BRNO UNIVERSITY OF TECHNOLOGY
Faculty of Information Technology

Practical Aspects of Software Design – 2019/2020

Profiling report

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1 Assignment

Using functions from your mathematical library, create a program (as a separate executable) to calculate the sample standard deviation from a sequence of numbers that the program reads from standard input (in C, for example, using the scanf function) until the end of the file and must be eble 1000 numbers. The input file contains only numbers and their number is not given in advance. The sample standard deviation formula to be used:

$$s = \sqrt{\frac{1}{N-1}\left(\sum_{i=1}^{N} x_i^2 - N\bar{x}^2\right)}$$
$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

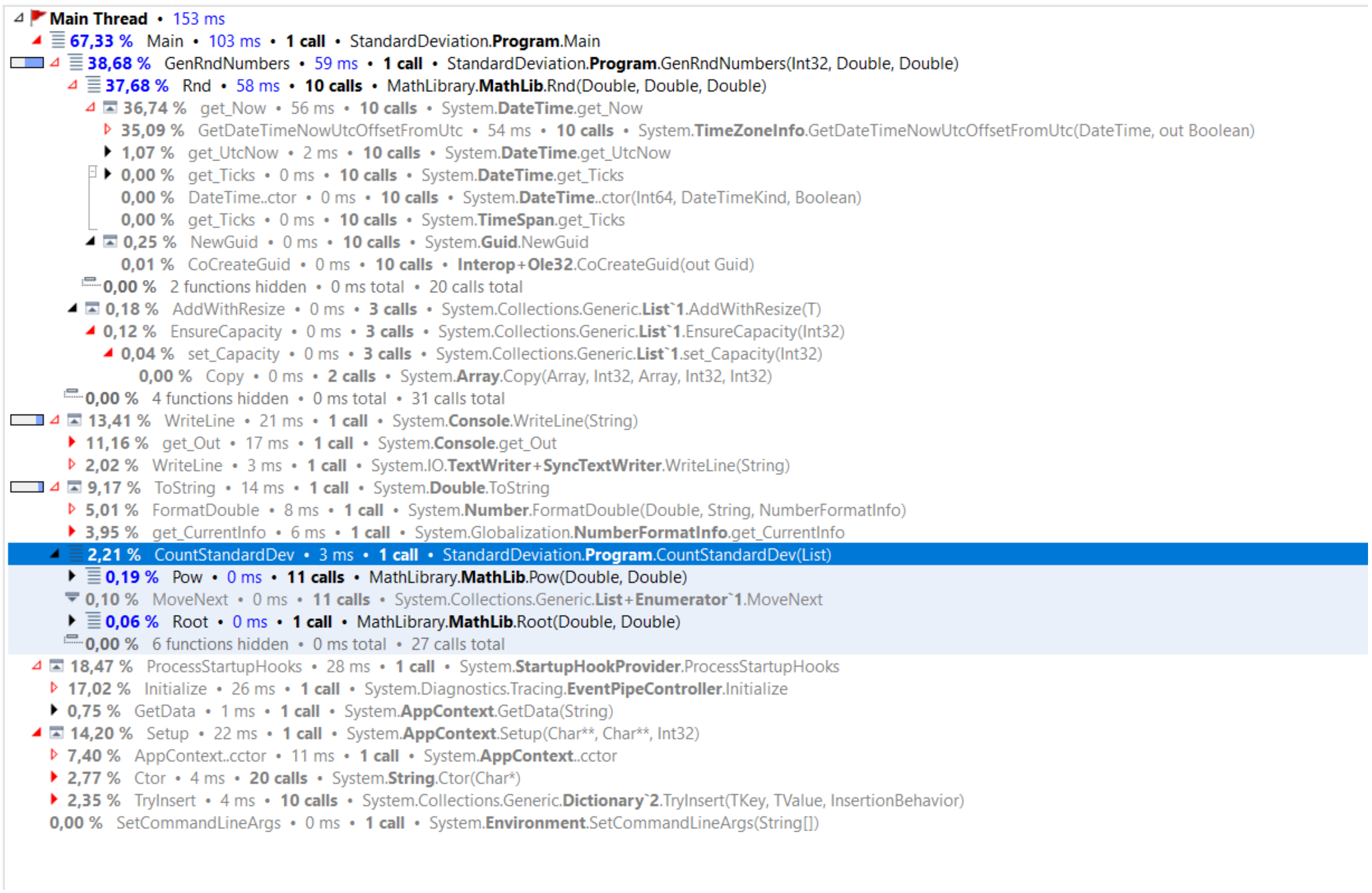
Example of running the program:
`./stddev < data.txt`

Profile this program with inputs of 10, 100 and 1000 numerical values. Submit a protocol containing the profiler output and a brief summary - where the program spends the most time and indicate and where focus on code optimization.

2 Tools

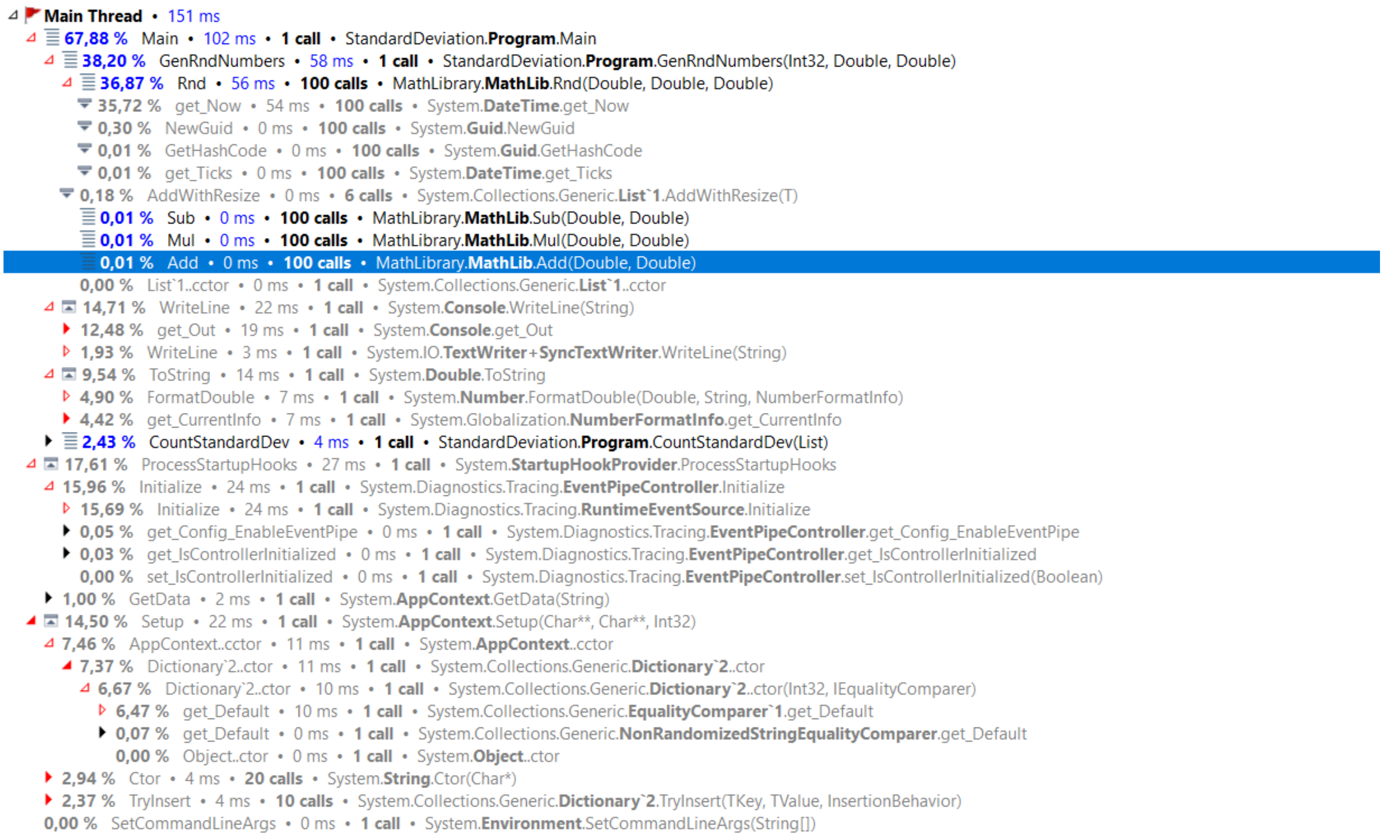
Written in `C#` in Visual Studio 2019 Community. Profiling was made by Jetbrains DotTrace profiling tool.

3 Results of Profiling



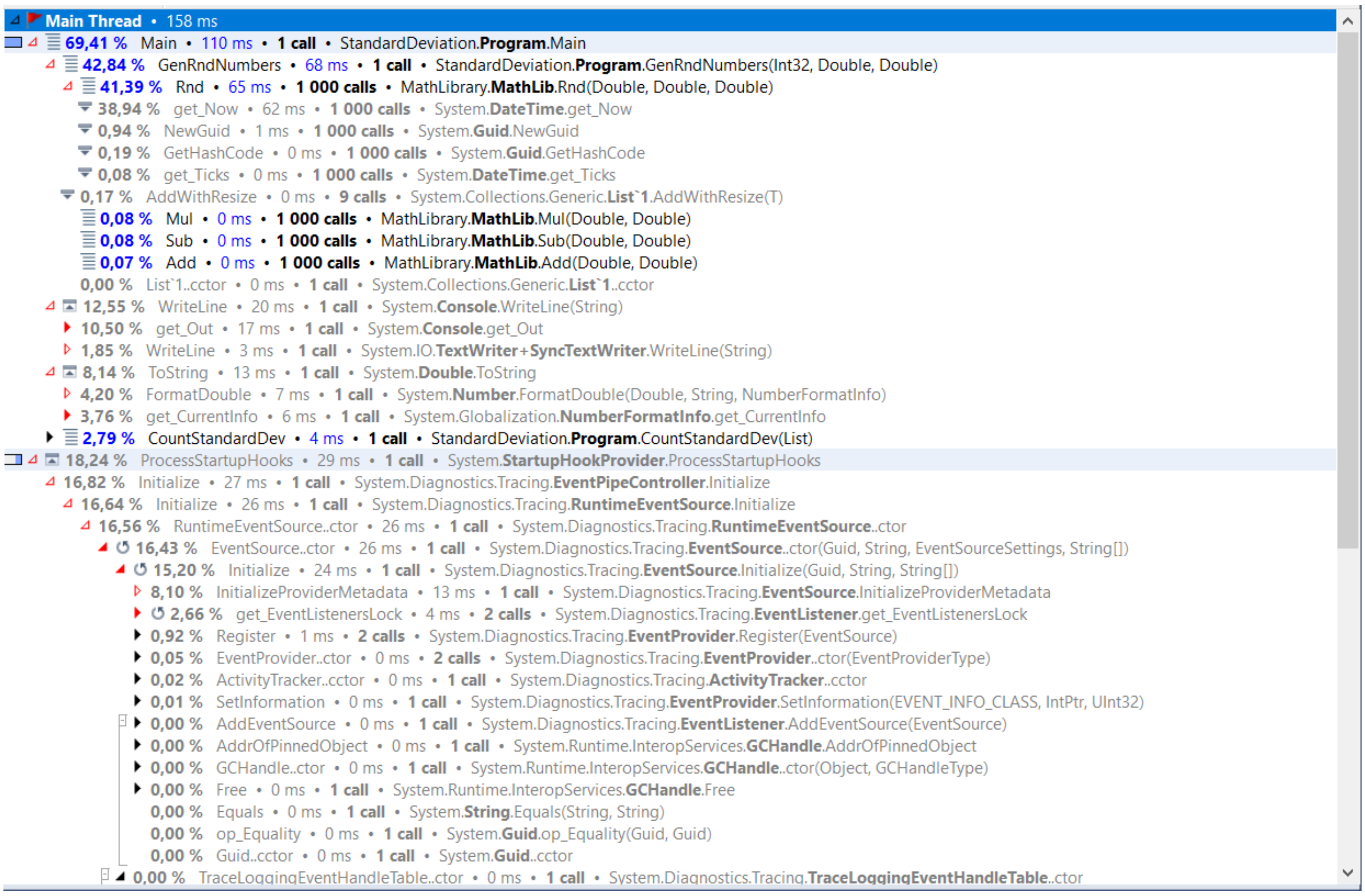
```
Main Thread • 153 ms
  67,33 % Main • 103 ms • 1 call • StandardDeviation.Program.Main
    38,68 % GenRndNumbers • 59 ms • 1 call • StandardDeviation.Program.GenRndNumbers(Int32, Double, Double)
      37,68 % Rnd • 58 ms • 10 calls • MathLibrary.MathLib.Rnd(Double, Double, Double)
        36,74 % get_Now • 56 ms • 10 calls • System.DateTime.get_Now
          35,09 % GetDateTimeNowUtcOffsetFromUtc • 54 ms • 10 calls • System.TimeZoneInfo.GetDateTimeNowUtcOffsetFromUtc(DateTime, out Boolean)
          1,07 % get_UtcNow • 2 ms • 10 calls • System.DateTime.get_UtcNow
          0,00 % get_Ticks • 0 ms • 10 calls • System.DateTime.get_Ticks
          0,00 % DateTime..ctor • 0 ms • 10 calls • System.DateTime..ctor(Int64, DateTimeKind, Boolean)
          0,00 % get_Ticks • 0 ms • 10 calls • System.TimeSpan.get_Ticks
        0,25 % NewGuid • 0 ms • 10 calls • System.Guid.NewGuid
          0,01 % CoCreateGuid • 0 ms • 10 calls • Interop+Ole32.CoCreateGuid(out Guid)
        0,00 % 2 functions hidden • 0 ms total • 20 calls total
      0,18 % AddWithResize • 0 ms • 3 calls • System.Collections.Generic.List`1.AddWithResize(T)
      0,12 % EnsureCapacity • 0 ms • 3 calls • System.Collections.Generic.List`1.EnsureCapacity(Int32)
        0,04 % set_Capacity • 0 ms • 3 calls • System.Collections.Generic.List`1.set_Capacity(Int32)
          0,00 % Copy • 0 ms • 2 calls • System.Array.Copy(Array, Int32, Array, Int32, Int32)
      0,00 % 4 functions hidden • 0 ms total • 31 calls total
    13,41 % WriteLine • 21 ms • 1 call • System.Console.WriteLine(String)
      11,16 % get_Out • 17 ms • 1 call • System.Console.get_Out
      2,02 % WriteLine • 3 ms • 1 call • System.IO.TextWriter+SyncTextWriter.WriteLine(String)
    9,17 % ToString • 14 ms • 1 call • System.Double.ToString
      5,01 % FormatDouble • 8 ms • 1 call • System.Number.FormatDouble(Double, String, NumberFormatInfo)
      3,95 % get_CurrentInfo • 6 ms • 1 call • System.Globalization.NumberFormatInfo.get_CurrentInfo
    2,21 % CountStandardDev • 3 ms • 1 call • StandardDeviation.Program.CountStandardDev(List)
      0,19 % Pow • 0 ms • 11 calls • MathLibrary.MathLib.Pow(Double, Double)
      0,10 % MoveNext • 0 ms • 11 calls • System.Collections.Generic.List+Enumerator`1.MoveNext
      0,06 % Root • 0 ms • 1 call • MathLibrary.MathLib.Root(Double, Double)
      0,00 % 6 functions hidden • 0 ms total • 27 calls total
  18,47 % ProcessStartupHooks • 28 ms • 1 call • System.StartupHookProvider.ProcessStartupHooks
    17,02 % Initialize • 26 ms • 1 call • System.Diagnostics.Tracing.EventPipeController.Initialize
    0,75 % GetData • 1 ms • 1 call • System.AppContext.GetData(String)
  14,20 % Setup • 22 ms • 1 call • System.AppContext.Setup(Char**, Char**, Int32)
    7,40 % AppContext..cctor • 11 ms • 1 call • System.AppContext..cctor
    2,77 % Ctor • 4 ms • 20 calls • System.String.Ctor(Char*)
    2,35 % TryInsert • 4 ms • 10 calls • System.Collections.Generic.Dictionary`2.TryInsert(TKey, TValue, InsertionBehavior)
  0,00 % SetCommandLineArgs • 0 ms • 1 call • System.Environment.SetCommandLineArgs(String[])
```

Results of profiling with 10 values.



```
Main Thread • 151 ms
  67,88 % Main • 102 ms • 1 call • StandardDeviation.Program.Main
    38,20 % GenRndNumbers • 58 ms • 1 call • StandardDeviation.Program.GenRndNumbers(Int32, Double, Double)
      36,87 % Rnd • 56 ms • 100 calls • MathLibrary.MathLib.Rnd(Double, Double, Double)
        35,72 % get_Now • 54 ms • 100 calls • System.DateTime.get_Now
        0,30 % NewGuid • 0 ms • 100 calls • System.Guid.NewGuid
        0,01 % GetHashCode • 0 ms • 100 calls • System.Guid.GetHashCode
        0,01 % get_Ticks • 0 ms • 100 calls • System.DateTime.get_Ticks
      0,18 % AddWithResize • 0 ms • 6 calls • System.Collections.Generic.List`1.AddWithResize(T)
        0,01 % Sub • 0 ms • 100 calls • MathLibrary.MathLib.Sub(Double, Double)
        0,01 % Mul • 0 ms • 100 calls • MathLibrary.MathLib.Mul(Double, Double)
        0,01 % Add • 0 ms • 100 calls • MathLibrary.MathLib.Add(Double, Double)
        0,00 % List`1..cctor • 0 ms • 1 call • System.Collections.Generic.List`1..cctor
    14,71 % WriteLine • 22 ms • 1 call • System.Console.WriteLine(String)
      12,48 % get_Out • 19 ms • 1 call • System.Console.get_Out
      1,93 % WriteLine • 3 ms • 1 call • System.IO.TextWriter+SyncTextWriter.WriteLine(String)
    9,54 % ToString • 14 ms • 1 call • System.Double.ToString
      4,90 % FormatDouble • 7 ms • 1 call • System.Number.FormatDouble(Double, String, NumberFormatInfo)
      4,42 % get_CurrentInfo • 7 ms • 1 call • System.Globalization.NumberFormatInfo.get_CurrentInfo
    2,43 % CountStandardDev • 4 ms • 1 call • StandardDeviation.Program.CountStandardDev(List)
  17,61 % ProcessStartupHooks • 27 ms • 1 call • System.StartupHookProvider.ProcessStartupHooks
    15,96 % Initialize • 24 ms • 1 call • System.Diagnostics.Tracing.EventPipeController.Initialize
      15,69 % Initialize • 24 ms • 1 call • System.Diagnostics.Tracing.RuntimeEventSource.Initialize
      0,05 % get_Config_EnableEventPipe • 0 ms • 1 call • System.Diagnostics.Tracing.EventPipeController.get_Config_EnableEventPipe
      0,03 % get_IsControllerInitialized • 0 ms • 1 call • System.Diagnostics.Tracing.EventPipeController.get_IsControllerInitialized
      0,00 % set_IsControllerInitialized • 0 ms • 1 call • System.Diagnostics.Tracing.EventPipeController.set_IsControllerInitialized(Boolean)
    1,00 % GetData • 2 ms • 1 call • System.AppContext.GetData(String)
  14,50 % Setup • 22 ms • 1 call • System.AppContext.Setup(Char**, Char**, Int32)
    7,46 % AppContext..cctor • 11 ms • 1 call • System.AppContext..cctor
      7,37 % Dictionary`2..ctor • 11 ms • 1 call • System.Collections.Generic.Dictionary`2..ctor
        6,67 % Dictionary`2..ctor • 10 ms • 1 call • System.Collections.Generic.Dictionary`2..ctor(Int32, IEqualityComparer)
          6,47 % get_Default • 10 ms • 1 call • System.Collections.Generic.EqualityComparer`1.get_Default
          0,07 % get_Default • 0 ms • 1 call • System.Collections.Generic.NonRandomizedStringEqualityComparer.get_Default
          0,00 % Object..ctor • 0 ms • 1 call • System.Object..ctor
    2,94 % Ctor • 4 ms • 20 calls • System.String.Ctor(Char*)
    2,37 % TryInsert • 4 ms • 10 calls • System.Collections.Generic.Dictionary`2.TryInsert(TKey, TValue, InsertionBehavior)
  0,00 % SetCommandLineArgs • 0 ms • 1 call • System.Environment.SetCommandLineArgs(String[])
```

Results of profiling with 100 values.



```
Main Thread • 158 ms
69,41 % Main • 110 ms • 1 call • StandardDeviation.Program.Main
  42,84 % GenRndNumbers • 68 ms • 1 call • StandardDeviation.Program.GenRndNumbers(Int32, Double, Double)
    41,39 % Rnd • 65 ms • 1 000 calls • MathLibrary.MathLib.Rnd(Double, Double, Double)
      38,94 % get_Now • 62 ms • 1 000 calls • System.DateTime.get_Now
      0,94 % NewGuid • 1 ms • 1 000 calls • System.Guid.NewGuid
      0,19 % GetHashCode • 0 ms • 1 000 calls • System.Guid.GetHashCode
      0,08 % get_Ticks • 0 ms • 1 000 calls • System.DateTime.get_Ticks
    0,17 % AddWithResize • 0 ms • 9 calls • System.Collections.Generic.List`1.AddWithResize(T)
    0,08 % Mul • 0 ms • 1 000 calls • MathLibrary.MathLib.Mul(Double, Double)
    0,08 % Sub • 0 ms • 1 000 calls • MathLibrary.MathLib.Sub(Double, Double)
    0,07 % Add • 0 ms • 1 000 calls • MathLibrary.MathLib.Add(Double, Double)
    0,00 % List`1..cctor • 0 ms • 1 call • System.Collections.Generic.List`1..cctor
  12,55 % WriteLine • 20 ms • 1 call • System.Console.WriteLine(String)
    10,50 % get_Out • 17 ms • 1 call • System.Console.get_Out
    1,85 % WriteLine • 3 ms • 1 call • System.IO.TextWriter+SyncTextWriter.WriteLine(String)
  8,14 % ToString • 13 ms • 1 call • System.Double.ToString
    4,20 % FormatDouble • 7 ms • 1 call • System.Number.FormatDouble(Double, String, NumberFormatInfo)
    3,76 % get_CurrentInfo • 6 ms • 1 call • System.Globalization.NumberFormatInfo.get_CurrentInfo
  2,79 % CountStandardDev • 4 ms • 1 call • StandardDeviation.Program.CountStandardDev(List)
18,24 % ProcessStartupHooks • 29 ms • 1 call • System.StartupHookProvider.ProcessStartupHooks
  16,82 % Initialize • 27 ms • 1 call • System.Diagnostics.Tracing.EventPipeController.Initialize
    16,64 % Initialize • 26 ms • 1 call • System.Diagnostics.Tracing.RuntimeEventSource.Initialize
      16,56 % RuntimeEventSource..ctor • 26 ms • 1 call • System.Diagnostics.Tracing.RuntimeEventSource..ctor
        16,43 % EventSource..ctor • 26 ms • 1 call • System.Diagnostics.Tracing.EventSource..ctor(Guid, String, EventSourceSettings, String[])
          15,20 % Initialize • 24 ms • 1 call • System.Diagnostics.Tracing.EventSource.Initialize(Guid, String, String[])
            8,10 % InitializeProviderMetadata • 13 ms • 1 call • System.Diagnostics.Tracing.EventSource.InitializeProviderMetadata
            2,66 % get_EventListenersLock • 4 ms • 2 calls • System.Diagnostics.Tracing.EventListener.get_EventListenersLock
            0,92 % Register • 1 ms • 2 calls • System.Diagnostics.Tracing.EventProvider.Register(EventSource)
            0,05 % EventProvider..ctor • 0 ms • 2 calls • System.Diagnostics.Tracing.EventProvider..ctor(EventProviderType)
            0,02 % ActivityTracker..cctor • 0 ms • 1 call • System.Diagnostics.Tracing.ActivityTracker..cctor
            0,01 % SetInformation • 0 ms • 1 call • System.Diagnostics.Tracing.EventProvider.SetInformation(EVENT_INFO_CLASS, IntPtr, UInt32)
            0,00 % AddEventSource • 0 ms • 1 call • System.Diagnostics.Tracing.EventListener.AddEventSource(EventSource)
            0,00 % AddrOfPinnedObject • 0 ms • 1 call • System.Runtime.InteropServices.GCHandle.AddrOfPinnedObject
            0,00 % GCHandle..ctor • 0 ms • 1 call • System.Runtime.InteropServices.GCHandle..ctor(Object, GCHandleType)
            0,00 % Free • 0 ms • 1 call • System.Runtime.InteropServices.GCHandle.Free
            0,00 % Equals • 0 ms • 1 call • System.String.Equals(String, String)
            0,00 % op_Equality • 0 ms • 1 call • System.Guid.op_Equality(Guid, Guid)
            0,00 % Guid..cctor • 0 ms • 1 call • System.Guid..cctor
          0,00 % TraceLoggingEventHandleTable..ctor • 0 ms • 1 call • System.Diagnostics.Tracing.TraceLoggingEventHandleTable..ctor
```

Results of profiling with 1000 values.

From these results can by inferred, that most timeconsuming function is `MathLibrary.MathLib.Rnd`, especialy getting actual time for random value. For optimalization, this should by considered as first choice.