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Packing Box

Playing with Executable Packing

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Outline

1. Introduction
2. Background
3. Framework
4. Quick Start
5. Advanced Use
6. Conclusion

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- Problem statement
- Objectives

Problem statement (1)

Packing =

- Set of transformations
- On binary file
- That preserves the original working at runtime

→ Large coverage in scientific literature

→ Often employed with malware

Problem statement (2)

Detection challenges :

- Diversity of packers
- Static analysis
- Reproducibility of related works
- Accurate ground truths
- Best features
- Best machine learning algorithms

- Currently no framework for the study of static detection
- Limited scope* of related works
- Poor repeatability of experiments

* typically PE malware

Objectives

1. Build a framework for repeatable experiments
2. Generate own (accurrate) datasets
3. Automate machine learning (ML) pipelines

+ Support for more than simply PE

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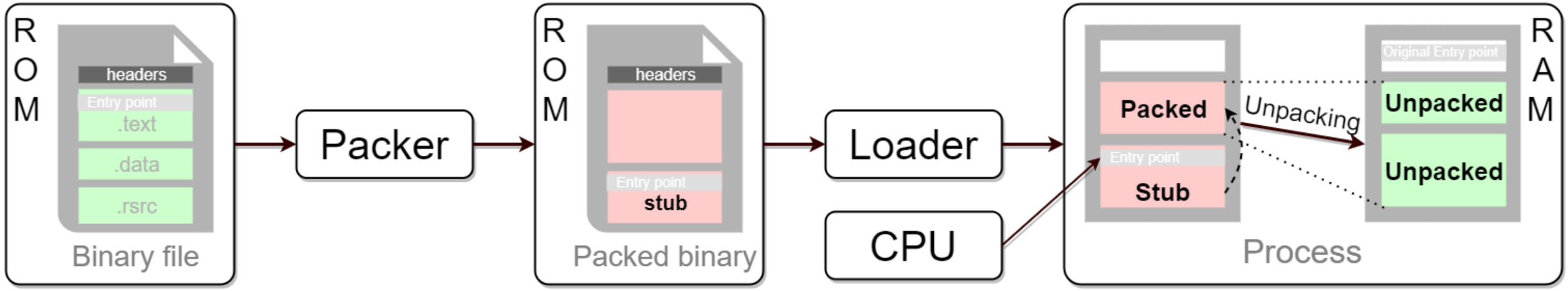
- Packing / unpacking
- Detection (static VS dynamic)
- Static features of binaries
- Learning pipeline

Packing / unpacking



Taxonomy of transformations :

- Compression
- Encryption
- Protection
- Bundling
- Mutation
- Virtualization

Common usage :

- Size reduction
- SW piracy prevention / License management
- Malware

Detection (static VS dynamic)

Static (no execution) :

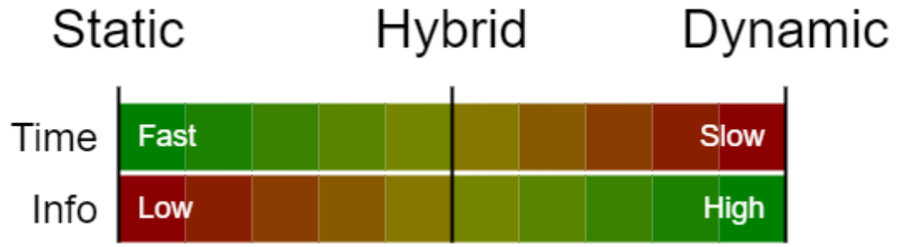
- Entropy threshold
- Pattern matching
- Signatures
- Disassembly
- …

VS

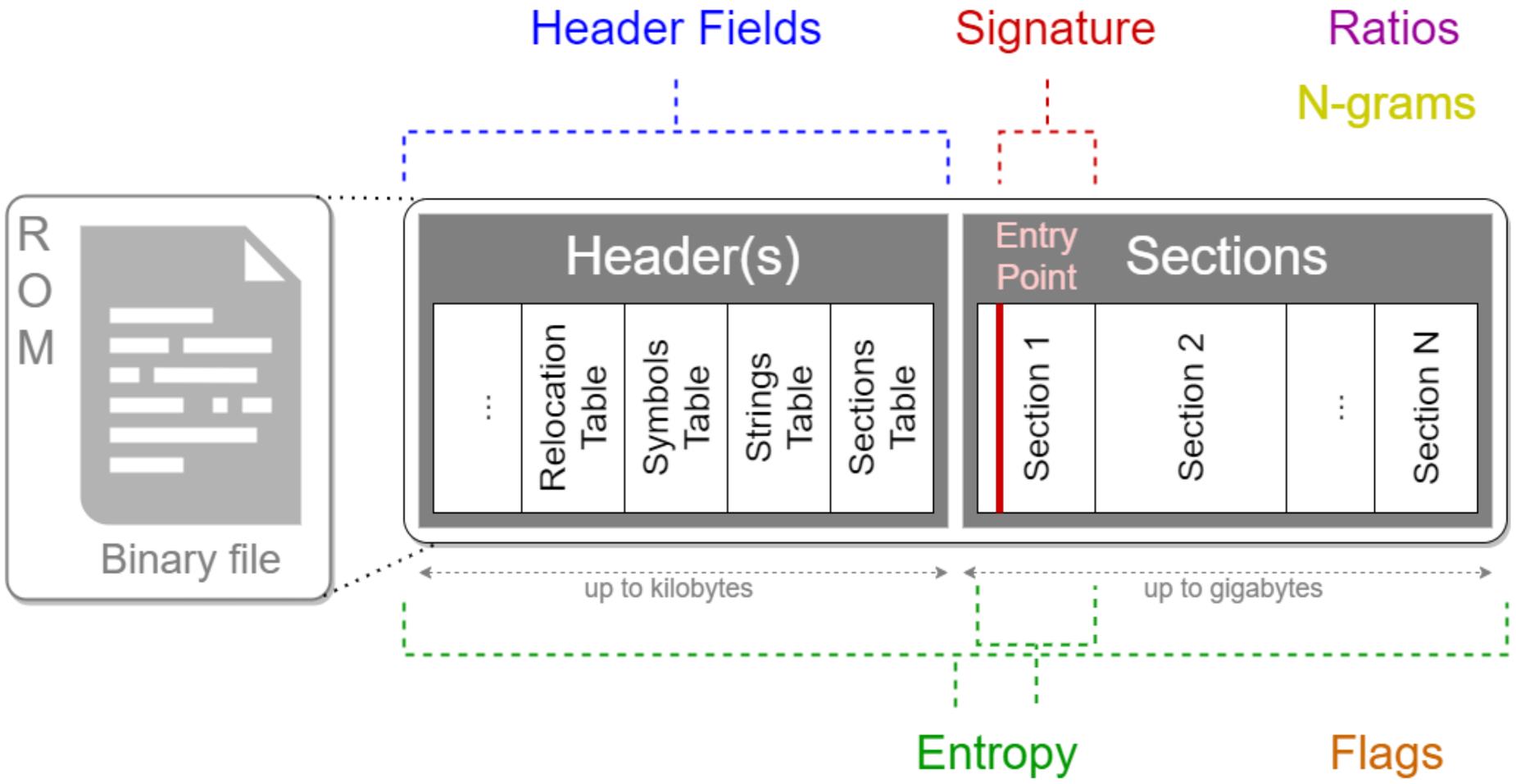
Dynamic (execution required) :

- Debugging
- Sandboxing
- Behavioral analysis
- Memory monitoring
- …

Time-information tradeoff :

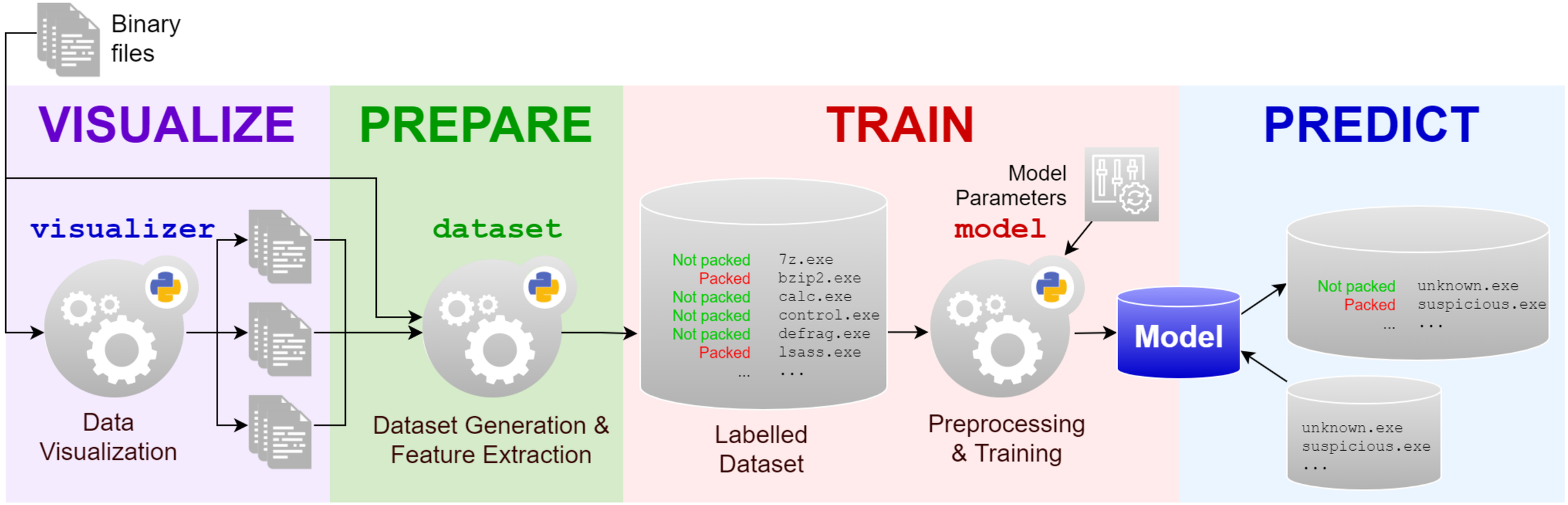


Static features of binaries



2. Background

Learning pipeline



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- Requirements
- Design principles
- Architecture
- Implementation
- Capabilities
- Related projects

Requirements

A. Scope : PE, ELF(, Mach-O)

B. Toolkit for supporting the complete ML pipeline

C. Easy integration of new items (detectors, packers, etc.)

D. Easy-to-manipulate Dataset structure

E. Easy tuning of the ML pipeline (algorithms, features, etc.)

Design principles

I. Terminal-based isolated full-featured container

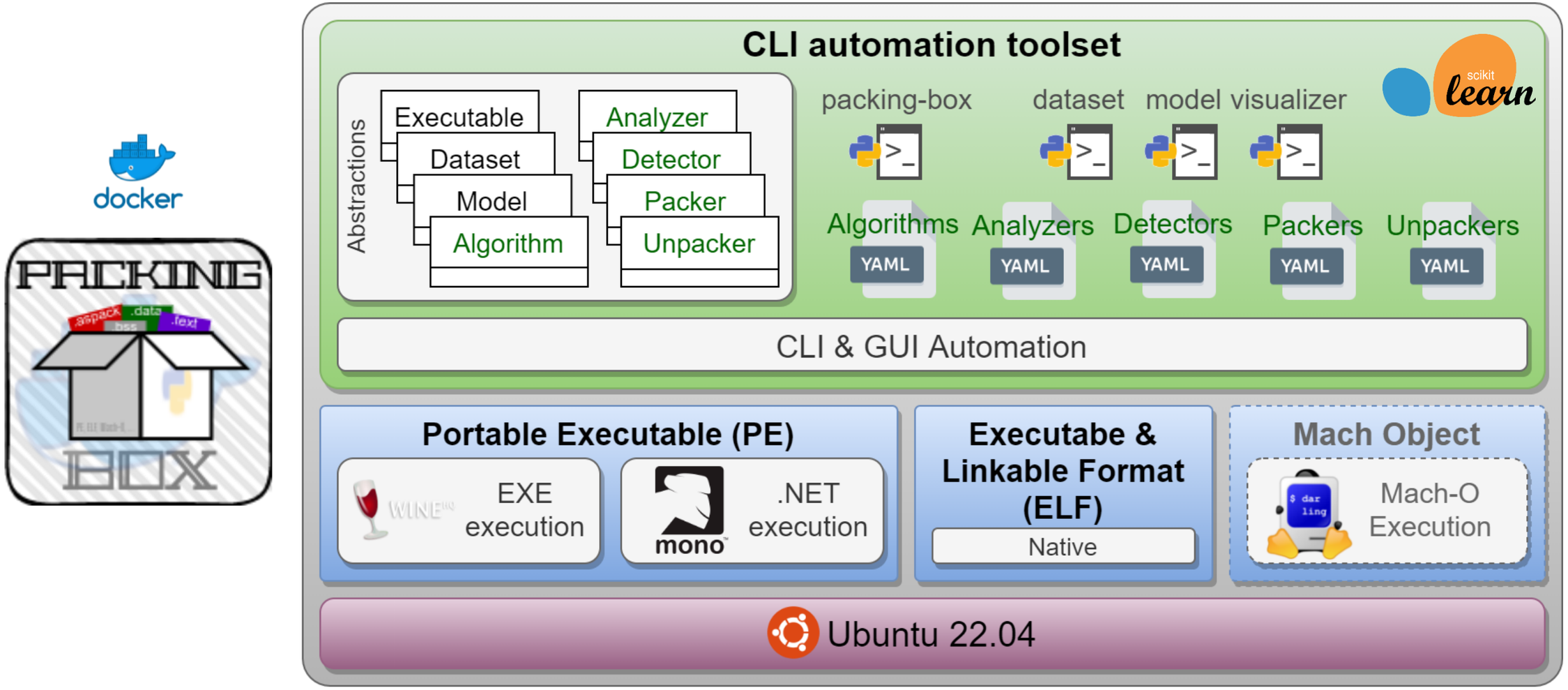
II. Automation layer (i.e. packers for mass-packing)

III. Configuration based on YAML

IV. Datasets & models management

V. Feature integration and combination

Architecture



Implementation

- YAML configurations
- Administration tool
- Toolkit for ML pipeline

```yaml
hXOR-Packer:
  categories:
    - compressor
    - cryptor
  description: A PE (Portable Executable) packer with Huffman Compression and Xor encryption.
  exclude:
    - DLL: PE32\+? executable \(DLL\)
  failure:
    hash: 1cc82b2855df0c2fb3c30dffe9f02512aebd79d7df8b00ce69aa0790aa60297e
  formats:
    - PE
  install:
    - wget: https://github.com/rurararura/hXOR-Packer:latest{hXOR-Packer}
    - unzip: $OPT
    - chmod: packer.exe
    - lwine: packer.exe
  references:
    - https://github.com/rurararura/hXOR-Packer
  source: https://github.com/rurararura/hXOR-Packer
  status: ok
  steps:
    - hxor-packer {{executable}} {{executable}} -ce {{key[randint]}}
  variants:
    hXOR-Compressor:
      categories:
        - compressor
      description: A PE (Portable Executable) packer with Huffman Compression.
      steps:
        - hxor-packer {{executable}} {{executable}} -c
```

Example configuration for hXOR-Packer

Capabilities

- Ground truth generation
- Dataset manipulation & sharing
- Model training & analysis
- Data visualization
- Performance analysis of state-of-the-art static detectors

Related projects

https://github.com/packing-box

- Resources

Awesome list gathering our whole bibliography and many other references to documentation, tools, etc.

Ready-to-use dataset of packed and not-packed ELF files

Ready-to-use dataset of packed and not-packed PE files from the enriched version of this repository

- Tools

Entropy-based tool inspired from the study of Lyda et al. in 2007

Operationalized fork of this un-maintained tool

Python fork of the popular tool, PEiD

Custom exchange format for datasets (supports conversion to ARFF, CSV, Packing-Box dataset)

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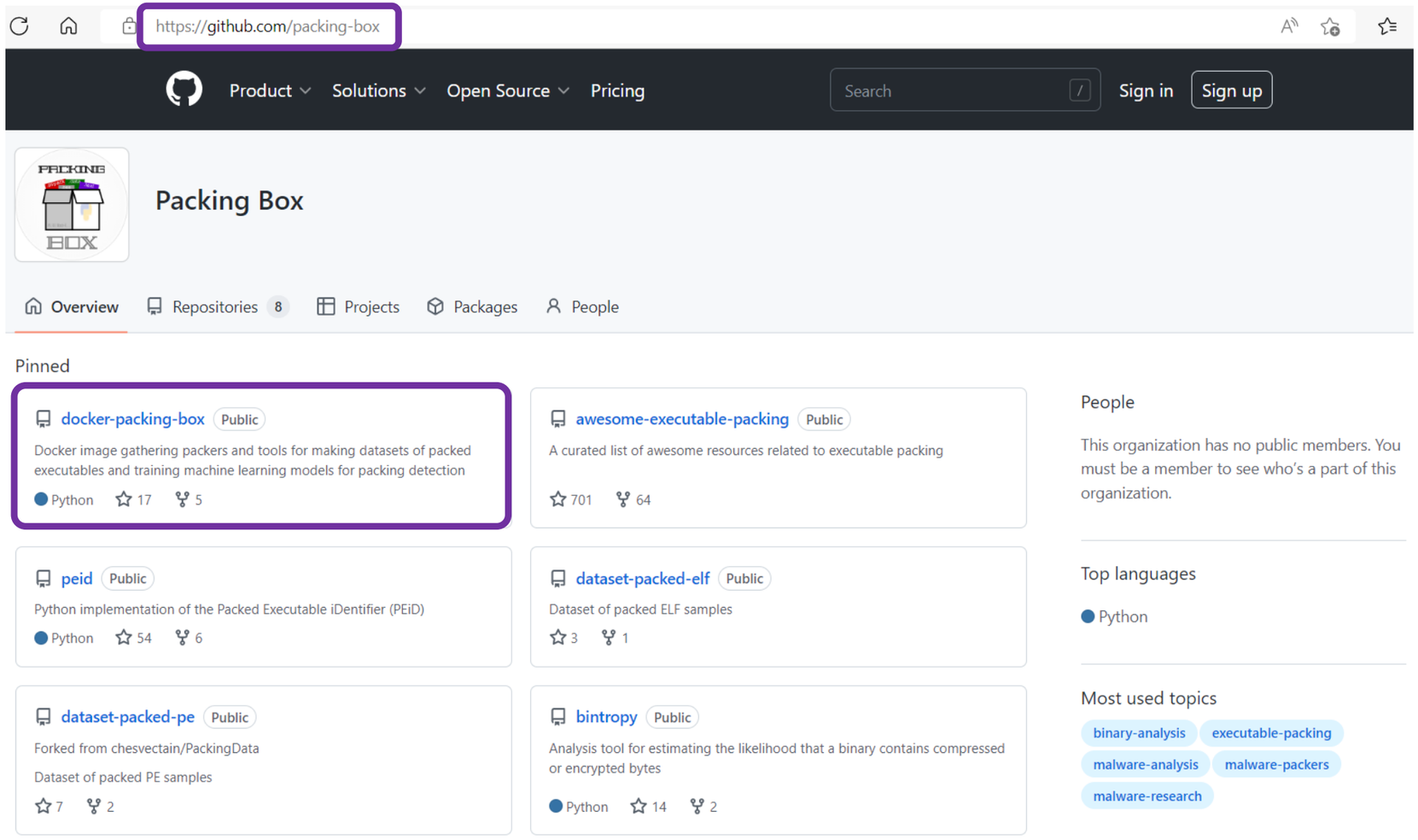
- Getting started
- Getting help
- Installing items
- Playing with datasets
- Playing with models

4. Quick Start

Getting started (1)

- Starting point :
  1. Open terminal
  2. Clone the repo



Please report any issue at : https://github.com/packing-box/docker-packing-box/issues

4. Quick Start

Getting started (2)

- Start : CLI open, Docker installed, repository cloned to **`[path_to_repo]`**
- Actions :

```
$ docker build -t dhondta/packing-box .
$ docker run -it -h packing-box -v `pwd`:/mnt/share dhondta/packing-box
```

- End state :
  - ✓ Packing Box CLI open
  - ✓ Startup message displaying the available items

Getting help

- Start : Packing Box CLI open
- Actions :

```
$ ?
$ ? -k packers
$ ? -i upx
```

- End state :
  - ✓ Help messages showing the status of in-scope items

Installing items

- Start : Packing Box CLI open
- Actions :

```
$ vim src/conf/packers.yml
$ packing-box -v setup packer upx
$ packing-box test packer upx
```

- End state :
  - ✓ UPX installed (verbose mode)
  - ✓ UPX tested on included samples

Playing with datasets

- Start : Packing Box CLI open, UPX installed
- Actions :

```
$ dataset make test-pe-upx -n 100 -f PE -p upx
$ dataset show test-pe-upx
$ dataset convert test-pe-upx
$ dataset edit test-pe-upx
```

- End state :
  - ✓ Dataset **`test-pe-upx`** of 100 UPX-packed PE samples
  - ✓ Dataset **`test-pe-upx`** converted to a fileless dataset (features computed)

4. Quick Start

Playing with models

- Start : Packing Box CLI open, **`test-pe-upx`** dataset created
- Actions :

```
$ model train test-pe-upx -a rf
$ model list
$ model show [model_name]
$ model test [model_name] test-pe-upx
```

- End state :
  - ✓ Model trained on the basis of **`test-upx`** (name generated automatically)
  - ✓ Model tested on the reference dataset for performance metrics

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- Model for PE packers
- Visualization of files & models
- Evaluation of detectors

Model for PE packers

- Start : Packing Box CLI open, **dataset-packer-pe** cloned
- Actions :

```
$ dataset update test-pe -s dataset-packer-pe/not-packed -l dataset-packer-pe/labels.json
$ for N in UPX RLPack TELock; do dataset update test-pe \
    -s dataset-packer-pe/packed/$N -l dataset-packer-pe/labels.json; done
$ model train test-pe -a dt
$ model test [model_name] test-pe-upx
```

- End state :
  - ✓ Dataset **test-pe** of mixed-packed PE samples based on **dataset-packer-pe**
  - ✓ Model trained on the basis of **test-pe**
  - ✓ Model tested on **test-pe-upx** for performance metrics

Visualization of files & models

- Start : Packing Box CLI open, `dataset-packer-pe` cloned, **`test-upx`** created
- Actions :

```
$ visualizer plot "PsExec.exe$" dataset-packed-pe -s -l not-packed -l MEW -l UPX
$ dataset plot test-upx byte_0_after_ep byte_1_after_ep --multiclass
$ model visualize [model_name]
```

- End state :
  - ✓ Visualization of `PsExec.exe` with multiple packed versions at scale
  - ✓ Visualization of bytes 0 and 1 after EP for a dataset with a mix of packers
  - ✓ Visualization of the given trained model

Evaluation of detectors

- Start : Packing Box CLI open
- Actions :

```
$ for N in {1..6}; do dataset make test-upx-variants -n 2 -f PE -p upx-3.9$N
    --pack-all; done
$ detector test-upx-variants -f -d die
$ detector test-upx-variants -f
```

- End state :
  - ✓ Dataset **`test-upx-variants`** with mixed samples (PE, ELF, …) all packed with multiple versions of UPX
  - ✓ Detector DIE then all the voting detectors (forming a superdetector) applied to the new dataset

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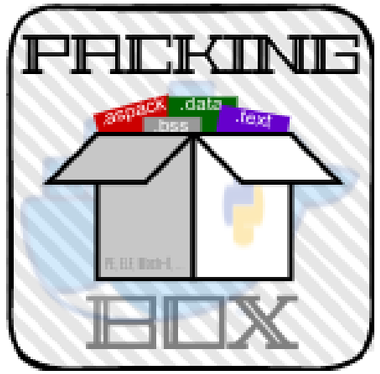
- Contribution
- Future works

Contribution



Toolkit for dataset manipulation and model training

- Support for many packers currently (incl. UPX, Ward, Yoda's Crypter, Amber, Eronana's Packer, …)
- Support for many detectors (incl. DIE, Bintropy, PEiD, PyPackerDetect, PEFrame, PEPack)
- Complete toolkit for the whole machine learning pipeline

Future works

- Research of best features
- Train models per category according to our taxonomy
- Adversarial learning based on altered datasets
- Semi-supervised and unsupervised learning