff

```
> diff int1.c int2.c
10,11c10,13
<    double xleft=-4.5,xright=4.5;
<    int    n=100;
---
>    double xleft, xright;
>    int    n;
>    printf("Enter no. of intervals and left and right
   integration limits: " );
>    scanf("%d %lf %lf", n, xleft, xright);
```

Debuggers

- **`dbx`** *with SunStudio*
- **`gdb`** *GNU debugger*
- **`totalview`** *commercial, add to $PATH*

- Step through code
- Examine variable values
- See where crash happened
- All require compilation with “**`-g`**”

TotalView

(Redirected from Totalview)

Summary

TotalView is a debugger specializing in debugging multi-processor programs. It contains both a graphical interface and a command line interface. It includes several features for MPI and OpenMP debugging.

Latest Version: 8.3.0

Location: placentia2, mahone2, fundy

Install Status: Testing

Notes

As a quick start, you can find the executables for TotalView at /usr/local/toolworks/totalview.8.3.0-0/bin. If you wish to use the command line interface, the command is *totalviewcli*. If you wish to use the graphical interface, the command is *totalview*. If you wish to use the graphical interface, you will need to tunnel the X11 display back to your desktop. For example, if you use ssh on Linux, you would include *-Y* as a parameter when you log in to the ACEnet cluster. This step will depend on exactly how you connect to the ACEnet clusters. For more detailed information, you can visit the main site and the associated documentation by following the links below.

Documentation: http://www.totalviewtech.com/Documentation/alltvdocs.htm

Vendor site: http://www.totalviewtech.com

Setup

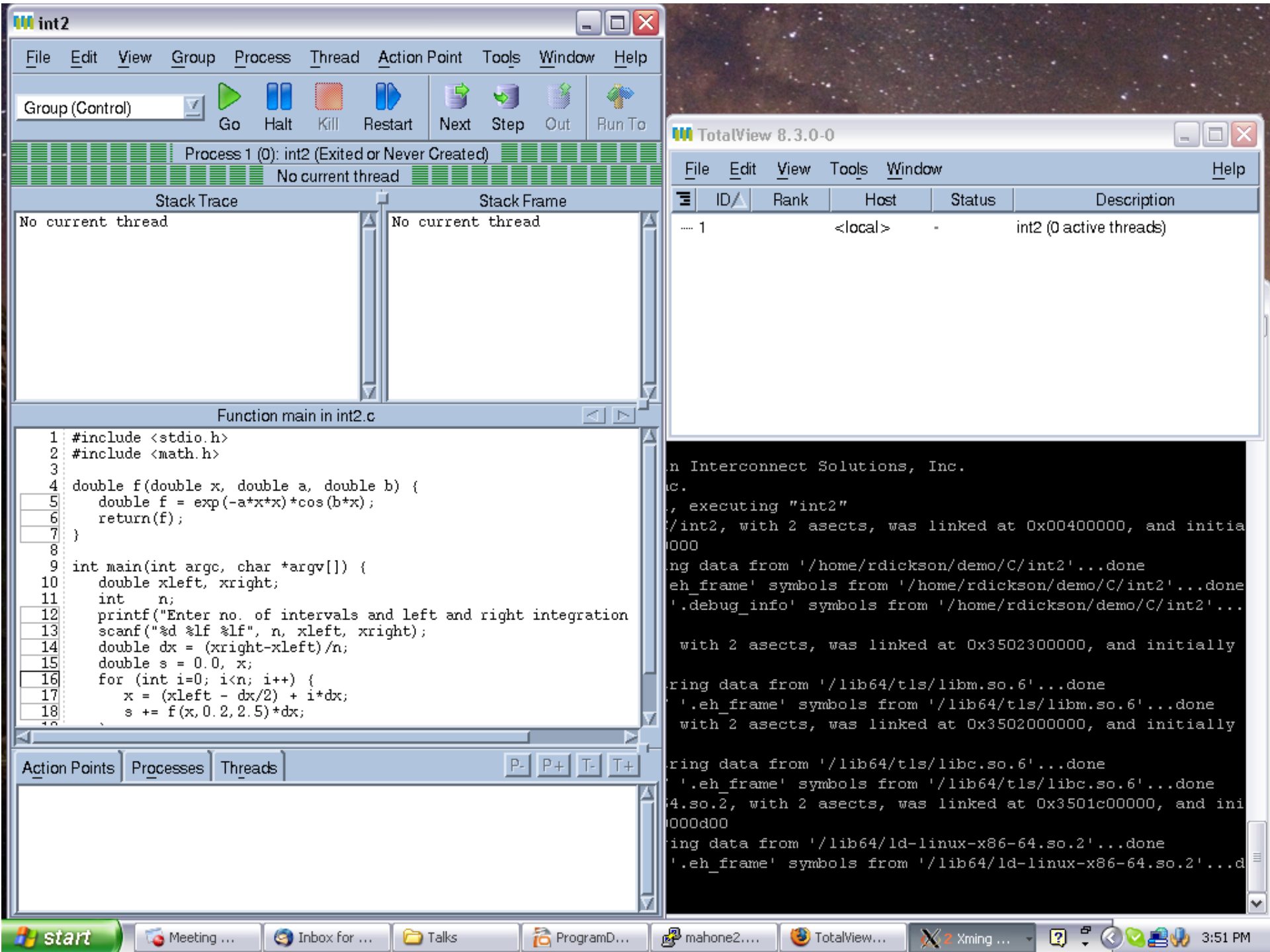
If your default shell is **tcsh**, you should add the following to your ~/.cshrc file:

TotalView

- graphical debugger
  - need X server

```
> which totalview
/usr/local/toolworks/totalview.8.3.0-0/bin/totalvi
> cc int2.c -lm -g -o int2
> totalview int2
```

- ...then GUI appears...


int2
File Edit View Group Process Thread Action Point Tools Window Help
Group (Control)
Go Halt Kill Restart Next Step Out Run To
Process 1 (0): int2 (Exited or Never Created)
No current thread
Stack Trace
No current thread
Stack Frame
No current thread
Function main in int2.c
1 #include <stdio.h>
2 #include <math.h>
3
4 double f(double x, double a, double b) {
5 double f = exp(-a*x*x)*cos(b*x);
6 return(f);
7 }
8
9 int main(int argc, char *argv[]) {
10 double xleft, xright;
11 int n;
12 printf("Enter no. of intervals and left and right integration
13 scanf("%d %lf %lf", n, xleft, xright);
14 double dx = (xright-xleft)/n;
15 double s = 0.0, x;
16 for (int i=0; i<n; i++) {
17 x = (xleft - dx/2) + i*dx;
18 s += f(x,0.2,2.5)*dx;
Action Points
Processes
Threads
P- P+ T- T+
TotalView 8.3.0-0
File Edit View Tools Window Help
ID
Rank
Host
Status
Description
1
<local>
-
int2 (0 active threads)
n Interconnect Solutions, Inc.
c.
, executing "int2"
/int2, with 2 asects, was linked at 0x00400000, and initia
000
ng data from '/home/rdickson/demo/C/int2'...done
eh_frame' symbols from '/home/rdickson/demo/C/int2'...done
'.debug_info' symbols from '/home/rdickson/demo/C/int2'...
with 2 asects, was linked at 0x3502300000, and initially
ring data from '/lib64/tls/libm.so.6'...done
'.eh_frame' symbols from '/lib64/tls/libm.so.6'...done
with 2 asects, was linked at 0x3502000000, and initially
ring data from '/lib64/tls/libc.so.6'...done
'.eh_frame' symbols from '/lib64/tls/libc.so.6'...done
4.so.2, with 2 asects, was linked at 0x3501c00000, and ini
000d00
ing data from '/lib64/ld-linux-x86-64.so.2'...done
'.eh_frame' symbols from '/lib64/ld-linux-x86-64.so.2'...d
start
Meeting ...
Inbox for ...
Talks
ProgramD...
mahone2....
TotalView...
2 Xming ...
3:51 PM

man


```
> man scanf
SCANF(3)                        Linux Programmer's Manual

NAME
       scanf, fscanf, sscanf, vscanf, vsscanf, vfscanf - input format co

SYNOPSIS
       #include <stdio.h>
       int scanf(const char *format, ...);
       int fscanf(FILE *stream, const char *format, ...);
       int sscanf(const char *str, const char *format, ...);

       #include <stdarg.h>
       int vscanf(const char *format, va_list ap);
       int vsscanf(const char *str, const char *format, va_list ap);
       int vfscanf(FILE *stream, const char *format, va_list ap);

DESCRIPTION
```

Call-by-value, call-by-reference

```
...
printf("Enter no. of intervals and left and
  right integration limits: " );
scanf("%d %lf %lf", &n, &xleft, &xright);
double dx = (xright-xleft)/n;
...
```

int3.c

```
> cc int3.c -lm -g -o int3
> ./int3
Enter no. of intervals and left and right
  integration limits: 100 -4.5 4.5
The integral is -0.008604
> ./int3
Enter no. of intervals and left and right
  integration limits: 1000 -4.5 4.5
The integral is -0.008857
> ./int3
Enter no. of intervals and left and right
  integration limits: 10000 -4.5 4.5
The integral is -0.008859
```

Independent compilation


```
> cc function.c int4.c -lm -o int4
function.c:
int4.c:
>
```

make

```
> cat Makefile
int4: function.c int4.c
        cc function.c int4.c -lm -g -o int4
> make
cc function.c int4.c -lm -g -o int4
function.c:
int4.c:
>
```

Where to go for help

- **`man`** pages
- "**`-help`**" options
  - `cc --help`
- ACEnet Wiki http://wiki.ace-net.ca/
- Search the web
- Books
  - Kernighan & Ritchie, *The C Programming Language*
  - many, many others!
- ACEnet support support@ace-net.ca