Search algorithm code library and instance generator

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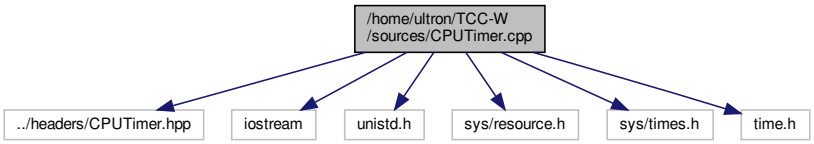
Chapter 1

File Documentation

1.1 /home/ultron/TCC-W/sources/CPUTimer.cpp File Reference

`#include "../headers/CPUTimer.hpp"`
Include dependency graph for CPUTimer.cpp:



1.2 CPUTimer.cpp

```
00001 /*
00002  *  CPUTimer.cpp
00003  *
00004  *  Created by Humberto Longo on 02/04/13.
00005  *  Instituto de Informatica - UFG
00006  *
00007  */
00008
00009 #include "../headers/CPUTimer.hpp"
00010
00011 //---------------------------------------------------------------------------
00012
00013 CPUTimer::CPUTimer()
00014 {
00015         started = false;
00016
00017         CPUCurrSecs = 0;
00018         CPUTotalSecs = 0;
00019         CronoCurrSecs = 0;
00020         CronoTotalSecs = 0;
00021 }
00022
00023 //---------------------------------------------------------------------------
00024
00025 double CPUTimer::getCPUCurrSecs()
00026 {
00027         return CPUCurrSecs;
00028 }
00029
00030 //---------------------------------------------------------------------------
00031
```

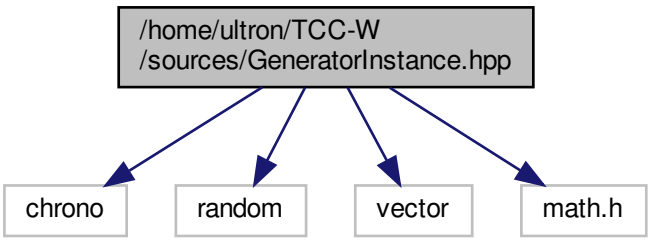
```
00032 double CPUTimer::getCPUTotalSecs()
00033 {
00034         return CPUTotalSecs;
00035 }
00036
00037 //-------------------------------------------------------------------------
00038
00039 double CPUTimer::getCronoCurrSecs()
00040 {
00041         return CronoCurrSecs;
00042 }
00043
00044 //-------------------------------------------------------------------------
00045
00046 double CPUTimer::getCronoTotalSecs()
00047 {
00048         return CronoTotalSecs;
00049 }
00050
00051 //-------------------------------------------------------------------------
00052
00053 bool CPUTimer::start()
00054 {
00055         bool status = true;
00056
00057         CPUCurrSecs = 0;
00058         CronoCurrSecs = 0;
00059
00060   CPUTStart = getCPUTime();
00061   CronoTStart = getRealTime();
00062
00063         gottime = false;
00064         started = status;
00065
00066         return ( status );
00067 }
00068
00069 //-------------------------------------------------------------------------
00070
00071 bool CPUTimer::stop()
00072 {
00073         bool status = true;
00074
00075         if (started)
00076         {
00077     CPUTStop = getCPUTime();
00078     CronoTStop = getRealTime();
00079
00080     CPUTotalSecs += CPUTStop - CPUTStart;
00081     CronoTotalSecs += CronoTStop - CronoTStart;
00082         }
00083         else
00084         {
00085                 std::cout « "CPUTimer::stop(): called without calling CPUTimer::start() first!\n";
00086                 status = false;
00087         }
00088
00089         started = false;
00090
00091         return status;
00092 }
00093
00094 //-------------------------------------------------------------------------
00095
00096 void CPUTimer::reset()
00097 {
00098         started = false;
00099
00100         CPUCurrSecs = 0;
00101         CPUTotalSecs = 0;
00102         CronoCurrSecs = 0;
00103         CronoTotalSecs = 0;
00104 }
00105
00106 //-------------------------------------------------------------------------
00107
00108 void CPUTimer::operator += ( CPUTimer t )
00109 {
00110         CPUCurrSecs += t.getCPUCurrSecs();
00111         CPUTotalSecs += t.getCPUTotalSecs();
00112         CronoCurrSecs += t.getCronoCurrSecs();
00113         CronoTotalSecs += t.getCronoTotalSecs();
00114 }
00115
00116 //-------------------------------------------------------------------------
00117
00122 double CPUTimer::getCPUTime( )
```

```
00123 {
00124   #if defined(_POSIX_TIMERS) && (_POSIX_TIMERS > 0)
00125   /* Prefer high-res POSIX timers, when available. */
00126   clockid_t id;
00127   struct timespec ts;
00128
00129   #if _POSIX_CPUTIME > 0
00130   /* Clock ids vary by OS.  Query the id, if possible. */
00131   if ( clock_getcpuclockid( 0, &id ) == -1 )
00132   #endif
00133   #if defined(CLOCK_PROCESS_CPUTIME_ID)
00134     /* Use known clock id for AIX, Linux, or Solaris. */
00135     id = CLOCK_PROCESS_CPUTIME_ID;
00136   #elif defined(CLOCK_VIRTUAL)
00137     /* Use known clock id for BSD or HP-UX. */
00138     id = CLOCK_VIRTUAL;
00139   #else
00140     id = (clockid_t) - 1;
00141   #endif
00142
00143   if ((id != (clockid_t) - 1) && (clock_gettime( id, &ts ) != -1))
00144     return ((double) ts.tv_sec + (double) ts.tv_nsec / 1000000000.0);
00145   #endif
00146
00147   #if defined(RUSAGE_SELF)
00148   struct rusage rusage;
00149
00150   if (getrusage( RUSAGE_SELF, &rusage ) != -1)
00151     return ((double) rusage.ru_utime.tv_sec + (double) rusage.ru_utime.tv_usec / 1000000.0);
00152   #endif
00153
00154         /* Failed. */
00155         return -1.0;
00156 }
00157
00158 //--------------------------------------------------------------------------
00159
00164 double CPUTimer::getRealTime()
00165 {
00166   #if defined(_POSIX_TIMERS) && (_POSIX_TIMERS > 0)
00167         struct timespec ts;
00168   #if defined(CLOCK_MONOTONIC_PRECISE)
00169         /* BSD. --------------------------------------------- */
00170         const clockid_t id = CLOCK_MONOTONIC_PRECISE;
00171   #elif defined(CLOCK_MONOTONIC_RAW)
00172         /* Linux. ------------------------------------------- */
00173         const clockid_t id = CLOCK_MONOTONIC_RAW;
00174   #elif defined(CLOCK_HIGHRES)
00175         /* Solaris. ----------------------------------------- */
00176         const clockid_t id = CLOCK_HIGHRES;
00177   #elif defined(CLOCK_MONOTONIC)
00178         /* AIX, BSD, Linux, POSIX, Solaris. ----------------- */
00179         const clockid_t id = CLOCK_MONOTONIC;
00180   #elif defined(CLOCK_REALTIME)
00181         /* AIX, BSD, HP-UX, Linux, POSIX. ------------------- */
00182         const clockid_t id = CLOCK_REALTIME;
00183   #else
00184   /* Unknown. */
00185         const clockid_t id = (clockid_t) - 1;
00186   #endif
00187
00188         if ((id != (clockid_t) - 1) && (clock_gettime( id, &ts ) != -1))
00189                 return ((double) ts.tv_sec + (double) ts.tv_nsec / 1000000000.0);
00190
00191   #elif defined(__MACH__) && defined(__APPLE__)
00192         /* OSX. --------------------------------------------- */
00193         static double timeConvert = 0.0;
00194
00195         if (timeConvert == 0.0)
00196         {
00197                 mach_timebase_info_data_t timeBase;
00198
00199                 (void) mach_timebase_info( &timeBase );
00200                 timeConvert = (double) timeBase.numer / (double) timeBase.denom / 1000000000.0;
00201         }
00202
00203         return (double) mach_absolute_time( ) * timeConvert;
00204   #else
00205
00206   /* Failed. */
00207         return -1.0;
00208   #endif
00209 }
00210
00211 //--------------------------------------------------------------------------
```

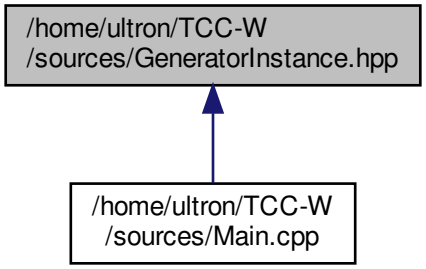
1.3 /home/ultron/TCC-W/sources/GeneratorInstance.hpp File Reference

```
#include <chrono>
#include <random>
#include <vector>
#include <math.h>
```

Include dependency graph for GeneratorInstance.hpp:



This graph shows which files directly or indirectly include this file:



Functions

- template<class ForwardIt , class T >
  void LinearIncreasingDistribution (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate an increasing uniform distribution.
- template<class ForwardIt , class T >
  void LinearDecreasingDistribution (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate a decreasing uniform distribution.
- template<class ForwardIt , class T >
  void LinearNormalDistribution (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate a normal uniform distribution.

- template<class ForwardIt , class T >
  void LinearIncreasingDistribution_2D (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Functions for generating a uniform distribution for a two-dimensional array.
- template<class ForwardIt , class T >
  void LinearDecreasingDistribution_2D (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate a decreasing uniform distribution for a two-dimensional array.
- template<class ForwardIt , class T >
  void LinearNormalDistribution_2D (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate a normal uniform distribution for a two-dimensional array.
- template<class ForwardIt , class T >
  void LinearIncreasingDistribution_3D (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Functions for generating a uniform distribution for a three-dimensional array.
- template<class ForwardIt , class T >
  void LinearDecreasingDistribution_3D (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate a decreasing uniform distribution for a three-dimensional array.
- template<class ForwardIt , class T >
  void LinearNormalDistribution_3D (ForwardIt first, ForwardIt last, const T &min_value, const T &max_value)

  Function to generate a normal uniform distribution for a three-dimensional array.

1.3.1 Function Documentation

1.3.1.1 LinearDecreasingDistribution()

```
template<class ForwardIt , class T >
void LinearDecreasingDistribution (
            ForwardIt first,
            ForwardIt last,
            const T & min_value,
            const T & max_value )
```

Function to generate a decreasing uniform distribution.

Parameters

first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

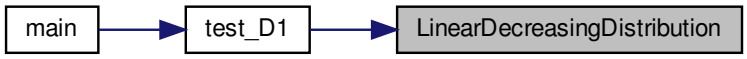
Definition at line 58 of file GeneratorInstance.hpp.

```
00058
        {
00059     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00060     std::mt19937_64 gen(seed);
00061     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00062     T offset;
```

```
00063     int N = (last - first); /* Array size.*/
00064     offset = (max_value - min_value+1.)  / (T)N; /*The values are generated within this range and
      added to the previous element of the sequence.*/
00065     for( int i = 0; i < N; ++i){
00066         if( i == 0)
00067             first[i] = (T)((offset) * (1. - std::sqrt(1.-dis(gen)))) + min_value;
00068         else
00069             first[i] = (T)((offset) * (1. - std::sqrt(1.-dis(gen)))) + first[i-1];
00070     }
00071 }
```

Referenced by test_D1().

Here is the caller graph for this function:



1.3.1.2 LinearDecreasingDistribution_2D()

```
template<class ForwardIt , class T >
void LinearDecreasingDistribution_2D (
             ForwardIt first,
             ForwardIt last,
             const T & min_value,
             const T & max_value )
```

Function to generate a decreasing uniform distribution for a two-dimensional array.

Parameters

first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

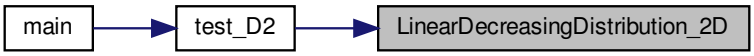
Definition at line 136 of file GeneratorInstance.hpp.

```
00136
          {
00137     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00138     std::mt19937_64 gen(seed);
00139     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00140     T offset;
00141     int M = (last - first); /* Size of the first dimension.*/
00142     int N = (first[0].size()); /* Size of the second dimension.*/
00143     offset = (max_value - min_value+1.)  / (T)(M+N); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00144     for( int i = 0; i < M; ++i){
00145         for( int j=0; j < N; ++j){
00146             if( i == 0 || j == 0){
00147                 if( i == 0 && j == 0)
00148                     first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + min_value;
```

```
00149                 else if( i == 0)
00150                     first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + first[i][j-1];
00151                 else
00152                     first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + first[i-1][j];
00153             }else
00154                 first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + std::max(first[i-1][j],
      first[i][j-1]);
00155         }
00156     }
00157 }
```

Referenced by test_D2().

Here is the caller graph for this function:



1.3.1.3 LinearDecreasingDistribution_3D()

```
template<class ForwardIt , class T >
void LinearDecreasingDistribution_3D (
             ForwardIt first,
             ForwardIt last,
             const T & min_value,
             const T & max_value )
```

Function to generate a decreasing uniform distribution for a three-dimensional array.

Parameters

first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

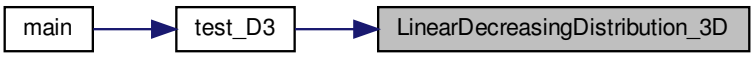
Definition at line 254 of file GeneratorInstance.hpp.

```
00254
            {
00255     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00256     std::mt19937_64 gen(seed);
00257     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00258     T offset;
00259     int M = (last - first); /* Size of the first dimension.*/
00260     int N = (first[0].size()); /* Size of the second dimension.*/
00261     int P =  (first[0][0].size()); /* Size of the third dimension.*/
00262     offset = (max_value - min_value+1.)  / (T)(M+N+P); /*The values are generated within this range
      and added to the previous element of the sequence.*/
00263     for( int i = 0; i < M; ++i){
00264         for( int j = 0; j < N; ++j){
00265             for( int k = 0; k < P; ++k){
00266                 if( i == 0 || j == 0 || k==0){
00267                     if( i == 0 && j == 0 && k==0)
```

```
00268                         first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) + min_value;
00269                     else if( i == 0){
00270                         if( k == 0)
00271                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j-1][k];
00272                         else if(j==0)
00273                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j][k-1];
00274                         else
00275                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i][j-1][k], first[i][j][k-1]);
00276                     }
00277                     else if(j == 0){
00278                         if( i == 0)
00279                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j][k-1];
00280                         else if(k==0)
00281                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i-1][j][k];
00282                         else
00283                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i-1][j][k], first[i][j][k-1]);
00284                     }else{
00285                         if( i == 0)
00286                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j-1][k];
00287                         else if(j==0)
00288                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i-1][j][k];
00289                         else
00290                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i-1][j][k], first[i][j-1][k]);
00291                     }
00292                 }else
00293                     first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i-1][j][k], std::max(first[i][j-1][k], first[i][j][k-1]));
00294             }
00295         }
00296     }
00297 }
```

Referenced by test_D3().

Here is the caller graph for this function:



1.3.1.4 LinearIncreasingDistribution()

```
template<class ForwardIt , class T >
void LinearIncreasingDistribution (
            ForwardIt first,
            ForwardIt last,
            const T & min_value,
            const T & max_value )
```

Function to generate an increasing uniform distribution.

Parameters

first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

Definition at line 36 of file GeneratorInstance.hpp.

```
00036
        {
00037     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00038     std::mt19937_64 gen(seed);
00039     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00040     T offset;
00041     int N = (last - first); /* Array size.*/
00042     offset = (max_value - min_value+1.) /(T)N; /*The values are generated within this range and added
      to the previous element of the sequence.*/
00043     for(int i = 0; i < N; ++i){
00044         if(i == 0)
00045             first[i] = (T)(offset * std::sqrt(dis(gen))) + min_value;
00046         else
00047             first[i] = (T)(offset * std::sqrt(dis(gen))) + first[i-1];
00048     }
00049 }
```

Referenced by test_D1().

Here is the caller graph for this function:

1.3.1.5 LinearIncreasingDistribution_2D()

```
template<class ForwardIt , class T >
void LinearIncreasingDistribution_2D (
            ForwardIt first,
            ForwardIt last,
            const T & min_value,
            const T & max_value )
```

Functions for generating a uniform distribution for a two-dimensional array.

Function to generate a growing uniform distribution for a two-dimensional array.

Parameters

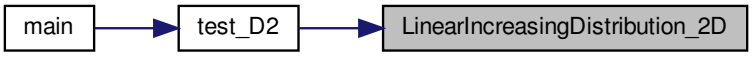
first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

Definition at line 106 of file GeneratorInstance.hpp.

```
00106
          {
00107     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00108     std::mt19937_64 gen(seed);
00109     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00110     T offset;
00111     int M = (last - first);  /* Size of the first dimension.*/
00112     int N = (first[0].size()); /* Size of the second dimension.*/
00113     offset = (max_value - min_value+1.) /(T)(M+N); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00114     for(int i = 0; i < M; ++i){
00115         for(int j = 0; j < N; ++j){
00116             if( i == 0 || j == 0){
00117                 if( i == 0 && j == 0)
00118                     first[i][j] = (T)(offset * std::sqrt(dis(gen))) + min_value;
00119                 else if( i == 0)
00120                     first[i][j] = (T)(offset * std::sqrt(dis(gen))) + first[i][j-1];
00121                 else
00122                     first[i][j] = (T)(offset * std::sqrt(dis(gen))) + first[i-1][j];
00123             }else
00124                 first[i][j] = (T)(offset * std::sqrt(dis(gen))) + std::max(first[i-1][j],
      first[i][j-1]);
00125         }
00126     }
00127 }
```

Referenced by test_D2().

Here is the caller graph for this function:



1.3.1.6 LinearIncreasingDistribution_3D()

```
template<class ForwardIt , class T >
void LinearIncreasingDistribution_3D (
             ForwardIt first,
             ForwardIt last,
             const T & min_value,
             const T & max_value )
```

Functions for generating a uniform distribution for a three-dimensional array.

Function to generate a growing uniform distribution for a three-dimensional array.

Parameters

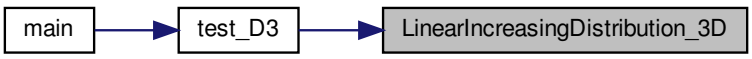
first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

Definition at line 201 of file GeneratorInstance.hpp.

```
00201
        {
00202     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00203     std::mt19937_64 gen(seed);
00204     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00205     T offset;
00206     int M = (last - first); /* Size of the first dimension.*/
00207     int N = (first[0].size()); /* Size of the second dimension.*/
00208     int P =  (first[0][0].size()); /* Size of the third dimension.*/
00209     offset = (max_value - min_value+1.) /(T)(M+N+P); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00210     for( int i = 0; i < M; ++i){
00211         for( int j = 0; j < N; ++j){
00212             for( int k = 0; k < P; ++k){
00213                 if( i == 0 || j == 0 || k==0){
00214                     if( i == 0 && j == 0 && k==0)
00215                         first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + min_value;
00216                     else if( i == 0){
00217                         if( k == 0)
00218                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j-1][k];
00219                         else if(j==0)
00220                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j][k-1];
00221                         else
00222                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) +
      std::max(first[i][j-1][k], first[i][j][k-1]);
00223                     }
00224                     else if(j == 0){
00225                         if( i == 0)
00226                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j][k-1];
00227                         else if(k==0)
00228                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i-1][j][k];
00229                         else
00230                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) +
      std::max(first[i-1][j][k], first[i][j][k-1]);
00231                     }else{
00232                         if( i == 0)
00233                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j-1][k];
00234                         else if(j==0)
00235                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i-1][j][k];
00236                         else
00237                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) +
      std::max(first[i-1][j][k], first[i][j-1][k]);
00238                     }
00239                 }else
00240                     first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + std::max(first[i-1][j][k],
      std::max(first[i][j-1][k], first[i][j][k-1]));
00241             }
00242         }
00243     }
00244 }
```

Referenced by test_D3().

Here is the caller graph for this function:



1.3.1.7 LinearNormalDistribution()

```
template<class ForwardIt , class T >
void LinearNormalDistribution (
```

```
            ForwardIt first,
            ForwardIt last,
            const T & min_value,
            const T & max_value )
```

Function to generate a normal uniform distribution.

Parameters

first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

Definition at line 80 of file GeneratorInstance.hpp.

```
00080
      {
00081     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00082     std::mt19937_64 gen(seed);
00083     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00084     T offset;
00085     int N = (last - first); /* Array size.*/
00086     offset = (max_value - min_value+1.)  / (T)N; /*The values are generated within this range and
      added to the previous element of the sequence.*/
00087     for( int i = 0; i < N; ++i){
00088         if(i == 0)
00089             first[i] = (T)((offset) * dis(gen)) + min_value;
00090         else
00091             first[i] = (T)((offset) * dis(gen)) + first[i-1];
00092     }
00093 }
```

Referenced by test_D1().

Here is the caller graph for this function:

1.3.1.8 LinearNormalDistribution_2D()

```
template<class ForwardIt , class T >
void LinearNormalDistribution_2D (
            ForwardIt first,
            ForwardIt last,
            const T & min_value,
            const T & max_value )
```

Function to generate a normal uniform distribution for a two-dimensional array.

Parameters

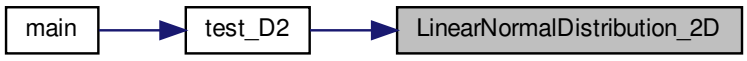
first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

Definition at line 167 of file GeneratorInstance.hpp.

```
00167
        {
00168     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00169     std::mt19937_64 gen(seed);
00170     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00171     T offset;
00172     int M = (last - first); /* Size of the first dimension.*/
00173     int N = (first[0].size()); /* Size of the second dimension.*/
00174     offset = (max_value - min_value+1.) / (T)(M+N); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00175     for( int i = 0; i < M; ++i){
00176         for( int j = 0; j < N; ++j){
00177             if( i == 0 || j == 0){
00178                 if( i == 0 && j == 0)
00179                     first[i][j] = (T)(offset * dis(gen)) + min_value;
00180                 else if( i == 0)
00181                     first[i][j] = (T)(offset * dis(gen)) + first[i][j-1];
00182                 else
00183                     first[i][j] = (T)(offset * dis(gen)) + first[i-1][j];
00184             }else
00185                 first[i][j] = (T)(offset * dis(gen)) + std::max(first[i-1][j], first[i][j-1]);
00186         }
00187     }
00188 }
```

Referenced by test_D2().

Here is the caller graph for this function:



1.3.1.9 LinearNormalDistribution_3D()

```
template<class ForwardIt , class T >
void LinearNormalDistribution_3D (
            ForwardIt first,
            ForwardIt last,
            const T & min_value,
            const T & max_value )
```

Function to generate a normal uniform distribution for a three-dimensional array.

Parameters

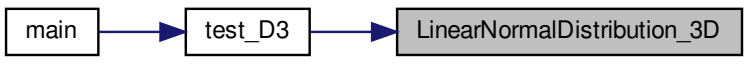
first	iterator to start of array.
last	iterator to end of matrix.
min_value	initial value of sequence.
max_value	maximum sequence offset.

Definition at line 307 of file GeneratorInstance.hpp.

```
00307
        {
00308     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00309     std::mt19937_64 gen(seed);
00310     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00311     T offset;
00312     int M = (last - first); /* Size of the first dimension.*/
00313     int N = (first[0].size()); /* Size of the second dimension.*/
00314     int P =  (first[0][0].size()); /* Size of the third dimension.*/
00315     offset = (max_value - min_value+1.) / (T)(M+N+P); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00316     for( int i = 0; i < M; ++i){
00317         for( int j = 0; j < N; ++j){
00318             for( int k = 0; k < P; ++k){
00319                 if( i == 0 || j == 0 || k==0){
00320                     if( i == 0 && j == 0 && k==0)
00321                         first[i][j][k] = (T)(offset * dis(gen)) + min_value;
00322                     else if( i == 0){
00323                         if( k == 0)
00324                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j-1][k];
00325                         else if(j==0)
00326                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j][k-1];
00327                         else
00328                             first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i][j-1][k],
      first[i][j][k-1]);
00329                     }
00330                     else if(j == 0){
00331                         if( i == 0)
00332                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j][k-1];
00333                         else if(k==0)
00334                             first[i][j][k] = (T)(offset * dis(gen)) + first[i-1][j][k];
00335                         else
00336                             first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i-1][j][k],
      first[i][j][k-1]);
00337                     }else{
00338                         if( i == 0)
00339                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j-1][k];
00340                         else if(j==0)
00341                             first[i][j][k] = (T)(offset * dis(gen)) + first[i-1][j][k];
00342                         else
00343                             first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i-1][j][k],
      first[i][j-1][k]);
00344                     }
00345                 }else
00346                     first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i-1][j][k],
      std::max(first[i][j-1][k], first[i][j][k-1]));
00347             }
00348         }
00349     }
00350 }
```

Referenced by test_D3().

Here is the caller graph for this function:



1.4 GeneratorInstance.hpp

```
00001
00012 /*
00013  *  GeneratorInstance.h
00014  *
00015  *  Created by Walisson Pereira de Jesus on 05/12/19.
00016  *  Instituto de Informatica - UFG
00017  *
00018  */
00019
00020 #ifndef GeneratorInstance_hpp
00021 #define GeneratorInstance_hpp
00022
00023 #include <chrono>
00024 #include <random>
00025 #include <vector>
00026 #include <math.h>
00027
00035 template<class ForwardIt, class T>
00036 void LinearIncreasingDistribution(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00037     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00038     std::mt19937_64 gen(seed);
00039     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00040     T offset;
00041     int N = (last - first); /* Array size.*/
00042     offset = (max_value - min_value+1.) /(T)N; /*The values are generated within this range and added
      to the previous element of the sequence.*/
00043     for(int i = 0; i < N; ++i){
00044         if(i == 0)
00045             first[i] = (T)(offset * std::sqrt(dis(gen))) + min_value;
00046         else
00047             first[i] = (T)(offset * std::sqrt(dis(gen))) + first[i-1];
00048     }
00049 }
00057 template<class ForwardIt, class T>
00058 void LinearDecreasingDistribution(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00059     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00060     std::mt19937_64 gen(seed);
00061     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00062     T offset;
00063     int N = (last - first); /* Array size.*/
00064     offset = (max_value - min_value+1.)  / (T)N; /*The values are generated within this range and
      added to the previous element of the sequence.*/
00065     for( int i = 0; i < N; ++i){
00066         if( i == 0)
00067             first[i] = (T)((offset) * (1. - std::sqrt(1.-dis(gen)))) + min_value;
00068         else
00069             first[i] = (T)((offset) * (1. - std::sqrt(1.-dis(gen)))) + first[i-1];
00070     }
00071 }
00079 template<class ForwardIt, class T>
00080 void LinearNormalDistribution(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00081     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00082     std::mt19937_64 gen(seed);
00083     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00084     T offset;
00085     int N = (last - first); /* Array size.*/
00086     offset = (max_value - min_value+1.)  / (T)N; /*The values are generated within this range and
      added to the previous element of the sequence.*/
00087     for( int i = 0; i < N; ++i){
00088         if(i == 0)
00089             first[i] = (T)((offset) * dis(gen)) + min_value;
00090         else
00091             first[i] = (T)((offset) * dis(gen)) + first[i-1];
00092     }
00093 }
00094
00095
00097
00105 template<class ForwardIt, class T>
00106 void LinearIncreasingDistribution_2D(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00107     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00108     std::mt19937_64 gen(seed);
00109     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00110     T offset;
00111     int M = (last - first);  /* Size of the first dimension.*/
00112     int N = (first[0].size()); /* Size of the second dimension.*/
00113     offset = (max_value - min_value+1.) /(T)(M+N); /*The values are generated within this range and
```

```
      added to the previous element of the sequence.*/
00114     for(int i = 0; i < M; ++i){
00115         for(int j = 0; j < N; ++j){
00116             if( i == 0 || j == 0){
00117                 if( i == 0 && j == 0)
00118                     first[i][j] = (T)(offset * std::sqrt(dis(gen))) + min_value;
00119                 else if( i == 0)
00120                     first[i][j] = (T)(offset * std::sqrt(dis(gen))) + first[i][j-1];
00121                 else
00122                     first[i][j] = (T)(offset * std::sqrt(dis(gen))) + first[i-1][j];
00123             }else
00124                 first[i][j] = (T)(offset * std::sqrt(dis(gen))) + std::max(first[i-1][j],
      first[i][j-1]);
00125         }
00126     }
00127 }
00135 template<class ForwardIt, class T>
00136 void LinearDecreasingDistribution_2D(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00137     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00138     std::mt19937_64 gen(seed);
00139     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00140     T offset;
00141     int M = (last - first); /* Size of the first dimension.*/
00142     int N = (first[0].size()); /* Size of the second dimension.*/
00143     offset = (max_value - min_value+1.)  / (T)(M+N); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00144     for( int i = 0; i < M; ++i){
00145         for( int j=0; j < N; ++j){
00146             if( i == 0 || j == 0){
00147                 if( i == 0 && j == 0)
00148                     first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + min_value;
00149                 else if( i == 0)
00150                     first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + first[i][j-1];
00151                 else
00152                     first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + first[i-1][j];
00153             }else
00154                 first[i][j] = (T)((offset)*(1. - std::sqrt(1.-dis(gen)))) + std::max(first[i-1][j],
      first[i][j-1]);
00155         }
00156     }
00157 }
00158
00166 template<class ForwardIt, class T>
00167 void LinearNormalDistribution_2D(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00168     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00169     std::mt19937_64 gen(seed);
00170     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00171     T offset;
00172     int M = (last - first); /* Size of the first dimension.*/
00173     int N = (first[0].size()); /* Size of the second dimension.*/
00174     offset = (max_value - min_value+1.) / (T)(M+N); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00175     for( int i = 0; i < M; ++i){
00176         for( int j = 0; j < N; ++j){
00177             if( i == 0 || j == 0){
00178                 if( i == 0 && j == 0)
00179                     first[i][j] = (T)(offset * dis(gen)) + min_value;
00180                 else if( i == 0)
00181                     first[i][j] = (T)(offset * dis(gen)) + first[i][j-1];
00182                 else
00183                     first[i][j] = (T)(offset * dis(gen)) + first[i-1][j];
00184             }else
00185                 first[i][j] = (T)(offset * dis(gen)) + std::max(first[i-1][j], first[i][j-1]);
00186         }
00187     }
00188 }
00189
00190
00192
00200 template<class ForwardIt, class T>
00201 void LinearIncreasingDistribution_3D(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00202     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00203     std::mt19937_64 gen(seed);
00204     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00205     T offset;
00206     int M = (last - first); /* Size of the first dimension.*/
00207     int N = (first[0].size()); /* Size of the second dimension.*/
00208     int P =  (first[0][0].size()); /* Size of the third dimension.*/
00209     offset = (max_value - min_value+1.) /(T)(M+N+P); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00210     for( int i = 0; i < M; ++i){
```

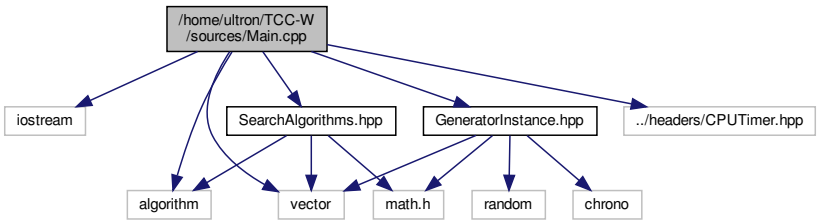
```
00211         for( int j = 0; j < N; ++j){
00212             for( int k = 0; k < P; ++k){
00213                 if( i == 0 || j == 0 || k==0){
00214                     if( i == 0 && j == 0 && k==0)
00215                         first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + min_value;
00216                     else if( i == 0){
00217                         if( k == 0)
00218                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j-1][k];
00219                         else if(j==0)
00220                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j][k-1];
00221                         else
00222                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) +
      std::max(first[i][j-1][k], first[i][j][k-1]);
00223                     }
00224                     else if(j == 0){
00225                         if( i == 0)
00226                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j][k-1];
00227                         else if(k==0)
00228                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i-1][j][k];
00229                         else
00230                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) +
      std::max(first[i-1][j][k], first[i][j][k-1]);
00231                     }else{
00232                         if( i == 0)
00233                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i][j-1][k];
00234                         else if(j==0)
00235                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + first[i-1][j][k];
00236                         else
00237                             first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) +
      std::max(first[i-1][j][k], first[i][j-1][k]);
00238                     }
00239                 }else
00240                     first[i][j][k] = (T)(offset * std::sqrt(dis(gen))) + std::max(first[i-1][j][k],
      std::max(first[i][j-1][k], first[i][j][k-1]));
00241             }
00242         }
00243     }
00244 }
00245
00253 template<class ForwardIt, class T>
00254 void LinearDecreasingDistribution_3D(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00255     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00256     std::mt19937_64 gen(seed);
00257     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00258     T offset;
00259     int M = (last - first); /* Size of the first dimension.*/
00260     int N = (first[0].size()); /* Size of the second dimension.*/
00261     int P =  (first[0][0].size()); /* Size of the third dimension.*/
00262     offset = (max_value - min_value+1.)  / (T)(M+N+P); /*The values are generated within this range
      and added to the previous element of the sequence.*/
00263     for( int i = 0; i < M; ++i){
00264         for( int j = 0; j < N; ++j){
00265             for( int k = 0; k < P; ++k){
00266                 if( i == 0 || j == 0 || k==0){
00267                     if( i == 0 && j == 0 && k==0)
00268                         first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) + min_value;
00269                     else if( i == 0){
00270                         if( k == 0)
00271                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j-1][k];
00272                         else if(j==0)
00273                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j][k-1];
00274                         else
00275                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i][j-1][k], first[i][j][k-1]);
00276                     }
00277                     else if(j == 0){
00278                         if( i == 0)
00279                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j][k-1];
00280                         else if(k==0)
00281                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i-1][j][k];
00282                         else
00283                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i-1][j][k], first[i][j][k-1]);
00284                     }else{
00285                         if( i == 0)
00286                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i][j-1][k];
00287                         else if(j==0)
00288                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      first[i-1][j][k];
00289                         else
```

```
00290                             first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i-1][j][k], first[i][j-1][k]);
00291                         }
00292                     }else
00293                         first[i][j][k] = (T)(offset * (1.-std::sqrt(1.-dis(gen)))) +
      std::max(first[i-1][j][k], std::max(first[i][j-1][k], first[i][j][k-1]));
00294                 }
00295             }
00296         }
00297 }
00298
00306 template<class ForwardIt, class T>
00307 void LinearNormalDistribution_3D(ForwardIt first, ForwardIt last, const T& min_value, const T&
      max_value){
00308     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count(); /* Random seed for
      distribution.*/
00309     std::mt19937_64 gen(seed);
00310     std::uniform_real_distribution<> dis(0.0, 1.0); /* Uniform value generated between 0 and 1.*/
00311     T offset;
00312     int M = (last - first); /* Size of the first dimension.*/
00313     int N = (first[0].size()); /* Size of the second dimension.*/
00314     int P =  (first[0][0].size()); /* Size of the third dimension.*/
00315     offset = (max_value - min_value+1.) / (T)(M+N+P); /*The values are generated within this range and
      added to the previous element of the sequence.*/
00316     for( int i = 0; i < M; ++i){
00317         for( int j = 0; j < N; ++j){
00318             for( int k = 0; k < P; ++k){
00319                 if( i == 0 || j == 0 || k==0){
00320                     if( i == 0 && j == 0 && k==0)
00321                         first[i][j][k] = (T)(offset * dis(gen)) + min_value;
00322                     else if( i == 0){
00323                         if( k == 0)
00324                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j-1][k];
00325                         else if(j==0)
00326                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j][k-1];
00327                         else
00328                             first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i][j-1][k],
      first[i][j][k-1]);
00329                     }
00330                     else if(j == 0){
00331                         if( i == 0)
00332                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j][k-1];
00333                         else if(k==0)
00334                             first[i][j][k] = (T)(offset * dis(gen)) + first[i-1][j][k];
00335                         else
00336                             first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i-1][j][k],
      first[i][j][k-1]);
00337                     }else{
00338                         if( i == 0)
00339                             first[i][j][k] = (T)(offset * dis(gen)) + first[i][j-1][k];
00340                         else if(j==0)
00341                             first[i][j][k] = (T)(offset * dis(gen)) + first[i-1][j][k];
00342                         else
00343                             first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i-1][j][k],
      first[i][j-1][k]);
00344                     }
00345                 }else
00346                     first[i][j][k] = (T)(offset * dis(gen)) + std::max(first[i-1][j][k],
      std::max(first[i][j-1][k], first[i][j][k-1]));
00347             }
00348         }
00349     }
00350 }
00351
00352 #endif
```

1.5 /home/ultron/TCC-W/sources/Main.cpp File Reference

```
#include <iostream>
#include <vector>
#include <algorithm>
#include "SearchAlgorithms.hpp"
#include "GeneratorInstance.hpp"
#include "../headers/CPUTimer.hpp"
```

Include dependency graph for Main.cpp:



Functions

- void test_D1 (int N, int ld, int min_value, int interval)
- void test_D2 (int M, int N, int ld, int min_value, int interval)
- void test_D3 (int M, int N, int P, int ld, int min_value, int interval)
- int main ()

  Function main.

1.5.1 Function Documentation

1.5.1.1 main()

```
int main ( )
```

Function main.

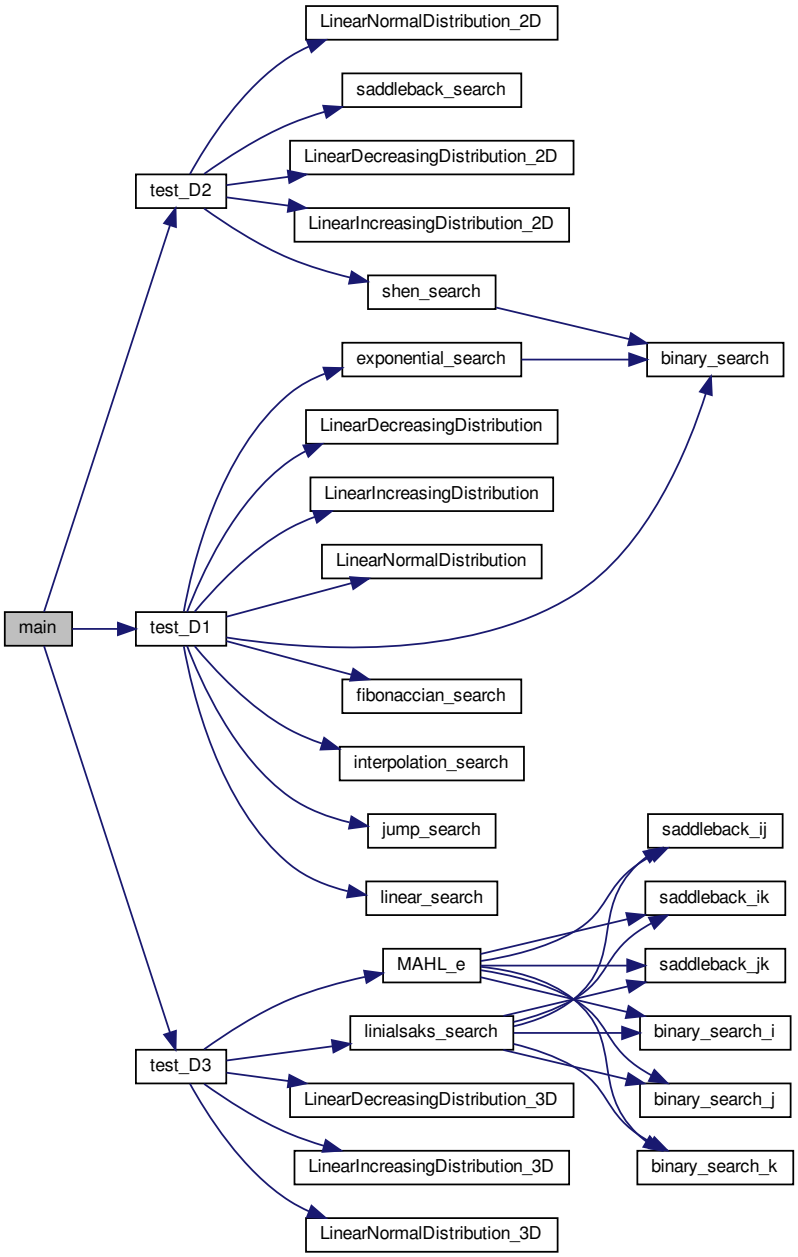
Definition at line 297 of file Main.cpp.

```
00297         {
00298     int option;
00299     do{
00300         printf("Test search algorithms for:\n1 - one-dimensional\n2 - two-dimensional\n3 -
      three-dimensional\nAnother value to leave:\n");
00301 
00302         scanf(" %d", &option);
00303         switch(option){
00304             case 1:{
00305                 int N, ld, min_value, interval;
00306                 printf("What kind of distribution?\n1 - LID\n2 - LDD \n3 - LND\n");
00307                 scanf(" %d", &ld);
00308                 printf("What is the size of the array? ");
00309                 scanf(" %d", &N);
00310                 printf("Start of break: ");
00311 
00312                 scanf(" %d", &min_value);
00313                 printf("End of break: ");
00314 
00315 
00316                 scanf(" %d", &interval);
00317                 test_D1(N, ld, min_value, interval);
00318                 break;
00319             }
00320             case 2:{
00321                 int M, N, ld, min_value, interval;
00322                 printf("What kind of distribution?\n1 - LID\n2 - LDD \n3 - LND\n");
00323                 scanf(" %d", &ld);
00324                 printf("What is the size of the array? \n");
```

```
00325                 printf("M: ");
00326                 scanf(" %d", &M);
00327                 printf("N: ");
00328                 scanf(" %d", &N);
00329                 printf("Start of break: ");
00330                 scanf(" %d", &min_value);
00331                 printf("End of break: ");
00332                 scanf(" %d", &interval);
00333                 test_D2(M, N, ld, min_value, interval);
00334                 break;
00335             }
00336             case 3:{
00337                 int  M, N, P, ld, min_value, interval;
00338                  printf("What kind of distribution?\n1 - LID\n2 - LDD \n3 - LND\n");
00339                 scanf(" %d", &ld);
00340                 printf("What is the size of the array? \n");
00341                 printf("M: ");
00342                 scanf("%d", &M);
00343                 printf("N: ");
00344                 scanf("%d", &N);
00345                 printf("P: ");
00346                 scanf(" %d", &P);
00347                 printf("Start of break: ");
00348                 scanf("%d", &min_value);
00349                 printf("End of break: ");
00350                 scanf("%d", &interval);
00351                 test_D3(M, N, P, ld, min_value, interval);
00352                 break;
00353             }
00354             default:
00355                 break;
00356         }
00357     }while(option > 0 && option  < 4);
00358     return 0;
00359 }
```

References test_D1(), test_D2(), and test_D3().

Here is the call graph for this function:



1.5.1.2 test_D1()

```
void test_D1 (
            int N,
            int ld,
```

```
            int min_value,
            int interval )
```

Definition at line 13 of file Main.cpp.

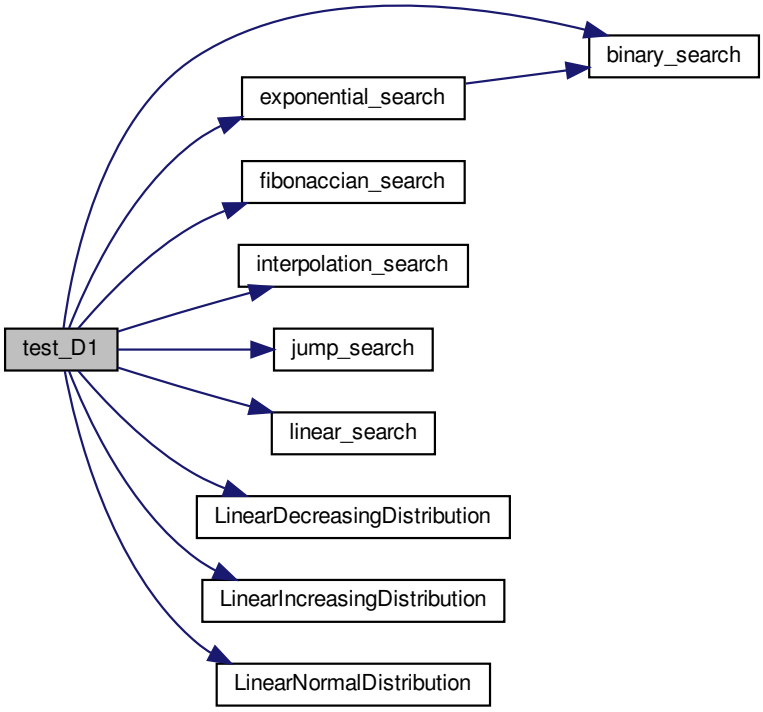
```
00013                                                   {
00014     vector<int> A(N);
00015     CPUTimer timer;
00016     if(ld == 1){
00017         printf("Linear Increasing Distribution\n");
00018         LinearIncreasingDistribution(A.begin(), A.end(), min_value, interval);
00019     }
00020     else if(ld == 2){
00021         printf("Linear Decreasing Distribution\n");
00022         LinearDecreasingDistribution(A.begin(), A.end(), min_value, interval);
00023     }
00024     else if(ld == 3){
00025         printf("Linear Normal Distribution\n");
00026         LinearNormalDistribution(A.begin(), A.end(), min_value, interval);
00027     }
00028     else
00029         return;
00030
00031     int query;
00032     printf("How many queries in the range: ");
00033     scanf(" %d", &query);
00034     while(query > 0){
00035         getchar();
00036         bool found;
00037         int key;
00038         printf("Search key value: ");
00039         scanf(" %d", &key);
00040
00041         /* ---------------------------------------- */
00042
00043        printf("-------------------------------------------------------------------------\n\n");
00044        printf("Key: %d\n", key);
00045        printf("N = %d\n", N);
00046
00047
00048
00049         timer.reset();
00050         found = false;
00051         timer.start();
00052         found = linear_search(A.begin(), A.end(), key);
00053         timer.stop();
00054         printf("Linear search: ");
00055         if(found == true){
00056             printf("YES\n");
00057         }
00058         else{
00059             printf("NO\n");
00060         }
00061         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00062
00063         /* ---------------------------------------- */
00064
00065         timer.reset();
00066         found = false;
00067         timer.start();
00068         found = jump_search(A.begin(), A.end(), key);
00069         timer.stop();
00070         printf("Jump search: ");
00071         if(found == true){
00072             printf("YES\n");
00073         }
00074         else{
00075             printf("NO\n");
00076         }
00077         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00078
00079         /* ---------------------------------------- */
00080
00081         timer.reset();
00082         found = false;
00083         timer.start();
00084         found = binary_search(A.begin(), A.end(), key);
00085         timer.stop();
00086         printf("Binary search: ");
00087         if(found == true){
00088             printf("YES\n");
00089         }
00090         else{
00091             printf("NO\n");
00092         }
00093          printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00094
```

```
00095         /* ---------------------------------------- */
00096
00097         timer.reset();
00098         found = false;
00099         timer.start();
00100         found = interpolation_search(A.begin(), A.end(), key);
00101         timer.stop();
00102         printf("Interpolation search: ");
00103         if(found == true){
00104             printf("YES\n");
00105         }
00106         else{
00107             printf("NO\n");
00108         }
00109         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00110
00111         /* ---------------------------------------- */
00112
00113         timer.reset();
00114         found = false;
00115         timer.start();
00116         found = exponential_search(A.begin(), A.end(), key);
00117         timer.stop();
00118         printf("Exponential search: ");
00119         if(found == true){
00120             printf("YES\n");
00121         }
00122         else{
00123             printf("NO\n");
00124         }
00125         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00126
00127         /* ---------------------------------------- */
00128
00129         timer.reset();
00130         found = false;
00131         timer.start();
00132         found = fibonaccian_search(A.begin(), A.end(), key);
00133         timer.stop();
00134         printf("Fibonaccian search: ");
00135         if(found == true){
00136             printf("YES\n");
00137         }
00138         else{
00139             printf("NO\n");
00140         }
00141         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00142         printf("------------------------------------------------------------------------\n\n");
00143         query--;
00144     }
00145     printf("\n");
00146 }
```

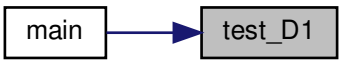
References binary_search(), exponential_search(), fibonaccian_search(), interpolation_search(), jump_search(), linear_search(), LinearDecreasingDistribution(), LinearIncreasingDistribution(), and LinearNormalDistribution().

Referenced by main().

Here is the call graph for this function:



Here is the caller graph for this function:



1.5.1.3 test_D2()

```
void test_D2 (
            int M,
            int N,
            int ld,
            int min_value,
            int interval )
```

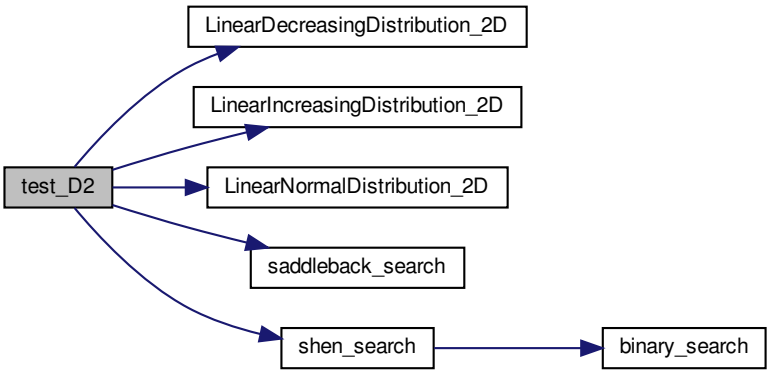
Definition at line 149 of file Main.cpp.

```
00149                                                                   {
00150
00151
00152
00153     vector<vector<int> > A(M, vector<int>(N));
00154
00155     CPUTimer timer;
00156
00157     if(ld == 1){
00158         printf("Linear Increasing Distribution\n");
00159         LinearIncreasingDistribution_2D(A.begin(), A.end(), min_value, interval);
00160     }
00161     else if( ld == 2){
00162         printf("Linear Decreasing Distribution\n");
00163         LinearDecreasingDistribution_2D(A.begin(), A.end(), min_value, interval);
00164     }
00165     else if( ld==3){
00166         printf("Linear Normal Distribution\n");
00167         LinearNormalDistribution_2D(A.begin(), A.end(), min_value, interval);
00168     }
00169     else
00170         return;
00171     int query;
00172     printf("How many queries in the range: ");
00173     scanf(" %d", &query);
00174     while(query>0){
00175         bool found;
00176         int key;
00177         printf("Search key value: ");
00178         scanf(" %d", &key);
00179
00180         /* ----------------------------------------- */
00181
00182         printf("-------------------------------------------------------------------------\n\n");
00183         printf("Key: %d\n", key);
00184         printf("M x N = %d x %d\n", M, N);
00185         timer.reset();
00186         found = false;
00187         timer.start();
00188         found = saddleback_search(A.begin(), A.end(), key);
00189         timer.stop();
00190         printf("Saddleback search: ");
00191
00192         if(found == true){
00193             printf("YES\n");
00194         }
00195         else{
00196             printf("NO\n");
00197         }
00198         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00199
00200         timer.reset();
00201         found = false;
00202         timer.start();
00203         found = shen_search(A.begin(), A.end(), key);
00204         timer.stop();
00205
00206         printf("Shen search: ");
00207         if(found == true){
00208             printf("YES\n");
00209         }
00210         else{
00211             printf("NO\n");
00212         }
00213         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00214         printf("-------------------------------------------------------------------------\n\n");
00215         query--;
00216     }
00217     printf("\n");
00218 }
```

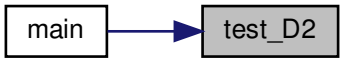
References LinearDecreasingDistribution_2D(), LinearIncreasingDistribution_2D(), LinearNormalDistribution_2D(), saddleback_search(), and shen_search().

Referenced by main().

Here is the call graph for this function:



Here is the caller graph for this function:



1.5.1.4 test_D3()

```
void test_D3 (
              int M,
              int N,
              int P,
              int ld,
              int min_value,
              int interval )
```

Definition at line 220 of file Main.cpp.

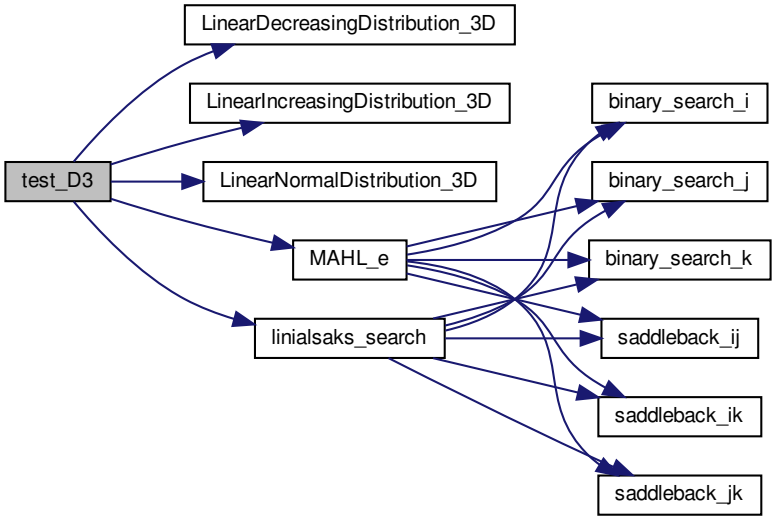
```
00220                                                                    {
00221
00222
00223     vector<vector<vector<int> > > A(M, vector<vector<int> >(N, vector<int>(P)));
00224     CPUTimer timer;
00225
00226     if( ld == 1){
00227         printf("Linear Increasing Distribution\n");
00228         LinearIncreasingDistribution_3D(A.begin(), A.end(), min_value, interval);
00229     }
00230     else if(ld == 2){
00231         printf("Linear Decreasing Distribution\n");
00232         LinearDecreasingDistribution_3D(A.begin(), A.end(), min_value, interval);
```

```
00233     }
00234     else if(ld == 3){
00235         printf("Linear Normal Distribution\n");
00236         LinearNormalDistribution_3D(A.begin(), A.end(), min_value, interval);
00237     }
00238     else
00239         return;
00240 
00241     int query;
00242     printf("How many queries in the range: ");
00243     scanf("%d", &query);
00244     while(query > 0){
00245         bool found;
00246         int key;
00247         printf("Search key value: ");
00248         scanf(" %d", &key);
00249 
00250         /* ---------------------------------------- */
00251 
00252         printf("--------------------------------------------------------------------------------\n\n");
00253         printf("Key: %d\n", key);
00254         printf("M x N x P = %d x %d x %d\n", M, N, P);
00255         if( M == N && M == P){
00256             timer.reset();
00257             found = false;
00258             timer.start();
00259             found = linialsaks_search(A.begin(), A.end(), key);
00260             timer.stop();
00261 
00262             printf("LinialSaks search: ");
00263             if(found == true){
00264                 printf("YES\n");
00265             }
00266             else{
00267                 printf("NO\n");
00268             }
00269             printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00270         }
00271 
00272         /* ---------------------------------------- */
00273 
00274         timer.reset();
00275         found = false;
00276         timer.start();
00277         found = MAHL_e(A.begin(), A.end(), key);
00278         timer.stop();
00279         printf("Shen3D search: ");
00280         if(found == true){
00281             printf("YES\n");
00282         }
00283         else{
00284             printf("NO\n");
00285         }
00286         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00287 
00288         printf("--------------------------------------------------------------------------------\n\n");
00289         query--;
00290     }
00291     printf("\n");
00292 }
```

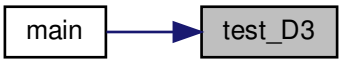
References LinearDecreasingDistribution_3D(), LinearIncreasingDistribution_3D(), LinearNormalDistribution_3D(), linialsaks_search(), and MAHL_e().

Referenced by main().

Here is the call graph for this function:



Here is the caller graph for this function:



1.6 Main.cpp

```
00001 #include <iostream>
00002 #include <vector>
00003 #include <algorithm>
00004
00005
00006 #include "SearchAlgorithms.hpp"
00007 #include "GeneratorInstance.hpp"
00008 #include "../headers/CPUTimer.hpp"
00009
00010 using namespace std;
00011
00012
00013 void test_D1(int N, int ld, int min_value, int interval){
00014     vector<int> A(N);
00015     CPUTimer timer;
00016     if(ld == 1){
00017         printf("Linear Increasing Distribution\n");
00018         LinearIncreasingDistribution(A.begin(), A.end(), min_value, interval);
00019     }
00020     else if(ld == 2){
00021         printf("Linear Decreasing Distribution\n");
00022         LinearDecreasingDistribution(A.begin(), A.end(), min_value, interval);
00023     }
00024     else if(ld == 3){
```

```
00025         printf("Linear Normal Distribution\n");
00026         LinearNormalDistribution(A.begin(), A.end(), min_value, interval);
00027     }
00028     else
00029         return;
00030 
00031     int query;
00032     printf("How many queries in the range: ");
00033     scanf(" %d", &query);
00034     while(query > 0){
00035         getchar();
00036         bool found;
00037         int key;
00038         printf("Search key value: ");
00039         scanf(" %d", &key);
00040 
00041         /* ---------------------------------------- */
00042 
00043        printf("--------------------------------------------------------------------------------\n\n");
00044        printf("Key: %d\n", key);
00045        printf("N = %d\n", N);
00046 
00047 
00048 
00049         timer.reset();
00050         found = false;
00051         timer.start();
00052         found = linear_search(A.begin(), A.end(), key);
00053         timer.stop();
00054         printf("Linear search: ");
00055         if(found == true){
00056             printf("YES\n");
00057         }
00058         else{
00059             printf("NO\n");
00060         }
00061         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00062 
00063         /* ---------------------------------------- */
00064 
00065         timer.reset();
00066         found = false;
00067         timer.start();
00068         found = jump_search(A.begin(), A.end(), key);
00069         timer.stop();
00070         printf("Jump search: ");
00071         if(found == true){
00072             printf("YES\n");
00073         }
00074         else{
00075             printf("NO\n");
00076         }
00077         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00078 
00079         /* ---------------------------------------- */
00080 
00081         timer.reset();
00082         found = false;
00083         timer.start();
00084         found = binary_search(A.begin(), A.end(), key);
00085         timer.stop();
00086         printf("Binary search: ");
00087         if(found == true){
00088             printf("YES\n");
00089         }
00090         else{
00091             printf("NO\n");
00092         }
00093          printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00094 
00095         /* ---------------------------------------- */
00096 
00097         timer.reset();
00098         found = false;
00099         timer.start();
00100         found = interpolation_search(A.begin(), A.end(), key);
00101         timer.stop();
00102         printf("Interpolation search: ");
00103         if(found == true){
00104             printf("YES\n");
00105         }
00106         else{
00107             printf("NO\n");
00108         }
00109         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00110 
00111         /* ---------------------------------------- */
```

```
00112
00113         timer.reset();
00114         found = false;
00115         timer.start();
00116         found = exponential_search(A.begin(), A.end(), key);
00117         timer.stop();
00118         printf("Exponential search: ");
00119         if(found == true){
00120             printf("YES\n");
00121         }
00122         else{
00123             printf("NO\n");
00124         }
00125         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00126
00127         /* ---------------------------------------- */
00128
00129         timer.reset();
00130         found = false;
00131         timer.start();
00132         found = fibonaccian_search(A.begin(), A.end(), key);
00133         timer.stop();
00134         printf("Fibonaccian search: ");
00135         if(found == true){
00136             printf("YES\n");
00137         }
00138         else{
00139             printf("NO\n");
00140         }
00141         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00142         printf("-------------------------------------------------------------------------\n\n");
00143         query--;
00144     }
00145     printf("\n");
00146 }
00147
00148
00149 void test_D2(int M, int N, int ld, int min_value, int interval){
00150
00151
00152
00153     vector<vector<int> > A(M, vector<int>(N));
00154
00155     CPUTimer timer;
00156
00157     if(ld == 1){
00158         printf("Linear Increasing Distribution\n");
00159         LinearIncreasingDistribution_2D(A.begin(), A.end(), min_value, interval);
00160     }
00161     else if( ld == 2){
00162         printf("Linear Decreasing Distribution\n");
00163         LinearDecreasingDistribution_2D(A.begin(), A.end(), min_value, interval);
00164     }
00165     else if( ld==3){
00166         printf("Linear Normal Distribution\n");
00167         LinearNormalDistribution_2D(A.begin(), A.end(), min_value, interval);
00168     }
00169     else
00170         return;
00171     int query;
00172     printf("How many queries in the range: ");
00173     scanf(" %d", &query);
00174     while(query>0){
00175         bool found;
00176         int key;
00177         printf("Search key value: ");
00178         scanf(" %d", &key);
00179
00180         /* ---------------------------------------- */
00181
00182         printf("-------------------------------------------------------------------------\n\n");
00183         printf("Key: %d\n", key);
00184         printf("M x N = %d x %d\n", M, N);
00185         timer.reset();
00186         found = false;
00187         timer.start();
00188         found = saddleback_search(A.begin(), A.end(), key);
00189         timer.stop();
00190         printf("Saddleback search: ");
00191
00192         if(found == true){
00193             printf("YES\n");
00194         }
00195         else{
00196             printf("NO\n");
00197         }
00198         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
```

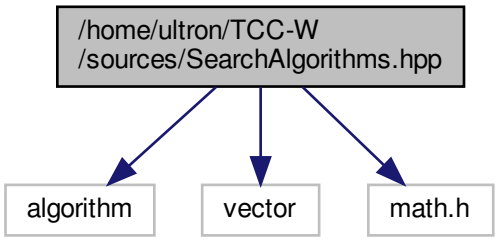
```
00199
00200         timer.reset();
00201         found = false;
00202         timer.start();
00203         found = shen_search(A.begin(), A.end(), key);
00204         timer.stop();
00205
00206         printf("Shen search: ");
00207         if(found == true){
00208             printf("YES\n");
00209         }
00210         else{
00211             printf("NO\n");
00212         }
00213         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00214         printf("------------------------------------------------------------------------\n\n");
00215         query--;
00216     }
00217     printf("\n");
00218 }
00219
00220 void test_D3(int M, int N, int P, int ld, int min_value, int interval){
00221
00222
00223     vector<vector<vector<int> > > A(M, vector<vector<int> >(N, vector<int>(P)));
00224     CPUTimer timer;
00225
00226     if( ld == 1){
00227         printf("Linear Increasing Distribution\n");
00228         LinearIncreasingDistribution_3D(A.begin(), A.end(), min_value, interval);
00229     }
00230     else if(ld == 2){
00231         printf("Linear Decreasing Distribution\n");
00232         LinearDecreasingDistribution_3D(A.begin(), A.end(), min_value, interval);
00233     }
00234     else if(ld == 3){
00235         printf("Linear Normal Distribution\n");
00236         LinearNormalDistribution_3D(A.begin(), A.end(), min_value, interval);
00237     }
00238     else
00239         return;
00240
00241     int query;
00242     printf("How many queries in the range: ");
00243     scanf("%d", &query);
00244     while(query > 0){
00245         bool found;
00246         int key;
00247         printf("Search key value: ");
00248         scanf(" %d", &key);
00249
00250         /* ----------------------------------------- */
00251
00252         printf("------------------------------------------------------------------------\n\n");
00253         printf("Key: %d\n", key);
00254         printf("M x N x P = %d x %d x %d\n", M, N, P);
00255         if( M == N && M == P){
00256             timer.reset();
00257             found = false;
00258             timer.start();
00259             found = linialsaks_search(A.begin(), A.end(), key);
00260             timer.stop();
00261
00262             printf("LinialSaks search: ");
00263             if(found == true){
00264                 printf("YES\n");
00265             }
00266             else{
00267                 printf("NO\n");
00268             }
00269             printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00270         }
00271
00272         /* ----------------------------------------- */
00273
00274         timer.reset();
00275         found = false;
00276         timer.start();
00277         found = MAHL_e(A.begin(), A.end(), key);
00278         timer.stop();
00279         printf("Shen3D search: ");
00280         if(found == true){
00281             printf("YES\n");
00282         }
00283         else{
00284             printf("NO\n");
00285         }
```

```
00286         printf("timer: %.10lf\n", timer.getCronoTotalSecs());
00287
00288         printf("-------------------------------------------------------------------------\n\n");
00289         query--;
00290     }
00291     printf("\n");
00292 }
00293
00297 int main(){
00298     int option;
00299     do{
00300         printf("Test search algorithms for:\n1 - one-dimensional\n2 - two-dimensional\n3 -
      three-dimensional\nAnother value to leave:\n");
00301
00302         scanf(" %d", &option);
00303         switch(option){
00304             case 1:{
00305                 int N, ld, min_value, interval;
00306                 printf("What kind of distribution?\n1 - LID\n2 - LDD \n3 - LND\n");
00307                 scanf(" %d", &ld);
00308                 printf("What is the size of the array? ");
00309                 scanf(" %d", &N);
00310                 printf("Start of break: ");
00311
00312                 scanf(" %d", &min_value);
00313                 printf("End of break: ");
00314
00315
00316                 scanf(" %d", &interval);
00317                 test_D1(N, ld, min_value, interval);
00318                 break;
00319             }
00320             case 2:{
00321                 int M, N, ld, min_value, interval;
00322                 printf("What kind of distribution?\n1 - LID\n2 - LDD \n3 - LND\n");
00323                 scanf(" %d", &ld);
00324                 printf("What is the size of the array? \n");
00325                 printf("M: ");
00326                 scanf(" %d", &M);
00327                 printf("N: ");
00328                 scanf(" %d", &N);
00329                 printf("Start of break: ");
00330                 scanf(" %d", &min_value);
00331                 printf("End of break: ");
00332                 scanf(" %d", &interval);
00333                 test_D2(M, N, ld, min_value, interval);
00334                 break;
00335             }
00336             case 3:{
00337                 int  M, N, P, ld, min_value, interval;
00338                  printf("What kind of distribution?\n1 - LID\n2 - LDD \n3 - LND\n");
00339                 scanf(" %d", &ld);
00340                 printf("What is the size of the array? \n");
00341                 printf("M: ");
00342                 scanf("%d", &M);
00343                 printf("N: ");
00344                 scanf("%d", &N);
00345                 printf("P: ");
00346                 scanf(" %d", &P);
00347                 printf("Start of break: ");
00348                 scanf("%d", &min_value);
00349                 printf("End of break: ");
00350                 scanf("%d", &interval);
00351                 test_D3(M, N, P, ld, min_value, interval);
00352                 break;
00353             }
00354             default:
00355                 break;
00356         }
00357     }while(option > 0 && option  < 4);
00358     return 0;
00359 }
```

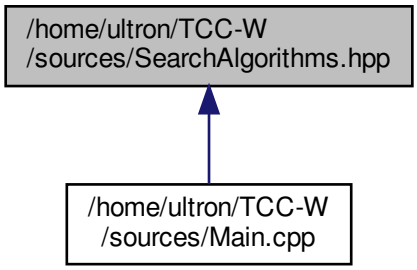
1.7 /home/ultron/TCC-W/sources/SearchAlgorithms.hpp File Reference

```
#include <algorithm>
#include <vector>
#include <math.h>
```

Include dependency graph for SearchAlgorithms.hpp:



This graph shows which files directly or indirectly include this file:



Functions

- template<class ForwardIt , class T >
  bool linear_search (ForwardIt first, ForwardIt last, const T &value)

  One-dimensional search functions.
- template<class ForwardIt , class T >
  bool jump_search (ForwardIt first, ForwardIt last, const T &value)

  Linear search function.
- template<class ForwardIt , class T >
  bool interpolation_search (ForwardIt first, ForwardIt last, const T &value)

  Interpolation search function.
- template<class ForwardIt , class T >
  bool exponential_search (ForwardIt first, ForwardIt last, const T &value)

  Exponential search function.
- template<class ForwardIt , class T >
  bool fibonaccian_search (ForwardIt first, ForwardIt last, const T &value)

  Fibonacci search function.

- template<class ForwardIt , class T >
  bool saddleback_search (ForwardIt first, int i1, int j1, int in, int jn, const T &value)

  Two-dimensional search functions.
- template<class ForwardIt , class T >
  bool saddleback_search (ForwardIt first, ForwardIt last, const T &value)

  Saddleback search function.
- template<class ForwardIt , class T >
  bool binary_search (ForwardIt first, int i1, int j1, int in, int jn, const T &value)

  Binary search function.
- template<class ForwardIt , class T >
  bool shen_search (ForwardIt first, int i1, int j1, int in, int jn, const T &value)

  Shen search function.
- template<class ForwardIt , class T >
  bool shen_search (ForwardIt first, ForwardIt last, const T &value)

  Shen search function.
- template<class ForwardIt , class T >
  bool saddleback_ij (ForwardIt first, int i1, int in, int j1, int jn, int k, const T &value)

  Saddleback search function for array ij face.
- template<class ForwardIt , class T >
  bool saddleback_ik (ForwardIt first, int i1, int in, int j, int k1, int kn, const T &value)

  Saddleback search function for array ik face.
- template<class ForwardIt , class T >
  bool saddleback_jk (ForwardIt first, int i, int j1, int jn, int k1, int k2, const T &value)

  Saddleback search function for array ik face.
- template<class ForwardIt , class T >
  int binary_search_i (ForwardIt first, int i1, int in, int j, int k, const T &value)

  Binary search function in subvetor i.
- template<class ForwardIt , class T >
  int binary_search_j (ForwardIt first, int i, int j1, int jn, int k, const T &value)

  Binary search function in subvetor j.
- template<class ForwardIt , class T >
  int binary_search_k (ForwardIt first, int i, int j, int k1, int kn, const T &value)

  Binary search function in subvetor k.
- template<class ForwardIt , class T >
  bool linialsaks_search (ForwardIt first, int i1, int j1, int k1, int in, int jn, int kn, const T &value)

  Linial and Saks search function.
- template<class ForwardIt , class T >
  bool linialsaks_search (ForwardIt first, ForwardIt last, const T &value)

  Linial and Saks search function.
- template<class ForwardIt , class T >
  bool MAHL_e (ForwardIt first, int i1, int j1, int k1, int im, int jn, int kp, const T &value)

  MAHL_e function.
- template<class ForwardIt , class T >
  bool MAHL_e (ForwardIt first, ForwardIt last, const T &value)

  MAHL_e function.

1.7.1 Function Documentation

1.7.1.1 binary_search()

```
template<class ForwardIt , class T >
bool binary_search (
             ForwardIt first,
             int i1,
             int j1,
             int in,
             int jn,
             const T & value )
```

Binary search function.

Parameters

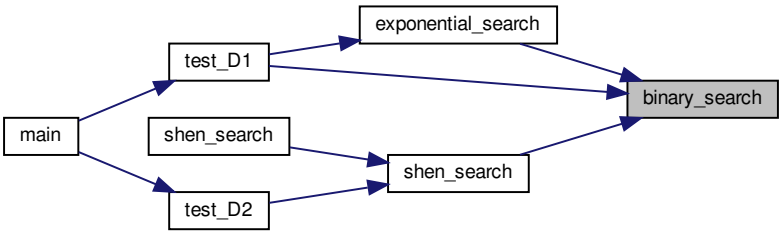
first	iterator to start of array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
value	is the search key.

Definition at line 221 of file SearchAlgorithms.hpp.

```
00221                                                                                                                {
00222     int lower, high;
00223     if((in-i1+1) < 4){
00224         for( int i = i1; i <= in ; i++){
00225             if(std::binary_search(first[i].begin(), first[i].end(), value)){
00226                 return true;
00227             }
00228         }
00229     }else{
00230         for( int i = j1; i <= jn; i++){
00231             lower = i1;
00232             high = in;
00233             while( lower <= high){
00234                 int mid = (lower+high)»1;
00235                 if( value == first[mid][i])
00236                     return true;
00237                 else if( value < first[mid][i])
00238                     high = mid-1;
00239                 else
00240                     lower = mid+1;
00241             }
00242         }
00243     }
00244     return false;
00245 }
```

Referenced by exponential_search(), shen_search(), and test_D1().

Here is the caller graph for this function:



1.7.1.2 binary_search_i()

```
template<class ForwardIt , class T >
int binary_search_i (
              ForwardIt first,
              int i1,
              int in,
              int j,
              int k,
              const T & value )
```

Binary search function in subvetor i.

Parameters

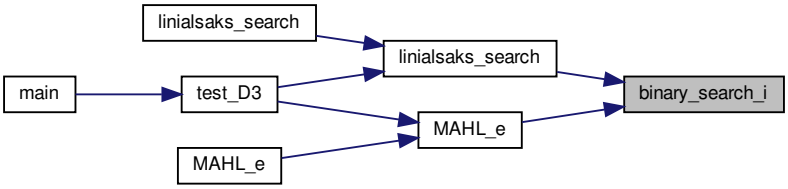
first	iterator to start of array.
i1	leftmost i position of the array.
in	rightmost i position of the array.
j	array j position.
k	array k position.
value	is the search key.

Definition at line 409 of file SearchAlgorithms.hpp.

```
00409                                                                                {
00410     int lo, hi;
00411     lo = i1;
00412     hi = in;
00413     while(lo <= hi){
00414         int mid = (lo+hi)»1;
00415         if( first[mid][j][k] < value)
00416             lo = mid+1;
00417         else if( first[mid][j][k] > value)
00418             hi = mid-1;
00419         else
00420             return mid;
00421     }
00422     return hi;
00423 }
```

Referenced by linialsaks_search(), and MAHL_e().

Here is the caller graph for this function:



1.7.1.3 binary_search_j()

```
template<class ForwardIt , class T >
int binary_search_j (
              ForwardIt first,
              int i,
              int j1,
              int jn,
              int k,
              const T & value )
```

Binary search function in subvetor j.

Parameters

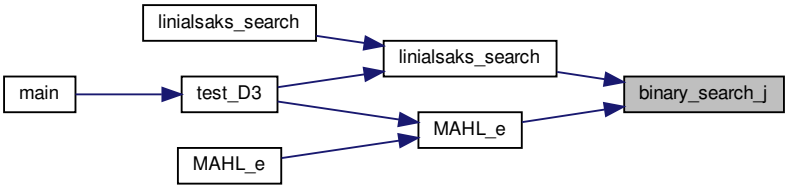
first	iterator to start of array.
i	array i position.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
k	array k position.
value	is the search key.

Definition at line 437 of file SearchAlgorithms.hpp.

```
00437                                                                                {
00438     int lo, hi;
00439     lo = j1;
00440     hi = jn;
00441     while(lo <= hi){
00442         int mid = (lo+hi)»1;
00443         if( first[i][mid][k] < value)
00444             lo = mid+1;
00445         else if( first[i][mid][k] > value)
00446             hi = mid-1;
00447         else
00448             return mid;
00449     }
00450     return hi;
00451 }
```

Referenced by linialsaks_search(), and MAHL_e().

Here is the caller graph for this function:



1.7.1.4 binary_search_k()

```
template<class ForwardIt , class T >
int binary_search_k (
             ForwardIt first,
             int i,
             int j,
             int k1,
             int kn,
             const T & value )
```

Binary search function in subvetor k.

Parameters

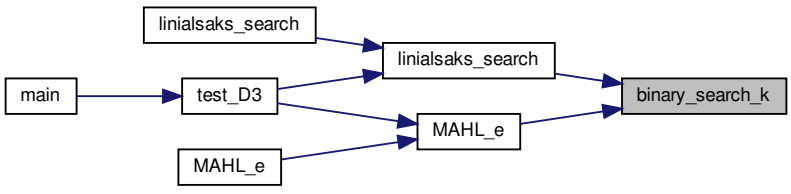
i	array i position.
j	array j position.
k1	leftmost k position of the array.
kn	rightmost k position of the array.
value	is the search key.

Definition at line 465 of file SearchAlgorithms.hpp.

```
00465                                                                    {
00466     int lo, hi;
00467     lo = k1;
00468     hi = kn;
00469     while(lo <= hi){
00470         int mid = (lo+hi)»1;
00471         if( first[i][j][mid] < value)
00472             lo = mid+1;
00473         else if( first[i][j][mid] > value)
00474             hi = mid-1;
00475         else
00476             return mid;
00477     }
00478     return hi;
00479 }
```

Referenced by linialsaks_search(), and MAHL_e().

Here is the caller graph for this function:



1.7.1.5 exponential_search()

```
template<class ForwardIt , class T >
bool exponential_search (
             ForwardIt first,
             ForwardIt last,
             const T & value )
```

Exponential search function.

Parameters

first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

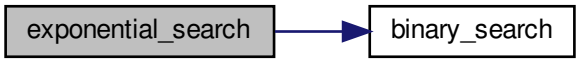
Definition at line 115 of file SearchAlgorithms.hpp.

```
00115                                                                    {
00116     int n;
00117     n = last - first;
00118     if(first[0] == value)
00119         return true;
00120     int i = 1;
00121     while(i < n && value > first[i]){
00122         i *= 2;
00123     }
00124     return std::binary_search( first+(i/2+1), first + ((i < n)? i+1 : n), value);
00125 }
```

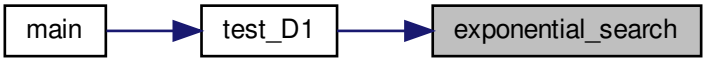
References binary_search().

Referenced by test_D1().

Here is the call graph for this function:



Here is the caller graph for this function:



1.7.1.6 fibonaccian_search()

```
template<class ForwardIt , class T >
bool fibonaccian_search (
             ForwardIt first,
             ForwardIt last,
             const T & value )
```

Fibonacci search function.

Parameters

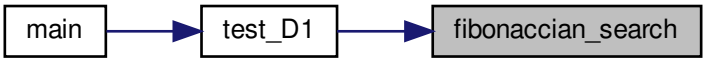
first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 135 of file SearchAlgorithms.hpp.

```
00135                                                                    {
00136     int f, f1, f2, n, offset, p;
00137     n = last - first;
00138     f2 = 0;
00139     f1 = 1;
00140     f = f1 + f2;
00141     while(f < n){
00142         f2 = f1;
00143         f1 = f;
00144         f = f1 + f2;
00145     }
00146     offset = -1;
00147     while(f > 1){
00148         p =  (offset + f2) < n-1? offset+f2 : n-1;
00149         if(value > first[p]){
00150             f = f1;
00151             f1 = f2;
00152             f2 = f - f1;
00153             offset = p;
00154         }else if(value < first[p]){
00155             f = f2;
00156             f1 -= f2;
00157             f2 = f - f1;
00158         }else{
00159             return true;
00160         }
00161     }
00162
00163     if(f > 0 && first[offset+1] == value){
00164         return true;
00165     }
00166     return false;
00167 }
```

Referenced by test_D1().

Here is the caller graph for this function:



1.7.1.7 interpolation_search()

```
template<class ForwardIt , class T >
bool interpolation_search (
              ForwardIt first,
              ForwardIt last,
              const T & value )
```

Interpolation search function.

Parameters

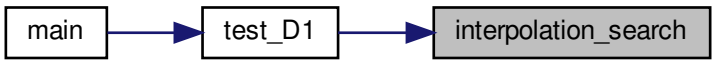
first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 88 of file SearchAlgorithms.hpp.

```
00088                                                                                {
00089     int i, n, j;
00090     i = 0;
00091     n = last - first;
00092     j = n-1;
00093     while(i <= j && first[i] != first[j] && value >= first[i] && value <= first[j]){
00094         int p = i + (((double)(j-i) / (first[j]-first[i]))*(value - first[i]));
00095         if( value == first[p]){
00096             return true;
00097         }
00098         else if(value < first[p])
00099             j = p-1;
00100         else
00101             i = p+1;
00102     }
00103     if(i < n-1 && value == first[i])
00104         return true;
00105     return false;
00106 }
```

Referenced by test_D1().

Here is the caller graph for this function:



1.7.1.8 jump_search()

```
template<class ForwardIt , class T >
bool jump_search (
              ForwardIt first,
              ForwardIt last,
              const T & value )
```

Linear search function.

Parameters

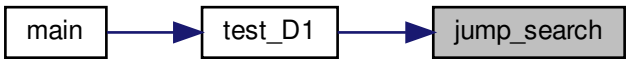
first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 54 of file SearchAlgorithms.hpp.

```
00054                                                                   {
00055     int i, n, step, j;
00056     i = 0;
00057     n = last - first;
00058     step = std::sqrt(n);
00059     j = step;
00060     while(j < n){
00061         if( value == first[j]){
00062             return true;
00063         }
00064         else if(value > first[j]){
00065             i = j;
00066             j += step;
00067         }else
00068             break;
00069     }
00070     j = j<n? j : n-1;
00071     while( i <= j){
00072         if(value == first[i])
00073             return true;
00074         else
00075             ++i;
00076     }
00077     return false;
00078 }
```

Referenced by test_D1().

Here is the caller graph for this function:



1.7.1.9 linear_search()

```
template<class ForwardIt , class T >
bool linear_search (
             ForwardIt first,
             ForwardIt last,
             const T & value )
```

One-dimensional search functions.

Function.

Parameters

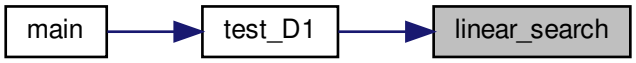
first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 39 of file SearchAlgorithms.hpp.

```
00039                                                                    {
00040     for( ; first != last; ++first){
00041         if( *first == value)
00042             return true;
00043     }
00044     return false;
00045 }
```

Referenced by test_D1().

Here is the caller graph for this function:



1.7.1.10 linialsaks_search() [1/2]

```
template<class ForwardIt , class T >
bool linialsaks_search (
             ForwardIt first,
             ForwardIt last,
             const T & value )
```

Linial and Saks search function.

Parameters

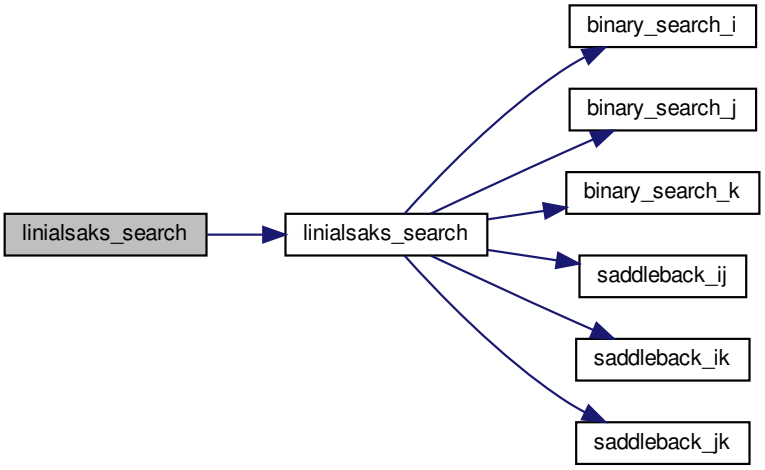
first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 582 of file SearchAlgorithms.hpp.

```
00582                                                                                {
00583     int in, jn, kn;
00584     in = (last - first) -1;
00585     jn = first[0].size() - 1;
00586     kn = first[0][0].size() - 1;
00587     return linialsaks_search(first, 0, 0, 0, in, jn, kn, value);
00588 }
```

References linialsaks_search().

Here is the call graph for this function:



1.7.1.11 linialsaks_search() [2/2]

```
template<class ForwardIt , class T >
bool linialsaks_search (
             ForwardIt first,
             int i1,
             int j1,
             int k1,
             int in,
             int jn,
             int kn,
             const T & value )
```

Linial and Saks search function.

Parameters

first	iterator to start of array.
i1	leftmost i position of the array.
in	rightmost i position of the array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
k1	leftmost k position of the array.
kn	rightmost k position of the array.
value	is the search key.

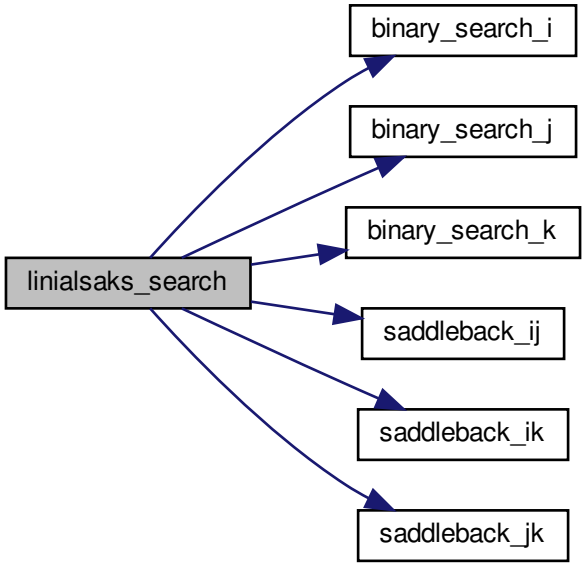
Definition at line 494 of file SearchAlgorithms.hpp.

```
00494
      {
00495     if(i1 > in || j1 > jn || k1 > kn)
00496         return false;
00497     if(i1 == in ||j1 == jn || k1 == kn){
00498         if(i1 == in && j1 == jn && k1 == kn){
00499                 if(value == first[i1][j1][k1])
00500                 return true;
00501                 else
00502                 return false;
00503         }
00504         else{
00505                 if(i1 == in){
00506                         return saddleback_jk(first, i1, j1, jn, k1, kn, value);
00507                 }
00508                 else if(j1 == jn){
00509                         return saddleback_ik(first, i1, in, j1, k1, kn, value);
00510                 }
00511                 else
00512                         return saddleback_ij(first, i1, in, j1, jn, k1, value);
00513         }
00514     }
00515
00516     int u1, u2, w1, w2, v1, v2;
00517
00518     /* Binary search in subarray u1. Variable u1 is the position returned in binary search. */
00519     u1 = binary_search_k(first, i1, jn, k1, kn, value);
00520     if(u1>= 0 && first[i1][jn][u1] == value)
00521         return true;
00522     /* Binary search in subarray w1. Variable w1 is the position returned in binary search.*/
00523     w1 = binary_search_i(first, i1, in, j1, kn, value);
00524     if(w1 >= 0 && first[w1][j1][kn] == value)
00525         return true;
00526
00527     /* Binary search in subarray u2. Variable u2 is the position returned in binary search.*/
00528     u2 = binary_search_k(first, in, j1, k1, kn, value);
00529     if(u2 >= 0 && first[in][j1][u2] == value)
00530         return true;
00531
00532     /* Binary search in subarray w2. Variable w2 is the position returned in binary search.*/
00533     w2 = binary_search_i(first, i1, in, jn, k1, value);
00534     if(w2 >= 0 && first[w2][jn][k1] == value)
00535         return true;
00536
00537     /* Binary search in subarray v1. Variable v1 is the position returned in binary search.*/
00538     v1 = binary_search_j(first, in, j1, jn, k1, value);
00539     if(v1 >= 0 && first[in][v1][k1] == value)
00540         return true;
00541
00542     /* Binary search in subarray v2. Variable v2 is the position returned in binary search.*/
00543     v2 = binary_search_j(first, i1, j1, jn, kn, value);
00544     if(v2 >= 0 && first[i1][v2][kn] == value)
00545         return true;
00546
00547     /* saddleback v2 u1...   (i1, v2+1, u1+1) to (i1, jn, kn)  */
00548     if(v2+1 <= jn && u1+1 <= kn && saddleback_jk(first, i1, v2+1, jn, u1+1, kn, value) == true)
00549         return true;
00550
00551     /* saddleback w2 v1...   (w2+1, v1+1, k1) to (in, jn, k1) */
00552     if(w2+1 <= in && v1+1<= jn && saddleback_ij(first, w2+1, in, v1+1, jn, k1, value)==true)
00553         return true;
00554
00555     /* saddleback u1 w2...   (i1, jn, k1) to (w2, jn, u1) */
00556     if(w2 >= 0 && u1 >= 0 && saddleback_ik(first, i1, w2, jn, k1, u1, value)==true)
00557         return true;
00558
00559     /* saddleback u2 w1 ...  (w1+1, j1, u2+1) to (in, j1, kn)*/
00560     if(w1+1 <= in && u2+1 <= kn && saddleback_ik(first, w1+1, in, j1, u2+1, kn, value)==true)
00561         return true;
00562
00563     /* saddleback u2 v1...   (in, j1, k1) to (in, v1, u2)*/
00564     if(v1 >= 0 && u2 >= 0 && saddleback_jk(first, in, j1, v1, k1, u2, value) == true)
00565         return true;
00566
00567     /* saddleback w1 v2...   (i1, j1, kn) to (w1, v2, kn)*/
00568     if(w1 >= 0 && v2 >= 0 && saddleback_ij(first, i1, w1, j1, v2, kn, value) == true)
00569         return true;
00570
00571     return linialsaks_search(first, i1+1, j1+1, k1+1, in-1, jn-1, kn-1, value);
00572 }
```

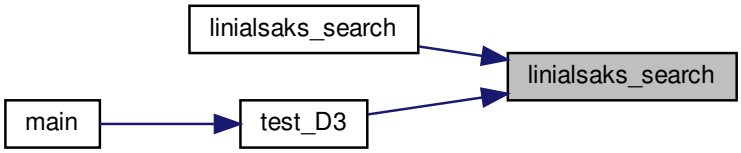
References binary_search_i(), binary_search_j(), binary_search_k(), saddleback_ij(), saddleback_ik(), and saddleback_jk().

Referenced by linialsaks_search(), and test_D3().

Here is the call graph for this function:



Here is the caller graph for this function:



1.7.1.12 MAHL_e() [1/2]

```
template<class ForwardIt , class T >
bool MAHL_e (
             ForwardIt first,
             ForwardIt last,
             const T & value )
```

MAHL_e function.

Parameters

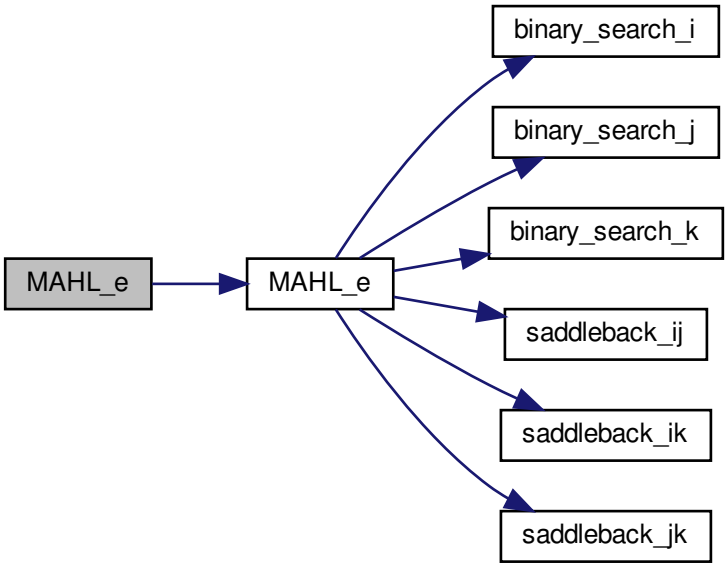
first	iterator to start of array.
last	iterator to end of array.
i1	leftmost i position of the array.
in	rightmost i position of the array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
k1	leftmost k position of the array.
kn	rightmost k position of the array.
value	is the search key.

Definition at line 698 of file SearchAlgorithms.hpp.

```
00698                                                                    {
00699     int im, jn, kp;
00700     im = (last - first) - 1;
00701     jn = first[0].size() - 1;
00702     kp = first[0][0].size() - 1;
00703     return MAHL_e(first, 0, 0, 0, im, jn, kp, value);
00704 }
```

References MAHL_e().

Here is the call graph for this function:



1.7.1.13 MAHL_e() [2/2]

```
template<class ForwardIt , class T >
bool MAHL_e (
             ForwardIt first,
             int i1,
             int j1,
             int k1,
             int im,
             int jn,
             int kp,
             const T & value )
```

MAHL_e function.

Parameters

first	iterator to start of array.
i1	leftmost i position of the array.
in	rightmost i position of the array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
k1	leftmost k position of the array.
kn	rightmost k position of the array.
value	is the search key.

Definition at line 618 of file SearchAlgorithms.hpp.

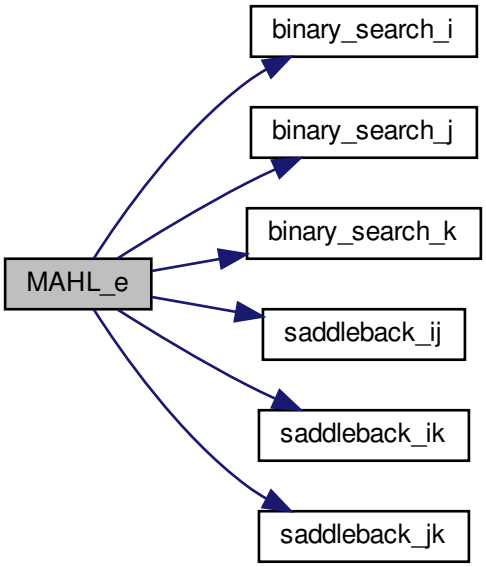
```
00618                                                                                                {
00619     if(i1 > im || j1 > jn || k1 > kp)
00620         return false;
00621     int diff_i = im - i1 + 1;
00622     int diff_j = jn - j1 + 1;
00623     int diff_k = kp - k1 + 1;
00624     /*If dimension i is less than 3 and smaller than dimensions j and k, apply the saddleback
      algorithm to it. */
00625     if(diff_i <= 3 && diff_i <= diff_j && diff_i <= diff_k){
00626         for( int i = i1; i <= im; ++i)
00627             if(saddleback_jk(first, i, j1, jn, k1, kp, value))
00628                 return true;
00629             return false;
00630     }
00631     /*If dimension j is less than 3 and smaller than dimensions i and k, apply the saddleback
      algorithm to it.*/
00632     if(diff_j <= 3 && diff_j <= diff_i && diff_j <= diff_k){
00633         for( int j = j1; j <= jn; ++j)
00634             if(saddleback_ik(first, i1, im, j, k1, kp, value))
00635                 return true;
00636             return false;
00637     }
00638     /*If dimension k is less than 3 and smaller than dimensions i and j, apply the saddleback
      algorithm to it.*/
00639     if(diff_k <= 3 && diff_k <= diff_i && diff_k <= diff_j){
00640         for( int k = k1; k <= kp; ++k)
00641             if(saddleback_ij(first, i1, im, j1, jn, k, value))
00642                 return true;
00643             return false;
00644     }
00645
00646     /*If dimension i is larger, apply the algorithm to it.*/
00647     if(diff_i >= diff_j && diff_i >= diff_k){
00648         int mid_j = (j1 + jn) >> 1; /* floor of N/2 */
00649         int mid_k = (k1 + kp) >> 1; /*  floor of P/2 */
00650
00651         int index_i = binary_search_i(first, i1, im, mid_j, mid_k, value);
00652         if( index_i >= 0 && first[index_i][mid_j][mid_k] == value)
00653             return true;
00654
00655         return MAHL_e(first, index_i+1, j1, k1, im, mid_j, kp, value) ||
00656         MAHL_e(first, i1, j1, mid_k, index_i, jn, kp, value) ||
```

```
00657         MAHL_e(first, i1, mid_j+1, k1, im, jn, mid_k-1, value);
00658     }
00659     /*If dimension j is larger, apply the algorithm to it.*/
00660     else if(diff_j >= diff_i && diff_j >= diff_k){
00661         int mid_i = (i1 + im) » 1; /* floor of M/2 */
00662         int mid_k = (k1 + kp) » 1; /*  floor of P/2 */
00663 
00664         int index_j = binary_search_j(first, mid_i, j1, jn, mid_k, value);
00665         if(index_j >= 0 && first[mid_i][index_j][mid_k] == value)
00666             return true;
00667         return MAHL_e(first, mid_i, j1, k1, im, index_j, kp, value) ||
00668         MAHL_e(first, i1, j1, mid_k, mid_i-1, jn, kp, value) ||
00669         MAHL_e(first, i1, index_j+1, k1, im, jn, mid_k-1, value);
00670     }
00671     /*If dimension k is larger, apply the algorithm to it.*/
00672     else{
00673         int mid_i = (i1 + im) » 1; /* floor of M/2 */
00674         int mid_j = (j1 + jn) » 1; /* foor of N/2 */
00675 
00676         int index_k = binary_search_k(first, mid_i, mid_j, k1, kp, value);
00677         if(index_k >= 0 && first[mid_i][mid_j][index_k] == value)
00678             return true;
00679         return MAHL_e(first, mid_i, j1, k1, im, mid_j, kp, value) ||
00680         MAHL_e(first, i1, j1, index_k+1, mid_i-1, jn, kp, value) ||
00681         MAHL_e(first, i1, mid_j+1, k1, im, jn, index_k, value);
00682     }
00683 }
```

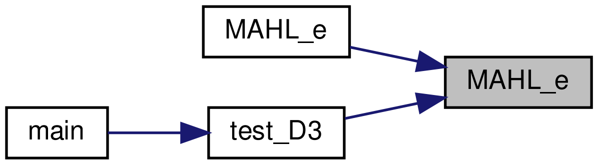
References binary_search_i(), binary_search_j(), binary_search_k(), saddleback_ij(), saddleback_ik(), and saddleback_jk().

Referenced by MAHL_e(), and test_D3().

Here is the call graph for this function:



Here is the caller graph for this function:



1.7.1.14 saddleback_ij()

```
template<class ForwardIt , class T >
bool saddleback_ij (
             ForwardIt first,
             int i1,
             int in,
             int j1,
             int jn,
             int k,
             const T & value )
```

Saddleback search function for array ij face.

Parameters

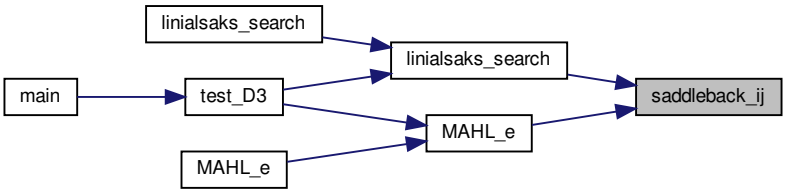
first	iterator to start of array.
i1	leftmost i position of the array.
in	rightmost i position of the array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
k	array k postition.
value	is the search key.

Definition at line 330 of file SearchAlgorithms.hpp.

```
00330                                                                                        {
00331     int x, y;
00332     x = i1;
00333     y = jn;
00334     while(x <= in && y >= j1){
00335         if(first[x][y][k] == value)
00336             return true;
00337         if(first[x][y][k] > value)
00338             y--;
00339         else
00340             x++;
00341     }
00342     return false;
00343 }
```

Referenced by linialsaks_search(), and MAHL_e().

Here is the caller graph for this function:



1.7.1.15 saddleback_ik()

```
template<class ForwardIt , class T >
bool saddleback_ik (
             ForwardIt first,
             int i1,
             int in,
             int j,
             int k1,
             int kn,
             const T & value )
```

Saddleback search function for array ik face.

Parameters

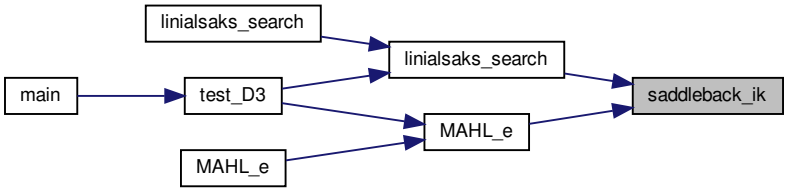
first	iterator to start of array.
i1	leftmost i position of the array.
in	rightmost i position of the array.
j	array j postition.
k1	leftmost k position of the array.
kn	rightmost k position of the array.
value	is the search key.

Definition at line 357 of file SearchAlgorithms.hpp.

```
00357                                                                                                {
00358     int x, z;
00359     x = in;
00360     z = k1;
00361     while( x >= i1 && z <= kn){
00362         if(first[x][j][z] == value)
00363             return true;
00364         if(first[x][j][z] > value)
00365             x--;
00366         else
00367             z++;
00368     }
00369     return false;
00370 }
```

Referenced by linialsaks_search(), and MAHL_e().

Here is the caller graph for this function:



1.7.1.16 saddleback_jk()

```
template<class ForwardIt , class T >
bool saddleback_jk (
            ForwardIt first,
            int i,
            int j1,
            int jn,
            int k1,
            int k2,
            const T & value )
```

Saddleback search function for array ik face.

Parameters

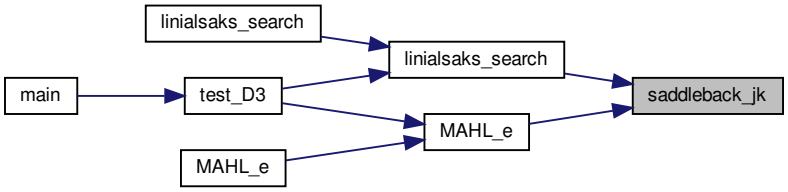
first	iterator to start of array.
i	array i position.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
k1	leftmost k position of the array.
k2	rightmost k position of the array.
value	is the search key.

Definition at line 383 of file SearchAlgorithms.hpp.

```
00383                                                                                                {
00384     int y, z;
00385     y = jn;
00386     z = k1;
00387     while(y >= j1 && z <= k2){
00388         if(first[i][y][z] == value)
00389             return true;
00390         if(first[i][y][z] > value)
00391             y--;
00392         else
00393             z++;
00394     }
00395     return false;
00396 }
```

Referenced by linialsaks_search(), and MAHL_e().

Here is the caller graph for this function:



1.7.1.17 saddleback_search() [1/2]

```
template<class ForwardIt , class T >
bool saddleback_search (
            ForwardIt first,
            ForwardIt last,
            const T & value )
```

Saddleback search function.

Parameters

first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 207 of file SearchAlgorithms.hpp.

```
00207                                                                    {
00208     int jn = first[0].size()-1;
00209     int in = last - first - 1;
00210     return saddleback_search(first, 0, 0, in, jn, value);
00211 }
```

References saddleback_search().

Here is the call graph for this function:

1.7.1.18 saddleback_search() [2/2]

```
template<class ForwardIt , class T >
bool saddleback_search (
             ForwardIt first,
             int i1,
             int j1,
             int in,
             int jn,
             const T & value )
```

Two-dimensional search functions.

Saddleback search function.

Parameters

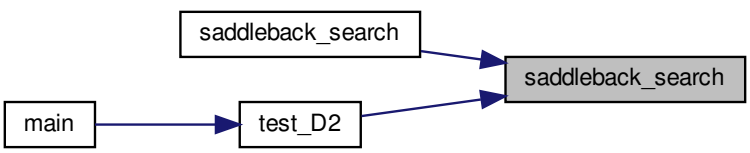
first	iterator to start of array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
value	is the search key.

Definition at line 183 of file SearchAlgorithms.hpp.

```
00183                                                                    {
00184     int  i, j;
00185     i = i1;
00186     j = jn;
00187     while( i <= in && j >= j1){
00188         if( first[i][j] == value){
00189             return true;
00190         }
00191         if( first[i][j] > value)
00192             j--;
00193         else
00194             i++;
00195     }
00196     return false;
00197 }
```

Referenced by saddleback_search(), and test_D2().

Here is the caller graph for this function:



1.7.1.19 shen_search() [1/2]

```
template<class ForwardIt , class T >
bool shen_search (
              ForwardIt first,
              ForwardIt last,
              const T & value )
```

Shen search function.

Parameters

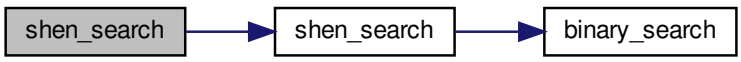
first	iterator to start of array.
last	iterator to end of array.
value	is the search key.

Definition at line 288 of file SearchAlgorithms.hpp.

```
00288                                                                    {
00289         int j = (int)first[0].size()-1;
00290         int in = last - first - 1;
00291     return shen_search(first, 0, 0, in, j, value);
00292 }
```

References shen_search().

Here is the call graph for this function:



1.7.1.20 shen_search() [2/2]

```
template<class ForwardIt , class T >
bool shen_search (
              ForwardIt first,
              int i1,
              int j1,
              int in,
              int jn,
              const T & value )
```

Shen search function.

Parameters

first	iterator to start of array.
j1	leftmost j position of the array.
jn	rightmost j position of the array.
value	is the search key.

Definition at line 255 of file SearchAlgorithms.hpp.

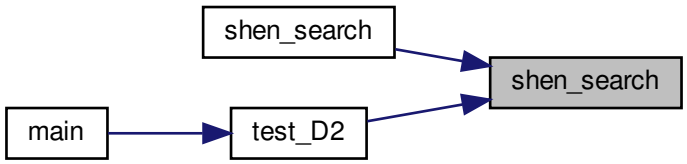
```
00255                                                                                                {
00256     if((in - i1+1) < 4 || (jn-j1+1) < 4){
00257         return binary_search(first, i1,j1, in, jn, value);
00258     }
00259     int i = (i1+in)»1;
00260     if(value == first[i][j1])
00261         return true;
00262     else{
00263         if( value < first[i][j1])
00264                 return shen_search(first, i1, j1, i-1, jn, value);
00265         else{
00266                 if( value > first[i][jn])
00267                     return shen_search(first, i+1, j1, in, jn, value);
00268                 else{
00269                     int j;
00270                     j = lower_bound(first[i].begin() + j1, first[i].begin()+jn+1, value) -
       first[i].begin();
00271                     if( first[i][j] != value)
00272                         return shen_search(first, i+1, j1, in, j, value) || shen_search(first, i1,
       j+1,  i-1, jn, value);
00273                     else
00274                         return true;
00275                 }
00276             }
00277     }
00278 }
```

References binary_search().

Referenced by shen_search(), and test_D2().

Here is the call graph for this function:

Here is the caller graph for this function:



1.8 SearchAlgorithms.hpp

```
00001
00005 /*
00006  *  SearchAlgorithms.h
00007  *
```

```
00008  *  Created by Walisson Pereira de Jesus on 05/12/19.
00009  *  Instituto de Informatica - UFG
00010  *
00011  */
00012
00023 #ifndef SearchAlgorithms_hpp
00024 #define SearchAlgorithms_hpp
00025
00026 #include <algorithm>
00027 #include <vector>
00028 #include <math.h>
00029
00031
00038 template<class ForwardIt, class T>
00039 bool linear_search(ForwardIt first, ForwardIt last, const T& value){
00040     for( ; first != last; ++first){
00041         if( *first == value)
00042             return true;
00043     }
00044     return false;
00045 }
00046
00053 template<class ForwardIt, class T>
00054 bool jump_search(ForwardIt first, ForwardIt last, const T& value){
00055     int i, n, step, j;
00056     i = 0;
00057     n = last - first;
00058     step = std::sqrt(n);
00059     j = step;
00060     while(j < n){
00061         if( value == first[j]){
00062             return true;
00063         }
00064         else if(value > first[j]){
00065             i = j;
00066             j += step;
00067         }else
00068             break;
00069     }
00070     j = j<n? j : n-1;
00071     while( i <= j){
00072         if(value == first[i])
00073             return true;
00074         else
00075             ++i;
00076     }
00077     return false;
00078 }
00079
00080
00087 template<class ForwardIt, class T>
00088 bool interpolation_search(ForwardIt first, ForwardIt last, const T& value){
00089     int i, n, j;
00090     i = 0;
00091     n = last - first;
00092     j = n-1;
00093     while(i <= j && first[i] != first[j] && value >= first[i] && value <= first[j]){
00094         int p = i + (((double)(j-i) / (first[j]-first[i]))*(value - first[i]));
00095         if( value == first[p]){
00096             return true;
00097         }
00098         else if(value < first[p])
00099             j = p-1;
00100         else
00101             i = p+1;
00102     }
00103     if(i < n-1 && value == first[i])
00104         return true;
00105     return false;
00106 }
00107
00114 template<class ForwardIt, class T>
00115 bool exponential_search(ForwardIt first, ForwardIt last, const T& value){
00116     int n;
00117     n = last - first;
00118     if(first[0] == value)
00119         return true;
00120     int i = 1;
00121     while(i < n && value > first[i]){
00122         i *= 2;
00123     }
00124     return std::binary_search( first+(i/2+1), first + ((i < n)? i+1 : n), value);
00125 }
00126
00127
00134 template<class ForwardIt, class T>
00135 bool fibonaccian_search(ForwardIt first, ForwardIt last, const T& value){
```

```
00136     int f, f1, f2, n, offset, p;
00137     n = last - first;
00138     f2 = 0;
00139     f1 = 1;
00140     f = f1 + f2;
00141     while(f < n){
00142         f2 = f1;
00143         f1 = f;
00144         f = f1 + f2;
00145     }
00146     offset = -1;
00147     while(f > 1){
00148         p =  (offset + f2) < n-1? offset+f2 : n-1;
00149         if(value > first[p]){
00150             f = f1;
00151             f1 = f2;
00152             f2 = f - f1;
00153             offset = p;
00154         }else if(value < first[p]){
00155             f = f2;
00156             f1 -= f2;
00157             f2 = f - f1;
00158         }else{
00159             return true;
00160         }
00161     }
00162 
00163     if(f > 0 && first[offset+1] == value){
00164         return true;
00165     }
00166     return false;
00167 }
00168 
00169 
00171 
00172 
00173 
00174 
00182 template<class ForwardIt, class T>
00183 bool saddleback_search(ForwardIt first, int i1, int j1, int in, int jn, const T& value){
00184     int  i, j;
00185     i = i1;
00186     j = jn;
00187     while( i <= in && j >= j1){
00188         if( first[i][j] == value){
00189             return true;
00190         }
00191         if( first[i][j] > value)
00192             j--;
00193         else
00194             i++;
00195     }
00196     return false;
00197 }
00198 
00199 
00206 template<class ForwardIt, class T>
00207 bool saddleback_search(ForwardIt first, ForwardIt last,  const T& value){
00208    int jn = first[0].size()-1;
00209    int in = last - first - 1;
00210    return saddleback_search(first, 0, 0, in, jn, value);
00211 }
00212 
00220 template<class ForwardIt, class T>
00221 bool binary_search(ForwardIt first, int i1, int j1, int in, int jn, const T& value){
00222     int lower, high;
00223     if((in-i1+1) < 4){
00224         for( int i = i1; i <= in ; i++){
00225             if(std::binary_search(first[i].begin(), first[i].end(), value)){
00226                 return true;
00227             }
00228         }
00229     }else{
00230         for( int i = j1; i <= jn; i++){
00231             lower = i1;
00232             high = in;
00233             while( lower <= high){
00234                 int mid = (lower+high)»1;
00235                 if( value == first[mid][i])
00236                     return true;
00237                 else if( value < first[mid][i])
00238                     high = mid-1;
00239                 else
00240                     lower = mid+1;
00241             }
00242         }
00243     }
```

```
00244     return false;
00245 }
00246
00254 template<class ForwardIt, class T>
00255 bool shen_search(ForwardIt first, int i1,int j1, int in, int jn, const T& value){
00256     if((in - i1+1) < 4 || (jn-j1+1) < 4){
00257         return binary_search(first, i1,j1, in, jn, value);
00258     }
00259     int i = (i1+in)»1;
00260     if(value == first[i][j1])
00261         return true;
00262     else{
00263         if( value < first[i][j1])
00264                 return shen_search(first, i1, j1, i-1, jn, value);
00265         else{
00266                 if( value > first[i][jn])
00267                     return shen_search(first, i+1, j1, in, jn, value);
00268                 else{
00269                     int j;
00270                     j = lower_bound(first[i].begin() + j1, first[i].begin()+jn+1, value) -
      first[i].begin();
00271                     if( first[i][j] != value)
00272                         return shen_search(first, i+1, j1, in, j, value) || shen_search(first, i1,
      j+1,  i-1, jn, value);
00273                     else
00274                         return true;
00275                 }
00276             }
00277     }
00278 }
00279
00280
00287 template<class ForwardIt, class T>
00288 bool shen_search(ForwardIt first, ForwardIt last, const T& value){
00289         int j = (int)first[0].size()-1;
00290         int in = last - first - 1;
00291     return shen_search(first, 0, 0, in, j, value);
00292 }
00293
00294
00295 /* Three-dimensional search functions */
00296
00297 /*
00298                         ___v*2___
00299                           /|      /|
00300                          / w1    u1 |
00301 (0,0,0)    /__|_____/__|
00302                    |  /     |  / (n, n, n)
00303                    | u2    w2 /
00304                    |/__v1___|/
00305
00306  vector u1 = (i1 j2, )
00307  binary search in u1, w1, u2, w2, v1 end v2.
00308  saddleback face in the 6 faces:
00309  u1 and v2
00310  v1 and w2
00311  u1 and w2
00312  w1 and u2
00313  v1 and u2
00314  w1 and v2
00315  */
00316
00317
00318
00329 template<class ForwardIt, class T>
00330 bool saddleback_ij(ForwardIt first, int i1, int in, int j1, int jn, int k, const T& value){
00331     int x, y;
00332     x = i1;
00333     y = jn;
00334     while(x <= in && y >= j1){
00335         if(first[x][y][k] == value)
00336             return true;
00337         if(first[x][y][k] > value)
00338             y--;
00339         else
00340             x++;
00341     }
00342     return false;
00343 }
00344
00345
00356 template<class ForwardIt, class T>
00357 bool saddleback_ik(ForwardIt first, int i1, int in, int j, int k1, int kn, const T& value){
00358     int x, z;
00359     x = in;
00360     z = k1;
00361     while( x >= i1 && z <= kn){
```

```
00362         if(first[x][j][z] == value)
00363             return true;
00364         if(first[x][j][z] > value)
00365             x--;
00366         else
00367             z++;
00368     }
00369     return false;
00370 }
00371
00382 template<class ForwardIt, class T>
00383 bool saddleback_jk( ForwardIt first,  int i, int j1, int jn, int k1, int k2, const T& value){
00384     int y, z;
00385     y = jn;
00386     z = k1;
00387     while(y >= j1 && z <= k2){
00388         if(first[i][y][z] == value)
00389             return true;
00390         if(first[i][y][z] > value)
00391             y--;
00392         else
00393             z++;
00394     }
00395     return false;
00396 }
00397
00398
00408 template<class ForwardIt, class T>
00409 int binary_search_i(ForwardIt first, int i1, int in, int j, int k, const T& value){
00410     int lo, hi;
00411     lo = i1;
00412     hi = in;
00413     while(lo <= hi){
00414         int mid = (lo+hi)»1;
00415         if( first[mid][j][k] < value)
00416             lo = mid+1;
00417         else if( first[mid][j][k] > value)
00418             hi = mid-1;
00419         else
00420             return mid;
00421     }
00422     return hi;
00423 }
00424
00425
00426
00436 template<class ForwardIt, class T>
00437 int binary_search_j(ForwardIt first, int i, int j1, int jn, int k, const T& value){
00438     int lo, hi;
00439     lo = j1;
00440     hi = jn;
00441     while(lo <= hi){
00442         int mid = (lo+hi)»1;
00443         if( first[i][mid][k] < value)
00444             lo = mid+1;
00445         else if( first[i][mid][k] > value)
00446             hi = mid-1;
00447         else
00448             return mid;
00449     }
00450     return hi;
00451 }
00452
00453
00454
00464 template<class ForwardIt, class T>
00465 int binary_search_k(ForwardIt first, int i, int j, int k1, int kn, const T& value){
00466     int lo, hi;
00467     lo = k1;
00468     hi = kn;
00469     while(lo <= hi){
00470         int mid = (lo+hi)»1;
00471         if( first[i][j][mid] < value)
00472             lo = mid+1;
00473         else if( first[i][j][mid] > value)
00474             hi = mid-1;
00475         else
00476             return mid;
00477     }
00478     return hi;
00479 }
00480
00493 template<class ForwardIt, class T>
00494 bool linialsaks_search(ForwardIt first, int i1, int j1, int k1, int in, int jn, int kn, const T&
       value){
00495     if(i1 > in || j1 > jn || k1 > kn)
00496         return false;
```

```
00497     if(i1 == in ||j1 == jn || k1 == kn){
00498         if(i1 == in && j1 == jn && k1 == kn){
00499                 if(value == first[i1][j1][k1])
00500                 return true;
00501                 else
00502                 return false;
00503         }
00504         else{
00505                 if(i1 == in){
00506                         return saddleback_jk(first, i1, j1, jn, k1, kn, value);
00507                 }
00508                 else if(j1 == jn){
00509                         return saddleback_ik(first, i1, in, j1, k1, kn, value);
00510                 }
00511                 else
00512                         return saddleback_ij(first, i1, in, j1, jn, k1, value);
00513         }
00514     }
00515
00516     int u1, u2, w1, w2, v1, v2;
00517
00518     /* Binary search in subarray u1. Variable u1 is the position returned in binary search. */
00519     u1 = binary_search_k(first, i1, jn, k1, kn, value);
00520     if(u1>= 0 && first[i1][jn][u1] == value)
00521         return true;
00522     /* Binary search in subarray w1. Variable w1 is the position returned in binary search.*/
00523     w1 = binary_search_i(first, i1, in, j1, kn, value);
00524     if(w1 >= 0 && first[w1][j1][kn] == value)
00525         return true;
00526
00527     /* Binary search in subarray u2. Variable u2 is the position returned in binary search.*/
00528     u2 = binary_search_k(first, in, j1, k1, kn, value);
00529     if(u2 >= 0 && first[in][j1][u2] == value)
00530         return true;
00531
00532     /* Binary search in subarray w2. Variable w2 is the position returned in binary search.*/
00533     w2 = binary_search_i(first, i1, in, jn, k1, value);
00534     if(w2 >= 0 && first[w2][jn][k1] == value)
00535         return true;
00536
00537     /* Binary search in subarray v1. Variable v1 is the position returned in binary search.*/
00538     v1 = binary_search_j(first, in, j1, jn, k1, value);
00539     if(v1 >= 0 && first[in][v1][k1] == value)
00540         return true;
00541
00542     /* Binary search in subarray v2. Variable v2 is the position returned in binary search.*/
00543     v2 = binary_search_j(first, i1, j1, jn, kn, value);
00544     if(v2 >= 0 && first[i1][v2][kn] == value)
00545         return true;
00546
00547     /* saddleback v2 u1...   (i1, v2+1, u1+1) to (i1, jn, kn)  */
00548     if(v2+1 <= jn && u1+1 <= kn && saddleback_jk(first, i1, v2+1, jn, u1+1, kn, value) == true)
00549         return true;
00550
00551     /* saddleback w2 v1...   (w2+1, v1+1, k1) to (in, jn, k1) */
00552     if(w2+1 <= in && v1+1<= jn && saddleback_ij(first, w2+1, in, v1+1, jn, k1, value)==true)
00553         return true;
00554
00555     /* saddleback u1 w2...   (i1, jn, k1) to (w2, jn, u1) */
00556     if(w2 >= 0 && u1 >= 0 && saddleback_ik(first, i1, w2, jn, k1, u1, value)==true)
00557         return true;
00558
00559     /* saddleback u2 w1 ...  (w1+1, j1, u2+1) to (in, j1, kn)*/
00560     if(w1+1 <= in && u2+1 <= kn && saddleback_ik(first, w1+1, in, j1, u2+1, kn, value)==true)
00561         return true;
00562
00563     /* saddleback u2 v1...   (in, j1, k1) to (in, v1, u2)*/
00564     if(v1 >= 0 && u2 >= 0 && saddleback_jk(first, in, j1, v1, k1, u2, value) == true)
00565         return true;
00566
00567     /* saddleback w1 v2...   (i1, j1, kn) to (w1, v2, kn)*/
00568     if(w1 >= 0 && v2 >= 0 && saddleback_ij(first, i1, w1, j1, v2, kn, value) == true)
00569         return true;
00570
00571     return linialsaks_search(first, i1+1, j1+1, k1+1, in-1, jn-1, kn-1, value);
00572 }
00573
00574
00581 template<class ForwardIt, class T>
00582 bool linialsaks_search(ForwardIt first, ForwardIt last, const T& value){
00583     int in, jn, kn;
00584     in = (last - first) -1;
00585     jn = first[0].size() - 1;
00586     kn = first[0][0].size() - 1;
00587     return linialsaks_search(first, 0, 0, 0, in, jn, kn, value);
00588 }
00589
```

```
00590
00591 /*
00592  *
00593  ( N,*0,P)                 _________________
00594                        /|                  /|   (M, N, P)
00595                       / |                 / |
00596  (M,0,0)     /__|_____________/__|
00597                       |  |              |  |
00598                       |  |______________|__| (0,N,P)
00599                       |  /              |  /
00600                       | /               | /
00601  (0,0,0)         |/_________________|/ (0,N,0)
00602
00603
00604  */
00605
00617 template<class ForwardIt, class T>
00618 bool MAHL_e(ForwardIt first, int i1, int j1, int k1, int im, int jn, int kp, const T& value){
00619     if(i1 > im || j1 > jn || k1 > kp)
00620         return false;
00621     int diff_i = im - i1 + 1;
00622     int diff_j = jn - j1 + 1;
00623     int diff_k = kp - k1 + 1;
00624     /*If dimension i is less than 3 and smaller than dimensions j and k, apply the saddleback
      algorithm to it. */
00625     if(diff_i <= 3 && diff_i <= diff_j && diff_i <= diff_k){
00626         for( int i = i1; i <= im; ++i)
00627             if(saddleback_jk(first, i, j1, jn, k1, kp, value))
00628                 return true;
00629             return false;
00630     }
00631     /*If dimension j is less than 3 and smaller than dimensions i and k, apply the saddleback
      algorithm to it.*/
00632     if(diff_j <= 3 && diff_j <= diff_i && diff_j <= diff_k){
00633         for( int j = j1; j <= jn; ++j)
00634             if(saddleback_ik(first, i1, im, j, k1, kp, value))
00635                 return true;
00636             return false;
00637     }
00638     /*If dimension k is less than 3 and smaller than dimensions i and j, apply the saddleback
      algorithm to it.*/
00639     if(diff_k <= 3 && diff_k <= diff_i && diff_k <= diff_j){
00640         for( int k = k1; k <= kp; ++k)
00641             if(saddleback_ij(first, i1, im, j1, jn, k, value))
00642                 return true;
00643             return false;
00644     }
00645
00646     /*If dimension i is larger, apply the algorithm to it.*/
00647     if(diff_i >= diff_j && diff_i >= diff_k){
00648         int mid_j = (j1 + jn) >> 1; /* floor of N/2 */
00649         int mid_k = (k1 + kp) >> 1; /*  floor of P/2 */
00650
00651         int index_i = binary_search_i(first, i1, im, mid_j, mid_k, value);
00652         if( index_i >= 0 && first[index_i][mid_j][mid_k] == value)
00653             return true;
00654
00655         return MAHL_e(first, index_i+1, j1, k1, im, mid_j, kp, value) ||
00656         MAHL_e(first, i1, j1, mid_k, index_i, jn, kp, value) ||
00657         MAHL_e(first, i1, mid_j+1, k1, im, jn, mid_k-1, value);
00658     }
00659     /*If dimension j is larger, apply the algorithm to it.*/
00660     else if(diff_j >= diff_i && diff_j >= diff_k){
00661         int mid_i = (i1 + im) >> 1; /* floor of M/2 */
00662         int mid_k = (k1 + kp) >> 1; /*  floor of P/2 */
00663
00664         int index_j = binary_search_j(first, mid_i, j1, jn, mid_k, value);
00665         if(index_j >= 0 && first[mid_i][index_j][mid_k] == value)
00666             return true;
00667         return MAHL_e(first, mid_i, j1, k1, im, index_j, kp, value) ||
00668         MAHL_e(first, i1, j1, mid_k, mid_i-1, jn, kp, value) ||
00669         MAHL_e(first, i1, index_j+1, k1, im, jn, mid_k-1, value);
00670     }
00671     /*If dimension k is larger, apply the algorithm to it.*/
00672     else{
00673         int mid_i = (i1 + im) >> 1; /* floor of M/2 */
00674         int mid_j = (j1 + jn) >> 1; /* foor of N/2 */
00675
00676         int index_k = binary_search_k(first, mid_i, mid_j, k1, kp, value);
00677         if(index_k >= 0 && first[mid_i][mid_j][index_k] == value)
00678             return true;
00679         return MAHL_e(first, mid_i, j1, k1, im, mid_j, kp, value) ||
00680         MAHL_e(first, i1, j1, index_k+1, mid_i-1, jn, kp, value) ||
00681         MAHL_e(first, i1, mid_j+1, k1, im, jn, index_k, value);
00682     }
00683 }
00684
```

```
00697 template<class ForwardIt, class T>
00698 bool MAHL_e(ForwardIt first, ForwardIt last, const T& value){
00699     int im, jn, kp;
00700     im = (last - first) - 1;
00701     jn = first[0].size() - 1;
00702     kp = first[0][0].size() - 1;
00703     return MAHL_e(first, 0, 0, 0, im, jn, kp, value);
00704 }
00705
00706 #endif
```

Index