

ECE 462

Object-Oriented Programming

using C++ and Java

Sound

Yung-Hsiang Lu
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Java Sound

MidiSystem (Java Platform SE 6) - Mozilla Firefox

File Edit View History Bookmarks Yahoo! Tools Help

http://java.sun.com/javase/6/docs/api/javax/sound/midi/MidiSystem. Google

MidiSystem (Java Platform SE 6) Sequencer (Java Platform SE 6) Amazon.com: Sams Teach Yourself Ja...

Overview Package Class Use Tree Deprecated Index Help

[PREV CLASS](#) [NEXT CLASS](#) [FRAMES](#) [NO FRAMES](#) [All Classes](#)

SUMMARY: NESTED | FIELD | CONSTR | [METHOD](#) DETAIL: FIELD | CONSTR | [METHOD](#)

javax.sound.midi

Class MidiSystem

[java.lang.Object](#)
└─[javax.sound.midi.MidiSystem](#)

```
public class MidiSystem
extends Object
```

The `MidiSystem` class provides access to the installed MIDI system resources, including devices such as synthesizers, sequencers, and MIDI input and output ports. A typical simple MIDI application might begin by invoking one or more `MidiSystem` methods to learn what devices are installed and to obtain the ones needed in that application.

Done

Sequencer (Java Platform SE 6) - Mozilla Firefox

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http://java.sun.com/javase/6/docs/api/javax/sound/midi/Sequencer.html

MidiSystem (Java Platform SE 6) Sequencer (Java Platform SE 6) Amazon.com: Sams Teach Yourself Ja...

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SUMMARY: [NESTED](#) | [FIELD](#) | CONSTR | [METHOD](#) DETAIL: [FIELD](#) | CONSTR | [METHOD](#)

*Java™ Platform
Standard Ed. 6*

javax.sound.midi

Interface Sequencer

All Superinterfaces:
[MidiDevice](#)

```
public interface Sequencer
extends MidiDevice
```

A hardware or software device that plays back a MIDI [sequence](#) is known as a *sequencer*. A MIDI sequence contains lists of time-stamped MIDI data, such as might be read from a standard MIDI file. Most sequencers also provide functions for creating and editing sequences.

Done

Amazon.com: Sams Teach Yourself Java 2 in 21 Days (2nd Edition): Laura Lemay, Rogers Cadenhead: Books - Mozilla Firefox

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http://www.amazon.com/gp/product/B00008CM4M/ref=pd_cp_b_0?p

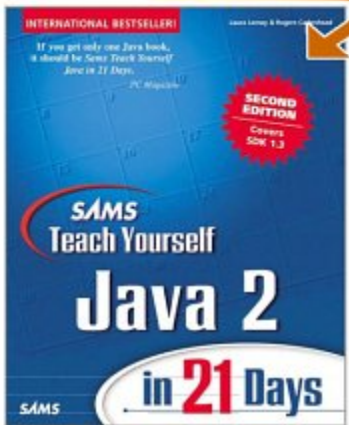
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Sams Teach Yourself Java 2 in 21 Days (2nd Edition) [BARGAIN PRICE] (Paperback)

by [Laura Lemay](#) (Author), [Rogers Cadenhead](#) (Author)

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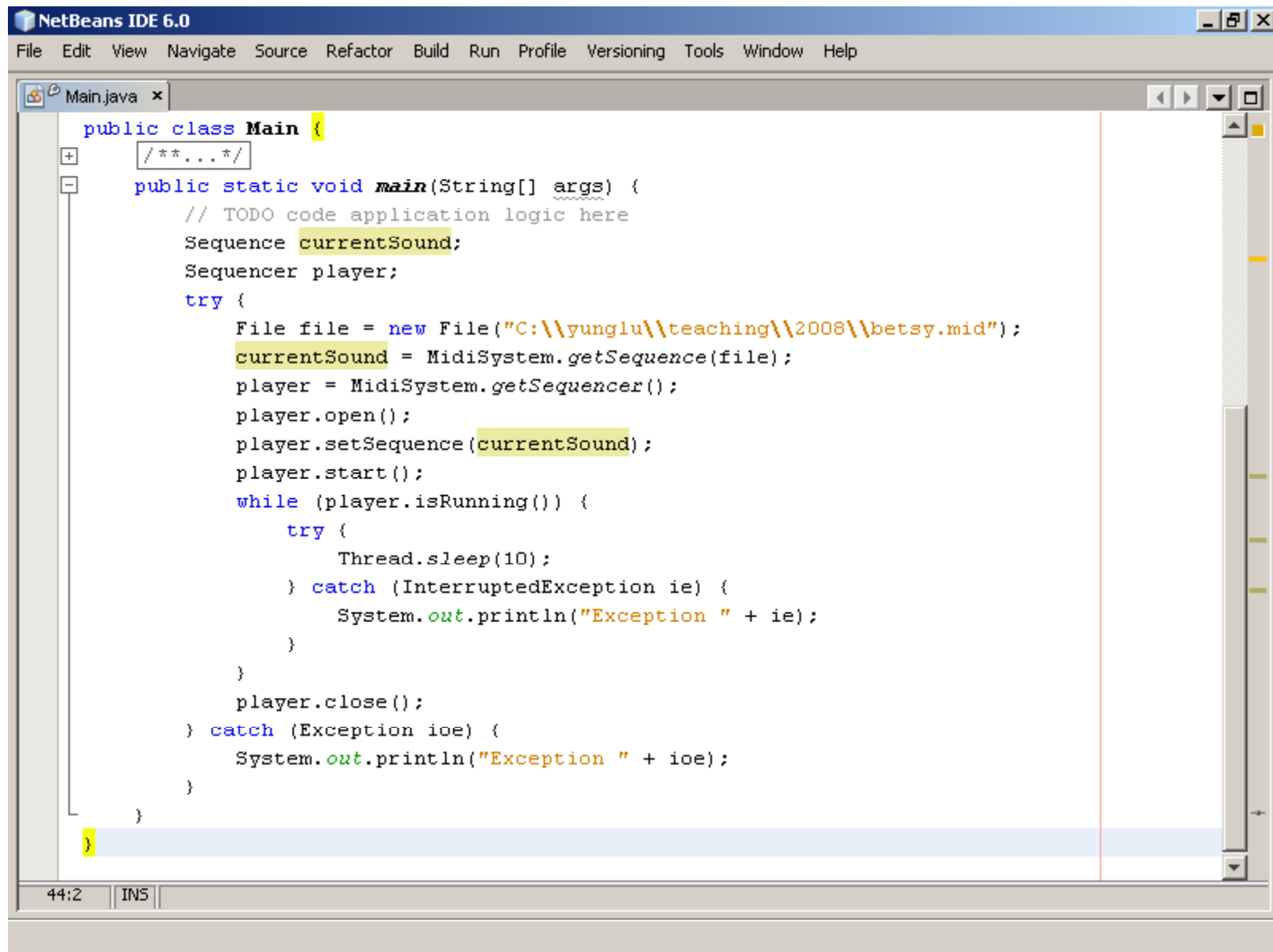
http://www.amazon.com/Books/b/ref=sv_b_4?ie=UTF8&node=549028

MIDI

(Musical Instrument Digital Interface)

- instructions for sound synthesizers (sequencers)
- .mid not recording (such as .wav files)
- music has not been played yet
- usually much smaller in file sizes
- may have high quality by good sound cards

```
File file = new File("betsy.mid");  
currentSound = MidiSystem.getSequence(file);  
player = MidiSystem.getSequencer();  
player.open();  
player.setSequence(currentSound);  
player.start();
```



MidiSystem (Java Platform SE 6) - Mozilla Firefox

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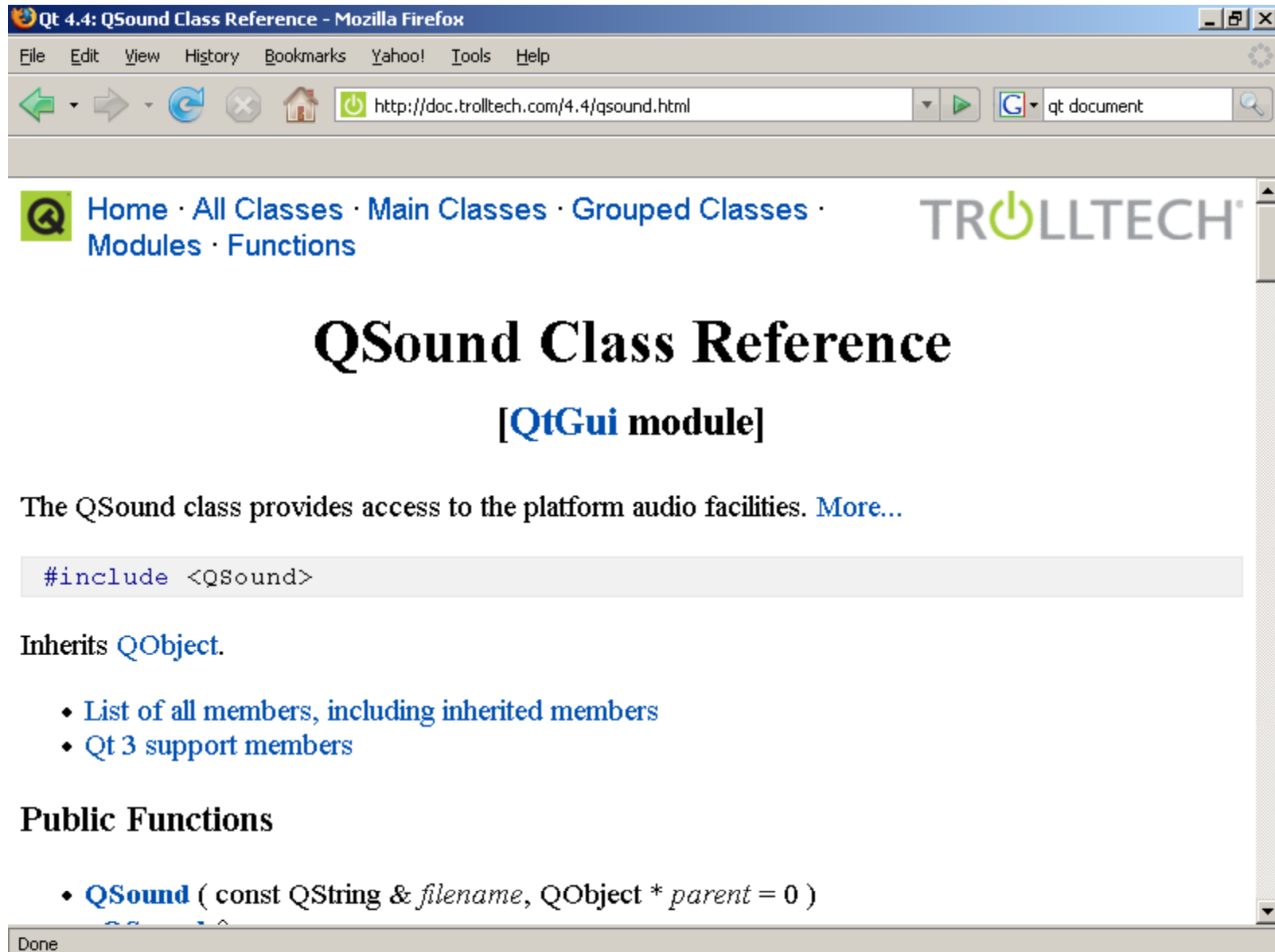
http://java.sun.com/javase/6/docs/api/javax/sound/midi/MidiSystem. midi

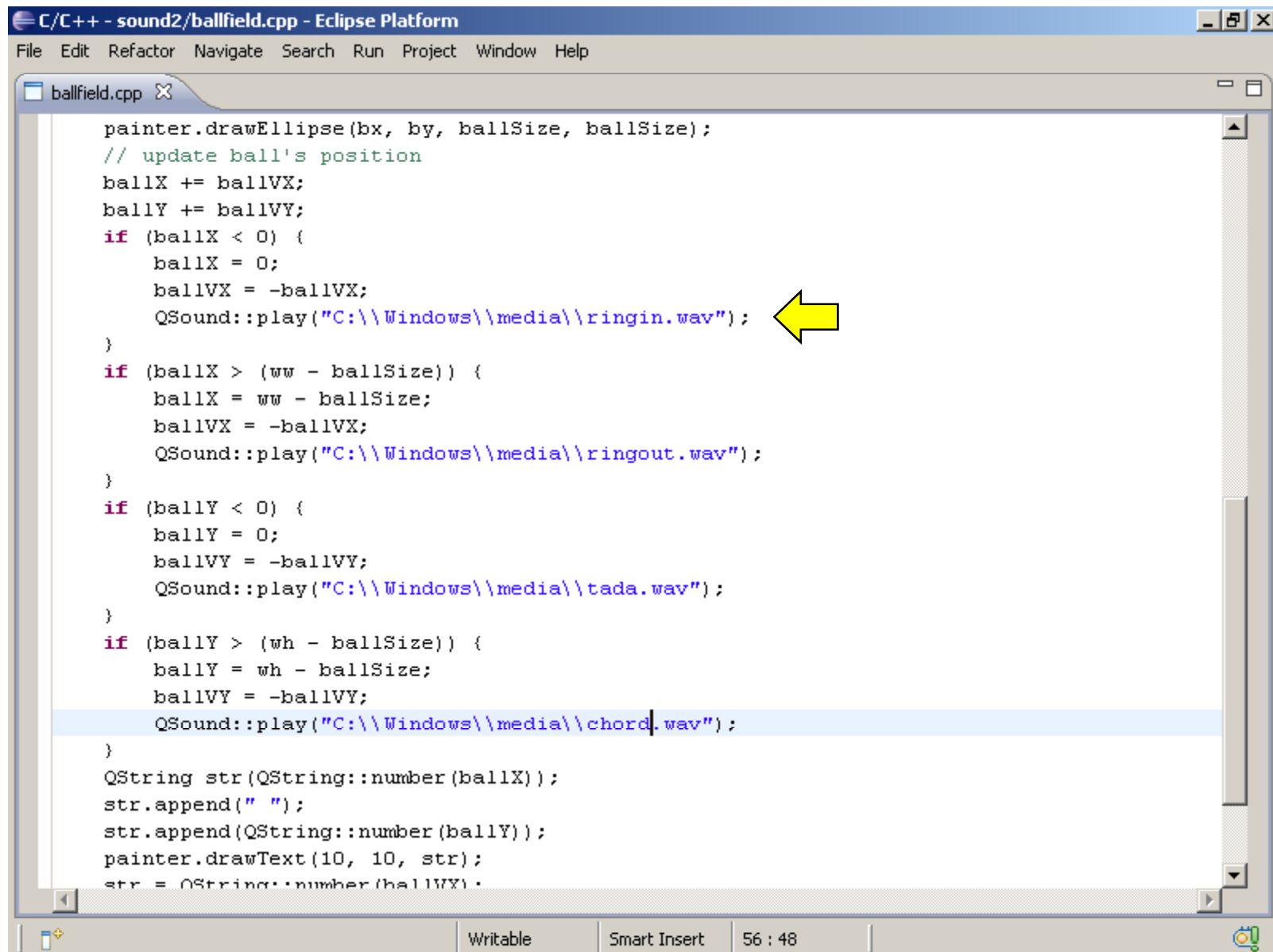
MidiSystem (Java Platform SE 6) Sequencer (Java Platform SE 6)

static Receiver	getReceiver () Obtains a MIDI receiver from an external MIDI port or other default device.
static Sequence	getSequence (File file) Obtains a MIDI sequence from the specified File.
static Sequence	getSequence (InputStream stream) Obtains a MIDI sequence from the specified input stream.
static Sequence	getSequence (URL url)  Obtains a MIDI sequence from the specified URL.
static Sequencer	getSequencer () Obtains the default sequencer connected to the system.

Done

Qt Sound

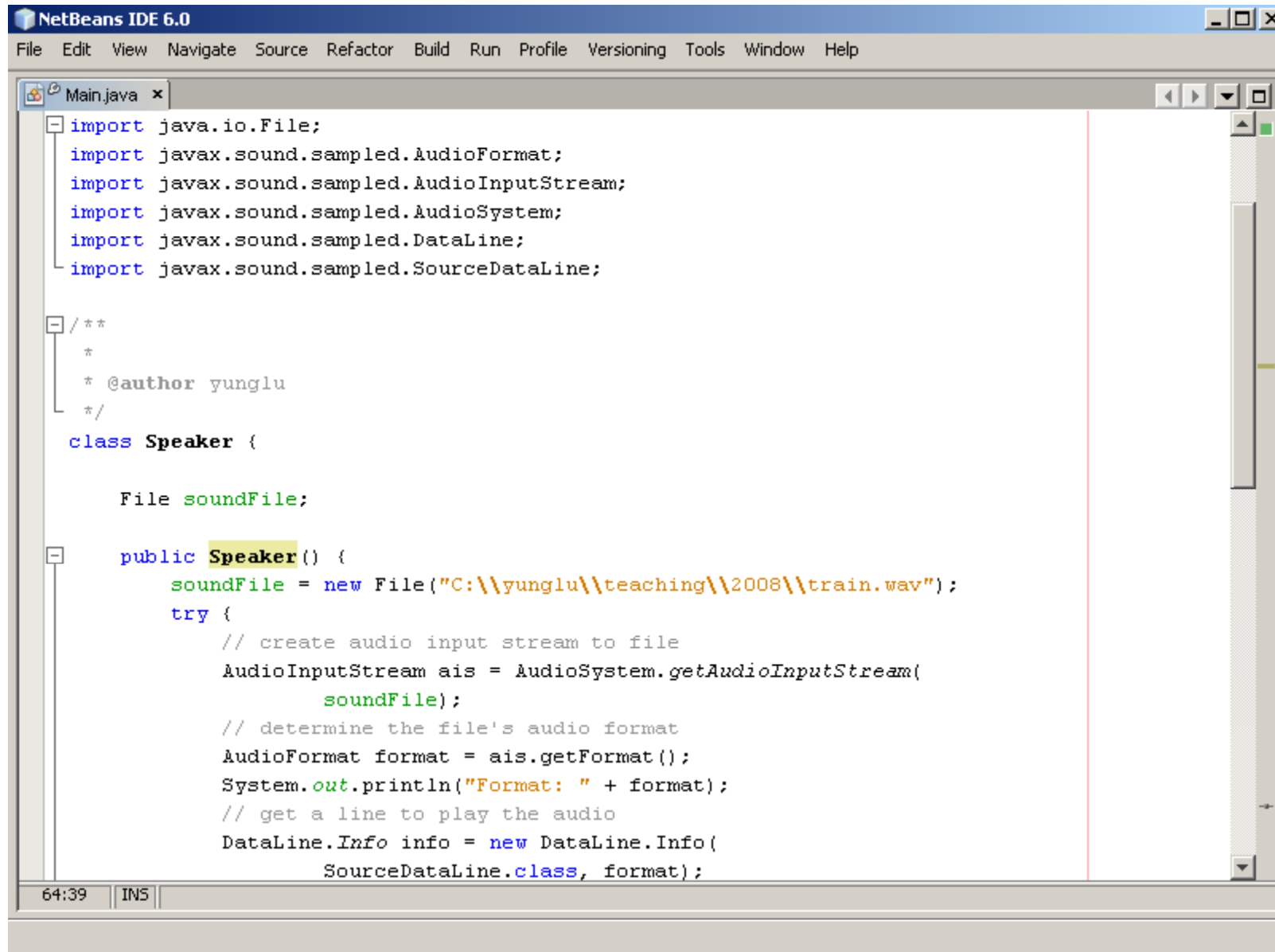




```
C/C++ - sound2/ballfield.cpp - Eclipse Platform
File Edit Refactor Navigate Search Run Project Window Help

ballfield.cpp
painter.drawEllipse(bx, by, ballSize, ballSize);
// update ball's position
ballX += ballVX;
ballY += ballVY;
if (ballX < 0) {
    ballX = 0;
    ballVX = -ballVX;
    QSound::play("C:\\Windows\\media\\ringin.wav");
}
if (ballX > (ww - ballSize)) {
    ballX = ww - ballSize;
    ballVX = -ballVX;
    QSound::play("C:\\Windows\\media\\ringout.wav");
}
if (ballY < 0) {
    ballY = 0;
    ballVY = -ballVY;
    QSound::play("C:\\Windows\\media\\tada.wav");
}
if (ballY > (wh - ballSize)) {
    ballY = wh - ballSize;
    ballVY = -ballVY;
    QSound::play("C:\\Windows\\media\\chord.wav");
}
QString str(QString::number(ballX));
str.append(" ");
str.append(QString::number(ballY));
painter.drawText(10, 10, str);
str = QString::number(ballVX);
```

Java Play Wave File



```
NetBeans IDE 6.0
File Edit View Navigate Source Refactor Build Run Profile Versioning Tools Window Help

Main.java x
import java.io.File;
import javax.sound.sampled.AudioFormat;
import javax.sound.sampled.AudioInputStream;
import javax.sound.sampled.AudioSystem;
import javax.sound.sampled.DataLine;
import javax.sound.sampled.SourceDataLine;

/**
 *
 * @author yunglu
 */
class Speaker {

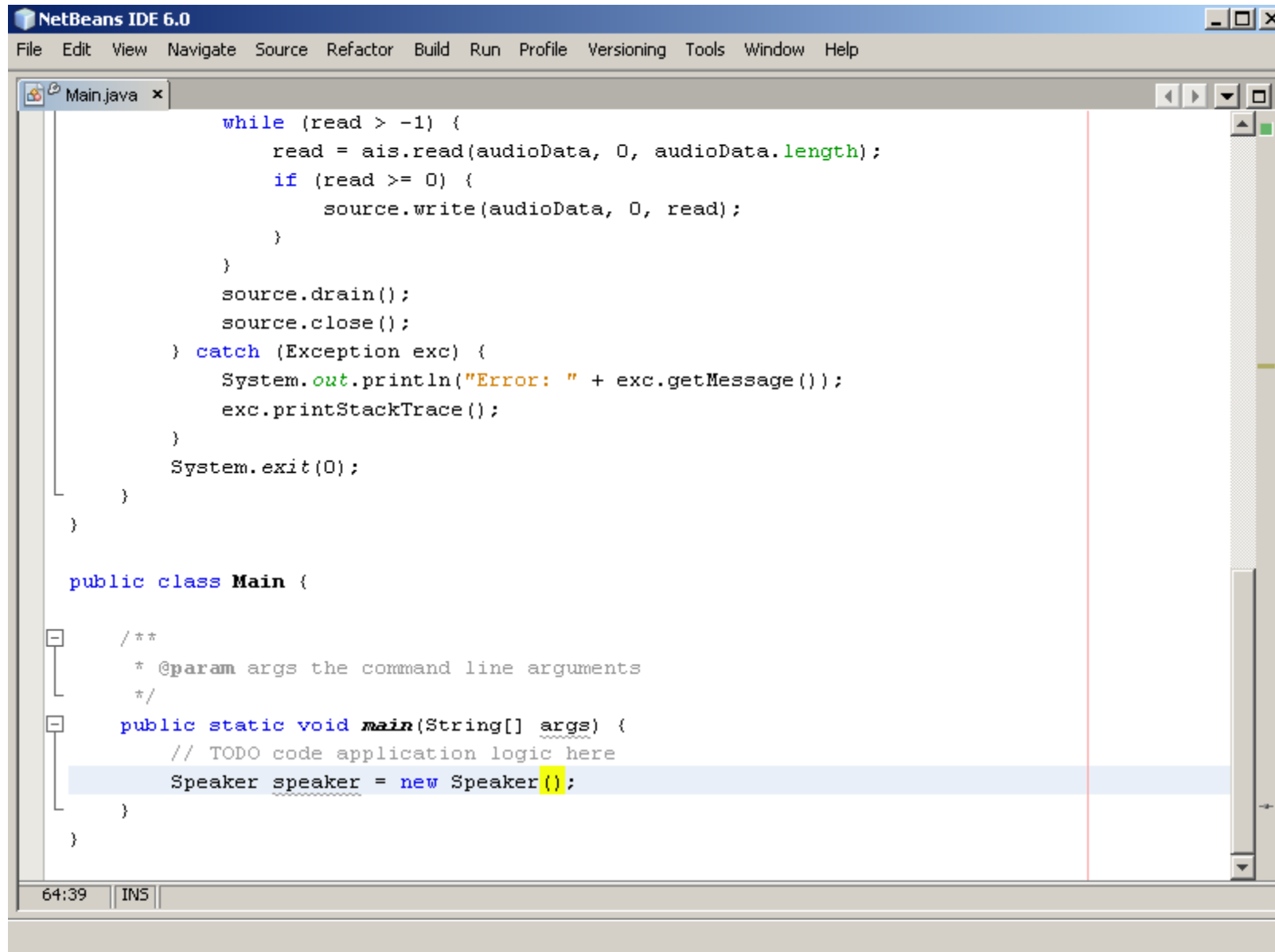
    File soundFile;

    public Speaker() {
        soundFile = new File("C:\\yunglu\\teaching\\2008\\train.wav");
        try {
            // create audio input stream to file
            AudioInputStream ais = AudioSystem.getAudioInputStream(
                soundFile);
            // determine the file's audio format
            AudioFormat format = ais.getFormat();
            System.out.println("Format: " + format);
            // get a line to play the audio
            DataLine.Info info = new DataLine.Info(
                SourceDataLine.class, format);
```

```
NetBeans IDE 6.0
File Edit View Navigate Source Refactor Build Run Profile Versioning Tools Window Help

Main.java x
// get a line to play the audio
DataLine.Info info = new DataLine.Info(
    SourceDataLine.class, format);
SourceDataLine source = (SourceDataLine) AudioSystem.getLine(
    info);
// play the file
source.open(format);
source.start();
int read = 0;
byte[] audioData = new byte[16384];
while (read > -1) {
    read = ais.read(audioData, 0, audioData.length);
    if (read >= 0) {
        source.write(audioData, 0, read);
    }
}
source.drain();
source.close();
} catch (Exception exc) {
    System.out.println("Error: " + exc.getMessage());
    exc.printStackTrace();
}
System.exit(0);
}

public class Main {
64:39 INS
```



ECE 462

Object-Oriented Programming

using C++ and Java

Performance Profile

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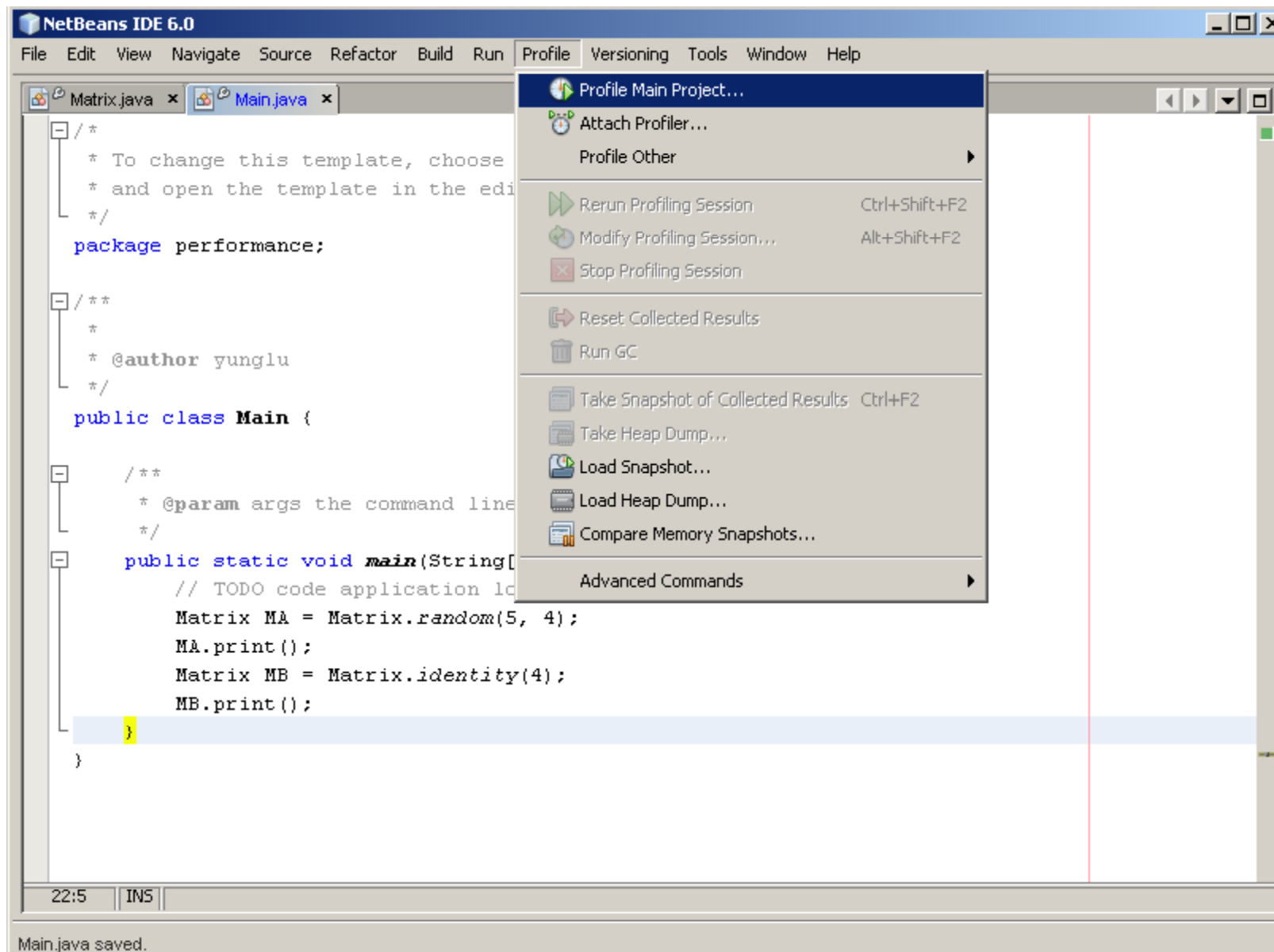
Program Performance

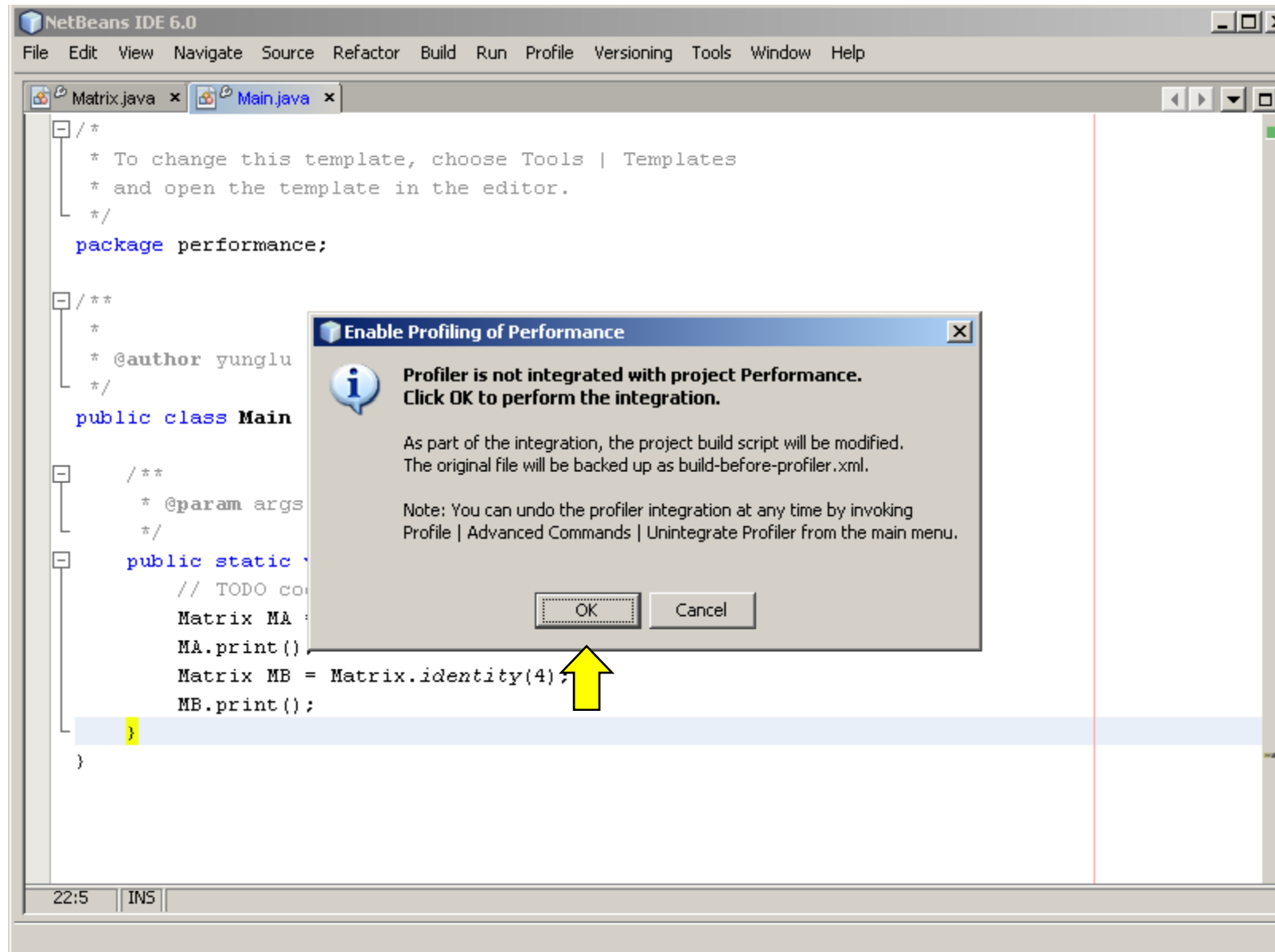
- In many cases, performance decides success.
 - # transactions
 - response time for collision detection and avoidance on airplanes
 - multimedia (video, music, voice ...)
 - interactive games
 - handwriting or voice recognition
- A successful software developer must pay attention to performance.

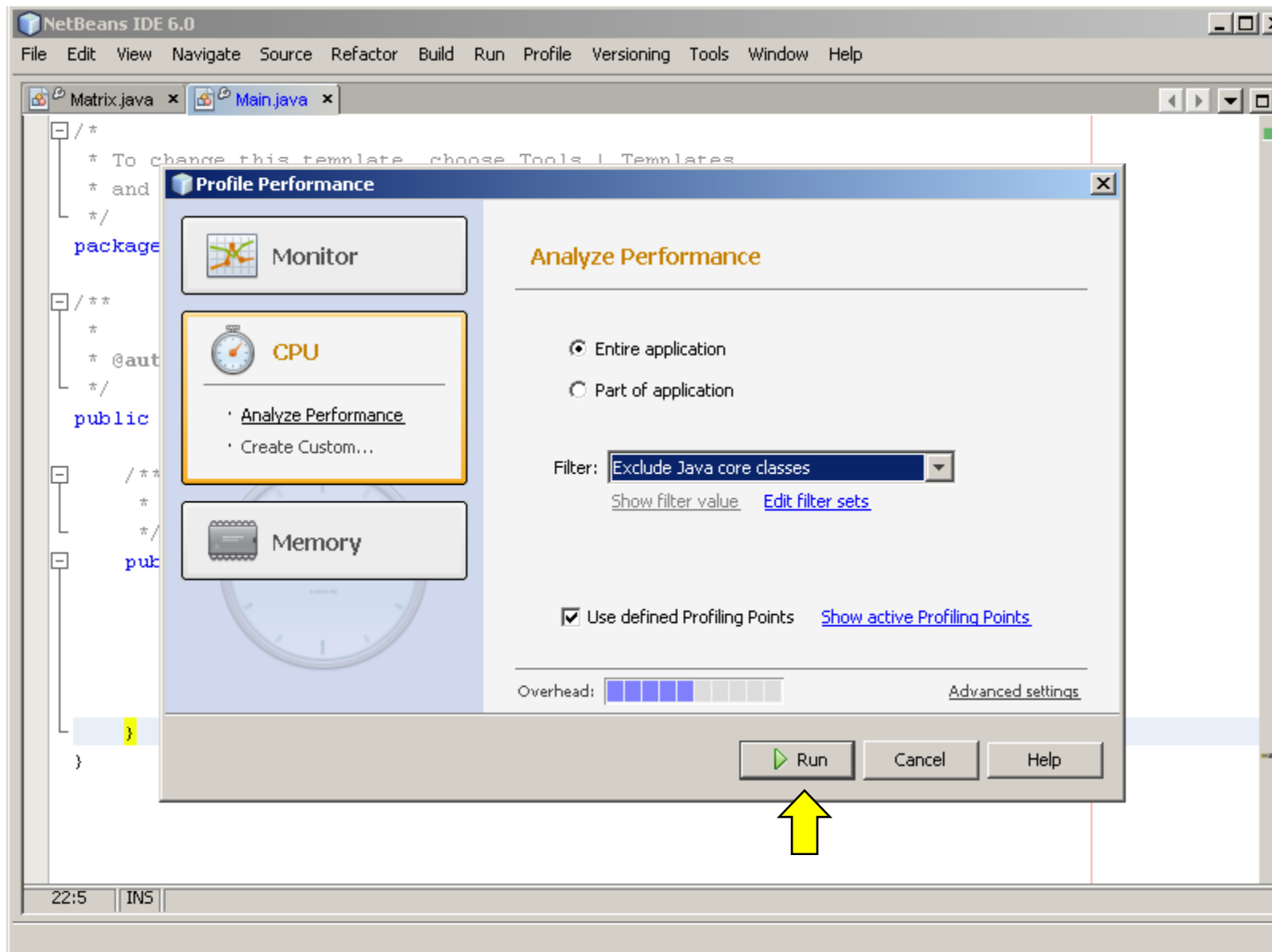
Performance Improvement

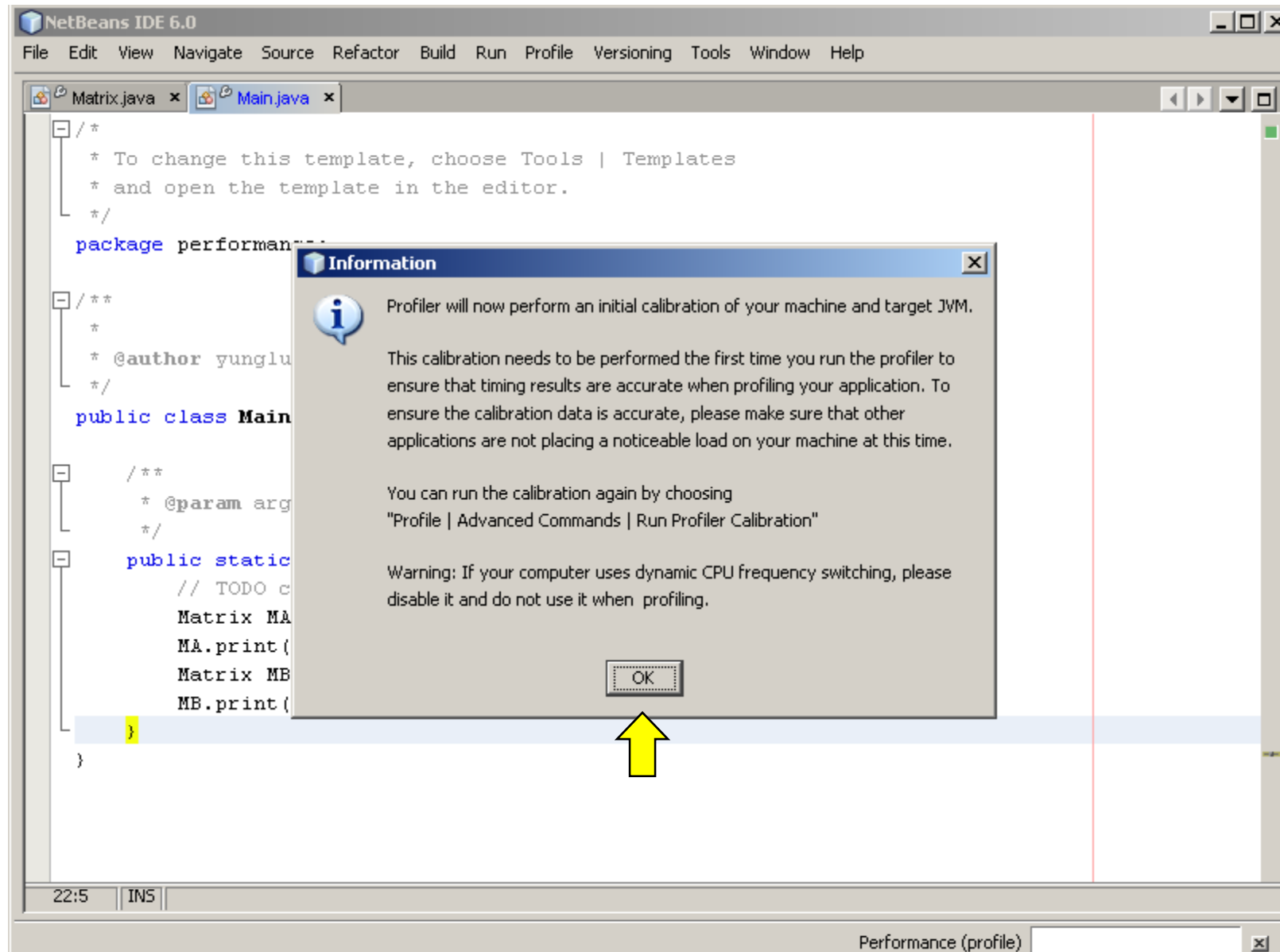
- make programs modular $\Rightarrow$ easier to understand where time is spent
- Keep It Simple (KIS)
- learn better algorithms and use well-known algorithms
- understand problems' requirements and limitations
- find approximate solutions, if they are good enough
- put your efforts at the right place $\Rightarrow$ know what matters

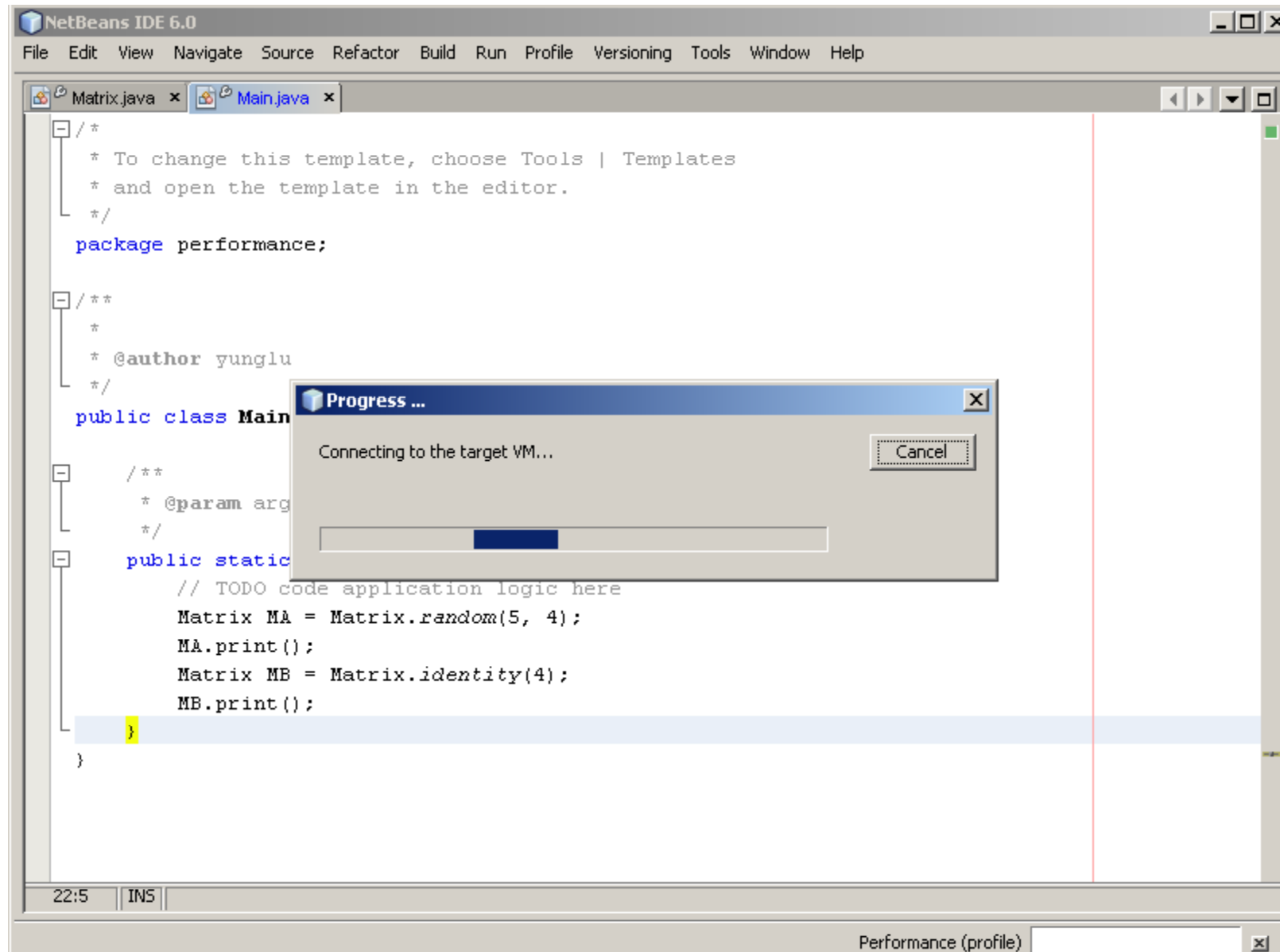
Profiling in Netbeans

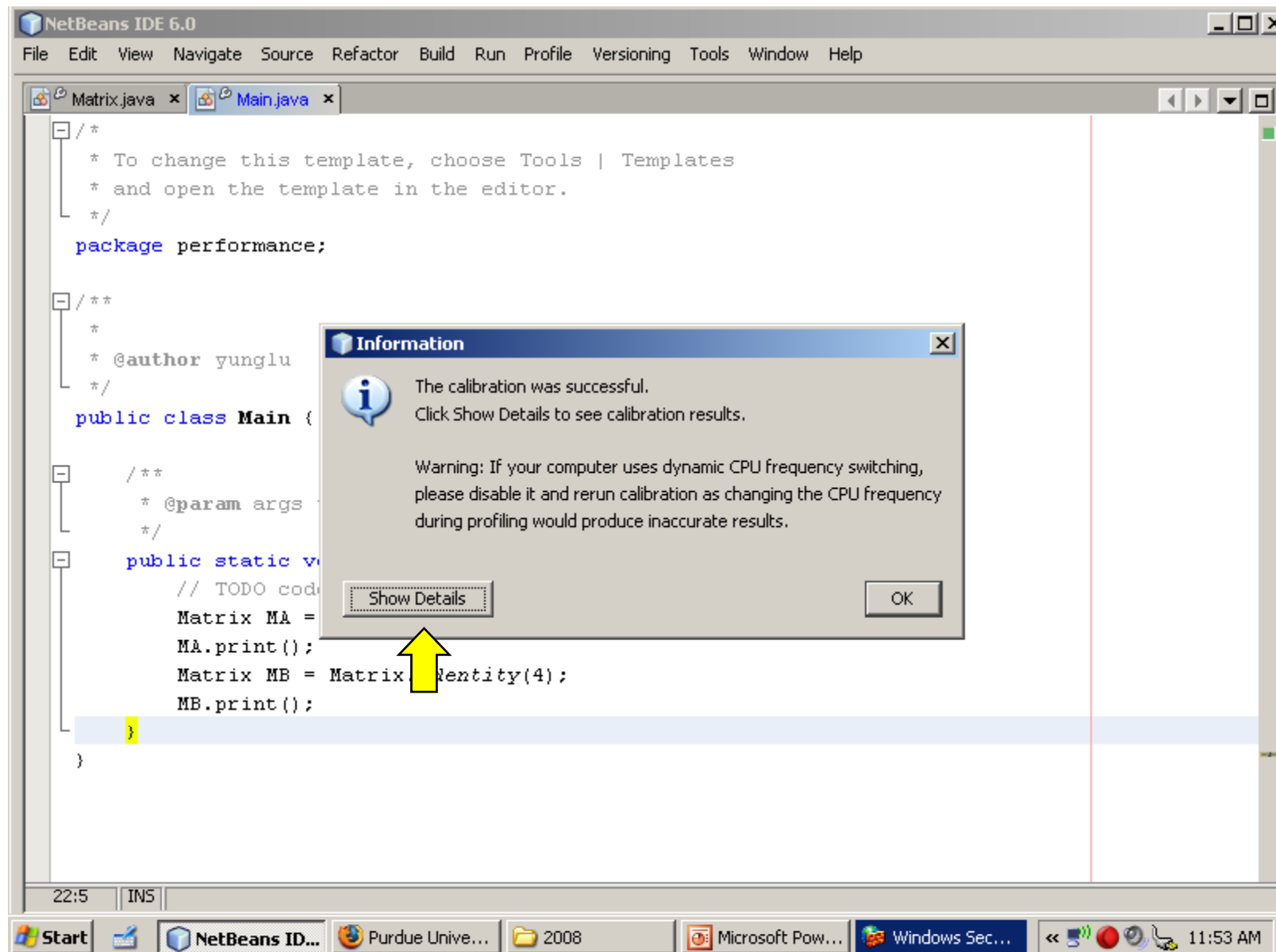












NetBeans IDE 6.0

File Edit View Navigate Source Refactor Build Run Profile Versioning Tools Window Help

Profiler

Matrix.java x Main.java x CPU: 11:54:35 AM * x

View: Methods

Call Tree - Method	Time [%]	Time	Invocations
All threads		149 ms (100%)	1
main		149 ms (100%)	1
performance.Main.main (String[])		149 ms (100%)	1
performance.Matrix.print ()		145 ms (97.2%)	2
Self time		4.4 ms (2.7%)	1
performance.Matrix.random (int, int)		0.164 ms (0.1%)	1
performance.Matrix.identity (int)		0.024 ms (0%)	1

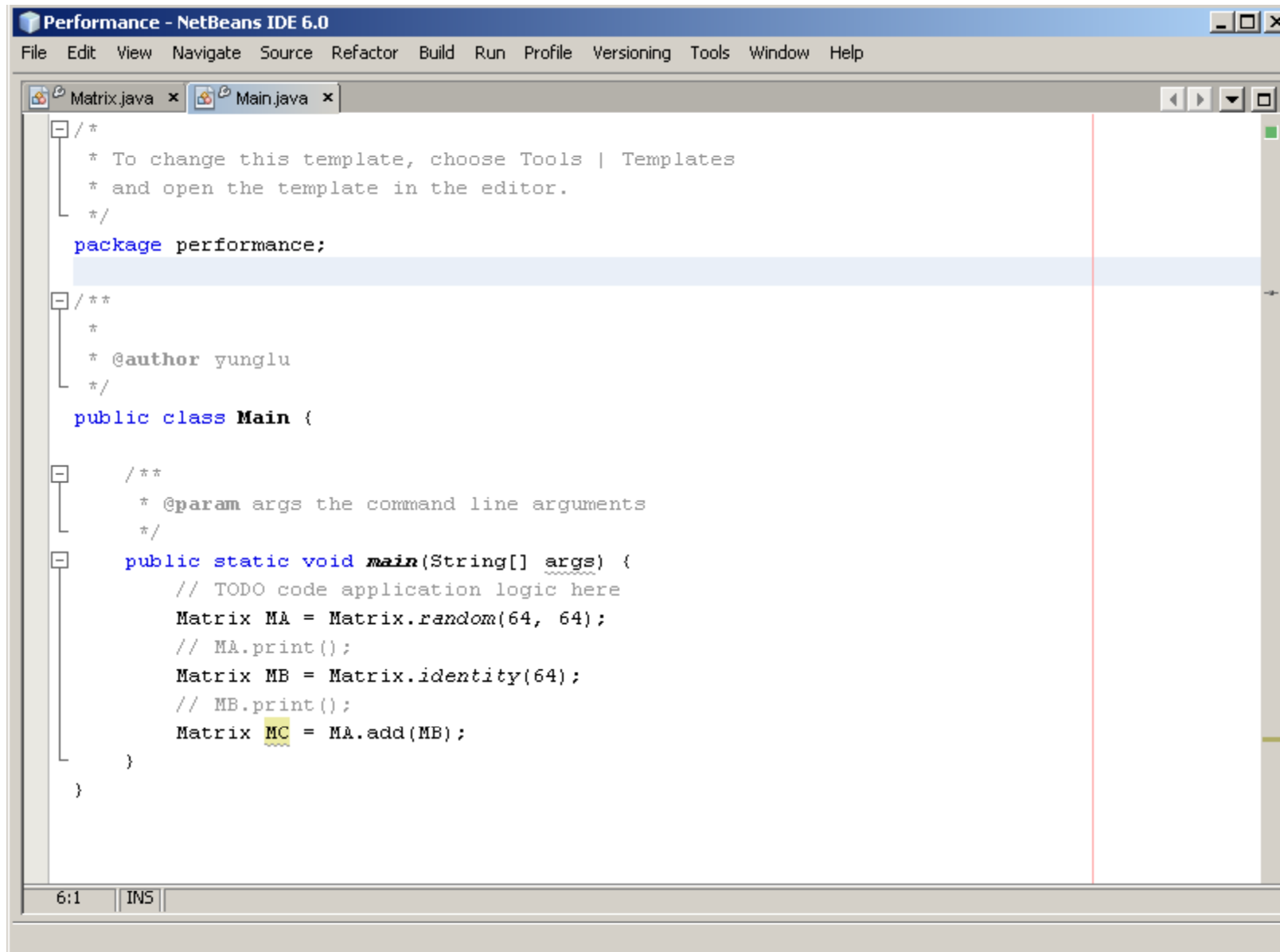
Call Tree Hot Spots Combined Info

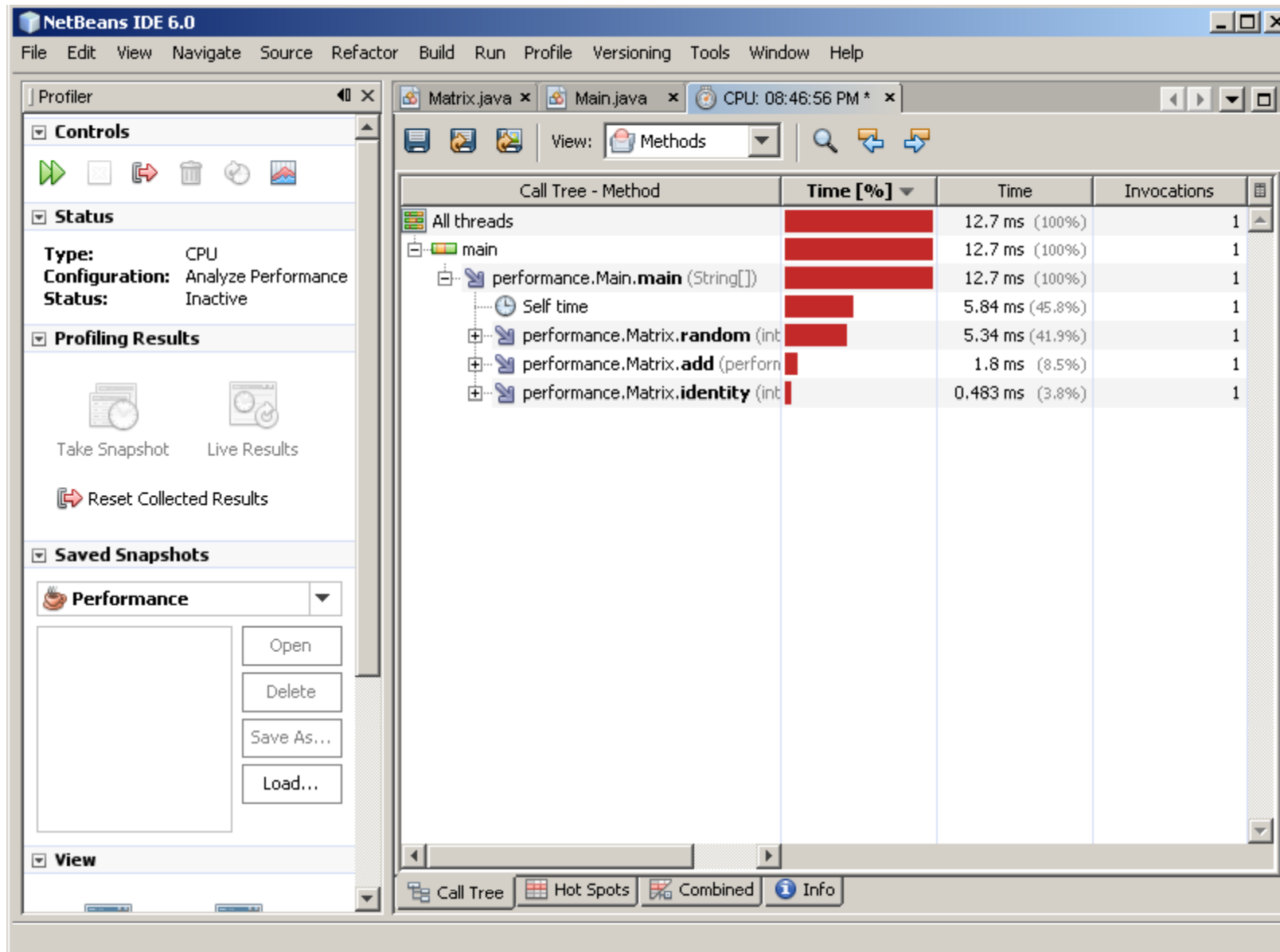
Output

```

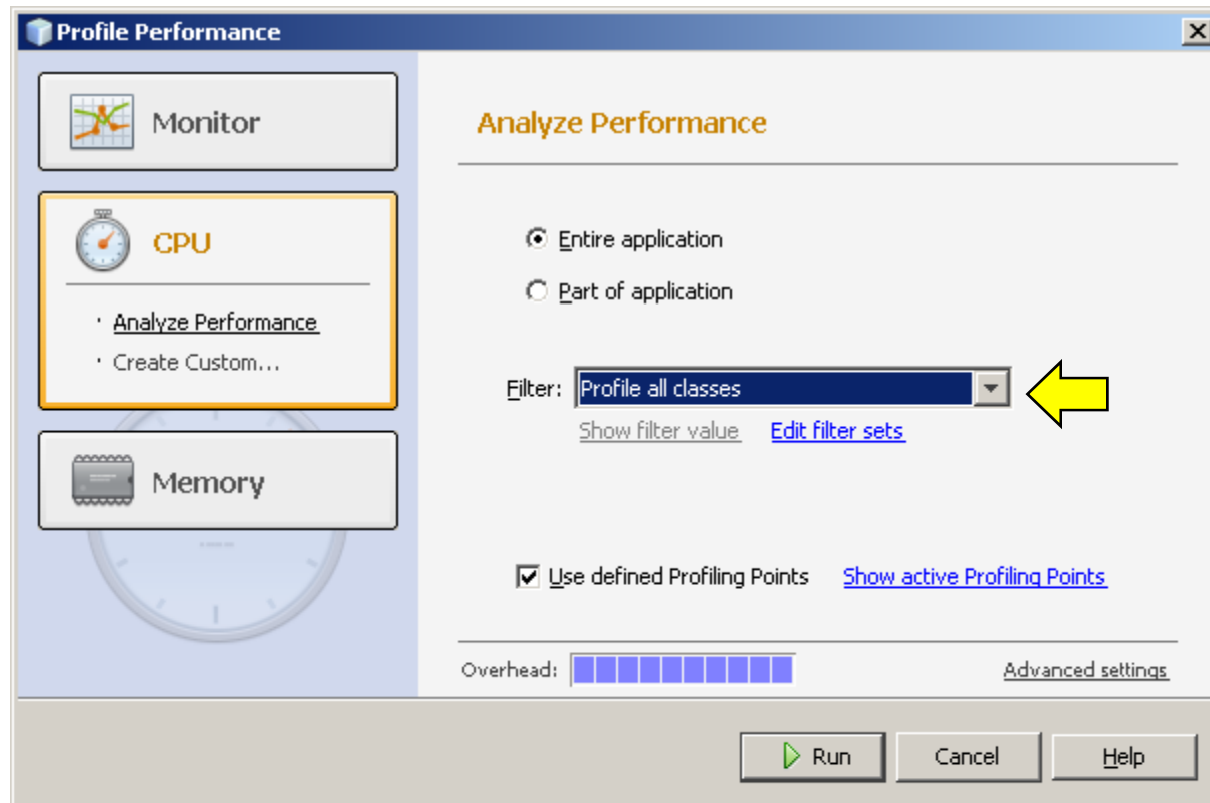
:ext:ee462b30@msee190pc6.ecn.purdue.edu:/home/shay/a/ee462b30/projects x Performance (profile) x
Profiler Agent: Initializing...
Profiler Agent: Options: >C:\yunglu\programs\netbeans\NetBeans 6.0\profiler2\lib,5140,10<
Profiler Agent: Initialized successfully
BUILD SUCCESSFUL (total time: 1 minute 57 seconds)

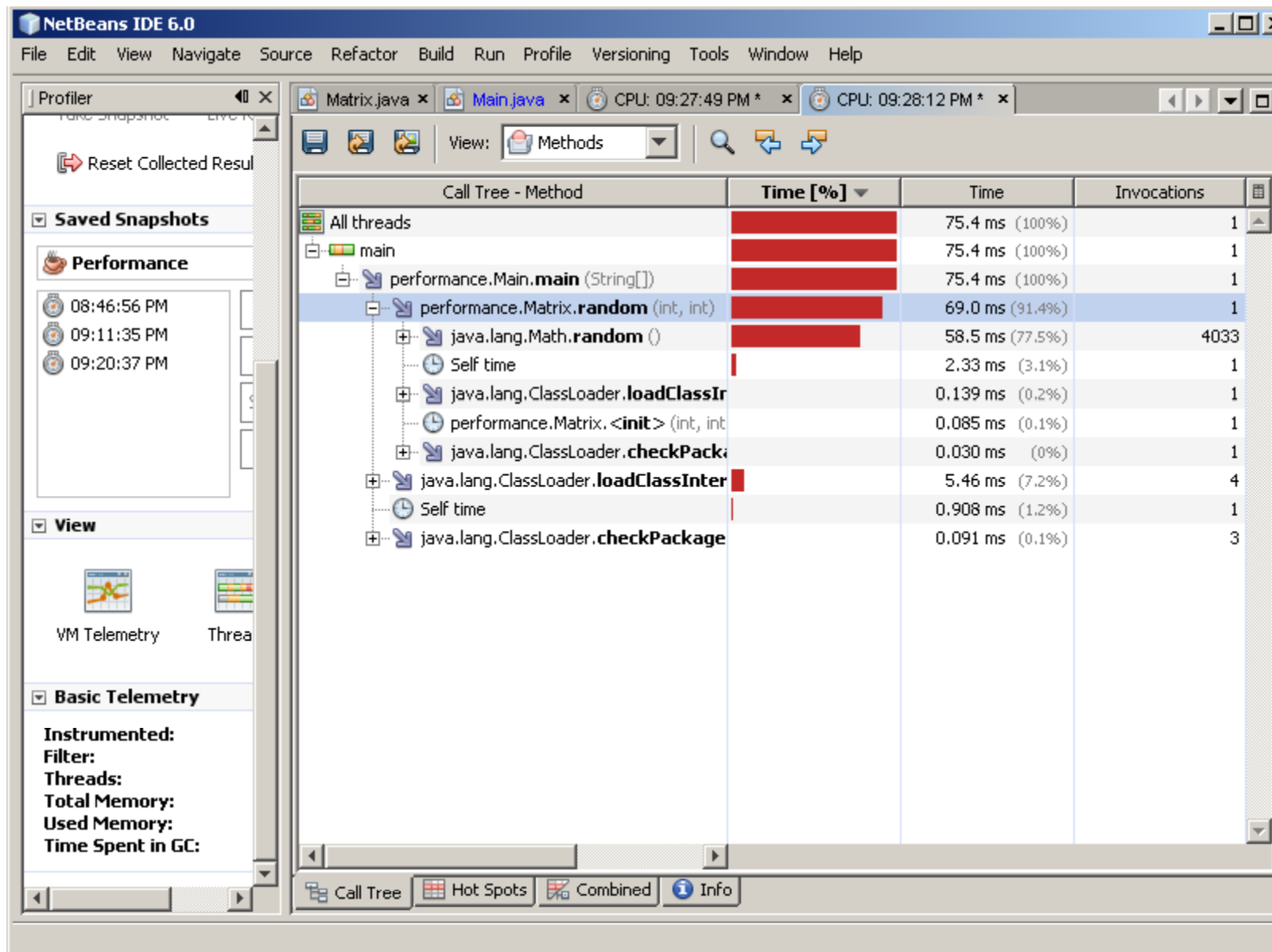
```

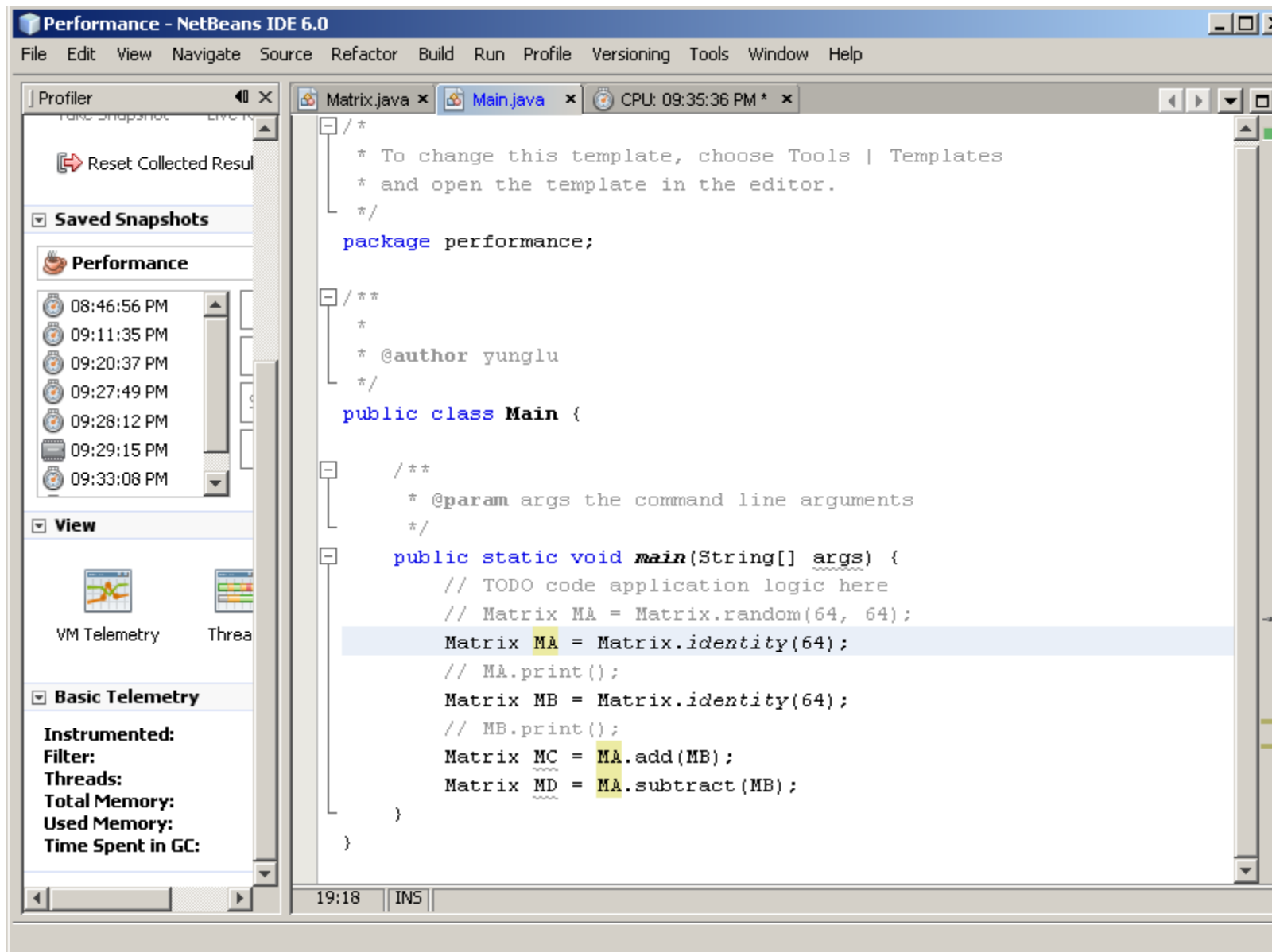


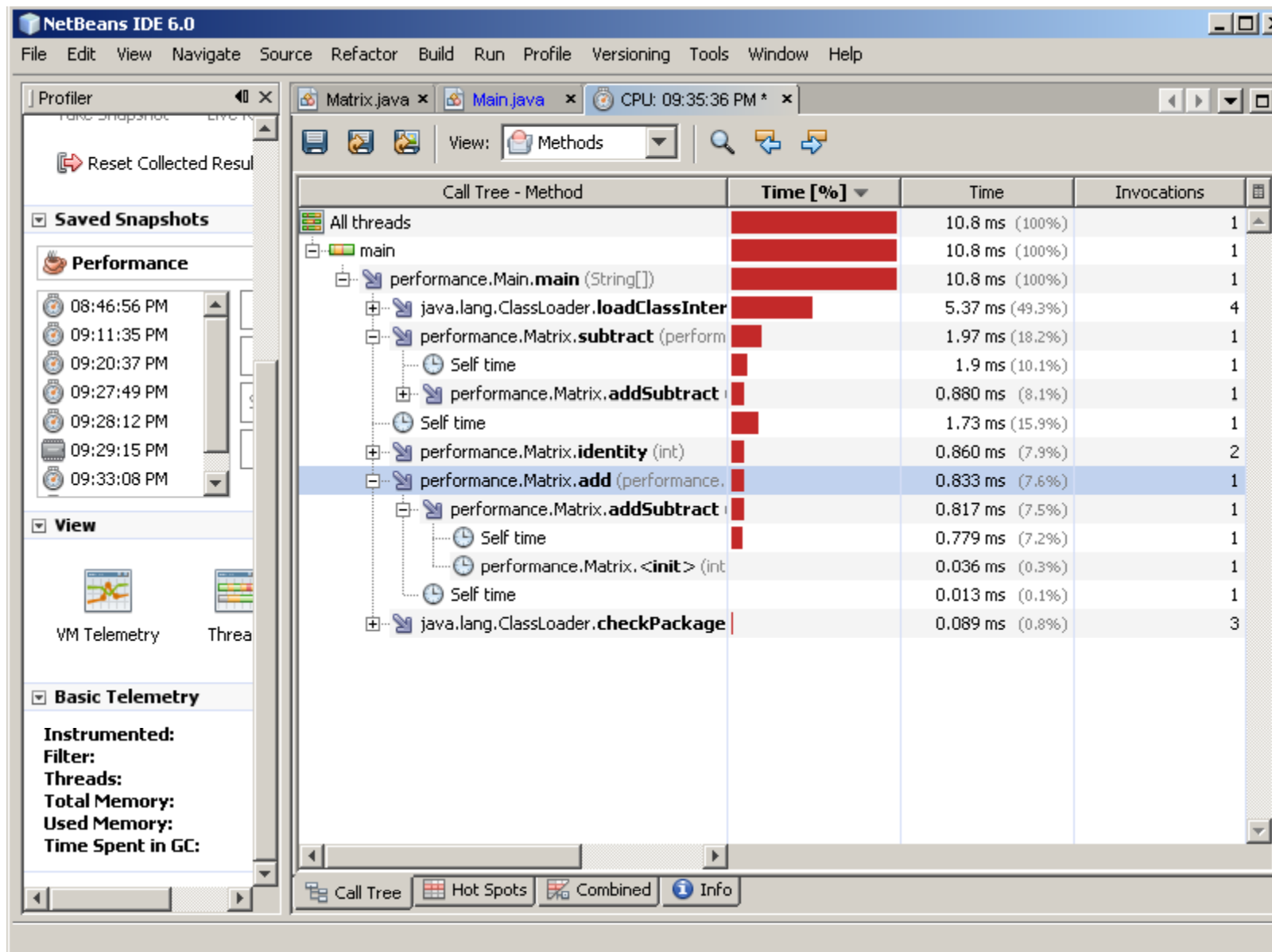


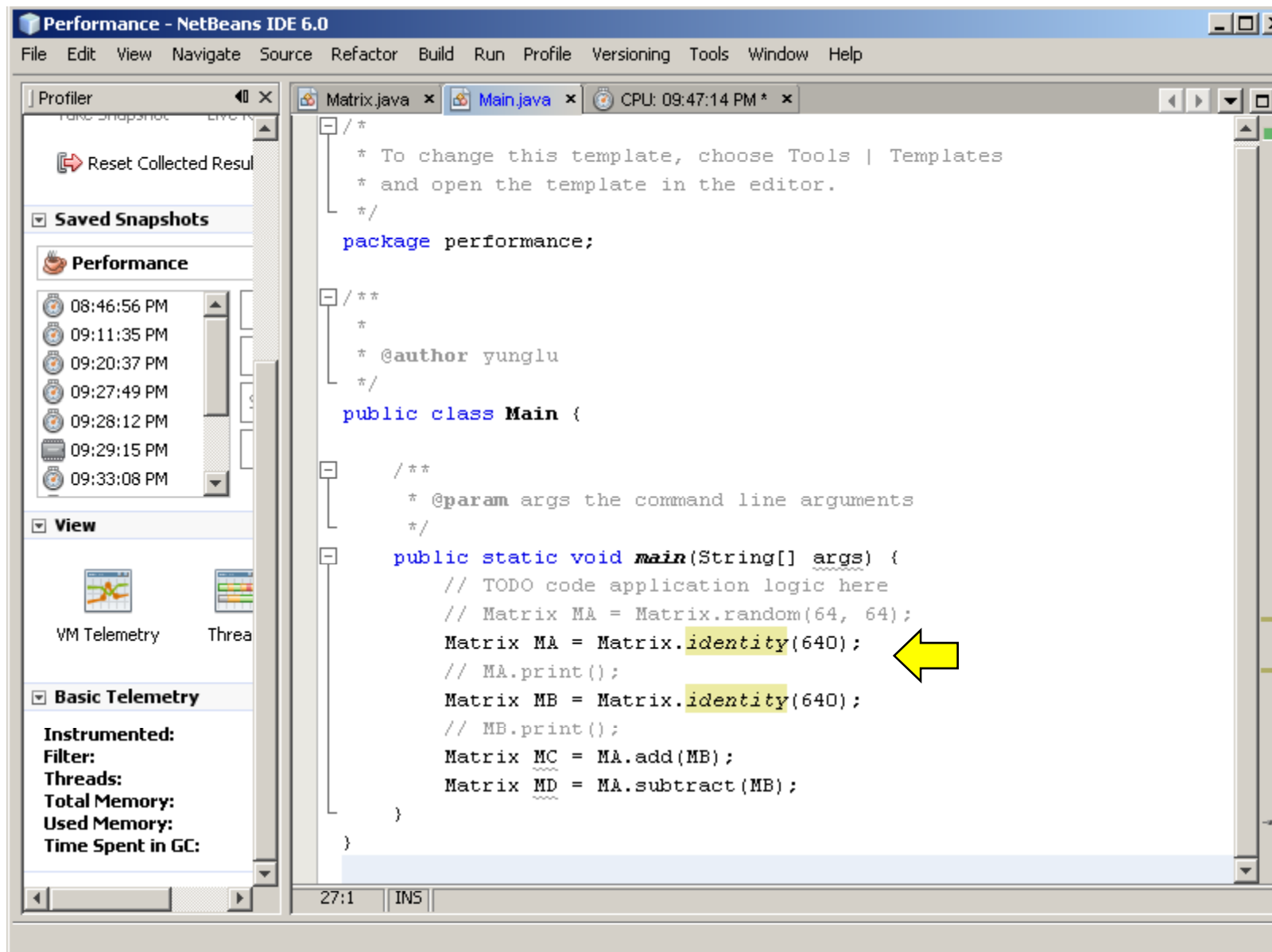
Include Java Core

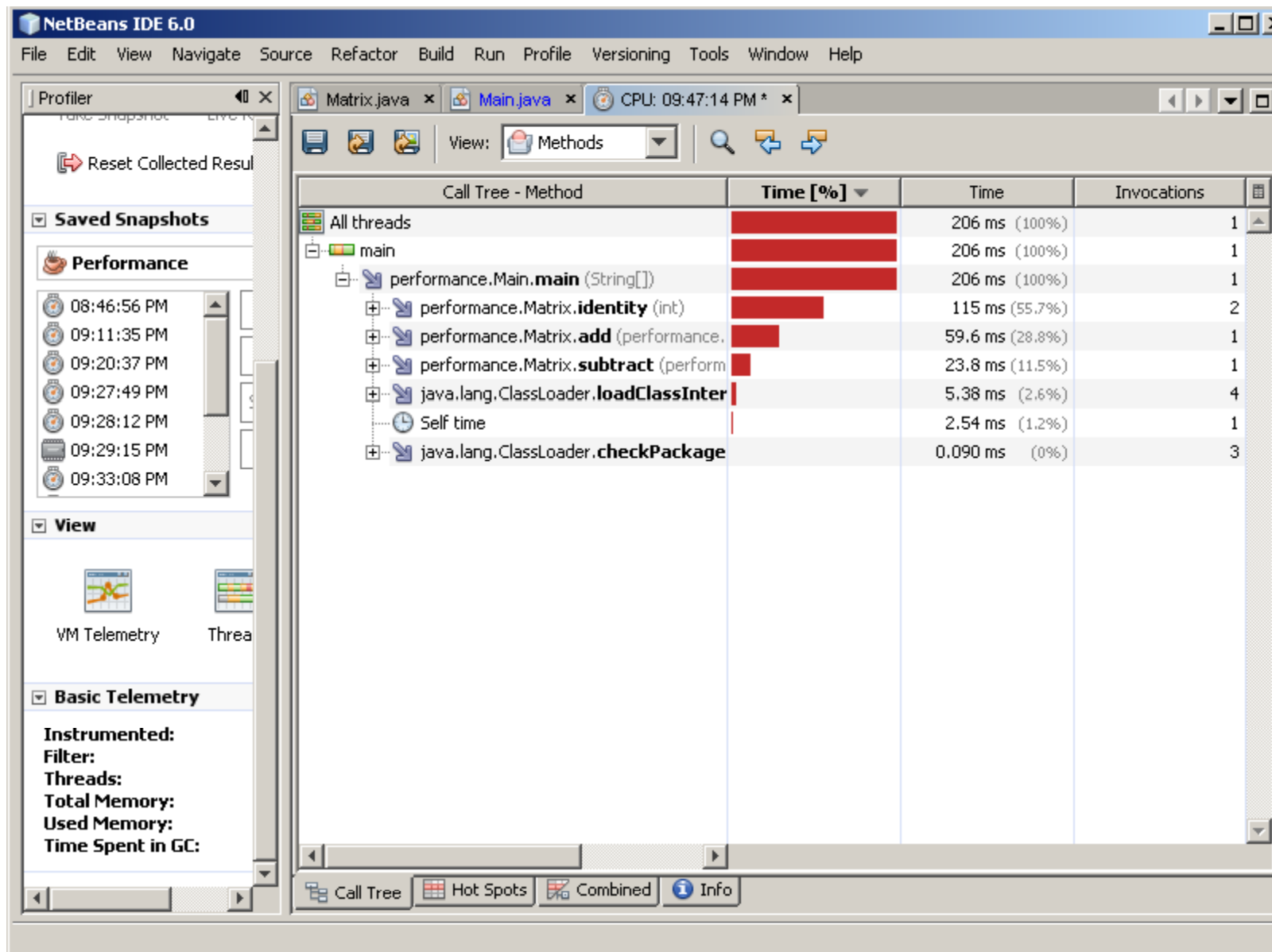












Netbeans Profiler

ECE 462

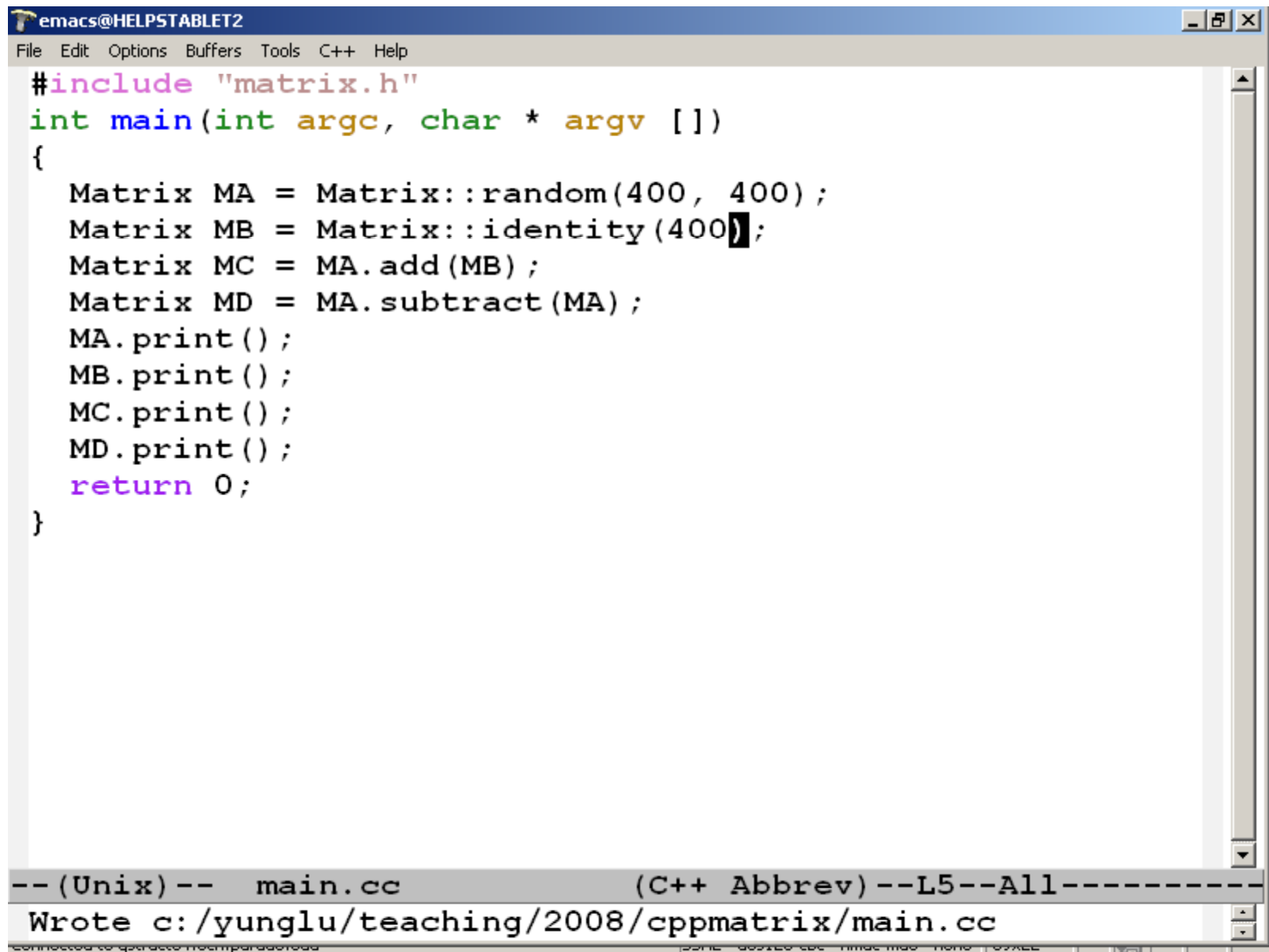
Object-Oriented Programming

using C++ and Java

C++ Performance Profile

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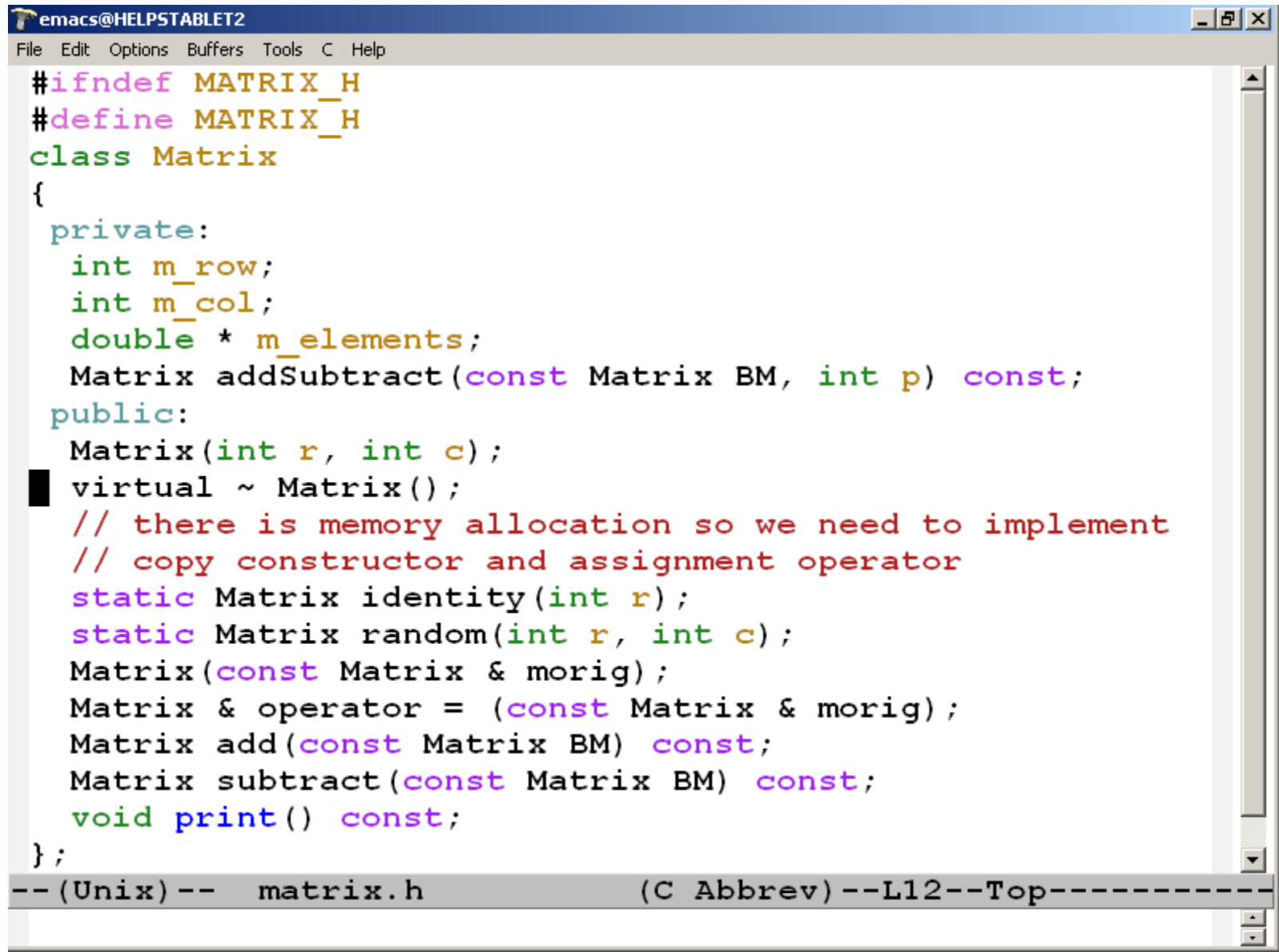
Using gprof



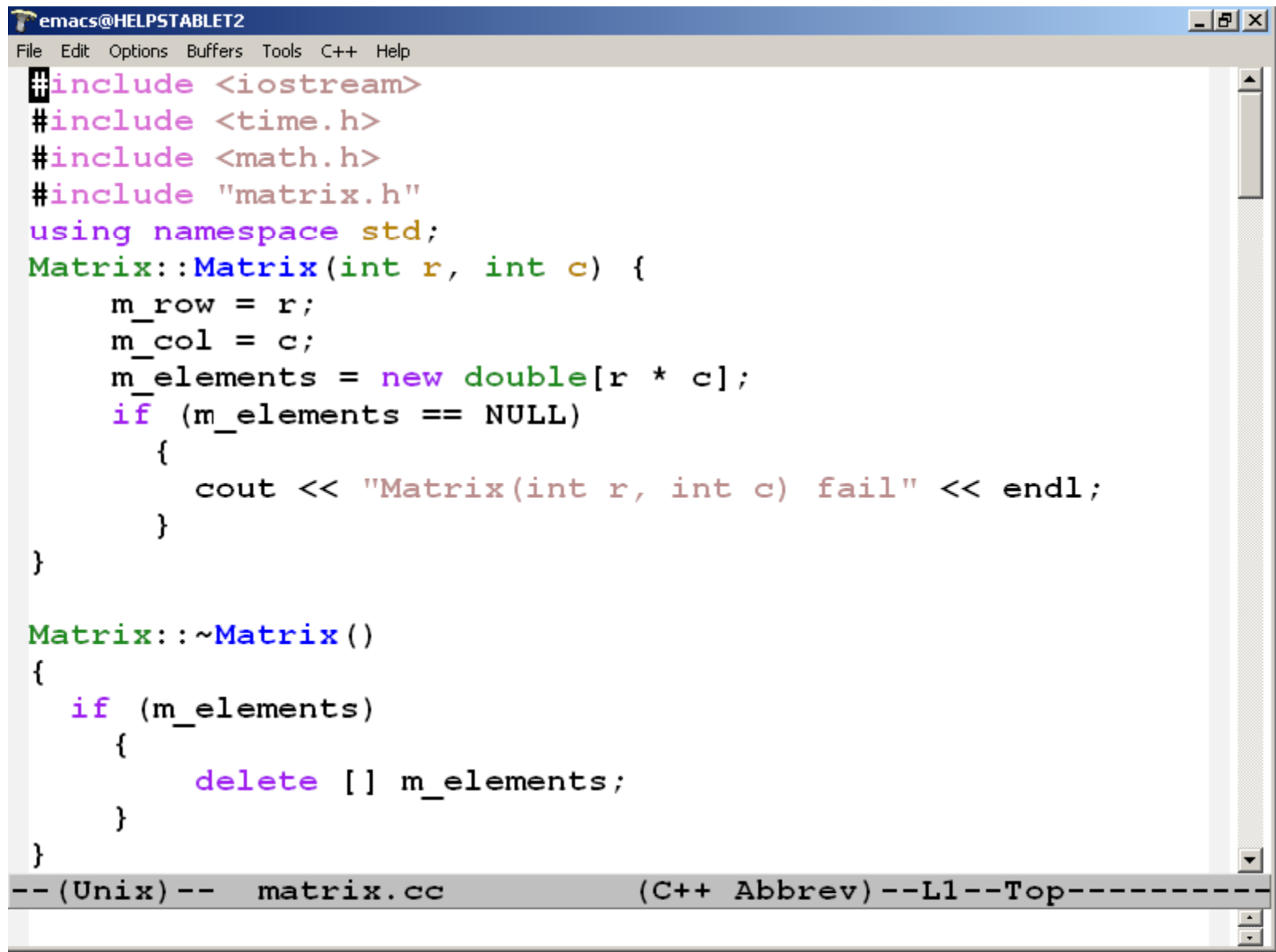
The image shows a screenshot of an Emacs editor window. The title bar at the top reads "emacs@HELPSTABLET2". Below the title bar is a menu bar with the following items: "File", "Edit", "Options", "Buffers", "Tools", "C++", and "Help". The main editing area contains the following C++ code:

```
#include "matrix.h"
int main(int argc, char * argv [])
{
    Matrix MA = Matrix::random(400, 400);
    Matrix MB = Matrix::identity(400);
    Matrix MC = MA.add(MB);
    Matrix MD = MA.subtract(MA);
    MA.print();
    MB.print();
    MC.print();
    MD.print();
    return 0;
}
```

At the bottom of the window, there is a status bar with the following text: "-- (Unix) -- main.cc (C++ Abbrev) --L5--All-----". Below the status bar, there is a message: "Wrote c:/yunglu/teaching/2008/cppmatrix/main.cc".



```
emacs@HELPSTABLET2
File Edit Options Buffers Tools C Help
#ifndef MATRIX_H
#define MATRIX_H
class Matrix
{
private:
    int m_row;
    int m_col;
    double * m_elements;
    Matrix addSubtract(const Matrix BM, int p) const;
public:
    Matrix(int r, int c);
    virtual ~ Matrix();
    // there is memory allocation so we need to implement
    // copy constructor and assignment operator
    static Matrix identity(int r);
    static Matrix random(int r, int c);
    Matrix(const Matrix & morig);
    Matrix & operator = (const Matrix & morig);
    Matrix add(const Matrix BM) const;
    Matrix subtract(const Matrix BM) const;
    void print() const;
};
--(Unix)-- matrix.h (C Abbrev)--L12--Top-----
```

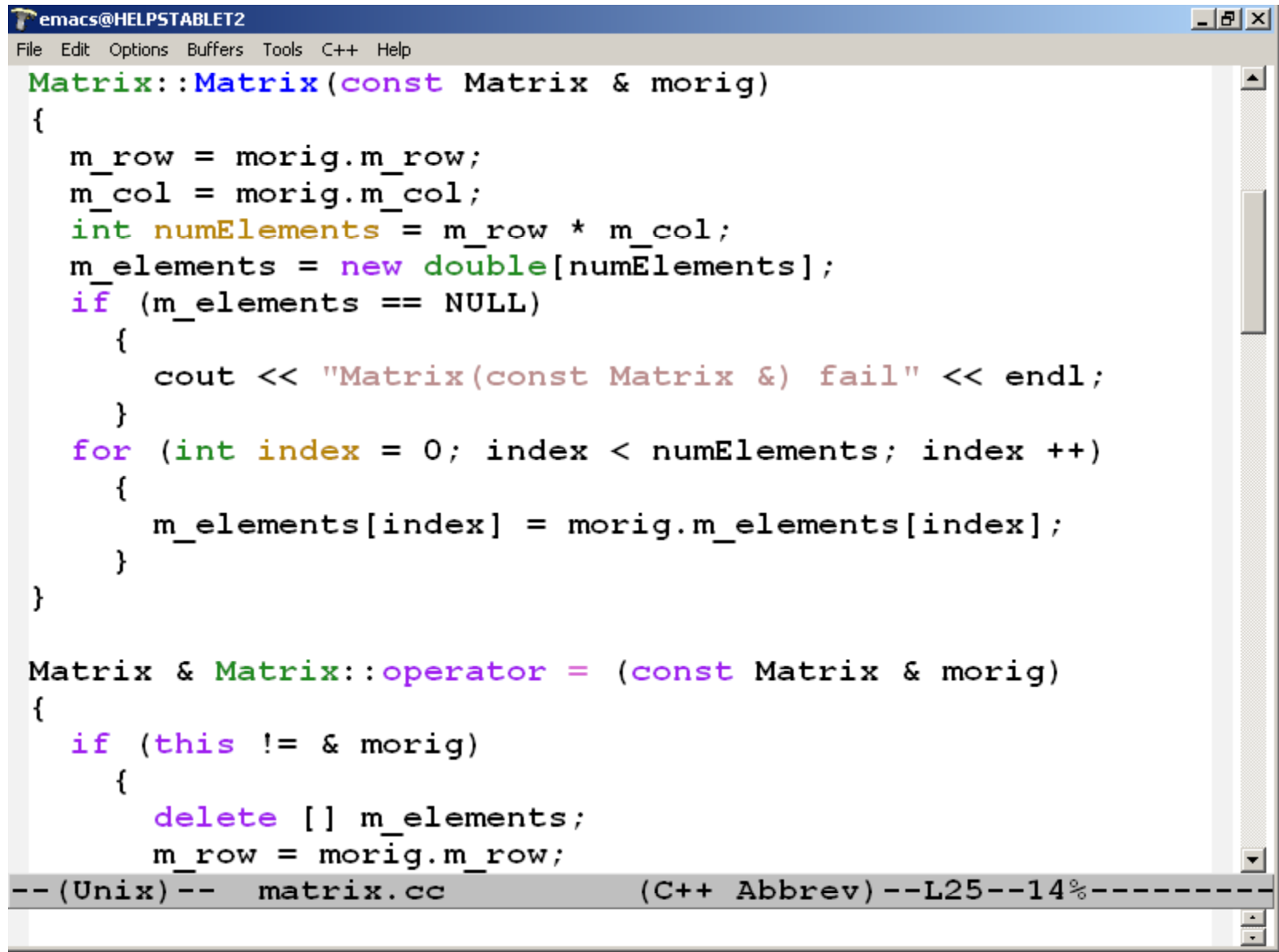


The image shows a screenshot of an Emacs editor window. The title bar at the top reads "emacs@HELPSTABLET2". Below the title bar is a menu bar with the following items: "File", "Edit", "Options", "Buffers", "Tools", "C++", and "Help". The main editing area contains C++ code for a Matrix class. The code is color-coded: preprocessor directives are pink, namespace and variable names are blue, and other identifiers are green. The code defines a Matrix class with a constructor, a destructor, and a data member array. The status bar at the bottom of the window displays "-- (Unix) -- matrix.cc (C++ Abbrev) --L1--Top-----".

```
#include <iostream>
#include <time.h>
#include <math.h>
#include "matrix.h"
using namespace std;
Matrix::Matrix(int r, int c) {
    m_row = r;
    m_col = c;
    m_elements = new double[r * c];
    if (m_elements == NULL)
    {
        cout << "Matrix(int r, int c) fail" << endl;
    }
}

Matrix::~Matrix()
{
    if (m_elements)
    {
        delete [] m_elements;
    }
}

-- (Unix) -- matrix.cc (C++ Abbrev) --L1--Top-----
```

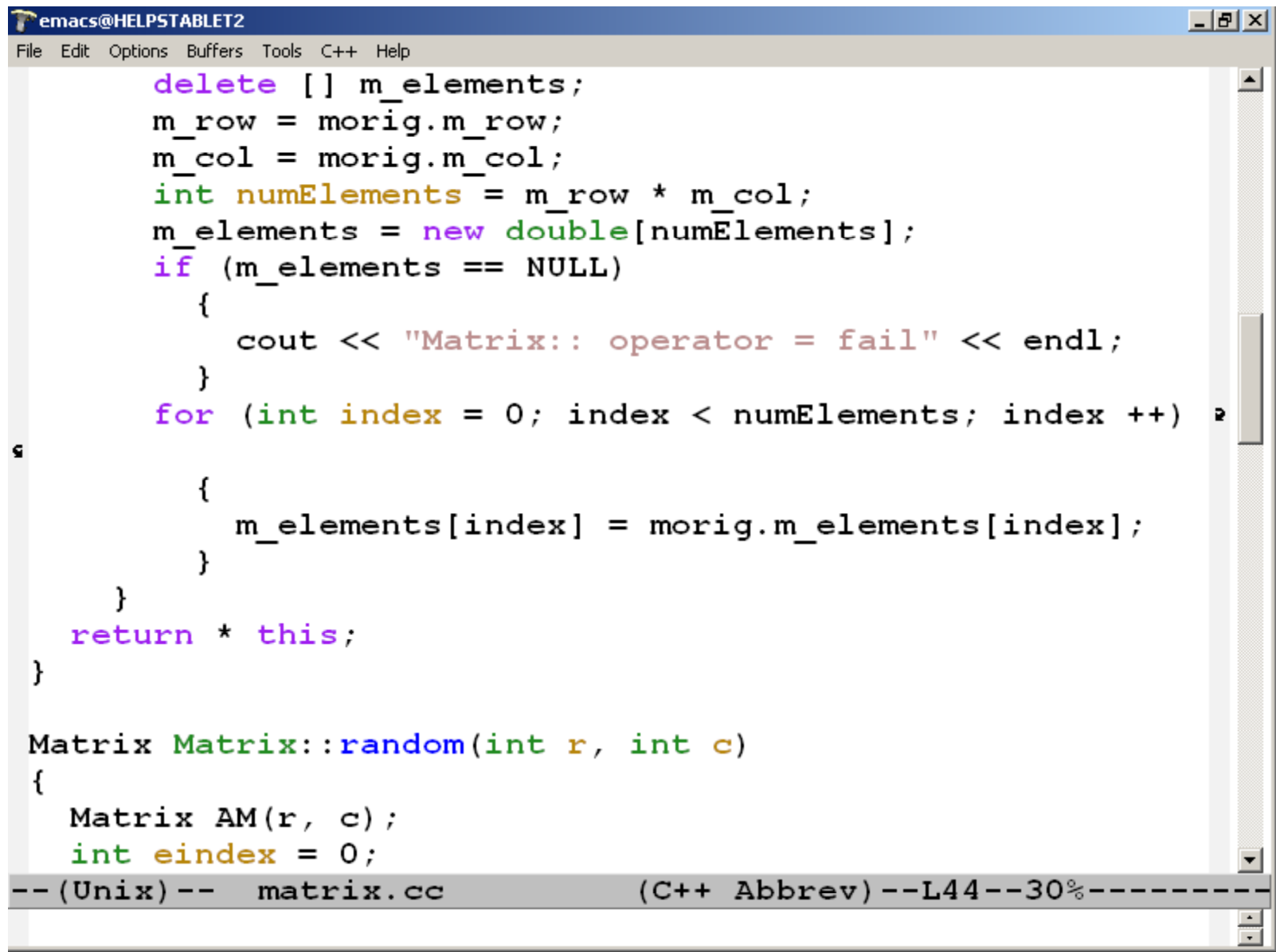


The image shows a screenshot of an Emacs editor window. The title bar at the top reads "emacs@HELPSTABLET2". Below the title bar is a menu bar with the following items: "File", "Edit", "Options", "Buffers", "Tools", "C++", and "Help". The main editing area contains C++ code for a Matrix class. The code is color-coded: keywords are in green, identifiers and variables are in black, and literals and comments are in red. The code defines a constructor for the Matrix class that takes a const reference to another Matrix object. It copies the row and column counts and the elements array. It also includes an error handling block that prints a message if the elements array is NULL. A second function, an operator=, is defined below the constructor, which checks for self-assignment and deletes the current elements array before copying the data from the other Matrix object. At the bottom of the window, a status bar shows "--(Unix)-- matrix.cc (C++ Abbrev) --L25--14%-----".

```
Matrix::Matrix(const Matrix & morig)
{
    m_row = morig.m_row;
    m_col = morig.m_col;
    int numElements = m_row * m_col;
    m_elements = new double[numElements];
    if (m_elements == NULL)
    {
        cout << "Matrix(const Matrix &) fail" << endl;
    }
    for (int index = 0; index < numElements; index++)
    {
        m_elements[index] = morig.m_elements[index];
    }
}

Matrix & Matrix::operator = (const Matrix & morig)
{
    if (this != & morig)
    {
        delete [] m_elements;
        m_row = morig.m_row;
    }
}

--(Unix)-- matrix.cc (C++ Abbrev) --L25--14%-----
```

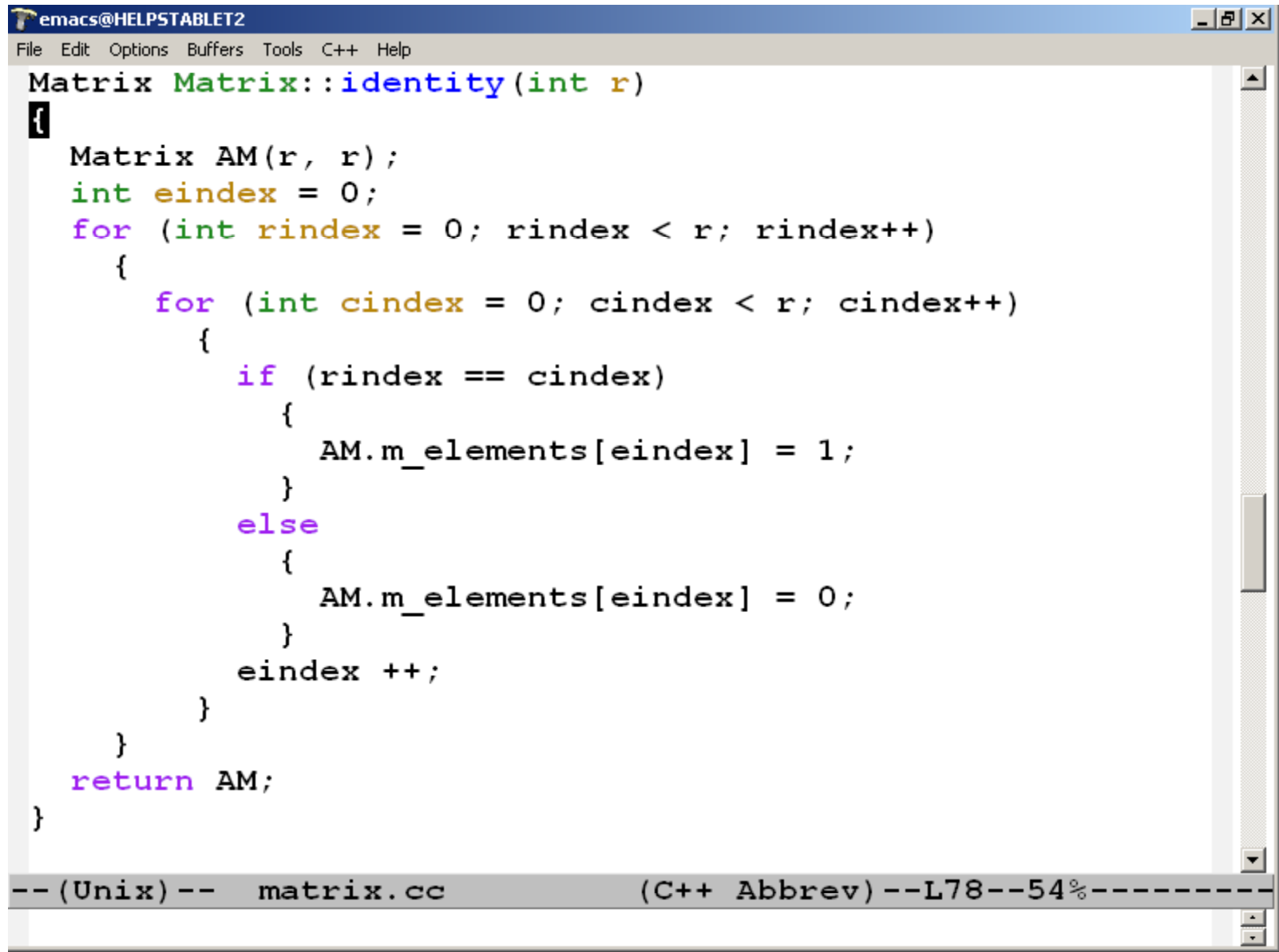


```
emacs@HELPSTABLET2
File Edit Options Buffers Tools C++ Help

    delete [] m_elements;
    m_row = morig.m_row;
    m_col = morig.m_col;
    int numElements = m_row * m_col;
    m_elements = new double[numElements];
    if (m_elements == NULL)
    {
        cout << "Matrix:: operator = fail" << endl;
    }
    for (int index = 0; index < numElements; index++)
    {
        m_elements[index] = morig.m_elements[index];
    }
    return * this;
}

Matrix Matrix::random(int r, int c)
{
    Matrix AM(r, c);
    int eindex = 0;
}

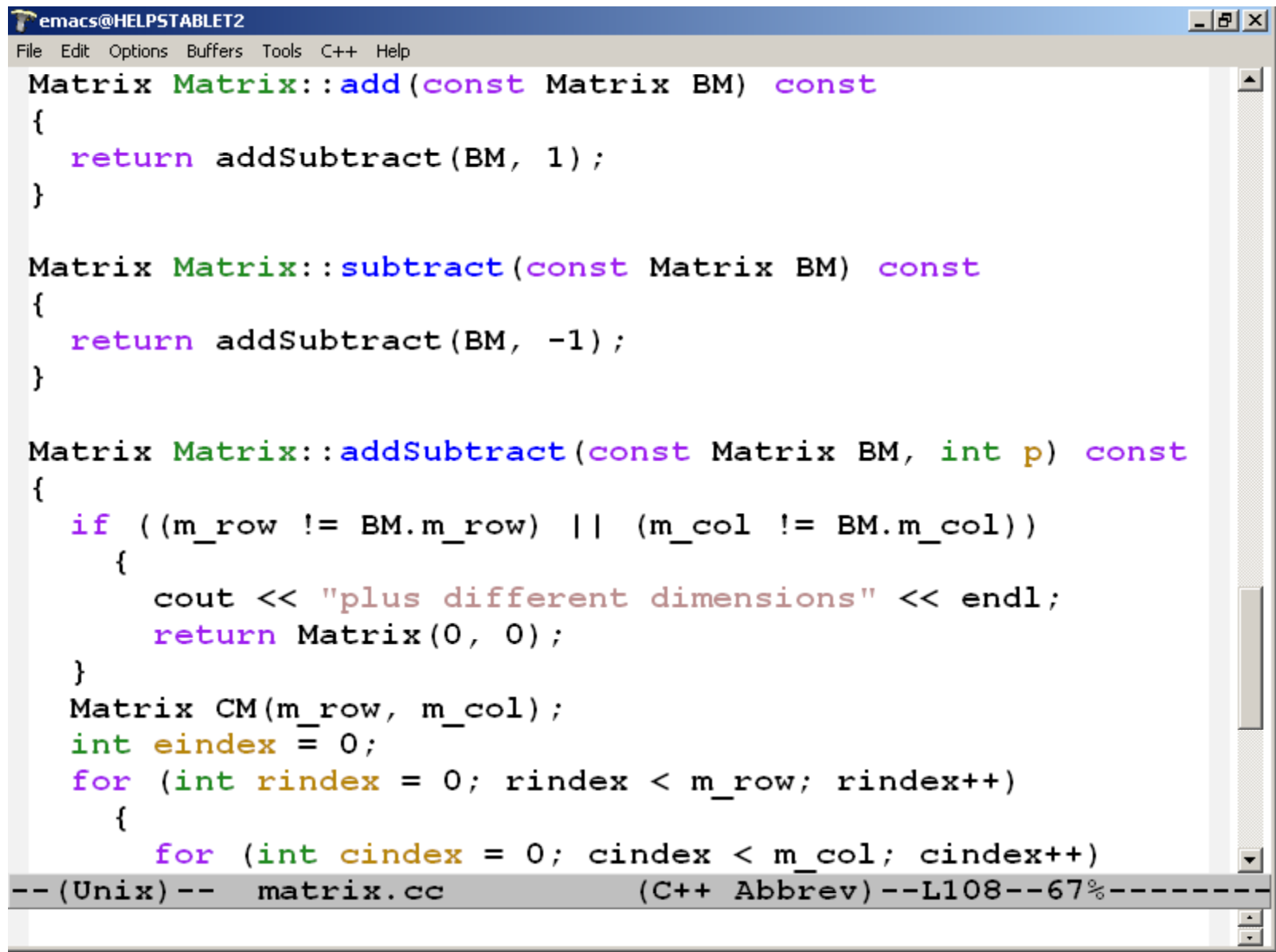
--(Unix)--  matrix.cc  (C++ Abbrev) --L44--30%-----
```



The image shows a screenshot of an Emacs editor window. The title bar at the top reads "emacs@HELPSTABLET2". Below the title bar is a menu bar with the following items: "File", "Edit", "Options", "Buffers", "Tools", "C++", and "Help". The main editing area contains the following C++ code:

```
Matrix Matrix::identity(int r)
{
    Matrix AM(r, r);
    int eindex = 0;
    for (int rindex = 0; rindex < r; rindex++)
    {
        for (int cindex = 0; cindex < r; cindex++)
        {
            if (rindex == cindex)
            {
                AM.m_elements[eindex] = 1;
            }
            else
            {
                AM.m_elements[eindex] = 0;
            }
            eindex ++;
        }
    }
    return AM;
}
```

At the bottom of the window, there is a status bar with the following text: "-- (Unix) -- matrix.cc (C++ Abbrev) --L78--54%-----".



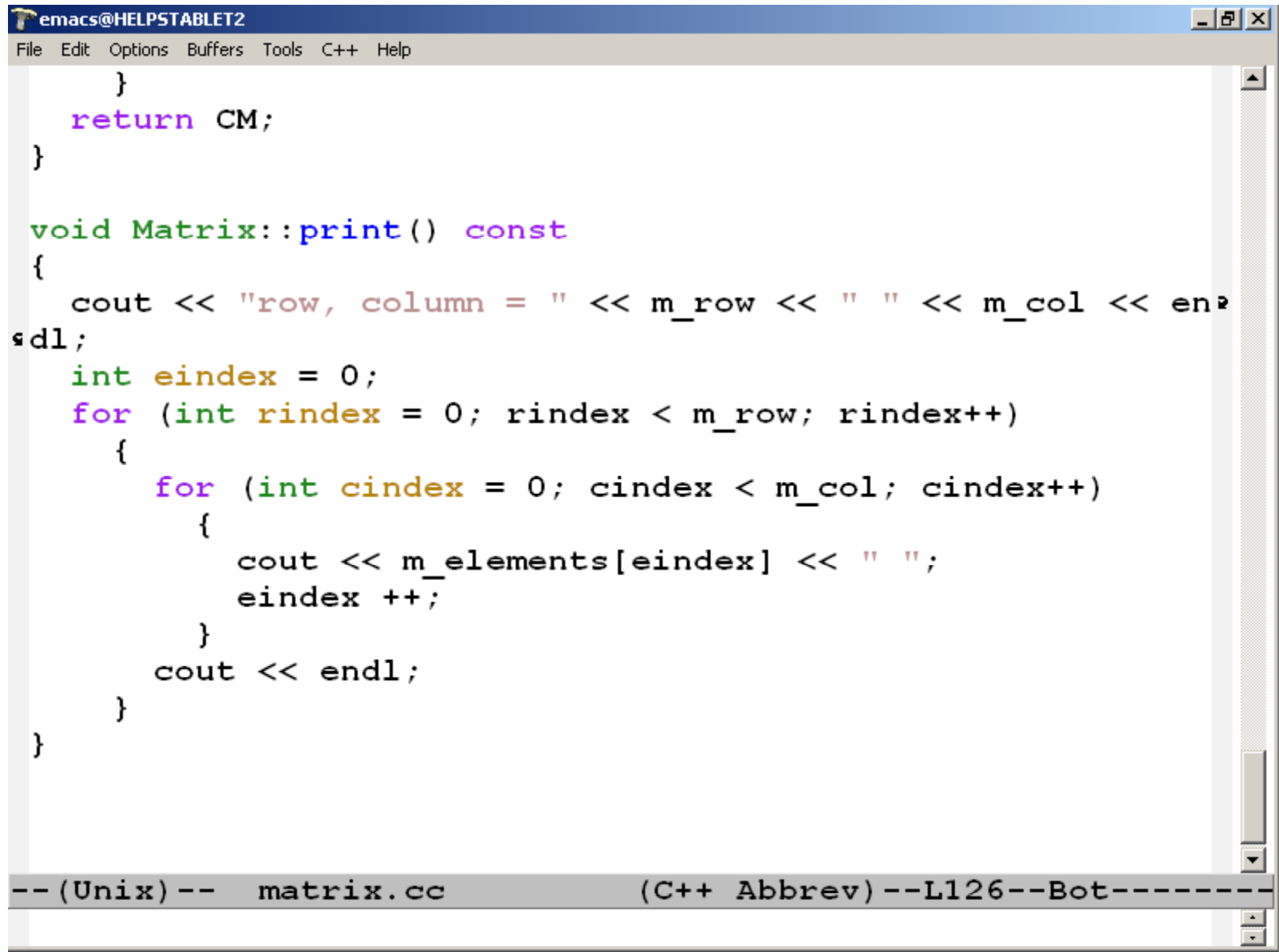
```
emacs@HELPSTABLET2
File Edit Options Buffers Tools C++ Help

Matrix Matrix::add(const Matrix BM) const
{
    return addSubtract(BM, 1);
}

Matrix Matrix::subtract(const Matrix BM) const
{
    return addSubtract(BM, -1);
}

Matrix Matrix::addSubtract(const Matrix BM, int p) const
{
    if ((m_row != BM.m_row) || (m_col != BM.m_col))
    {
        cout << "plus different dimensions" << endl;
        return Matrix(0, 0);
    }
    Matrix CM(m_row, m_col);
    int eindex = 0;
    for (int rindex = 0; rindex < m_row; rindex++)
    {
        for (int cindex = 0; cindex < m_col; cindex++)
        {
            CM.m_data[eindex] = BM.m_data[rindex * m_col + cindex] * p;
        }
        eindex++;
    }
    return CM;
}

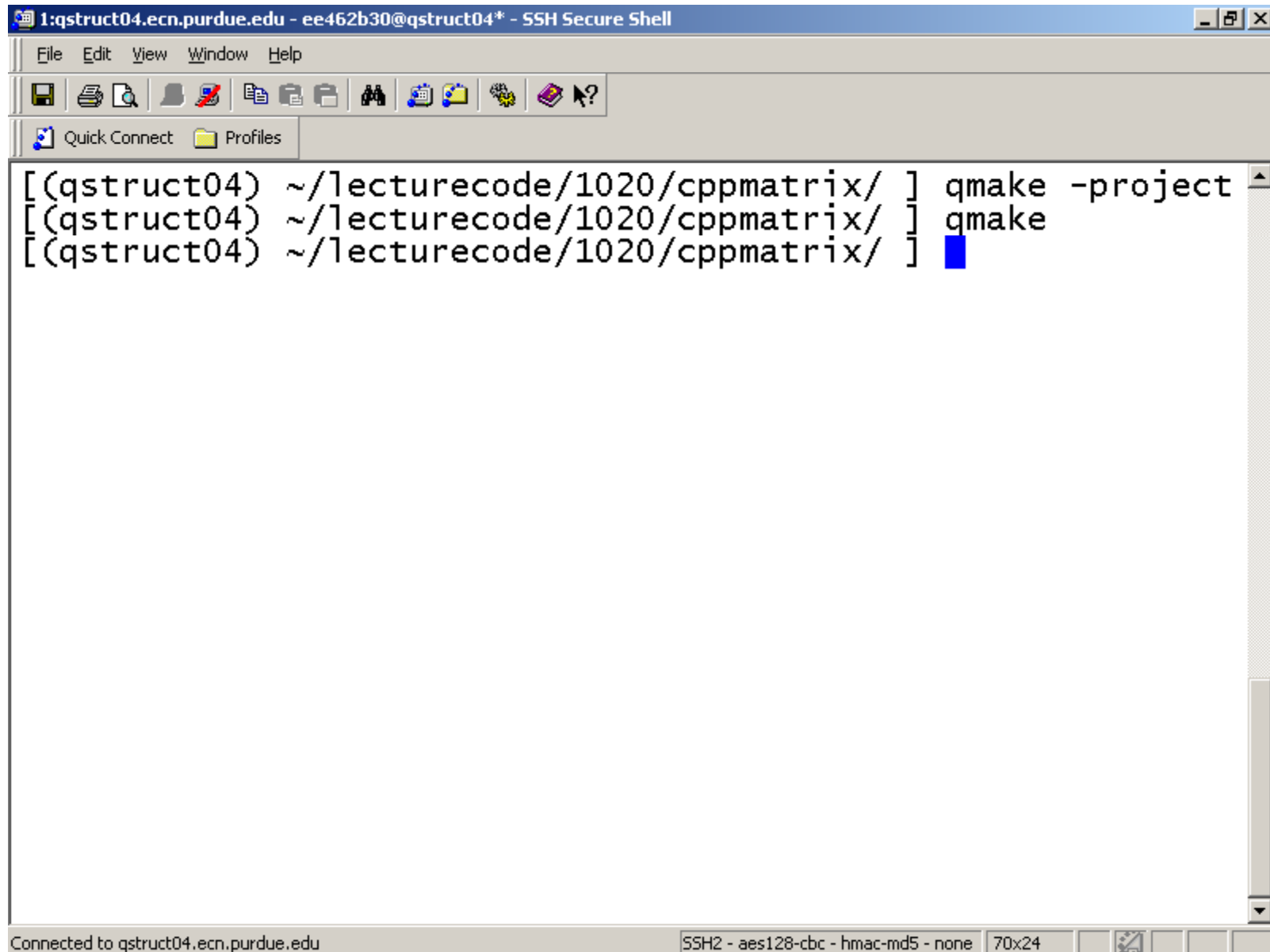
--(Unix)-- matrix.cc (C++ Abbrev) --L108--67%-----
```



```
    }
    return CM;
}

void Matrix::print() const
{
    cout << "row, column = " << m_row << " " << m_col << endl;
    int eindex = 0;
    for (int rindex = 0; rindex < m_row; rindex++)
    {
        for (int cindex = 0; cindex < m_col; cindex++)
        {
            cout << m_elements[eindex] << " ";
            eindex ++;
        }
        cout << endl;
    }
}
```

-- (Unix) -- matrix.cc (C++ Abbrev) --L126--Bot-----



The image shows a screenshot of an SSH terminal window. The title bar at the top reads "1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell". Below the title bar is a menu bar with "File", "Edit", "View", "Window", and "Help". Underneath the menu bar is a toolbar with various icons for file operations and system functions. Below the toolbar are two tabs labeled "Quick Connect" and "Profiles". The main area of the window is a text-based terminal. It shows three lines of text, each starting with a prompt "[(qstruct04) ~/lecturecode/1020/cppmatrix/]". The first line is followed by the command "qmake -project". The second line is followed by the command "qmake". The third line has a blue cursor block at the end. At the bottom of the window, there is a status bar. The left part of the status bar says "Connected to qstruct04.ecn.purdue.edu". The right part of the status bar shows "SSH2 - aes128-cbc - hmac-md5 - none" and "70x24".

```
[ (qstruct04) ~/lecturecode/1020/cppmatrix/ ] qmake -project
[ (qstruct04) ~/lecturecode/1020/cppmatrix/ ] qmake
[ (qstruct04) ~/lecturecode/1020/cppmatrix/ ]
```

Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 70x24

```
1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles

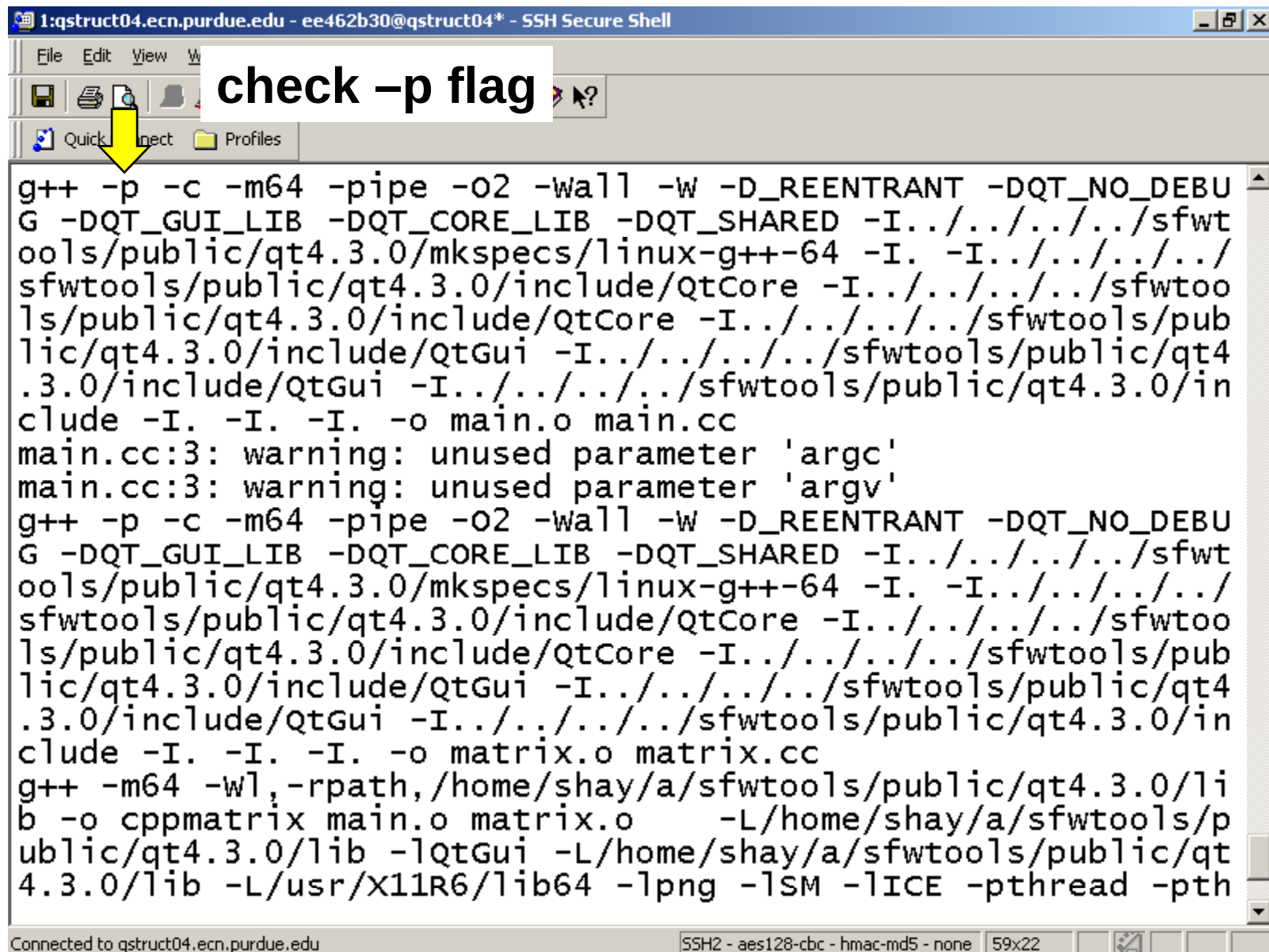
File Edit Options Buffers Tools Makefile Help
#####
#####
# Makefile for building: cppmatrix
# Generated by qmake (2.01a) (Qt 4.3.0) on: Thu Jun 19 11:35
# Project:  cppmatrix.pro
# Template: app
# Command: /home/shay/a/sfwtools/public/qt4.3.0/bin/qmake -u
kefile cppmatrix.pro
#####
#####

##### Compiler, tools and opt

CC          = gcc -p
CXX         = g++ -p
DEFINES     = -DQT_NO_DEBUG -DQT_GUI_LIB -DQT_CORE_LIB -DC
CFLAGS      = -m64 -pipe -O2 -Wall -W -D_REENTRANT $(DEFIN
CXXFLAGS    = -m64 -pipe -O2 -Wall -W -D_REENTRANT $(DEFIN
INCPATH     = -I.././.././../sfwtools/public/qt4.3.0/mkspec
++-64 -I. -I.././.././../sfwtools/public/qt4.3.0/include/QtCc
.././../sfwtools/public/qt4.3.0/include/QtCore -I.././.././..
-uu-:---E1 Makefile (Makefile)--l 12--Top-----
Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 70x24
```

add -p to the
compiler flag





1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell

File Edit View W

check -p flag

Quick Connect Profiles

```
g++ -p -c -m64 -pipe -O2 -Wall -W -D_REENTRANT -DQT_NO_DEBU
G -DQT_GUI_LIB -DQT_CORE_LIB -DQT_SHARED -I../.../sfwt
ools/public/qt4.3.0/mkspecs/linux-g++-64 -I. -I../.../.../
sfwtools/public/qt4.3.0/include/QtCore -I../.../.../sfwtoo
ls/public/qt4.3.0/include/QtCore -I../.../.../sfwtools/pub
lic/qt4.3.0/include/QtGui -I../.../.../sfwtools/public/qt4
.3.0/include/QtGui -I../.../.../sfwtools/public/qt4.3.0/in
clude -I. -I. -I. -o main.o main.cc
main.cc:3: warning: unused parameter 'argc'
main.cc:3: warning: unused parameter 'argv'
g++ -p -c -m64 -pipe -O2 -Wall -W -D_REENTRANT -DQT_NO_DEBU
G -DQT_GUI_LIB -DQT_CORE_LIB -DQT_SHARED -I../.../sfwt
ools/public/qt4.3.0/mkspecs/linux-g++-64 -I. -I../.../.../
sfwtools/public/qt4.3.0/include/QtCore -I../.../.../sfwtoo
ls/public/qt4.3.0/include/QtCore -I../.../.../sfwtools/pub
lic/qt4.3.0/include/QtGui -I../.../.../sfwtools/public/qt4
.3.0/include/QtGui -I../.../.../sfwtools/public/qt4.3.0/in
clude -I. -I. -I. -o matrix.o matrix.cc
g++ -m64 -wl,-rpath,/home/shay/a/sfwtools/public/qt4.3.0/li
b -o cppmatrix main.o matrix.o -L/home/shay/a/sfwtools/p
ublic/qt4.3.0/lib -lQtGui -L/home/shay/a/sfwtools/public/qt
4.3.0/lib -L/usr/X11R6/lib64 -lpng -lSM -lICE -pthread -pth
```

Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 59x22

1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell

File Edit View Window Help

Quick Connect Profiles

execute the program

```
[(qstruct04) ~/lecturecode/1020/cppmatrix/ ] ./cppmatrix
row, column = 4 4
-356.567 -243.108 341.958 67.7321
-376.531 -217.754 -225.702 -172.67
410.501 -166.877 -426.153 -13.7912
-25.7591 320.088 475.14 216.214
row, column = 4 4
1 0 0 0
0 1 0 0
0 0 1 0
0 0 0 1
row, column = 4 4
-355.567 -243.108 341.958 67.7321
-376.531 -216.754 -225.702 -172.67
410.501 -166.877 -425.153 -13.7912
-25.7591 320.088 475.14 217.214
row, column = 4 4
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0
[(qstruct04) ~/lecturecode/1020/cppmatrix/ ]
```

Connected to qstruct04.ecn.purdue.edu

SSH2 - aes128-cbc - hmac-md5 - none 59x22

1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell

File Edit View Window Help

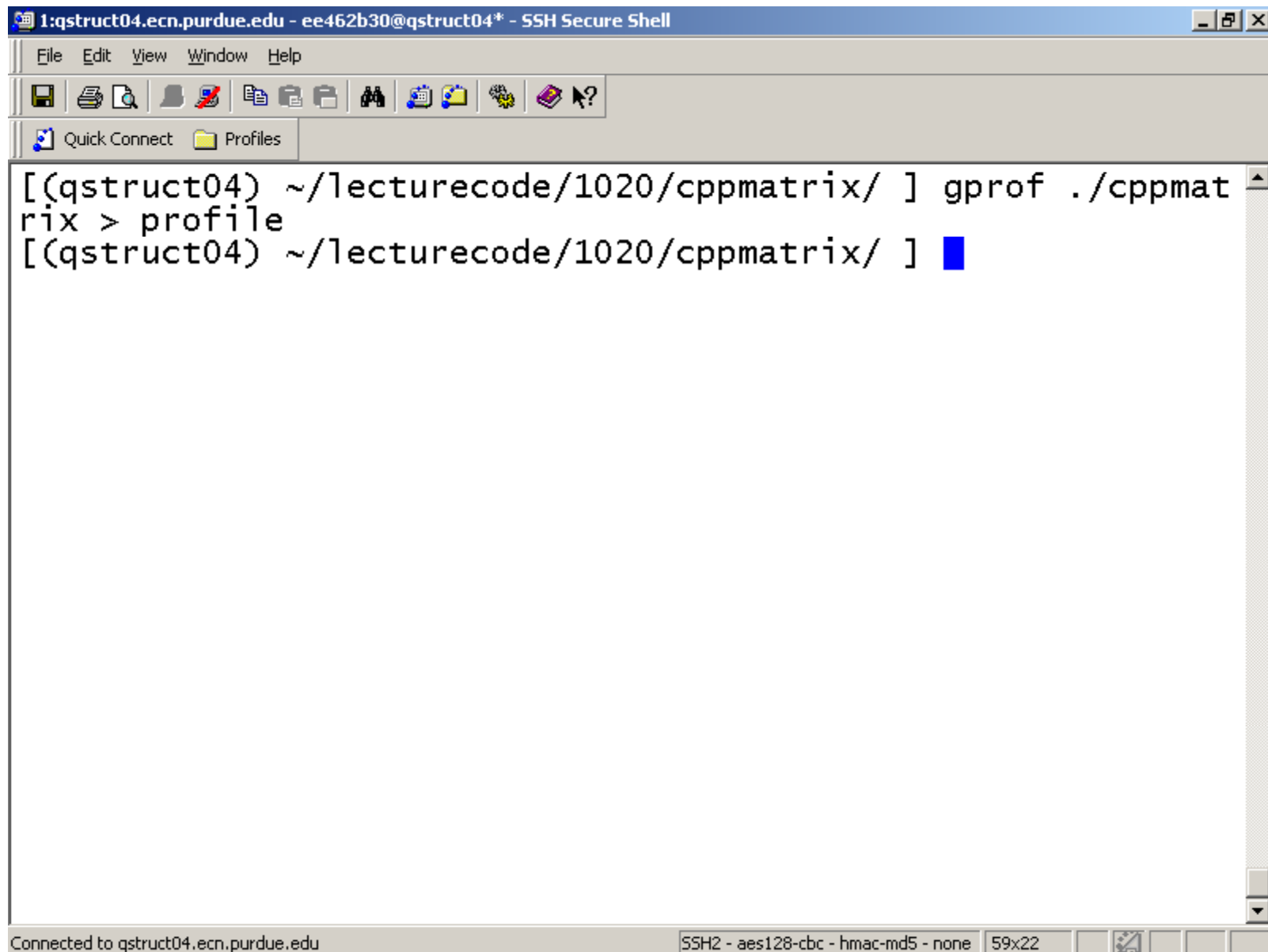
Quick Connect Profiles

profile information

```
473.303 88.3587 -63.7457 -29.1282
-49.5626 -112.383 313.548 -43.5151
-219.462 -362.018 -230.947 -211.618
row, column = 4 4
1 0 0 0
0 1 0 0
0 0 1 0
0 0 0 1
row, column = 4 4
130.453 -7.64368 -260.949 -207.482
473.303 89.3587 -63.7457 -29.1282
-49.5626 -112.383 314.548 -43.5151
-219.462 -362.018 -230.947 -210.618
row, column = 4 4
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0
[(qstruct04) ~/lecturecode/1020/cppmatrix/ ] ls
cppmatrix*      gmon.out  main.o      matrix.cc    matrix.o
cppmatrix.pro   main.cc   Makefile    matrix.h
[(qstruct04) ~/lecturecode/1020/cppmatrix/ ]
```

Connected to qstruct04.ecn.purdue.edu

SSH2 - aes128-cbc - hmac-md5 - none 59x22



The image shows a screenshot of an SSH terminal window. The title bar at the top reads "1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell". Below the title bar is a menu bar with "File", "Edit", "View", "Window", and "Help". Underneath the menu bar is a toolbar with various icons for file operations and system functions. Below the toolbar are two tabs labeled "Quick Connect" and "Profiles". The main area of the window is a text-based terminal. It shows a prompt "[qstruct04) ~/lecturecode/1020/cppmatrix/]" followed by the command "gprof ./cppmatrix > profile". The next line shows the prompt again, followed by a blue cursor block. At the bottom of the window, there is a status bar that says "Connected to qstruct04.ecn.purdue.edu" on the left, "SSH2 - aes128-cbc - hmac-md5 - none" in the middle, and "59x22" on the right.

```
1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell
File Edit View Window Help
[Icons]
Quick Connect Profiles
[qstruct04) ~/lecturecode/1020/cppmatrix/ ] gprof ./cppmat
rix > profile
[qstruct04) ~/lecturecode/1020/cppmatrix/ ] █
Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 59x22
```

1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell						
File Edit View Window Help						
Quick Connect Profiles						
time	seconds	seconds	calls	ms/call	ms/call	name
66.85	0.02	0.02	4	5.01	5.01	Matri
x::print()	const					
33.48	0.03	0.01	2	5.01	5.01	Matri
x::addSubtract(Matrix, int)	const					
0.00	0.03	0.00	10	0.00	0.00	Matri
x::~~Matrix()						
0.00	0.03	0.00		0.00	0.00	Matri
x::Matrix(Matrix const&)			4	0.00	0.00	Matri
x::Matrix(int, int)			1	0.00	0.00	globa
1 constructors keyed to _ZN6MatrixC2Eii						
0.00	0.03	0.00	1	0.00	0.00	Matri
x::random(int, int)			1	0.00	0.00	Matri
x::identity(int)			1	0.00	5.01	Matri
x::add(Matrix)	const					
:						

Connected to qstruct04.ecn.purdue.edu

SSH2 - aes128-cbc - hmac-md5 - none

59x22

3:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell

File Edit View Window Help

Quick Connect Profiles

```
File Edit Options Buffers Tools C++ Help
#include "matrix.h"
int main(int argc, char * argv [])
{
    Matrix MA = Matrix::random(10000, 10000);
    Matrix MB = Matrix::identity(10000);
    Matrix MC = MA.add(MB);
    Matrix MD = MA.subtract(MA);
    // MA.print();
    // MB.print();
    // MC.print();
    // MD.print();
    return 0;
}
```

-uu-:---F1 main.cc (C++ Abbrev)--L8--A11-----

Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 59x22

```

1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles
File Edit Options Buffers Tools Help
Each sample counts as 0.01 seconds.
% cumulative self self total
time seconds seconds calls s/call s/call name
55.05 5.85 5.85 6 0.97 0.97 Matrix::Matrix(Matrix const&)
24.17 8.41 2.57 2 1.28 2.26 Matrix::addsubtract(Matrix, int) const
12.84 9.78 1.36 1 1.36 1.36 Matrix::random(int, int)
8.22 10.65 0.87 1 0.87 0.87 Matrix::identity(int)
0.00 10.65 0.00 10 0.00 0.00 Matrix::~Matrix()
0.00 10.65 0.00 4 0.00 0.00 Matrix::Matrix(int, int)
0.00 10.65 0.00 1 0.00 0.00 global constructors keyed to _ZN6MatrixC2\
Eii
0.00 10.65 0.00 1 0.00 3.23 Matrix::add(Matrix) const
0.00 10.65 0.00 1 0.00 3.23 Matrix::subtract(Matrix) const

% the percentage of the total running time of the
time program used by this function.

cumulative a running sum of the number of seconds accounted
seconds for by this function and those listed above it.

self the number of seconds accounted for by this
seconds function alone. This is the major sort for this
listing.

calls the number of times this function was invoked, if
this function is profiled, else blank.

self the average number of milliseconds spent in this
ms/call function per call, if this function is profiled,
else blank.

total the average number of milliseconds spent in this
uu-:---F1 profile (Fundamental)--L2-- 1%-----

```

Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 96x36

Performance Improvement using Pass by Reference

```
3:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles

File Edit Options Buffers Tools C Help
#ifndef MATRIX_H
#define MATRIX_H
class Matrix
{
private:
    int m_row;
    int m_col;
    double * m_elements;
    Matrix addSubtract(const Matrix & BM , int p) const;
public:
    Matrix(int r, int c);
    virtual ~ Matrix();
    // there is memory allocation so we need to implement
    // copy constructor and assignment operator
    static Matrix identity(int r);
    static Matrix random(int r, int c);
    Matrix(const Matrix & morig);
    Matrix & operator = (const Matrix & morig);
    Matrix add(const Matrix & BM ) const;
    Matrix subtract(const Matrix & BM ) const;
    void print() const;
--uu-:---F1 matrix.h (C A prev)--L4--Top-----

```

```

1:qstruct04.ecn.purdue.edu - ee462b30@qstruct04* - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles
File Edit Options Buffers Tools Help
Each sample counts as 0.01 seconds.
% cumulative self self total
time seconds seconds calls s/call s/call name
38.45 2.59 2.59 2 1.29 2.27 Matrix::addSubtract(Matrix const&, int) c\
onst
28.92 4.53 1.95 2 0.97 0.97 Matrix::Matrix(Matrix const&)
19.82 5.87 1.33 1 1.33 1.33 Matrix::random(int, int)
13.12 6.75 0.88 1 0.88 0.88 Matrix::identity(int)
0.00 6.75 0.00 6 0.00 0.00 Matrix::~Matrix()
0.00 6.75 0.00 4 0.00 0.00 Matrix::Matrix(int, int)
0.00 6.75 0.00 1 0.00 0.00 global constructors keyed to _ZN6MatrixC2\
Eii
0.00 6.75 0.00 1 0.00 2.27 Matrix::add(Matrix const&) const
0.00 6.75 0.00 1 0.00 2.27 Matrix::subtract(Matrix const&) const

% the percentage of the total running time of the
time program used by this function.

cumulative a running sum of the number of seconds accounted
seconds for by this function and those listed above it.

self the number of seconds accounted for by this
seconds function alone. This is the major sort for this
listing.

calls the number of times this function was invoked, if
this function is profiled, else blank.

self the average number of milliseconds spent in this
ms/call function per call, if this function is profiled,
else blank.

-uu-:---F1 profile (Fundamental)--L2-- 1%-----

```

Connected to qstruct04.ecn.purdue.edu SSH2 - aes128-cbc - hmac-md5 - none 96x36

ECE 462

Object-Oriented Programming

using C++ and Java

Improve Performance

Yung-Hsiang Lu
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Procedure

- find performance bottlenecks
 - use profilers
 - select appropriate data and metrics
- develop a strategy to reduce or remove the bottleneck
 - change a better algorithm
 - don't do it
 - don't do it so often
 - don't do it now
- evaluate the benefits of the strategy
- implement the changes
- repeat the procedure

Don't Do It Often

```
X& operator=( const X& other )
{
    if ( this == &other )
    { return *this; }
    // release memory
    // allocate memory
    // copy elements
    return *this;
}
```

```
X& operator=( const X& other )
{
    if ( this == &other )
    { return *this; }
    if (they have the different
        amounts of memory)
    {
        // release memory
        // allocate memory
    }
    // copy elements
    return *this;
}
```

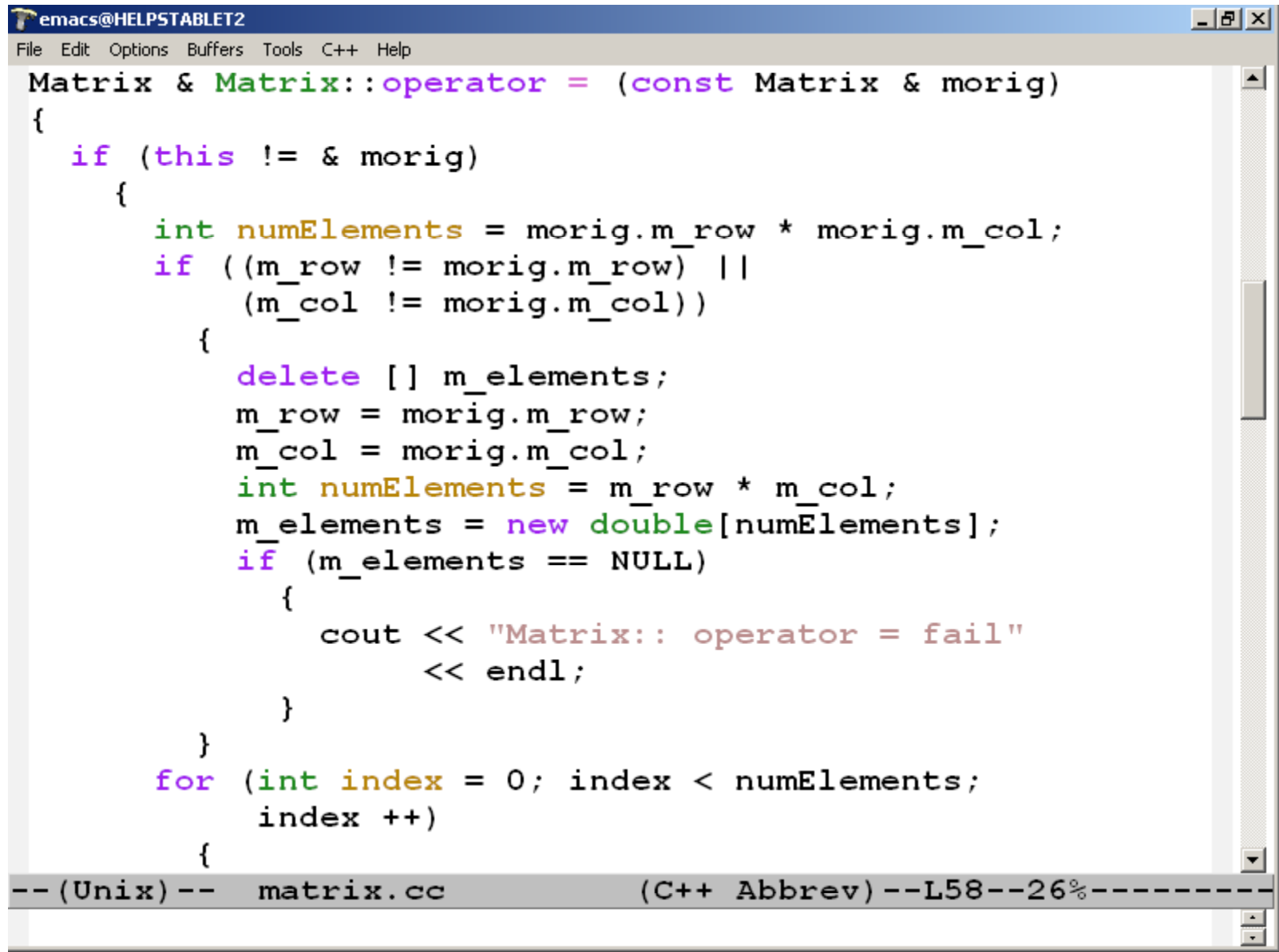
Performance in Interactive Programs

- show progress
- allow other activities simultaneously
- give users options
- remain responsive (by using multiple threads)
- anticipate a user's actions and pre-compute

```
emacs@HELPSTABLET2
File Edit Options Buffers Tools C++ Help

#include "matrix.h"
#include <stdlib.h>
int main(int argc, char * argv [])
{
    int row = 1000;
    if (argc > 1)
        { row = atoi(argv[1]); }
    if (row < 1000)
        { row = 1000; }
    Matrix MA = Matrix::identity(row);
    Matrix MB = Matrix::identity(row);
    Matrix MC = MA.add(MB);
    Matrix MD = MA.subtract(MA);
    MC = MA.subtract(MA);
    MD = MA.add(MB);
    MC = MB.subtract(MD);
    MD = MC.add(MA);
    MA = MA;
    MC = MA;
    MD = MB;
    return 0;
}

--(Unix)-- main.cc (C++ Abbrev) --L7--All-----
menu-bar buffer
```



```
emacs@HELPSTABLET2
File Edit Options Buffers Tools C++ Help

Matrix & Matrix::operator = (const Matrix & morig)
{
    if (this != & morig)
    {
        int numElements = morig.m_row * morig.m_col;
        if ((m_row != morig.m_row) ||
            (m_col != morig.m_col))
        {
            delete [] m_elements;
            m_row = morig.m_row;
            m_col = morig.m_col;
            int numElements = m_row * m_col;
            m_elements = new double[numElements];
            if (m_elements == NULL)
            {
                cout << "Matrix:: operator = fail"
                    << endl;
            }
        }
        for (int index = 0; index < numElements;
            index++)
        {

```

-- (Unix) -- matrix.cc (C++ Abbrev) --L58--26%-----

Compiler Optimization

add **-O** to g++ flag

```
qstruct04.ecn.purdue.edu - ee462b30@qstruct04 - SSH Secure Shell
File Edit View Window Help
[Icons: Save, Print, Find, Copy, Paste, Undo, Redo, Home, Up, Down, Left, Right, Search, etc.]
Quick Connect Profiles

[(qstruct04) ~/lecturecode/1020/cppmatrix/ ] more Makefile
CXX          = g++
CXXFLAGS     = -p -O

cppmatrix: main.o matrix.o
    $(CXX) $(CXXFLAGS) main.o matrix.o -o cppmatrix

main.o: main.cc matrix.h
    $(CXX) -c $(CXXFLAGS) main.cc

matrix.o: matrix.cc matrix.h
    $(CXX) -c $(CXXFLAGS) matrix.cc

clean:
    rm -f *.o cppmatrix

[(qstruct04) ~/lecturecode/1020/cppmatrix/ ]
```

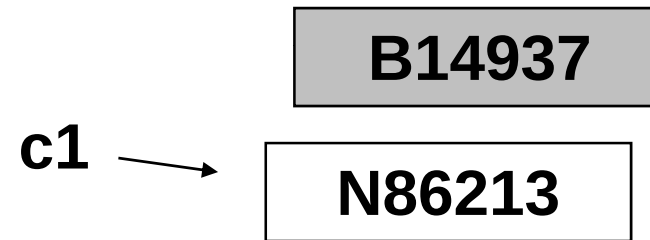
Memory Management in Java

Garbage Collection

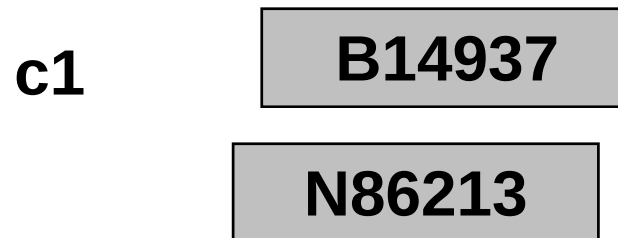
Car c1 = new Car("B14937");



c1 = new Car("N86213");



c1 = null;

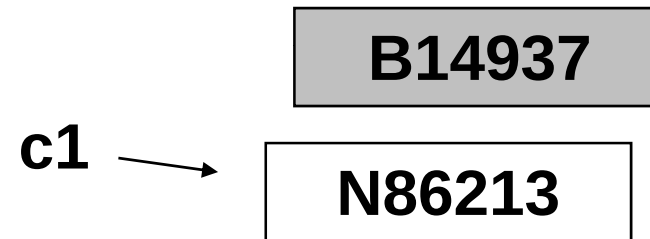


Garbage Collection

```
Car c1 = new Car("B14937");
```

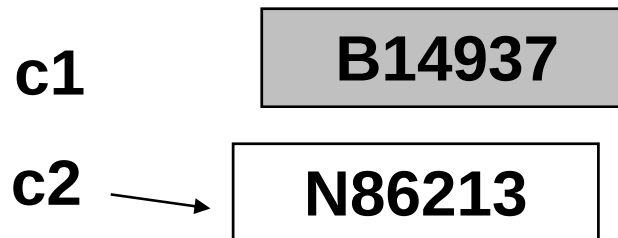
```
Car c2;
```

```
c1 = new Car("N86213");
```



```
c2 = c1
```

```
c1 = null;
```



Object Creation in Java

- set unneeded objects to null
- reuse objects' (by changing some attributes), avoid creating short-life objects
- set objects' attributes to be sufficiently large to prevent frequent resizing
- use static attributes when applicable
- avoid creating intermediate objects

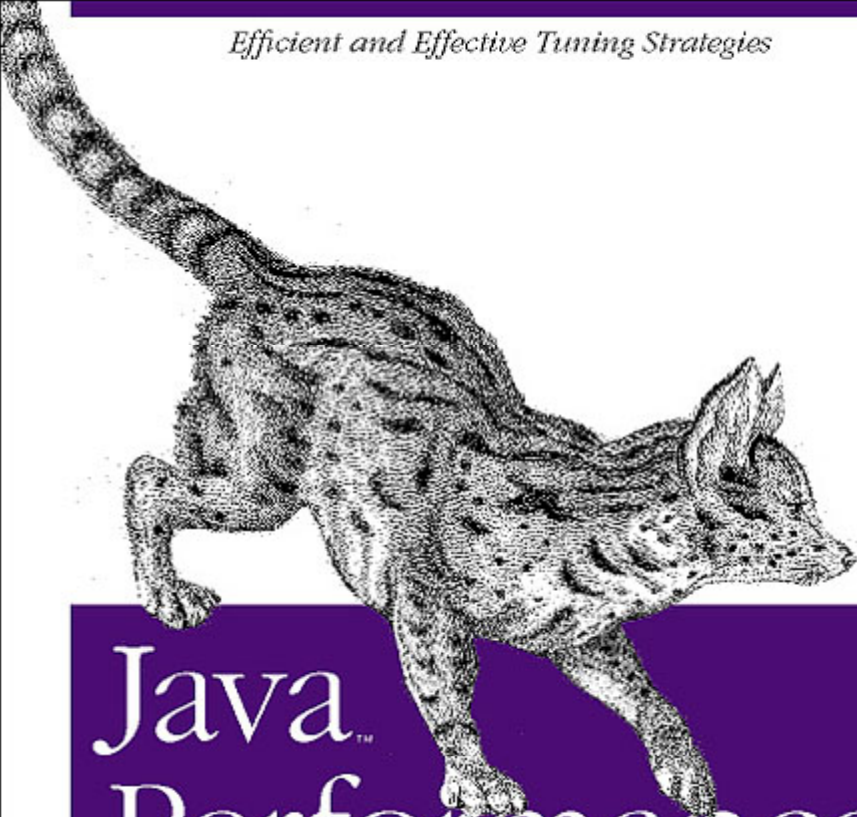
```
String str = new String("11");  
int sval = Integer.parseInt(str);
```

```
String str = new String("11");  
int sval = new Integer(str).intValue();
```

Integer (Java Platform SE 6) - Mozilla Firefox	
File Edit View History Bookmarks Yahoo! Tools Help	
 http://java.sun.com/javase/6/docs/api/java/lang/Integer.html 	
	lowest-order ("rightmost") one-bit in the specified <code>int</code> value.
static int	<code>numberOfLeadingZeros</code> (int i) Returns the number of zero bits preceding the highest-order ("leftmost") one-bit in the two's complement binary representation of the specified <code>int</code> value.
static int	<code>numberOfTrailingZeros</code> (int i) Returns the number of zero bits following the lowest-order ("rightmost") one-bit in the two's complement binary representation of the specified <code>int</code> value.
static int	<code>parseInt</code> (String s)  Parses the string argument as a signed decimal integer.
static int	<code>parseInt</code> (String s, int radix) Parses the string argument as a signed integer in the radix specified by the second argument.
static int	<code>reverse</code> (int i) Returns the value obtained by reversing the order of the bits in the two's complement binary representation of the specified <code>int</code> value.
static int	<code>reverseBytes</code> (int i) Returns the value obtained by reversing the order of the bytes in the two's complement representation of the specified <code>int</code> value.
static int	<code>rotateLeft</code> (int i, int distance)

Done

Efficient and Effective Tuning Strategies



Java™ Performance Tuning

O'REILLY®

Jack Shirazi