CoCoALib Minicourse

http://cocoa.dima.unige.it/

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Recap of C++

- C++ is evolving: C++03, C++11, C++14, C++17(?)
- small language + standard template library (STL)

C++ language

- explicit static typing
- few basic types: `bool`, `int`, `double`, `char`
- `if ( cond ) { cmds } else { cmds }` ⟵ `then` is implicit!
- `for (int i = 1; i <= n; ++i) { cmds }`
- `while ( cond ) { cmds }`
- `continue`, `break`, `return`
- user defined functions

C++ Standard Template Library

- contains many basic functions *e.g.* `sqrt`, `log`
- STL is very large (and evolving)
  - $\longrightarrow$ books by Scott Meyers
  - $\longrightarrow$ book by Nikolai Josuttis
  - $\longrightarrow$ websites `cppreference`, `cplusplus`, ...
- many "extended types"
  - input and output `cout` $\longleftrightarrow$ screen
  - `std::vector`, array with indices from 0 to $n-1$ (not checked)
  - `std::string` for strings
  - iterators
  - common algorithms, smart pointers, ...

Each Read-Only Parameter

- pass-by-value if data-structure is small ⟵ makes a copy
- pass-by-const-reference is data-structure may be big

Each Write-Only or Read-Write Parameter

- pass-by-reference

```
bool IsPrime(long n);
bool IsPrime(const BigInt& N);
void QuoRem(long& q, long& r, long a, long b);
BigInt ReduceMod(const BigInt& A, const BigInt& B);
void ReduceMod(BigInt& A, const BigInt& B);
```

`void` means fn returns no value.

Recap of Object Oriented Programming

Object oriented is a set of guidelines for clean, safe programming.

An object is a value belonging to some "class" $\longleftrightarrow$ "type".

- an object comprises 0 or more (private) data members
- constructors create an object (from given initial arguments)
- destructor destroys an object, incl. related resources
- accessor functions ("setter" and "getter" fns)
- member fns, friend fns $\Longrightarrow$ direct access to data members
- (non-friend) non-member fns $\Longrightarrow$ no access to data members

Example: see `ex-c++-class.C`

More advanced features of C++

- Exceptions:
  - alternative way of leaving a function
  - typically used to “report errors”
  - need specific exception handlers
- class inheritance, virtual functions, “polymorphism”
- template classes, template functions

Programming with CoCoALib

CoCoALib basic types:

- `BigInt` integers “without size limit”
- `BigRat` rationals “without size limit”
- `ring` various commutative rings CoCoA knows about
- `RingElem` element of a `ring`

CoCoALib basic rings:

- `RingZZ()` ring of integers
- `RingQQ()` field of rationals
- `NewZZmod(p)` finite field
- `NewPolyRing(RingQQ(), symbols("x,y,z"));`

CoCoALib documentation

- many example programs, names of the form `ex-XYZ.C`
- useful example: `ex-empty.C`, does (almost) nothing
- HTML manual pages (where are they?)

Writing and Compiling

First thing to do: create `CoCoA::GlobalManager` object
$\longrightarrow$ constructor initializes CoCoALib "foundations"
$\longrightarrow$ destructor does final cleaning.

Easy way to start writing your program:

$\longrightarrow$ take a copy of `ex-empty.C` (or another example) and edit it.

Compilation: simpler via a `Makefile`

Exercises

- look at all examples `ex-c++-XXX.C`, read, understand.
- look at `ex-BigInt1.C`
- look at `ex-ring1.C`, `ex-RingQQ1.C`, `ex-RingElem1.C`

Try compiling and running the examples (after understanding them!)

Try completing `lesson2-fibonacci.C` ...
... and compiling it ...
... and running it!

The End

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