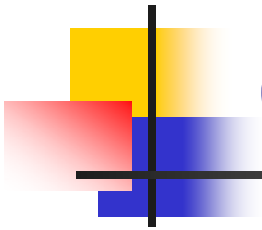
COMP5102
Computer Systems

Programming: Behind The Scenes

Mario Gongora

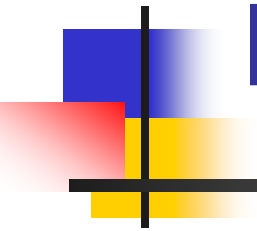
mgongora@dmu.ac.uk

http://www.cse.dmu.ac.uk/~mgongora

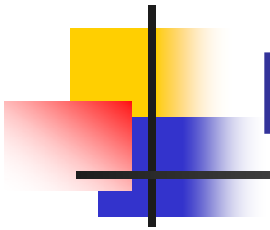


Overview

- Programming Levels
- Low Level programming
- High Level Programming



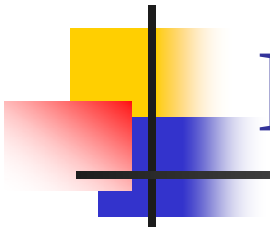
Programming Levels



Programming Levels

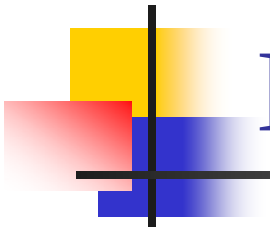
- Low Level programming:
  - Taking into account the hardware of the machine.
- High Level programming e.g. C language
  - Abstracting from hardware, but program still is hardware “aware”
- High Level Programming e.g. Java
  - Abstracting from hardware completely.

Low Level Programming



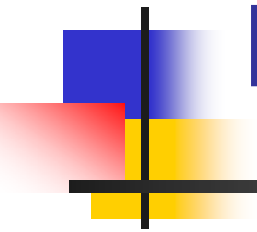
Low Level Programming

- Machine Code
  - The ONLY language the computer really understand
  - The ONLY programs that can be executed
  - Based on binary numbers (words)
  - Numbers represent either instructions or data

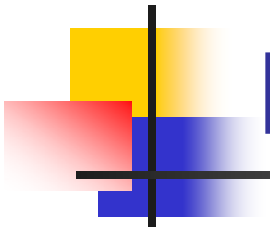


Low Level Programming

- Assembly language
  - Direct representation of machine code
  - In human readable mnemonics and labels
  - Needs to be "*assembled*" into machine code

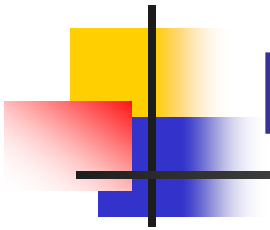


High Level Programming



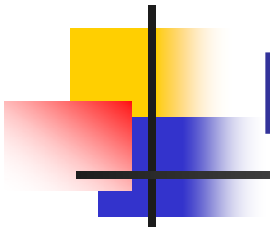
High Level Programming

- Human readable languages
  - Use of highly human readable languages
  - Direct (or nearly direct) representations of algorithms rather than machine instructions
  - Defined and strict Syntax
  - Defined and strict structure
  - Needs to be transformed somehow to machine code



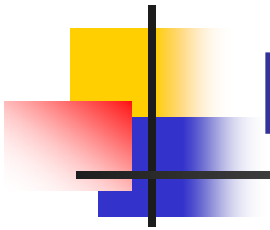
High Level Programming

- C Language (compiler based, to machine code)
  - Representation in an algorithmic language
  - Easily human readable
  - Strict syntax and structure
  - Abstracts the machine language completely
  - Needs to be compiled to an assembly type language (object code) and then be linked to libraries
  - Converted then to machine code



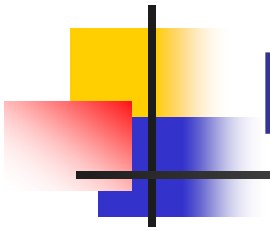
High Level Programming

- Matlab (Interpreted)
  - Representation in an algorithmic language
  - Easily human readable
  - Strict syntax and structure
  - Abstracts the machine language completely
  - Needs to be interpreted by an application which converts instructions to machine code, one by one



High Level Programming

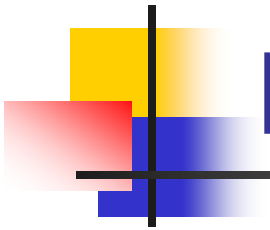
- Java (Compiled to Bytecode)
  - Representation in an algorithmic language
  - Easily human readable
  - Strict syntax and structure
  - Abstracts the machine language AND architecture completely
  - Needs to be compiled and linked into Bytecode



High Level Programming

- Java (Compiled to Bytecode)
  - Bytecode is executed by an Universal Virtual Machine
  - For Java is called the JVM (*J*ava *V*irtual *M*achine)
  - There has to be a JVM which runs in machine code for every existing computer architecture
  - But ALL JVMs run ALL Bytecode

Programming: Behind the Scenes



- Java → Compiled to Bytecode → JVM
- Matlab → Interpreted by Application
- C → Compiled to
- Assembly → Assembled to
- Machine Code → The Computer Can Execute