**Start:** Nov-16-2018

Tutorials: https://www.learncpp.com/cpp-tutorial/introduction-to-these-tutorials/

**VS Code TIPS**

1. VS Code setup: <https://code.visualstudio.com/docs/languages/cpp>
2. Use tasks.json to set command and action.

Cmd+p => command palate

Cmd+p => task <name of task to run>

**Tip**

1. Learn how to program

2. Lean how not to program

3. Mainly learn to debug.

Practice. Practice. Practice.

**Best Practices**

1. Problem solving approach
   1. Define vision. (vague)
   2. Drill down and define requirements (specifics)
   3. Start simple. 1 area at a time. Add features incrementally
   4. TDD have proved very useful for mission critical software
2. Usually 20% on dev and 80% on other activites.
   1. Document code
   2. Simplified code
   3. Modular and organized
   4. Robust with edge cases
3. Treat warnings as errors. In g++ -Werror
4. Comments
   1. At the library, program, or function level, describe *what*
   2. Inside the library, program, or function, describe *how*
   3. At the statement level, describe *why*.
5. Variables, Functions
   1. Uninitialized is a common trap
   2. Use namespace. Avoid global naming - avoid name conflicts and for clarity
6. Headers
   1. For standard library, use with “.h” extension and from namespace (ex: #include <iostream> and std::cout
   2. Have .h or .hpp extension
   3. Use **header guard** to avoid duplicate inclusion. #ifndef UNIQUE\_NAME #define …. #endif
   4. Don’t do definition in header file. Only declare.
   5. Avoid variables. Have only constants.
   6. Avoid relative path, include Search Path / Include Path (-I)
   7. Have same names for header files as source definition file. Ex: calculator.h, calculator.cc
7. Macros, Header Guards
   1. Avoid using for function or text substitution.
   2. Used mainly as header guards.
   3. Header guards are local!
8. Variables
   1. Prefer direct or uniform initialization.
   2. Define variables as to its usage as possible for code clarity.
9. Integer Type
   1. Preferable to use signed. Use unsigned cautiously. C++ freely converts between them.
   2. Use fixed width integer types. #include <cstdint> .. std::int16\_t val;
   3. Optionally use fast/least variants. Std::int\_fast16\_t or std::int\_least16\_t
10. Float
    1. Use ‘f’ suffix to make it explicit
    2. Use exponent representation. 9.234e-2 for 0.09234
    3. Careful about precision. Use double wherever possible.
    4. Common pitfall -> Rounding errors.
11. Const, Constexpr, Symbolic constants
    1. Don’t use magic numbers
    2. Prefer constexpr
    3. Prefer putting all constants as constexpr in a header under a namespace.
12. Operators
    1. Use parenthesis to make order of evaluation explicit.
    2. When using bitwise operators, always use “unsigned integers”.

**Introduction-to-programming-languages**

1. Machine code / Instruction set: 0s and 1s. Specific to CPU architecture.

2. Assembly language: notation. Ex: mov al, 016h

Assembly -> Assembler -> Machine code

3. High level language: C/C++. Ex: a = 16;

Program -> Compiler -> Executable. (Efficient, compiler optimization, less flexible, C/C++)

Program -> Interpreter -> Execute. (Moderately efficient, less optimizations, more flexible, Python/JS)

**Introduction to C++**

1. History: C. 1972, Dennis Ritchie, Bell Lab. Objective-Cross hardware, high level, developer friendly, fine grained control on memory and resources.

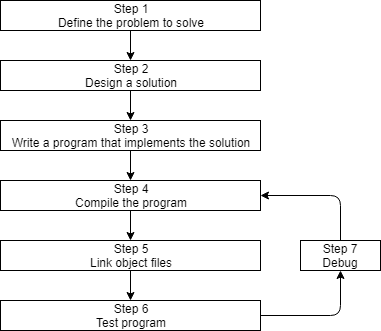
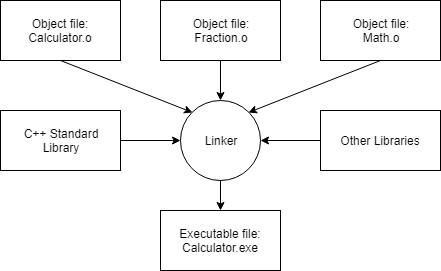
2. C++: Bjarne Stroustrup. Bell Labs. 1979. Most interesting extension - Object Oriented Programming Concept.

3. Philosophy - “Trust the developer”. You control. Hard but good. Programs that requires fine grained control - ML, DB, low latency programs, Embedded etc.

4. C++03 -> Standard published in 2003. C++11 -> Widely used. Published in 2011. Latest C++17 -> 2017

**Programming in C++**

1. Can have .cpp or .cc extension
2. Output of compiler is object file with .obj or .o extension
3. Linker links user programs, libraries used and creates one executable.
4. There is a standard library which is mostly used. Iostream is one functionality in standard library. Referred to as std::
5. Linkers automatically link standard libraries.
6. In large software system, people use “Make” or “CMake” to define how to compile and link CPP programs.

* Always define clearly **what** you want to solve.
* Have basic idea of **how**.
* Usually 20% on dev and 80% on other activites.
  + Document code
  + Simplified code
  + Modular and organized
  + Robust with edge cases

**Structure of a Program**

1. Things end with “;”
2. Statement => Expression (requires evaluation) => Function
3. Main is necessary. Have main.cc or project\_name.cc for file having main()
4. Preprocessors at the top. Special directive to compiler. #include makes it to include the “header file”.
5. Comments – Single line (//), multi line (/\*….\*/)
6. Variables – Define, Initialize, Assignment. There is no default initialization.
7. std::cout, std::endl. std::cout << x
8. std::cin >> x
9. Functions -> Reusable sequence of statements.
10. Functions -> Nested functions are not allowed in CPP. Default is pass by value.
11. Variables -> Cannot start with capital letters or numbers. Only “\_” is allowed.
12. Literals -> A value. X = 5; X is a variable, 5 is a literal. A literal evaluates to themselves.
13. Forward declaration / pure declarations. Functions and variables declared earlier and defined later.

**Functions, Namespace**

1. Each file is compiled independent of each other. Forward declaration or include header file is necessary.
2. Header files – Only declarations to avoid tedious forward declarations. Can have (.h, .hpp or no extensions). Declare once and use everywhere.
   1. Use angled brackets to include header files that come with the compiler. Use double quotes to include any other header files.
   2. Angular bracket tells it is a standard runtime library header.
   3. .h extension in standard library is for backward compatibility. Without extensions are new one. This happened when things got moved to std:: namespace.
   4. Use header guard to avoid duplicate inclusion. #ifndef UNIQUE\_NAME #define …. #endif
   5. Preprocessor just copies the content.
   6. Angular brackets (<…>) for standard libraries, quotes (“…”) for user defined.
3. Preprocessor
   1. Starts with #
   2. Macros and Includes
   3. Macros – Text substitution and function definition.
      1. Avoid both.
      2. Use mainly for header guards.
      3. Scope for that file only.
4. Fundamental Types
   1. Short, int, long, long long
   2. Float, double, long double
   3. Char, chart\_16t, char\_32t
   4. Bool
   5. Void
5. Initialization
   1. Copy Initialization: Ex: int val = 5;
   2. Direct Initialization: Ex: int val(5);
   3. Uniform initialization: Ex: int val{5};
      1. Prefered.
      2. Initializes to default if given empty. Ex: int val{}; //val => 0
   4. Prefer uniform initialization.
6. Integer:
   1. Signed or unsigned
   2. Signed preferred
   3. Size\_t => unsigned int => Type to represent size of data types. i.e., sizeof(int) return value is of type size\_t.
   4. Controversy – Size of int change based on the architecture.
   5. Solution – From C++ 11 – <cstdint>. Fixed width integers. Int8\_t, int16\_t, int32\_t, int64\_t, uint8\_t, uint16\_t, uint32\_t, uint64\_t
   6. But, slow, hence, some more types. fast/least variants. Std::int\_fast16\_t or std::int\_least16\_t
7. Floating:
   1. Large or small numbers. With decimal.
   2. Float, double, long double.
   3. Ex: float 123.33; float 123.33f; float 1.2333e2
   4. Default cout precision – 7.
   5. #include <iomanip> ; std::setprecision(17)
   6. 1.2 x 104, 1.2 is the significand and 4 is the exponent
   7. The digits in the significand (the part before the E) are called the **significant digits**. The number of significant digits defines a number’s **precision**. The more digits in the significand, the more precise a number is.
   8. INF -> Infinity
   9. NaN -> Not a number
8. Boolean:
   1. Int under the hood.
   2. True -> 1, false -> 0
   3. Cin silently fails if neither 0 or 1 is taken as input;
9. Char:
   1. 1 byte signed integer
   2. ASCII – 0 to 127. 0-32 unused. ‘a’ -> 97. ‘A’ -> 65
   3. Static\_cast<int>(var)
   4. Char16\_t, char32\_t => used for UNICODES. UTF-16 OR UTF-32
10. Const, constexpr, symbolic constant
    1. When you know initialization value – const. ex: const int pi(3.14159);
    2. When you don’t know initialization value – constexpr. Ex: constexpr int age = today – dob;
    3. Don’t do - #define MAX\_STUDENTS 30
    4. Prefer putting all constants in a header file as constexpr
11. Logical Operators:
    1. && (AND) has higher precedence than || (OR)
    2. !x && !y is not same as !(x && y)
12. Bitwise:
    1. Signed and unsigned
    2. 1st digit on left most used as signed bit.
    3. -5 in binary => 5 in binary (0000 0101). Invert and add 1. 1111 1010 + 1 => 1111 1011.