Static Verification of Message Passing Programs

Wytse Oortwijn, Stefan Blom, and Marieke Huisman

Formal Methods and Tools, University of Twente

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Writing software correctly is hard

Motivational examples

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$400 million Pentium bug

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Static verification

Hoare logic extensions

- **Reynolds:** Separation logic (2002)
- **Boyland:** Permission-based separation logic (2003)
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the VerCors toolset

Verification of concurrent software
Proving *data race freedom* and
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Research question

Can we leverage verification techniques for concurrent software to message passing programs?

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Our solution

1. Use separation logic for local correctness.
2. Capture communication behaviour in abstract models, called *futures*.
3. Model checking the futures to show functional correctness.

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MPI program
+ separation logic

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Abstract model
of the communication behaviour.
(process algebra)

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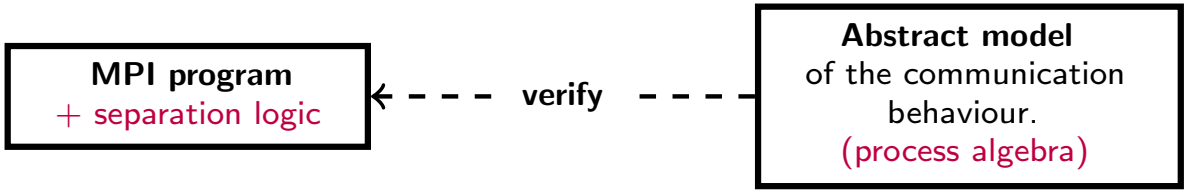

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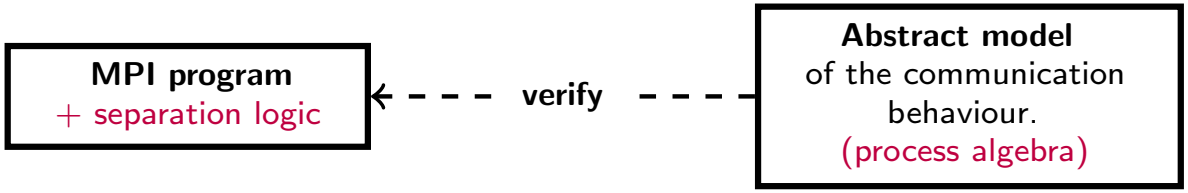

Temporal properties
Safety properties, e.g.
resource leakage, deadlocks, etc.

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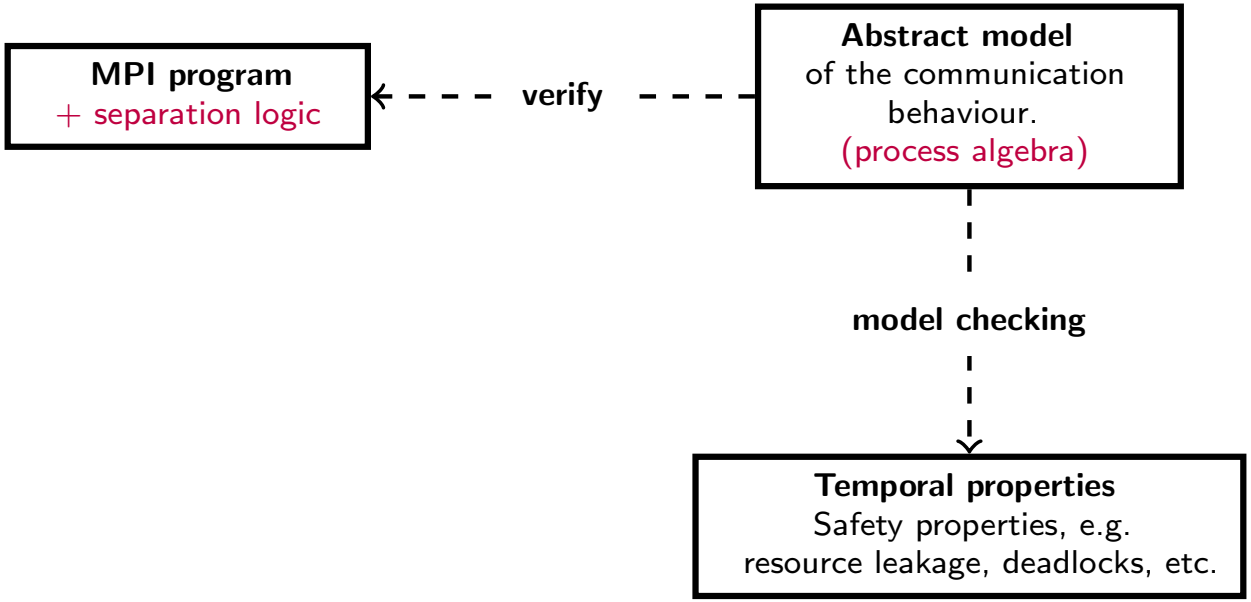

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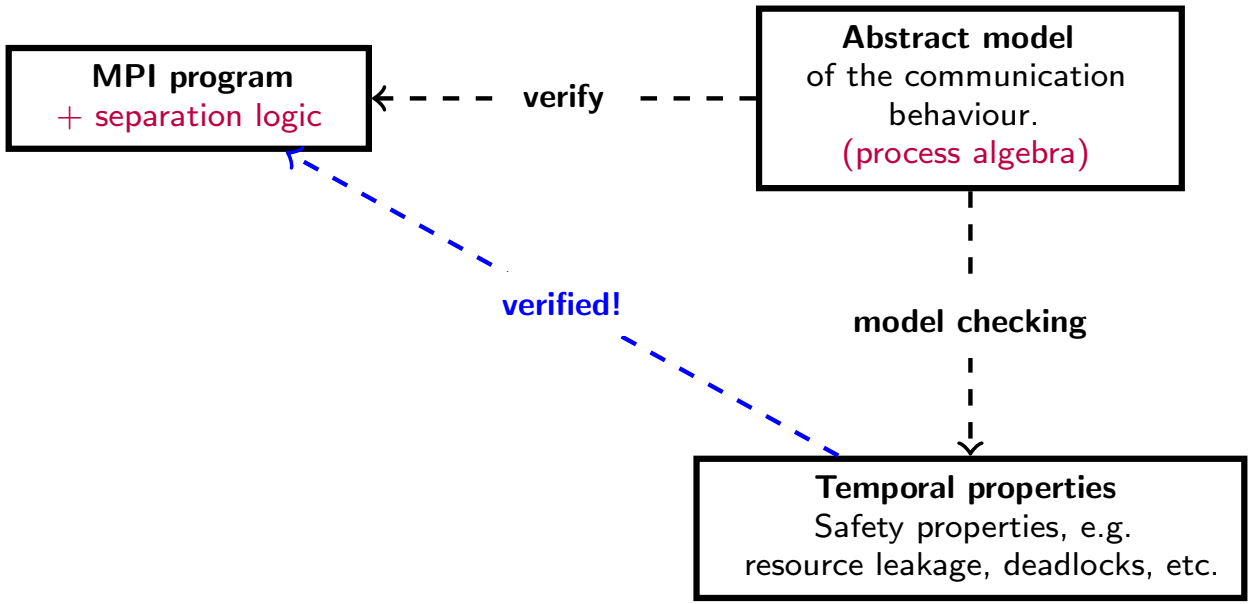

mCRL2: Process algebra

Example vending machine

$$\textbf{process}\ \text{Machine}() \equiv \textbf{coin} \cdot$$

$$(\textbf{water} \cdot \text{Machine}() + \textbf{coin} \cdot \textbf{cola} \cdot \text{Machine}())$$

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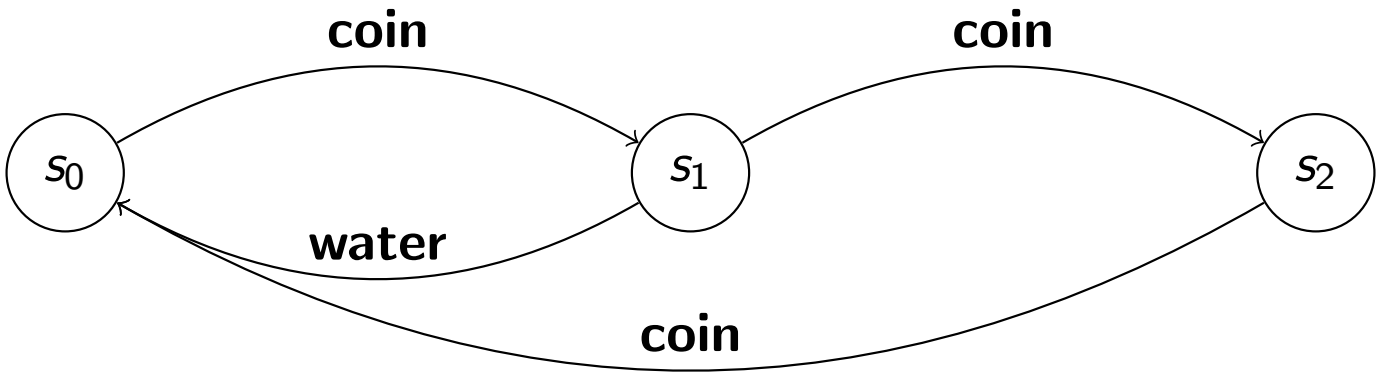

Abstracting MPI primitives

MPI primitives $\rightsquigarrow$ corresponding actions

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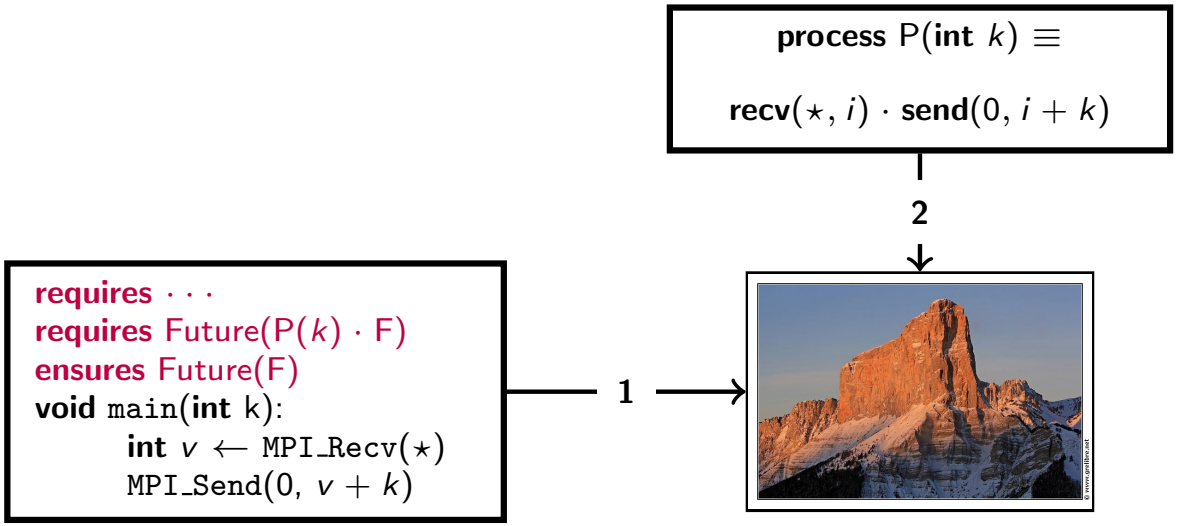

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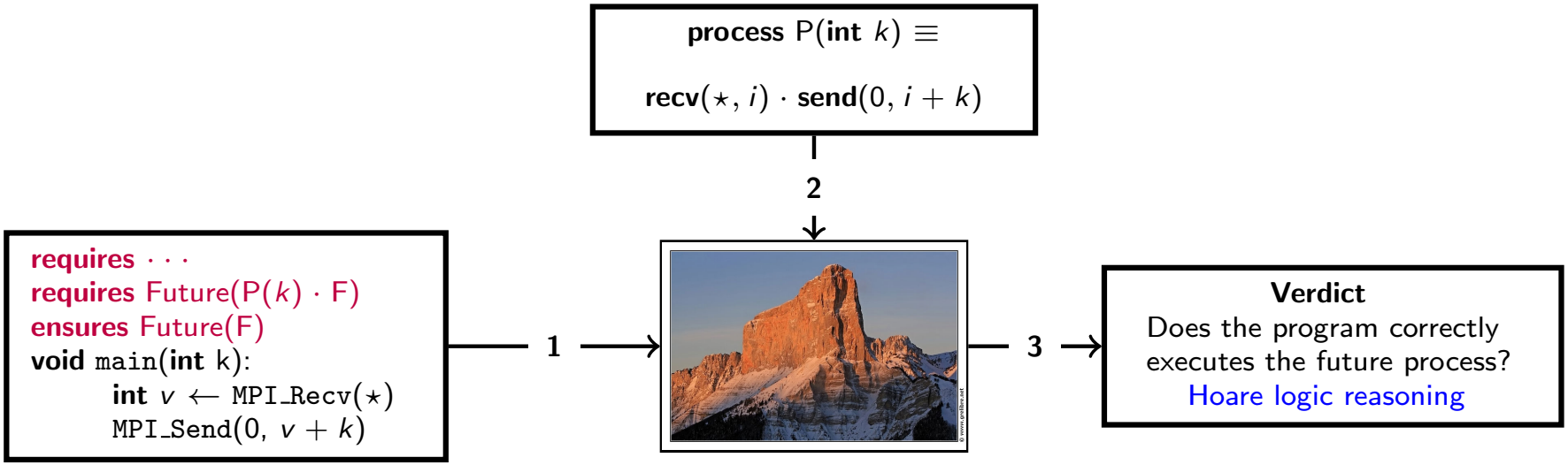

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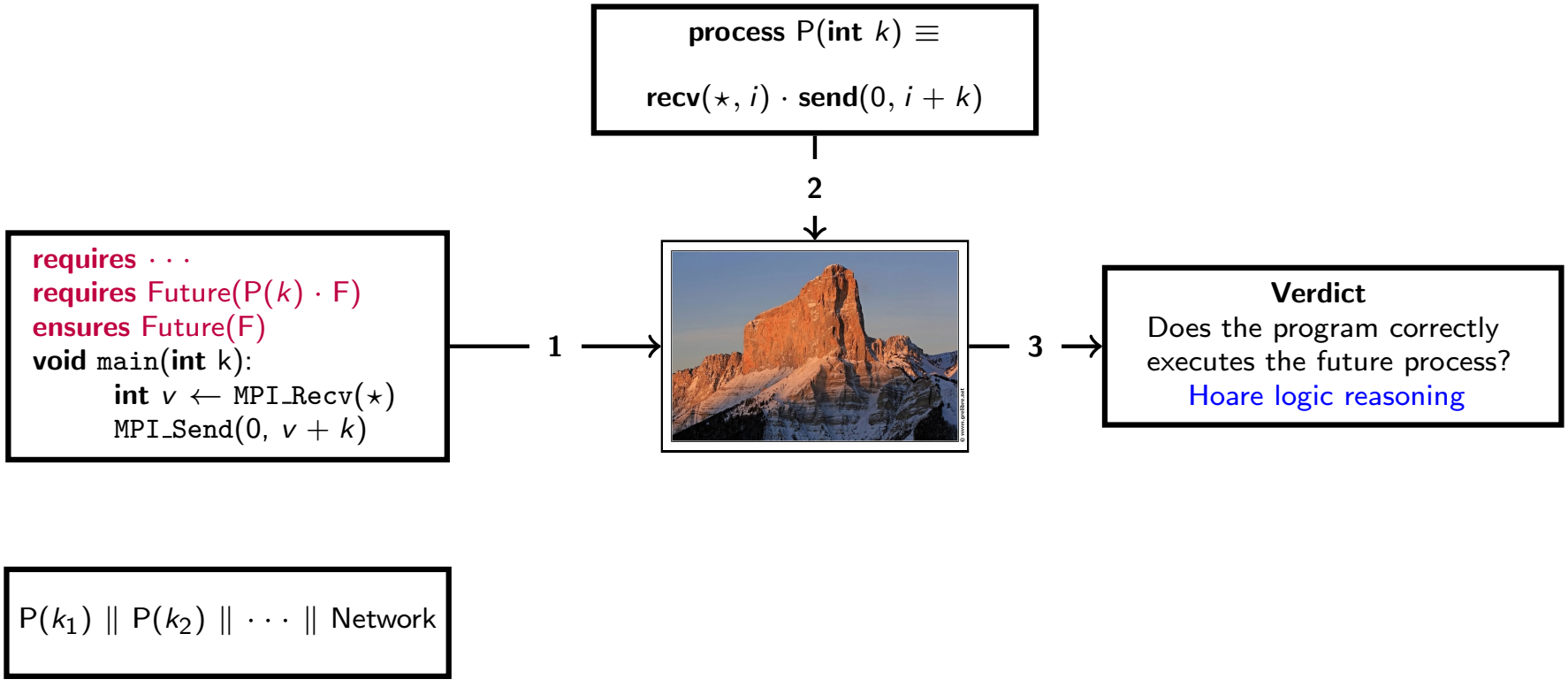

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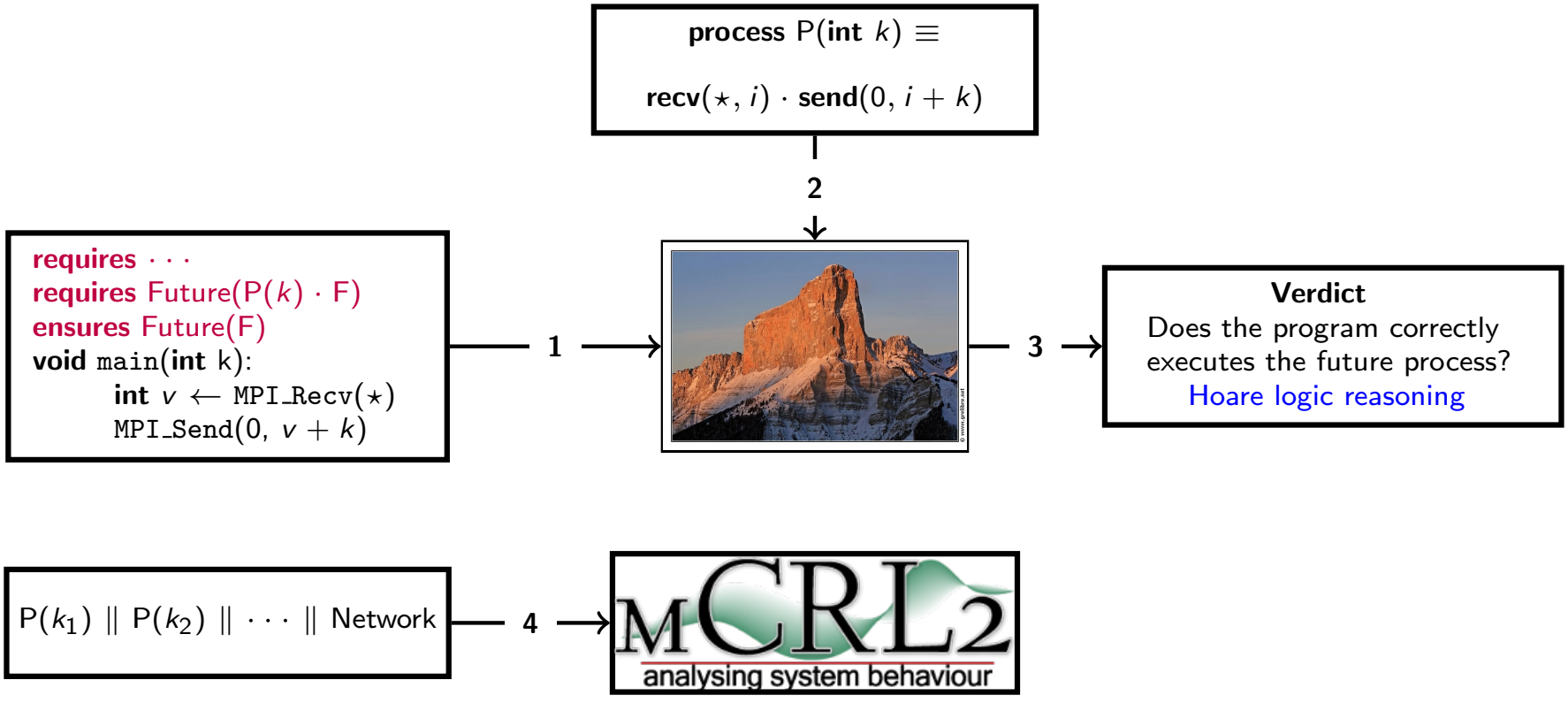

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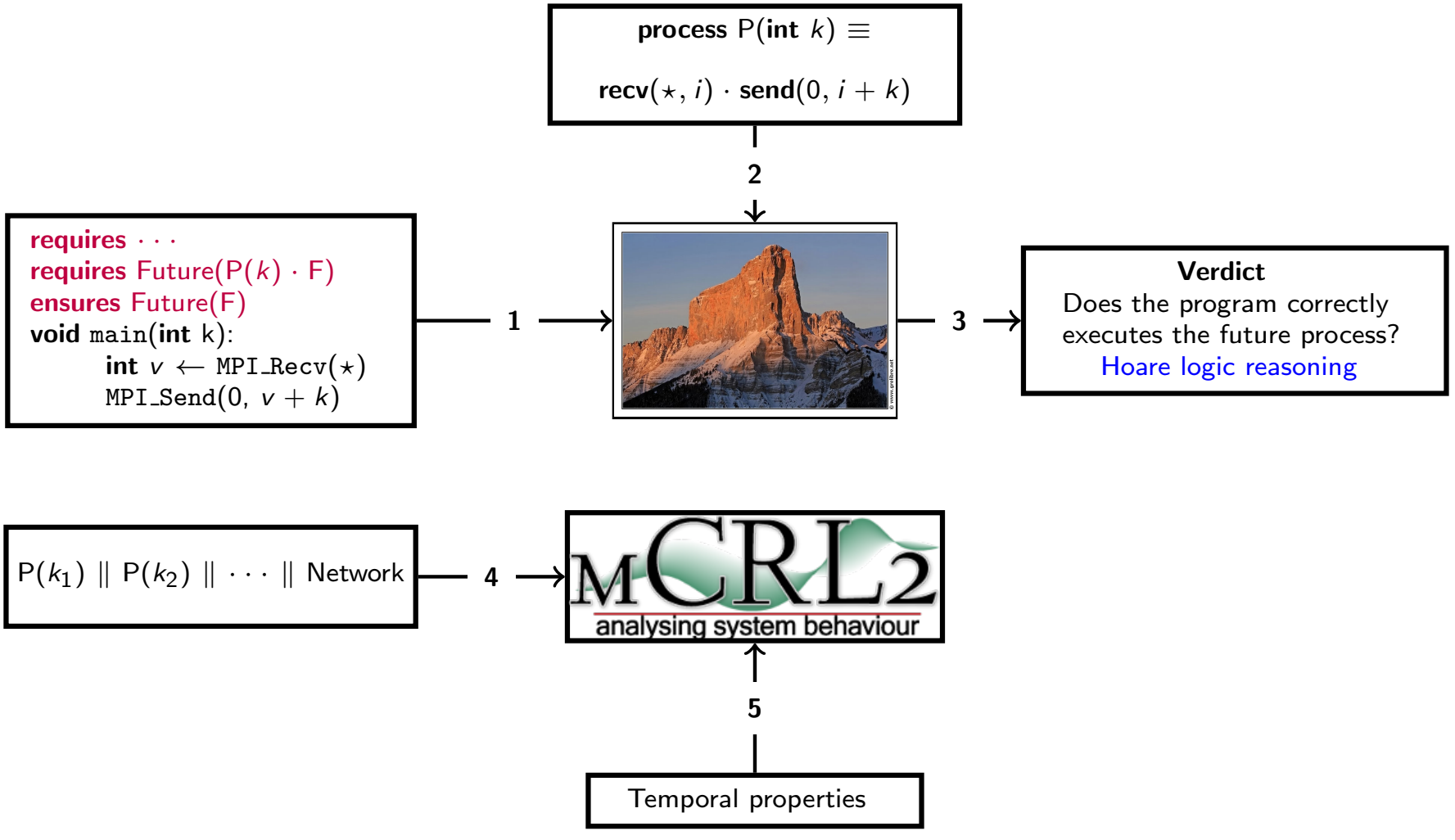

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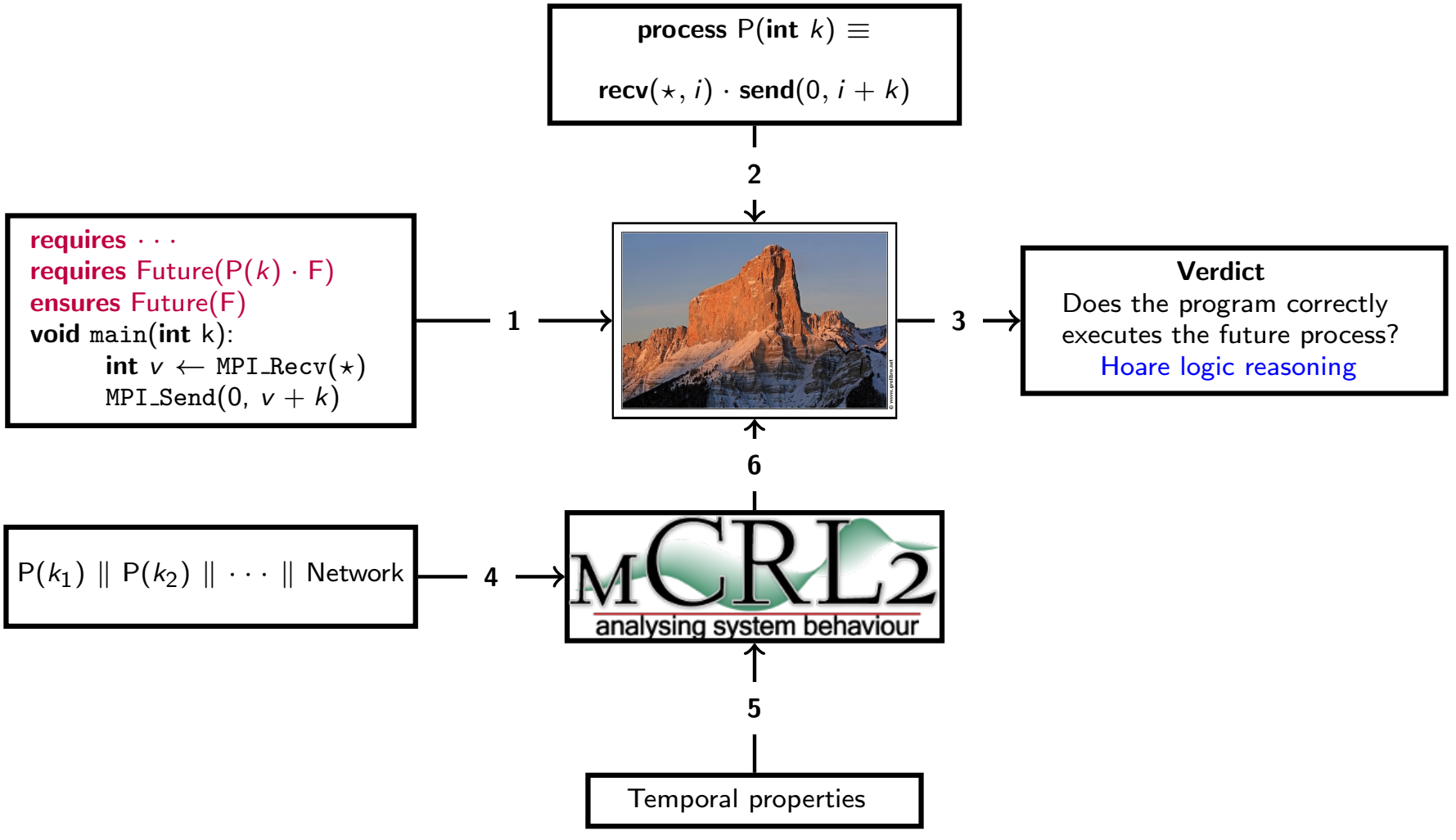

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