GIS Programming 1

GIST 7010

Module 01 Lecture

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Learning outcomes

- Explain how computers work
- List the reasons we create programs
- Explain the art and science of programming
- Distinguish between programming languages
- Explain how Java works
- Describe the elements of the Java language
- Describe the programing problem solving process

Computers and how they work

Computer systems

- Computer systems:
  - Hardware
  - Software

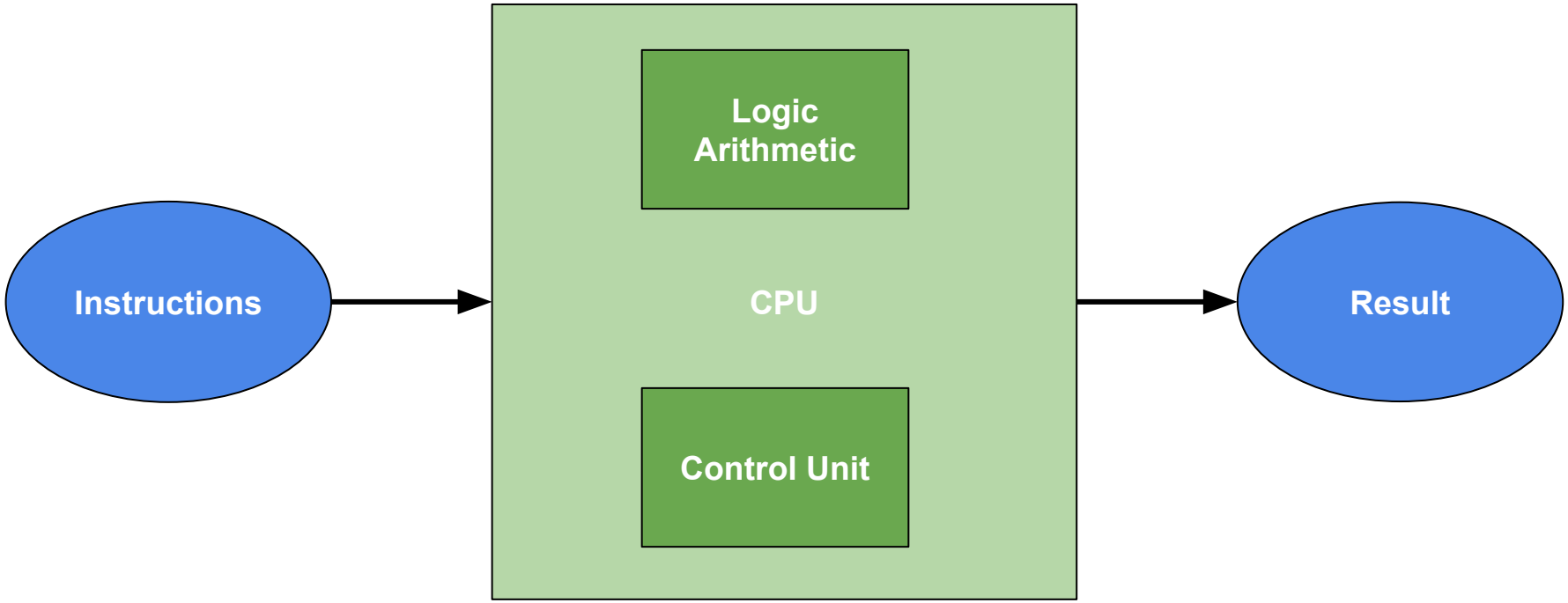
Hardware

- CPU
- Main memory
- Secondary storage (internal and external)
- Input
- Output

CPU

- Instructions IN
- Result OUT
- In the middle is:
  - Control unit
  - Arithmetic unit
  - Logic unit
- Cycle
  - Fetch … decode .. execute

CPU Diagram



Software

- Operating system and related programs
  - Manages the CPU
  - Manages the IO devices (drivers)
- Applications
  - Libreoffice
  - Postgresql GUI tools (pgAdmin III)
  - Programs that you will write
- Middleware
  - Java virtual machine
  - JDBC/ODBC

What is program?

What is program?

- A program is:
  - A set of instructions for the CPU to follow
  - Very rigid, structured … why? … computers are dumb
- Machine language (1GL)
  - Instructions are in written in machine code
  - Just 1's and 0's CPU likes 1's and 0's
  - On or off
    - Simple
    - A computer can understand on and off
      - That is about it though

Why program?

Why program?

- Why write a program (app)?
  - Typically to solve a problem
    - Sometimes for fun … rare
    - Problems can range from:
      - Big to small
      - Simple to complex
      - Annoying to business critical
  - Increase consistency
  - Gain time on a project
    - No time machine ➡ automate

Languages and how they work

The generations

- 1GL Machine Language
  - Punch cards (prehistoric)
- 2GL Assembler (2GL)
  - Old school and fast but too many lines
- 3GL Today's popular languages
  - C++, Java, Visual Basic, Python, PHP, etc
- 4GL Looks "less procedural" more declarative SQL
  - More want and less how

Popular languages

Language	Description
BASIC	Beginners All-purpose Symbolic Instruction Code is a general-purpose, procedural programming language. It was originally designed to be simple enough for beginners to learn.
FORTRAN	FORmula TRANslator is a procedural language designed for programming complex mathematical algorithms.
COBOL	Common Business-Oriented Language is a procedural language designed for business applications.
Pascal	Pascal is a structured, general-purpose, procedural language designed primarily for teaching programming.
C	C is a structured, general-purpose, procedural language developed at Bell Laboratories.
C++	Based on the C language, C++ offers object-oriented features not found in C. C++ was also invented at Bell Laboratories.
C#	Pronounced "C sharp." It is a language invented by Microsoft for developing applications based on the Microsoft .NET platform.
Java	Java is an object-oriented language invented at Sun Microsystems, and is now owned by Oracle. It may be used to develop stand-alone applications that operate on a single computer, applications that run over the Internet from a Web server, and applets that run in a Web browser.
JavaScript	JavaScript is a programming language that can be used in a Web site to perform simple operations. Despite its name, JavaScript is not related to Java.
Perl	A general-purpose programming language used widely on Internet servers.
PHP	A programming language used primarily for developing Web server applications and dynamic Web pages.
Python	Python is an object-oriented programming language used in both business and academia. Many popular Web sites contain features developed in Python.
Ruby	Ruby is a simple but powerful object-oriented programming language. It can be used for a variety of purposes, from small utility programs to large Web applications.
Visual Basic	Visual Basic is a Microsoft programming language and software development environment that allows programmers to create Windows-based applications quickly.

Paradigms

- Procedural Subs and Functions
  - Programs start and races to the end
- Object Very complex data types with behavior
  - Mimics the real world
- Event The GUI world
  - The program runs forever waiting for certain events
- Problem:
  - O and E happened at the same time … confusion
  - In a 3GL or 4GL the paradigms can blur and fuse

Why the jargon?

- Why all the distinctions?
- You need to know the lingo
- So you can … Ignore the noise … the hype
- Do not get sucked into 'techno weenie debates'
  - E.g. Object versus class
  - E.g. HTML5 versus native apps
- As a GIS professional …. You want stuff to work
  - Does it work? Does it look good? It is fast?

The art and science of programing

The art and science of programming

- Computers are very structured
  - The world is not
- Programming languages have an exact syntax
  - A human workflow is flexible
- Designing solutions
  - The art part of programming is hard
  - Mapping a real world problem into structured boxes
  - Taking a complex problem and making it so simple a computer can do it
    - That is the real challenge

Why Java?

Why Java?

- Why not?
- Have to start somewhere
- But ArcGIS uses python!
- ArcGIS (Server, Runtimes, Android, iOS) uses
  - Objective C
  - QT (C++)
  - Java
  - JavaScript
  - And yes python

How Java works?

Java has many forms and works almost everywhere

- Java works in a lot of places and has many forms:
  - Applications (Desktop)
    - Headless (no UI) and UI (formerly GUI)
  - Applets
    - Inside a browser
    - Being replaced by HTML5 apps
  - Web Containers (Tomcat, Geronimo, Jetty, Glassfish)
    - Servlets
    - JSP and JSF
  - Mobile (phones, tablets and phablets)
    - JAVAME and Android (mobile)

Java language elements

Language Element	Description
Key Words	These are words that have a special meaning in the programming language. They may be used for their intended purpose only. Key words are also known as *reserved words*.
Operators	Operators are symbols or words that perform operations on one or more operands. An operand is usually an item of data, such as a number.
Punctuation	Most programming languages require the use of punctuation characters. These characters serve specific purposes, such as marking the beginning or ending of a statement, or separating items in a list.
Programmer-Defined Names	Unlike key words, which are part of the programming language, these are words or names that are defined by the programmer. They are used to identify storage locations in memory and parts of the program that are created by the programmer. Programmer-defined names are often called *identifiers*.
Syntax	These are rules that must be followed when writing a program. Syntax dictates how key words and operators may be used, and where punctuation symbols must appear.

Key words

- These words have special meaning
- They can only be used for their intended purpose
- Examples:
  - public
  - class
  - static
  - void
  - int
  - double
  - string

Operators

- Symbols that perform an operation on operands
- Examples
  - = and ==
  - < and <=
  - > and >=
  - * and /
  - - and +
  - -- and ++
  - && and ||

Punctuation

- All languages reserve certain characters for punctuations:
  - Semicolon ;
  - Colon :
  - Braces {}
  - Brackets []
  - Parentheses ()

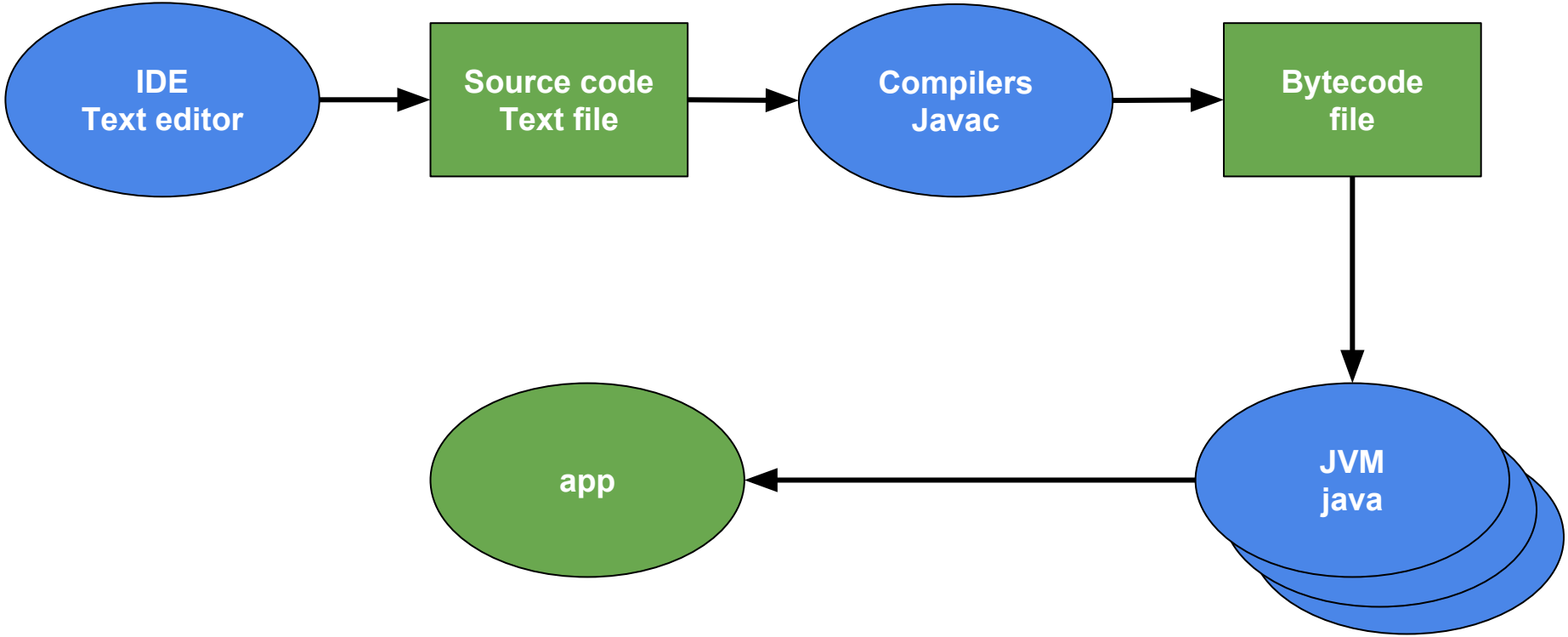
Identifiers

- A name that a programmer gives to something there created
- Examples
  - variables
  - class
  - methods

Syntax

- The rules on how all the previous items:
  - Work together
  - Resolve to a value
  - Combine

Java diagram



Programming problem solving process

WAR: core tools

- When solving a problem in programming there are three core "tools":
  - Variables AKA data bukets
  - Branching/Control/Decision Structures/Selections
  - Loops/Repeating
- Everything else ... IKEA for code
  - Noise … focus on … does it work … how do I make it work

WAR: PPSP steps 1-5

- Restate the problem in 10 words or less
- Identify any inputs
- Identify any outputs
- Identify any choices, options and special cases
- Identify any repetition

WAR: PPSP 6-10

- Break the program into manageable "chunks"
- Within a "chunk" map the information into variables, decisions and loops
- Start with small code segments and always test
  - "One line at a time"
- Continually add comments as you progress
- Have someone else test you program and then YOU fix the errors

WAR: chunks

- Chunks are important
  - Chunks are small (big problem small problem)
  - Chunks are manageable
  - Otherwise you will freak yourself out
  - GIS professionals do not freak themselves out
  - At least not on a regular basis
- Steady effective progress
  - Try … test … repeat

Data types and structured data

WAR on data-types

- Cannot avoid them
- ArcGIS use them
- Databases use them
- Java uses them
- They work
- We like things that work
- More on DT and variables next week

Lab

- To send a message to the user
  - System.out.println();
- Data types and variables
  - Java has data types … strict … strict is good
  - String for text/messages
  - Little 'd' double for numbers with decimals (d vd D?)
- To get data (in this case numbers) from the user:
  - Scanner.nextDouble();

The End

Extended time