Preliminary exploratory analysis: PMD Alerts + Commits

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Contents

1 Introduction

This document shows the how to collect PMD alerts related to each commit of a project and introduces an analysis about this information.

In the Section 2, this document explains briefly how PMD Source Code Analyzer works and which kind of alerts it generates. In the Section 3 the data collection and a brief analysis using the project Twitter4J is shown. The section 4 discusses the conclusions and potential next steps for the work aiming an article or a PhD thesis.

2 PMD Alerts

PMD is a source code analyzer that finds common flaws, like unused variables, empty catch blocks, unnecessary object creation and so forth (Dangel 2019).

In Java, the programing language in which Twittter4J is written, there are 8 groups of alerts:

- Best Practices: enforce generally accepted best practices, e.g. the usage of foreach instead of for when applicable, avoidance of hard coded IP addresses, avoidance of the reassignment of loop variables.

3 Preliminary analysis

3.1 Collecting Data

The following code collects data from every commit made to Twitter4J project.

Each commit is checked out and the PMD alerts are generated.

In the end, all the PMD alerts are stored.

```
unlink("repository/Twitter4J", recursive = TRUE, force = TRUE)

clone("https://github.com/Twitter4J/Twitter4J.git","repository/Twitter4J")

repository <- repository("repository/Twitter4j")

iteracao <- 0

check_out_and_pmd <- function(commit){

    iteracao <<- iteracao + 1
    print(iteracao)
    temp <- (paste0(UUIDgenerate(),".csv"))
    print(commit$sha)
    checkout(commit, force = TRUE)
    shell(paste0("pmd/bin/pmd.bat -d repository/Twitter4J -f csv -R rulesets/java/quickstart.xml -cache
    conteudo <- read_csv(temp) %>%
        mutate(sha = commit$sha)
    file.remove(temp)
    conteudo

}


line_count <- function (commit){

    iteracao <<- iteracao + 1
    print(iteracao)
    print(commit$sha)
    checkout(commit, force = TRUE)

    result <- shell("git -C repository/Twitter4J diff --stat 4b825dc642cb6eb9a060e54bf8d69288fbee4904",
        enframe(value = "word") %>%
        separate(col = word, into = c("file","number"), sep = "\\|") %>%
        filter(str_detect(file, ".java")) %>%
        mutate(lines = str_extract(number, "[0-9]+")) %>%
        filter(!is.na(lines)) %>%
        mutate(lines = as.integer(lines)) %>%
        summarise(lines = sum(lines)) %>%
        mutate(sha = commit$sha)


    result

}


check_out_and_pmd_possibly <- possibly(check_out_and_pmd, otherwise = tibble(sha = "erro"))

commits <-  commits(repository) %>%
    map_df(as_tibble)
```

```
saveRDS(commits, file =  "commits.rds")

commits_alerts <-  commits(repository) %>%
    map_dfr(check_out_and_pmd_possibly)

saveRDS(commits_alerts, file =  "commits_alerts.rds")

line_count_possibly <- possibly(line_count, otherwise = tibble(sha = "erro"))

line_counts <-  commits(repository) %>%
    map_df(line_count_possibly)

saveRDS(line_counts, file =  "line_counts.rds")
```

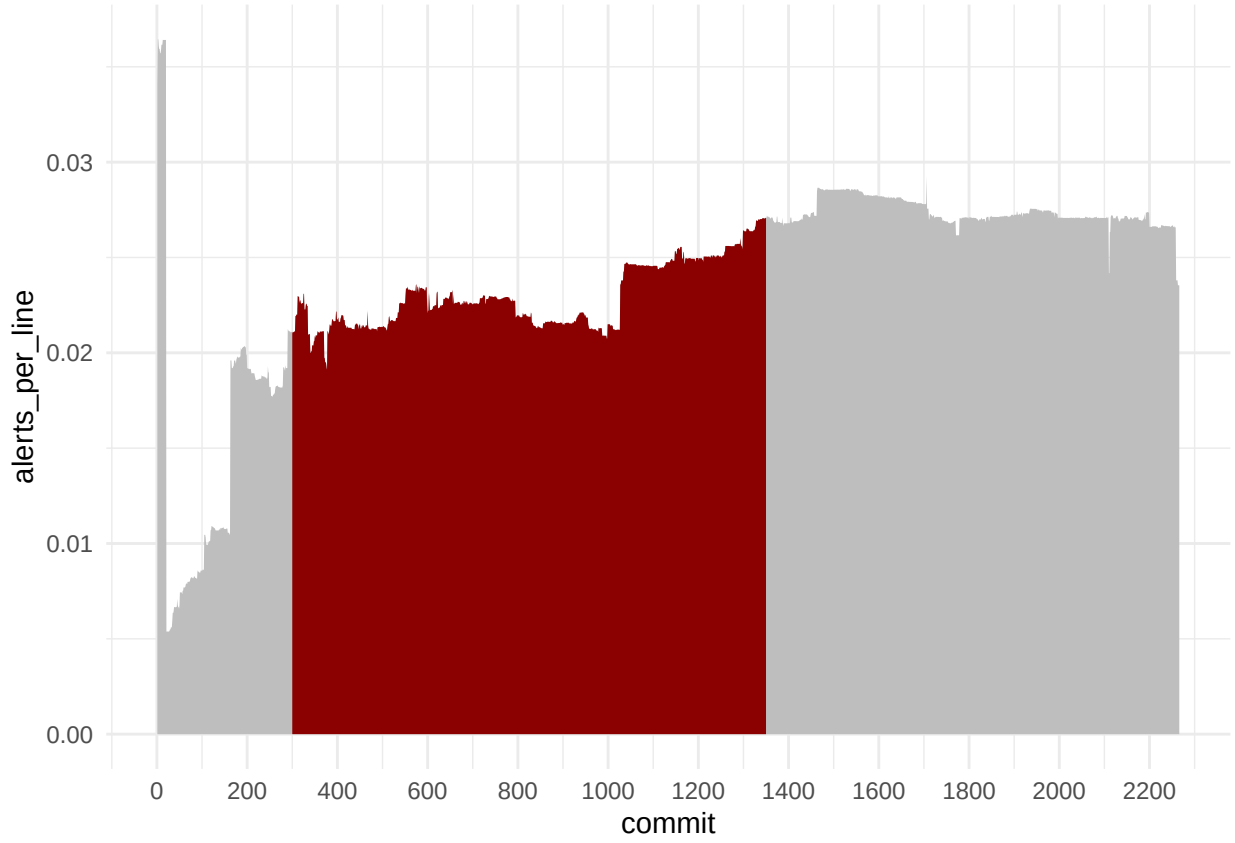
Data can be loaded from the files that serve as cache

```
commits_from_cache <- read_rds("commits.rds")

alerts_from_cache <- read_rds("commits_alerts.rds")

lines_from_cache <- read_rds("line_counts.rds")


all_data <-  commits_from_cache %>%
    inner_join(alerts_from_cache, by = c("sha")) %>%
    inner_join(lines_from_cache, by = c("sha"))
```

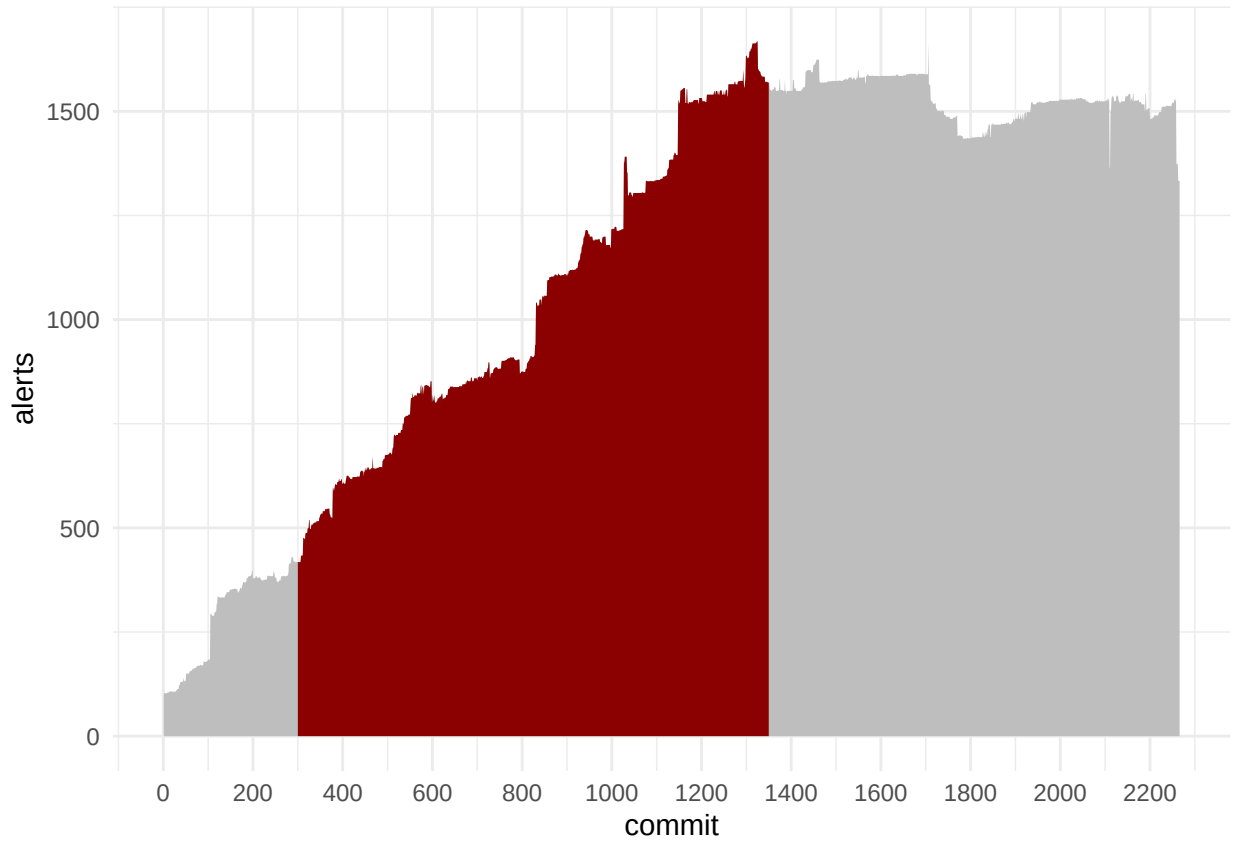
3.2 Evolution of the code size

After an instability, it seems that the project evolves from the commit 300 until aproximately commit 1300. After that the number of lines of code ceases to increase, and so do the number of alerts and the number of alerts per line of code.

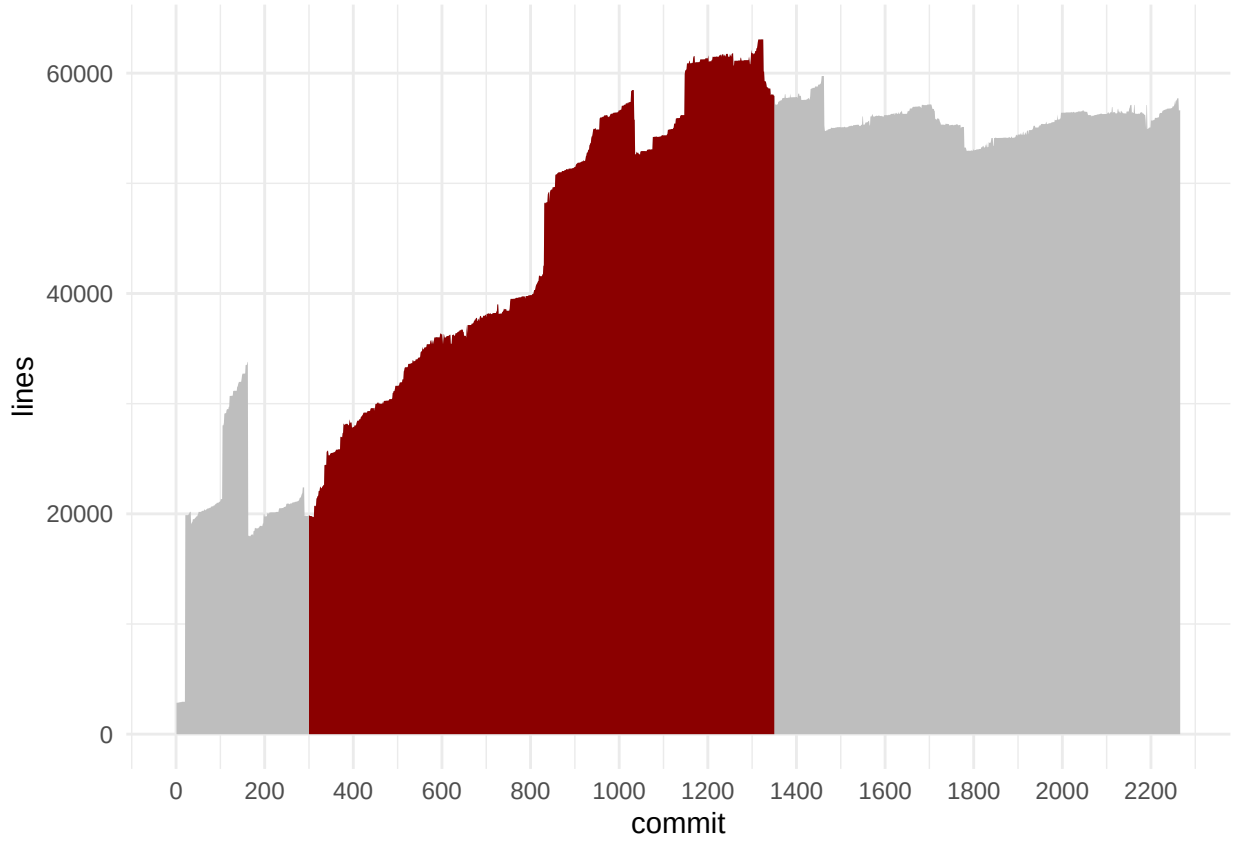
```
alerts_total <- all_data %>%
    group_by(sha, when) %>%
    summarise(alerts_per_line = n()/mean(lines), lines = mean(lines), alerts = n() ) %>%
    ungroup() %>%
    arrange(when) %>%
    mutate(commit = row_number())

alerts_evolving <-  alerts_total %>%
    filter(between(commit,300, 1350))


ggplot(alerts_total) +
    geom_area(aes(x = commit, y = alerts_per_line ), fill = "gray") +
    geom_area(data = alerts_evolving, aes(x = commit, y = alerts_per_line ), fill = "darkred") +
    theme_minimal() +
    scale_x_continuous(breaks = seq(0,to = 2500, by = 200))
```



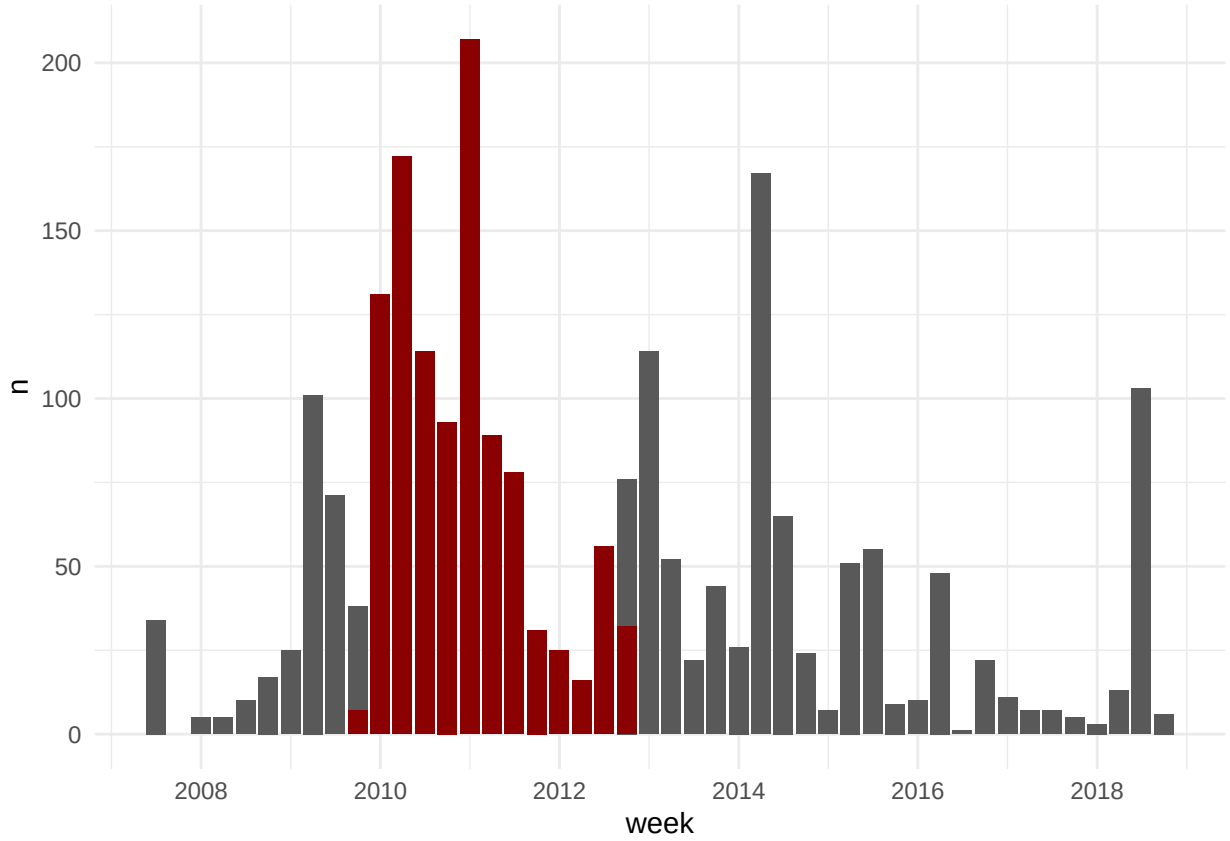

```
ggplot(alerts_total) +
    geom_area(aes(x = commit, y = alerts ), fill = "gray") +
    geom_area(data = alerts_evolving, aes(x = commit, y = alerts ), fill = "darkred") +
    theme_minimal() +
    scale_x_continuous(breaks = seq(0,to = 2500, by = 200))
```




```
ggplot(alerts_total) +
    geom_area(aes(x = commit, y = lines ), fill = "gray") +
    geom_area(data = alerts_evolving, aes(x = commit, y = lines ), fill = "darkred") +
    theme_minimal() +
    scale_x_continuous(breaks = seq(0,to = 2500, by = 200))
```

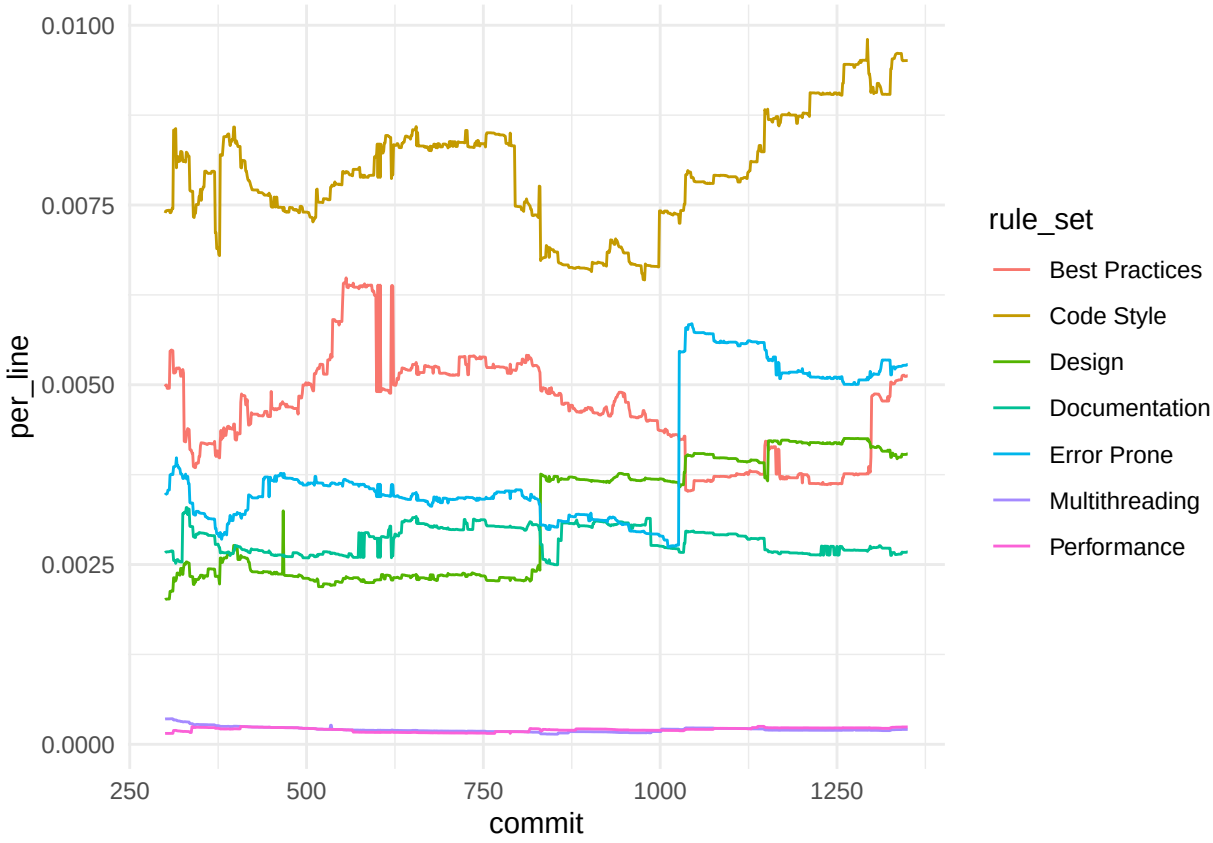



```
commits_per_week <- alerts_total %>%
    mutate(week = round_date(when, "quarter") ) %>%
    group_by(week) %>%
    count(n = n())

commits_per_week_evolving <- alerts_evolving %>%
    mutate(week = round_date(when, "quarter") ) %>%
    group_by(week) %>%
    count(n = n())

ggplot(commits_per_week) +
    geom_col(aes(x = week, y = n)) +
    geom_col(data = commits_per_week_evolving, aes(x = week, y = n), fill = "darkred") +
    theme_minimal()
```

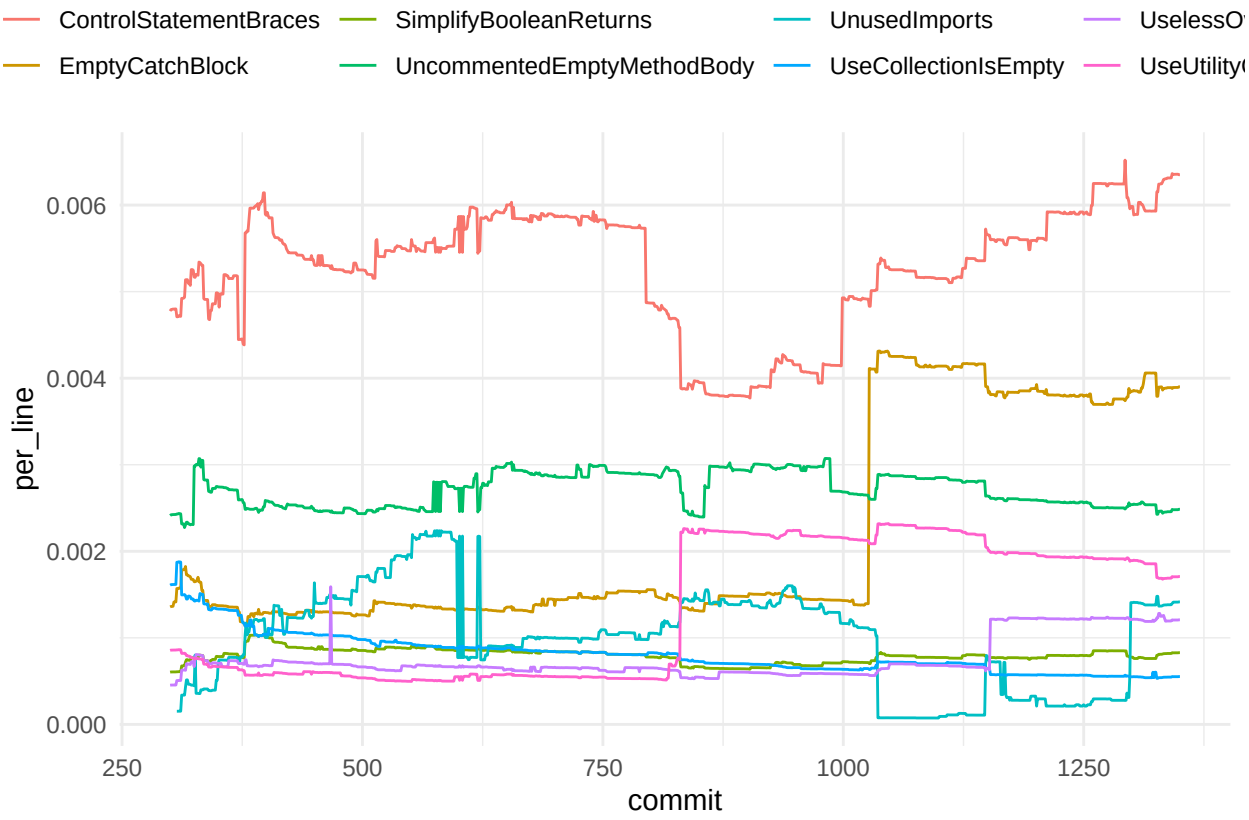


3.3 Types of alert

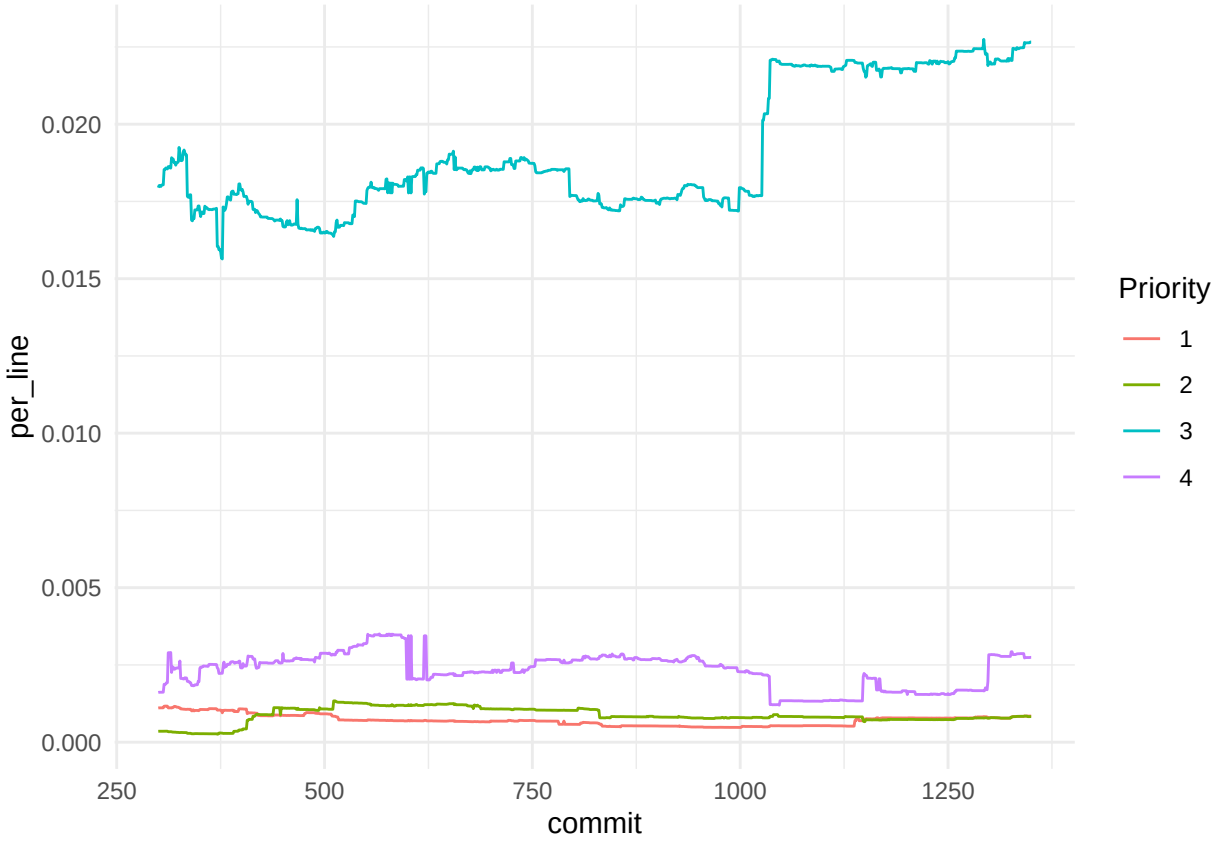
```
rule_set <- all_data %>%
    rename(
        rule_set = `Rule set`
    ) %>%
    select(sha, when, author, Package, File, Priority, rule_set, Rule, lines) %>%
    inner_join(alerts_total, by = c("sha")) %>%
    mutate(per_line = 1/lines.x) %>%
    group_by(commit, rule_set) %>%
    summarise(per_line = sum(per_line)) %>%
    filter(between(commit, 300, 1350 ))


ggplot(rule_set) +
    geom_line(aes(color = rule_set, x = commit, y = per_line)) +
    theme_minimal()
```




```
rule <- all_data %>%
    rename(
        rule_set = `Rule set`,
        rule = Rule
    ) %>%
    select(sha, when, author, Package, File, Priority, rule_set, rule, lines) %>%
    inner_join(alerts_total, by = c("sha")) %>%
    mutate(per_line = 1/lines.x) %>%
    group_by(commit, rule) %>%
    summarise(per_line = sum(per_line)) %>%
    ungroup() %>%
    filter(between(commit, 300, 1350 )) %>%
    mutate(rule = fct_lump(rule, n = 8, w = per_line, other_level = "Other"))


ggplot() +
    geom_line(data = rule %>% filter(rule != "Other"), aes(color = rule, x = commit, y = per_line)) +
    theme_minimal() +
    theme(legend.position = "top")
```




```
rule_set <- all_data %>%
    rename(
        rule_set = `Rule set`
    ) %>%
    select(sha, when, author, Package, File, Priority, rule_set, Rule, lines) %>%
    inner_join(alerts_total, by = c("sha")) %>%
    mutate(per_line = 1/lines.x) %>%
    group_by(commit, Priority) %>%
    summarise(per_line = sum(per_line)) %>%
    ungroup() %>%
    mutate(Priority = as.factor(Priority)) %>%
    filter(between(commit, 300, 1350 ))


ggplot(rule_set) +
    geom_line(aes(color = Priority, x = commit, y = per_line)) +
    theme_minimal()
```



4 Conclusions and next steps

5 References

Dangel, Andreas et. al. 2019. “PMD Source Code Analyzer.” 2019. https://pmd.github.io/.