QuickSearch

Experiment

An experiment to measure time and accuracy of the implemented method.

The quick search method

Consider we have a set of D-dimensional points $S = \{x_1, \ldots, x_N\}$. The nearest point search is a task to find the point among S that is nearest to a given point y;

$$\hat{x} = \arg\min_{x \in S} ||x - y||^2$$

The naive method examines all points in S. However, when N is large, this operation takes a long time.

The cluster-based search first clusters the points in S into M clusters, where $M \ll N$. The quick search procedures first finds K nearest points among the centroids of the clusters, and then examines all points only in the nearest K clusters.

Experimental conditions

We created 100,000 points randomly, where one point was a 10-dimensional vector. Then we created 100 clusters for doing the quick search. Then we chose one point randomly, and found the nearest point from the previously-generated 100,000 points. We iterated this experiment 103 times and took an average.

The computer was a linux server (Ubuntu 22.04 LTS) with Corei9-9820X 3.3GHz CPU and 96GB memory.

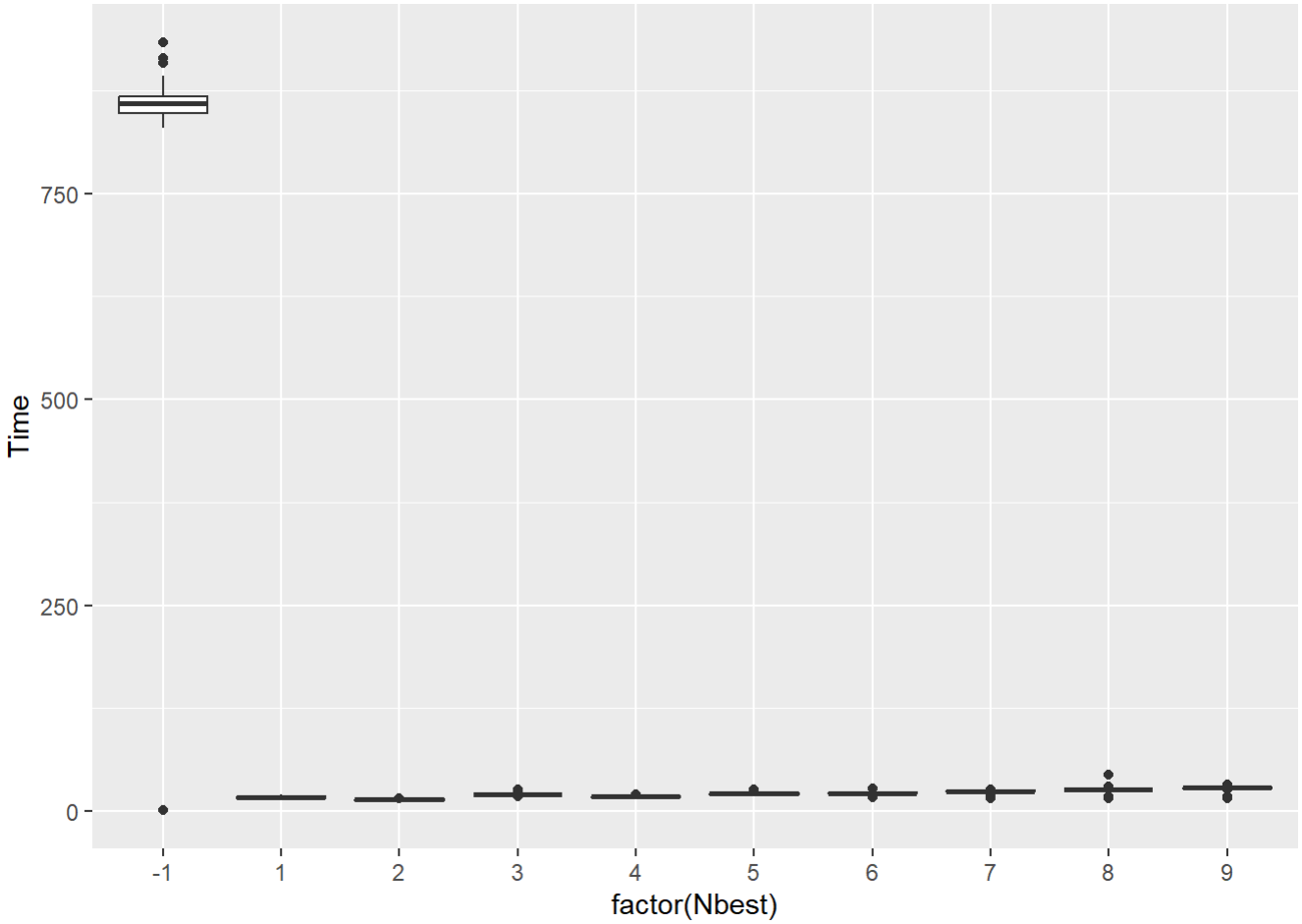
```
library(tidyverse)
```

```
── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
✓ dplyr     1.1.4     ✓ readr     2.1.5
✓ forcats   1.0.0     ✓ stringr   1.5.1
✓ ggplot2   3.5.1     ✓ tibble    3.2.1
✓ lubridate 1.9.3     ✓ tidyr     1.3.1
✓ purrr     1.0.2
── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become
errors
```

```
x <- read.csv("out.csv")
```

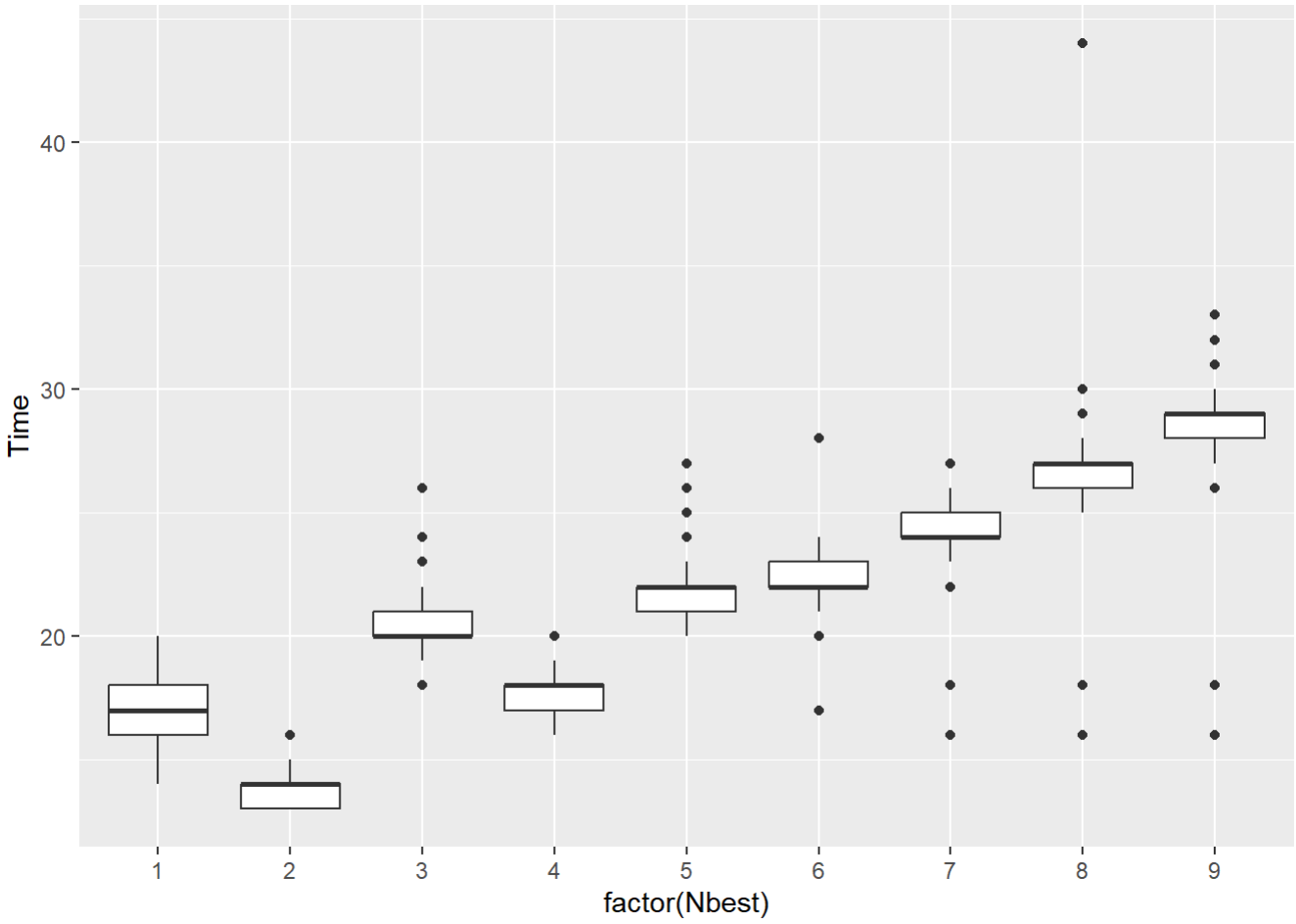
Time to take for one search (microsecond); -1 means no cluster search (the naive method)

```
x %>% ggplot(aes(x=factor(Nbest),y=Time))+geom_boxplot()
```



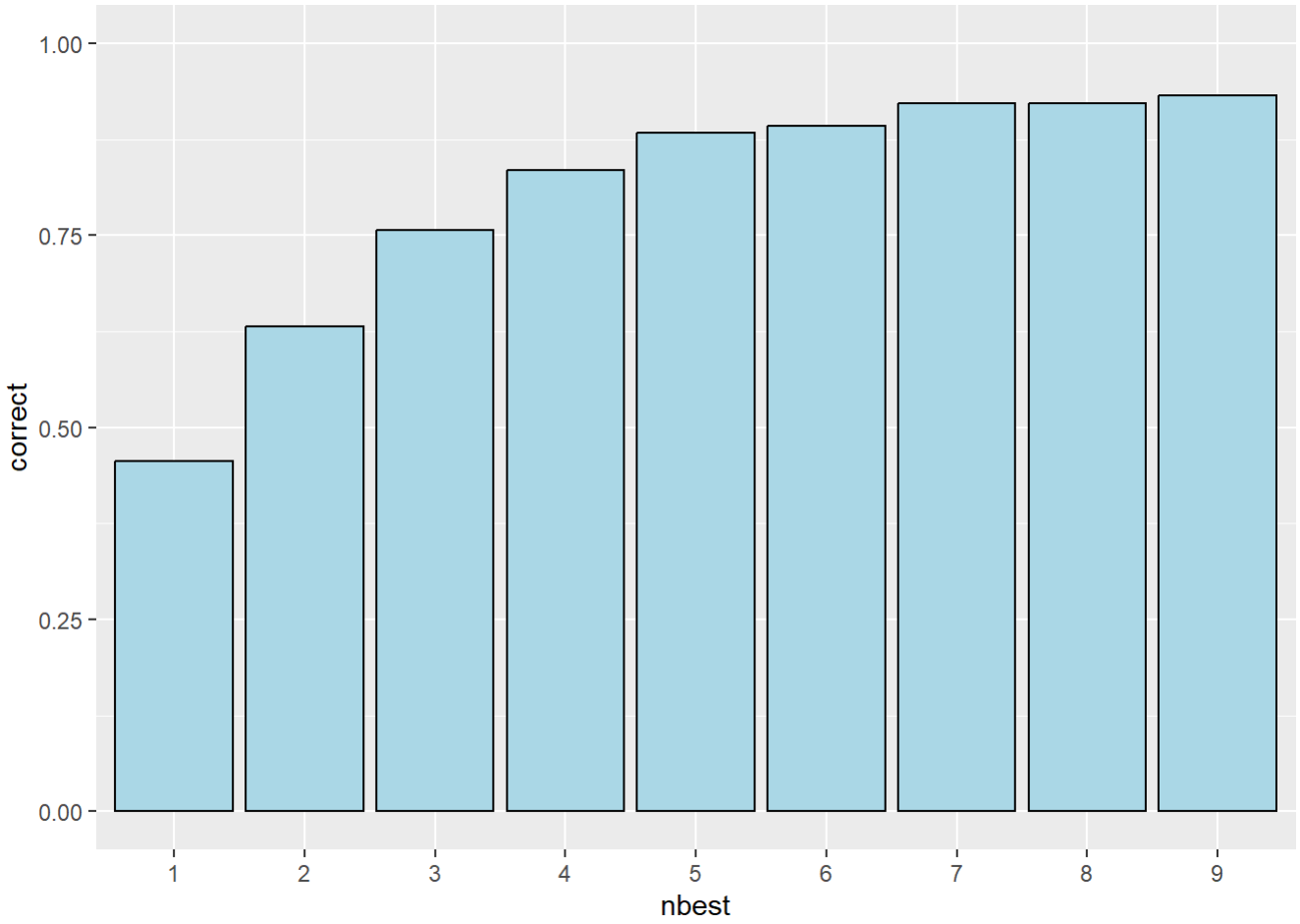
Time distribution of the n-best cluster search (in microsecond). Increasing N results increased search time, but the absolute time differences are small.

```
x %>% filter(Nbest>0) %>%
  ggplot(aes(x=factor(Nbest),y=Time))+geom_boxplot()
```



The correctness of the search result. Since this method is an approximation, there is no guarantee to find the best solution. Trying nine-best clusters, the correctness of the found solution is 93.2%.

```
x %>% filter(Nbest>0) %>%
  mutate(nbest=factor(Nbest)) %>%
  group_by(nbest) %>%
  summarise(correct=mean(Correct)) %>%
  ggplot(aes(x=nbest,y=correct))+
  geom_bar(stat="identity",position="dodge",fill="lightblue",col="black")+
  ylim(0,1)
```




```
x %>% filter(Nbest>0) %>%
  mutate(nbest=factor(Nbest)) %>%
  group_by(nbest) %>%
  summarise(correct=mean(Correct))
```

```
# A tibble: 9 × 2
  nbest correct
  <fct>   <dbl>
1 1       0.456
2 2       0.631
3 3       0.757
4 4       0.835
5 5       0.883
6 6       0.893
7 7       0.922
8 8       0.922
9 9       0.932
```