Exercises for the Lecture Series

# "Object-Oriented Programming for Scientific Computing"

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## Exercise 1 Static vs. dynamic polymorphism

We want to investigate runtime differences of programs when using static or dynamic polymorphism. As an example we again consider the numerical integration program.

Instead of using dynamic polymorphism, we may also select the quadrature rule and/or the function to be integrated using static polymorphism (templates).

1. Write three additional variants of the integration program you have already developed, with the following features:
   (a) Static selection of the quadrature rule, dynamic selection of the function.
   (b) Dynamic selection of the quadrature rule, static selection of the function.
   (c) Static selection of the quadrature rule, static selection of the function.
2. Measure the time required for integration in the four main routines. Use the `<chrono>` header for this, it provides a namespace `std::chrono` with timer functionality. Try to familiarize yourself with this header, here is an example on how to use it:

```
const auto start = std::chrono::high_resolution_clock::now();
// compute integral here
const auto end = std::chrono::high_resolution_clock::now();
const auto ms = std::chrono::duration_cast<std::chrono::nanoseconds>
  (end-start).count() / 1000.;
// ms contains elapsed time in milliseconds
// print it using std::cout, for example
```

3. Measure the time for all four versions, once without optimization (compiler option "-O0") and once with optimization (compiler option "-O3"). Use the integration of $\int_{-3}^{13} 2t^2 + 5$ with 100.000 nodes as a test case. Measure both the Simpson and the trapezoidal rule, and fill a table with the results.
4. Are there time differences between the different versions? Interpret and justify the results! Is it worth it to think about the form of polymorphism in this situation? If so, why? If not, why not?

*20 Points*