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Experiential Learning Phase -I : CS235AI Operating Systems

DETECTING MEMORY ABNORMALITIES USING MEMORY SCANNER

by

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Problem Statement

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The objective of this project is to develop a memory scanning tool capable of detecting various types of memory abnormalities in computer systems.

Memory abnormalities can lead to system crashes, data corruption, and other critical issues, making it essential to identify and address them promptly. The memory scanner should be able to analyze the system's memory and identify potential problems such as memory leaks, buffer overflows, invalid memory accesses, and other memory-related vulnerabilities.



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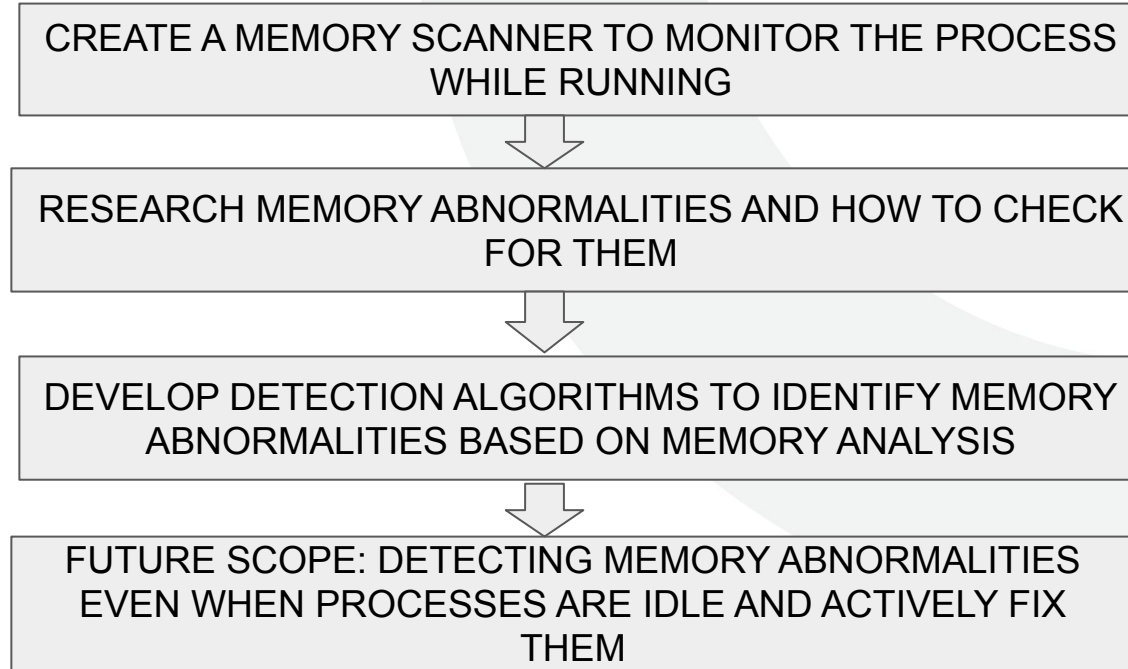
Relevance of Project in Current Course

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- The Operating Systems course in our curriculum covers memory management and virtual memory of applications
- Our project aims to make use of APIs available through C to access the memory of currently running applications
- Using these APIs we can peek and at particular memory locations, and also check for various abnormalities



Methodology





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Tools/APIs Used

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- <windows.h> C library
- VirtualQueryEx: Used to retrieve information about a range of pages within the address space of a specified process.
- ReadProcessMemory: Reads data from the specified process's memory.
- WriteProcessMemory: Writes data to the specified process's memory.



Working of the Memory Scanner

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- The memory scanner takes 3 primary inputs: PID of process to scan, size of data to scan, and initial value of data
- Using this information, it creates a linked-list of memory blocks of the memory of the process satisfying these criteria
- Initially, there may be multiple instances of the similar memory content, so we iteratively enter the updated values of the data that we want to find
- Finally it, you will be able to peek into the memory of the app, and check for abnormalities



Structure of linked list “MEMBLOCK”:

HANDLE hProc
unsigned char *addr
int size
unsigned char *buffer
unsigned char *searchmask
int matches
int data_sizes
struct _MEMBLOCK *next

Represents the handle to the process
Points to the base address of the memory block
Size of memory blocks in bytes
Buffer to copy data into while reading/manipulating
Search mask for tracking matching conditions
Number of matches in the memory block
Size of data elements in the memory block
Pointer to next memory block



Applications

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- Identifying and fixing memory leaks in software applications, which can lead to resource depletion and performance issues.
- Detecting buffer overflows and other memory-related vulnerabilities, which can be exploited for security breaches.
- Assisting in the debugging process by pinpointing memory-related issues during application development and testing.
- Monitoring system memory usage and detecting potential memory-related issues in servers, workstations, and other critical systems.
- Conducting security audits and penetration testing by identifying memory-related vulnerabilities that could be exploited by attackers.
- Analyzing the memory footprint of applications and systems to detect potential memory-related attack vectors.
- Detecting memory abnormalities in resource-constrained embedded devices and IoT sensors, where memory leaks or buffer overflows can have severe consequences.



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Summary of the Phase I report

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Phase 1 of our project has concluded with the successful development of the MemBlock memory scanner module, facilitating peek operations within targeted memory spaces. All APIs have been tested, ensuring proper functionality. Next steps involve implementing abnormality detecting operations, refining existing functionalities, optimizing performance. Documentation and reporting will be maintained throughout the development process. Phase 1's achievements lay a solid foundation for the project's progression, positioning us to enhance the capabilities and effectiveness of our memory scanning tool in subsequent phases.



Various Memory Abnormalities

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Memory abnormalities, in the context of computer systems, refer to unexpected or anomalous behaviors related to memory usage or memory management. These abnormalities can arise from various factors, including software bugs, security vulnerabilities, hardware failures, or malicious activities. Detecting and addressing memory abnormalities is crucial for maintaining system stability, security, and reliability.

Examples:

1. **Memory Leaks:** occur when a program allocates memory dynamically but fails to release it after it's no longer needed.
2. **Buffer Overflows:** occur when a program writes data beyond the bounds of a buffer, leading to corruption of adjacent memory locations.
3. **Code Injection:** involves inserting and executing malicious code into a running process's memory space.
4. **Heap corruption:** it is the unintended modifications of memory allocated on the heap



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