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Title:

Automating the efficiency comparison of programs

Speaker:

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Current status: Basically, I have not done anything else but read Python manuals.

Today: I will explain my ideas. Can you see any new features that should be in the system?

STL: find

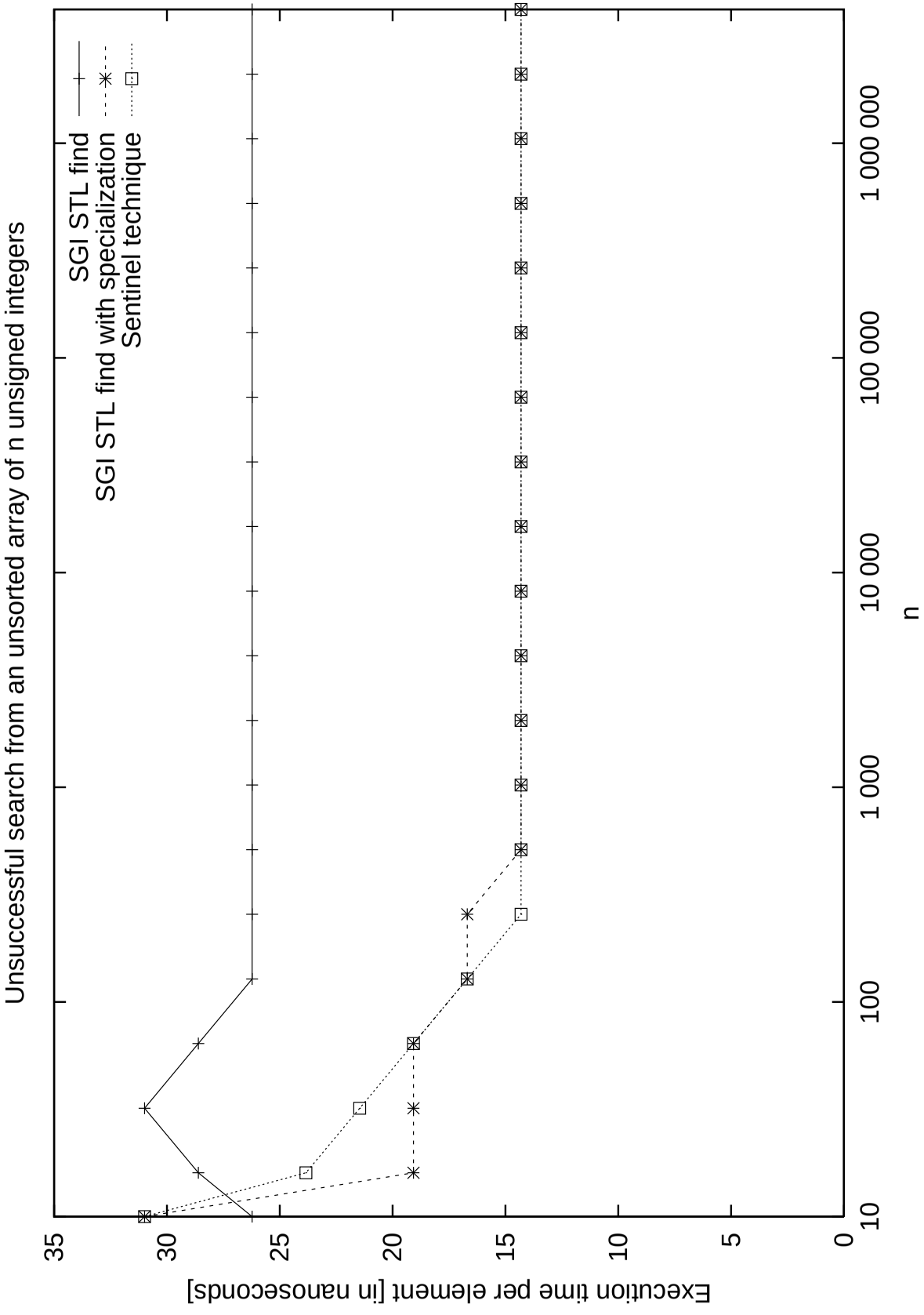
```
#include <iterator> // defines std::iterator_traits

// SGI STL find here renamed as STL_find

template <typename position, typename element>
inline position STL_find (
  position p,
  position one_past_the_end,
  const element& value,
  input_iterator_tag
) {

  while (p != one_past_the_end && *p != value) {
    ++p;
  }
  return p;
}

template <typename position, typename element>
inline position STL_find (
  position first,
  position one_past_the_end,
  const element& value
) {

  return STL_find(first, one_past_the_end, value,
    std::iterator_traits<position>::iterator_category());
}
```

```
template <typename position, typename element>
position STL_find (
  position p,
  position one_past_the_end,
  const element& value,
  random_access_iterator_tag
) {

  std::iterator_traits<position>::difference_type
    trip_count = (one_past_the_end - p) >> 2;

  for ( ; trip_count > 0 ; --trip_count) {
    if (*p == value) return p;
    ++p;
    if (*p == value) return p;
    ++p;
    if (*p == value) return p;
    ++p;
    if (*p == value) return p;
    ++p;
  }

  switch(one_past_the_end - p) {
  case 3:
    if (*p == value) return p;
    ++p;
  case 2:
    if (*p == value) return p;
    ++p;
  case 1:
    if (*p == value) return p;
    ++p;
  case 0:
  default:
    return one_past_the_end;
  }
}
```

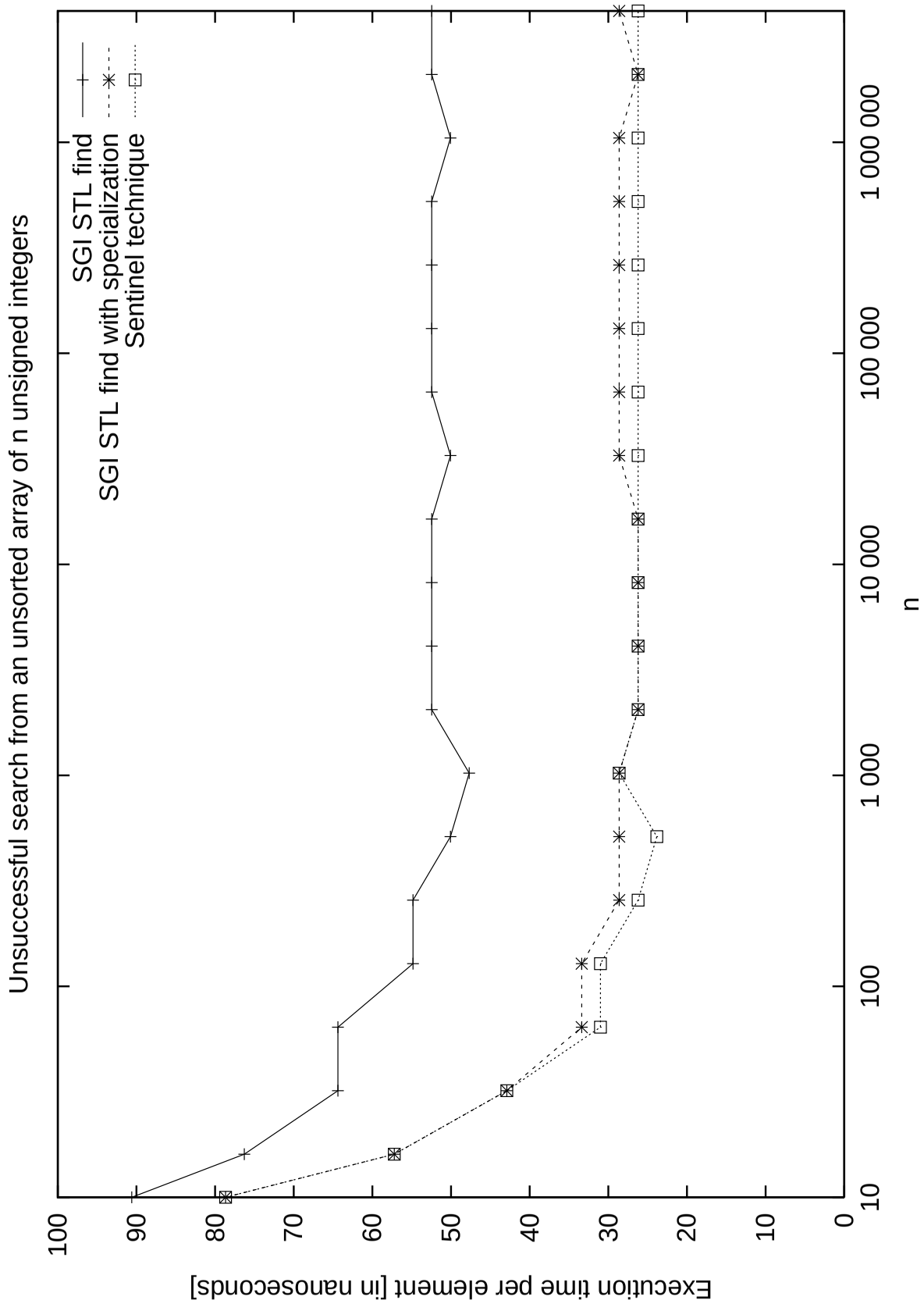
Sentinel Technique

```
template<typename position, typename element>
position STL_find (
  position first,
  position one_past_the_end,
  const element& value,
  bidirectional_iterator_tag  // plus something extra
) {

  if (first == one_past_the_end) {
    return one_past_the_end;
  }

  position last = one_past_the_end;
  --last;
  element temp = *last;
  *last = value;

  position p = first;
  while (*p != value) {
    ++p;
  }

  *last = temp;
  if (p == last && temp != value) {
    return one_past_the_end;
  }
  else {
    return p;
  }
}
```

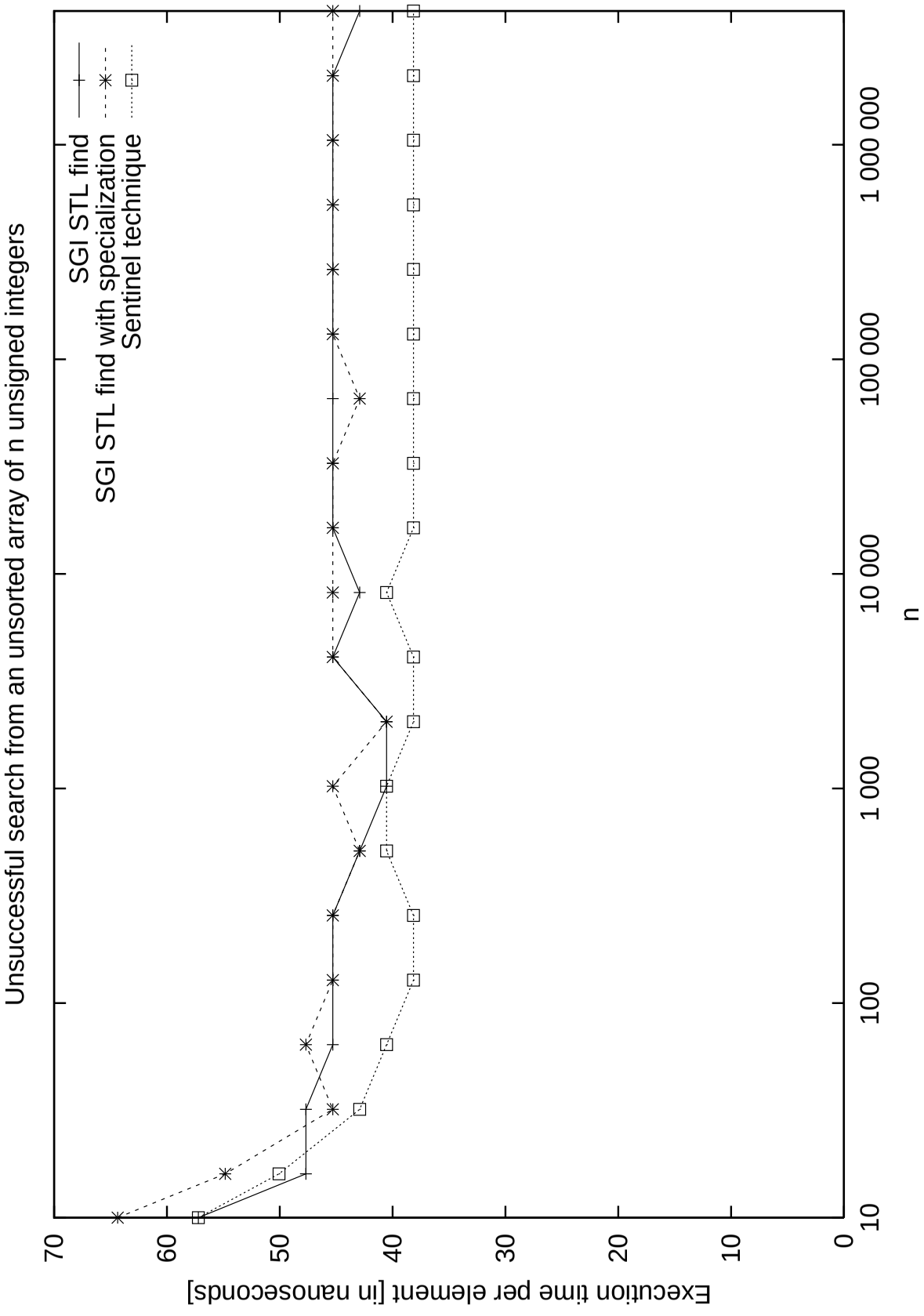
Integers; Many Arrays; Pentium



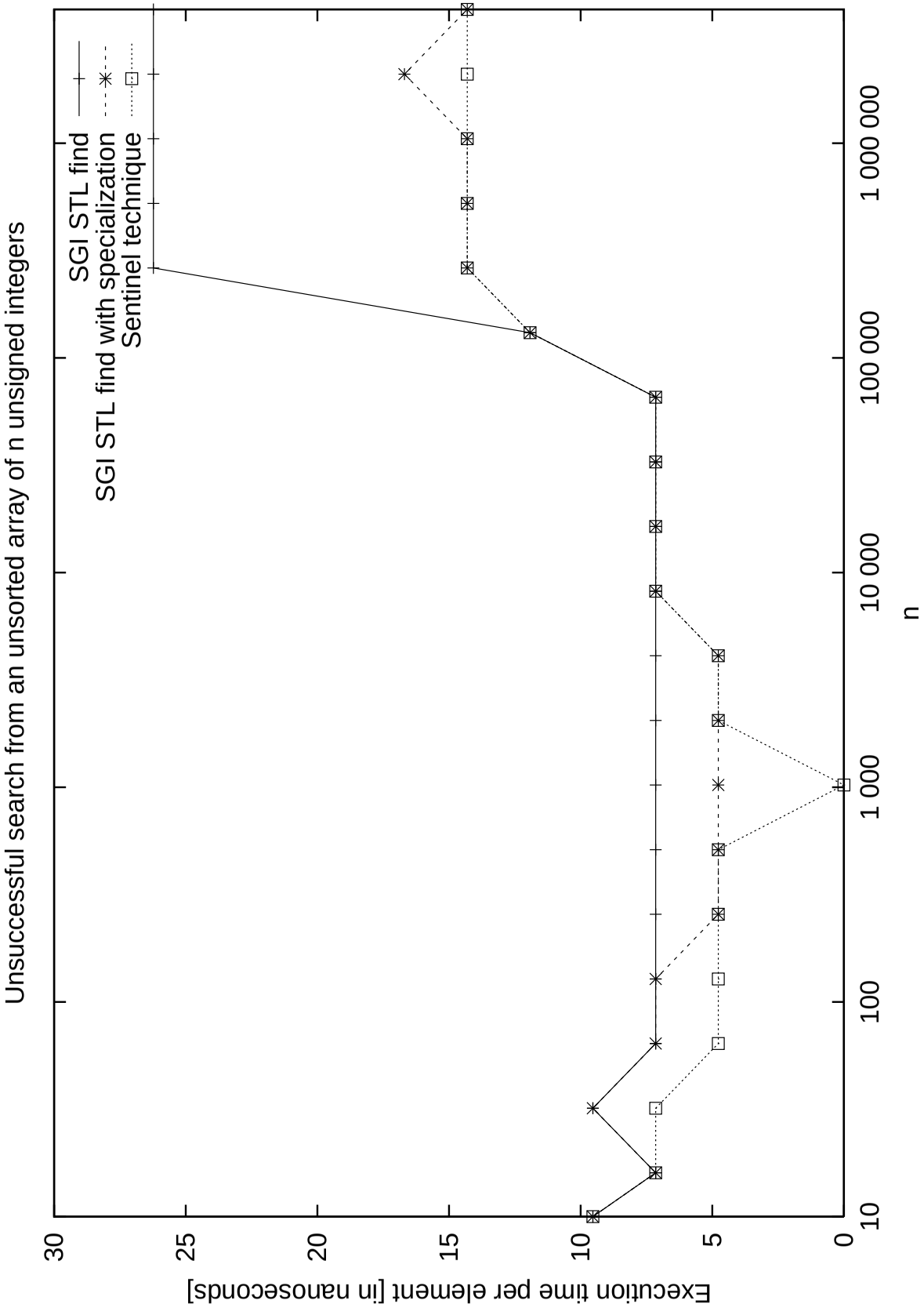
Integers; Many Arrays; HP9000



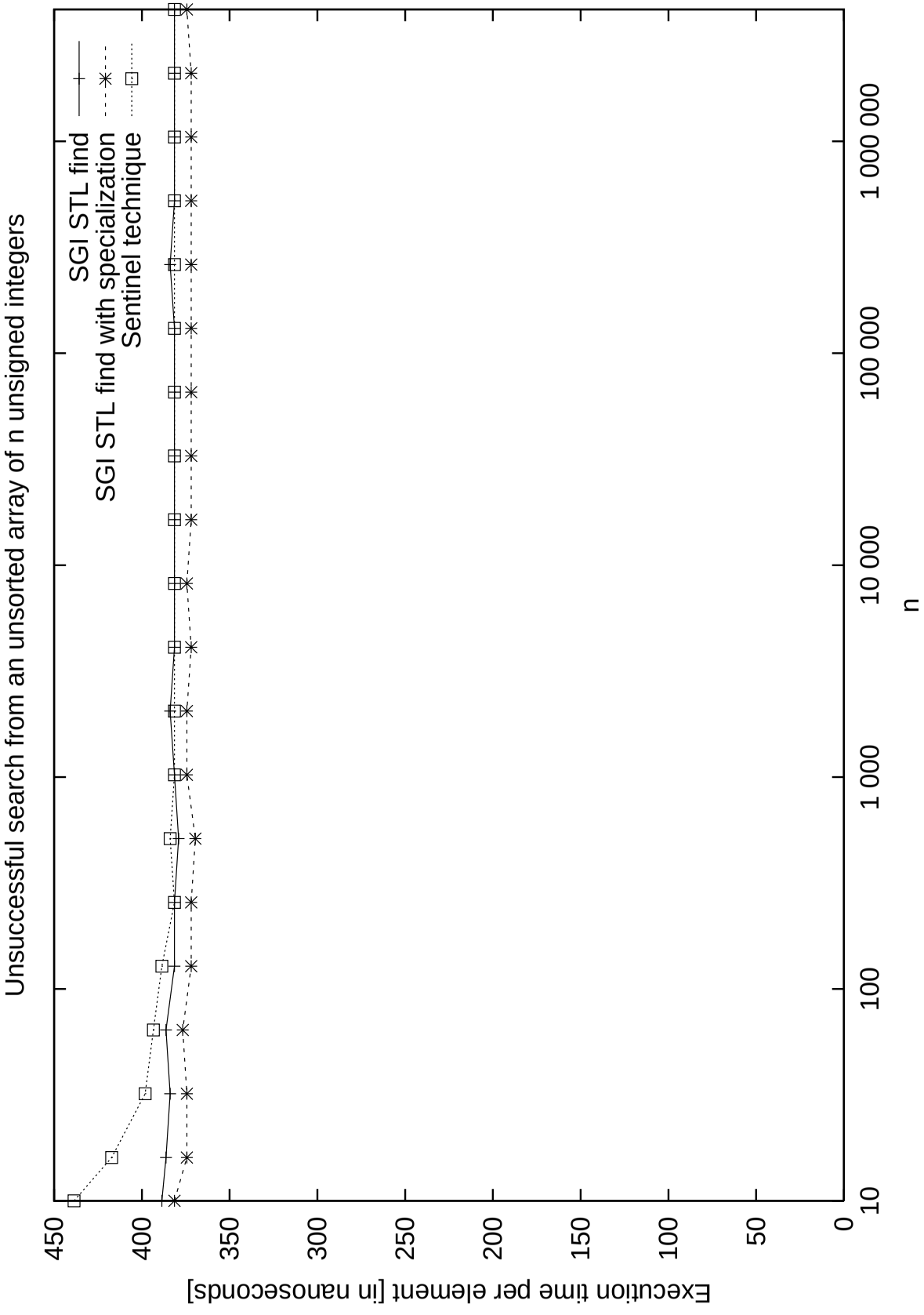
Integers; Many Arrays; Sun



Integers; One Array; Pentium



Strings; Many Arrays; Pentium



Directory Structure

```
makefile

Driver:
do_nothing.cc           uint-driver-many.cc
do_nothing.o            uint-driver-one.cc
string-driver-many.cc

Figure:
freja-uint-many.ps    nanna-string-many.ps
guldfaxe-uint-many.ps nanna-uint-many.ps
loke-uint-many.ps     nanna-uint-one.ps

Gnuplot:
plot.gp

SGI-in:
drive      find.cc    find.o     plot.data

SGI-ran:
drive      find.cc    find.o     plot.data

Script:
find.sh

Sentinel:
drive      find.cc    find.o     plot.data

core:
```

Goal

- write the programs to be compared
- fill a form or two
- generate the plots **automatically**

Example Form

```
Start execution: 23.10.2000 02:00
Notification: e-mail

Compiler: g++
Compiler options: -O4 -Wall

Computers: nanna freja loke

Sequence type: (unsigned int)[]
Sequence form: increasing

Clock precision: 1 s
Repetitions: distinct sequences

Include files: find1.cc find2.cc find3.cc
Routine names: find find find
Routine texts: "SGI STL find" "SGI STL find with \
  specialization" "Sentinel technique"
# parameters: 3
1st: first; step: 2^{i}, i \in [4, 5 .. 22]
2nd: first + 2^{i}; step: 2^{i}, i \in [4, 5 .. 22]
3rd: const 2^{22}

Plot title: "Unsuccessful search: n unsigned integers"
x-label: "n"
y-label: "Execution time per element [in nanoseconds]"
x-axis: 2^{i}, i \in [4, 5 .. 22]
y-axis: time / x
x-scale: logarithmic
x-range: [10 .. 2^{22}]
x-tics: ["10" 10, "100" 100, "1 000" 1000, "10 000" 10000,
         "100 000" 100000, "1 000 000" 1000000]
```

Your Written Projects

- write alternative implementations of your module
- use my tool to generate plots
- use Doxygen to generate documentation of your programs
- use LaTeX to write a short report about your work; we provide you a template file.

Beginning of My Makefile

```
MAXSIZE = 4194304  # The maximum length of the test array

CXX = g++  # Compiler used
CXXFLAGS = -O4 -Wall -DMAXSIZE=$(MAXSIZE)

PROGRAMS = SGI-in/drive SGI-ran/drive Sentinel/drive
DRIVER   = Driver/uint-driver-one.cc

all: $(PROGRAMS)

plot: plot.ps

plot.ps: Gnuplot/plot.gp SGI-in/plot.data\
         SGI-ran/plot.data Sentinel/plot.data
gnuplot Gnuplot/plot.gp

Driver/do_nothing.o: Driver/do_nothing.cc
$(CXX) Driver/do_nothing.cc -c -o Driver/do_nothing.o

# SGI STL find with input iterators

SGI-in/find.o: SGI-in/find.cc
$(CXX) $(CXXFLAGS) -c -o SGI-in/find.o SGI-in/find.cc

SGI-in/drive: $(DRIVER) Driver/do_nothing.o SGI-in/find.o
$(CXX) $(CXXFLAGS) -ISGI-in $(DRIVER) -o SGI-in/drive

SGI-in/plot.data: Script/find.sh SGI-in/drive
Script/find.sh SGI-in > SGI-in/plot.data #2> /dev/null
```

Kernel of a Driver

```
// Dual loop

generate(first, one_past_the_end);

clock_t start = clock();
for (volatile unsigned int k = 0; k < repetitions; k++) {
  volatile position beg = first + k * n;
  volatile position end = first + (k+1) * n;
  element x = element(MAXSIZE);
  volatile position answer = do_nothing(beg, end, x);
  assert(answer == end);
}
clock_t extra = clock() - start;

start = clock();
for (volatile unsigned int k = 0; k < repetitions; k++) {
  volatile position beg = first + k * n;
  volatile position end = first + (k+1) * n;
  element x = element(MAXSIZE);
  volatile position answer = search(beg, end, x);
  assert(answer == end);
}
clock_t ticks = clock() - start - extra;

double ns_per_n = 1.0e9 / (double(CLOCKS_PER_SEC) *  \
  double(n));
printf("%ld \t %f\n", n,  ns_per_n * double(ticks) / \
  double(repetitions));
```

Shell Script

```
#!/usr/local/bin/tcsh -f

# Modified from the script written by:
# Jesper Bojesen
# e-mail: Jesper.Bojesen@uni-c.dk

# Version: 1.0
# May 2000

##########################################

nice

#./drive <n> <type> <seed>

$1/drive 10  1
$1/drive 16  1
$1/drive 32  1
$1/drive 64  1
$1/drive 128  1
$1/drive 256  1
$1/drive 512  1
$1/drive 1024  1
$1/drive 2048  1
$1/drive 4096  1
$1/drive 8192  1
$1/drive 16384  1
$1/drive 32768  1
$1/drive 65536  1
$1/drive 131072  1
$1/drive 262144  1
$1/drive 524288  1
$1/drive 1048576 1
$1/drive 2097152 1
$1/drive 4194304 1
```

Gnuplot Control

```
# Modified from the script written by:
# Jesper Bojesen
# e-mail: Jesper.Bojesen@uni-c.dk

# Version: 1.1
# October 2000

##########################################

set xrange [10:4194304]
set logscale x

set xtics ( "10" 10, \
         "100" 100, \
         "1 000" 1000, \
         "10 000" 10000, \
         "100 000" 100000, \
         "1 000 000" 1000000 \
)

set output "Figure/plot.ps"
set terminal postscript landscape monochrome dashed
set title 'Unsuccessful search from an unsorted array\
  of n unsigned integers'
set xlabel 'n'
set ylabel 'Execution time per element [in nanoseconds]'
plot "SGI-in/plot.data" title "SGI STL find" with \
     linespoints 1 1,\
     "SGI-ran/plot.data" title "SGI STL find with  \
     specialization" with linespoints 3 3,\
     "Sentinel/plot.data" title "Sentinel technique" \
     with linespoints 4 4,\
     0 notitle
```