bash + make + git + vim

```
#------------#
# TMUX-SHELL #
#------------#

$ C-l                           # clear screen
$ C-w                           # delete word
$ C-_                           # undo
$ C-c                           # kill
$ C-d                           # exit
$ C-Z                           # suspend process
$ fg                            # restore process
$ C-a                           # jump to the strt of the line
$ C-e                           # jump to the end of the line
$ open <directory path>         # open in finder
#-------------------------------------------------------------#
$ C-space ""                    # split pane
$ C-space %                     # split pane
$ C-space arrow                 # jump panw
$ C-space {                     # move pane
% C-space }                     # move pane
$ C-space x                     # kill pane
$ C-space q                     # show pane number
$ C-space q 1                   # goto pane 1

$ :resize-pane -D               # resizes down
$ :resize-pane -U               # resizes upward
$ :resize-pane -L               # resizes left
$ :resize-pane -R               # resizes right
$ :resize-pane -D 10            # resizes down by 10 cells
$ :resize-pane -U 10            # resizes upward by 10 cells
$ :resize-pane -L 10            # resizes left by 10 cells
$ :resize-pane -R 10            # resizes right by 10 cells
#-------------------------------------------------------------#
$ C-space s                     # list session
$ C-space :new                  # new session
$ tmux kill-session -t <name>   # kill session
$ tmux attach -t <name>         # re-attach session
#-------------------------------------------------------------#
$ ssh hostname                  # hostname-c_user SSH port22
$ ssh -i foo.pem hostname       # hostname-identity file
$ ssh user@hostname             # hostname-user-SSH port22
$ ssh user@hostname -p 8765     # hostname-user-custom port
$ ssh ssh://user@hostname:8765  # hostname-user-custom port
$ scp .txt ubuntu@hostname:/home# copy foo.txt into remote dir
#-------------------------------------------------------------#
$ cat foo.c                     # create file with content
$ touch foo.c                   # create file without content
#-------------------------------------------------------------#
$ mkdir test                    # create dir
$ rmdir test                    # remove dirgit

$ cd ../snippets/               # navigate subdir of parnt dir
$ cd ./mmio.h                   # navigate curr dir

$ cp ./file.xyz ../target/      # copy into subdir of parent
$ mv Makefile Makefile_ex       # rename old->new
$ mv * ../                      # move all upper folder

$ &&                            # chain command in bash
$ pwd                           # get location of current dir
$ find /root/sid/ -name "*matrix*"  # search for file
$ rm -rf spmv_openmp            # force remove
$ cp -R t1/. t2/                # copy content
```

```
#------#
# MAKE #
#------#

# compiling with linking in non-default name '-o'
# read.o is dependency
# if timestap changed on read.o it will be re-linked
read: read.o mmio.o
    cc -fopenmp -O4 -Wall -g read.o mmio.o -o read

# compiling without linking '-c';
# multiple pre-requisites used if anyhting changed
# -Wall gives all the warning; -g turns on the debugger
read.o: example_read.c ../lib/mmio.c
    cc -fopenmp -O4 -c -Wall -g example_read.c -o read.o
    cc -fopenmp -O4 -c -Wall -g ../lib/mmio.c -o mmio.o

clean:
    rm -f read read.o mmio.o
```

```
# 1_login remotely
$ ssh -X sid@crescent.central.cranfield.ac.uk
$ password
$ module load fosscuda/2019b
$ export CC=$(which gcc)

# 2_create source file
$ vim ex1.c
$ vim Makefile

# 3_compile manually / with Make / recompile with Make
# o gives it a custom name instead of default
$ gcc -fopenmp -O4 -o ex1 ex1.c
$ make ex1
cc -Wall -g     ex1.c   -o ex1
$ make clean
rm -f ex1
$ make ex1
cc -Wall -g     ex1.c   -o ex1

# 4_run executable
$ ./ex1
# or add input data and run
$ ./read ../test/cage4.mtx

# 5_create, submit job file
$ vim ex1.sub
$ qsub ex1.sub

# 6_status
$ qstat
$ ls
$ more openMP.02300565

# 7_copy remotely into local
$ scp sid@crescent.central.cranfield.ac.uk:
  openMP.o230565 /Documents/lib/ex2_3.test
```

```
#-----#
# GIT #
#-----#

# create a repo on github
# then create a local project folder
$ mkdir SpMV_OpenMP

# initialise git on current folder and push it
$ git init
$ git add README.md
$ git commmit -m "first commit"
$ git branch -M main
$ git remote add origin git@github.com:marcellgyorei/
                         spmv_openmp.git
$ git push -u origin main

# or clone repo
$ git clone git@github.com:marcellgyorei/SpMV_OpenMP.git

# check changes have been made before committing
$ git status
# what changes have been made
$ git diff
# see changes on particular file
# which lines have been added/deleted
git diff R/modified.R

# use one global .gitignore whenever check git status
$ nvim ~/.gitignore_global
# add lines into it
*~
.*~
.DS_Store
.Rhistory
.RData
$ git config --global core.excludesfile ~/.gitignore_global

# check log of commits
$ git log
# compressed log
$ git log --pretty=oneline
# commits of certain author
$ git log --author=marcellgyorei
# only files have changed
git log --name-status
# tree log
$ git log --graph --oneline --decorate --all

# drop local changes-commits, fetch latest history from server
$ git fetch origin
$ git reset --hard origin/main

# delete local git repo
$ rm -fr .git
# verify status
```

```
$ git status

# delete local folder and re-clone it
$ rm -rf ~/spmv_openmp
$ git clone git@github.com:myname/myproject.git ~/spmv_openmp

# adda a folder content
$ git add foldername/\*

$ git add --all
$ git commit -am "<commit message>"
$ git push

$ git pull --rebase

# is there are unstaged changes list files that prevent pull
$ git status
$ git restore .DS_Store
# delete all local changes
git reset --hard
```

```
/*-----------*/
/* VIM_MODE */
/*-----------*/

save as ex1                     :w! ex1
quit/save & quit                :!q     :wq
insert/command mode             i       ESC

/*------------*/
/* VIM_FORMAT */
/*------------*/

indent line forward/backward    i C-t   i C-d

/*------------------------*/
/* VIM_SELECT-COPY-PASTE */
/*------------------------*/

line selection                  V
select word forward/backward    vw      vb
/*-------------------------------------------------------------*/
copy lines by number            :<number>yy
copy current line               yy
copy selection                  y
/*-------------------------------------------------------------*/
paste buffer before/after crsr  p       P
undo                            u

/*-------------*/
/* VIM_REPLACE */
/*-------------*/

replace text                    :%s/<match>/<replace>
replace with '                  r'
switch case under the char      ~

/*------------*/
/* VIM_SEARCH */
/*------------*/

show lines match                [I
/*-------------------------------------------------------------*/
search forward/backward         /<match> ?<match>
search word nrst frwrd/bckwrd   *       #
repeat search forward/backward  n       N

/*-----------*/
/* VIM_JUMP */
/*-----------*/

next/prev page                  C-f     C-b
half page up/down               C-u     C-d
/*-------------------------------------------------------------*/
top/middle/bottom line          H       M       L
set line numbering              :set number
goto line                       :<line number>
/*-------------------------------------------------------------*/
to first/last line of a text    gg      G
/*-------------------------------------------------------------*/
end of the line                 $
first char of the line [blank]  0
first char of the line          ^
/*-------------------------------------------------------------*/
next word                       w       W
end of the word                 e       E
prev word                       b       B
prev space                      F[]
/*-------------------------------------------------------------*/
next 'e' char in line           fe
repeat [opposite]               ;       ,
```

```
/*-------------------------------------------------------------*/
bracket to bracket              %
left/right/down/up              h       l       j       k

/*------------*/
/* VIM_DELETE */
/*------------*/

until first/last line in text   dgg     dG
bracket content                 dt%
/*-------------------------------------------------------------*/
current line                    dd              cc
current & prev/next line        dk      dj
until end of the line           d$
/*-------------------------------------------------------------*/
start of the word forward       dw      dW      cw
end of the word forward         de      dE
start of the word backward      db      dB
/*-------------------------------------------------------------*/
until " char                    dt"
current char                    x
```

vscode + cmake + llbd + catch

```
/#-----------------#/
/# 0.1-KEYBINDINGS #/
/#-----------------#/

$ S-C-e                         # explorer
$ C1-‘                          # terminal
$ cd build && cmake .. && make  # build make files and ex
/* or */
$ F7                            # build make files [cmake]
$ C-S-b                         # build task [cmake]
/* */
$ S-C-d                         # run & debug
$ S-C-p                         # command palette

/#------------#/
/# 0.2-CONFIG #/
/#------------#/

# CMakeLists.txt                # cmake config [make]
# .vscode/c_cpp_properties.json # intellisense config
# .vscode/tasks.json            # task built config [cmake]
# .vscode/launch.json           # run & debug [llbd+task]
# build/compile_command.json    # compiler commands [clang++]


/#---------------------------------------#/
/# 1-SETUP WORKSPACE CREATE SOURCE FILES #/
/#---------------------------------------#/

$ C-o                           # add new folder to workspace
$ C-k f                         # close workspace
$ touch main.cpp                # add new file [bash] C1-O-C-n
$ S-C-f                         # search
$ C-s                           # save
```

```
/#-----------------------------#/
/# 2.1-GENERATE CMakeList.txt #/
/#-----------------------------#/

$ S-C-p
^ CMAKE:Quick Start
^ Clang 10.0.0
^ projectname
^ Executable

$ F7                            # cmake build from
                                # compile_commands.json
// or
$ cd build $$ cmake ..          # build make files
$ make                          # build executable
```

```
/#-------------------------------------#/
/# 2.2-ADD SOURCE FILES TO CMakeList.txt #/
/#-------------------------------------#/

/# to generate Make files using CMake */

cmake_minimum_required(VERSION 3.0.0)
project(pcmake VERSION 0.1.0)
include(CTest)
enable_testing()
add_executable(HelloWorld main.cpp Pet.cpp)
set(CPACK_PROJECT_NAME ${PROJECT_NAME})
```

```
set(CPACK_PROJECT_VERSION ${PROJECT_VERSION})
include(CPack)
```

```
/#------------------------#/
/# 3.1-SETUP Intellisense #/
/#------------------------#/

^ C/C++:Edit Configuration (JSON)
^ c_cpp_properties.json
```

```
/*---------------------------------*/
/* 3.2-CHECK c_cpp_properties.json */
/*---------------------------------*/

{
"configurations": [
{
"name": "Mac",
"includePath": [
    "${workspaceFolder}/**",
    // "${workspaceFolder}/include"
],
"defines": [],
"macFrameworkPath": [
    "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/
     System/Library/Frameworks"
],
"compilerPath": "/usr/bin/clang",
"cStandard": "c17",
"cppStandard": "c++17",
"intelliSenseMode": "macos-clang-arm64",
"configurationProvider": "ms-vscode.cmake-tools"

}
],
"version": 4
}
```

```
/#------------------------------#/
/# 4.1-GENERATE CMake-Make TASK #/
/#------------------------------#/

$ touch ./.vscode/tasks.json
```

```
/*-----------------------------------------------*/
/* 4.2-INSERT CMake TASK COMMANDS INTO task.json  */
/*-----------------------------------------------*/

/* assign CMake built process to a VSC task */

{
// See https://go.microsoft.com/fwlink/?LinkId=733558
// for the documentation about the tasks.json format
"version": "2.0.0",
"isShellCommand":true,
"options": {
"cwd":"${workspaceRoot}/build"  // workspaceRoot is the
                                // directory
                                // of the workspace
},
"tasks": [
{
"label": "cmake",               // allows vsc to reference the
                                // task name when running the
                                //  task
"command": "cmake -G 'Unix Makefiles' -DCMAKE_BUILD_TYPE=Debug
      ..", "type": "shell",
"presentation": {
"echo": true,
"reveal": "always",
"panel": "shared"
}
},
{
"label": "make",
"command":"make -j 8",          // it means running the
                                // complier in parallel with
                                // max 8 source files
"presentation": {
"echo": true,
"reveal": "always",
"panel": "shared"
},
"isBuildCommand":true           // if true to be executed with
                                // Tasks: Run Build Task
}
]
}
```

```
/#----------#/
/# RUN TASK #/
/#----------#/

^ Run Task
^ cmake
^ enter

$ C-S-b

// check
$ .build/pcmake
```

```
/#----------------------#/
/# GENERATE launch.json #/
/#----------------------#/

$ touch launch.json
```

```
/*--------------------*/
/* MODIFY launch.json */
/*--------------------*/

/* assign VSC task and llbd to run & debug */

{
// Use IntelliSense to learn about possible attributes.
// Hover to view descriptions of existing attributes.
// For more information, visit: https://go.microsoft.com/
    fwlink/? linkid=830387
"version": "0.2.0",
"configurations": [
{
"name": "(lldb) Launch",
"type": "cppdbg",
"request": "launch",
"program": "${workspaceFolder}/build/pcmake",
"args": [],
"stopAtEntry": false,
"cwd": "${workspaceFolder}",
"environment": [],
"externalConsole": true,
"MIMode": "lldb"
}
]
}
```

```
/#------------#/
/# CHECK lldb #/
/#------------#/

$ which lldb
$ F5
```

```
/#------------------#/
/# SETUP GOOGLETEST #/
/#------------------#/

# C++_1.38__Introduction to Google Test and CMake
# https://www.youtube.com/watch?v=0XwsD37qHPY

$ C-k f
$ mkdir gexample
$ C-o
$ git clone https://github.com/google/googletest.git
$ touch CMakeList.txt
```

```
cmake_minimum_required(VERSION 3.8)

set(gexample) #[[project name]]

project(${This} C CXX)

set(CMAKE_C_STANDARD 17)
set(CMAKE_CXX_STANDARD 17)
set(CMAKE_POSITION_INDEPENDENT_CODE ON) #[[libraries & ex
    mixed]]

enable_testing() #[[have unit test]]

add_subdirectory(googletest) #[[add dependency]]

#[[variables defining what will be built]
set(Headers
    Example.hpp
)
set(Sources
    Example.cpp
)
```

```
22
23 #[[link other things to for programs - code is the library
       that is tested and statically linked, gtest is the
       program]]
24 add_library(${This} STATIC ${Sources} ${Headers})
25
26 #[[put the test into a subdirectory; it looks for another
       CMakeLists.txt and runs that in a child node in the build
        system]]
27 add_subdirectory(test)
```

```
1 $ touch Example.cpp
2 $ touch Example.hpp
3 $ mkdir test
4 $ touch CMakeLists.txt
```

```
1 cmake_minimum_requied(VERSION 3.8)
2
3 set(gexampletests)
4
5 #[[no need for headers for tests]]
6 set(Sources
7     ExampleTests.cpp
8 )
9 #[[instead of making linked to the program we are making the
       program itself]]
10 add_executable(${This} ${Sources})
11
12 #[[linking in the main program into the test provided by
       googletest]]
13 #[[need the thing testing]]
14 #[[clue for the complier where to find header files]]
15 target_link_libraries(${This} PUBLIC
16     gtest_main
17     Example
18 )
19
20 #[[this is a unit test]]
21 add_test(
22     NAME ${This}
23     COMMAND ${This}
24 )
```

```
1 $ ExampleTests.cpp
2 ^ reload
3 # builds the build system after choosing a compiler
4 ^ Clang 5.01
5 # builds the executables
6 $ F7
7
8 # fix built-vscode directory name
9 ^ Preferences: OpenSettings (JSON)
10 ^ USER SETTINGS
11 ^ "cmake.buildDirectory": "${workspaceroot}/build", #line22
12
13 # fix wether linked statically or dynamically (should be
       linked statically)
14 ^ build/CMakeCache.txt
15 ^ search: lib #line294
16 ^ gtest_force_shared_crt:BOOL=ON
17 ^ Clean rebuild #under CMake tab #find shortcut later to CMake
        Clean rebuild
18
19 # run the test for vscode
20 ^ CMake: Run tests
```

```
1 /*------------------------*/
2 /* FILL ExampleTests.cpp  */
3 /*------------------------*/
4
5 #include <gtest/gtest.h>
6
7 bool f() {
8     return false;
9 }
10
11 TEST(gexampletests, DemonstrateGtestMacros)
12     // sanity checking
13     EXPECT_TRUE(false);
14     // if we don't pass the line don't continue
15     ASSERT_TRUE(false);
16     EXPECT_EQ(true, true);
17
18     // expected value first and actual value second
19     const bool result = f();
20     EXPECT_EQ(true, result); // that won't pass as return =
        false
21 }
22 // 15:55
23
```

1 c++

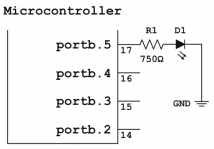
```
/*------------------*/
/* LEARNING SOURCES */
/*------------------*/

/* REAL-TIME */

1st C++_2.16__E_Christopher Kormanyos - Real-Time C++ 2021

/* CLEARITY */

2nd C++_2.18__E_Rainer - C++ Core Guidelines Explained 2022
/**/
2nd C++_1.23__Jason Turner - C++ Best Practices 2020
ref C++_1.34__S_ISO_IEC 14882_2020 Sixth edition 2020
ref C++_2.17__S_Bjarne - CppCoreGuidelines

/* CORE BASICS 2020 & STL */

2nd C++_1.36__E_Pitt - Guide to Scientific Computing 2018
/**/
ref C++_1.37__Bjarne - A Tour of C++ 2018
ref C++_1.38__Bjarne - PPP C++ 2021
/**/
ref C++_1.31__E_Paul Deitel - C++ for Programmers 2022
ref C++_1.28__E_Hacking C++ - C++ Cheat Sheets & Infogrph STL

/* LOW BUILT-TIME */
/* DATA STRUCTURES, ALGORITHMS */

C++_2.7__S_Joe Gibson - C++ Data Str & Algo Cheat Sheet

/* TEST */

    C++_2.15__E_Leetcode - C++

    /* TDD */

        C++_1.38__Introduction to Google Test and CMake

    /* COMPETITIVE PROGRAMMING */

/* REQS, DESIGN, SPECS */
/* EMBEDDED CPS */
Edward Ashford Lee - Introduction to Embedded Systems 2017
    UseCaseDiagram
    StructureModelling
    // UML paperback
    // omnigraffle/window/stencil/search uml
    // sketch

/* WHITE-BOARDING */
/* DESIGN TOOL */
/* TRADING TOOL */


/* ONLINE POOL */
    STRATEGY
    // https://medium.com/@alexander.s.augenstein/how-i-passed
     -the-c-code-interview-in-3-weeks-a3e350214a01

    PROBLEM SOLVING PATTERNS
    // https://www.designgurus.io/blog/dont-just-leetcode
```

```
/* DOCTEST */

#define DOCTEST_CONFIG_IMPLEMENT_WITH_MAIN
#include <doctest.h>

int fact(int n) { retiung n <= 1 ? n : fact(n-1) * n; }

TEST_CASE("testing the factorial function") {
    CHECK(fact(0) == 1); // will fail
    CHECK(fact(1) == 1);
    CHECK(fact(2) == 2);
    CHECK(fact(10) == 3628800);
}
// CppCon 2017
```

```

/* PPP C++ */
/* #17 VECTOR, POINTERS */

```

```
/* TURNER - C++ BEST PRACTICES 2020 */
// #18

float divide(float numerator, float denominator)
{
    return numerator / denominator;
}

int divide(int numerator, int denominator)
{
    return numerator / denominator;
}

template<typename Arithmetic>
Arithmetic divide(Aritmetic numerator, Arithmetic denominator)
{
    return numerator / denominator;
}

// lambda alternative
```

```
/* #35 STRONG TYPES (NO BOOLEAN ARGUMENTS) */

struct Widget
{
    enum struct Visible { True, False };
    enum struct Resizable { True, False };

    Widget(Visible visible, Resizable resizable);
}
```




```
/* KORMANYOS - REAL-TIME C++ 2021 */
/* LED PROGRAM [PAGE 4] */

#include <cstdint>
#include "mcal_reg.h"

class led
{
public:
    typedef std::uint8_t port_type;
    typedef std::uint8_t bval_type;

    led(const port_type p,
        const bval_type b) : port(p),
                             bval (b)
```

```
/* COMPOUND ASSIGNMENT */


```

```
/* OBJECTS & INSTANCES [PAGE 12] */

const led led_b5
{
    mcal::reg::portb,
    mcal::reg::bval5
};

// led_b5 is an instance of the led class
// parameters in the constructor of led_b5 use uniform
    initialization syntax
// led_b5 is a constant object that wont be modified for the
    entire lifetime of the program
// compiler initialize automatically the led_b5 static
    instance before would be used in main() - this called
    startup code
```

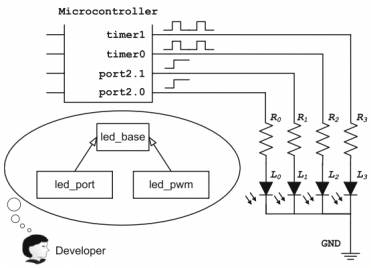
```
// led.h
class led
{
public:
    led(const port_type p,
        const bval_type b);

    void toggle() const;
};
```

```
// led.cpp
```

$$\vec{u} \cdot \vec{v} = uv$$

```cpp
/* NUMERIC [PAGE 54] */
/* INNER PRODUCT */
#include <array>
#include <numeric>

const std::array<int, 3U> u
{
    { 1, 2, 3 }
};

const std::array<int, 3U> v
{
    { 4, 5, 6 }
};

const int uv = std:inner_product(u.begin(),
                                 u.end(),
                                 v.begin(),
                                 0);
$ 32
```

```cpp
/* RANDOM [PAGE 64] */
```




```cpp
/* INHERITANCE [PAGE 76]*/
```

```cpp
/* CUSTOM MEMORY ALLOCATION [ON HEAP] [PAGE 238] */


```

```cpp
/* RING ALLOCATOR [PAGE 244] */
```

strategy

- Basic syntax
- Ranged for loops
- Templates
- Operator overloading
- Preprocessor statements and macros
- Namespaces
- Exceptions
- Const and mutable (and friend functions)
- Static and dynamic casting
- Pointers / void pointers / smart pointers
- Enums
- String streams
- Virtual functions and virtual inheritance and vtables
- Runtime type information (RTTI)
- Helpful 3rd party libraries (Qt, OpenGL, TensorFlow, OpenCV, Eigen, Drake)
- The Standard Library (STL) (containers , the algorithms over them , and the iterators that connect them)
- Visual studio debug tools (breakpoints, memory view)
- Package management
- g++
- gtest
- cmake

best practice

- Memory allocation as initialization
- Dont use casts
- Avoid naked new and naked delete
- Avoid macros except for include guards
- Avoid unions
- Hide arrays from interfaces, keep them in low-level if needed
- Prefer immutable to mutable data
- Encapsulate messy constructs rather than spreading them thru the code
- Interfaces are the single most important aspect of code organization, make them explicit, encapsulate rule violations
- State preconditions, prefer Expects() for expressing preconditions and Ensures() for postconditions
- Prefer <vector> by default, prefer <array> to C-style arrays if needed
- C++98 added templates, containers, <algorithm>, <string>, <iostream>
- C++11 added auto, function pointers / lambdas, multithreading, regexp, smart pointers, hash tables
- C++14 added read-write locks, generic lambdas //C++17 added parallel algorithms
- C++20 added the spaceship operator and templated lambdas

2 c

```c
/*---------------------------------*/
/* USER DEFINED FUNCTION EXAMPLE */
/*---------------------------------*/

//  pre-processor directive necessary when using math library
#include <math.h>

//  function prototype
double gen_sqrt(double);

//  main function
int main()
{
    //  variables
    double val,sqroot;

    //  ask the user to enter a real number
    printf("Enter a floating point value > 0");

    //  get the value from the user
    scanf("%lf",&val);

    //  call the function to compute the generalised sq root
    sqroot=gen_sqrt(val);

    //  print out the result
    printf("The generalised square root of %lf is %lf\n",val,
           sqroot);

    return 0;
}

//  user-defined function gen_sqrt
double gen_sqrt(double x)
{
    double result;
    if(x <0.0)
    {
        result=-sqrt(-x);
    else
    {
        result=sqrt(x);
    }
    return (result);
}
```

```c
/*-----------*/
/* VARIABLES */
/*-----------*/

auto        break       char        double
else        extern      int         return
struct      case        enum        long
```

```
register    switch      typedef     union
const       continue    float       for
short       unsigned    default     goto
signed      sizeof      void        do
static      volatile    if          while
```

```
/*-------------*/
/* DATA TYPES */
/*-------------*/

Type         PC  Dec MIPS     Dec Alpha        Dec Alpha
                 (OSF/1)      (ULTRIX)         (OPEN VMS)

char         1   1            1            1
short int    2   2            2            2
int          2   4            4            4
long int     4   4            8            4
float        4   4            8            4
double       8   8            8            8
```

```
/*------------*/
/* INCREMENT */
/*------------*/

//  output i: 1
int main()
{
    int i=0;
    printf("i: %d\n",++i);
    return 0;
}

//  output i: 0
int main()
{
    int i=0;
    printf("i: %d\n",i++);
    return 0;
}
```

```
/*------*/
/* LOOP */
/*------*/

/*
[expression-1]: evaluated before the first loop itereation
[expression-2]: determines wether to terminate the loop;
                evaluated before each loop iteration
[expression-3]: evaluated after each iteration
*/

#include  <stdio.h>

void action1();
void action2();

int main()
{
    int a;

    for(;;)
    {
        printf("Enter a choice\n");
        printf("\t 1. Action 1\n");
        printf("\t 2. Action 2\n");
        printf("\t 3. Exit\n");

        scanf("%d",&a);

        switch(a)
        {
            case 1: action1();
            break;
            case 2: action2();
            break;
            case 3: printf("Exit...\n");
            default: printf("Incorect choice\n");
        }
    }
    return 0;
}

//  action routines
void action1()
{
      printf("This is the action1 routine\n");
}

void action2()
{
      printf("This is the action2 routine\n");
}
```

```
/*-----------------*/
/* JUMP STATEMENTS */
/*-----------------*/

//  never use goto unless for error handling

for (...)
{
    ...
    for (...)
        ...
        if (disaster)
            goto error;
    ...
...
}

error:
    /* error handling */
    return;
```

```

/*----------------------*/
/* FUNCTION PROTOTYPES */
/*----------------------*/

//  function definition
char func(int lower, int *upper, char (*func)(), double y )
{}

//  prototype declaration v1
char func(int lower, int *upper, char (*func)(), double y);

//  v2
char func(int a, int *b, char (*c)(), double d );

//  v3
char func(int, int *, char (*)(), double );

```

```
/*----------------*/
/* DYNAMIC MEMORY */
/*----------------*/

pointer = malloc(number-of-bytes);

//  simple.c
```

```
/*---------------------------------*/
/* BUFFERED I/O - PRINTF & FPRINTF */
/*---------------------------------*/

printf(format-string, argument, ...)

printf("%10.2f\n", i);
//  %10.2f: field specification
//  m[10]:  minimum field width
//  p[2]:   precision; number of digits after the decml point
//  f:      conversion character
//          displays a floating-point number in "fixed decml"

//  conversion characters:
%d - prints in short int
%c - prints integer as character
%o - prints in octal
%x - prints in hexadecimal
%f - prints both float and double
%l - prints in long int

//  examples:
//  print a floating point number with 2 dig after dec point
printf("Profit: $%.2f\n", profit);
profit: $2150.48
//  print the number use at least 3 characters
printf("Number: ->%3d<-\n", 12);
->.12<-
//  print with at least 3 characters; left-justify it
printf("Number: ->%-3d<-\n", 12);
->12.<-
//  print with at least 3 characters
printf("Number: ->%3d<-\n", 1234);
->1234<-

//  predefined files:
stdin - standard in; normal program input
```

```
stdout - standard out; normal program output
stderr - standard error; error output

//  printf replaces fprintf(stdout, ...)
//  writing to a predefined file and/or opened file:
fprintf(stdout, "Everything is OK\n");
fprintf(stderr, "ERROR: Something bad happened\n");
```

```
/*-------------------------------*/
/* BUFFERED I/O - FGETS & SSCANF */
/*-------------------------------*/

//  reading data from opened file and/or predef files)
fgets(line, sizeof(line), stdin);
sscanf(line, "%d %d", &aInteger, &anotherInteger);

//  general form fgets:
char* result = fgets(buffer, size, file);

//  result: is a pointer to the string that was just read
//  (buffer) or NULL if end of the file has been reached

//  buffer: is a chrctr array where the line is to be placed

//  file: is a file handle indicating which file to read
//  (stdin in this case)

if (fgets(line, sizeof(line), stdin) == NULL)
{
    fprintf(sterr, "ERROR: Expected two integers, got EOF\n");
    return (ERROR);
}
//  ampersands used because it needs to modify the arguments
//  therefore arguments must be passed by address
//  sscanf returns the number of items it converted
if (sscanf(line, "%d %d", &aInteger, &anotherInteger) != 2)
{
    fprintf(stderr, "ERROR: Expected two integers.\n");
    return (ERROR)
}
```

```
/*----------------------*/
/* BUFFERED I/O - FOPEN */
/*----------------------*/

//  opening file
#include <stdio.h>

int main()
{
    //  declare a new file handle
    FILE* outFile = fopen("hello.txt", "w");
    if (outFile == NULL)
    {
        fprintf(stderr, "ERROR: Unable to open
                'hello.txt'\n");
        exit((8);
    }
    if (fprintf(outFile, "Hello World!\n") <= 0)
    {
        fprintf(stderr, "ERROR: Unable to write to
                        'hello.txt'\n");
        exit(8);
    }
    return(0);
}

//  general form fopen:
result = fopen(filename, mode);

//  mode can be of the following:
r:  read only
w:  write only
r+: read and write
a:  append (write but start at the end of file)
b:  used in combination with the other modes for binary files

//  syntax on mac & linux:
FILE* fopen("/root/file.txt", "w);

//  syntax on win (backslash is the separator but \r is return
      char, and \f is the form char):
FILE* fopen("\\root\\file.txt", "w);
```

```
/*-------------------------------------------------*/
/* BUFFERED I/O - FREAD & FWRITE & FFLUSH & FCLOSE */
/*-------------------------------------------------*/

//  reading binary file
//  buffer is a pinter to the data buffer in which data placed
//  elementSize is always 1; returns 0 for the end of the file
//  returns negative if there is an error
//  size of the buffer (number of bytes)
//  inFile is the file to read
result = fread(buffer, elementSize, size, inFile);
result = fwrite(buffer, elementSize, size, inFile);

//  copy infile.bin to outfile.bin

#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>

int main()
{
    //  the input file
    //  rb mode; r: read; b: binary
    FILE* inFile = fopen("infile.bin", "rb");
    if (inFile == NULL)
    {
        fprintf(stderr, "ERROR: Could not open onfile.bin\n");
        exit(8);
    }

    //  the output file
    FILE* outFile = fopen("outfile.bin", "wb");
    if (outFile == NULL)
    {
        fprintf(stderr, "ERROR: Could not create
                outfile.bin\n");
        exit(8);
    }

    //  data buffer
    char buffer[512];

    while (true)
    {
        //  return value is ssize_t: standard type that is
        //  big enough to hold
        //  the size of the largest object
        //  (structure, array, union)
        //  it also holds -1 for error condition)
        ssize_t readSize = fread(buffer, 1, sizeof(buffer)
     inFile);
        if (readSize < 0)
        {
            fprintf(stderr, "ERROR: Read error seen\n");
            exit(8);
        }
        if (readSize == 0)
        {
            break;
        }

        //  returns a size_t value
        //  it is an unsigned type holds the size of the
        //  largest object
        //  it cannot hold an error value
        //  need casting between signed and unsigned
        //  types (size_t)readSize
        if (fwrite(buffer, 1, readSize, outFile) !+
           (size_t)readSize)
        {
            fprintf(stderr, "ERROR: Write error seen\n");
            exit(8);
        }
    }
    fclose(inFile);
    fclose(outFile);
    return (0);
}

//  write the buffered data out now; ensures that data can be
      seen
printf("Before divide ");
fflush(stdout);

//  close the file
int result = fclose(file);
```

```
/*----------------------*/
/* COMMND LINE ARGMNTS */
/*----------------------*/

//  print the command line arguments
#include <stdio.h>

int main(const int argc, const char* argv[])
{
```

```
    for (int i = 0; i < argc; ++i)
    {
        printf("argv[%d] = %s\n", i, argv[i]);
    }
    return (0);
}

$ ./prog first second third

argc    4
argv[0] ./prog
argv[1] first
argv[2] second
argv[3] third
```

```
/*---------*/
/* RAW I/O */
/*---------*/

//  copy one file to another using buffer size of 1024 bytes
#include <stdio.h>
#include <stdbool.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

//  conditional compilation
//  linux does not have a O_BINARY flag but macos/win do have
//  checks wether the O_BINARY is not defined; linux it isn't
//  if os has that #define won't be compiled
#ifndef O_BINARY
//  define O_BINARY with 0 value if not defined (for linux)
#define O_BINARY 0
#endif // O_BINARY

int main(int argc, char* argc[])
{
    if (argc != 3)
    {
        fprintf(stderr, "Usage is %s <infile> <outfile>\n",
                argv[0]);
        exit(8);
    }

    //  the fd (file-descriptor) of the input file
    //  fd = open(filename, flags)
    //  flags indicate how the input file is to be opened
    //  O_RDONLY flag opens the input file read-only
    //  O_BINARY flag indicates that the input file is binary
    //  don't use text files - not compatible between oss
    int inFd = open(argv[1], O_RDONLY|O_BINARY);
    if (inFd < 0)
    {
        fprintf(stderr, "ERROR: Could not open %s for
                input\n", argv[1]);
        exit(8);
    }

    //  the fd (file-descriptor) of the output file
    //  fd = open(filename, flags)
    //  flags indicate how the output file is to be opened
    //  O_WRONLY flag opens the output file write only
    //  O_CREAT flag creates the file if needed
    //  O_BINARY flag indicates that the output file is binary

    //  0666 is an octal number each digit representing a
    //  protection user set and each bit a protection type

    //  1st user read and write (6) <user>
    //  2nd accounts are in the same group as the user get
    //      read /write access (6) <group>
    //  3rd anyone else gets the same read/write
    //      permission (6) <other>
    int outFd = open(argv[2], O_WRONGLY|O_CREAT|O_BINARY,
                0666);
    if (outFd < 0)
    {
        fprintf(stderr, "ERROR: Could not open %s for
                writing\n", argv[2]);
        exit(8);
    }

    while (true)
    {
        //  buffer to read and write
        char buffer[1024];

        //  size of the last read
        size_t readSize;

        //  once the file open do the copy
        //  bytes_read = read(fd, buffer, size);
        //  size is the maximum number of characters read
        //  if that's negative it indicates an error
        readSize = read(inFd, buffer, sizeof(buffer));

        //  check for an error
        if (readSize < 0)
        {
            fprintf(stderr, "ERROR: Read error for file
                    %s\n", argv[1]);
        }

        //  check wether reached the end of the line and
        //  done transferring data
        if (readSize == 0)
            break;

        // write that data
        // bytes_written = write(fd, buffer, size);

        // check for error
        if (write(outFd, buffer, readSize) != readSize)
        {
            fprintf(stderr, "ERROR: Write error for %s\n",
                    argv[2]);
            exit(8);
        }
    }

    //  close the file descriptors
    close(inFd);
    close(outFd);
    return (0);
}

$ ./copy input-file output-file
```

```
/*----------------*/
/* FLOATING-POINT */
/*----------------*/

//  used in scientific or 3d graphics but not in embedded
      programming
//  1.0 = 1.
//  1.0e33 = 1.0 x 10^33
//  float (single prec), double (double prec), long double (
      more precise)
//  floating point constant
//  F suffix: makes double to a single-precision float
//  L suffic: makes float a long double

//  decimal point is required otherwise this is integer divide
float f1 = 1/3;
0.0
float f2 = 1.0/3.0;
0.3333

//  sign (+), fraction (four digits), exponent (e+56)
+1.234e+56

//  numerical analysis and IEEE-754 deals with floating-point
      numbers
//  floating point operations takes 1000 times longer than
      integer
//  counterparts using libraries with no native support
//  better chips with native support still calculates 10 times
       longer

//  alternative - fixed point number

12.34   1234
00.01   1
12.00   1200
...
```

```
/*---------*/
/* MODULAR */
/*---------*/

/*-----bad_example----*/
//  main.c
#include <stdio.h>

//  extern keywords tells that the function is another file
//  it does not always match the actual declaration (don't use
      it)
extern void funct(void);
int main()
```

```c
{
    printf("In main ()\n");
    funct();
    return (0);
}

//  func.c
#include <stdio.h>
void funct(void)
{
    printf("In funct()\n");
}

//  makefile
//  main must be rebuilt if main.c or func.c changes
main: main.c func.c
//  compile both files and use them to make the program
      gcc -g -Wall -Wextra -o main main.c
func.c

/*-----good_example----*/
//  main.c
#include <stdio.h>
//  quotation marks indicate that the file to be included is user generated
//  compiler will search for it in the current directory
//  instead of searching through the system files
//  inclusion provide the definition of the function
#include "func.h"
int main()
{
    printf("In main()\n");
    funct();
    return (0);
}

//  func.c
#include <stdio.h>
//  compiler check the definition of the function
#include "func.h"
void funct(void)
{
    printf("In funct()\n");
}

//  create a header file to hold the extern definition
//  don't need to add extern function funct in several diff files
//  #ifnded/#endif is double inclusion protection (if funct is in
//  multiple header files).h
#ifndef __FUNC_H__
#define __FUNC_H__
extern void funct(void);
#endif // __FUNC_H__

//  makefile
//  compile program macro
CFLAGS = -g -Wall -Wextra
//  OBJ macro contains list of objects used to make the program
OBJS = main.o func.o
main: $(OBJS)
        gcc -g -Wall -Wextra -o main $(OBJS)
//  create main.o from main.c and func.h
main.o: main.c fun.h
func.o: func.c func.h

//  rules:

//  each module should have a header file with the same name as the module
//  header file should contain the definitions of the public types,
//  variables, and functions and nothing else
//  every module should include its own header file so C can check
//  to make sure the header file and implementation match
//  modules should include code used for a common purpose
//  modules should expose minimum information into the outside
//  information modules expose via extern declarations is global
//  (seen by the entire program)

//  namespaces - no namespaces in C; no function symbol duplication is allowed; prefixes are used;
    HAL_StatusTypeDef; it means StatusTypeDef belongs to HAL library
```

3 config

```
/*------*/
/* NVIM */
/*------*/

// show line numbers automatically
$ ~/.config/nvim
$ nvim init.vim
source ~/.vimrc
$ ~/
$ nvim .vimrc
set number

/*------*/
/* TMUX */
/*------*/

//  ~.tmux.conf
unbind C-Space
set -g prefix C-Space
bind C-Space send-prefix
set -g mouse on
set-option -g history-limit 5000

/*-----*/
/* SSH */
/*-----*/

//  ~.ssh/config
$ cat ~/.ssh/config
Host name
  User foo
  Hostname 127.0.0.1
  Port 8765
$ ssh name

/*------*/
/* MAKE */
/*------*/

//  Makefile
CFLAGS=-Wall -g
clean:
    rm -f ex1
```

```
/*-----*/
/* GIT */
/*-----*/

$ git config --global user.name "marcellgyorei"
$ git config --global user.email "marcell.gyorei@gmail.com"
$ git config --global color.ui true
$ git config --global core.editor nvim

//  config values
nano            nano
vim             vim
neovim          nvim
emacs           emacs
sublime text    subl -n -w
atom            atom --wait
vscode          code --wait

//  create keygen in ~/.ssh folder
//  id_rsa & id_rsa.pub files will be created
$ ssh-keygen -t rsa -C "marcell.gyorei@gmail.com"

//  github.com/Account Settings/SSH Keys
//  Add SSH Key ("My laptop")
//  copy ssh public key into the given box

//  test connection
$ ssh -T git@github.com

//  check if SSH key fingerprint matching with public ones
Hi username! You've successfully authenticated ..
```

```
/*--------------*/
/* GIT-CRESCENT */
/*--------------*/

//  keygen folder on cresent
/scratch/s392494/.ssh/id_rsa.pub

//  go back into root
cd ~
```

notes

```
/*-----------------------------*/
/* APPENDIX - LEARNING SOURCES */
/*-----------------------------*/

/* SUPPLEMENTARY */

    // https://cplusplus.com/doc/tutorial/functions/
    // C++_4.12__Eijkhout - Intro to Scientific Pr in C++ 2022
    // C++_1.24__Introduction to C++ MIT_6.096 2011
    // C++_1.35__E_Marc Gregoire - Professional C++ 2021 [Int Ch]
    // xB_1.13__E_Gayle - Cracking the Coding Interview 2015
    // C++_2.8__Adnan Aziz - Elements of Programming Int 2015
    // xB_1.12__E_Georgevich - The Complete Interview Answer
    // Peter Sherar - N-CST-SSPP_ C++ Programming
    // keywords: linked compilation
    // C++_2.5__INT-S_Pat Morin - Open Data Structures.pdf
    // Siemens - Parasolid kernel
    // Siemens - D-Cubed constraint solver
```

4 design

```

    Cyber-Physical System Approach

        -Modelling [Dynamics = Evolution in Time]

            -Actor Models [Continuous-time systems with Feedback Control; all modelled as Functions]:

                --- [Stage 0]
                -Project [Logical]
                --- [Stage 1]
                -Context [Logical]
                --- [Stage 2]
                -Operation [Logical]
                --- [Stage 2-3-4]
                -System [Logical & Physical]
                --- [Stage 5]
                -Assembly [Physical]
                -Product [Physical]

            -Abstract to High Fidelity Representations of dynamics and static properties of Actor Models
            -Hierarchical State Machines
            -Supervisory Control [Abstract Process on 5 Reps]
            -Dataflow Models
            -Time Models

        -Design
            -Memory Architectures
            -Multitasking
            -Scheduling

        -Analysis
            -Requirements of Hierarchical State Machines
```