Rcpp — Solutions to Exercises

Rcpp — Exercises Part 1

- Find out why the following code gives a compile error:

```
#include<Rcpp.h>
// [[Rcpp::plugins("cpp11")]]

NumericVector x{1, 2, 3, 4, 5};
IntegerVector id{1};

double y = x[id]; // produces compile error
```

Solution:

`x[id]` returns a subview class of `Rcpp::Vector` which is *not* a double. It is important to note that coercion to another type is not as easily done as in `R`!

- Benchmark the functions below against each other for `x<-rnorm(1e2)`, `x<-rnorm(1e4)` and `x<-rnorm(1e6)`. Comment on the results.

```
NumericVector test_clone_return(NumericVector A) {
  NumericVector B = clone(A);
  B[1] = 0.5;
  return B;
}
```

```
NumericVector test_reference_return(NumericVector A) {
  A[1] = 0.5;
  return A;
}
```

Solution:

```
bench::press(
  A = c(1e2, 1e4, 1e6),
  {
    A <- rnorm(A)
    bench::mark(
      test_clone_return(A),
      test_reference_return(A),
      check = F,
      relative = T
    )
  }
)
```

Obviously, cloning (that is, copying on function call) is a bad idea!

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The second appearance of `x.begin()` refers to the beginning of the output range, i.e. the first element of `x`.

Slide 44 `Rcpp` — Exercises Part 2

1. Note that `f(n)` returns the nth Fibonacci number. Here are two `Rcpp` approaches. `f_rec_cpp()` is a one-to-one implementation of the recursive `R` function `f()`. `f_cpp()` uses a loop for the computation.

```cpp
// [[Rcpp::export]]
int f_rec_cpp(const int& n) {
  if (n < 3) return(n);
  return (f_rec_cpp(n - 1)) + f_rec_cpp(n - 2);
}

// [[Rcpp::export]]
IntegerVector f_cpp(const int& n) {
  IntegerVector x(n);
  x[0] = 1;
  x[1] = 2;
  for (int i = 2; i < n; i++){
    x[i] = x[i-2] + x[i-1];
  }
  return(tail(x, 1));
}
```

Let's microbenchmark these functions:

```r
bench::mark(
  f = f(20),
  f_rec_cpp(20),
  f_cpp = f_cpp(20),
  relative = T
)
```

```
## # A tibble: 3 x 6
##   expression      min median `itr/sec` mem_alloc `gc/sec`
##   <bch:expr>    <dbl>  <dbl>     <dbl>     <dbl>    <dbl>
## 1 f             5259.  4400.        1       Inf      Inf
## 2 f_rec_cpp(20)  43.0   35.5      123.      Inf      NaN
## 3 f_cpp             1      1     3627.      NaN      NaN
```

The overhead of recursive function calling in `R` is much bigger than in `C++`. The `Rcpp` implementation `f_rec_cpp()` already gives an impressive speedup. However, using a `for` loop in `f_cpp` is even faster!

2.
```r
set.seed(1234)

# let's generate a large vector to be (partially) sorted
v <- rnorm(1e5)
n <- 1e4

# benchmark n^th partial sort
bench::mark(
  nth_partial_sort(v, n),
  sort(v, partial = 1:n),
  check = F,
  relative = T
)
```

```
## # A tibble: 2 x 6
##   expression               min median `itr/sec` mem_alloc `gc/sec`
```

```
##   <bch:expr>                <dbl> <dbl>    <dbl>    <dbl>    <dbl>
## 1 nth_partial_sort(v, n)    1     1        10.2     1        5.76
## 2 sort(v, partial = 1:n)   11.1  10.2      1        1.56     1
```

3. Here are very basic **Rcpp** versions for vector input:

```
Rcpp::cppFunction('
bool all_cpp(const LogicalVector& x) {
  int n = x.size();

  for(size_t i = 0; i < n; i++) {
    if(x[i] != true) return false;
  }

  return true;
}
')


Rcpp::cppFunction('
NumericVector range_cpp(const NumericVector& x) {
  NumericVector out = {min(x), max(x)};
  return out;
}
')


Rcpp::cppFunction('
double var_cpp(const NumericVector& x) {
    int n = x.size() - 1;
    return 1./n * sum(pow(x - mean(x), 2));
}
')
```