# Towards Practical Verification of Protocols in mCRL2*

*Ongoing* work by
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- Current work: formulas for model checking.

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- Running example global type with participants Alice ($a$), Bob ($b$), and Coin ($c$):

$$
G_{\mathsf{coin}} := \mathsf{rec}\, X \,.\, a \twoheadrightarrow b\langle \mathsf{nat} \rangle \,.\, a \twoheadrightarrow b \left( \begin{array}{l} \mathsf{heads}.c \twoheadrightarrow b \begin{pmatrix} \mathsf{heads}.b \twoheadrightarrow a(\mathsf{win}.X), \\ \mathsf{tails}.b \twoheadrightarrow a(\mathsf{lose}.\mathsf{end}) \end{pmatrix}, \\ \mathsf{tails}.c \twoheadrightarrow b \begin{pmatrix} \mathsf{heads}.b \twoheadrightarrow a(\mathsf{lose}.\mathsf{end}), \\ \mathsf{tails}.b \twoheadrightarrow a(\mathsf{win}.X) \end{pmatrix} \end{array} \right)
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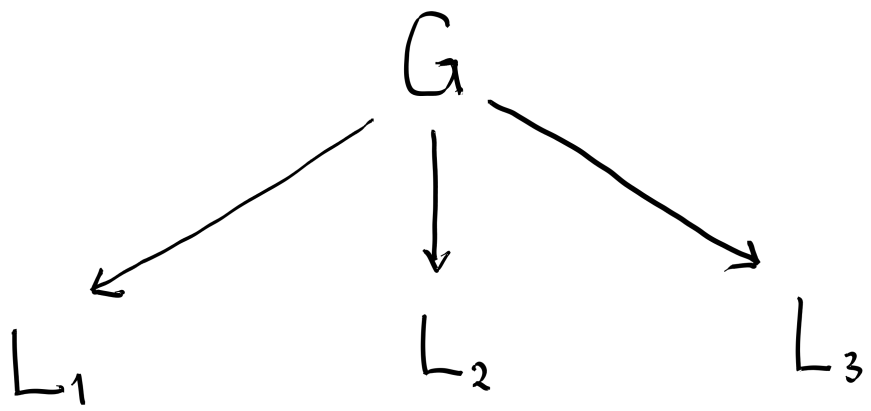


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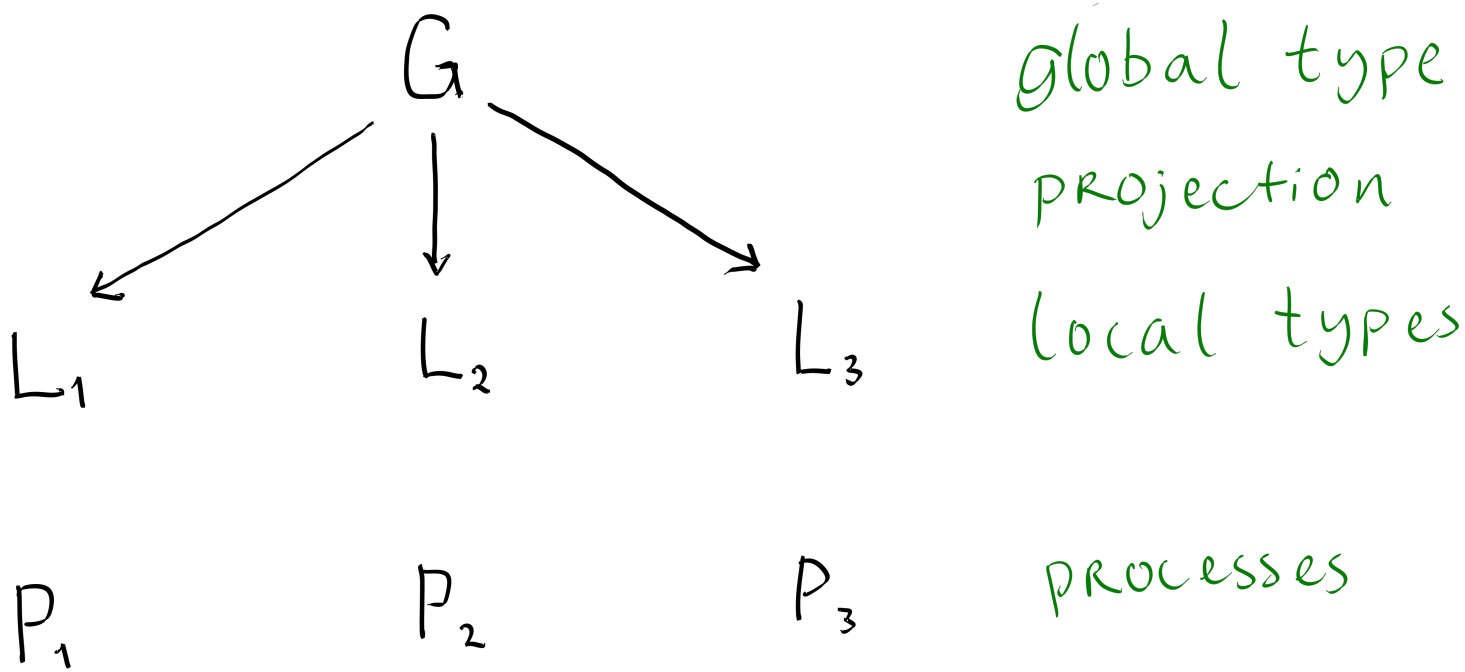

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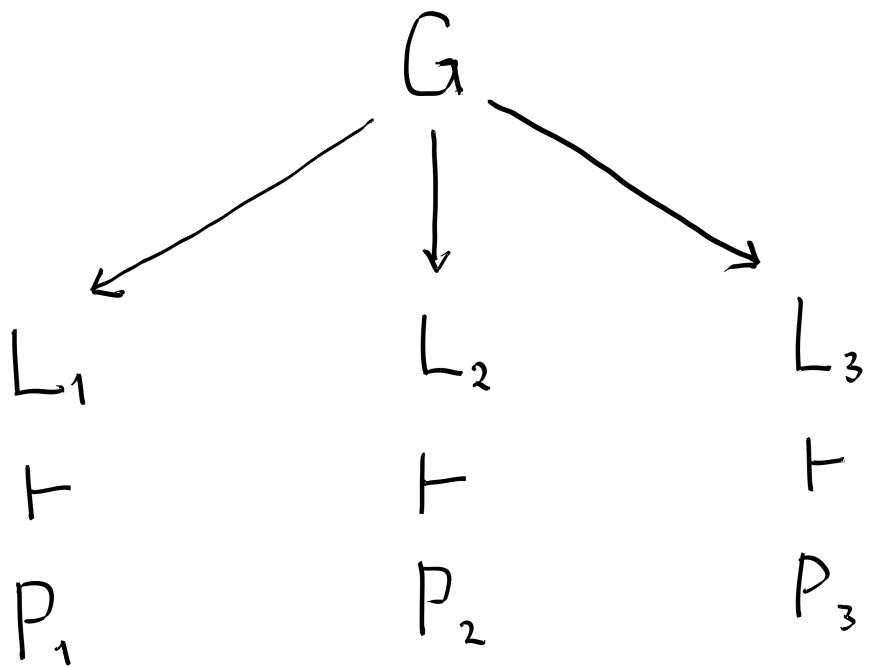
- Process implementations are type checked using the local types.

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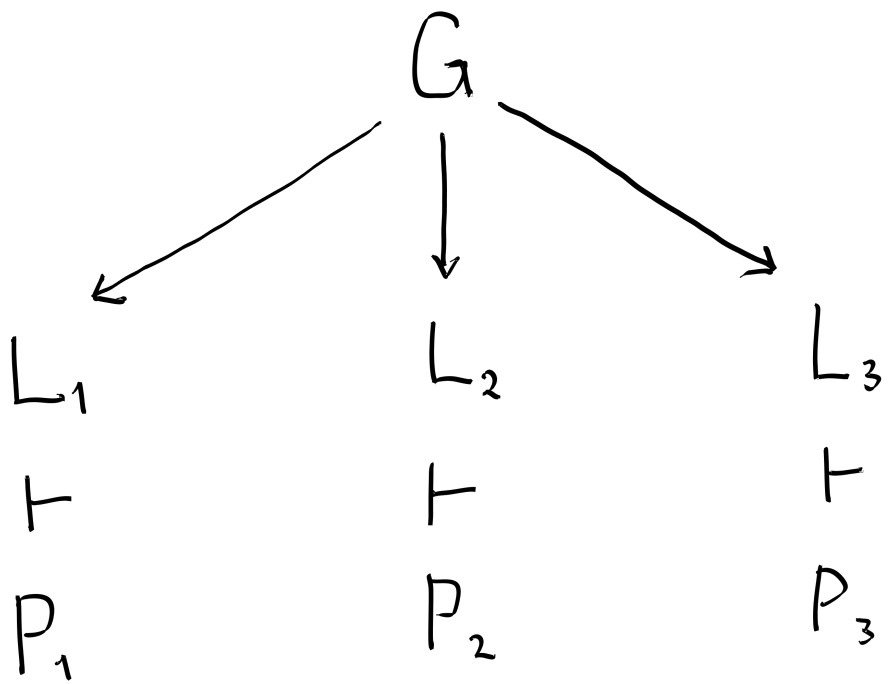


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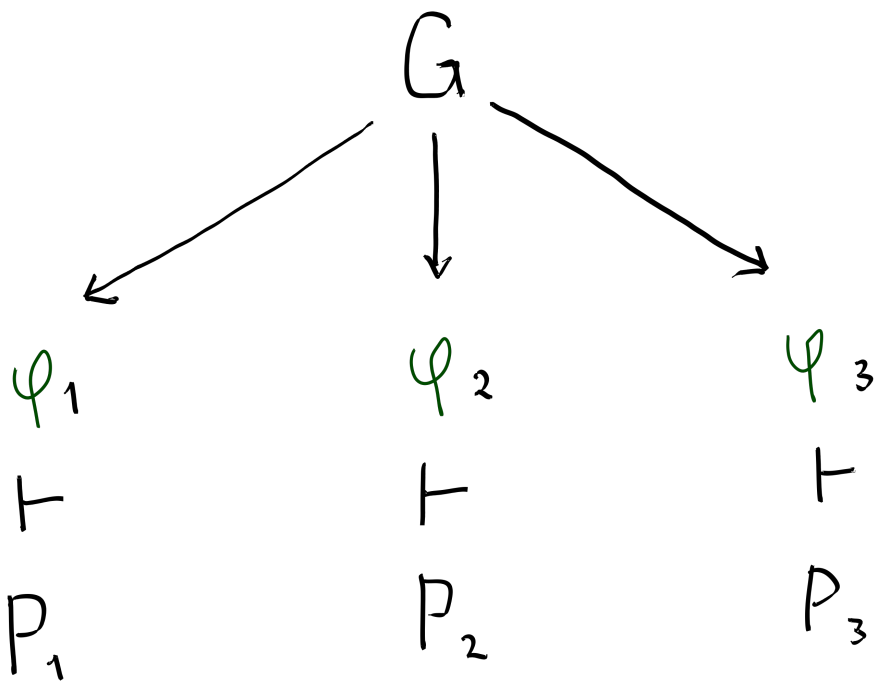


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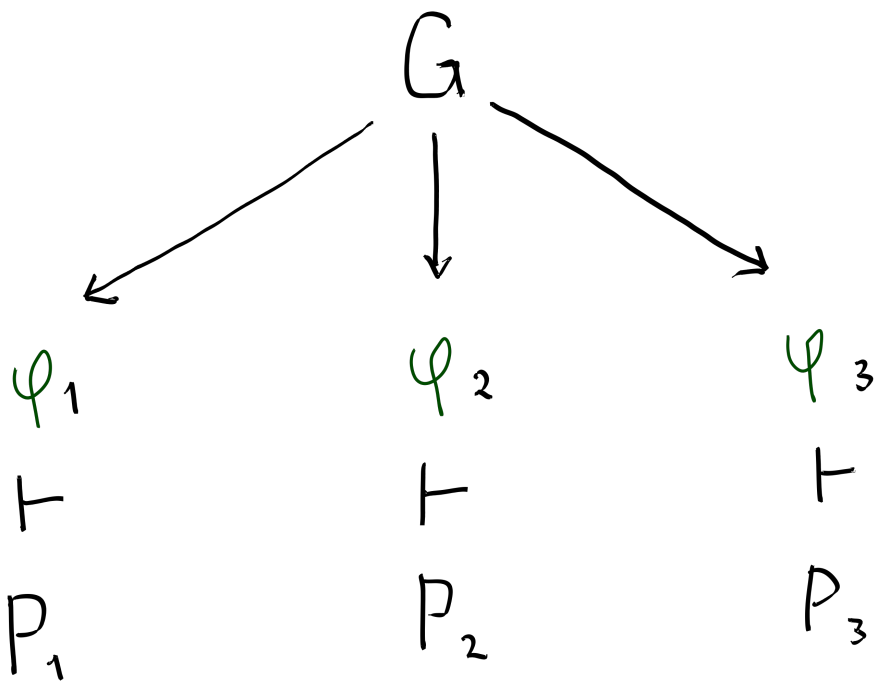


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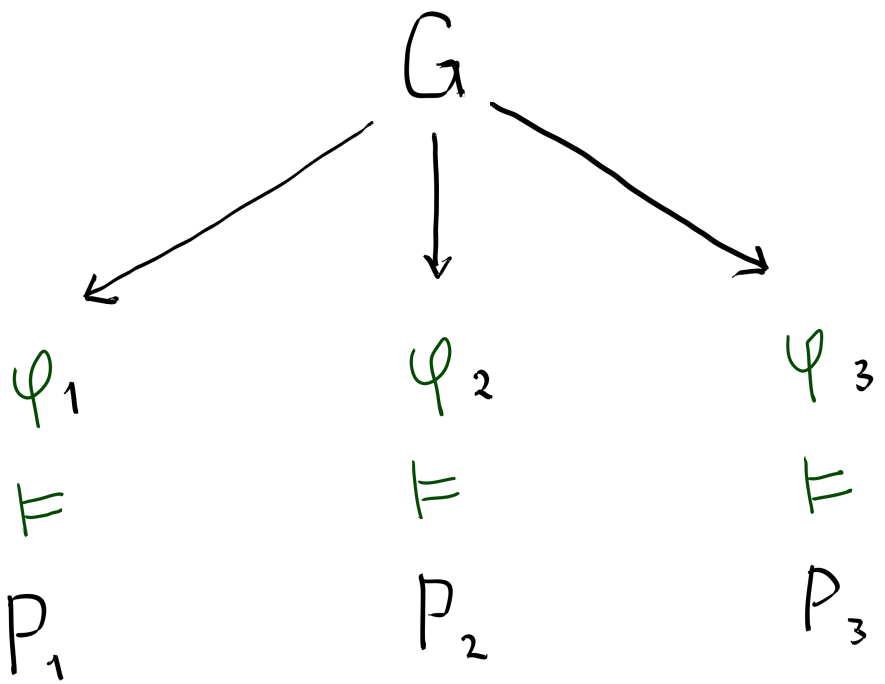


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- Ultimate goal:
  compiler from global type specifications to mCRL2 projects.

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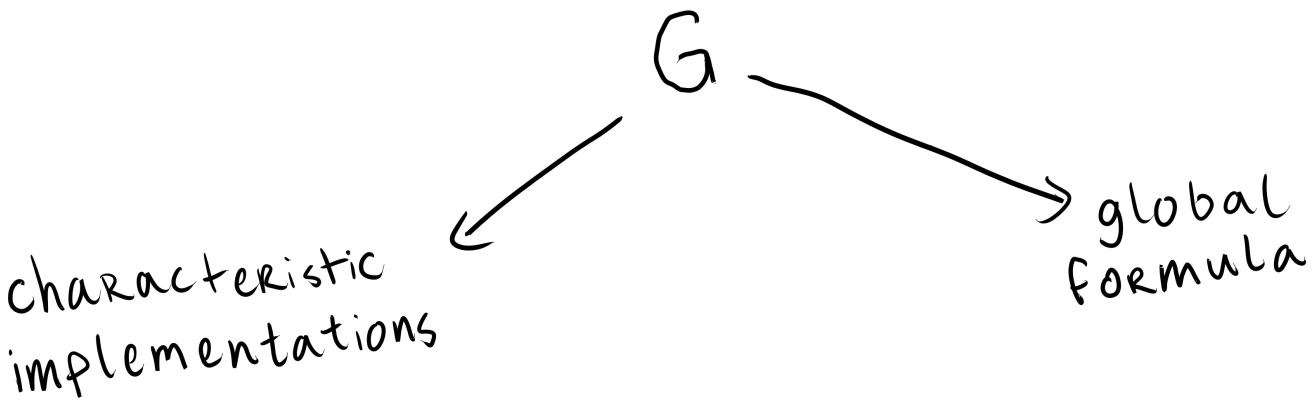

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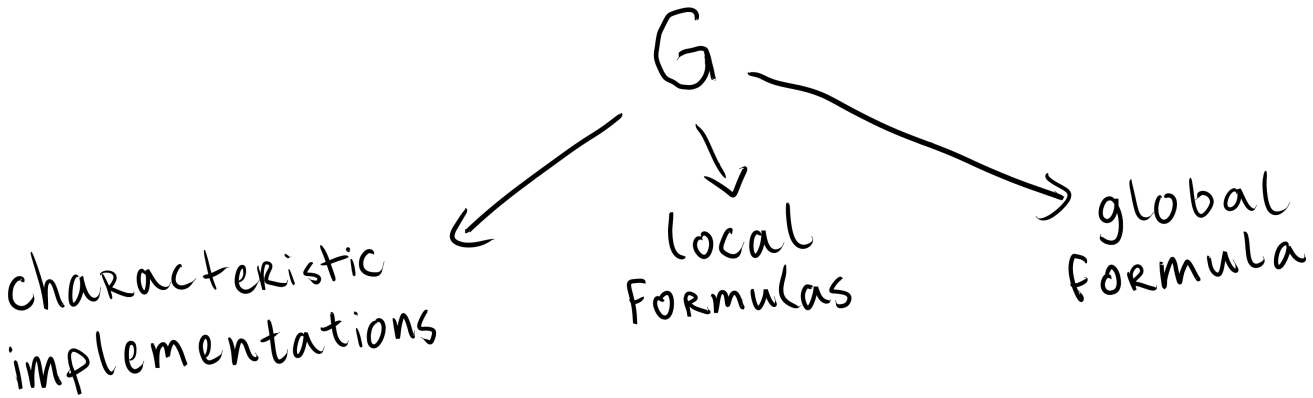

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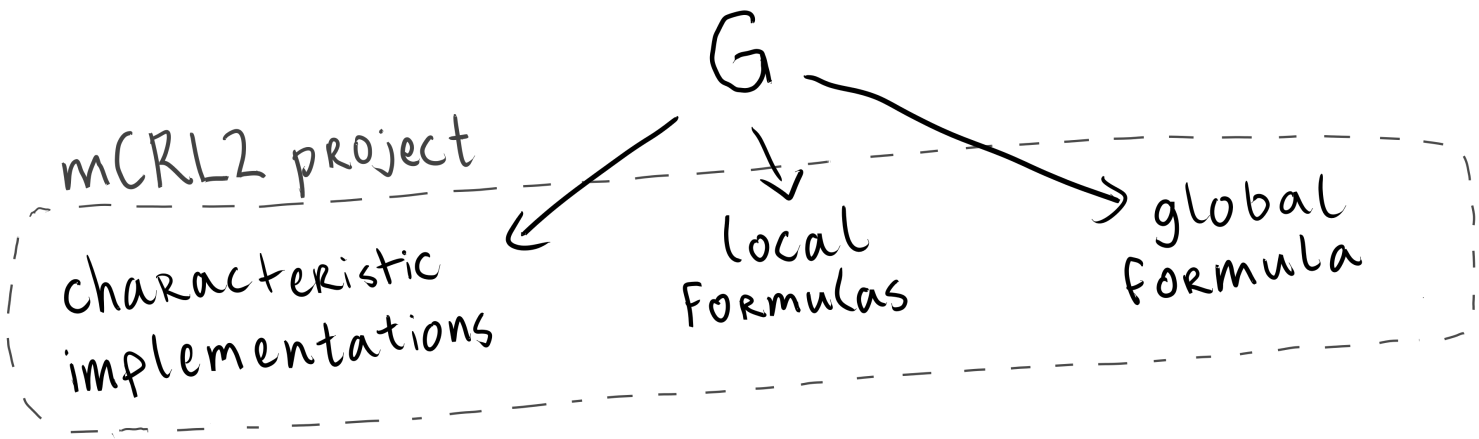

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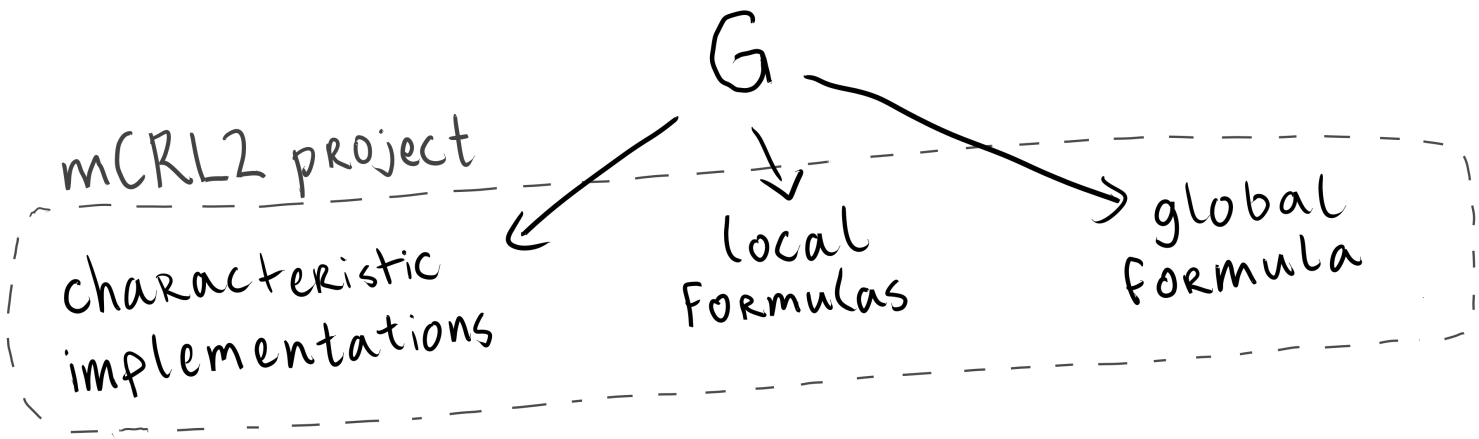


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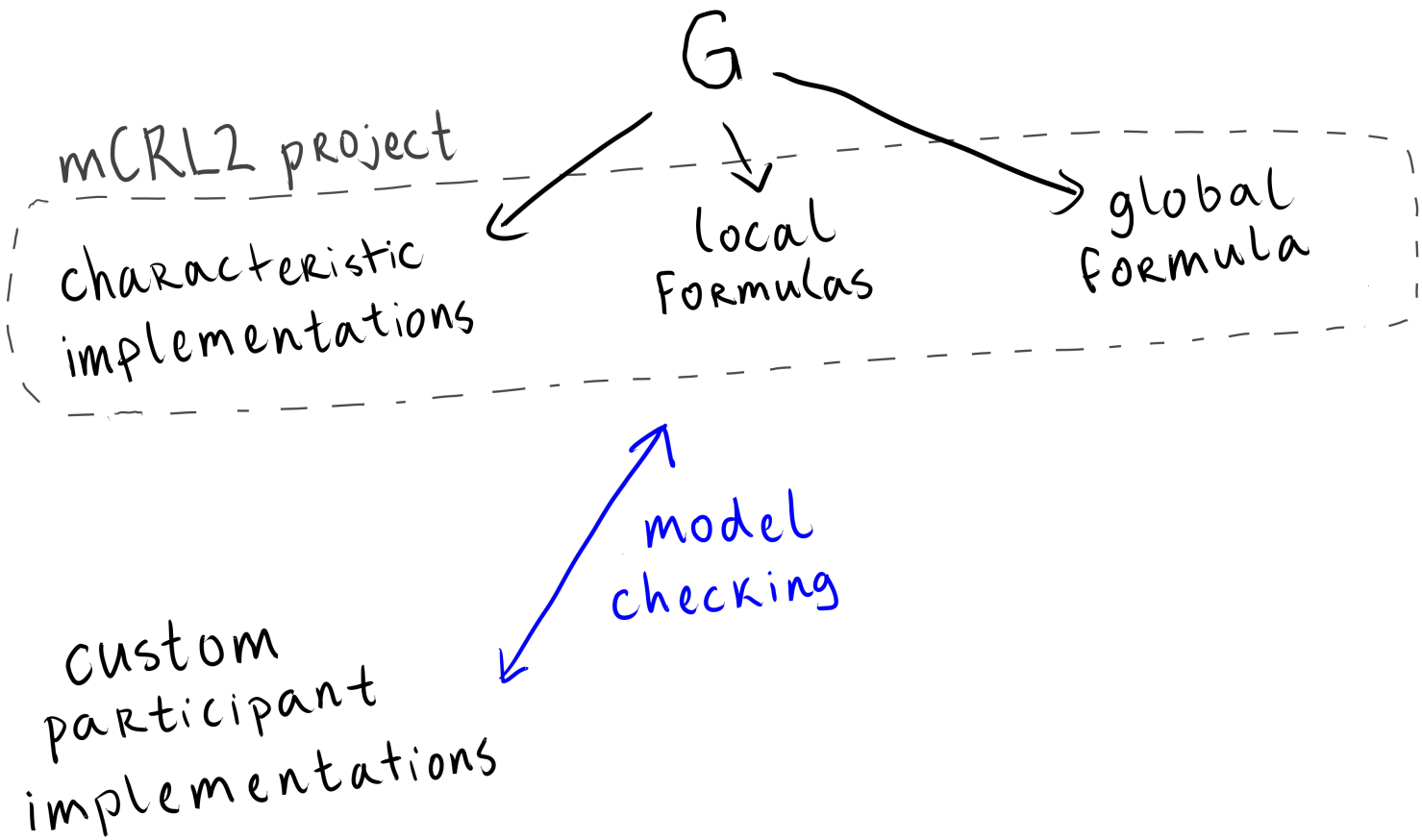

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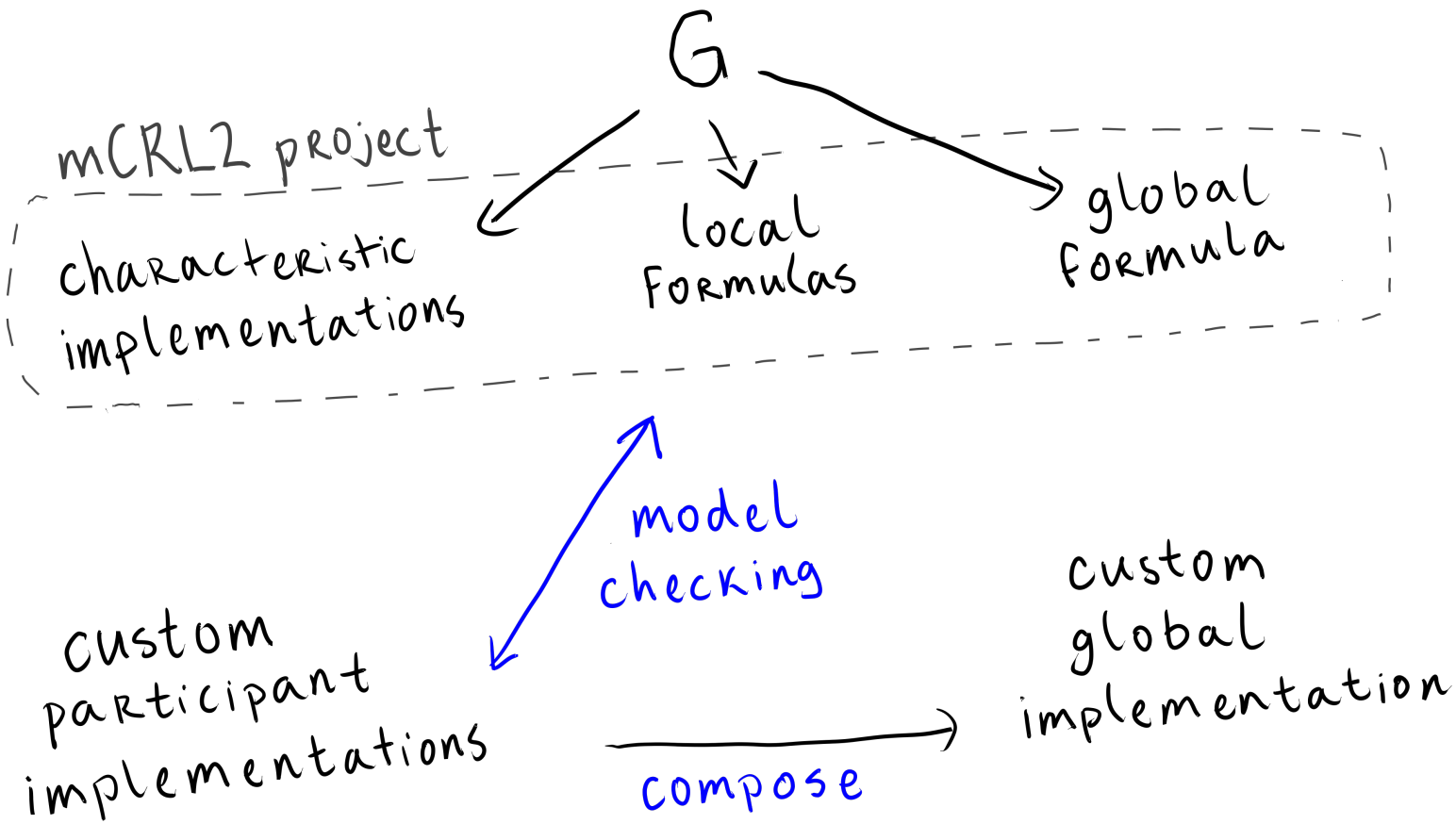

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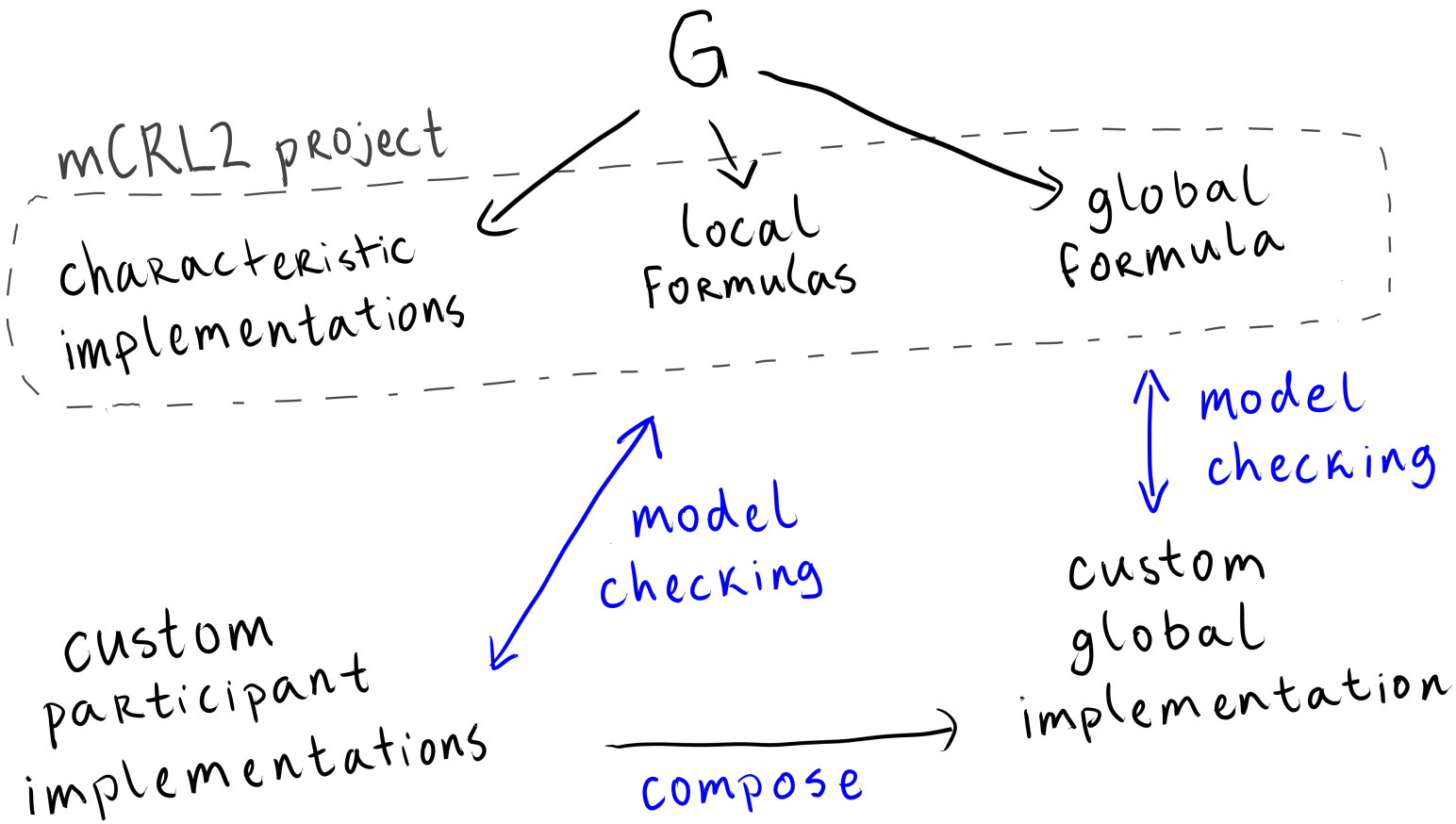

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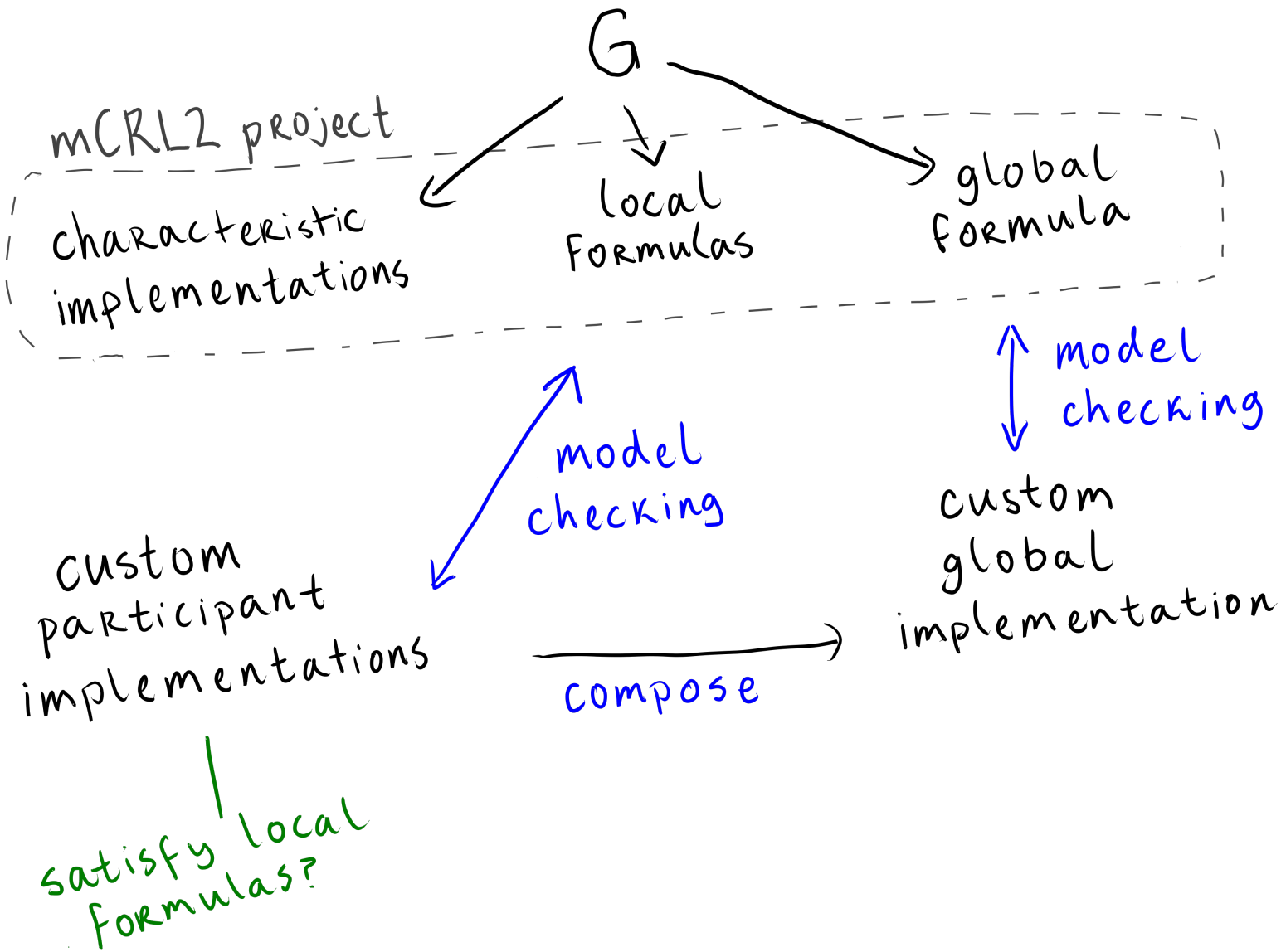

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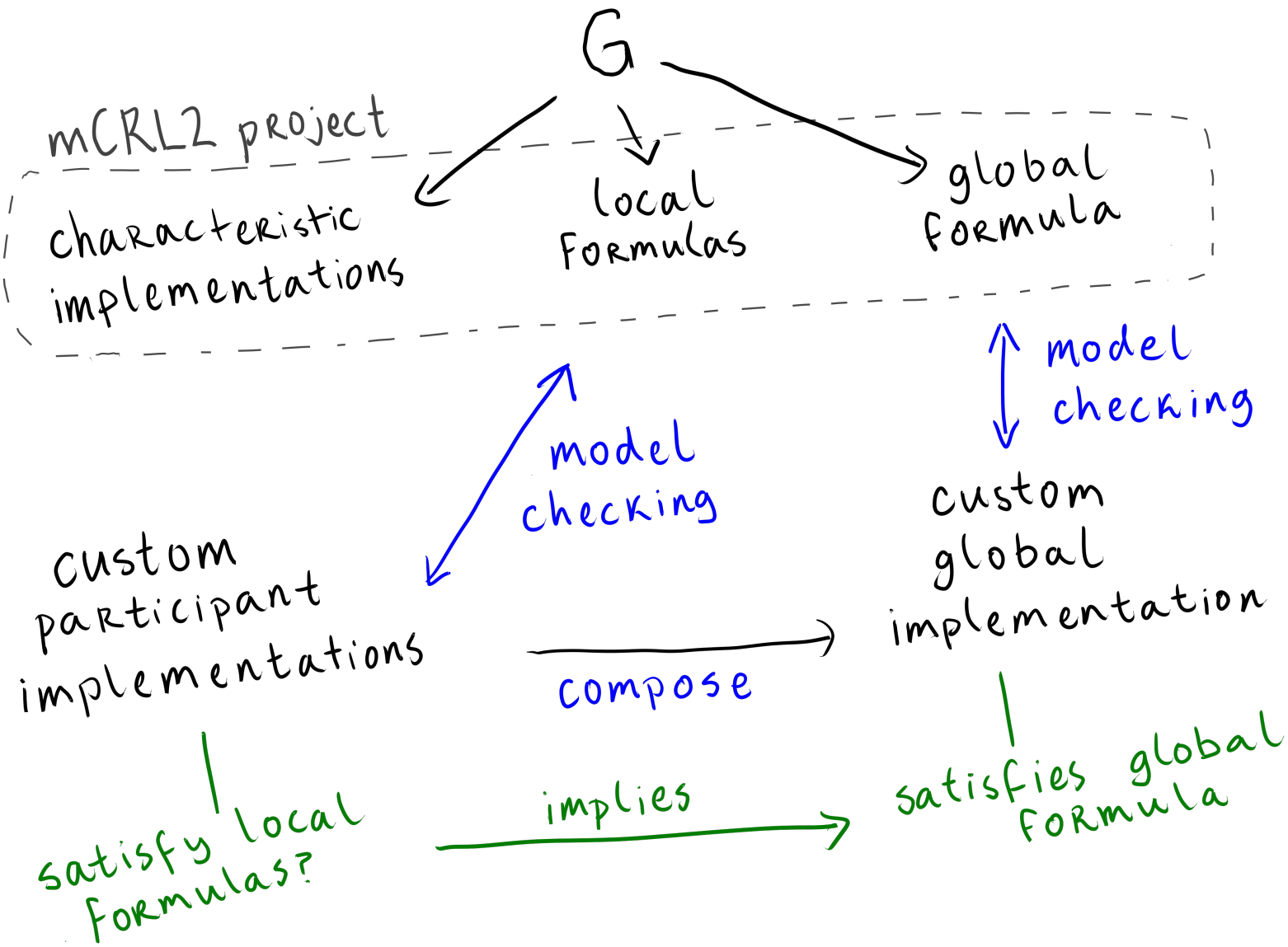

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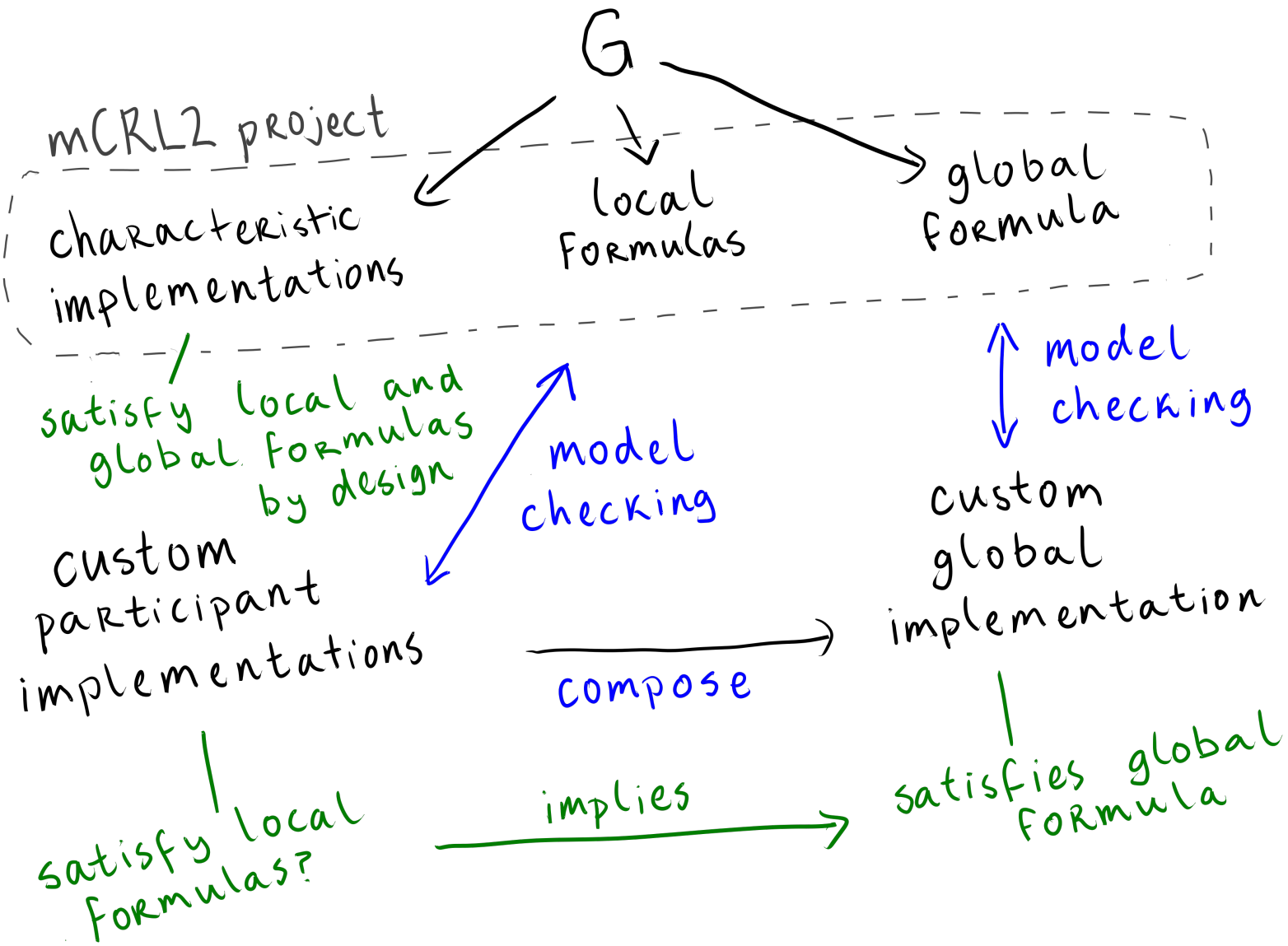

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- Our solution: number the exchanges in the global type, annotate protocol actions accordingly. E.g.,
  $a_2[\text{heads}] \mid b_2(\text{heads}) \mapsto ab_2\langle\text{heads}\rangle$ and
  $c_3[\text{heads}] \mid b_3(\text{heads}) \mapsto cb_3\langle\text{heads}\rangle$.

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- Example participant implementations:

$$P_a := a_1[42] \,.\, a_2[\text{heads}] \,.\, (a_4(\text{win}) \,.\, P_a + a_5(\text{lose}) \,.\, a_6\text{end})$$

$$P_b := \sum_{x \in \mathbb{N}} b_1(x) \,.\, \left( \begin{array}{l} b_2(\text{heads}) \,.\, \left( \begin{array}{l} b_3(\text{heads}) \,.\, b_4[\text{win}] \,.\, P_b \\ + b_3(\text{tails}) \,.\, b_5[\text{lose}] \,.\, b_6\text{end} \end{array} \right) \\ + b_2(\text{tails}) \,.\, \left( \begin{array}{l} b_7(\text{heads}) \,.\, b_8[\text{lose}] \,.\, b_9\text{end} \\ + b_7(\text{tails}) \,.\, b_{10}[\text{win}] \,.\, P_b \end{array} \right) \end{array} \right)$$

$$P_c := c_3[\text{heads}] \,.\, P_c + c_3[\text{tails}] \,.\, c_6\text{end} \\ + c_7[\text{heads}] \,.\, c_9\text{end} + c_7[\text{tails}] \,.\, P_c$$

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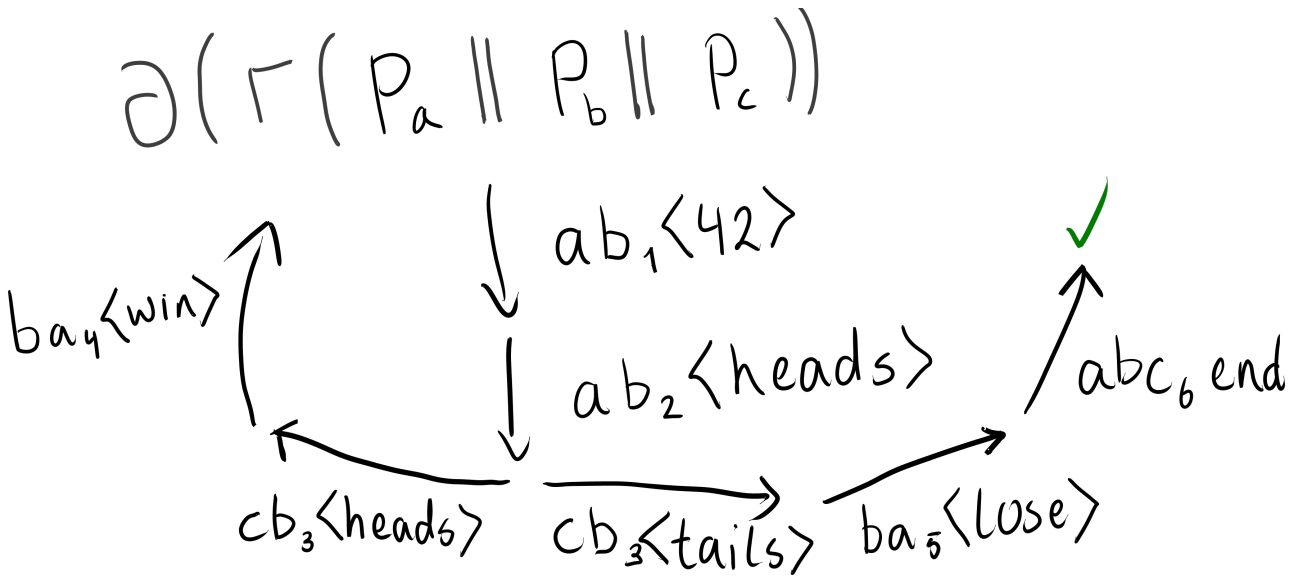
- Labeled transition system of global implementation:

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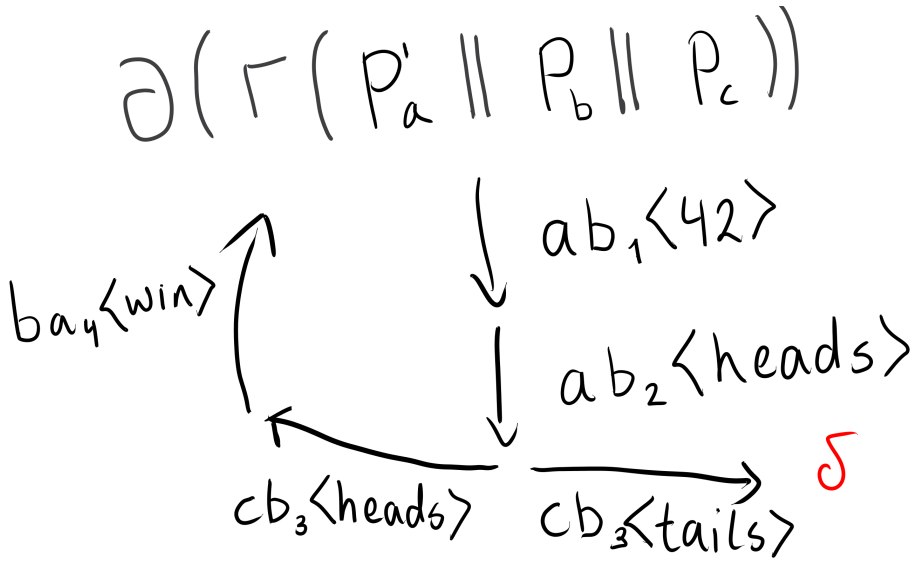


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- Solution (for now): rule out independent exchanges with well-formedness condition.

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- Solution: work in progress.

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- Future work: support independent exchanges, and embed data constraints in global type specifications.
- Questions or comments? Let's discuss now, or send us an email b.van.den.heuvel@rug.nl and j.a.perez@rug.nl.