POLITECNICO MILANO 1863
DIPARTIMENTO DI ELETTRONICA INFORMAZIONE E BIOINGEGNERIA

UNIVERSITÀ DEGLI STUDI DI MILANO

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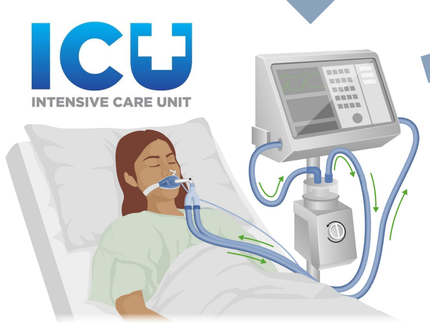
Capturing Medical Knowledge into a Safe and Trustworthy Digital Twin

Bruno Guindani, Livia Lestingi, Matteo Camilli, Marcello Bersani, Raffaela Mirandola

Context

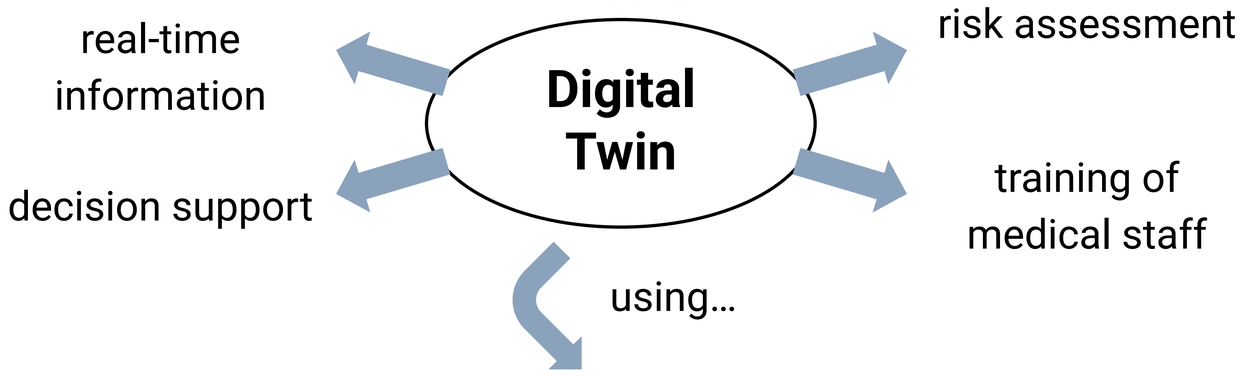
Domain:
Medical Cyber-Physical Systems, e.g., mechanical ventilators



Challenges: component heterogeneity, uncertainty

Requests from stakeholders:

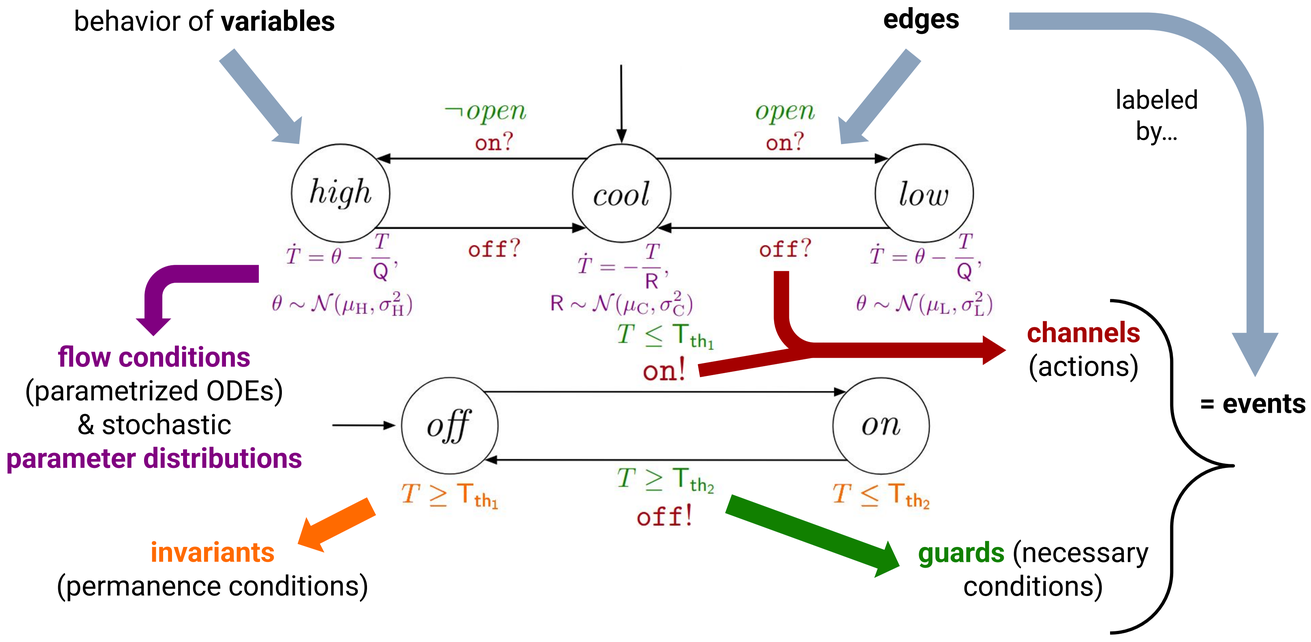
Solution:



Stochastic Hybrid Automata (SHA)

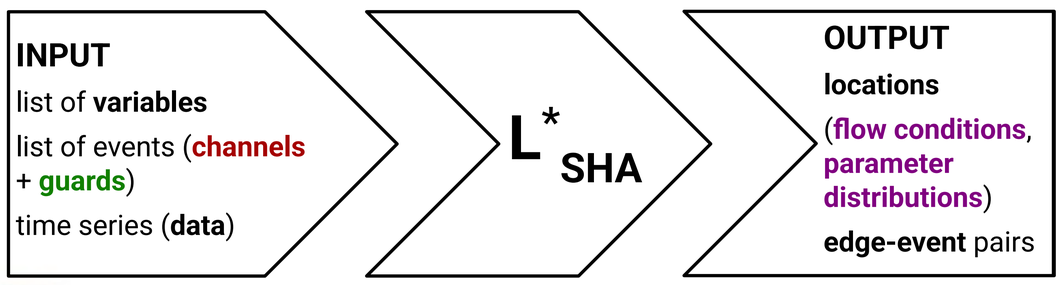
locations with different behavior of **variables**

edges labeled by...

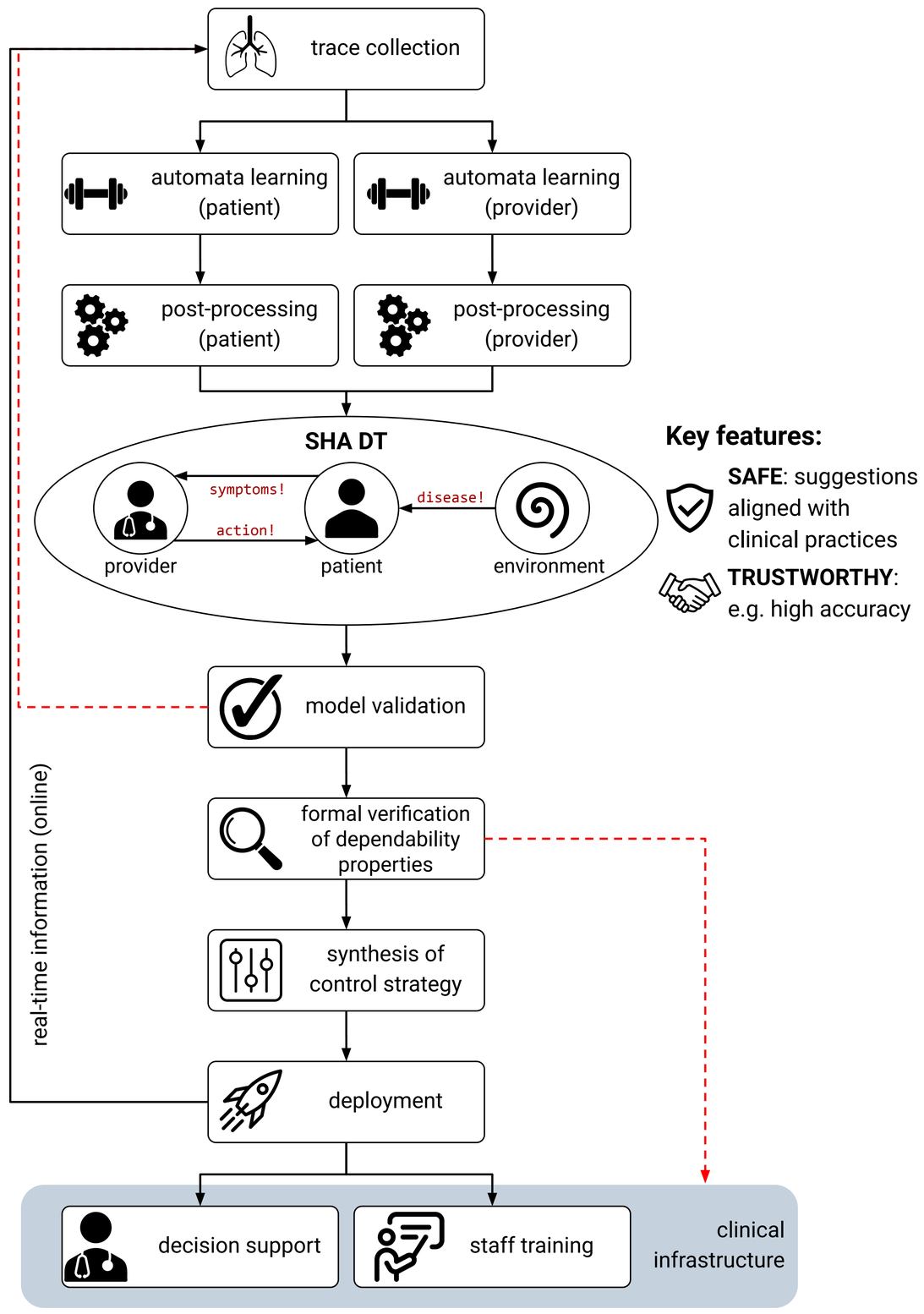


Advantages: conciseness; formal verification of properties; explainability

Automata learning algorithms



Proposed workflow



Key features:

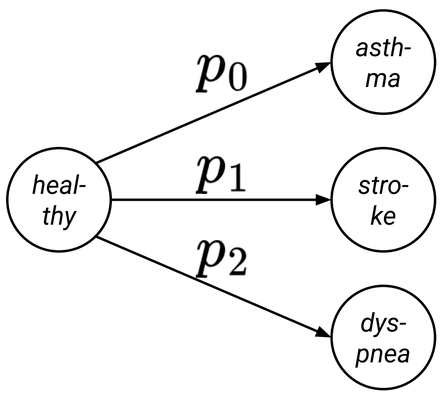
SAFE: suggestions aligned with clinical practices

TRUSTWORTHY: e.g. high accuracy

SHA Bayesian extensions

For improved risk assessment

$$s \sim Beta(a, b)$$
$$y_i | s \overset{iid}{\sim} Bernoulli(s)$$
$$s | y_{1:n} \sim Beta(a_n, b_n)$$



Bayesian stress level models:

- flexible Beta distributions for different provider profiles
- models likelihood s of ignoring suggestions
- updates with real-time data y_i

$$p_{0:2} \sim Dir(\alpha_{0:2})$$

transition probabilities between locations, modeled with Dirichlet distributions