转发: Your ICCAD 2023 Submission (Number 568)

XIN HONG <XIN.HONG@student.uts.edu.au>
周五 2023/11/3 15:20
收件人:by.gdc@outlook.com <By.gdc@outlook.com>

发件人: start@z.softconf.com <start@z.softconf.com> 代表 Program Chair, ICCAD 2023 <iccad2023_n@softconf.com>
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收件人: XIN HONG <xin.hong@student.uts.edu.au>
主题: Your ICCAD 2023 Submission (Number 568)

Dear Xin Hong:
I am sorry to inform you that the following submission was not selected by the program committee to appear at ICCAD 2023:
Image Computation for Quantum Transition Systems
The selection process was very competitive. A total of 748 papers have gone through the complete review process. Because of time and space limitations, we could only choose a small number of the submitted papers to appear on the program.
I have enclosed the reviewer comments for your perusal. The review comments are also available in your Softconf console. Please remember to update your Softconf email address to obtain the latest updates.
If you have any additional questions, please feel free to get in touch.
Best Regards,
Jinjun Xiong, Program Chair, ICCAD 2023
ICCAD 2023

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ICCAD 2023 Reviews for Submission #568
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Title: Image Computation for Quantum Transition Systems
Authors: Xin Hong, Dingchao Gao, Shenggang Ying, Sanjiang Li and Mingsheng Ying


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                            REVIEWER #1
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Reviewer's Scores
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                Relevance to ICCAD (1-5): 3
        Novelty of technical ideas (1-5): 3
               Theoretically sound (1-5): 3
                Practically useful (1-5): 3
      Thoroughness of the research (1-5): 2
              Clarity and language (1-5): 2
            Overall Recommendation (1-5): 2

Summary
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This paper presents a basic algorithm and a set of optimization techniques to
calculate the image for quantum transition systems based on the tensor-network
representation of the quantum systems. This idea can be used to conduct model-
checking for quantum circuits.
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Strengths

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1. The topic is timely and interesting.
2. The problem is complex and requires a lot of effort.

Weaknesses

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1. The motivation, challenge and benefit of the proposed system are not clear.
2. The writing needs improvement.
3. Not sure what is the success metric.

Detailed Comments

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1. I am not sure I understand why the proposed system is needed. A lot of assumptions need clarification. For example, why does the quantum circuit need model checking? What is an "image"? An image in this scenario seems to be an intermediate state during the involvement of a quantum system.

2. The proposed system is tightly related to the tensor-network representation of the quantum systems. It is useful to clarify what are operations available from a tensor-network perspective and what are unique features proposed by this work.

3. In addition, the tensor network is known as not suitable for noise simulation. This work seems to aim to model how the errors/noise impact the quantum system and how its tensor network gets transitioned. It would be great to see if this is the goal, but it seems that at least this is not the goal of the current version of the paper.

4. It is not clear how exactly the model checking task is conducted over quantum systems, and why the proposed image calculation framework can help.

5. The evaluation section needs to be restructured: what are the research questions that need to be answered? How do you call yourself successful? etc.

REVIEWER #2

Reviewer's Scores

Relevance to ICCAD (1-5): 5
Novelty of technical ideas (1-5): 4
Theoretically sound (1-5): 4
Practically useful (1-5): 3
Thoroughness of the research (1-5): 3
Clarity and language (1-5): 4
Overall Recommendation (1-5): 4

Summary

The authors aim to implement model checking (via image computation) for quantum transition systems.

Strengths

Well written paper.

Good speedup results.

Weaknesses

Lack of complexity analysis

Detailed Comments

1- The introduction lacks emphasis on the contribution of the work. The authors should highlight the significance of their algorithms and provide some initial results to support their claim of improved efficiency in image computation for quantum transition systems.

2- The complexity of the implementation is not discussed. Quantum circuits with a large number of qubits and complex operations can lead to high-dimensional images, making visualization and comprehension challenging as the quantum system size increases.

3- It would be beneficial for the authors to delve into the topic of information loss. Since quantum states are described by complex probability amplitudes, visual representations may not fully capture their intricacies. Image computations often simplify or aggregate information, potentially resulting in the loss of fine-grained details and subtle quantum effects.

REVIEWER #3

Reviewer's Scores

Relevance to ICCAD (1-5):	3
Novelty of technical ideas (1-5):	2
Theoretically sound (1-5):	4
Practically useful (1-5):	2
Thoroughness of the research (1-5):	3
Clarity and language (1-5):	3
Overall Recommendation (1-5):	4

Summary

This paper develops efficient image computation algorithms based on tensor networks and tensor decision diagrams, advancing model checking for quantum systems. Experimental results demonstrate the significant improvements in efficiency for image computation in quantum transition systems achieved by proposed contraction partition-based algorithm.

Strengths

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1. This work is theoretically sound.
2. The proposed method is effective in the evaluated benchmarks.

Weaknesses

The article does not explicitly specify the scope of applicability for the proposed methods.

Detailed Comments

The formal verification of the quantum system is important from the long-term perspective. This work introduces TDD-based methods for efficient model verification of quantum systems and achieves satisfactory results on several benchmarks. The presentation of this paper is theoretically sound and logically coherent.

However, I have some concerns regarding the scope of this paper.

1. Does this approach work for "quantum hardware"? In the introduction, the authors claim that "Notwithstanding these achievements, applications of model checking to quantum hardware verification is still an under developed research area." However, in my perspective, this work focuses on verifying quantum circuits, which are graphical representations of quantum programs and do not encompass the concept of 'quantum hardware' that typically refers to physical implementations such as superconducting quantum chips.
2. I would suggest the authors to clearly illustrate what kinds of quantum circuits their approach is effective for. It is known that TDD are compact representations of quantum systems, but I think it is not that useful for arbitrary quantum circuits since a quantum system with randomized states can be hardly represented in this version. Moreover, the evaluation is done on only 5 kinds of quantum circuits and does not cover important NISQ variational algorithms, thus it is difficult to justify whether this approach is practically useful in NISQ era.

There're some minor issues with this paper.
1. The description of Fig. 1 and the labels of the figure do not match. The TDD shown in the figure starts from x_0, y_0, while the text description starts from x_1, y_1.
2. According to Fig. 1 (right) and the definition of TDD. The value $\phi_{x_1x_2x_3y_1y_2y_3}(110111)$ should be "-1/2 \times 1 \times 1 \times 1 \times 1 \times 1 \times -1", i.e., five 1s rather than four.
3. The "index terms" are missing below the abstract.

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