

Compiler Assignment 1

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1 Part 1

1.1 Code

```
#include <stdio.h>
#define SUCCESS 0

int main(int argc, char **argv) {
    int c;
    printf("\n Hello World %d %d\n", c, argc);

    return (SUCCESS);
}
```

1.2 Logs generated by GCC

1.2.1 Logs Part 1

```

sm@pop-os: ~/Public/Intern July/LeetCode/compiler
λ compiler gcc -Wall --verbose --save-temps -o test test.c
Using built-in specs.
COLLECT_GCC=gcc
COLLECT_LTO_WRAPPER=/usr/lib/gcc/x86_64-linux-gnu/11/lto-wrapper
OFFLOAD_TARGET_NAMES=nvptx-none:amdgc-nvptx-amdhsa
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-linux-gnu
Configured with: ../src/configure -v --with-pkgversion='Ubuntu 11.4.0-1ubuntu1~22.04' --with-bugurl=file:///usr/share/doc/gcc-11/README.Bugs --enable-languages=c,ada,c++,go,brig,d,fortran,objc,obj-c++,m2 --prefix=/usr --with-gcc-major-version-only --program-suffix=-11 --program-prefix=x86_64-linux-gnu- --enable-shared --enable-linker-build-id --libexecdir=/usr/lib --without-included-g
ettext --enable-threads=posix --libdir=/usr/lib --enable-nls --enable-bootstrap --enable-clocale=gnu --enable-libstdc++-debug --e
nable-libstdc++-time=yes --with-default-libstdc++-abi=new --enable-gnu-unique-object --disable-vtable-verify --enable-plugin --en
able-default-pie --with-system-zlib --enable-libphobos-checking=release --with-target-system-zlib=auto --enable-objc-gc=auto --en
able-multiarch --disable-werror --enable-cet --with-arch=32-i686 --with-abi=m64 --with-multilib-list=m32,m64,mx32 --enable-multil
ib --with-tune=generic --enable-offload-targets=nvptx-none=/build/gcc-11-XeT9lY/gcc-11-11.4.0/debian/tmp-nvptx/usr,amdgc-nvptx-amdhsa=
/build/gcc-11-XeT9lY/gcc-11-11.4.0/debian/tmp-gcn/usr --without-cuda-driver --enable-checking=release --build=x86_64-linux-gnu --
host=x86_64-linux-gnu --target=x86_64-linux-gnu --with-build-config=bootstrap-lto-lean --enable-link-serialization=2
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 11.4.0 (Ubuntu 11.4.0-1ubuntu1~22.04)
COLLECT_GCC_OPTIONS='-Wall' '-v' '-save-temps' '-o' 'test' '-mtune=generic' '-march=x86-64'
/usr/lib/gcc/x86_64-linux-gnu/11/cc1 -F -quiet -v -imultiarch x86_64-linux-gnu test.c -mtune=generic -march=x86-64 -Wall -fpcp-p
reprocess -fasynchronous-unwind-tables -fstack-protector-strong -Wformat-security -fstack-clash-protection -fcf-protection -o tes
t.i
ignoring nonexistent directory "/usr/local/include/x86_64-linux-gnu"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-linux-gnu/11/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-linux-gnu/11/../../../../x86_64-linux-gnu/include"
#include "..." search starts here:
#include <...> search starts here:
/usr/lib/gcc/x86_64-linux-gnu/11/include
/usr/local/include
/usr/include/x86_64-linux-gnu
/usr/include
End of search list.
COLLECT_GCC_OPTIONS='-Wall' '-v' '-save-temps' '-o' 'test' '-mtune=generic' '-march=x86-64'
/usr/lib/gcc/x86_64-linux-gnu/11/cc1 -fpreprocessed test.i -quiet -dumpbase test.c -dumpbase-ext .c -mtune=generic -march=x86-64
-Wall -version -fasynchronous-unwind-tables -fstack-protector-strong -Wformat-security -fstack-clash-protection -fcf-protection
-o test.s

```

1.2.2 Logs Part 2

```

sm@pop-os: ~/Public/Intern July/LeetCode/compiler
COLLECT_GCC_OPTIONS='-Wall' '-v' '-save-temps' '-o' 'test' '-mtune=generic' '-march=x86-64'
/usr/lib/gcc/x86_64-linux-gnu/11/cc1 -fpreprocessed test.i -quiet -dumpbase test.c -dumpbase-ext .c -mtune=generic -march=x86-64
-Wall -version -fasynchronous-unwind-tables -fstack-protector-strong -Wformat-security -fstack-clash-protection -fcf-protection
-o test.s
GNU C17 (Ubuntu 11.4.0-1ubuntu1~22.04) version 11.4.0 (x86_64-linux-gnu)
compiled by GNU C version 11.4.0, GMP version 6.2.1, MPFR version 4.1.0, MPC version 1.2.1, isl version isl-0.24-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
GNU C17 (Ubuntu 11.4.0-1ubuntu1~22.04) version 11.4.0 (x86_64-linux-gnu)
compiled by GNU C version 11.4.0, GMP version 6.2.1, MPFR version 4.1.0, MPC version 1.2.1, isl version isl-0.24-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 50eaa2331df977b8016186198deb2d18
test.c: In function 'main':
test.c:6:5: warning: 'c' is used uninitialized [-Wuninitialized]
6 |     printf("\n Hello World %d\n", c, argc);
  |     ~~~~~^~~~~~
COLLECT_GCC_OPTIONS='-Wall' '-v' '-save-temps' '-o' 'test' '-mtune=generic' '-march=x86-64'
as -v --64 -o test.o test.s
GNU assembler version 2.38 (x86_64-linux-gnu) using BFD version (GNU Binutils for Ubuntu) 2.38
COMPILER_PATH=/usr/lib/gcc/x86_64-linux-gnu/11:/usr/lib/gcc/x86_64-linux-gnu/11:/usr/lib/gcc/x86_64-linux-gnu:/usr/lib/gcc/x86_64-l
inux-gnu/11:/usr/lib/gcc/x86_64-linux-gnu/
LIBRARY_PATH=/usr/lib/gcc/x86_64-linux-gnu/11:/usr/lib/gcc/x86_64-linux-gnu/11/../../../../x86_64-linux-gnu:/usr/lib/gcc/x86_64-l
inux-gnu/11/../../../../lib:/usr/lib/x86_64-linux-gnu:/lib/../../../../lib:/usr/lib/x86_64-linux-gnu:/usr/lib/../../../../lib:/usr/lib
linux-gnu/11/../../../../lib:/usr/lib/
COLLECT_GCC_OPTIONS='-Wall' '-v' '-save-temps' '-o' 'test' '-mtune=generic' '-march=x86-64' '-dumpdir' 'test.'
/usr/lib/gcc/x86_64-linux-gnu/11/collect2 -plugin /usr/lib/gcc/x86_64-linux-gnu/11/liblto_plugin.so -plugin-opt=/usr/lib/gcc/x86_64-l
inux-gnu/11/lto-wrapper -plugin-opt=-fresolution=test.res -plugin-opt=-pass-through=lgcc -plugin-opt=-pass-through=lgcc_s
-plugin-opt=-pass-through=lc -plugin-opt=-pass-through=lgcc -plugin-opt=-pass-through=lgcc_s --build-id --eh-frame-hdr -m elf
x86_64 --hash-style=gnu --as-needed -dynamic-linker /lib64/ld-linux-x86_64.so.2 -pie -z now -z relro -o test /usr/lib/gcc/x86_64-
linux-gnu/11/../../../../x86_64-linux-gnu/Scrt1.o /usr/lib/gcc/x86_64-linux-gnu/11/../../../../x86_64-linux-gnu/crti.o /usr/lib/gcc/x86_
64-linux-gnu/11/crtbeginS.o -L/usr/lib/gcc/x86_64-linux-gnu/11 -L/usr/lib/gcc/x86_64-linux-gnu/11/../../../../x86_64-linux-gnu -L/u
sr/lib/gcc/x86_64-linux-gnu/11/../../../../lib -L/lib/x86_64-linux-gnu -L/lib/../../../../lib -L/usr/lib/x86_64-linux-gnu -L/usr/lib/..
lib -L/usr/lib/gcc/x86_64-linux-gnu/11/../../../../test.o -lgcc --push-state --as-needed -lgcc_s --pop-state -lc -lgcc --push-state --
as-needed -lgcc_s --pop-state /usr/lib/gcc/x86_64-linux-gnu/11/ertrand5.o /usr/lib/gcc/x86_64-linux-gnu/11/../../../../x86_64-linux-g
nu/crti.o
COLLECT_GCC_OPTIONS='-Wall' '-v' '-save-temps' '-o' 'test' '-mtune=generic' '-march=x86-64' '-dumpdir' 'test.'
λ compiler

```

1.3 Files generated by GCC

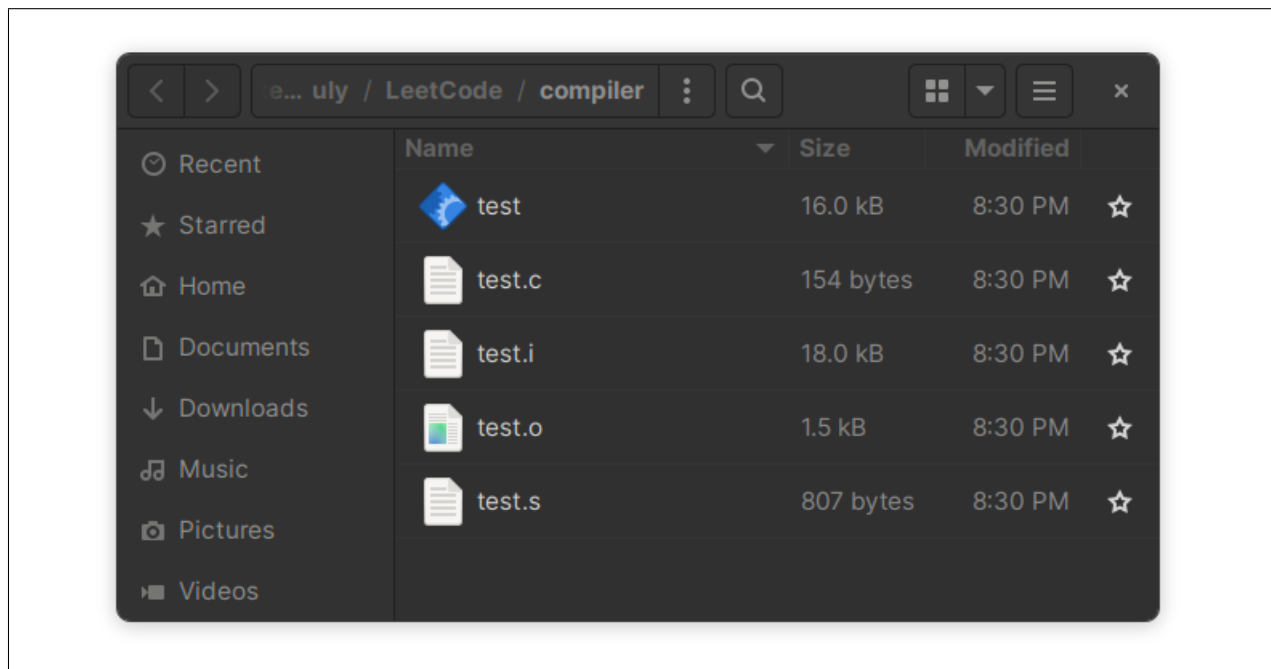


Figure 1: Folder View of the files generated by GCC

1.3.1 Preprocessed Output : `test.i`

1.3.2 Assembly Output: `test.s`

```
.file      "test.c"
.text
.section   .rodata

.LC0:
.string    "\n HELlo World %d %d\n"
.text
.globl     main
.type      main, @function

main:
.LFB0:
.cfi_startproc
endbr64
pushq      %rbp
.cfi_def_cfa_offset 16
.cfi_offset 6, -16
movq       %rsp, %rbp
.cfi_def_cfa_register 6
subq       $32, %rsp
movl       %edi, -20(%rbp)
movq       %rsi, -32(%rbp)
movl       -20(%rbp), %edx
movl       -4(%rbp), %eax
```

```

    movl    %eax, %esi
    leaq    .LC0(%rip), %rax
    movq    %rax, %rdi
    movl    $0, %eax
    call    printf@PLT
    movl    $0, %eax
    leave
    .cfi_def_cfa 7, 8
    ret
    .cfi_endproc

.LFE0:
    .size    main, .-main
    .ident    "GCC: (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0"
    .section    .note.GNU-stack,"",@progbits
    .section    .note.gnu.property,"a"
    .align 8
    .long    1f - 0f
    .long    4f - 1f
    .long    5
0:
    .string    "GNU"
1:
    .align 8
    .long    0xc0000002
    .long    3f - 2f
2:
    .long    0x3
3:
    .align 8
4:

```

1.3.3 Object file: test.o

1.3.4 Linked executable: test.out

1.4 Compilation steps

Compilation comprises of the following steps:

1.4.1 Preprocessor

converts 'c' file to 'i' file (expands headers and macros/symbolic constants)

1.4.2 Compiler

converts 'i' file to 's' file (assembly code)

1.4.3 Assembler

converts 's' file (assembly code) to 'o' file (object code)

1.4.4 Linker

if multiple source codes are involved, multiple object code files are generated which are linked together to generate a single executable file ('.exe')

1.4.5 Loader

includes dynamically linked files with the executable and loads it into main memory during execution

2 Part 2

Demonstrating the various steps of compilation for Visual Prolog language:

- Create a New project
- Select Console as the target application type

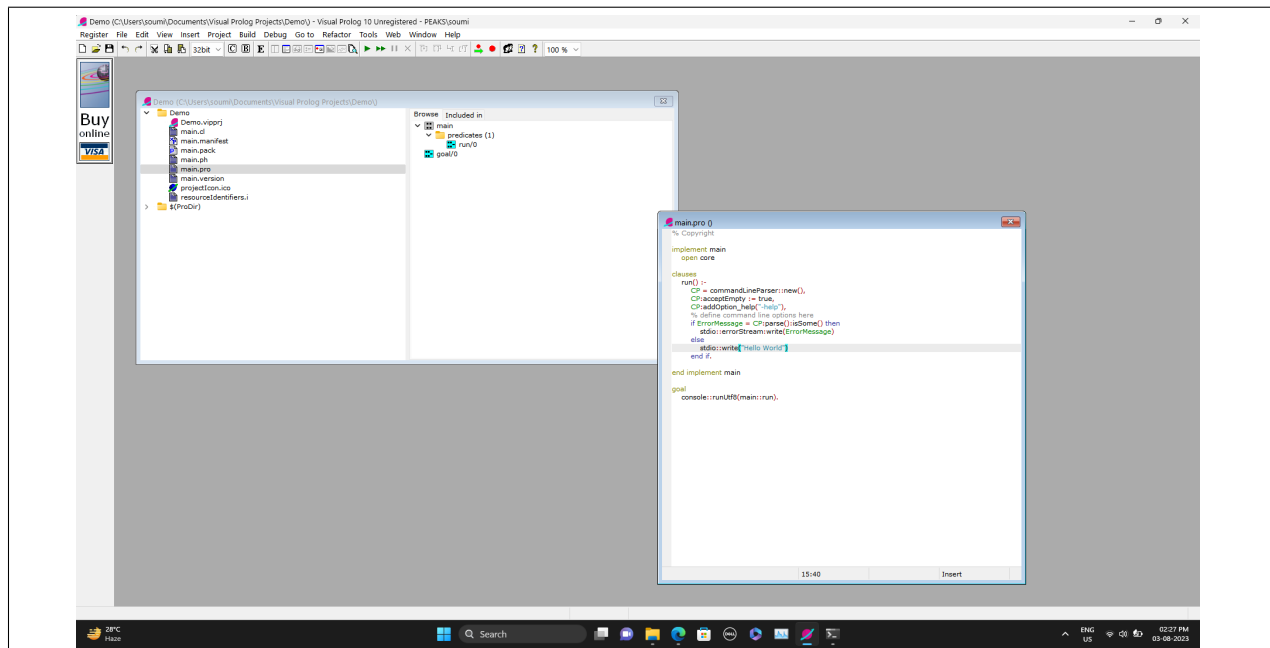
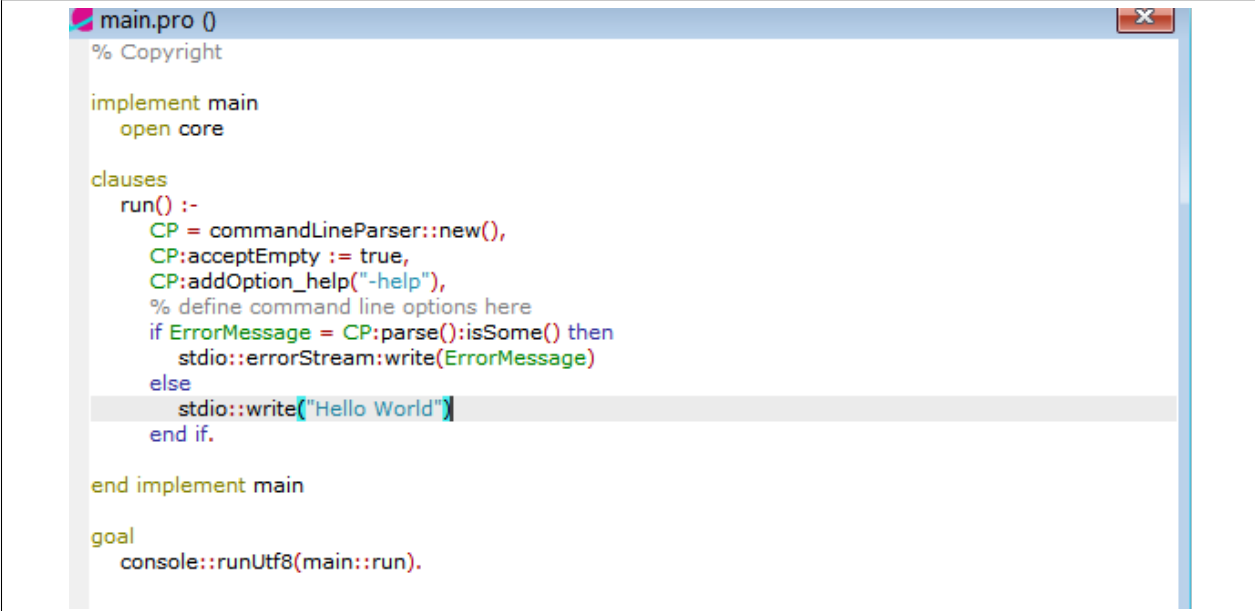


Figure 2: IDE Window

- In the `main.pro` file, write the Hello World program
- Go to **Build** and build/compile the project
- Thereafter run the project in a new window

2.1 Compilation steps

Since Visual Prolog is a proprietary language, it does not export its intermediate representations. This means that the language's specifications, implementation, and distribution are under the exclusive ownership of Borland, and access to the language and its tools are restricted. However we have the object files and the final linked executable as follows:



```
main.pro ()
% Copyright

implement main
  open core

clauses
  run() :-
    CP = commandLineParser::new(),
    CP:acceptEmpty := true,
    CP:addOption_help("-help"),
    % define command line options here
    if ErrorMessage = CP:parse():isSome() then
      stdio::errorStream:write(ErrorMessage)
    else
      stdio::write("Hello World")
    end if.

end implement main

goal
  console::runUtf8(main::run).
```

Figure 3: Source Code

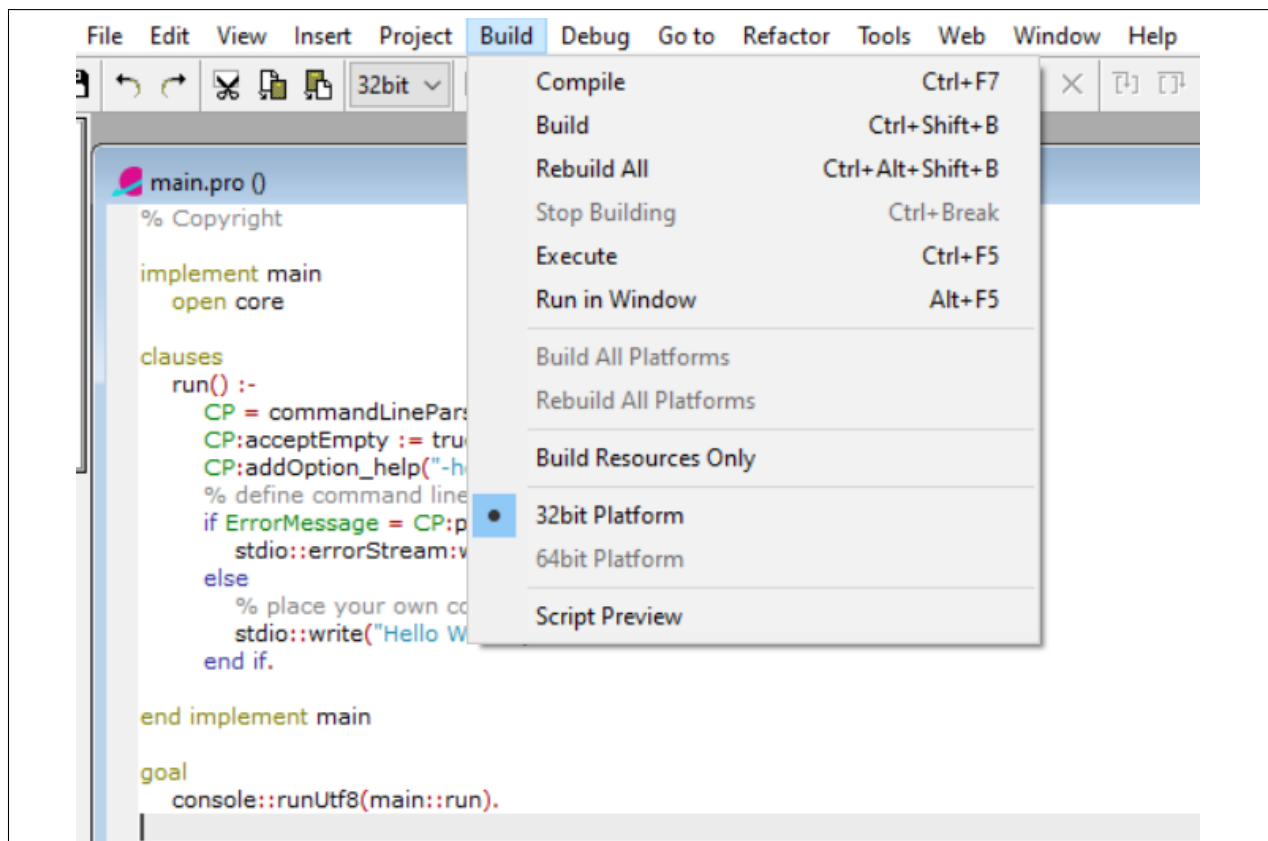


Figure 4: IDE Menu

```

C:\WINDOWS\system32\cmd.exe

C:\Users\shubh\OneDrive\Documents\Visual Prolog Projects\Demo\exe>"C:\Users\shubh\OneDrive\Documents\Visual Prolog Projects\Demo\exe\Demo.exe"
Hello World
C:\Users\shubh\OneDrive\Documents\Visual Prolog Projects\Demo\exe>pause
Press any key to continue . . .

```

Figure 5: Terminal Output

arrayM_inline.F665267A.obj	basicInterfaces.63D9152F.obj	binary.248EF86D.obj	boolean.DE5055E8.obj
collection.A520841C.obj	collectionMsupport.3A44ED4E.obj	collectionSupport.A039CC0D.obj	com_api.B45865D0.obj
comDomains.234349D9.obj	commandLineParser.67E728BA.obj	comSupport.C599FD18.obj	console.E8EB4F3C.obj
console_api.1787DB80.obj	core.5D9B9483.obj	criticalSectionSupport.6958A988.obj	Demo.map
Demo.res	event.D92D3A63.obj	exception.B6F320E8.obj	exceptionDump.2B9C9E40.obj
exceptionHandling.2B4136FF.obj	exe.D80FC844.obj	exe_api.026B8342.obj	fileSystem.580F823E.obj
fileSystem_api.C588AF1A.obj	gui_api.9FE53D0D.obj	guid.EF75E950.obj	guid_api.488B7439.obj
hash_api.9688CAEE.obj	iEnumXXX.DED4A0C0.obj	inputStreamSupport.7AF62102.obj	inputSupport_mode.ADC075EF.obj
iso8601Parser.F0F6BC83.obj	iStream_api.935D2F36.obj	iterator.60C55021.obj	list.A75CEA31.obj
locale_api.2E000328.obj	main.789E136F.obj	mapM_redBlack.875A0474.obj	mapMSupport.8CD6C048.obj
mapSupport.C7248B7B.obj	math.5D7D6037.obj	memory.568C55F8.obj	memory_api.EF10D306.obj
modifiableSupport.5D48FF11.obj	multiThread.32507C62.obj	multiThread_api.57E3A62D.obj	namedValue.6D52B2A6.obj
outputStreamSupport.6F229CFB.obj	pack.obj.options	presenter.E6E77556.obj	programControl.2B27F1CB.obj
queueM_fact.744E8FC1.obj	random.27B461AB.obj	redBlackSet.LDC1C3622.obj	redBlackTree.401E21A0.obj
redBlackTreeRep.E6A269FA.obj	reflection.ACE59E5C.obj	registry.917E8C91.obj	registry_api.CF388C66.obj
runTime_api.B1A642EC.obj	safeArray_api.9604C1AC.obj	segmented.E9C86B20.obj	segmented_binary.C16992E7.obj
segmented_utf16.76E668A2.obj	segmentedSupport.28AFE67D.obj	setM_redBlack.16EF8DC5.obj	Shell_api.E8D4E14B.obj
snwLock.8CC714FD.obj	standardInterfaces.E508E9F3.obj	std.2DE0EC97.obj	stream.8B55AAA7.obj
string.19AABD3B.obj	string_api.2E13EA53.obj	string8.355639C6.obj	string8_api.53D65538.obj
systemInformation_api.809129C1.obj	time.6AFD2988.obj	time_api.32F5932A.obj	timeAndFingerPrint.ScopeInfo
typeLibrary.6EC19AA0.obj	uncollectable.CD38F31A.obj	varM.B882E173.obj	vpiDomains.E7102A6D.obj
weakReference.0A1AF11C.obj	windowsAPI.FC171F8F.obj	winErrors.9B153E38.obj	

Figure 6: Object Files

Capdos.cmd	03-08-2023 02:18 PM	Windows Comm...	1 KB
Demo.exe	03-08-2023 02:17 PM	Application	1,670 KB
vipKernel.dll	31-03-2021 01:04 PM	Application exte...	275 KB
vipRun.dll	31-03-2021 01:04 PM	Application exte...	399 KB

Figure 7: Executable Files














 exe	03-08-2023 02:18 PM	File folder	
 obj	03-08-2023 02:17 PM	File folder	
 Demo.env	03-08-2023 02:32 PM	ENV File	2 KB
 Demo.prjgrd	03-08-2023 02:32 PM	PRJGRD File	0 KB
 Demo.vipprj	03-08-2023 02:16 PM	Vip7 Project	8 KB
 main.cl	03-08-2023 02:16 PM	Vip7 Class	1 KB
 main.manifest	03-08-2023 02:16 PM	MANIFEST File	1 KB
 main.pack	04-03-2021 06:44 PM	Vip7 Package	1 KB
 main.ph	03-08-2023 02:16 PM	Vip7 Package H...	1 KB
 main.pro	03-08-2023 02:17 PM	Vip7 Implement...	1 KB
 main.version	03-08-2023 02:16 PM	VERSION File	1 KB
 projectIcon.ico	14-01-2021 08:21 AM	ICO File	1 KB
 resourceIdentifiers.i	03-08-2023 02:16 PM	Vip7 Interface	1 KB

Figure 8: Folder Structure