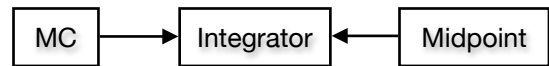


You must submit your exam by **Wednesday 10 Feb at 13:30** following the instruction at <http://www.roma1.infn.it/people/rahatlou/cmp/>

### Integration with Strategy Pattern

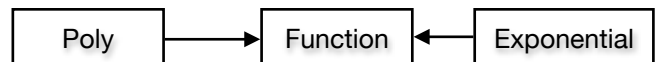
Use the strategy pattern to implement polymorphic methods of numerical integration for polymorphic functions in C++. The integration methods to implement are

1. Monte Carlo
2. Midpoint or rectangle method



For the functions, you have to define a base class Function and implement the polymorphic functions

1. Exponential
2. Poly (generic polynomial of degree n)



**Nota bene: this exercise is different from the one in the lab!**

- **Integrator** and **Function** must be abstract
- **Integrator** class should not have any data member of type **Function**
- **Function** must use a concrete **Integrator** object

As an example, the following code should work

```
Function* g = new Exponential(...); // with proper arguments
Integrator* mc = new MCIntegrator(...);
g->SetIntegrator( mc );
g->Integrate(a,b);
```

```
Integrator* mid = new MidPointIntegrator(...);
g->SetIntegrator( mid );
g->Integrate(a,b);
```

For each class provide a header and source file. Choice of data members, interface, arguments and return types of functions, and correct mathematical integration will be criteria of evaluation.

In order to test the correct implementation of the code, a test **app.cc** must also be provided producing the following plots.

1. Choose an interval  $[a, b]$  and evaluate the integral with both methods for each function
2. For each function repeat the evaluation of the integral with increasing number of points, e.g. from 10 to  $10^6$  points.
3. For each function plot the difference between numerical integral and the analytical integral as a function of number of integration points.

Provide one pdf file for each function (**exponential.pdf** and **gauss.pdf**) showing simultaneously the residual (numerical-analytical) as a function of integration points. Use different colors, and proper legend and axis labels. The zip file should contain