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# **malduck**

***Release 4.0.2***

**CERT Polska**

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Malduck is your ducky companion in malware analysis journeys. It is mostly based on [Roach](#) project, which derives many concepts from [mlib](#) library created by [Maciej Kotowicz](#). The purpose of fork was to make Roach independent from [Cuckoo Sandbox](#) project, but still supporting its internal *procmem* format.

Main goal is to make library for malware researchers, which will be something like [pwntools](#) for CTF players.

Malduck provides many improvements resulting from CERT.pl codebase, making malware analysis scripts much shorter and more powerful.



## STATIC CONFIGURATION EXTRACTOR ENGINE

### 1.1 Module interface

**class** malduck.extractor.Extractor (*parent*)

Base class for extractor modules

Following parameters need to be defined:

- *family* (see extractor.Extractor.family)
- *yara\_rules*
- *overrides* (optional, see extractor.Extractor.overrides)

Example extractor code for Citadel:

```
from malduck import Extractor

class Citadel(Extractor):
    family = "citadel"
    yara_rules = ("citadel",)
    overrides = ("zeus",)

    @Extractor.string("briankerbs")
    def citadel_found(self, p, addr, match):
        log.info('[+] `Coded by Brian Krebs` str @ %X' % addr)
        return True

    @Extractor.string
    def cit_login(self, p, addr, match):
        log.info('[+] Found login_key xor @ %X' % addr)
        hit = p.uint32v(addr + 4)
        print(hex(hit))
        if p.is_addr(hit):
            return {'login_key': p.asciiz(hit)}

        hit = p.uint32v(addr + 5)
        print(hex(hit))
        if p.is_addr(hit):
            return {'login_key': p.asciiz(hit)}
```

Decorated methods are always called in order:

- @Extractor.extractor methods
- @Extractor.string methods

- *@Extractor.rule* methods
- *@Extractor.final* methods

### @string

Decorator for string-based extractor methods. Method is called each time when string with the same identifier as method name has matched

Extractor can be called for many number-suffixed strings e.g. *\$keyex1* and *\$keyex2* will call *keyex* method.

You can optionally provide the actual string identifier as an argument if you don't want to name your method after the string identifier.

Signature of decorated method:

```
@Extractor.string
def string_identifier(self, p: ProcessMemory, addr: int, match:
↳YaraStringMatch) -> Config:
    # p: ProcessMemory object that contains matched file/dump representation
    # addr: Virtual address of matched string
    # Called for each "$string_identifier" hit
    ...
```

If you want to use same method for multiple different named strings, you can provide multiple identifiers as *@Extractor.string* decorator argument

Extractor methods should return *dict* object with extracted part of configuration, *True* indicating a match or *False/None* when family has not been matched.

For strong methods: truthy values are transformed to *dict* with *{“family”: self.family}* key.

New in version 4.0.0: Added *@Extractor.string* as extended version of *@Extractor.extractor*

**Parameters** *strings\_or\_method* (\*str, optional) – If method name doesn't match the string identifier, pass yara string identifier as decorator argument. Multiple strings are accepted

### @extractor

Simplified variant of *@Extractor.string*.

Doesn't accept multiple strings and passes only string offset to the extractor method.

```
from malduck import Extractor

class Citadel(Extractor):
    family = "citadel"
    yara_rules = ("citadel",)
    overrides = ("zeus",)

    @Extractor.extractor("briankerbs")
    def citadel_found(self, p, addr):
        # Called for each $briankerbs hit
        ...

    @Extractor.extractor
    def cit_login(self, p, addr):
        # Called for each $cit_login1, $cit_login2 hit
        ...
```

### @rule

Decorator for rule-based extractor methods, called once for rule match after string-based extraction methods.



Method is called each time when rule with the same identifier as method name has matched.

You can optionally provide the actual rule identifier as an argument if you don't want to name your method after the rule identifier.

Rule identifier must appear in `yara_rules` tuple.

Signature of decorated method:

```
@Extractor.rule
def rule_identifier(self, p: ProcessMemory, matches: YaraMatch) -> Config:
    # p: ProcessMemory object that contains matched file/dump representation
    # matches: YaraMatch object with offsets of all matched strings related
    # with the rule
    # Called for matched rule named "rule_identifier".
    ...
```

New in version 4.0.0: Added `@Extractor.rule` decorator

```
from malduck import Extractor

class Evil(Extractor):
    yara_rules = ("evil", "weird")
    family = "evil"
    ...

    @Extractor.rule
    def evil(self, p, matches):
        # This will be called each time evil match.
        # `matches` is YaraMatch object that contains information about
        # all string matches related with this rule.
        ...
```

**Parameters** `string_or_method(str, optional)` – If method name doesn't match the rule identifier pass yara string identifier as decorator argument

## @final

Decorator for final extractor methods, called once for each single rule match after other extraction methods.

Behaves similarly to the `@rule`-decorated methods but is called for each rule match regardless of the rule identifier.

Signature of decorated method:

```
@Extractor.rule
def rule_identifier(self, p: ProcessMemory) -> Config:
    # p: ProcessMemory object that contains matched file/dump representation
    # Called for each matched rule in self.yara_rules
    ...
```

```
from malduck import Extractor

class Evil(Extractor):
    yara_rules = ("evil", "weird")
    family = "evil"
    ...
```

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```
@Extractor.needs_pe
@Extractor.final
def get_config(self, p):
    # This will be called each time evil or weird match
    cfg = {"urls": self.get_cncls_from_rsrc(p)}
    if "role" not in self.collected_config:
        cfg["role"] = "loader"
    return cfg
```

#### @weak

Use this decorator for extractors when successful extraction is not sufficient to mark family as matched.

All “weak configs” will be flushed when “strong config” appears.

Changed in version 4.0.0: Method must be decorated first with @extractor, @rule or @final decorator

```
from malduck import Extractor

class Evil(Extractor):
    yara_rules = ("evil", "weird")
    family = "evil"

    ...

    @Extractor.weak
    @Extractor.extractor
    def dga_seed(self, p, hit):
        # Even if we're able to get the DGA seed, extractor won't produce_
↪config
        # until is_it_really_evil match as well
        dga_config = p.readv(hit, 128)
        seed = self._get_dga_seed(dga_config)
        if seed is not None:
            return {"dga_seed": seed}

    @Extractor.final
    def is_it_really_evil(self, p):
        # If p starts with 'evil', we can produce config
        return p.read(p.imgbase, 4) == b'evil'
```

#### @needs\_pe

Use this decorator for extractors that need PE instance. (p is guaranteed to be malduck.procmem.ProcessMemoryPE)

Changed in version 4.0.0: Method must be decorated first with @extractor, @rule or @final decorator

#### @needs\_elf

Use this decorator for extractors that need ELF instance. (p is guaranteed to be malduck.procmem.ProcessMemoryELF)

Changed in version 4.0.0: Method must be decorated first with @extractor, @rule or @final decorator.

#### property collected\_config

Shows collected config so far (useful in “final” extractors)

**Return type** dict

#### family = None

Extracted malware family, automatically added to “family” key for strong extraction methods

### property globals

Container for global variables associated with analysis

**Return type** dict

### handle\_match(*p, match*)

Override this if you don't want to use decorators and customize ripping process (e.g. yara-independent, brute-force techniques)

Called for each rule hit listed in `Extractor.yara_rules`.

Overriding this method means that all Yara hits must be processed within this method. Ripped configurations must be reported using `push_config()` method.

#### Parameters

- **p** (`malduck.procmem.ProcessMemory`) – ProcessMemory object
- **match** (`malduck.yara.YaraRuleMatch`) – Found yara matches for currently matched rule

### property log

Logger instance for Extractor methods

**Returns** `logging.Logger`

### property matched

Returns True if family has been matched so far

**Return type** bool

### on\_error(*exc, method\_name*)

Handler for all Exception's thrown by extractor methods.

#### Parameters

- **exc** (`Exception`) – Exception object
- **method\_name** (`str`) – Name of method which throwed exception

### overrides = []

Family match overrides another match e.g. citadel overrides zeus

### push\_config(*config*)

Push partial config (used by `Extractor.handle_match()`)

**Parameters** **config** (`dict`) – Partial config element

### push\_procmem(*procmem: malduck.procmem.procmem.ProcessMemory, \*\*info*)

Push extracted procmem object for further analysis

#### Parameters

- **procmem** (`malduck.procmem.ProcessMemory`) – ProcessMemory object
- **info** – Additional info about object

### yara\_rules = ()

Names of Yara rules for which handle\_match is called

### class malduck.extractor.ExtractManager(*modules: malduck.extractor.extract\_manager.ExtractorModules*)

Multi-dump extraction context. Handles merging configs from different dumps, additional dropped families etc.

**Parameters** **modules** (`ExtractorModules`) – Object with loaded extractor modules

### property config

Extracted configuration (list of configs for each extracted family)

### property extractors

Bound extractor modules :rtype: List[Type[*malduck.extractor.Extractor*]]

**on\_error** (*exc: Exception, extractor: malduck.extractor.extractor.Extractor*) → None

Handler for all Exception's thrown by *Extractor.handle\_yara()*.

Deprecated since version 2.1.0: Look at *ExtractManager.on\_extractor\_error()* instead.

#### Parameters

- **exc** (Exception) – Exception object
- **extractor** (*malduck.extractor.Extractor*) – Extractor object which threw exception

**on\_extractor\_error** (*exc: Exception, extractor: malduck.extractor.extractor.Extractor, method\_name: str*) → None

Handler for all Exception's thrown by extractor methods (including *Extractor.handle\_yara()*).

Override this method if you want to set your own error handler.

#### Parameters

- **exc** (Exception) – Exception object
- **extractor** (*extractor.Extractor*) – Extractor instance
- **method\_name** (*str*) – Name of method which threw exception

**push\_file** (*filepath: str, base: int = 0*) → Optional[str]

Pushes file for extraction. Config extractor entriypoint.

#### Parameters

- **filepath** (*str*) – Path to extracted file
- **base** (*int*) – Memory dump base address

**Returns** Family name if ripped successfully and provided better configuration than previous files. Returns None otherwise.

**push\_procmem** (*p: malduck.procmem.procmem.ProcessMemory, rip\_binaries: bool = False*) → Optional[str]

Pushes ProcessMemory object for extraction

#### Parameters

- **p** (*malduck.procmem.ProcessMemory*) – ProcessMemory object
- **rip\_binaries** – Look for binaries (PE, ELF) in provided ProcessMemory and try to perform extraction using

specialized variants (*ProcessMemoryPE*, *ProcessMemoryELF*) :type *rip\_binaries*: bool (default: False)  
:return: Family name if ripped successfully and provided better configuration than previous procmems.

Returns None otherwise.

### property rules

Bound Yara rules :rtype: *malduck.yara.Yara*

**class** *malduck.extractor.ExtractorModules* (*modules\_path: Optional[str] = None*)

Configuration object with loaded Extractor modules for *ExtractManager*

**Parameters** **modules\_path** (*str*) – Path with module files (Extractor classes and Yara files, default '~/.malduck')

**on\_error** (*exc: Exception, module\_name: str*) → None  
 Handler for all Exception's thrown during module load  
 Override this method if you want to set your own error handler.

#### Parameters

- **exc** (*Exception*) – Exception object
- **module\_name** (*str*) – Name of module which threw exception

## 1.2 Internally used classes and routines

**class** `malduck.extractor.extract_manager.ProcmemExtractManager` (*parent: malduck.extractor.extract\_manager.ExtractManager*)

Single-dump extraction context (single family)

**collected\_config** = None  
 Collected configuration so far (especially useful for “final” extractors)

**property config**  
 Returns collected config, but if family is not matched - returns empty dict. Family is not included in config itself, look at `ProcmemExtractManager.family`.

**family** = None  
 Matched family

**on\_extractor\_error** (*exc: Exception, extractor: malduck.extractor.extractor.Extractor, method\_name: str*) → None  
 Handler for all Exception's thrown by extractor methods.

#### Parameters

- **exc** (*Exception*) – Exception object
- **extractor** (*extractor.Extractor*) – Extractor instance
- **method\_name** (*str*) – Name of method which threw exception

**parent** = None  
 Bound ExtractManager instance

**push\_config** (*config: Dict[str, Any], extractor: malduck.extractor.extractor.Extractor*) → None  
 Pushes new partial config

If strong config provides different family than stored so far and that family overrides stored family - set stored family Example: citadel overrides zeus

#### Parameters

- **config** (*dict*) – Partial config object
- **extractor** (*malduck.extractor.Extractor*) – Extractor object reference

**push\_procmem** (*p: malduck.procmem.procmem.ProcessMemory, \_matches: Optional[malduck.yara.YaraRulesetMatch] = None*) → None  
 Pushes ProcessMemory object for extraction

#### Parameters

- **p** (*malduck.procmem.ProcessMemory*) – ProcessMemory object
- **\_matches** (*malduck.yara.YaraRulesetMatch*) – YaraRulesetMatch object (used internally)



## MEMORY MODEL OBJECTS (PROC MEM)

### 2.1 ProcessMemory (procmem)

`malduck.procmem`

alias of `malduck.procmem.procmem.ProcessMemory`

**class** `malduck.procmem.procmem.ProcessMemory` (*buf*, *base=0*, *regions=None*, *\*\*\_*)

Basic virtual memory representation

Short name: *procmem*

#### Parameters

- **buf** (*bytes*, *mmap*, *memoryview* or *bytearray* object) – Object with memory contents
- **base** (*int*, optional (default: 0)) – Virtual address of the region of interest (or beginning of *buf* when no regions provided)
- **regions** (List[*Region*]) – Regions mapping. If set to *None* (default), *buf* is mapped into single-region with VA specified in *base* argument

Let's assume that *notepad.exe\_400000.bin* contains raw memory dump starting at 0x400000 base address. We can easily load that file to *ProcessMemory* object, using *from\_file()* method:

```
from malduck import procmem

with procmem.from_file("notepad.exe_400000.bin", base=0x400000) as p:
    mem = p.readv(...)
    ...
```

If your data are loaded yet into buffer, you can directly use *procmem* constructor:

```
from malduck import procmem

with open("notepad.exe_400000.bin", "rb") as f:
    payload = f.read()

p = procmem(payload, base=0x400000)
```

Then you can work with PE image contained in dump by creating *ProcessMemoryPE* object, using its *from\_memory()* constructor method

```
from malduck import procmem

with open("notepad.exe_400000.bin", "rb") as f:
```

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```
payload = f.read()

p = procmem(payload, base=0x400000)
ppe = procmempe.from_memory(p)
ppe.pe.resource("NPENCODINGDIALOG")
```

If you want to load PE file directly and work with it in a similar way as with memory-mapped files, just use *image* parameter. It also works with `ProcessMemoryPE.from_memory()` for embedded binaries. Your file will be loaded and relocated in similar way as it's done by Windows loader.

```
from malduck import procmempe

with procmempe.from_file("notepad.exe", image=True) as p:
    p.pe.resource("NPENCODINGDIALOG")
```

**addr\_region** (*addr*)

Returns *Region* object mapping specified virtual address

**Parameters** *addr* – Virtual address

**Return type** *Region*

**asciiiz** (*addr*)

Read a null-terminated ASCII string at address.

**close** (*copy=False*)

Closes opened files referenced by ProcessMemory object owned by this object.

If copy is False (default): invalidates the object.

**Parameters** *copy* (*bool*) – Copy data into string before closing the mmap object (default: False)

**disasmv** (*addr*, *size=None*, *x64=False*, *count=None*)

Disassembles code under specified address

Changed in version 4.0.0: Returns iterator instead of list of instructions

**Parameters**

- **addr** (*int*) – Virtual address
- **size** (*int* *optional*) – Size of disassembled buffer
- **count** (*int* *optional*) – Number of instructions to disassemble
- **x64** (*bool* *optional*) – Assembly is 64bit

**Returns** `List[Instruction]`

**extract** (*modules=None*, *extract\_manager=None*)

Tries to extract config from ProcessMemory object

**Parameters**

- **modules** (*malduck.extractor.ExtractorModules*) – Extractor modules object (optional, loads '~/.malduck' by default)
- **extract\_manager** (*malduck.extractor.ExtractManager*) – ExtractManager object (optional, creates ExtractManager by default)

**Returns** Static configuration(s) (*malduck.extractor.ExtractManager.config*) or None if not extracted



**Return type** List[dict] or None

**findbytesp** (*query*, *offset=None*, *length=None*)

Search for byte sequences (e.g., `4? AA BB ?? DD`). Uses `yarap()` internally

If offset is None, looks for match from the beginning of memory

New in version 1.4.0: Query is passed to yarap as single hexadecimal string rule. Use Yara-compatible strings only

**Parameters**

- **query** (*str* or *bytes*) – Sequence of wildcarded hexadecimal bytes, separated by spaces
- **offset** (*int* (optional)) – Buffer offset where searching will be started
- **length** (*int* (optional)) – Length of searched area

**Returns** Iterator returning next offsets

**Return type** Iterator[int]

**findbytesv** (*query*, *addr=None*, *length=None*)

Search for byte sequences (e.g., `4? AA BB ?? DD`). Uses `yarav()` internally

If addr is None, looks for match from the beginning of memory

New in version 1.4.0: Query is passed to yarav as single hexadecimal string rule. Use Yara-compatible strings only

**Parameters**

- **query** (*str* or *bytes*) – Sequence of wildcarded hexadecimal bytes, separated by spaces
- **addr** (*int* (optional)) – Virtual address where searching will be started
- **length** (*int* (optional)) – Length of searched area

**Returns** Iterator returning found virtual addresses

**Return type** Iterator[int]

Usage example:

```
from malduck import hex

findings = []

for va in mem.findbytesv("4? AA BB ?? DD"):
    if hex(mem.readv(va, 5)) == "4aaabccdd":
        findings.append(va)
```

**findmz** (*addr*)

Tries to locate MZ header based on address inside PE image

**Parameters** **addr** (*int*) – Virtual address inside image

**Returns** Virtual address of found MZ header or None

**findp** (*query*, *offset=None*, *length=None*)

Find raw bytes in memory (non-region-wise).

If offset is None, looks for substring from the beginning of memory

**Parameters**

- **query** (*bytes*) – Substring to find
- **offset** (*int (optional)*) – Offset in buffer where searching starts
- **length** (*int (optional)*) – Length of searched area

**Returns** Generates offsets where bytes were found

**Return type** Iterator[int]

**findv** (*query, addr=None, length=None*)

Find raw bytes in memory (region-wise)

If *addr* is None, looks for substring from the beginning of memory

**Parameters**

- **query** (*bytes*) – Substring to find
- **addr** (*int (optional)*) – Virtual address of region where searching starts
- **length** (*int (optional)*) – Length of searched area

**Returns** Generates offsets where regex was matched

**Return type** Iterator[int]

**classmethod from\_file** (*filename, \*\*kwargs*)

Opens file and loads its contents into ProcessMemory object

**Parameters** **filename** – File name to load

**Return type** *ProcessMemory*

It's highly recommended to use context manager when operating on files:

```
from malduck import procmem

with procmem.from_file("binary.dmp") as p:
    mem = p.readv(...)
    ...
```

**classmethod from\_memory** (*memory, base=None, \*\*kwargs*)

Makes new instance based on another ProcessMemory object.

Useful for specialized derived classes like CuckooProcessMemory

**Parameters**

- **memory** (*ProcessMemory*) – ProcessMemory object to be copied
- **base** (*int (optional, default is provided by specialized class)*) – Virtual address of region of interest (imgbase)

**Return type** *ProcessMemory*

**int16p** (*offset, fixed=False*)

Read signed 16-bit value at offset.

**int16v** (*addr, fixed=False*)

Read signed 16-bit value at address.

**int32p** (*offset, fixed=False*)

Read signed 32-bit value at offset.

**int32v** (*addr, fixed=False*)

Read signed 32-bit value at address.

**int64p** (*offset, fixed=False*)

Read signed 64-bit value at offset.

**int64v** (*addr, fixed=False*)

Read signed 64-bit value at address.

**int8p** (*offset, fixed=False*)

Read signed 8-bit value at offset.

**int8v** (*addr, fixed=False*)

Read signed 8-bit value at address.

**is\_addr** (*addr*)

Checks whether provided parameter is correct virtual address :param addr: Virtual address candidate :return: True if it is mapped by ProcessMemory object

**iter\_regions** (*addr=None, offset=None, length=None, contiguous=False, trim=False*)

Iterates over Region objects starting at provided virtual address or offset

This method is used internally to enumerate regions using provided strategy.

**Warning:** If starting point is not provided, iteration will start from the first mapped region. This could be counter-intuitive when length is set. It literally means “get <length> of mapped bytes”. If you want to look for regions from address 0, you need to explicitly provide this address as an argument.

New in version 3.0.0.

#### Parameters

- **addr** (*int (default: None)*) – Virtual address of starting point
- **offset** (*int (default: None)*) – Offset of starting point, which will be translated to virtual address
- **length** (*int (default: None, unlimited)*) – Length of queried range in VM mapping context
- **contiguous** (*bool (default: False)*) – If True, break after first gap. Starting point must be inside mapped region.
- **trim** (*bool (default: False)*) – Trim Region objects to range boundaries (addr, addr+length)

**Return type** Iterator[[Region](#)]

#### property length

Returns length of raw memory contents :rtype: int

**p2v** (*off, length=None*)

Buffer (physical) offset to virtual address translation

Changed in version 3.0.0: Added optional mapping length check

#### Parameters

- **off** – Buffer offset
- **length** – Expected minimal length of mapping (optional)

**Returns** Virtual address or None if offset is not mapped

**patchp** (*offset*, *buf*)

Patch bytes under specified offset

**Warning:** Family of *\*p* methods doesn't care about contiguity of regions.  
Use *p2v()* and *patchv()* if you want to operate on contiguous regions only

#### Parameters

- **offset** (*int*) – Buffer offset
- **buf** (*bytes*) – Buffer with patch to apply

Usage example:

```
from malduck import procmempe, aplib

with procmempe("mall.exe.dmp") as ppe:
    # Decompress payload
    payload = aplib().decompress(
        ppe.readv(ppe.imgbase + 0x8400, ppe.imgend)
    )
    embed_pe = procmem(payload, base=0)
    # Fix headers
    embed_pe.patchp(0, b"MZ")
    embed_pe.patchp(embed_pe.uint32p(0x3C), b"PE")
    # Load patched image into procmempe
    embed_pe = procmempe.from_memory(embed_pe, image=True)
    assert embed_pe.asciiz(0x1000a410) == b"StrToIntExA"
```

**patchv** (*addr*, *buf*)

Patch bytes under specified virtual address

Patched address range must be within single region, ValueError is raised otherwise.

#### Parameters

- **addr** (*int*) – Virtual address
- **buf** (*bytes*) – Buffer with patch to apply

**readp** (*offset*, *length=None*)

Read a chunk of memory from the specified buffer offset.

**Warning:** Family of *\*p* methods doesn't care about contiguity of regions.  
Use *p2v()* and *readv()* if you want to operate on contiguous regions only

#### Parameters

- **offset** – Buffer offset
- **length** – Length of chunk (optional)

**Returns** Chunk from specified location

**Return type** bytes

**readv** (*addr*, *length=None*)

Read a chunk of memory from the specified virtual address

**Parameters**

- **addr** (*int*) – Virtual address
- **length** (*int*) – Length of chunk (optional)

**Returns** Chunk from specified location

**Return type** bytes

**readv\_regions** (*addr=None*, *length=None*, *contiguous=True*)

Generate chunks of memory from next contiguous regions, starting from the specified virtual address, until specified length of read data is reached.

Used internally.

Changed in version 3.0.0: Contents of contiguous regions are merged into single string

**Parameters**

- **addr** – Virtual address
- **length** – Size of memory to read (optional)
- **contiguous** – If True, readv\_regions breaks after first gap

**Return type** Iterator[Tuple[int, bytes]]

**readv\_until** (*addr*, *s*)

Read a chunk of memory until the stop marker

**Parameters**

- **addr** (*int*) – Virtual address
- **s** (*bytes*) – Stop marker

**Return type** bytes

**regexp** (*query*, *offset=None*, *length=None*)

Performs regex on the memory contents (non-region-wise)

If offset is None, looks for match from the beginning of memory

**Parameters**

- **query** (*bytes*) – Regular expression to find
- **offset** (*int* (optional)) – Offset in buffer where searching starts
- **length** (*int* (optional)) – Length of searched area

**Returns** Generates offsets where regex was matched

**Return type** Iterator[int]

**regexv** (*query*, *addr=None*, *length=None*)

Performs regex on the memory contents (region-wise)

If addr is None, looks for match from the beginning of memory

**Parameters**

- **query** (*bytes*) – Regular expression to find
- **addr** (*int* (optional)) – Virtual address of region where searching starts

- **length** (*int* *optional*) – Length of searched area

**Returns** Generates offsets where regex was matched

**Return type** Iterator[int]

**Warning:** Method doesn't match bytes overlapping the border between regions

**uint16p** (*offset, fixed=False*)

Read unsigned 16-bit value at offset.

**uint16v** (*addr, fixed=False*)

Read unsigned 16-bit value at address.

**uint32p** (*offset, fixed=False*)

Read unsigned 32-bit value at offset.

**uint32v** (*addr, fixed=False*)

Read unsigned 32-bit value at address.

**uint64p** (*offset, fixed=False*)

Read unsigned 64-bit value at offset.

**uint64v** (*addr, fixed=False*)

Read unsigned 64-bit value at address.

**uint8p** (*offset, fixed=False*)

Read unsigned 8-bit value at offset.

**uint8v** (*addr, fixed=False*)

Read unsigned 8-bit value at address.

**utf16z** (*addr*)

Read a null-terminated UTF-16 ASCII string at address.

**Parameters** **addr** – Virtual address of string

**Return type** bytes

**v2p** (*addr, length=None*)

Virtual address to buffer (physical) offset translation

Changed in version 3.0.0: Added optional mapping length check

**Parameters**

- **addr** – Virtual address
- **length** – Expected minimal length of mapping (optional)

**Returns** Buffer offset or None if virtual address is not mapped

**yarap** (*ruleset, offset=None, length=None, extended=False*)

Perform yara matching (non-region-wise)

If offset is None, looks for match from the beginning of memory

Changed in version 4.0.0: Added *extended* option which allows to get extended information about matched strings and rules. Default is False for backwards compatibility.

**Parameters**

- **ruleset** (*malduck.yara.Yara*) – Yara object with loaded yara rules
- **offset** (*int* *optional*) – Offset in buffer where searching starts

- **length** (*int (optional)*) – Length of searched area
- **extended** (*bool (optional, default False)*) – Returns extended information about matched strings and rules

**Return type** `malduck.yara.YaraMatches`

**yarav** (*ruleset, addr=None, length=None, extended=False*)

Perform yara matching (region-wise)

If *addr* is *None*, looks for match from the beginning of memory

Changed in version 4.0.0: Added *extended* option which allows to get extended information about matched strings and rules. Default is *False* for backwards compatibility.

#### Parameters

- **ruleset** (`malduck.yara.Yara`) – Yara object with loaded yara rules
- **addr** (*int (optional)*) – Virtual address of region where searching starts
- **length** (*int (optional)*) – Length of searched area
- **extended** (*bool (optional, default False)*) – Returns extended information about matched strings and rules

**Return type** `malduck.yara.YaraRulesetOffsets` or `malduck.yara.YaraRulesetMatches` if *extended* is set to *True*

**class** `malduck.procmem.procmem.Region` (*addr: int, size: int, state: int, type\_: int, protect: int, offset: int*)

Represents single mapped region in `ProcessMemory`

**contains\_addr** (*addr: int*) → *bool*

Checks whether region contains provided virtual address

**contains\_offset** (*offset: int*) → *bool*

Checks whether region contains provided physical offset

**property end**

Virtual address of region end (first unmapped byte)

**property end\_offset**

Offset of region end (first unmapped byte)

**intersects\_range** (*addr: int, length: int*) → *bool*

Checks whether region mapping intersects with provided range

**property last**

Virtual address of last region byte

**property last\_offset**

Offset of last region byte

**p2v** (*off: int*) → *int*

Physical offset to translation. Assumes that offset is valid within `Region`. :param *off*: Physical offset :return: Virtual address

**to\_json** () → *Dict[str, Union[int, str, None]]*

Returns JSON-like dict representation

**trim\_range** (*addr: int, length: Optional[int] = None*) → *Optional[malduck.procmem.region.Region]*

Returns region intersection with provided range :param *addr*: Virtual address of starting point :param *length*: Length of range (optional) :rtype: `Region`

**v2p** (*addr: int*) → int

Virtual address to physical offset translation. Assumes that address is valid within Region. :param addr: Virtual address :return: Physical offset

## 2.2 ProcessMemoryPE (procmempe)

malduck.**procmempe**

alias of *malduck.procmem.procmempe.ProcessMemoryPE*

**class** malduck.procmem.procmempe.**ProcessMemoryPE** (*buf: Union[bytes, bytearray, mmap.mmap], base: int = 0, regions: Optional[List[malduck.procmem.region.Region]] = None, image: bool = False, detect\_image: bool = False*)

Representation of memory-mapped PE file

Short name: *procmempe*

PE files can be read directly using inherited `ProcessMemory.from_file()` with *image* argument set (look at `from_memory()` method).

**property** *imgend*

Address where PE image ends

**is\_image\_loaded\_as\_memdump** () → bool

Checks whether memory region contains image incorrectly loaded as memory-mapped PE dump (image=False).

```
embed_pe = procmempe.from_memory(mem)
if not embed_pe.is_image_loaded_as_memdump():
    # Memory contains plain PE file - need to load it first
    embed_pe = procmempe.from_memory(mem, image=True)
```

**is\_valid** () → bool

Checks whether imgbase is pointing at valid binary header

**property** *pe*

Related PE object

**store** () → bytes

Store ProcessMemoryPE contents as PE file data.

**Return type** bytes

## 2.3 ProcessMemoryELF (procmemelf)

malduck.**procmemelf**

alias of *malduck.procmem.procmemelf.ProcessMemoryELF*

**class** malduck.procmem.procmemelf.**ProcessMemoryELF** (*buf: Union[bytes, bytearray, mmap.mmap], base: int = 0, regions: Optional[List[malduck.procmem.region.Region]] = None, image: bool = False, detect\_image: bool = False*)



Representation of memory-mapped ELF file

Short name: *procmemelf*

ELF files can be read directly using inherited `ProcessMemory.from_file()` with *image* argument set (look at `from_memory()` method).

**property elf**

Related `ELFFile` object

**property imgend**

Address where ELF image ends

**is\_image\_loaded\_as\_memdump()**

Uses some heuristics to deduce whether contents can be loaded with *image=True*. Used by *detect\_image*

**is\_valid()** → bool

Checks whether imgbase is pointing at valid binary header

## 2.4 CuckooProcessMemory (cuckoomem)

`malduck.cuckoomem`

alias of `malduck.procmem.cuckoomem.CuckooProcessMemory`

**class** `malduck.procmem.cuckoomem.CuckooProcessMemory` (*buf: Union[bytes, bytearray, mmap.mmap], base: Optional[int] = None, \*\*\_*)

Wrapper object to operate on process memory dumps in Cuckoo 2.x format.

## 2.5 IDAProcessMemory (idamem)

`malduck.idamem`

alias of `malduck.procmem.idamem.IDAProcessMemory`

**class** `malduck.procmem.idamem.IDAProcessMemory`

ProcessMemory representation operating in IDAPython context [BETA]



## X86 DISASSEMBLER

**class** malduck.disasm.Disassemble

**disassemble** (*data: bytes, addr: int, x64: bool = False, count: int = 0*) → Iterator[malduck.disasm.Instruction]  
Disassembles data from specific address

Changed in version 4.0.0: Returns iterator instead of list of instructions, accepts maximum number of instructions to disassemble

short: disasm

### Parameters

- **data** (*bytes*) – Block of data to disassemble
- **addr** (*int*) – Virtual address of data
- **x64** (*bool (default=False)*) – Disassemble in x86-64 mode?
- **count** (*int (default=0)*) – Number of instructions to disassemble

**Returns** Returns iterator of instructions

**Return type** Iterator[*Instruction*]

**class** malduck.disasm.Instruction (*mnem: Optional[str] = None, op1: Optional[malduck.disasm.Operand] = None, op2: Optional[malduck.disasm.Operand] = None, op3: Optional[malduck.disasm.Operand] = None, addr: Optional[int] = None, x64: bool = False*)

Represents single instruction in *Disassemble*

short: insn

Properties correspond to the following elements of instruction:

```
00400000  imul    ecx,    edx,    0
[addr]    [mnem]  [op1], [op2], [op3]
```

Usage example:

```
def get_move_value(self, p, hit, *args):
    # find move value of `mov eax, x`
    for ins in p.disasmv(hit, 0x100):
        if ins.mnem == 'mov' and ins.op1.value == 'eax':
            return ins.op2.value
```

See also:

`malduck.procmem.ProcessMemory.disasmv()`

**property addr**

Instruction address

**property op1**

First operand

**property op2**

Second operand

**property op3**

Third operand

**class** `malduck.disasm.Operand` (*op: capstone.x86.X86Op, x64: bool*)

Operand object for single *Instruction*

**property is\_imm**

Is it immediate operand?

**property is\_mem**

Is it memory operand?

**property is\_reg**

Is it register operand?

**property mem**

Returns *Memory* object for memory operands

**property reg**

Returns register used by operand.

For memory operands, returns base register or index register if base is not used. For immediate operands or displacement-only memory operands returns None.

**Return type** str

**property value**

Returns operand value or displacement value for memory operands

**Return type** str or int or None

**class** `malduck.disasm.Memory` (*size, base, scale, index, disp*)

**property base**

Alias for field number 1

**property disp**

Alias for field number 4

**property index**

Alias for field number 3

**property scale**

Alias for field number 2

**property size**

Alias for field number 0

## PE WRAPPER

```
class malduck.pe.PE(data: Union[ProcessMemory, bytes], fast_load: bool = False)
    Wrapper around pefile.PE, accepts either bytes (raw file contents) or ProcessMemory instance.

    directory (name: str) → Any
        Get pefile directory entry by identifier

        Parameters name – shortened pefile directory entry identifier (e.g. 'IMPORT' for 'IMAGE_DIRECTORY_ENTRY_IMPORT')

        Return type pefile.Structure

    property dos_header
        Dos header

    property file_header
        File header

    property headers_size
        Estimated size of PE headers (first section offset). If there are no sections: returns 0x1000 or size of input
        if provided data are shorter than single page

    property is32bit
        Is it 32-bit file (PE)?

    property is64bit
        Is it 64-bit file (PE+)?

    property nt_headers
        NT headers

    property optional_header
        Optional header

    resource (name: Union[int, str, bytes]) → Optional[bytes]
        Retrieves single resource by specified name or type

        Parameters name (int or str or bytes) – String name (e2) or type (e1), numeric identifier name (e2) or RT_* type (e1)

        Return type bytes or None

    resources (name: Union[int, str, bytes]) → Iterator[bytes]
        Finds resource objects by specified name or type

        Parameters name (int or str or bytes) – String name (e2) or type (e1), numeric identifier name (e2) or RT_* type (e1)

        Return type Iterator[bytes]
```

**section** (*name: Union[str, bytes]*) → Any

Get section by name

**Parameters** **name** (*str or bytes*) – Section name

**property sections**

Sections

**structure** (*rva: int, format: Any*) → Any

Get internal pefile Structure from specified rva

**Parameters**

- **rva** – Relative virtual address of structure
- **format** – pefile.Structure format (e.g. pefile.PE.\_\_IMAGE\_LOAD\_CONFIG\_DIRECTORY64\_format\_\_)

**Return type** pefile.Structure

**validate\_import\_names** () → bool

Returns True if the first 8 imported library entries have valid library names

**validate\_padding** () → bool

Returns True if area between first non-bss section and first 4kB doesn't have only null-bytes

**validate\_resources** () → bool

Returns True if first level of resource tree looks consistent

## YARA WRAPPER

**class** malduck.yara.Yara (rule\_paths=None, name='r', strings=None, condition='any of them')  
Represents Yara ruleset. Rules can be compiled from set of files or defined in code (single rule only).

Most simple rule (with default identifiers left):

```
from malduck.yara import Yara, YaraString

Yara(strings="MALWR").match(data=b"MALWRMALWARMALWR").r.string == [0, 11]
```

Example of more complex rule defined in Python:

```
from malduck.yara import Yara, YaraString

ruleset = Yara(name="MalwareRule",
strings={
    "xor_stub": YaraString("This program cannot", xor=True, ascii=True),
    "code_ref": YaraString("E2 34 ?? C8 A? FB", type=YaraString.HEX),
    "mal1": "MALWR",
    "mal2": "MALRW"
}, condition="( $xor_stub and $code_ref ) or any of ($mal*)")

# If mal1 or mal2 are matched, they are grouped into "mal"

# Print appropriate offsets

match = ruleset.match(data=b"MALWR MALRW")

if match:
    # ["mal1", "mal", "mal2"]
    print(match.MalwareRule.keys())
    if "mal" in match.MalwareRule:
        # Note: Order of offsets for grouped strings is undetermined
        print("mal*", match.MalwareRule["mal"])
```

### Parameters

- **rule\_paths** (*dict*) – Dictionary of {"namespace": "rule\_path"}. See also *Yara.from\_dir()*.
- **name** (*str*) – Name of generated rule (default: "r")
- **strings** (*dict* or *str* or *YaraString*) – Dictionary representing set of string patterns ({"string\_identifier": YaraString or plain str})
- **condition** (*str*) – Yara rule condition (default: "any of them")

**static from\_dir** (*path*, *recursive=True*, *followlinks=True*)

Find rules (recursively) in specified path. Supported extensions: \*.yar, \*.yara

**Parameters**

- **path** (*str*) – Root path for searching
- **recursive** (*bool*) – Search recursively (default: enabled)
- **followlinks** (*bool*) – Follow symbolic links (default: enabled)

**Return type** *Yara*

**match** (*offset\_mapper=None*, *extended=False*, *\*\*kwargs*)

Perform matching on file or data block

**Parameters**

- **filepath** (*str*) – Path to the file to be scanned
- **data** (*str*) – Data to be scanned
- **offset\_mapper** (*function*) – Offset mapping function. For unmapped region, should returned None. Used by `malduck.procmem.ProcessMemory.yarav()`
- **extended** (*bool (optional, default False)*) – Returns extended information about matched strings and rules

**Return type** `malduck.yara.YaraRulesetOffsets` or `malduck.yara.YaraRulesetMatches` if *extended* is set to `True`

**class** `malduck.yara.YaraString` (*value*, *type=<YaraStringType.TEXT: 0>*, *\*\*modifiers*)

Formatter for Yara string patterns

**Parameters**

- **value** (*str*) – Pattern value
- **type** (`YaraString.TEXT` / `YaraString.HEX` / `YaraString.REGEX`) – Pattern type (default is `YaraString.TEXT`)
- **modifiers** – Yara string modifier flags

`malduck.yara.YaraMatches`

alias of `malduck.yara.YaraRulesetOffsets`

`malduck.yara.YaraMatch`

alias of `malduck.yara.YaraRuleOffsets`



## CRYPTOGRAPHY

Common cryptography algorithms used in malware.

### 6.1 AES

AES (Advanced Encryption Standard) block cipher.

Supported modes: CBC, ECB, CTR.

```
from malduck import aes

key = b'A'*16
iv = b'B'*16
plaintext = b'data'*16
ciphertext = aes.cbc.encrypt(key, iv, plaintext)
```

#### 6.1.1 AES-CBC mode

`malduck.aes.cbc.encrypt` (*key: bytes, iv: bytes, data: bytes*) → bytes

Encrypts buffer using AES algorithm in CBC mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (128, 192 or 256 bits)
- **iv** (*bytes*) – Initialization vector
- **data** (*bytes*) – Buffer to be encrypted

**Returns** Encrypted data

**Return type** bytes

`malduck.aes.cbc.decrypt` (*key: bytes, iv: bytes, data: bytes*) → bytes

Decrypts buffer using AES algorithm in CBC mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (128, 192 or 256 bits)
- **iv** (*bytes*) – Initialization vector
- **data** (*bytes*) – Buffer to be decrypted

**Returns** Decrypted data

**Return type** bytes

### 6.1.2 AES-ECB mode

`malduck.aes.ecb.encrypt` (*key: bytes, data: bytes*) → bytes  
 Encrypts buffer using AES algorithm in ECB mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (128, 192 or 256 bits)
- **data** (*bytes*) – Buffer to be encrypted

**Returns** Encrypted data

**Return type** bytes

`malduck.aes.ecb.decrypt` (*key: bytes, data: bytes*) → bytes  
 Decrypts buffer using AES algorithm in ECB mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (128, 192 or 256 bits)
- **data** (*bytes*) – Buffer to be decrypted

**Returns** Decrypted data

**Return type** bytes

### 6.1.3 AES-CTR mode

`malduck.aes.ctr.encrypt` (*key: bytes, nonce: bytes, data: bytes*) → bytes  
 Encrypts buffer using AES algorithm in CTR mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (128, 192 or 256 bits)
- **nonce** (*bytes*) – Initial counter value, big-endian encoded
- **data** (*bytes*) – Buffer to be encrypted

**Returns** Encrypted data

**Return type** bytes

`malduck.aes.ctr.decrypt` (*key: bytes, nonce: bytes, data: bytes*) → bytes  
 Decrypts buffer using AES algorithm in CTR mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (128, 192 or 256 bits)
- **nonce** (*bytes*) – Initial counter value, big-endian encoded
- **data** (*bytes*) – Buffer to be decrypted

**Returns** Decrypted data

**Return type** bytes

## 6.2 Blowfish (ECB only)

Blowfish block cipher.

Supported modes: ECB.

```
from malduck import blowfish

key = b'blowfish'
plaintext = b'data'*16
ciphertext = blowfish.ecb.encrypt(key, plaintext)
```

`malduck.blowfish.ecb.encrypt` (*key: bytes, data: bytes*) → bytes  
Encrypts buffer using Blowfish algorithm in ECB mode.

### Parameters

- **key** (*bytes*) – Cryptographic key (4 to 56 bytes)
- **data** (*bytes*) – Buffer to be encrypted

**Returns** Encrypted data

**Return type** bytes

`malduck.blowfish.ecb.decrypt` (*key: bytes, data: bytes*) → bytes  
Decrypts buffer using Blowfish algorithm in ECB mode.

### Parameters

- **key** (*bytes*) – Cryptographic key (4 to 56 bytes)
- **data** (*bytes*) – Buffer to be decrypted

**Returns** Decrypted data

**Return type** bytes

## 6.3 DES/DES3 (CBC only)

Triple DES block cipher.

Fallbacks to single DES for 8 byte keys.

Supported modes: CBC.

```
from malduck import des3

key = b'des3des3'
iv = b'3des3des'
plaintext = b'data'*16
ciphertext = des3.cbc.decrypt(key, plaintext)
```

`malduck.des3.cbc.encrypt` (*key: bytes, iv: bytes, data: bytes*) → bytes  
Encrypts buffer using DES/DES3 algorithm in CBC mode.

### Parameters

- **key** (*bytes*) – Cryptographic key (16 or 24 bytes, 8 bytes for single DES)
- **iv** (*bytes*) – Initialization vector

- **data** (*bytes*) – Buffer to be encrypted

**Returns** Encrypted data

**Return type** bytes

`malduck.des3.cbc.decrypt` (*key: bytes, iv: bytes, data: bytes*) → bytes

Decrypts buffer using DES/DES3 algorithm in CBC mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (16 or 24 bytes, 8 bytes for single DES)
- **iv** (*bytes*) – Initialization vector
- **data** (*bytes*) – Buffer to be decrypted

**Returns** Decrypted data

**Return type** bytes

## 6.4 Serpent (CBC only)

Serpent block cipher.

Supported modes: CBC

```
from malduck import serpent

key = b'a'*16
iv = b'b'*16
plaintext = b'data'*16
ciphertext = serpent.cbc.encrypt(key, plaintext, iv=iv)
```

`malduck.serpent.cbc.encrypt` (*key: bytes, data: bytes, iv: Optional[bytes] = None*) → bytes

Encrypts buffer using Serpent algorithm in CBC mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (4-32 bytes, must be multiple of four)
- **data** (*bytes*) – Buffer to be encrypted
- **iv** (*bytes, optional*) – Initialization vector (defaults to `b"" * 16`)

**Returns** Encrypted data

**Return type** bytes

`malduck.serpent.cbc.decrypt` (*key: bytes, data: bytes, iv: Optional[bytes] = None*) → bytes

Decrypts buffer using Serpent algorithm in CBC mode.

**Parameters**

- **key** (*bytes*) – Cryptographic key (4-32 bytes, must be multiple of four)
- **data** (*bytes*) – Buffer to be decrypted
- **iv** (*bytes, optional*) – Initialization vector (defaults to `b"" * 16`)

**Returns** Decrypted data

**Return type** bytes

## 6.5 Rabbit

Rabbit stream cipher.

```
from malduck import rabbit

key = b'a'*16
iv = b'b'*16
plaintext = b'data'*16
ciphertext = rabbit(key, iv, plaintext)
```

`malduck.rabbit` (*key: bytes, iv: bytes, data: bytes*) → bytes

Encrypts/decrypts buffer using Rabbit algorithm

### Parameters

- **key** (*bytes*) – Cryptographic key (16 bytes)
- **iv** (*bytes*) – Initialization vector (8 bytes)
- **data** (*bytes*) – Buffer to be encrypted/decrypted

**Returns** Encrypted/decrypted data

**Return type** bytes

## 6.6 RC4

RC4 stream cipher.

```
from malduck import rc4

key = b'a'*16
plaintext = b'data'*16
ciphertext = rc4(key, plaintext)
```

`malduck.rc4` (*key: bytes, data: bytes*) → bytes

Encrypts/decrypts buffer using RC4 algorithm

### Parameters

- **key** (*bytes*) – Cryptographic key (from 3 to 256 bytes)
- **data** (*bytes*) – Buffer to be encrypted/decrypted

**Returns** Encrypted/decrypted data

**Return type** bytes

## 6.7 XOR

XOR “stream cipher”.

```
from malduck import xor

key = b'a'*16
```

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```
xored = b'data'*16
unxored = xor(key, xored)
```

`malduck.xor` (*key*: *Union[int, bytes]*, *data*: *bytes*) → *bytes*  
XOR encryption/decryption

**Parameters**

- **key** (*int* (single byte) or *bytes*) – Encryption key
- **data** (*bytes*) – Buffer containing data to decrypt

**Returns** Encrypted/decrypted data

**Return type** *bytes*

## 6.8 RSA (BLOB parser)

`malduck.rsa`  
alias of `malduck.crypto.rsa.RSA`

**class** `malduck.crypto.rsa.RSA`

**static export\_key** (*n*: *int*, *e*: *int*, *d*: *Optional[int] = None*, *p*: *Optional[int] = None*, *q*: *Optional[int] = None*, *crt*: *Optional[int] = None*) → *bytes*

Constructs key from tuple of RSA components

**Parameters**

- **n** – RSA modulus *n*
- **e** – Public exponent *e*
- **d** – Private exponent *d*
- **p** – First factor of *n*
- **q** – Second factor of *n*
- **crt** – CRT coefficient *q*

**Returns** RSA key in PEM format

**Return type** *bytes*

**static import\_key** (*data*: *bytes*) → *Optional[bytes]*

Extracts key from buffer containing *PublicKeyBlob* or *PrivateKeyBlob* data

**Parameters** **data** (*bytes*) – Buffer with *BLOB* structure data

**Returns** RSA key in PEM format

**Return type** *bytes*

## 6.9 BLOB struct

**class** `malduck.crypto.winhdr.BLOBHEADER`  
Windows BLOBHEADER structure

**See also:**

BLOBHEADER structure description (Microsoft Docs): <https://docs.microsoft.com/en-us/windows/win32/api/wincrypt/ns-wincrypt-publickeystruc>

**class** malduck.crypto.aes.PlaintextKeyBlob  
*BLOB* object (*PLAINTEXTKEYBLOB*) for *CALG\_AES*

**See also:**

malduck.crypto.BLOBHEADER

**export\_key** () → Optional[Tuple[str, bytes]]

Exports key from structure or returns None if no key was imported

**Returns** Tuple (*algorithm*, *key*). *Algorithm* is one of: “AES-128”, “AES-192”, “AES-256”

**Return type** Tuple[str, bytes]

**parse** (*buf*: *\_io.BytesIO*) → None

Parse structure from buffer

**Parameters** *buf* (*io.BytesIO*) – Buffer with structure data

**class** malduck.crypto.rsa.PublicKeyBlob

**class** malduck.crypto.rsa.PrivateKeyBlob





## COMPRESSION ALGORITHMS

### 7.1 aPLib

`malduck.aplib` (*buf*: bytes, *headerless*: bool = False) → Optional[bytes]  
aPLib decompression

```
from malduck import aplib

# Headerless compressed buffer
aplib(b'T\x00he quick\xecb\x0erown\xcef\xae\x80jumps\xed\xee4veur`t?
↳ lazy\xead\xfe\x00\x00')
# Header included
aplib(b
↳ 'AP32\x18\x00\x00\x00\r\x00\x00\x00\xbc\x9ab\x9b\x0b\x00\x00\x00\x85\x11J\rh8el\x8eo
↳ wnr\xecd\x00')
```

#### Parameters

- **buf** (bytes) – Buffer to decompress
- **headerless** (bool (default: *True*)) – Force headerless decompression (don't perform 'AP32' magic detection)

**Return type** bytes

### 7.2 gzip

`malduck.gzip` (*buf*: bytes) → bytes  
gzip/zlib decompression

```
from malduck import gzip, unhex

# zlib decompression
gzip(unhex(b'789ccb48cdc9c95728cf2fca4901001a0b045d'))
# gzip decompression (detected by 1f8b08 prefix)
gzip(unhex(b
↳ '1f8b08082199b75a0403312d3100cb48cdc9c95728cf2fca49010085114a0d0b000000'))
```

**Parameters** **buf** (bytes) – Buffer to decompress

**Return type** bytes

## 7.3 lznt1 (RtlDecompressBuffer)

`malduck.lznt1(buf: bytes) → bytes`

Implementation of LZNT1 decompression. Allows to decompress data compressed by `RtlCompressBuffer`

```
from malduck import lznt1

lznt1(b"\compress\edtestdataalot")
```

**Parameters** `buf` (*bytes*) – Buffer to decompress

**Return type** `bytes`

## HASHING ALGORITHMS

### 8.1 CRC32

`malduck.crc32 (val: bytes) → int`  
Computes CRC32 checksum for provided data

### 8.2 MD5

`malduck.md5 (s: bytes) → bytes`

### 8.3 SHA1

`malduck.sha1 (s: bytes) → bytes`

### 8.4 SHA224/256/384/512

`malduck.sha224 (s: bytes) → bytes`

`malduck.sha256 (s: bytes) → bytes`

`malduck.sha384 (s: bytes) → bytes`

`malduck.sha512 (s: bytes) → bytes`



## COMMON BITWISE OPERATIONS

### 9.1 Rotate left/right

`malduck.bits.rol` (*value: int, count: int, bits: int = 32*) → int

Bitwise rotate left

#### Parameters

- **value** – Value to rotate
- **count** – Number of bits to rotate
- **bits** – Bit-length of rotated value (default: 32-bit, DWORD)

See also:

`malduck.ints.IntType.rol()`

`malduck.bits.ror` (*value: int, count: int, bits: int = 32*) → int

Bitwise rotate right

#### Parameters

- **value** – Value to rotate
- **count** – Number of bits to rotate
- **bits** – Bit-length of rotated value (default: 32-bit, DWORD)

See also:

`malduck.ints.IntType.ror()`

### 9.2 Align up/down

`malduck.bits.align` (*value: int, round\_to: int*) → int

Rounds value up to provided alignment

`malduck.bits.align_down` (*value: int, round\_to: int*) → int

Rounds value down to provided alignment



## FIXED-INTEGER TYPES

### 10.1 Object properties

**class** `malduck.ints.IntType`

Fixed-size variant of `int` type with C-style operators and casting

Supports ctypes-like multiplication for unpacking tuple of values

- **Unsigned types:** `UInt64` (QWORD), `UInt32` (DWORD), `UInt16` (WORD), `UInt8` (BYTE or CHAR)
- **Signed types:** `Int64`, `Int32`, `Int16`, `Int8`

`IntTypes` are derived from `int` type, so they are fully compatible with other numeric types

```
res = u32(0x8080FFFF) << 16 | 0xFFFF
> 0xFFFFFFFF
res = Int32(res)
> -1
```

Using `IntTypes` you don't need to mask everything with `0xFFFFFFFF`, only if you remember about appropriate casting.

```
from malduck import DWORD

def rol7_hash(name: bytes):
    hh = 0
    for c in name:
        hh = DWORD(x).rol(7) ^ c
    return x

def sdbm_hash(name: bytes):
    hh = 0
    for c in name:
        hh = DWORD(c) + (hh << 6) + (hh << 16) - hh
    return hh
```

Type coercion between native and fixed integers depends on LHS type:

```
UInt32 = UInt32 + int
int = int + UInt32
```

`IntTypes` can be multiplied like ctypes classes for unpacking tuple of values:

```
values = (BYTE * 3).unpack('\x01\x02\x03')

values -> (1, 2, 3)
```

**pack()** → bytes

Pack value into bytes with little-endian order

**pack\_be()** → bytes

Pack value into bytes with big-endian order

**rol**(*other*) → malduck.ints.IntType

Bitwise rotate left

**ror**(*other*) → malduck.ints.IntType

Bitwise rotate right

**classmethod unpack**(*other*: bytes, *offset*: int = 0, *fixed*: bool = True) → Union[malduck.ints.IntType, int, None]

Unpacks single value from provided buffer with little-endian order

#### Parameters

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool* (*default*: True)) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

**classmethod unpack\_be**(*other*: bytes, *offset*: int = 0, *fixed*: bool = True) → Union[malduck.ints.IntType, int, None]

Unpacks single value from provided buffer with big-endian order

#### Parameters

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool* (*default*: True)) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

**class** malduck.ints.IntTypeBase

Base class representing all IntType instances

**class** malduck.ints.MultipliedIntTypeBase

Base class representing all MultipliedIntType instances

**class** malduck.ints.MetaIntType

Metaclass for IntType classes. Provides ctypes-like behavior e.g. (QWORD\*8).unpack(...) returns tuple of 8 QWORDS



**property invert\_mask**

Mask for sign bit

**property mask**

Mask for potentially overflowing operations

## 10.2 UInt64/UInt32/UInt16/UInt8 (QWORD/DWORD/WORD/BYTE)

malduck.**QWORD**

alias of *malduck.ints.UInt64*

malduck.**DWORD**

alias of *malduck.ints.UInt32*

malduck.**WORD**

alias of *malduck.ints.UInt16*

malduck.**BYTE**

alias of *malduck.ints.UInt8*

**class** malduck.ints.**UInt64**

**class** malduck.ints.**UInt32**

**class** malduck.ints.**UInt16**

**class** malduck.ints.**UInt8**

## 10.3 Int64/Int32/Int16/Int8

**class** malduck.ints.**Int64**

**class** malduck.ints.**Int32**

**class** malduck.ints.**Int16**

**class** malduck.ints.**Int8**



## COMMON STRING OPERATIONS (PADDING, CHUNKS, BASE64)

Supports most common string operations e.g.:

- **packing/unpacking:** `p64()`, `p32()`, `p16()`, `p8()`  
`u64()`, `u32()`, `u16()`, `u8()`
- **chunks:** `chunks_iter()`, `chunks()`

### 11.1 chunks/chunks\_iter

`malduck.chunks_iter(s: T, n: int) → Iterator[T]`

Yield successive n-sized chunks from s.

`malduck.chunks(s: T, n: int) → List[T]`

Return list of successive n-sized chunks from s.

### 11.2 asciiz/utf16z

`malduck.asciiz(s: bytes) → bytes`

Treats s as null-terminated ASCII string

**Parameters** `s (bytes)` – Buffer containing null-terminated ASCII string

`malduck.utf16z(s: bytes) → bytes`

Treats s as null-terminated UTF-16 ASCII string

**Parameters** `s (bytes)` – Buffer containing null-terminated UTF-16 string

**Returns** ASCII string without ‘\0’ terminator

**Return type** bytes

### 11.3 enhex/unhex

`malduck.enhex(s: bytes) → bytes`

Changed in version 2.0.0: Renamed from `malduck.hex()`

`malduck.unhex(s: Union[str, bytes]) → bytes`

`malduck.uleb128(s: bytes) → Optional[Tuple[int, int]]`

Unsigned Little-Endian Base 128

`malduck.base64` (*s: Union[str, bytes]*) → bytes  
Base64 encoder/decoder

## 11.4 Padding (null/pkcs7)

`malduck.pad` (*s: bytes, block\_size: int*) → bytes  
Padding PKCS7/NULL

`malduck.unpad` (*s: bytes*) → bytes  
Unpadding PKCS7/NULL

## 11.5 Packing/unpacking (p64/p32/p16/p8, u64/u32/u16/u8, bigint)

`malduck.uint64` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

### Parameters

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool (default: True)*) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.uint32` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

### Parameters

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool (default: True)*) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.uint16` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

### Parameters

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool (default: True)*) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.uint8` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool (default: True)*) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.u64` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool (default: True)*) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.u32` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool (default: True)*) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.u16` (*other: bytes, offset: int = 0, fixed: bool = True*) → Union[malduck.ints.IntType, int, None]  
Unpacks single value from provided buffer with little-endian order

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset

- **fixed** (*bool* (*default*: *True*)) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.u8 (other: bytes, offset: int = 0, fixed: bool = True) → Union[malduck.ints.IntType, int, None]`  
 Unpacks single value from provided buffer with little-endian order

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **offset** (*int*) – Buffer offset
- **fixed** (*bool* (*default*: *True*)) – Convert to fixed-size integer (IntType instance)

**Return type** IntType instance or None if there are not enough data to unpack

**Warning:** Fixed-size integer operations are 4-5 times slower than equivalent on built-in integer types

`malduck.p64 (v)`

`malduck.p32 (v)`

`malduck.p16 (v)`

`malduck.p8 (v)`

`malduck.bigint.unpack (other: bytes, size: Optional[int] = None) → int`  
 Unpacks bigint value from provided buffer with little-endian order

New in version 4.0.0: Use `bigint.unpack` instead of `bigint()` method

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **size** (*bytes*, *optional*) – Size of bigint in bytes

**Return type** int

`malduck.bigint.pack (other: int, size: Optional[int] = None) → bytes`  
 Packs bigint value into bytes with little-endian order

New in version 4.0.0: Use `bigint.pack` instead of `bigint()` method

**Parameters**

- **other** (*int*) – Value to be packed
- **size** (*bytes*, *optional*) – Size of bigint in bytes

**Return type** bytes

`malduck.bigint.unpack_be (other: bytes, size: Optional[int] = None) → int`  
 Unpacks bigint value from provided buffer with big-endian order

**Parameters**

- **other** (*bytes*) – Buffer object containing value to unpack
- **size** (*bytes*, *optional*) – Size of bigint in bytes

**Return type** `int`

`malduck.bigint.pack_be (other: int, size: Optional[int] = None) → bytes`

Packs bigint value into bytes with big-endian order

New in version 4.0.0: Use `bigint.pack` instead of `bigint()` method

**Parameters**

- **other** (*int*) – Value to be packed
- **size** (*bytes*, *optional*) – Size of bigint in bytes

**Return type** `bytes`

## 11.6 IPv4 `inet_ntoa`

`malduck.ipv4 (s: Union[bytes, int]) → Optional[str]`

Decodes IPv4 address and returns dot-decimal notation

**Parameters** **s** (*int* or *bytes*) – Buffer or integer value to be decoded as IPv4

**Return type** `str`





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