Exercise 9. *Deadline: 18 May 2009.*

COURSE OF C++ PROGRAMMING LANGUAGE

EXPRESSION TREE

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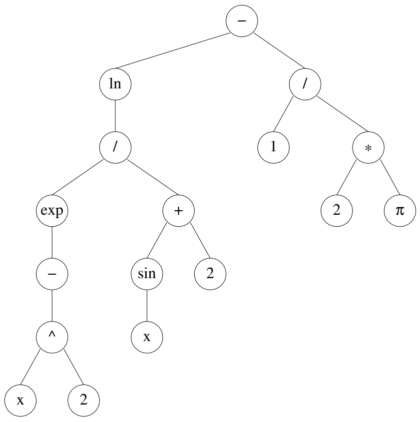
Exercise

An expression tree is a rooted tree, which is used to represent a mathematical expression. Each internal node in the tree is an arithmetic operation or mathematical function, and all leaves are operands (constants or variables). For example, the expression $\ln \frac{e^{x^2}}{\sin x+2} - \frac{1}{2\pi}$ could be shown as the following expression tree:



Define abstract base class `Expression`, which will represent an arithmetic expression. Let us insert into the class a pure virtual method `value()` that will calculate a value of the expression.

```
class Expression
{
public:
    virtual double value () = 0;
    virtual ~Expression () = 0;
};
```

In the next step, define derived classes `Real` (a constant real number), `Var` (a variable), and other classes for arithmetic operations (addition, subtraction, multiplication, division, etc.) and mathematical functions. Design a class hierarchy for mathematical operations. Place the set of variables `map<string,double>` into the class `Var` as a static data member.

Finally write a short program, which will test your implementation of the mathematical expressions. Create an expression from the example, and calculate its value for $x = 0.0, 0.1, 0.2, \ldots, 1.0$.

Suggestion

Partition your code into the header and source files.

Hint

Some information about the class `map<>` from STL (a sorted associative array of unique keys and associated data) can be found on the webpage:

`http://en.wikipedia.org/wiki/Map_(C%2B%2B_container)`

Some information about the expression tree can be found on the webpage:

`http://www.brpreiss.com/books/opus5/html/page264.html`