BiiPS

MCMSki IV: Recent Developments in Software for MCMC ...and SMC

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Goals/aims

BiiPS = **B**ayesian **i**nference with **i**nteracting **P**article **S**ystems

Motivation:

- Last 20 years: success of SMC in many applications
- No general and easy-to-use software for SMC

Objectives:

- Inference in graphical models defined in BUGS language
- Use SMC methods as inference engine instead of MCMC
- User-friendly, "black-box" implementation

History

- Started in **Dec. 2009**: Adrien Todeschini is recruited as engineer, funded by Inria (2009-2012) and CEA (2012)
- **June 2012**: First beta release with R interface
- **Sept. 2012**: Marc Fuentes (Inria engineer) is assigned to *BiiPS* project for 1.5 year
- **Jan. 2014**: New release (soon) with Matlab interface

Technical implementation 1/2

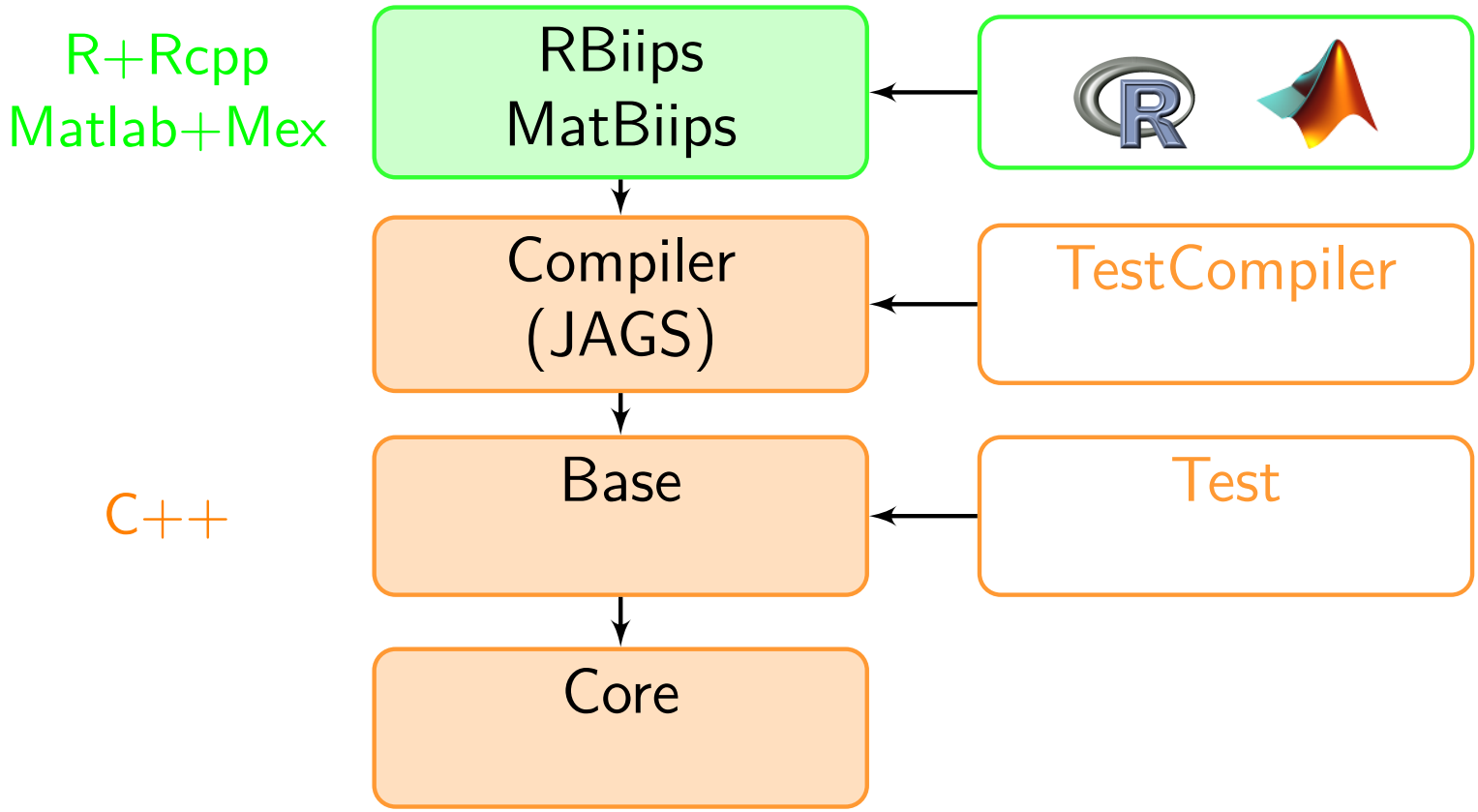


Figure : *BiiPS* architecture

Technical implementation 2/2

- SMC for general BUGS graphical models

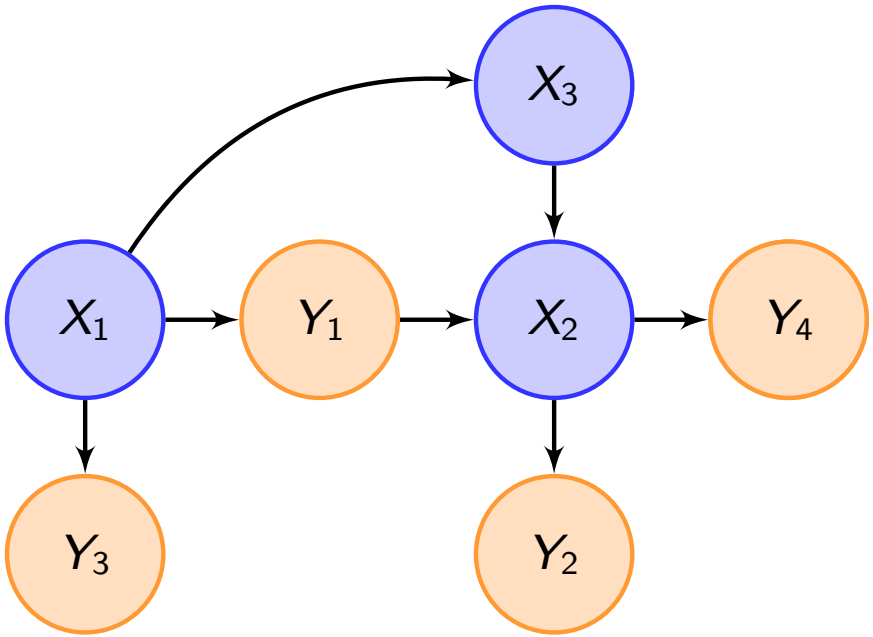


Figure : Graphical model before rearrangement

Technical implementation 2/2

- SMC for general BUGS graphical models

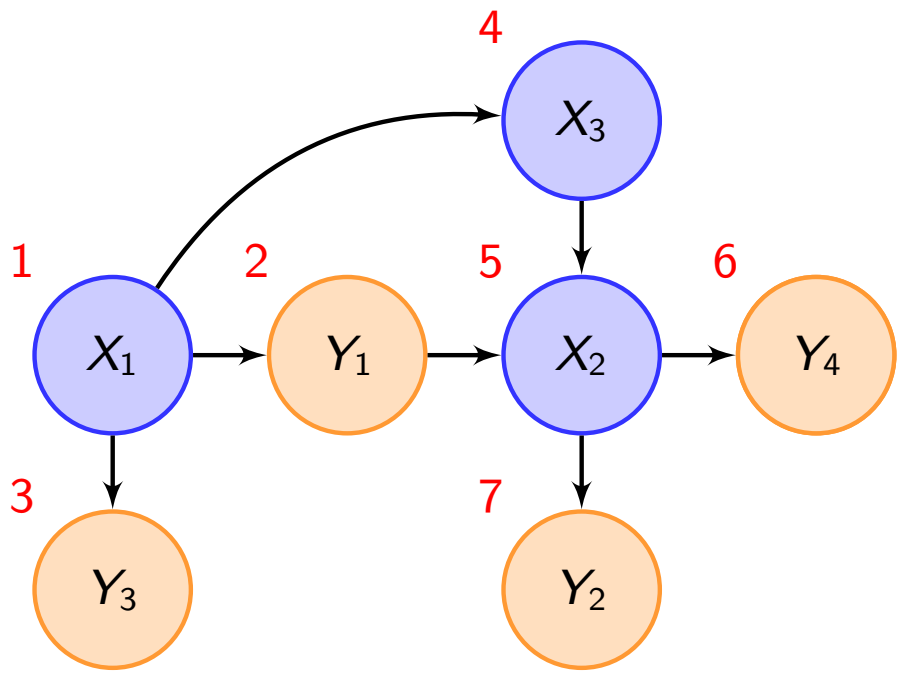
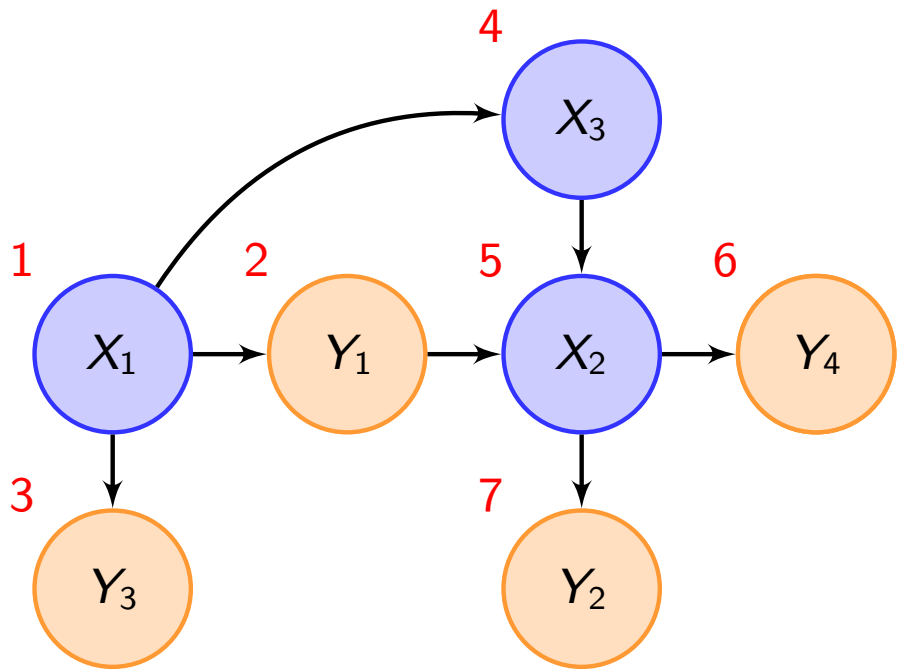


Figure : Topological sort (with priority to measurement nodes):
$(X_1, Y_1, Y_3, X_3, X_2, Y_4, Y_2)$

Technical implementation 2/2

- SMC for general BUGS graphical models



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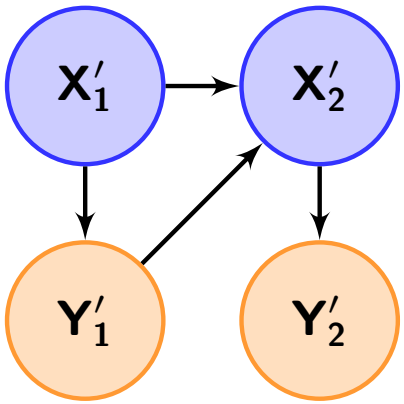

Figure : Rearrangement of a directed acyclic graph. $\mathbf{X}'_1 = X_1$, $\mathbf{Y}'_1 = \{Y_1, Y_3\}$, $\mathbf{X}'_2 = (X_3, X_2)$ and $\mathbf{Y}'_2 = \{Y_2, Y_4\}$

Strength

- Use of **SMC** methods
- Automatic implementation on **general graphical model** (not restricted to state-space models)
- **BUGS** language
- Automatic **forward filtering**, **forward smoothing** and **backward smoothing** algorithms, with standard adaptive resampling schemes
- **Adaptive PMMH** algorithm for static parameters inference (only RBiips currently)
- **Automatic proposal** distribution in some conjugate cases
- Interfaces with **R/Matlab** at the C++ level (using Rcpp/Mex)
- Easy extension of BUGS language with **user-defined** R/Matlab functions
- **Multi-platform**: Windows, Linux, Mac

Limitations

- Not really "automagic"...
  - Too much flexibility?
  - Need a more expert system?
- Lack of automatic diagnosis:
  - How to tune the number of particles?
  - Is ESS is sufficient?
- Not parallel
- Interpreted BUGS language $\rightarrow$ slow, large memory occupied by the model
- Missing some BUGS language features

Alternative: *LibBi* software [Lawrence Murray, 2013]

Current and future development

- Particle MCMC algorithms for Matlab
- Particle Gibbs algorithm
- Open code to external contributions
- Improve robustness
- Improve performance: optimization, parallelization...
- More BUGS language features: functions, distributions...
- More advanced and conjugate samplers
- More tutorial examples and documentation

http://alea.bordeaux.inria.fr/biips