NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA
Department of Computer Science and Engineering

ARTIFICIAL INTELLIGENCE IN ANTI-VIRUS TECHNOLOGY

Guide : Mr K Vinay Kumar

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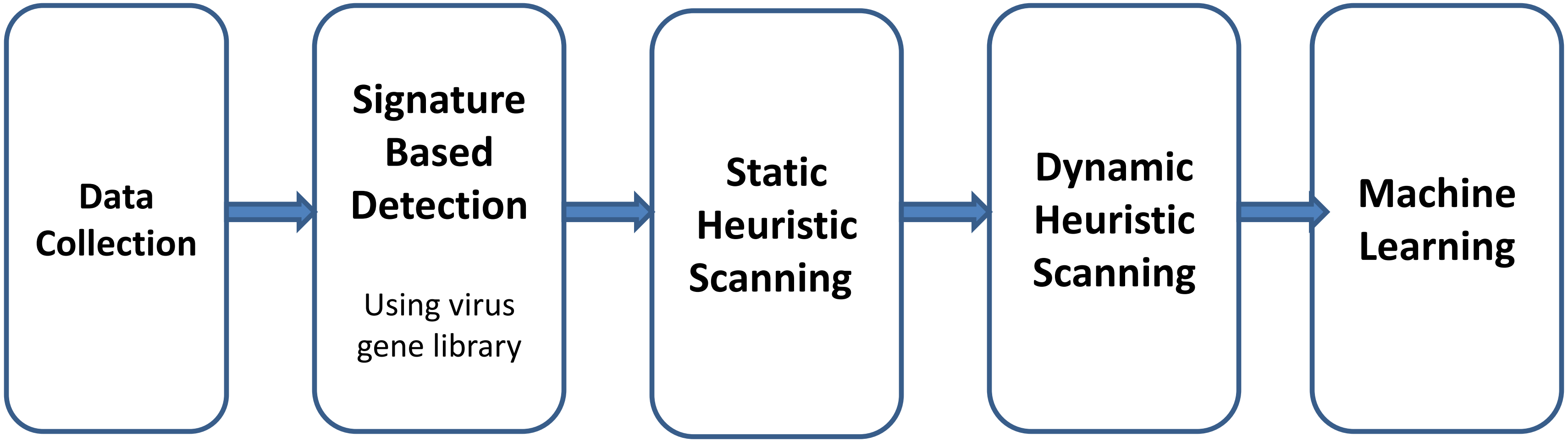
PROBLEM DEFINITION AND OBJECTIVE

- Problem Definition: Currently used AI techniques detect large number of false positives

- Objective: Reduce the number of false positives using Learning techniques.



Data Collection

Signature Based Detection

Using virus gene library

Static Heuristic Scanning

Dynamic Heuristic Scanning

Machine Learning

SIGNATURE BASED DETECTION

- Use of virus gene library

- 3,00,000 signatures

- Advantages
  - Fast
  - Available signatures

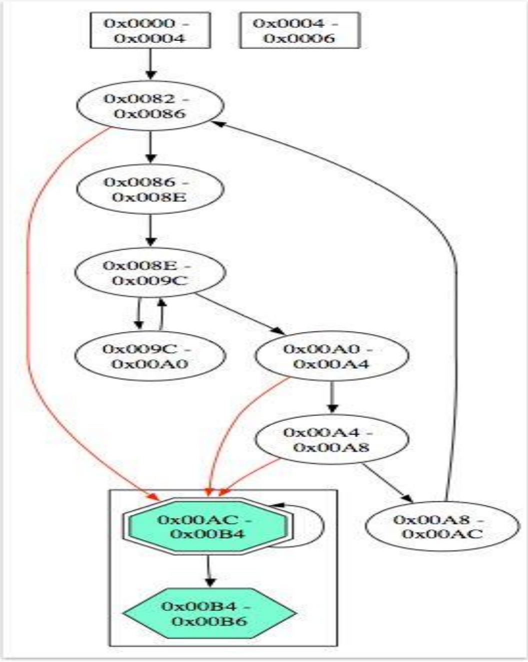
- Disadvantages
  - Cannot detect viruses without signatures

STATIC HEURISTIC SCANNING

- Search for behavior by static code analysis
- Challenges
  - Metamorphic (Obfuscation)
  - Polymorphic (Encryption)
- Obfuscation types
  - Register reassignment
  - Dead Code Insertion
  - Code Transposition
  - Code Substitution
- Obfuscation Handling
  - Regular Expression
  - Control Flow Graph
- Advantages
  - Not computation intensive

Code snippet

```
E800 0000 00(90)*
5B(90)* 8D4B
42(90)* 51(90)*
50(90)* 50(90)*
0F01 4C24 FE(90)*
5B(90)* 83C3 C(90)*
FA(90)*8B2B
```



DYNAMIC HEURISTIC SCANNING

- Decision parameters
  - System calls
  - Unusual destination
  - Analysis of file types and file system
  - Analysis of memory usage – buffer overflow analysis, system registery
  - Access of executables, mutex
  - Access of disk
  - Replication
  - Attempts to hide other files
  - Attempts to terminate programs
  - Attempts to open other executables.

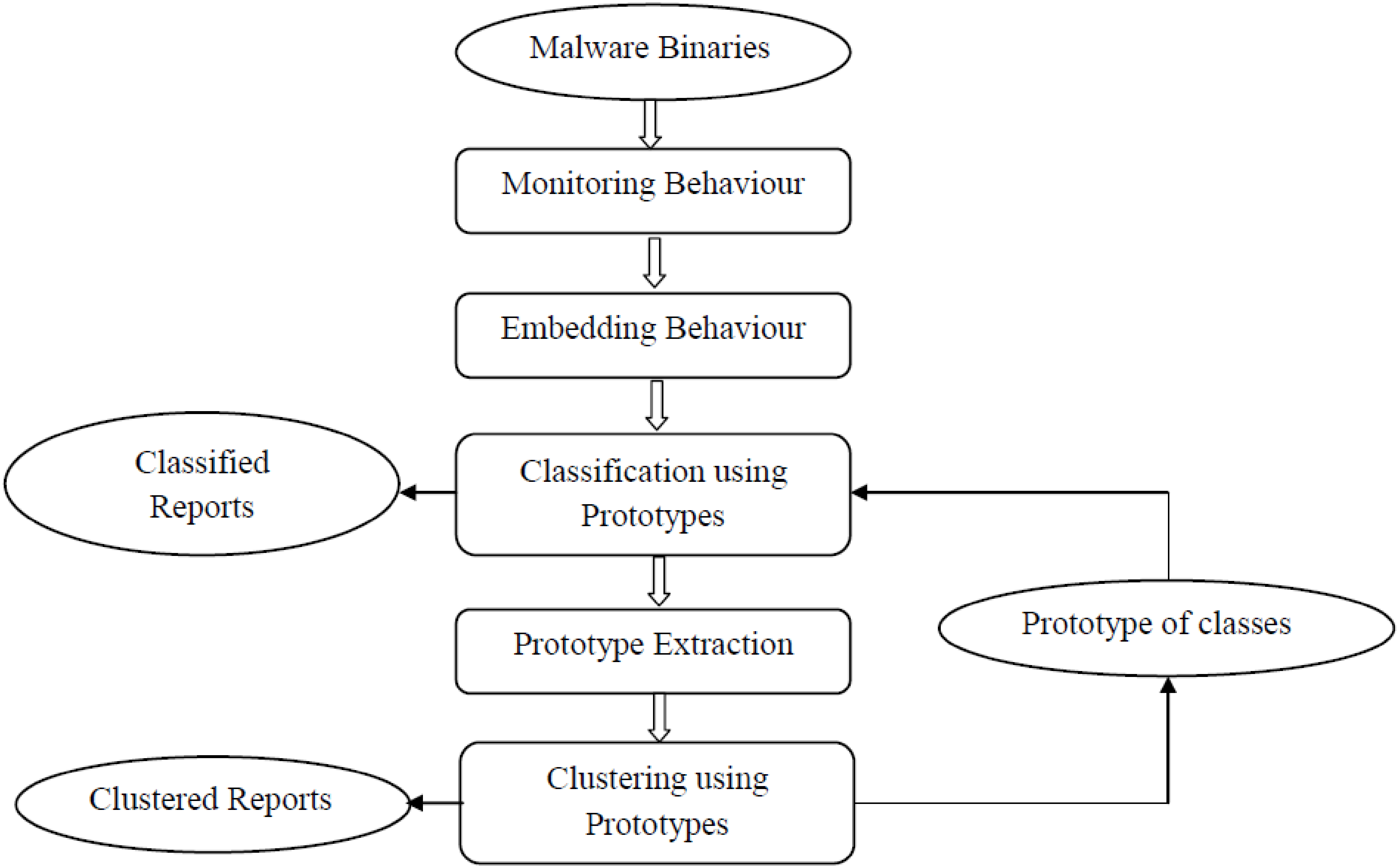
DYNAMIC HEURISTIC SCANNING

- Implementation Details
  - Sandbox Environment
  - Reports of malware binaries

- Advantages
  - Can detect encrypted viruses
  - Sandboxing helps in CPU emulation without affecting the system

- Disadvantages
  - CPU Emulation is expensive

MACHINE LEARNING



MACHINE LEARNING

- Prototype Extraction – Gonzalez algorithm – O (kn)
  - K – number of prototypes, n – number of reports
- Clustering using prototypes
  - Complete linkage - O(k^2 log k + n)

  v/s
  - hierarchical clustering - O(n^2 log n)
  - Speed-up factor of square root n/k
- Classification
  - Clustered malware classes used for training and learning behavior
  - O (kn)
- Incremental analysis
  - Better than batch analysis
  - Uses prototypes stored from previous runs
  - O(nm + k^2 log k)
    - M – number of prototypes from previous run

RESULTS AND ANALYSIS

	Signature Matching	Static Heuristic Scanning	Dynamic Heuristic Scanning	Artificial Learning
Detection of known virus	✓	✓	✓	✓
Detection of unknown viruses	Fails when signature is unavailable	✓	✓	62%
Robustness	Fails when signature is unavailable	✓	✓✓	✓
False positives	No false positives	✓	✓	Reduces false positives
High speed detection	✓✓	✓	Requires CPU emulation	Learning algorithms consume time
Detect metamorphic/ oligomorphic viruses	Fails since virus encrypts itself	✓	✓✓	Efficient only after detection by heuristic scanning
Obfuscation	Fails since virus obfuscates itself	✓	✓✓	After heuristic scanning

RESULTS AND ANALYSIS

Technique	F-measure
Clustering using Prototype	0.950
Classification using Prototype	0.981
Classification using SVM and XML	0.807

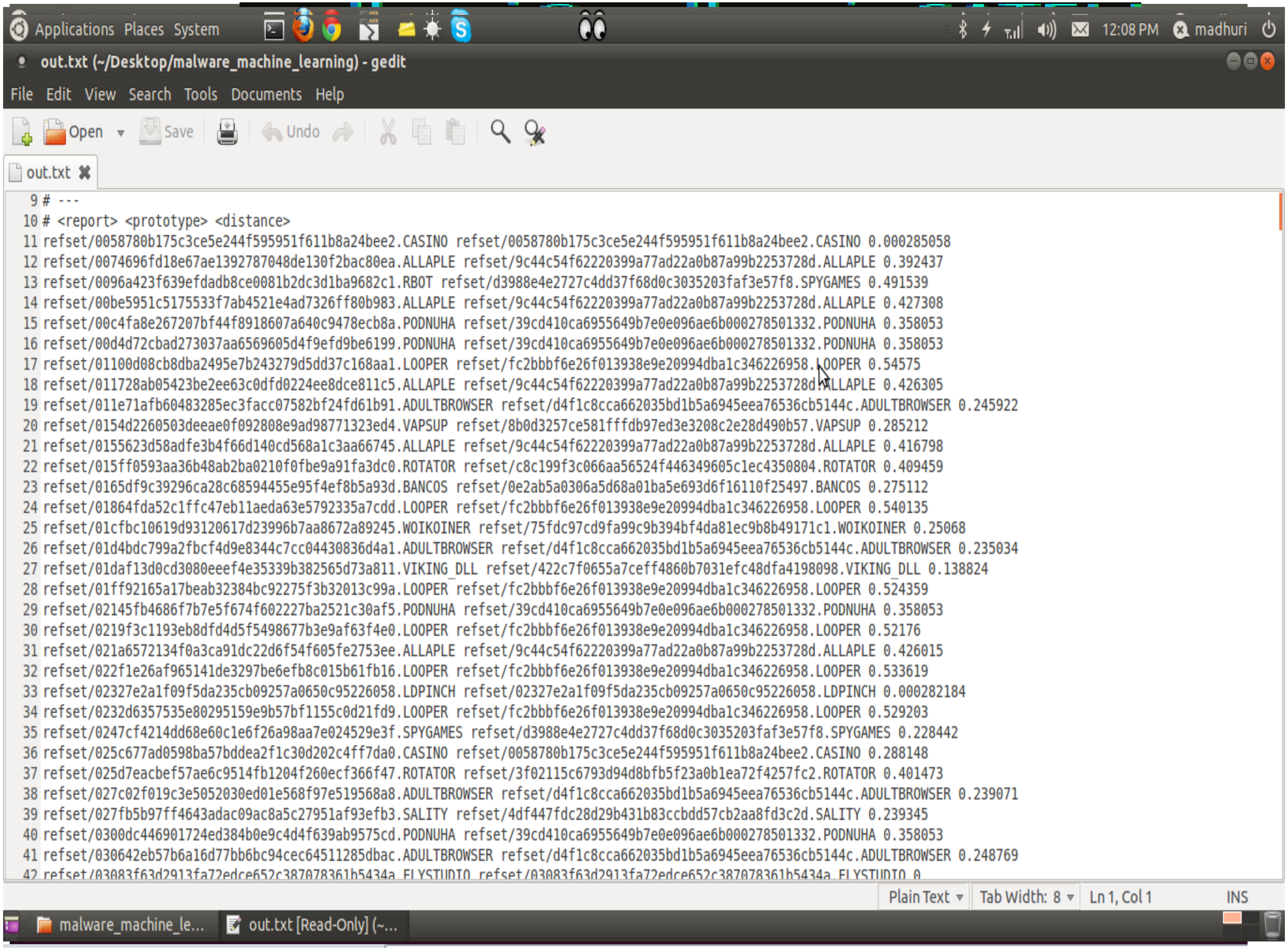
$$\text{Precision} = \frac{tp}{tp + fp}$$

$$\text{Recall} = \frac{tp}{tp + fn}$$

$$F = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

- Precision - how well individual clusters agree with malware classes
- Recall - extent to which classes are scattered across clusters
- Inverse relation between Precision and Recall
- F-measure – Combines Precision and Recall
  - 1 => perfect classification
  - 0 => completely incorrect classification

SCREENSHOTS


Applications Places System
12:08 PM madhuri
out.txt (~/Desktop/malware_machine_learning) - gedit
File Edit View Search Tools Documents Help
Open
Save
Undo
out.txt
Plain Text
Tab Width: 8
Ln 1, Col 1
INS
malware_machine_le...
out.txt [Read-Only] (~...

```
# ---
# <report> <prototype> <distance>
refset/0058780b175c3ce5e244f595951f611b8a24bee2.CASINO refset/0058780b175c3ce5e244f595951f611b8a24bee2.CASINO 0.000285058
refset/0074696fd18e67ae1392787048de130f2bac80ea.ALLAPLE refset/9c44c54f62220399a77ad22a0b87a99b2253728d.ALLAPLE 0.392437
refset/0096a423f639efdadb8ce0081b2dc3d1ba9682c1.RBOT refset/d3988e4e2727c4dd37f68d0c3035203faf3e57f8.SPYGAMES 0.491539
refset/00be5951c5175533f7ab4521e4ad7326ff80b983.ALLAPLE refset/9c44c54f62220399a77ad22a0b87a99b2253728d.ALLAPLE 0.427308
refset/00c4fa8e267207bf44f8918607a640c9478ecb8a.PODNUHA refset/39cd410ca6955649b7e0e096ae6b000278501332.PODNUHA 0.358053
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refset/01d4bdc799a2fbcf4d9e8344c7cc04430836d4a1.ADULTBROWSER refset/d4f1c8cca662035bd1b5a6945eea76536cb5144c.ADULTBROWSER 0.235034
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refset/01ff92165a17beab32384bc92275f3b32013c99a.LOOPER refset/fc2bbbf6e26f013938e9e20994dba1c346226958.LOOPER 0.524359
refset/02145fb4686f7b7e5f674f602227ba2521c30af5.PODNUHA refset/39cd410ca6955649b7e0e096ae6b000278501332.PODNUHA 0.358053
refset/0219f3c1193eb8dfd4d5f5498677b3e9af63f4e0.LOOPER refset/fc2bbbf6e26f013938e9e20994dba1c346226958.LOOPER 0.52176
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refset/02327e2a1f09f5da235cb09257a0650c95226058.LDPINCH refset/02327e2a1f09f5da235cb09257a0650c95226058.LDPINCH 0.000282184
refset/0232d6357535e80295159e9b57bf1155c0d21fd9.LOOPER refset/fc2bbbf6e26f013938e9e20994dba1c346226958.LOOPER 0.529203
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```

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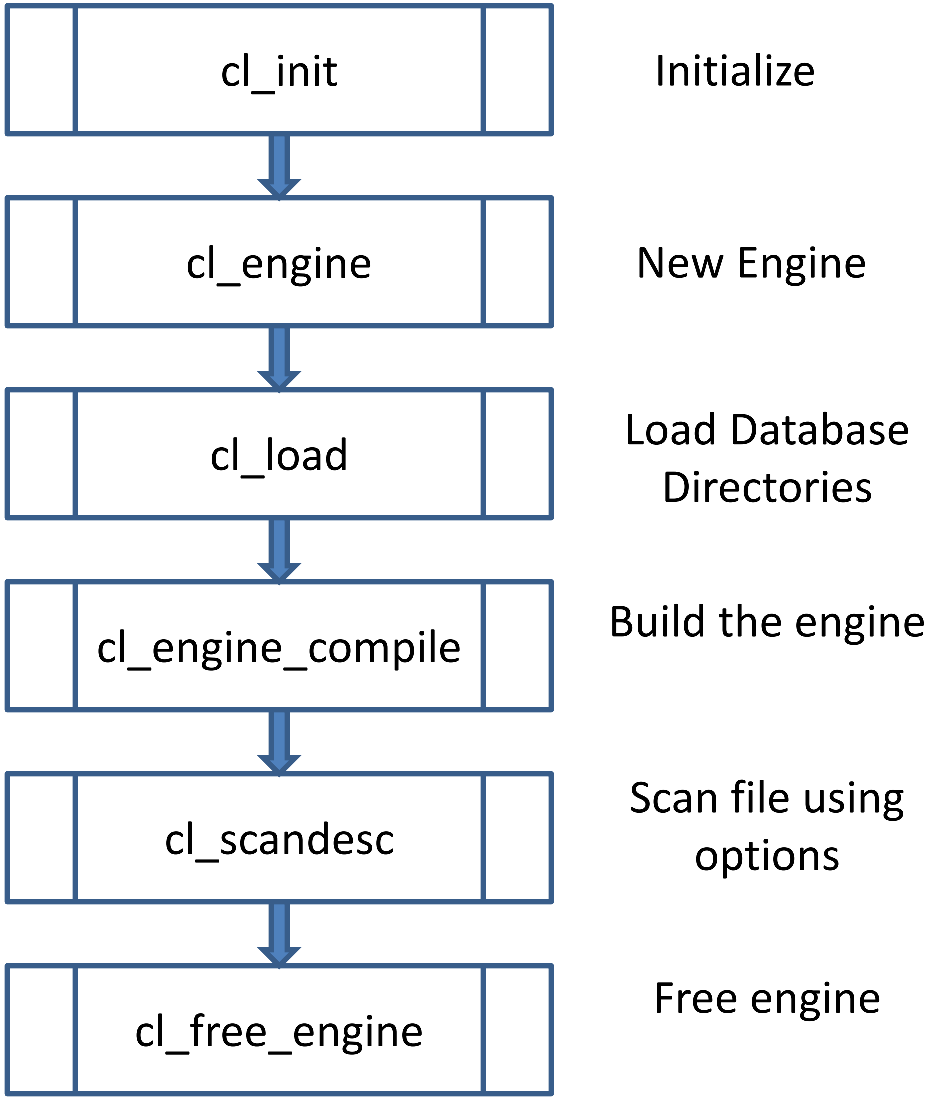
Appendix 1 - Implementation of Signature Based Detection

- Use of ClamAV engine
- Provides an API – libClamAV
- Provides an in-memory database of signatures
- Provides regular updates to two database files
    - main.cvd
    - daily.cvd



cl_init — Initialize

cl_engine — New Engine

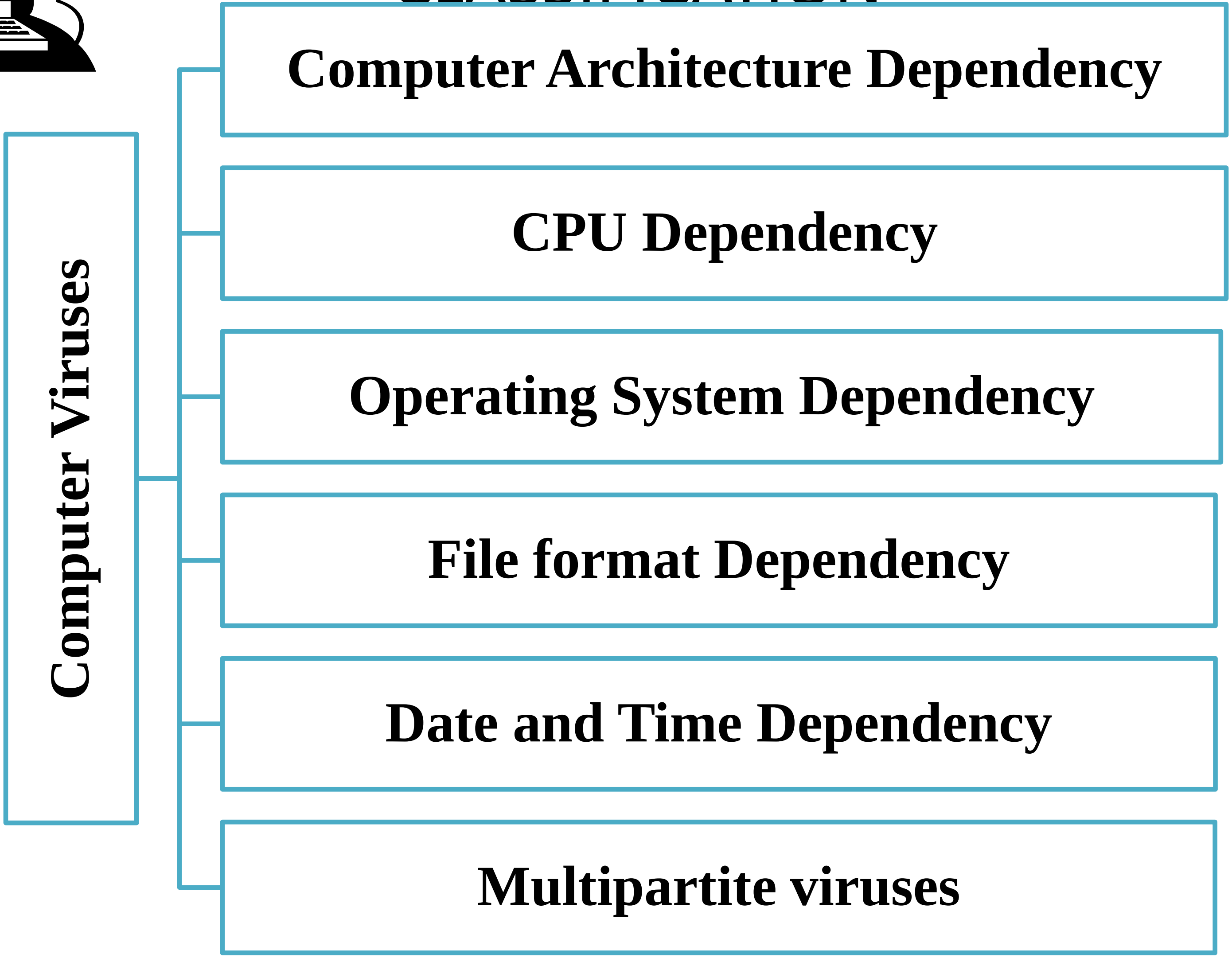
cl_load — Load Database Directories

cl_engine_compile — Build the engine

cl_scandesc — Scan file using options

cl_free_engine — Free engine

Appendix 2 - DEPENDENCY BASED CLASSIFICATION



Computer Viruses

Computer Architecture Dependency

CPU Dependency

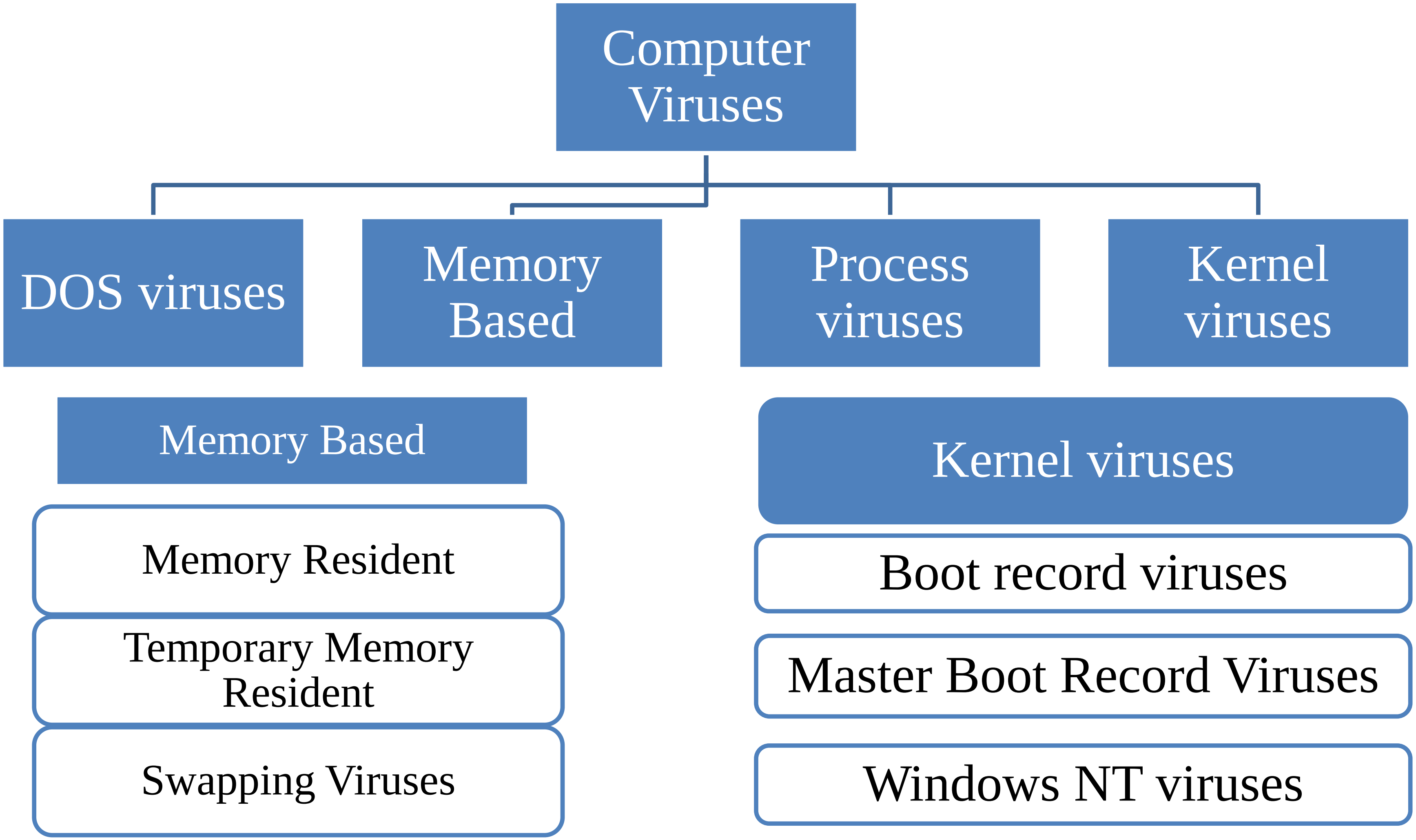
Operating System Dependency

File format Dependency

Date and Time Dependency

Multipartite viruses

Appendix 3 - BEHAVIOR BASED CLASSIFICATION



Computer Viruses

DOS viruses

Memory Based

Process viruses

Kernel viruses

Memory Based

- Memory Resident
- Temporary Memory Resident
- Swapping Viruses

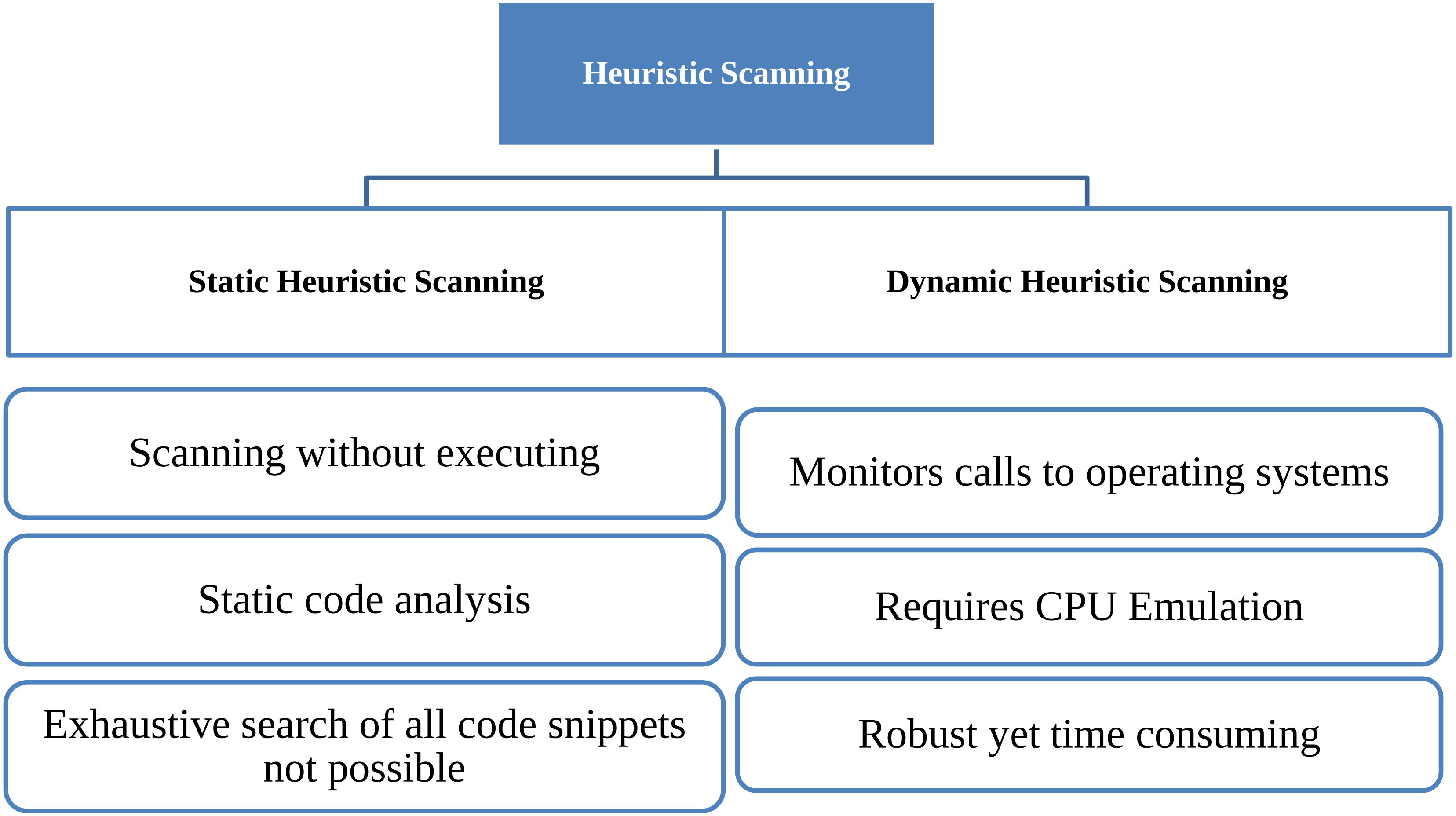
Kernel viruses

- Boot record viruses
- Master Boot Record Viruses
- Windows NT viruses

Appendix 4 - HEURISTIC SCANNING PARAMETERS

- Output using sample data
- Unusual destination
- File types and File System
- Memory Usage – Buffer overflow analysis, system registry
- Access of executables
- Access of disk
- Replication
- Attempts to hide other files
- Source code content matched using wild card characters

Appendix 5 - IMPLEMENTATION OF HEURISTIC SCANNING



Heuristic Scanning

Static Heuristic Scanning	**Dynamic Heuristic Scanning**
Scanning without executing	Monitors calls to operating systems
Static code analysis	Requires CPU Emulation
Exhaustive search of all code snippets not possible	Robust yet time consuming