DNA circuits for diagnostics and evolution.

Molecular programming techniques based on synthetic DNA oligonucleotides are opening unprecedented opportunities for the exploration of molecular-scale information processing. Emerging molecular languages provide generic tools to control simultaneously the topology and the internal dynamics of molecular circuits. This opens a unique opportunity to better understand structure/function relationships at the level of biological networks –by building test-tube or microscale models of the internal dynamics of living systems, but also to use such molecular circuits in practical applications. I will focus my talk on this last aspect.

A first possible application concerns the field of molecular diagnostics. Here, one needs to convert the information concerning the presence/absence of specific compounds at low concentrations in a sample into a macroscopic observable. An *in vitro* nucleic acid circuit that is specifically designed for this task and contains conversion, amplification, thresholding and signaling modules can detect specific nucleic acid target sequences with ultimate sensitivity. This approach has several advantages, for example modularity, over the current gold-standard PCR-based methods.

Molecular algorithms can also be used to implement stochastic search strategies directly at the molecular level. A case in hand concern the evolutionary design of molecular compounds with precise characteristics. I will show how simple molecular circuits based on the PEN DNA toolbox can be used to shape the fitness landscape of a self-replicating process in such a way, that predefined properties get selected. This approach could represent a versatile strategy for the directed evolution of improved enzymes.