# Kestrel

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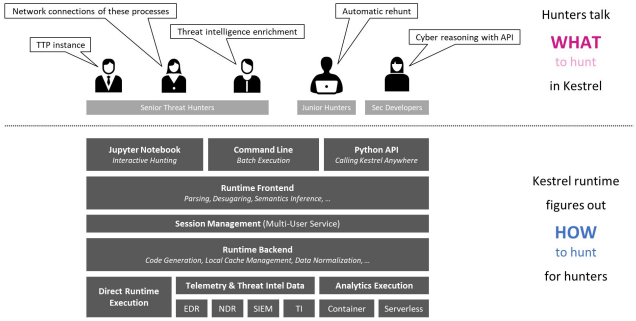
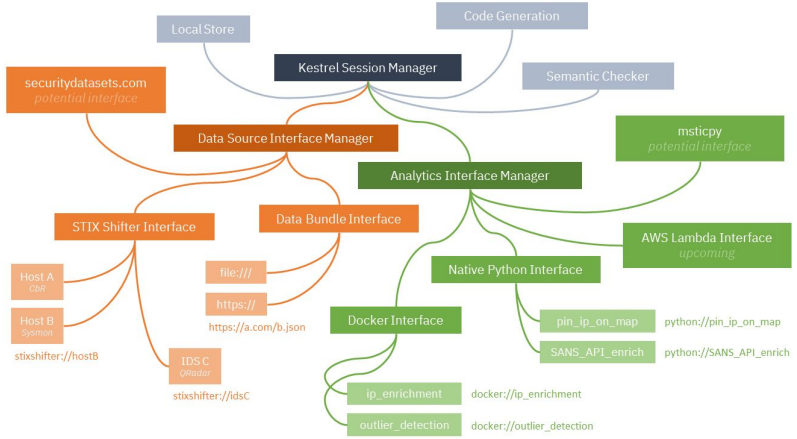
# Background

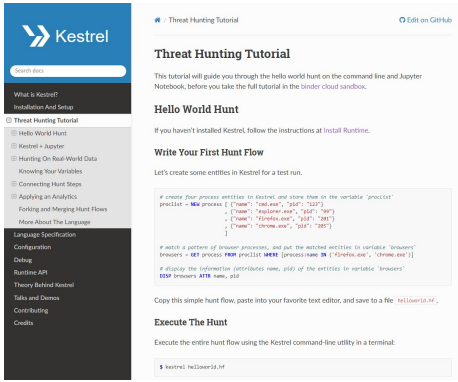

- Open Cybersecurity Alliance (OCA)
- What is Kestrel? A loose explanation.
  - Cyber threat hunting language and runtime composed of Python (for the most part)
- Runtime environment requirements
  - LInux/Mac only, Python 3, SQLite (version 3.24 or newer)
  - Frontend: command line, Jupyter Notebook, or Python API



# Kestrel

- Goals:
  - provide a layer of abstraction to build reusable, composable, and shareable hunt-flow
  - (eventually) train AI to the point where it can look for “what to hunt” on its own
- GitHub Repositories:
  - kestrel-lang (main)
  - kestrel-huntbook
  - kestrel-analytics
  - kestrel-jupyter
  - data-bucket-kestrel



# VirusTotal API
## (#124)

David Coletta (& Jaisal Patel)

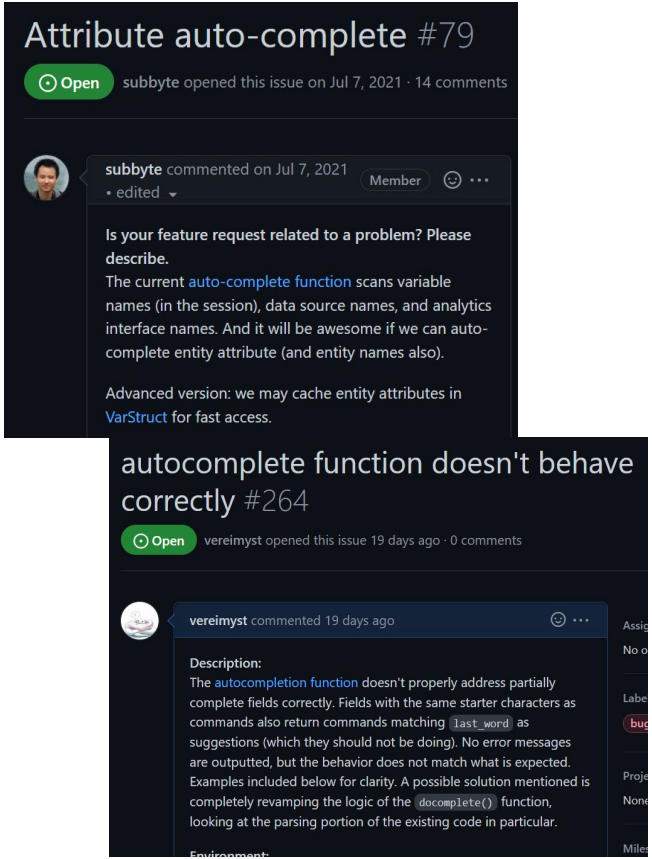
# Kestrel Analytics + VirusTotal API

I worked on connecting the VirusTotal API to the Kestrel language.

- Getting an API key from the virustotal website
- Write a python function that interfaces with the API
- Wrap this function as a Kestrel Analytics (Python module)

# Attribute auto-complete (#79 & #264)

Megan Huang



# Attribute Autocompletion

- understanding the issue
- issue breakdown
- points of confusion
  - do_complete() function flow
  - structure of code base
  - variable names
  - how + where to get information
- other troubles

- Case 1: `token == ATTRIBUTES` (old `STIXPATHS`)
  - e.g. `DISP <variable> ATTR <autocomplete>`
- Case 2: `token == STIXPATTERNBODY`
  - e.g. `WHERE <autocomplete>`

```
prefix = code[:cursor_pos]
words = prefix.split(" ")
last_word = words[-1]
last_char = prefix[-1]
_logger.debug('code="%s" prefix="%s" last_word="%s"', code, prefix, last_word)

if "START" in prefix or "STOP" in prefix:
    return self._get_complete_timestamp(last_word)
elif "://" in last_word:
    scheme, path = last_word.split("://")
```

```
else:
    _logger.debug("standard auto-complete")

    try:
        stmt = self.parse(prefix)
        _logger.debug("first parse: %s", stmt)
        last_stmt = stmt[-1]
        if last_stmt["command"] == "assign" and last_stmt["output"] == "_":
            # Special case for a varname alone on a line
            allnames = [
                v for v in self.get_variable_names() if v.startswith(prefix)
            ]
            if not allnames:
                return ["=", "+"] if prefix.endswith(" ") else []

        # If it parses successfully, add something so it will fail
        self.parse(prefix + " @autocompletions@")
    except KestrelSyntaxError as e:
        _logger.debug("exception: %s", e)
        varnames = self.get_variable_names()
        keywords = set(get_keywords())
        _logger.debug("keywords: %s", keywords)
        tmp = []
        for token in e.expected:
            _logger.debug("token: %s", token)
            if token == "VARIABLE":
                tmp.extend(varnames)
```

# Debugging

```
20:38:40 DEBUG kestrel.session varname: browsers
20:38:40 DEBUG kestrel.session BEFORE attribute autocompletion: []
20:38:40 DEBUG firepit.sqlitestorage Executing query: PRAGMA table_info("browsers")
20:38:40 DEBUG firepit.sqlitestorage browsers columns = ['name', 'pid', 'id']
20:38:40 DEBUG firepit.sqlitestorage Executing query: SELECT DISTINCT "pid" FROM "browsers"
20:38:40 DEBUG kestrel.session pid
```

- function return values
  - get_entity_id_attribute() ⟶ session.store.columns()
- attribute subvalues
  - _ref.id/value under ipv4/ipv6-addr tables
- new bug uncovered

```
17:39:38 DEBUG kestrel.session code="DISP conns ATTR p" prefix="DISP conns ATTR p"
last_word="p"
17:39:38 DEBUG kestrel.session standard auto-complete
17:39:39 DEBUG kestrel.session first parse: [{'command': 'disp', 'input': 'conns',
'transform': None, 'attrs': 'p'}]
17:39:39 DEBUG kestrel.session exception: [ERROR] KestrelSyntaxError: invalid character "@"
at line 1 column 18, expects one of ['GET', 'FIND', 'SAVE', 'LIMIT', 'TRANSFORM', 'NEW',
'GROUP', 'JOIN', 'LOAD', 'VARIABLE', 'SORT', 'DISP', 'APPLY', 'INFO', 'OFFSET']
rewrite the failed statement.
17:39:39 DEBUG kestrel.session ['TIMESTAMPED', '_', 'apply', 'conns', 'disp', 'find', 'get',
'group', 'info', 'join', 'limit', 'load', 'new', 'offset', 'save', 'sort'] -> []
```

```
DISP conns ATTR
```

dst_port
dst_ref
end
id
protocols
src_port
src_ref
start

```
tmp = NEW proce
DISP tmp ATTR r
```

```
# create four p
proclist = NEW
```

# What we learned

- Forking repositories
- How to use Kestrel
- Working on large existing codebases
- Getting comfortable with looking at previously written code
- Working with
  - APIs & API keys
  - syntax parsers (Lark)
- Running test scripts

# Thank you for watching!

(links to additional resources can be found after this slide)

# Any questions?

# Citations

All pictures are linked to their respective sources (exceptions are local testing and debug logs).

Information taken from Kestrel's Official Documentation, the kestrel-lang repository, IBM Researcher Profiles, and the OCA GitHub Profile.

# More about Xiaokui Shu

OCA Articles

ACM Interview (recommended for beginners interested in working on Kestrel)

GitHub

IBM Research

RSA Conference

Google Scholar

# Kestrel Resources

Kestrel documentation

GitHub repository for kestrel-lang

IBM article on Kestrel

Black Hat 2022 Demo

InfoSec Jupyterthon 2021 Kestrel Demo

Kestrel Interactive Tutorial

Black Hat Hunting Lab