ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Programming Techniques for Scientific Simulations Exercise 9

HS 12
Prof. M. Troyer

Problem 9.1 Report B - Benchmarks of Simpson integrations

Please hand in the report for block B.
You should benchmark the four different implementations you have already made:

- the easiest version with the hard-coded function;
- the version with function pointer;
- the version with (templated) function objects;
- the version with virtual function, allowing for run-time polymorphism.

We suggest using optimization flags `-O3 -funroll-loops`.
Repeat the benchmarks for functions of different complexity: $f_1(x) = 0$, $f_2(x) = 1$, $f_3(x) = x$, $f_4(x) = x^2$, $f_5(x) = \sin(x)$, $f_6(x) = \sin(5x)$.
Discuss the results.

Problem 9.2 Monte Carlo integration (no block assignment)

Calculate the value of π using Monte Carlo integration using `boost::lagged_fibonacci607` and `drand48` as your random number generator. In order to use a boost random number generator you need to include the `boost/random.hpp` header.
See the documentation on `http://www.boost.org`.

- Draw random numbers and check whether they are within the unit circle. The number of hits divided by the total number of trials gives you an estimate for $\frac{\pi}{4}$.
- Calculate the standard error of the mean.[1]
- Calculate the difference of the Monte Carlo estimate for π with the actual value of π.[2] Compare this difference with the standard error of the mean. What do you observe concerning the two random number generators?

[1] You may consult `http://en.wikipedia.org/wiki/Standard_error_(statistics)` for the formula.
[2] If your compiler does not recognize the macro `M_PI` in `cmath`, you may retrieve the value of π as $4\arctan(1)$.