Monolith vs. Microservices: CPU, Latency & Throughput Analysis

Projeto de Arquitetura de Software

1. Pacotes e utilitários

```r
library(dplyr)
library(tidyr)
library(ggplot2)
library(readr)
library(here)
library(lubridate)
```

2. Carregamento dos dados

```r
# ajuste o path dos results
df_cpu <- read_csv(here("merged_all.csv"))
df_locust <- read_csv(here("merged_locust.csv"))

# nomes fixos das colunas
cpu_metric_col <- "cores"   # ajuste para o nome correto no merged_all
latency_col    <- "total_median_response_time" # ajuste para o nome correto no merge_locust
throughput_col <- "req_s"
```

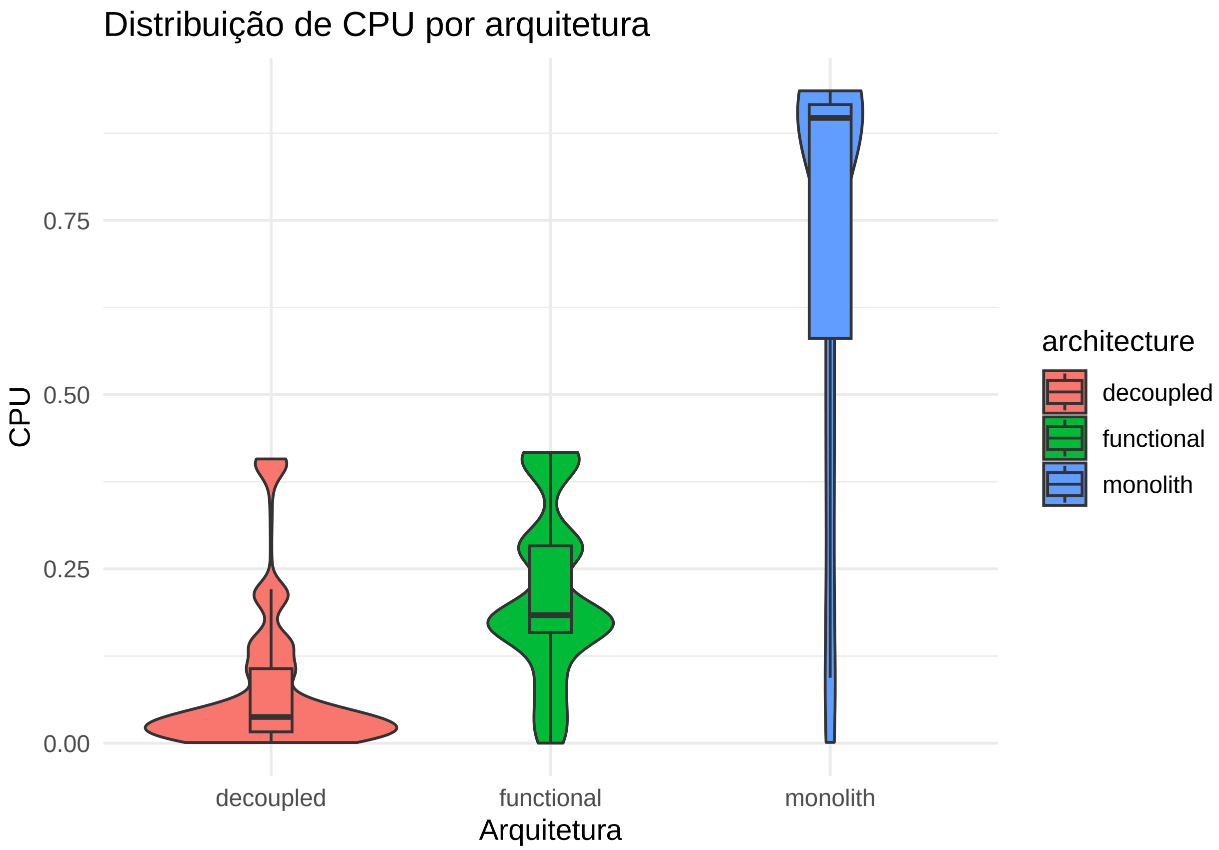
3. CPU

3.1 Entre arquiteturas

```r
df_cpu %>%
  group_by(architecture) %>%
  summarise(
    cpu_mean   = mean(.data[[cpu_metric_col]], na.rm = TRUE),
    cpu_median = median(.data[[cpu_metric_col]], na.rm = TRUE),
    cpu_p95    = quantile(.data[[cpu_metric_col]], 0.95, na.rm = TRUE)
  )
```

```
## # A tibble: 3 x 4
##   architecture cpu_mean cpu_median cpu_p95
##   <chr>           <dbl>      <dbl>   <dbl>
## 1 decoupled      0.0816     0.0376   0.393
## 2 functional     0.213      0.184    0.414
## 3 monolith       0.721      0.897    0.930
```

```
df_cpu %>%
  ggplot(aes(x = architecture, y = .data[[cpu_metric_col]], fill = architecture)) +
  geom_violin(trim = TRUE) +
  geom_boxplot(width = 0.15, outlier.shape = NA) +
  labs(title = "Distribuição de CPU por arquitetura",
       x = "Arquitetura", y = "CPU") +
  theme_minimal()
```

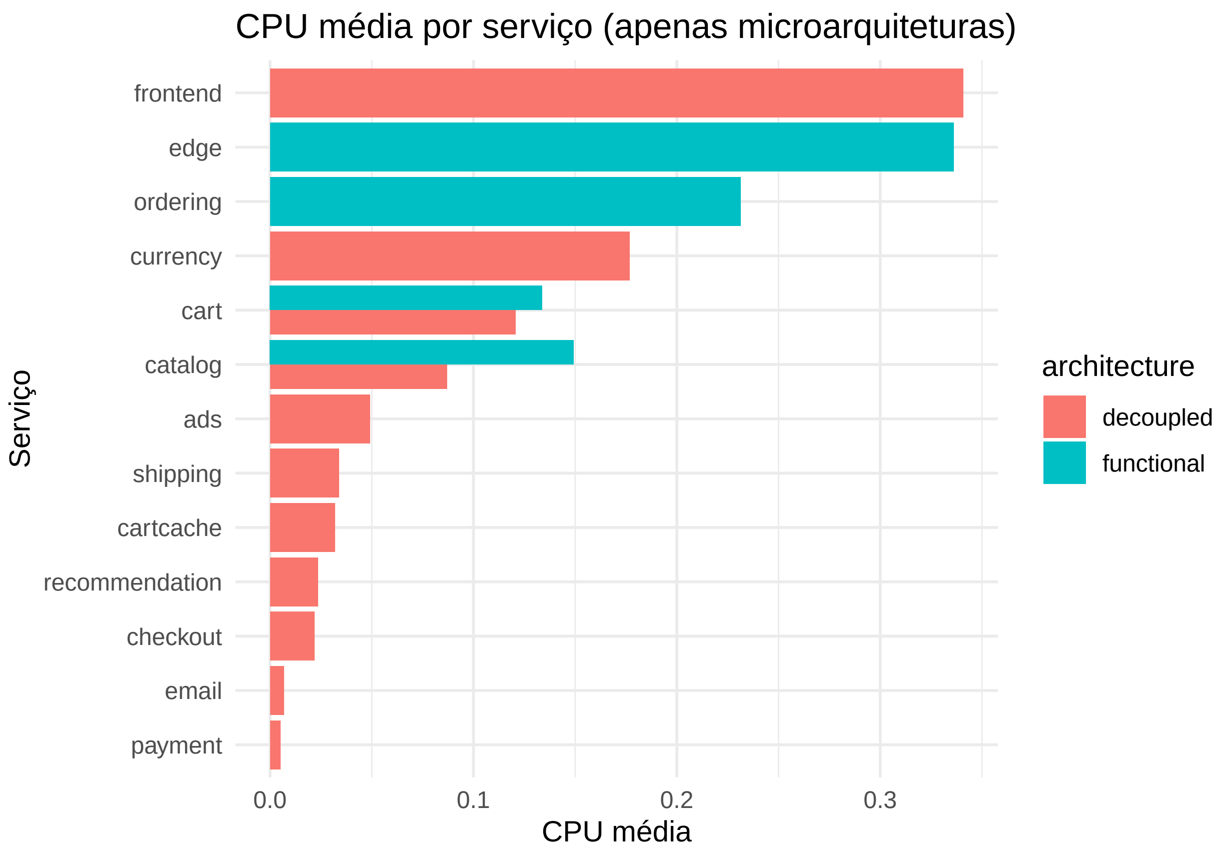


3.2 Entre serviços (somente microarquiteturas)

```
df_cpu %>%
  filter(architecture %in% c("decoupled", "functional")) %>%
  group_by(architecture, service) %>%
  summarise(
    cpu_mean = mean(.data[[cpu_metric_col]], na.rm = TRUE),
    .groups = "drop"
  ) %>%
  arrange(architecture, desc(cpu_mean))
```

```
## # A tibble: 15 x 3
##    architecture service        cpu_mean
##    <chr>        <chr>             <dbl>
##  1 decoupled    frontend        0.341
##  2 decoupled    currency        0.177
##  3 decoupled    cart            0.121
##  4 decoupled    catalog         0.0869
##  5 decoupled    ads             0.0491
##  6 decoupled    shipping        0.0338
##  7 decoupled    cartcache       0.0319
##  8 decoupled    recommendation  0.0236
##  9 decoupled    checkout        0.0218
## 10 decoupled    email           0.00676
## 11 decoupled    payment         0.00508
## 12 functional   edge            0.336
## 13 functional   ordering        0.231
## 14 functional   catalog         0.149
## 15 functional   cart            0.134
```

```
df_cpu %>%
  filter(architecture %in% c("decoupled", "functional")) %>%
  group_by(architecture, service) %>%
  summarise(cpu_mean = mean(.data[[cpu_metric_col]], na.rm = TRUE), .groups = "drop") %>%
  ggplot(aes(x = reorder(service, cpu_mean), y = cpu_mean, fill = architecture)) +
  geom_col(position = "dodge") +
  coord_flip() +
  labs(title = "CPU média por serviço (apenas microarquiteturas)",
       x = "Serviço", y = "CPU média") +
  theme_minimal()
```

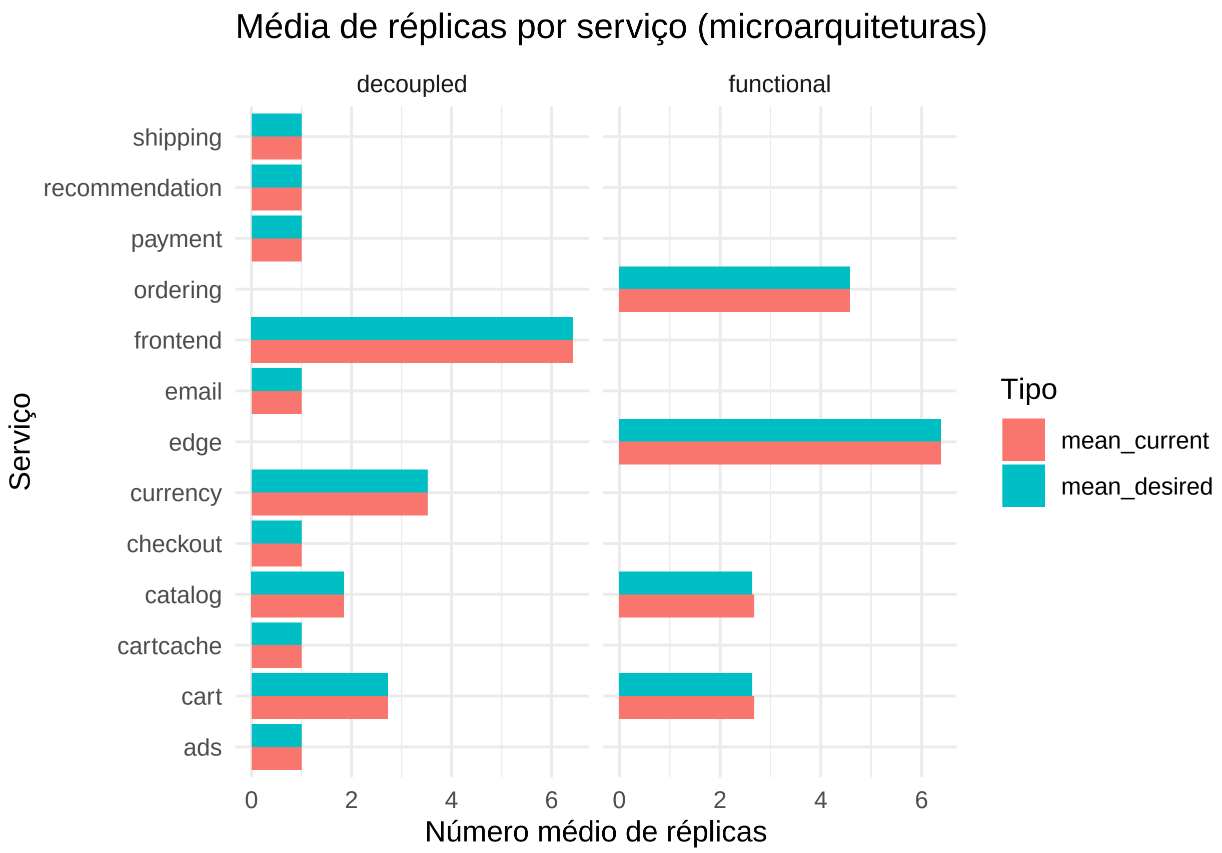


3.3 Réplicas — comparação entre serviços (microarquiteturas)

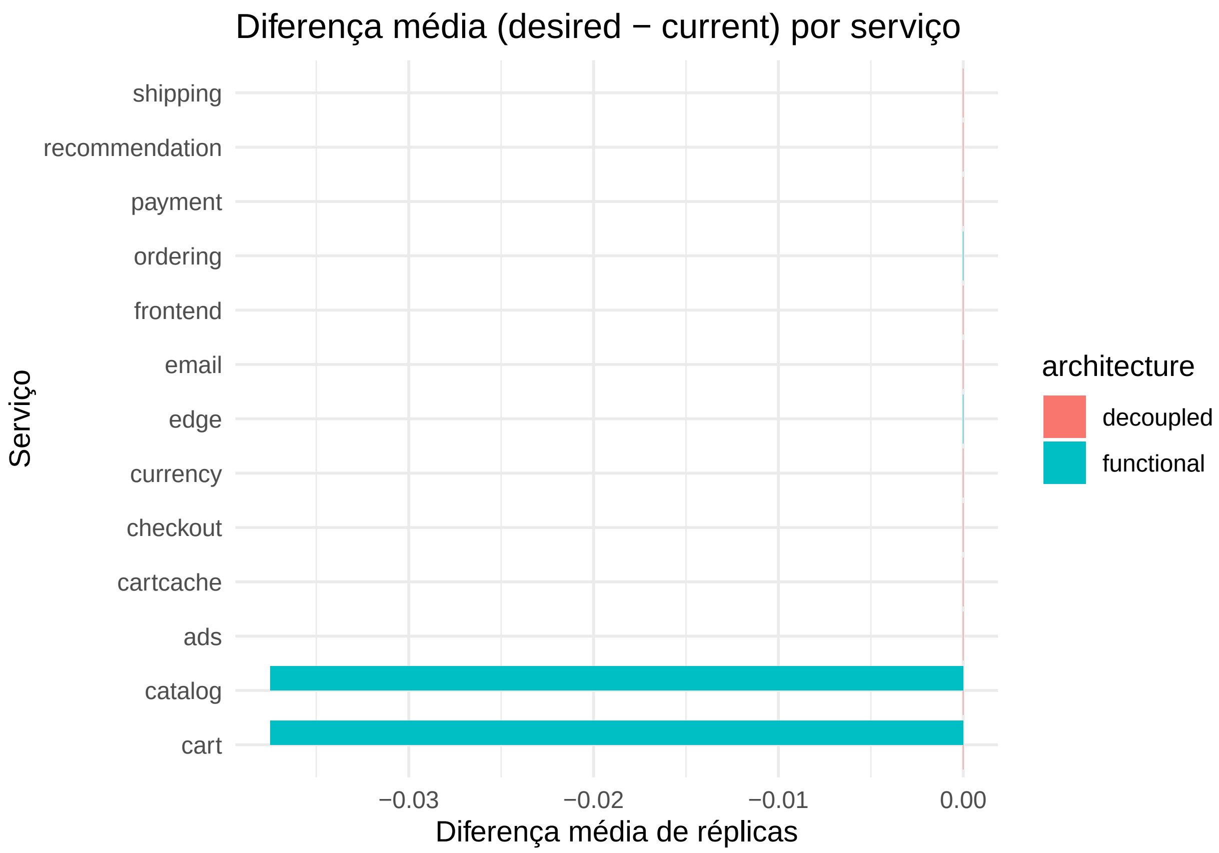
```
df_cpu %>%
  filter(architecture %in% c("decoupled", "functional")) %>%
  group_by(architecture, service) %>%
  summarise(
    max_repl     = max(max_replicas, na.rm = TRUE),
    mean_desired = mean(desired_replicas, na.rm = TRUE),
    mean_current = mean(current_replicas, na.rm = TRUE),
    .groups = "drop"
  ) %>%
  arrange(architecture, desc(mean_current))
```

```
## # A tibble: 15 x 5
##    architecture service        max_repl mean_desired mean_current
##    <chr>        <chr>             <dbl>        <dbl>        <dbl>
##  1 decoupled    frontend             10         6.42         6.42
##  2 decoupled    currency             10         3.52         3.52
##  3 decoupled    cart                 10         2.73         2.73
##  4 decoupled    catalog              10         1.85         1.85
##   5 decoupled    ads                  10         1            1
##   6 decoupled    cartcache            10         1            1
##   7 decoupled    checkout             10         1            1
##   8 decoupled    email                10         1            1
##   9 decoupled    payment              10         1            1
##  10 decoupled    recommendation       10         1            1
##  11 decoupled    shipping             10         1            1
##  12 functional   edge                 10         6.38         6.38
##  13 functional   ordering             10         4.58         4.58
##  14 functional   cart                 10         2.64         2.68
##  15 functional   catalog              10         2.64         2.68
```

```
df_cpu %>%
  filter(architecture %in% c("decoupled", "functional")) %>%
  group_by(architecture, service) %>%
  summarise(
    mean_desired = mean(desired_replicas, na.rm = TRUE),
    mean_current = mean(current_replicas, na.rm = TRUE),
    .groups = "drop"
  ) %>%
  pivot_longer(cols = c(mean_desired, mean_current),
               names_to = "replica_type", values_to = "replicas") %>%
  ggplot(aes(x = service, y = replicas, fill = replica_type)) +
  geom_col(position = "dodge") +
  facet_wrap(~ architecture, scales = "free_x") +
  coord_flip() +
  labs(title = "Média de réplicas por serviço (microarquiteturas)",
       x = "Serviço", y = "Número médio de réplicas",
       fill = "Tipo") +
  theme_minimal()
```



```r
df_cpu %>%
  filter(architecture %in% c("decoupled", "functional")) %>%
  mutate(diff_desired_current = desired_replicas - current_replicas) %>%
  group_by(architecture, service) %>%
  summarise(
    mean_diff = mean(diff_desired_current, na.rm = TRUE),
    .groups = "drop"
  ) %>%
  ggplot(aes(x = reorder(service, mean_diff), y = mean_diff, fill = architecture)) +
  geom_col(position = "dodge") +
  coord_flip() +
  labs(title = "Diferença média (desired - current) por serviço",
       x = "Serviço", y = "Diferença média de réplicas") +
  theme_minimal()
```

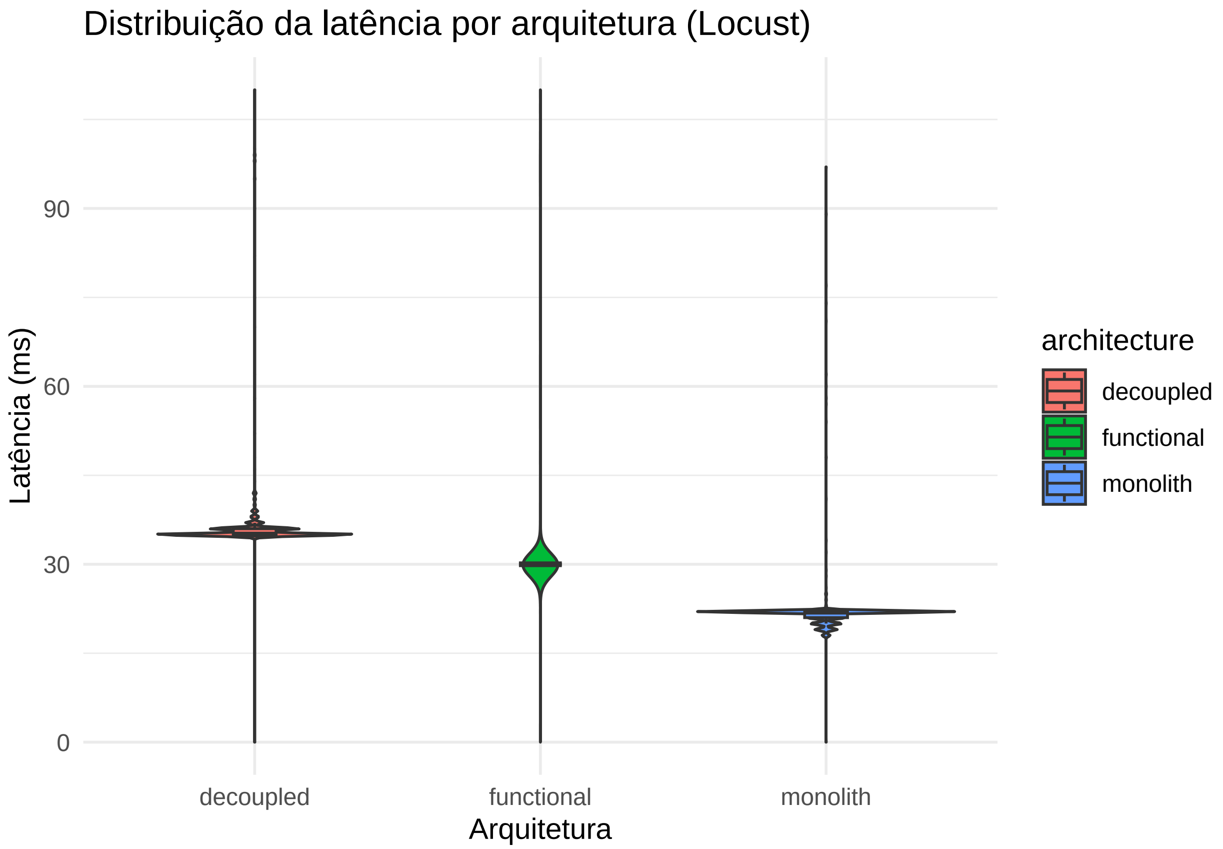


4. Latência (Locust)

```r
df_locust %>%
  group_by(architecture) %>%
  summarise(
    latency_mean   = mean(.data[[latency_col]], na.rm = TRUE),
    latency_median = median(.data[[latency_col]], na.rm = TRUE),
    latency_p95    = quantile(.data[[latency_col]], 0.95, na.rm = TRUE)
  )
```

```
## # A tibble: 3 x 4
##   architecture latency_mean latency_median latency_p95
##   <chr>               <dbl>          <dbl>       <dbl>
## 1 decoupled            36.6             35          39
## 2 functional           31.0             30          30
## 3 monolith             22.0             22          22
```

```r
df_locust %>%
  ggplot(aes(x = architecture, y = .data[[latency_col]], fill = architecture)) +
  geom_violin(trim = TRUE) +
  geom_boxplot(width = 0.15, outlier.shape = NA) +
  labs(title = "Distribuição da latência por arquitetura (Locust)",
       x = "Arquitetura", y = "Latência (ms)") +
  theme_minimal()
```

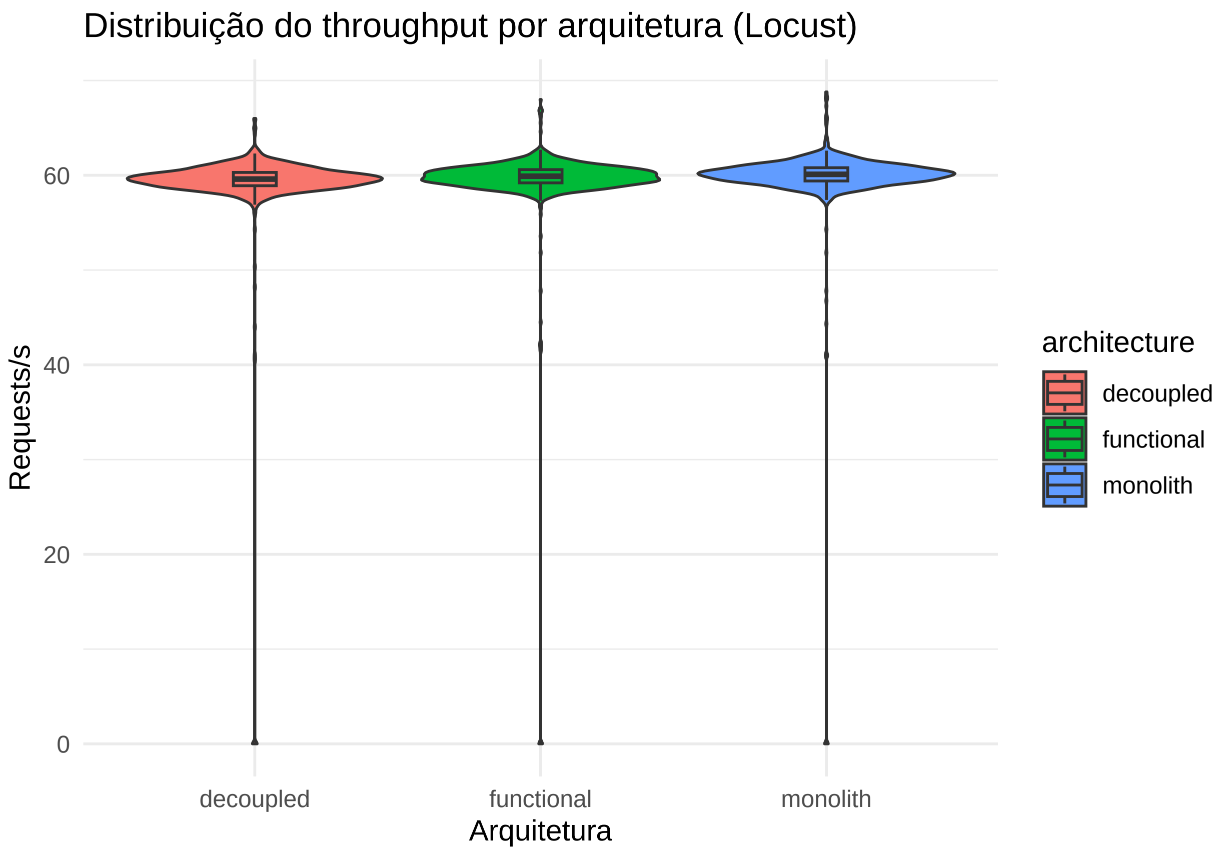


5. Throughput (Locust)

```
df_locust %>%
  group_by(architecture) %>%
  summarise(
    thr_mean   = mean(.data[[throughput_col]], na.rm = TRUE),
    # thr_median = median(.data[[throughput_col]], na.rm = TRUE),
    thr_p95    = quantile(.data[[throughput_col]], 0.95, na.rm = TRUE)
  )
```

```
## # A tibble: 3 x 3
##   architecture thr_mean thr_p95
##   <chr>           <dbl>   <dbl>
## 1 decoupled        59.3    61.5
## 2 functional       59.6    61.7
## 3 monolith         59.9    61.9
```

```r
df_locust %>%
  ggplot(aes(x = architecture, y = .data[[throughput_col]], fill = architecture)) +
  geom_violin(trim = TRUE) +
  geom_boxplot(width = 0.15, outlier.shape = NA) +
  labs(title = "Distribuição do throughput por arquitetura (Locust)",
       x = "Arquitetura", y = "Requests/s") +
  theme_minimal()
```


Distribuição do throughput por arquitetura (Locust)
Requests/s
decoupled
functional
monolith
Arquitetura
architecture
decoupled
functional
monolith