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The Sensor Organism

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1 What?

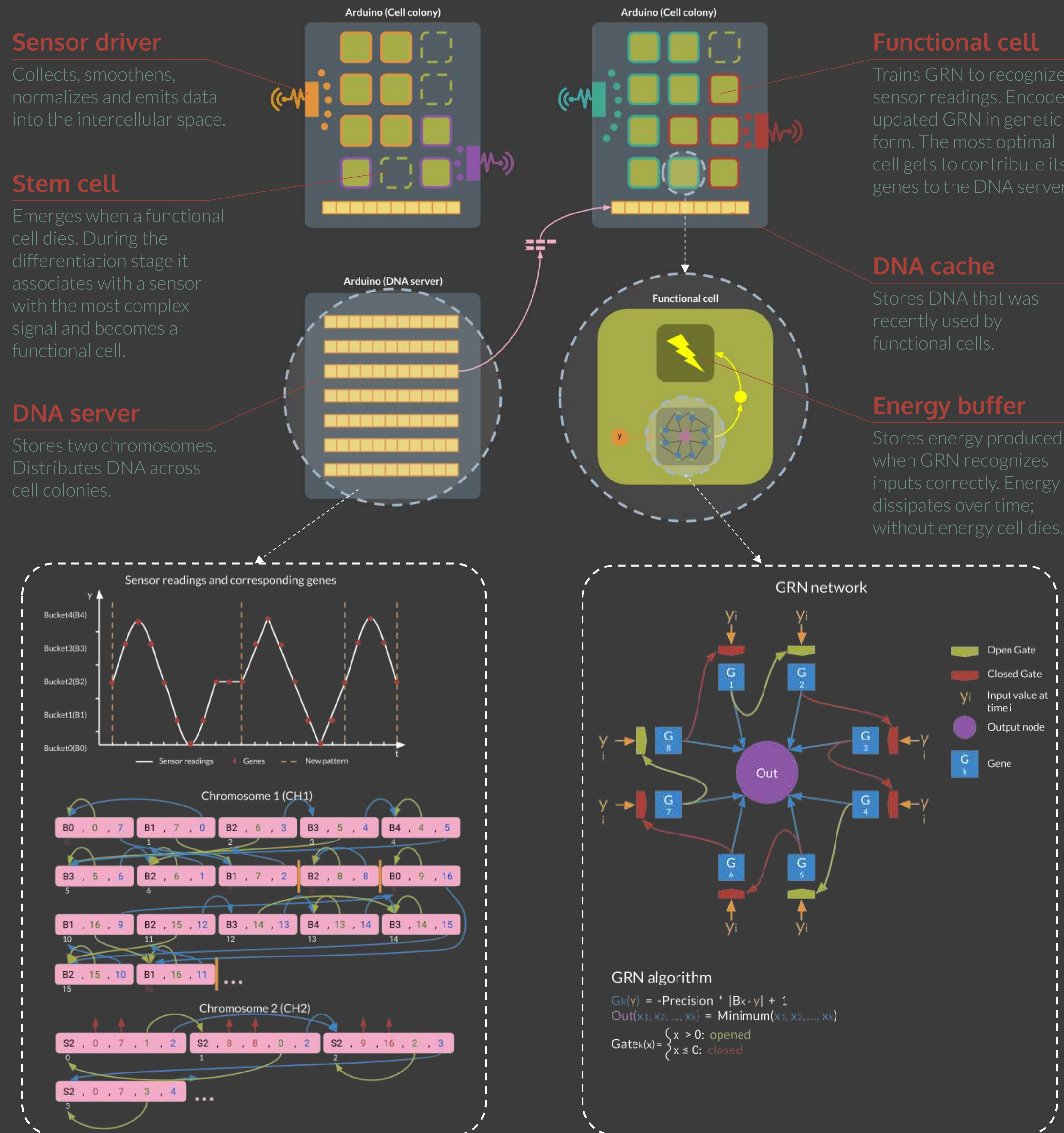
Biologically-inspired heterogeneous multicellular model of *Wireless Sensor Network (WSN)* based on *Genetic Regulatory Network (GRN)*. With little prior knowledge of problem domain the model learns to recognize patterns in sensor readings. The model solves the problems of *anomaly detection* and *fault detection*. The model is optimized for constrained embedded platform such as Arduino microcontroller.

2 Why?

Biological cell systems that this system is modelled after *self-organize* and *adapt* to the environment – a property necessary for a generic WSN. They are *fault-tolerant*, *flexible* and *scalable*; inherently *parallelizable*, they are good fit for distributed systems such as WSN.

3 Project outputs

UML-model defined on four levels: organism, cell colony, single cell and GRN.
C++ OOP library implementing ZigBee Radio Communication functionality and several components of the model.



4 How?

Model defines two Arduino specializations: cell colony and DNA server. *Cell colony* consists of *sensors*, *sensor drivers* and *cells*. Initially colony is filled with *stem cells*; as time goes, stem cells train on sensor readings, specialize in particular patterns and transform into *functional cells*. By recognizing patterns correctly, cells obtain *energy*; if energy runs out, cells die. *DNA Server* is an Arduino dedicated to store *genetically encoded data*, that is shared between cell colonies. Only the most optimal cells get to contribute to the DNA server. *The anomaly is reported* when *cell death rate rises*, i.e. when majority of cells do not recognize the pattern and die. The model requires supervision during the learning stage, when anomalies are reported frequently as all patterns are observed for the first time.

5 Applications

This generic WSN model is potentially applicable to any problem that is solvable using a WSN. However, it is expected to be the most optimal solution when input data changes quickly and in different ways. Examples include *Machine health monitoring*, *Structural health monitoring*, *Terrain mapping* using moving agents and *Biometric observation*.

