MIT-IIT Robotics Program

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Outline

1. Introduction
   - Curriculum
2. Environment
   - Terminal and Basic Commands
   - Editor
3. Basics
   - Input and Output
   - Variables
   - Expressions
   - Comments
   - Example
4. Exercises

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Instructors

- IIT Kharagpur
  - Mayank Bhushan
  - Sudarshan Sharma
  - Manish Agarwal
  - Sayan Sinha
  - Mehul Nirala
  - Rahul Kumar
- MIT
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C++ Basics

- Environment
  - Ubuntu Linux
  - Using the Terminal
  - Compiling and Running C++ Code
- Variables and Data Types
- Booleans, Comparison and Logic Flow
- Arrays and Loops
- Functions and Recursion

Advanced C++

Subject to change, based on feedback.

- Standard Template Library
  - Set
  - Map
- Graphics (with Processing)
  - 2D Graphics
  - Small Video Game
- Object Oriented Programming
- Algorithms
  - Searching
  - Sorting

- Control Theory (PID controller)
- Programming an Arduino
- Using a Resistive Touchscreen
- Driving Servo Motors

Final Project

Ball and Plate Balancing System

graphics

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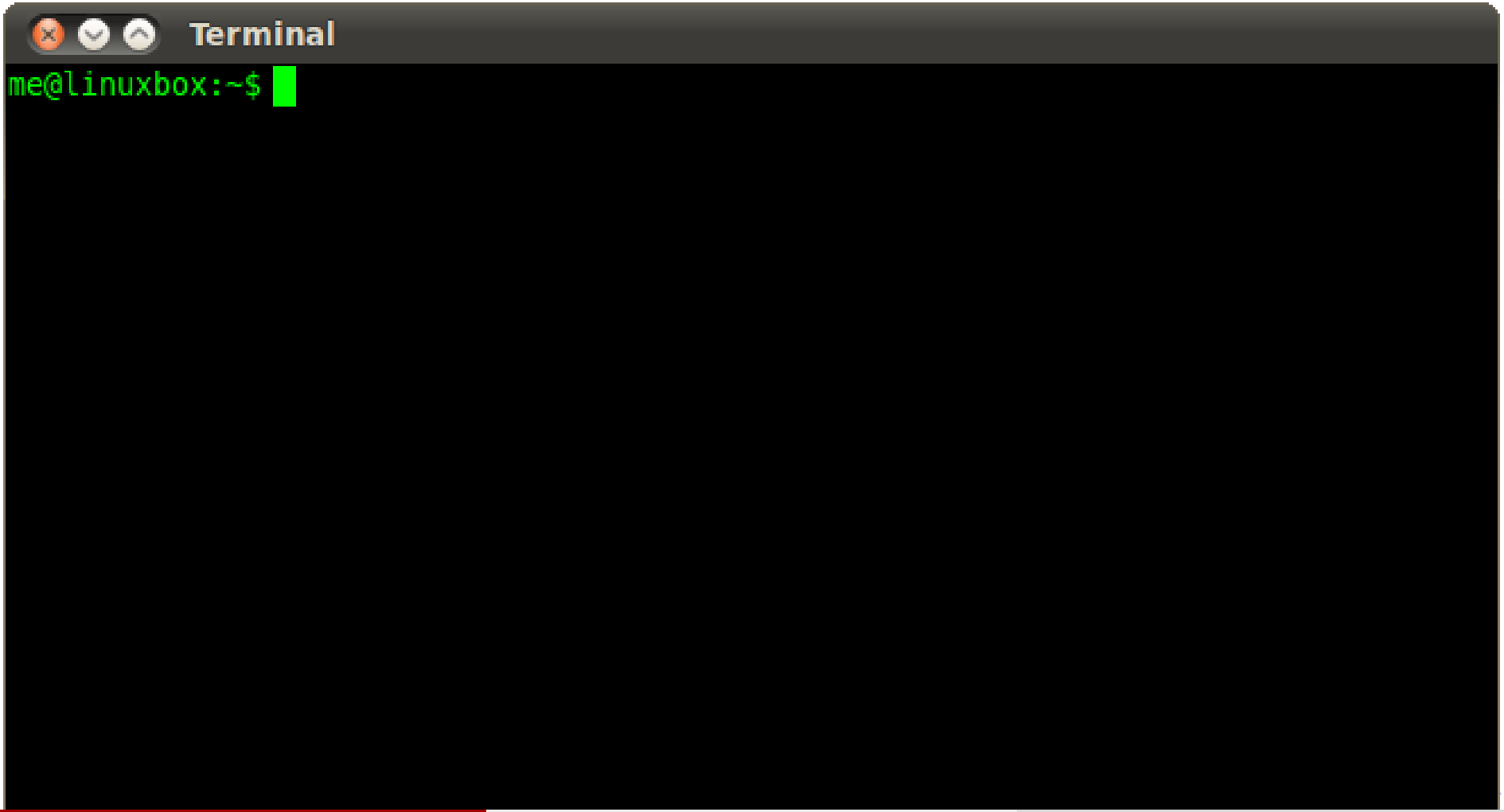
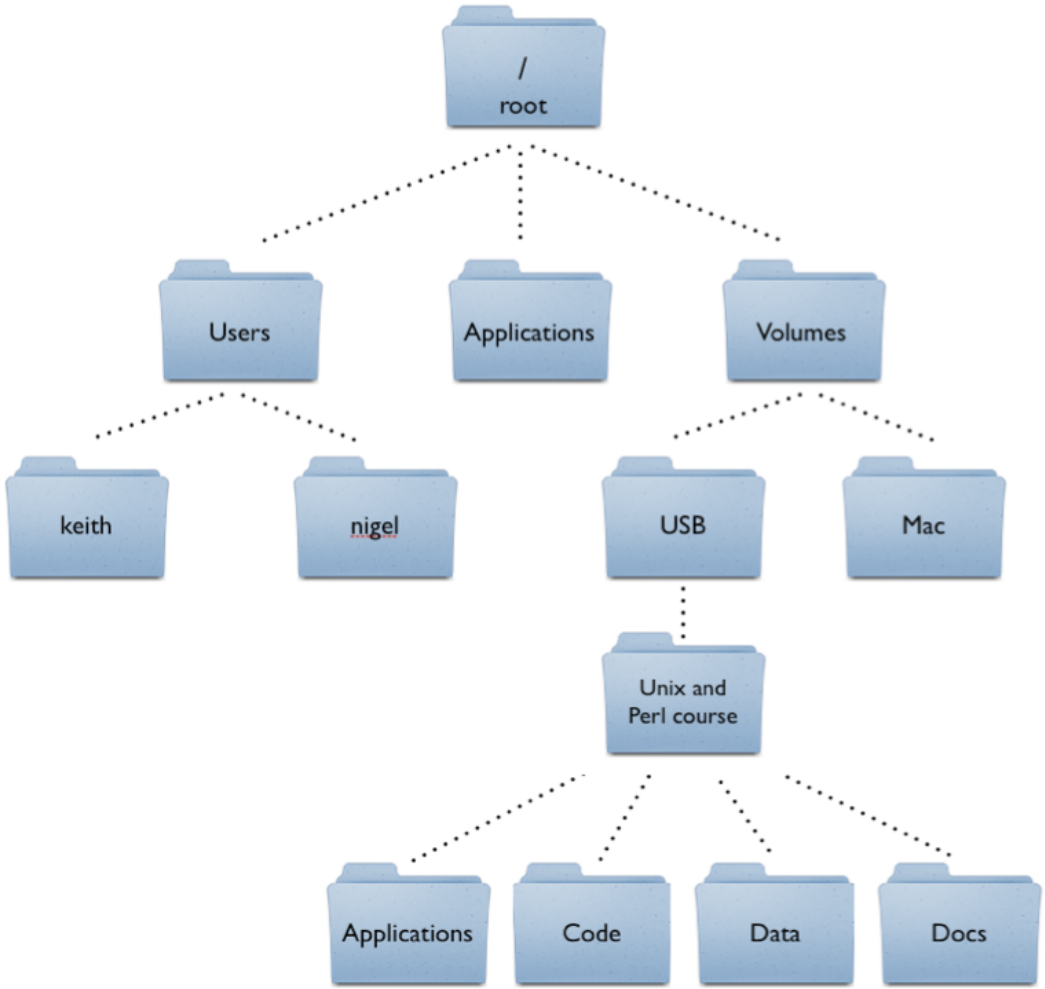
Terminal

Opening Terminal

Open a terminal window by pressing **Ctrl+Alt+T**



Directory Structure



Terminal Navigation

- Make a new directory (folder)–

```
mkdir <directory_name>
```

- Enter a directory –

```
cd <directory_name>
```

- Type a command in the terminal, and then press **Enter**

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- Write your code in a text editor
  - Notepad, Vim, Emacs, etc.

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- Open *gedit*

```
gedit &
```

- Open a file with *gedit*

```
gedit my_file.cpp &
```

Text Editor

- Write your code in a text editor
  - Notepad, Vim, Emacs, etc.
- We will use **gedit**
- Open *gedit*

```
gedit &
```

- Open a file with *gedit*

```
gedit my_file.cpp &
```

  - Note that the file should be present in your current directory
  - If file doesn't exist, it will be created

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Hello World !

The First C++ Program

```
#include <iostream>

using namespace std;

int main() {

    cout << "Hello World !" << endl;

    return 0;

}
```

Compiling and Running

- Use the following command to compile –

```
g++ -Wall hello_world.cpp
```

- This should create a file called **a.out** in your current directory.
- Use the following command to run the executable –

```
./a.out
```

Taking Input from User

```
#include <iostream>

using namespace std;

int main() {

    int N;

    cout << "Enter a number: ";
    cin >> N;
    cout << "You entered the number " << N << endl;

    return 0;

}
```

Syntax

- Statements are terminated by semicolons

```
cout << "Hello World !";
```

- A block is several statements inside curly brackets

```
{
    int N;
    cin >> N;
    cout << N << endl;
    return 0;
}
```

Try it out

Download Code

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What is a Variable ?

A variable is a **name** that refers to a memory location.

Memory Location

Data Types

Type	Keyword	Examples
Integer	int	0, -5, 43, 6
Floating point	float	2.5, -0.3, 0.0012, 1.0
Double Floating point	double	0.5, 9.1, -0.7, 7.0

Variable Declaration

- Variable contains Garbage Value (Un-initialized)

```
int a;
```

- Initializing with a value.

```
double b = 5.0;
```

- Declare multiple variables

```
int a, b, c, d;
```

Variable Assignment

NOT the same as "equals"

Left side is name. Right side is value.

```
a = 5;
b = a + 5;
```

We **"assign"** a value to a variable.

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Arithmetic in C++

How to make a Calculator

Operation	Symbol	Expression	Equivalent To
Addition	$+$	$a + b$	–
Subtraction	$-$	$a - b$	–
Multiplication	$*$	$a * b$	–
Division	$/$	a/b	–
Remainder	%	$a\%b$	–

Arithmetic in C++

How to make a Calculator

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Addition	$+$	$a + b$	$-$
Subtraction	$-$	$a - b$	$-$
Multiplication	$*$	$a * b$	$-$
Division	$/$	a/b	$-$
Remainder	%	$a\%b$	$-$
Increment	$++$	$++a$	$a = a + 1$
Decrement	$--$	$--a$	$a = a - 1$

Order of Operations

Use Brackets to Define Order of Operations

```
((a+b)*(c+d))/5
(a/b)*(c/d)
```

Example

```
float pi=3.14159, R=5.0;
float volume = (4.0/3.0)*pi*R*R*R;
```

Integer Division

- What is the value of the expression $(5/2)$?
  - Answer: 2
- How to do actual division ?
  - $(5.0/2)$
  - $(5/2.0)$
- If you are dealing with variables – $(x/2)$
  - $(x * 1.0/2)$
  - $(x/2.0)$

Shorthand

Expression	Equivalent To
$a \mathrel{+}= b$	$a = a + b$
$a \mathrel{-}= b$	$a = a - b$
$a \mathrel{*}= b$	$a = a * b$
$a \mathrel{/}= b$	$a = a/b$
$a \mathrel{\%}= b$	$a = a\%b$

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Comments

Explaining what your code does

Anything following // will be ignored.

Single Line Comment

```
a += 5; //Adding 5 to the value of a
```

Anything between /* and */ will be ignored.

Multi Line Comment

```
int N = 0;
/* This is a comment
that spans
multiple lines */
cin >> N;
```

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Computing Squares

Putting it All Together

```
#include <iostream>

using namespace std;

int main() {

    double N, square;

    cout << "Enter a number: ";
    cin >> N;          //Take input from user
    square = N*N;      //Compute Square
    cout << "The square of " << N << " is " << square << endl;

    return 0;

}
```

Computing Cubes

```
#include <iostream>

using namespace std;

int main() {

    double N, cube;

    cout << "Enter a number: ";
    cin >> N;          //Take input from user
    cube = N*N*N;      //Compute cube
    cout << "The cube of " << N << " is " << cube << endl;

    return 0;

}
```

Coding Practice

Area of Circle

Write a program that takes as input the length of the radius of a circle, and outputs its area.

Sum of First N Natural Numbers

Write a program that takes as input an integer N, and computes the sum $(1+2+3+\cdots+N)$. You may use the fact that $1+2+\cdots+N = \frac{N\cdot(N+1)}{2}$

Write a program that takes as input an integer N, and computes the sum of the last three digits of N. If there are less than three digits, just sum all of them.

If you are familiar with C/C++

Write a program that takes as input an integer N, and computes the following sum.

$\frac{6}{1^2} + \frac{6}{2^2} + \frac{6}{3^2} + \frac{6}{4^2} + \cdots + \frac{6}{N^2}$