

## Integrated Circuit Design for Deep Learning and AI Applications

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### Abstract:

Integrated circuits are omnipresent. We not only use mobile phones, personal computers but we are surrounded by systems whose operation highly depends on advanced sensors, processing systems, controllers etc. such as home appliances, cars, smart cards, smart energy systems, bio-medical equipment, smart offices, transportation systems and many others. There are more and more new applications appearing in the picture with enormous data flows to deal with and process for our advantage. One of these application areas is Artificial Intelligence (AI) and specifically Deep Learning in various domains of applications. For these new envisaged applications we will need electronic systems with much improved, maybe 1000 times, performance in terms of power consumption, speed of operation and reliability. Data transfer bottleneck, power consumption and scalability become major obstacles to be overcome. As the sizing of transistors in current technologies comes to the atomic distance limitations further development becomes possible by either introduction of new disruptive technologies or changing in geometric arrangements and architectures of the elements and building blocks. Some limitations in microcircuit constructions can be avoided by putting whole building blocks and sub-circuits in stacks. Such an approach allows for more efficient space usage at the same time allowing circuit footprint reduction. New routing solutions offer very significant wire-length reductions thus reducing power dissipations and signal delays. 3D integration looks as a fantastic area of development, however, there are many new challenges and problems to be solved for the next generation of nano systems. 3D integration offers also unprecedented opportunities by allowing blocks fabricated in heterogeneous technologies to be integrated in one chip. This allows for stacking and integration of microprocessors, memories, RF circuitry, sensors, batteries and hyper-capacitors, energy harvesting blocks, biological and chemical sensors and many new types of building blocks in one chip. However, innovation is needed for new developments. AI acceleration requires still better solutions! In this lecture we will present the state-of-the-art and an outlook with commentaries what kind of new solutions might be needed.



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