Structure and Content of the Quantum Architectures (Q-AR) Knowledge Unit (KU) Proposal for the CS2023 Report: Curricular Maps and Analysis of Industry Feedback

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ABSTRACT

Continuing a process that began more than 50 years ago with the publication of Curriculum 68 ACM, IEEE—Computer Society and AAAI have sponsored five efforts to establish international curricular guidelines for undergraduate programs in computing on a roughly 10-year cycle. Over the last 15 years significant advances in quantum technologies have led to a new awareness about their impact on computing (QC). There are now 60 companies worldwide that build quantum computers. In the US the Quantum Economic Development Consortium (QED-C) was created in 2018 to accelerate the quantum industry by establishing a robust supply chain and infrastructure, including workforce and standards. But the continued absence of any serious education in quantum mechanics in a large fraction of traditional US engineering programs, including computer engineering and the closely related CS and data science programs, present many BS degree STEM graduates with the daunting problem of how to get trained quickly and efficiently to pursue the new opportunities in Quantum Information Science and Technology (QIST). To address this issue the ACM Board of Education has teamed up with the QED-C Workforce Development TAC and has developed (for the first time ever and over a period of 18 months) a Quantum Architectures (Q-AR) Knowledge Unit (KU) for CS2023. In November 2022 we asked the QED-C members (industry, academia, national labs, and government agencies) to comment on the proposed competency-based curricular plans along with the selected topics and learning outcomes. We present the analysis of the data we collected during that process.

CCS CONCEPTS

• **Hardware → Quantum computation**.

ITiCSE 2023, July 8–12, 2023, Turku, Finland

ACM ISBN 979-8-4007-0139-9/23/07.
https://doi.org/10.1145/3587103.3594180

KEYWORDS

quantum architectures for the CS undergraduate curriculum

ACM Reference Format:
Dan-Adrian German, Marcelo Pias, Qiao Xiang, and Pei-Ying Chen. 2023. Structure and Content of the Quantum Architectures (Q-AR) Knowledge Unit (KU) Proposal for the CS2023 Report: Curricular Maps and Analysis of Industry Feedback. In *Proceedings of the 2023 Conference on Innovation and Technology in Computer Science Education V. 2 (ITiCSE 2023), July 8–12, 2023, Turku, Finland*. ACM, New York, NY, USA, 1 page. https://doi.org/10.1145/3587103.3594180

CONTENT

We present three different curricular maps (aimed for distinct, different instructional purposes) representing the core of our SIGCSE 2023 proposal [1] which was itself the result of a task force working closely with a loosely selected (and somewehat fluid) focus group of experts. Each curriculum map shows where within the curriculum student learning outcomes are taught and assessed as well as how student competencies build on each other. The goal of our proposal was to provide a sound and operational foundation on which any school or department could establish a mastery-based curriculum satisfying their specific instructional needs. The work started roughly in February 2021 and was completed in July 2022. From September to November of 2022, QED-C membership (industry, academia, national labs, and government agencies) were asked to rate and comment on the various aspects of our proposal and data was collected for analysis. We used descriptive and multivariate statistics techniques, such as factor analysis and canonical analysis, to explore the relationships between proposed topics and associated learning outcomes. The results from both statistical analysis and open-ended answers were then graphically summarized.

REFERENCES

[1] Adrian German, Marcelo Pias, and Qiao Xiang. 2023. On the Design and Implementation of a Quantum Architectures Knowledge Unit for a CS Curriculum. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1* (Toronto ON, Canada) *(SIGCSE 2023)*. Association for Computing Machinery, New York, NY, USA, 1150–1156. https://doi.org/10.1145/3545945.3569845