

CSC270 Scientific programming

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Course requirements, posted Lessons and Assignments are summarized at
the CSI Website **COURSE SYLLABUS**

CAMPUS LIFE-> CSI Buildings-> Astrophysical Observatory

Or just google "CSI Astrophysical Observatory" to get the next link

<https://csivc.csi.cuny.edu/supernova7/files/home.html>

(this website may be moved during the term fall 2019)

Then linking with my Name And then the course CSC 270

[ALTERNATE COURSE SITE](#)

**Be sure to read the class SYLLABUS there and understand how
your grade is computed and when assignments are due!**



CSC 270 Scientific Programming

This course will emphasize mathematical problem solving in the C++ programming language.

Required:

- 1. C++ PDF files online. By Prof. Irv Robbins available on line at the course web site. Study these carefully***
- 2. Engineering Problem Solving with C++ 3rd or 4th Edition***
by Delores Etter and Jeanine Ingber Pearson publishing

THIS TEXT ABOVE IS REQUIRED FOR OPEN BOOK EXAMS

USE IT OFTEN FOR HW AND LAB EXERCISES TO BE FAMILIAR WHERE INFO CAN BE FOUND. NOT USING IT WILL MAKE ALMOST IMPOSSIBLE FOR YOU TO SOLVE THE QUESTIONS ON THE MIDTERM AND FINAL EXAMS!!

Additional REFERENCE TEXT (for those wanting a deeper approach to computing in C++ in general)

C++ Programming by D.S. Malik Cengage Learning publisher



- **BRING A NOTEBOOK TO CLASS OR PAPER TO DO “IN CLASS” PROBLEMS THAT WILL BE ASSIGNED!**
- **GRADE POLICY :SUBJECT TO CHANGE**
- **Grade AVERAGE = +20% GENERAL HW + 25% FOR PROGRAMS(laboratory exercises) + 25%Midterm Exam + 30% Comprehensive Final EXAM) +Extra credit added to average for HW assignments and labs**
- **Extra Credit 5 PTS MAX. FOR YOUR FINAL CLASS AVERAGE**
- **- POINTS FOR EXCESSIVE ABSENCE**
- **(LEAVING CLASS EARLY IS AN ABSENCE WITHOUT MY APPROVAL!).**

Over cutting more than 13 hrs (EQUIVALENT TO TWO WEEKS+) reduces your final average

REMINDER: Midterm and Final Exam you can bring your textbook: STUDY THE HW AND LAB EXERCISES YOU DID BEFORE THE EXAM. ONLY THE TEXTBOOK IS PERMITTED!

WARNING:

if you did not do the HW and Lab exercises not only will your average be poor but the textbook will be of little value to you on the EXAMS!

- **TO REVIEW CLASS LESSONS! THESE SLIDES HAVE A LOT OF EXTRA**
- **INFORMATION NOT COVERED IN CLASS FOR YOU TO REVIEW!**
- **ALL LESSONS IN PDF FORMAT WILL BE FOUND AT THE CLASS SYLLABUS AT THE WEB SITES MENTIONED ABOVE. (ADOBE READER NEEDED)**

FOR YOUR SUCCESS IN THIS COURSE FOLLOW THESE RECOMMENDATIONS

1. Know what is expected of you. HW wanted and programs assigned

Take notes in class when assignments are given

1. Hand in work on time

2. Read and study the assigned sections in the C++ text book

(you will miss very important subtleties of the subject by not doing so!)

BE SURE TO DO ALL THE **“PRACTICE” QUESTIONS** IN A CHAPTER WHICH **HAVE ANSWERS**

IN APPENDIX E. ALSO GO OVER ALL KEY TERMS AT THE END OF CHAPTER

AS A REVIEW. NOT DOING THE LATTER WILL HURT YOUR UNDERSTANDING

AND YOUR GRADE! THESE DO NOT HAVE TO BE HANDED IN UNLESS ASKED FOR.

4. Come to class on time for lectures and try to pay attention to what is being presented.

ASKING YOUR NEIGHBOR FOR HELP IS OK BUT AVOID BEING DISTRACTED BY

LONG WINDY CONVERSATIONS WHILE WORKING ON LAB ASSIGNMENTS

(A WASTE OF VALUABLE TIME!)

5. Do ask questions in class if you do not understand. (but not excessive!).

See me for help or a computer science tutor for C++ problems or a math tutor

For MATLAB concepts you have trouble with.

6. Go over and study all posted lectures and notes at the class web site

7. Stay organized: REVIEW THESE NOTES OFTEN TO “STAY ON TRACK”!

WARNING: LEAVING CLASS EARLY WILL RESULT IN AN ABSENCE BEING ENTERED

(UNLESS THERE IS A VERY GOOD REASON). IF YOU ARE HAVING DIFFICULTY IN

CLASS SEE ME FOR HELP. STUDENTS WHO LEAVE EARLY USUALLY MISS THE

IMPORTANT POINTS OF THE LESSONS AND EITHER FAIL THE COURSE OR GET A “D”

GRADE. SO FOR YOUR OWN GOOD STAY THE FULL COURSE TIME. (STEPPING OUT

FOR COFFEE OR A SMALL BREAK IS FINE BUT NOT TO BE ABUSED).

ADVANCED HW #1 HAND IN HW by Due date assigned in class else it has no value average of all HW is 20% of your grade. 21 points this HW

- Read/Study sections 1.1,1.2,1.3,1.4 (basic data representation and data types we will not study conversions to the different bases) and section 1.5. then do the following.
#1. DO EXAM PRACTICE PROBLEMS 1 to 9 AT THE END OF THE CHAPTER ON AND BE SURE TO PUT **YOUR NAME** ON THE PAPERS (STANDARD SIZE) 9 pts
- #2 EXAM PRACTICE 14,15,16 SHORT PARAGRAPHS FOR EACH OF YOUR CHOICES. 3 pts
- #3 List the five steps of the problem solving methodology given in this chapter 2 pts
- #4 Which of the following is not computer software? 2pts
 - a USB memory stick the operating system a C++ compiler a spreadsheet
- #5 Which of the following is responsible for interpreting the instructions stored in memory? 2 pts
 - the ALU (arithmetic logic unit) the control unit the software the accumulator
- #6 High-speed registers for the temporary storage of values are found in ... 2 pts
 - the computers hard disk the computer's primary memory the accumulator the C++ program
- #7 Define **linking** in one sentence? 2 pts
- **NOTICE PLEASE.**
- You will be handing in HW and also LABPRATORY Programs you will construct. Please keep all assignment separate to avoid my missing your work. If more than one page per assignment **then staple** them to avoid the loss of pages.
- **DO NOT STAPLE MORE THAN ONE ASSIGNMENT TOGETHER. PLEASE PUT THE DATE, NAME OF THE ASSIGNMENT OR LAB, YOUR NAME ON THE TOP OF THE FIRST PAGE..**
- **EXAMPLE. 09/16/18 HW#1 YOUR NAME**

GREAT Engineering Achievements

Why scientific programming for Engineers?

Engineers use Science to create solutions to problems.

Most of the Science they use is mathematical in nature and

Can be quite complex. Computers make this process a lot easier

Then pencil and paper as it used to be!

- Computer simulations of models to see if our ideas are correct advanced

ENGINEERS CHANGE THE WORLD! Enormous changes due to the computer being able to calculate

Models very quickly in almost all fields of Engineering, Science, Medicine

For Good or Bad, Aerospace, Military abilities expanded immensely.

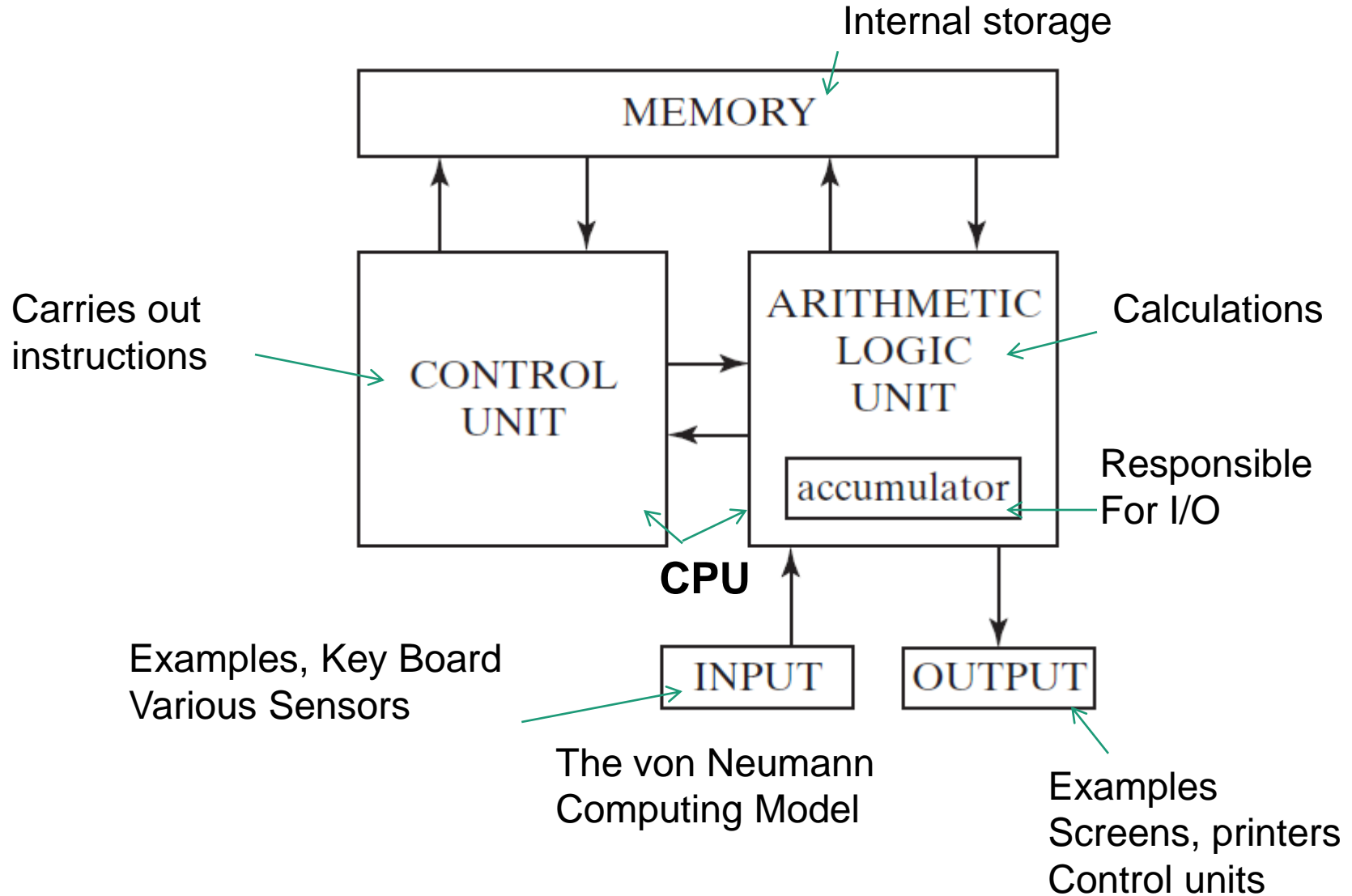
- All fields of endeavor. See link below for the 20th century.

<http://www.greatachievements.org>

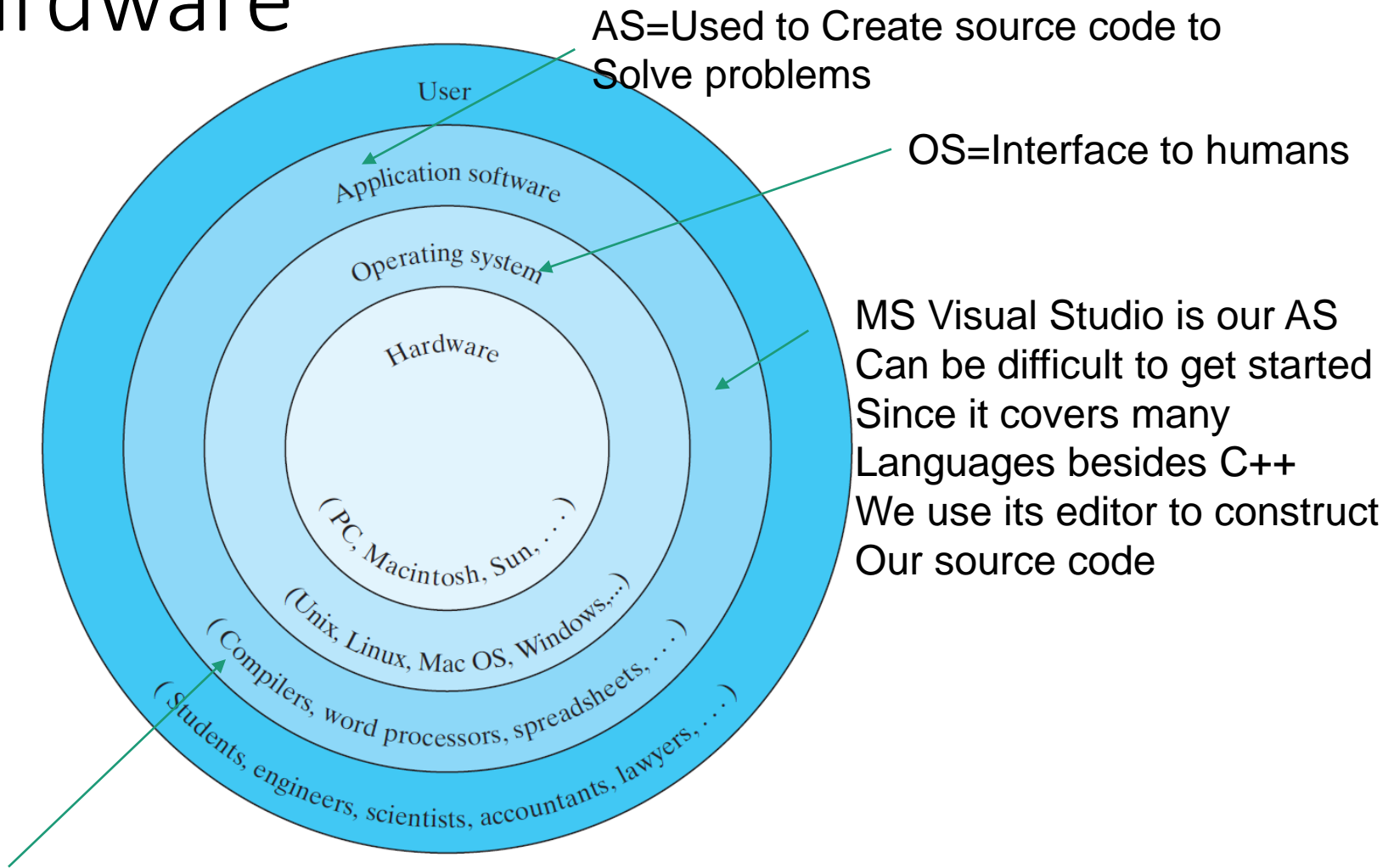
**EXTRA CREDIT: SUMMERIZE WHAT ARE THE LATEST 21ST CENTURY
ENGINEERING ACHIEVEMENTS**

**Learn this subject well and you will be on the road to a very successful
Engineering career and help change the world for the better!**

The Basic Model OF A Computing System (to fully appreciate the C++ environment)



Software Interface to Computer Hardware



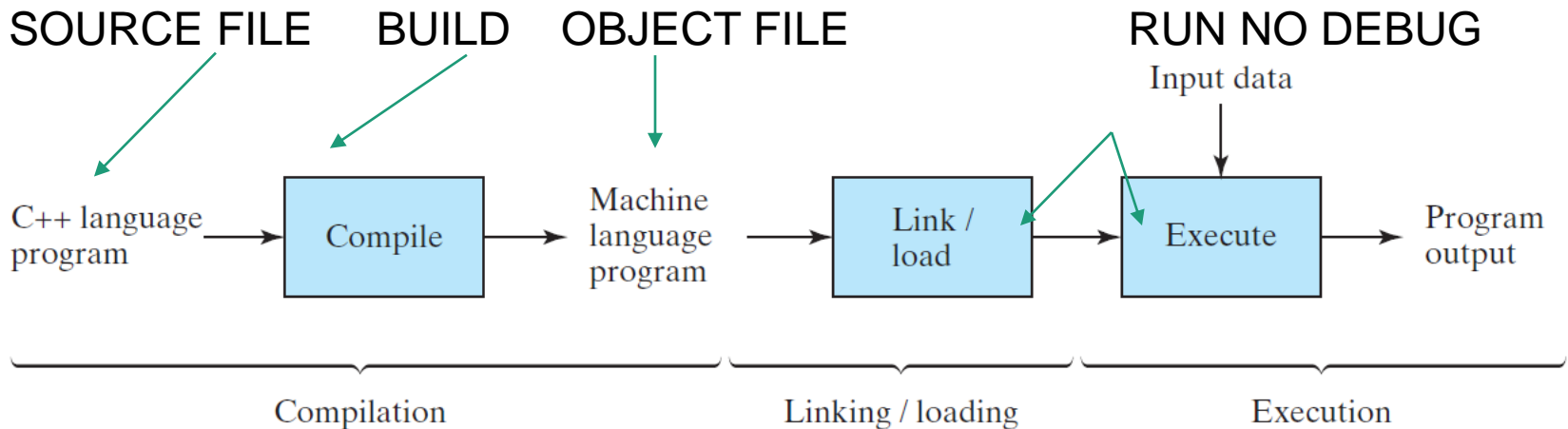
Compiler translates source code to computer understandable code for execution (We compile our source code in the MSVS environment called a BUILD!)

And can execute it immediately (assuming no errors)(RUN in MSVS)

STEPS IN Programming

- Computers only understand machine language.
- High-level languages like C++ and MATLAB must be translated to machine language for execution.

Editor creates C++ (illustrated below) or MATLAB programs. MATLAB environment can run many of these early steps immediately or run a submitted program as the C++ program below. (the “m” files in MATLAB). The “link” step brings in other necessary items to get our program to “run” properly



Some Key Terms

- **Source Program** (.CPP or c++ files)
 - printable/Readable Program file
 - What we create with the editor
- **Object Program** (we don't see this now)
 - nonprintable machine readable file
- **Executable Program** (.exe files in windows)
 - nonprintable executable code FROM LINKING THE OBJECT PROGRAM TO LIBRARIES OF ROUTINES NEEDED.

Errors in Programs

- Syntax/Parse Errors
 - Mistakes with the language. --YOU WILL MAKE PLENTY DON'T PANIC
 - Always reported by the compiler
- Linking Errors -----OCCASIONALLY HAPPENS!
 - Missing pieces prevent the final assembly of an executable program.
- Run-time Errors
 - Occur when program is executing.
 - May or may not be reported.
 - Can be the **toughest to find**. *Always run a simple case, especially with numerical calculations, that you know the answer if the code gets complicated to minimize Run-time errors*
 - When selected the computer carries out its instructions and strange results will happen.

Logic Errors

- Can be difficult to find.
- Debugging can be time consuming.
 - Better tools for find bugs
- It is important to carefully check the output of your programs for errors. WE TEST SIMPLE CASES THAT WE CAN DO THE CALCULATIONS BY HAND!. **DOES THE ANSWER MAKE SENSE!**
 - Even programs that appear to work correctly may have bugs!
 - WE TRY TO AVOID THIS BY CAREFULLY CODING THAT IS EASY TO READ **USING INDENTATION!**
 - AVOID “SPAGETTI CODE” OR A LOGICALLY STEP BY STEP EXECUTION OF OUR TASKS THAT WE CAN FOLLOW.
 - WE ALSO USE **LOTS OF COMMENTS** TO HELP US UNDERSTAND WHAT WE ARE DOING AND USE **VARIABLE NAMES THAT DESCRIBE WHAT WE ARE CALCULATING.** LIKE INSTEAD OF “V” WE WOULD USE “VELOCITY” WHICH MAKES IT ABSOLUTLY CLEAR.
 - I EXPECT THE LATTER IN ALL YOUR WORK FOR FULL CREDIT OR THE BEST GRADES, NOT DOING SO WILL REDUCE GRADES ON LAB PROJECTS.
 - NOTE: THERE ARE MANY WAYS TO GET A PROGRAM TO WORK PROPERLY SO IF I AM HAPPY I WILL JUST GIVE IT A GOOD GRADE. IF I THINK IT NEEDS MORE WORK I WILL GIVE IT AN “R” GRADE FOR YOU TO REPEAT IT, ALONG WITH COMMENTS ON WHAT SHOULD BE DONE TO IMPORVE THE PROGRAM. NOT REPEATING AN ‘R’ IS EQUIVALENT TO AN “F”.
 - IF YOU WANT ME TO **COMMENT ON A EXERCISE I GAVE A GOOD GRADE** THAN PLEASE **SEE ME** SO WE CAN DISCUSS WHY I THINK ITS GOOD.

Debugging or GET THE BUGS OUT.

Early computers used vacuum tubes whose glass parts were glued with horse glue and roaches would die and short circuit the computer. Getting the bugs out was real, bugs that is!

- TODAY the Process of eliminating logic errors (i.e. bugs) from programs.
- User-friendly programming environments such as MATLAB AND Microsoft Visual C++ integrate The environment and show problems early on.
- such as code errors, tools to debug and test, etc.
- THE LATTER MAKES IT EASIER FOR US TO REMOVE THE PROBLEMS FROM OUR PROGRAM.

WONDERING HOW DO WE DO IT in C++?

Creating Your first program IN CLASS

- 1. we use IN CLASS the IDE (integrated software environment) known as **MS VISUAL STUDIO**: Different versions are in the CSI lab classes (There is a “COMMUNITY” VERSION FOR YOU
- AT HOME OTHER ONES LIKE “PROFESSIONAL” and
- “Ultimate” IN OUR LABS). I also will recommend to use at home for PC’S OR MAC the IDE known as **CODEBLOCK**
- **We use the IDE to create C++ programs by creating projects.(other languages also available)**
- **For MSVS in windows, in school we will use the empty project or “ console application”” for home use we use the console application.**

- **We can call the steps in creating a program as:**
- **1. WRITE (source code), in an editor that helps us.**
- **2. EDIT(source code if needed), work errors out.**
- **3. COMPILE(create Machine language OBJECT CODE) AND LINK LIBRARY ROUTINES TO**
- **4. EXECUTE.**
- **Steps 3 and 4 are also known as BUILD and RUN!**

Let's create together your first program in C++

I will demonstrate how to use the MSVS environment to create our first program via the empty project

Your first program should look like

- Hopefully you can now create an empty project in the editor and now can type the following BUT NOTE THE INFO
- I PROVIDED

- `// LAB #1 TODAY's date YOUR NAME!` as a SIMPLE comment
- `#include<iostream>`
- `using namespace std;`
- `int main()`
- `{`
- `cout << "Hello Universe I am here!";`
- `cin.get();` THIS LINE MAY NOT BE NECESSARY
- `return 0;`
- `}`

AFTER A SUCCESSFUL BUILD AND RUN WE GET OUTPUT IN A WINDOW (SOMETIMES CALED A CONSOLE)

- AND COPY THE OUTPUT AS WILL BE SHOWN AND PLACED AT THE END OF THE SOURCE CODE AS COMMENT!
- `// Hello Universe I am here!` Here output is attached as a comment PRINT AND HAND IN!

A CLOSER LOOK!

The C++ Software Environment: For home.

I recommend at first to get *the CODEBLOCK* IDE AT HOME SINCE THE MSVS COMMUNITY CODE IS MORE INVOLVED AS A STARTING EXPERIENCE.

TO HELP YOU I ENCOURE YOU TO USE “Learn C++ by mike Danes an excellent short tutorials using codeblock, on YOUTUBE!

With 31 lessons you will surly learn many of The concepts we will cover in class And more..

Start with lessons 1 to 4! This link! [MIKE DANES CODE academy](#) These intro Lessons show you how to install CODEBLOCK on Windows and Mac computers. BE SURE to use subsequent lessons as we cover the topics in class or just go ahead on your own pace to learn C++!

I will now give instructions for installing CODEBLOCK and MSVS

Getting CODEBLOCK IDE for home, laptops- simple environment to work with C++ very good YOUTUBE tutorials will be recommended.

- Go to [codeblock](https://codeblocks.org/) and pick downloads and pick **Binary** download and select your operating system (windows or mac or linux). Follow directions to install options. For mac just one option, for Windows choose “codeblocks-17.12mingw-setup.exe”(includes editor and compiler) download from “Sourceforge”. Installer downloads (run it or save it and run after). Pick default at installation. An Icon should be created.
- To Start program first time!, pick “create a new project” then “console application” from list of types. (empty is also available but not the same as MSVS do not use!) Then C++ language then before your first project name be sure to create a directory, then put in a name. Ignore configurations that pop up next. On workspace on the left click source and the main.cpp that has been created for you. This program “hello world” should look very familiar from class. To compile(build) and run pick the menu at the top under build option use “build and run”! Note icon for this action.
- SEE MIKE DANES LESSON 2 FOR WINDOWS, LESSON 3 FOR MACS

Getting MSVS COMMUNITY

You can obtain copies of the C++ language which is one language option in the COMPLEX *Microsoft Visual Studio Environment IDE.*

Current versions are called “Community” are free. You will encounter other versions in the labs at CSI which are basically the same with more “bells and Whistles” Current version 2019 is confusing to get WITH MANY OPTIONS TO CHOOSE! PICK VISUAL STUDIO COMMUNITY BELOW

BE SURE BEFORE PICKING OPTIONS DURING THE INSTALLER DOWNLOAD TO SEE THE EXAMPLE ON THE LOWER LEFT “BUILD AN APP.. Create your first “Hello, World!” C++ console app with Visual Studio 2019.” TO SEE WHAT OPTIONS TO PICK. ALSO WHEN YOU RUN THE VS PICK “ NEW PROJECT” AND IN THE SEARCH AREA ENTER “EMPTY PROJECT” AND PICK c++ EMPTY PROJECT. This template will appear as a choice the next time you run VS. The latter IS USED IN The TEXTBook AND YOUR CLASS – CONFUSED SEE ME!

For “Community version” use links below for “Windows” or “MacOS”

<https://www.visualstudio.com/en-us/products/visual-studio-community-vs.aspx>

or here if the above is not working

<https://www.visualstudio.com/en-us/products/free-developer-offers-vs.aspx>

THERE ARE MANY C++ COMPILERS FOR PC AND MACS AND EVEN SMART PHONES. YOU CAN USE ANY OF THESE FOR LAB PROJECTS AND LEARNING BUT ALL FINAL PROJECTS HAVE TO BE PRINTED UP WITH THERE OUTPUT. THE LATTER MUST SATISFY THE REQUIREMENTS OF THE PROJECT. BE SURE TO READ WHAT IS WANTED CAREFULLY ON EACH ASSIGNMENT.

IF YOU WANT TO USE C++ LANGUAGE COMMANDS NOT COVERED IN CLASS THAT IS FINE WITH ME. BUT BE SURE YOU KNOW, HOW TO, ELSE COMPLICATIONS CAN STOP YOUR PROGRAM FROM A SUCCESFUL RUN.

Data Representation

and Storage is important to understand in C++ ,
The MATLAB environment you may have learned
is more forgiving since it handles many of the fine
points for us

- Digital computers store information as a sequence of **bits (binary digits)**.
- The value or state of a bit at any given time can be 0 or 1 (off or on). This can be achieved in hardware as high vs low voltage, magnetic spot vs none, etc.
- Digital communication also sends packets of bits.
- Data in computers is stored as a sequence of **bytes**.
 - A byte is a sequence of 8 bits.
 - **Words** are built with bytes

Memory Diagram low level
you will learn to keep track of what is
happening in the memory on a high level
(the value of variables, outputs etc)

Address	Sixteen Bit Word
000	0000101011011101
001	1010001011010100
010	1011010010100101
011	0101001101010101
010	0101000111001110
010	1100110000111010
110	0100011101001001
111	0101110001001000

Address Space = 8
Word Size = 16
= 2 bytes

Data Types (in memory two basic numerical types to handle integers and decimal numbers (floating point) for efficiency in calculations but can have serious numerical errors if the programmer does not take this into account in some languages like C++, not very much a problem in MATLAB.

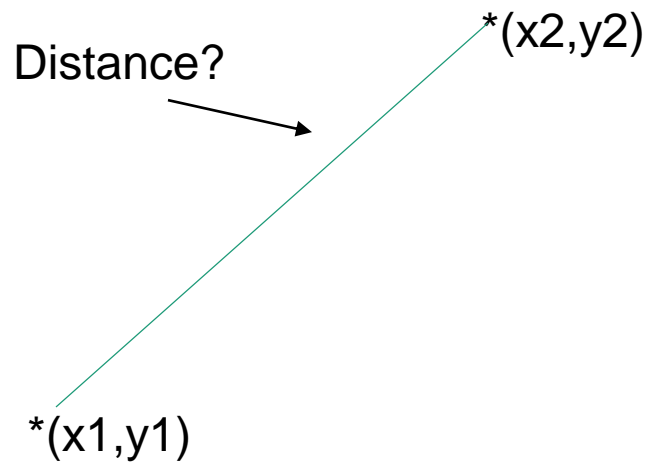
- Integer Data Type:

- Often represented in 4 bytes (System Dependent)
- IE a word = 4 bytes or =32 bits
- Left most bit is reserved for the **sign** of the number
- Remaining 31 bits represent the **magnitude** of the number.
- INTEGER DATA TYPE = Binary number which can also be used to represent ALPHANUMERICS or all the symbols on your key pads. In a code (“ASCII character code” used today)
- Example of ASCII letter “A” = $1000001 = 65_{10}$

Data Type for decimal numbers

- Floating Point Data
 - Floating point types represent real numbers, such as 1.25, that include a decimal point.
 - Digits to the right of the decimal point form the fractional part of the number.
 - Digits to the left of the decimal point form the integer part of the number.

PROBLEM What is the distance between two points in the xy plane



A Solution to What is the distance between two points in the xy plane?

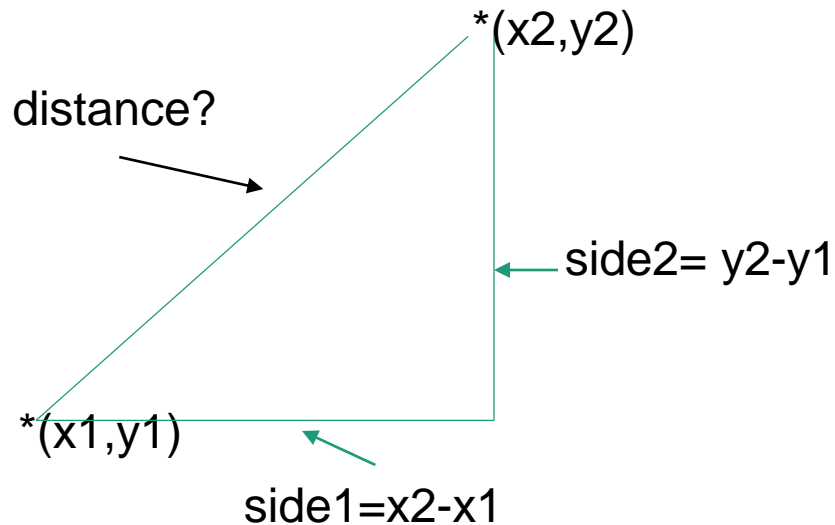
First Algebraic solution

We form a right triangle of sides 1 and 2

Using the known points we get side1 and side2

Then use the Pythagorean theorem for the distance

Get numbers for the two points and solve for the answer.



$$\text{Distance} = (\text{side1}^2 + \text{side2}^2)^{1/2}$$

What is the distance between 1,7 and 4,11

Side 1 = $x_2 - x_1 = 4 - 1 = 3$ side2 = $y_2 - y_1 = 11 - 7 = 4$

Distance = $(3^2 + 4^2)^{1/2} = (9 + 16)^{1/2} = (25)^{1/2} = 5!$

An illustrated C++ Program More Detail in the next chapter to solve for the distance

```
/*-----  
 * Program chapter1_1  
 * This program computes the distance between two points in a plane, x,y  
 coordinates.  
 */  
#include <iostream> // Required for cout, endl.  
#include <cmath> // Required for sqrt() LIBRARY  
  
using namespace std; // all programs must have this  
int main() {  
 // Declare and initialize objects. Comment for you  
 double x1(1), y1(5), x2(4), y2(7),  
 side1, side2, distance;  
 // Compute sides of a right triangle. Comment for you  
 side1 = x2 - x1;  
 side2 = y2 - y1;  
 distance = sqrt(side1*side1 + side2*side2);  
 // Print distance. Comment for you  
 cout << "The distance between the two points is "  
 << distance << endl;  
 // Exit program. Comment for you  
 return 0;  
}
```

Always add comments for
<-You the programmer.
What does it do?

<- includes and names space
Bring in library routines to make stuff
Work

Here all comments are for the programmer
Which is you. Later we will add comments that
Are printed on screen for the user of the program
When data is to be added!
All programs you will do must have both types
Of comments for full credit!

```
/*-----  
// Important aspects of the language are; the preprocessor directives ( includes),  
using namespace (library names), int main() function and use {} to mark a block of  
code , comments * and // and /*...*/ comments,  
declaration types(double) and names of variables.  
Statements for calculations (like distance =) and output.
```

HAND IN HW #1 HAND IN HW by Due date assigned in class else it has no value average of all HW is 20% of your grade. 21 points this HW

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- **EXAMPLE.** HW#1 YOUR NAME