Introduction
Drawing inspiration from the self-healing ability of biological cellular systems, we suggest that a stem cell algorithm can be used to self-organise an array of identical computing cells that, in the event of local failure, is capable of self-repair. This is achieved by enlisting redundant cells to replace the faulty ones.

Self-diagnosis
Redundancy
Healthy neighbours
Rules & strategies
Stem Cell Algorithm
Working state

Rules for Convergence
A transition function determines the next state:

\[ C_{i,j,t+1} = nC_{i,j,t} + wC_{i,j,t} + d \]

Convergence is achieved by ensuring that the next state is independent of the initial state:

\[ 1 - A/C - D = 0 \]

Convergent patterns

Future platforms for self-repair
Singel Event Upsets (SEU) cause transient and permanent failures at the cell level of an electronic device. Our cellular automata approach to electronics permits restoration of operation by a) replacing faulty cells using redundant cells and b) automatic re-organisation after transient events.

The LEON-SPARC microprocessor is capable of withstanding a SEU at the register level. However this is achieved by triple Modular Redundancy (TMR) on sequential logic blocks and hence only a single fault can be permitted. Our approach is inherently more robust and depends on the number of redundant cells included in the design.

Since current FPGA technology does not provide dynamic re-routing capability during execution, an extension of this work is to define the basis of new a hardware architecture for CCA implementations.

The Cellular Automata (CA)
The cellular automata comprises an array of identical computing cells with external connections, a current state and a LUT storing rules that determine the next state. An array of these cells represents a computing device whose global state is driven by the rules and boundary values.

Robust logic unit based on cellular automata
A full adder logic unit has been made robust by implementing high-level functional logic on top of an underlying convergent cellular automata (CCA). The CCA rules guarantee self-organisation of the underlying adder circuitry, irrespective of the initial arrangement.

FPGA test platform
Field-programmable gate arrays (FPGA) comprise a 2-D array of logic elements (LE), interconnect fabric and global logic. A LE may be conceptually regarded as being similar to a CCA cell that with the necessary I/O and LUT logic to execute rules. An Altera Stratix II FPGA was therefore chosen to implement a logic unit based on a CCA.