Lab 3: Perform Static Malware Analysis

Task 1: Perform Online Malware Scanning using VirusTotal

VirusTotal is a free service that analyzes suspicious files and URLs and facilitates the quick detection of viruses, worms, Trojans, and other kinds of malware.

VirusTotal aims to improve the anti-virus and security industry and make the Internet a safer place through the development of free tools and services. VirusTotal simply acts as an information aggregator. The aggregated data are the output of different antivirus engines, website scanners, file and URL analysis tools, and user contributions. The malware signatures of antivirus solutions present in VirusTotal are periodically updated as they are developed and distributed by anti-virus companies. The update polling frequency is 15 minutes—thus ensuring that these products are using the latest signature sets. Website scanning is done via API queries to the different companies providing the solution; hence, the most updated version of their dataset is always used.

VirusTotal helps ethical hackers and penetration testers to analyze files and URLs, enabling the identification of viruses, worms, Trojans, and other malicious content detected by anti-virus engines and website scanners.

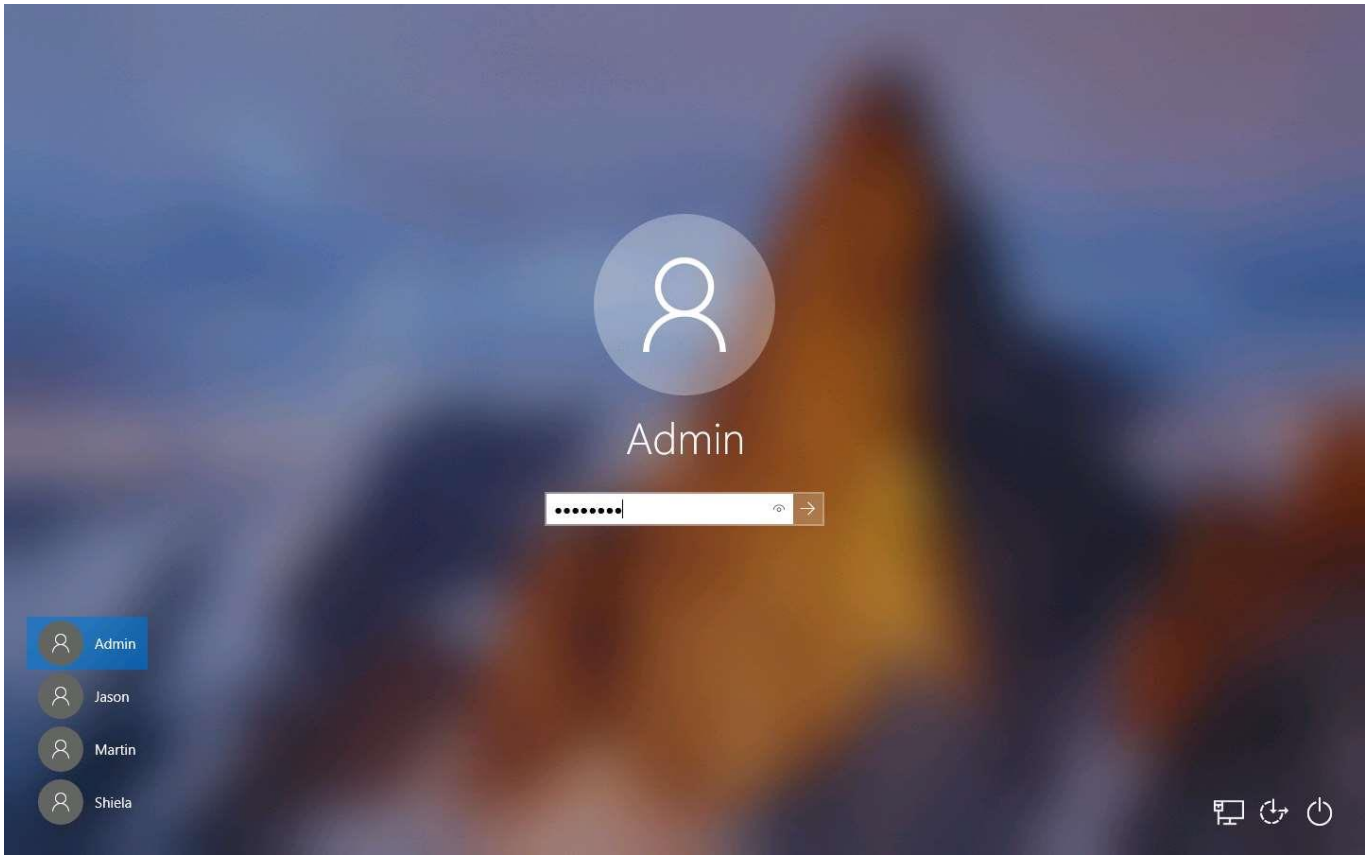
This lab activity will demonstrate how to analyze malware using online virus analysis services.

1. By default, **Windows 10** machine selected, click Ctrl+Alt+Delete.

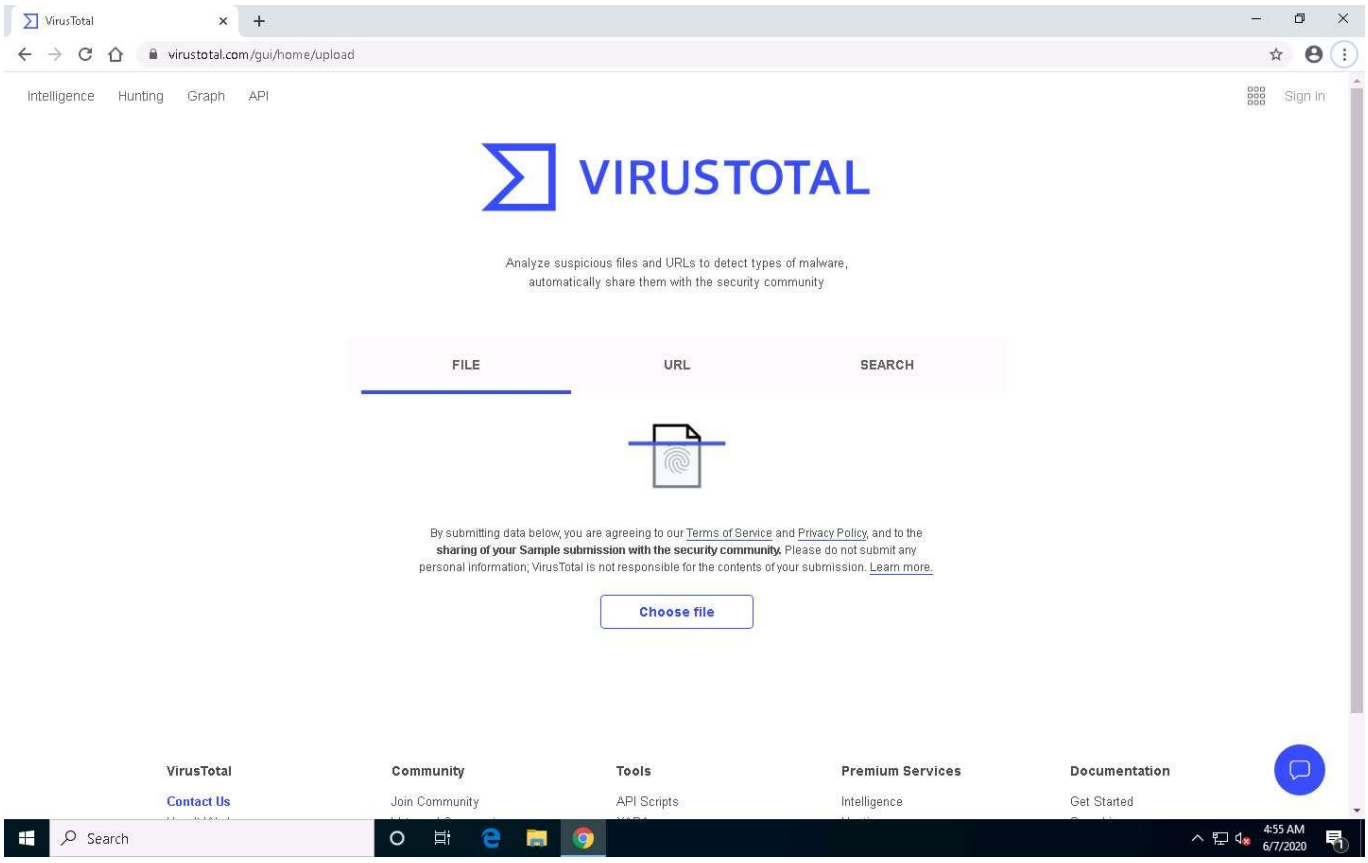
   Alternatively, you can also click **Ctrl+Alt+Delete** button under **Windows 10** machine thumbnail in the **Resources** pane or Click **Ctrl+Alt+Delete** button under Commands (**thunder** icon) menu.

2. By default, **Admin** user profile is selected, click Pa$$w0rd to paste the password in the Password field and press **Enter** to login.

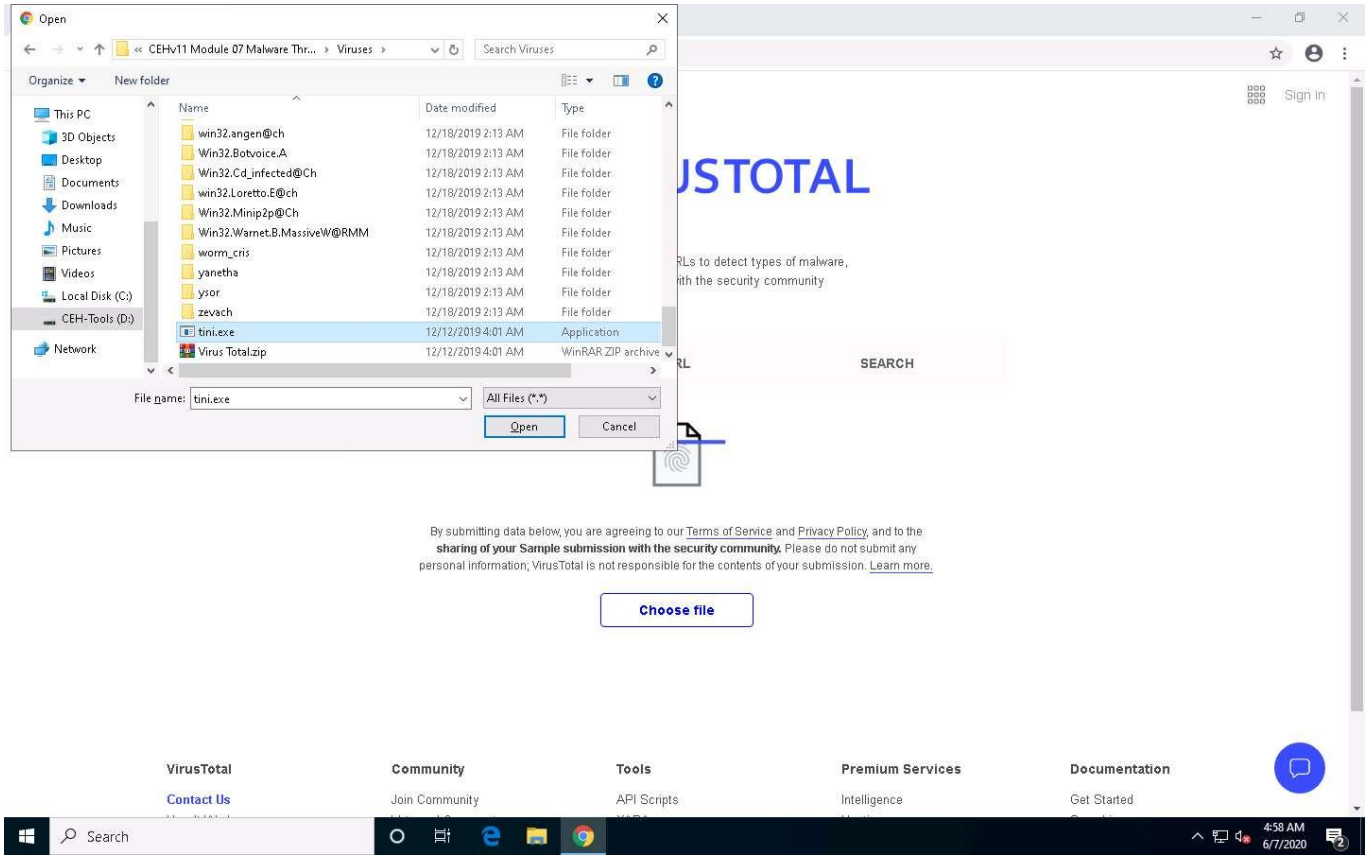
   Alternatively, you can also click **Pa$$w0rd** under **Windows 10** machine thumbnail in the **Resources** pane or Click **Type Text | Type Password** button under Commands (**thunder** icon) menu.
   Networks screen appears, click **Yes** to allow your PC to be discoverable by other PCs and devices on the network.



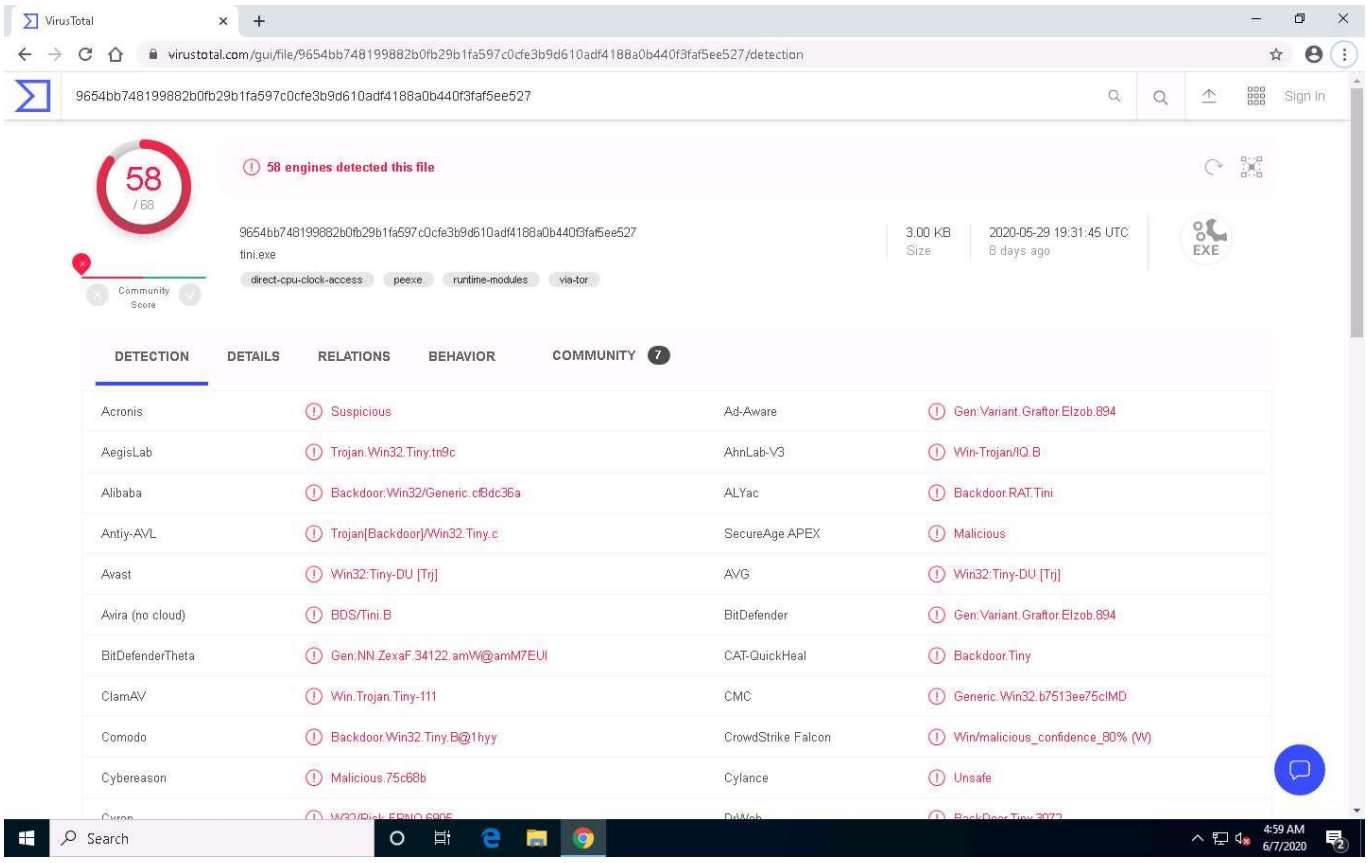
3. Open any web browser (here, **Google Chrome**).In the address bar of the browser place your mouse cursor and click https://www.virustotal.com and press **Enter**.
4. The **VirusTotal** main analysis site appears; click **Choose file** to upload a virus file.



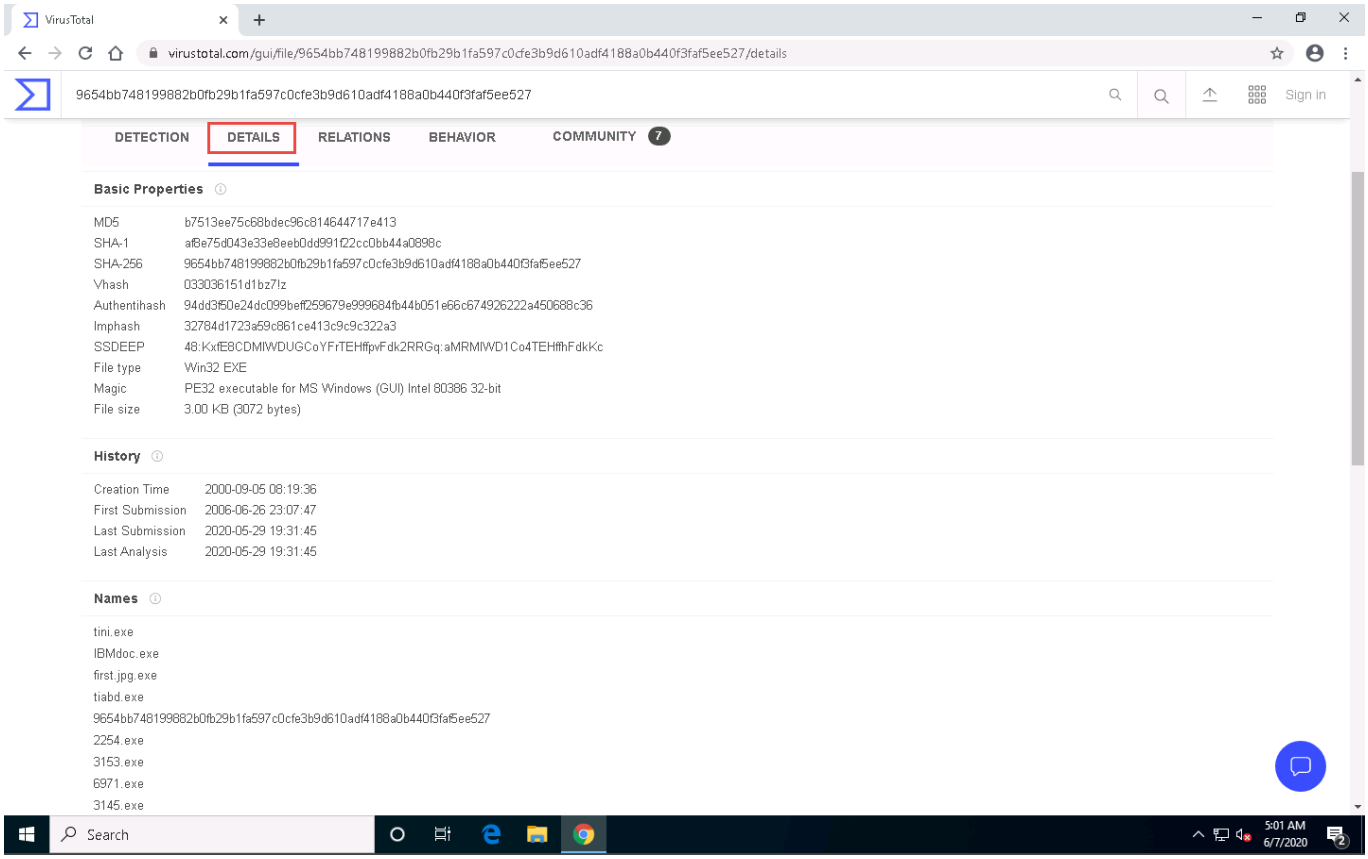
5. The **Open** window appears; navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses**, select **tini.exe**, and click **Open**.



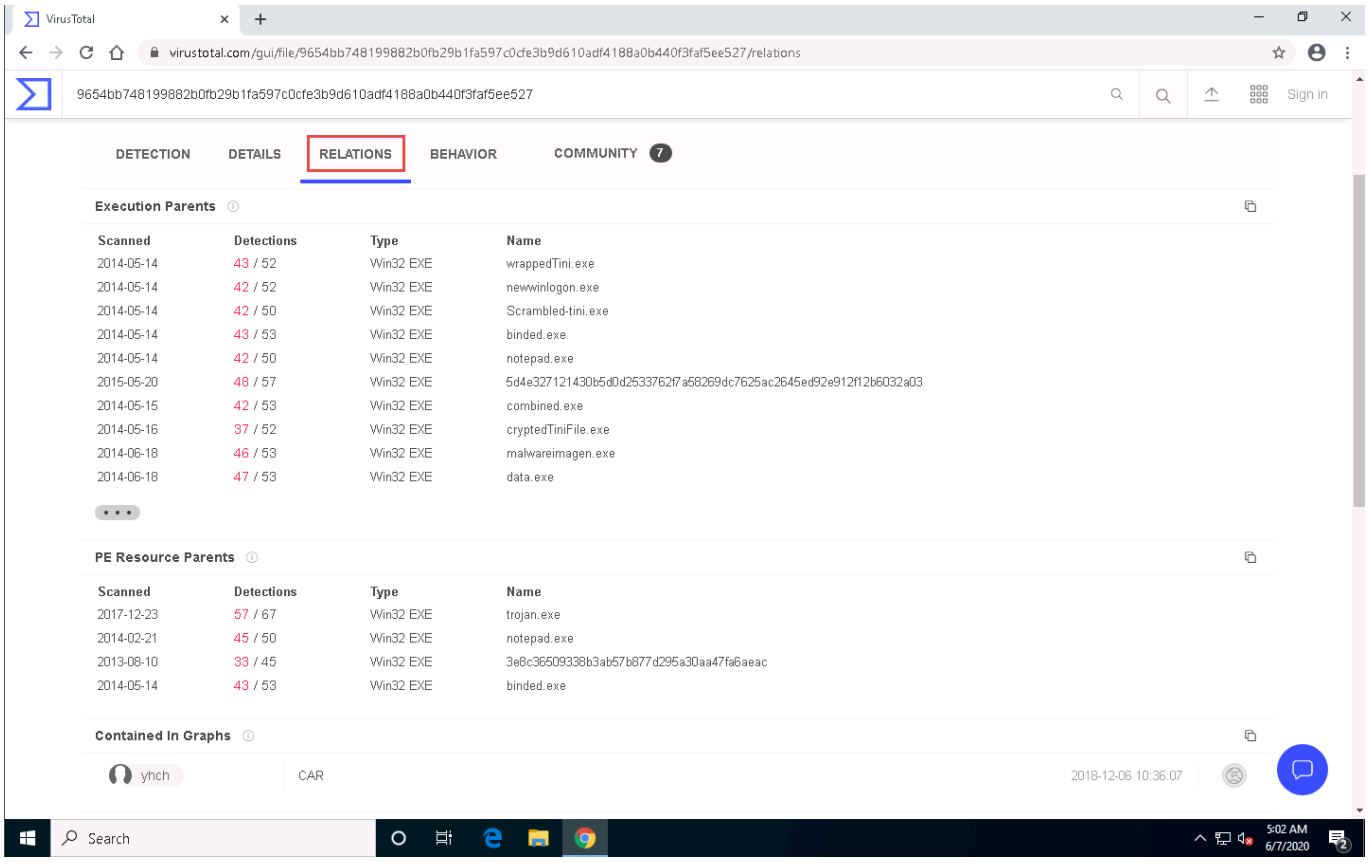
6. The selected file will be sent to the VirusTotal server for analysis.
7. VirusTotal returns a detailed report displaying the result of each anti-virus for the selected **tini.exe** malicious file under the **DETECTION** tab, as shown in the screenshot.



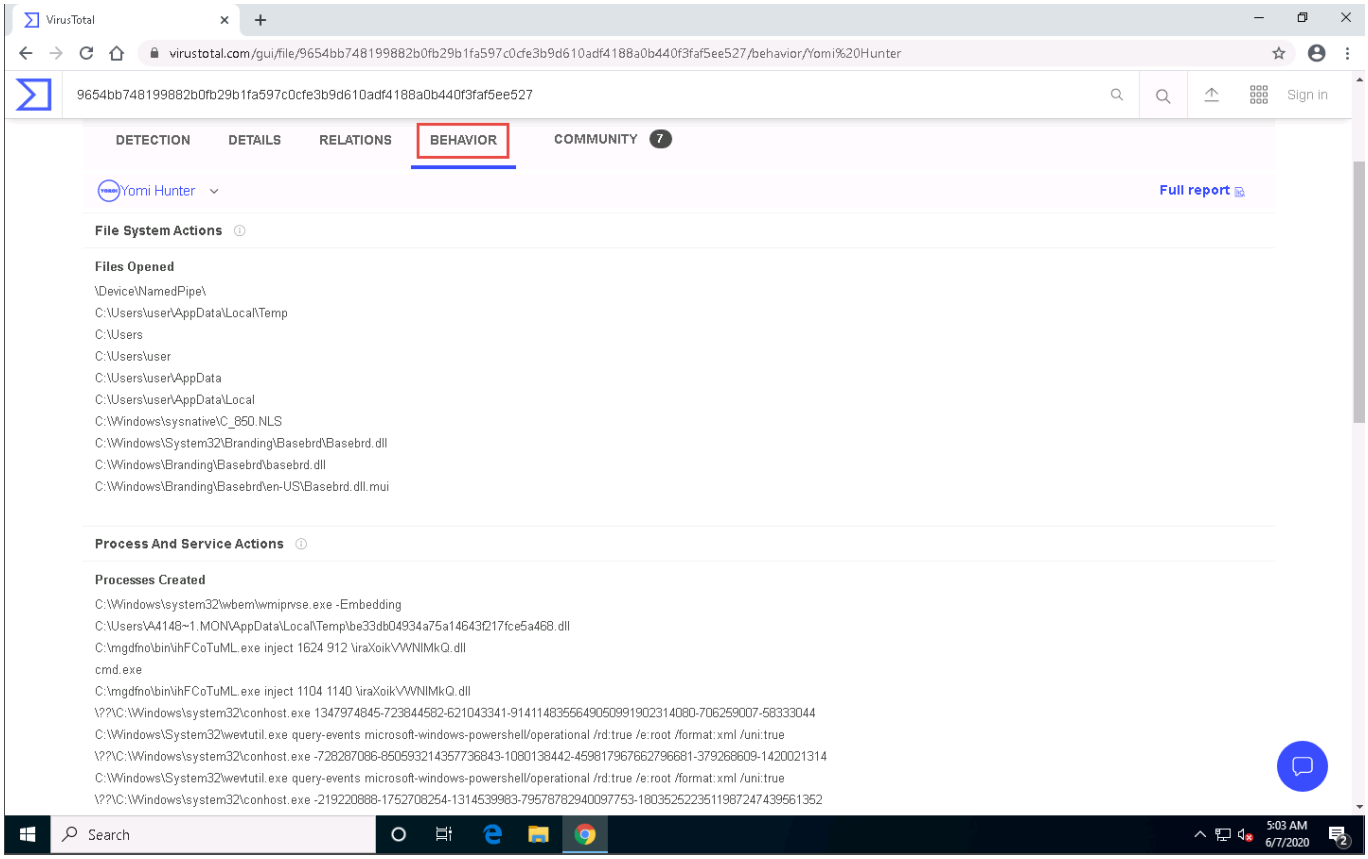
8. Now, click the **DETAILS** tab to view the malicious file details such as Basic Properties, History, Names, Portable Executable Info, Sections, Imports, and ExifTool File Metadata.



9. ☐ Click the **RELATIONS** tab to view Execution Parents, PE Resource Parents, Contained in Graphs, and Graph Summary. Scroll down to view other details.
10. ☐ To view **Graph Summary**, you will need a VirusTotal account.



11. ☐ Click the **BEHAVIOR** tab to view the File System Actions, Process and Service Actions, Shell Commands, and Synchronization Mechanisms & Signals.



12. Close the web browser once the analysis is complete.
13. You can also use other local and online malware scanning tools such as **Hybrid Analysis** (https://www.hybrid-analysis.com), **Cuckoo Sandbox** (https://cuckoosandbox.org), **Jotti** (https://virusscan.jotti.org), or **Valkyrie Sandbox** (https://valkyrie.comodo.com) to perform online malware scanning.

Task 2: Perform a Strings Search using BinText

Software programs include some strings that are commands to perform specific functions such as printing output. Strings communicate information from a program to its user. Various strings that could represent the malicious intent of a program such as reading the internal memory or cookie data, are embedded in the compiled binary code.

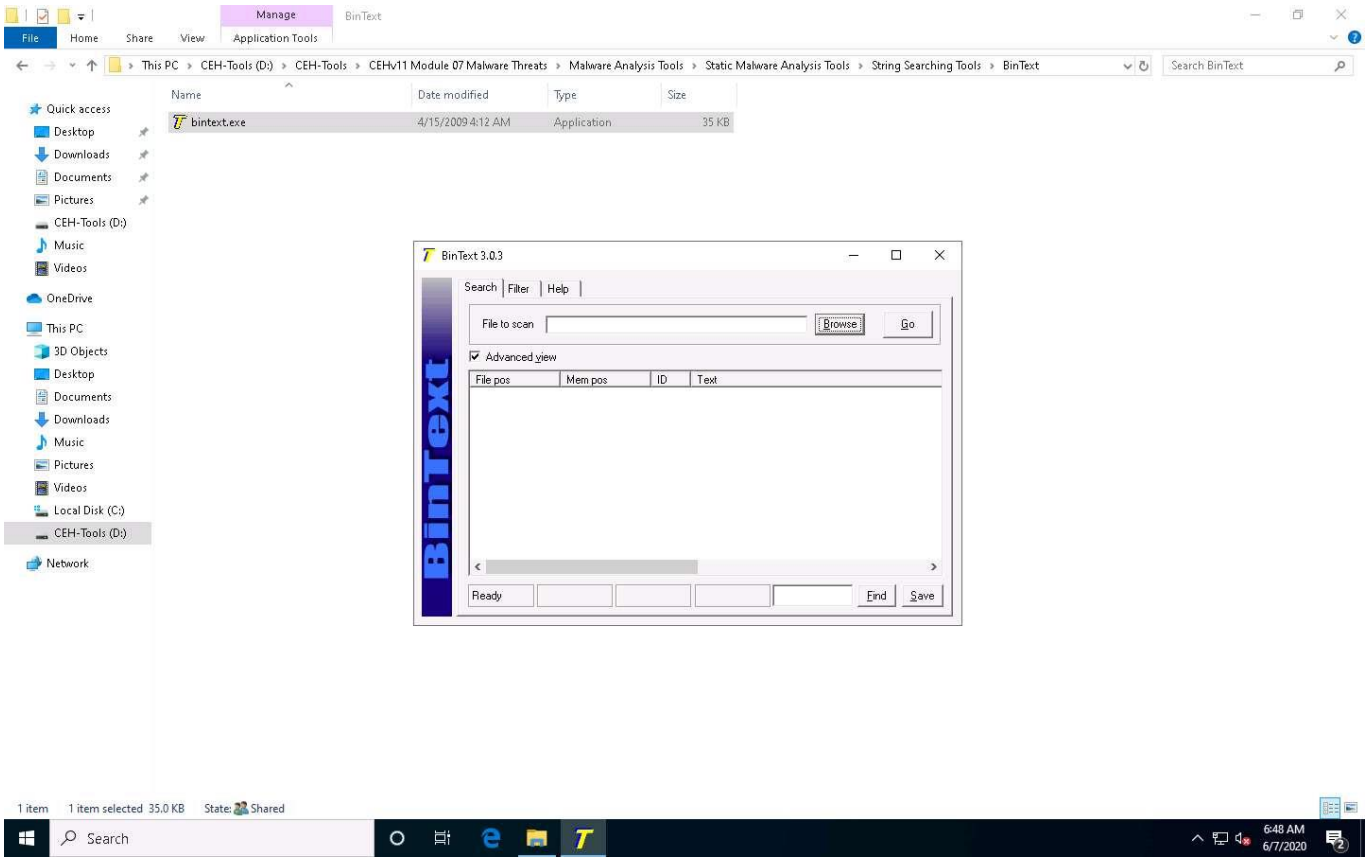
Searching through strings can provide information about the basic functionality of any program. During malware analysis, search for malicious strings that could determine the harmful actions that a program can perform. For instance, if the program accesses a URL, it will have that URL string stored in it. You should be attentive while looking for strings and search for the embedded and encrypted strings for a complete analysis of the suspect file.

BinText is a text extractor that can extract text from any file. It includes the ability to find plain ASCII text, Unicode text, and Resource strings, providing useful information for each item.

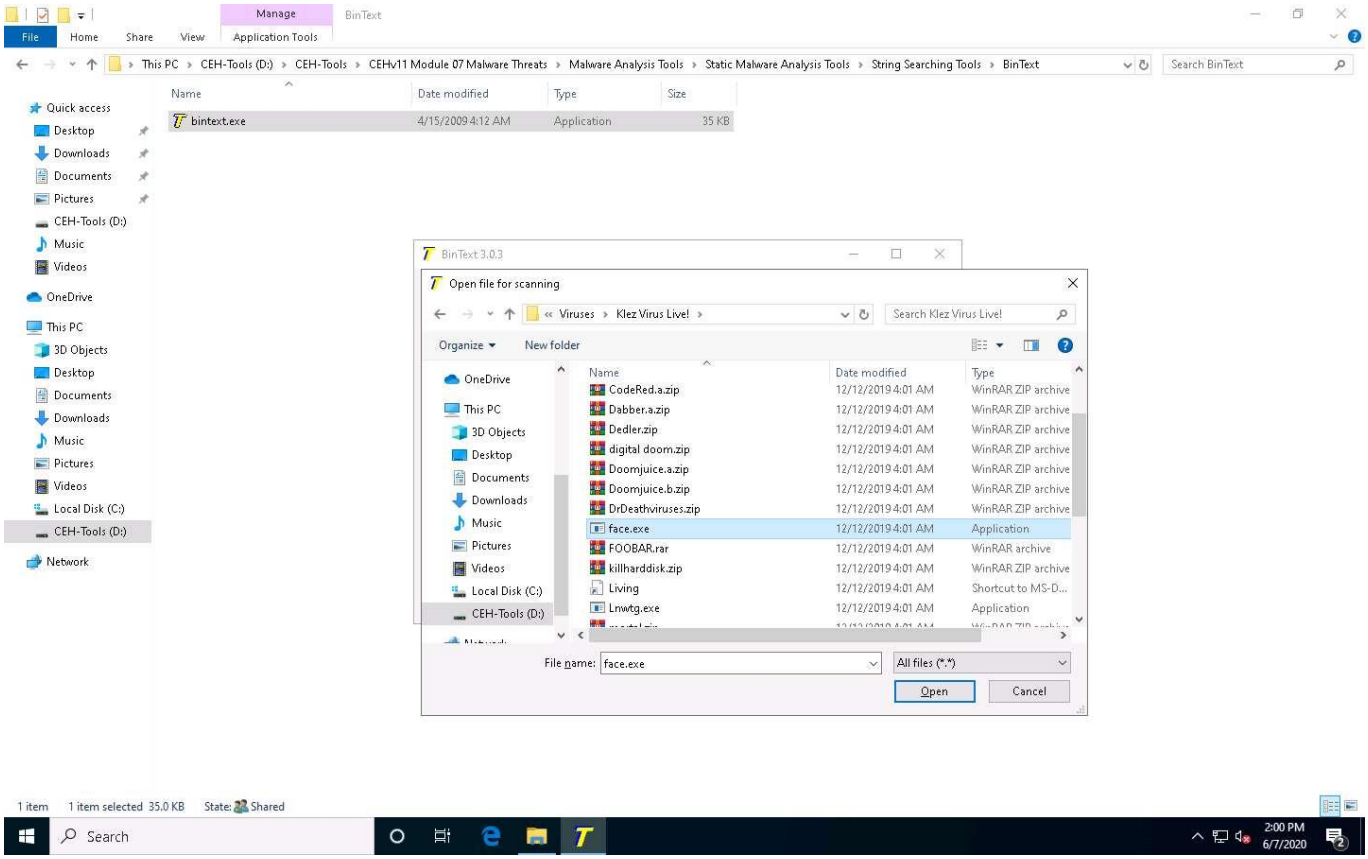
Here, we will use the BinText tool to extract embedded strings from executable files.

1. On the **Windows 10** machine, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\String Searching Tools\BinText** and double-click **bintext.exe**.

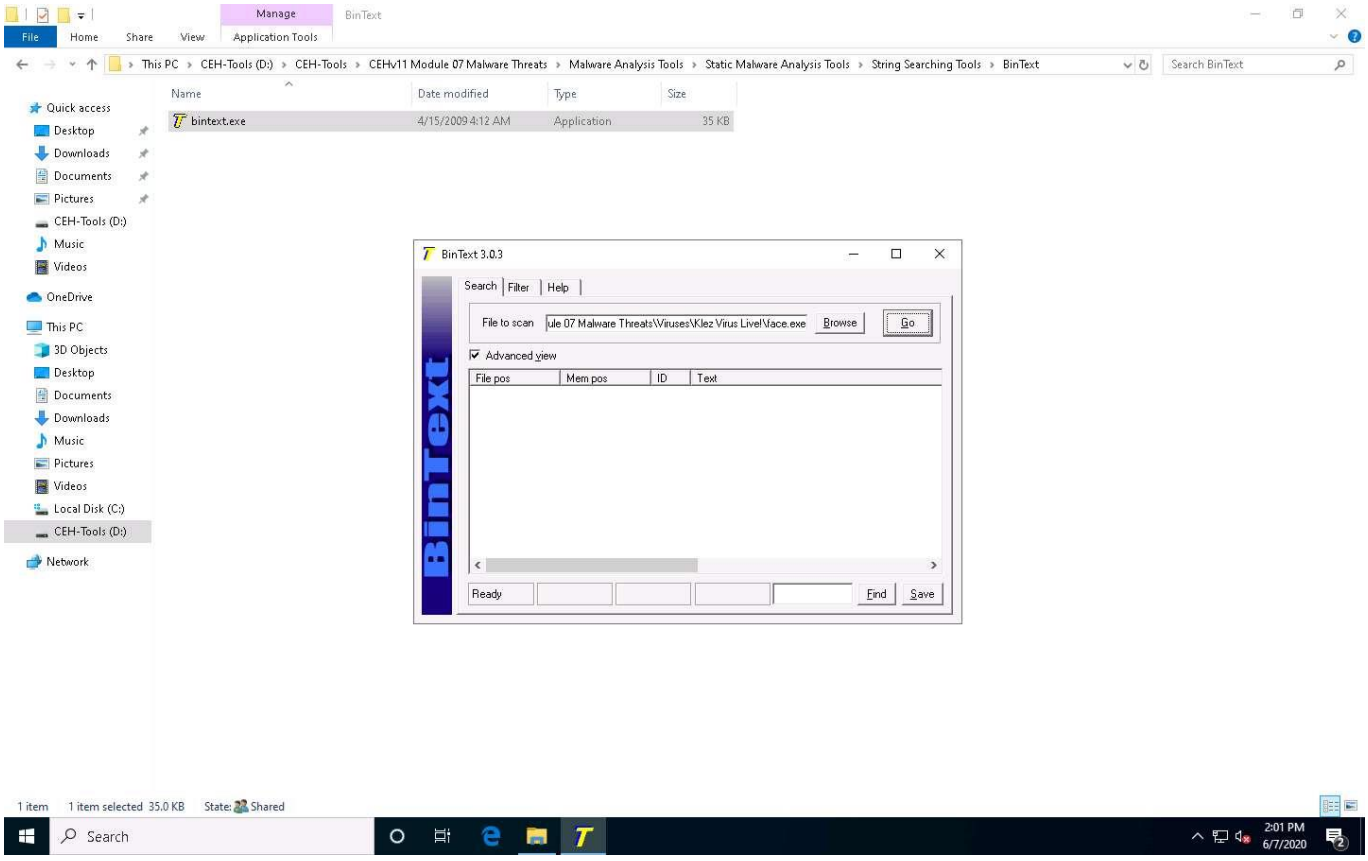
2. The **BinText** main window appears; click **Browse** to provide a file to scan. Here, we need to provide a malicious file to analyze the text.
3. Make sure that the **Advanced view** option is checked.



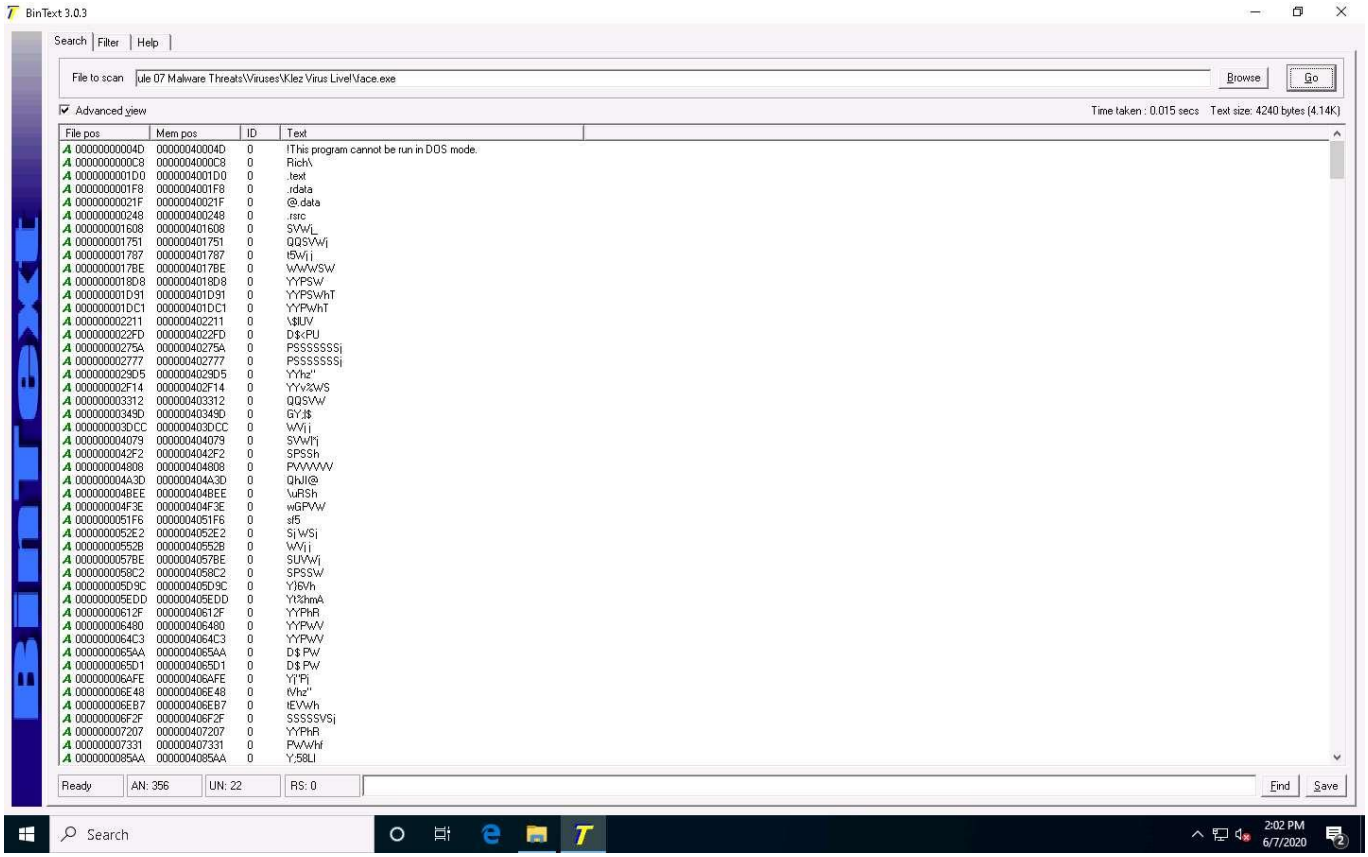
4. The **Open file for Scanning** window appears, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses\Klez Virus Live!** and select **face.exe**, the malicious file, and click **Open** to extract the text from the malicious file.



5. As soon as the file is provided for scan, click **Go**. BinText will start extracting the text from the designated malicious file.



6. BinText extracts the provided malicious file's critical information, as shown in the screenshot.



7. ☐ The type of string is designated by a colored letter to the left of the list. ANSI strings are marked with a green "A," Unicode strings (double byte ANSI) have a red "U," and resource strings have a blue "R."
8. ☐ "File pos" is the HEX position at which the text is located in the file.
9. ☐ "Mem pos" if the file is a Win32 PE file (such as Win95 EXEs and DLLs), then this is the HEX address at which the text is referred to in the memory at runtime, as determined by its sections table.
10. ☐ "ID" is the decimal string resource ID or 0 if it is not a resource string.
11. ☐ Close all windows once the analysis is complete.
12. ☐ You can also use other string searching tools such as **FLOSS** (https://www.fireeye.com), **Strings** (https://docs.microsoft.com), **Free EXE DLL Resource Extract** (http://www.resourceextract.com), or **FileSeek** (https://www.fileseek.ca) to perform string search.

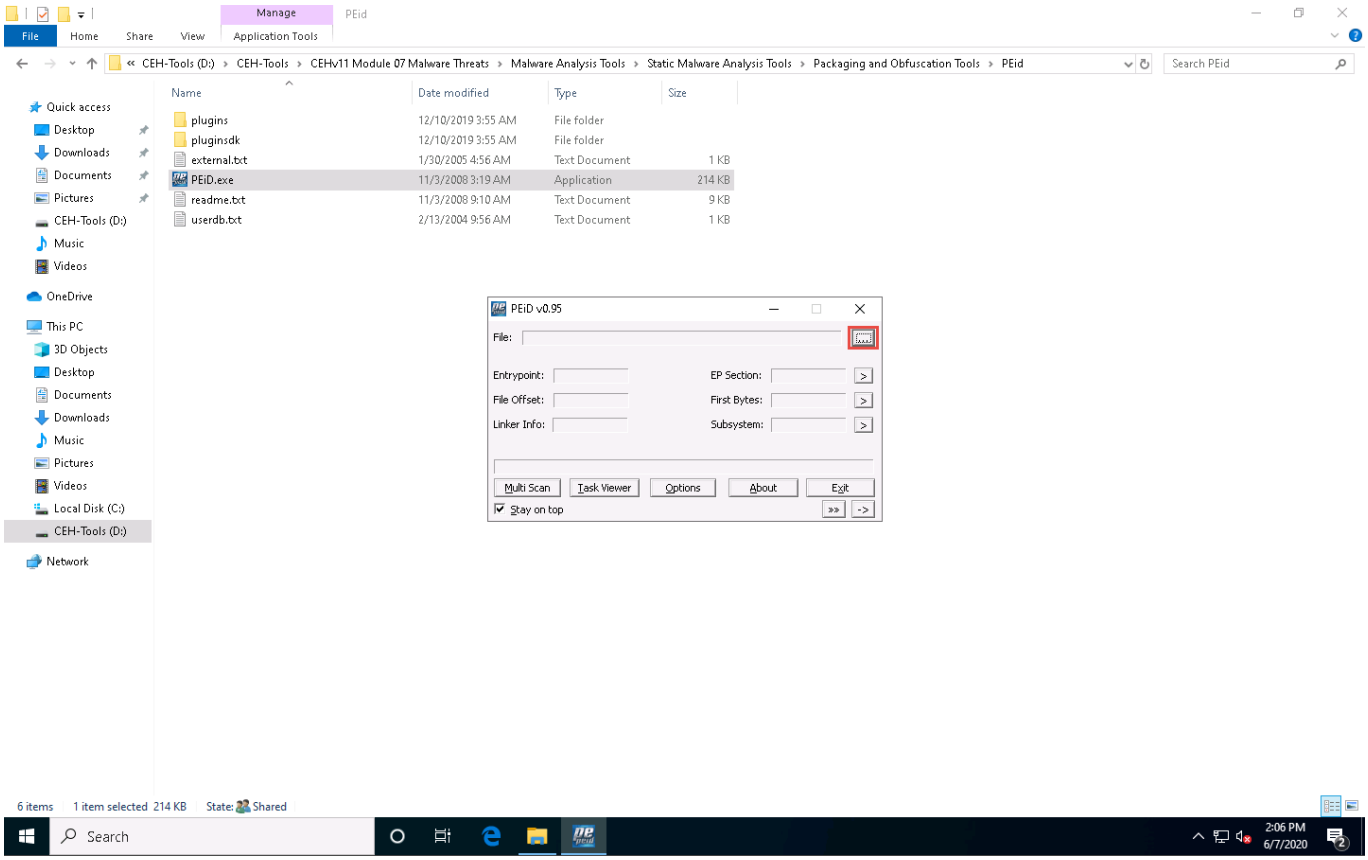
Task 3: Identify Packaging and Obfuscation Methods using PEid

Attackers often use packing and obfuscation or a packer to compress, encrypt, or modify a malware executable file to avoid detection. Obfuscation also hides the execution of the programs. When the user executes a packed program, it also runs a small wrapper program to decompress the packed file, and then runs the unpacked file. It complicates the task of reverse engineers to determine the actual program logic and other metadata via static analysis. The best approach is to try and identify if the file includes packed elements and locate the tool or method used to pack it.

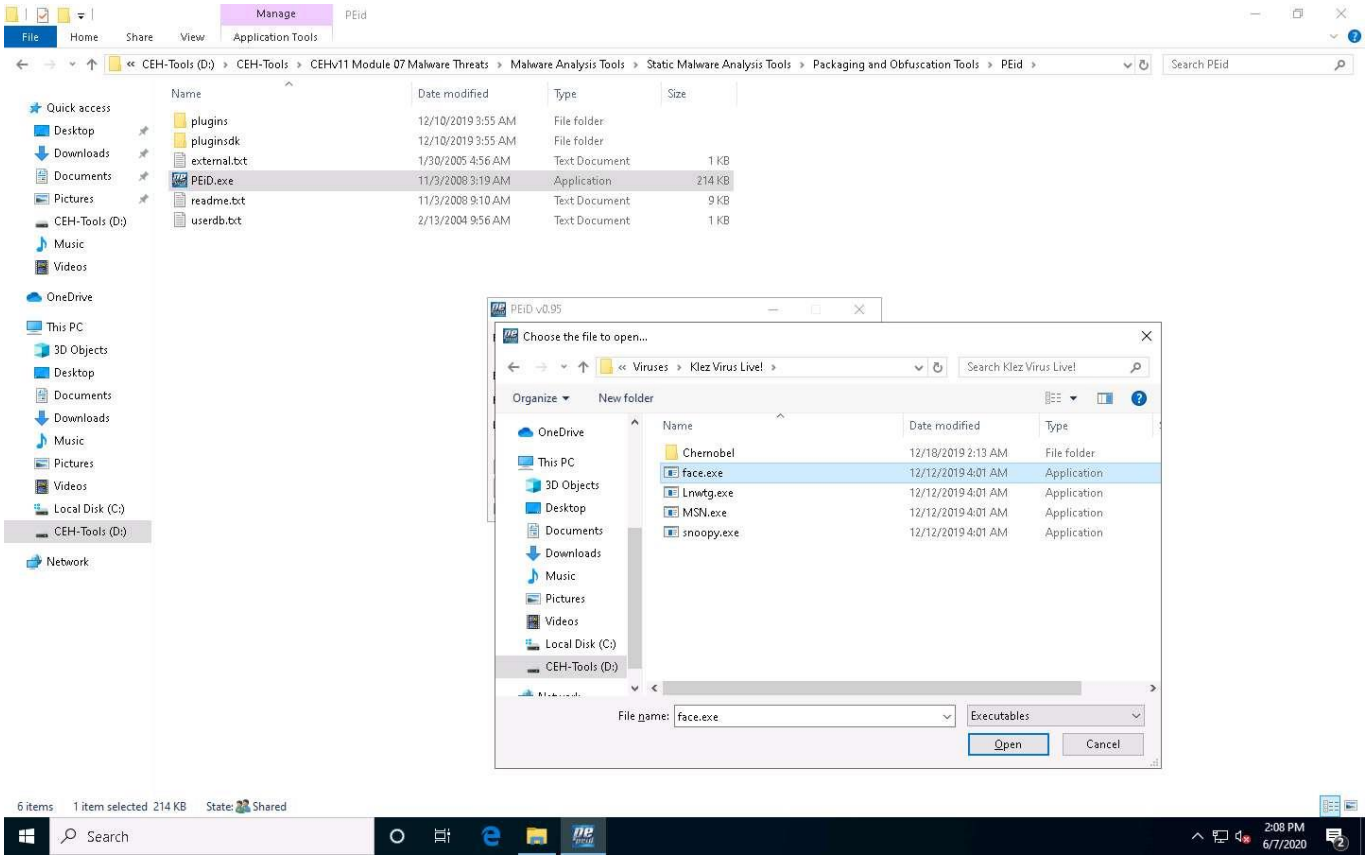
PEid is a free tool that provides details about Windows executable files. It can identify signatures associated with over 600 different packers and compilers. This tool also displays the type of packer used in packing a program.

Here, we will use the PEid tool to detect common packers, cryptors, and compilers for PE executable files.

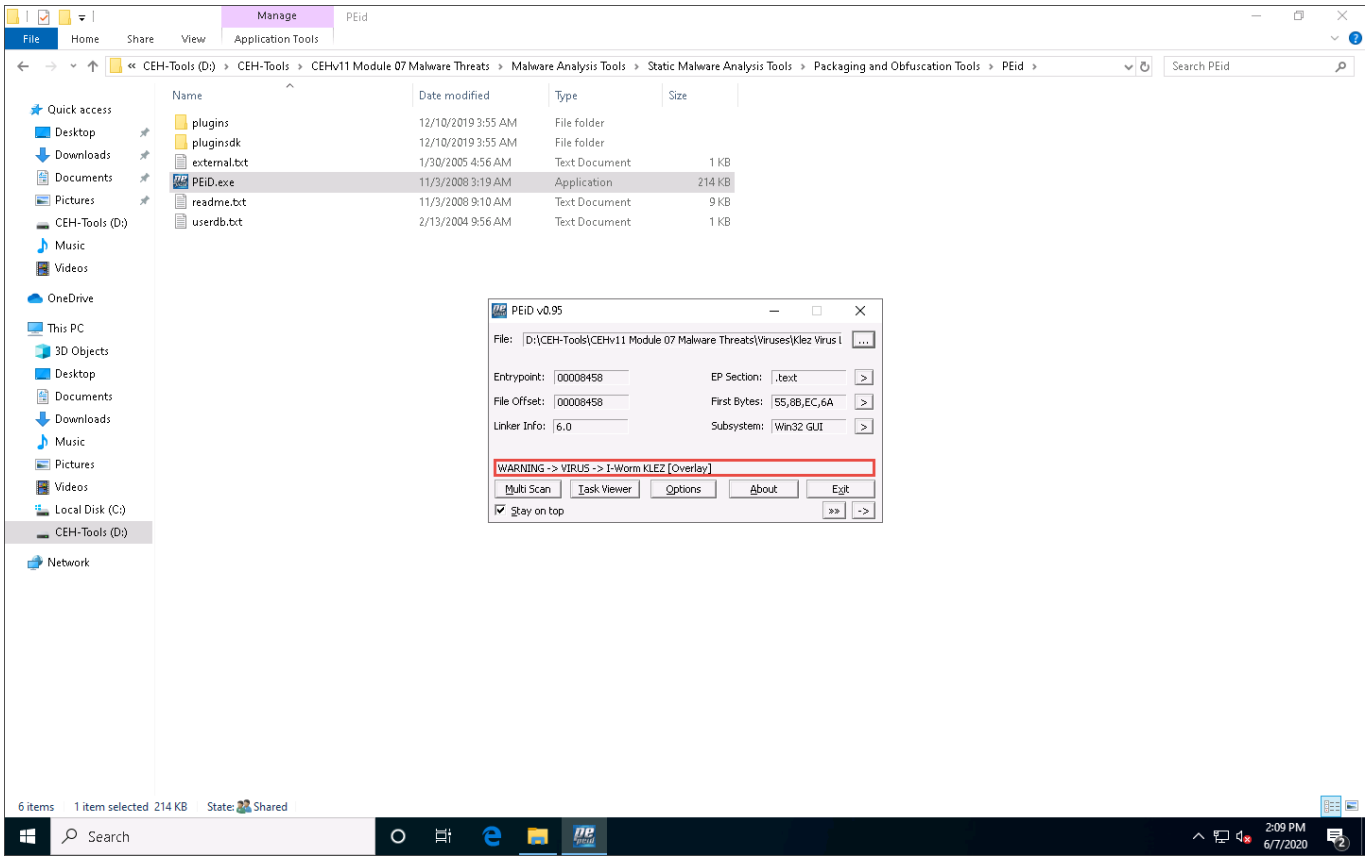
1. In the **Windows 10** machine, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\Packaging and Obfuscation Tools\PEid** and double-click **PEiD.exe**.
2. The **PEiD** main window appears. Click the **Browse** button to upload a malicious file for analysis.



3. The **Choose the file to open** window appears; navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses\Klez Virus Live!**, select the **face.exe** file, and click **Open**.



4. As soon as you click **Open**, PEiD analyzes the file and provides information, as shown in the screenshot.



5. Close all windows once the analysis is complete.
6. You can also use other packaging/obfuscation tools such as **Macro_Pack** (https://github.com), **UPX** (https://upx.github.io), or **ASPack** (http://www.aspack.com) to identify packing/obfuscation methods.

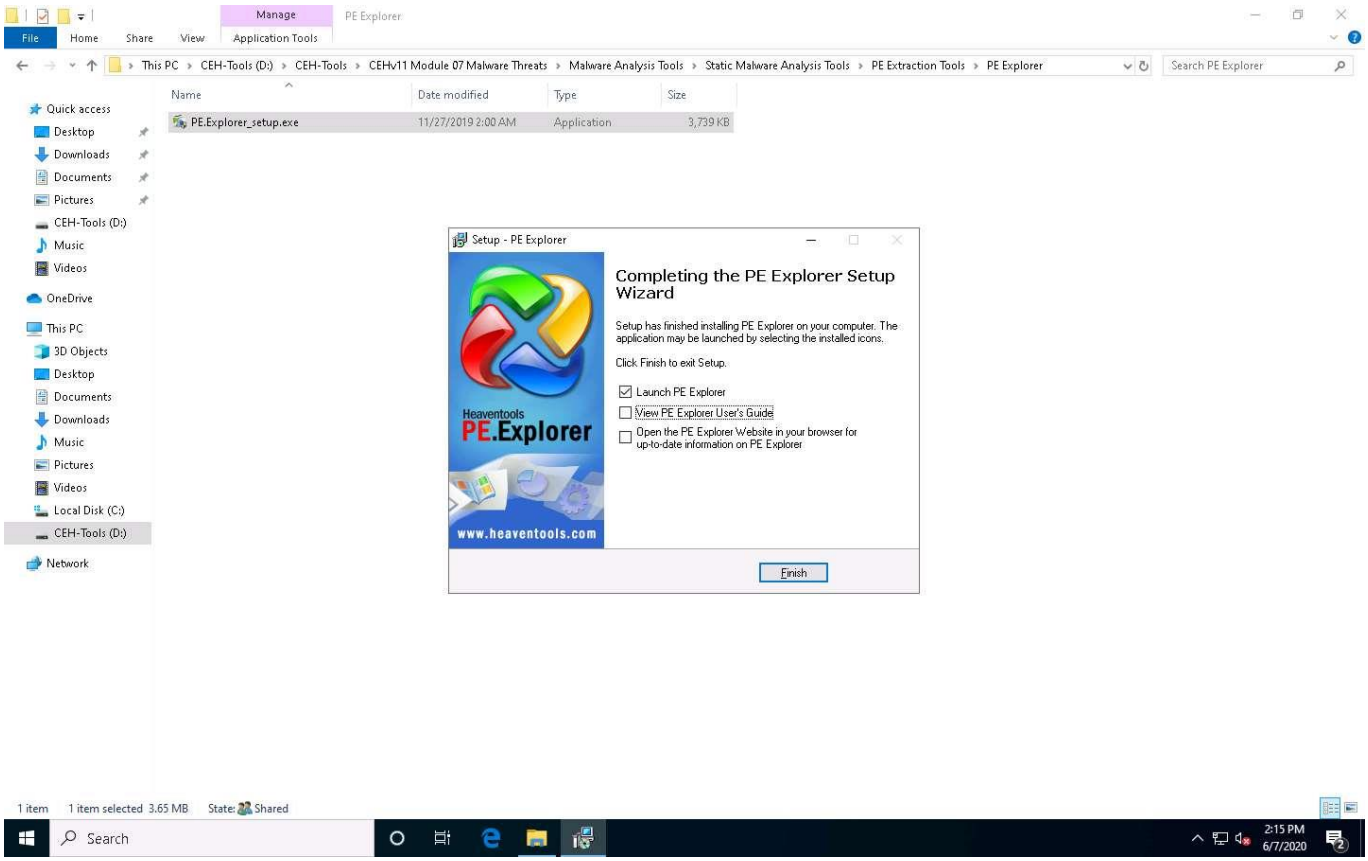
Task 4: Find the Portable Executable (PE) Information of a Malware Executable File using PE Explorer

The Portable Executable (PE) format is the executable file format used on Windows OSes that stores the information a Windows system requires to manage the executable code. The PE stores metadata about the program, which helps in finding additional details of the file. For instance, the Windows binary is in PE format that consists of information such as time of creation and modification, import and export functions, compilation time, DLLs, and linked files, as well as strings, menus, and symbols.

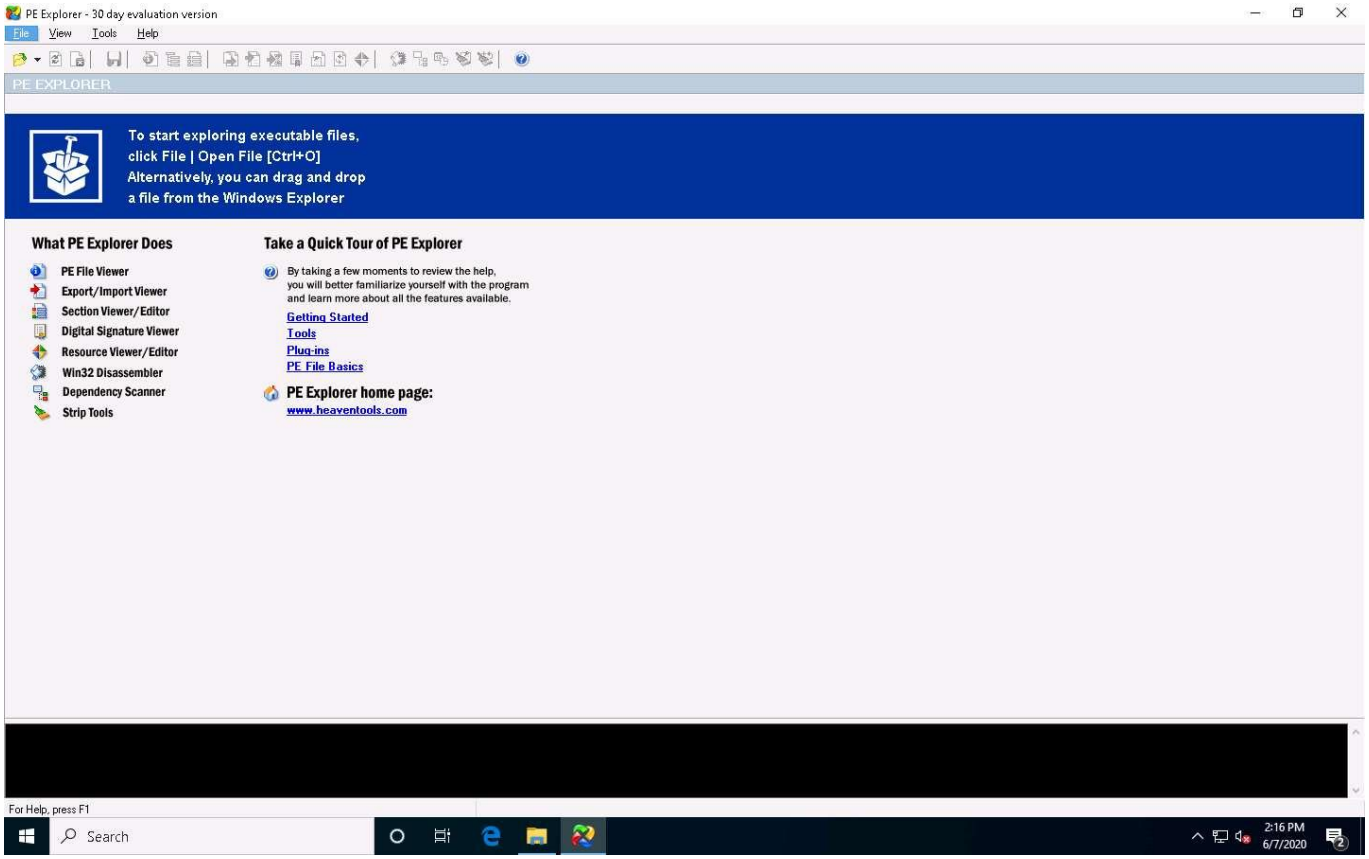
PE Explorer lets you open, view, and edit a variety of different 32-bit Windows executable file types (also called PE files) ranging from common such as EXE, DLL, and ActiveX Controls to less familiar types such as SCR (Screensavers), CPL (Control Panel Applets), SYS, MSSTYLES, BPL, DPL, and more (including executable files that run on MS Windows Mobile platform).

Here, we will use the PE Explorer tool to view the PE information of a malware executable file.

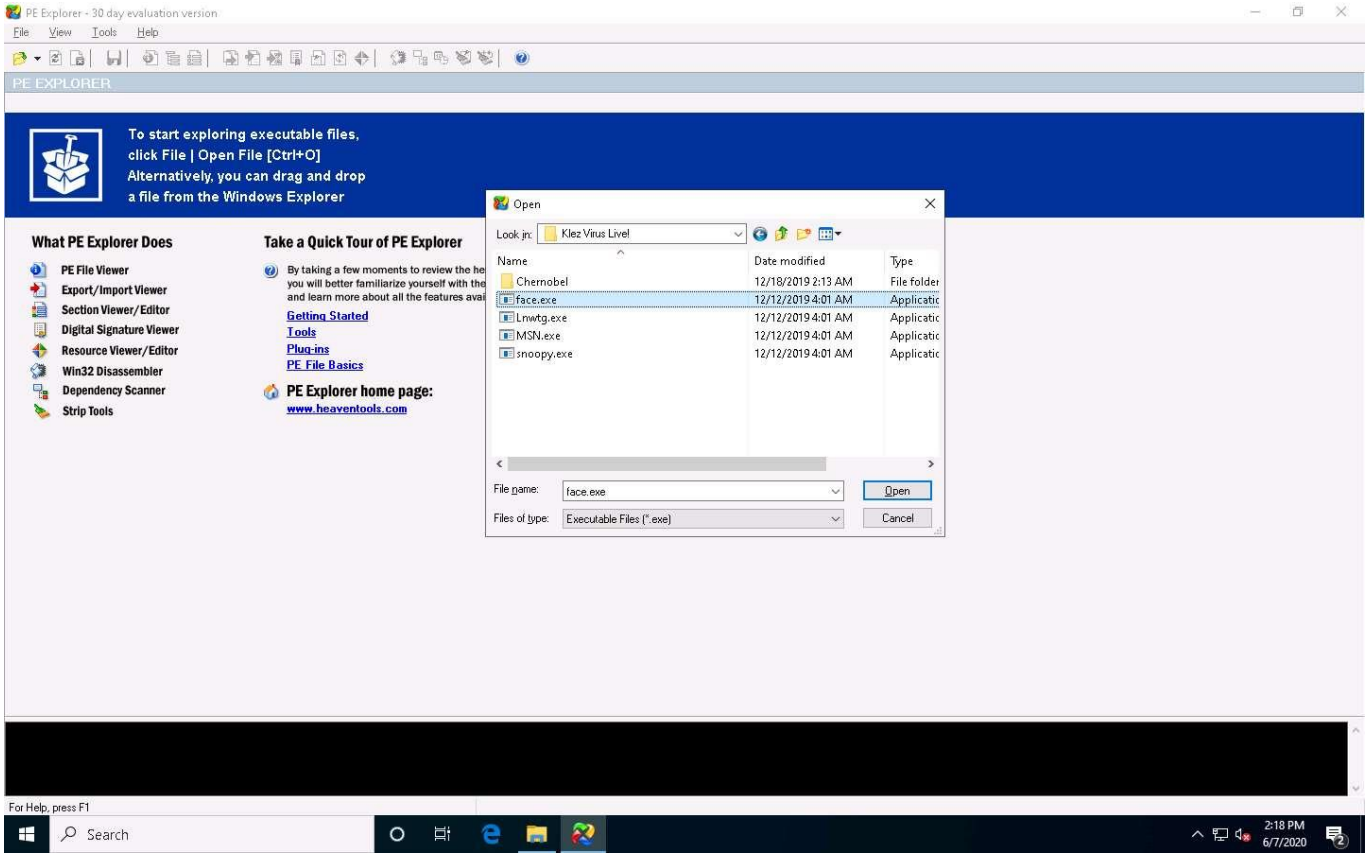
1. On the **Windows 10** machine, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\PE Extraction Tools\PE Explorer** and double-click **PE.Explorer_setup.exe**.
2. If a **User Account Control** pop-up appears, click **Yes**.
3. Follow the wizard-driven installation steps to install PE Explorer.
4. In the last step of the installation, make sure that the **Launch PE Explorer** option is checked to launch the application automatically; uncheck the **View PE Explorer User's Guide** option and click **Finish**.



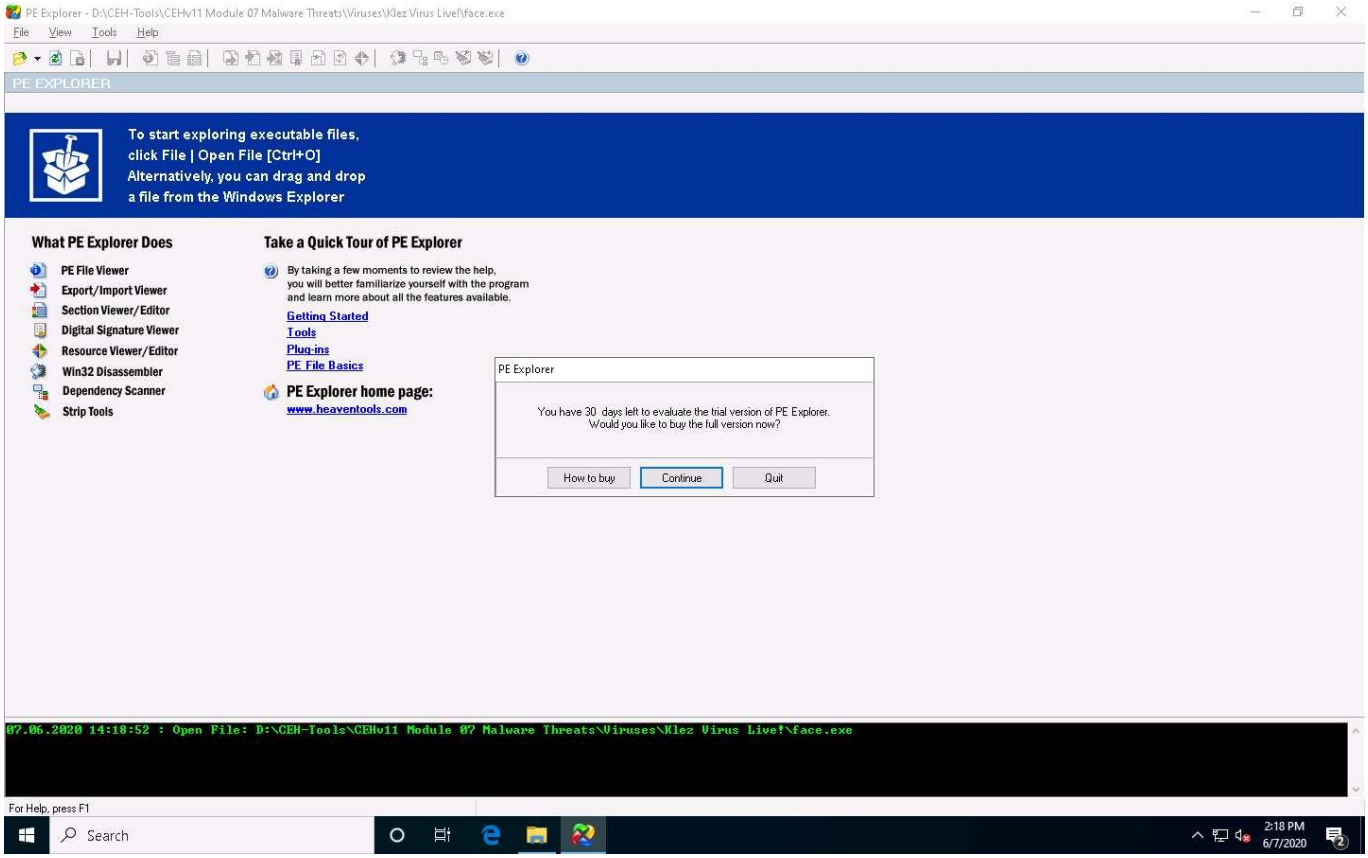
5. The **PE Explorer** main window appears. Navigate to **File** and click **Open File** from the menu to start exploring executable files. You can drag and drop the file into the PE Explorer window.



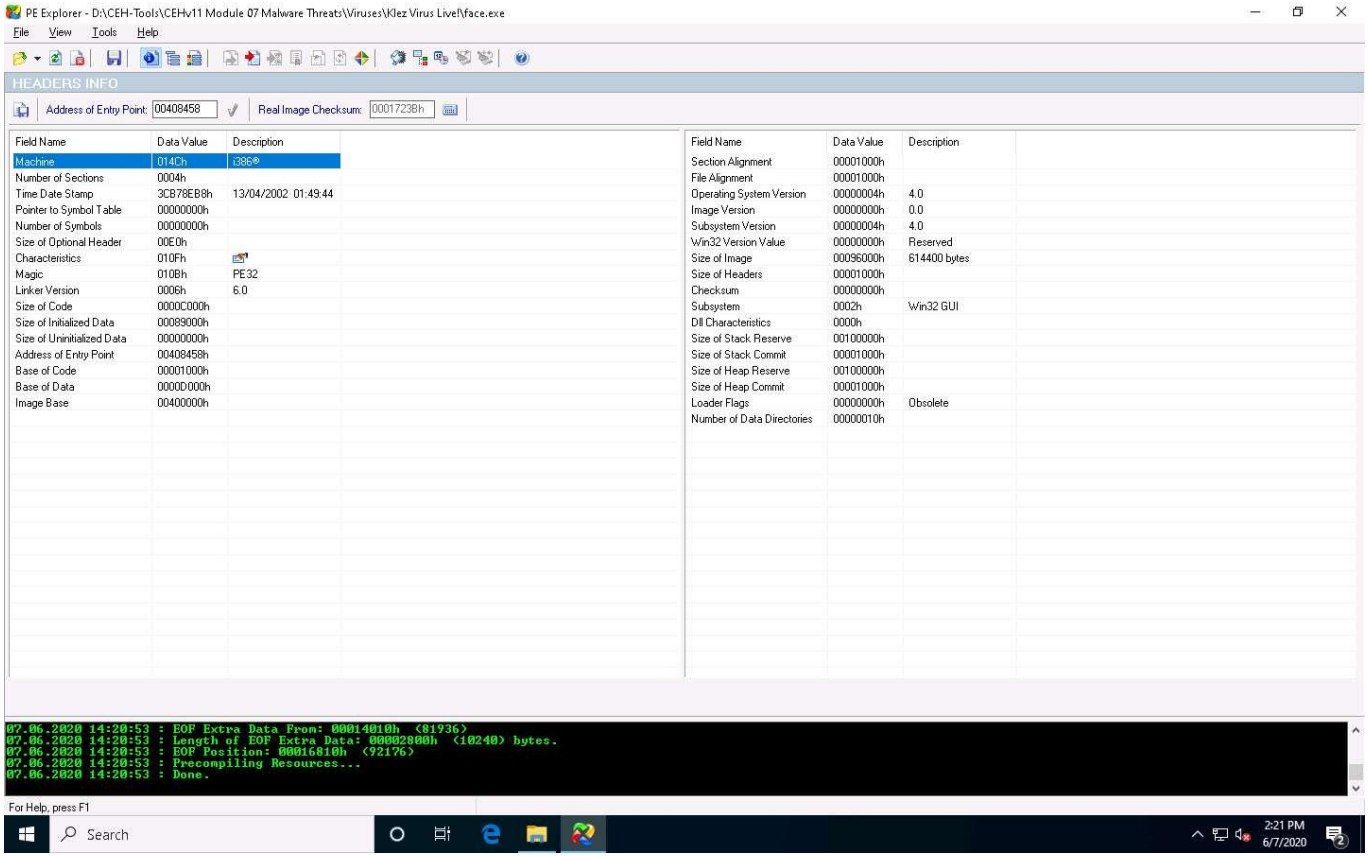
6. An **open** window appears; navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses\Klez Virus Live!**. Select the **face.exe** file and click **Open**.



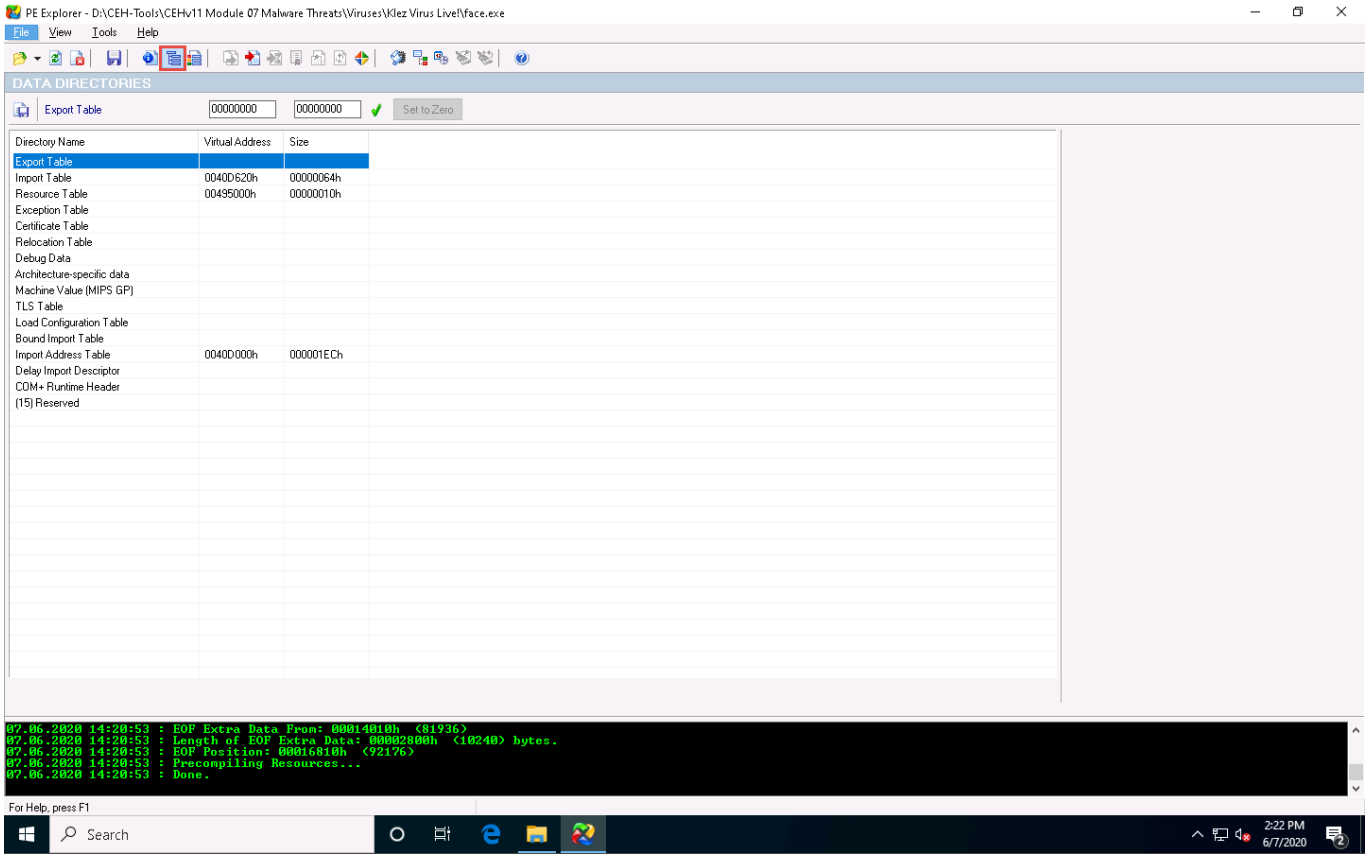
7. The **PE Explorer** evaluation pop-up appears; click **Continue**.



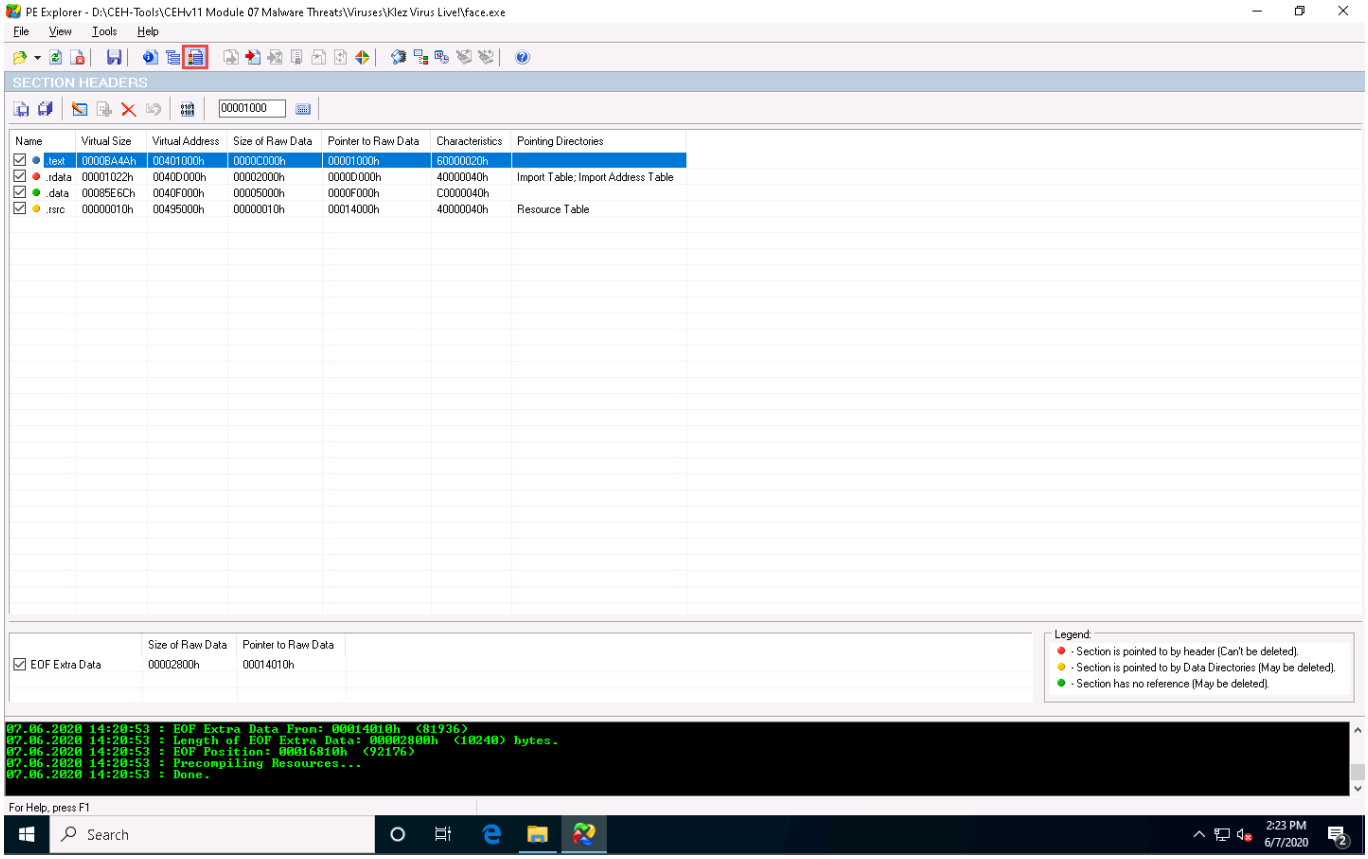
8. PE Explorer provides you with an analysis of the file, as shown in the screenshot.
9. The **HEADERS INFO** section provides you with the ability to:
   - View and save a text report on the file headers information
   - Modify the entry point value
   - Updates the value of the checksum in the header
   - Set flag bits in the file header characteristics field



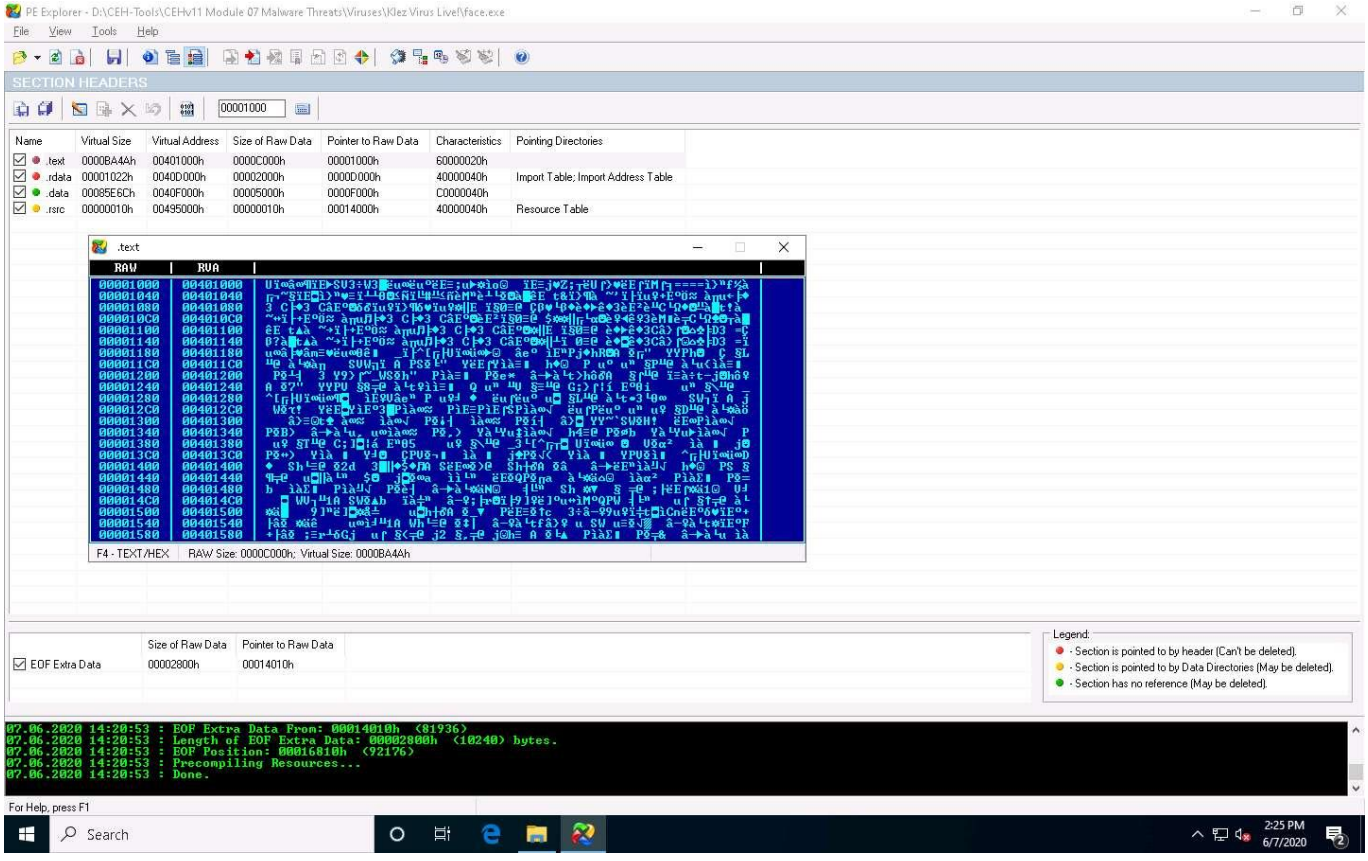
10. ☐ Click the **Data Directories** icon from the menu bar. This will provide you with the **DATA DIRECTORIES** information such as the ability to view and edit the virtual address and size of the chosen directory describing provisions of parts of the code.
11. ☐ The trailing array of Data Directories cover pointers to the data in the sections.



12. Click **Section Headers** icon from the menu bar. This will provide you with the **SECTION HEADERS** information, allowing you to view all sections and information about their location and size.



13. Double click on any section to view the raw content. This will open a mini hex viewer window.
14. Close the hex viewer window after analysis.



15. This is how to analyze a malicious file using PE Explorer. Close all open windows.
16. You can also use other PE extraction tools such as **Portable Executable Scanner** (**pescan**) (https://tzworks.net), **Resource Hacker** (http://www.angusj.com), or **PEView** (https://www.aldeid.com) to find the Portable Executable (PE) information of a malware executable file.

Task 5: Identify File Dependencies using Dependency Walker

Any software program depends on the various inbuilt libraries of an OS that help in performing specified actions in a system. Programs need to work with internal system files to function correctly. Programs store their import and export functions in a kernel32.dll file. File dependencies contain information about the internal system files that the program needs to function properly; this includes the process of registration and location on the machine.

Find the libraries and file dependencies, as they contain information about the run-time requirements of an application. Then, check to find and analyze these files to provide information about the malware in the file. File dependencies include linked libraries, functions, and function calls. Check the dynamically linked list in the malware executable file. Finding out all library functions may allow guessing about what the malware program can do. You should know the various DLLs used to load and run a program.

Some of the standard DLLs are:

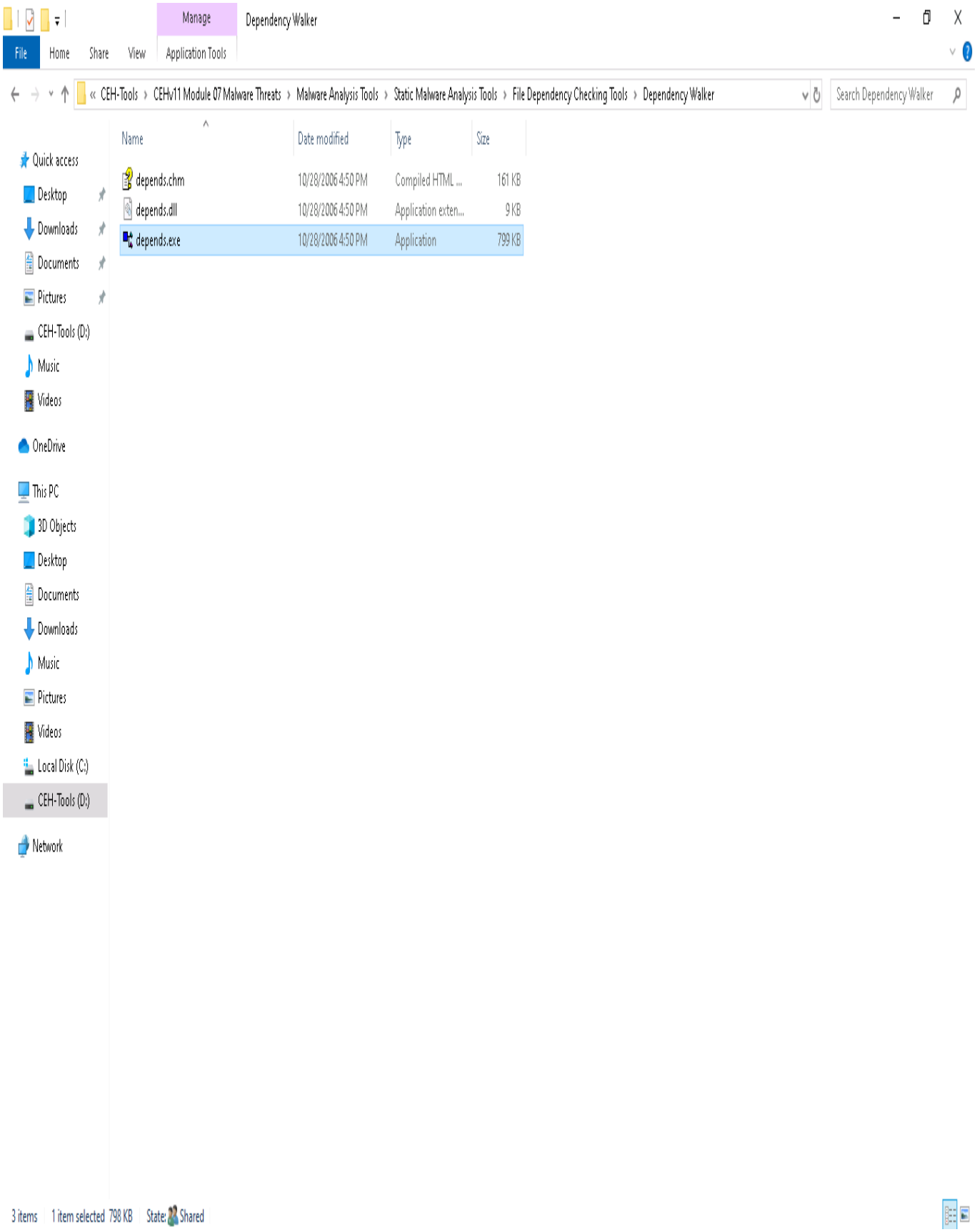
DLLs	Description of contents
Kernel32.dll	Core functionality such as access and manipulation of memory, files, and hardware
Advapi32.dll	Provides access to advanced core Windows components such as the Service Manager and Registry
User32.dll	User-interface components such as buttons, scrollbars, and components for controlling and responding to user actions
Gdi32.dll	Functions for displaying and manipulating graphics
Ntdll.dll	Interface to the Windows kernel
WSock32.dll and Ws2_32.dll	Networking DLLs that help to connect to a network or perform network-related tasks
Wininet.dll	Supports higher-level networking functions

The Dependency Walker tool lists all dependent modules of an executable file and builds hierarchical tree diagrams. It also records all functions that each module exports and calls. Further, it detects many common

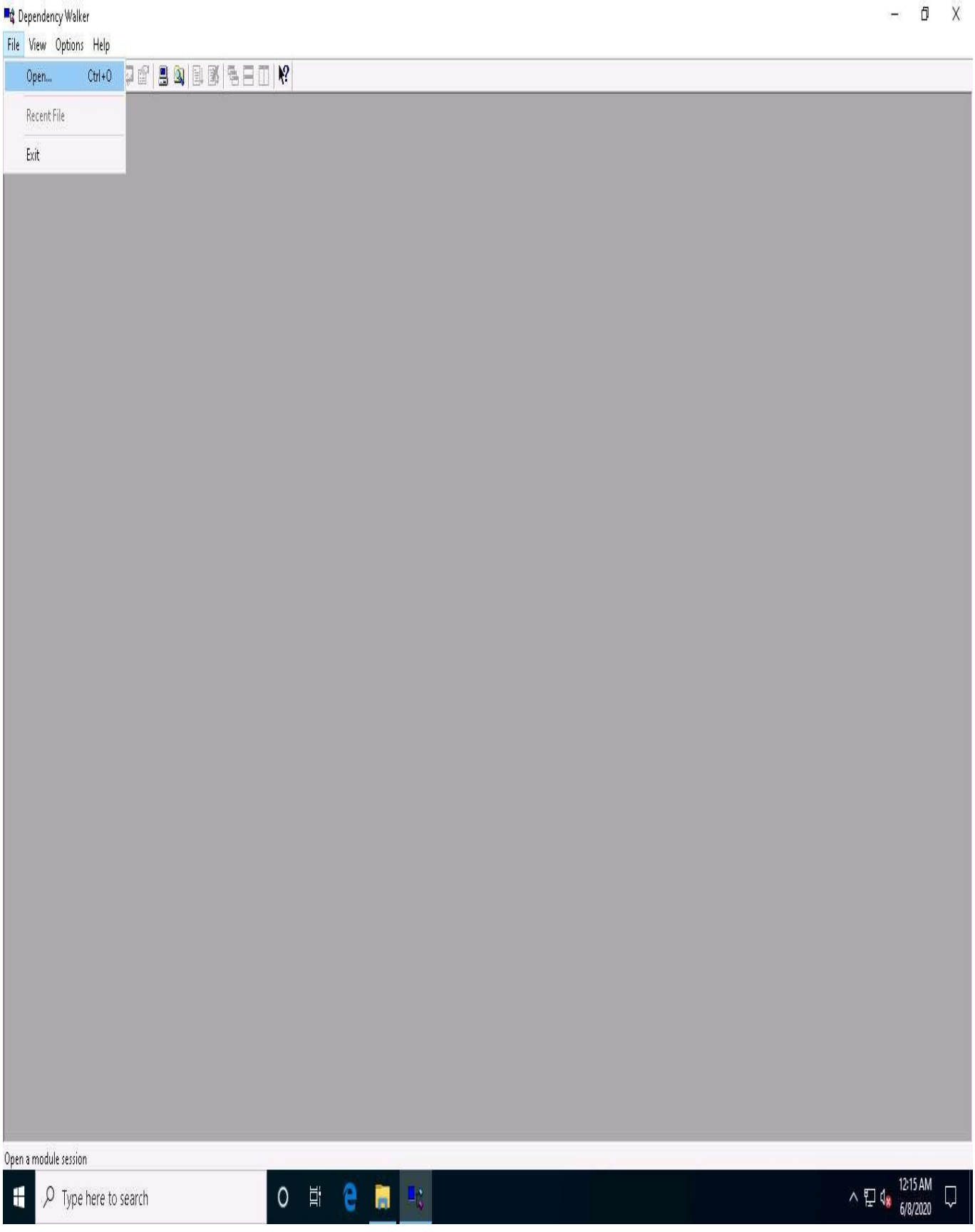
application problems such as missing and invalid modules, import and export mismatches, circular dependency errors, mismatched machine modules, and module initialization failures.

Here, we will use the Dependency Walker tool to identify the file dependencies of an executable file.

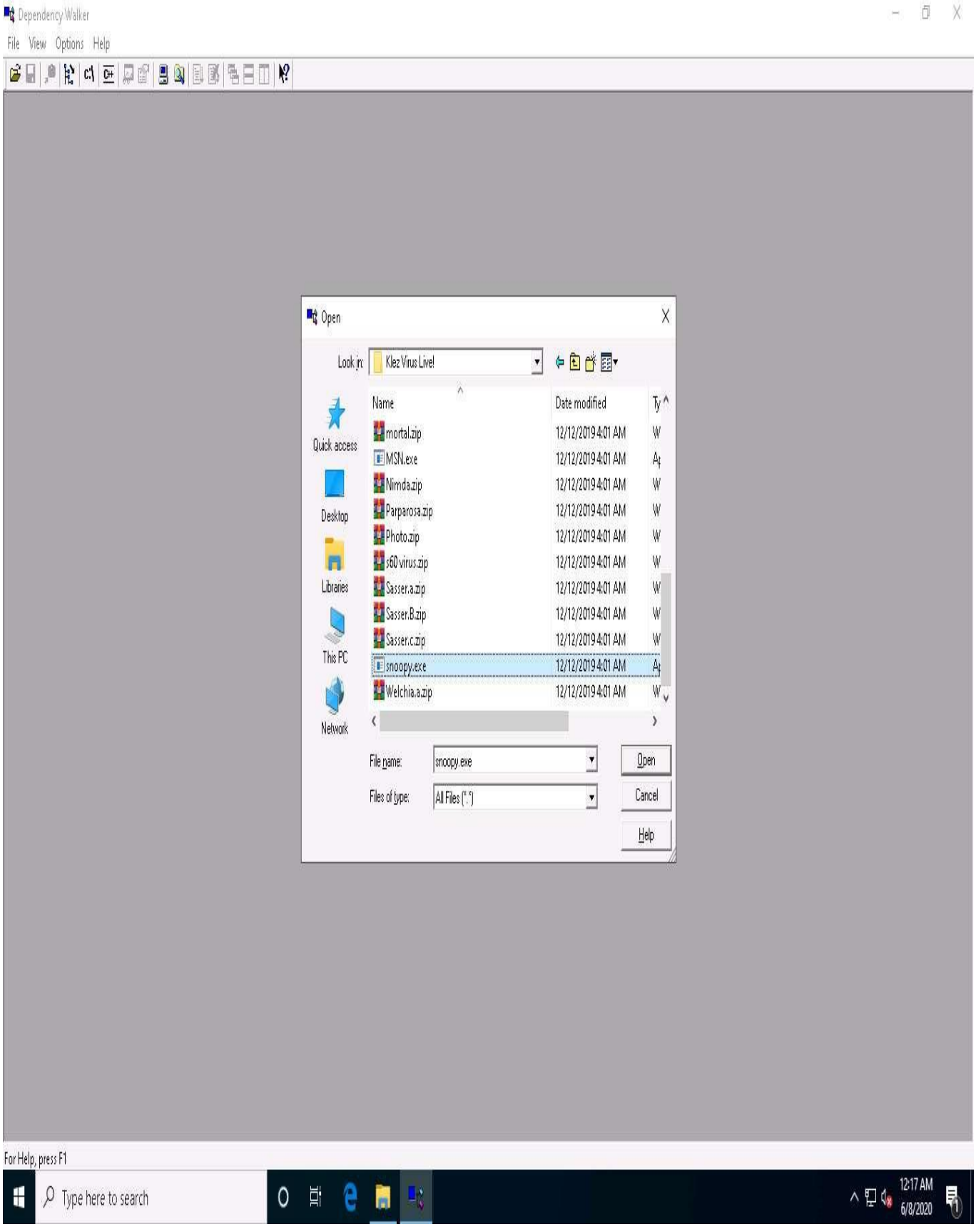
1. On the **Windows 10** machine, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\File Dependency Checking Tools\Dependency Walker**, and double-click **depends.exe**.



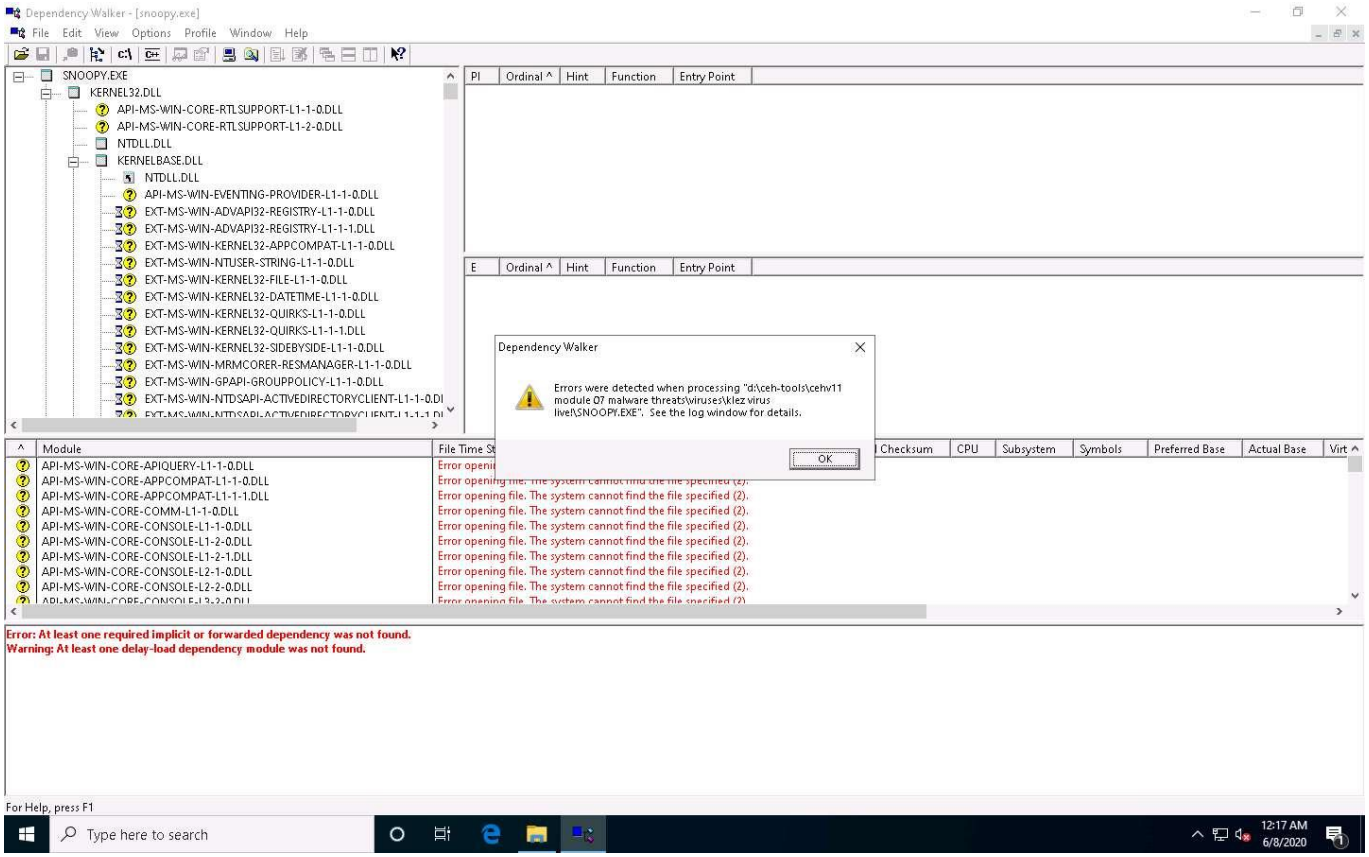
2. The **Dependency Walker** main window appears; navigate to **File** and click **Open** to import the malicious file.



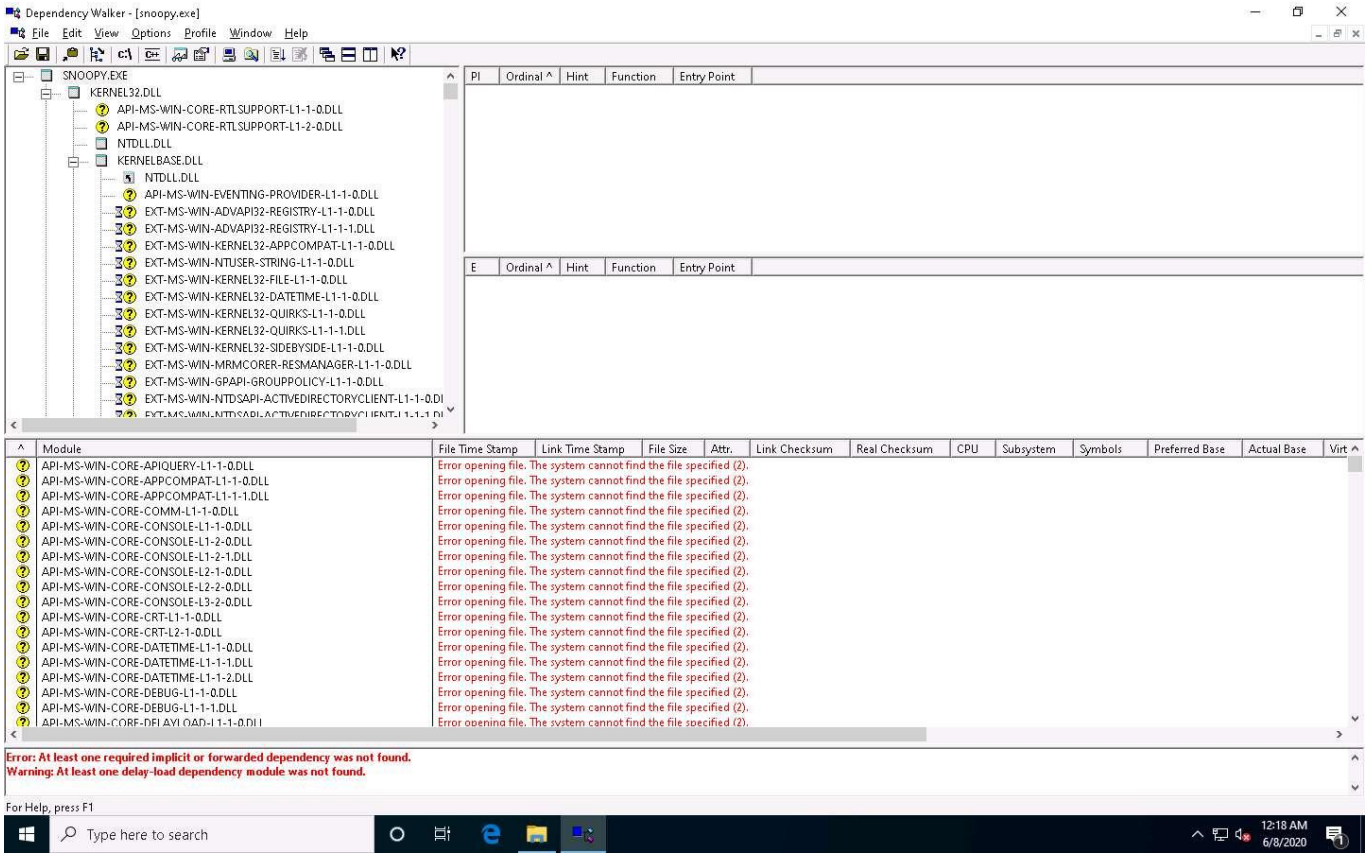
3. ☐ The **open** window appears; navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses\Klez Virus Live!**. Select the **snoopy.exe** file and click **Open**.



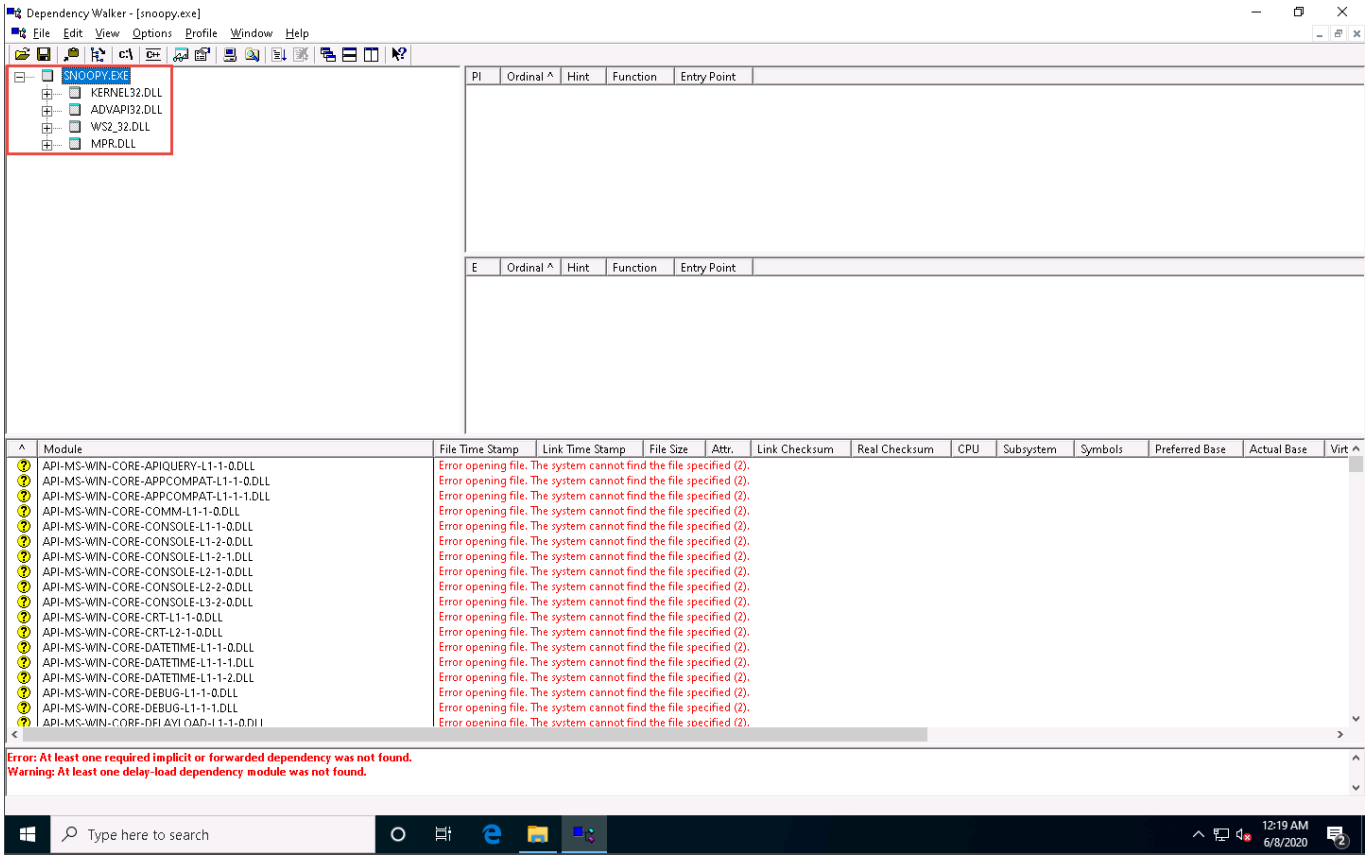
4. ☐ The **Dependency Walker** pop-up appears, along with the error detected while processing the file; click **OK**.



5. The **SNOOPY.EXE** file is imported to the Dependency Walker, as shown in the screenshot.
6. Shrink the **.DLL** nodes to view all available DLLs for the malicious file.

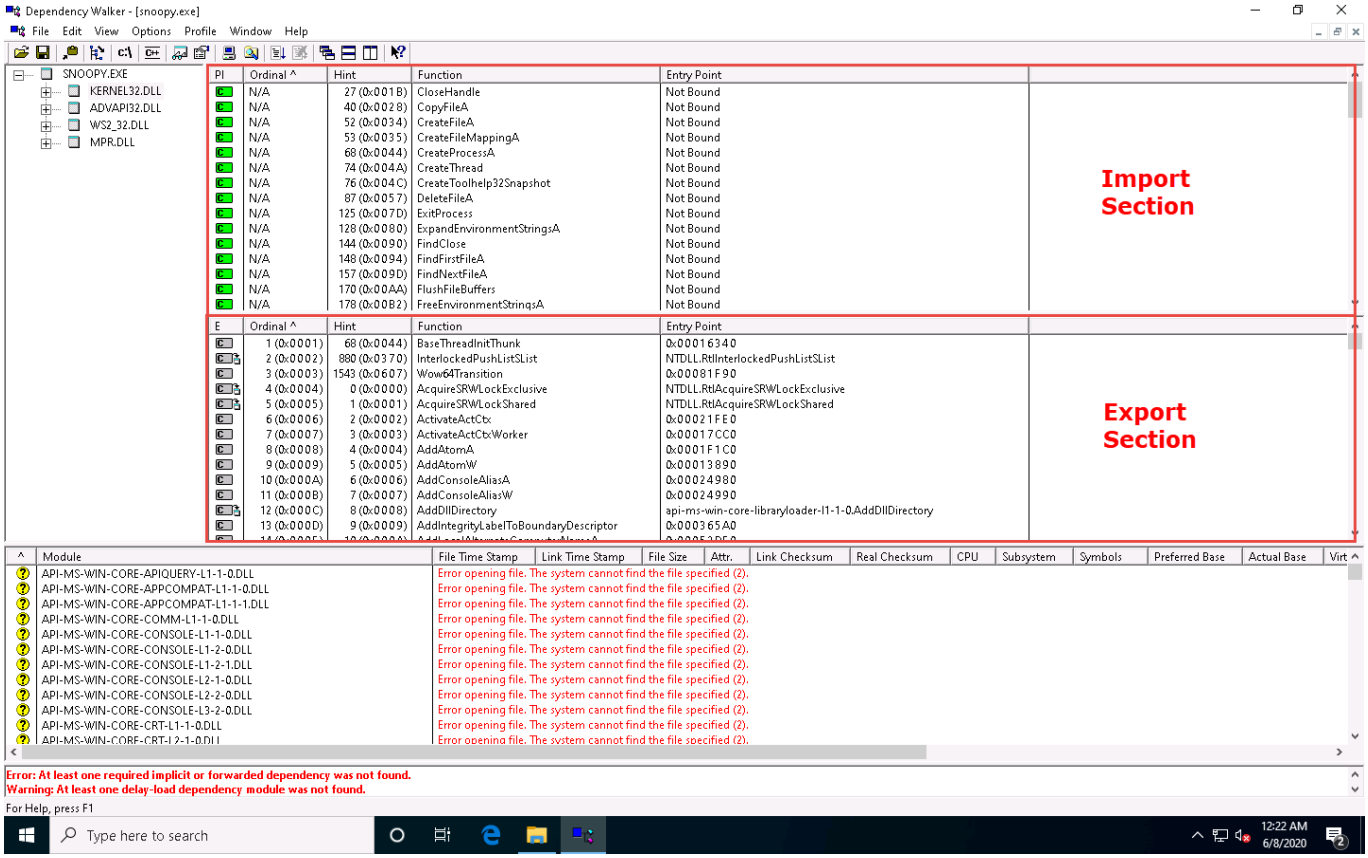


7. The available DLLs for snoopy.exe are listed, as shown in the screenshot.



8. Click on any DLL dependency to view the details of the DLL file. In this lab, we are choosing **KERNEL32.DLL**.

9. As soon as you select the DLL, the Dependency Walker displays the DLL details in the **Import Section** and **Export Section**, as shown in the screenshot.



10. Analyze all DLL dependencies of the imported malicious file. Close all open windows once the analysis is complete.
11. You can also use other dependency checking tools such as **Dependency-check** (https://jeremylong.github.io), **Snyk** (https://snyk.io), **Hakiri** (https://hakiri.io), or **RetireJS** (https://retirejs.github.io) to identify file dependencies.

Task 6: Perform Malware Disassembly using IDA and OllyDbg

Static analysis also includes the dismantling of a given executable into binary format to study its functionalities and features. This process helps identify the language used for programming the malware, look for APIs that reveal its function, and retrieve other information. Based on the reconstructed assembly code, you can inspect the program logic and recognize its threat potential. This process uses debugging tools such as IDA Pro and OllyDbg.

IDA As a disassembler, IDA explores binary programs, for which the source code might not be available, to create maps of their execution. The primary purpose of a disassembler is to display the instructions actually executed by the processor in a symbolic representation called "assembly language." However, in real life, things are not always simple. Hostile code usually does not cooperate with the analyst. Viruses, worms, and Trojans are often armored and obfuscated; as such, more powerful tools are required. The debugger in IDA complements the static analysis capabilities of the disassembler. By allowing an analyst to single-step through the code being investigated, the debugger often bypasses the obfuscation. It helps obtain data that the more powerful static disassembler will be able to process in depth.

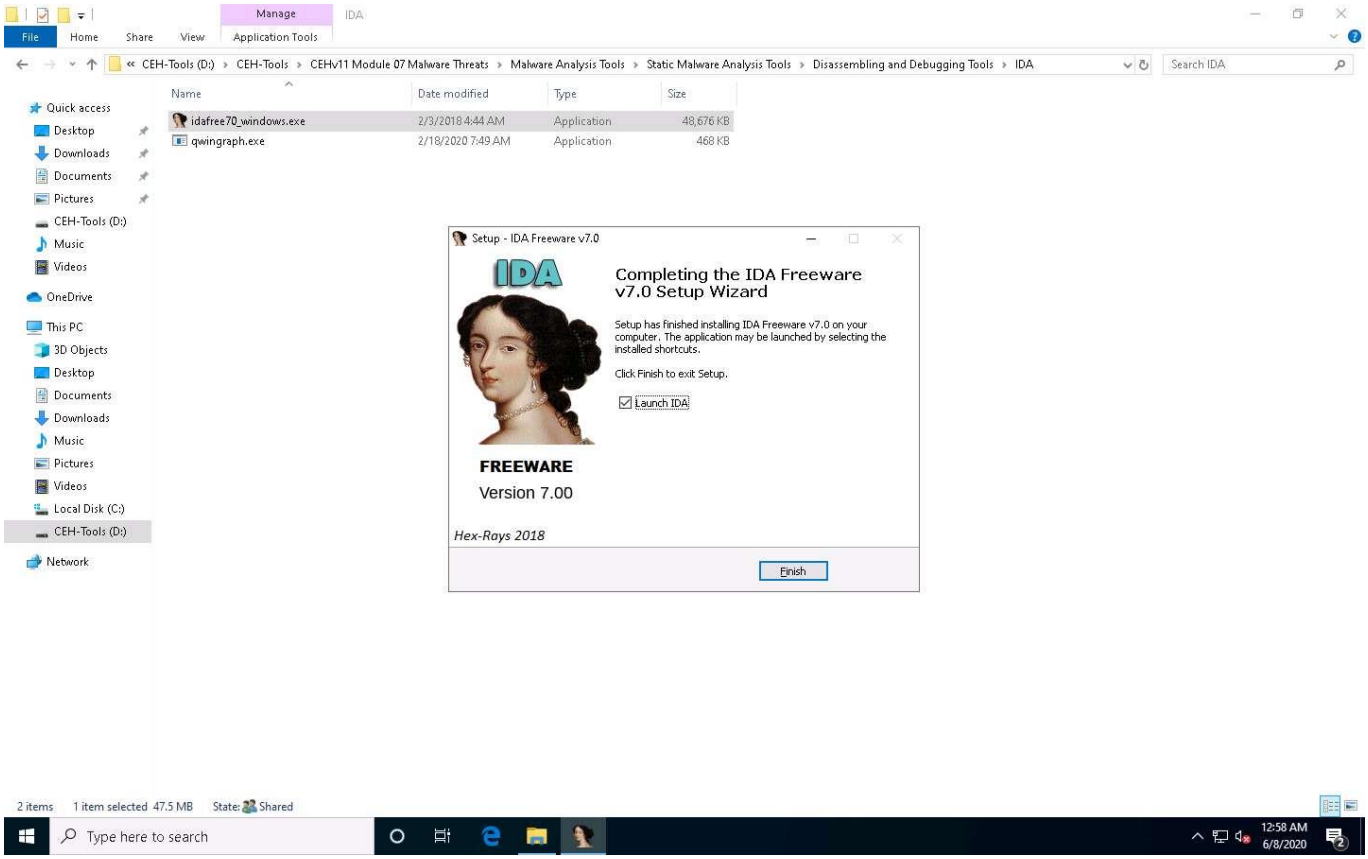
OllyDbg OllyDbg is a debugger that emphasizes binary code analysis, which is useful when source code is unavailable. It traces registers, recognizes procedures, API calls switches, tables, constants, and strings, and locates routines from object files and libraries.

There is a new debugging option, "Set permanent breakpoints on system calls." When active, it requests OllyDbg to set breakpoints on KERNEL32.UnhandledExceptionFilter(), NTDLL.KiUserExceptionDispatcher(), NTDLL.ZwContinue(), and NTDLL.NtQueryInformationProcess().

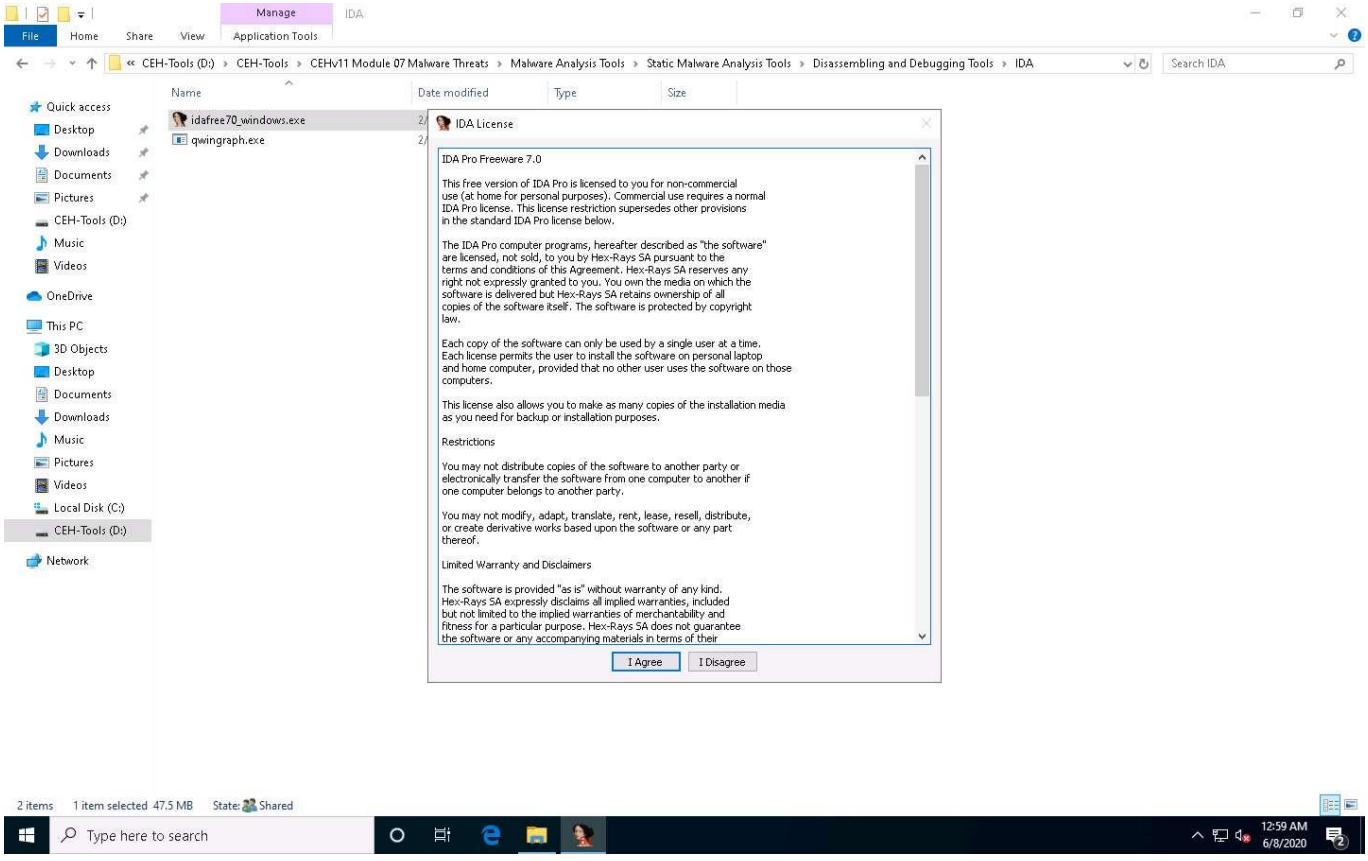
1. On the **Windows 10** machine, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\Disassembling and Debugging Tools\IDA** and double-click **idafree70_windows.exe**.
2. If a **User Account Control** window appears, click **Yes**.

   If an **Open File - Security Warning** pop-up appears, click **Run**.

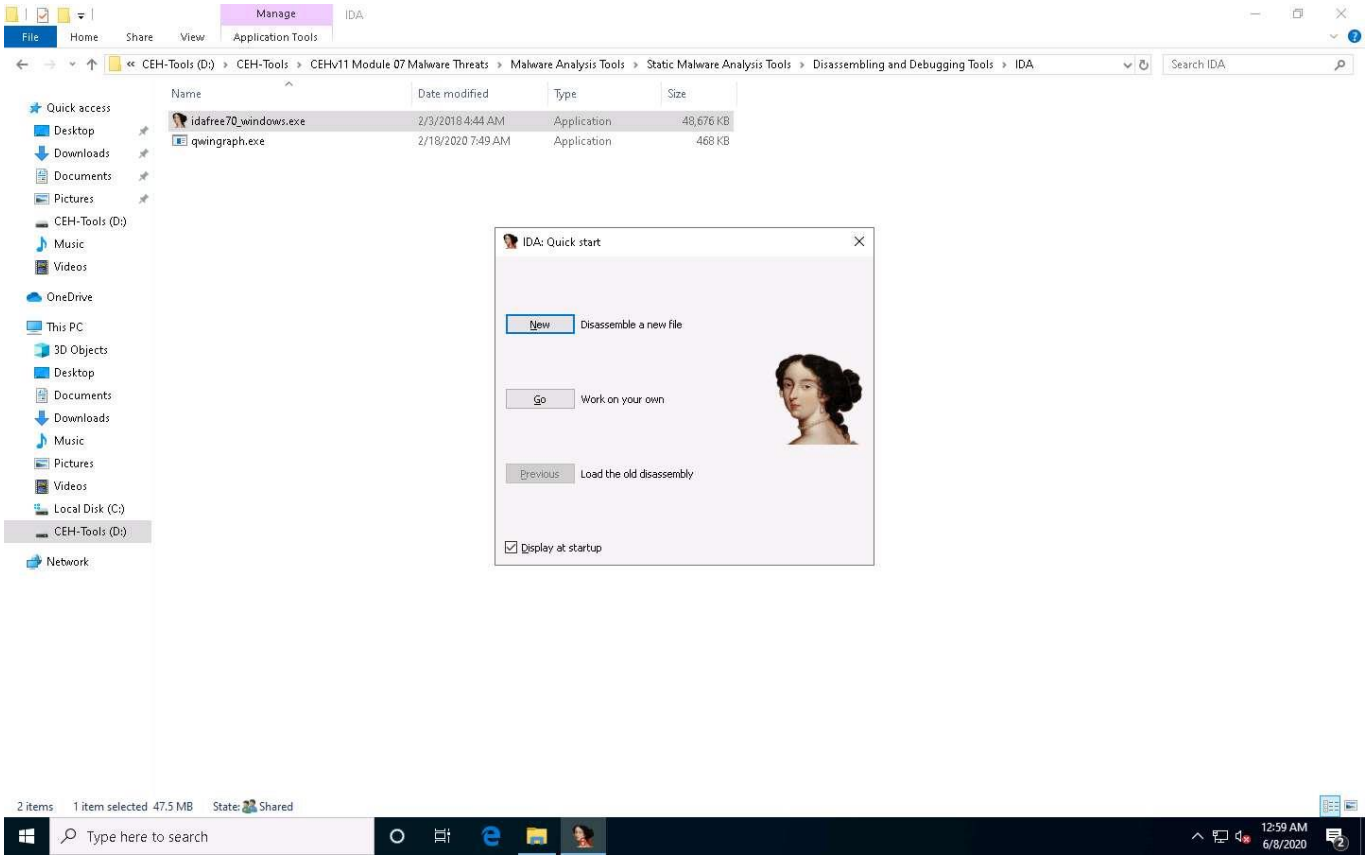
3. The IDA installation wizard appears; follow the wizard-driven installation steps to install IDA.
4. In the final step of the installation, ensure that the **Launch IDA** option is checked; this will launch the application automatically once you click **Finish**.



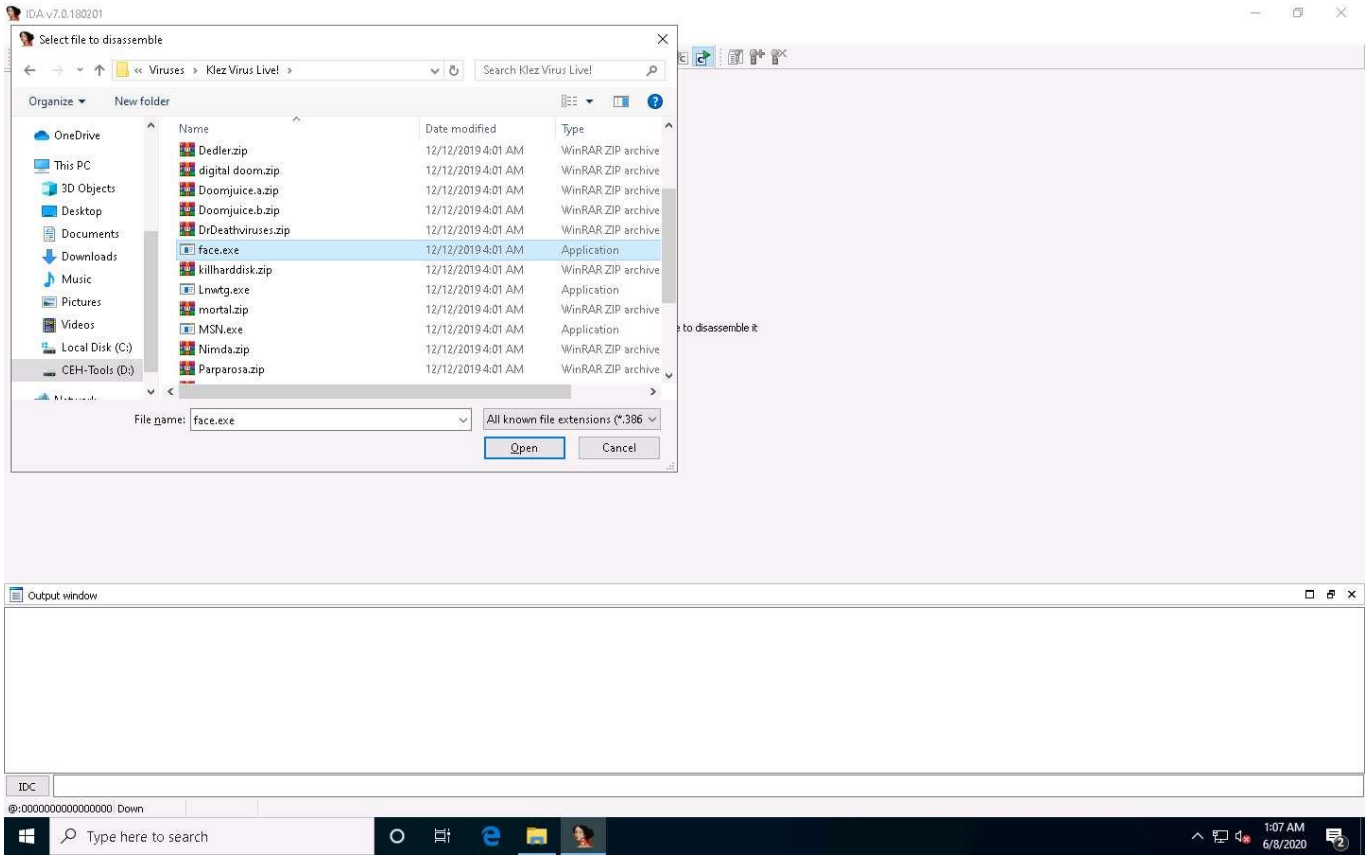
5. If the **IDA License** window appears, click on **I Agree**.



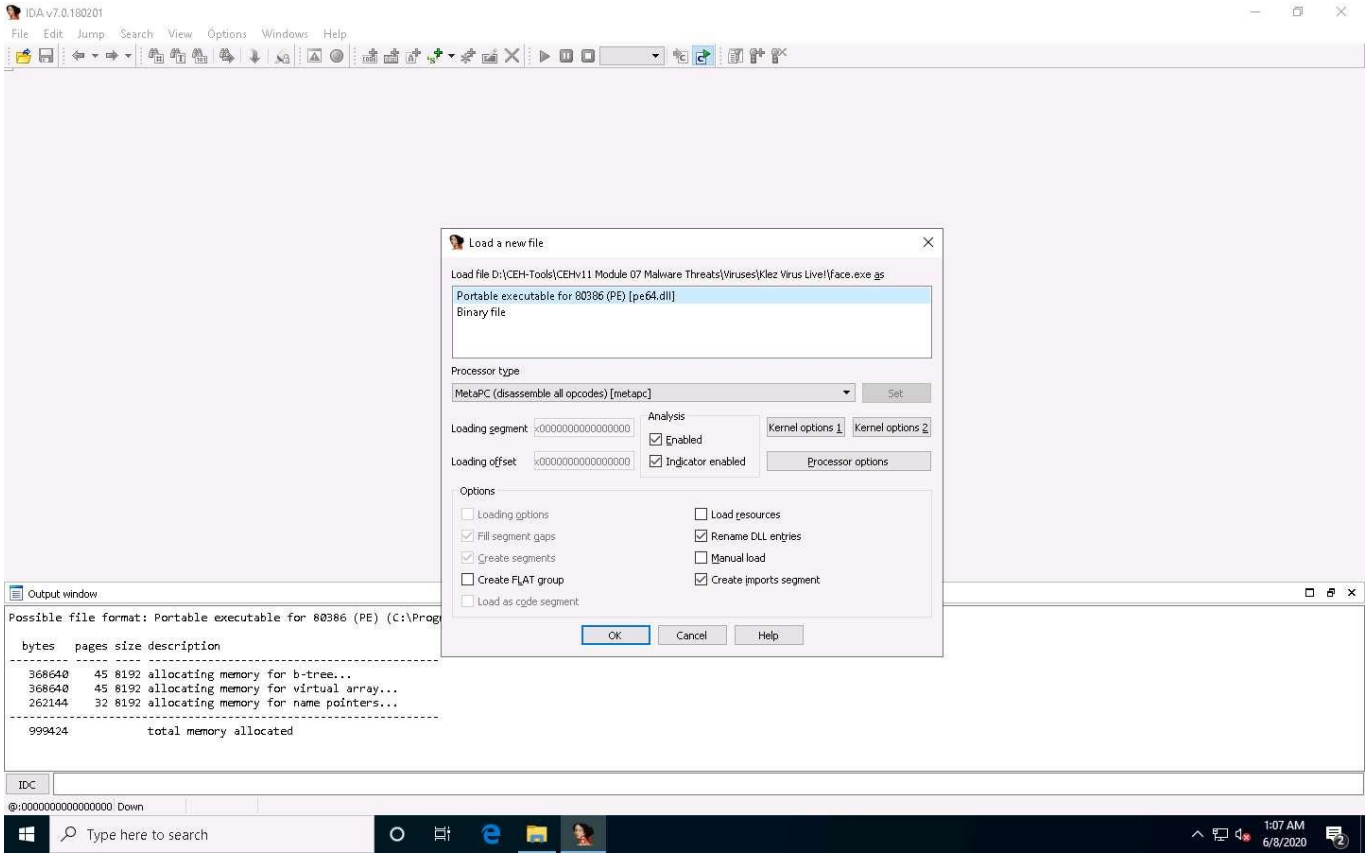
6. The **IDA: Quick start** pop-up appears; click on **New** to select a malicious file for disassembly.



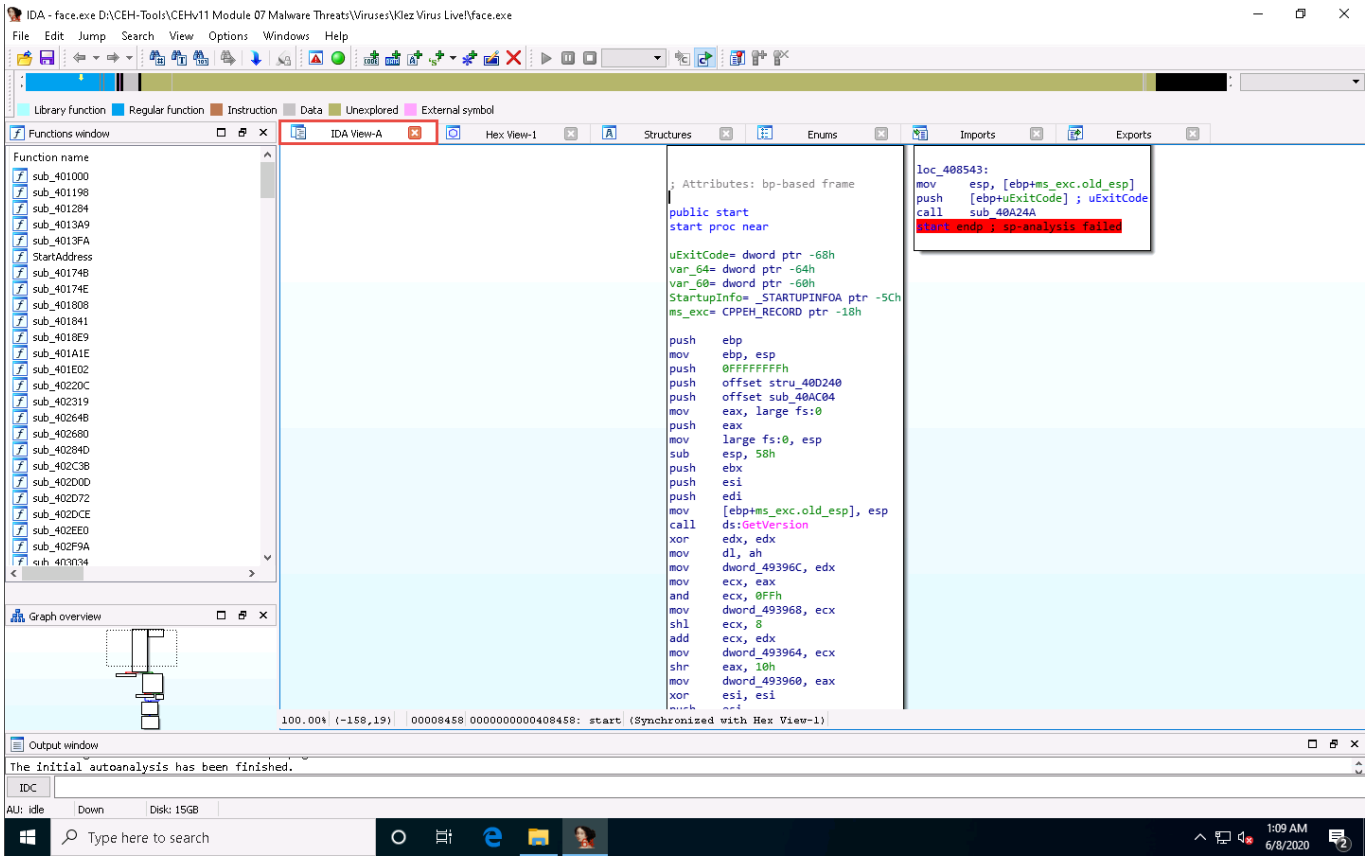
7. ☐ The **IDA** main window appears, along with the **Select file to disassemble** window.
8. ☐ In the **Select file to disassemble** window, navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses\Klez Virus Live!**, select **face.exe**, and click **Open**.



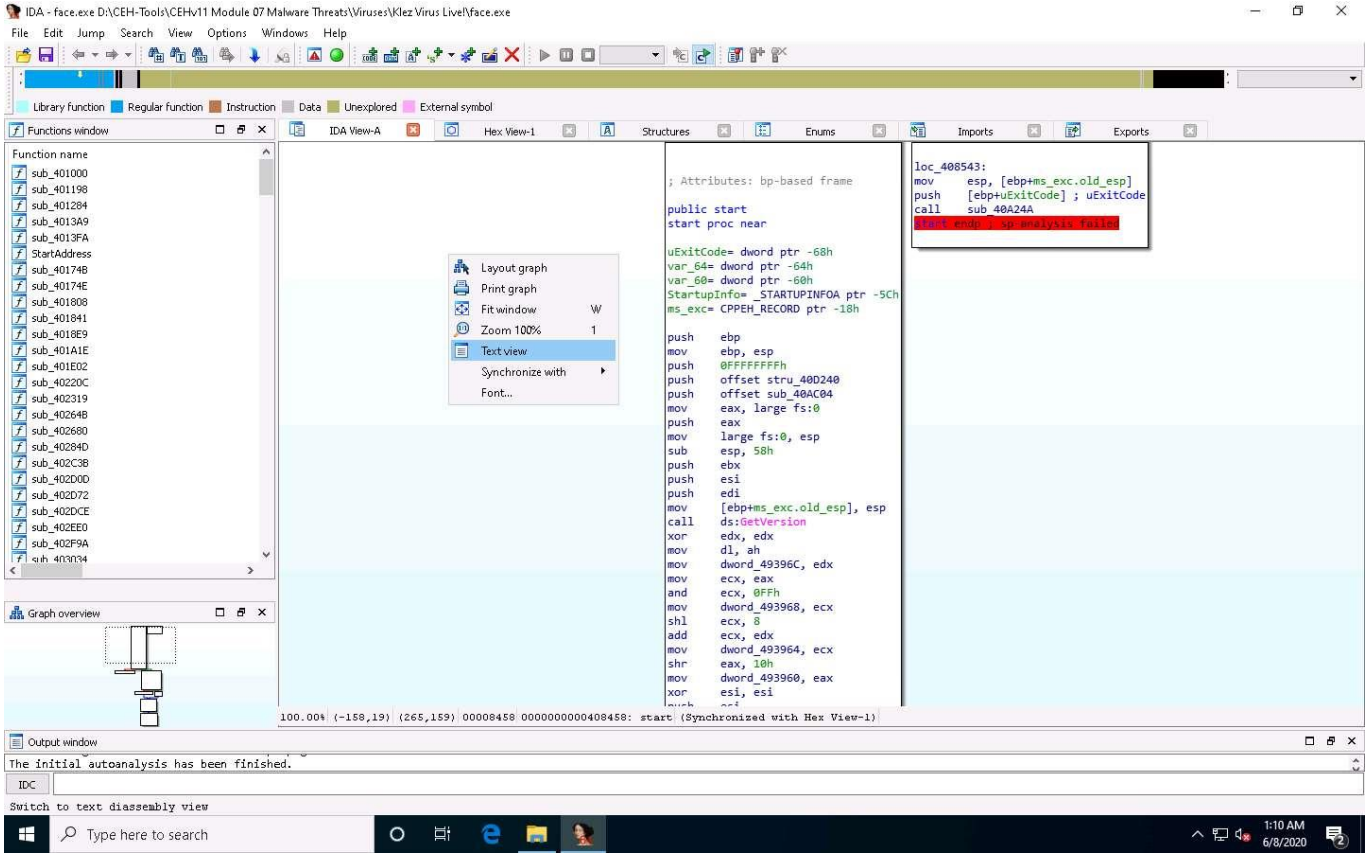
9. ☐ The **Load a new file** window appears; by default, the **Portable executable for 80386 (PE) [pe64.dll]** option selected; click **OK**.



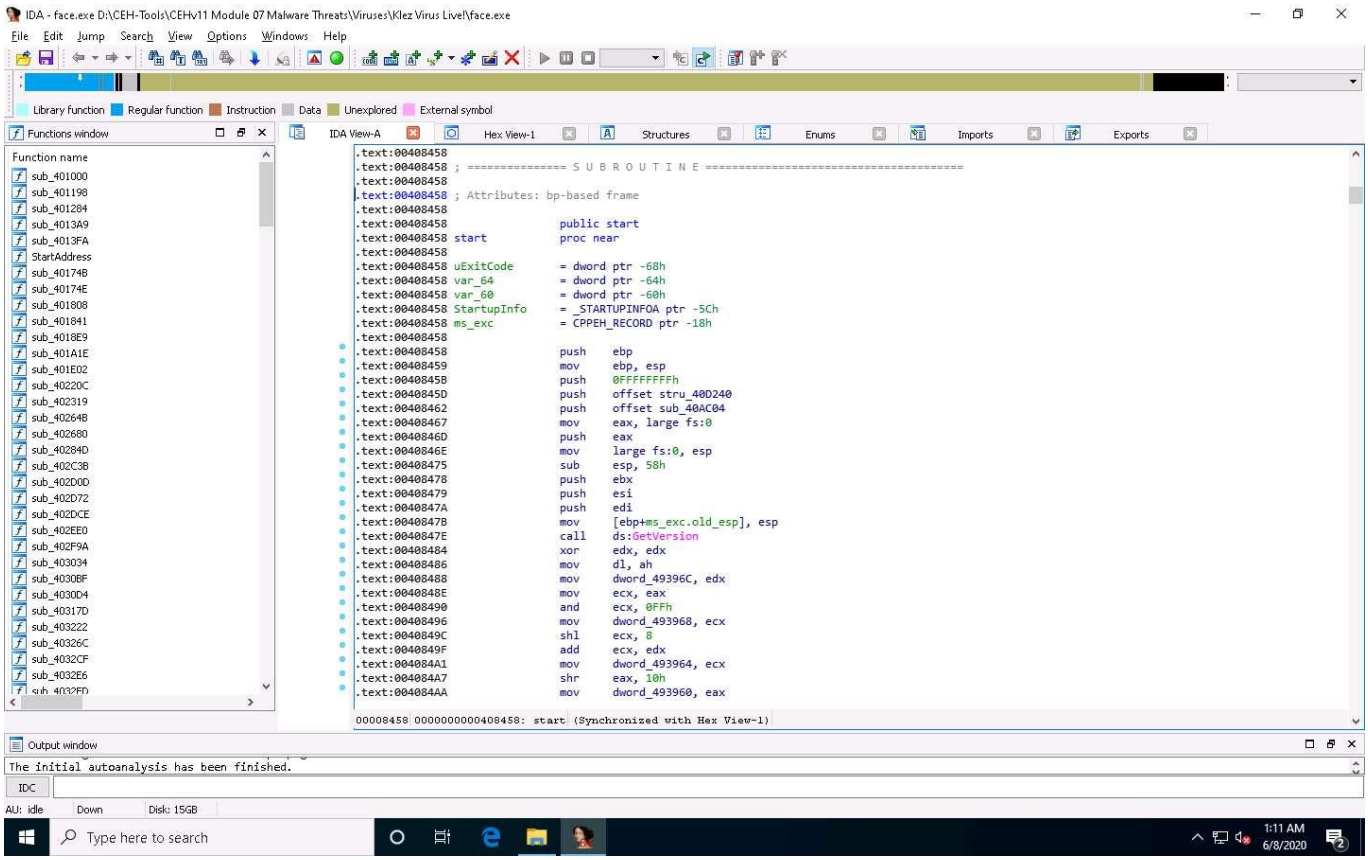
10. If a **Warning** pop-up appears, click **OK**.
11. If a **Please confirm** dialog-box appears, read the instructions carefully, and then click **Yes**.
12. IDA completes the analysis of the imported malicious file and displays the results in the **IDA View-A** tab, as shown in the screenshot.



13. In the **IDA View-A** section, right-click anywhere and choose **Text view** from the context menu to view the text information of the malicious file uploaded to IDA for analysis.



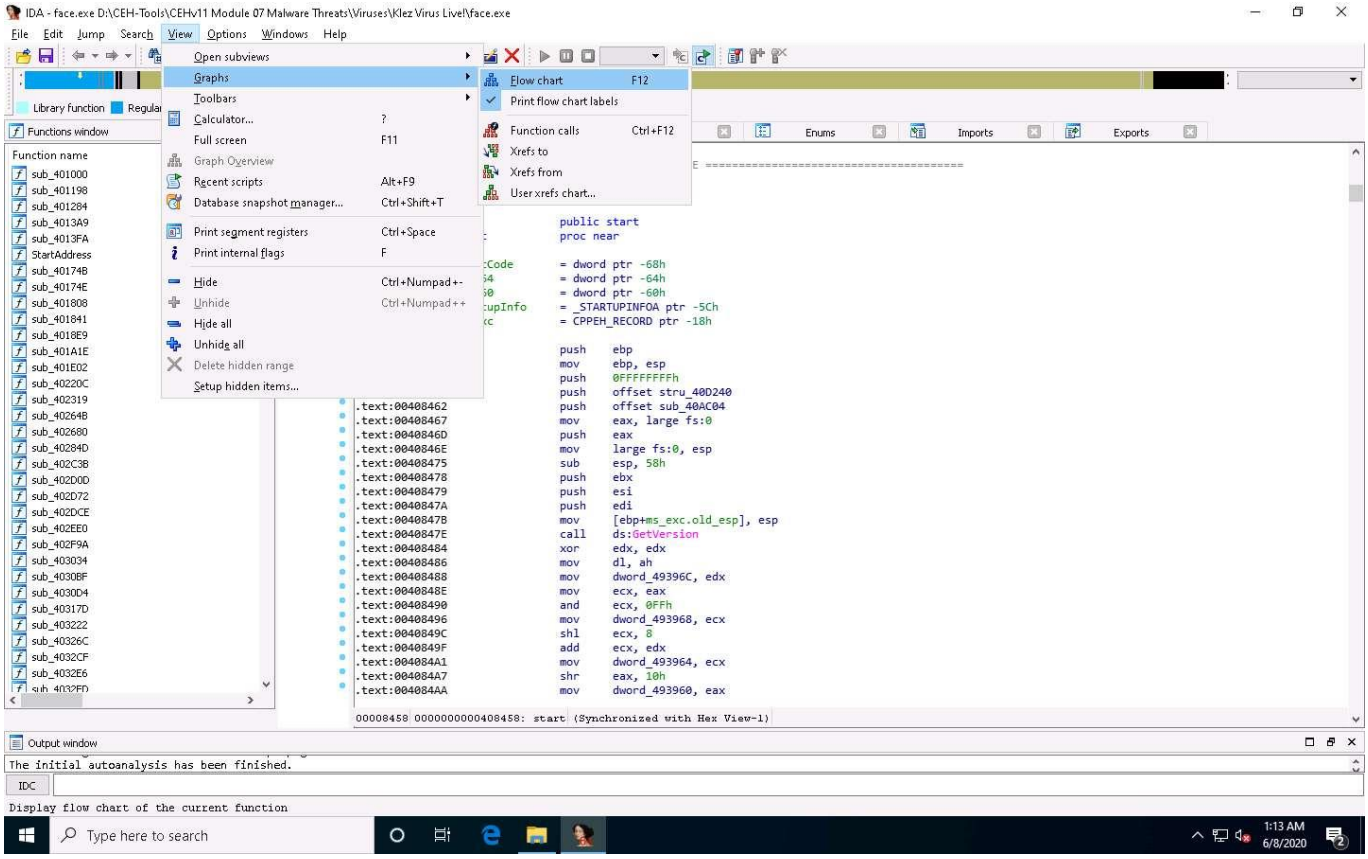
14. This reveals the text view of the malicious file, allowing analysis of its information.



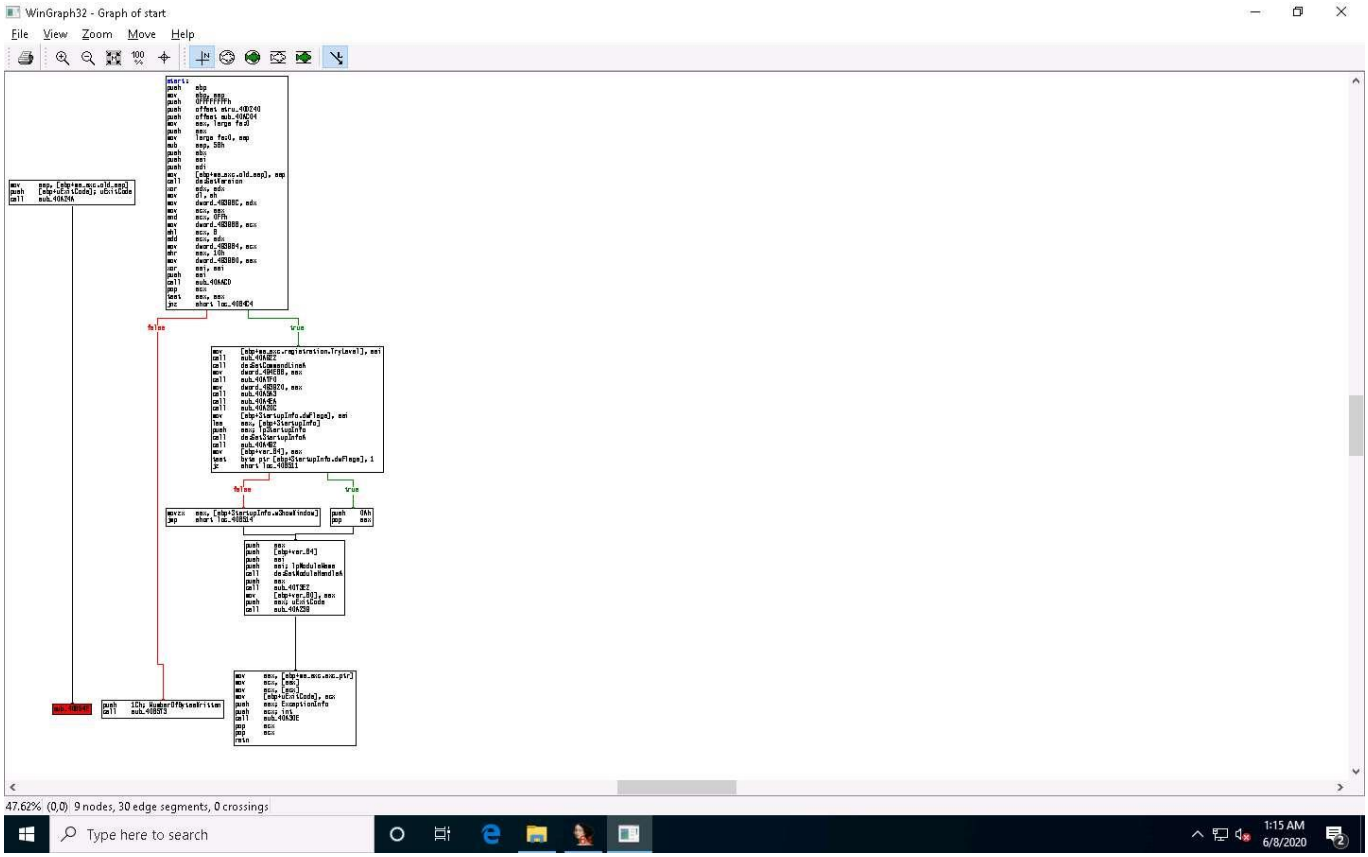
15. Now, minimize the IDA window, and navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\Disassembling and Debugging Tools\IDA**. Copy the **qwingraph.exe** file and paste it in IDA's installation location. In this lab, the location is **C:\Program Files\IDA Freeware 7.0**.

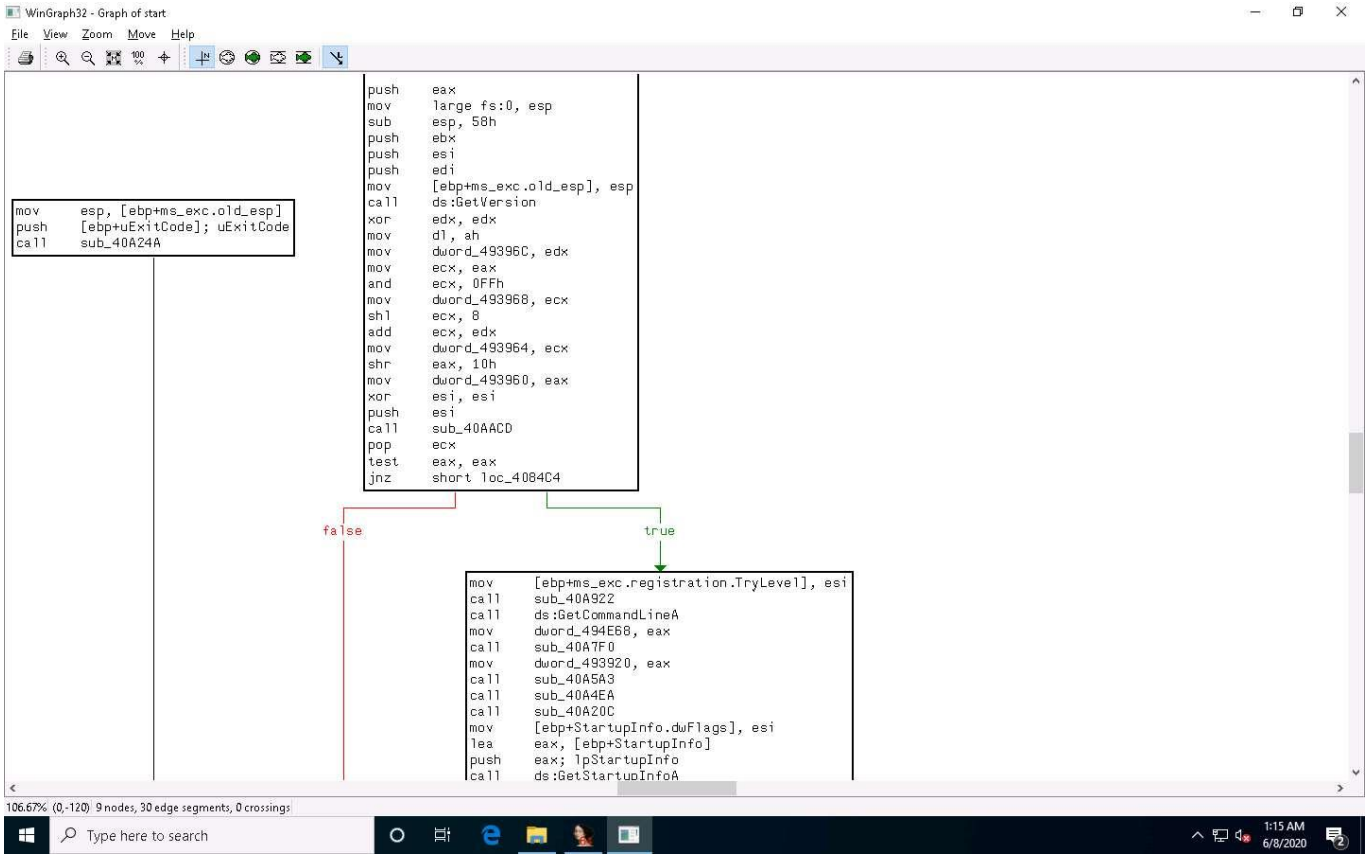
If a **Destination Folder Access** Denied notification appears, click **Continue**.

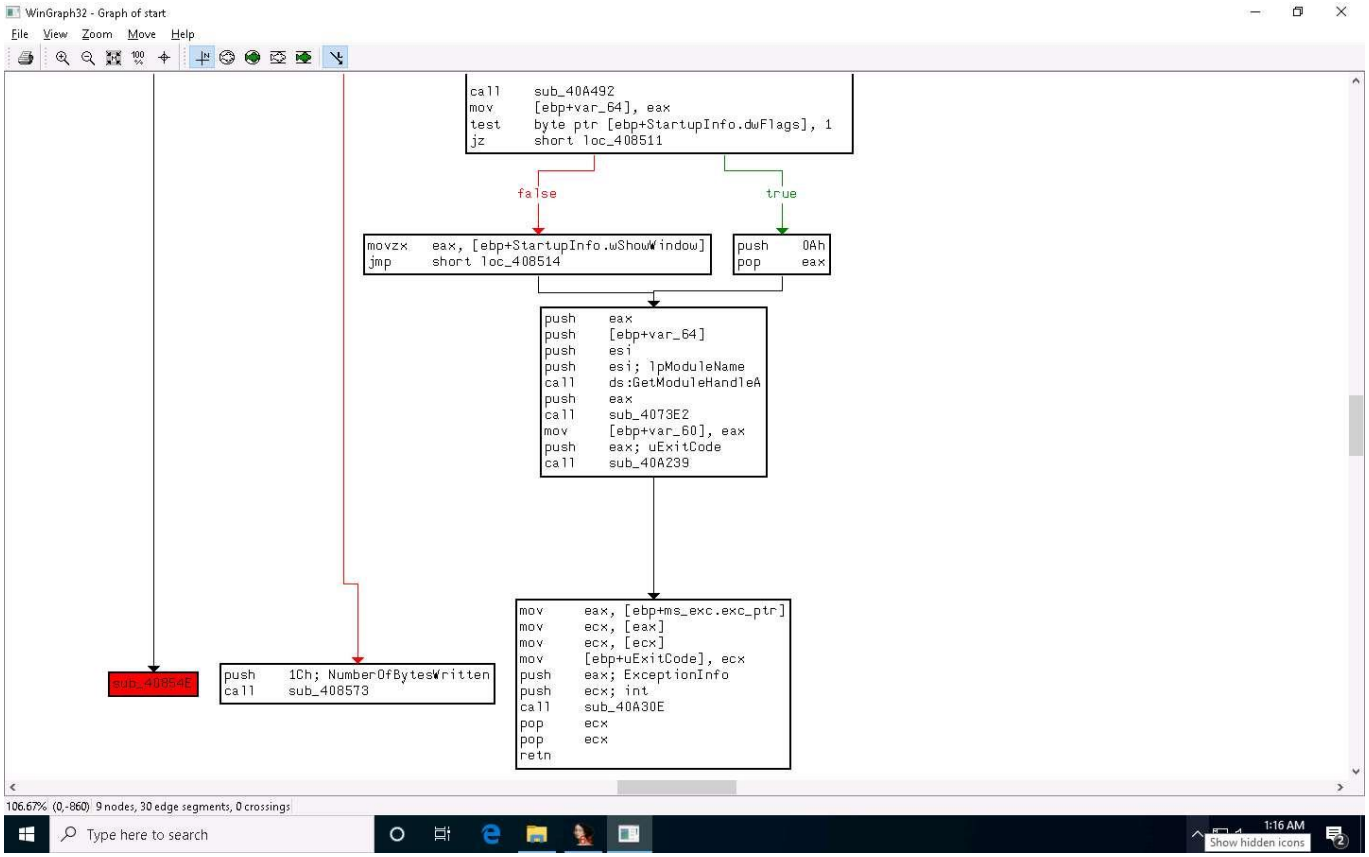
16. Maximize the IDA window. To view the flow of the uploaded malicious file, navigate to **View** --> **Graphs** and click **Flow chart**.



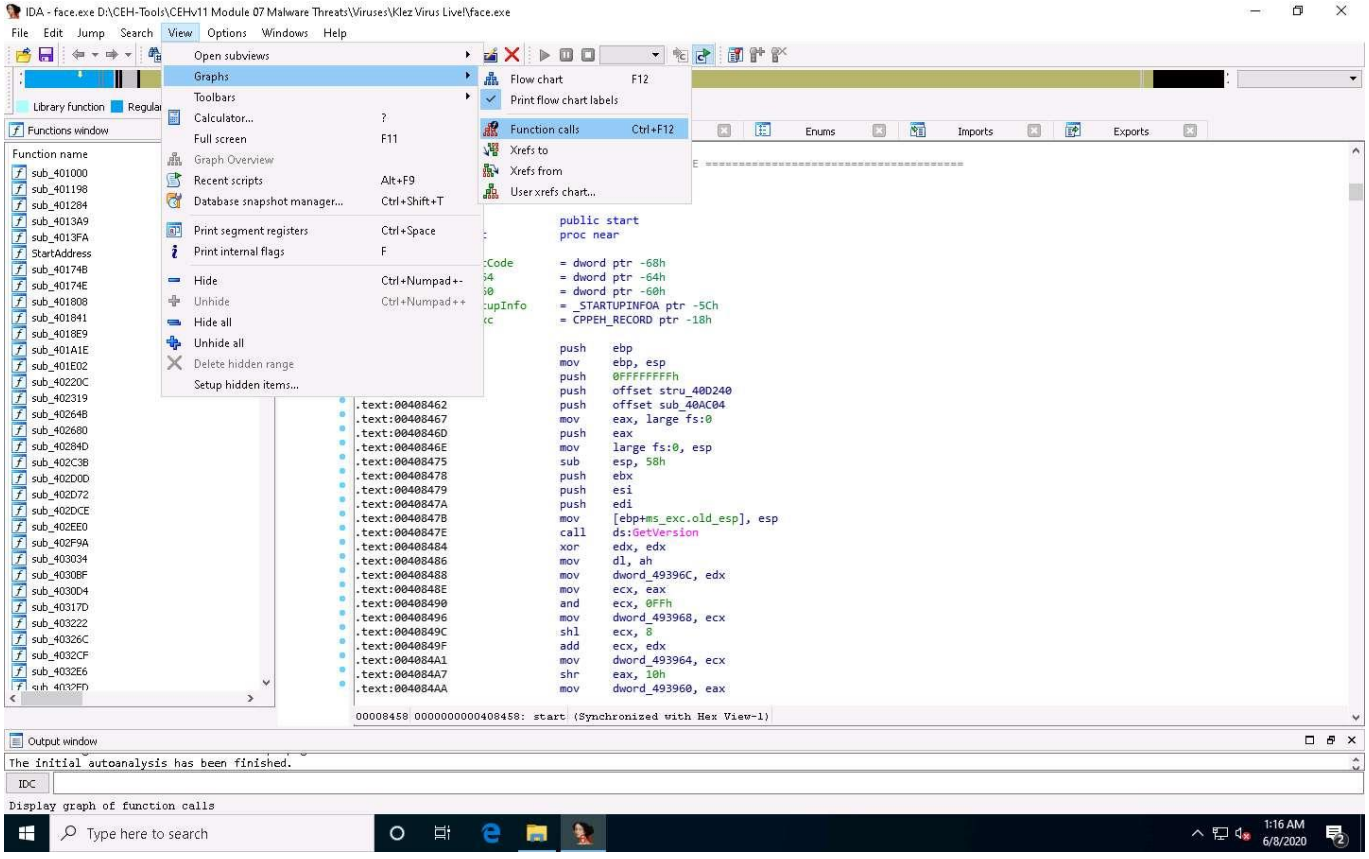
17. A **Graph** window appears with the flow. You may zoom in to view this more clearly.


WinGraph32 - Graph of start
File View Zoom Move Help
47.62% (0,0) 9 nodes, 30 edge segments, 0 crossings
Type here to search
1:15 AM
6/8/2020

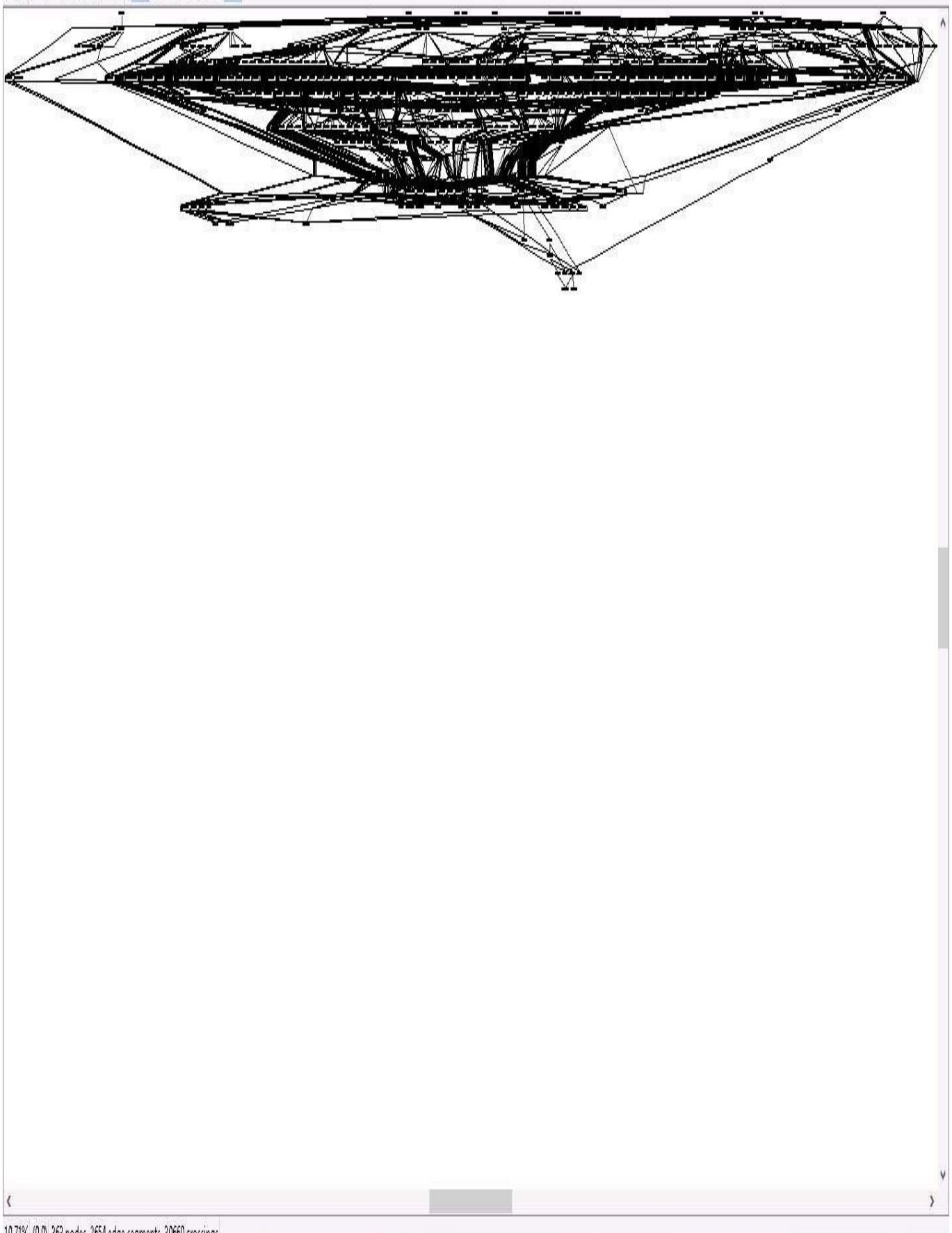

WinGraph32 - Graph of start
File View Zoom Move Help
push eax
mov large fs:0, esp
sub esp, 58h
push ebx
push esi
push edi
mov [ebp+ms_exc.old_esp], esp
call ds:GetVersion
xor edx, edx
mov dl, ah
mov dword_49396C, edx
mov ecx, eax
and ecx, 0FFh
mov dword_493968, ecx
shl ecx, 8
add ecx, edx
mov dword_493964, ecx
shr eax, 10h
mov dword_493960, eax
xor esi, esi
push esi
call sub_40AACD
pop ecx
test eax, eax
jnz short loc_4084C4
mov esp, [ebp+ms_exc.old_esp]
push [ebp+uExitCode]; uExitCode
call sub_40A24A
false
true
mov [ebp+ms_exc.registration.TryLevel], esi
call sub_40A922
call ds:GetCommandLineA
mov dword_494E68, eax
call sub_40A7F0
mov dword_493920, eax
call sub_40A5A3
call sub_40A4EA
call sub_40A20C
mov [ebp+StartupInfo.dwFlags], esi
lea eax, [ebp+StartupInfo]
push eax; lpStartupInfo
call ds:GetStartupInfoA
106.67% (0,-120) 9 nodes, 30 edge segments, 0 crossings
Type here to search
1:15 AM
6/8/2020

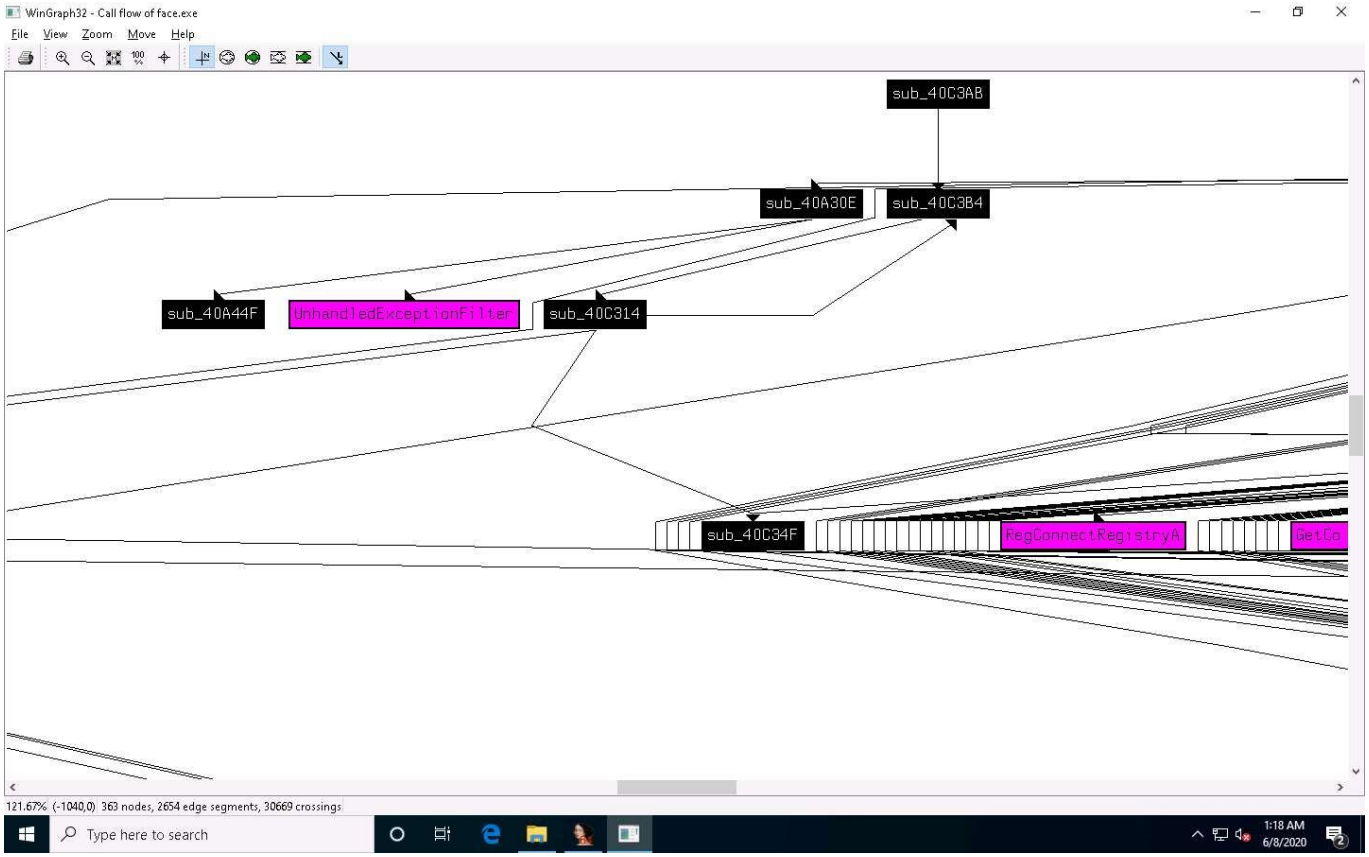


18. ☐ Close the **Graph** window, go to **View** --> **Graphs**, and click **Function calls** from the menu bar.

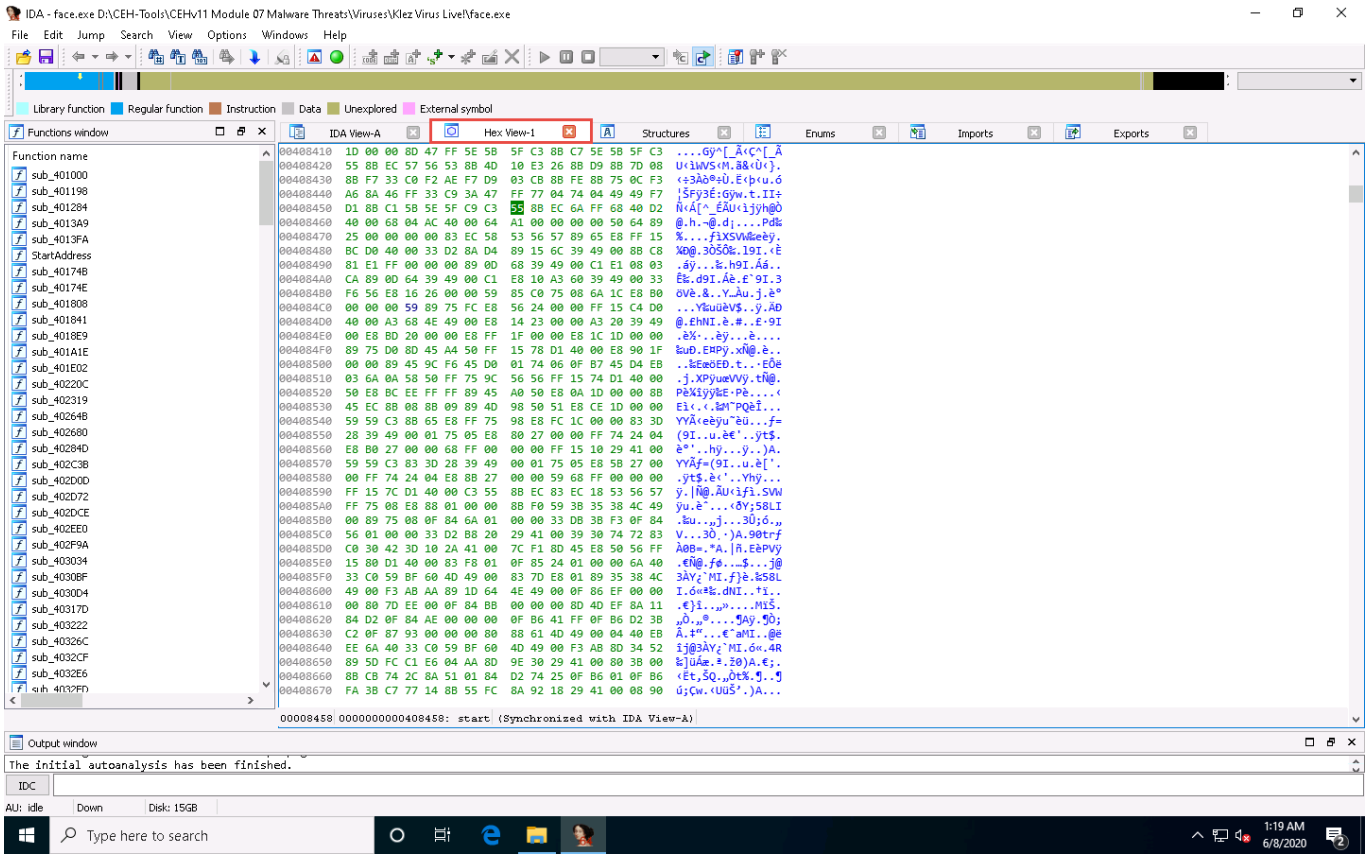


19. ☐ A window showing **call flow** appears; zoom in for a better view. Close the **WinGraph32 Call flow** window after completing the analysis.


WinGraph32 - Call flow of face.exe
File View Zoom Move Help
10.71% (0,0) 363 nodes, 2654 edge segments, 30669 crossings
Type here to search
1:17 AM
6/8/2020

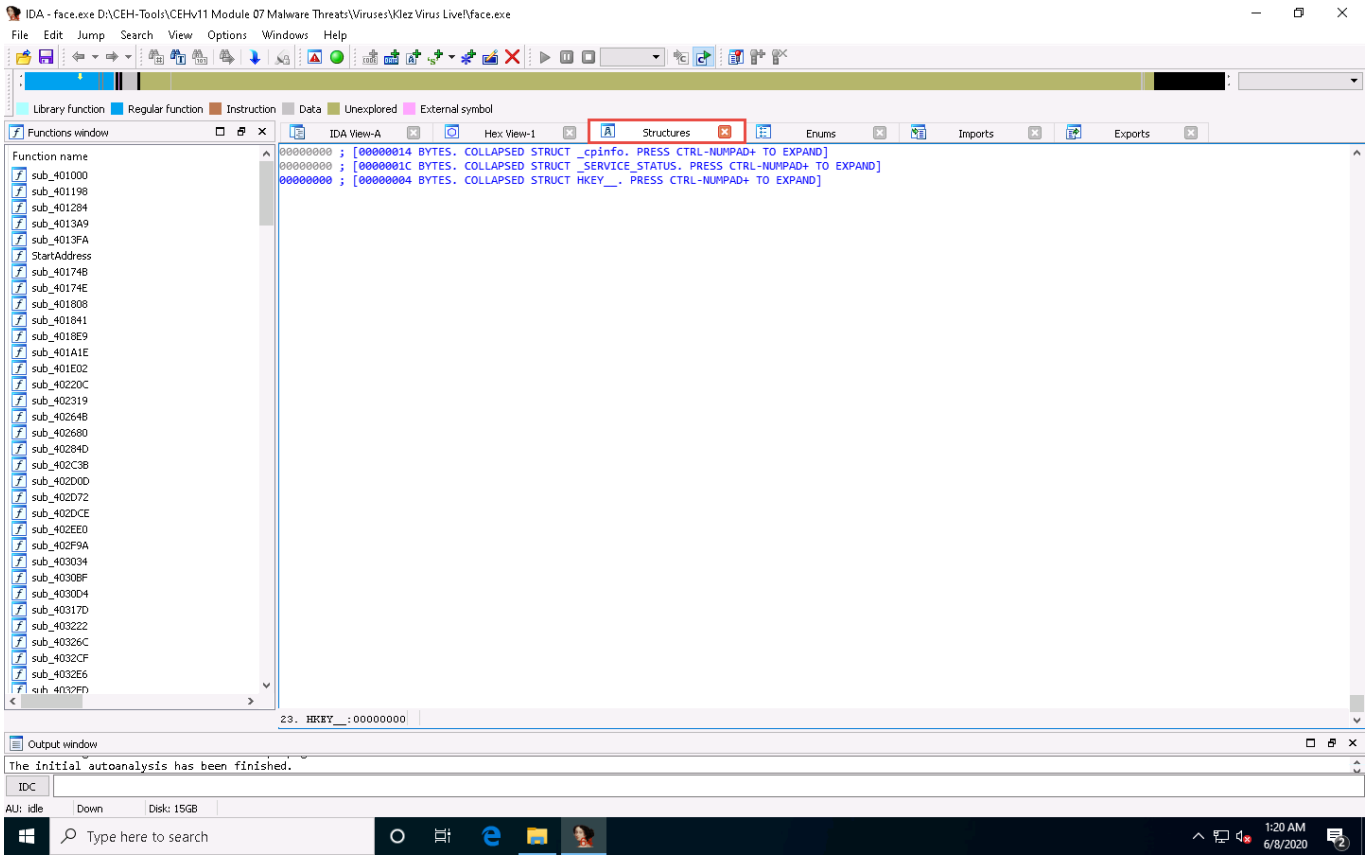


20. ☐ Click the **HexView-1** tab to view the hex value of the malicious file.

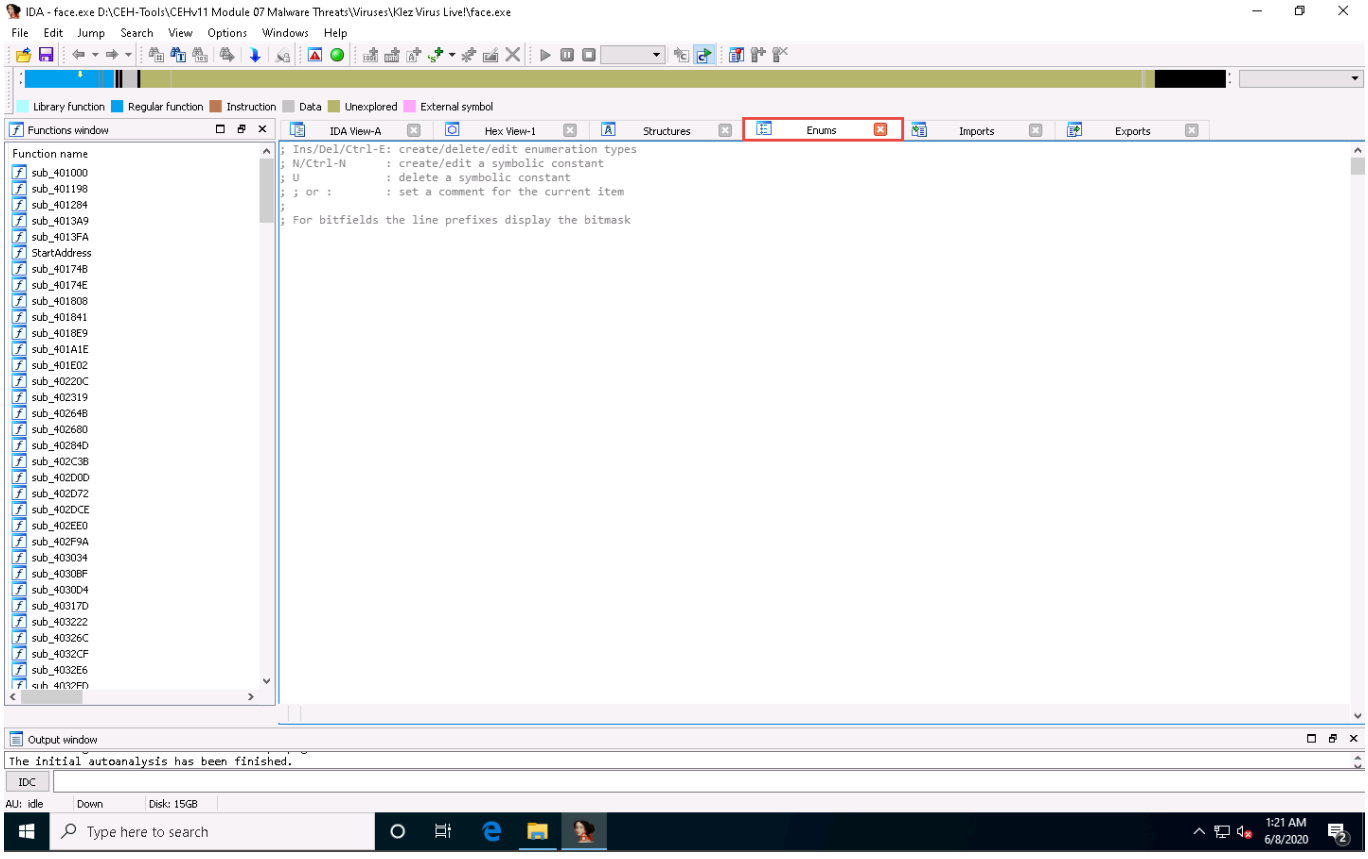


21. ☐ Click the **Structures** tab to view the structure of the file, as shown in the screenshot.

22. ☐ IDA displays all **Structures** (to expand the structures, click on **Ctrl** and **+**).



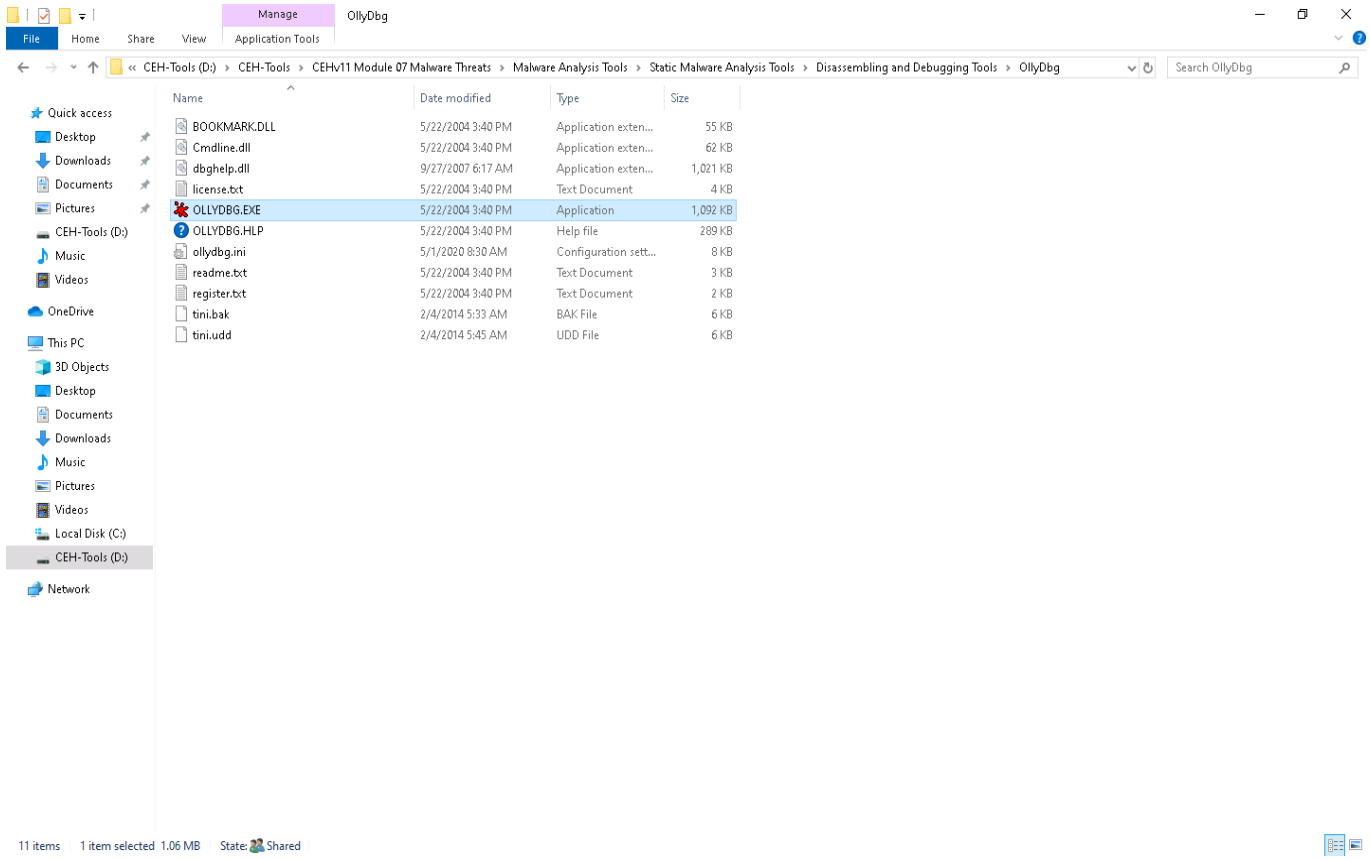
23. Click the **Enums** tab to view the Windows Enum results, as shown in the screenshot



24. Close all open windows.

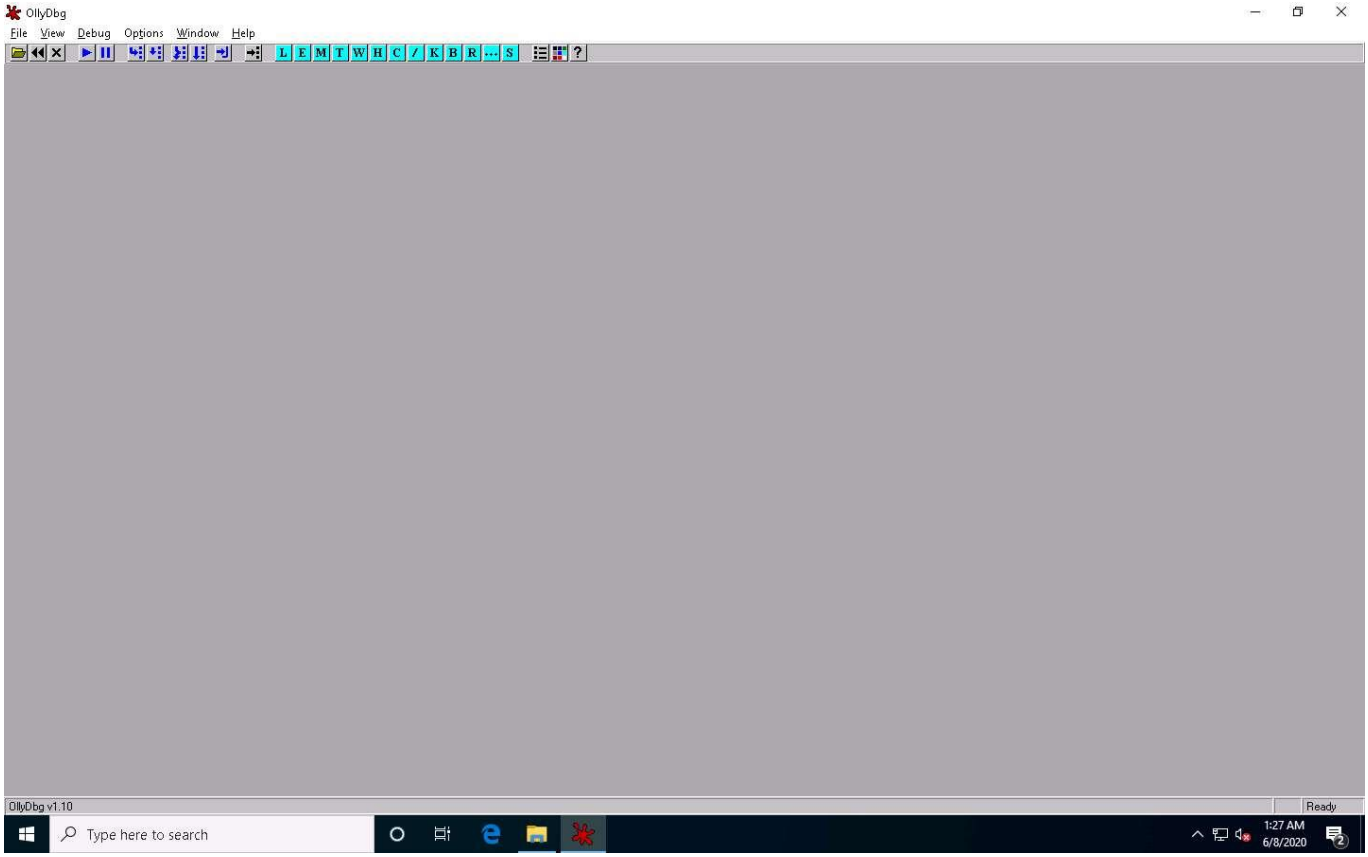
25. Navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Malware Analysis Tools\Static Malware Analysis Tools\Disassembling and Debugging Tools\OllyDbg** and double-click **OLLYDBG.EXE**.

If an **Open File - Security Warning** pop-up appears, click **Run**.

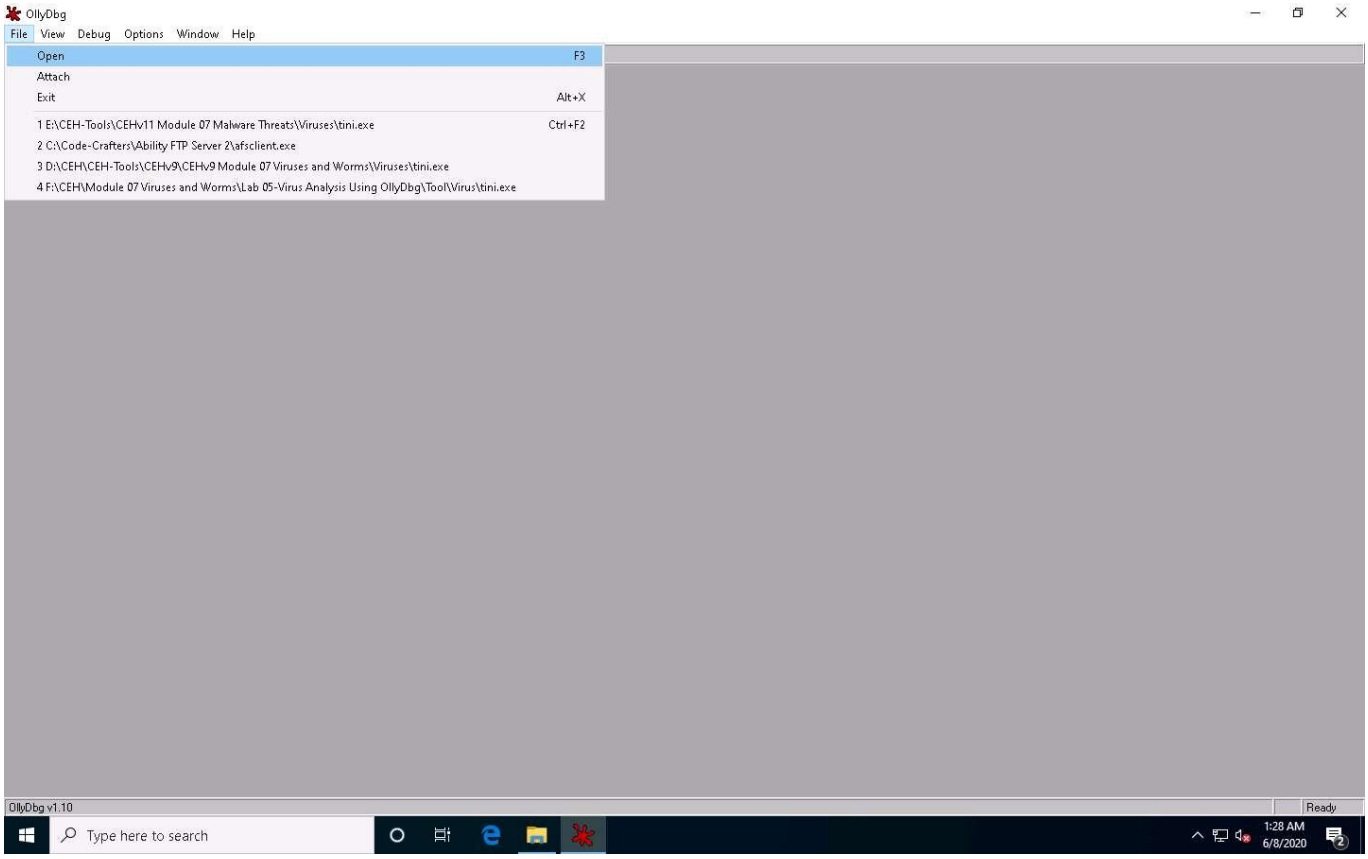


26. ☐ If a **UDD Directory Absent** dialog box appears, click **OK**.
27. ☐ If an OllyDbg warning message appears, for administrative rights, click **OK**.
28. ☐ The **OllyDbg** main window appears, as shown in the screenshot.

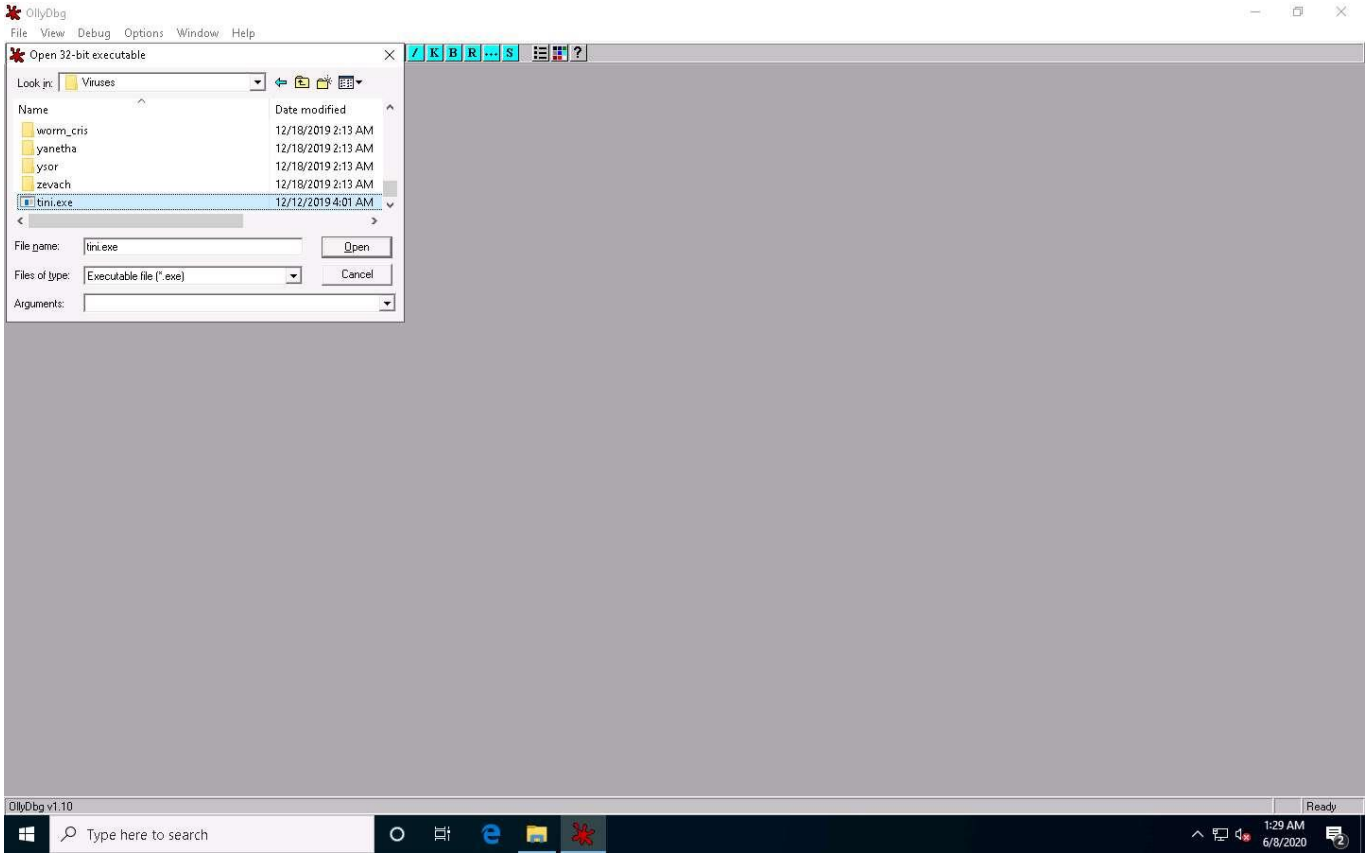
When you launch OllyDbg for the first time, several sub-windows might appear in the main window of OllyDbg; close them all.



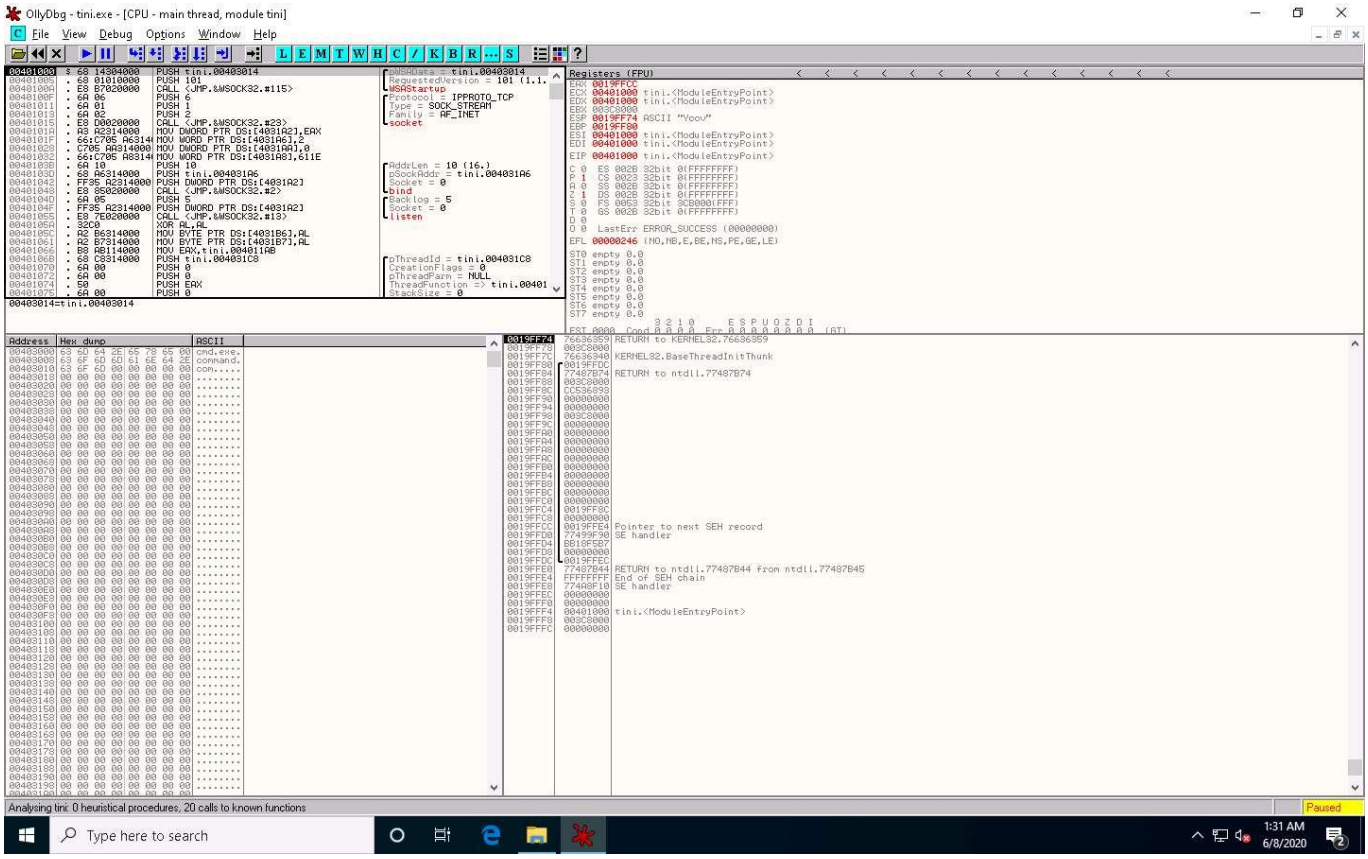
29. Choose **File** from the menu bar, and then choose **Open**.



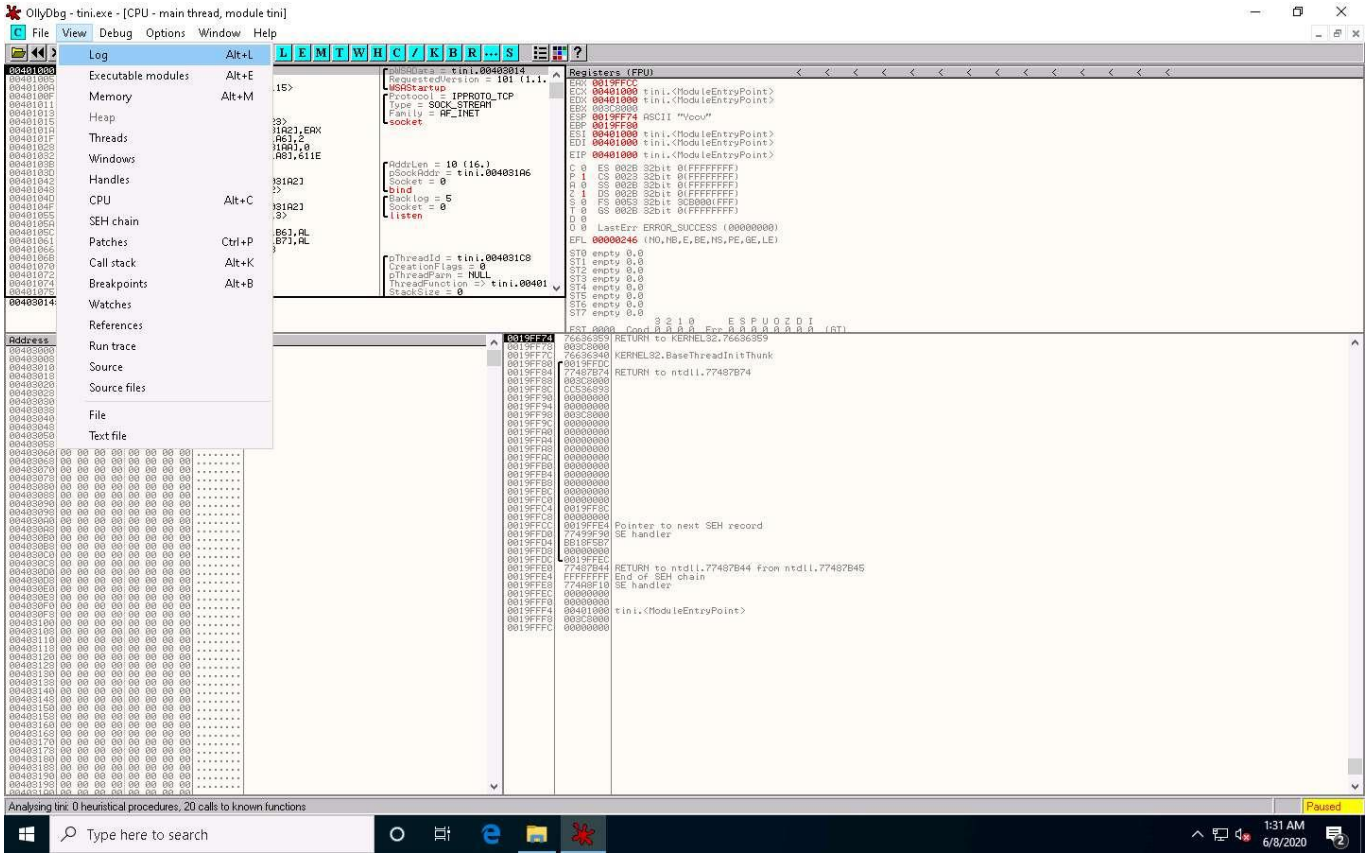
30. The **Open 32-bit executable** window appears; navigate to **D:\CEH-Tools\CEHv11 Module 07 Malware Threats\Viruses**, select **tini.exe**, and click **Open**.



31. The output appears in a window named **CPU - main thread, module ntdll**, maximize the window.

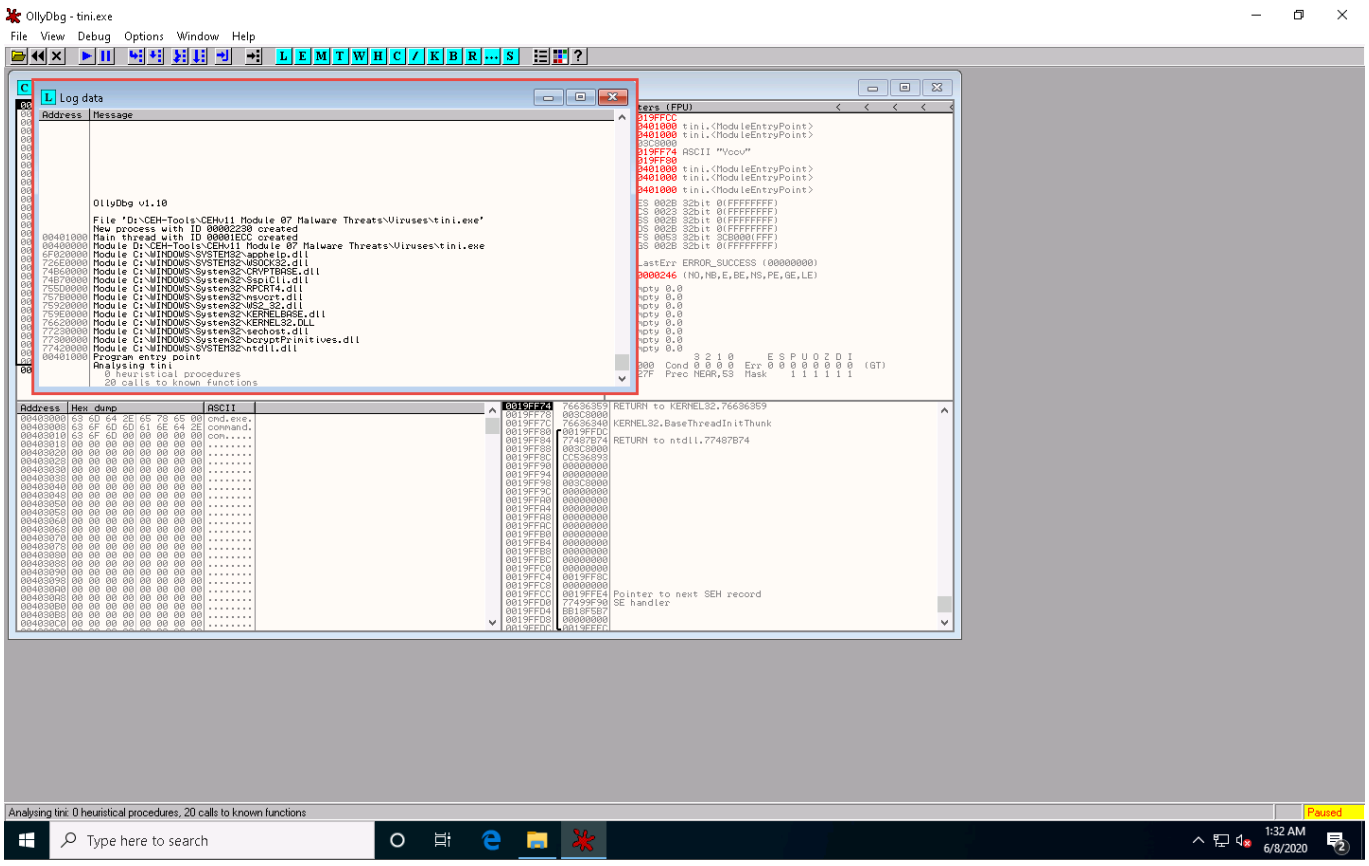


32. Choose **View** in the menu bar, and then choose **Log**.

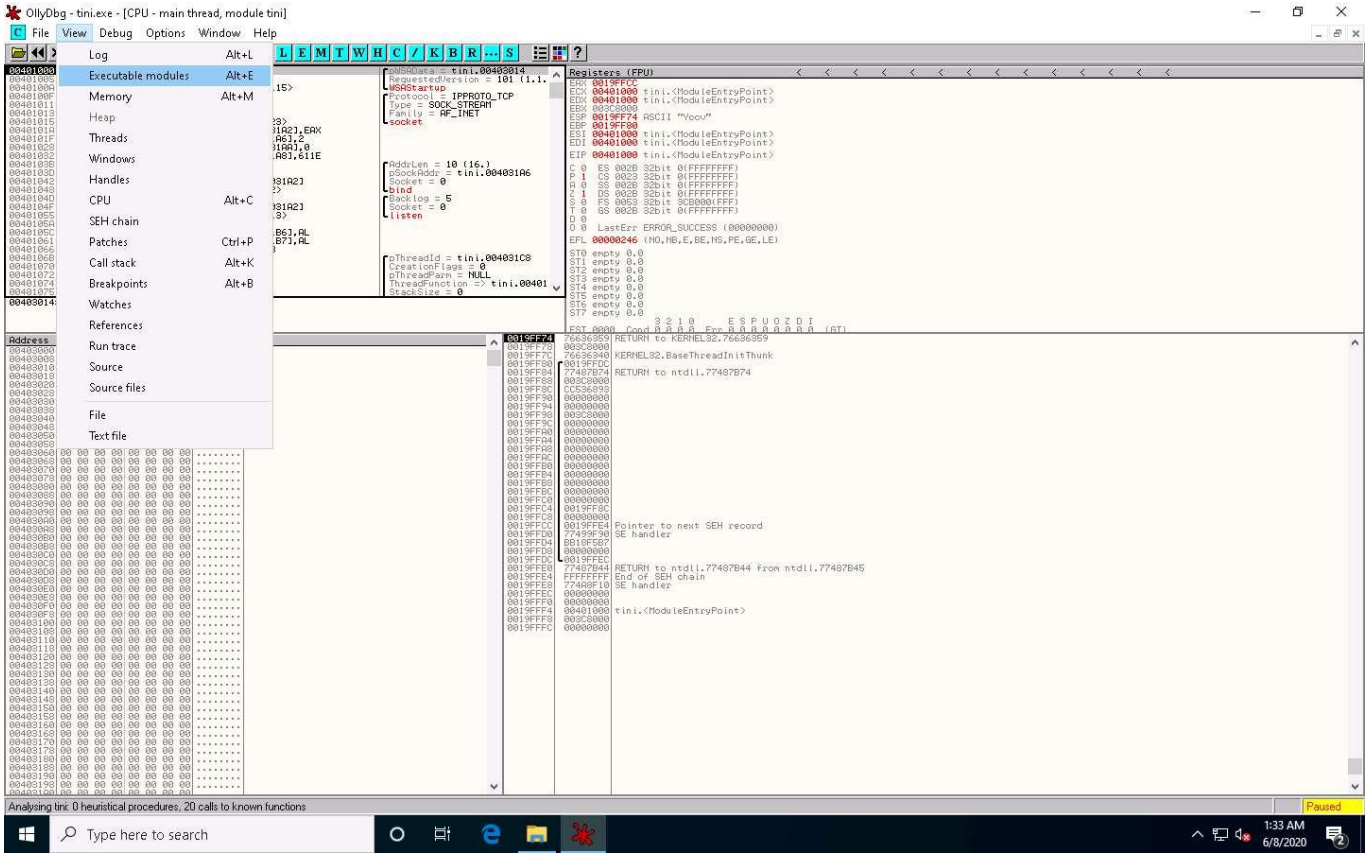


33. ☐ A window named **Log data** appears in OllyDbg, displaying the log details, as shown in the screenshot.

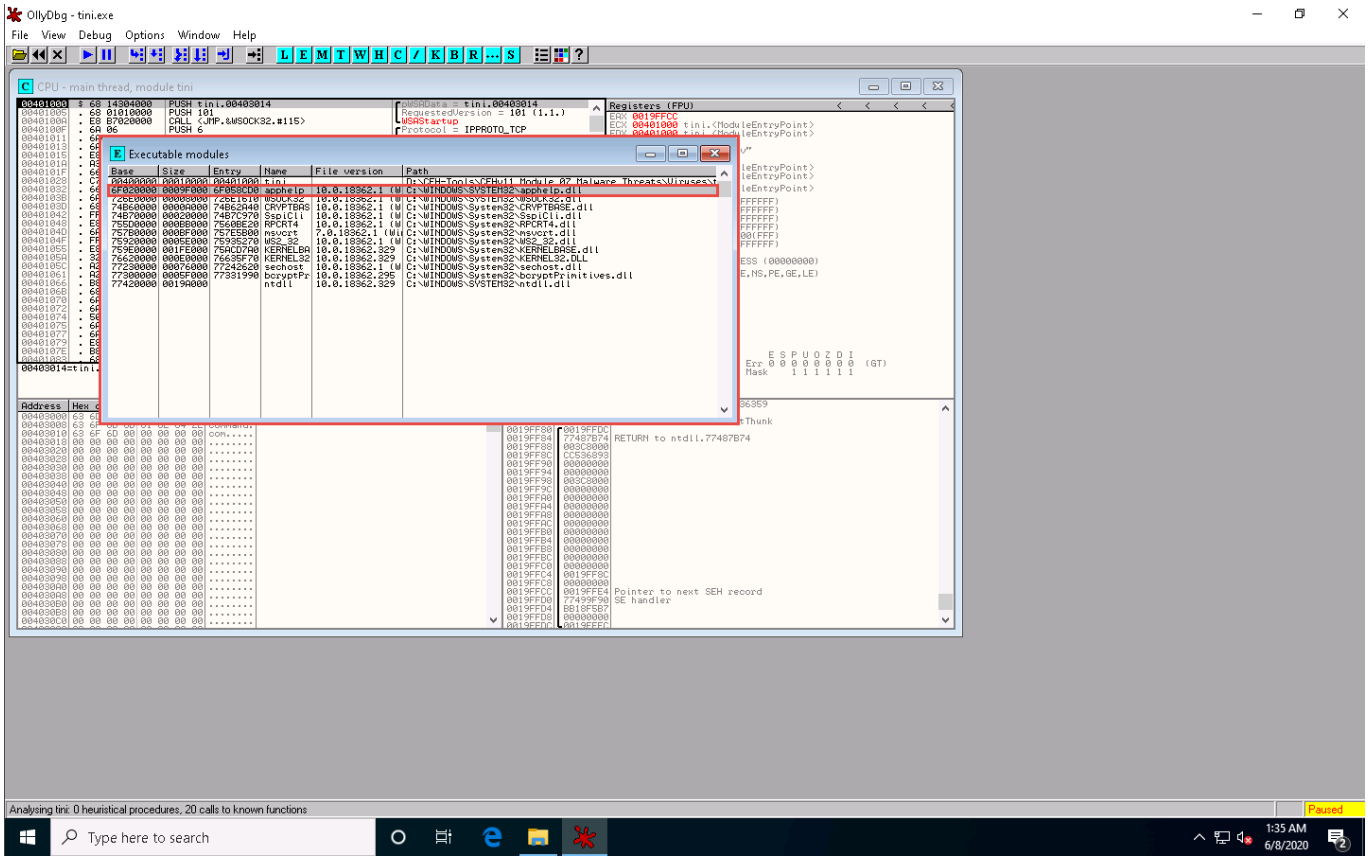
34. ☐ The **Log data** also displays the program entry point and its calls to known functions. Close the **Log data** window after completing the analysis.



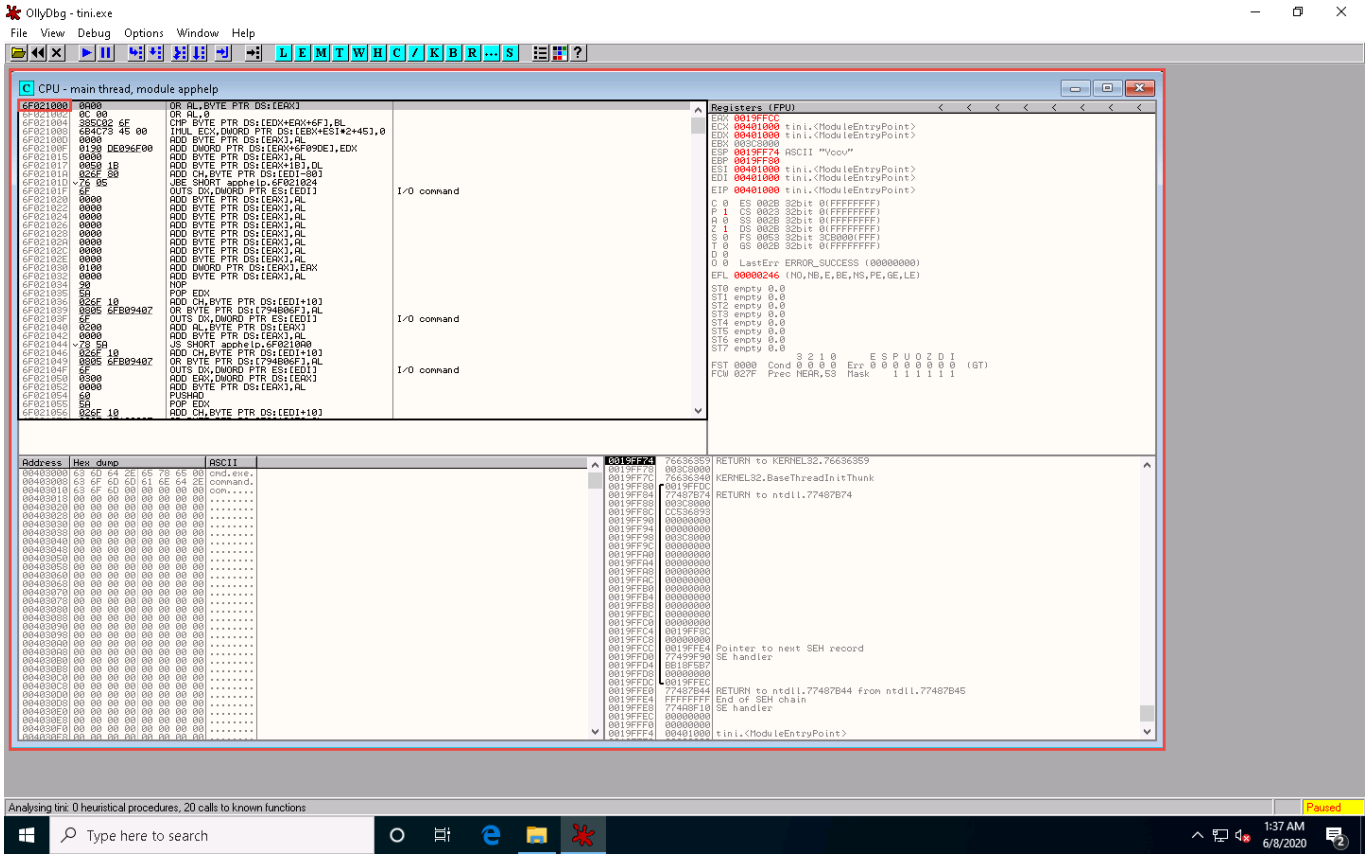
35. ☐ Choose **View** in the menu bar, and then choose **Executable modules**.



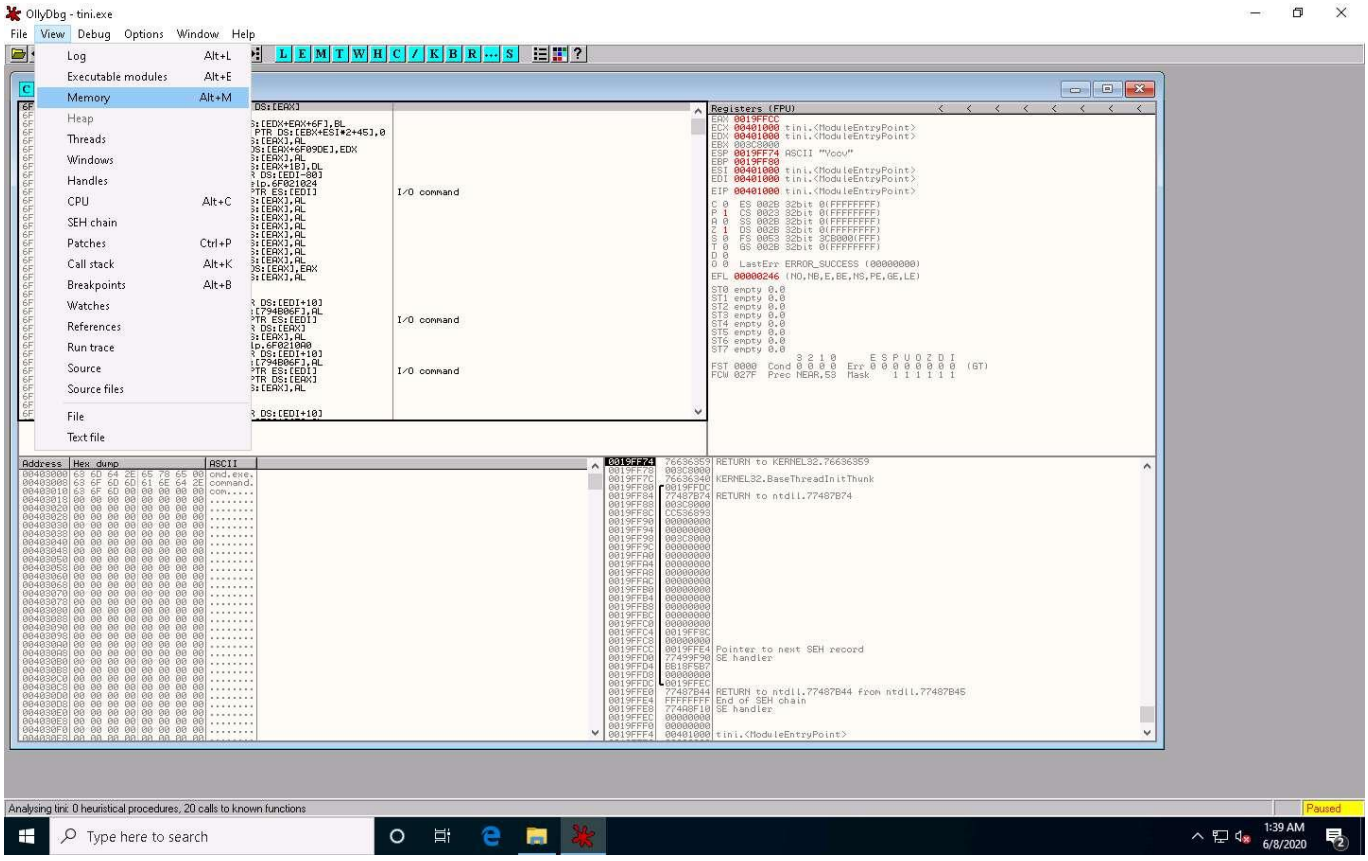
36. ☐ A window named **Executable modules** appears in OllyDbg, displaying all executable modules, as shown in the screenshot.
37. ☐ Double-click any module to view the complete information of the selected module.
38. ☐ In this exercise, we are choosing the **6F020000** module.



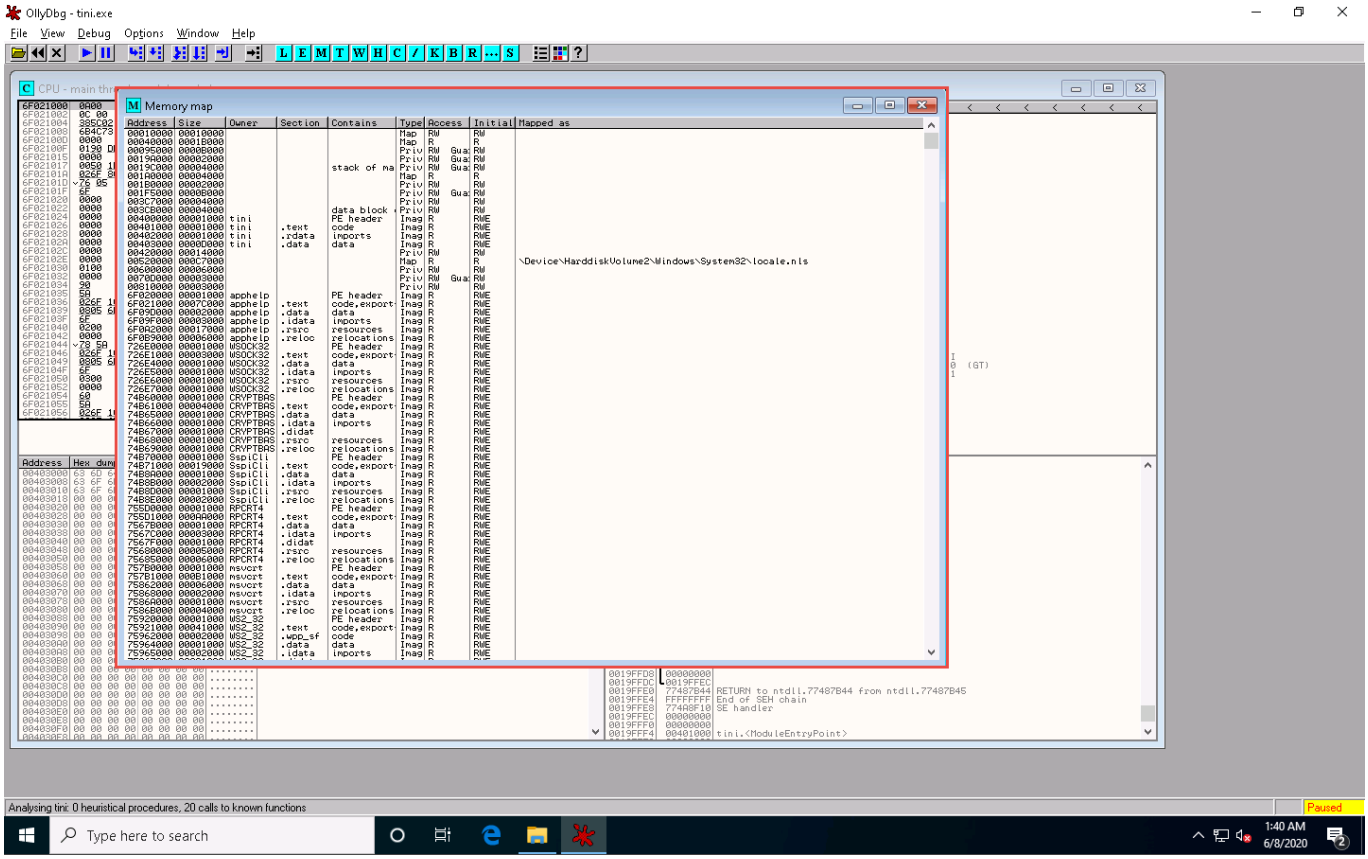
39. This will redirect you to the **CPU - main thread** window, as shown in the screenshot.



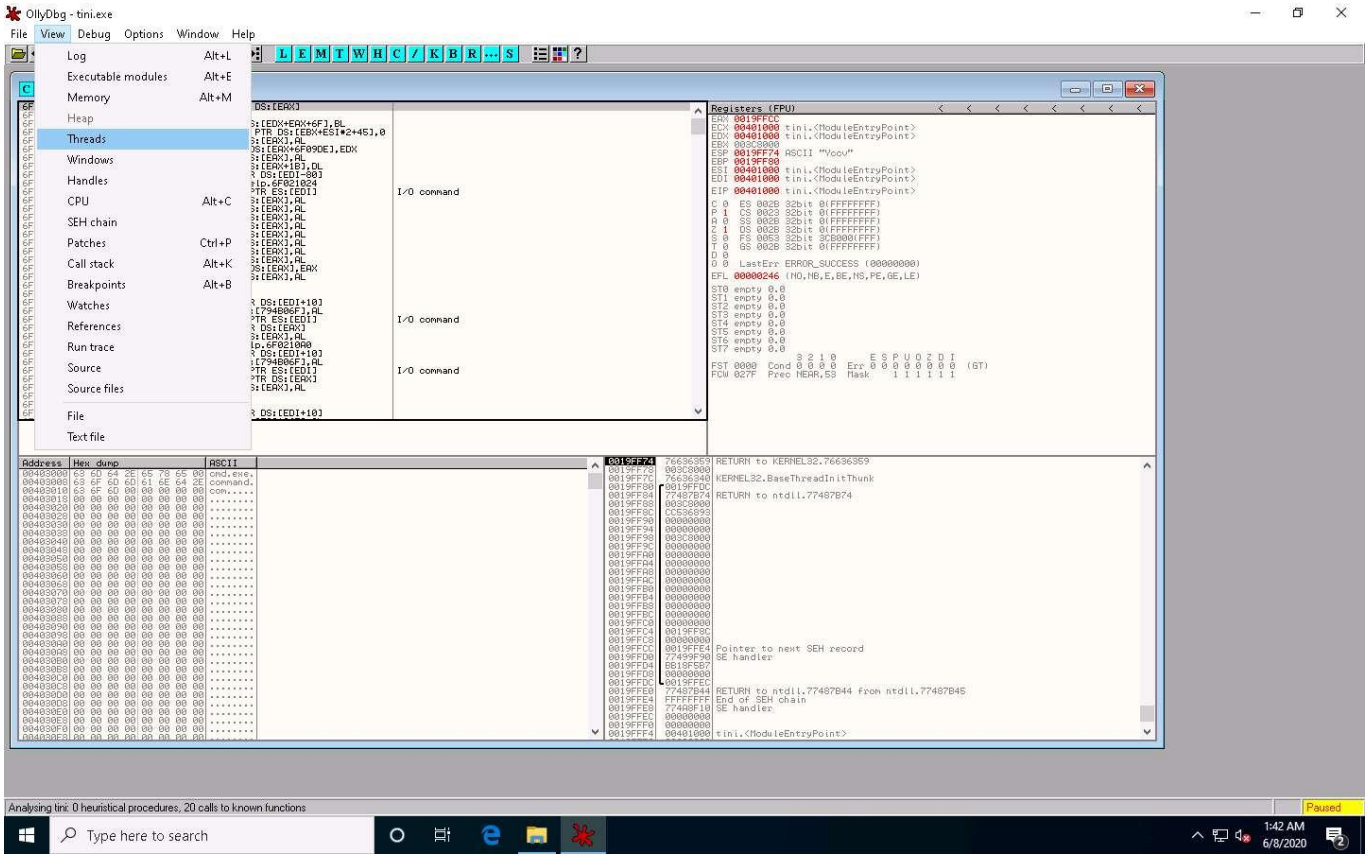
40. Choose **View** in the menu bar, and then choose **Memory**.



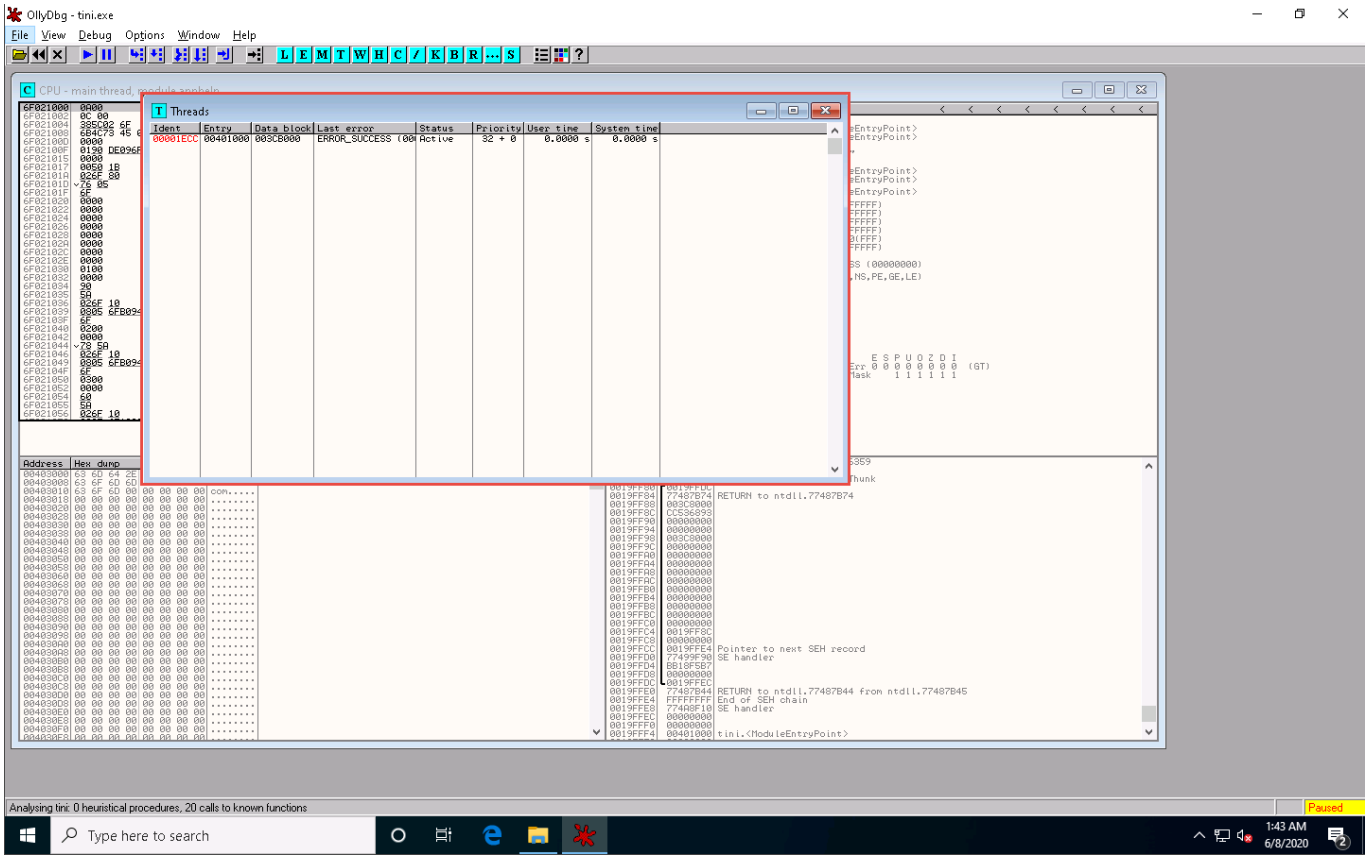
41. A window named **Memory map** appears in OllyDbg, displaying all memory mappings, as shown in the screenshot. Close the **Memory map** window.



42. Choose **View** in the menu bar, and then choose **Threads**.



43. A window named **Threads** appears in OllyDbg, displaying all threads, as shown in the screenshot.



44. ☐ This way, you can scan files and analyze the output using OllyDbg.
45. ☐ Close all open windows.
46. ☐ You can also use other disassembling and debugging tools such as **Ghirda** (https://ghidra-sre.org), **Radare2** (https://rada.re), **WinDbg** (http://www.windbg.org), and **ProcDump** (https://docs.microsoft.com) to perform malware disassembly.