

IAS

Platform level Generation

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1 Context

One of the current frontiers of Artificial Intelligence is the imitation of human creativity. Computational Creativity is the field of research concerned with the production of diverse objects using computational methods, including AI. Automated journalism, music, design and video games are among the most industrially-walled fields. AI collaborates with humans: the input to the system is often made by a human, and the output is usually modified (or chosen, curated) by a human too.

Video games are an ideal application field for these techniques, for creating new game objects, new character classes, or even generating entire game levels. Techniques can be based on the use of templates (e.g. for "mission" generators in certain online games) or constructive methods with human-made building blocks, but they can also use heuristic search or machine learning algorithms. The infinite Mario game, for example, automatically generates levels¹.

2 Project

This project allows you to explore procedural content generation, as part of level generation for 2D platform games, in an extremely simplified framework so that you can concentrate on the methods. You won't have to create stand-alone characters, just static backgrounds and object placements. If you wish, you can use freely licensed graphics resources such as these (for image generation and level unity). The resources are available for unity on the *asset store* too) :

<https://pixelfrog-assets.itch.io/pixel-adventure-1>

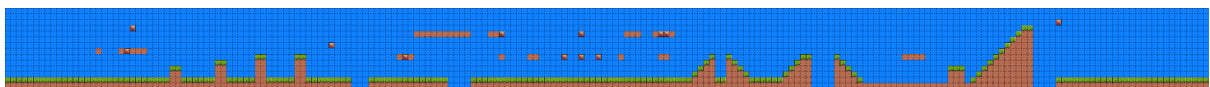


For this purpose, a platform game level can be seen as a 2D image.

On this image, we'll create a mosaic of equal-sized elements.

You have the option of using Unity3D (with 2D tools), which will enable you to make use of the available resources and templates, as well as certain libraries. But you can also work with images, or other tools, especially if you're not comfortable with Unity3D or if it doesn't motivate you more than that, or choose according to the algorithms available.

Below: a simple level inspired by the first level of the Mario game, edited with the Tiled tool from the resources available on <https://pixelfrog-assets.itch.io/pixel-adventure-1> to give you an idea of what's expected on output. A code example will be provided to get you started.



¹<https://supermariobros.io/infinite-mario-bros>

2.1 Getting to know the problem without AI

In the first stage, you'll use rules, or constraints, that you define, to place the elements of the game one by one. This is called a "constructive" approach. Depending on how well you complete this stage, you can earn up to 10 points. You could, for example, start by generating columns from tiles, then work with a pre-defined set of tile columns, or some other arrangement.

For example, a constraint might be that no "holes" should be too wide, or that the difference in height between two successive columns should not be too great.

Once you've understood the problem, you can implement one of the following approaches to get a better score.

2.2 Wave Function Collapse

This technique, which is close to machine learning, has the particularity of requiring only a single example of data, and can achieve spectacular results for level generation. There is an implementation of this algorithm for Unity, which you can use for this project. You can also use this algorithm, which exists for various languages, on images.

The idea of the algorithm is to start from a model example, and go through it piece by piece, "learning" the rules of its construction sample by sample.

See a tutorial here for several implementations: <http://www.procjam.com/tutorials/wfc/>.

You can find spectacular examples of how to use this algorithm, for example here: <https://marian42.de/article/wfc/>

2.3 Local Search and Metaheuristic search

In this approach, we consider the space/set of all possible levels, and define a function *fitness* (like a cost function), in order to search this space for the "best" levels to select for generation. Classical algorithms: Hill Climbing, simulated annealing, genetic search algorithm.

Several methods are described in this paper. Matthew Guzdial, a teacher-researcher in procedural generation, introduces these methods in this video.

3 Deliverables

In addition to the project deliverables, you'll submit a few levels generated by your programs that you like, and tell us why.

4 References

- working with Tilemaps in Unity
- Matthew Guzdial channel: researcher in procedural generation for games https://www.youtube.com/channel/UCWNuToQtu_EGUWo4Ct-2aFQ
- Genetic search for platform level generation
- Wave Function Collapse for Unity: <https://selfsame.itch.io/unitywfc>
- Wave Function Collapse for images: <http://www.procjam.com/tutorials/wfc/>