

Quantum Annealing and Deep Learning: Advances for Virtual Humans

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Abstract — Conversation-like exchanges of information between users and computer-generated virtual humans can be computationally demanding. Many of the Grand Challenges facing the simulation community will further stress the concerned computer resources. These computer/human interfaces are currently being enhanced and will require both technical advances and societal changes. This paper offers a list of Virtual Human Grand Challenges, solicited from leaders in the community, for purposes of this discussion. Then the authors report on emerging technologies that will further enhance the “human” qualities of the previously mentioned interfaces. Some of these technologies are hardware based while others come from software developments. Further, system engineering advances are presented with the intention of making better use of all the aspects of the system to achieve simulation goals. On the hardware side, there is the emerging technology comprised of several threads of quantum computing, *e.g.* USC’s 2,000 Qubit Quantum Annealer. Software advances of note are discussed in the areas of voice recognition, natural language processing, and

deep learning. The use of quantum annealing to enhance deep learning is particularly examined. Systems engineering issues are analyzed, as these emerging technologies do not stand alone and must be integrated into or replace legacy systems, mandating close adherence to a range of standards. In each of these cases, the authors discuss theirs and others’ experience with the technologies and explicate both the benefits and the costs of such implementations. The paper is written so as to assist the researcher and the systems implementers in choosing which of the new technologies warrants consideration for inclusion in their own work and which technologies will eventually require adoption in order to stay compatible with other systems. Other technologies may require more effort in implementation than they would provide utility in practice.

Keywords—*quantum computing, deep learning, virtual humans.*