Enhancing Manufacturing with AI in the Industrial Metaverse

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Challenges of AI in Manufacturing (Especially Pharma)

1 Process Complexity
- Complex manufacturing processes
- Chemical reactions
- Process documentation

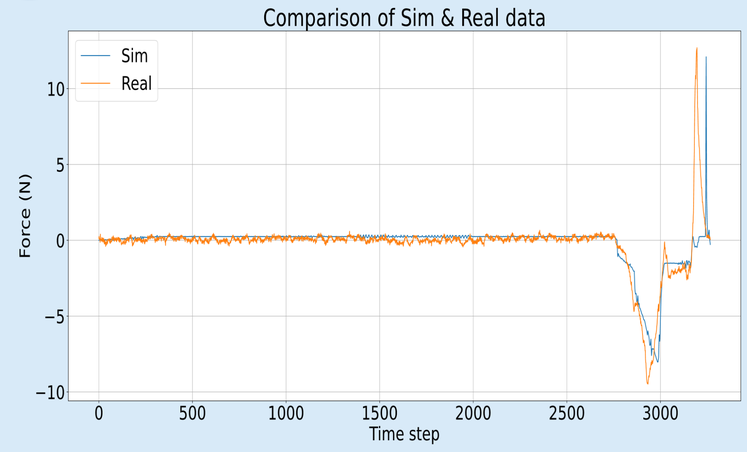
2 Simulation
- Direct simulation is often intractable
- Dimensionality
- Non-linear relationships
- Difficult-to-explore latent spaces

3 Reliability and Consistency
- Customer (patient) safety,
- Quality standards
- Audits
    - Blackbox not ok
- Out of Distribution data during run time
- Effects of variations (e.g., raw material shifts, sensor noise)
    - *Example: Risk of false rejections or acceptance of substandard product batches in process verification*

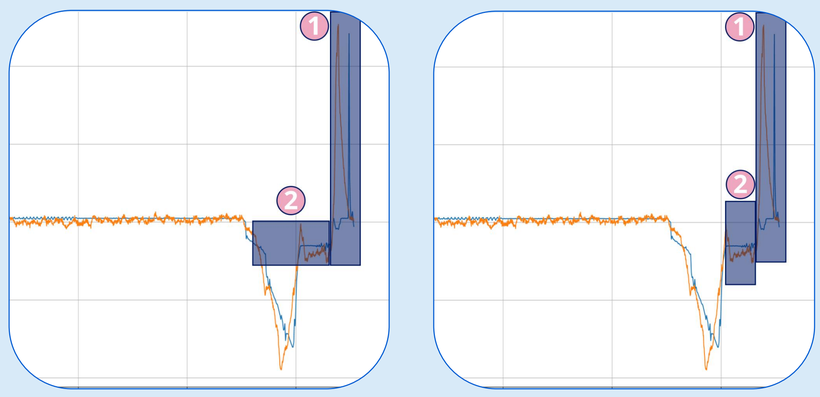
4 Cautious Adoption
- Leads to cautious adoption of ML in critical roles
    - *Example: Real-time process verification based on live sensor data*

Sample Use Case

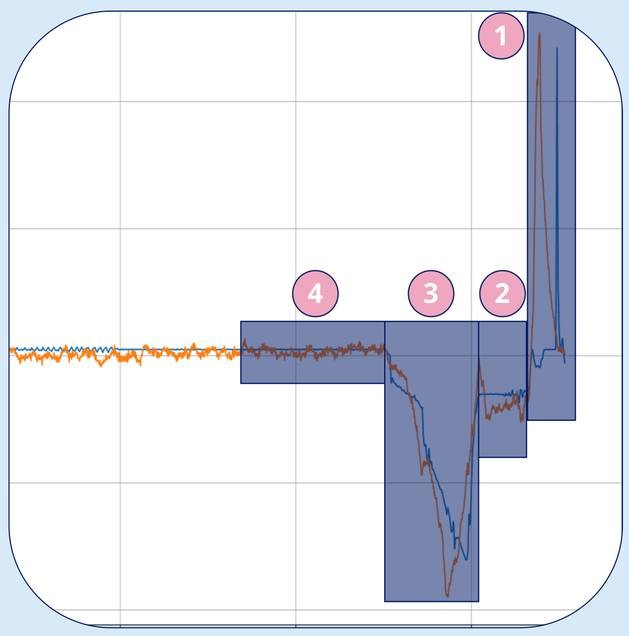
A Process Data



B Constructive steps



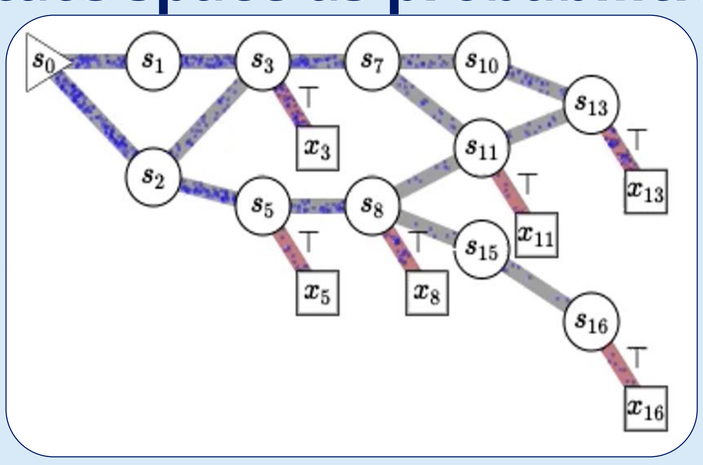
C Optimal Verification



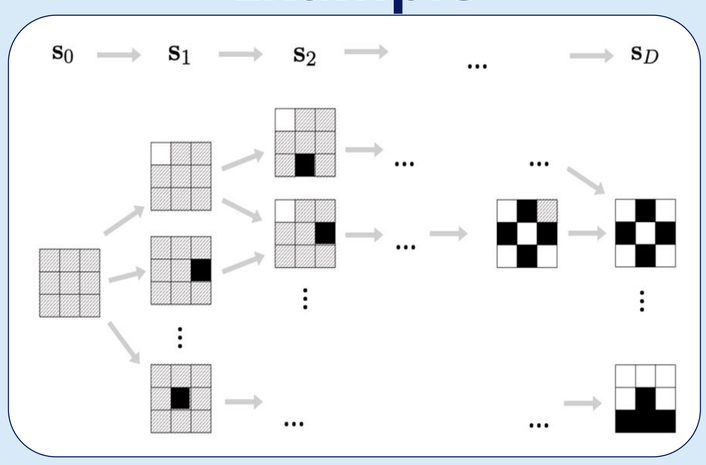
Generative Flow Networks

Advantages
- Directed Acyclic Graphs
- Sparse reward function
- Mixed continues and discrete space
    - *Example: pixel (x,y) W^2 + shade R*

State space as probabilities



Example



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