A Perspective on Petri Net Learning

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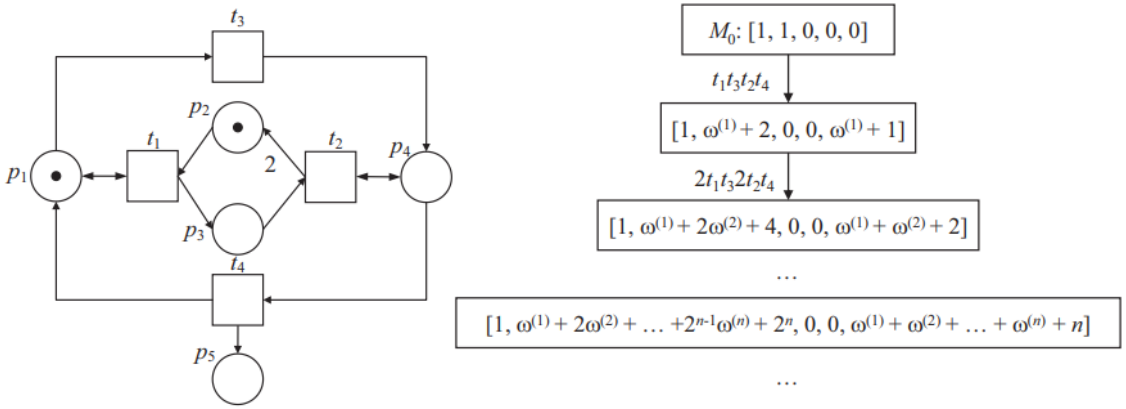
Problems & Ideas

- The state space explosion problem of Petri nets:
  - The state space of PNs grows exponentially with PNs' size. Even the fundamental reachability problem is still an NP-Hard problem in general.
  - There is no efficient and accurate algorithm to solve the problem.

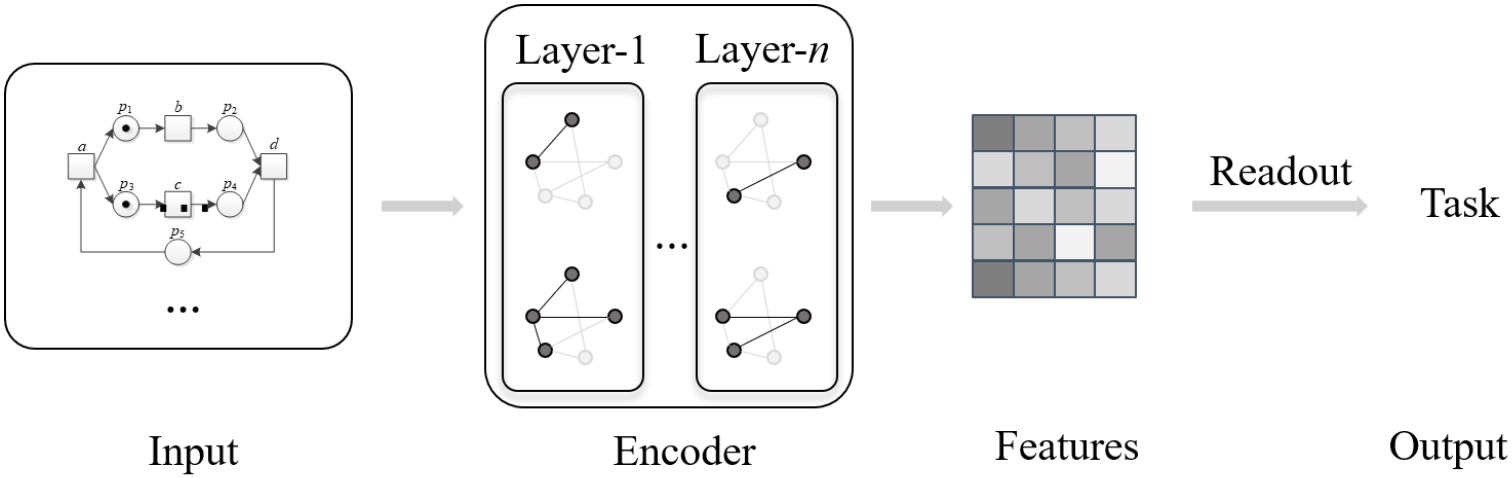
Ideas: Inspired by machine learning, our team proposes a probabilistic approximate solution method avoiding the state space explosion problem from a data-driven perspective



Both large bounded PNs and unbounded PNs suffer from state space explosion problems. However, unbounded PNs are more complex and suffer from the problem of infinite state space. Fig. 1 shows an unbounded PN with a non-semilinear reachability set and part of the reachability tree. The infinite reachability set of the unbounded PN cannot be represented by the tree totally. Thus, the reachability problem of the PN cannot be solved exactly by the tree.

Main Contributions

- Contributions:
  - A novel perspective that utilizes correlation relation in the field of machine learning as an approximate alternative to causality in the field of PNs;
  - Suitable learning algorithm for supporting the quantitative analysis of PNs, considering the static topology of PNs and their unique dynamic operation mechanism;
  - The strategy that finite state space approximates the whole state space of PNs, aiming at the state space explosion.



PNs (inputs) and corresponding tasks (outputs) are involved as training data. During the training phase, the method encodes the data to obtain hidden information by deep neural networks and further establishes the mapping function for the corresponding tasks. The method will update the parameters of the deep neural networks through backpropagation and adjust the model so that the gap between the predicted and actual output is as tiny as possible.