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19th century is usually referred to as the century of steam and electricity, and 20th century is then called the century of electronics and information science. We predict that the 21st century will belong to the biological sciences. The first important findings regarding current flow through electronic elements were made in 18th and 19th centuries and and resulted in the discovery of three basic passive electronic elements: resistors, capacitors and inductors. The fourth basic element, memristor, memristor, was introduced theoretically well after (in 1971) and it took additional 37 years for its physical realization. Since then, memristors have become the objects of intense research efforts. The most important feature of memristors is their close functional similarity to the most elemental constituent of neural systems of all animals – the synapse. In fact memristors are electronic equivalents of synapses and exhibit quite similar characteristics. Furthermore, electronic circuits comprising several memristors behave like simple neural networks. This fact may suggest straight translation of the fundamental theories/models between semiconductor-based electronics and the most complex natural structure – the brain.

The second very important inspiration for the presented research project is the quest for renewable energy sources, in particular solar cells. The newest research indicate several new promising materials, among them the most rapid development can be observed in the field of perovskites. They have very high commercial potential because perovskite photovoltaic cells can be easily fabricated from relatively cheap raw materials. Furthermore, they can be fabricated on flexible substrates which implies new possible applications. At the same time, however, they show several drawbacks, among them the hysteresis is one of the most serious. Upon short illumination the efficiency of the perovskite solar cells decreases dramatically, but recovers after certain period of time in the dark. Although this feature may seem to be undesired, it can be regarded, on the other hand, as a light-induced memory.

Neurons in the brain are blind: except for some highly specialized cells, they do not respond to the light stimulation, but only to electrical and chemical signals. Photovoltaic cells, in turn, are light sensitive and are capable to respond upon electrical and chemical stimulation. In some of the cases they also exhibit some simple memory effects. Therefore within the project we are going to search for the common features of living neurons and photovoltaic cells in terms of memory phenomena. We are going to design and fabricate novel class of optoelectronic elements which will not only transform light into electric pulses, but also show functionalities of synapses and neurons. We believe that these novel elements will constitute a basis of future computing systems based on the Nature-inspired architecture.