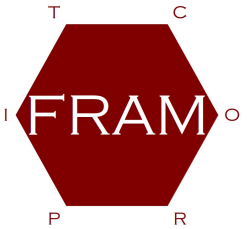

The way ahead: FRAM extensions and add-ons

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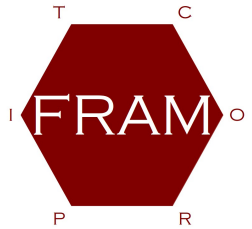
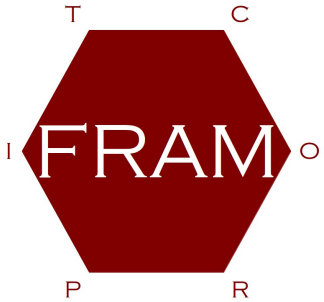
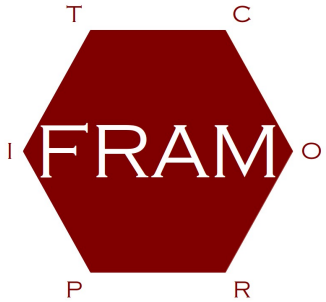
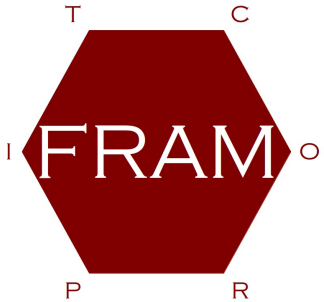




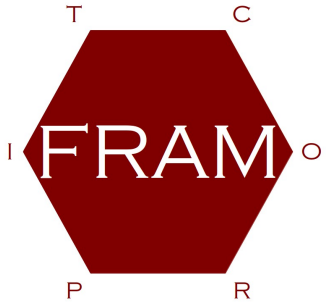
FRAM combined with other methods



Quantification of FRAM models

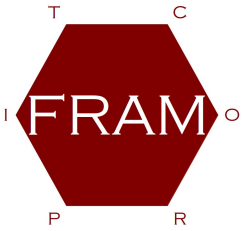


Visualisation / animation of FRAM models



Interpretation / simulation of FRAM models

FRAM combined with other methods



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Frost, B. and Mo, J. P. T. (2014). System Hazard Analysis of a Complex Socio-Technical System: The Functional Resonance Analysis Method in Hazard Identification. Australian System Safety Conference, Melbourne Australia. 28 – 30 May 2014.

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Duan, G., Tian, J. & Wu, J. (2015). Extended FRAM by Integrating with Model Checking to Effectively Explore Hazard Evolution. Mathematical Problems in Engineering, Article ID 196107.

Tian, J.,Wu,J., Yang, Q. & Zhao, T. (2016). FRAMA: A safety assessment approach based on Functional Resonance Analysis Method. Safety Science, 85, 41–52.

FRAMA

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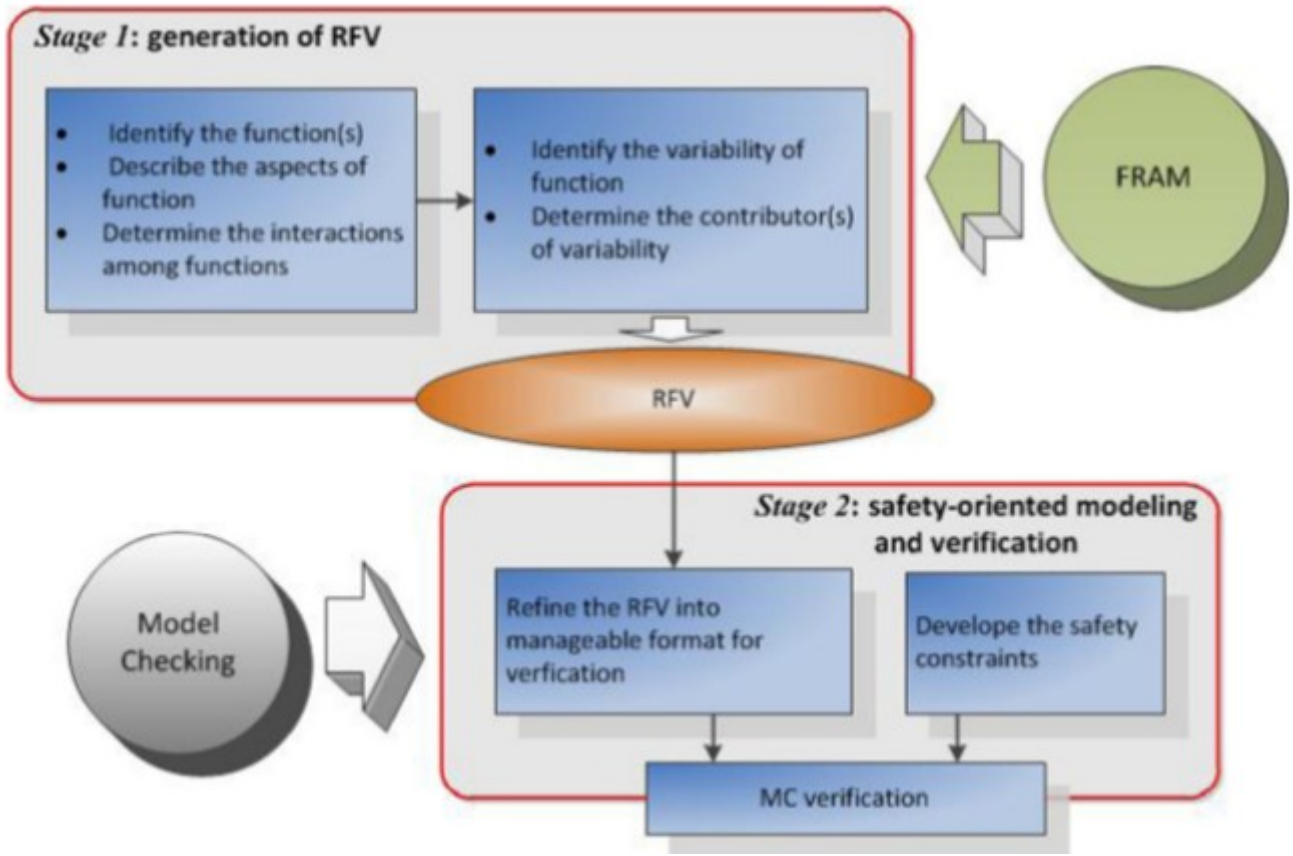
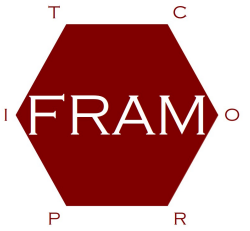


Quantification of FRAM models



Slater, D. (2014). Probability numbers for linked dependency models and external feeds. Cambrensis.

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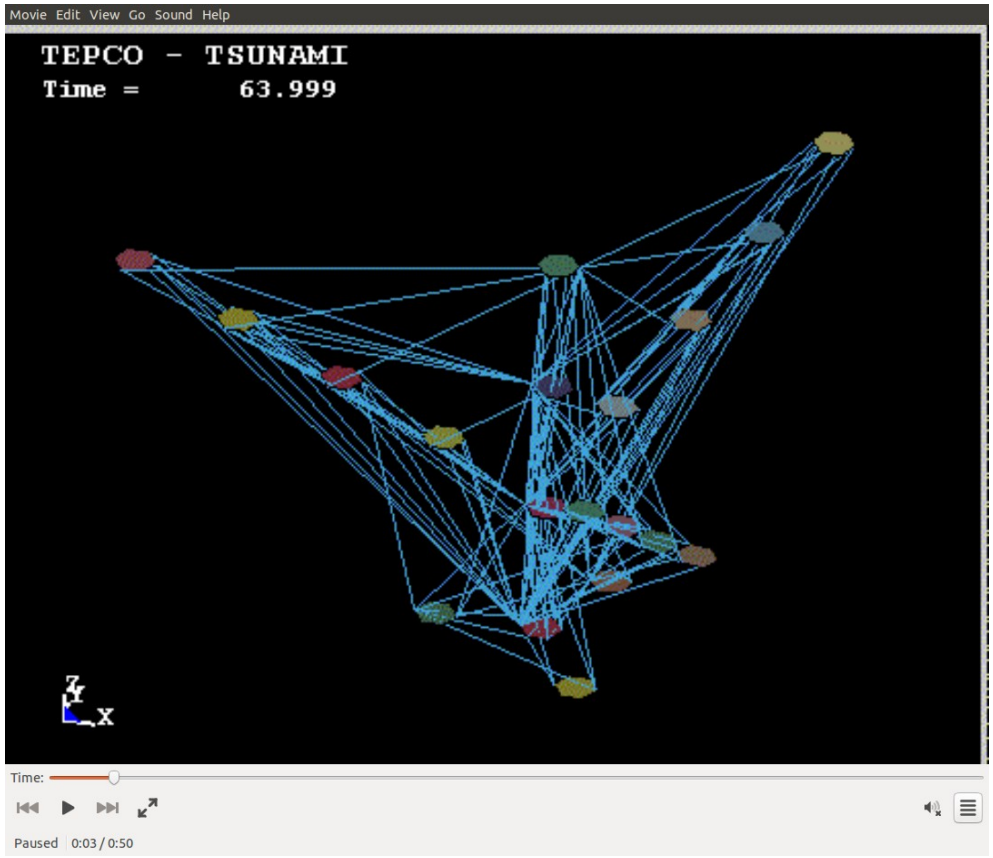
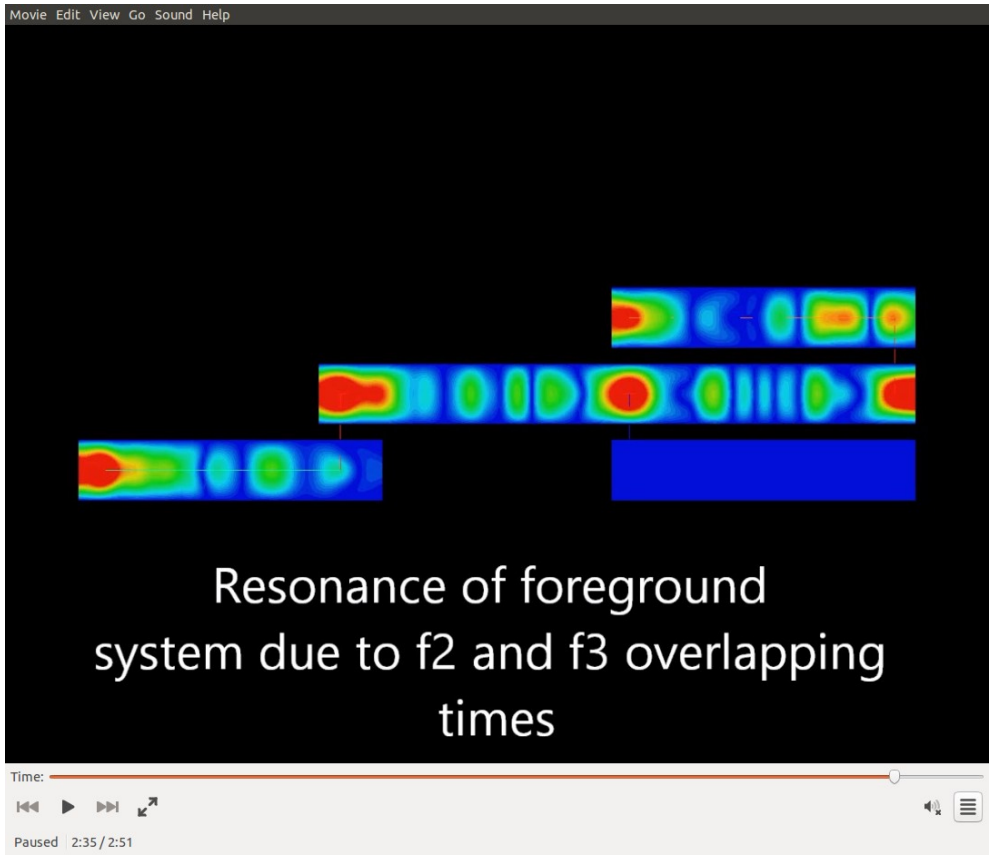
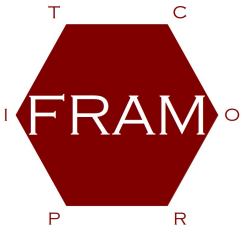
Patriarca, R. Di Gravio, G. & Costantino, F. (2016). A quantitative evolution of the Functional Resonance Analysis Method (FRAM) for risk assessment in the Air Traffic Management system. Department of Mechanical and Aerospace Engineering, University of Rome - La Sapienza.

Visualisation of FRAM models (dynamic)





Interpretation of FRAM models



Creating an instantiation of a model is currently done "manually" - charting a path through the model through step-by-step reasoning.

A FRAM model is neither a process model, nor a graph or a network model.

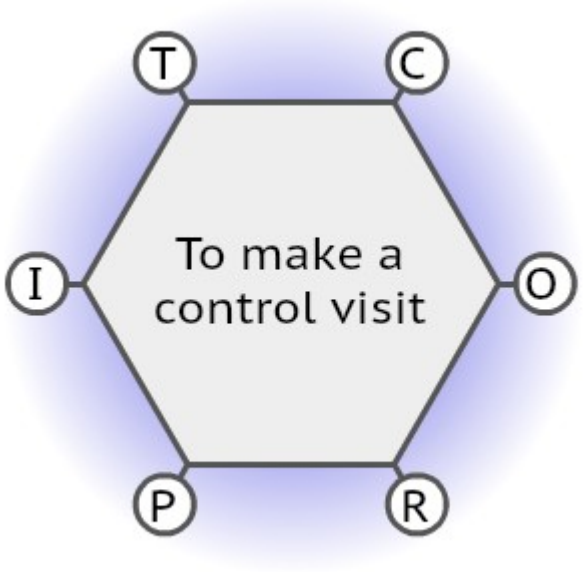
A function is executed whenever conditions are met (primarily Input and Preconditions). Each function has a Method, which generates the function's Output.

> Production rules: The rules (algorithm) that describe what the function does, i.e., its purpose.
>
> Variability: The rules that determine the variability of the Output(s).

In an interpretation of a FRAM model all functions should be examined simultaneously rather than sequentially (chaining).

Van Kleef, E. (2014). Discrete Event Simulation of a FRAM model in SimPy

Specification of what a function does



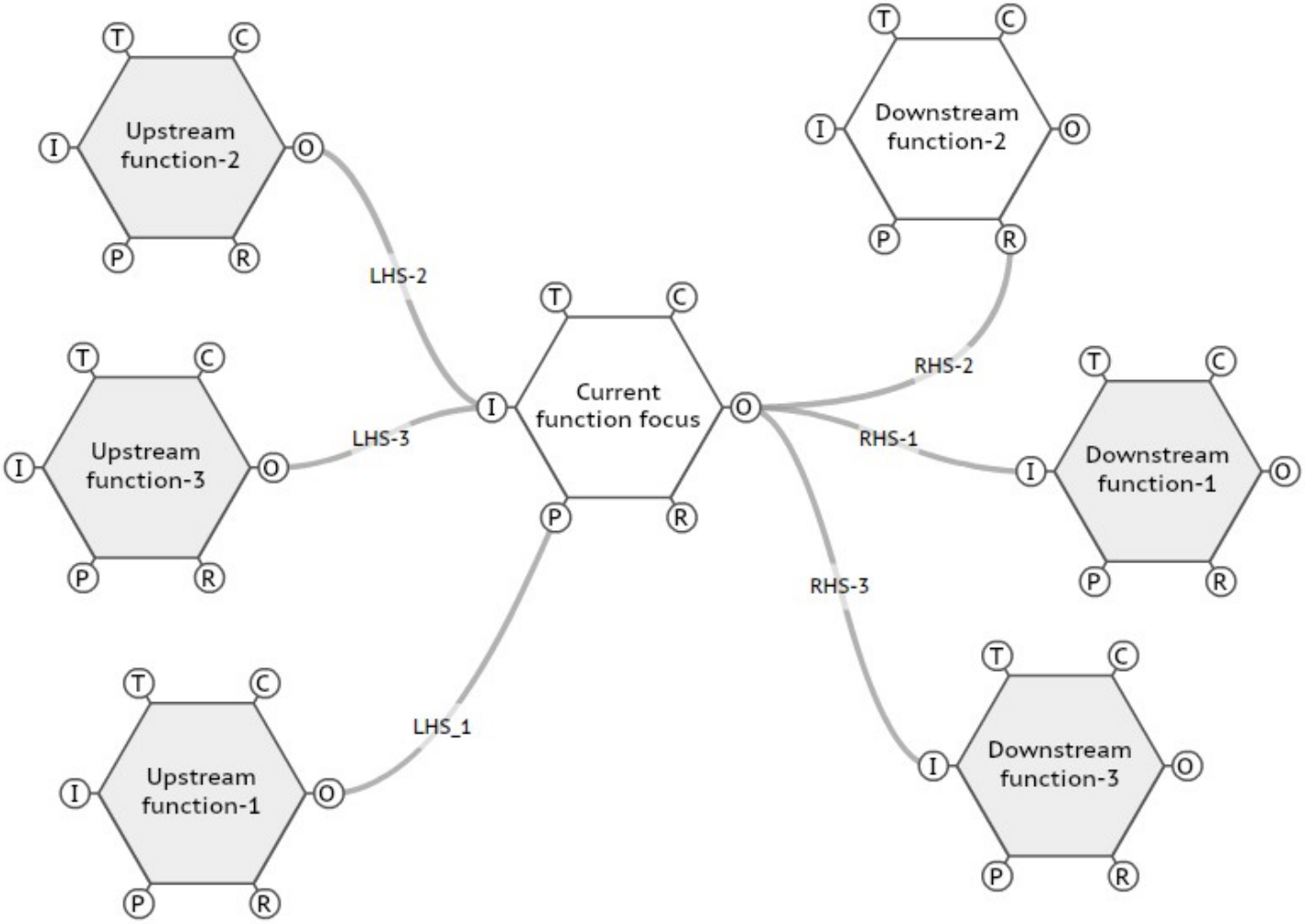
Each function has an associated METHOD, which describes the "inner workings" of the function.

The 'production rule' part of the method specifies how the Output(s) are generated. The state of the Outputs from the upstream functions determines when a function will become active (LHC) and the method specifies what the outcomes (RHC) will be.

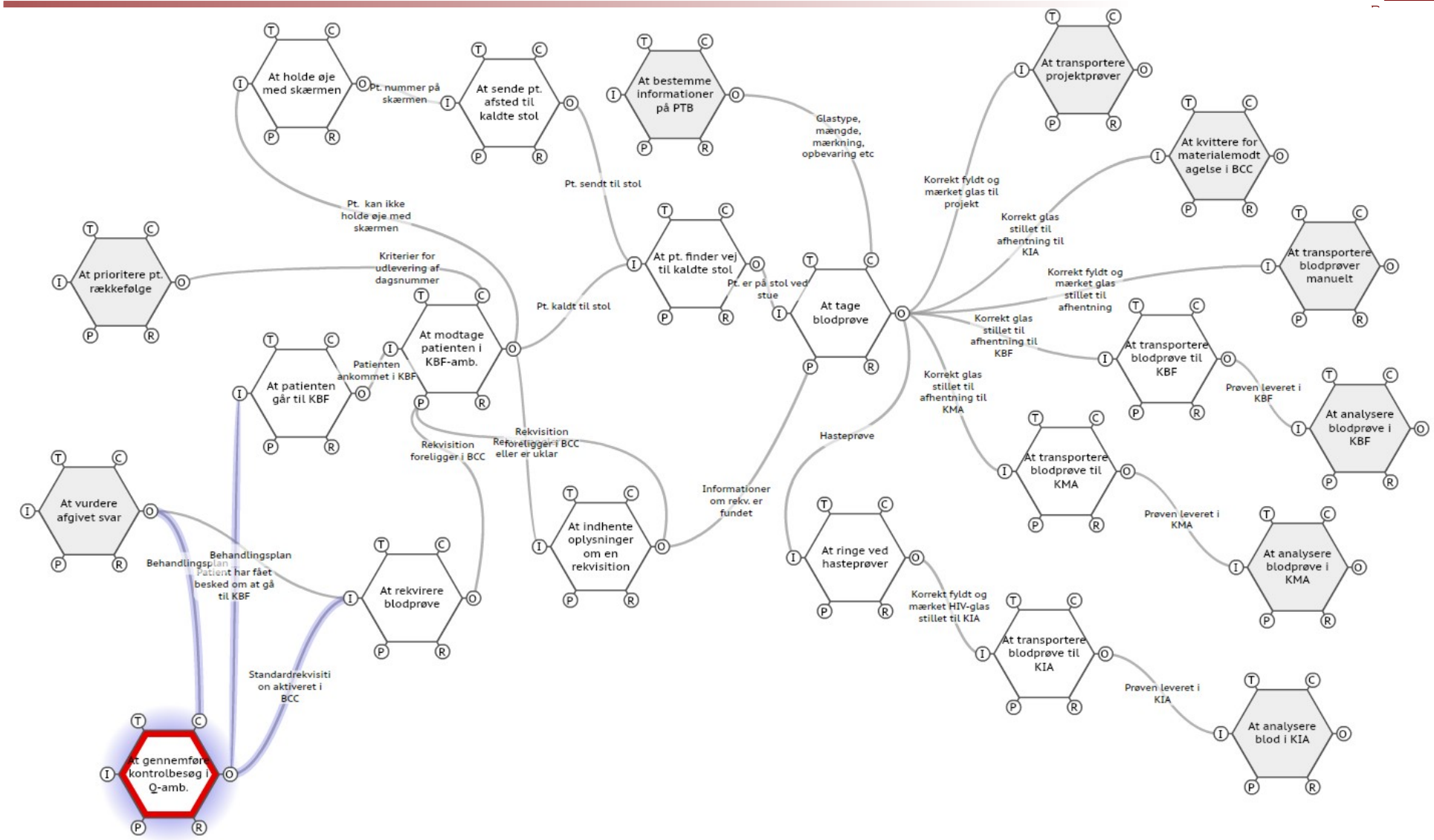
A 'variability' part of the method describes how the variability of the upstream Outputs relative to the current state of the function have an impact on how the 'production rules' are implemented, hence on the variability of the Output.

Upstream Outputs

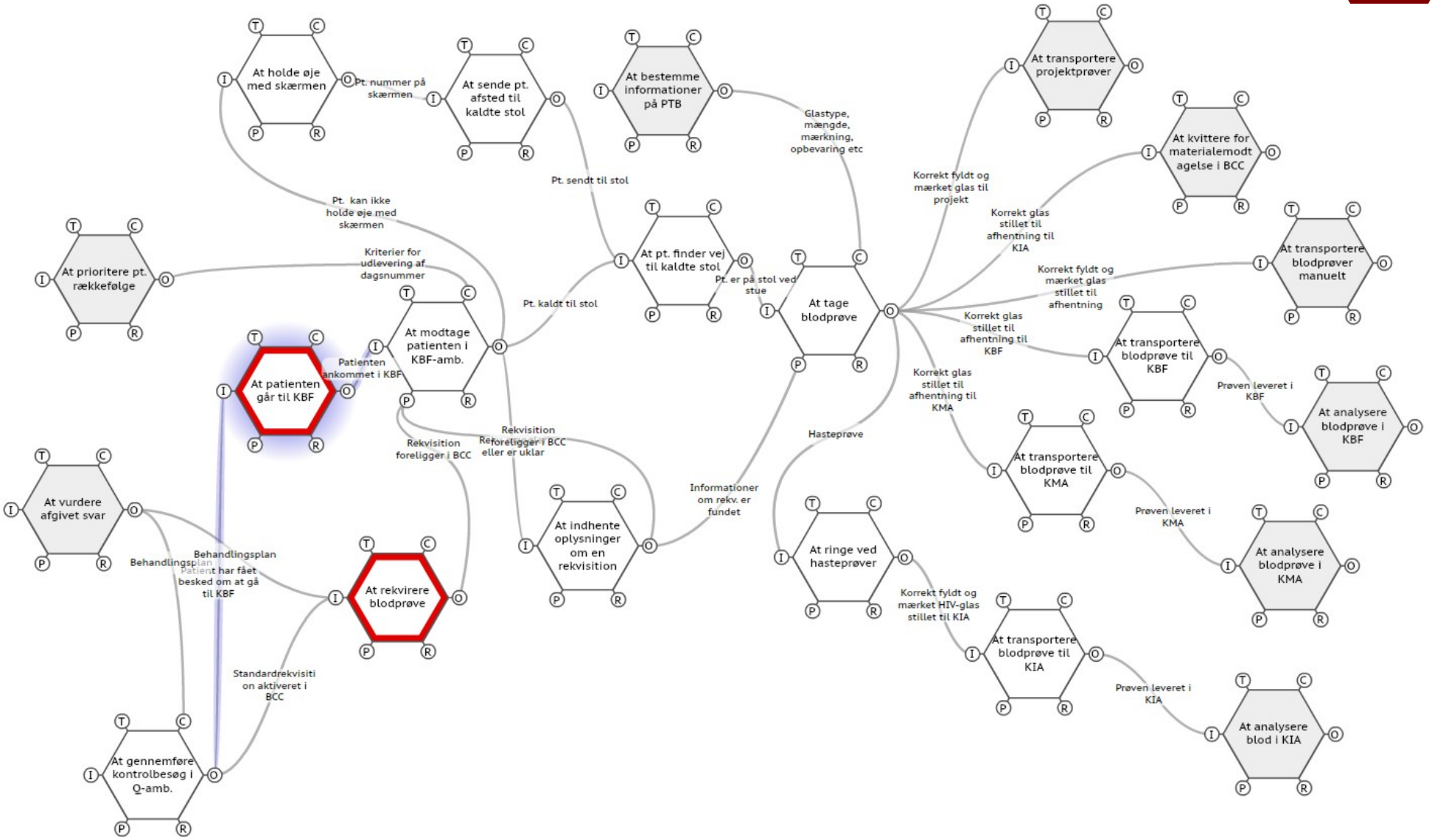
Outputs (to downstream functions)



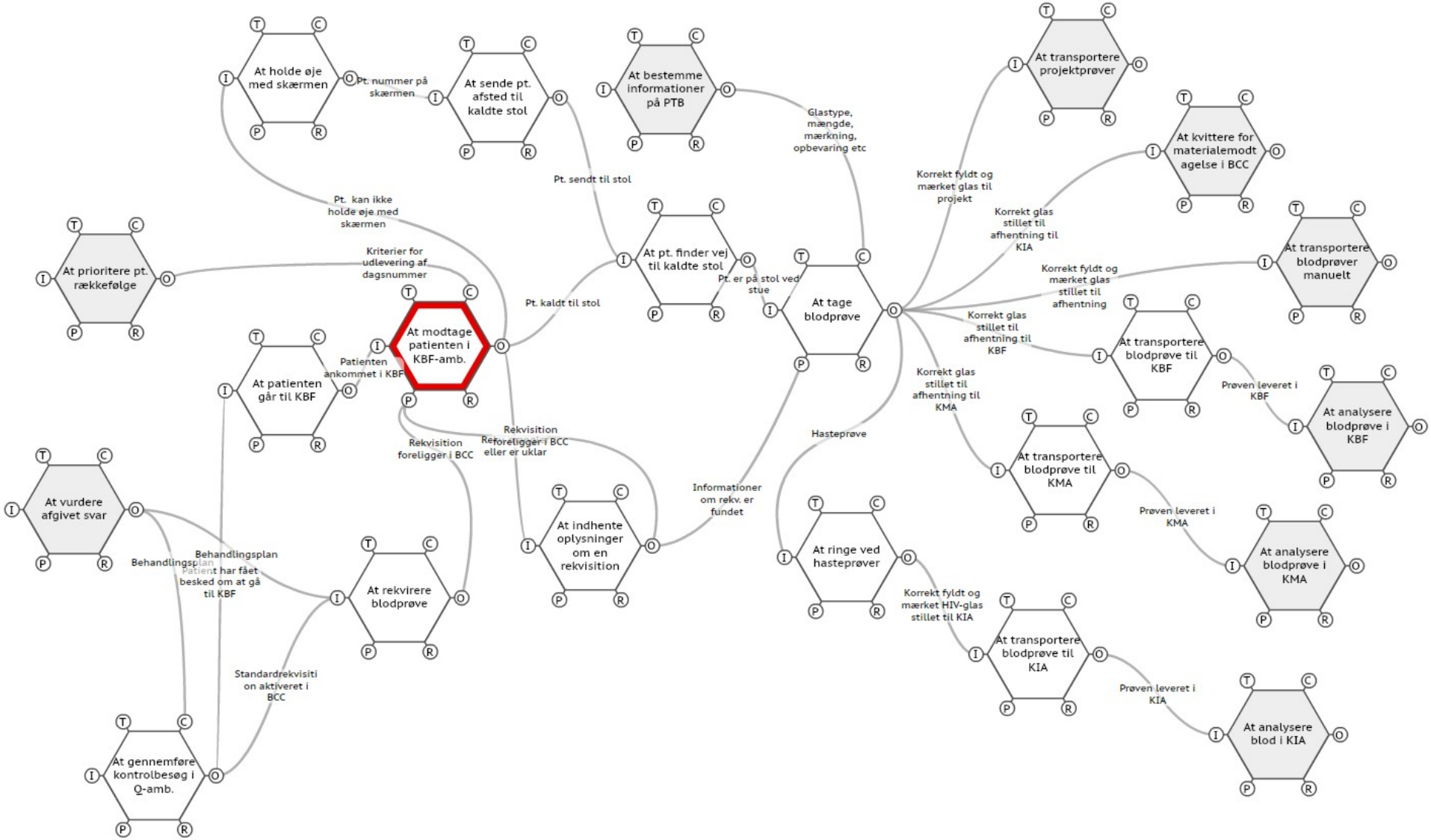
Iteration #1



Iteration #2



Iteration #3



Iteration #4