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Cellular computation: lessons from synthetic biology

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The search for general principles of organization in biological systems has been often driven by a few well-defined theoretical frameworks. These include, in particular, selection, optimality and self-organization. With the increased understanding of different case studies at different scales, it became obvious that in some cases optimal structures were at work, but in most of them suboptimawere more likely to be the rule. Moreover, constraints are known to play a key role in shaping complex biosystems, and that seems specially clear within the context of biological networks. The raise of synthetic biology has opened a new approach to this problem, since it offers (inprinciple) the opportunity of building de novo structures that are not present in nature. To a large extent, synthetic biology is seen by many as a branch of engineering involving living matter as the basic substrate. Using computation as a special feature of biological systems, we will approach a number of problems faced by synthetic biology, showing the limits of the engineering-centered view and how successful engineered systems can be obtained only if we ignore some assumptions made by following the generative rules of man-made artifacts.