### C++ for R Programmers

Dr. Dirk Eddelbuettel edd@debian.org dirk.eddelbuettel@R-Project.org

Invited Session: What other languages should R users know about ?

useR! 2012 Vanderbilt University June 14, 2012



• Asking Google leads to 51,600,000 hits.

- Asking Google leads to 51,600,000 hits.
- No, I didn't read all of those.

- Asking Google leads to 51,600,000 hits.
- No, I didn't read all of those.
- Wikipedia starts with C++ (pronounced "cee plus plus") is a statically typed, free-form, multi-paradigm, compiled, general-purpose, powerful programming language.

- Asking Google leads to 51,600,000 hits.
- No, I didn't read all of those.
- Wikipedia starts with C++ (pronounced "cee plus plus") is a statically typed, free-form, multi-paradigm, compiled, general-purpose, powerful programming language.
- We could spend this session discussing just that sentence.

- Asking Google leads to 51,600,000 hits.
- No, I didn't read all of those.
- Wikipedia starts with C++ (pronounced "cee plus plus") is a statically typed, free-form, multi-paradigm, compiled, general-purpose, powerful programming language.
- We could spend this session discussing just that sentence.
- C++ is industrial-strength, widely-used, vendor-independent and still evolving.

- Asking Google leads to 51,600,000 hits.
- No, I didn't read all of those.
- Wikipedia starts with C++ (pronounced "cee plus plus") is a statically typed, free-form, multi-paradigm, compiled, general-purpose, powerful programming language.
- We could spend this session discussing just that sentence.
- C++ is industrial-strength, widely-used, vendor-independent and still evolving.
- In science and research, it is one of the most widely-used languages. If there is something you want to use or connect to, it probably has a C/C++ API.

- Asking Google leads to 51,600,000 hits.
- No, I didn't read all of those.
- Wikipedia starts with C++ (pronounced "cee plus plus") is a statically typed, free-form, multi-paradigm, compiled, general-purpose, powerful programming language.
- We could spend this session discussing just that sentence.
- C++ is industrial-strength, widely-used, vendor-independent and still evolving.
- In science and research, it is one of the most widely-used languages. If there is something you want to use or connect to, it probably has a C/C++ API.
- As a widely used language it also has good tool support (debuggers, [memory] profilers, code analysis).

## A popular view on "What C++ is" From Scott Meyers highly-regarded "Effective C++"

Item 1: "View C++ as a federation of languages"

• C provides a rich inheritance and interoperability as Unix, Windows, ... are all build on C.

#### A popular view on "What C++ is" From Scott Meyers highly-regarded "Effective C++"

- C provides a rich inheritance and interoperability as Unix, Windows, ... are all build on C.
- **2** Object-Oriented C++ just to provide endless discussions about exactly what OO is or should be (and R really helps here having three different ones to offer :-/ ).

- C provides a rich inheritance and interoperability as Unix, Windows, ... are all build on C.
- Object-Oriented C++ just to provide endless discussions about exactly what OO is or should be (and R really helps here having three different ones to offer :-/).
- Templated C++ which is mighty powerful; template meta programming unequalled in other languages.

- C provides a rich inheritance and interoperability as Unix, Windows, ... are all build on C.
- Object-Oriented C++ just to provide endless discussions about exactly what OO is or should be (and R really helps here having three different ones to offer :-/).
- Templated C++ which is mighty powerful; template meta programming unequalled in other languages.
- The STL which is a specific template library which is powerful but has its own conventions.

- C provides a rich inheritance and interoperability as Unix, Windows, ... are all build on C.
- Object-Oriented C++ just to provide endless discussions about exactly what OO is or should be (and R really helps here having three different ones to offer :-/).
- Templated C++ which is mighty powerful; template meta programming unequalled in other languages.
- The STL which is a specific template library which is powerful but has its own conventions.

# A popular view on "What C++ is" From Scott Meyers highly-regarded "Effective C++"

Item 1: "View C++ as a federation of languages"

- C provides a rich inheritance and interoperability as Unix, Windows, ... are all build on C.
- Object-Oriented C++ just to provide endless discussions about exactly what OO is or should be (and R really helps here having three different ones to offer :-/).
- Templated C++ which is mighty powerful; template meta programming unequalled in other languages.
- The STL which is a specific template library which is powerful but has its own conventions.

And C++11 adds many more goodies that could be called a fifth language.



 "Barbell" portfolios mean those comprised of both long and short duration bonds – as opposed to "bullet" portfolio concentrated at one (middle) duration.

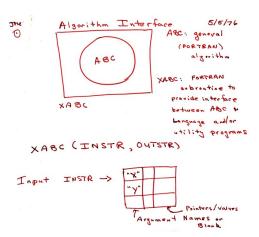
- "Barbell" portfolios mean those comprised of both long and short duration bonds – as opposed to "bullet" portfolio concentrated at one (middle) duration.
- I feel language choice is similar: It is rare to have one single solution for all problems. Python may be close; Julia may get there too.

- "Barbell" portfolios mean those comprised of both long and short duration bonds – as opposed to "bullet" portfolio concentrated at one (middle) duration.
- I feel language choice is similar: It is rare to have one single solution for all problems. Python may be close; Julia may get there too.
- But I am a realist, and I have *never* been on a project or team that was single-language, single-solution.

- "Barbell" portfolios mean those comprised of both long and short duration bonds – as opposed to "bullet" portfolio concentrated at one (middle) duration.
- I feel language choice is similar: It is rare to have one single solution for all problems. Python may be close; Julia may get there too.
- But I am a realist, and I have never been on a project or team that was single-language, single-solution.
- In practice, people will always mix. So let's face this head-on and pick tools which mix well.

- "Barbell" portfolios mean those comprised of both long and short duration bonds – as opposed to "bullet" portfolio concentrated at one (middle) duration.
- I feel language choice is similar: It is rare to have one single solution for all problems. Python may be close; Julia may get there too.
- But I am a realist, and I have never been on a project or team that was single-language, single-solution.
- In practice, people will always mix. So let's face this head-on and pick tools which mix well.
- It so happens that I think R and C++ mix well via Rcpp and RInside.

## And John agrees



Source: John Chambers' talk at Google, 2010.

Essentially, any R object is represented internally as a SEXP.

- Essentially, any R object is represented internally as a SEXP.
- The .Call interface lets you send SEXPs back and forth.

- Essentially, any R object is represented internally as a SEXP.
- The .Call interface lets you send SEXPs back and forth.
- SEXP can be nested just like R objects: lists of lists of ...

- Essentially, any R object is represented internally as a SEXP.
- The .Call interface lets you send SEXPs back and forth.
- SEXP can be nested just like R objects: lists of lists of ...
- Rcpp makes the interchange of R objects a little easier than the plain C API for R.

- Essentially, any R object is represented internally as a SEXP.
- The .Call interface lets you send SEXPs back and forth.
- SEXP can be nested just like R objects: lists of lists of ...
- Rcpp makes the interchange of R objects a little easier than the plain C API for R.
- "Empirically speaking", 68 CRAN packages (as of 3 June 2012) using Rcpp seem to agree.

## Possible with R's API, easier with Rcpp

- Essentially, any R object is represented internally as a SEXP.
- The .Call interface lets you send SEXPs back and forth.
- SEXP can be nested just like R objects: lists of lists of ...
- Rcpp makes the interchange of R objects a little easier than the plain C API for R.
- "Empirically speaking", 68 CRAN packages (as of 3 June 2012) using Rcpp seem to agree.
- This makes Rcpp the most widely used foreign-language interface package for R (as it overtook rJava recently). Of course, there is the plain C API...

## Python

## Python



Trust me, Mogli.... Seriously?

### Julia

#### <u>J</u>ulia



This is my Julia and until I find a matching language "Anna" ...