What's next in Computing - In Bits, AI & Qubits ?

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Advances in semiconductor science and technology have influenced and powered nearly every aspect of our life for more than 50 years and continue to push the limits of computing performance. The transistor has been demonstrated for the first time in 1947 and is still the basic building block of microprocessors, the core of our modern digital computers. Sustained innovation in materials, new device structures and architectures as well as in fabrication techniques including lithography have been driving the industry for these many years. Reducing the power consumption and increasing the performance as well as density will remain the driving force for future advancements.

However these important innovations in classical computing are not sufficient to cope with the extreme demands for compute power in the area of artificial intelligence (AI). To power AI specialized technologies are developed like approximate computing and analog in-memory computing, with the potential to achieve a significant speed up and decrease the power consumption.

Despite these advances there are still many significant and relevant problems that are intractable to classical computers and AI accelerators but could be addressed by quantum computers. The last few years have witnessed a strong evolution in quantum computing technologies developing the entire stack from the bottom up. These quantum systems continue to scale in size, quality and speed reaching quantum processor units with more than 1000 Qubits. The implementation of recent error mitigation approaches starts to enable interesting computational regimes in which quantum computers run circuits beyond the reach of brute-force classical simulations. Furthermore, the technology roadmaps are paving the way toward future error-corrected systems within the next decade.

In my presentation I will give an overview about the challenges and the recent progress to develop the next bits, neurons and qubits to advance computing with special emphasis on challenges in materials.