List of Topics

Contents

General Concepts

Students should understand the meaning and importance of the following notions. This statement should be read as "understand the first sentence or paragraph on a wikipedia article", taking high-level programming language[1] *as an example.*

- Programming languages types and paradigms
  - Machine language instructions
  - Assembly instructions
  - High-Level Programming Languages
  - Object-oriented paradigm and data hiding
- The difference between roles (user, tester, programmer)
- How complex piece of software *reuse* previous pieces.
- The importance of security
  - Types of attack (malware, phishing, social engineering, zero-day)
  - Types of loss (loss of integrity / availability / confidentiality)

Writing and Compiling Programs

- Understand what the "flow of development" is:
  - Having a goal
  - Writing down specifications
  - Creating the source code
  - Running the compiler
  - Reading the compiler's output, warning and error messages
  - Looking for documentation and help on-line and off-line
  - Testing
  - Making sure the program is secure
  - Editing
  - Reusing
- Using an IDE to
  - Create a project,
  - Perform some of the steps of the "flow of development",
  - Correctly save and re-open projects,
  - Understand basic features of break points and debugging.

[1] https://en.wikipedia.org/wiki/High-level_programming_language

The IDE used can be MonoDevelop[2] *or Visual Studio*[3]*, the student can pick other IDEs if they wish but they will not be supported.*

Computer Usage

- How to download and install an IDE in a secure way
- How to share and zip a project
- How to use shortcuts
- How to look for on-line documentation

The Structure of a Program

First Program - Hello World

The students should understand all the components of a simple "Hello World" program:

- Comments (in line and block)
- `using` statements and namespace / API concepts
- blank lines and spacing
- indentation
- intro to classes and methods' structures (body / header)
- status of `main` method
- intro to Console's `Write` and `WriteLine`
- string literal

Rules and Conventions

- The difference between a "rule" (e.g. case-sensitivity) and a "convention" (commenting your code).
- Reserved words
- Identifiers and naming conventions
- That the distinction can vary with the programming language
- Importance and role of `{` and `}`

Datatypes and Operators

Variable

- Datatype (numerical, boolean, string, character) – including a mention of reference datatypes
- Declaration, assignment, initialization
- Naming variables correctly
- The absence of default value after declaration (un-assigned variables)

[2] https://www.monodevelop.com/
[3] https://visualstudio.microsoft.com/

Numerical Values

- Integers (`int`, `long`) – range and size, signature (`uint`)
- Floating Point (`float`, `double`, and `decimal`) – range, size and precision,
- Type casting (e.g. from `int` to `double`, and legal operations between different datatypes) and casting operator (e.g. `(int)`).
- Overflow and underflow

Booleans

- Possible values (`true`, `false`)
- Usage
- That boolean variables are called "switches"

Operators

- Binary arithmetic operators: `*`, `/`, `%`, `+`, `-`
- Unary arithmetic operators: `++`, `--`
- The difference between postfix and infix notation for unary operators
- Comparison operators: `!=`, `==`, `>`, `>=`, `<`, `<=`
- Boolean logical operators: `&&`, `||`, `!`
- Precedence and "vadidity" of some expressions (typically, `! 2 < 3` is not a valid expression)
- Combined assignment operators: `+=`, `*=`, `-=`, `/=`, `%=`

Strings

- `ReadLine` method
- Concatenation (+)
- Interpolation
- Additional methods: `ToLower`, `ToUpper`, `Contains`

Displaying Strings on the Screen

- Format specifiers[4] for numbers: – Currency (`C`),
  - Fixed-point (`F`) or Number (`N`)
  - Percent (`P`)
  - Exponential (`E`)
- The `String.Format` method

Characters

- Possible values and the existence of binary, oct, dec and hex representation (cf. for instance wikipedia[5])

[4] https://docs.microsoft.com/en-us/dotnet/standard/base-types/standard-numeric-format-strings

[5] https://en.wikipedia.org/wiki/ASCII#Printable_characters

- Escape character and sequences: `\n`, `\t`, `\\`
- Conversion between glyph and decimal value.
- Various methods: `ToLower`, `ToUpper`, `Contains`, `StartsWith`, `EndsWith`

Lists

- Creating a list of numbers or strings
- Adding items using the `Add` method
- Accessing items using `[]`
- Removing and Inserting (`Remove`, `RemoveAt`, `Insert`)
- `Count` property

Basic Control Structures

Selection Statements

For each of the following structure:

- `if`
- `if-else`
- `if-else if`
- nested `if`s
- `switch`

The student should understand

- Their importance,
- Their usage,
- Their syntax,
- Their flow,
- When to use one or the other,
- The common pitfals (e.g., writing a condition in a `switch`).

Repetition Statements

For each of the following structure:

- `foreach`
- `while`
- `for`
- `do{…}while(…)`

The student should understand:

- Their importance,
- Their usage,
- Their syntax,
- Their flow,

- When to use one or the other,
- The common pitfals (e.g. = instead of ==, `<= n` vs `< n`)

As well as being capable of identifying the difference between

- Counter-controlled,
- Sentinel-controlled,
- User-controlled

and defining the term "accumulator"

Object-oriented programming

Class Conception

- Need and interest of specification
- UML Class diagram: interest, usage, and simple case (single class with attributes, methods and constructor).
- Access modifier (private, public)
- Principle of least privilege (private variables and methods where possible)

Class Implementation

- Attributes (and their default value, as well as how to change them)
- Get and Set methods
- Properties
- Method signature
- Overloading
- Variable shadowing[6]
- Constructors: default constructor and "custom" constructor

Class Usage

- The `new` keyword
- Object creation using default and custom constructors
- Object manipulation: calling a method, setting an attribute, calling the `ToString` method implicitely.

Additional Considerations

- `toString` method
- static class and methods
- `Math` Class[7] (`Abs`, `Sqrt`, `Pow`)

[6] https://en.wikipedia.org/wiki/Variable_shadowing
[7] https://docs.microsoft.com/en-us/dotnet/api/system.math?view=net-5.0

Random Class

- Creating a generator with `new Random()`
- Generating non-negative integers,
- Generating integers between ranges,
- Generating double,
- Generating a random word
- Potential problems with deterministic generators

Testing and Debugging

- How to test intelligently
- How to test every instruction
- How to test boundary conditions

Interacting with Users

- Input validation
- `TryParse` in the `int` and `decimal` classes.
- Reading a single character from the user

Data structures

Constant

- The `const` keyword
- Example usages (Avogadro constant, miles-to-kilometer ratio, speed of light) and use case.
- `Math.PI`
- Static constant

Enumerated Datatype

- Define enumerated datatypes using `enum`
- Enum values (i.e. numerical values assigned to enumerated values by default)
- Use enumerated datatypes (variable declaration, assignment, displaying).

Arrays

Only one-dimensional arrays should be discussed.

- Vocabulary: index (starting at 0), bounds.
- `Length` property
- `Resize` method

- Different syntaxes for initializing and declaring arrays
- Buffer overflow

Exceptions

- `try…catch` blocks
- Types of exceptions
- `finally`
- Defining your own exception

File I/O

- `StreamWriter` and `StreamReader` classes
- Manipulating binary and text files
- `File` class