Illuminating the Space of Beatable Lode Runner Levels Produced By Various Generative Adversarial Networks

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Introduction

Generative Adversarial Networks (GANs) can generate convincing fake results that are indistinguishable from a training set. However, the size and diversity of the training set affects the quality of the GAN. Lode Runner levels are generated using GANs trained with different sizes and mixtures of training examples.

Lode Runner

A platform game where the player must collect all of the gold in the level by running across ground, climbing ladders and ropes, and avoiding enemies.

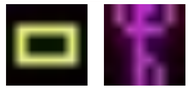


Figure1: Gold and Enemy Tiles

Generative Adversarial Networks

- GANs generate new fake results based off of a specific training set.
- Previous work [1] has proved that GAN networks can generate convincing fake results based off of the training sets it is trained on to generate new and unique video game levels
- We were able to generate unique and beatable levels using GAN networks.

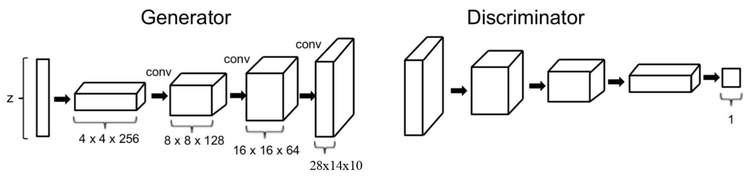


Figure 2: The generator (left) uses a training set from the original levels to learn the structure of the levels to generate convincing fakes. The discriminator (right) tries to determine if the level outputted from the generator is real or fake.

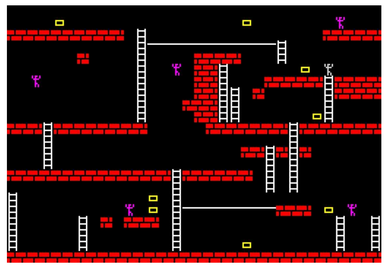
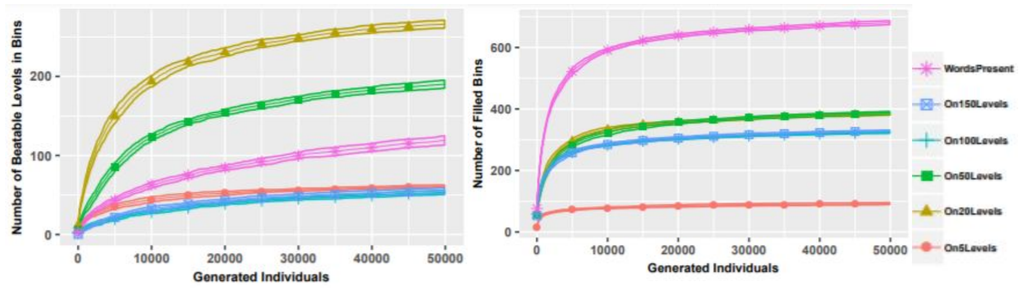
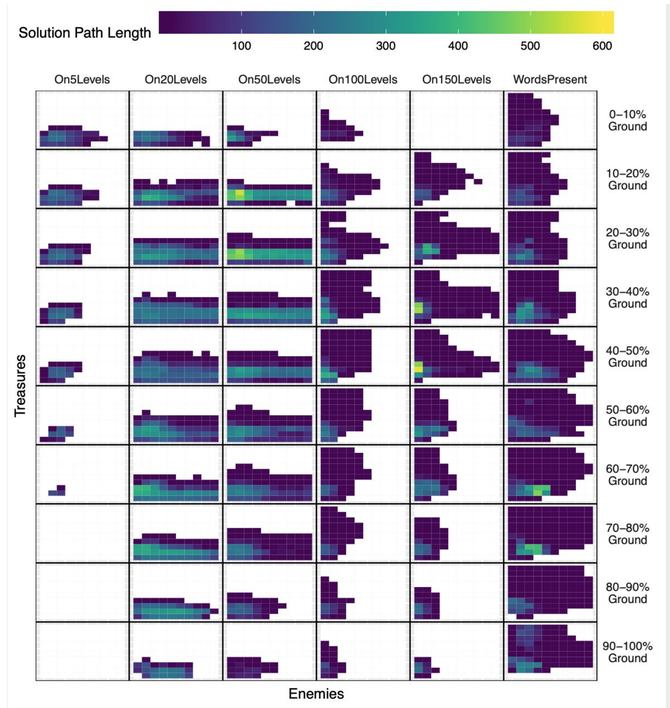


Figure 3: A level that was generated by the GAN in the tile based representation that resembles the original game.





The top left shows the number of beatable levels generated. The top right shows the total number of levels from each GAN (not all are beatable). The heat map on the left shows how the bins are defined and the solution path length for each generated level. Each column corresponds to a single GAN and columns with more white space mean the GAN generates less diverse levels. Dark purple levels are not beatable.

Generating Levels

- GANs are trained on Lode Runner level data from VGLC [2].
- The levels in the training set for each GAN influence the variety of levels it produces. For example the WordsPresent set contains levels where obstacles are shaped like letters or words.
- The GAN learns the structure of the training levels to generate levels that are similar in structure but completely new in design.

Experiment and Results

- MAP-Elites generates a diverse array of quality levels. Diversity is defined in terms of the percent of the level that is solid, and the numbers of enemies and treasures in the level. Levels with longer solution paths are considered to have higher quality.
- The heat map shows the solution path length where light colors mean longer solution paths.
- The most beatable levels were generated by the GANs trained on 20 and 50 levels. WordsPresent filled the most bins even though most of these were unbeatable.
- On20Levels had the most beatable levels and WordPresent filled the most bins.

References

[1] Vanessa Volz, Jacob Schrum, Jialin Liu, Simon M. Lucas, Adam M. Smith, and Sebastian Risi (2018). Evolving Mario Levels in the Latent Space of a Deep Convolutional Generative Adversarial Network, Proceedings of the Genetic and Evolutionary Computation Conference (GECCO 2018).
[2] Summerville, A., Sam Snodgrass, M. Mateas and S. Ontañón (2016). "The VGLC: The Video Game Level Corpus." Proceedings of the 7th Workshop on Procedural Content Generation.