

Validation and enhancement of hybrid models for control and health monitoring

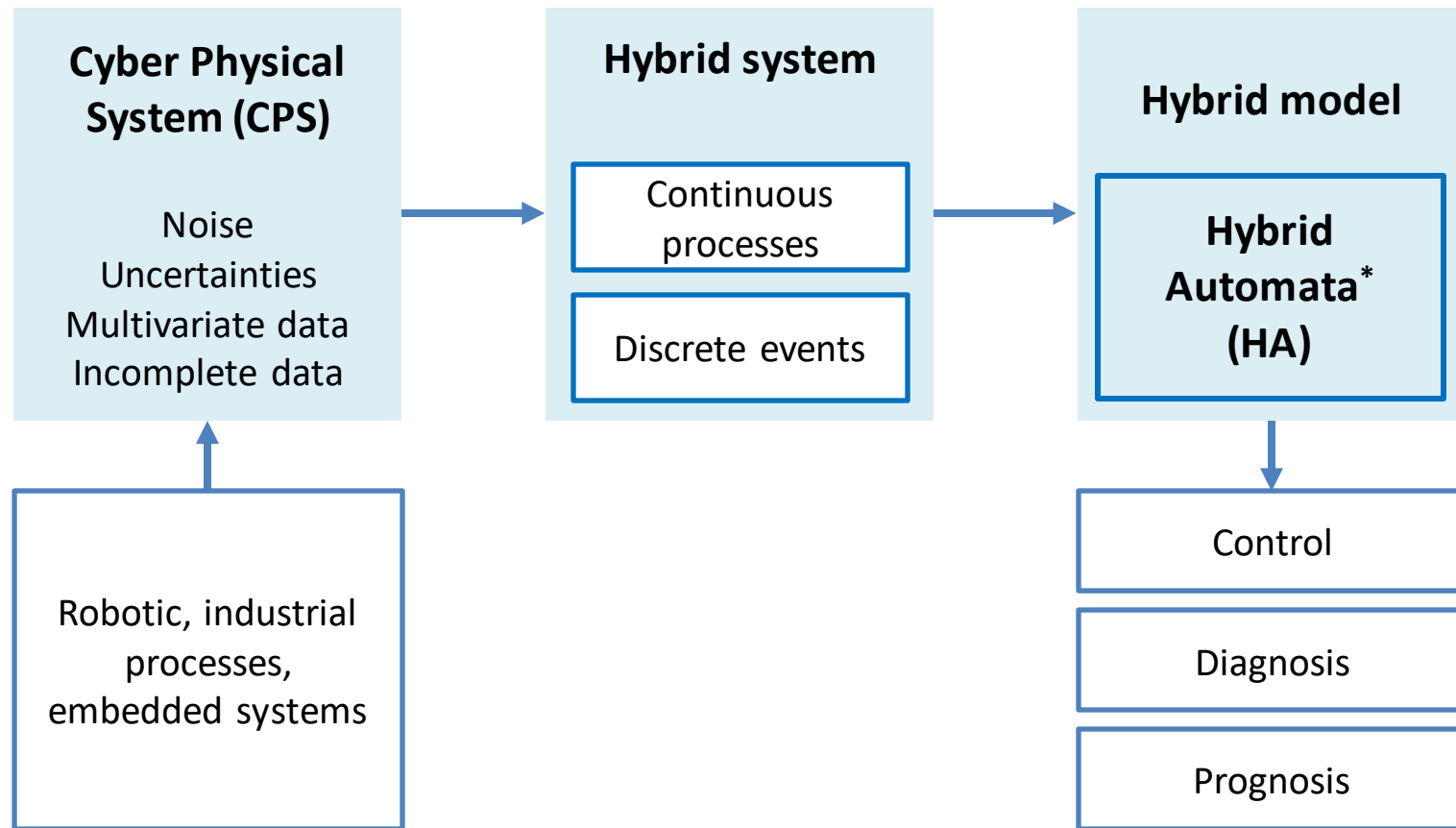
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Équipe DISCO

Keywords: Hybrid automata, hybrid systems, model learning, model update,
control, health monitoring

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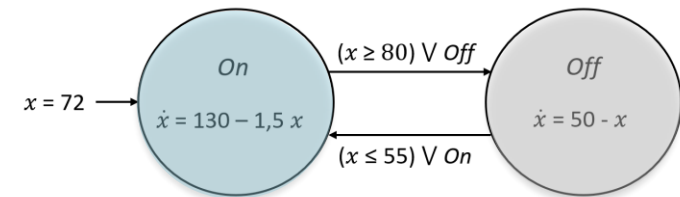
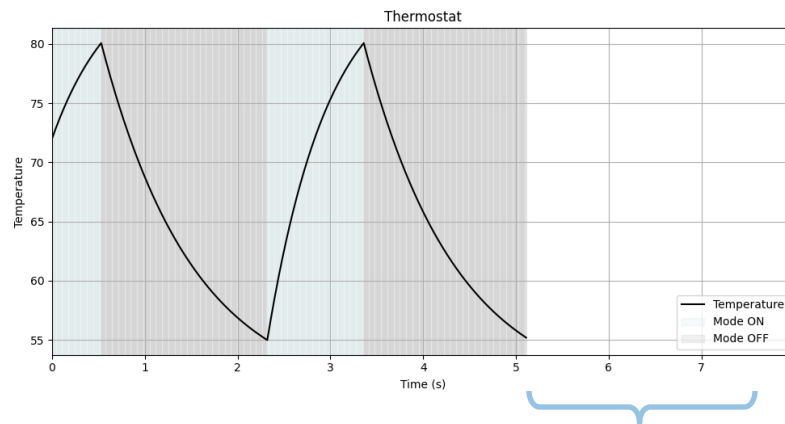




* HENZINGER, Thomas A. The theory of hybrid automata. In : *Proceedings 11th Annual IEEE Symposium on Logic in Computer Science*. IEEE, 1996. p. 278-292.

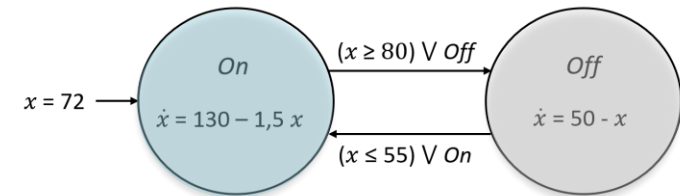
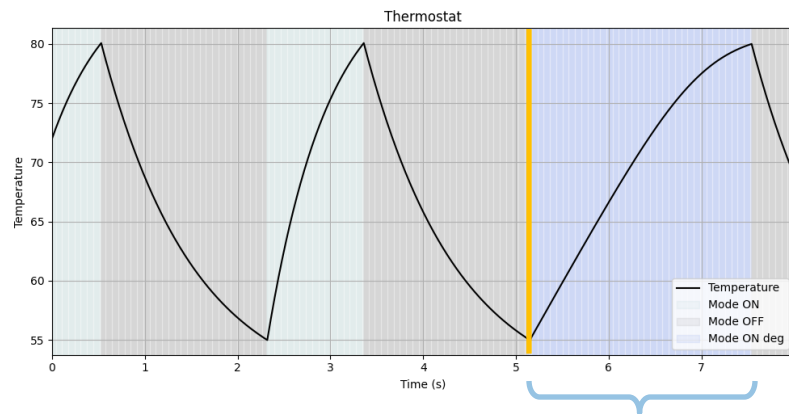
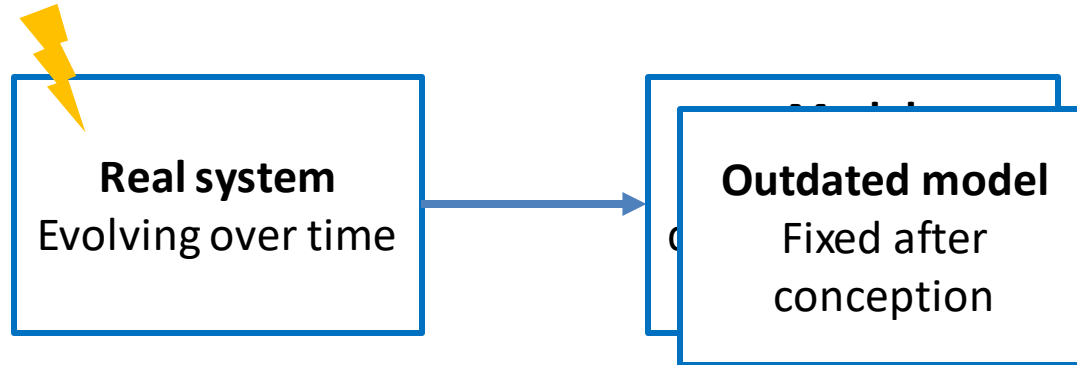
Real system
Evolving over time

Model
used for control,
diagnosis or health
monitoring



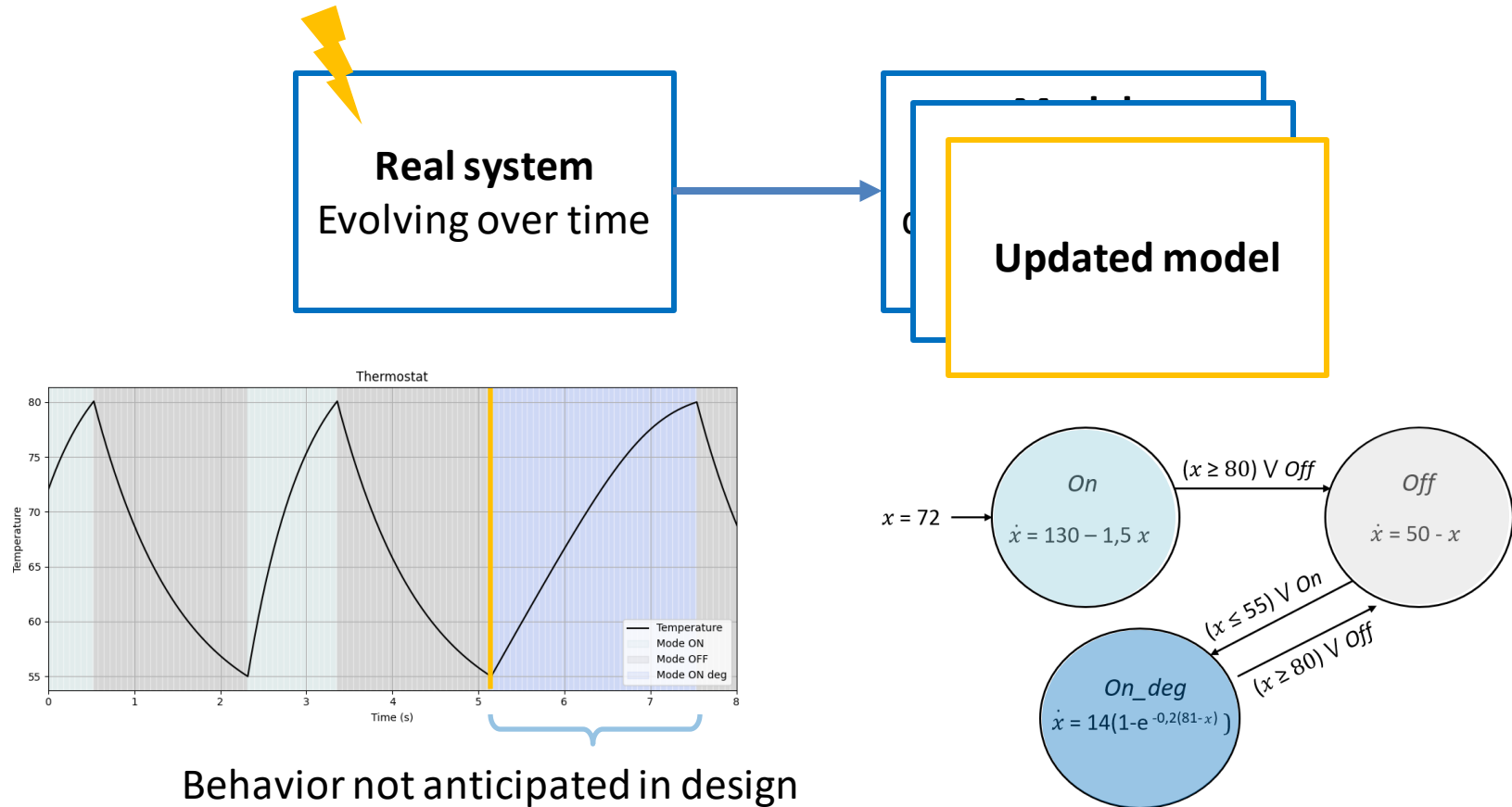
Behavior not anticipated in design
(new sensors / actuators, faults, degradations)

Degradations

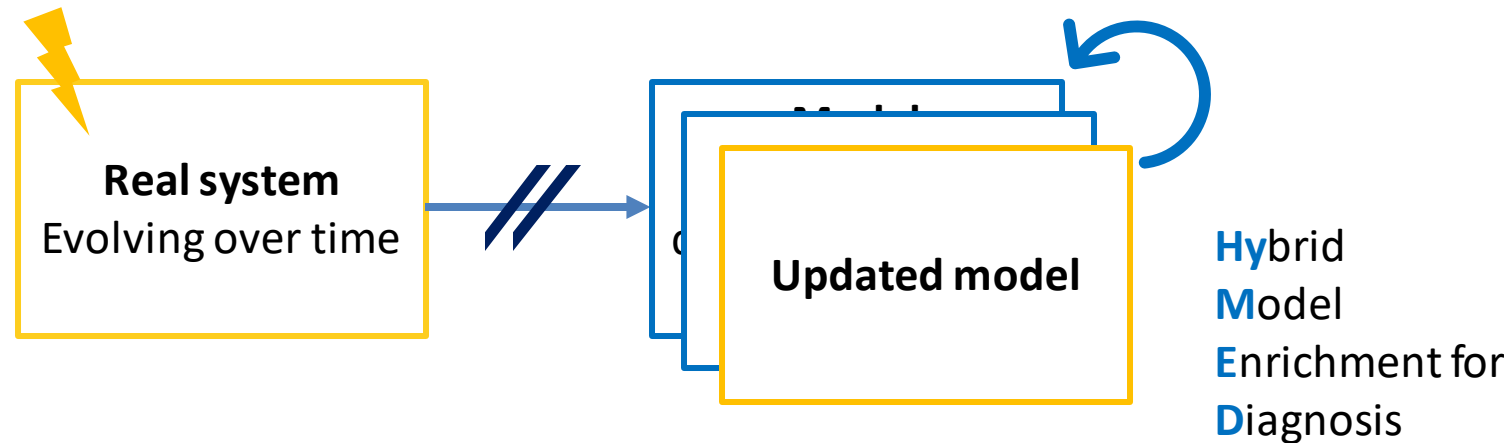


Behavior not anticipated in design
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Degradations

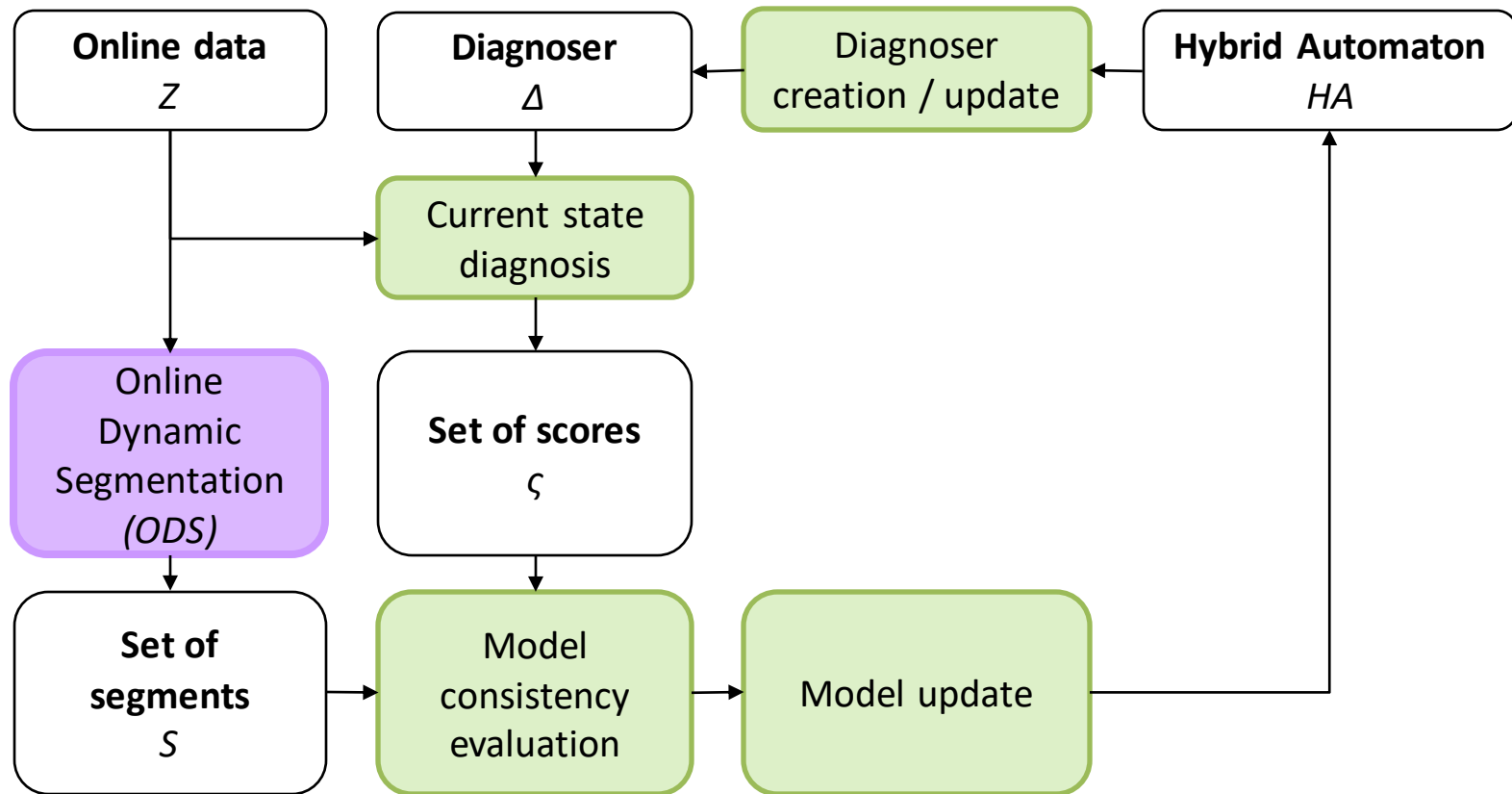


Degradations

**Objectives:**

- Update the existing model
- Create a methodology that is not too time and data intensive, online and passive
- Improve the effectiveness of monitoring and diagnostic methods without requiring a complete re-identification
- Keep determinism of the model for control



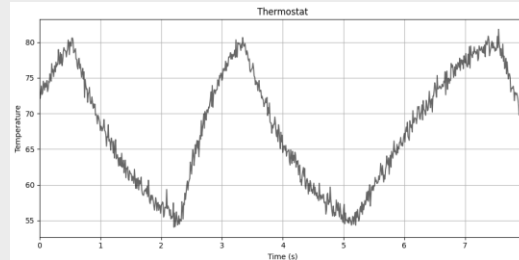


Online data

Z

Online
Dynamic
Segmentation
(ODS)

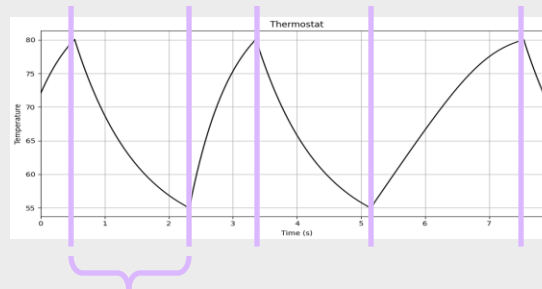
Set of
segments
 S



Observations as multivariate time series

Filters gaussian noise + segments

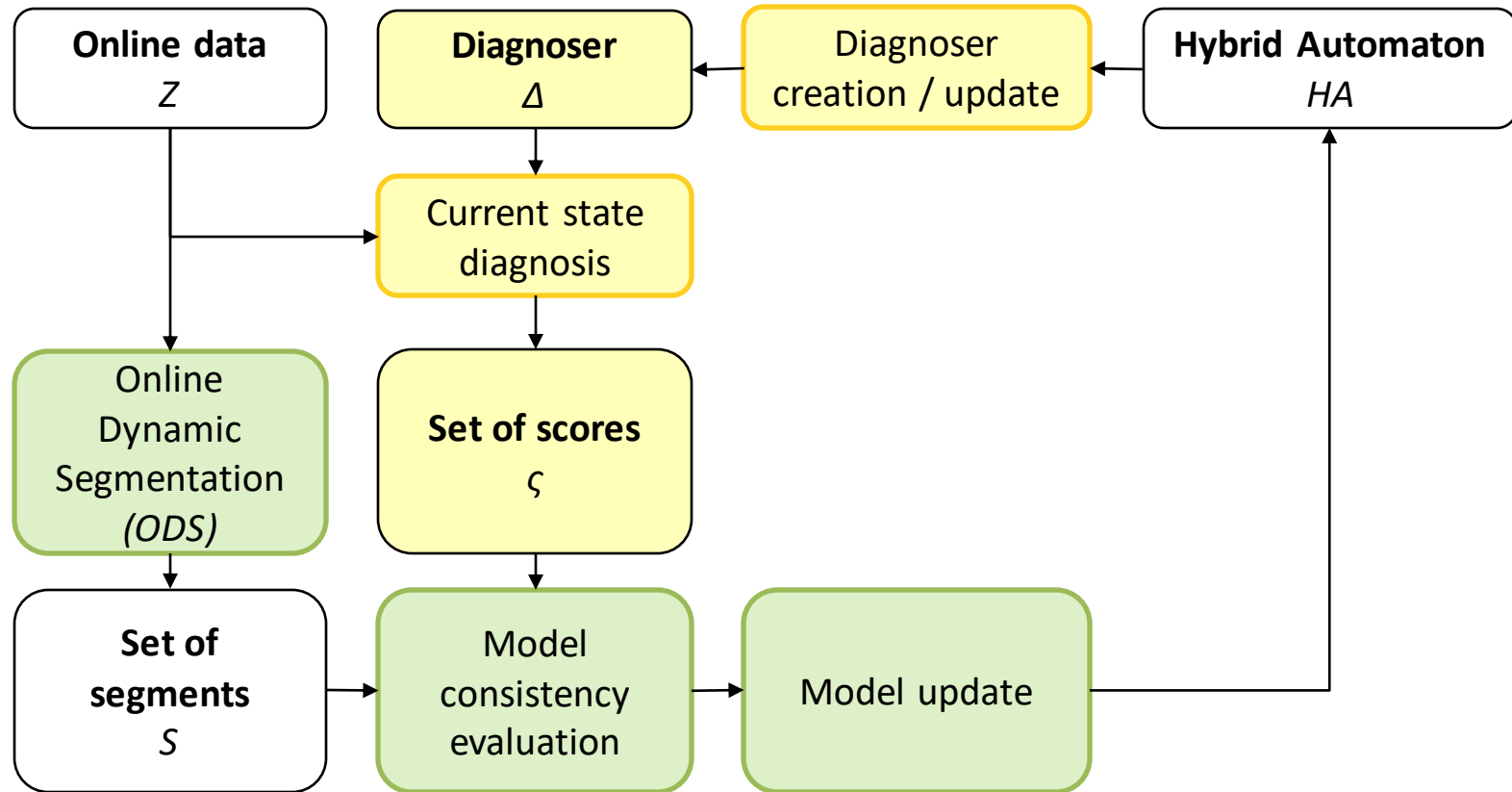
- No a priori knowledge
- Detects transition points
- Automatic hyperparameter selection

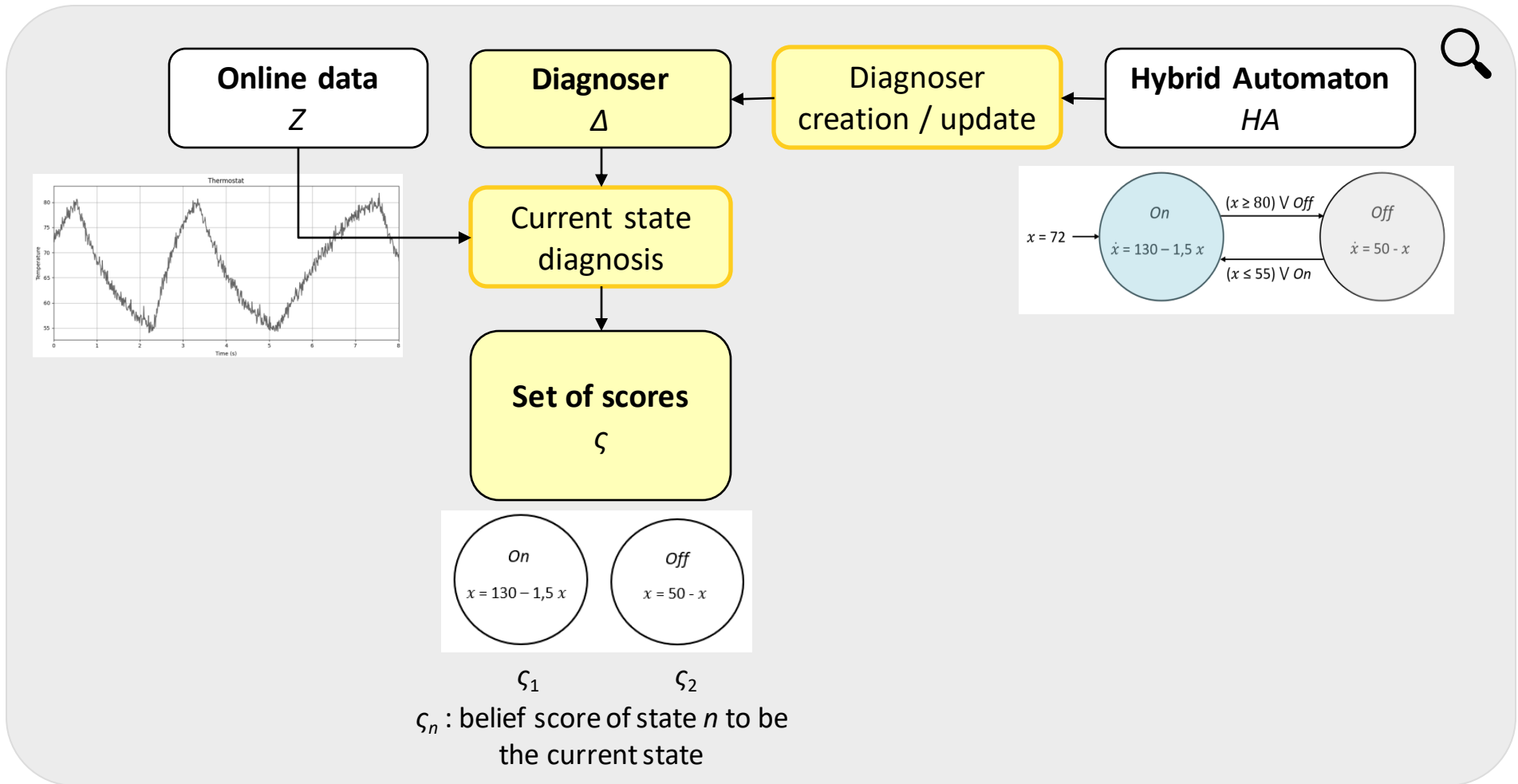


1 segment $\rightarrow$ 1 mode

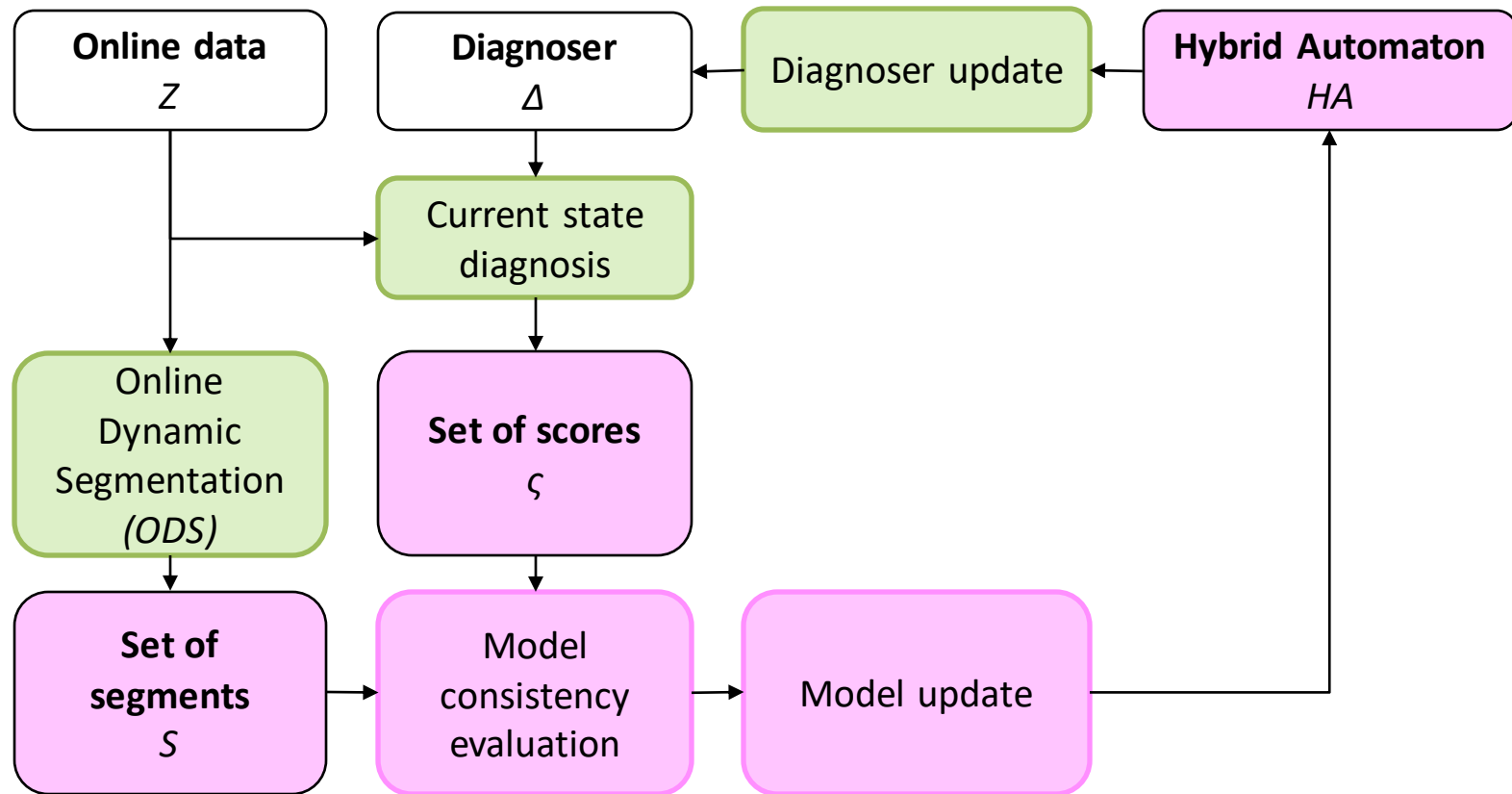


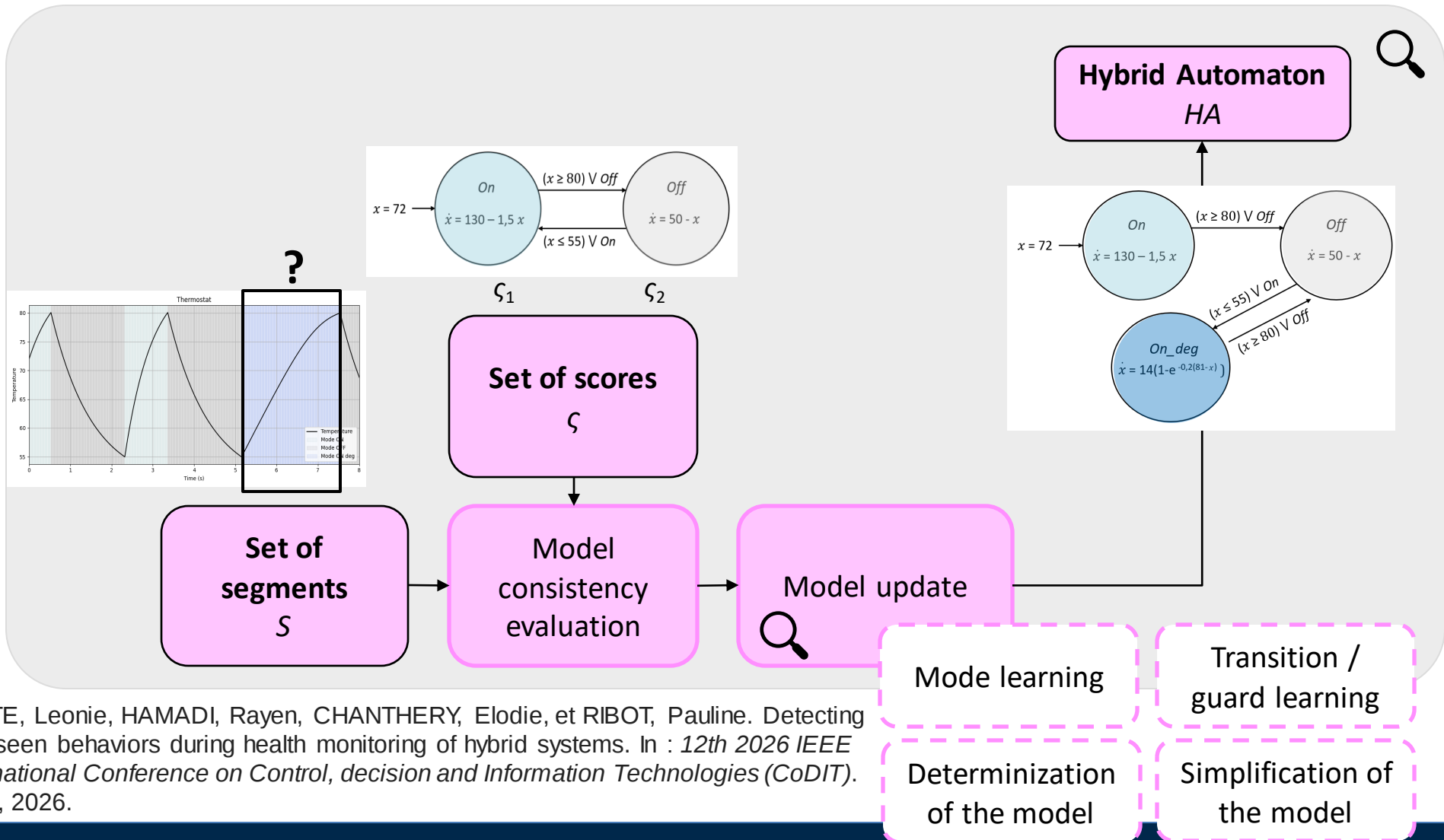
HATTE, Leonie, RIBOT, Pauline, et CHANTHERY, Elodie. Dynamic time series segmentation for health monitoring of hybrid systems. In : 2025 IEEE International Conference on Systems, Man, and Cybernetics (SMC). IEEE, 2025. p. 7269-7274.





VIGNOLLES, Amaury, CHANTHERY, Elodie, et RIBOT, Pauline. A holistic advanced diagnosis approach for systems under uncertainty. In : *32nd International Workshop on Principle of Diagnosis-DX 2021*.





HATTE, Leonie, HAMADI, Rayen, CHANTHERY, Elodie, et RIBOT, Pauline. Detecting unforeseen behaviors during health monitoring of hybrid systems. In : *12th 2026 IEEE International Conference on Control, decision and Information Technologies (CoDIT)*. IEEE, 2026.

Heater simulator (1 room)

- Univariate
- Easy to understand
- Not complex
- For demonstration

Henzinger standard
model

Engine timing system

- Multivariate
- Not complex

Simulink model

Upgraded heater simulator (2 rooms and fault injections)

- Multivariate
- Easy to understand
- Complex dynamics
- Dependencies between variables
- Fault injections

Contribution

Water network simulator

- Multivariate
- Complex dynamics
- Dependencies between variables
- Fault injections
- User friendly

INSA Toulouse students

HyMED

- Hybrid models enrichment for diagnosis
- No historical data
- Online method
- Frugal AI
- Structural constraints
- Integration of a diagnoser
- Integration of expert knowledge
- Preservation of determinism for control

Perspectives

- Applications on real systems
- Optimization for reducing computational costs

Thank you for your attention
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