

Intel Inspector XE

Claudia Blaas-Schenner

VSC Research Center, TU Wien

inspxe-gui

```
v227-044:~ claudia$ ssh -X trainee00@vsc3.vsc.ac.at
```

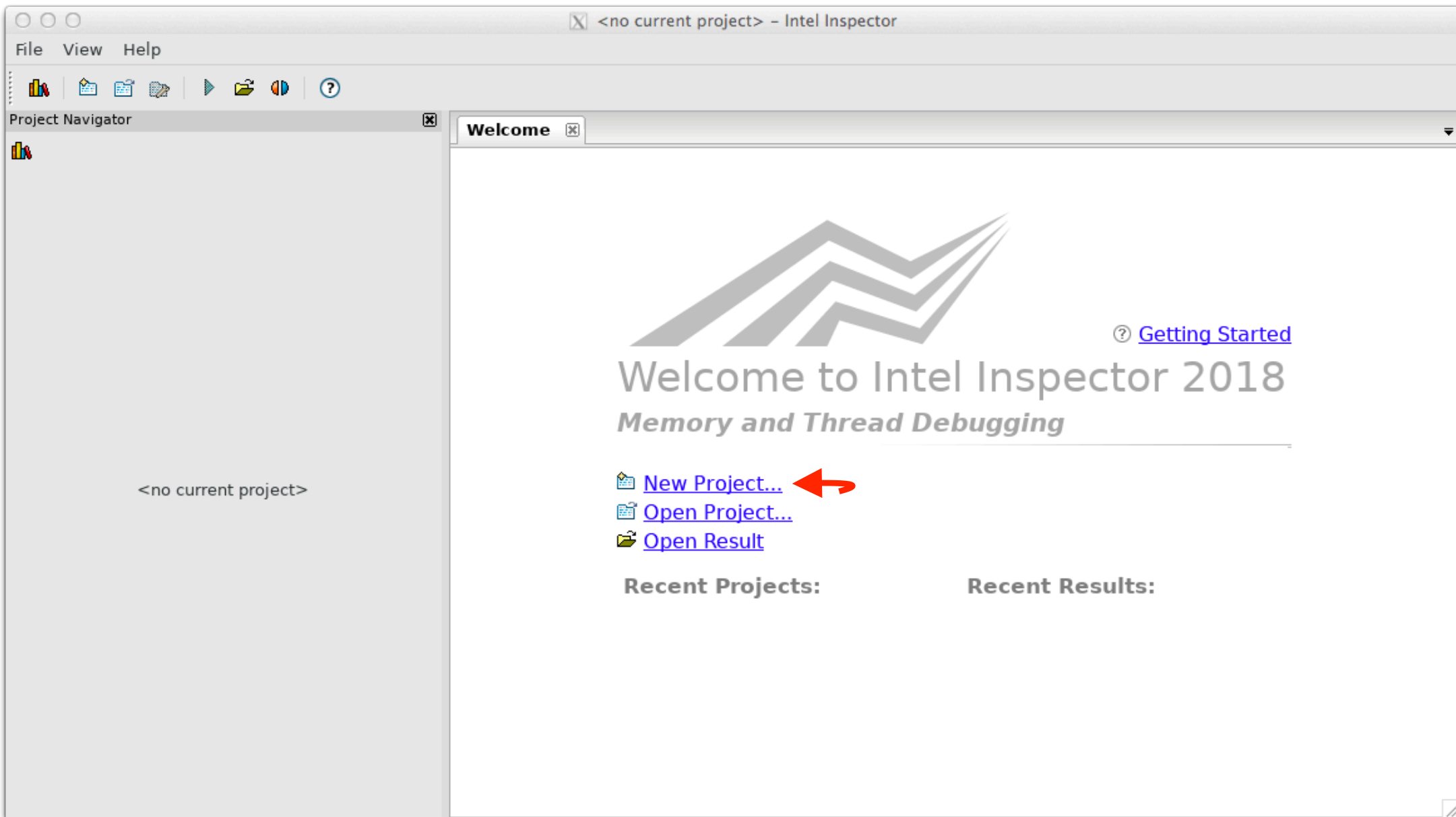
```
Password:
```

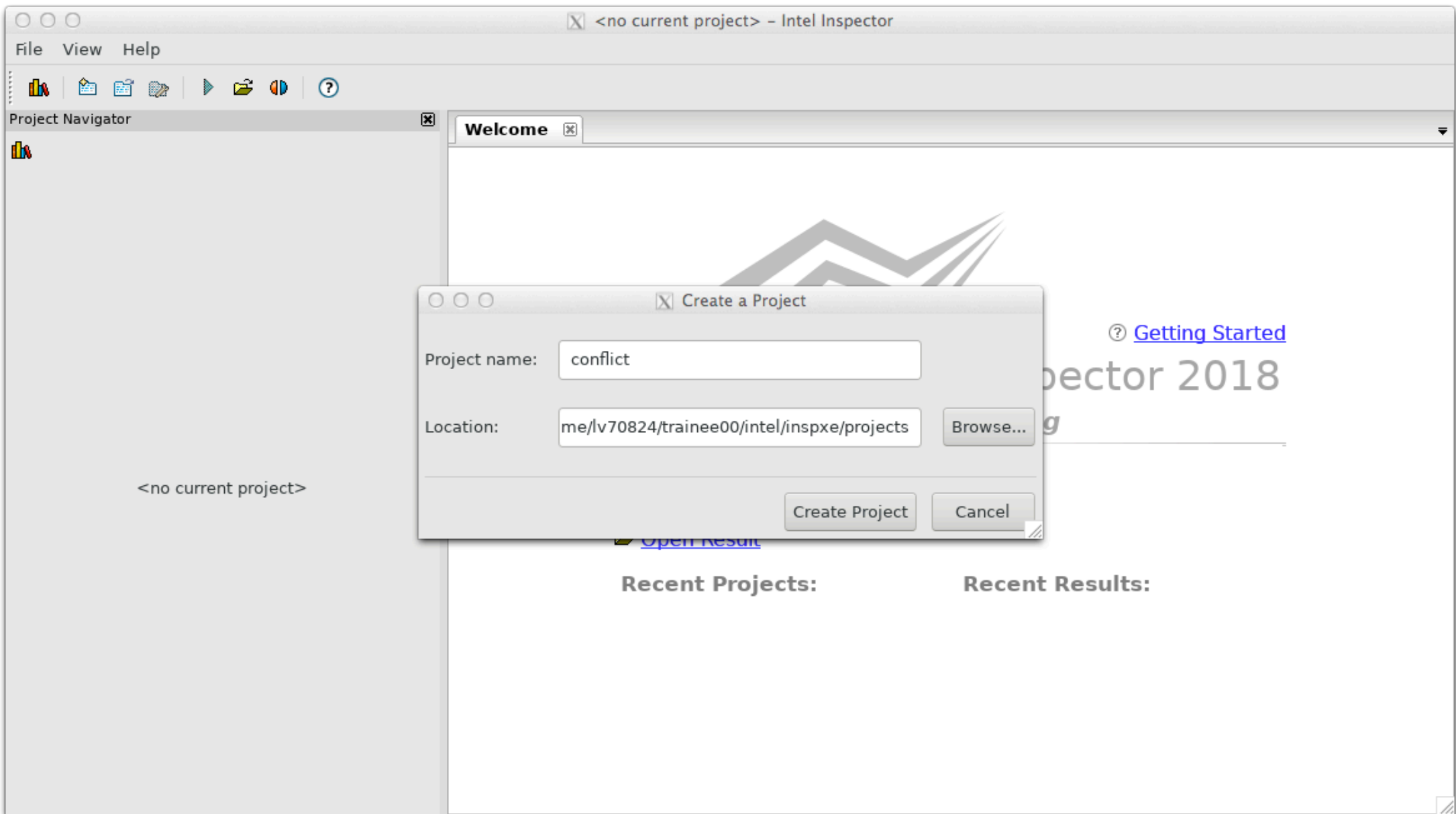
```
sms challenge sent, please enter OTP: 
```

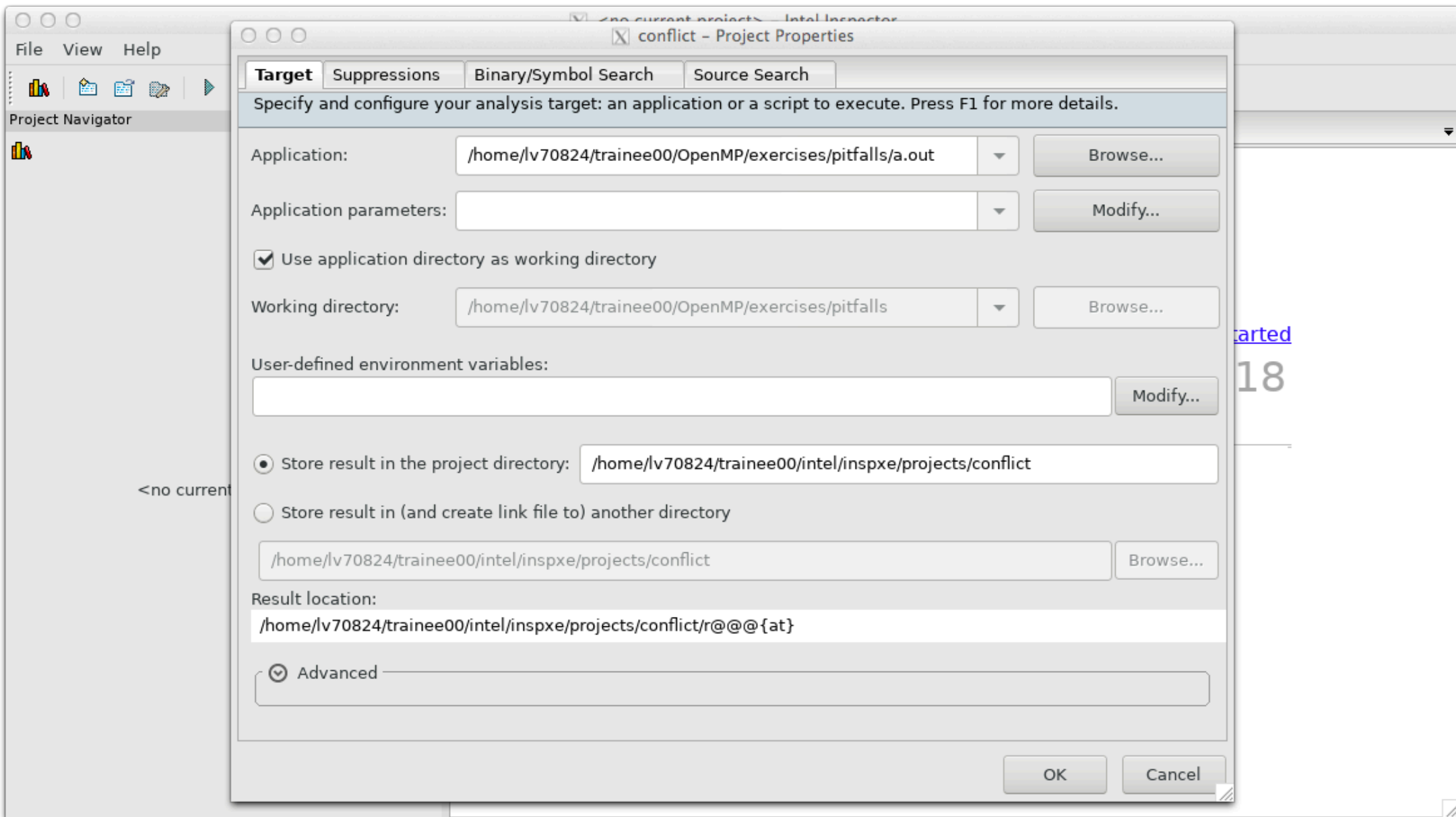
```
claudia — trainee00@n320-001:~ — ssh — 80x24
[trainee00@L33 ~]$ salloc -N 1 -L intel@vsc --reservation=training
salloc: Pending job allocation 8489280
salloc: job 8489280 queued and waiting for resources
salloc: job 8489280 has been allocated resources
salloc: Granted job allocation 8489280
  Loading intel/18 from: /cm/shared/apps/intel/compilers_and_libraries_2018.5.274/linux
  Loading intel-mpi/2018 from: /cm/shared/apps/intel/compilers_and_libraries_2018.5.274/linux/mpi
[trainee00@L33 ~]$
[trainee00@L33 ~]$
[trainee00@L33 ~]$ srun hostname
n320-001.vsc3.prov
[trainee00@L33 ~]$
[trainee00@L33 ~]$
[trainee00@L33 ~]$ ssh -X n320-001
Warning: Permanently added 'n320-001,10.161.20.1' (ECDSA) to the list of known hosts.
trainee00@n320-001's password:
  Loading intel/18 from: /cm/shared/apps/intel/compilers_and_libraries_2018.5.274/linux
  Loading intel-mpi/2018 from: /cm/shared/apps/intel/compilers_and_libraries_2018.5.274/linux/mpi
[trainee00@n320-001 ~]$
```

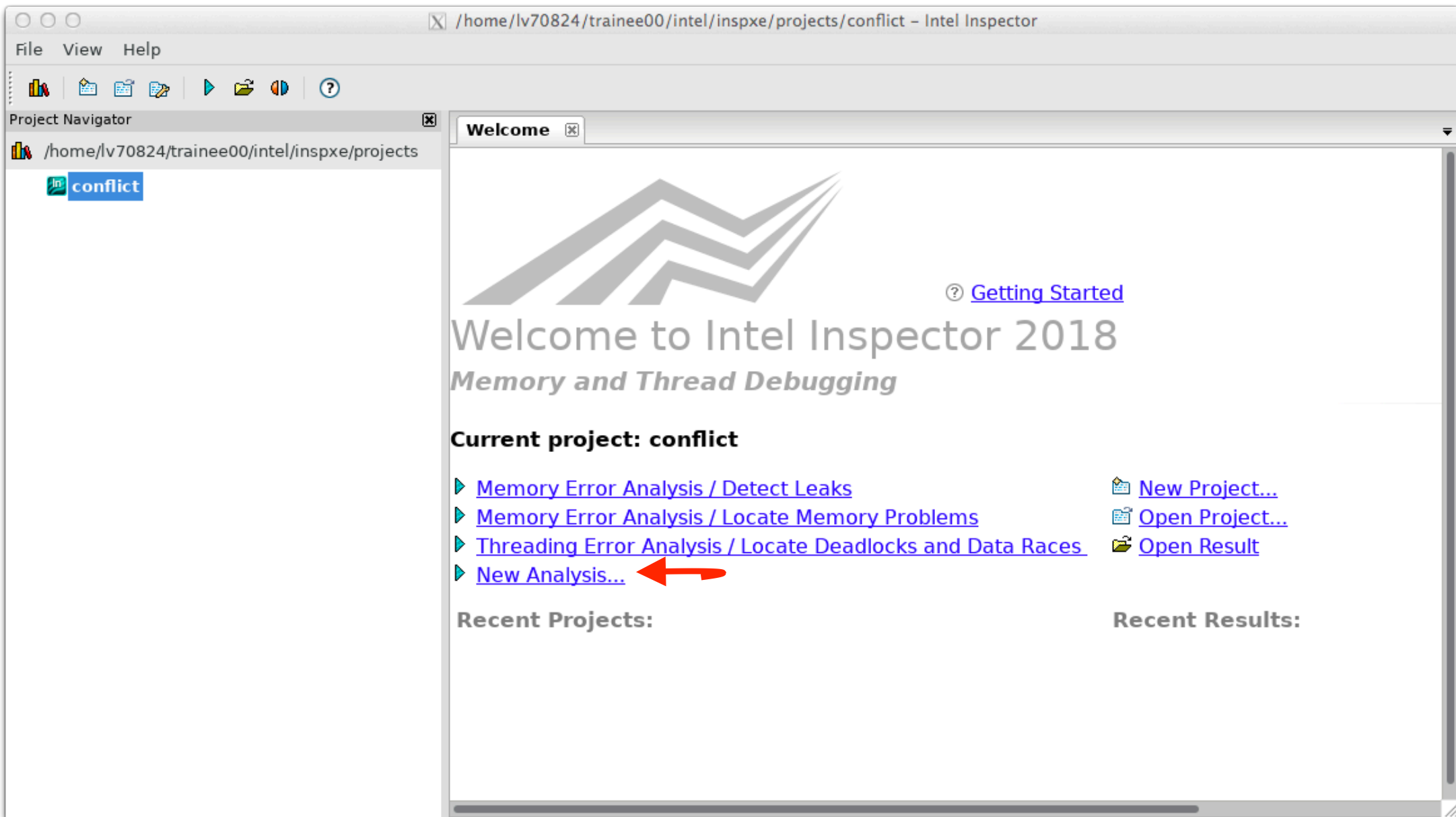
```
claudia — trainee00@n320-001:~/OpenMP/exercises/pitfalls — ssh — 80x24
[trainee00@n320-001 ~]$
[trainee00@n320-001 ~]$
[trainee00@n320-001 ~]$ cd ~/OpenMP/exercises/pitfalls/
[trainee00@n320-001 pitfalls]$
[trainee00@n320-001 pitfalls]$
[trainee00@n320-001 pitfalls]$ icc -qopenmp -O0 -g conflict.c
[trainee00@n320-001 pitfalls]$
[trainee00@n320-001 pitfalls]$
[trainee00@n320-001 pitfalls]$ inspxe-gui &
[1] 9890
[trainee00@n320-001 pitfalls]$
[trainee00@n320-001 pitfalls]$
(inspxe-gui:9890): Gtk-WARNING **: 20:18:56.971: Attempting to store changes into
`/home/lv70824/trainee00/.local/share/recently-used.xbel', but failed: Failed
to create file "/home/lv70824/trainee00/.local/share/recently-used.xbel.VZRNK0":
No such file or directory

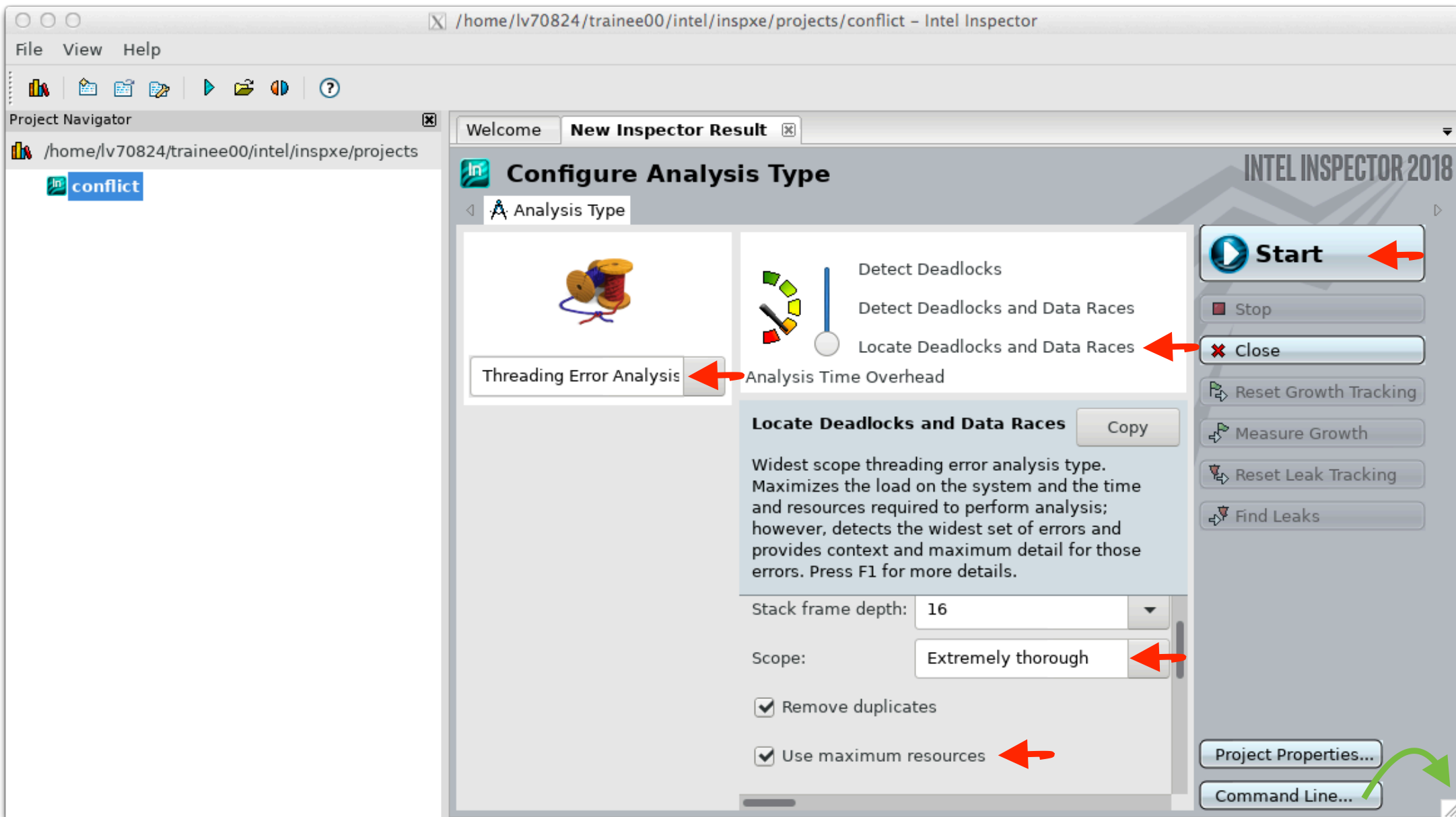
(inspxe-gui:9890): Gtk-WARNING **: 20:18:56.971: Attempting to set the permissions of
`/home/lv70824/trainee00/.local/share/recently-used.xbel', but failed: No
such file or directory
1
0.5
0.333333
0.583333
```













Project Navigator

/home/lv70824/trainee00/intel/inspxe/projects

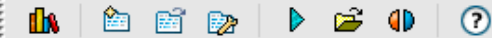
- conflict
 - r000ti3

Welcome r000ti3

Analysis Completed Successfully

INTEL INSPECTOR 2018

- Start
- Stop
- Close
- Reset Growth Tracking
- Measure Growth
- Reset Leak Tracking
- Find Leaks



Project Navigator

/home/lv70824/trainee00/intel/inspxe/projects

- conflict
 - r000ti3

Welcome r000ti3

Locate Deadlocks and Data Races

INTEL INSPECTOR 2018

Target Analysis Type Collection Log Summary

Problems

ID	Type	Sources	Modules	State
P1	Data race	conflict.c	a.out	New

Filters

Severity

Error 1 item(s)

Type

Data race 1 item(s)

Source

conflict.c 1 item(s)

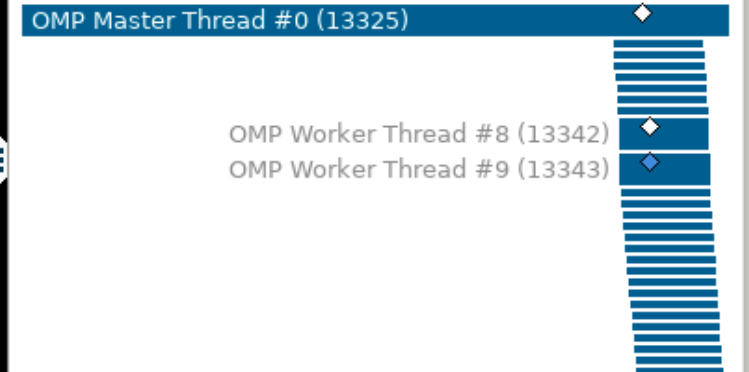
Module

a.out 1 item(s)

1 of 3 All

Descript...	Source	Function	Module	Variable
Read	conflict.c...	main	a.out	a
21	for(i=1; i<NMAX;		a.out!main - co	
22	a[i]=1.0/i;			
23	b[i]=a[i-1]+a[i			
24	}			
25	}/ * end parallel*			
Write	conflict.c...	main	a.out	a
20	#pragma omp for		a.out!main - co	
21	for(i=1; i<NMAX;			
22	a[i]=1.0/i;			

Timeline





Project Navigator

/home/lv70824/trainee00/intel/inspxe/projects

- conflict
 - r000ti3

Welcome r000ti3

Locate Deadlocks and Data Races

INTEL INSPECTOR 2018

Target Analysis Type Collection Log Summary

Problems

ID	Type	Sources	Modules	State
P1	Data race	conflict.c	a.out	New

Filters

Severity

Error 1 item(s)

Type

Data race 1 item(s)

Source

conflict.c 1 item(s)

Module

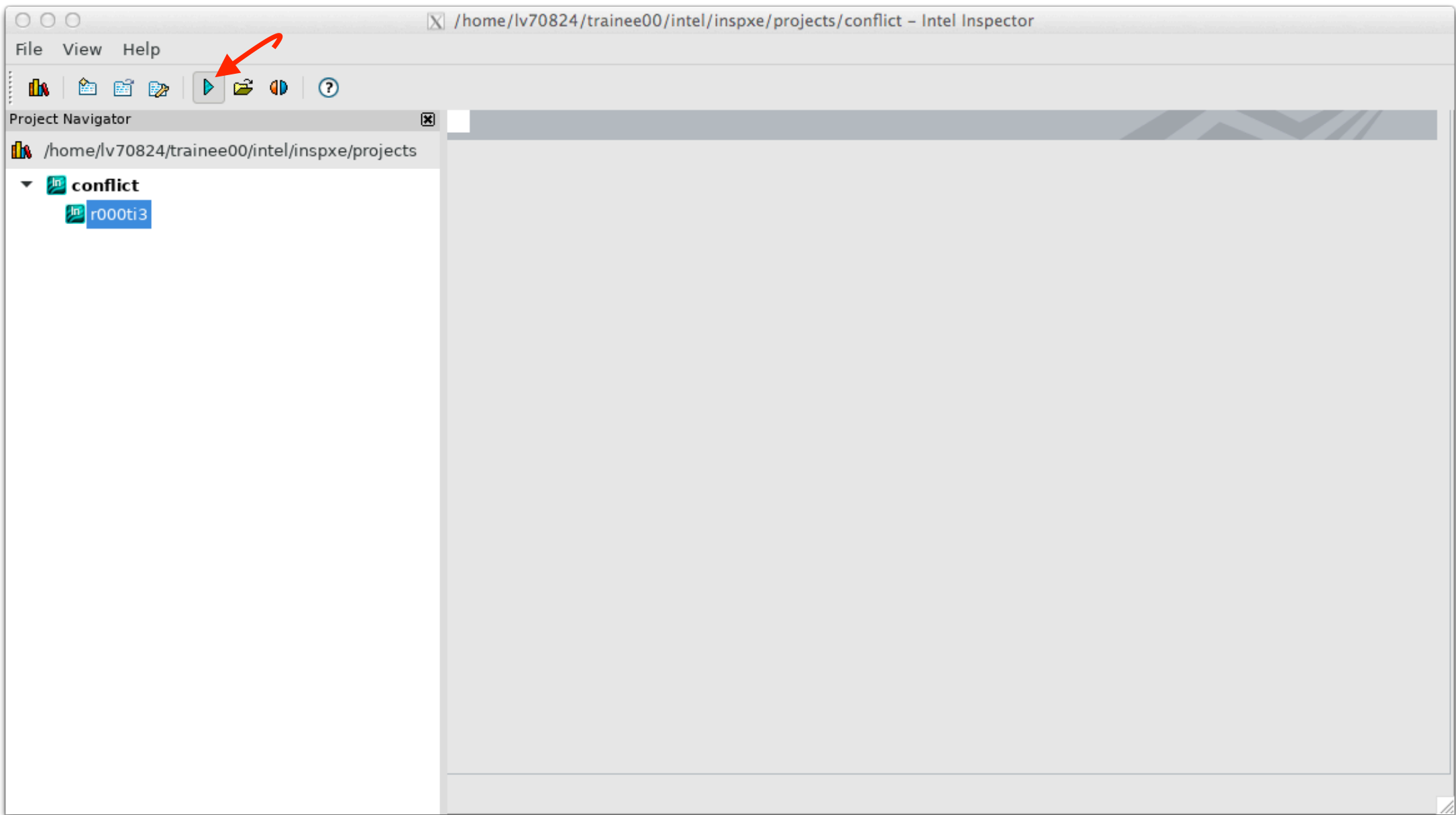
a.out 1 item(s)

1 of 3 All Code Locations: Data race

Description	Source	Function	Module	Variable
Read	conflict.c:23	main	a.out	a
<pre>21 for(i=1; i<NMAX; i++){ 22 a[i]=1.0/i; 23 b[i]=a[i-1]+a[i]; 24 } 25 }/* end parallel*/</pre>				
Write	conflict.c:22	main	a.out	a
<pre>20 #pragma omp for 21 for(i=1; i<NMAX; i++){ 22 a[i]=1.0/i;</pre>				

```
10 double a[NMAX];
11 double b[NMAX];
12
13
14 int main(void){
15     int i;
16     a[0]=0.0;
17
18     #pragma omp parallel
19     {
20     #pragma omp for
21     for(i=1; i<NMAX; i++){
22         a[i]=1.0/i;
23         b[i]=a[i-1]+a[i];
24     }
25     }/* end parallel*/
26
27     for(i=1;i<NMAX; i++){
28         printf("%g\n",b[i]);
29     }
30
31     return 0;
32 }
```

```
10 double a[NMAX];
11 double b[NMAX];
12
13
14 int main(void){
15     int i;
16     a[0]=0.0;
17
18     #pragma omp parallel
19     {
20     #pragma omp for
21     for(i=1; i<NMAX; i++){
22         a[i]=1.0/i;
23         b[i]=1.0/(i-1)+a[i];
24     }
25     }/* end parallel*/
26
27     for(i=1;i<NMAX; i++){
28         printf("%g\n",b[i]);
29     }
30
31     return 0;
32 }
```





Project Navigator

/home/lv70824/trainee00/intel/inspxe/projects

- conflict
 - r000ti3
 - r001ti3

Welcome r000ti3 r001ti3 **New Inspector Result**

Configure Analysis Type

Analysis Type



Threading Error Analysis



Analysis Time Overhead

- Detect Deadlocks
- Detect Deadlocks and Data Races
- Locate Deadlocks and Data Races

Locate Deadlocks and Data Races

Copy

Widest scope threading error analysis type. Maximizes the load on the system and the time and resources required to perform analysis; however, detects the widest set of errors and provides context and maximum detail for those errors. Press F1 for more details.

Stack frame depth: 16

Scope: Extremely thorough

- Remove duplicates
- Use maximum resources

INTEL INSPECTOR 2018

Start

Stop

Close

Reset Growth Tracking

Measure Growth

Reset Leak Tracking

Find Leaks

Project Properties...

Command Line...





Project Navigator

/home/lv70824/trainee00/intel/inspxe/projects

- conflict
 - r000ti3
 - r001ti3
 - r002ti3

Welcome r000ti3 r001ti3 r002ti3

Analysis Completed Successfully

INTEL INSPECTOR 2018

- Start
- Stop
- Close
- Reset Growth Tracking
- Measure Growth
- Reset Leak Tracking
- Find Leaks



Project Navigator

/home/lv70824/trainee00/intel/inspxe/projects

- conflict
 - r000ti3
 - r001ti3
 - r002ti3

Welcome r000ti3 r001ti3 r002ti3

Locate Deadlocks and Data Races

INTEL INSPECTOR 2018

Target Analysis Type Collection Log Summary

Problems

Filters

- Severity
- Type
- Source
- Module
- State
- Suppressed
- Investigated

No Problems Detected
Intel Inspector detected no problems at this analysis scope. If this result is unexpected, try rerunning the target using an analysis type with a wider scope. Press F1 for more information.



```
20 #pragma omp for
21   for(i=1; i<NMAX; i++){
22     a[i]=1.0/i;
23     b[i]=a[i-1]+a[i];
24   }
```

**What's wrong ?
How to fix ?**



Reason:
loop iterations are NOT independent

Solution:
two separate loops (bad cache reuse) OR

**Repeat until
no errors reported**

```
20 #pragma omp for
21   for(i=1; i<NMAX; i++){
22     a[i]=1.0/i;
23     b[i]=1.0/(i-1)+a[i];
24   }
```

inspxe-cl

```
claudia — trainee00@l33:~/OpenMP/exercises/pitfalls — ssh — 80x24
[trainee00@l33 ~]$
[trainee00@l33 ~]$
[trainee00@l33 ~]$ cd ~/OpenMP/exercises/pitfalls/
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ icc -qopenmp -O0 -g conflict.c
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ vi job-inspxe-cl.sh
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ sbatch job-inspxe-cl.sh
Submitted batch job 8489311
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ vi slurm-8489311.out
```


0.236111

0.211111

1 new problem(s) found

1 Data race problem(s) detected

Source	Line	Severity	ID	ID	Type	Description	Function	Module
--------	------	----------	----	----	------	-------------	----------	--------

"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/conflict.c"	"23"	"Error"	"X12"	"P1"	"Data race"	"Read"	"main"	"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/a.out"
--	------	---------	-------	------	-------------	--------	--------	---

"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/conflict.c"	"22"	"Error"	"X13"	"P1"	"Data race"	"Write"	"main"	"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/a.out"
--	------	---------	-------	------	-------------	---------	--------	---

"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/conflict.c"	"22"	"Error"	"X15"	"P1"	"Data race"	"Write"	"main"	"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/a.out"
--	------	---------	-------	------	-------------	---------	--------	---

"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/conflict.c"	"23"	"Error"	"X16"	"P1"	"Data race"	"Read"	"main"	"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/a.out"
--	------	---------	-------	------	-------------	--------	--------	---

"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/conflict.c"	"18"	"Error"	"X17"	"P1"	"Data race"	"HINT: Synchronization allocation site"	"main"	"/home/lv70824/trainee00/OpenMP/exercises/pitfalls/a.out"
--	------	---------	-------	------	-------------	---	--------	---


```
claudia — trainee00@l33:~/OpenMP/exercises/pitfalls — ssh — 80x24
[trainee00@l33 ~]$
[trainee00@l33 ~]$
[trainee00@l33 ~]$ cd ~/OpenMP/exercises/pitfalls/
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ icc -qopenmp -O0 -g conflict.c
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ vi job-inspxe-cl.sh
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ sbatch job-inspxe-cl.sh
Submitted batch job 8489311
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ vi slurm-8489311.out
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$ vi conflict.c
[trainee00@l33 pitfalls]$
[trainee00@l33 pitfalls]$
```

```
10 double a[NMAX];
11 double b[NMAX];
12
13
14 int main(void){
15     int i;
16     a[0]=0.0;
17
18     #pragma omp parallel
19     {
20     #pragma omp for
21     for(i=1; i<NMAX; i++){
22         a[i]=1.0/i;
23         b[i]=a[i-1]+a[i];
24     }
25     }/* end parallel*/
26
27     for(i=1;i<NMAX; i++){
28         printf("%g\n",b[i]);
29     }
30
31     return 0;
32 }
```

```
10 double a[NMAX];
11 double b[NMAX];
12
13
14 int main(void){
15     int i;
16     a[0]=0.0;
17
18     #pragma omp parallel
19     {
20     #pragma omp for
21     for(i=1; i<NMAX; i++){
22         a[i]=1.0/i;
23         b[i]=1.0/(i-1)+a[i];
24     }
25     }/* end parallel*/
26
27     for(i=1;i<NMAX; i++){
28         printf("%g\n",b[i]);
29     }
30
31     return 0;
32 }
```

```
claudia — trainee00@l33:~/OpenMP/exercises/pitfalls — ssh — 80x24
#!/bin/bash
#SBATCH -J inspxe                # SLURM_JOB_NAME           ==> jobname
#SBATCH -N 1                     # SLURM_JOB_NUM_NODES      ==> @course 1 !!!!!
#SBATCH --tasks-per-node=16      # SLURM_NTASKS_PER_NODE    [default: 16/32]
#SBATCH --export=NONE            # do not inherit the submission environment
#SBATCH --reservation=training   # !! node-reservation !! ==> @course only !!
#SBATCH --time=00:01:00         # time limit               ==> @course [1 min]
#SBATCH -L intel@vsc            # licence for Intel Inspector XE
module purge                    # always start with a clean environment
module load intel/18           # load modules needed

# Intel Inspector XE --> command line interface --> use within job scripts:
# compile - C:                   icc    -qopenmp -O0 -g conflict.c
# compile - Fortran:             ifort  -qopenmp -O0 -g conflict.f90

export OMP_NUM_THREADS=4

inspxe-cl -collect ti3 -knob terminate-on-deadlock=false -knob stack-depth=16 -knob
scope=extreme -knob remove-duplicates=true -knob use-maximum-resources=true
-module-filter-mode=include -appdebug=off -no-trace-mpi -result-dir=conflict_2 -
- ./a.out

inspxe-cl -report=problems -format=csv -result-dir=conflict_2 # conflict_2 !!!
"job-inspxe-cl.sh" 20L, 1238C written                20,76                ALL
```

```
Unloading intel/18
Unloading intel-mpi/2018
Loading intel/18 from: /cm/shared/apps/intel/compilers_and_libraries_2018.5.27
4/linux
inf
1.5
0.833333
0.583333
0.45
0.366667
0.309524
0.267857
0.236111
0.211111

0 new problem(s) found
"Source","Line","Severity","ID","ID","Type","Description","Function","Module"
~
~
~
~
~
~
"slurm-8489319.out" 17L, 318C 1,3 All
```

```
20 #pragma omp for
21   for(i=1; i<NMAX; i++){
22     a[i]=1.0/i;
23     b[i]=a[i-1]+a[i];
24   }
```

**What's wrong ?
How to fix ?**

Reason:
loop iterations are NOT independent

Solution:
two separate loops (bad cache reuse) OR

**Repeat until
no errors reported**

```
20 #pragma omp for
21   for(i=1; i<NMAX; i++){
22     a[i]=1.0/i;
23     b[i]=1.0/(i-1)+a[i];
24   }
```