

The architecture of a software tool for reachability analysis of hybrid systems

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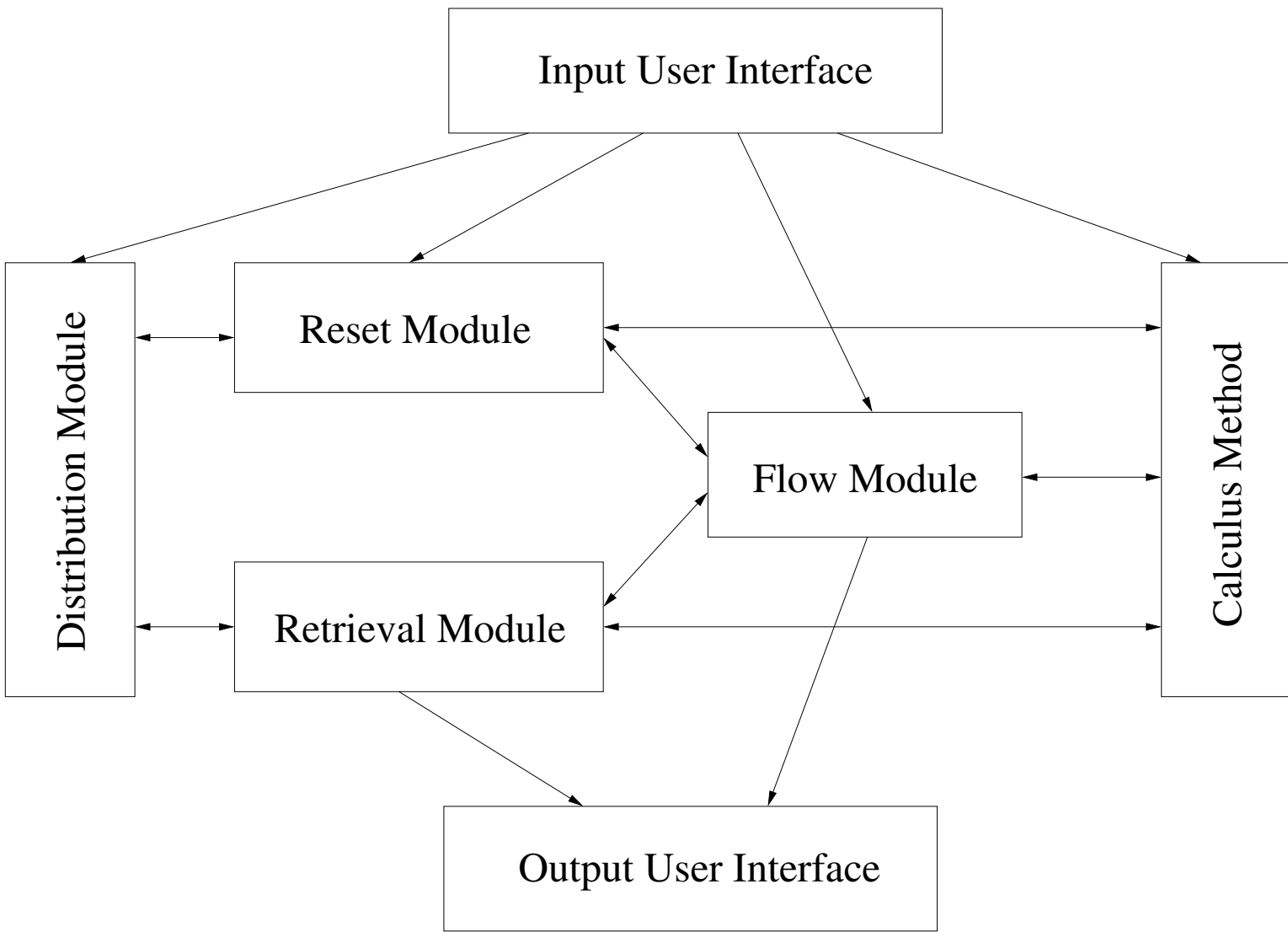
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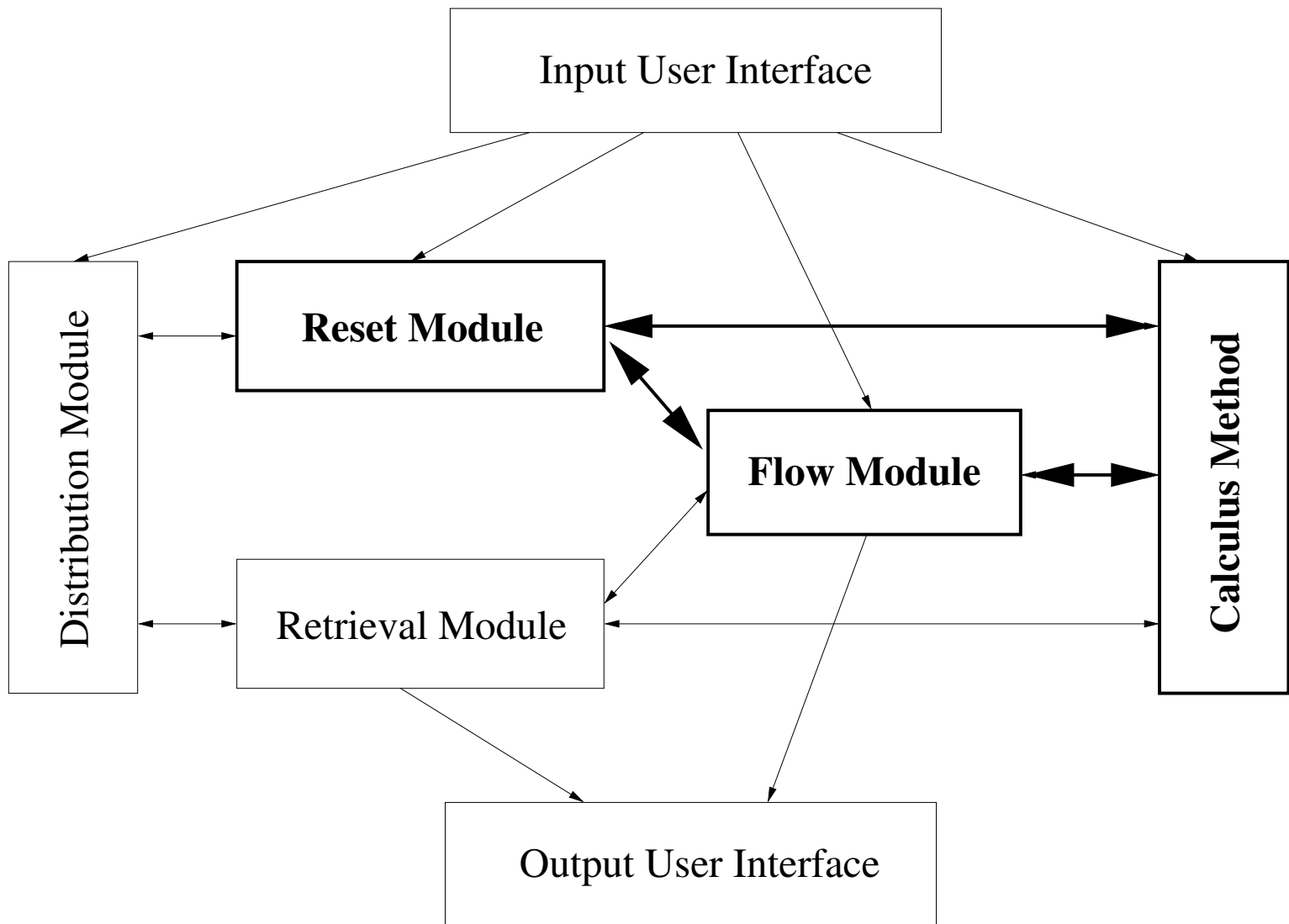
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The architecture



The architecture's core



A calculus method:

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- represents sets of states (polyhedra, ellipsoids, etc.);

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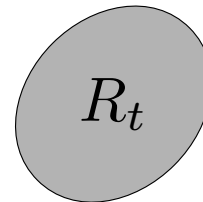
Calculus method

A calculus method:

- represents sets of states (polyhedra, ellipsoids, etc.);
- implements basic operations between sets (union, intersection, etc.);
- implements (linear) transformations of sets.

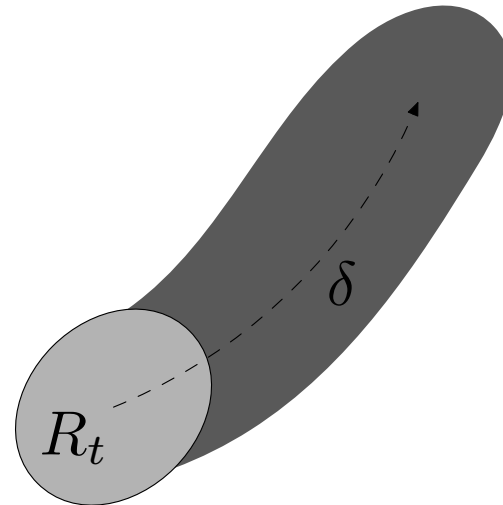
Flow-tube evaluation

1. consider a region of states R_t ;



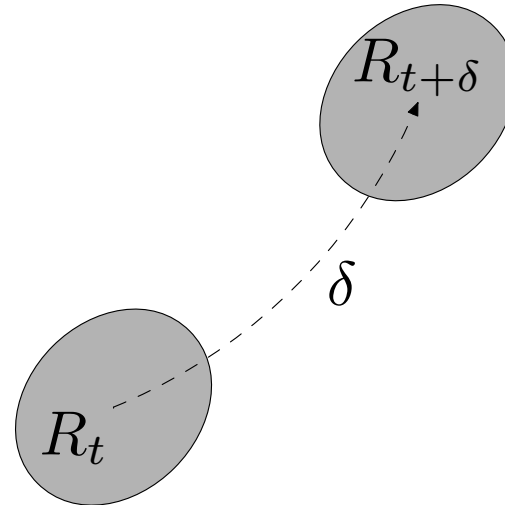
Flow-tube evaluation

1. consider a region of states R_t ;
2. evaluate a δ -timed “slice” of the flow tube from the current region;



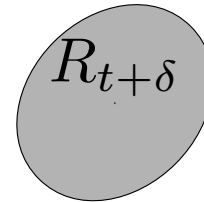
Flow-tube evaluation

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3. compute the region $R_{t+\delta}$ of states reachable from the current region with exactly a δ -time flow;



Flow-tube evaluation

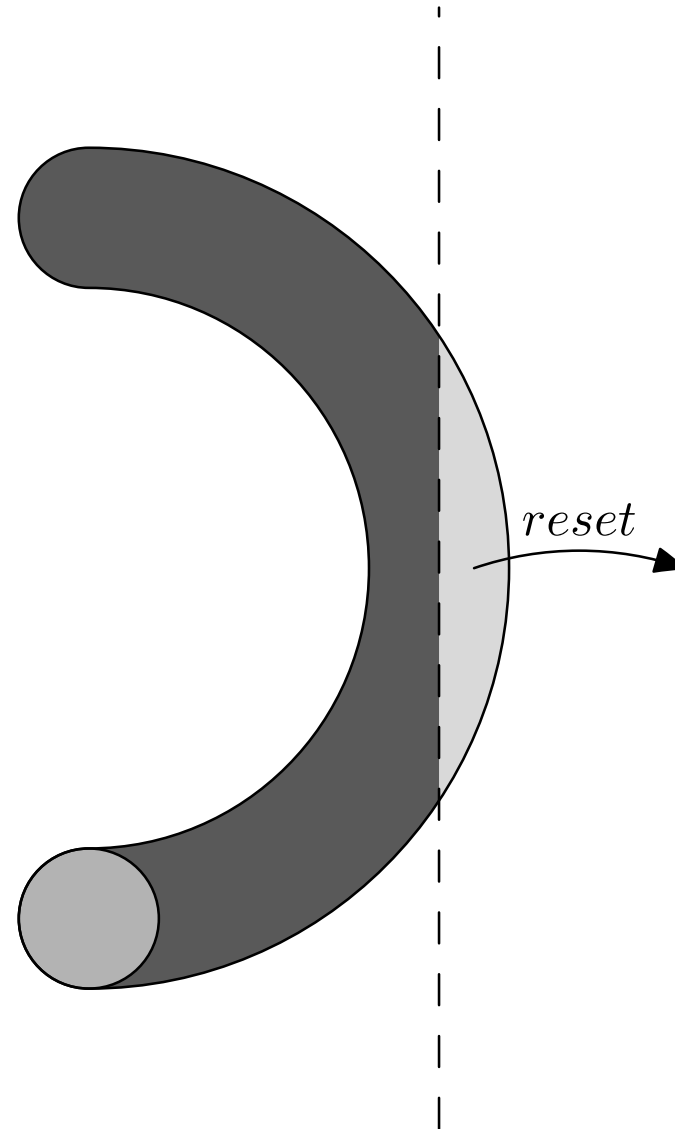
1. consider a region of states R_t ;
2. evaluate a δ -timed “slice” of the flow tube from the current region;
3. compute the region $R_{t+\delta}$ of states reachable from the current region with exactly a δ -time flow;
4. if $t < t_{max}$, repeat from 2.



Reset evaluation

The reset module resets the intersection of reached regions with activation regions.

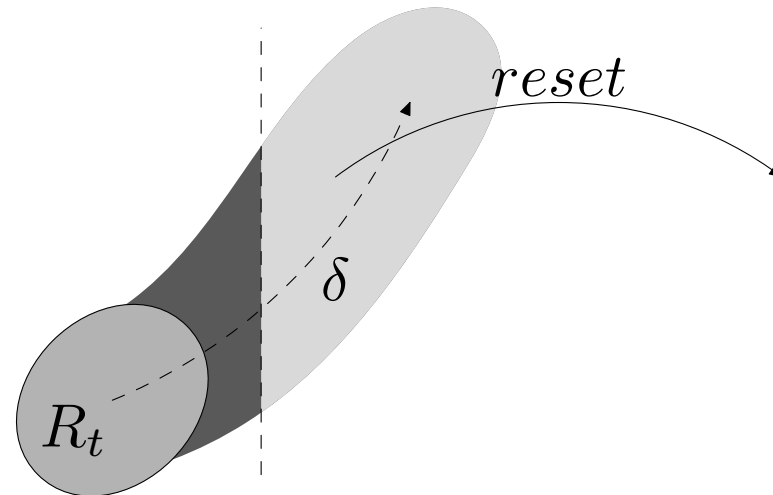
- at the end of the flow tube evaluation;



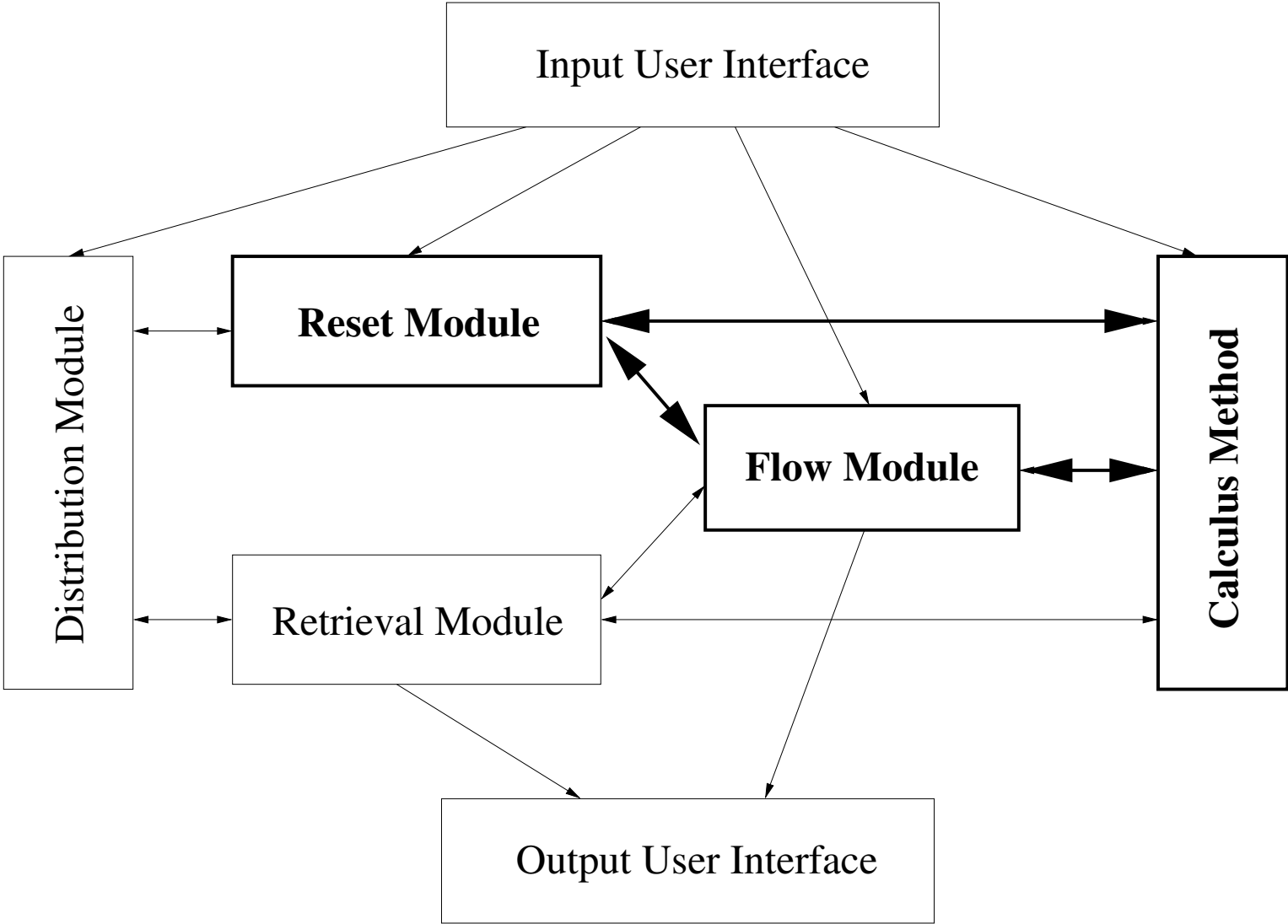
Reset evaluation

The reset module resets the intersection of reached regions with activation regions.

- at the end of the flow tube evaluation;
- after each flow tube “slice” evaluation.



Flow, reset and calculus interactions

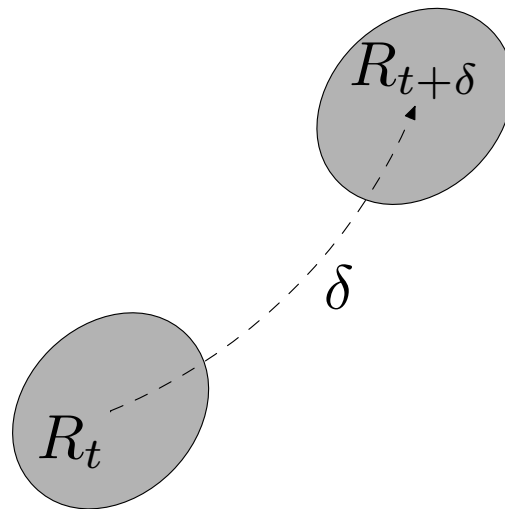


Re-evaluations of flow-tube

We may repeat evaluations already done.

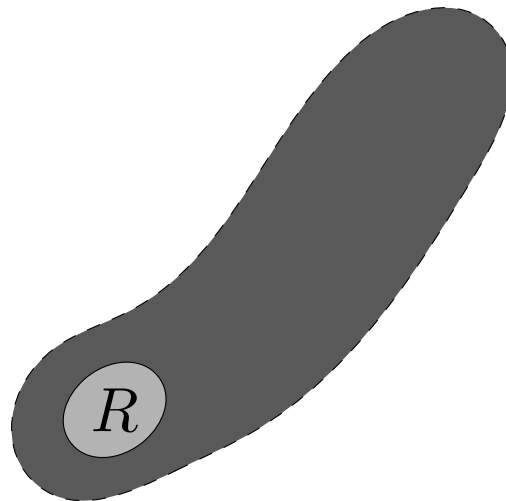
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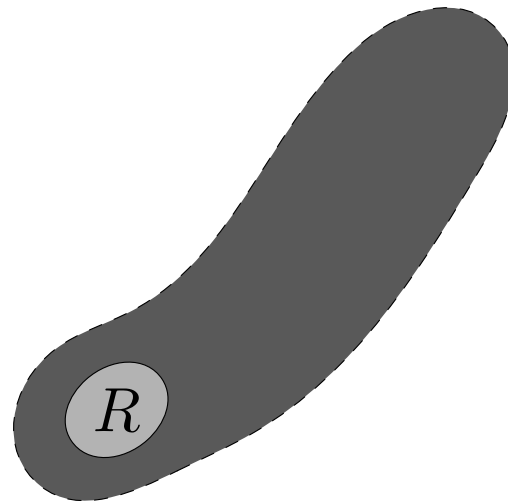
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Re-evaluations of flow-tube

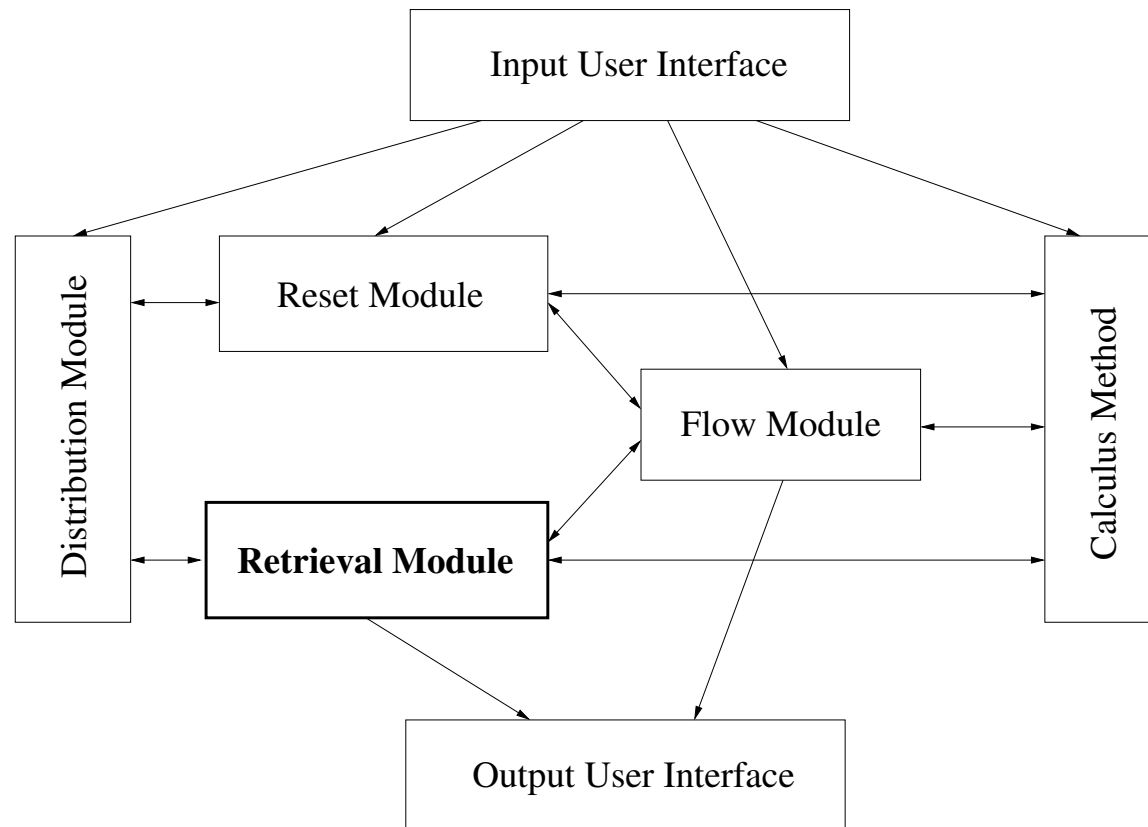
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The re-evaluation of the flow tube from R is *useless*.

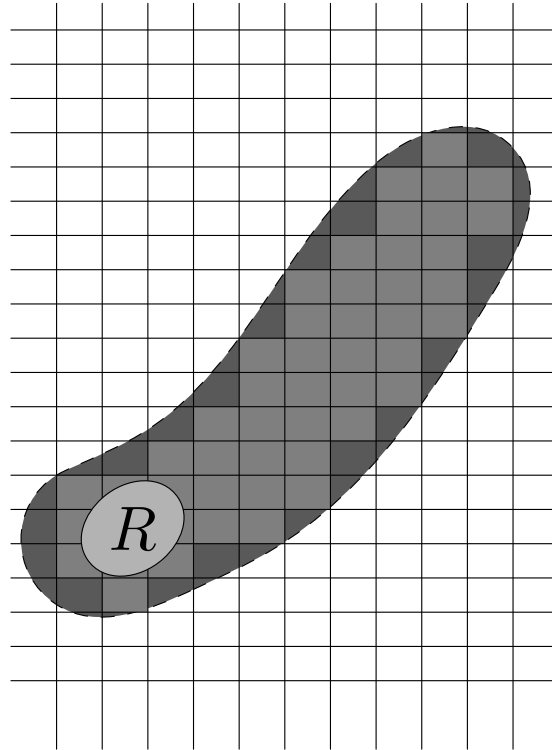
Avoiding recomputations

We include a *retrieval module* that “remembers” the states reached in each location.



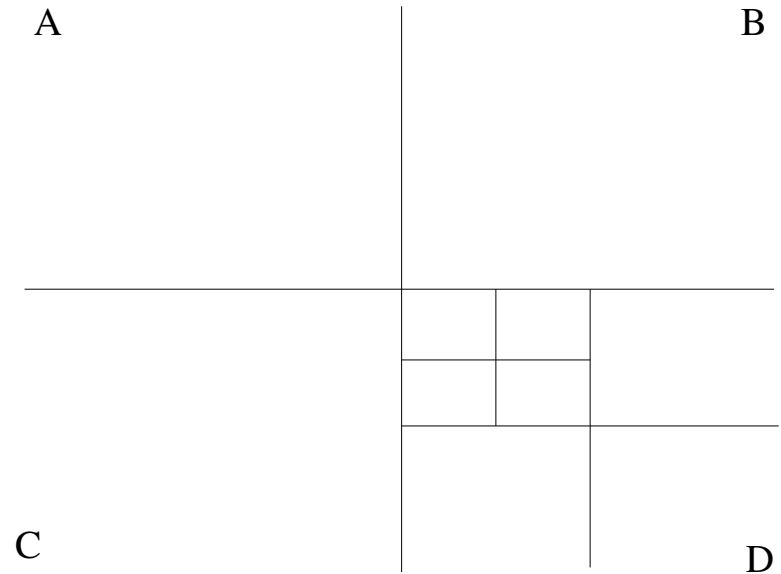
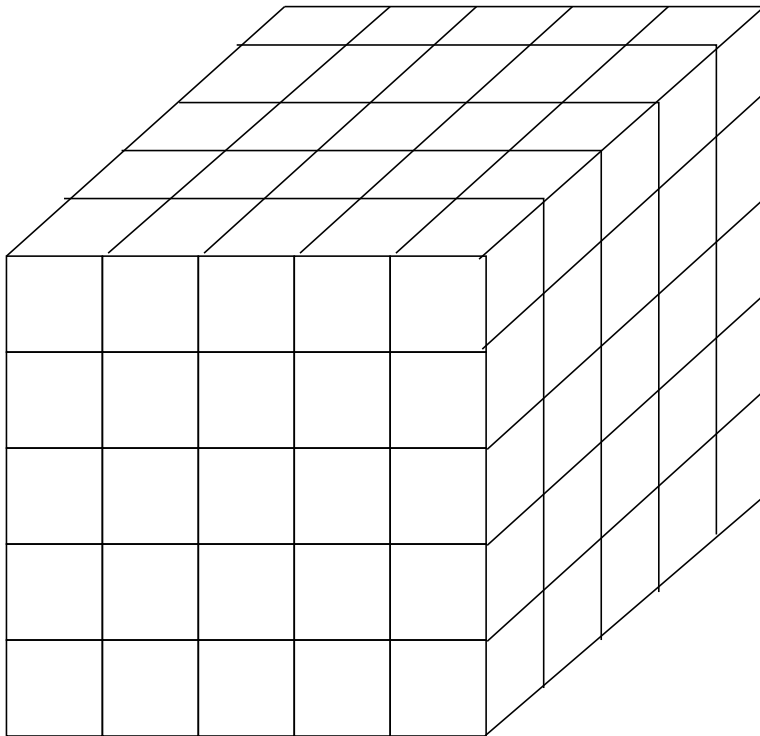
The retrieval module

If we split the phase space into a grid, we can associate to each cell of the grid a reachability attribute.



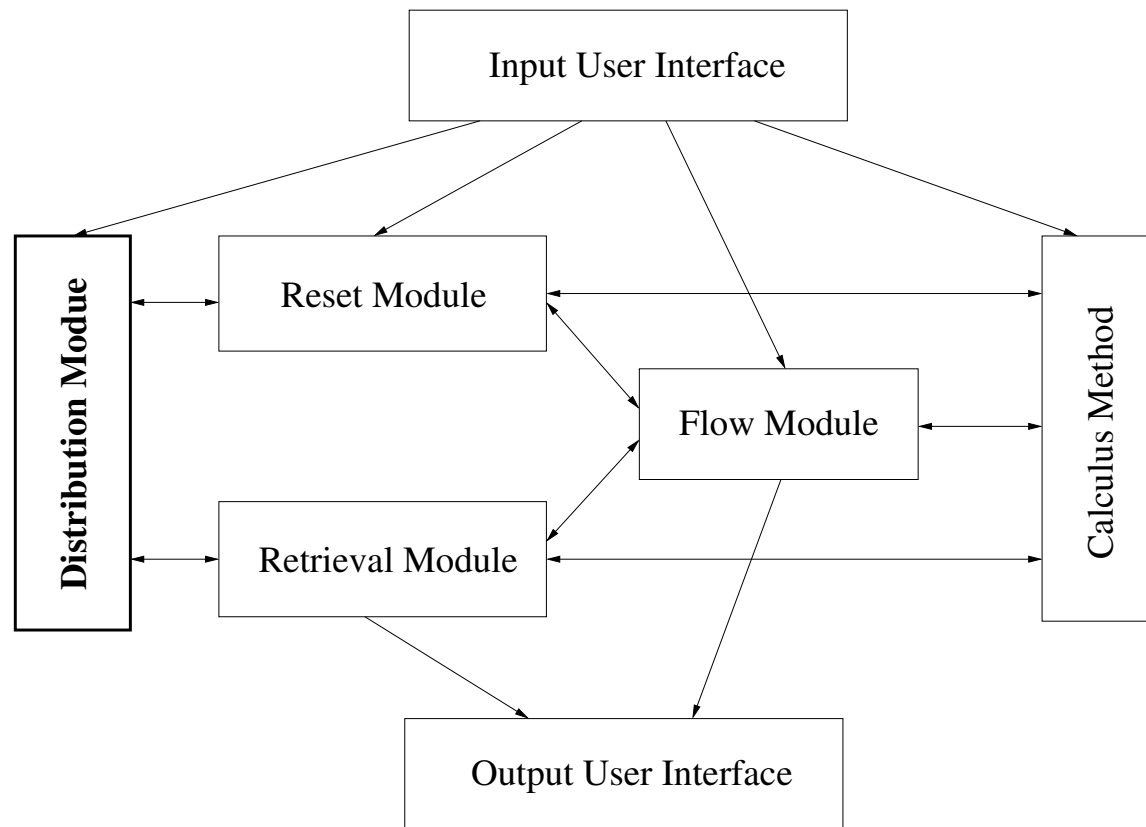
The grid

To implement the grid we can use *quad trees* and *grid files*.



Distributed computation

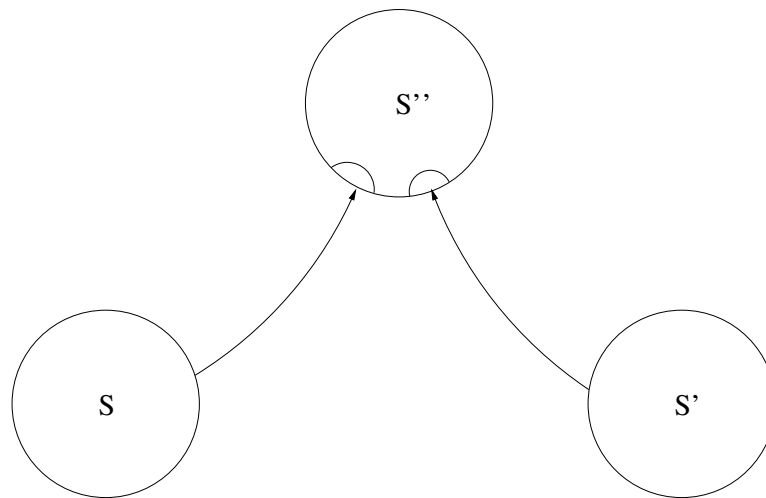
Every time a reset is called, the distribution module “migrates” the subsequent flow evaluation.



Tasks of distribution module

It should:

- distribute the evaluation of flows over a mesh of heterogeneous computers;
- handle communication between nodes of the mesh;
- provide a way to synchronize reached sets computed through different transitions to the same location.



Implementation

The distribution module will be implemented using **LAM/MPI**.

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LAM/MPI library implements:

- communication primitives;
- synchronization techniques;
- facilities for defining a mesh.

Interactions of modules

