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State space optimization of finite state machines from the viewpoint of control theory

Key words: Finite state machines; Finite-valued systems; Logical systems; Logical networks; Semi-tensor product of matrices; Space optimization

Corresponding author: Yongyi YAN

E-mail: yuyan@mail.nankai.edu.cn

 ORCID: <https://orcid.org/0000-0002-7181-5894>

Motivation

1. It is hard for most existing results to explain the mathematics of the state space optimization of finite state machines (FSMs) .
2. Some ideas and concepts in the control theory, such as equilibrium points of dynamic systems, can be borrowed to the field of FSMs.
3. FSMs and logical dynamic systems have essential connections, and thus we want to build a bridge between them using the control theory.

Method

1. View FSMs as logical dynamic systems.
2. Borrow the concept of equilibrium points of dynamic systems in the control theory to introduce the concepts of t -equivalent states and t -source equivalent states for FSMs.
3. By establishing the formulation of the t -equivalent states and t -source equivalent states, all the states of an FSM of both kinds can be obtained.
4. With the t -equivalent states and t -source equivalent states, an optimization method for the state space is proposed.

Main contributions

1. A state space optimization of FSMs is proposed.
2. An example is used to verify the correctness and effectiveness.

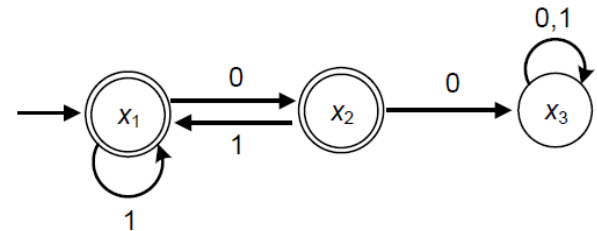
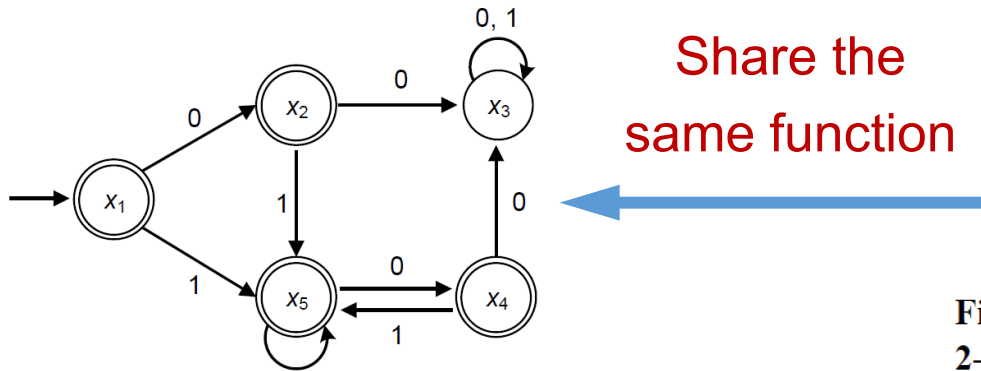


Fig. 5 Finite state machine produced by merging 2-equivalent states x_1 and x_4

Fig. 2 Finite state machine to be reduced

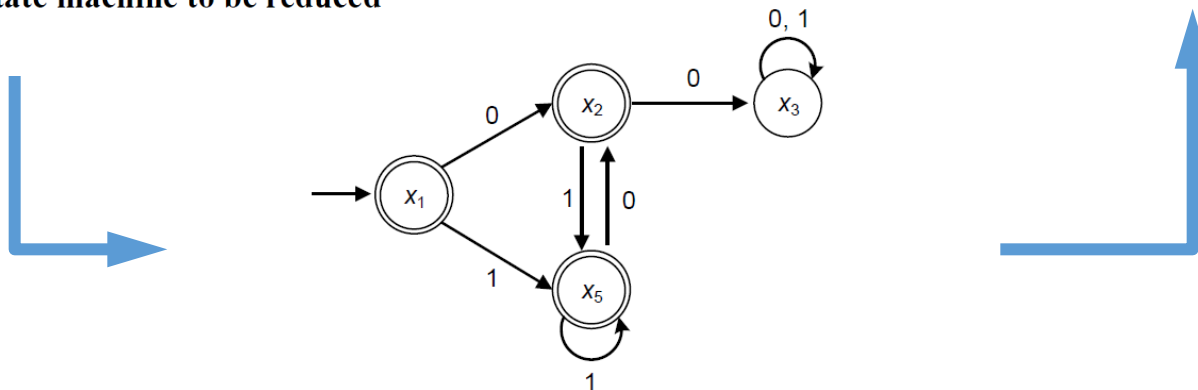


Fig. 4 Finite state machine produced by merging 1-equivalent states x_2 and x_4

Future outlook

An open question: does the relationship $T_{\text{new}}=g(T)$ between T_{new} and T exist? If yes, what is it?

If the open question is solved, the proposed optimization method can be further improved into unattended ones.