IMPROVING AUTOMATIC DIFFERENTIATION OF OBJECT-ORIENTED PARADIGMS USING CLAD

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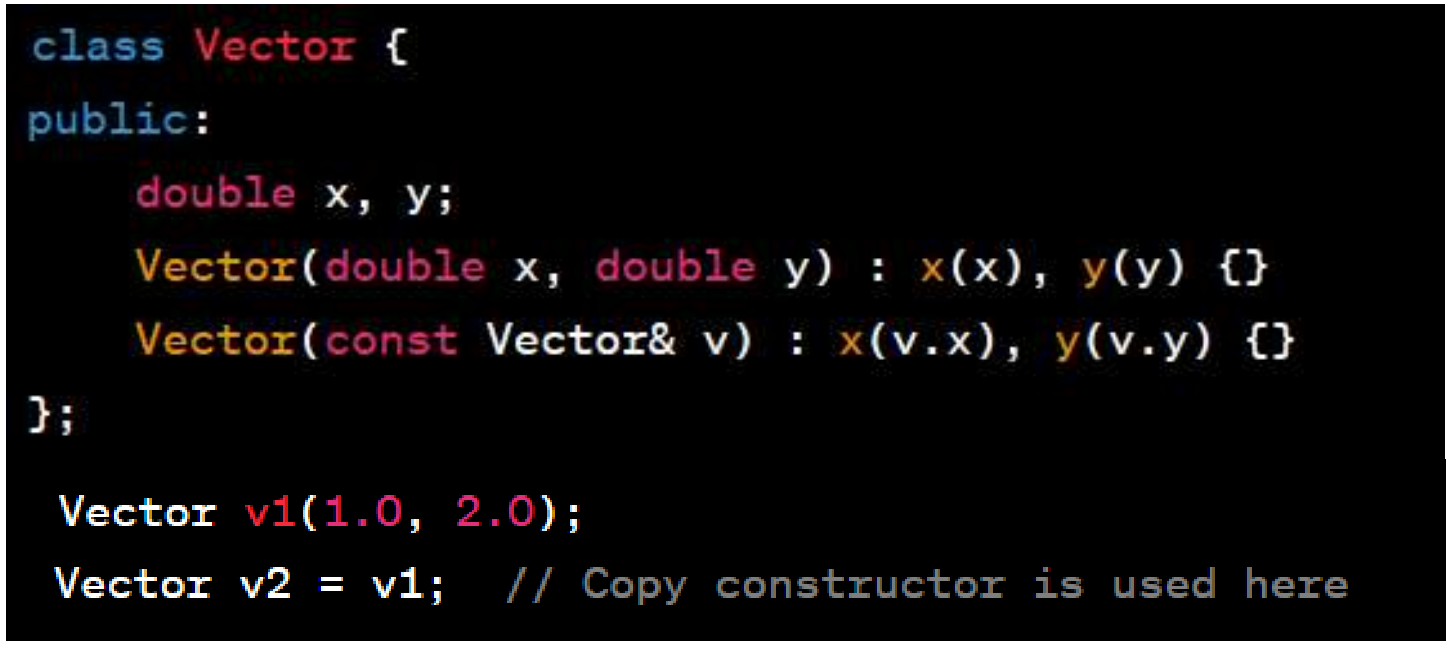
MOTIVATION TO SUPPORT OOP IN CLAD

- Supporting object oriented paradigms in clad will allow users to compute derivatives to the algorithms in their projects seamlessly.
- Our goal is to finally enable users to realize clad's potential by making it compatible with Softsusy and Eigen libraries codebases.
- I will introduce to you what I plan to do during this summer.

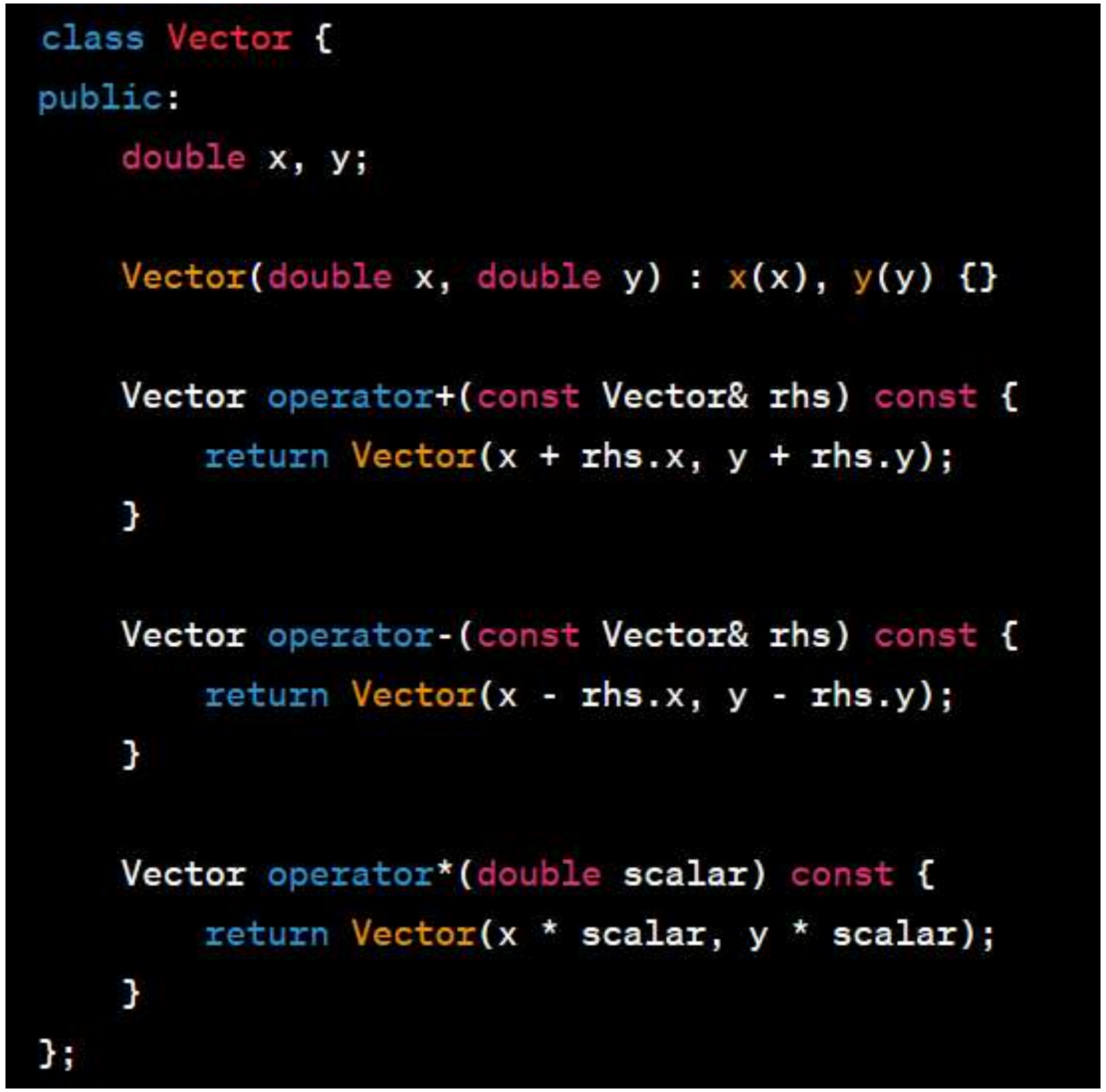
ADD SUPPORT FOR DIFFERENTIATION OF SPECIAL MEMBER FUNCTIONS



```
class Vector {
public:
    double x, y;
    Vector(double x, double y) : x(x), y(y) {}
    Vector(const Vector& v) : x(v.x), y(v.y) {}
};

 Vector v1(1.0, 2.0);
 Vector v2 = v1;  // Copy constructor is used here
```

- We can perform copy operations on class types similar to those on builtin types, such as "int y = x;" -> "classA y = x“.

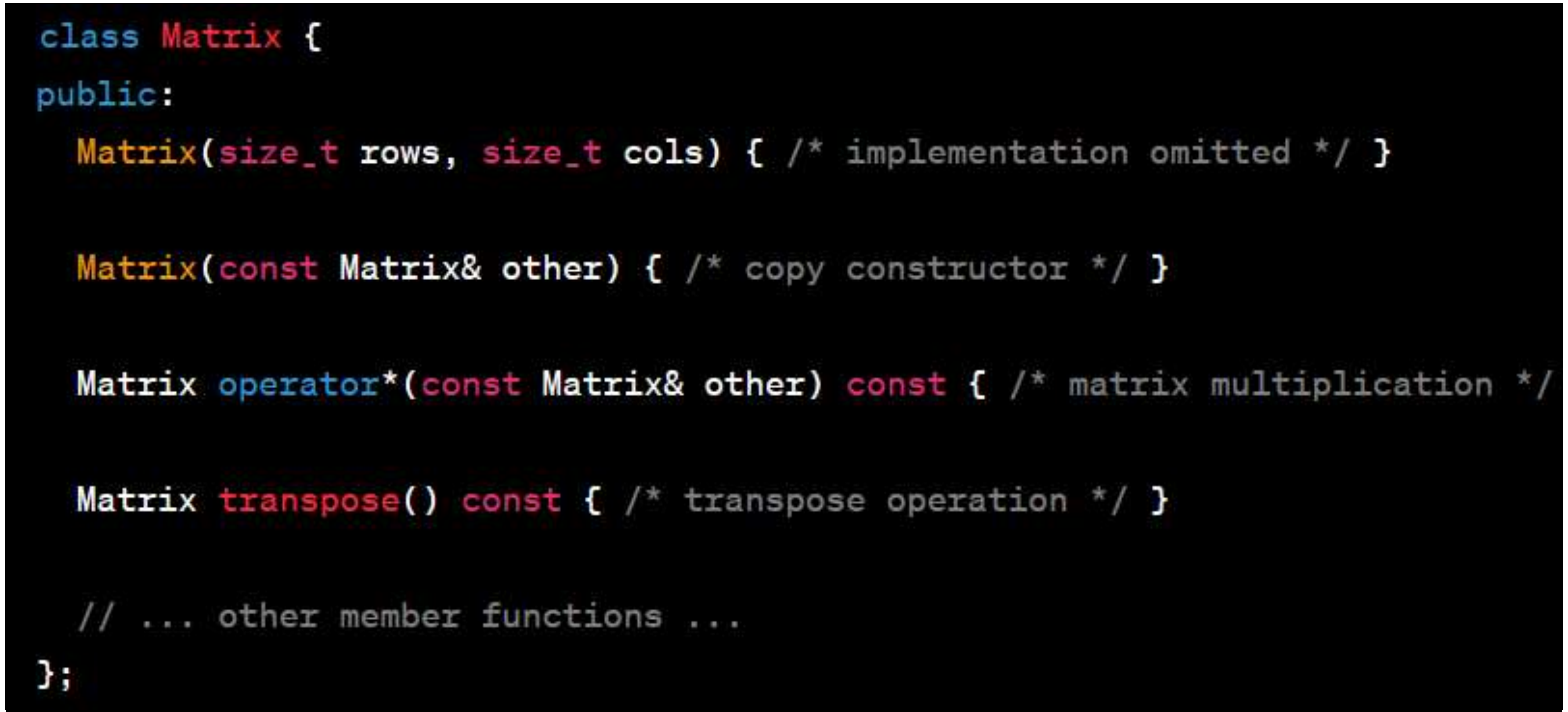
IMPROVE SUPPORT FOR DIFFERENTIATION OF OPERATOR OVERLOADS



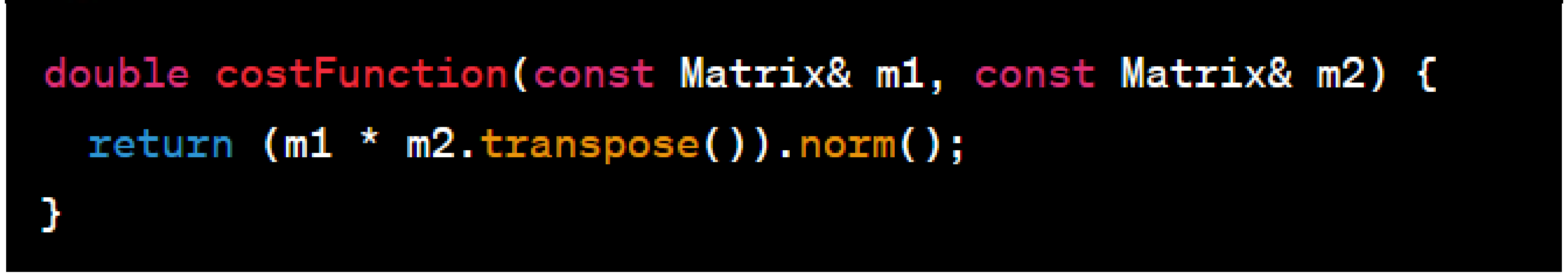
```
class Vector {
public:
    double x, y;

    Vector(double x, double y) : x(x), y(y) {}

    Vector operator+(const Vector& rhs) const {
        return Vector(x + rhs.x, y + rhs.y);
    }

    Vector operator-(const Vector& rhs) const {
        return Vector(x - rhs.x, y - rhs.y);
    }

    Vector operator*(double scalar) const {
        return Vector(x * scalar, y * scalar);
    }
};
```

- Currently, clad already supports member functions and the () operator in reverse mode.
- Other operator overloads are similar to this in that they involve an indirect call to member.

ADD SUPPORT FOR CUSTOM DERIVATIVES FOR SPECIAL MEMBER FUNCTIONS

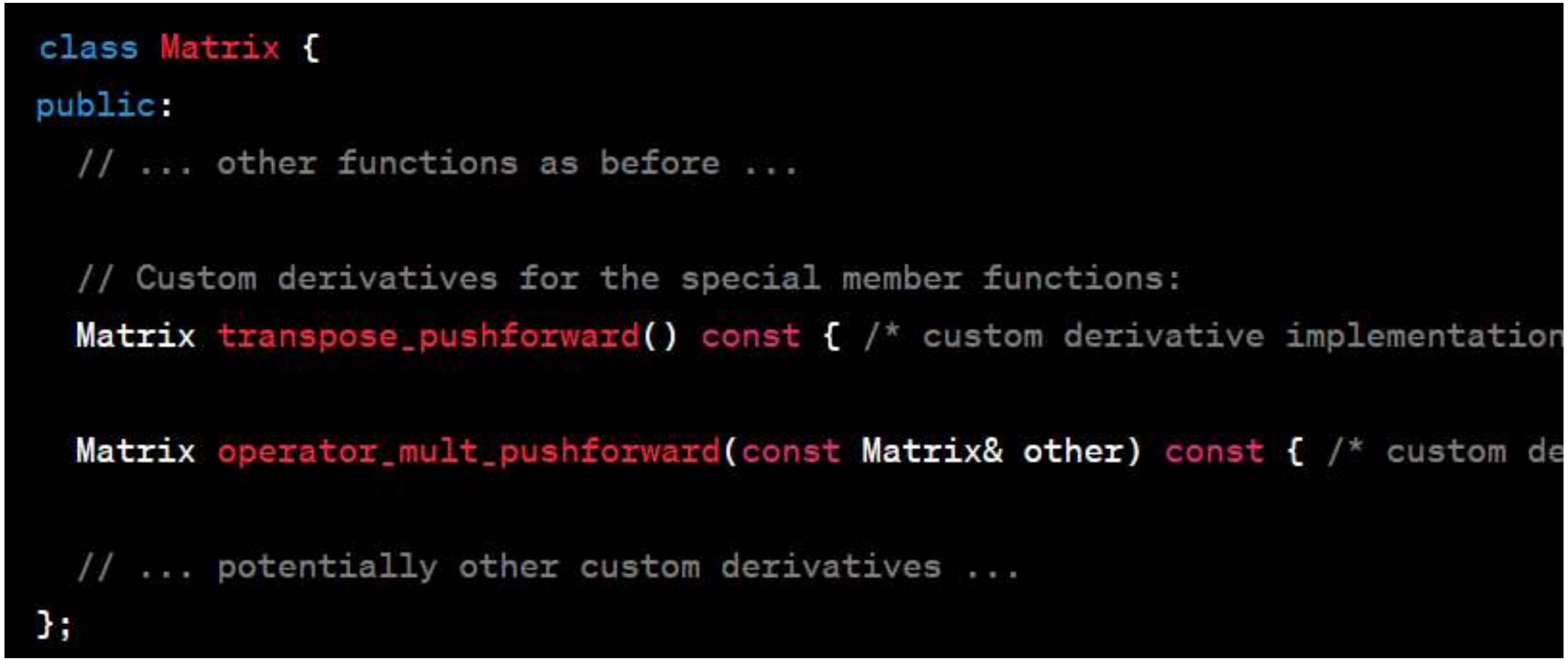


```
class Matrix {
public:
  Matrix(size_t rows, size_t cols) { /* implementation omitted */ }

  Matrix(const Matrix& other) { /* copy constructor */ }

  Matrix operator*(const Matrix& other) const { /* matrix multiplication */

  Matrix transpose() const { /* transpose operation */ }

  // ... other member functions ...
};
```



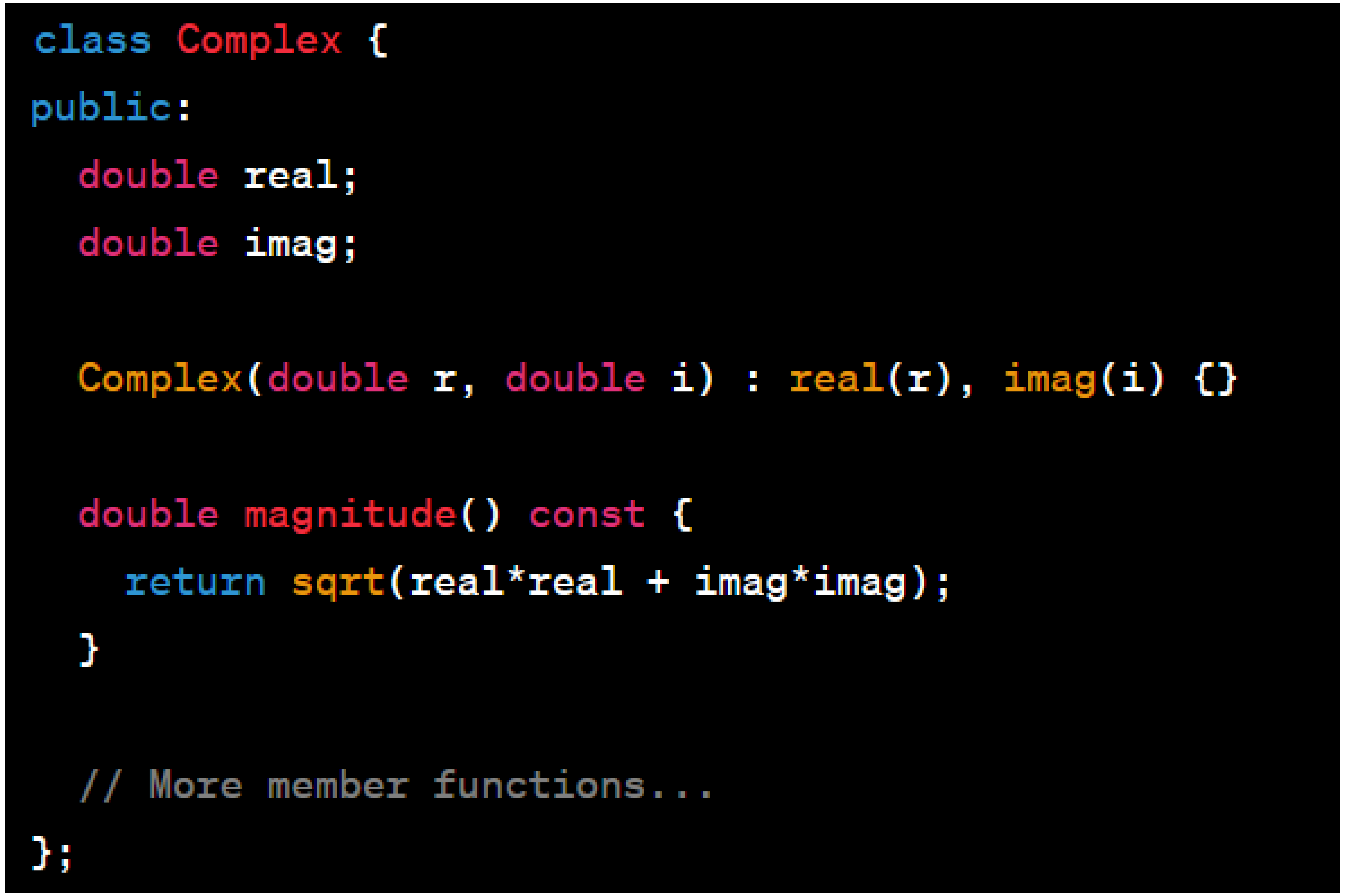
```
double costFunction(const Matrix& m1, const Matrix& m2) {
  return (m1 * m2.transpose()).norm();
}
```

ADD SUPPORT FOR CUSTOM DERIVATIVES FOR SPECIAL MEMBER FUNCTIONS



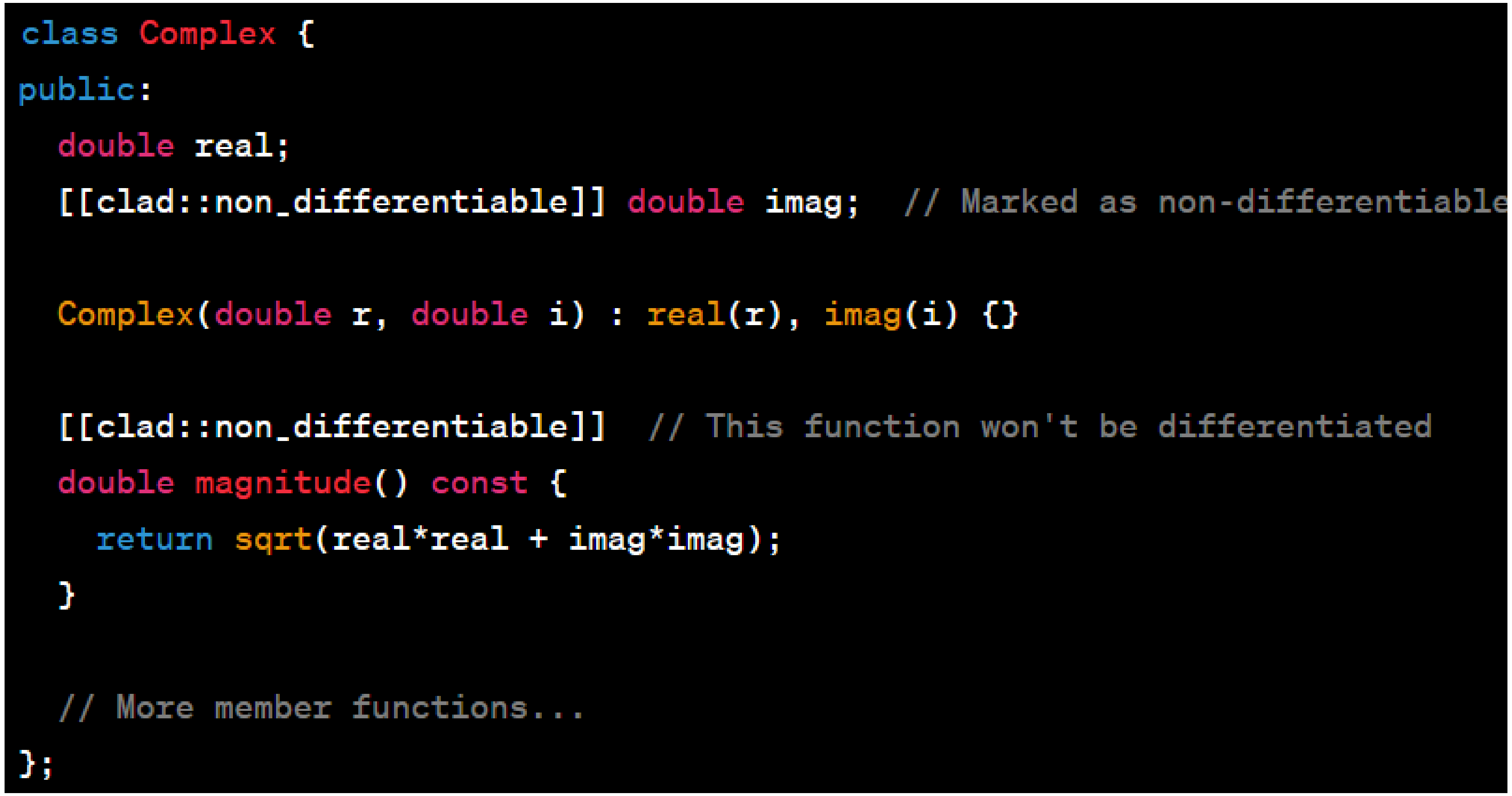
```
class Matrix {
public:
  // ... other functions as before ...

  // Custom derivatives for the special member functions:
  Matrix transpose_pushforward() const { /* custom derivative implementation

  Matrix operator_mult_pushforward(const Matrix& other) const { /* custom de

  // ... potentially other custom derivatives ...
};
```

RESEARCH WAYS TO IMPROVE CLAD OBJECT-ORIENTED DIFFERENTIABLE MODEL



```cpp
class Complex {
public:
  double real;
  double imag;

  Complex(double r, double i) : real(r), imag(i) {}

  double magnitude() const {
    return sqrt(real*real + imag*imag);
  }

  // More member functions...
};
```

RESEARCH WAYS TO IMPROVE CLAD OBJECT-ORIENTED DIFFERENTIABLE MODEL



```cpp
class Complex {
public:
  double real;
  [[clad::non_differentiable]] double imag;  // Marked as non-differentiable

  Complex(double r, double i) : real(r), imag(i) {}

  [[clad::non_differentiable]]  // This function won't be differentiated
  double magnitude() const {
    return sqrt(real*real + imag*imag);
  }

  // More member functions...
};
```

THANK YOU!