

Spaceship search in the Game of Life

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Proposal

Motivation

The game of life has often been seen as a toy project. It is idealistic in its representation, as it is fully observable, episodic and deterministic. However, its simple rules give rise to complex structures that are not easy to find. Those structures can be large and looking for them is unfeasible with the current methods. In general, conventional graph search methods adapted to the task are used, but they are slow and require large amounts of memory, and as mentioned, they cannot find objects that are too large. There is, as of yet, no efficient way to search for these structures, and the question remains whether there is a way to do it.

The concept of using deep learning to find structures in cellular automata has not yet been explored. With the advent and rise of neural networks, previously thought to be impossible problems have been unlocked, either by solving them directly or speeding up existing search algorithms. Since this is a difficult search problem, it stands to reason that solving it will potentially give new insights into how to solve similar problems.

Aims

In this paper, we will be trying to find interesting structures in the game of life. Our particular interest will be in oscillating objects that move a set amount of space, so-called 'Spaceships'. The main goal will be to test and see if neural networks can speed up the search, and how different deep learning techniques fare against each other and other conventional search methods. The expectation is that the network will greatly decrease the time it takes to find novel structures or recognise structures that are classified as spaceships.

Progress

- The literature review is almost complete
- The introduction and the background parts of the paper are near completion
- A first prototype has been worked on, with some results- lots of code/tools made
- Different neural networks have been trained
- Lots learned on pytorch and the game of life in general
- There is a good idea of where to take the project next

Problems and risks

Problems

The main issue so far comes with using the networks that recognize spaceships. The idea right now is to 'fix' broken spaceships or use them in a search that can help identify a spaceship. So far, using the probability of a cell improving a model has not worked, and a general tree-searching approach might be the way to go.

Risks

An issue that might arise is that there is no general pattern to spaceships. This would mean that a deep learning network to recognize spaceships may not work at a fundamental level, as this means that any attempt to use one as a search algorithm would only find existing spaceships. This in turn may imply that a different method of search will be needed. However, a tree search using a neural network may still be useful if a different neural network is used.

Plan

The first step will be to get a working prototype to fix existing spaceships, which should be easy to do since the neural network seems to learn the structure of the spaceships that were exposed to it. After that is done, experiments on non-existing kinds of spaceships will be done, to see if it works. Hopefully that will be the case, if not, a new neural network will need to be created to maybe assign a usefulness category of a certain structure, combined with a spaceship detection algorithm.

With a bit of luck, the algorithm that was found will be enough to detect new spaceships in a quick manner. Either way, the new solution will need to be tested against existing ones. This will mean that success parameters will need to be devised and test the efficacy of the different algorithms to compare them. The results then need to be analyzed and compared, which can be done in concurrence to writing up the methodology of the paper.

Once all the results have been gathered, the analysis and results section of the paper can be written up, as well as future work. During this time, the prototype can try to be optimized, and better results may still be found. If the prototype still does not work after this period, the results of the paper will be that the new solution simply does not work as well as existing ones.

The final month will be checking that everything is alright, making the paper more professional, fixing any errors, and formatting the paper in general with nice graphs/better wording.