FRIENDS

EXAMPLE 6: UNDERSTAND THE ACCESS MODIFIERS: PRIVATE, PUBLIC AND PROTECTED

RECAP

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MEMBER FUNCTIONS AND MEMBER VARIABLES CAN BE MARKED AS PUBLIC (IF USABLE OUTSIDE THE CLASS) OR PRIVATE (INTERNAL TO THE CLASS)

PROTECTED IS SIMILAR, BUT RELATED TO INHERITANCE - MORE LATER

RECAP

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```
class ComplexNumber
{
private:
  float realPart;
  float complexPart;
public:
  ComplexNumber() : realPart(0.0),complexPart(0.0)
  {
    cout << "No arg-constructor called" << endl;
  }
  ComplexNumber(double c, double r) : realPart(r) , complexPart(c)
  {
    cout << "Inside the 2-argument constructor" << endl;
  }
  void setRealPart(double r)
  {
    realPart = r;
  }

  void setComplexPart(double c)
  {
    complexPart = c;
  }

  float getRealPart()
```

A SECTION MARKED `public` THAT IS FOR MEMBER FUNCTIONS AND DATA ACCESSIBLE TO CODE OUTSIDE THE CLASS AS WELL

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```

CODE ANYWHERE CAN ACCESS PUBLIC PORTIONS

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A SECTION MARKED `private` THAT IS FOR MEMBER FUNCTIONS AND DATA ACCESSIBLE ONLY INSIDE THE CLASS

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IF CODE OUTSIDE A CLASS TRIES TO ACCESS THIS, A COMPILE ERROR WILL RESULT

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BUT ALL OBJECTS OF A CLASS CAN ACCESS EACH OTHERS PRIVATE PARTS

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THERE'S A LOT GOING ON HERE - LET'S TAKE IT SLOW

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A SECTION MARKED `private` THAT IS FOR MEMBER FUNCTIONS AND DATA ACCESSIBLE ONLY INSIDE THE CLASS

IF CODE OUTSIDE A CLASS TRIES TO ACCESS THIS, A COMPILE ERROR WILL RESULT

```
int main()
{

   ComplexNumber c1(1.414,1.414);
   cout << "Trying to access a private member: " << c1.realPart <<  endl;


class ComplexNumber
{
private:
   float realPart;
   float complexPart;
```

RECAP

A SECTION MARKED `private` THAT IS FOR MEMBER FUNCTIONS AND DATA ACCESSIBLE ONLY INSIDE THE CLASS

```
int main()
{

   ComplexNumber c1(1.414,1.414);
   cout << "Trying to access a private member: " << c1.realPart <<  endl;
```

IF CODE OUTSIDE A CLASS TRIES TO ACCESS THIS, A COMPILE ERROR WILL RESULT

```
Vitthals-MacBook-Pro:~ vitthalsrinivasan$ g++ -Wall Example6.cpp
Example6.cpp:57:55: error: 'realPart' is a private member of 'ComplexNumber'
  cout << "Trying to access a private member: " << c1.realPart <<  endl;
                                                      ^

Example6.cpp:8:9: note: declared private here
  float realPart;
        ^

1 error generated.
```

RECAP

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RECAP

ERRM..ACTUALLY, THERE IS A WAY AROUND THIS

A SECTION MARKED `private` THAT IS FOR MEMBER FUNCTIONS AND DATA ACCESSIBLE ONLY INSIDE THE CLASS

IF CODE OUTSIDE A CLASS TRIES TO ACCESS THIS, A COMPILE ERROR WILL RESULT

IT INVOLVES THE `friend` KEYWORD

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THE IDEA IS PRETTY SIMPLE: ANY CLASS CAN MARK ANOTHER CLASS, OR EVEN A STANDALONE FUNCTION AS A `friend`

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THE `friend` CAN THEN ACCESS THE PRIVATE MEMBER DATA OF THAT CLASS

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THERE IS NO COMPULSION THAT `friend`-SHIP BE MUTUAL, AND IT RARELY IS

JOKES ABOUT THE `friend` KEYWORD ARE UNIVERSAL

"THERE IS NO COMPULSION THAT `friend`-SHIP BE MUTUAL, AND IT RARELY IS"

"A `friend` CAN TOUCH YOUR PRIVATE PARTS"

"LIKE IN REAL LIFE, `friends` ARE USUALLY MORE TROUBLE THAN THEY ARE WORTH"

JOKES ABOUT THE `friend` KEYWORD ARE UNIVERSAL

"THERE IS NO COMPULSION THAT `friend`-SHIP BE MUTUAL AND IT RARELY IS"

"A FRIEND CAN TOUCH YOUR KIDNEY"

USING `friend` IS QUITE CONTROVERSIAL - IT BREAKS ENCAPSULATION, AND OTHER LANGUAGES DON'T INCLUDE SUCH AN IDEA, BUT..

"LIKE IN REAL LIFE, `friends` ARE USUALLY MORE TROUBLE THAN THEY ARE WORTH"

JOKES ABOUT THE `friend`
KEYWORD ARE UNIVERSAL

"THERE IS NO GUARANTEE THAT FRIENDSHIP BE MUTUAL, AND IT RARELY IS"

"A FRIEND CAN TOUCH YOUR PRIVATE PARTS"

THERE ARE SPECIFIC SITUATIONS WHERE `friend` IS A LIFE-SAVER (OPERATOR OVERLOADING OF CERTAIN OPERATORS, FOR INSTANCE)

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THERE ARE SPECIFIC SITUATIONS WHERE `friend` IS A LIFE-SAVER (OPERATOR OVERLOADING OF CERTAIN OPERATORS, FOR INSTANCE)

MORE ON THIS WHEN WE GET TO OPERATOR OVERLOADING

EXAMPLE 42

DECLARE A FRIEND FUNCTION, AND USE IT

EXAMPLE 42 DECLARE A FRIEND FUNCTION, AND USE IT

THIS IS A COMPLICATED EXAMPLE,
WITH 2 CLASSES, AND 5 FILES!

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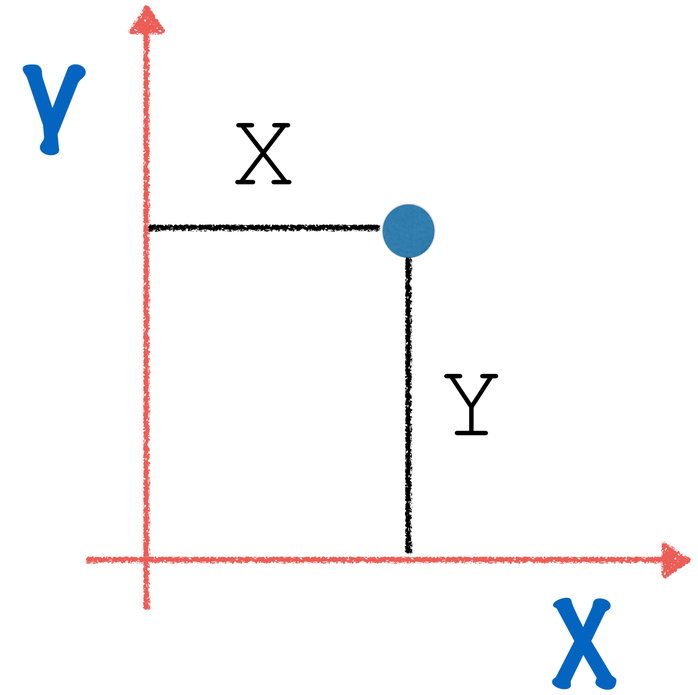
CLASS #1: A COMPLEX NUMBER CLASS (CARTESIAN COORDINATES)

$$z = x + iy$$

CLASS #2: A COMPLEX NUMBER CLASS (POLAR COORDINATES)

$$z = r(\cos t + i \sin t)$$

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!



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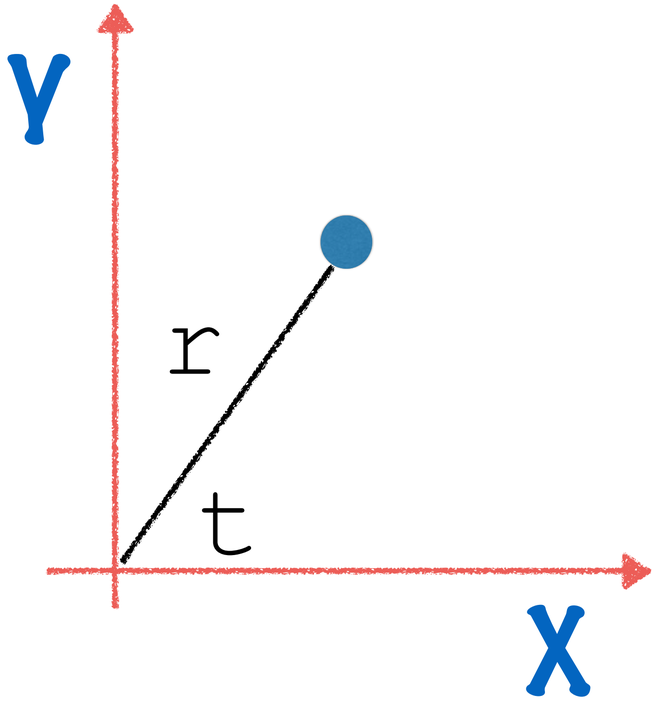

$$z = r(\cos t + i \sin t)$$

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!

CLASS #1: A COMPLEX NUMBER CLASS (CARTESIAN COORDINATES)

```
z = x + iy
```

```
realPart (x),
imaginaryPart (Y)
```

CLASS #2: A COMPLEX NUMBER CLASS (POLAR COORDINATES)

```
z = r(cos t + i sin t)
```

```
modulus (r),
argument (t)
```

TWO MEMBER VARIABLES IN EACH CLASS

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!

CLASS #1: A COMPLEX NUMBER CLASS (CARTESIAN COORDINATES)

CLASS #2: A COMPLEX NUMBER CLASS (POLAR COORDINATES)

SEPARATE THE DECLARATIONS AND DEFINITIONS INTO .CPP FILE, .H FILE

AND THE MAIN FUNCTION IN A SEPARATE .CPP FILE

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!

Example42_ComplexNumber.h

Example42_ComplexNumber.cpp

Example42_ComplexNumber_Polar.h

Example42_ComplexNumber_Polar.cpp

Example42_Main.cpp

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!

Example42_**ComplexNumber.h** DECLARATION OF THE CARTESIAN

Example42_**ComplexNumber.cpp** DEFINITION OF THE CARTESIAN

Example42_**ComplexNumber_Polar.h** DECLARATION OF THE POLAR

Example42_**ComplexNumber_Polar.cpp** DEFINITION OF THE POLAR

Example42_**Main.cpp**

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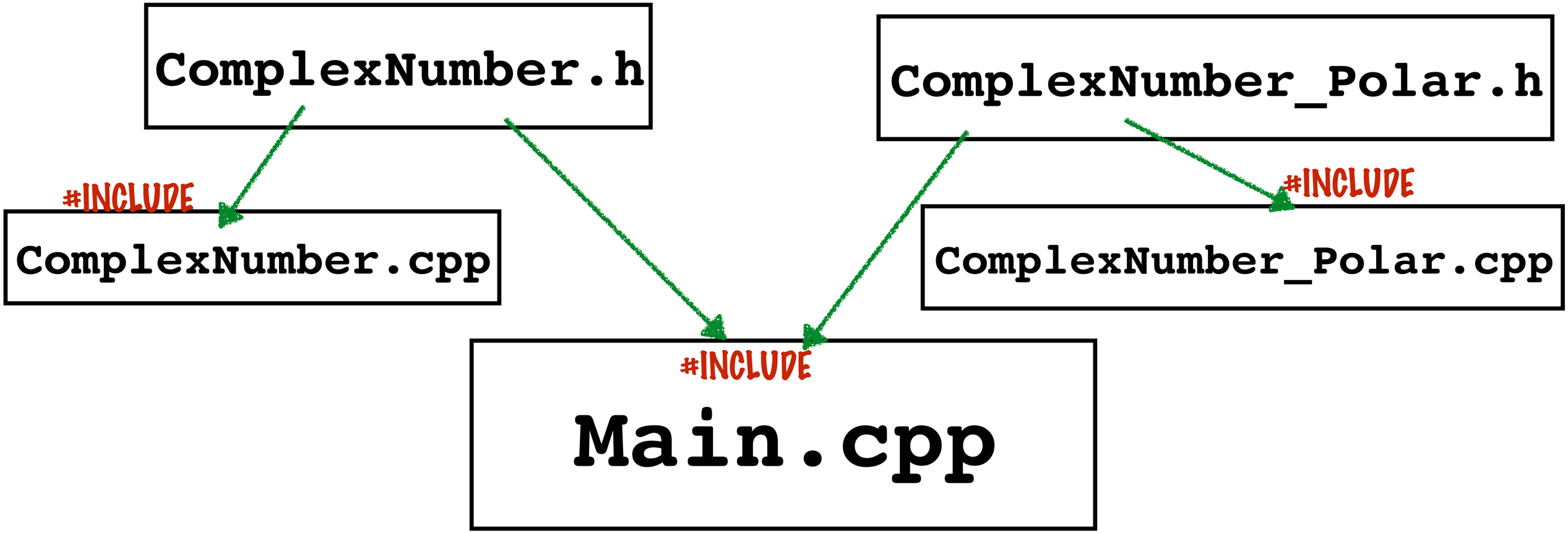

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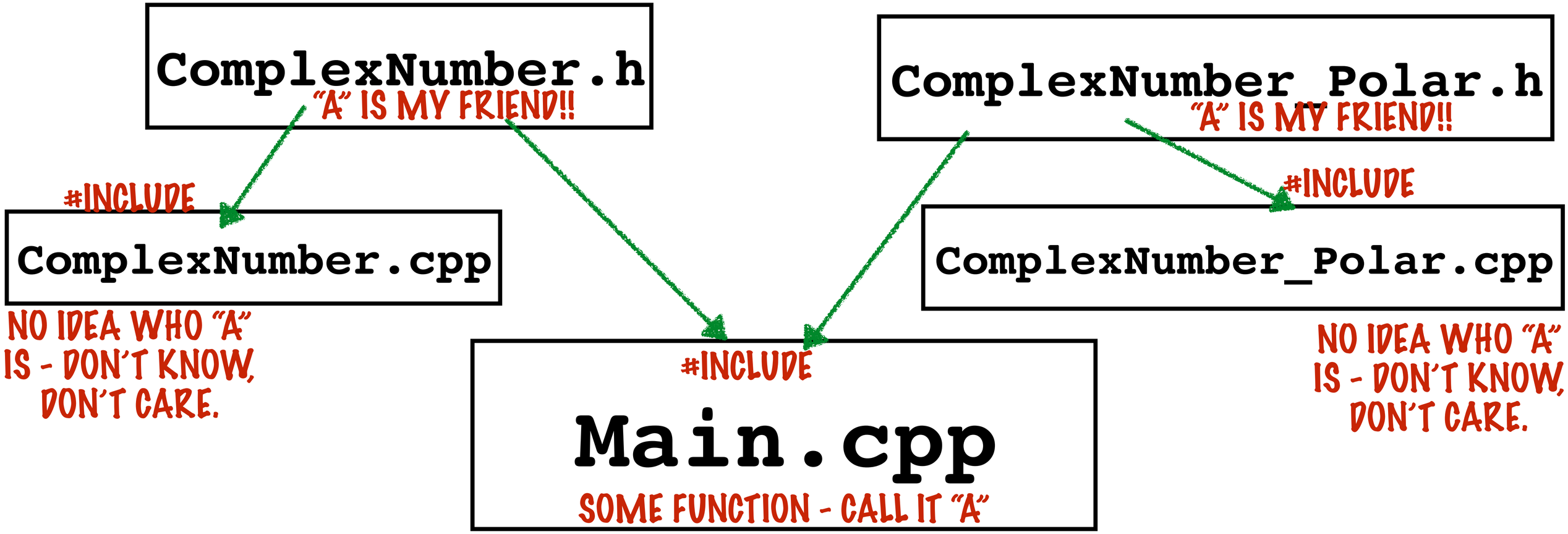

Main.cpp

```cpp
include <iostream>
#include <cmath>

#include "Example42_ComplexNumber.h"
#include "Example42_ComplexNumber_Polar.h"


ComplexNumber addTwoComplexNumbers
  (const ComplexNumber& cart,
   const ComplexNumber_Polar& polar)
{
  float realPart = polar.modulus * cos(polar.argument * ComplexNumber::PI/180);
  float complexPart = polar.modulus * sin(polar.argument * ComplexNumber::PI/180);

  ComplexNumber result(realPart + cart.realPart, complexPart + cart.complexPart);
  return result;

}


int main()
{

  ComplexNumber cart(5,5);
  ComplexNumber_Polar polar(10,45);
  ComplexNumber sumOfTwoComplexNumbers = addTwoComplexNumbers(cart,polar);
  cout << "Real part = " << sumOfTwoComplexNumbers.getRealPart()
       << "Complex part = " << sumOfTwoComplexNumbers.getComplexPart() << endl;
}
```

Main.cpp

#INCLUDE BOTH THE .H FILES

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THIS FUNCTION ACCESSES THE PRIVATE MEMBER DATA OF BOTH OF THOSE CLASSES

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}
```

AND SO, EACH OF THOSE 2 CLASSES MUST DECLARE THIS FUNCTION TO BE A FRIEND

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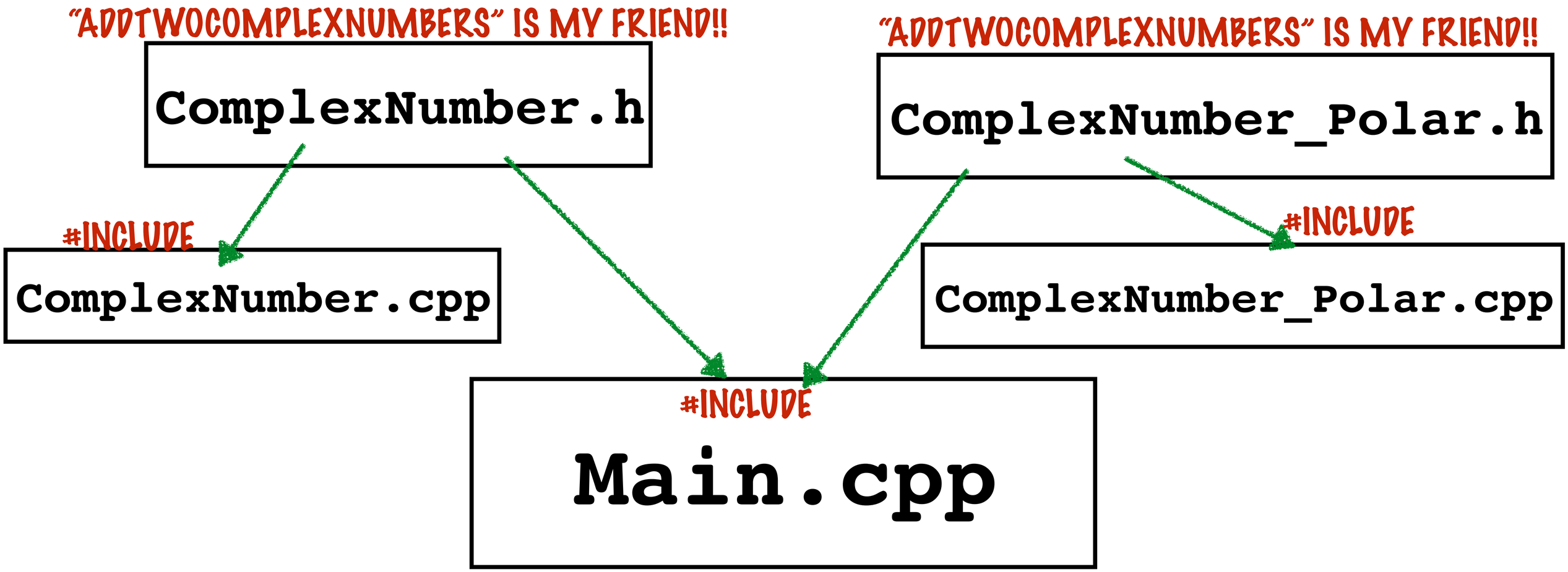

Complex Number.h

```cpp
#include <iostream>

using namespace std;

class ComplexNumber_Polar;

class ComplexNumber
{
private:
  float realPart;
  float complexPart;
  static int numObjectsCreated;
public:
  const static double PI;

  ComplexNumber();

  ComplexNumber(double c, double r);

  ComplexNumber(const ComplexNumber& rhs);

  ~ComplexNumber();

  float getRealPart() const;

  void  setRealPart(float r);


  float getComplexPart() const;
  void  setComplexPart(float c);

friend ComplexNumber addTwoComplexNumbers
  (const ComplexNumber& cart,
   const ComplexNumber_Polar& polar);

};
```

THE .H FILE NOW CONTAINS ONLY THE DECLARATIONS, NOT THE DEFINITIONS (THOSE ARE IN THE .CPP FILE)

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class ComplexNumber_Polar;

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THIS IS WHERE THE DECLARATION OF **friend**-SHIP MUST RESIDE

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WAIT! HOW WILL OUR CLASS KNOW ANYTHING ABOUT THIS OTHER OBJECT?

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  float getRealPart() const;

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  friend ComplexNumber addTwoComplexNumbers
    (const ComplexNumber& cart,
     const ComplexNumber_Polar& polar);
};
```

ESPECIALLY SINCE WE DON'T #include ITS DECLARATION?

WAIT! HOW WILL OUR CLASS KNOW ANYTHING ABOUT THIS OTHER OBJECT?

Complex Number.h

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using namespace std;

class ComplexNumber_Polar;

class ComplexNumber
{
  float realPart;
  float complexPart;
  static double radiansPerDegree;
public:
  const static double PI;

  ComplexNumber();

  ComplexNumber(double r, double c);

  ComplexNumber(const ComplexNumber& rhs);

  ~ComplexNumber();

  float getRealPart() const;

  void  setRealPart(float r);


  float getComplexPart() const;
  void  setComplexPart(float c);

  friend ComplexNumber addTwoComplexNumbers
    (const ComplexNumber& cart,
     const ComplexNumber_Polar& polar);

};
```

AHA! THAT'S WHY WE HAVE A FORWARD DECLARATION OF THAT CLASS!

WAIT! HOW WILL OUR CLASS KNOW ANYTHING ABOUT THIS OTHER OBJECT?

ESPECIALLY SINCE WE DON'T #include ITS DECLARATION?

FORWARD DECLARATION

THIS IS AN IMPORTANT POINT - REMEMBER TO ADD ANY FORWARD DECLARATIONS FOR TYPES THAT ARE NOT #-INCLUDED IN YOUR FILE

THINK OF THIS AS A PLACEHOLDER CLASS SO THE COMPILER DOES NOT COMPLAIN, YOU KNOW THE REAL CLASS IS GOING TO BE DEFINED AND DECLARED ELSEWHERE

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Complex Number.h

```
#include <iostream>

using namespace std;

class ComplexNumber_Polar;

class ComplexNumber
{
private:
  float realPart;
  float complexPart;
  static double objectsCreated;
public:
  const static double PI;

  ComplexNumber();

  ComplexNumber(double r, double c);

  ComplexNumber(const ComplexNumber& rhs);

  ~ComplexNumber();

  float getRealPart() const;

  void  setRealPart(float r);


  float getComplexPart() const;
  void  setComplexPart(float c);

  friend ComplexNumber addTwoComplexNumbers
    (const ComplexNumber& cart,
     const ComplexNumber_Polar& polar);

};
```

AHA! THAT'S WHY WE HAVE A FORWARD DECLARATION OF THAT CLASS!

WAIT! HOW WILL OUR CLASS KNOW ANYTHING ABOUT THIS OTHER OBJECT?

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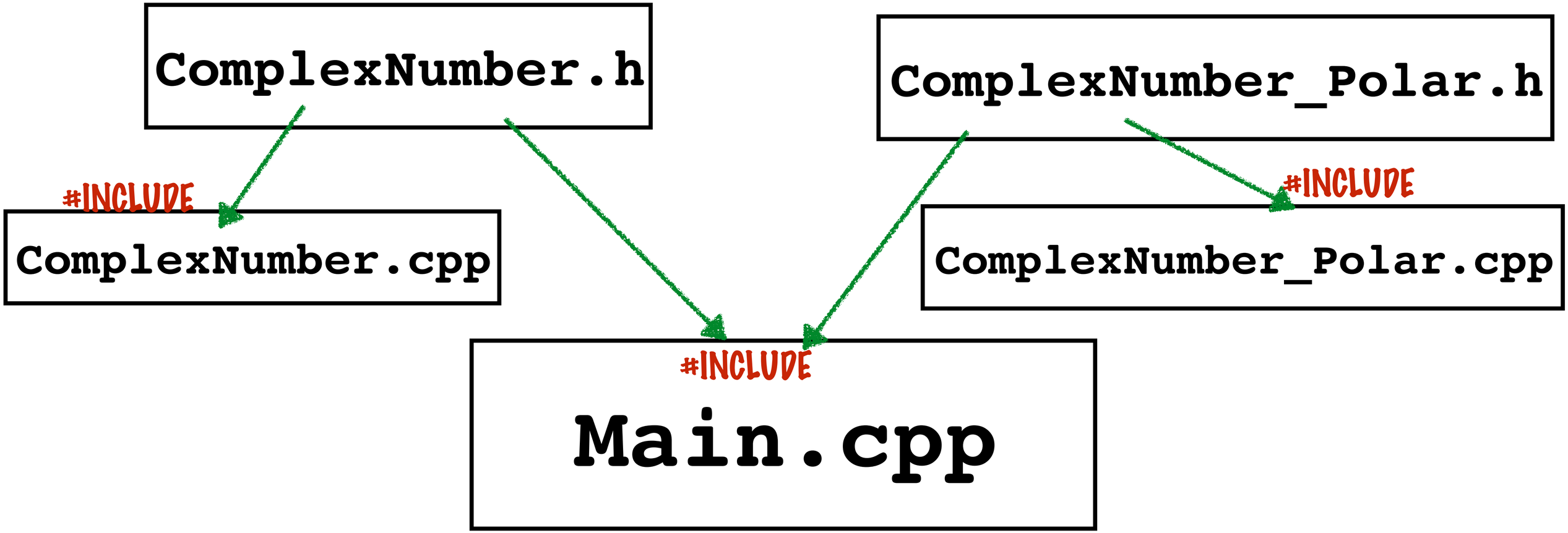
THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!



Complex Number. cpp

```cpp
#include <iostream>
#include "Example42_ComplexNumber.h"

using namespace std;

int ComplexNumber::numObjectsCreated = 0; // define the static variable
const double ComplexNumber::PI = 3.1415;


ComplexNumber::ComplexNumber() : realPart(0.0),complexPart(0.0)
{
  // increment the static variable keeping track of objects created                    \

  numObjectsCreated++;
  cout << "No arg-constructor called" << endl;
}

ComplexNumber::ComplexNumber(double c, double r) : realPart(r) , complexPart(c)
{
  // increment the static variable keeping track of objects created                    \

  numObjectsCreated++;
  cout << "Inside the 2-argument constructor" << endl;
}

ComplexNumber::ComplexNumber(const ComplexNumber& rhs) :
  realPart(rhs.realPart), complexPart(rhs.complexPart)
{
  // increment the static variable keeping track of objects created                    \

  numObjectsCreated++;
  cout << "Inside the copy constructor" << endl;
}

ComplexNumber::~ComplexNumber()
{
  cout << "Inside the destructor: realPart = " << realPart <<" complexPart = " << complexPart << endl;
}

float ComplexNumber::getRealPart() const { return realPart; }
void  ComplexNumber::setRealPart(float r) { realPart = r;}

float ComplexNumber::getComplexPart() const { return complexPart; }
void  ComplexNumber::setComplexPart(float c) { complexPart = c;}
```

THE .CPP FILE SIMPLY INCLUDES ALL THE DEFINITIONS

Complex Number.cpp

```
#include "Example42_ComplexNumber.h"
```

THE .CPP FILE MUST INCLUDE THE .H FILE OF COURSE

THE .CPP FILE SIMPLY INCLUDES ALL THE DEFINITIONS

```cpp
int ComplexNumber::numObjectsCreated = 0; // define the static variable
const double ComplexNumber::PI = 3.1415;

ComplexNumber::ComplexNumber()
```

ComplexNumber.cpp

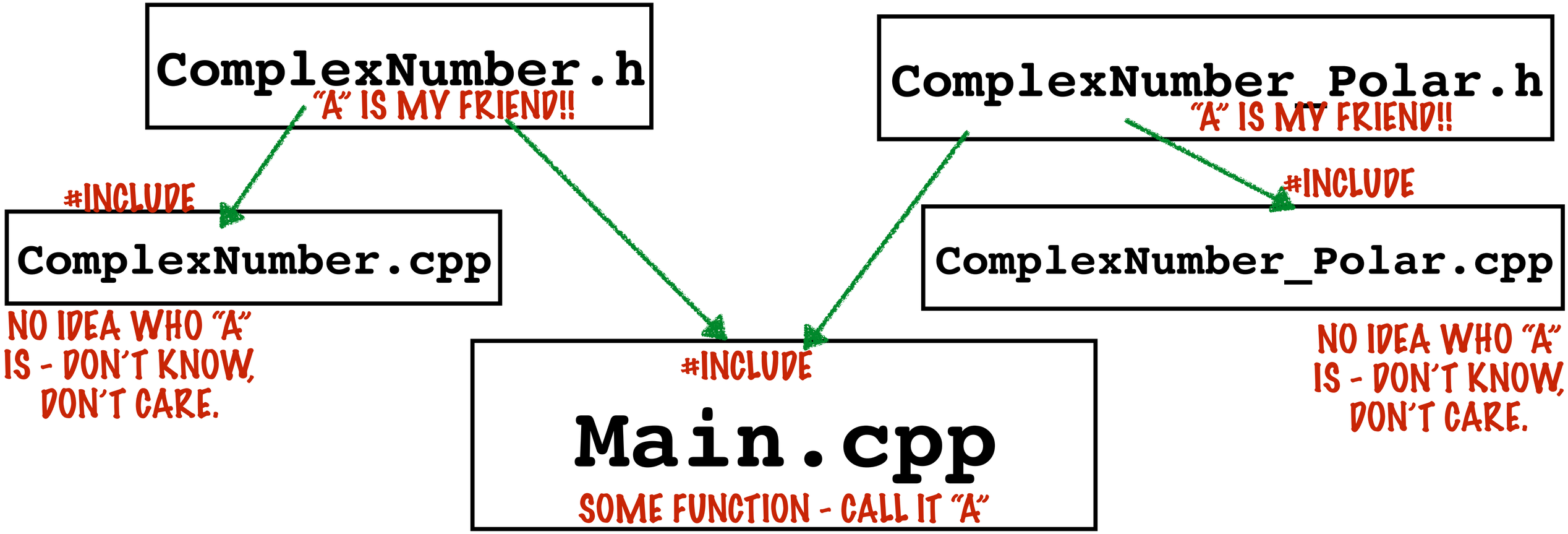
THE .CPP FILE SIMPLY INCLUDES ALL THE DEFINITIONS

```cpp
ComplexNumber::ComplexNumber(double c, double r)
```

ALL DEFINITIONS USE THE SCOPE RESOLUTION OPERATOR OF COURSE

```cpp
ComplexNumber::ComplexNumber(const ComplexNumber& rhs)
```

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!



THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!

```
Vitthals-MacBook-Pro:~ vitthalsrinivasan$ g++ -Wall Example42*.cpp
```

BTW, TO COMPILE A PROJECT WITH MANY FILES USING G++, ONLY COMPILE THE CPP FILES

THIS IS A COMPLICATED EXAMPLE, WITH 2 CLASSES, AND 5 FILES!

```
Vitthals-MacBook-Pro:~ vitthalsrinivasan$ g++ -Wall Example42*.cpp
```

BTW, TO COMPILE A PROJECT WITH MANY FILES USING G++, ONLY COMPILE THE CPP FILES

EXAMPLE 43

DECLARE A FRIEND CLASS, AND USE IT

THE `friend` KEYWORD

THE IDEA IS PRETTY SIMPLE: ANY CLASS CAN MARK ANOTHER CLASS, OR EVEN A STANDALONE FUNCTION AS A `friend`

RECAP

THE `friend` KEYWORD

THE IDEA IS PRETTY SIMPLE: ANY CLASS CAN MARK ANOTHER CLASS, OR EVEN A STANDALONE FUNCTION AS A `friend`

RECAP

THE `friend` KEYWORD

THE IDEA IS PRETTY SIMPLE: ANY CLASS CAN MARK ANOTHER CLASS, OR EVEN A STANDALONE FUNCTION AS A FRIEND. EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

RECAP

THE `friend` KEYWORD

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

LET'S SAY THAT THESE CLASSES ARE DECLARED IN THE SAME FILE

```
class Student
{
private:
  string studentName;
public:
  Student(const char* name) : studentName(name)
  {
    cout << "Initialized string to: " << studentName << endl;
  }


};
```

CLASS STUDENT

```
class School
{
private:
  string schoolName;
public:
  School(const char* name) : schoolName(name)
  {
    cout << "Initialized string to: " << schoolName << endl;
  }

  void admitStudent(const Student& s)
  {
    cout << "Admitting student " << s.studentName << endl;
  }

  void expelStudent(const Student& s)
  {
    cout << "Expelling student " << s.studentName << endl;
  }


};
```

CLASS SCHOOL

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

CLASS STUDENT HAS A PRIVATE MEMBER VARIABLE

```
class Student
{
private:
   string studentName;
public:
   Student(const char* name) : studentName(name)
   {
      cout << "Initialized string to: " << studentName << endl;
   }


};
```

CLASS STUDENT

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

CLASS STUDENT HAS A PRIVATE MEMBER VARIABLE

```
class Student
{
private:
  string studentName;
public:
  Student(const char* name) : studentName(name)
  {
    cout << "Initialized string to: " << studentName << endl;
  }


};
```

CLASS STUDENT

THAT CLASS SCHOOL ATTEMPTS TO ACCESS

```
class School
{
private:
  string schoolName;
public:
  School(const char* name) : schoolName(name)
  {
    cout << "Initialized string to: " << schoolName << endl;
  }

  void admitStudent(const Student& s)
  {
    cout << "Admitting student " << s.studentName << endl;
  }

  void expelStudent(const Student& s)
  {
    cout << "Expelling student " << s.studentName << endl;
  }


};
```

CLASS SCHOOL

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

```
class School
{
private:
  string schoolName;
public:
  School(const char* name) : schoolName(name)
  {
    cout << "Initialized string to: " << schoolName << endl;
  }

  void admitStudent(const Student& s)
  {
    cout << "Admitting student " << s.studentName << endl;
  }

  void expelStudent(const Student& s)
  {
    cout << "Expelling student " << s.studentName << endl;
  }
```

CLASS STUDENT HAS A PRIVATE MEMBER VARIABLE

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CLASS SCHOOL

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND

```
class School
{
private:
  string schoolName;
public:
  School(const char* name) : schoolName(name)
  {
    cout << "Initialized string to: " << schoolName << endl;
  }

  void admitStudent(const Student& s)
  {
    cout << "Admitting student " << s.studentName << endl;
  }

  void expelStudent(const Student& s)
  {
    cout << "Expelling student " << s.studentName << endl;
  }
```

CLASS STUDENT HAS A PRIVATE MEMBER VARIABLE

THAT CLASS SCHOOL ATTEMPTS TO ACCESS

CLASS SCHOOL

THE RESULT IS AN ERROR

```
Vitthals-MacBook-Pro:~ vitthalsrinivasan$ g++ -Wall Example43*.cpp
Example43.cpp:33:39: error: 'studentName' is a private member of 'Student'
    cout << "Admitting student " << s.studentName << endl;
                                      ^

Example43.cpp:11:10: note: declared private here
  string studentName;
         ^

Example43.cpp:38:39: error: 'studentName' is a private member of 'Student'
    cout << "Expelling student " << s.studentName << endl;
                                      ^

Example43.cpp:11:10: note: declared private here
  string studentName;
         ^

2 errors generated.
```

WHICH IS EASILY FIXED BY HAVING STUDENT DECLARE THAT SCHOOL IS A FRIEND!

WHICH IS EASILY FIXED BY HAVING STUDENT DECLARE THAT SCHOOL IS A FRIEND!

```
class Student
{
private:
  string studentName;
public:
  Student(const char* name) : studentName(name)
  {
    cout << "Initialized string to: " << studentName << endl;
  }
  friend class School;
};
```

WHICH IS EASILY FIXED BY HAVING STUDENT DECLARE THAT SCHOOL IS A FRIEND!

```
class Student
{
private:
  string studentName;
public:
  Student(const char* name) : studentName(name)
  {
    cout << "Initialized string to: " << studentName << endl;
  }
  friend class School;
};
```

IN THIS PARTICULAR INSTANCE, NO FORWARD DECLARATION IS NEEDED BECAUSE THE CLASSES ARE IN THE SAME FILE

THE CODE COMPILES AND RUNS FINE NOW!

```
Vitthals-MacBook-Pro:~ vitthalsrinivasan$ g++ -Wall Example43*.cpp
Vitthals-MacBook-Pro:~ vitthalsrinivasan$ ./a.out
 Initialized string to: Vitthal
 Initialized string to: St Johns
Admitting student Vitthal
Expelling student Vitthal
```

NOTE THAT BOTH MEMBER FUNCTIONS OF THE SCHOOL CLASS COULD NOW ACCESS THE PRIVATE PARTS OF STUDENT

THE `friend` KEYWORD

WHEN YOU DECLARE AN ENTIRE CLASS TO BE A `friend` -

EVERY MEMBER FUNCTION OF THAT CLASS BECOMES A FRIEND