Package ‘RcppProgress’

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License  GPL (>= 3)
Title  An Interruptible Progress Bar with OpenMP Support for C++ in R
Packages
Type  Package
LazyLoad  yes
Author  Karl Forner <karl.forner@gmail.com>
Description  Allows to display a progress bar in the R
console for long running computations taking place in c++ code,
and support for interrupting those computations even in multithreaded
code, typically using OpenMP.
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BugReports  https://github.com/kforner/rcpp_progress/issues
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RcppProgress-package

An interruptible progress bar with OpenMP support for c++ in R packages

Description

This package allows to display a progress bar in the R console for long running computations taking place in c++ code, and provides support for interrupting those computations even in a multithreaded code.

Details

When implementing CPU intensive computations in C++ in R packages, it is natural to want to monitor the progress of those computations, and to be able to interrupt them, even when using multithreading for example with OpenMP. Another feature is that it can be done so that the code will still work even without OpenMP support. This package offers some facilities to help implementing those features. It is biased towards the use of OpenMP, but it should be compatible when using multithreading in other ways.

quick try: There are two tests functions provided by the package to get a quick overview of what can be done.

These tests are:

- `RcppProgress:::test_sequential(max, nb, display_progress)` - a sequential code, i.e. single threaded
- `RcppProgress:::test_multithreaded(max, nb, threads, display_progress)` - a multithreaded code using OpenMP

They both are wrappers for examples implemented in the RcppProgressExample package located in the examples directory of the RcppProgress installed package.

Both tests call the very same function that implements a long computation. The `max` parameter controls the number of computations, and `nb` controls the duration of a single computation, that is quadratic in `nb`. The `threads` is as expected the number of threads to use for the computation. The `progress` parameter toggles the display of the progress bar.

On my platform,

```r
system.time( RcppProgress:::test_multithreaded(100, 3000, 4) )
```

is a good start.

C++ usage:

There are usually two locations in the c++ code that needs to be modified. The first one is the main loop, typically on the number of jobs or tasks. This loop is a good candidate to be parallelized using OpenMP. I will comment the code corresponding to the tests included with the package.

```c++
void test_multithreaded_omp(int max, int nb, int threads
, bool display_progress) {
    #ifdef _OPENMP
```
if ( threads > 0 )
    omp_set_num_threads( threads );
REprintf("Number of threads=%i\n", omp_get_max_threads());
#endif

Progress p(max, display_progress); // create the progress monitor
#pragma omp parallel for schedule(dynamic)
for (int i = 0; i < max; ++i) {
    if ( ! p.is_aborted() ) { // the only way to exit an OpenMP loop
        long_computation(nb);
        p.increment(); // update the progress
    }
}
}

Here we create a Progress object with the number of tasks to perform, then before performing a
task we test for abortion (p.is_aborted()), because we can not exit an OpenMP loop the usual
way, suing a break for example, then when after the computation, we increment the progress
monitor.

Then let us look at the computation function (that is completely useless):

double long_computation(int nb) {
    double sum = 0;
    for (int i = 0; i < nb; ++i) {
        if ( Progress::check_abort() ) // check for user abort
            return -1;
        for (int j = 0; j < nb; ++j) {
            sum += Rf_dlnorm(i+j, 0.0, 1.0, 0);
        }
    }
    return sum;
}

Here the only interesting line is the Progress::check_abort() call. If called from the master
thread, it will check for user interruption, and if needed set the abort status code. When called
from another thread it will just check the status. So all the art is to decide where to put his call: it
should not be called not too often or not frequently enough. As a rule of thumb it should be called
roughly every second.

Using RcppProgress in your package:
Please note that we provide the RcppProgressExample example package along with this pack-
age, located in the examples directory of the installed package.
Here are the steps to use RcppProgress in a new package:

skeleton  create a package skeleton using Rcpp

library(Rcpp)
Rcpp.package.skeleton("RcppProgressExample")
**DESCRIPTION**

edit the DESCRIPTION file and add RcppProgress to the Depends: and LinkingTo: lines. e.g.

```plaintext
Depends: Rcpp (>= 0.9.4), RcppProgress (>= 0.1)
LinkingTo: Rcpp, RcppProgress
```

**MakeVars**

edit `src/MakeVars` and replace its content by

```plaintext
PKG_LIBS = `$(R_HOME)/bin/Rscript -e "Rcpp:::LdFlags()" $(SHLIB_OPENMP_CXXFLAGS)`
```

```plaintext
PKG_CXXFLAGS += -Ilibsrc $(SHLIB_OPENMP_CXXFLAGS) `$(R_HOME)/bin/Rscript -e "RcppProgress:::CxxFlags()"`
```

**c++ code**

Put your code in `src`. You may for instance copy the RcppProgressExample/src/tests.cpp file in `src`, and RcppProgressExample/R/tests.R in `R`, and try to compile the package (R CMD INSTALL -l test .) and execute the tests:

```r
>library(RcppProgressExample, lib.loc="test")
>RcppProgressExample::test_multithreaded(100, 600, 4)
```

**Using RcppProgress with RcppArmadillo:**

We also provide the RcppProgressArmadillo example package along with this package, located in the examples directory of the installed package.

The peculiarity is that you have to include the RcppArmadillo.h header before the progress.hpp RcppProgress header, and add the RcppArmadillo in the LinkingTo: field of the package DESCRIPTION file.

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**See Also**

OpenMP API specification for parallel programming: [http://openmp.org](http://openmp.org)

Rcpp [http://r-forge.r-project.org/projects/rcpp](http://r-forge.r-project.org/projects/rcpp)

**Examples**

```r
# these are implemented as examples inside RcppProgress provided
# example package: examples/RcppProgressExample
# check the source code

# the underlying test_test_multithreaded c++ function is multithreaded
# , has a progress bar and is still interruptible
## Not run:
RcppProgress:::test_multithreaded(nb = 300, threads = 4, recompile = TRUE)

## End(Not run)
```
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