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TECHNISCHE UNIVERSITÄT DARMSTADT

SCIENTIFIC COMPUTING

Source Transformation Tool to Globally Replace API Calls

1. Motivation

In many scientific applications derivatives are needed for optimizations or data assimilation to match physical observations and model tuning.
In this context, algorithmic differentiation (AD) allows for the semantic augmentation of codes yielding the ability to compute derivatives.
Typically in C++, the double data type is replaced by a user-defined AD type which overloads all operators and mathematical functions. The code structure, thus, stays mostly unchanged.
The new type, in addition to the normal function value, also calculates the derivative value:

```
1 double f(double x) {
2   double y = x * x + x;
3   return y;
4 }
```

```
1 #include "adouble.h"
2 adouble f(adouble x) {
3   adouble y = x * x + x;
4   return y;
5 }
```

```
1 class adouble {
2   double value;
3   double derivative;
4 public:
5   adouble(double);
6   adouble(const adouble&);
7   adouble operator*(const adouble&);
8   adouble operator+(const adouble&);
9 };
```

There are several different such AD tools, applying them to the same code base allows for, e.g., the verification of the numerical results.
While all overload the same set of operators and mathematical functions, certain API calls are different. As such, whenever a different AD is introduced several areas of the code need to be modified.

2. Task Description

Your task is to compare the APIs of two AD tools. Subsequently, you develop a (*proof of concept*) source transformation tool that is able to replace the current AD tool with a different one.

3. Technologies

Technology is flexible. The transformation target C++ code bases.
As an example, **C++11** and the **Clang/LLVM compiler framework** can be utilized. But you are free to chose a different tool set.

For further discussion or clarification, please contact me.

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