Implementation of an email-based alert system for large-scale system resources

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#roedunet2021

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Motivation

Within a research department:

Scientific community

- Tackle different problems
- Construct a codebase for a particular issue
- Develop a scenario for executing simulations
- Request access to computing resources (submit jobs)

System administration community

- Manage allocation of the computing resources for each job
- Monitor executing simulations
- Monitor idling resources
- Keep track of incoming jobs

Simulations

Scientific community

- *Unoptimized* simulations lead to:
    - Long execution time (will cause delays in the pipeline)
    - Low degree of parallelism (cannot take full advantage of multiple core/threads)
    - Excessive memory consumption (limited resource)

        - Simulation testing + optimization is required

Resource management + monitoring

Sysadmin community

- Allocate jobs (e.g., simulations) to the computing cluster

- Manage computing nodes (updates, services)

- Observe *unexpected* behavior of the running simulations
- Check *idling* resources for potential issues

- Keeping track of all these aspects 24/7 is very challenging

Project Goals

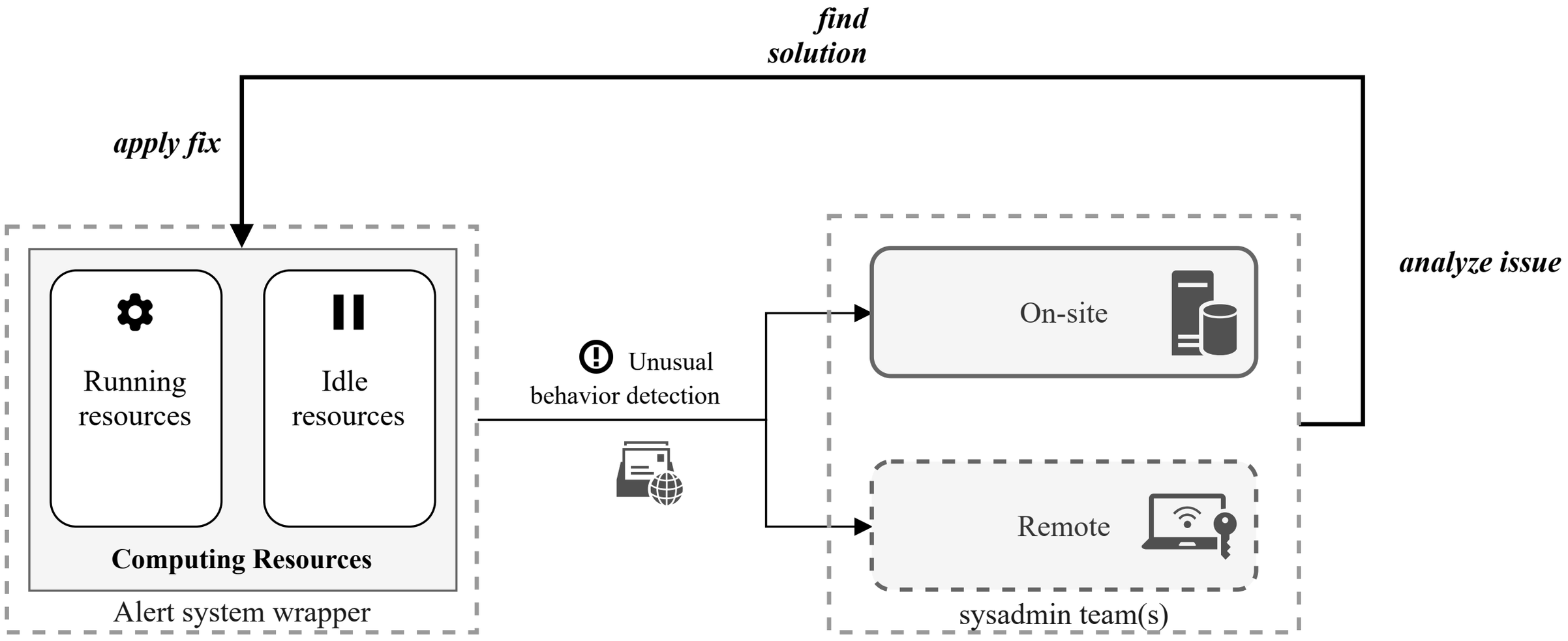
- Create a service which:

  1. ⚙️ Monitor multiple computing nodes/clusters (system resources, executing services, etc.)
  2. ⚠️ Identify potential issues within the resources
  3. ✉️ Inform the sysadmin in realtime on the occurring issue(s) - via e-mail

  Alert system

Alert system

General workflow



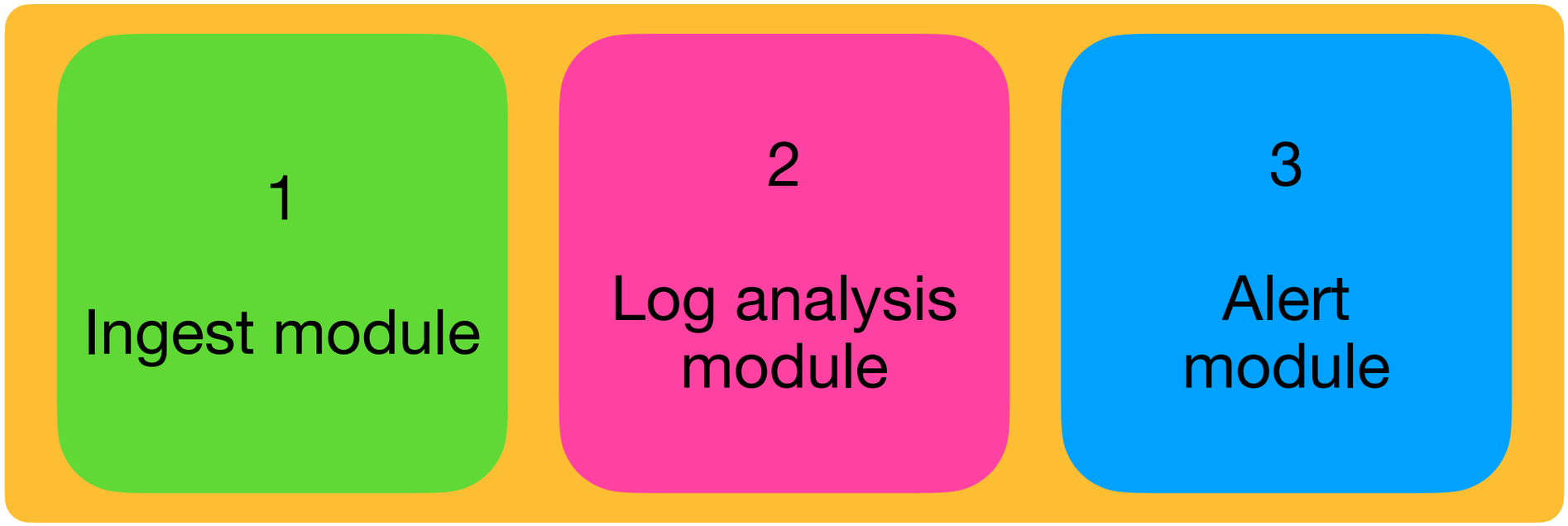
Alert system

Main features

- Developed in Python
    - Great system compatibility
    - Plenty of packages
    - Strong development community
- Works with virtual environments
- Improved package management using `pipenv`
- Built in a modular way

Alert system

Modules



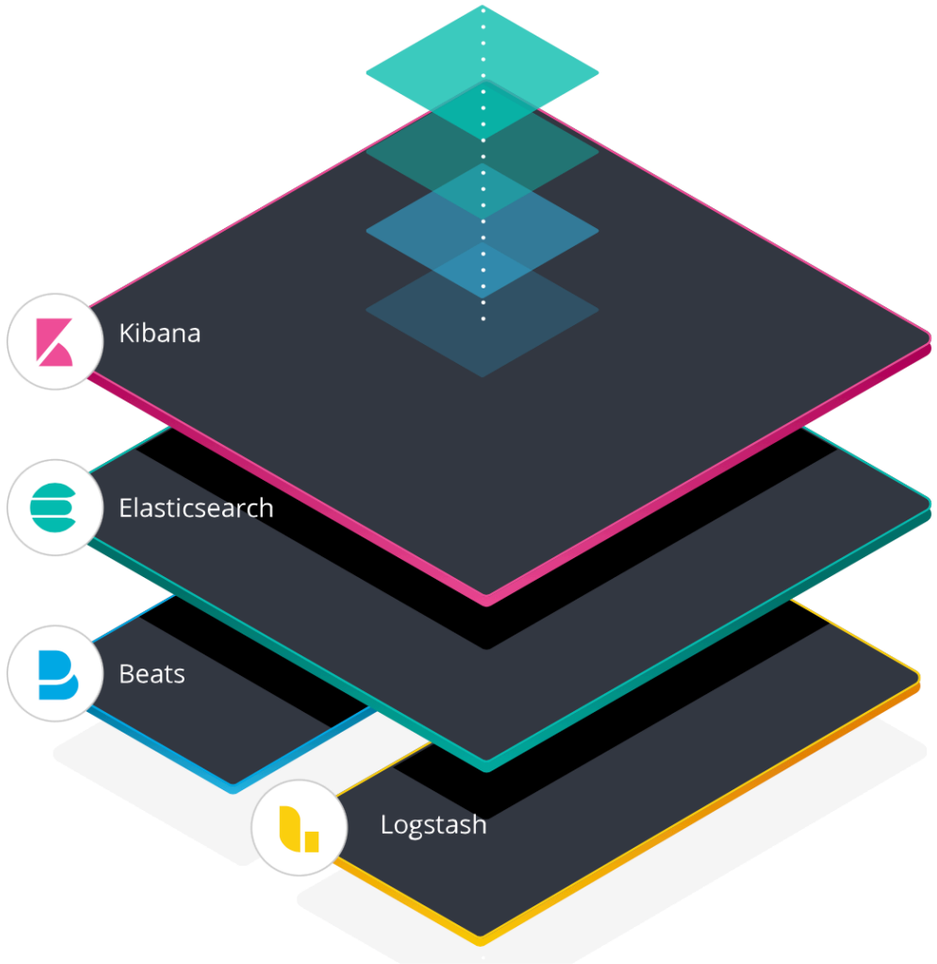
1. Get the incoming log information from its corresponding file(s)
2. Perform analysis on the ingested log data
3. Decides if alert(s) should be sent to the sysadmin

Receiving system information

- The underlying computing infrastructure must send information containing its current status
- Each node on the cluster should send system information (e.g., CPU usage, RAM usage, network activity, running services) to a centralized *master node*
- The alert system runs on the master node
- Information is send as log files, via a *log shipper.*

Filebeat

Log shipper

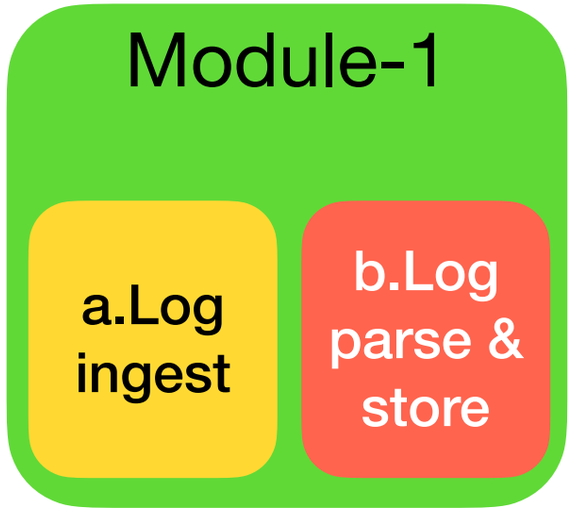


https://www.elastic.co/what-is/elk-stack

- Developed by Elastic™
- Part of the Elasticsearch stack (ELK)
- Lightweight shipper for logs
- Runs as a service on the system
- Sends logs to (not only) any other node on the network

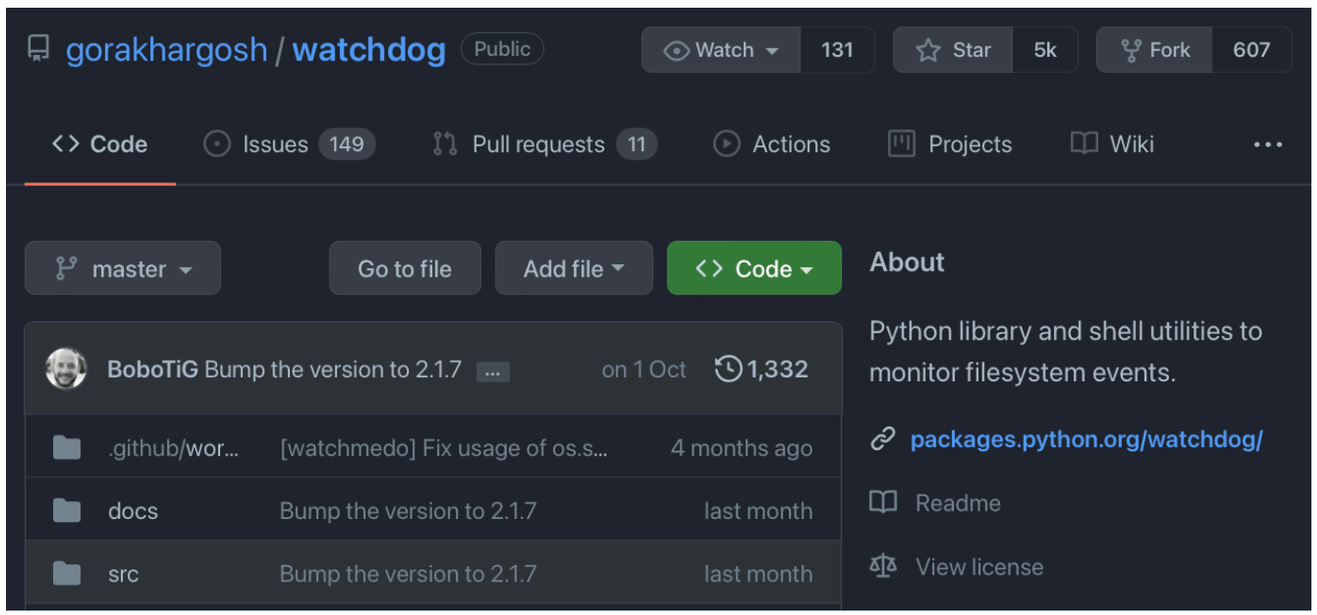
Log monitoring I

Watching log file(s) for changes



- The master node runs the python alert service
- Module-1 reads the log files that arrive on the master node → sub-module **1a**
- Sub-module **1a** is able to read every new log entry as it arrives. This is possible using the `watchdog` package.
- Watchdog uses event handlers to keep track of any changes in the monitored files

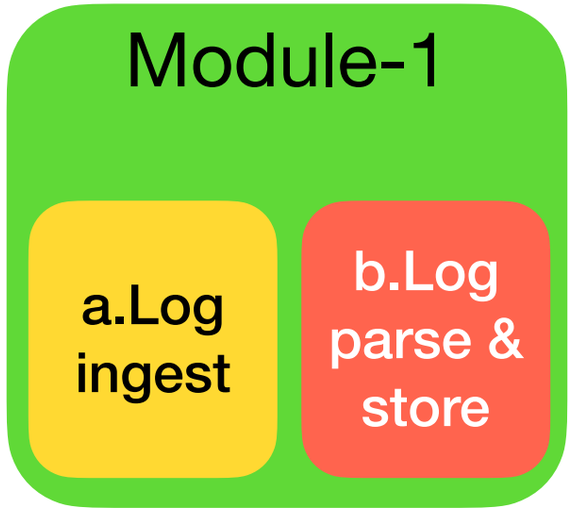
```
event_handler = LoggingEventHandler()
    observer = Observer()
    observer.schedule(event_handler, path, recursive=True)
    observer.start()
    try:
        while True:
            /* do something */
    finally:
        observer.stop()
        observer.join()
```



https://github.com/gorakhargosh/watchdog

Log monitoring II

Parse & collect data



- With the incoming log data, it is furthermore stored in memory → sub-module **1b**

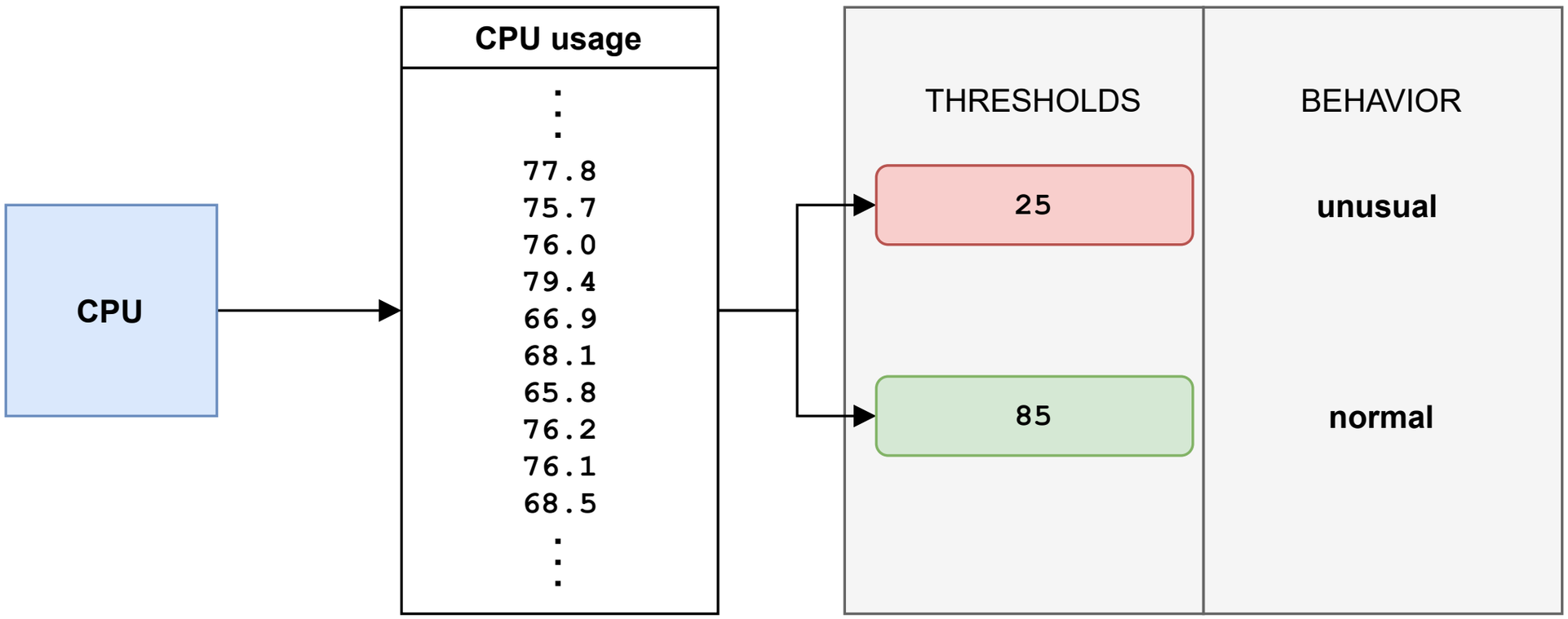
- Sub-module **1b** is able to parse the data in a proper format:
  - Extract only relevant fields → system stat(s)
  - Format data in a specific format (e.g., CPU usage should be a number)
  - Store extracted stats in their corresponding array

Log analysis

- **Configuration setup** of the alert system:
  - Set thresholds for each system stat
  - Thresholds indicate **normal / unusual** system behavior
  - Get an *averaged* value for a system stat (over a fixed time interval → `cycle_time`)
  - Compare every *averaged stat* with its corresponding threshold → decides behavior of the system

2

Log analysis module



Alert via email ✉️

- Module 3 is triggered **only if unusual** behavior is detected by module 2.

- Sub-module **3a** creates attachments:

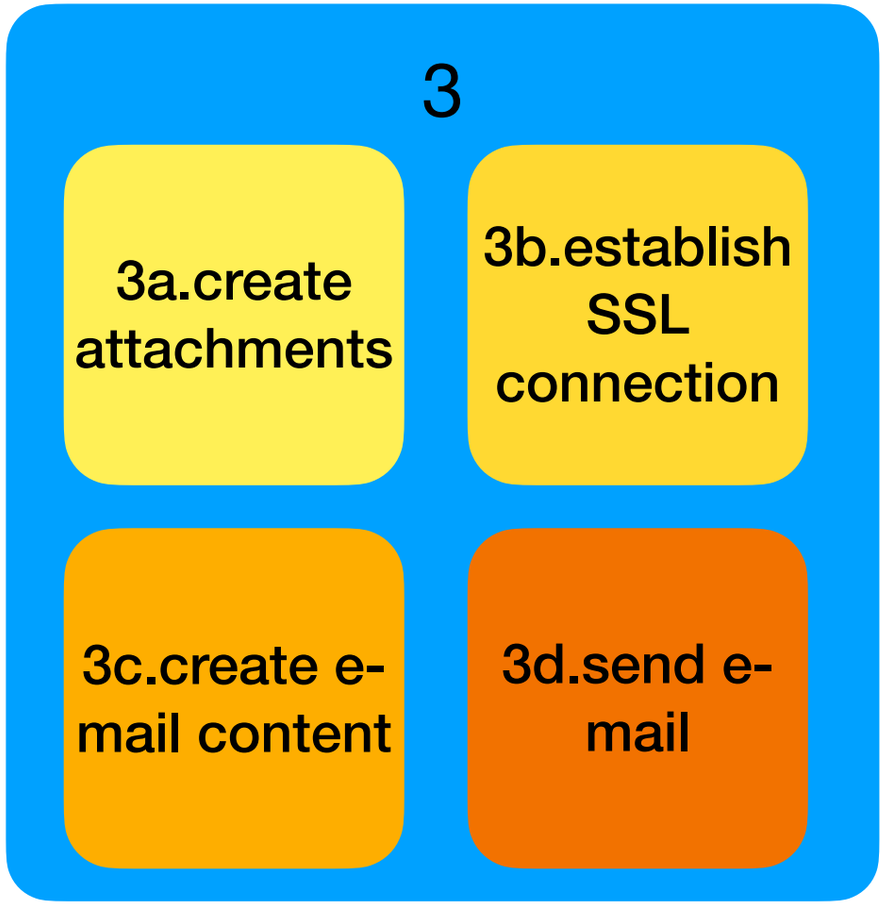
    1. Graphical representations with the evolution of the system stats over a period of time

    2. `.csv` files with containing the system stats

2. Sub-module **3b** uses **`smtplib`** and **`ssl`** modules to establish connection with an SMTP server (e.g., gmail)

3. Sub-module **3c** prepares the actual e-mail that will be sent to the sysadmin team

4. Sub-module **3d** finally sends the email securely.



Structure of module 3

```
with smtplib.SMTP_SSL("smtp.gmail.com",
                      PORT, context=CONTEXT) as mail_server:
    time_stamp = str(datetime.utcnow())[0:19]
    # log-in stage
    try:
        mail_server.login(ROOT_EMAIL, UNICORN_ID)
    except Exception as exc:
        ...
    else:
        ...
    # sending stage
    try:
        mail_server.sendmail(ROOT_EMAIL,
                             email_address, final_alert)
    except Exception as exc:
        ...
    else:
        ...
```

Alert via email ✉️

Overview