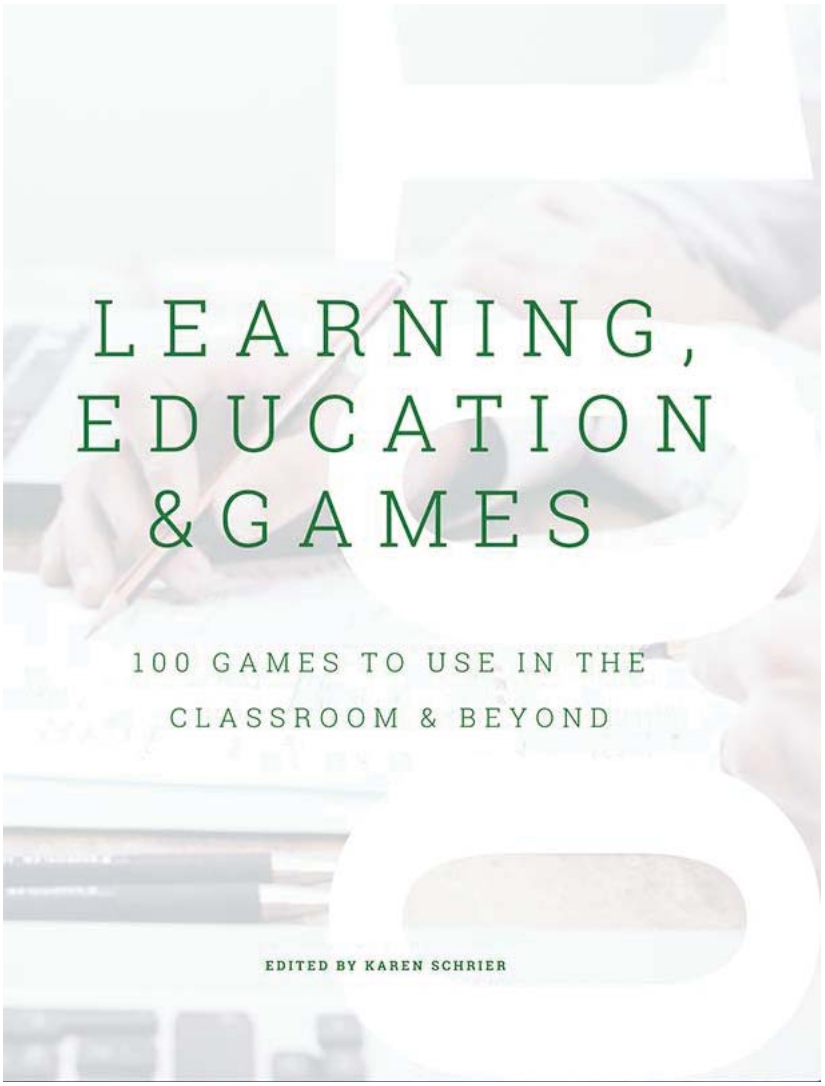
LEARNING,
EDUCATION
&GAMES
100 GAMES TO USE IN THE
CLASSROOM & BEYOND
EDITED BY KAREN SCHRIER

LEARNING, EDUCATION & GAMES, VOLUME 3

100 Games to Use in the Classroom & Beyond

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Carnegie Mellon University: ETC Press

Pittsburgh, PA

DEFENSE: EVOLUTION

ROBERTO DILLON

Game: *Defense: Evolution*
Developer: Adsumsoft
Year: 2014
Platform: Mobile (Android)
Number of players: Single player
Genre: Strategy
Curricular connections: Cellular automata; artificial intelligence; computing; game design; biology
Possible skills taught: Scientific reasoning, planning, mathematical modelling, programming
Audience: 18+; college students; young adults
Length of time: 1 hour
Where to play: Home; school; after school
Cost: Free
URL: http://adsumsoft.programandplay.com/com.adsumsoft.defenseevolution.apk

SUMMARY

Cellular Automata are mathematical models based on a regular grid of cells where each one can assume different states (e.g. on/off) according to specific conditions. They are widely used in many fields of science for modeling a broad range of phenomena, from biology to artificial intelligence and cryptography. The game discussed here offers a smooth introduction to such topics by implementing the "Game of Life" model proposed by John Conway in 1970 (Gardner, 1970). This is one of the most well-known cellular automaton since it is not only relatively simple to understand, making it a perfect learning tool, but it also has plenty of applications across different fields (Adamatzki, 2010). The Game of Life is based on a set of simple rules (see Figure 1), which apply to an infinite bi-dimensional regular grid. Unfortunately, a direct study of the rules without a chance of seeing how they actually interact in practice can be quite a dry and boring experience while, as Conway himself remarked, *"it is marvelous to sit watching [it evolve] on the computer screen"* (Gardner, 1970). The idea of turning the model into a game to let students experience and experiment with the underlying ruleset in an interactive way was then a logical step and *Defense: Evolution* was developed as a mobile game with this primary purpose

in mind. The game tasks players to defend a central group of cells (see Figure 2) against an invading cell population which will move follow certain patterns (see Figure 3) by placing their own units, in a sort of simplified tower defense type of gameplay. Gameplay is essentially turn-based, with the player triggering each generation explicitly, even though it is possible to let the system evolve automatically, hence giving the game an almost real-time type of flavor.

#	Rule
1	Any live cell with fewer than two live neighbours dies, as if caused by under population.
2	Any live cell with two or three live neighbours lives on to the next generation.
3	Any live cell with more than three live neighbours dies, as if by overpopulation.
4	Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

Figure 1. Original rules in the Game of Life.

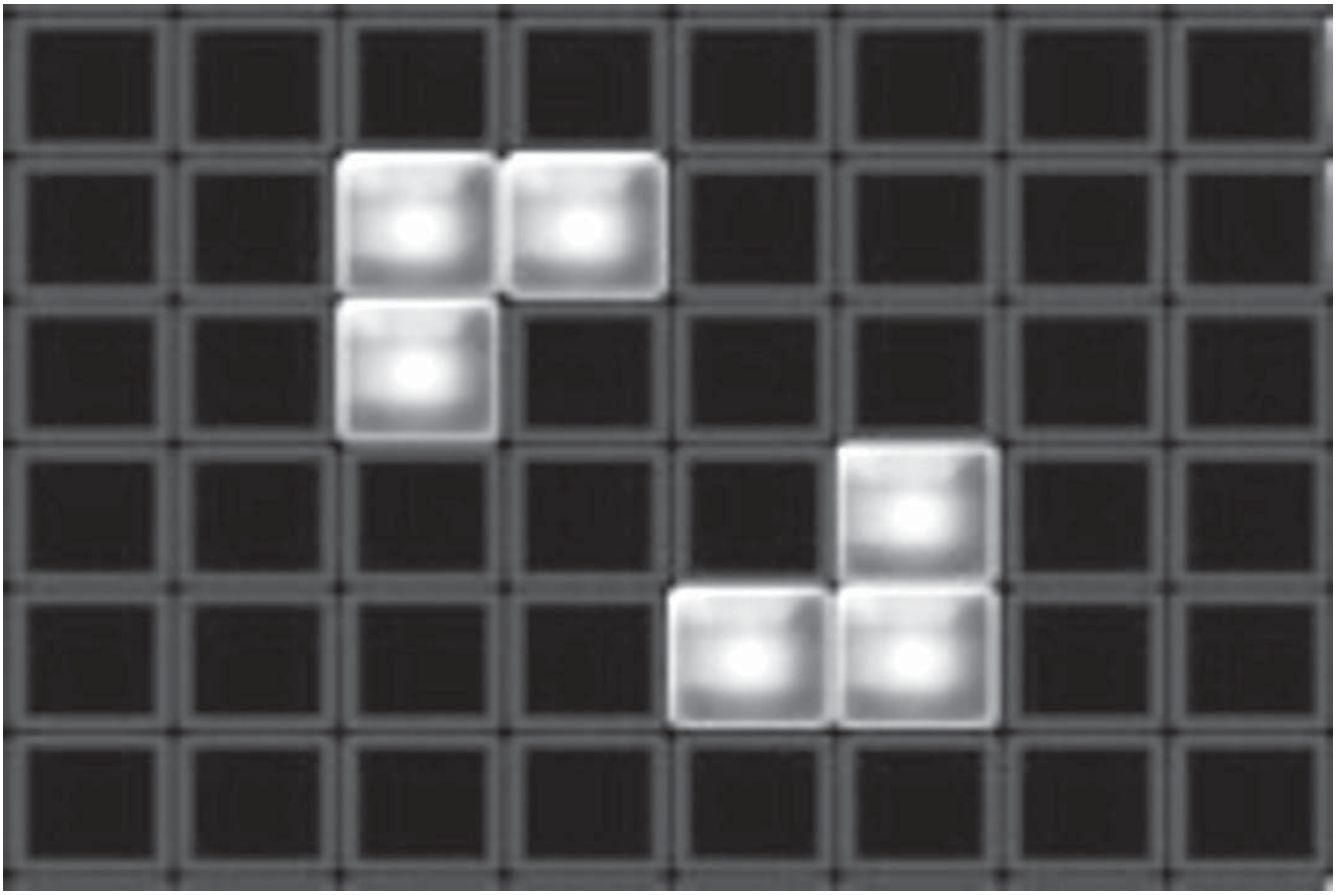

Figure 2. The center of the grid is occupied by a few green cells placed in a "beacon" type of configuration: the innermost cells appear and disappear regularly (due to rules 3 and 4 in Figure 6) unless the configuration is disturbed by other neighboring cells. If all the green cells die, the game is over.

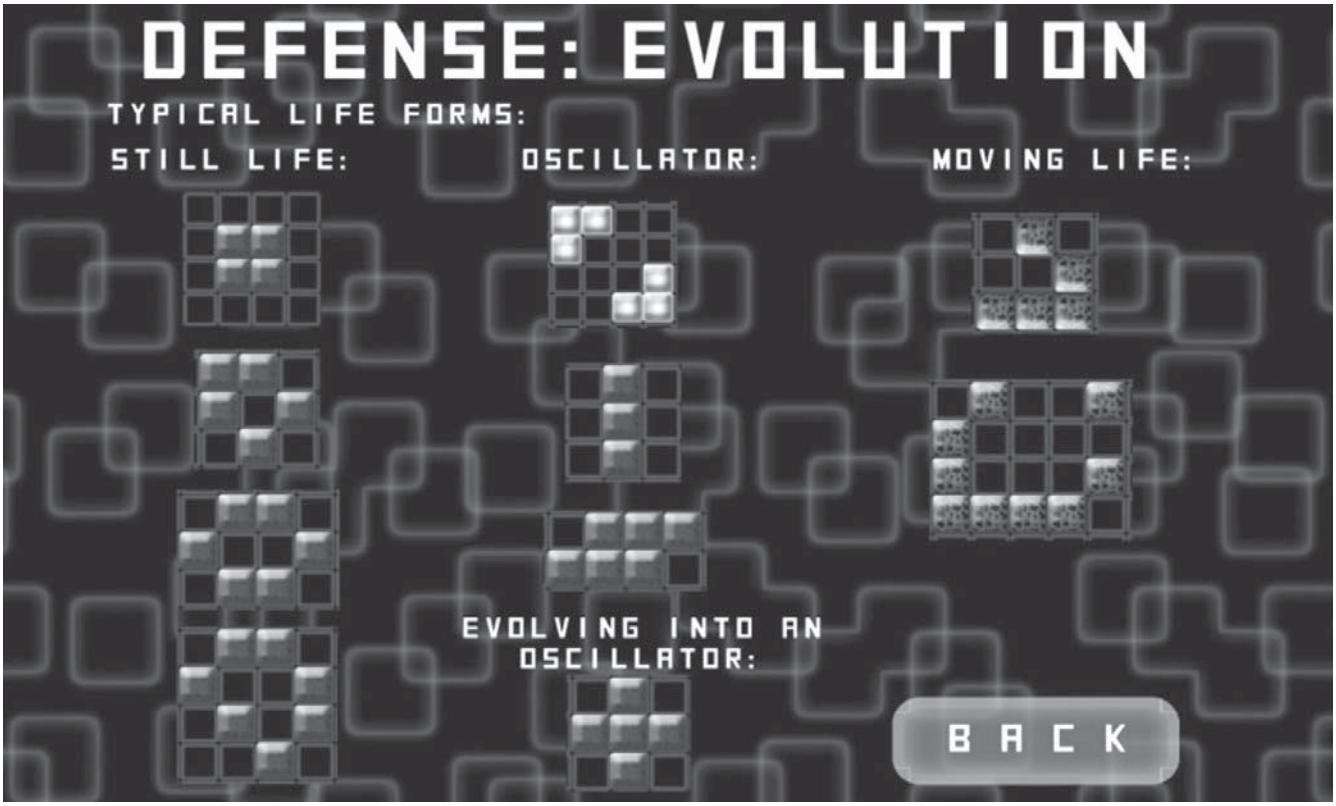

Figure 3. Help screen showing a few common cell configurations. Blue cells will appear as "moving life" forms such as the "glider" (top) and the "spaceship" (bottom).

HOW TO USE THE GAME

Given the complexity and inherently academic nature of the topic, it is useful to research first how such a mathematical concept can be turned into a game and how such a game should be played, especially in the context of a game design class. Actually, the first attempt of adapting the Game of Life ruleset into an actual video game came as early as 1983 with "Cosmic Life" (Dillon, 2015), a simple two-player territorial acquisition game aimed at kids and released by Spinnaker on the Commodore 64 (see Figure 4). Following this early attempt, *Defense: Evolution* turned the original concept into a simplified tower defense game suitable for an older audience. Comparing similarities and differences between both games can also be considered as an interesting analysis exercise for game design students.

The game could be of interest in a variety of classes, including Game Development, Computer Science, Math and other science-related curricula (e.g. Biology), to introduce the topic of Cellular Automata in a playful way (see Figure 5). While instruction pages explaining the underlying rules are provided within the game itself (see Figure 6), students may be encouraged to start the game and play around with the system on their own to figure out how the rules actually work and how they can be used effectively to survive in the game.

As a turn-based game, students may play in pairs cooperatively to decide their next move and try to predict how a certain configuration may evolve or for how many turns it will survive. Alternatively,

one student may decide the next move while another student tries to guess what is going to happen after that.

Trying to "reverse engineer" the rules by playing the game first is also a very interesting exercise in itself. Note that the help screen previously shown in Image 4, summarizing some useful configurations, is always accessible by touching the question mark icon in the GUI, if needed, and can assist in this regard.

A more advanced use in a computer science curriculum can also be encouraged. The game was developed as a HTML5 project using Construct 2 and it is possible to request the source code to the developer so that interested students can experiment and modify the underlying code. This could enable them to appreciate how even small changes in the original rule-set can have a dramatic impact on the model and easily break the equilibrium and balance of the simulation. Implementing the ruleset and remaking the core part of the game in a familiar game creation tool is also a possible exercise that can be accomplished within a few hours of work. In biology classes, the lecturer could present natural phenomena that behave in a similar way and then present the game, asking students to find and discuss similarities and differences.

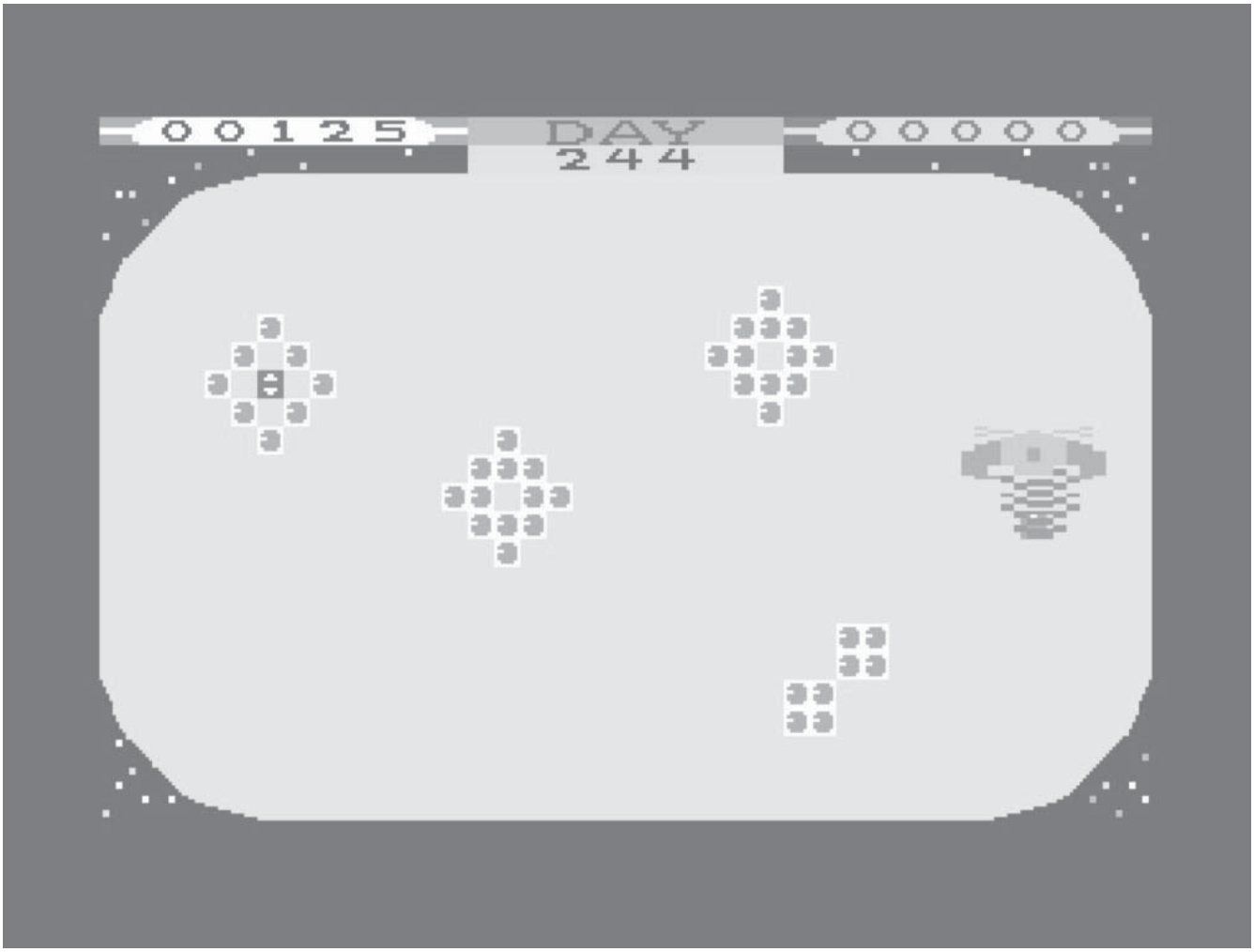

Figure 4. "Cosmic Life": the first video game that turned Conwell's ruleset into an interactive experience and the inspiration for "Defense: Evolution."

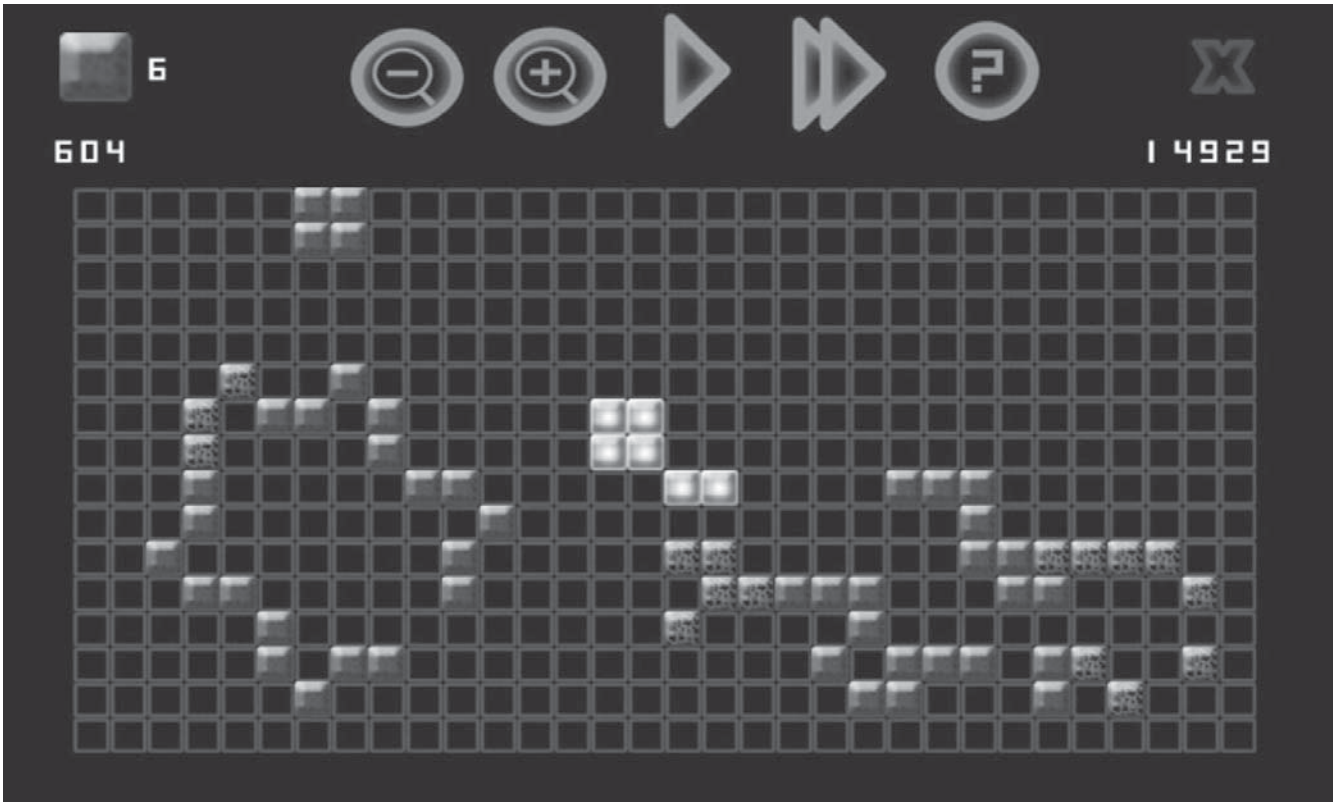

Figure 5. The battle between red and blue cells is in full swing. Note that the green beacon cells can also be affected and eventually killed by the player's own red cells, according to the overpopulation rule. The player also needs to be constantly aware of how its own army evolves!

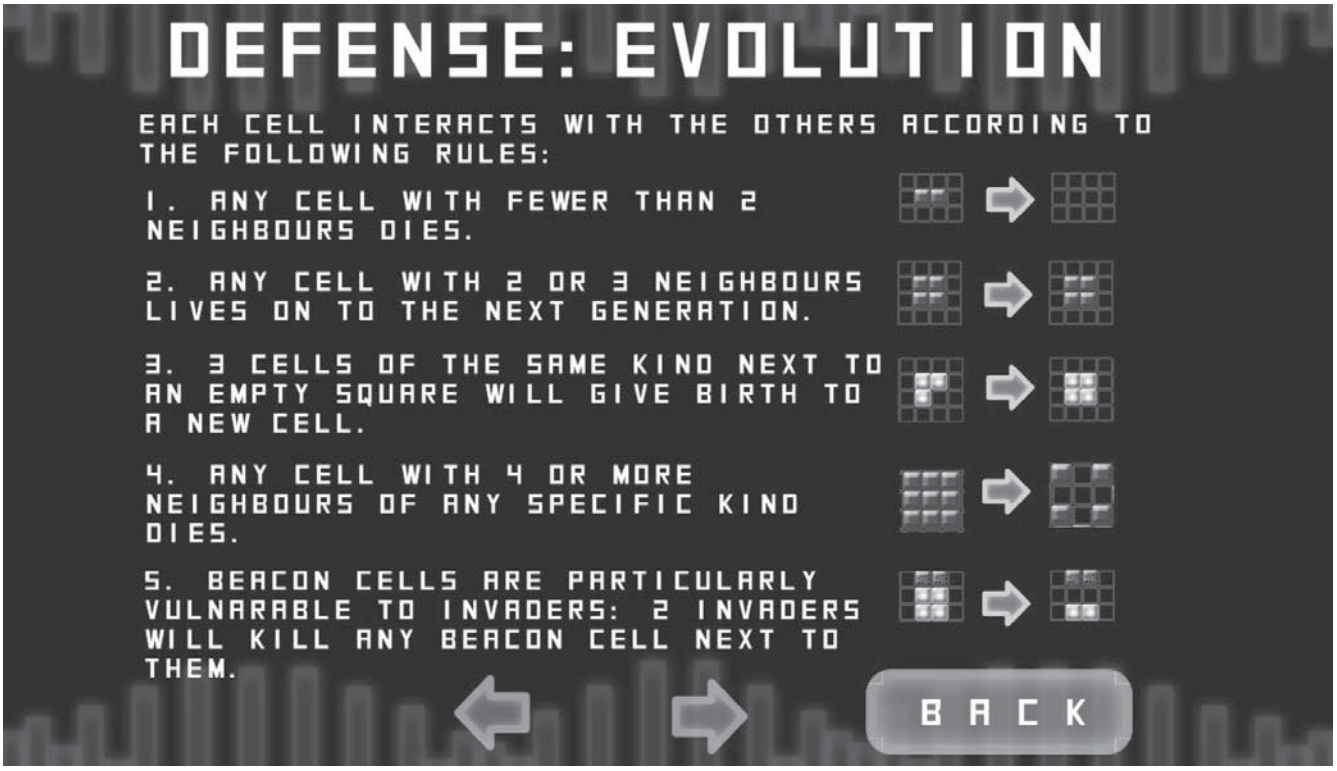

Figure 6. One of the instructions screen explaining how the underlying rules of the game work.

TIPS & BEST PRACTICES

1. Teachers can have students play the game after introducing Cellular Automata in class to make the topic more engaging.
2. This is a short game that can be played and understood within one hour.
3. Longer workshops can be planned by playing and comparing *Defense: Evolution* with the original *Cosmic Life* game.
4. If rules are not disclosed beforehand, students may be invited to discuss with the rest of the class on what they think is at the core of the system or can write a short report about it.
5. If students are interested in modifying the source code or write a new simulation to experiment with a slightly different rules, a later class where each group showcases their own modified project to other students for discussion and feedback should be arranged.

RELATED GAMES & MEDIA

Cosmic Life (http://www.c64.com/games/1917)

VICE C64 emulator (http://vice-emu.sourceforge.net/index.html)

Construct 2 (https://www.scirra.com/construct2)

FURTHER READING

Gardner, M. (1970). "Mathematical games – The fantastic combinations of John Conway's new solitaire game "Life." *Scientific American*, 223, 120–123.

Adamatzky, A. (Ed.) (2010). *Game of Life Cellular Automata*, New York, NY, Springer

Dillon, R. (2015). *Ready. A Commodore 64 Retrospective*. Singapore, SG, Springer