Cavern Generation using Cellular Automata Annotated Bibliography

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1 PITCH

I would like to experiment with using cellular automata to generate maze structures. This has applications in procedural level generation for video games, artistic potential, and depending on the techniques used, it could also be useful in real world geological simulations. There has already been some work done in the area which gives ample room for extension and exploration. Most of the materials seem to be focused on 2D maze generation, so it may be fruitful to focus on generating 3D structures, or extending the existing techniques from 2D CA TO 3D.

2 ANNOTATIONS

Automatic Generation of Diverse Cavern Maps with Morphing Cellular Automata

- Matthew Kreitzer, Daniel Ashlock, and Rajesh Pereira. 2019. Automatic generation of diverse cavern maps with morphing cellular automata. In 2019 IEEE Conference on Games (CoG). IEEE, 1–8.
  - Introduces the concept of Morphing for Cellular Automata, a technique that may be useful in generating more varied and interesting caves, as well as more complex behaviors for my CA.
  - Uses von Neumann neighborhoods. It would be interesting to try using differing neighborhood schemes to see what fits a certain evaluation scheme best, or to see which creates the most aesthetically pleasing caves and choose based upon that.
  - Provides a fitness equation which may be used to evaluate results of my own CA.

Cave propagation and open pit interaction at the Ernest Henry Mine

- AD Campbell, E Mu, and CR Lilley. 2016. Cave propagation and open pit interaction at the Ernest Henry mine. In Seventh International Conference and Exhibition on Mass Mining, Sydney.
  - The primary focus of the paper is not CA's, but it does use them in conjunction with a 3D non-linear discontinuum finite element model to simulate cave growth from real life caves. The techniques the paper outlines could be used to generate more natural caves.
  - Includes a list of factors that govern cave propogation that may be interesting to incorporate into CA work.

Cellular automata for real-time generation of infinite cave levels

- Lawrence Johnson, Georgios N Yannakakis, and Julian Togelius. 2010. Cellular automata for real-time generation of infinite cave levels. In Proceedings of the 2010 Workshop on Procedural Content Generation in Games. 1–4.
  - This paper is cited as being the source of the idea to use CA to generate caves. This study can be useful in locating additional papers on the topic, as well as learning the language commonly used with the approach, as well as potential evaluation techniques.
  - Provides a number of initial conditions that can be set for the CA to run. Could be useful to experiment with these further, or see what else may be parameterized.
  - Includes suggestions for using this technique combined with projection, or 3D CA's to generate 3D cave systems. This is of particular interest to me as I would like to attempt to build this. As a result, papers that cite this one may yield results in the 3D direction already, and may merit future investigation and possible extension.

Evolvable fashion-based cellular automata for generating cavern systems

- Daniel Ashlock. 2015. Evolvable fashion-based cellular automata for generating cavern systems. In2015 IEEE Conference on Computational Intelligence and Games(CIG). IEEE, 306–313.
  - This paper is the precursor to a few other papers in this list. It defines Fashion-Based automata, and gives a good idea as to why these may be useful in generating caves. This study holds merit as it demonstrates how experiments can be performed within the topic of cave generation.
  - Includes a description of the general rule set used for the CA, as well as an allusion to why this rule system works well for generating caves.
  - Includes a solid description of the experiments done on the CA which could lead to replication or extension later on. Its use depends on whether I use evolution in my CA.
  - Includes a description of the merits of using their evolution model as a way to select for more desirable outcomes. This can be used when weighing options for CA types/additional techniques to use.

Integrated simulation and optimisation tools for production scheduling using finite element analysis caving geomechanics simulation coupled with 3D cellular automata

- S Arndt, T Bui, T Diering, I Austen, and R Hocking. 2018. Integrated simulation and optimisation tools for production

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scheduling using finite element analysis caving geomechanics simulation coupled with 3D cellular automata. In Proceedings of the Fourth International Symposium on Block and Sublevel Caving. Australian Centre for Geomechanics, 247–260.
  - Presents ways of displaying 3D CA output results in an efficient manner. This will be a crucial resource in presenting any 3D findings I produce, in addition to influencing the architecture of any 3D CA I produce.
  - Includes details about different material qualities that I may want to include if I decide to try to incorporate real world cave simulation ideas into the CA.
  - Includes a list of future work which could function as inspiration.

Three-dimensional simulation of cave initiation, propagation and surface subsidence using a coupled finite difference–cellular automata solution

- Y Hebert and G Sharrock. 2018. Three-dimensional simulation of cave initiation, propagation and surface subsidence using a coupled finite difference–cellular automata solution. In Proceedings of the Fourth International Symposium on Block and Sublevel Caving. Australian Centre for Geomechanics, 151–166.
  - Refers to CAVESIM, a CA for simulating gracity flow of caved rock in block and sublevel caves (Paper's words). Could be used as a base, or to compare against for tests.
  - Describes how hybrid systems that link CA's to other techniques can be used to more accurately simulate cave growth and behavior. It may be worth looking into some of these other systems and then applying them to the less scientific CA's like the ones in some of the above papers.
  - Use of more scientifically inspired CA systems like the ones in these geology papers could be used in conjunction with the evolutionary models of some of the other papers to select for CA rule sets that lead to more structurally sound or accurate caves.
  - includes mention of caveability as a method of assessing a cave. Could be investigated and then applied for future experimentation.

Using compression to find interesting one-dimensional cellular automata

- Nadim Ahmed and William J Teahan. 2020. Using compression to find interesting one-dimensional cellular automata. Complex & Intelligent Systems6, 1 (2020),123–146.
  - Introduces "Interestingness" as a measure of how interesting a given CA is. This is largely measured through ease of compression. Could be used as a metric for seeing how interesting a given cave structure is. Could then be used for training an evolutionary algorithm, or for fitness in fashion based CA's.