

The latest research and developments in cognitive science and bio-engineering have made it possible to understand more about the functionality of primary biological systems and principles. Concurrently, the effective use of emerging nanoscale electronics requires accompanying research on circuits and architectures to take advantage of the increased density and to handle arising challenges such as low-power operation, reliable and asynchronous computing or manageable design complexity. Combining both research fields, neural principles can serve as inspirations for designing novel and innovative architectures in these emerging technologies. This work deals with the analysis and the design of adaptive systems based on artificial neural networks with respect to their robustness to perturbations and tolerance to faults and defects. Therefore, mathematical metrics are developed that allow analysing and judging different network topologies with respect to those properties. Moreover, these criteria can be used during the design phase in order to improve the robustness and the fault tolerance of adaptive systems. Finally, the effect of different neuron architectures that are designed in digital and analogue circuits is investigated with respect to scaling trends of emerging silicon technologies. For these systems, function approximation serves as the field of application.