

# CoCoALib

a C++ library for Computations in Commutative Algebra



**John Abbott**

Università di Genova, Italy

- What is **CoCoALib**?
  - The old and the new
  - Current state
  - Inheritance
  - Twin floats
  - Where to begin?
- Some examples of **CoCoALib**
  - Empty
  - Change of coordinates

## 4, Lib, Server, and 5?

- **CoCoA-4** current system 4.7.2 (in C, old and arthritic)
- **CoCoALib** C++ library (in C++, young, spritely and flexible)
- **CoCoAServer** “server program” coupled with **CoCoA-4**, gives access to some features of **CoCoALib**. Easily extensible.
- **CoCoA-5** future system whose core will be **CoCoALib**, extended language and capabilities (still vapourware)

**ApCoCoALib** is a C++ library built on top of **CoCoALib**, developed by the team in Germany (<http://www.apcocoa.org>). It is linked in **CoCoAServer** and will be in **CoCoA-5**.

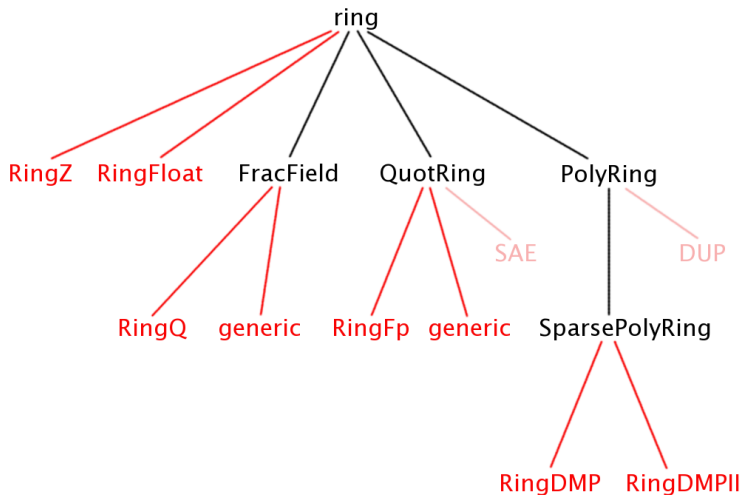
# Current state

- types for representing **poly. rings, ideals and submodules**
- the **coefficient rings** include  $\mathbb{Q}$ ,  $\mathbb{F}_p$ ,  $\mathbb{R}$ , and  $k(a_0, \dots, a_n)$
- general **term-orderings** and **multi-gradings** (for both poly. rings and modules over them)
- **Gröbner bases** and several other ideal/module operations (faster and more flexible than **CoCoA-4**)
- **ring homomorphisms** for mapping values between rings
- Accessible via prototype **CoCoAServer** from **CoCoA-4**.

We develop our code on **GNU/Linux** machines and **MacOS X**.

We use GMP for big integer arithmetic and high precision floats.

# Ring Inheritance Diagram



# Twin Float Arithmetic

Each value is represented as a pair of high-precision floats, and both components must have approximately the same value. Based on idea in Traverso & Zanoni, ISSAC 2002.

Colour key: Precision requested; guard digits; trouble; noise.

“Safe” value  $\left\{ \begin{array}{l} 1.00000000000000005357 \\ 1.00000000000000001079 \end{array} \right\}$

Noise just acceptable  $\left\{ \begin{array}{l} 1.0000000000003141592 \\ 1.0000000000014142135 \end{array} \right\}$

Noise unacceptable  $\left\{ \begin{array}{l} 1.0000000000031415926 \\ 1.0000000000141421356 \end{array} \right\} \Rightarrow \text{ERROR insuff. prec.}$

- 1 The green and blue digits must always match.
- 2 We trust only the green digits to be correct.

# Where to begin?

## Prerequisites

- Some knowledge of basic C++ programming
- Mild familiarity with compilation and `make`

## What to do

- Download **CoCoALib**  
current version: `CoCoALib-0.9907`
- Configure and compile  
`./configure; make`
- Experiment!  
`cd examples; make;`